DON GRAF'S DATA SHEETS

Thousands of Simplified Facts about Building Materials, Planning, and Construction

by Don Graf, A.I.A., M. Arch.

Second Edition

Revised and Enlarged

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FOREWORD

This book began as a collection of loose-leaf sheets about manufactured products and basic design data to help the author in active architectural practice. From 1932 to 1942, these sheets were published and augmented with the help of many manufacturers represented in this volume.

The bound book was issued and copyrighted by Reinhold Publishing Corporation in 1944, and is herein completely revised. Because the material is basic, many of the references to specific products were deleted. It is suggested that the reader turn to specific manufacturers' literature for information on availability and design changes.

Thanks are due every manufacturer who cooperated with this revision, and where the text varies with their recommendations, it is the judgment of the author that such was necessary for the purpose of the book. The outstanding associations and manufacturers who have assisted in the assembly of the material are listed, for your convenience, on the following pages.

DON GRAF

RFD 2, Ossining, New York
May 15, 1949

ACKNOWLEDGEMENT

ACOUSTIC MATERIALS ASSOCIATION, 350 Fifth Ave., New York, N. Y.

AMATEUR ATHLETIC UNION OF U. S., 233 Broadway, New York, N. Y.

AMERICAN BUILDER (Publication), 30 Church St., New York, N. Y.

AMERICAN LAUNDRY MACHINERY CO., Cincinnati 12, Ohio

ARMCO STEEL CORP., Middletown, O.....*Roofing, siding and flashings*

AMERICAN SPORTS PUBLISHING CO., 45 Rose St., New York, N. Y.

AMERICAN TELEPHONE & TELEGRAPH CO., 195 Broadway, New York 7, N. Y.

ARKANSAS SOFT PINE BUREAU, Little Rock, Ark.

ARMSTRONG CORK CO., Lancaster, Pa..............................*Linoleum*

BARBER ASPHALT CORP., 485 Madison Ave., New York 22, N. Y. ....*Mastic flooring*

BARROWS PORCELAIN ENAMEL CO., Langdon Rd., Cincinnati 12, Ohio..........................*Porcelain enamel letter for signs*

BRUNSWICK-BALKE-COLLENDER CO., 623 S. Wabash, Chicago 5, Ill......................................*Billiard tables, bowling alleys*

CARBIDE & CARBON CHEMICALS CORP., 30 E. 42nd St., New York 17, N. Y......................................*Liquified petroleum gas*

CARNEGIE ILLINOIS STEEL CORP., Pittsburgh 30, Pa. ....*Porcelain enamel construction*

W. A. CASE & SON MFG. CO., 33 Main St., Buffalo 3, N. Y. ....*Plumbing fixtures*

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.....*Plumbing fixtures*

DOUGLAS FIR PLYWOOD ASS'N., Tacoma Bldg., Tacoma 2, Wash.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.............................*Darkrooms, home movie equipment*

THE ELECTRIC STORAGE BATTERY CO., Allegheny Ave., Philadelphia, Pa..............................*Emergency lighting*

FAIRBANKS, MORSE & CO., 600 S. Michigan Ave., Chicago 5, Ill. ....*Water systems, well pumps*

GENERAL ELECTRIC CO., Nela Park, Cleveland, Ohio.................. ....*Underwater lighting*

HEYWOOD-WAKEFIELD CO., 666 Lake Shore Drive, Chicago, Ill. ....*Theater seating*

HOFFMAN SPECIALTY CO., 500 Fifth Ave., New York, N. Y. ....*Heating specialties*

THE IMPERIAL BRASS MFG. CO., 1200 W. Harrison St., Chicago 7, Ill..............................*Sump pumps*

INDEPENDENT PROTECTION CO., 1603-09 S. Main St., Goshen, Ind..............................*Lighting protection equipment*

INLAND STEEL CO., 38 S. Dearborn St., Chicago 3, Ill.................. ....*Stair treads, hatchway covers*

KEASBEY & MATTISON CO., Ambler, Pa..............*Asbestos shingles*

KOHLER CO., Kohler, Wis..............................*Plumbing fixtures*

KOPPERS CO., Inc., Tar Products Division, Pittsburgh 19, Pa. ....*Coal tar pitch products*

LIBBEY-OWENS-FORD CO., Nicholas Bldg., Toledo 3, Ohio.......... ....*Multiple glazing*

METAL LATH MFGRS. ASS'N., Engineers Bldg., Cleveland 14, Ohio

MICHAEL FLYNN MFG. CO., 700 East Godfrey Ave., Philadelphia 24, Pa.......*Steel windows*

MISSISSIPPI GLASS CO., 200 Fifth Ave., New York 10, N. Y.

MONTGOMERY ELEVATOR CO., Moline, Ill.......*Elevator systems*

MUTSCHLER BROS. CO., Nappanee, Ind.......*Kitchen cabinets*

NATIONAL ADEQUATE WIRING BUREAU, 155 E. 44th St., New York, N. Y.

NATIONAL BOARD OF FIRE UNDERWRITERS, 85 John St., New York 7, N. Y.

NATIONAL ELECTRIC PRODUCTS CORP., Chamber of Commerce Bldg., Pittsburgh 30, Pa.......*Raceways, receptacles*

NATIONAL GYPSUM CO., Buffalo 2, N. Y.......*Plaster partitions*

NATIONAL LIGHTNING PROTECTION CO., Jefferson St. St. Louis 3, Mo.......*Lightning protection equipment*

NATIONAL LUMBER MFGRS. ASS'N., 1319 18th St., NW, Washington, D. C.

NATIONAL RADIATOR CO., Johntown, Pa.......*Heating equipment*

NATIONAL TERRAZZO & MOSAIC ASS'N., 1420 New York Ave., Washington, D. C.

NATIONAL THEATER SUPPLY CO., 92 Gold St., New York 7, N. Y.

PECORA PAINT CO., 3501 N. Fourth St., Philadelphia 40, Pa. ....*Mastics and calking*

THE PEELE CO., Stewart and Flushing Aves., Brooklyn 6, N. Y. ....*Fire doors*

PITTSBURGH-CORNING CORP., Pittsburgh, Pa.......*Glass block, architectural glass*

PITTSBURGH PLATE GLASS CO., 632 Duquesne Way, Pittsburgh 22, Pa.......*Glass, paint, store front settings*

PORTLAND CEMENT ASSOC., 33 W. Grand Ave., Chicago 10, Ill.

REPUBLIC STEEL CORP., Republic Bldg., Cleveland, Ohio.......*Stainless steel*

ROTARY LIFT CO., P.O. Box 2177, Memphis 2, Tenn.......*Hydraulic lifts*

THE RUBEROID CO., 500 Fifth Ave., New York, N. Y.......*Built-up roofing*

SCOTT PAPER CO., Chester, Pa.......*Washroom equipment*

SISALKRAFT CO., 205 W. Wacker Dr., Chicago, Ill.......*Fiber-reinforced building paper*

THE STANDARD LIME & STONE CO., First National Bank Bldg., Baltimore 3, Md.......*Rock wool insulation*

THE STANLEY WORKS, New Britain, Conn.......*Hardware*

STRUCTURAL CLAY PRODUCTS INSTITUTE, 1756 K St., NW, Washington, D. C.

TIMBER ENGINEERING CO., 1319 18th ST., NW, Washington, D. C.......*Termite shields*

UNITED STATES PLYWOOD CORP., 55 W. 44th St., New York 18, N. Y.

U. S. DEPT. OF COMMERCE, Bureau of Standards, Washington 25, D. C.

U. S. PUBLIC HEALTH SERVICE, Federal Security Agency, Washington, D. C.

UNIVERSAL ATLAS CEMENT CO., 135 E. 42nd St., New York 17, N. Y.

WARREN WEBSTER & CO., 17th and Federal Sts., Camden, N. J. ....*Heating systems*

WEBER COSTELLO CO., Chicago Hts., Ill.......*Chalkboards, tackboards*

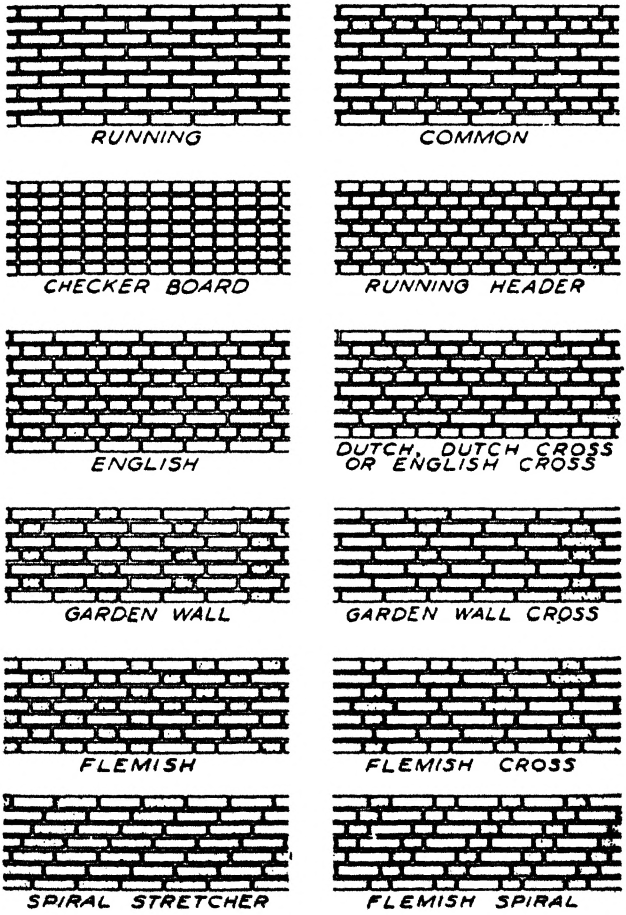
HENRY WEIS MFG. CO., Elkhart, Ind.......*Shower stalls*

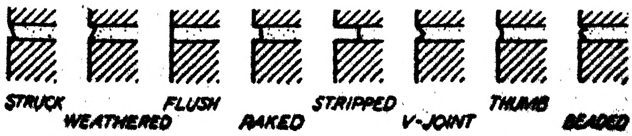
Errata:

Page 65, paragraphs should not be numbered.

Pages 177 to 195 should be entitled "Mantissa" of numbers

BRICK BONDS AND MORTAR JOINTS





HEIGHTS FOR 2½" BRICK COURSES

BASED ON STANDARD BRICK 2¼" + ¼" JOINT

No. of Courses	Vertical Height	No. of Courses	Vertical Height	No. of Courses	Vertical Height
1	2½"	50	10'- 5"	100	20'-10"
2	5"	51	10'- 7½"	101	21'- 0½"
3	7½"	52	10'-10"	102	21'- 3"
4	10"	53	11'- 0½"	103	21'- 5½"
5	1'- 0½"	54	11'- 3"	104	21'- 8"
6	1'- 3"	55	11'- 5½"	105	21'-10½"
7	1'- 5½"	56	11'- 8"	106	22'- 1"
8	1'- 8"	57	11'-10½"	107	22'- 3½"
9	1'-10½"	58	12'- 1"	108	22'- 6"
		59	12'- 3½"	109	22'- 8½"
10	2'- 1"	60	12'- 6"	110	22'-11"
11	2'- 3½"	61	12'- 8½"	111	23'- 1½"
12	2'- 6"	62	12'-11"	112	23'- 4"
13	2'- 8½"	63	13'- 1½"	113	23'- 6½"
14	2'-11"	64	13'- 4"	114	23'- 9"
15	3'- 1½"	65	13'- 6½"	115	23'-11½"
16	3'- 4"	66	13'- 9"	116	24'- 2"
17	3'- 6½"	67	13'-11½"	117	24'- 4½"
18	3'- 9"	68	14'- 2"	118	24'- 7"
19	3'-11½"	69	14'- 4½"	119	24'- 9½"
20	4'- 2"	70	14'- 7"	120	25'- 0"
21	4'- 4½"	71	14'- 9½"	121	25'- 2½"
22	4'- 7"	72	15'- 0"	122	25'- 5"
23	4'- 9½"	73	15'- 2½"	123	25'- 7½"
24	5'- 0"	74	15'- 5"	124	25'-10"
25	5'- 2½"	75	15'- 7½"	125	26'- 0½"
26	5'- 5"	76	15'-10"	126	26'- 3"
27	5'- 7½"	77	16'- 0½"	127	26'- 5½"
28	5'-10"	78	16'- 3"	128	26'- 8"
29	6'- 0½"	79	16'- 5½"	129	26'-10½"
30	6'- 3"	80	16'- 8"	130	27'- 1"
31	6'- 5½"	81	16'-10½"	131	27'- 3½"
32	6'- 8"	82	17'- 1"	132	27'- 6"
33	6'-10½"	83	17'- 3½"	133	27'- 8½"
34	7'- 1"	84	17'- 6"	134	27'-11"
35	7'- 3½"	85	17'- 8½"	135	28'- 1½"
36	7'- 6"	86	17'-11"	136	28'- 4"
37	7'- 8½"	87	18'- 1½"	137	28'- 6½"
38	7'-11"	88	18'- 4"	138	28'- 9"
39	8'- 1½"	89	18'- 6½"	139	23'-11½"
40	8'- 4"	90	18'- 9"	140	29'- 2"
41	8'- 6½"	91	18'-11½"	141	29'- 4½"
42	8'- 9"	92	19'- 2"	142	29'- 7"
43	8'-11½"	93	19'- 4½"	143	29'- 9½"
44	9'- 2"	94	19'- 7"	144	30'- 0"
45	9'- 4½"	95	19'- 9½"	145	30'- 2½"
46	9'- 7"	96	20'- 0"	146	30'- 5"
47	9'- 9½"	97	20'- 2½"	147	30'- 7½"
48	10'- 0"	98	20'- 5"	148	30'-10"
49	10'- 2½"	99	20'- 7½"	149	31'- 0½"

HEIGHTS FOR 2⅝" BRICK COURSES

BASED ON STANDARD BRICK 2¼" + ⅜" JOINT

No. of Courses	*Vertical Height*	*No. of Courses*	*Vertical Height*	*No. of Courses*	*Vertical Height*
		50	10'-11¼"	100	21'-10½"
1	2⅝"	51	11'- 1⅞"	101	22'- 1⅛"
2	5¼"	52	11'- 4½"	102	22'- 3¾"
3	7⅞"	53	11'- 7⅛"	103	22'- 6⅜"
4	10½"	54	11'- 9¾"	104	22'- 9"
5	1'- 1⅛"	55	12'- 0⅜"	105	22'-11⅝"
6	1'- 3¾"	56	12'- 3"	106	23'- 2¼"
7	1'- 6⅜"	57	12'- 5⅝"	107	23'- 4⅞"
8	1'- 9"	58	12'- 8¼"	108	23'- 7½"
9	1'-11⅝"	59	12'-10⅞"	109	23'-10⅛"
10	2'- 2¼"	60	13'- 1½"	110	24'- 0¾"
11	2'- 4⅞"	61	13'- 4⅛"	111	24'- 3⅜"
12	2'- 7½"	62	13'- 6¾"	112	24'- 6"
13	2'-10⅛"	63	13'- 9⅜"	113	24'- 8⅝"
14	3'- 0¾"	64	14'- 0"	114	24'-11¼"
15	3'- 3⅜"	65	14'- 2⅝"	115	25'- 1⅞"
16	3'- 6"	66	14'- 5¼"	116	25'- 4½"
17	3'- 8⅝"	67	14'- 7⅞"	117	25'- 7⅛"
18	3'-11¼"	68	14'-10½"	118	25'- 9¾"
19	4'- 1⅞"	69	15'- 1⅛"	119	26'- 0⅜"
20	4'- 4½"	70	15'- 3¾"	120	26'- 3"
21	4'- 7⅛"	71	15'- 6⅜"	121	26'- 5⅝"
22	4'- 9¾"	72	15'- 9"	122	26'- 8¼"
23	5'- 0⅜"	73	15'-11⅝"	123	26'-10⅞"
24	5'- 3"	74	16'- 2¼"	124	27'- 1½"
25	5'- 5⅝"	75	16'- 4⅞"	125	27'- 4⅛"
26	5'- 8¼"	76	16'- 7½"	126	27'- 6¾"
27	5'-10⅞"	77	16'-10⅛"	127	27'- 9⅜"
28	6'- 1½"	78	17'- 0¾"	128	28'- 0"
29	6'- 4⅛"	79	17'- 3⅜"	129	28'- 2⅝"
30	6'- 6¾"	80	17'- 6"	130	28'- 5¼"
31	6'- 9⅜"	81	17'- 8⅝"	131	28'- 7⅞"
32	7'- 0"	82	17'-11¼"	132	28'-10½"
33	7'- 2⅝"	83	18'- 1⅞"	133	29'- 1⅛"
34	7'- 5¼"	84	18'- 4½"	134	29'- 3¾"
35	7'- 7⅞"	85	18'- 7⅛"	135	29'- 6⅜"
36	7'-10½"	86	18'- 9¾"	136	29'- 9"
37	8'- 1⅛"	87	19'- 0⅜"	137	29'-11⅝"
38	8'- 3¾"	88	19'- 3"	138	30'- 2¼"
39	8'- 6⅜"	89	19'- 5⅝"	139	30'- 4⅞"
40	8'- 9"	90	19'- 8¼"	140	30'- 7½"
41	8'-11⅝"	91	19'-10⅞"	141	30'-10⅛"
42	9'- 2¼"	92	20'- 1½"	142	31'- 0¾"
43	9'- 4⅞"	93	20'- 4⅛"	143	31'- 3⅜"
44	9'- 7½"	94	20'- 6¾"	144	31'- 6"
45	9'-10⅛"	95	20'- 9⅜"	145	31'- 8⅝"
46	10'- 0¾"	96	21'- 0"	146	31'-11¼"
47	10'- 3⅜"	97	21'- 2⅝"	147	32'- 1⅞"
48	10'- 6"	98	21'- 5¼"	148	32'- 4½"
49	10'- 8⅝"	99	21'- 7⅞"	149	32'- 7⅛"

HEIGHTS FOR 2¾″ BRICK COURSES

BASED ON STANDARD BRICK 2¼″ + ½″ JOINT

No. of Courses	Vertical Height	No. of Courses	Vertical Height	No. of Courses	Vertical Height
1	2¾″	50	11′- 5½″	100	22′-11″
2	5½″	51	11′- 8¼″	101	23′- 1¾″
3	8¼″	52	11′-11″	102	23′- 4½″
4	11″	53	12′- 1¾″	103	23′- 7¼″
5	1′- 1¾″	54	12′- 4½″	104	23′-10″
6	1′- 4½″	55	12′- 7¼″	105	24′- 0¾″
7	1′- 7¼″	56	12′-10″	106	24′- 3½″
8	1′-10″	57	13′- 0¾″	107	24′- 6¼″
9	2′- 0¾″	58	13′- 3½″	108	24′- 9″
10	2′- 3½″	59	13′- 6¼″	109	24′-11¾″
11	2′- 6¼″	60	13′- 9″	110	25′- 2½″
12	2′- 9″	61	13′-11¾″	111	25′- 5¼″
13	2′-11¾″	62	14′- 2½″	112	25′- 8″
14	3′- 2½″	63	14′- 5¼″	113	25′-10¾″
15	3′- 5¼″	64	14′- 8″	114	26′- 1½″
16	3′- 8″	65	14′-10¾″	115	26′- 4¼″
17	3′-10¾″	66	15′- 1½″	116	26′- 7″
18	4′- 1½″	67	15′- 4¼″	117	26′- 9¾″
19	4′- 4¼″	68	15′- 7″	118	27′- 0½″
20	4′- 7″	69	15′- 9¾″	119	27′- 3¼″
21	4′- 9¾″	70	16′- 0½″	120	27′- 6″
22	5′- 0½″	71	16′- 3¼″	121	27′- 8¾″
23	5′- 3¼″	72	16′- 6″	122	27′-11½″
24	5′- 6″	73	16′- 8¾″	123	28′- 2¼″
25	5′- 8¾″	74	16′-11½″	124	28′- 5″
26	5′-11½″	75	17′- 2¼″	125	28′- 7¾″
27	6′- 2¼″	76	17′- 5″	126	28′-10½″
28	6′- 5″	77	17′- 7¾″	127	29′- 1¼″
29	6′- 7¾″	78	17′-10½″	128	29′- 4″
30	6′-10½″	79	18′- 1¼″	129	29′- 6¾″
31	7′- 1¼″	80	18′- 4″	130	29′- 9½″
32	7′- 4″	81	18′- 6¾″	131	30′- 0¼″
33	7′- 6¾″	82	18′- 9½″	132	30′- 3″
34	7′- 9½″	83	19′- 0¼″	133	30′- 5¾″
35	8′- 0¼″	84	19′- 3″	134	30′- 8½″
36	8′- 3″	85	19′- 5¾″	135	30′-11¼″
37	8′- 5¾″	86	19′- 8½″	136	31′- 2″
38	8′- 8½″	87	19′-11¼″	137	31′- 4¾″
39	8′-11¼″	88	20′- 2″	138	31′- 7½″
40	9′- 2″	89	20′- 4¾″	139	31′-10¼″
41	9′- 4¾″	90	20′- 7½″	140	32′- 1″
42	9′- 7½″	91	20′-10¼″	141	32′- 3¾″
43	9′-10¼″	92	21′- 1″	142	32′- 6½″
44	10′- 1″	93	21′- 3¾″	143	32′- 9¼″
45	10′- 3¾″	94	21′- 6½″	144	33′- 0″
46	10′- 6½″	95	21′- 9¼″	145	33′- 2¾″
47	10′- 9¼″	96	22′- 0″	146	33′- 5½″
48	11′- 0″	97	22′- 2¾″	147	33′- 8¼″
49	11′- 2¾″	98	22′- 5½″	148	33′-11″
		99	22′- 8¼″	149	34′- 1¾″

HEIGHTS FOR 2⅞" BRICK COURSES

BASED ON STANDARD BRICK 2¼" + ⅝" JOINT

No. of Courses	Vertical Height	No. of Courses	Vertical Height	No. of Courses	Vertical Height
		50	11'-11¾"	100	23'-11½"
1	2⅞"	51	12'-2⅝"	101	24'-2⅜"
2	5¾"	52	12'-5½"	102	24'-5¼"
3	8⅝"	53	12'-8⅜"	103	24'-8⅛"
4	11½"	54	12'-11¼"	104	24'-11"
5	1'-2⅜"	55	13'-2⅛"	105	25'-1⅞"
6	1'-5¼"	56	13'-5"	106	25'-4¾"
7	1'-8⅛"	57	13'-7⅞"	107	25'-7⅝"
8	1'-11"	58	13'-10¾"	108	25'-10½"
9	2'-1⅞"	59	14'-1⅝"	109	26'-1⅜"
10	2'-4¾"	60	14'-4½"	110	26'-4¼"
11	2'-7⅝"	61	14'-7⅜"	111	26'-7⅛"
12	2'-10½"	62	14'-10¼"	112	26'-10"
13	3'-1⅜"	63	15'-1⅛"	113	27'-0⅞"
14	3'-4¼"	64	15'-4"	114	27'-3¾"
15	3'-7⅛"	65	15'-6⅞"	115	27'-6⅝"
16	3'-10"	66	15'-9¾"	116	27'-9½"
17	4'-0⅞"	67	16'-0⅝"	117	28'-0⅜"
18	4'-3¾"	68	16'-3½"	118	28'-3¼"
19	4'-6⅝"	69	16'-6⅜"	119	28'-6⅛"
20	4'-9½"	70	16'-9¼"	120	28'-9"
21	5'-0⅜"	71	17'-0⅛"	121	28'-11⅞"
22	5'-3¼"	72	17'-3"	122	29'-2¾"
23	5'-6⅛"	73	17'-5⅞"	123	29'-5⅝"
24	5'-9"	74	17'-8¾"	124	29'-8½"
25	5'-11⅞"	75	17'-11⅝"	125	29'-11⅜"
26	6'-2¾"	76	18'-2½"	126	30'-2¼"
27	6'-5⅝"	77	18'-5⅜"	127	30'-5⅛"
28	6'-8½"	78	18'-8¼"	128	30'-8"
29	6'-11⅜"	79	18'-11⅛"	129	30'-10⅞"
30	7'-2¼"	80	19'-2"	130	31'-1¾"
31	7'-5⅛"	81	19'-4⅞"	131	31'-4⅝"
32	7'-8"	82	19'-7¾"	132	31'-7½"
33	7'-10⅞"	83	19'-10⅝"	133	31'-10⅜"
34	8'-1¾"	84	20'-1½"	134	32'-1¼"
35	8'-4⅝"	85	20'-4⅜"	135	32'-4⅛"
36	8'-7½"	86	20'-7¼"	136	32'-7"
37	8'-10⅜"	87	20'-10⅛"	137	32'-9⅞"
38	9'-1¼"	88	21'-1"	138	33'-0¾"
39	9'-4⅛"	89	21'-3⅞"	139	33'-3⅝"
40	9'-7"	90	21'-6¾"	140	33'-6½"
41	9'-9⅞"	91	21'-9⅝"	141	33'-9⅜"
42	10'-0¾"	92	22'-0½"	142	34'-0¼"
43	10'-3⅝"	93	22'-3⅜"	143	34'-3⅛"
44	10'-6½"	94	22'-6¼"	144	34'-6"
45	10'-9⅜"	95	22'-9⅛"	145	34'-8⅞"
46	11'-0¼"	96	23'-0"	146	34'-11¾"
47	11'-3⅛"	97	23'-2⅞"	147	35'-2⅝"
48	11'-6"	98	23'-5¾"	148	35'-5½"
49	11'-8⅞"	99	23'-8⅝"	149	35'-8⅜"

HEIGHTS FOR 3″ BRICK COURSES

BASED ON STANDARD BRICK 2¼″ + ¾″ JOINT

No. of Courses	Vertical Height	No. of Courses	Vertical Height	No. of Courses	Vertical Height
		50	12′-6″	100	25′-0″
1	3″	51	12′-9″	101	25′-3″
2	6″	52	13′-0″	102	25′-6″
3	9″	53	13′-3″	103	25′-9″
4	1′-0″	54	13′-6″	104	26′-0″
5	1′-3″	55	13′-9″	105	26′-3″
6	1′-6″	56	14′-0″	106	26′-6″
7	1′-9″	57	14′-3″	107	26′-9″
8	2′-0″	58	14′-6″	108	27′-0″
9	2′-3″	59	14′-9″	109	27′-3″
10	2′-6″	60	15′-0″	110	27′-6″
11	2′-9″	61	15′-3″	111	27′-9″
12	3′-0″	62	15′-6″	112	28′-0″
13	3′-3″	63	15 ″	113	28′-3″
14	3′-6″	64	16′-0″	114	28′-6″
15	3′-9″	65	16′-3″	115	28′-9″
16	4′-0″	66	16′-6″	116	29′-0″
17	4′-3″	67	16′-9″	117	29′-3″
18	4′-6″	68	17′-0″	118	29′-6″
19	4′-9″	69	17′-3″	119	29′-9″
20	5′-0″	70	17′-6″	120	30′-0″
21	5′-3″	71	17′-9″	121	30′-3″
22	5′-6″	72	18′-0″	122	30′-6″
23	5′-9″	73	18′-3″	123	30′-9″
24	6′-0″	74	18′-6″	124	31′-0″
25	6′-3″	75	18′-9″	125	31′-3″
26	6′-6″	76	19′-0″	126	31′-6″
27	6′-9″	77	19′-3″	127	31′-9″
28	7′-0″	78	19′-6″	128	32′-0″
29	7′-3″	79	19′-9″	129	32′-3″
30	7′-6″	80	20′-0″	130	32′-6″
31	7′-9″	81	20′-3″	131	32′-9″
32	8′-0″	82	20′-6″	132	33′-0″
33	8′-3″	83	20′-9″	133	33′-3″
34	8′-6″	84	21′-0″	134	33′-6″
35	8′-9″	85	21′-3″	135	33′-9″
36	9′-0″	86	21′-6″	136	34′-0″
37	9′-3″	87	21′-9″	137	34′-3″
38	9′-6″	88	22′-0″	138	34′-6″
39	9′-9″	89	22′-3″	139	34′-9″
40	10′-0″	90	22′-6″	140	35′-0″
41	10′-3″	91	22′-9″	141	35′-3″
42	10′-6″	92	23′-0″	142	35′-6″
43	10′-9″	93	23′-3″	143	35′-9″
44	11′-0″	94	23′-6″	144	36′-0″
45	11′-3″	95	23′-9″	145	36′-3″
46	11′-6″	96	24′-0″	146	36′-6″
47	11′-9″	97	24′-3″	147	36′-9″
48	12′-0″	98	24′-6″	148	37′-0″
49	12′-3″	99	24′-9″	149	37′-3″

HEIGHTS FOR 3⅛" BRICK COURSES

BASED ON STANDARD BRICK 2¼" + ⅞" JOINT

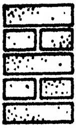
No. of Courses	*Vertical Height*	*No. of Courses*	*Vertical Height*	*No. of Courses*	*Vertical Height*
		50	13'- 0¼"	100	26'- 0½"
1	3⅛"	51	13'- 3⅜"	101	26'- 3⅝"
2	6¼"	52	13'- 6½"	102	26'- 6¾"
3	9⅜"	53	13'- 9⅝"	103	26'- 9⅞"
4	1'- 0½"	54	14'- 0¾"	104	27'- 1"
5	1'- 3⅝"	55	14'- 3⅞"	105	27'- 4⅛"
6	1'- 6¾"	56	14'- 7"	106	27'- 7¼"
7	1'- 9⅞"	57	14'-10⅛"	107	27'-10⅜"
8	2'- 1"	58	15'- 1¼"	108	28'- 1½"
9	2'- 4⅛"	59	15'- 4⅜"	109	28'- 4⅝"
10	2'- 7¼"	60	15'- 7½"	110	28'- 7¾"
11	2'-10⅜"	61	15'-10⅝"	111	28'-10⅞"
12	3'- 1½"	62	16'- 1¾"	112	29'- 2"
13	3'- 4⅝"	63	16'- 4⅞"	113	29'- 5⅛"
14	3'- 7¾"	64	16'- 8"	114	29'- 8¼"
15	3'-10⅞"	65	16'-11⅛"	115	29'-11⅜"
16	4'- 2"	66	17'- 2¼"	116	30'- 2½"
17	4'- 5⅛"	67	17'- 5⅜"	117	30'- 5⅝"
18	4'- 8¼"	68	17'- 8½"	118	30'- 8¾"
19	4'-11⅜"	69	17'-11⅝"	119	30'-11⅞"
20	5'- 2½"	70	18'- 2¾"	120	31'- 3"
21	5'- 5⅝"	71	18'- 5⅞"	121	31'- 6⅛"
22	5'- 8¾"	72	18'- 9"	122	31'- 9¼"
23	5'-11⅞"	73	19'- 0⅛"	123	32'- 0⅜"
24	6'- 3"	74	19'- 3¼"	124	32'- 3½"
25	6'- 6⅛"	75	19'- 6⅜"	125	32'- 6⅝"
26	6'- 9¼"	76	19'- 9½"	126	32'- 9¾"
27	7'- 0⅜"	77	20'- 0⅝"	127	33'- 0⅞"
28	7'- 3½"	78	20'- 3¾"	128	33'- 4"
29	7'- 6⅝"	79	20'- 6⅞"	129	33'- 7⅛"
30	7'- 9¾"	80	20'-10"	130	33'-10¼"
31	8'- 0⅞"	81	21'- 1⅛"	131	34'- 1⅜"
32	8'- 4"	82	21'- 4¼"	132	34'- 4½"
33	8'- 7⅛"	83	21'- 7⅜"	133	34'- 7⅝"
34	8'-10¼"	84	21'-10½"	134	34'-10¾"
35	9'- 1⅜"	85	22'- 1⅝"	135	35'- 1⅞"
36	9'- 4½"	86	22'- 4¾"	136	35'- 5"
37	9'- 7⅝"	87	22'- 7⅞"	137	35'- 8⅛"
38	9'-10¾"	88	22'-11"	138	35'-11¼"
39	10'- 1⅞"	89	23'- 2⅛"	139	36'- 2⅜"
40	10'- 5"	90	23'- 5¼"	140	36'- 5½"
41	10'- 8⅛"	91	23'- 8⅜"	141	36'- 8⅝"
42	10'-11¼"	92	23'-11½"	142	36'-11¾"
43	11'- 2⅜"	93	24'- 2⅝"	143	37'- 2⅞"
44	11'- 5½"	94	24'- 5¾"	144	37'- 6"
45	11'- 8⅝"	95	24'- 8⅞"	145	37'- 9⅛"
46	11'-11¾"	96	25'- 0"	146	38'- 0¼"
47	12'- 2⅞"	97	25'- 3⅛"	147	38'- 3⅜"
48	12'- 6"	98	25'- 6¼"	148	38'- 6½"
49	12'- 9⅛"	99	25'- 9⅜"	149	38'- 9⅝"

HEIGHTS FOR 3¼" BRICK COURSES

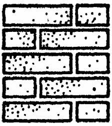
BASED ON STANDARD BRICK 2¼" + 1" JOINT

No. of Courses	Vertical Height	No. of Courses	Vertical Height	No. of Courses	Vertical Height
1	3¼"	50	13'-6½"	100	27'-1"
2	6½"	51	13'-9¾"	101	27'-4¼"
3	9¾"	52	14'-1"	102	27'-7½"
4	1'-1"	53	14'-4¼"	103	27'-10¾"
5	1'-4¼"	54	14'-7½"	104	28'-2"
6	1'-7½"	55	14'-10¾"	105	28'-5¼"
7	1'-10¾"	56	15'-2"	106	28'-8½"
8	2'-2"	57	15'-5¼"	107	28'-11¾"
9	2'-5¼"	58	15'-8½"	108	29'-3"
		59	15'-11¾"	109	29'-6¼"
10	2'-8½"	60	16'-3"	110	29'-9½"
11	2'-11¾"	61	16'-6¼"	111	30'-0¾"
12	3'-3"	62	16'-9½"	112	30'-4"
13	3'-6¼"	63	17'-0¾"	113	30'-7¼"
14	3'-9½"	64	17'-4"	114	30'-10½"
15	4'-0¾"	65	17'-7¼"	115	31'-1¾"
16	4'-4"	66	17'-10½"	116	31'-5"
17	4'-7¼"	67	18'-1¾"	117	31'-8¼"
18	4'-10½"	68	18'-5"	118	31'-11½"
19	5'-1¾"	69	18'-8¼"	119	32'-2¾"
20	5'-5"	70	18'-11½"	120	32'-6"
21	5'-8¼"	71	19'-2¾"	121	32'-9¼"
22	5'-11½"	72	19'-6"	122	33'-0½"
23	6'-2¾"	73	19'-9¼"	123	33'-3¾"
24	6'-6"	74	20'-0½"	124	33'-7"
25	6'-9¼"	75	20'-3¾"	125	33'-10¼"
26	7'-0½"	76	20'-7"	126	34'-1½"
27	7'-3¾"	77	20'-10¼"	127	34'-4¾"
28	7'-7"	78	21'-1½"	128	34'-8"
29	7'-10¼"	79	21'-4¾"	129	34'-11¼"
30	8'-1½"	80	21'-8"	130	35'-2½"
31	8'-4¾"	81	21'-11¼"	131	35'-5¾"
32	8'-8"	82	22'-2½"	132	35'-9"
33	8'-11¼"	83	22'-5¾"	133	36'-0¼"
34	9'-2½"	84	22'-9"	134	36'-3½"
35	9'-5¾"	85	23'-0¼"	135	36'-6¾"
36	9'-9"	86	23'-3½"	136	36'-10"
37	10'-0¼"	87	23'-6¾"	137	37'-1¼"
38	10'-3½"	88	23'-10"	138	37'-4½"
39	10'-6¾"	89	24'-1¼"	139	37'-7¾"
40	10'-10"	90	24'-4½"	140	37'-11"
41	11'-1¼"	91	24'-7¾"	141	38'-2¼"
42	11'-4½"	92	24'-11"	142	38'-5½"
43	11'-7¾"	93	25'-2¼"	143	38'-8¾"
44	11'-11"	94	25'-5½"	144	39'-0"
45	12'-2¼"	95	25'-8¾"	145	39'-3¼"
46	12'-5½"	96	26'-0"	146	39'-6½"
47	12'-8¾"	97	26'-3¼"	147	39'-9¾"
48	13'-0"	98	26'-6½"	148	40'-1"
49	13'-3¼"	99	26'-9¾"	149	40'-4¼"

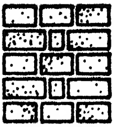
WIDTHS OF BRICK PIERS



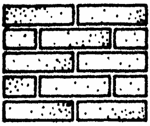
ONE STRETCHER



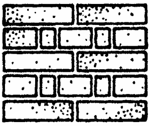
STRETCHER & HEADER



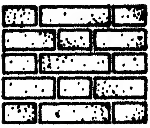
THREE HEADERS



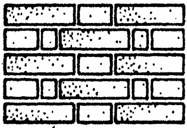
TWO STRETCHERS



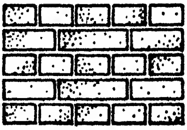
TWO STRETCHERS



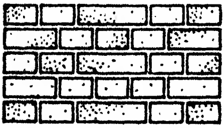
STRETCHER & TWO HEADERS



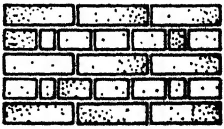
HEADER AND TWO STRETCHERS



FIVE HEADERS



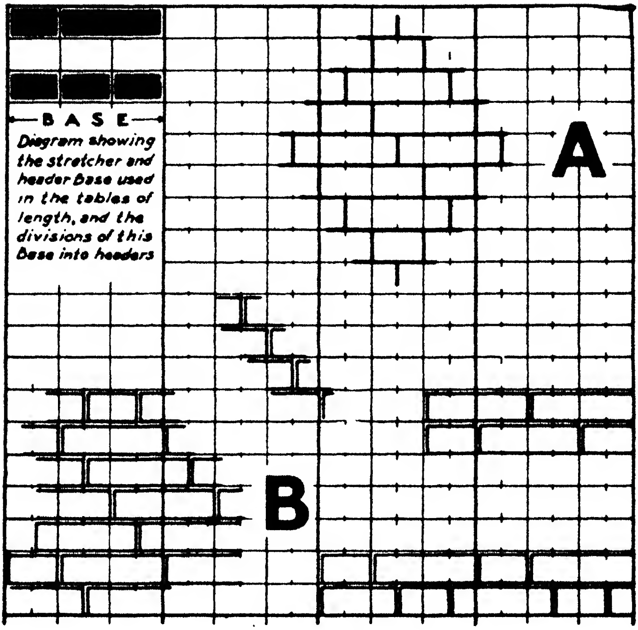
STRETCHER AND FOUR HEADERS



THREE STRETCHERS

Width of pier determined by	Thickness of vertical mortar joints ¼"	⅜"	½"	⅝"	¾"	⅞"	1"
One Stretcher			8				
Stretcher & Header	12	12⅛	12¼	12⅜	12½	12⅝	12¾
Three Headers	11¾	12	12¼	12½	12¾	13	13¼
Two Stretchers	16¼	16⅜	16½	16⅝	16¾	16⅞	17
Stretcher & 2 Headers	16	16¼	16½	16¾	17	17¼	17½
Header & 2 Stretchers	20¼	20½	20¾	21	21¼	21½	21¾
Five Headers	19¾	20¼	20¾	21¼	21¾	22¼	22¾
Stretcher & 4 Headers	24	24½	25	25½	26	26½	27
Three Stretchers	24½	24¾	25	25¼	25½	25¾	26

LAYING OUT PATTERN BRICKWORK



The first step in laying out ornamental patterns in brickwork is the construction of a bond diagram, as shown above.

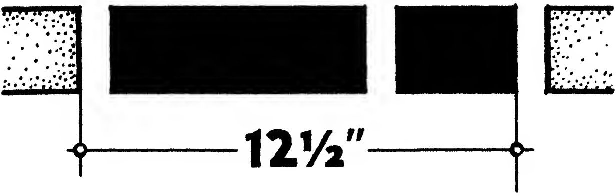
As an example, suppose the brick selected is 2¼" thick, 3¾" wide and 8" long. The joints are to be ½". The proper vertical scale would be 2¾", which is equal to the height of one brick plus one joint. The proper horizontal scale would be 12¾", which equals 8" plus 3¾" plus two ½" joints.

The basis of most ornamental joints is the shifting of the vertical joints in successive courses one-quarter brick, as indicated in the diagram above. To make the diagram, the base should be laid off using the proper horizontal scale, with lines one-half brick apart. The vertical divisions are drawn by using the proper vertical scale.

In making *small scale* diagrams, it is sufficient to indicate the mortar joints by solid lines, as indicated at "A." It is most convenient in making *large scale* drawings, to use the guide lines of the diagram as the bottom and right-hand edge of the brick itself, as shown in several examples at "B."

All diagonal brickwork patterns require an *odd* number of vertical courses to make the pattern come out right.

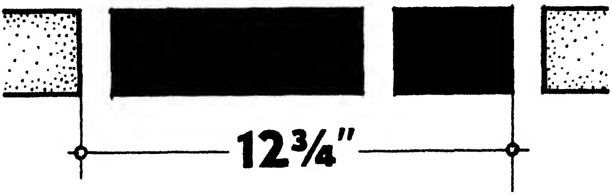
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	*Width*	*Number of Half Bricks*	*Width*	*Number of Half Bricks*	*Width*
1	4⅙″	25	8′- 8⅙″	49	17′- 0⅙″
2	8⅓″	26	9′- 0⅓″	50	17′- 4⅓″
3	1′- 0½″	27	9′- 4½″	51	17′- 8½″
4	1′- 4⅔″	28	9′- 8⅔″	52	18′- 0⅔″
5	1′- 8⅚″	29	10′- 0⅚″	53	18′- 4⅚″
6	2′- 1″	30	10′- 5″	54	18′- 9″
7	2′- 5⅙″	31	10′- 9⅙″	55	19′- 1⅙″
8	2′- 9⅓″	32	11′- 1⅓″	56	19′- 5⅓″
9	3′- 1½″	33	11′- 5½″	57	19′- 9½″
10	3′- 5⅔″	34	11′- 9⅔″	58	20′- 1⅔″
11	3′- 9⅚″	35	12′- 1⅚″	59	20′- 5⅚″
12	4′- 2″	36	12′- 6″	60	20′-10″
13	4′- 6⅙″	37	12′-10⅙″	61	21′- 2⅙″
14	4′-10⅓″	38	13′- 2⅓″	62	21′- 6⅓″
15	5′- 2½″	39	13′- 6½″	63	21′-10½″
16	5′- 6⅔″	40	13′-10⅔″	64	22′- 2⅔″
17	5′-10⅚″	41	14′- 2⅚″	65	22′- 6⅚″
18	6′- 3″	42	14′- 7″	66	22′-11″
19	6′- 7⅙″	43	14′-11⅙″	67	23′- 3⅙″
20	6′-11⅓″	44	15′- 3⅓″	68	23′- 7⅓″
21	7′- 3½″	45	15′- 7½″	69	23′-11½″
22	7′- 7⅔″	46	15′-11⅔″	70	24′- 3⅔″
23	7′-11⅚″	47	16′- 3⅚″	71	24′- 7⅚″
24	8′- 4″	48	16′- 8″	72	25′- 0″

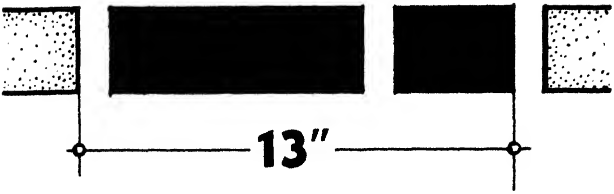
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	Width	Number of Half Bricks	Width	Number of Half Bricks	Width
1	4¼"	25	8'-10¼"	49	17'- 4¼"
2	8½"	26	9'- 2½"	50	17'- 8½"
3	1'- 0¾"	27	9'- 6¾"	51	18'- 0¾"
4	1'- 5"	28	9'-11"	52	18'- 5"
5	1'- 9¼"	29	10'- 3¼"	53	18'- 9¼"
6	2'- 1½"	30	10'- 7½"	54	19'- 1½"
7	2'- 5¾"	31	10'-11¾"	55	19'- 5¾"
8	2'-10"	32	11'- 4"	56	19'-10"
9	3'- 2¼"	33	11'- 8¼"	57	20'- 2¼"
10	3'- 6½"	34	12'- 0½"	58	20'- 6½"
11	3'-10¾"	35	12'- 4¾"	59	20'-10¾"
12	4'- 3"	36	12'- 9"	60	21'- 3"
13	4'- 7¼"	37	13'- 1¼"	61	21'- 7¼"
14	4'-11½"	38	13'- 5½"	62	21'-11½"
15	5'- 3¾"	39	13'- 9¾"	63	22'- 3¾"
16	5'- 8"	40	14'- 2"	64	22'- 8"
17	6'- 0¼"	41	14'- 6¼"	65	23'- 0¼"
18	6'- 4½"	42	14'-10½"	66	23'- 4½"
19	6'- 8¾"	43	15'- 2¾"	67	23'- 8¾"
20	7'- 1"	44	15'- 7"	68	24'- 1"
21	7'- 5¼"	45	15'-11¼"	69	24'- 5¼"
22	7'- 9½"	46	16'- 3½"	70	24'- 9½"
23	8'- 1¾"	47	16'- 7¾"	71	25'- 1¾"
24	8'- 6"	48	17'- 0"	72	25'- 6"

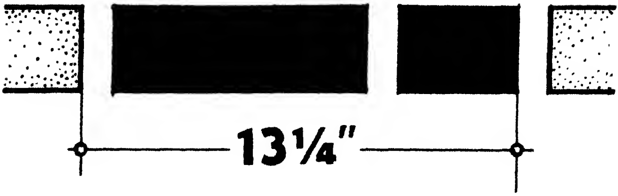
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	Width	Number of Half Bricks	Width	Number of Half Bricks	Width
1	4⅓"	25	9'- 0⅓"	49	17'- 8⅓"
2	8⅔"	26	9'- 4⅔"	50	18'- 0⅔"
3	1'- 1"	27	9'- 9"	51	18'- 5"
4	1'- 5⅓"	28	10'- 1⅓"	52	18'- 9⅓"
5	1'- 9⅔"	29	10'- 5⅔"	53	19'- 1⅔"
6	2'- 2"	30	10'-10"	54	19'- 6"
7	2'- 6⅓"	31	11'- 2⅓"	55	19'-10⅓"
8	2'-10⅔"	32	11'- 6⅔"	56	20'- 2⅔"
9	3'- 3"	33	11'-11"	57	20'- 7"
10	3'- 7⅓"	34	12'- 3⅓"	58	20'-11⅓"
11	3'-11⅔"	35	12'- 7⅔"	59	21'- 3⅔"
12	4'- 4"	36	13'- 0"	60	21'- 8"
13	4'- 8⅓"	37	13'- 4⅓"	61	22'- 0⅓"
14	5'- 0⅔"	38	13'- 8⅔"	62	22'- 4⅔"
15	5'- 5"	39	14'- 1"	63	22'- 9"
16	5'- 9⅓"	40	14'- 5⅓"	64	23'- 1⅓"
17	6'- 1⅔"	41	14'- 9⅔"	65	23'- 5⅔"
18	6'- 6"	42	15'- 2"	66	23'-10"
19	6'-10⅓"	43	15'- 6⅓"	67	24'- 2⅓"
20	7'- 2⅔"	44	15'-10⅔"	68	24'- 6⅔"
21	7'- 7"	45	16'- 3"	69	24'-11"
22	7'-11⅓"	46	16'- 7⅓"	70	25'- 3⅓"
23	8'- 3⅔"	47	16'-11⅔"	71	25'- 7⅔"
24	8'- 8"	48	17'- 4"	72	26'- 0"

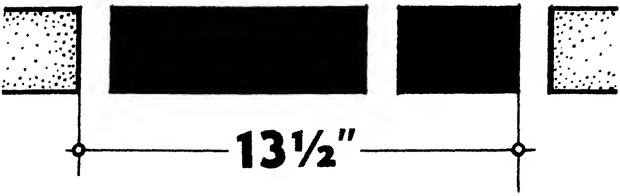
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	*Width*	*Number of Half Bricks*	*Width*	*Number of Half Bricks*	*Width*
1	4 5/12"	25	9'- 2 5/12"	49	18'- 0 5/12"
2	8 5/6"	26	9'- 6 5/6"	50	18'- 4 5/6"
3	1'- 1¼"	27	9'-11¼"	51	18'- 9¼"
4	1'- 5⅔"	28	10'- 3⅔"	52	19'- 1⅔"
5	1'-10 1/12"	29	10'- 8 1/12"	53	19'- 6 1/12"
6	2'- 2½"	30	11'- 0½"	54	19'-10½"
7	2'- 6 11/12"	31	11'- 4 11/12"	55	20'- 2 11/12"
8	2'-11⅓"	32	11'- 9⅓"	56	20'- 7⅓"
9	3'- 3¾"	33	12'- 1¾"	57	20'-11¾"
10	3'- 8⅙"	34	12'- 6⅙"	58	21'- 4⅙"
11	4'- 0 7/12"	35	12'-10 7/12"	59	21'- 8 7/12"
12	4'- 5"	36	13'- 3"	60	22'- 1"
13	4'- 9 5/12"	37	13'- 7 5/12"	61	22'- 5 5/12"
14	5'- 1 5/6"	38	13'-11 5/6"	62	22'- 9 5/6"
15	5'- 6¼"	39	14'- 4¼"	63	23'- 2¼"
16	5'-10⅔"	40	14'- 8⅔"	64	23'- 6⅔"
17	6'- 3 1/12"	41	15'- 1 1/12"	65	23'-11 1/12"
18	6'- 7½"	42	15'- 5½"	66	24'- 3½"
19	6'-11 11/12"	43	15'- 9 11/12"	67	24'- 7 11/12"
20	7'- 4⅓"	44	16'- 2⅓"	68	25'- 0⅓"
21	7'- 8¾"	45	16'- 6¾"	69	25'- 4¾"
22	8'- 1⅙"	46	16'-11⅙"	70	25'- 9⅙"
23	8'- 5 7/12"	47	17'- 3 7/12"	71	26'- 1 7/12"
24	8'-10"	48	17'- 8"	72	26'- 6"

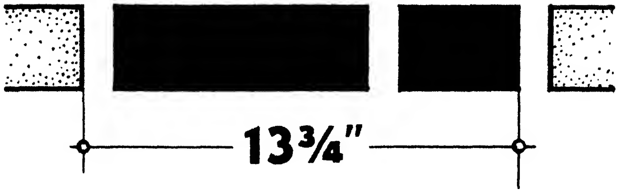
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	*Width*	*Number of Half Bricks*	*Width*	*Number of Half Bricks*	*Width*
1	4½"	25	9′- 4½"	49	18′- 4½"
2	9"	26	9′- 9"	50	18′- 9"
3	1′- 1½"	27	10′- 1½"	51	19′- 1½"
4	1′- 6"	28	10′- 6"	52	19′- 6"
5	1′-10½"	29	10′-10½"	53	19′-10½"
6	2′- 3"	30	11′- 3"	54	20′- 3"
7	2′- 7½"	31	11′- 7½"	55	20′- 7½"
8	3′- 0"	32	12′- 0"	56	21′- 0"
9	3′- 4½"	33	12′- 4½"	57	21′- 4½"
10	3′- 9"	34	12′- 9"	58	21′- 9"
11	4′- 1½"	35	13′- 1½"	59	22′- 1½"
12	4′- 6"	36	13′- 6"	60	22′- 6"
13	4′-10½"	37	13′-10½"	61	22′-10½"
14	5′- 3"	38	14′- 3"	62	23′- 3"
15	5′- 7½"	39	14′- 7½"	63	23′- 7½"
16	6′- 0"	40	15′- 0"	64	24′- 0"
17	6′- 4½"	41	15′- 4½"	65	24′- 4½"
18	6′- 9"	42	15′- 9"	66	24′- 9"
19	7′- 1½"	43	16′- 1½"	67	25′- 1½"
20	7′- 6"	44	16′- 6"	68	25′- 6"
21	7′-10½"	45	16′-10½"	69	25′-10½"
22	8′- 3"	46	17′- 3"	70	26′- 3"
23	8′- 7½"	47	17′- 7½"	71	26′- 7½"
24	9′- 0"	48	18′- 0"	72	27′- 0"

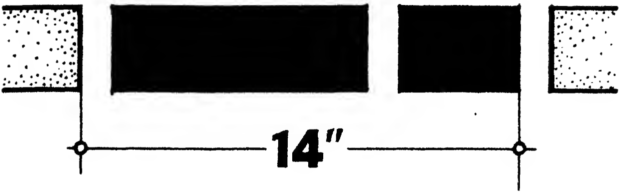
HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	Width	Number of Half Bricks	Width	Number of Half Bricks	Width
1	4 7/12"	25	9'- 6 7/12"	49	18'- 8 7/12"
2	9 1/6"	26	9'-11 1/6"	50	19'- 1 1/6"
3	1'- 1 3/4"	27	10'- 3 3/4"	51	19'- 5 3/4"
4	1'- 6 1/3"	28	10'- 8 1/3"	52	19'-10 1/3"
5	1'-10 11/12"	29	11'- 0 11/12"	53	20'- 2 11/12"
6	2'- 3 1/2"	30	11'- 5 1/2"	54	20'- 7 1/2"
7	2'- 8 1/12"	31	11'-10 1/12"	55	21'- 0 1/12"
8	3'- 0 2/3"	32	12'- 2 2/3"	56	21'- 4 2/3"
9	3'- 5 1/4"	33	12'- 7 1/4"	57	21'- 9 1/4"
10	3'- 9 5/6"	34	12'-11 5/6"	58	22'- 1 5/6"
11	4'- 2 5/12"	35	13'- 4 5/12"	59	22'- 6 5/12"
12	4'- 7"	36	13'- 9"	60	22'-11"
13	4'-11 7/12"	37	14'- 1 7/12"	61	23'- 3 7/12"
14	5'- 4 1/6"	38	14'- 6 1/6"	62	23'- 8 1/6"
15	5'- 8 3/4"	39	14'-10 3/4"	63	24'- 0 3/4"
16	6'- 1 1/3"	40	15'- 3 1/3"	64	24'- 5 1/3"
17	6'- 5 11/12"	41	15'- 7 11/12"	65	24'- 9 11/12"
18	6'-10 1/2"	42	16'- 0 1/2"	66	25'- 2 1/2"
19	7'- 3 1/12"	43	16'- 5 1/12"	67	25'- 7 1/12"
20	7'- 7 2/3"	44	16'- 9 2/3"	68	25'-11 2/3"
21	8'- 0 1/4"	45	17'- 2 1/4"	69	26'- 4 1/4"
22	8'- 4 5/6"	46	17'- 6 5/6"	70	26'- 8 5/6"
23	8'- 9 5/12"	47	17'-11 5/12"	71	27'- 1 5/12"
24	9'- 2"	48	18'- 4"	72	27'- 6"

HORIZONTAL DIMENSIONS FOR BRICKWORK



BASE: 1½ Bricks + 2 Vertical Joints

Number of Half Bricks	*Width*	*Number of Half Bricks*	*Width*	*Number of Half Bricks*	*Width*
1	4⅔"	49	9'- 8⅔"	25	19'- 0⅔"
2	9⅓"	50	10'- 1⅓"	26	19'- 5⅓"
3	1'- 2"	51	10'- 6"	27	19'-10"
4	1'- 6⅔"	52	10'-10⅔"	28	20'- 2⅔"
5	1'-11⅓"	53	11'- 3⅓"	29	20'- 7⅓"
6	2'- 4"	54	11'- 8"	30	21'- 0"
7	2'- 8⅔"	55	12'- 0⅔"	31	21'- 4⅔"
8	3'- 1⅓"	56	12'- 5⅓"	32	21'- 9⅓"
9	3'- 6"	57	12'-10"	33	22'- 2"
10	3'-10⅔"	58	13'- 2⅔"	34	22'- 6⅔"
11	4'- 3⅓"	59	13'- 7⅓"	35	22'-11⅓"
12	4'- 8"	60	14'- 0"	36	23'- 4"
13	5'- 0⅔"	61	14'- 4⅔"	37	23'- 8⅔"
14	5'- 5⅓"	62	14'- 9⅓"	38	24'- 1⅓"
15	5'-10"	63	15'- 2"	39	24'- 6"
16	6'- 2⅔"	64	15'- 6⅔"	40	24'-10⅔"
17	6'- 7⅓"	65	15'-11⅓"	41	25'- 3⅓"
18	7'- 0"	66	16'- 4"	42	25'- 8"
19	7'- 4⅔"	67	16'- 8⅔"	43	26'- 0⅔"
20	7'- 9⅓"	68	17'- 1⅓"	44	26'- 5⅓"
21	8'- 2"	69	17'- 6"	45	26'-10"
22	8'- 6⅔"	70	17'-10⅔"	46	27'- 2⅔"
23	8'-11⅓"	71	18'- 3⅓"	47	27'- 7⅓"
24	9'- 4"	72	18'- 8"	48	28'- 0"

SAFE LOADS ON LIMESTONE LINTELS

SAFE SUPERIMPOSED UNIFORM LOAD PER FOOT OF SPAN FOR SIMPLY SUPPORTED LINTELS 1" THICK.

Height of Lintel	Span in Feet Coefficient of Deflection in italics.									
	4 *.014*	5 *.021*	6 *.031*	7 *.042*	8 *.054*	9 *.069*	10 *.085*	12 *.123*	14 *.167*	16 *.218*
6"	25	14	8	4	2	0				
8"	48	28	17	10	6	3	1	0		
10"	77	46	29	18	12	7	4	0		
1'- 0"	114	68	44	29	19	13	8	2	0	
1'- 2"	157	96	62	42	29	20	13	5	0	
1'- 4"	208	128	74	57	40	28	20	9	1	0
1'- 6"	264	163	108	74	53	38	27	13	5	0
1'- 8"	330	204	136	94	67	49	36	19	8	2
1'-10"	403	248	166	116	84	62	46	25	12	4
2'- 0"	480	298	200	140	102	75	56	32	17	7
2'- 2"	565	352	238	167	122	91	69	40	22	11
2'- 4"	656	410	280	196	144	107	81	48	28	15
2'- 6"	757	472	320	227	167	126	96	57	34	19
2'- 8"	860	542	368	261	192	145	111	63	41	24
2'-10"	980	614	416	296	220	166	128	71	49	29
3'- 0"		692	470	334	249	188	145	90	57	36
3'- 2"		770	526	374	278	212	163	103	65	40
3'- 4"		858	584	418	310	236	184	115	74	47
3'- 6"		946	645	466	344	263	204	129	84	54
3'- 8"			712	510	380	291	227	144	94	62
3'-10"			776	555	416	320	250	160	105	70

Table is based on the following conditions:

- Extreme fibre stress = 125 lbs. per □ inch.
- Unit shear = 150 lbs. per □ inch.
- Modulus of elasticity = 4 400 000.
- Factor of safety = 8 to 10.
- Weight of the lintel itself has been deducted.
- Weight of limestone taken as 144 lbs. per cubic foot.

The deflection of the lintel in inches when loaded with the superimposed loads shown in the table may be found by dividing the deflection coefficient by the height of the lintel in inches.

Formulae used in calculating table values:

Superimposed bending load $= 14\ d^2 / L^2 - d$.

Superimposed shear load $= 300\ d / L - d$.

Maximum deflection $= L^2 / 1173\ d$.

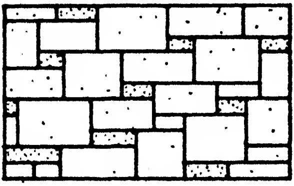
d = height of lintel in inches.

L = span of lintel in feet.

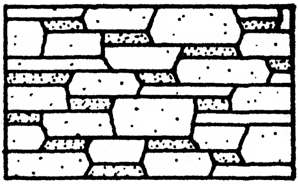
UNCOURSED STONEWORK

Stone dressed to permit laying with uniformly thick horizontal joints of ½" or less is called *ashlar*. Stone roughly dressed to permit laying with uniformly thick horizontal joints of over ½" is called *squared stone,* and is adapted to the same bonds as ashlar. Natural stone which does not permit laying with uniformly thick joints, or dressed stone not permitting horizontal joints, is classed as *rubble.*

Stone laid without continuous horizontal joints is called *uncoursed,* or *random.* (Note particularly the distinction between random masonry and random coursed masonry.)

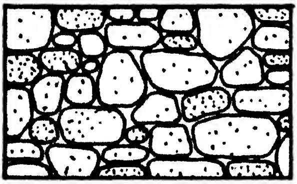


"THREE UNIT"-ie stones of three heights have been used.

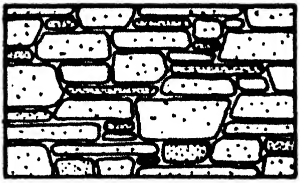


"BROKEN END"- cut beds with angular broken ends.

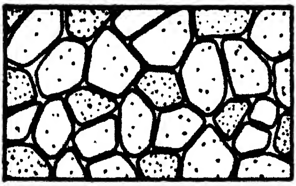
RANDOM ASHLAR



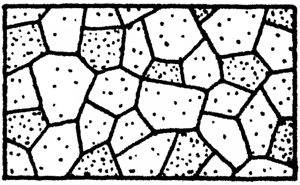
Undressed stone resulting in joints of varying thickness



Stratified undressed stone resulting in fairly level beds



"MOSAIC"-Stone roughly shaped, joints of varying thickness.



"POLYGONAL"-Stone accurately dressed to result in uniform joints.

RANDOM RUBBLE

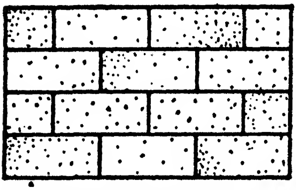
COURSED STONEWORK

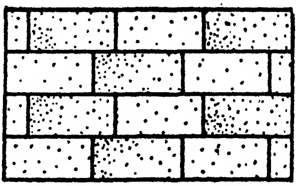
Stone dressed to permit laying with uniformly thick horizontal joints of ½" or less is called *ashlar*. Stone roughly squared to permit laying with uniformly thick joints of only greater than ½" is called *squared stone*, and is adapted to the same bonds as ashlar. Regular coursed square-stone masonry is occasionally termed *block in course* masonry or as *hammer dressed ashlar.*

It should be evident that undressed natural stone is not adapted to the bonds shown on this sheet, on account of its inherent variety of thicknesses and unevenness.

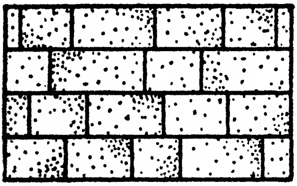
If the stones are coursed and of equal lengths with the vertical joints over the center of the preceding course, the masonry is said to be laid in *plumb bond.*

Stone laid with continuous horizontal joints is called *coursed,* or *range work.*

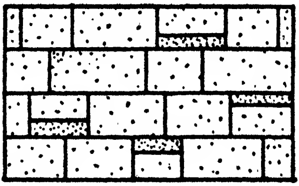




All stones same length and height. Equal course heights may also be jointed as at (6), lower right illustration below.

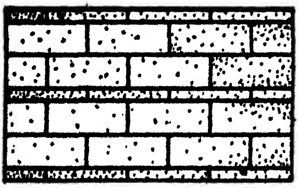


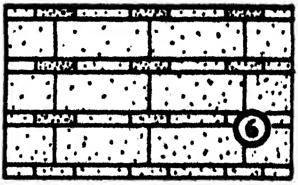
Irregular lengths, all stones are the same height.



Same as at left except that small stones spals are added

REGULAR COURSED ASHLAR





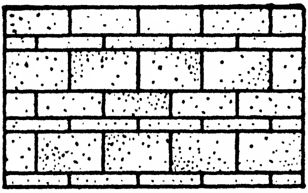
Two heights of stone alternating in a regular arrangement.

ALTERNATING COURSED ASHLAR

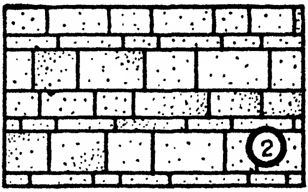
COURSED STONEWORK

Stone dressed to permit laying with uniformly thick horizontal joints of ½" or less is called *ashlar*. Stone roughly dressed to permit laying with uniformly thick horizontal joints only greater than ½" is called *squared stone*, and is adapted the same bonds as ashlar. Natural stone which does not permit laying with uniformly thick joints, or dressed stone not permitting horizontal joints, is classed as *rubble*.

Stone laid with continuous horizontal joints is called *coursed*, or *range work*. If the heights of the courses are in no regularly recurring arrangement it is called *random coursed*. (Note the distinction between random coursed masonry and random masonry.) If the horizontal courses are continuous for short distances only, it is called *broken range*.

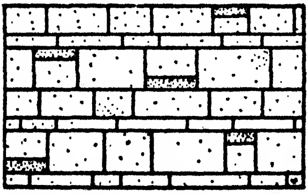


Stones of various heights but all the same lengths.



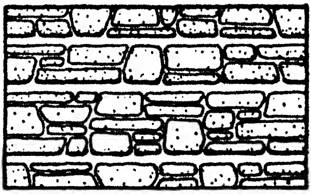
Stones of various heights and lengths.

RANDOM COURSED ASHLAR



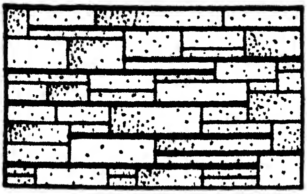
Same as (2) above except that small stone spots are added.

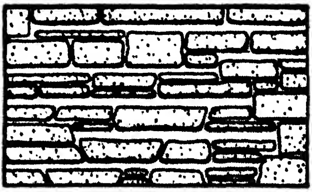
RANDOM COURSED ASHLAR



Random rubble of stratified stones brot to level beds at varying vertical intervals.

RANDOM COURSED RANDOM RUBBLE





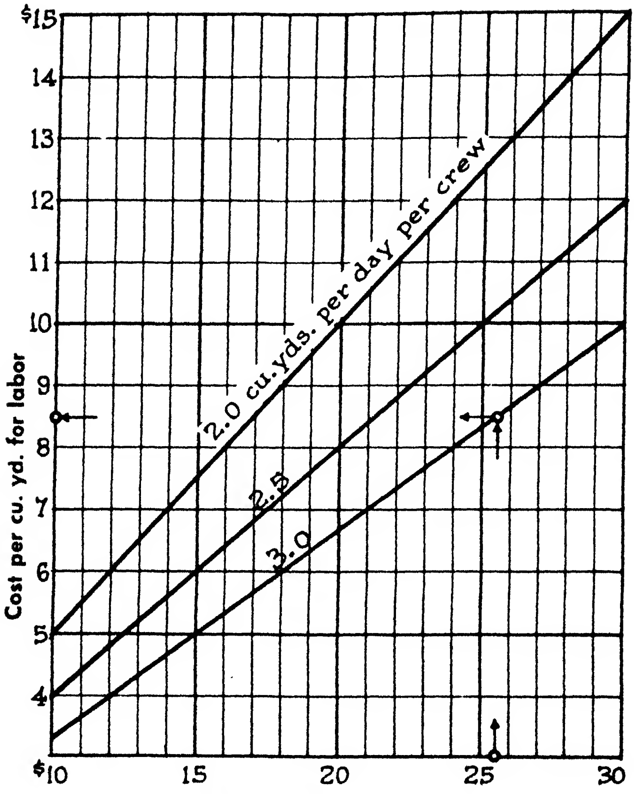
Horizontal joints are continuous for short distances (up to 8'-0")

BROKEN RANGE RANDOM ASHLAR

BROKEN RANGE RANDOM RUBBLE

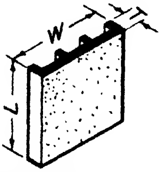
53 #39

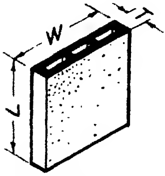
LABOR COST TO LAY RUBBLE

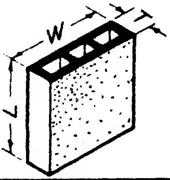


Across the bottom of the chart is given a range of figures for the daily wages of the mason and a sufficient crew to keep him supplied with stone and mortar. The diagonal lines are the amount of stonework laid by the crew in a day, a fair average being 2½ cubic yards for uncoursed rubble. The figures on the left side give the cost per cubic yard in place. EXAMPLE: If the mason's and helpers' combined wages are $25.50 per day, and they lay 3 cubic yards, the stonework costs $8.50 a yard for labor.

PARTITION TILE



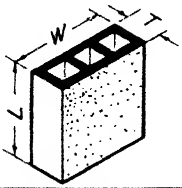


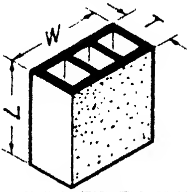


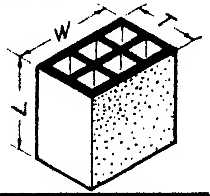
2"x 12"x 12" FURRING			
ACTUAL SIZE	T	W	L
TYPICAL	2"	12"	12"
MODULAR	2"	11½"	11½"

2"x 12"x 12"			
SIZE	T	W	L
TYPICAL	2"	12"	12"
MODULAR	2"	11½"	11½"

3"x 12"x 12"			
SIZE	T	W	L
TYPICAL	3"	12"	12"
MODULAR	3"	11½"	11½"



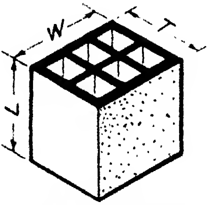


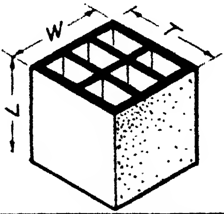


4"x 12"x 12"			
ACTUAL SIZE	T	W	L
TYPICAL	4"	12"	12"
MODULAR	4"	11½"	11½"

6"x 12"x 12"			
SIZE	T	W	L
TYPICAL	6"	12"	12"
MODULAR	6"	11½"	11½"

8"x 12"x 12"			
SIZE	T	W	L
TYPICAL	8"	12"	12"
MODULAR	8"	11½"	11½"



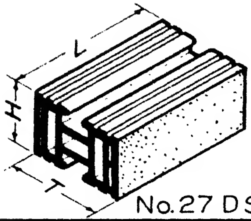


10"x 12"x 12"			
ACTUAL SIZE	T	W	L
TYPICAL	10"	12"	12"
MODULAR	10"	11½"	11½"

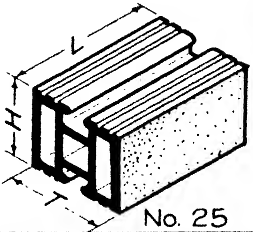
12"x 12"x 12"			
ACTUAL SIZE	T	W	L
TYPICAL	12"	12"	12"
MODULAR	12"	11½"	11½"

Tile may be scored, combed or roughened "plaster-base" finish, or "exposed-wall" finish for painted or unfinished walls. Since the faces are square it makes no difference whether the tiles are laid vertically or horizontally in the detailing of drawings.

KWIKLAY LOAD-BEARING CLAY TILE



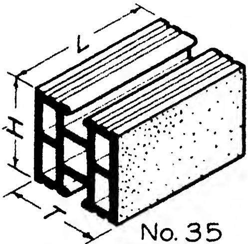
No. 27 DS



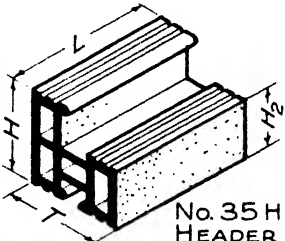
No. 25

ACTUAL SIZE	T	H	L
TYPICAL	$7\frac{3}{4}$"	5"	12"
MODULAR *	$7\frac{1}{2}$"	$4\frac{5}{6}$"	$11\frac{1}{2}$"

ACTUAL SIZE	T	H	L
TYPICAL	$7\frac{3}{4}$"	$6\frac{3}{8}$"	12"
MODULAR *	$7\frac{1}{2}$"	$6\frac{1}{6}$"	$11\frac{1}{2}$"



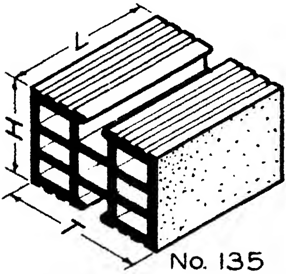
No. 35



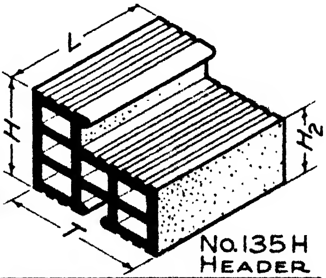
No. 35 H
HEADER

ACTUAL SIZE	T	H	L
TYPICAL	$7\frac{3}{4}$"	$7\frac{5}{8}$"	12"
MODULAR *	$7\frac{1}{2}$"	$7\frac{1}{2}$"	$11\frac{1}{2}$"

ACTUAL SIZE	T	H	H_2	L
TYPICAL	$7\frac{3}{4}$"	$7\frac{5}{8}$"	5"	12"
MODULAR *	$7\frac{1}{2}$"	$7\frac{1}{2}$"	$4\frac{5}{6}$"	$11\frac{1}{2}$"



No. 135



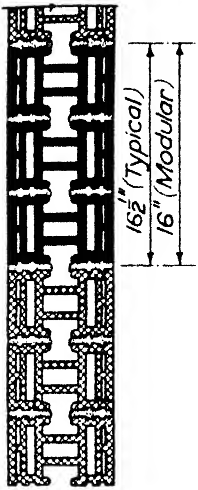
No. 135 H
HEADER

ACTUAL SIZE	T	H	L
TYPICAL	$11\frac{3}{4}$"	$7\frac{5}{8}$"	12"
MODULAR *	$11\frac{1}{2}$"	$7\frac{1}{2}$"	$11\frac{1}{2}$"

ACTUAL SIZE	T	H	H_2	L
TYPICAL	$11\frac{3}{4}$"	$7\frac{5}{8}$"	5"	12"
MODULAR *	$11\frac{1}{2}$"	$7\frac{1}{2}$"	$4\frac{5}{6}$"	$11\frac{1}{2}$"

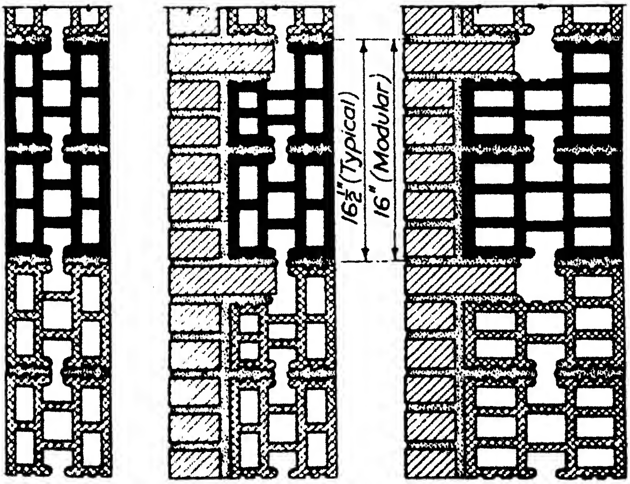
* AS DESIGNED FOR USE WITH $\frac{1}{2}$" MORTAR JOINTS

KWIKLAY LOAD-BEARING CLAY TILE



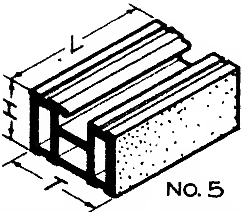
8" WALL

The lips on each of the tile shapes enables the mason to pick up the piece in almost any position and place it with one hand, leaving the other free to use the trowel. There are no through mortar joints so that travel of moisture from the outside by capillary action is eliminated. In some localities, a number of the shapes are available with smooth or textured surfaces for exposed wall finishes. The Kwiklay series of shapes are structural tiles, and their range of sizes and shapes makes them versatile in meeting a great number of various construction requirements. Half-width stretchers are readily made on the site by splitting full units through the webs.

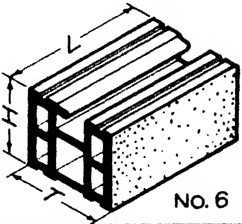


8" WALL 12" WALL 16" WALL

SPEEDTILE LOAD-BEARING CLAY TILE

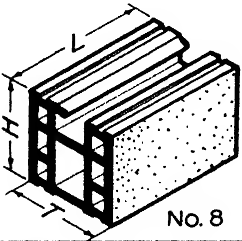


No. 5

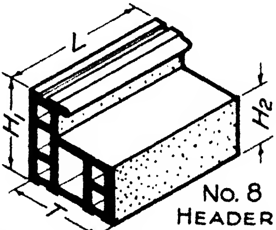


No. 6

ACTUAL SIZE	T	H	L	ACTUAL SIZE	T	H	L
TYPICAL	7¾"	5"	12"	TYPICAL	7¾"	6¼"	12"
MODULAR *	7½"	4⅚"	11½"	MODULAR *	7½"	6⅙"	11½"

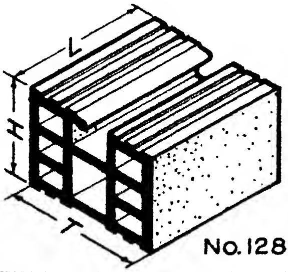


No. 8

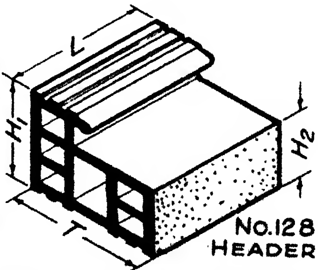


No. 8 HEADER

ACTUAL SIZE	T	H	L	ACTUAL SIZE	T	H_1	H_2	L
TYPICAL	7¾"	7¾"	12"	TYPICAL	7¾"	7¾"	5"	12"
MODULAR *	7½"	7½"	11½"	MODULAR *	7½"	7½"	4⅚"	11½"



No. 128

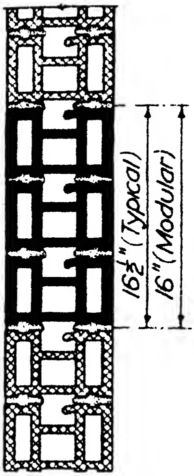


No. 128 HEADER

ACTUAL SIZE	T	H	L	ACTUAL SIZE	T	H_1	H_2	L
TYPICAL	11¾"	7¾"	12"	TYPICAL	11¾"	7¾"	5"	12"
MODULAR *	11½"	7½"	11½"	MODULAR *	11½"	7½"	4⅚"	11½"

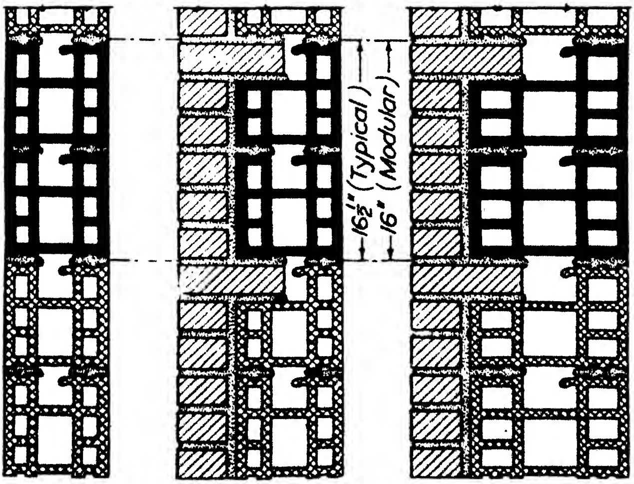
*AS DESIGNED FOR USE WITH ½" MORTAR JOINTS

SPEEDTILE LOAD-BEARING CLAY TILE



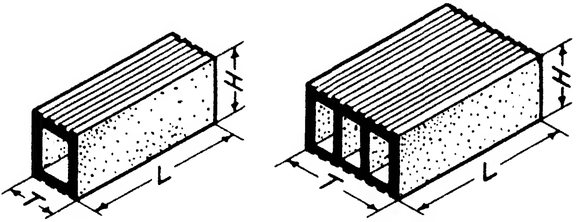
8" WALL

One of the most widely used types of structural clay tile for load bearing single and brick-faced wall construction is shown here. In some localities Speedtile is available as facing tile to be used for exposed exterior and interior wall surfaces. The lips on each of the tile shapes makes it simple for the mason to lift and place with one hand. Capillarity is prevented by the break in the mortar joint so that moisture cannot penetrate. To supplement the basic stretchers, nominal 8″ lengths are manufactured for use at corners, jambs, wall-closures, recesses for ground blocks and nailing strips, piers between doors and windows. In certain areas a nominal 10″ thick unit (9¼″) is made.



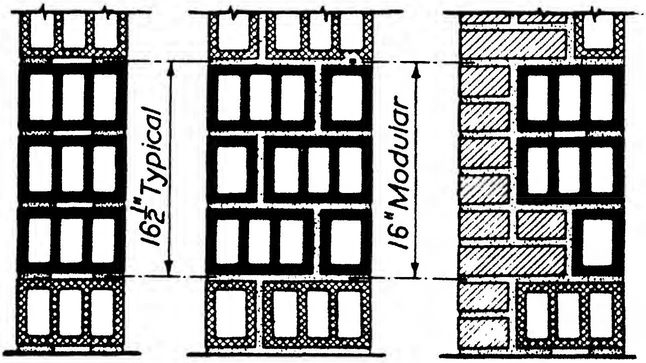
8" WALL 12" WALL 16" WALL

BACKUP LOAD-BEARING CLAY TILE



4" BAKUP				8" BAKUP			
ACTUAL SIZE	T	H	L	SIZE	T	H	L
TYPICAL	3¾"	5"	12"	TYPICAL	8"	5"	12"
MODULAR *	3½"	4⅚"	11½"	MODULAR *	7½"	4⅚"	11½"

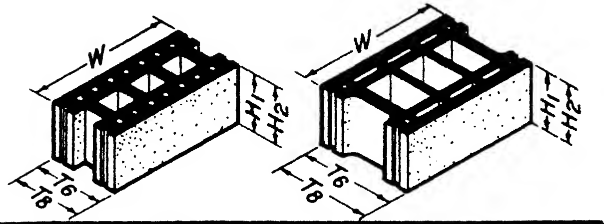
* WITH ½" JOINTS



8" WALL (a) | 12" WALL (b) | 12" WALL (c)

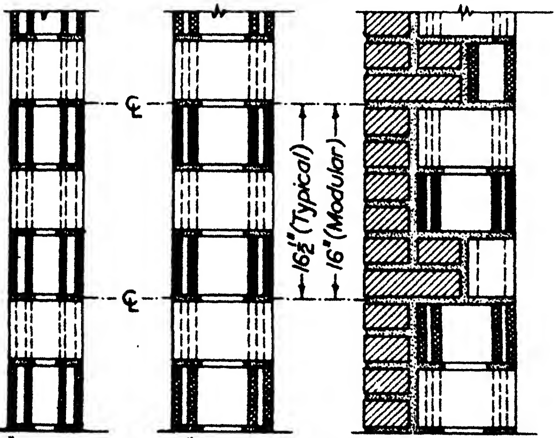
The two most basic and universally available load-bearing structural clay tile units are the Backup units. They may be used in one or both wythes in cavity walls, in nominal 4" and 5" thick partitions, 8" single-unit load-bearing walls. Their principal use is in composite walls as shown at (c). The units are generally furnished with one 5" face scored for plaster application, permitting a smooth exposed wall finish if turned about in composite walls. Salt-glazed and other finishes are made in some areas.

VERTICAL-CELL LOAD-BEARING CLAY TILE



CORED-SHELL						DOUBLE-SHELL					
ACTUAL SIZE	T_6	T_8	W	H_1	H_2	ACTUAL SIZE	T_6	T_8	W	H_1	H_2
TYPICAL	$5\frac{3}{4}$"	8"	12"	$3\frac{3}{4}$"	5"	TYPICAL	$5\frac{3}{4}$"	8"	12"	$3\frac{3}{4}$"	5"
MODULAR*	$5\frac{1}{2}$"	$7\frac{1}{2}$"	$11\frac{1}{2}$"	$3\frac{1}{2}$"	$4\frac{5}{8}$"	MODULAR*	$5\frac{1}{2}$"	$7\frac{1}{2}$"	$11\frac{1}{2}$"	$3\frac{1}{2}$"	$4\frac{5}{8}$"

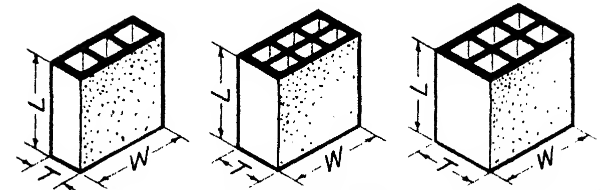
*WITH $\frac{1}{2}$" JOINTS



6" WALL (a) | 8" WALL (b) | 12" WALL (c)

The vertical-cell tile shapes shown are designed principally for single-unit-wall construction. In some sections the composite brick and tile walls shown in detail (c) are very popular. Units are generally furnished with one textured and one smooth face, but local manufacturers and suppliers may be willing to supply other combinations of plaster-base finish and exposed-wall finishes.

SIDE OR END CONSTRUCTION LOAD-BEARING WALL TILE

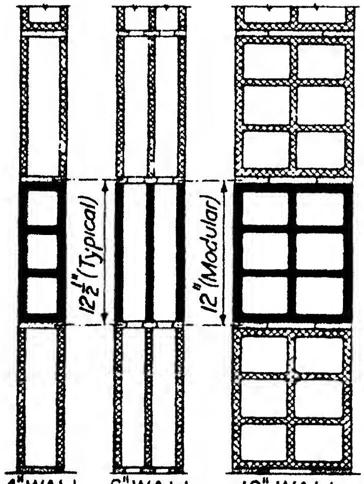


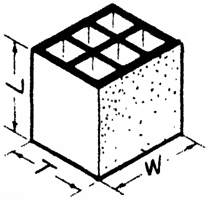
4" x 12" x 12"			
ACTUAL SIZE	T	W	L
TYPICAL	3¾"	12"	12"
MODULAR *	3½"	11½"	11½"

6" x 12" x 12"			
SIZE	T	W	L
TYP.	6"	12"	12"
MOD. *	5½"	11½"	11½"

8" x 12" x 12"			
SIZE	T	W	L
TYP.	8"	12"	12"
MOD. *	7½"	11½"	11½"

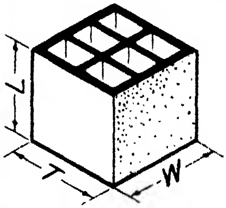
* WITH ½" JOINTS





10" x 12" x 12"

SIZE	T	W	L
TYPICAL	10"	12"	12"
MODULAR	9½"	11½"	11½"

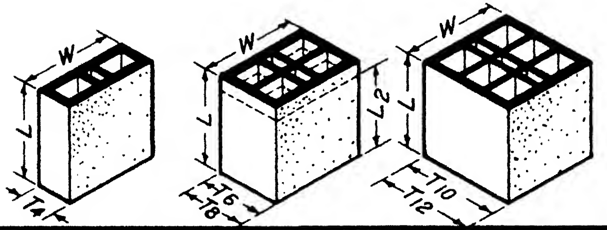


12" x 12" x 12"

SIZE	T	W	L
TYPICAL	12"	12"	12"
MODULAR	11½"	11½"	11½"

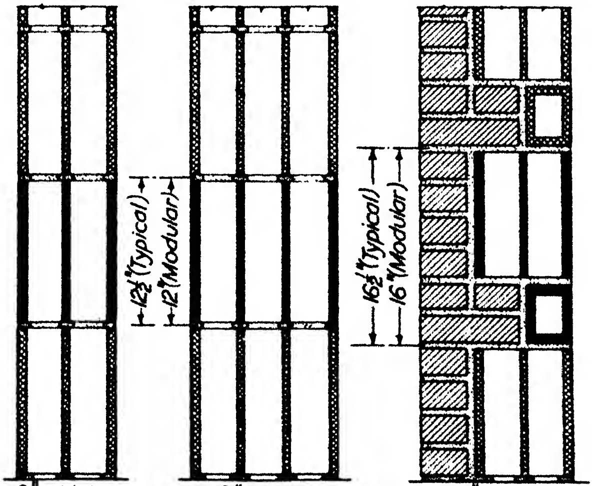
LOAD-BEARING WALL TILE is used for either interior or exterior bearing walls. Surface may be *plaster-base* finish which is roughened; or *exposed-wall* finish which is smooth, combed or roughened: or *universal* finish which is light wire-cut texture suitable for painted or exposed walls or to receive plaster.

END CONSTRUCTION
LOAD-BEARING WALL TILE



4" x 12" x 12"				6" & 8" x 12" x 12"					10" & 12" x 12" x 12"				
SIZE	T_4	W	L	SIZE	T_6	T_8	W	L_2	SIZE	T_{10}	T_{12}	W	L
TYPICAL	3¾"	12"	12"	TYP.	6"	8"	12"	10½"	TYP	10"	12"	12"	12"
MODULAR*	3½"	11½"	11½"	MOD.*	5½"	7½"	11½"	10⅙"	MOD.*	9½"	11½"	11½"	11½"

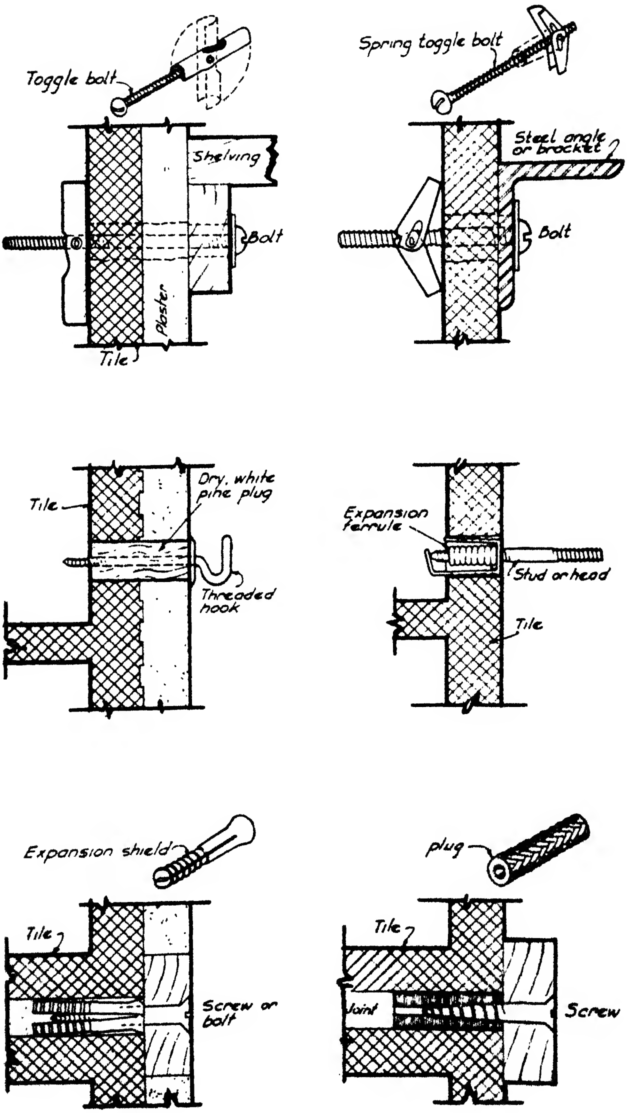
*WITH ½" JOINTS



8" WALL 12" WALL 12" WALL

LOAD-BEARING WALL TILE is used for either interior or exterior bearing walls. Surface may be *plaster-base* finish which is roughened; or *exposed-wall* finish which is smooth, combed or roughened; or *universal* finish which is a light wire-cut texture suitable for painted or exposed walls or to receive plaster. The tile is designed to carry the superimposed load plus that of the facing material such as stucco, brick, plaster, etc.

ATTACHMENT METHODS FOR CLAY TILE



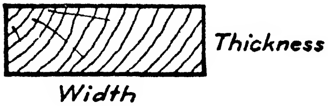
DECAY RESISTANCE OF WOODS

The natural decay resistance of all common native species of wood lies in the heartwood. When untreated, the sapwood of substantially all species has low resistance to decay and usually has a short life under decay-producing conditions. The decay resistance or durability of heartwood in service is greatly affected by differences in the character of the wood, the attacking fungus, and the conditions of exposure.

The following grouping divides some of the more common native species into five classes listed in accordance with the resistance of heartwood to decay. The classification is based on service records, when they are available, and on general experience.

Heartwood durable even when used under conditions that favor decay	Cedar, Alaska Cedar, eastern red Cedar, northern white Cedar, Port Orford Cedar, southern white Cedar, western red Chestnut Cypress, southern Locust, black Osage-orange Redwood Walnut, black Yew, Pacific
Heartwood of intermediate durability, but nearly as durable as some of the species named in the high-durability group	Douglas fir (dense) Honey locust Oak, white Pine, southern yellow (dense)
Heartwood of intermediate durability	Douglas fir (unselected) Gum, red Larch, western Pine, southern yellow (unselected) Tamarack
Heartwood between the intermediate and the nondurable group	Ash, commercial white Beech Birch, sweet Birch, yellow Hemlock, eastern Hemlock, western Hickory Maple, sugar Oak, red Spruce, black Spruce, Engelman Spruce, red Spruce, Sitka Spruce, white
Heartwood low in durability when used under conditions that favor decay.	Aspen Basswood Cottonwood Fir, commercial white Willow, black

STANDARD DIMENSIONS OF SOFTWOOD LUMBER



THICKNESSES (S1S or S2S)

Nominal	Actual
5/16	5/16
7/16	7/16
9/16	9/16
11/16	11/16
1	25/32
1 1/4	1 1/16
1 1/2	1 5/16
1 3/4	1 7/16
2	1 5/8
2 1/2	2 1/8
3	2 5/8
4	3 5/8
6	5 1/2
8	7 1/2
10	9 1/2
12	11 1/2
14	13 1/2
16	15 1/2
18	17 1/2
20	19 1/2
24	23 1/2

WIDTHS (S1E or S2E)

Nominal	Actual
2	1 5/8
3	2 5/8
4	3 5/8
5	4 5/8
6	5 5/8
7	6 5/8
8	7 1/2
9	8 1/2
10	9 1/2
11	10 1/2
12	11 1/2
14	13 1/2
16	15 1/2
18	17 1/2
20	19 1/2
22	21 1/2
24	23 1/2
26	25 1/2
28	27 1/2
30	29 1/2

LENGTHS. Come in multiples of two feet only, except as follows: 2x4, 6x8: 9′ and 11′; 2x8, 2x10: 13′; 2x10: 15′; 8x8, 10x10, 10x12, 12x12, 14x14, 16x16, 18x18: 11′ and 13′; 6x16, 6x18, 8x16, 8x18: 15′ and 17′.

ROUGH. It is understood that the standard dimensions of rough lumber are in excess of the dimensions of finished lumber of the corresponding nominal size, by the amount necessary to permit of surfacing either 1 side or 2 sides and/or 1 edge or 2 edges.

LUMBER CLASSIFICATIONS

USE, SIZE CLASSIFICATION

YARD LUMBER. Lumber of all sizes and patterns which is intended for general building purposes. The grading of yard lumber is based on the intended use of the particular grade and is applied to each piece with reference to its size and length when graded, without consideration to further manufacture.

1. *Strips*—Yard lumber less than 2" thick and less than 8" wide.
2. *Boards*—Yard lumber less than 2" thick, 8" or more wide.
3. *Dimension*—All yard lumber except boards, strips, and timbers; that is, yard lumber from 2" to but not including 5" thick, and of any width.
4. *Timbers*—Lumber 5" or more in least dimension.

STRUCTURAL LUMBER. Lumber that is 2" or more thick and 4" or more wide, intended for use where working stresses are required. The grading of structural lumber is based on the strength of the piece and the use of the entire piece.

1. *Dimension (joists and planks)*—Lumber from 2" to but not including 5" thick, and 4" or more wide.
2. *Timbers*—Lumber 5" or more in least dimension.
   - 2a. *Beams and stringers*—Pieces of rectangular cross section 5" or more thick, and 8" or more wide.
   - 2b. *Posts and timbers*—Pieces of square or approximately square cross section 5"x5" and larger.

FACTORY AND SHOP LUMBER. Lumber intended to be cut up for use in further manufacture. It is graded on the basis of the percentage of the area which will produce a limited number of cuttings of a specified, or of a given minimum, size and quality.

QUALITY CLASSIFICATION OF YARD LUMBER

SELECT

Suitable for natural finishes

Grade A—Practically clear.

Grade B—Of high quality—generally clear.

Suitable for paint finishes

Grade C—Adapted to high quality paint finishes.

Grade D—Intermediate between higher finishing grades and common grades, and partaking somewhat of the nature of both.

COMMON

Suitable for use without waste

No. 1—Sound and tight knotted. May be considered watertight.

No. 2—Less restricted in quality than No. 1, but of the same general character.

Permitting some waste

No. 3—Prevailing grade characteristics larger than in No. 2.

No. 4—Low quality.

No. 5—Lowest recognized grade, but must be usable.

LUMBER NOMENCLATURE

In the interest of good trade practice and of protecting the consumer from obtaining inferior woods under the guise of misleading names, it is important that so far as practicable different trees and woods bear distinctive common names, that the names be uniformly used, and that concerted efforts be made to prevent adding to the present confusion through getting into circulation further misleading or ill-chosen names.

The following list is offered as a means of acquainting lumber users with the standard names employed by the forest service for lumber and for the trees from which it is cut. In large measure the names applied to the lumber correspond with those used for the trees. The list will also help to clear up a great deal of confusion among lumber consumers resulting from use in the trade of needlessly multiplied and often misleading names.

Correct Name of Lumber and Botanical Name of Tree	*Other Names Loosely or Erroneously Employed*
CEDAR, Alaska (*Chamaecyparis nootkatensis*)	Alaska Yellow Cedar
CEDAR, Northern White (*Thuja occidentalis*)	White Cedar Michigan White Cedar New Brunswick Cedar
CEDAR, Southern White (*Chamaecyparis thyoides*)	White Cedar (Juniper)
CEDAR, Port Orford (*Chamaecyparis lawsoniana*)	Port Orford (White) Cedar
CYPRESS, Southern (*Taxodium distichum*)	Red Cypress Yellow Cypress White Cypress Black Cypress Louisiana Red Cypress Gulf Red Cypress Tidewater Red Cypress Gulf Coast Red Cypress Gulf Cypress Cypress
DOUGLAS FIR (*Pseudotsuga taxifolia*)	Douglas Yellow Fir Oregon Fir Fir Red Fir Pacific Coast Douglas Fir Montana Fir National Yellow Fir Yellow Fir Oregon Pine Golden Rod Douglas Fir Yellow Douglas Fir "Santian" Quality Fir

LUMBER NOMENCLATURE

Correct Name of Lumber and Botanical Name of Tree.	*Other Names Loosely or Erroneously Employed.*
FIR, Balsam *(Abies balsamea)* *(Abies fraseri)*	**Eastern Fir** Balsam
FIR, California Red *(Abies magnifica)*	Golden Fir
FIR, Noble *(Abies nobilis)*	Larch
FIR, Silver *(Abies amabilis)*	Larch White Fir
FIR, White *(Abies concolor)* *(Abies grandis)*	Balsam Fir
HEMLOCK, Eastern *(Tsuga canadensis)*	West Virginia Hemlock Hemlock Wisconsin White Hemlock Pennsylvania Hemlock Pennsylvania White Hemlock Huron Pine
HEMLOCK, Western *(Tsuga heterophylla)*	West Coast Hemlock Pacific Hemlock Pacific Coast Hemlock Pacific (western) Hemlock Hemlock
LARCH, Western *(Larix occidentalis)*	Larch Montana Larch
OAK, Red, comprises these species:	
Red Oak *(Quercus borealis maxima)*	West Viriginia Soft Red Oak
Black Oak *(Quercus velutina)*	Tanbark Oak
Southern Red Oak *(Quercus rubra)*	
Swamp Red Oak *(Quercus rubra pagòdaefolia)*	Spanish Oak
Pin Oak *(Quercus palustris)*	Swamp Oak
Water Oak *(Quercus nigra)*	Pin Oak
Texas Red Oak *(Quercus texana)*	
Willow Oak *(Quercus phellos)*	Pin Oak

LUMBER NOMENCLATURE

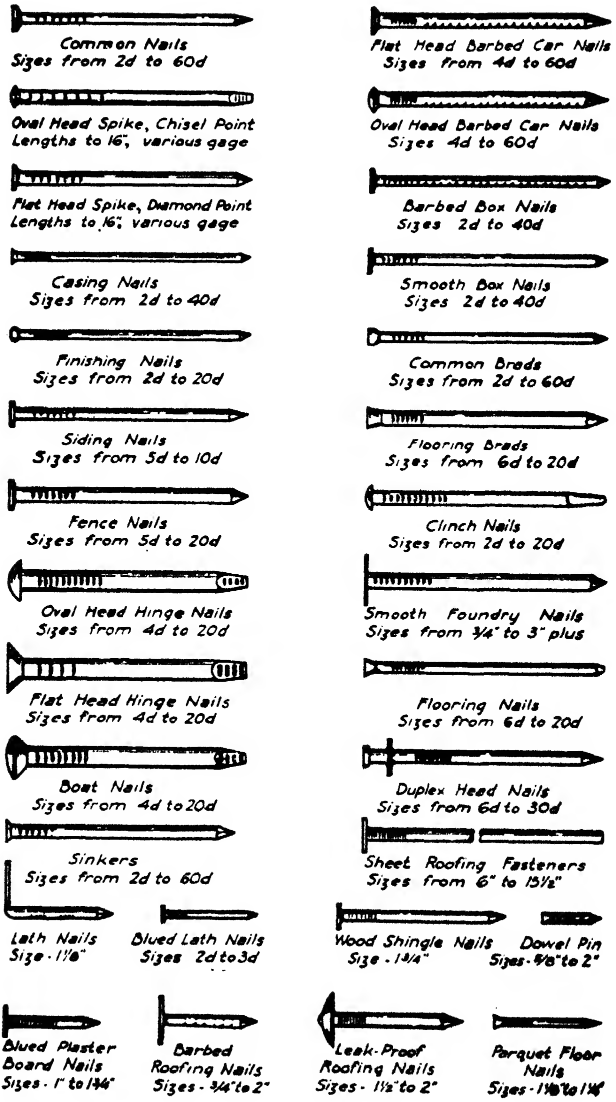
Correct Name of Lumber and Botanical Name of Tree.	*Other Names Loosely or Erroneously Employed.*
OAK, White, comprises these species:	
White Oak *(Quercus alba)*	West Virginia Soft White Oak Forked Leaf White Oak
Post Oak *(Quercus stellata)*	
Swamp Chestnut Oak *(Quercus prinus)*	Cow Oak
Overcup Oak *(Quercus lyrata)*	Swamp Post Oak
Swamp White Oak *(Quercus bicolor)*	Swamp Oak
Bur Oak *(Quercus macrocarpa)*	Overcup Oak
Chinquapin Oak *(Quercus muehlenbergii)*	Pin Oak
Chestnut Oak *(Quercus montana)*	Tanbark Oak
PINE, Lodgepole *(Pinus contorta)*	Tamarack
PINE, Northern White *(Pinus strobus)*	Northern Pine Canadian White Pine Soft White Pine White Pine Wisconsin White Pine Soft Cork White Pine Minnesota White Pine
PINE, Norway *(Pinus resinosa)*	Red Pine Hard Pine
PINE, Southern Yellow, comprises these species:	
Loblolly Pine *(Pinus taeda)*	North Carolina Pine Virginia Pine Arkansas Soft Pine Southern Pine Southern Yellow Pine
Shortleaf Pine *(Pinus echinata)*	Arkansas Soft Pine North Carolina Pine Shortleaved Yellow Pine Arkansas Shortleaf Pine
Longleaf Pine *(Pinus palustris)*	Florida Longleaf Yellow Pine Georgia Yellow Pine Hard Pine Yellow Pine
Pitch Pine *(Pinus rigida)*	Southern Pine Hard Pine
Pond Pine *(Pinus rigida serotina)*	Southern Pine

LUMBER NOMENCLATURE

Correct Name of Lumber and Botanical Name of Tree	*Other Names Loosely or Erroneously Employed*
PINE, Southern Yellow*—*Continued*	
Slash Pine (*Pinus caribaea*)	
PINE, Arkansas Soft, comprises the following species:	
Shortleaf Pine (*Pinus echinata*)	Yellow Pine Spruce Pine
Loblolly Pine (*Pinus taeda*)	Yellow Pine Old-field Pine
PINE, North Carolina, comprises the following species:	
Loblolly Pine (*Pinus taeda*)	Yellow Pine Old-field Pine
Shortleaf Pine (*Pinus echinata*)	Yellow Pine Spruce Pine
Virginia Pine (*Pinus virginiana*)	
PINE, Sugar (*Pinus lambertiana*)	California Sugar Pine Big Pine Genuine White Pine
PINE, Ponderosa (*Pinus ponderosa*)	Arizona White Pine Western Soft Pine Western Yellow Pine California White Pine Bull Pine
PINE, Western White (*Pinus monticola*)	Idaho White Pine** White Pine
REDWOOD (*Sequoia sempervirens*)	Sequoia
SPRUCE, Eastern, comprises the following species:	
Red Spruce (*Picea rubra*)	Adirondack Spruce Canadian Spruce
White Spruce (*Picea glauca*)	Adirondack Spruce Canadian Spruce
Black Spruce (*Picea mariana*)	
SPRUCE, Engelmann (*Picea engelmannii*)	Balsam Mountain Spruce White Spruce Silver Spruce
SPRUCE, Sitka (*Picea sitchensis*)	Yellow Spruce Silver Spruce
TAMARACK (*Larix laricina*)	Larch

*Called "Southern Pine" also, with correctness.
**Manufacturer claims this to be correct name for lumber.

TYPES OF NAILS



NAILS AND NAILING REQUIREMENTS

Use	*Size*	*Nailings*	*Kind of Nails*	*Length*
Shiplap, or square-edged such as used for platforms, floors, or sheathing.	1 x 4 1 x 6 1 x 8 1 x 10 1 x 12	2 2 2 2 3	8d common	2 1/2"
	2 x 4 2 x 6 2 x 8 2 x 10 2 x 12	2 2 2 3 3	20d common	4"
	3 x 4 3 x 6 3 x 8 3 x 10 3 x 12	2 2 2 3 3	60d common	6"
Base, chairrails	1 1/16	2	6d finish	2"
Casing, per opng			6d & 8d casing	2"-2 1/2
Ceiling	3/4 x 4 1/2 x 5/8	1 1	8d finish 6d finish	2 1/2" 2"
Finish	25/32 1 1/16	2 2	8d finish 10d finish	2 1/2" 3"
Flooring	1 x 3 1 x 4 1 x 6	1	8d floor brads	2 1/2"
Framing	2 x 4 to 2 x 16 3 x 4 to 3 x 14		10d common to 20d common 60d common	3" 4" 6"
Drop Siding	1 x 4 1 x 6 1 x 8	2	8d casing	2 1/2"
Bevel Siding	1/2 x 4 1/2 x 6 1/2 x 8	1	6d finish	2"
Lath	48"	16"o/c	3d fine	1 1/8"
Shingles			3d shingle	1 1/4"
Thick shingles, shakes, and re-roofing over old shingles			5d shingle	1 3/4"

SUITABILITY OF WOODS FOR TRIM

EXTERIOR HOUSE TRIM

Usual requirements: Medium decay resistance, good painting and weathering characteristics, easy working qualities, maximum freedom from warp.

Highly suitable: Cedars, cypress, redwood—adapted to blinds, rails, and balcony and porch trim, where decay hazard is high. (Heartwood only.) Northern white pine, sugar pine, western white pine, yellow poplar—adapted to ordinary trim where decay hazard is moderate or low. (Heartwood only.)

Special architectural treatments: **Chestnut, white oak—used with natural finish. (Heartwood only.)**

Good suitability: Hemlocks, ponderosa pine, spruces, white fir—when drainage is good. Douglas fir, western larch, southern yellow pine—special priming treatment advisable to improve paint-holding qualities.

Grades used: A, B, or B and Better finish is used in the best construction. C and D finish in more economical construction. No. 1 or No. 2 boards where appearance is not important.

INTERIOR HOUSE TRIM WITH NATURAL FINISH

Usual requirements: Pleasing figure, hardness, freedom from warp.

Highly suitable: Ash, birch, cherry, chestnut, oak, quartered sycamore, walnut.

Special architectural treatment: Pecky cypress, etched or special grain cypress, Douglas fir, western larch, southern yellow pine, curly or bird's-eye maple. Other woods which are used but which lack the hardness of the preceding group, are knotty cedars, ponderosa pine, spruces, sugar pine and white pine.

Good suitability: Cypress, Douglas fir, western hemlock, western larch, southern yellow pine, redwood, beech, maple, red gum.

Grades used: High-class hardwood interior trim is usually of A grade. The softwood grade A or B and Better is commonly used in high-class construction. In the more economical types of construction C grade is serviceable. D grade requires special selection or some cutting to obtain clear material. Special grades of knotty pine, pecky cypress, and sound wormy oak and chestnut are available to meet special architectural requirements in some types of high-class construction.

INTERIOR HOUSE TRIM WITH PAINT FINISH

Usual requirements: Fine and uniform texture, hardness, absence of discoloring pitch, freedom from warp and shrinkage.

Highly suitable: Birch, cherry, walnut, yellow poplar. The following woods may be used where liability to marring is negligible and special priming is used—northern white pine, ponderosa pine, sugar pine, western white pine.

Good suitability: Hemlocks, redwood, spruce, white fir, basswood, beech, red gum, maple, tupelo. Where requirements for smoothness of finish are not exacting, the following woods may be used satisfactorily—cypress, Douglas fir, western larch, southern yellow pine, ash, chestnut, oak.

Grades used: C is the lowest softwood grade commonly used for high-class paint and enamel finish. D can be used but requires some selection or cutting. No. 1 is used for ordinary or rough-paint finishes. In cheaper and more economical homes No. 2 may be used for ordinary or rough-paint finishes. Smooth-paint finishes are difficult to obtain and maintain over knots in No. 1, No. 2, and No. 3 grades. The A trim grade in the hardwoods is used for exacting requirements of high-class paint and enamel finish in high-cost homes. The standard grade of Firsts and Seconds is also used but requires some selection or cutting. No. 2 Common hardwoods are used for interior trim in the low-cost home, but in this class of home soft woods are generally used for the interior trim that is to be painted.

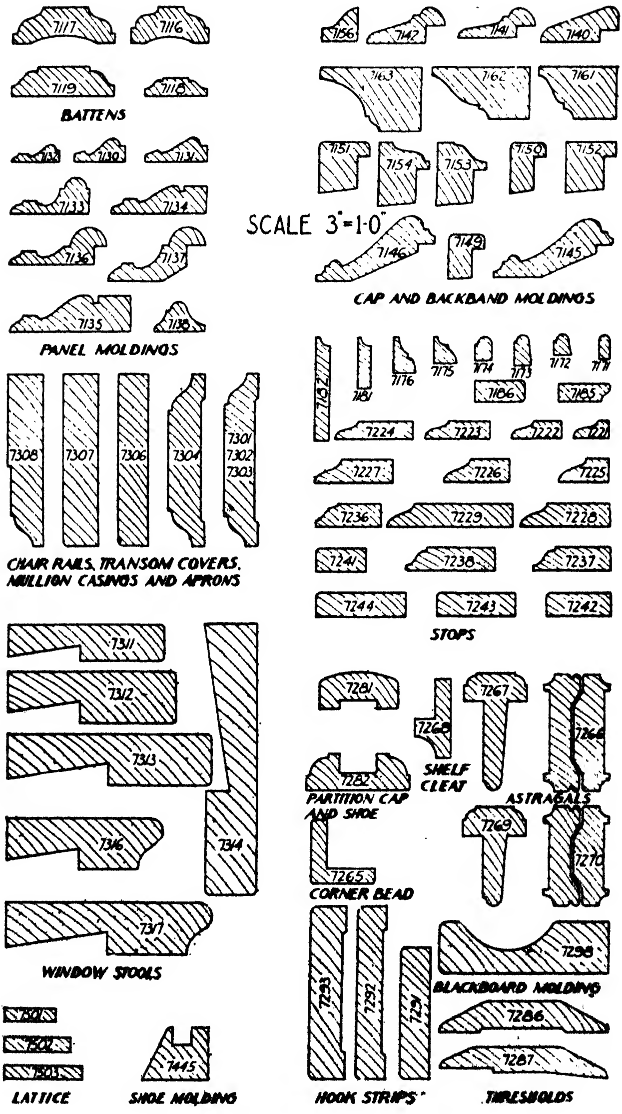
GRADES OF ARKANSAS SOFT PINE TO SPECIFY

The easily worked pine of uniform extra soft texture, produced chiefly from *short-leaf* stands in the Ozark-Ouchita region of Arkansas, is called Arkansas Soft Pine and is identified by trade and grade marks stamped on the material

Use	*Arkansas Soft Pine Grade Recommended*
Sills on foundation wall, floor more than 18" above ground	No. 1 Arkansas Dimension
Sills on foundation wall, floor within 18" of ground	No. 1 Dense Arkansas Dimension (*) or (†)
Sills on posts or piers, floor more than 18" above ground	No. 1 Dense Arkansas Timbers
Sills on posts or piers, floor within 18" above ground	No. 1 Dense Arkansas Timbers (*) or (†)
Basement posts or columns	No. 1 Dense Arkansas Timbers
Girders	No. 1 Dense Arkansas Timbers, No. 1 Dense Arkansas Dimension, or No. 1 Dense Arkansas Laminated
Floor joists over 18" above ground	No. 1 Dense Arkansas Timbers
Floor joists within 18 of ground	No. 1 Dense Arkansas Dimension
Roof rafters and ceiling joists	No. 1 Arkansas Dimension
Studding	No. 1 Dense Arkansas, No. 1 or No. 2 Arkansas Dimension
Lath	No. 1 Lath
Sub-flooring and sheathing	Arkansas Center-Matched in End-Matched or Plain-end, No. 2 or No. 3 Grade
Finish flooring exposed	"A" or "B", Edge Grain End-matched or Random length Plain end
Finish flooring to receive linoleum or carpet	"C" grade Flat Grain End-matched or Plain end
Porch flooring	"A" or "B" Heart Edge Grain Plain End Flat
Drop siding, interior trim, exterior trim, window and door frames	"A" or "B" grade
Exterior trim	"A" or "B" grade (Back-primed with white lead or aluminum paint)

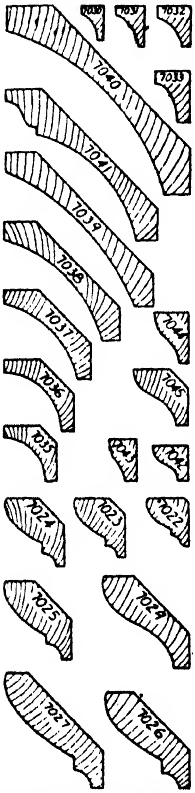
* *Preservative treated*
† *All Heart*

STANDARD WOOD MOLDINGS

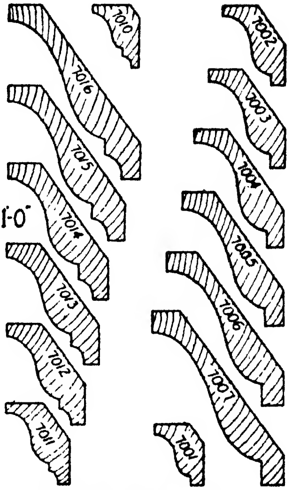


STANDARD
WOOD MOLDINGS

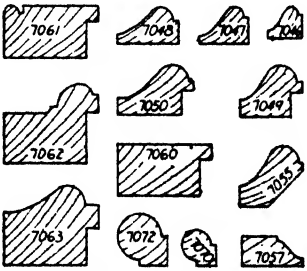
SCALE 3"=1'-0"



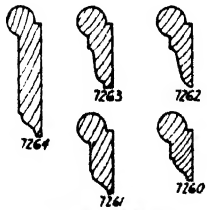
BED AND COVE MOLDINGS



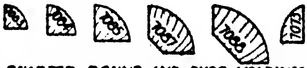
CROWN MOLDINGS



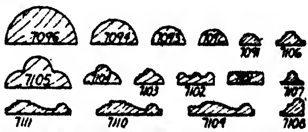
STAFF BEAD AND BRICK MOLDINGS



PICTURE MOLDING



QUARTER ROUND AND SHOE MOLDINGS



PANEL, HALF ROUND AND SCREEN MOLDINGS

GENERAL INFORMATION
ARKANSAS SOFT PINE

WHAT IS ARKANSAS SOFT PINE? Commercial Southern Pine is a general name for a number of closely related species consisting chiefly of:

Short-leaf	*Pinus echinata*
Long-leaf	*Pinus palustris*
Loblolly	*Pinus taeda*
Slash	*Pinus caribaea*
Pond Pine	*Pinus rigida serotina*

The easily worked pine of uniform extra soft texture, produced chiefly from *short-leaf* stands in the Ozark-Ouchita region of Arkansas, is called Arkansas Soft Pine and is identified by trade and grade marks stamped on the material (see below).

WHERE TO BUY: From responsible local lumber dealers and planing mills east of the Rockies and excepting the Gulf States east of the Mississippi River; elsewhere by special arrangement thru the Bureau.

PHYSICAL CHARACTERISTICS. Tables of characteristics of the southern pines often treat the 5 species as a group rather than as individual types of wood and for this reason may be misleading. ARKANSAS SOFT PINE possesses freedom from excessive pitch, has a light, soft, lustrous texture and fine grain which distinguish it from the more resinous and heavy southern pines.

WORKABILITY. Carpenters who have worked in Northern White Pine (*Pinus strobus*) endorse ARKANSAS SOFT PINE as the nearest approach to that famous wood in softness and workability. ARKANSAS SOFT PINE is a material of great toughness of fiber which cuts readily, holds nails securely, and yet does not split easily when nailed.

CHARACTER OF FINISHED STOCK. It is from the thick, clear sapwood with its fine, lustrous texture and virtual absence of resinous oils that the highest grade of interior finish is manufactured. It is because of the large percentage of this clear material peculiar to ARKANSAS SOFT PINE timber that the wood attains its maximum of value and beauty when employed as interior trim and wall paneling.

MOISTURE CONTENT. ARKANSAS SOFT PINE, in all grades, is accurately seasoned down to that moisture content which provides proper conditioning for the intended use of each item specified.

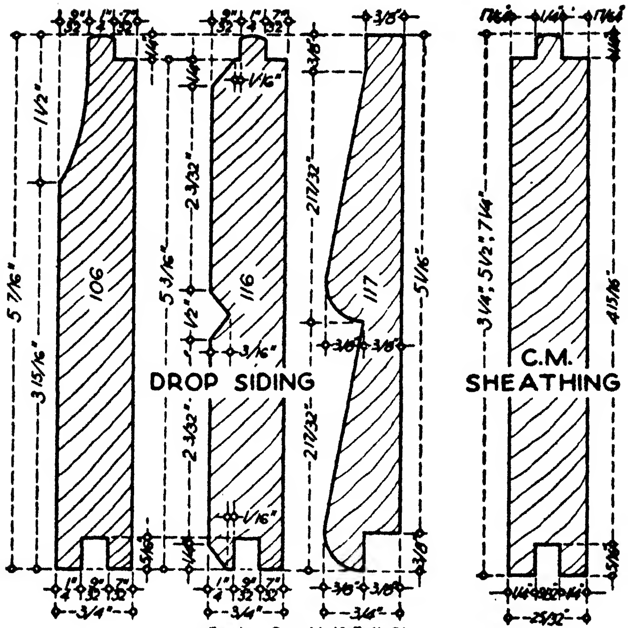
GRADE MARKING. Each grade of lumber in any species is more than the individual manufacturer's idea of the grade. It represents the composite opinion of the entire industry in the region wherein the species grows. ARKANSAS SOFT PINE is graded under the rules of the Southern Pine Inspection Bureau. All grades are stamped with the grade mark symbols with which the building profession is familiar. ARKANSAS SOFT PINE qualifies for Federal Specifications MM-L-751 b.

STRUCTURAL STRENGTH. ARKANSAS SOFT PINE possesses adequate strength for all stresses and loads to be expected in the construction of residences and those of stores and apartments of moderate size. Grades below conform to American Lumber Standards for Dense material.

Grade	*Unit Shear**	*Bending Extreme Fiber*	*Modulus Elasticity*	*Perpendicular Compression*
Dense Select Structural	120	2,000	1,600,000	380
Dense Structural	120	1,800	1,600,000	380
Dense Structural SE&S	120	1,600	1,600,000	380
Dense No. 1 Structural	100	1,200	1,600,000	380

** Shear values of 150 or 175 lbs. may be obtained in any grade by so specifying, without changing any other feature of the grading rule.*

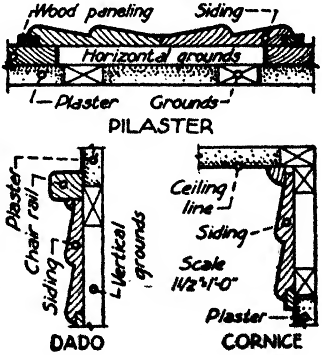
DROP SIDING AND CENTER-MATCHED SHEATHING



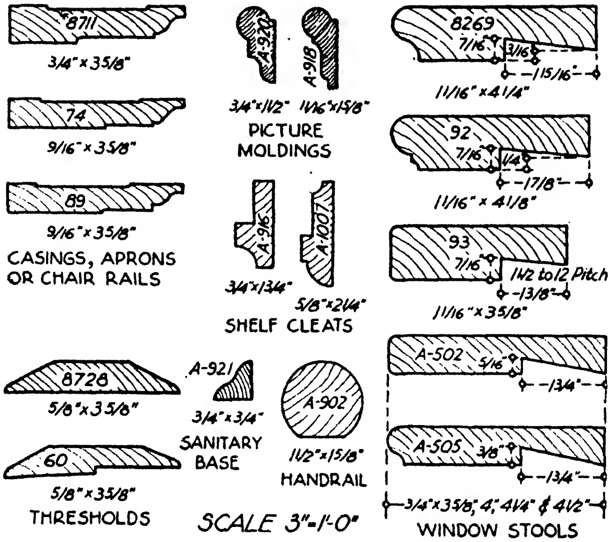
Scale – One Half Full Size

DROP SIDING. Arkansas Soft Pine Drop Siding is available in the above and other patterns. It is extensively used both with undersheathing or without it where economy requires. The use of drop siding as a decorative material is a field which the designer might find it interesting to explore. A number of suggestions appear in the small drawing at the right.

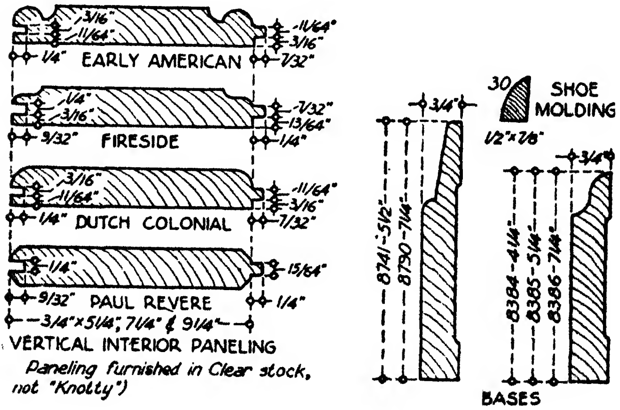
CENTER-MATCHED SHEATHING. Center-matched sheathing which is surfaced 2 sides is available in No. 1, No. 2 and No. 3 grades. This is a kiln-dried material running 20" and longer, furnished in bundles when end-matched, and plain end in random lengths not bundled. Particular care should be taken when using End-matched for sub-flooring or roof sheathing, to specify that no board may be placed so that it is not nailed to at least 2 joists. The end-matching allows the use of this material at considerable saving in manufacture and labor in laying.



STANDARDIZED TRIM IN ARKANSAS SOFT PINE



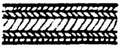
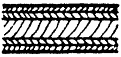
NOTE—Outside New England the 8000 Molding List is standard. Numbers carrying a letter prefix are from the Bureau's "New England Moulding Book." *Copies of both showing all patterns will be furnished on request to the Bureau.*



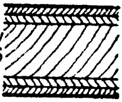
HARDWOOD VENEER PLYWOODS

The dimensions apply to all the common woods and about 150 foreign woods which carry a great variety of figure and color including red, purple, green, black, brown and yellow. All widths and lengths apply to each other and to all thicknesses within the classification. Length is measured with the grain of the face veneer.

STOCK SIZES OF PANELS

Thicknesses		*Widths*	*Lengths*
1/4" 	3-ply	24	48
		30	60
3/8" 	5-ply	36	72
		42	84
1/2" 	5-ply	48	96

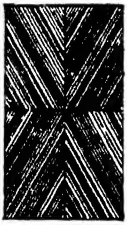
STOCK SIZES OF COUNTER FRONTS

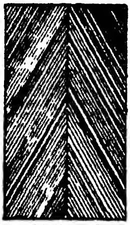
Thickness		*Widths*	*Lengths*
		120	28
13/16" 	5-ply	144	36
			42

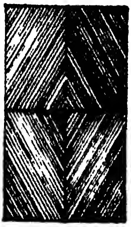
SPECIAL SIZES OF PLYWOOD PANELS

Any odd number of plys, and up to 3" thick. Widths from 4' to 7', and lengths from 12' to 16'


BLOCK MATCHED

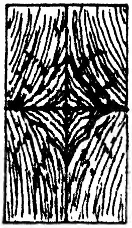

REVERSED DIAMOND


"V" MATCHED


DIAMOND MATCHED


BURL


CENTER MATCH


4-WAY BUTT


HALF ROUND CUT

COLORS OF DECORATIVE PLYWOODS

BROWN—*Colors vary from light yellowish-brown to almost black.*

Madrone Burl
Maidhu Burl
Locust
Circassian Walnut
French Walnut
Claro Walnut
American Black Walnut
Turkish Walnut
Black Sea Walnut
English Walnut
Olivewood
Iroko
Crotch Walnut
Burl Walnut
Butt Walnut
Red Gum
Quartered Red Gum
Carpathian Elm Burl
Koko
Brown Ash
Tamo
Bellinga
Marnut
Gonzalo Alves
Cocobola
Bosse
Thuya Burl
Orientalwood
English Brown Oak
Butternut
Levoa
Teak
Redwood Burl
Amargosa
Carretta
Acacia
Myrtle Burl
Indian Laurel
Pollard Oak
Spicewood
Acle
Chaplash
Collmar
Dao
Ipil
Peartree
Yuba

RED—*Colors vary from a pale pinkish-red to almost vermillion.*

Macacahula
Bloodwood
Australian Maple
African Padouk
Blackwood
East Indian Rosewood
Apple
Canaletta
Bataan
Spanish Cedar
Aromatic Red Cedar
Birch
Curarie
Citron
Rosadura
Western Laurel
Tiama
Red Oak
Honduras Mahogany
Cuban Mahogany
Mexican Mahogany
African Mahogany
Maple Burl
African Cherry
Black Cherry
Lacewood
Curly Birch
Andaman Padouk
Brazilian Rosewood
Bubinga
Macca
Lauan
French Satine
Rosewood Crotch
Faux Rose
Congo Rosewood
Sabicu
Fiddleback Mahogany
Letterwood

YELLOW—*Most of the woods listed under this color are on the dividing line between white, yellow and grey.*

East Indian Satinwood
Amarillo
Aspen
Aspen Crotch
Maple Burl
Blistered Maple
Curly Maple
Birdseye Maple
Plain Maple
Birch
Harewood, Natural
Ayous
Eucalyptus
German Oak
Russian Oak
French Oak
American White Oak
Sycamore
Koa
Tasmanian Oak
Yellow Padouk
San Domingo Satinwood
Canary
Prima Vera
Palo Blanco
Elm
Avodire
English Ash
Poplar
Yellow Pine
Italian Olive
Douglas Fir

WHITE—*The woods in this group are as nearly white as it is possible to get.*

White Birch
Boxwood
Holly
Basswood
Tupelo
Lemonwood
Camphorwood, has fine pink stripe
White Pine

STRIPED—*Woods carrying a prominent stripe of different color.*

Zebrawood, Cream and Brown (Brown Stripe)
Tulipwood, Cream and Pink (Pink Stripe)

BLACK—*Following are nearly clear black.*

Macassar Ebony, has light brown striped in black
Ebonized Maple, Jet Black
Baboon Ebony, Jet Black

PURPLE

Purpleheart
East Indian Rosewood

GREEN

Greenheart

GREY

English Harewood
Empirewood
English Ash Burl

DOUGLAS FIR PLYWOOD

	Name and Function	Widths	Length	Thickness	FHA Acceptance
	EXTERIOR TYPE* Siding and all Outdoor uses	3′, 3½′ and 4′ Also from 12″, increasing by 2″ units to 30″	4′-0″, 5′-0″, 6′-0″, 7′-0″, and 8′-0″	¼″ (3-ply sanded 2 sides) increasing by 1/16″ thicknesses to 1-3/16″ (7-ply)	Exterior type (EXT-DFPA) for Siding.
Interior Types*	PLYPANEL Sound One Side (S01S) Wall and Ceilings	2′-0″, 2′-6″, 3′-0″ and 4′-0″	5′-0″, 6′-0″, 7′-0″, and 8′-0″	⅛″, 3/16″, ¼″, ⅜″ 3-ply; and ½″, ⅝″ and ¾″ 5-ply. All thicknesses sanded on both sides.	Interior finish, one side exposed.
Interior Types*	PLYPANEL Sound Two Sides (S02S) Cabinets and Built-ins	2′-0″, 2′-6″, 3′-0″ and 4′-0″	5′-0″, 6′-0″, 7′-0″, and 8′-0″	⅛″, 3/16″, ¼″, ⅜″ 3-ply; and ½″, ⅝″ and ¾″ 5-ply. All thicknesses sanded on both sides.	Interior finish, both sides exposed.
Interior Types*	PLYSCORD Sheathing and Sub-floors	3′-0″ and 4′-0″	8′-0″	5/16″ and ⅜″ 3-ply unsanded; ½″ and ⅝″ 3-ply or 5-ply unsanded.	Plyscord for wall sheathing, roof sheathing and sub-flooring.
Interior Types*	PLYFORM (Concrete Forms)	3′-0″ and 4′-0″	60″ 72″ 84″ 96″	½″, 9/16″, ⅝″ and ¾″ all 5-ply, sanded both sides; also, ¼″ 3-ply sanded both sides.	

Larger or odd size panels may be secured on special order.

Twenty-six companies manufacturing plywood from Douglas Fir (*Pseudo-tsuga taxifolia*) comprise the membership of the Douglas Fir Plywood Association, with headquarters at Tacoma, Wash. The products of the member companies are produced in types and grades listed above. Grading rules of the Association have been recognized and promulgated through the U. S. Department of Commerce in the document "Commercial Standards CS45-47." These rules require that Douglas fir plywood bear the grade trade-mark of the Association. These marks are the user's assurance that the material meets the rigid quality requirements.

**Exterior Type Douglas Fir plywood is available in several appearance grades, in general, similar to the various grades within the Interior Type; all Exterior is manufactured with completely waterproof adhesives and edge-branded "EXT-DFPA."*

INTERIOR TYPE DOUGLAS FIR PLYWOOD

This type represents the ultimate in moisture resistance, a plywood that will retain its original form and strength when repeatedly wet and dried and otherwise subjected to the elements, and suitable for permanent exterior use. It is free from both gaps and core voids that impair the strength or serviceability of the panel. No veneer thicker than 3/16" is used. All Exterior Type fir plywood produced in accordance with U.S. Commercial Standard CS45-47 should be so designated by a distinctive symbol "EXT-DFPA," branded or stamped on the edge of each panel.

Exterior Type Douglas fir plywood is made in the following grades and sizes:

Grades	Width (Inches)	Length (Inches)	Thickness[1] (Inches)
Sound One Side (S01S) EXT-DFPA) Sound Two Sides (S02S, EXT-DFPA) *Good One Side (G1S, EXT-DFPA) *Good Two Sides (G2S, EXT-DFPA)	36", 42" and 48"; also from 12" to 30", increasing by 2" units	48 60 72 84 96	3/16" 3-ply to 1-3/16" 7-ply, increasing by 1/16" thickness. All thicknesses sanded both sides
Sheathing Exterior (Sheathing EXT-DFPA)	48	96	5/16", ⅜" and ½" 3-ply ⅝" 5-ply All thicknesses unsanded
Concrete Form Exterior (Concrete Form EXT-DFPA)	36", 42" and 48"; also from 12" to 30", increasing by 2" units	48 60 72 84 96	⅝" and ¾" 5-ply All thicknesses sanded both sides
Industrial Exterior (Industrial EXT-DFPA)	As ordered	As ordered	¼" 3-ply to ¾" 5-ply, increasing by 1/16" thickness; Also ⅞" 5-ply All thicknesses unsanded

[1]Number of plies listed under thickness is minimum.
*Available only on special order.

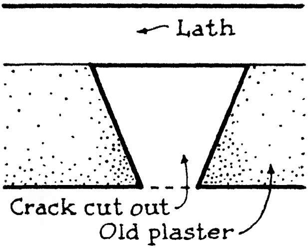
EXTERIOR TYPE
DOUGLAS FIR PLYWOOD

This type material is intended for all interior applications and for such structural parts of homes and buildings as roof and wall sheathing and sub-flooring. It now is manufactured with improved, highly moisture-resistant (but NOT waterproof) glues. Veneers 1/12" or more are used in the construction of interior type panels ¼" and up in thickness. Specifications for all grades of Interior Type Douglas Fir plywood are set forth in U.S. Commercial Standard CS45-47.

Interior Type Douglas Fir plywood is made in the following grades and sizes:

Grades	Width (Inches)	Length (Inches)	Thickness (Inches)
Plypanel Sound One Side Plypanel (S01S) Plypanel Sound Two Sides Plypanel (S02S)	24 30 36 48	60 72 84 96	⅛", 3/16", ¼" and ⅜" 3-ply ½", ⅝"• and ¾" 5-ply All thicknesses sanded both sides
Plyscord	36 48	96	5/16", and ⅜" 3-ply ½" and ⅝" 3-ply or 5-ply All thicknesses unsanded
Plyform	36 48	60 72 84 96	¼" 3-ply ½" 9/16", ⅝" and ¾" 5-ply All thicknesses sanded both sides
Industrial	As ordered up to 48	As ordered up to 96	¼", 5/16", ⅜" 3-ply ½", 9/16", ⅝", 11/16", ¾" and ⅞" 5-ply ⅞" 7-ply All thicknesses unsanded

PLASTER TO RECEIVE PAINT



WASHING PLASTER WALLS. New paint will not adhere well to greasy walls. Washing with a vigorous alkali and rinsing with clean water helps to remove gloss as well as dirt from old paint or enamel. Remaining gloss should be sanded off so that the new paint will have good adhesion.

REPAIRING PLASTER CRACKS. Repair all cracks and damaged plaster before repainting. Undercut the plaster along the cracks with an Undercutter tool to form a dovetail joint which will retain the patching material. The areas of new patching material must be allowed to dry thoroly and then be primed. When patching must match the texture of old sand or plastic designed surfaces, the patched sections should be patted with a rough tool, piece of old carpet, scrub brush or sponge. Hair cracks can be puttied with oil and whiting putty.

VERY BAD WALLS. In old buildings, the plaster sometimes becomes so badly cracked, or piled up with repeated applications of paint or wallpaper, that a satisfactory redecorating job is impossible. In such cases it is more economical and satisfactory to cover the entire wall and/or ceiling with plywood, plaster board, or other wall boards. Sometimes it becomes possible in such cases to increase the insulating value of the wall at the same time, by the choice of a wall board or by stripping and insulating.

PAINT-VARNISH REMOVER. Put a pint of benzol in a clean bottle and warm it by placing the bottle in a pan of warm water. (Caution! benzol is extremely explosive!) Add 2 cubic inches of paraffine which has been shaved or grated, and shake to dissolve. Add ½ pint of acetone and ½ pint of denatured alcohol. Shake the mixture before using. Apply with a brush generously. After 5 to 30 minutes old paint should soften for easy removal with putty knife. Repeat process with stubborn areas. Wash with turps after cleaning, sandpaper if required, and apply paint.

FLOOR FINISHES

PRESENT FLOOR FINISH CUSTOM. According to a recent estimate, 70% of the floors in large cities in the East are being finished with *shellac*, 20% with *floor seals*, and 10% with *varnish*. These proportions obtain in contradiction to nearly all who give technical advice about floor finishing. Shellac as usually employed rates as the least desirable of the three. Shellac finish, when used as a seal only upon which a wax finish is maintained at all times, provides an attractive and durable floor. Shellac and varnish finishes maintained by waxing to prevent the creation of worn spots are giving general satisfaction under conditions of wide usage.

HOT LINSEED OIL FINISH. Years ago floors were commonly finished with hot linseed oil. Each application was buffed by hand. When the surface was saturated with oil, it was waxed and maintained by waxing at suitable intervals. Unbodied drying oils penetrate into wood relatively deep, necessitating a good many applications, making the process rather laborious. (An unbodied oil is one that has not been treated or heated to increase the viscosity substantially. Raw, refined and boiled linseed oil, raw and refined soy bean oil, tung oil and perilla oil are all unbodied oils.) Hot linseed oil finish was durable, did not show scratches and was readily patched at places of maximum wear, dried hard enuf to be free from tackiness, made a floor easily kept clean by dry mopping. In time the finish darkened, deepening the original color.

As time passed, adulteration with non-drying mineral oils increased. The finish was tacky and darkened with age to a color almost, if not completely, black. Oil finish fell into disrepute and was replaced by other finishes. Now a growing trend back to old oil finish is taking place. However, in place of linseed oil, specially designed products known as *floor seals* are now being used because they are obtainable in satisfactory quality and are more economical in labor of application than unbodied linseed oil.

MODERN FLOOR SEALS. These may be regarded as thin varnishes or bodied drying oils prepared to penetrate less deeply into the wood than unbodied oils. Fewer applications are required. They penetrate more deeply than ordinary floor varnishes, saturating a surface layer of the wood. Floor seals are relatively new products on the market and composition and properties vary widely. Inadequate instructions for application are often given. It is important that those using seals for the first time make sure of the exact procedure to obtain the excellent service of which the finishes are capable.

Modern floor seal finishes have the following characteristics. They provide (1) minimum slipperiness when waxed, (2) less luster than varnish or shellac, (3) a minimum of maintenance is required, (4) worn spots may be patched without refinishing the entire floor.

SHELLAC FINISH. This is widely used chiefly because it dries so rapidly. A floor may be finished or refinished and be put back into service in 24 hours. Shellac forms a coating of substantial thickness over the surface of the wood in contrast to finishes which penetrate into the surface of the wood. A shellac finish has the following characteristics: (1) A highly lustrous appearance, (2) extreme slipperiness unless wax coating is kept very thin, (3) finish turns white from water, (4) worn areas can rarely be patched without showing edges.

VARNISH FINISH. These coatings, even the quick-drying variety, require longer intervals between coats, necessitating several days for finishing. Varnish has better resistance to water than does shellac. Other characteristics are similar.

SHELLAC-VARNISH FINISH. This comprises a first coat of shellac with varnish put over it. Like most compromises, it retains disadvantages of both sides with new shortcomings of its own. Water may still turn the shellac white under the varnish. The finish is usually marred easily by scratches.

HOW TO FINISH ARKANSAS SOFT PINE

FINISH ON ARKANSAS SOFT PINE. This is an ideal wood for finishing owing to its fine texture and close grain. It is well adapted to paint and enamel finishing, as it absorbs the undercoating and enamel evenly As there are no pitch streaks in ARKANSAS SOFT PINE interior trim, there is no possibility of raised grain. The absence of rosin or oil content insures against staining the finished surface from underneath. The ultimate finish equals in every respect that which is obtained by using more costly woods.

For information regarding finishes and finishing not covered by the following specifications, write the ARKANSAS SOFT PINE BUREAU, Boyle Building, Little Rock, Arkansas.

"SUEDE" FINISH EFFECTS. The following finishes utilize DuPont Penetrating Wood Finish. DuPont finishes may be secured from local retail paint and varnish dealers anywhere in the United States.

LIGHT COLOR

1st Coat: DuPont Penerating Wood Finish, to each gallon of which is added one-third of a gallon composed of equal parts of DuPont Light Oak and Walnut Oil Stain.
2nd Coat: DuPont Penetrating Wood Finish.

MEDIUM LIGHT

1st Coat: DuPont Penetrating Wood Finish, to each gallon of which is added one-third of a gallon composed of equal parts DuPont Light Oak and Dark Oak Stain.
2nd Coat: DuPont Penetrating Wood Finish.

HONEY COLOR

1st Coat: DuPont Penerating Wood Finish, to each gallon of which is added one-third of a gallon composed of equal parts DuPont Light Oak and Walnut Oil Stain.
2nd Coat: DuPont Penetrating Wood Finish.
3rd Coat: No. 7 "Duco" Wax.

DULL WAX RUB FINISH. For finishes which have the soft luster provided by rubbed wax, the following specifications have been developed in cooperation with S. C. Johnson & Son, Inc., Racine, Wisconsin, whose products are carried by local paint and varnish dealers.

LIGHT BROWN

1 part Johnson's No. 126 Wood Dye
3 parts Naphtha
1 coat White Shellac
2 coats Johnson's Prepared Wax

MEDIUM BROWN

1 part Johnson's No. 126 Wood Dye
1 part Naphtha
1 coat White Shellac
2 coats Johnson's Prepared Wax

"PICKLED PINE"

1 coat Pickeld Pratique Stain No. SF12928
reduced 50-50 with Pratique Thinner
1 coat Johnson's Floor Lacquer
Polished with Johnson's Paste Wax

Continued on next Data Sheet

HOW TO FINISH ARKANSAS SOFT PINE, Cont.

ENAMEL, VARNISH, STAIN, FINISHES. The following Pratt & Lambert finishes are recommended as dependable but not to the exclusion of those of any other responsible paint manufacturer. Pratt & Lambert will answer any questions regarding the finish of ARKANSAS SOFT PINE. Address their nearest office in Buffalo, Long Island City, Chicago.

NATURAL OR ENAMEL FINISH. The surface should be cleaned and sandpapered smooth with No. 0 or No. 00 sandpaper. Touch up knots or sappy places with Pure White Shellac. Machine-sanding is advisable when possible.

GLOSS OR RUBBED ENAMEL FOR INTERIOR TRIM
- 1 coat P&L Interior Trim Primer
- 1 coat Vitralite Enamel Undercoating
- 2 coats Vitralite Enamel Gloss, left in gloss or rubbed dull

EGGSHELL ENAMEL FOR INTERIOR TRIM
- 1 coat P&L Interior Trim Primer
- 1 coat Vitralite Enamel Undercoating
- 1 coat Vitralite Enamel Gloss
- 1 coat Vitarlite Enamel Eggshell

GLOSS ENAMEL FOR INTERIOR TRIM (A *Less Expensive Enamel Finish*)
- 1 coat P&L Interior Trim Primer
- 1 coat "61" Enamel Undercoating
- 1 coat "61" Enamel Gloss or "61" Quick Drying Enamel Gloss (may be had in colors as well as in White)

EGGSHELL ENAMEL FOR INTERIOR TRIM (*A Less Expensive Enamel Finish*)
- 1 coat P&L Interior Trim Primer
- 1 coat "61" Enamel Undercoating
- 1 coat "61" Enamel Eggshell

GLOSS NATURAL VARNISH FOR FLOORS AND INTERIOR TRIM
- 3 coats "61" Quick Drying Floor Varnish Clear Gloss

SATIN FINISH NATURAL VARNISH FOR FLOORS AND INTERIOR TRIM
- 2 coats "61" Quick Drying Floor Varnish Clear Gloss
- 1 coat "61" Quick Drying Floor Varnish Satin Finish

DULL FINISH NATURAL VARNISH FOR FLOORS AND INTERIOR TRIM
- 2 coats "61" Quick Drying Floor Varnish Clear Gloss
- 1 coat "61" Quick Drying Floor Varnish Dull Finish

FLAT NATURAL VARNISH FOR INTERIOR TRIM
- 1 coat Shellac
- 1 coat Tonetic Flat Varnish

STAINED AND VARNISH FINISHES.

GLOSS FOR FLOORS AND INTERIOR TRIM
- 1 coat P&L Oil Stain
- 3 coats "61" Quick Drying Floor Varnish Clear Gloss

SATIN FINISH FOR FLOORS AND INTERIOR TRIM
- 1 coat P&L Oil Stain
- 2 coats "61" Quick Drying Floor Varnish Clear Gloss
- 1 coat "61" Quick Drying Varnish Satin Finish

DULL FINISH FOR FLOORS AND INTERIOR TRIM
- 1 coat P&L Oil Stain
- 2 coats "61" Quick Drying Floor Varnish Clear Gloss
- 1 coat "61" Quick Drying Floor Varnish Dull Finish

FLAT FINISH FOR INTERIOR TRIM
- 1 coat P&L Acid Stain
- 1 coat Shellac
- 1 coat Tonetic Flat Varnish

BASIC SPECIFICATIONS FOR PAINTING

Complete descriptions of all Pittsburgh Paint Products together with detailed specifications for their use, will be found in Sweet's Catalog.

1. GENERAL CONDITIONS. The general conditions bound herewith are a part of this Section. The sub-contractor for work in this Section is to read them and be bound thereby.

2. WORK INCLUDED. This Section includes all labor and materials necessary to complete the painting and finishing of the building.

3. WORK NOT INCLUDED. This Section does not include shop coats.

4. MATERIALS. Use materials manufactured by the Pittsburgh Plate Glass Company. Deliver materials to the work in the original sealed containers. Do all required mixing on the premises. Do not reduce or change materials in any way except as and when specified.

5. SAMPLES. Prepare required samples well in advance of the work so as to cause no delay, to meet the approval of the architect as to color, and match the approved sample accurately in the finished work.

6. PROTECTION OF PROPERTY. Protect adjacent work and materials from damage.

7. PREPARATION OF SURFACES. The sub-contractor for work in this Section is wholly responsible for the finish of his work. Do not commence any part of the work until the surface is in proper condition. Apply 1 coat of shellac to all knots or sappy spots 10 hours before painting. Putty nail holes, cracks and blemishes after the priming coat has become dry. Putty shall match the shade of the finished coat. Clean greasy or oily surfaces with turpentine or benzine before applying any materials. Remove rust and scale by scraping, wire brushing or sandblasting.

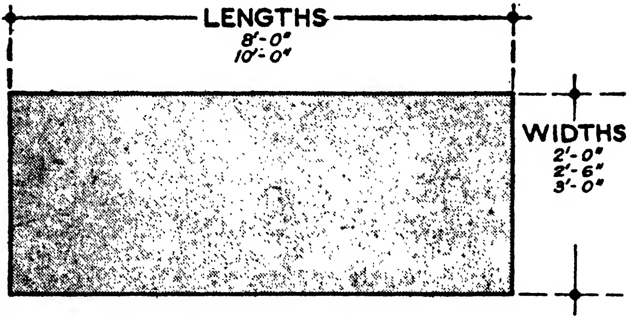
8. WORKMANSHIP. No exterior painting shall be done in rainy, damp or frosty weather. No interior painting or finishing shall be done until the building has been thoroly dried out by artificial heat. Allow exterior oil paints to dry 48 hours between coats and interior paints 24 hours between coats. Allow enamels and varnishes to dry 48 hours between coats. Lightly sand enamels and varnishes with No. 0 sandpaper and dust between coats. After applying paste wood fillers, carefully clean excess from the surface by rubbing across the grain.

9. REMOVAL. When the work is completed, remove all surplus materials and equipment. Clean all misplaced paint, varnish, etc., to leave the premises in perfect condition. This sub-contract will not be deemed fulfilled until final approval of the architect.

U. S. S. GAGE FOR IRON AND STEEL SHEETS

Number of Gage	*Approximate Thickness In Inch Fractions*	*Approximate Thickness In Inch Decimals*	*Weight per Square Foot*
0000000	1/2	0.5	20.00 lbs.
000000	15/32	0.46875	18.75 "
00000	7/16	0.4375	17.50 "
0000	13/32	0.40625	16.25 "
000	3/8	0.375	15.00 "
00	11/32	0.34375	13.75 "
0	5/16	0.3125	12.50 "
1	9/32	0.28125	11.25 "
2	17/64	0.265625	10.63 "
3	1/4	0.25	10.00 "
4	15/64	0.234375	9.38 "
5	7/32	0.21875	8.75 "
6	13/64	0.203125	8.13 "
7	3/16	0.1875	7.50 "
8	11/64	0.171875	6.88 "
9	5/32	0.15625	6.25 "
10	9/64	0.140625	5.63 "
11	1/8	0.125	5.00 "
12	7/64	0.109375	4.38 "
13	3/32	0.09375	3.75 "
14	5/64	0.078125	3.13 "
15	9/128	0.0703125	2.81 "
16	1/16	0.0625	2.50 "
17	9/160	0.05625	2.25 "
18	1/20	0.05	2.00 "
19	7/160	0.04375	1.75 "
20	3/80	0.0375	1.50 "
21	11/320	0.034375	1.38 "
22	1/32	0.03125	1.25 "
23	9/320	0.028125	1.13 "
24	1/40	0.025	1.00 "
25	7/320	0.021875	14 oz.
26	3/160	0.01875	12 "
27	11/640	0.0171875	11 "
28	1/64	0.015625	10 "
29	9/640	0.0140625	9 "
30	1/80	0.0125	8 "
31	7/640	0.0109375	7 "
32	13/1280	0.01015625	6½ oz.
33	3/320	0.009375	6 "
34	11/1280	0.00859375	5½ "
35	5/640	0.0078125	5 "
36	9/1280	0.00703125	4½ "
37	17/2560	0.00664062	4¼ "
38	1/160	0.00625	4 "

PROPERTIES OF STAINLESS STEEL SHEETS



Stainless steel may be fabricated by forming (bending), rolling, drawing or casting. Because of its extreme toughness it is not easily extruded.

There are two Enduro stainless alloys developed for architectural use. Enduro 18-8 and Enduro A-A.

The sizes of sheets shown above are available at most warehouses.

ENDURO 18-8. The number is an approximate classification of its chromium content (18%) and nickel content (8%). It can be welded. The addition of nickel to the stainless analysis extends the corrosion resistance. Any desired finish may be obtained from an unpolished to a mirror finish on one or both sides, or brushed or satin finishes.

ENDURO A-A. This is less expensive than Enduro 18-8 and is used for interior work only. Its resistance to corrosion is not equal to 18-8. Fabrication in general is similar to 18-8 except that A-A does not possess the same degree of ductility or welding properties.

Gage	*Thickness in Inches*	*Wt. per Sq. Ft. Enduro* 18-8	*Wt. per Sq. Ft. Enduro* A-A
10 gage	.140625	5.9062 lbs.	5.7937 lbs.
12 gage	.109375	4.5937	4.5063
14 gage	.078125	3.2812	3.2187
16 gage	.0625	2.6250	2.575
18 gage	.05	2.1	2.06
20 gage	.0375	1.575	1.545
22 gage	.03125	1.3125	1.2875
24 gage	.025	1.05	1.03

STAINLESS STEEL FINISHES

STAINLESS STEEL. Strictly speaking, there is a distinction between stainless iron and stainless steel, altho the term "stainless steel" is popularly, if erroneously, used to designate all stainless alloys. Stainless steel is an alloy of iron, chromium and carbon. This branch of the stainless family is especially suitable for applications where hardness and wear resistance are required. "Enduro" is the trade name identifying the group of stainless alloys perfected by the Republic Steel Corporation. These alloys are silvery white and cannot chip, crack or wear thin, as a section thru the metal is homogeneous. Stainless steel does not tarnish, corrode or become dull. It can be given a number of different finishes or may be etched and enameled to produce unusual effects. The properties of *Enduro* stainless alloys indicate their use for the finest decorative effects and for any purpose requiring resistance to corrosion.

FINISHES OF *ENDURO*. *Enduro* has no coating to wear off. The finish possible on *Enduro* sheets will depend to a considerable extent on the amount of forming that is necessary.

NO. 1 FINISH. This is an unpolished, fully annealed and pickled sheet. It is adaptable to extra deep drawing where score marks from dies are likely to occur in forming or where it is necessary to re-anneal to make a second drawing operation. No. 1 finish may be used where appearance is not a primary factor but where corrosion resistance is important.

NO. 2B AND NO. 2D FINISHES. These finishes can be used for practically the same applications as is the No. 1 finish except where extra deep drawing is a factor. These finishes are slightly higher than the No. 1 finish, because they are obtained by cold rolling.

NO. 4 FINISH. This is a ground and polished finish which is particularly satisfactory for interior application. It possesses a medium luster and is considered the best commercial type of finish for restaurant and soda fountain equipment, trim for cabinets, etc.

NO. 6 TAMPICO BRUSHED FINISH. This has found more favor for exterior application than No. 4 finish. It has a satin luster but does not have as high a reflectivity as No. 4. It can be used in combination with finishes of higher luster or with other metals. Not recommended on surfaces subject to abrasion, such as doors, table tops, etc.

NO. 7 FINISH. This is a buffed finish producing a high luster polish.

NO. 8 FINISH. This is the highest finish obtainable in commercial practice. All of the grinding lines are removed and a sheet of high reflectivity is obtained. This sheet is used for mirrors and other trim where highest luster is required.

IN SPECIFYING. Samples of the various finishes possible will be submitted upon request. If a finish on one side of the sheet only is to be visible, the surface finish is applied to that side when using Nos. 4, 6, 7 or 8 finishes.

OPEN SPECIFICATION
GLASS AND GLAZING

GENERAL CONDITIONS. The current edition of the "General Conditions of the Contract," as issued by the American Institute of Architects, is a part of this specification. The contractor for the work required by this Section is to read it and be bound thereby.

WORK INCLUDED. This Section includes all mirrors, glass and glazing required to complete the building, unless specifically excepted.

WORK NOT INCLUDED. The following work will be executed by others ....

(*a*) *Glazing Skylights. Unless local jurisdictional awards give this work to him, the glazing contractor rarely glazes skylights.*
(*b*) *Metal Windows, Revolving Doors, Elevator Doors. The specifier should follow local practice in glazing these items.*
(*c*) *Structural Glass.*
(*d*) *Medicine Cabinet Mirrors.*
(*e*) *Vault Lights.*
(*f*) *Leaded and Art Glass.*
(*g*) *Cleaning Glass. The cleaning of glass and the removal of rubbish incident to the glazing contract should not be included in this Section. Formerly, glass was packed in excelsior but now inclusion of the removal of rubbish in the glazing contract is not necessary. The General Contractor should be required to clean the glass just before the building is turned over to the Owner.*

SAMPLES. Submit samples to the Architect for his approval at any time he may require it, together with such other evidence as he may demand, to establish that the materials meet the requirements of the contract documents.

COOPERATION WITH OTHER TRADES. Refer to the sections of these specifications containing references to other work which must be executed in conjunction with Glass and Glazing.

ALTERNATES. The General Contractor is required to submit separate figures for ....

GLASS BREAKAGE. Replace all breakage caused in executing the work or by faulty installation, without cost to the Owner.

GLASS SIZES. Obtain glass sizes from the work at the building or from the manufacturer of frames, sash, etc., in which the glass is to be set. Responsibility for correct glass sizes rests with the glass and glazing sub-contractor.

ACCEPTANCE. Improperly set glass or glass which does not fully meet the requirements of its grade will not be accepted. Such glass must be replaced to the satisfaction of the Architect, without cost to the Owner.

PUTTY. For glazing wood sash use (*whiting putty or white lead and whiting putty conforming to U.S.G.M. Spec. No. 283; or a mastic glazing compound*). Putty is to be (*natural, or slate color*) in color.

For glazing metal sash use (*whiting putty with 5% of litharge, or metal sash elastic glazing compound*).

(*a*) *Whiting Putty. The FHA specifications call for this type which consists of finely powdered natural chalk, a minimum of pure tinting color and pure raw linseed oil.*

(Continued on next Data Sheet)

OPEN SPECIFICATION
GLASS AND GLAZING

(*b*) *White Lead and Whiting Putty. Consists of* 10% *white lead, a minimum of tinting colors, natural chalk, and pure raw linseed oil.*

(*c*) *Elastic Glazing Compounds. The principal difference between these and putty is that specially treated oils are used so that the compound will remain elastic even under extreme conditions of vibration and exposure. These proprietary glazing compounds are usually available in standard colors.*

(*d*) *Litharge. Litharge is lead oxide and is added to putty to make it set from the bottom rather than just skimming the top.*

QUALITY OF GLASS. The qualities and thicknesses of glass called for in this specification refer to U.S.G.M. Spec. No. 123, insofar as it establishes requirements. Qualities of mirrors refer to Commercial Standards No. CS27-36 published by the U. S. Dept. of Commerce, insofar as it establishes requirements. Other qualities and thicknesses refer to recognized standards. All glass and mirrors must be labeled. Do not remove labels until glass and mirrors are inspected and approved by the Architect.

EIGHTH-INCH PLATE GLASS. Glaze (*all, all exterior, or enumerate locations*) openings with ⅛" plate glass of (*glazing, mirror glazing*) quality.

STANDARD PLATE GLASS. Glaze (*all, all exterior, or enumerate locations*) openings with standard plate glass (⅛", 13/64", ¼") thick of (*glazing, mirror glazing*) quality.

HEAVY PLATE GLASS. Glaze (*enumerate locations*) openings with heavy plate glass (⅜", ½", ⅝", ¾", ⅞", 1", 1¼") thick of (*commercial or selected*) quality.

HORIZONTAL PLATE GLASS SURFACES. Use (*standard or heavy*) plate glass in (*state thickness*) thickness for (*desk tops, counter tops, deal plates*). Tops are to be (*polished or honed*) and the edges are to be polished. Drill to receive metal or other fittings where required. Set to provide an even bearing with a foundation of felt or billiard cloth of (*state color*) color as approved by the Architect.

CLEAR WINDOW GLASS. Glaze (*all, all exterior, or enumerate locations*) openings with (*S.S., D.S., etc.*) clear window glass in (*A, B*) quality.

HEAT ABSORBING GLASS. Glaze (*all, all exterior, or enumerate locations*) openings with ¼" heat absorbing plate glass of glazing quality.

Heat absorbing glass has the ability to retard the transmission of solar heat without interfering with the transmission of visible light.

TEMPERED PLATE GLASS. Use (*specify type, quality and thickness*) glass which has been subjected to the tempering process for (*enumerate locations*).

(*Continued on next Data Sheet*)

OPEN SPECIFICATION
GLASS AND GLAZING

BULLET-RESISTING GLASS. Glaze (*enumerate locations*) with commercial quality bullet-resisting glass (½", ¾", ⅞", 1", 1⅛", 1½", 2") *thickness.*

BENT GLASS. Architect will furnish full size templet of curve for bent glass in (*enumerate locations*) using (*specify type, quality and thickness*) glass.

TINTED PLATE GLASS. Glaze (*enumerate locations*) with tinted plate glass in (*blue, flesh*) color of selected quality $\frac{13}{64}$" thick.

"Solex" plate glass is faint bluish green in color and may be used as a tinted glass.

WIRE GLASS. Use (*rough, polished, processed, figured, ribbed, corrugated*) wire glass for (*enumerate locations*) bearing the Underwriters Laboratory approval, in (¼", ⅜" ½", ⅝", ¾") thickness. Conceal by the stop a minimum of ¼" of glass on all edges.

OBSCURE GLASS. Glaze (*enumerate locations*) openings with (*chipped 1 or 2 sides, acid-etched 1 or 2 sides, sandblasted 1 or 2 sides, rolled figured sheet, colored rolled figured sheet, figured plate glass polished 1 side, prism*) in (. . .) design of (. . .) thickness. Where figured glass is used on the exterior, set with smooth side out.

X-RAY LEAD GLASS. Install X-Ray Lead Glass (*enumerate locations*).

STRUCTURAL GLASS. Install structural glass where indicated and of colors and thicknesses as shown on the drawings, including hardware and accessories necessary for installation. Install structural glass in strict accordance with the manufacturer's recommendations.

COPPER-BACK MIRRORS. Mirrors are to be manufactured from (*specify thickness, quality, kind and color*) glass protected on the back by an electrolytically deposited layer of copper over which is applied a coating of pure shellac followed by a coat of mirror backing paint. Provide mirrors with (*Standard* 1½", *or* ¾", 1", 1¼", 1¾", 2") beveled edge. Where indicated bore mirrors to allow for the installation of electric lights, metal, glass or compo ornaments or fastenings. Wheel cut mirrors in design shown with incisions (*polished, unpolished*). Grind and polish exposed edges of mirrors.

Any type of glass may be silvered. Quality of the mirror will depend upon the quality of glass which is used, Mastic set mirrors have an extra protective coating which should be specified if this setting is to be used. In addition to usual silvering, decorative mirrors can be made with gold, gunmetal, copper, bronze or aluminum reflective coating.

MIRROR FRAMES AND ACCESSORIES. Furnish and install metal mirror frames for flush mounting with concealed fastenings. Furnish and install (*metal, cut glass, composition*) rosettes where indicated. Furnish and install (*chromium, nickel, etc.*) supports for glass shelves.

(*Continued on next Data Sheet*)

OPEN SPECIFICATION
GLASS AND GLAZING

29. SETTING MIRRORS WITH MOLDINGS. Set mirrors to reflect as true an image as possible. Support mirrors on the bottom edge with white pine blocks placed in the rabbet. Do not use felt in any manner. Mirrors shown with muntin divisions are to be in one piece with false muntins. Stain the reflected surface of beads, rabbets, moldings and the false muntins a flat jet black.

(*a*) *Ventilation of Mirror Back. The temperature of the front and back of the mirror should be equal. On exterior walls, particularly, it is necessary to prevent sweating on the back of the mirror.*

(*b*) *False Muntins. Separate panes, unless in perfect alignment, would reflect a distorted image. The use of a single mirror with false muntins will reflect a true image.*

30. SETTING MIRRORS WITH MASTIC. Use special mirror setting mastic recommended by the manufacturers of the mirror. Apply a bond coat to the wall to insure close affinity to the mastic. Walls behind mirrors must be firm, thoroly dry and having no projections. Apply 6" diameter spots of the mastic so that the area covered is not more than 25% of the back surface.

31. GLAZING EXTERIOR WOOD FRAMES. Thoroly paint or oil rabbet so that putty will adhere. Bed glass in putty. Use 2 white pine blocks at bottom of each pane to act as cushions. Secure glass with zinc glaser's points 10" o/c and face putty. Run putty neatly and cleanly even with the inside edge of frame members.

(*a*) *Do not try to back-putty glass with figured surfaces. The putty cannot be removed from the ridges.*

32. GLAZING WITH BEADS. Remove and reset glazing beads carefully to avoid marking or defacing any portion of sash, door, bead or setting screws. Set glass without a putty bed. Back and face putty after setting to prevent rattling.

33. ARCHITECTURAL GLASS. Where shown install stock shapes of Architectural glass. Architectural glass is to be manufactured from crystal type of glass. The molded surface is to be clear. The back surface is to be (*matted, polished, silvered*). Furnish and install metal shapes as detailed where required for setting of Architectural glass. Sides and ends of pieces are to be (*cut, ground, polished*) as required by the designs.

34. STORE FRONTS. Furnish and install (*specify make*) store front metal construction and glazing of (*give thickness, kind, quality*) glass. Wood framing for store front construction will be provided in another section. Set moldings and sash accurately and neatly. Furnish and install calking where required to make show windows tight.

WINDOW GLASS SIZES, WEIGHTS, DESCRIPTION

DESCRIPTION. Window glass is drawn vertically and held absolutely flat from molten state to finished sheet. During the drawing process, no rolls nor foreign substances of any kind touch the surface of the glass until it has cooled sufficiently to be beyond injury. Consequently, it has an unusually brilliant, reflective and unmarred surface finish on both sides of the sheet. Modern window glass is made of the purest and most carefully selected ingredients which results in remarkable transparency providing clear, true vision and the transmission of the true colors of all objects seen thru it. The transparency is permanent, the glass retaining its clarity indefinitely.

Window glass is graded at the factory by experts in accordance with U. S. Government standards and a label is affixed to each light which indicates its quality.

AA QUALITY. This is the best quality of window glass obtainable. Because it is higher in quality than commercially necessary, it is made only on special order and is priced accordingly.

A QUALITY. This quality contains no imperfections that will appreciably interfere with straight vision. This is the standard quality grade for commercial purposes.

B QUALITY. This quality admits of the same kind of defects as the A quality, but they may be larger, heavier and more numerous.

Classification	*Qualities Available*	*Approx. Thickness*	*Oz. per sq. ft.*	*Maximum Size*
Picture Glass	AA, A, B	1/16″	14.0	3′-0″ x 4′-2″
Single Strength	AA, A, B	3/32″	19.0	3′-4″ x 4′-2″
Double Strength	AA, A, B	1/8″	26.0	5′-0″ x 6′-8″
40 oz. Heavy Sheet	A, B	3/16″	40.0	50 sq. ft.
45 oz. Heavy Sheet	A, B	7/32″	45.0	60 sq. ft.
Greenhouse	Greenhouse	1/8″	26.0	16″ x 18″ 16″ x 24″ 18″ x 20″

GRADING PROCEDURE FOR WINDOW GLASS

GENERAL PRINCIPLES. All flat glass contains some imperfections. The principles employed in grading is to exclude defects that would be objectionable in a given grade. This is difficult of accomplishment, since there are no sharp lines of demarkation between grades and experienced inspectors will differ in judgment as a quality of the glass approaches the limits of the grades. Small lights must be quite free from imperfections as compared with larger ones. The center of any sheet should be clear, whereas the edges may contain more pronounced defects.

METHOD OF EXAMINATION. The method of examination must be established in order to make the results of grading more uniform. The distance from the glass, the angle between the glass and the line of sight and the intensity of light all affect the visibility of imperfections.

The glass should be examined when placed in a position similar to that of a glazed light. The observer's eye should be on a level with the center of the sheet and looking through the glass from a distance of about 36 inches into the light from a clear sky without any sun or close background.

REQUIREMENTS FOR A QUALITY. The defects permitted in this quality are faint strings or lines, slight burn, small seeds, small blisters, and light scratches. No light shall contain all of these defects, and those present may not be grouped when in the central area of the sheet. Strings, lines or burn specks shall not be of such intensity that they are visible when observing the sheet at an angle greater than 30° between the line of sight and the glass. Waves shall not be visible at an angle greater than 20° with the glass. Blisters shall not exceed ¼ inch in length unless they occur near the edge of the sheet.

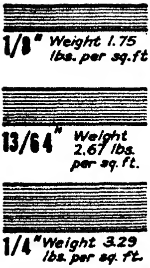
In general, the central area of the light shall be practically free from defects, and the appearance of the light as a whole shall be such that there is no perceptible interference with the vision as long as one is not looking thru the glass at an acute angle.

REQUIREMENTS FOR B QUALITY. This quality admits of the same kind of defects as A quality, but they may be larger, heavier, and more numerous. Occasional scattered blisters not more than ½ inch long may occur over the central area of the sheet. Larger blisters up to 1 inch in length may occur about the bordering areas.

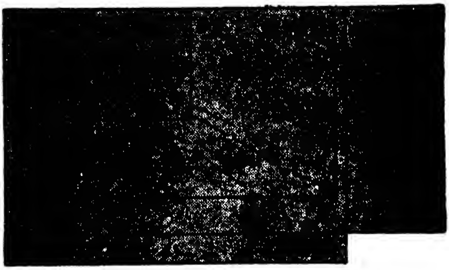
Waves should not be of such intensity that they are visible when observing the sheet at an angle greater than 45° with the glass unless on the border.

Burn spots may be visible when looking directly thru the glass, but they must not cause any appreciable depression, and the speckled appearance must not be so great as to interfere with vision when examining the glass in the specified position.

STANDARD PLATE GLASS



Thicknesses



Maximum Sizes

MANUFACTURE OF PLATE GLASS. Plate glass is transparent, flat, relatively thin glass having plane polished surfaces. Plate glass is made by casting and rolling large sheets which are then ground and polished mechanically to true flat surfaces, having great brilliance and high reflectivity. Because the 2 surfaces of the glass form true and parallel planes, polished plate glass affords perfect undistorted vision or reflection from any angle.

QUALITY OF PLATE GLASS. Plate glass is available in 3 qualities —*silvering* quality, *mirror glazing* quality and *glazing* quality. It should be evident that small pieces of plate glass can be selected to have fewer imperfections than larger sheets. For this reason the grading specifications are less stringent as the size of the sheet increases. Sizes of sheets are divided into 4 divisions for purposes of grading:

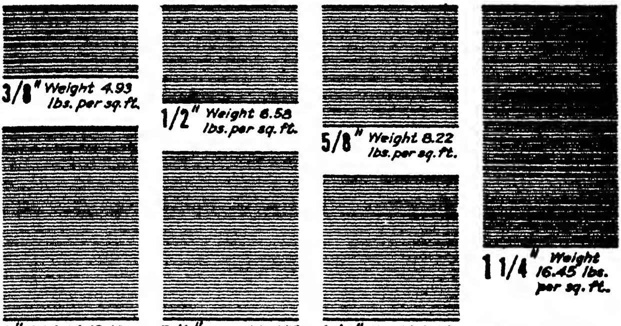
Division 1—Sheets up to and including 10 square feet.
Division 2—Greater than 10 square feet up to and including 25 square feet.
Division 3—Greater than 25 square feet up to and including 75 square feet.
Division 4—Greater than 75 square feet.

SILVERING QUALITY. Silvering quality is invariably used where the highest standard is required. This quality is rarely sold for glazing purposes in sizes over 20 square feet.

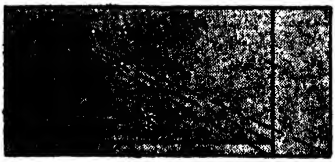
MIRROR GLAZING QUALITY. This is specified where absolute perfection is not required. This quality is exceptionally free from defects.

GLAZING QUALITY. Glazing quality represents the usual selection of plate glass which is specified where the ordinary glazing installation is required.

HEAVY PLATE GLASS



Thicknesses.



3/8" and 1/2"---6'-8" x 13'-9"
5/8" and 3/4"---6'-8" x 12'-4"
7/8" and 1"----5'-10" x 12'-4"
1¼"----------5'-9" x 12'-4"

Maximum Sizes

DESCRIPTION OF HEAVY PLATE GLASS. Plate glass in thicknesses of ⅜" to 1¼" is termed *Heavy Plate Glass.* Since the strength of plate glass increases in direct proportion to the square of the thickness, it will readily be appreciated that this material is adaptable to many uses where great strength is required. Heavy plate glass is manufactured by casting and rolling large sheets which are then ground and polished. It has a true flat surface with great brilliance and high reflectivity. It is clear and affords perfect vision.

USES FOR HEAVY PLATE GLASS. Heavy plate glass is widely used for book shelves, decorative panels, partitions, shower bath skylights, telephone stall partitions, theater marquees, valances, lighting fixtures, radio sound control rooms, refrigerator doors, show case tops, soda fountain counters, aquaria, table tops, modern furniture.

SELECTED QUALITY. This is the best of the heavy plates. It is little used since the conditions under which heavy plates are ordinarily employed do not demand this extremely high quality.

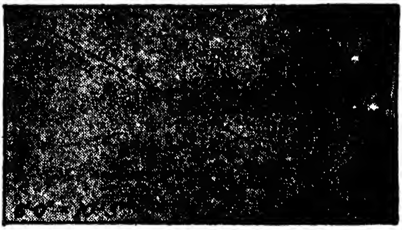
COMMERCIAL QUALITY. This grade is the most widely used.

EIGHTH-INCH PLATE GLASS

1/8" *Weight 1.75 lbs. per sq. ft. Actual thickness will vary from 8 to 9-64 ths.*

Thickness

Maximum Size



DESCRIPTION OF 1/8" PLATE GLASS. 1/8" Plate Glass was developed to meet a definite need in the building industry and satisfies the demand for a fine plate glass which can be used for general glazing, but which is low enough in cost to warrant wide use and which can be glazed in standard 1 3/8" sash with standard sash weights. It has all the advantages of the heavier standard plate glass. It is highly polished on both surfaces, giving a brilliant luster and high reflection. This glass is absolutely free from distortion, transmitting all objects seen thru it with perfect clarity. It has sufficient strength and durability to assure permanence in residences or other buildings.

MAXIMUM SIZE FOR EXTERIOR GLAZING. Sizes over 7 square feet in area are not recommended for exterior glazing.

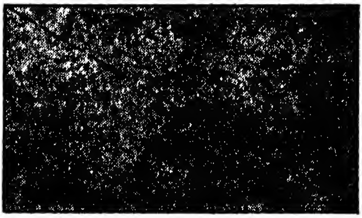
QUALITY OF 1/8" PLATE GLASS. Is available in 3 qualities——*silvering quality, mirror glazing quality* and *glazing quality*. The requirements for these 3 qualities are identical with the standards established for the grading of plate glass. *Silvering quality* is used where the highest standard is required. *Mirror glazing quality* is specified where exceptional freedom from defects is required but absolute perfection is not mandatory. *Glazing quality* represents the usual selection of 1/8" plate glass, and is supplied when the quality is not otherwise definitely specified.

BLUE AND FLESH TINTED PLATE GLASS

13/64" *Weight 2.67 lbs. per sq. ft.*

Thickness

Maximum Size

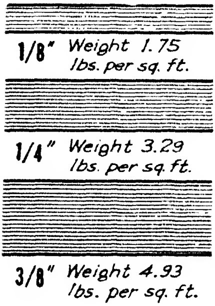


DESCRIPTION OF BLUE PLATE GLASS. This is a true plate glass of rich blue color, ideal for decorative use in modern building. It makes extraordinarily attractive and attention-compelling mirrors which are finding wide acceptance in commercial work.

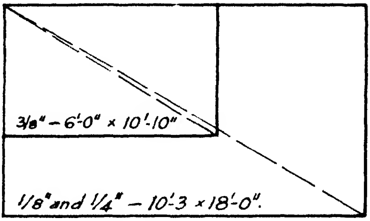
DESCRIPTION OF FLESH TINTED PLATE GLASS. This glass approximates in color the shading commonly found in the skin of Caucasians. The color is slight in surface section, showing considerably stronger in transverse section. Used in mirrors, flesh tinted plate glass produces reflections which minimize blues and violets and emphasize flesh colors, thus offering flattering images.

QUALITIES OF BLUE AND FLESH TINTED PLATE GLASS. Both types are available in selected quality only.

HEAT ABSORBING PLATE GLASS



Thicknesses



Maximum Size

DESCRIPTION OF HEAT-ABSORBING PLATE GLASS. This glass is made by a special process which gives it the capacity for absorbing heat without interfering with the transmission of visible light. Thus, while it admits 70% to 75% of the sun's total light, it transmits less than 43% of the total solar heat. When windows, skylights, etc., of a building are glazed with this glass, the heat entering the building is greatly reduced. Persons sitting near windows with heat-absorbing glass are far more comfortable, and the glare resulting from high light intensity is considerably lessened.

USES OF HEAT-ABSORBING GLASS. The low heat transmission of this glass fits it for a wide variety of uses. It may be employed to advantage in southern and western exposures of all types of buildings—schools, residences, factories, hotels, office buildings.

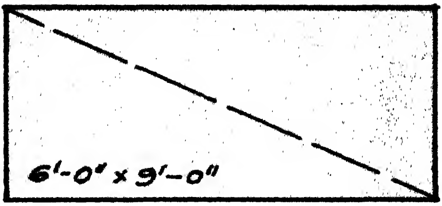
PHYSICS OF LIGHT. The wave length of visible light varies from 400 to 680 millimicrons. Below this range occurs the ultra-violet and above this range from 700 to 2800 millimicrons, are the infra-red or heat rays. Heat-absorbing glass combines the ability to transmit visible light while absorbing a large proportion of the infra-red.

COLOR OF HEAT-ABSORBING GLASS. This glass is faint bluish in color. Light coming through windows glazed with it has a tendency to make colors appear natural, giving the quality of natural light corresponding to the artificial light from so-called daylight bulbs. It is not glaring nor depressing.

QUALITY. Heat-absorbing glass is produced in 1 quality only—*glazing quality*. The grading requirements for this quality are identical with the requirements for grading regular plate glass. Every light of heat-absorbing glass is identified with a sticker which allows the architect to assure himself as to the identity of the product during construction.

TEMPERED PLATE GLASS

Maximum Size



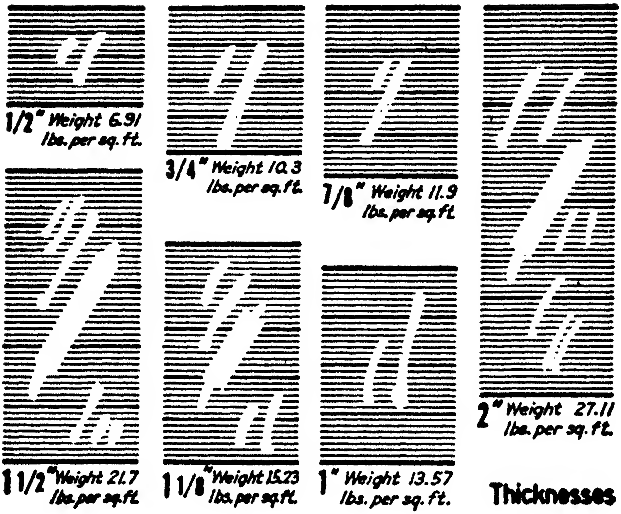
DESCRIPTION OF TEMPERED PLATE GLASS. Tempered plate glass is finished, polished plate glass which has been specially processed by heat and chilling after completion. It will support a weight 4 times as great as ordinary plate glass. It will bend 4 times as far without breaking. Its resistance to impact is 7 to 8 times greater. It is not affected by varying surface temperatures—being able to withstand without breaking a temperature of 650° F. on one surface while the other is at ordinary atmospheric temperature.

Tempered plate glass resists shock and impact as well at low temperatures as at ordinary or high temperatures. When this glass does shatter from terrific impact, it does not break into sharp fragments like ordinary glass, but disintegrates into innumerable small fragments which are comparatively blunt-edged. All fabrication of the glass must be done before tempering, as this glass cannot be worked or cut in the field.

USES FOR TEMPERED PLATE GLASS. This glass has innumerable uses where strength and safety are important considerations. It proves extraordinarily satisfactory for aquaria, cell doors, doors, fire screens, flooring, kitchen equipment, laboratory equipment, partitions, shelves, show cases, table and counter tops, under water lighting, portlights, pressure gages.

QUALITIES. Since any type of glass may be subjected to the tempering process, the quality of the finished glass will be determined by the grade of glass which has been used. Plate glasses subjected to the tempering process retain their original properties while taking on the greater resistance to temperature and increased strength that is characteristic of tempered plate glass.

BULLET-RESISTING GLASS



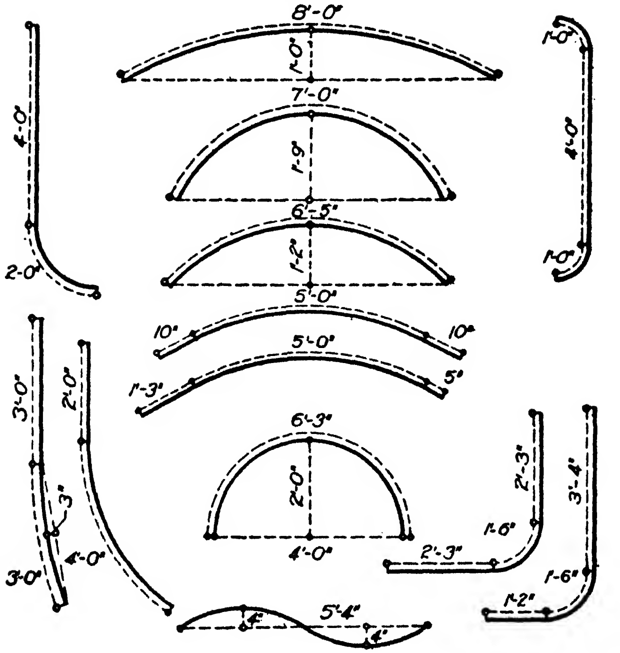
DESCRIPTION OF BULLET-RESISTING GLASS. This glass is a laminated glass for use where special protection against impact and firearms is required. Altho bullet-resisting, this glass offers all the desirable qualities of plate glass, being brilliant of finish and offering perfect, undistorted vision and accurate reflections. This bullet-resisting glass is checked and tested regularly, and listed by, the Underwriters' Laboratories. The drawings above, showing the thickness of bullet-resisting glass are diagrammatic only.

MAXIMUM SIZE. The maximum size of bullet-resisting glass is 3'-9" x 7'-0".

USES FOR BULLET-RESISTING GLASS. The thicknesses of bullet-resisting glass from 1/2" up to and including 1" are bullet-resisting to a certain degree. These thicknesses are generally used for machine guards as protection against flying objects, but sometimes are used for resistance against bullets where conditions will not permit installation of heavier thicknesses. Thicknesses less than 1 1/8" are not recommended for installations requiring resistance against bullets. The 1 1/8" thickness is the thickness most commonly used to withstand shots from common side arms. The 1 1/2" thickness is prepared especially for resistance to the Smith & Wesson .357 Magnum revolver. The 2" thickness provides resistance to short bursts of .45-caliber submachine gun fire and single shots from high-powered rifles.

QUALITY. This glass is available in 1 quality only, designated as *Commercial Quality*.

REQUIREMENTS FOR BENT GLASS



HOW GLASS IS BENT. All kinds of glass can be bent—including window glass, plate, and structural glass. A flat sheet of manufactured glass is placed over a mold made in the desired shape. The glass is heated until it softens and sinks, taking the shape of the mold. It is then carefully annealed.

BENDING PLATE GLASS. Plate glass is the best type of transparent glass for bending, the polished surface retaining its brilliance and undistorted transparency.

SIZES OF CURVES. The maximum size which can be bent is 12'-6" x 15'-0". It is important that a pattern or templet of the desired curve be submitted in all cases even when regular curves are ordered. It is not recommended that plate glass be bent to a curve exceeding a half circle nor to acute bends approaching right angles, for such extreme curves involve great risk of breakage and of injury to polished surfaces. Some typical bends are shown in the drawings above, but these drawings do not indicate the range of the material. Segments of ellipses, parabolas and compound curves can be obtained. It should be noted that curves will be accurate for practical purposes but they will not be microscopically accurate. Plates with cash openings or speaking holes cut for information booths, bank fixtures, ticket offices, etc., cannot be bent without great risk of breakage. Orders for such glass are accepted with the understanding that the customer assumes the cost of plates that may be broken in the bending process.

TYPES OF MIRRORS

PLATE GLASS MIRRORS. The United States produces the finest quality of plate glass in the world and the specification "French Plate" mirrors is obsolete.

ORDINARY TYPE. The usual protective backing consists of a coat of shellac followed by a coat of mirror-back paint. The paint has a special base giving it moisture-resisting properties. The possible maximum size of mirrors of the ordinary type is governed by the size of glass which is available.

COPPER-BACK. Copper-back mirrors were developed to meet the demand for mirrors which would have high resistance against deterioration. In this process the glass receives a double coat of silver. A layer of copper is deposited over the silvering by electrolysis. Then a coating is applied, followed by a coat of specially prepared mirror-backing paint. Every copper-back mirror is identified with a label. The maximum size of copper-back mirrors is 7′-2″ x 14′-0″.

COPPER-BACK STRUCTURAL MIRRORS. These mirrors are specially fabricated for use with mastic in order to give the maximum service. When mirrors are to be set with mastic, specify and use copper-back structural mirrors. Structural mirrors differ from other types in that they have an additional protective coating.

DURABILITY. Copper-back mirrors are guaranteed against silver spoilage from climatic or atmospheric conditions and defective workmanship and will be resilvered and re-copper-plated free of charge by the manufacturer if silver spoilage is evidenced from either of these causes within a period of five years from date of manufacture. Copper-back mirrors cannot be guaranteed when installed in bathrooms or showers where there is excessive moisture or on the exterior of buildings where the mirrors are exposed to the elements.

THE MIRROR AS A LOOKING-GLASS. Where a mirror is intended to reflect an accurate and undistorted image, it is necessary to use plate glass since the silvered surface of a mirror magnifies and accentuates the quality of the glass to a high degree. It must be remembered that extreme sizes of plate glass free from objectionable defects are difficult to obtain—and the larger the glass, the more likely these defects are to be present. The quality of the mirror will be limited by the quality of the plate glass specified.

BEVELING. The standard width of bevel is 1 1/2″ and all beveled plate mirrors are so furnished unless otherwise specified.

WHEEL-CUTTING. Plate glass mirrors may have V-cut lines in any suitable design cut into the surface by a wheel. The cut surfaces may be either polished or unpolished, as desired.

DECORATIVE MIRRORS. Flesh-tinted plate glass mirrors produce reflections which minimize the blues and violets and emphasize the flesh tones, offering flattering images of the persons reflected. Blue plate glass mirrors are a rich blue in color. Other decorative mirrors may be made of cool green heat-absorbing glass, backed as silver, gold or gunmetal mirrors.

WINDOW GLASS, OR SHOCK MIRRORS, are produced by silvering window glass. The reflection is generally wavy and the image produced somewhat distorted. Window glass mirrors, however, fill a definite decorative need but are supplied only in smaller sizes for special purposes. Shock mirrors are not guaranteed as to silvering.

INSTALLATION OF MIRRORS

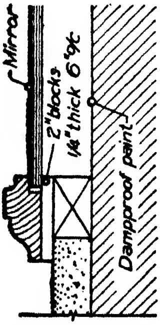
MASTIC SET MIRRORS. At the right is shown a method of setting mirrors with special mirror setting mastic where moldings are objectionable because of the design. Ordinary mastic must not be used as it is likely to contain ingredients injurious to the mirror backing. *Structural Copper-back Mirrors* must be specified.

INSTALLATION OF MASTIC MIRRORS. Where mirrors are to be installed against finished plaster, the plaster must be sound and firm and thoroly dry. Mirrors may be set over masonry provided that it is extremely smooth with no projections which will penetrate the ⅛" space allowed for mastic, touching the back of the mirror with resulting danger of scratching. The mastic is applied in spots about 6" in diameter, so that the area covered by the mastic is not more than 25% of the back surface.

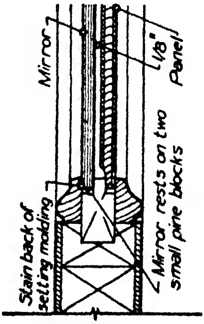
SUPPORT AND LEVELING OF MIRRORS. A bond coat must be applied to the wall of such composition so as to insure close affinity with the mastic. The mastic acts both as an adhesive and as a leveling medium but it is necessary to support the weight of the mirror by some structural method—by resting it on a chair rail, molding, metal inserts or some other method. The plan drawing at the right shows grounds used for bearing to insure the plumbness of adjacent mirrors, so that reflections of the room will be true. Single mirrors require no bearing grounds.

MIRRORS SET WITH WOOD MOLDINGS. Where the backs of the mirrors are likely to sweat, ventilation must be provided, as shown in the drawing below. All mirrors set in wood moldings are supported on the bottom edge on 2 tiny white pine blocks placed in the rabbet. The use of felt is never necessary in the setting of mirrors and because of its ability to hold moisture, may do harm. The backs of all setting moldings and the rabbet should be *stained* black, not painted.

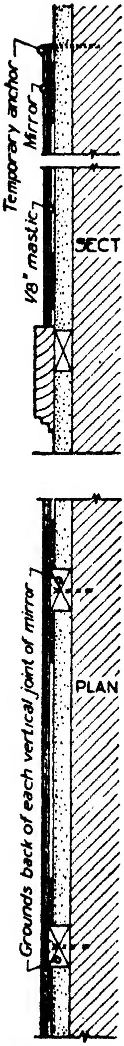
ROSETTES. Clean 3"-square white pine grounds, surfaced all sides, should be screwed to the wall with counter-sunk flat head screws for setting mirrors with rosettes. Drilled holes in mirrors should be located at least 2" from the edges. Grounds should be kept at least ¼" back of the mirror edges.



SET IN WOOD MOLDINGS



MIRROR DOOR



MASTIC SET MIRROR

DESCRIPTION OF SEALED MULTIPLE GLAZING

Composed of two or more lights of glass which are separated from each other by 1/4" or 1/2" or dehydrated air space and hermetically sealed at the edges, these panes provide a high resistance to heat loss, reduce the radiant cooling effect, reduce street noises, cut down condensation, and have many other advantages.

Various combinations and types of glass may be used on special order. Glass thicknesses in any unit may not vary more than 1/16". Possible types of units that may be obtained can be made from the following kinds of glass, but since size limits vary widely according to the glass that is used it is wise to consult the manufacturer before deciding on any design:

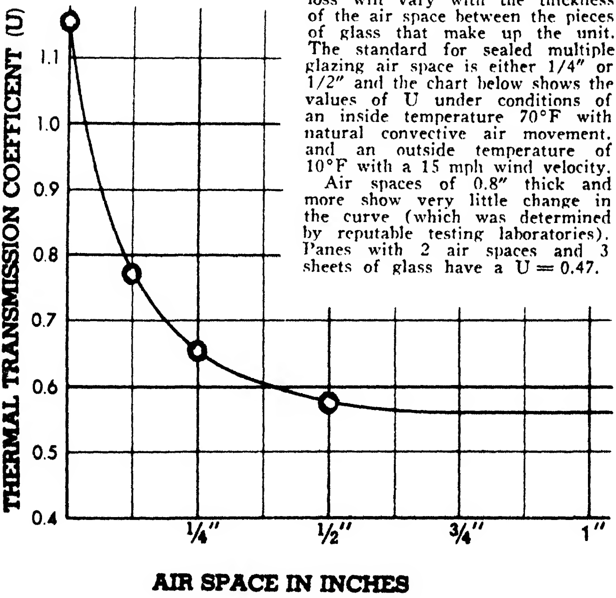
"A" quality window (sheet) glass Double Strength (1/8")
1/8" or 1/4" clear polished plate glass
1/8" or 1/4" heat-absorbing plate glass
1/4" heat-strengthened plate glass
1/8" or 1/4" Glare-reducing glass
1/8" or 7/32" figured glass of certain patterns.

Wire glass cannot be obtained at this time. Sandblast on one or two inside surfaces can be specified where diffusion and obscurity is required. No special edge finishes are available.

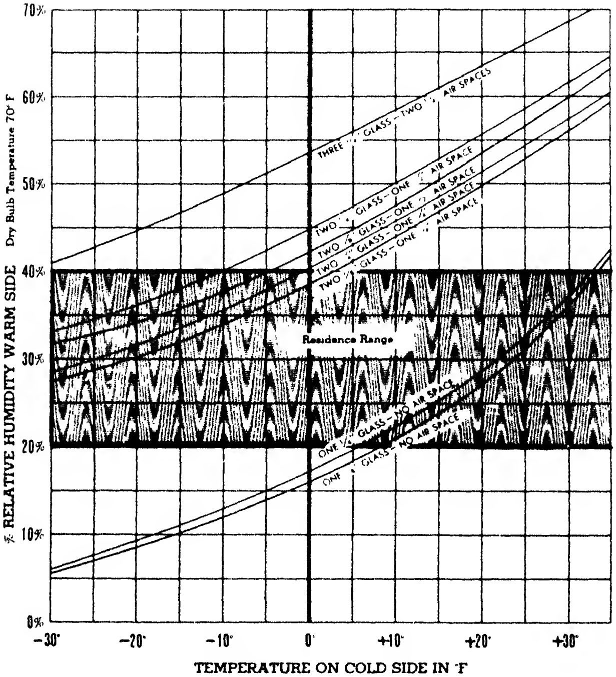
In designing casement or double-hung sash or sash of other types it should be observed that sealed double glass units take a deeper rabbet and are considerably heavier than a single light of glass. Certain standard sizes have been developed in cooperation with manufacturers of wood and steel sash.

The over-all thermal conductivity or thermal resistance to heat loss will vary with the thickness of the air space between the pieces of glass that make up the unit. The standard for sealed multiple glazing air space is either 1/4" or 1/2" and the chart below shows the values of U under conditions of an inside temperature 70°F with natural convective air movement, and an outside temperature of 10°F with a 15 mph wind velocity.

Air spaces of 0.8" thick and more show very little change in the curve (which was determined by reputable testing laboratories). Panes with 2 air spaces and 3 sheets of glass have a U = 0.47.



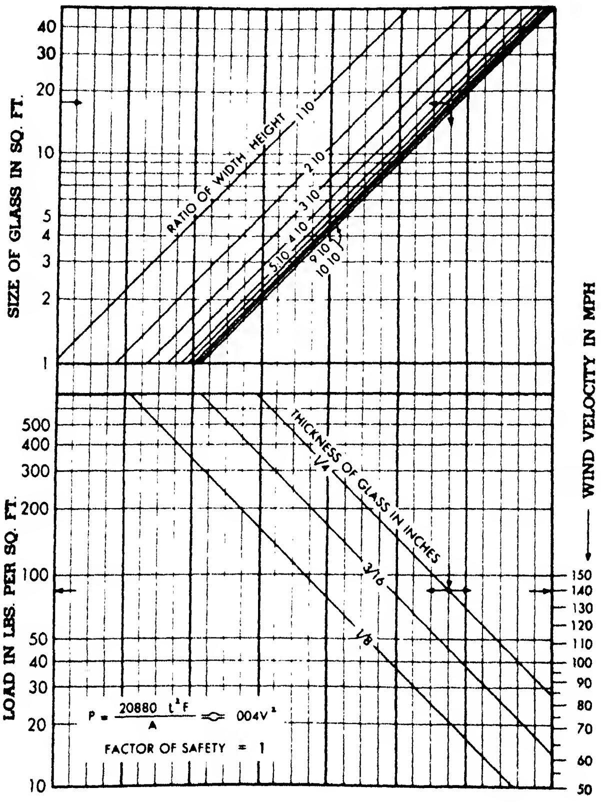
DEWPOINTS OF SEALED MULTIPLE GLAZING



The chart above shows the conditions under which condensation will occur during cold weather on the inside of windows with both single panes and sealed multiple panes. The chart is calculated for free air movement of normal convection currents on the warm side. Condensation will occur at slightly higher temperatures than shown if air movement is restricted by curtains, shades, or other means.

The inside surface temperature of openings glazed with sealed multiple panes greatly reduces the amount of heat that must be supplied near such areas. This permits design flexibility, promotes physical comfort, allows visibility because of the absence of frost, and eliminates the storm-sash semi-annual problem.

STRENGTH OF GLASS IN WIND



As an example of the use of this chart, suppose we wish to design a glass panel of 18 square feet with a width to height ratio of 1:7. Read across the upper part of the chart from the 18 square foot size of glass to the diagonal line 1:7 for the ratio of width to height. At this intersection read down to the lower diagonal lines for the thickness of glass. The intersection with the diagonal line shows that a ¼″ thickness will stand 84 pounds per square foot on the left hand scale. Reading to the right from this intersection we find this is equivalent to 140 mph wind velocity.

CHARACTERISTICS OF STRUCTURAL GLASS

CHARACTERISTICS OF STRUCTURAL GLASS. Structural glass is strong and durable—a truly structural glass which is annealed to withstand rigorous use both indoors and out. It will not check, craze, stain or change color with age. It will not absorb odors of any kind. It is impervious to grease, grime, chemicals, oils, pencil marks. It is easily cleaned. It retains its brilliant luster. It is homogeneous and uniform in structure.

STRUCTURAL GLASS COLORS. The *standard* colors are gray-green, ivory, gray, white, black. *Special* colors are wine, blue, orange, green, beige.

SURFACE FINISHES. *Polished*: Produced by mechanically grinding and polishing to a high luster. *Suede*: A less reflective finish mechanically imparted to soften reflections, available in all colors, 11/32" thickness only.

BENT STRUCTURAL GLASS. The bending of structural glass is subject to the same conditions as those for *bent glass,* found in the "Plate Glass" section of this Handbook.

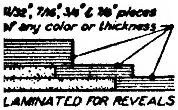
MAXIMUM SIZE GOVERNED BY CONDITIONS OF USE. Except under severe conditions, interior panels may be used as large as 15 square feet. The maximum for toilet partitions is 25 square feet. The maximum for exterior installations is 10 square feet when below a line 15'-0" above the sidewalk. Above the 15'-0" line, the maximum size is 6 square feet.

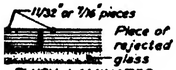
SIZE LIMITED BY THE MATERIAL ITSELF. The standard stock sheet of structural glass is 6'-0" x 10'-10". Laminated, sandblasted, or carved ornamental work, not over 15 square feet. Standard ashlars are available in whole inch sizes only, minimum dimension 8", maximum dimension 16".

Uses	*Usual Thickness Used*	*Wt. per sq. ft.*	*Colors Available*	*Finish*[1]
Obscure Glazing	1/4"	3.29	Black	1 or 2 sides polished
Ceilings Wainscot[2]	11/32"	4.50	All colors	1 side polished or suede
Wainscot[2] Store Fronts Strips, Caps, Bases[3] Bulkheads	7/16"	5.76		1 side polished
	3/4"	9.67		
Laminated Partitions Solid Partitions Door & Window Trim Deal Plates	7/8"	11.51	Standard colors	1 or 2 sides polished
Counter tops Toilet Lintels Toilet Stiles Shower Seats	1 1/4"	16.45		

[1] Honed Finish available in Black, 11/32" and thicker.
[2] Size of single pieces desired will determine thickness.
[3] Severity of service will determine thickness as 3/4" or 7/16"
[4] Gray-green not manufactured in 3/4" thickness.

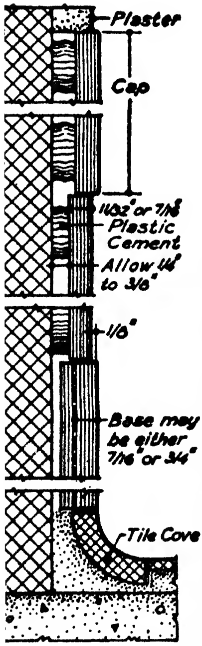
STRUCTURAL GLASS FOR INTERIOR WALL SURFACES



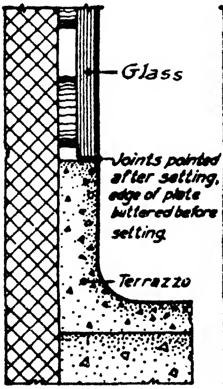


DECORATIVE EFFECTS. Structural glass pieces in different colors can be laminated for special decorative effects. Pilasters and breaks can be created with reveals and offsets, as shown in the sketches. Structural glass can be sandblasted with any design desired, bringing out the pattern either in shallow or deep relief. These designs may be further enriched by the application of gold, silver or color which is sprayed on at the factory. Sandblasted fluting has no depth—it is a surface shading to give the effect of fluting.

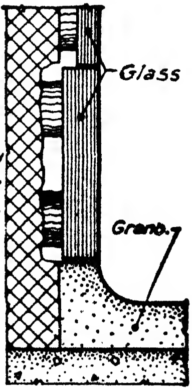
INSTALLATION IN NEW CONSTRUCTION. Masonry of almost any kind provides the necessary rigidity and strength required for background. Structural glass may also be applied over metal lath on frame which has received a heavy coat of cement plaster. Wood background should be avoided. The entire background must be painted with a bond coat. Structural glass is held in place by means of a plastic cement which bonds permanently with the glass and the wall, yet allows for settling, shrinkage and expansion. Mechanics installing structural glass are instructed in the recommended methods of setting by the manufacturer, thereby insuring proper installation.



Base and Tile Cove

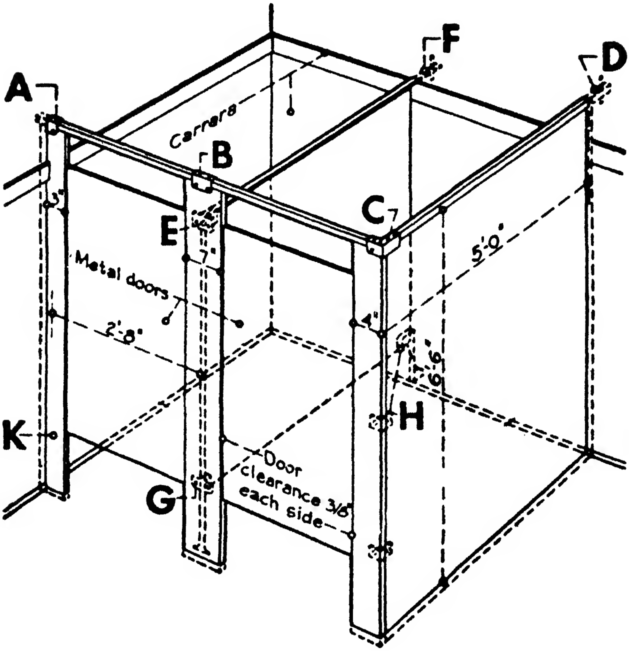


Terrazzo Base and Cove



Flush Base, Grano. Cove

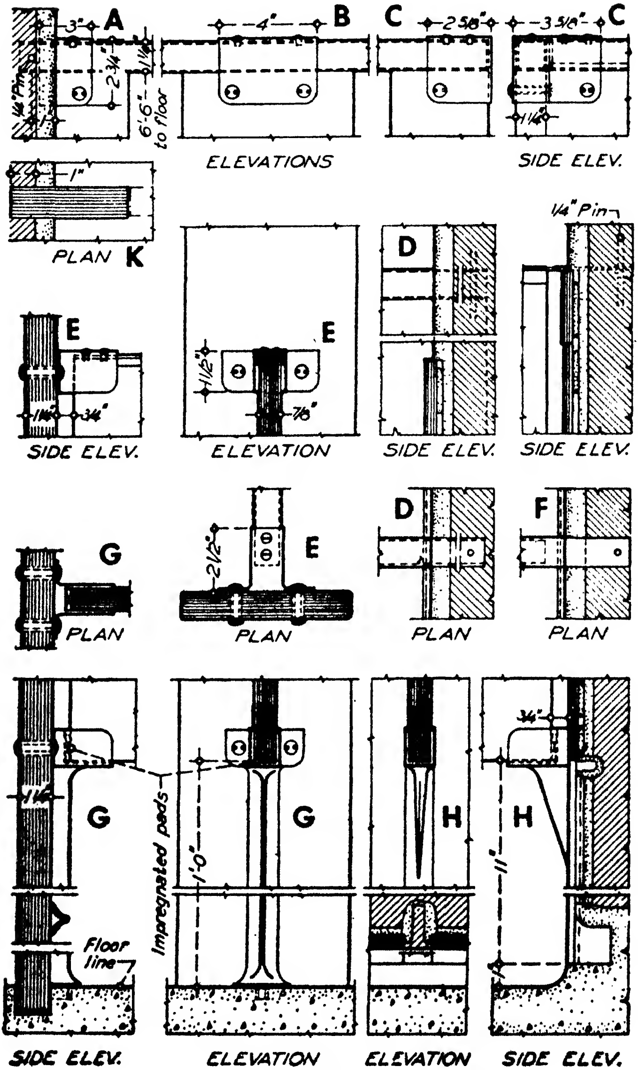
STRUCTURAL GLASS TOILET INCLOSURES (GOV'T TYPE)



STRUCTURAL GLASS TOILET INCLOSURES. Laminated toilet partitions consist of 2 pieces of 7/16" polished one side glass laminated back to back, with an adhesive in the center. Laminated partitions could be made to other thicknesses but are not because toilet partitions are almost exclusively specified 7/8" thick. No laminated glass should be used for inclosure fronts on which doors are attached and no laminated glass should be used where the edges will be exposed to view. (Horizontal edges 6'-6" or more above the floor line are not considered as exposed.) The manufacturer supplies all hardware necessary for the erection of structural glass, and will drill the slabs for any hardware or fixtures which are not supplied—such as hinges, strikes, etc.—provided they are furnished with the location and dimensions so that the drilling may be done at the factory. It should be remembered that structural glass is an ideal material for shower stalls.

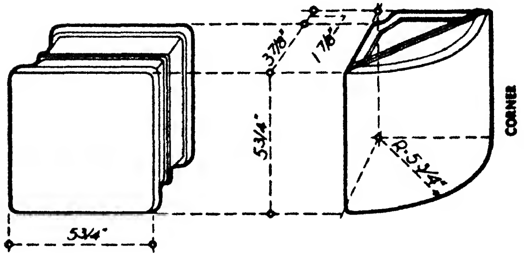
A typical installation is shown in the drawing above. The letters refer to larger scale details on another of these *Data Sheets,* which see. The erection hardware is shown available in plated bronze finish. In addition to the Government type illustrated, conventional types of toilet inclosures are available.

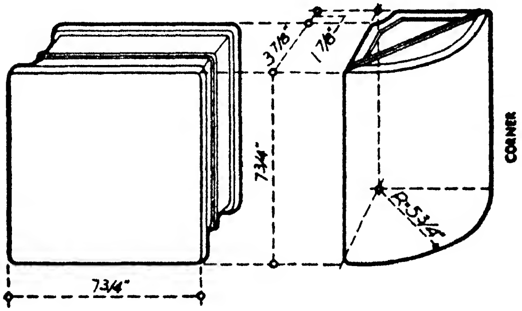
STRUCTURAL GLASS TOILET INCLOSURE DETAILS

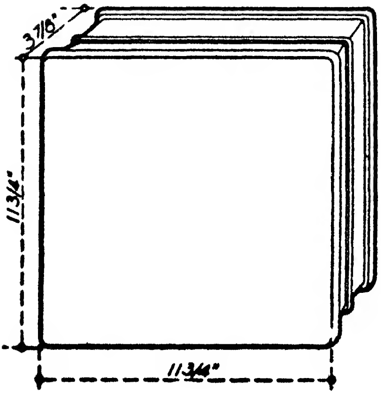


SCALE 1½" = 1'-0"

DIMENSIONS AND SHAPES OF GLASS BLOCK







Not all of the patterns of glass block are available in all of the sizes. Radial and corner blocks can be obtained in some but not all of the 5 3/4" and 7 3/4" patterns, but not in the 11 3/4" sizes. The manufacturer of the block to be used should be consulted on patterns, sizes, and accessory blocks to find the material that is currently available, since changes may occur in the line.

DESCRIPTION AND PROPERTIES OF GLASS BLOCK

PATTERNS. Blocks with ribs parallel or at right angles, or with wavy or checkered interior surfaces permit a wide choice of decorative effects. A type that allows vision thru the block is available, as well as a light-directing type with prisms on the inside faces that is described in the following pages. One ribbed type has a glass wool mat sealed inside to produce complete light diffusion.

CRUSHING STRENGTH. Glass block panels should never be used to carry loads other than their own superimposed weight within the limits of allowable panel sizes. Glass blocks have unusual strength in compression but such factors as non-uniform distribution of load forbids their use as a load-bearing material.

BOND TO MORTAR. Edges are coated with a material providing a strong mechanical bond between the cement mortar and the blocks.

HEAT INSULATION. One of the advantages of glass block construction over single glazed windows is the greater heat insulation efficiency due to the dead air space within the blocks. The following values apply to panels of 8" glass blocks constructed in the standard recommended manner;

STILL AIR—U = 0.38 to 0.40 Btu/hr./degree F/per sq. ft.
MOVING AIR—U = 0.46 to 0.49

SURFACE CONDENSATION. Tests show that moisture will not condense on the warm side of glass block panels in normal use, even under conditions of extreme exposure. In those special industries or cases where inside temperatures and humidities are higher than normal, humidities considerably greater than those possible with single glazed sash can exist before condensation will form.

WIND RESISTANCE. From tests on many glass block panels it has been found that any panel (within the limits of areas recommended) will withstand a safe load of 20 lbs. per sq. ft. with a factor of safety of at least 2.7.

SOUND INSULATION. Glass block panels have a sound reduction factor of 37.6 to 42.0 decibels and will improve the acoustics of rooms where they replace single-glazed sash because of their insulating properties against *transmitted* sound.

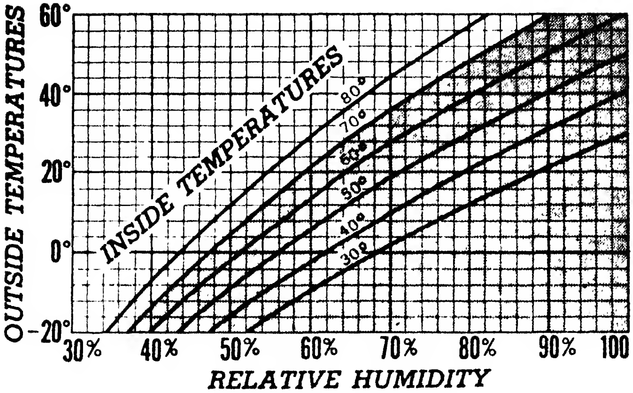
LIGHT TRANSMISSION. Glass blocks are made of clear, colorless glass, admitting light of full daylight tone. With proper selection of pattern, the light and decorative effect can be controlled within a wide range.

SOLAR HEAT GAIN. The use of glass block for light-transmitting areas results in a marked reduction in the total solar heat gain as compared with conventional windows. This factor is of considerable advantage in air-conditioned buildings. However, it does not eliminate the need for adequate ventilation or shading in rooms that are not air-conditioned.

Based upon tests, suggested figures for design computations are a maximum hourly rate of 41 Btu and maximum daily rate of 250 Btu total heat gain per square foot of glass block panel on south exposure at 40° north latitude for August 1st.

More complete data on solar radiation appear in the current *Guide* of the American Society of Heating and Ventilating.

DESCRIPTION AND PROPERTIES OF GLASS BLOCK



INTERIOR SURFACE CONDENSATION. For the average installation the accompanying chart gives outside temperatures required to produce surface condensation on the inside surface of a glass block panel. Panels with deep jambs or panels with draperies or blinds which impede the free flow of air over the surface will not require as low outside temperatures as shown to produce condensation.

WIND RESISTANCE. Any panel with the area limits recommended by the manufacturers will withstand a safe load of 20 pounds per square foot with a factor of safety of at least 2.7. Tests at Purdue University on a panel 7′-3″ wide by 8′-8″ high showed that the panel is entirely elastic under repeated loadings with a pressure of 40 pounds per square foot, corresponding to a wind velocity of about 100 mph.

BUILDING CODES. Most building authorities' requirements for strength, wind resistance, fire and hose stream resistance, and other properties are fully met if the manufacturer's recommendations are followed. However, West Coast and City of New York approvals demand smaller panel sizes and additional reinforcement.

SOUND REDUCTION. Glass block panels are considerably more effective than most types of fenestration in reducing transmitted sounds, comparing with a 4″ clay tile partition plastered both sides.

INSTALLATION OF GLASS BLOCK

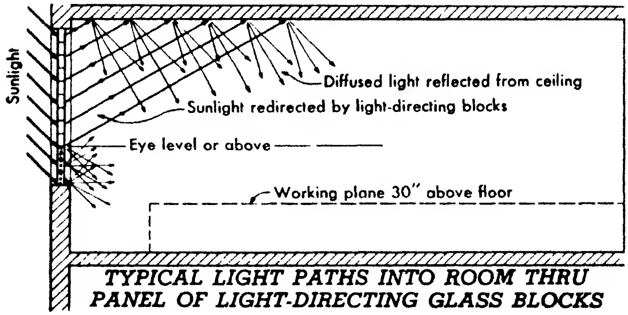
EXTERIOR INSTALLATION. Glass blocks have unusual strength in compression but such factors as non-uniform distribution of load forbid their use as a load bearing building material. The basic principles of installation are to provide (1) complete freedom of movement of the panel within the enframing construction, and (2) proper anchorage of the panel at head, sill and jambs.

Basically the installation procedure is as follows:

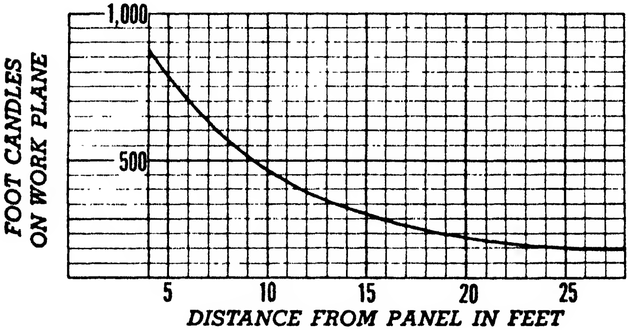
1. The sill is coated with asphalt emulsion as a bond breaker.
2. Resilient expansion strips are placed around the perimeter of the panel opening except at the sills.
3. Blocks are laid with full mortar beds, using a mix of 1 part Portland cement, 1 part lime and 4 parts of sand, or a prepared masonry mortar of low volume change.
4. Joint reinforcement is placed at intervals on the horizontal joints.
5. If glass block panels are not set in chases, wall anchors are built from the enframing construction into the horizontal mortar joints of the glass block panels, crimped to permit movement in the plane of the wall, but supporting the panel against wind pressure.
6. Mortar joints are tooled.
7. Oakum is packed at jamb and/or head if recessed. The perimeter of the panel is calked on the interior and exterior.

LIGHT TRANSMISSION. Percentage figures for light transmission of glass block panels do not convey any true picture of performance. For example, light-directing units produce the least illumination on overcast days and the highest percentage of any block pattern on sunny days in direct sunlight. Measurements by different laboratories would probably give completely different percentage figures for the *same blocks,* because there is no recognized standard test procedure. With these qualifications in mind it may be stated that total transmission percentage of an individual block is 65%, by the sphere method using diffused artificial light.

LIGHT-DIRECTING GLASS BLOCK



TYPICAL LIGHT PATHS INTO ROOM THRU PANEL OF LIGHT-DIRECTING GLASS BLOCKS



Laboratory tests show unshaded single glazed steel sash to transmit 4900 fc at 4'-0" on the working plane. Intensity falls sharply to 900 foot candles at 8'-0". Intensity falls again to 500 foot candles at 13'-0". Intensity at 28'-0" is about 240 foot candles. All tests were made on a sunny day with an outdoor intensity 7200 fc.

DESCRIPTION. Light-directing glass blocks depend upon optical refraction of light which is produced by horizontal prisms pressed into the interior faces. This refraction redirects the incident light upward where the ceiling reflection (especially if painted in a light color) helps to cast the illumination farther into the remote areas of the room. A uniform curve of illumination is obtained and at the same time no excessive brightness-contrast is created if the blocks are installed above eye-level.

LIGHT-DIRECTING GLASS BLOCK

SIZES AND SHAPES. The light-directing blocks are made with 7 3/4″ square faces by 3 7/8″ thickness to lay up with 1/4″ joints 8″ o/c.

Regular blocks can be laid with wedge-shaped joints to a minimum radius of 5′-9″ for curved walls, giving a 5/8″ vertical mortar joint on the outside of the curve.

Radial block of a similar appearance, but not an exact match, are available for use with light-directing block, which permit laying to a radius of 3′-3″ with a 1/4″ vertical joint on the outside of the curve.

Corner blocks of a similar appearance, but not an exact match, are available for use with light-directing block.

AIR LEAKAGE. Properly installed, no appreciable amount of air leakage should occur in a glass block panel and calculations for infiltration may ordinarily be neglected. Entrance of dust and dirt is eliminated.

In addition to controlling the direction of incident light, light-directing glass blocks (as compared to some other usual types of fenestration) provide certain other characteristics as follows:

a. Limits solar heat gain
b. Has relatively low thermal conductivity
c. Reduces condensation
d. Minimizes or eliminates air leakage
e. Reduces sound transmission
f. Provides privacy
g. Provides an interesting design medium

Since diffused light incident on a north exposed wall is of lower intensity than direct sunlight and is not refracted regularly, the light-directing blocks are not used on the north side of buildings. Neither are they used in interior partition panels, for the same reason.

On east, south, and west sides of the building the light-directing blocks are used above eye level. Below eye level a diffusing block of similar appearance is used.

LIGHT-DIRECTING GLASS BLOCK

HEAT GAIN THROUGH GLASS BLOCKS FOR AUGUST 1st *Btu per Sq. Ft. per Hour* (Solar Radiation Plus Normal Transmission — Inside Temperature 78° F)							
Sun Time	Outside Air Temp F°	East	West	South			
		North Latitude Degrees					
		30° to 45°		30°	35°	40°	45°
7:00	74	61.0	—	-4.5	-2.0	-0.5	1.0
8:00	76	77.5	—	0.0	2.0	4.0	5.0
9:00	79	73.5	5.0	5.0	7.0	10.0	12.0
10:00	83	57.5	6.5	11.0	15.0	18.0	20.8
11:00	87	45.0	7.5	16.5	22.0	25.5	32.0
12:00	90	36.5	10.5	21.5	28.0	33.8	40.8
1:00	93	30.0	22.0	25.0	31.8	38.5	46.0
2:00	94	24.0	35.0	26.0	32.0	39.0	47.0
3:00	95	19.5	55.0	24.0	29.8	36.5	45.0
4:00	95	15.5	77.0	20.0	25.5	31.5	40.5
5:00	93	12.5	85.5	15.0	20.0	25.2	33.5
6:00	91	10.5	55.0	9.5	13.5	18.0	25.5
7:00	89	8.0	18.5	3.5	7.0	11.0	18.0

SOLAR HEAT GAIN. The approximate percentage transmission of solar heat according to an ASHVE test conducted on August 25th is 27.1% for south exposure. This compares with single glazing in steel sash for south exposure of 56.5%. The prismatic glass block, therefore, admits about 1/2 the solar heat of single glazing.

Three methods may be used to further control solar heat input: shading, ventilation, air conditioning. Curved panels should be used with caution since the center of curvature may create a point of solar heat focus.

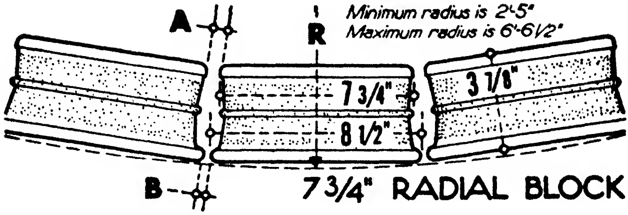
For use in calculating air conditioning loads the total heat gain, consisting both of the radiant heat and the film conduction, is shown in the table.

THERMAL CONDUCTIVITY. Tests by both Purdue University and Pittsburgh Testing Laboratory on panels of 8" x 8" glass blocks give the overall transmission coefficients U in Btu/sq. ft./hour/°F approximately as follows:

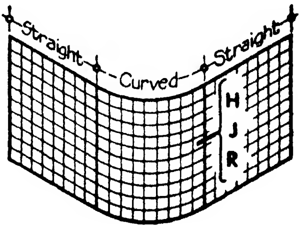
Still air 0.42
15 mph wind 0.49

WEATHERING. Tests in which large panels or glass blocks have been subjected to a 15 mph wind-driven water spray for 8 hours followed by 16 hours of spray without wind, have shown that the construction is capable of withstanding severe conditions of storm exposure without water penetration. Large test panels exposed to repeated cycles of alternate water spray and freezing (at temperatures down to −30° F) have withstood this treatment without evidence of leakage, cracking or other structural deterioration.

CURVED WALLS OF GLASS BLOCK



7¾" RADIAL BLOCK

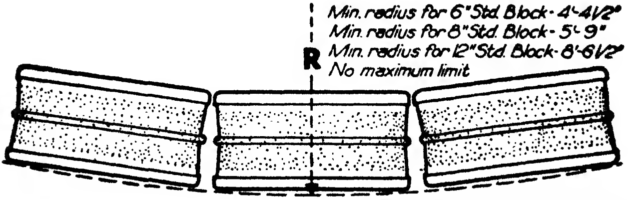


7¼" RADIAL BLOCK

R Radius		A Joint		B Joint
2'- 5"	(Min.)	⅛"	......	⅝"
2'-10"	......	⅛"	......	⅜"
2'-10¼"	......	⅜"	......	⅝"
3'- 3"	......	⅛"	......	¼"
3'- 4¼"	......	½"	......	⅝"
3'- 8"	......	⅛"	......	⅛"
3'-10½"	......	⅝"	......	⅝"
4'- 1½"	......	3/16"	......	⅛"
4'- 3¾"	......	⅝"	......	[illegible]/16"
4'- 7"	......	¼"	......	⅛"
4'- 9¼"	......	⅝"	......	½"
5'- 0½"	......	[illegible]/16"	......	⅛"
5'- 2½"	......	⅝"	......	7/16"
5'- 6"	......	⅜"	......	⅛"
5'- 7¾"	......	⅝"	......	⅜"
5'-11½"	......	⅜"	......	⅛"
6'- 1¼"	......	⅝"	......	[illegible]/16"
6'- 4¾"	......	7/16"	......	⅛"
6'- 6½"	(Max.)	⅝"	......	5/16"

Radii given are for 90° arcs without fractional blocks.

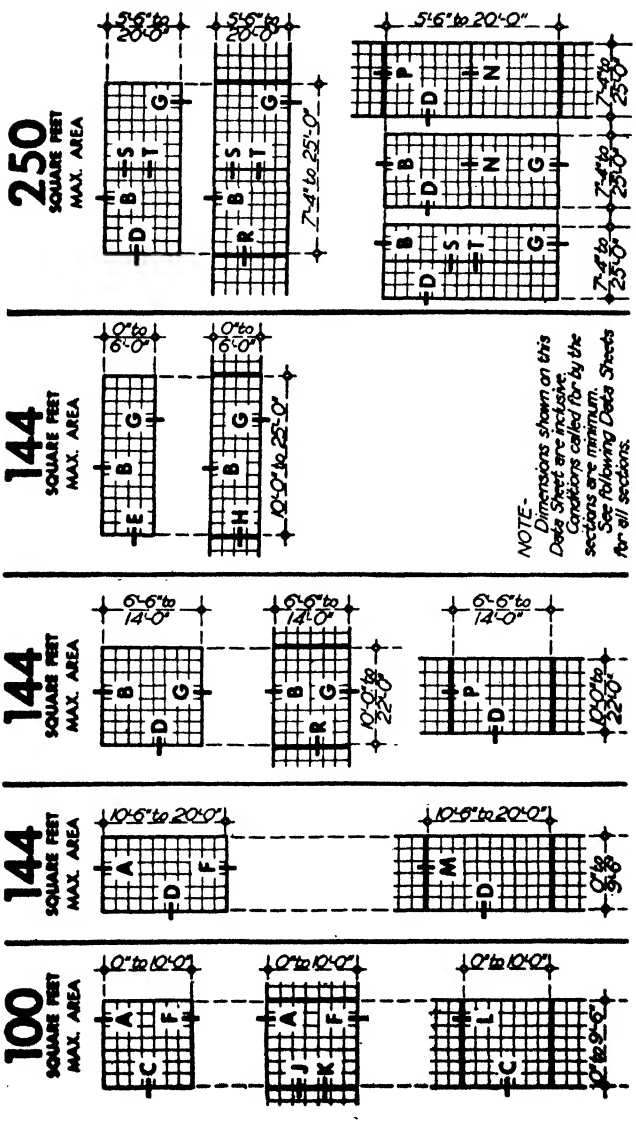
For panel size limitations with minimum anchorage requirements, see detail sheets. Combinations of flat and curved panels forming integral glass block areas can be installed in manner described for the respective limitations shown on detail sheets. However, it is suggested that curved areas be separated from flat areas by means of intermediate expansion joints and supports as indicated on the small diagram above. For intermediate expansion joints and supports, see detail sheets.



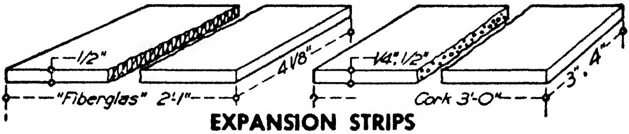
STANDARD BLOCKS

For curved walls, either standard blocks or 7¾" radial block may be used. The diagrams show the limits resulting from a minimum vertical joint thickness of ⅛" and a maximum joint thickness of ⅝". The radial block is a companion to the 7¾" standard block.

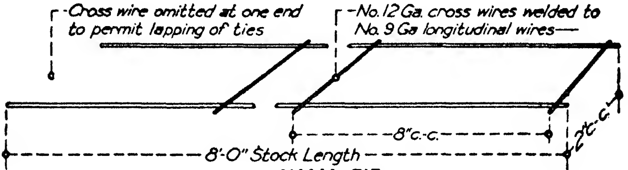
KEY TO REQUIREMENTS FOR EXTERIOR PANELS



ANCHORS, TIES, CUSHIONS

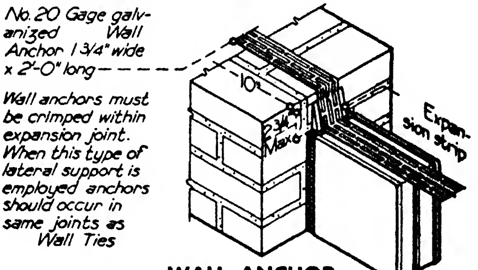


EXPANSION STRIPS

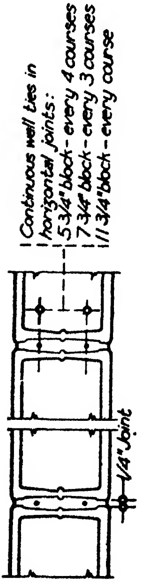


WALL TIE

Wall Ties are made of galvanized wire. For continuous use lap ends of wall ties 6" min. Wall ties must not bridge expansion joints and shall run from end to end of panels.



WALL ANCHOR



WALL TIE DATA

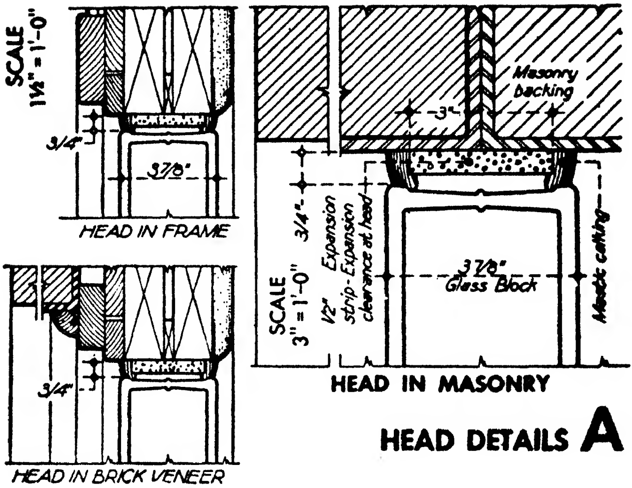
ACCESSORIES. Expansion strips, wall ties, and wall anchores have been especially developed for the erection of glass block panels.

EXPANSION STRIPS. *Glass Blocks* are non-load bearing. Adequate provision must be made for support of construction above glass block panels. Expansion is provided for by the use of expansion strips at the jambs and head. These expansion strips are premolded in sizes shown above.

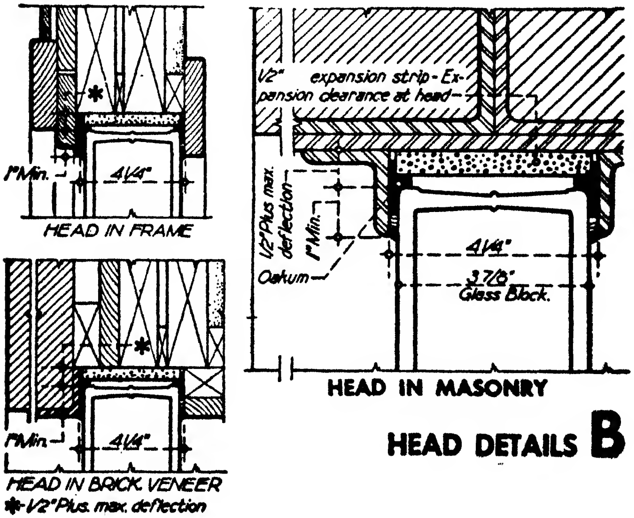
WALL TIES. The lower half of mortar bed is first placed without furrowing. Then the wall tie is placed and covered with the upper half of the mortar bed without furrowing.

WALL ANCHORS. In new structures wall anchors should be built into the wall 10". In existing construction wall anchors may be attached with 4" expansion bolts.

EXTERIOR PANELS
HEADS A, B.

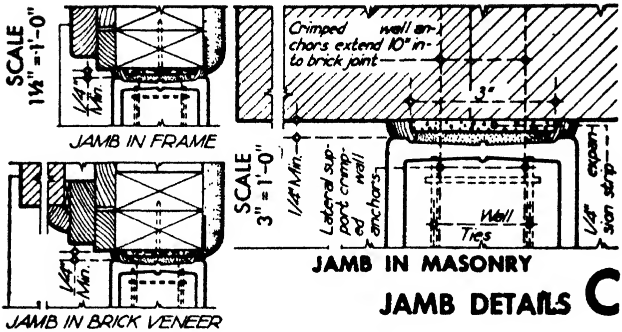


HEAD DETAILS A

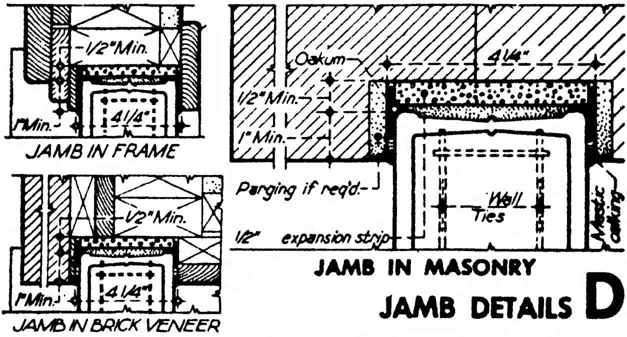


HEAD DETAILS B

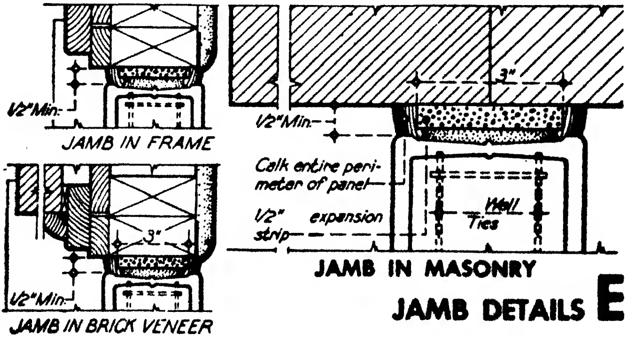
EXTERIOR PANELS
JAMBS C, D, E.



JAMB DETAILS C

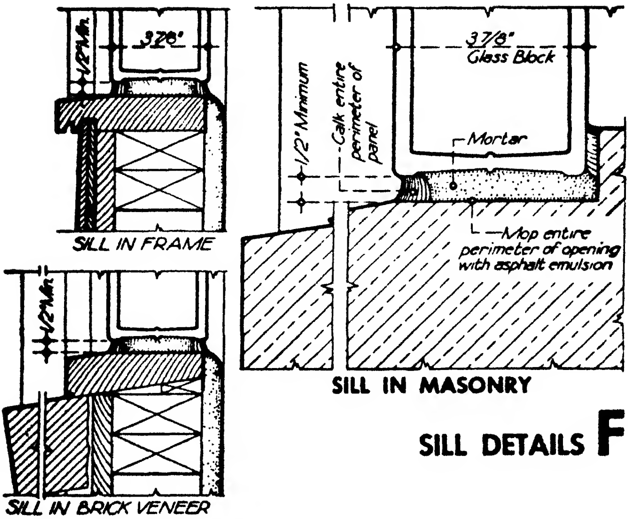


JAMB DETAILS D

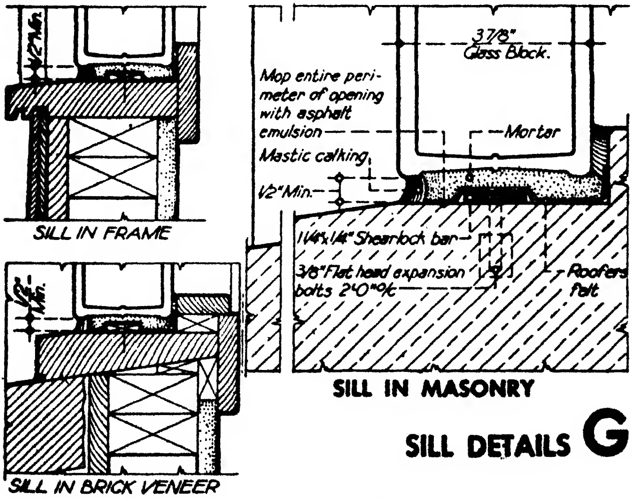


JAMB DETAILS E

EXTERIOR PANELS
SILLS F, G.



SILL DETAILS F

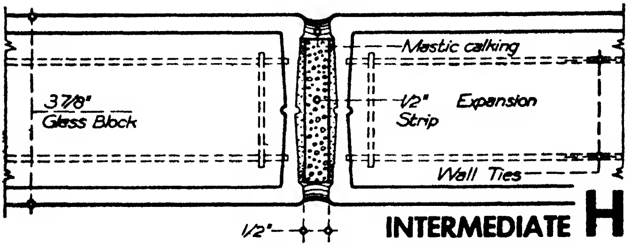


SILL DETAILS G

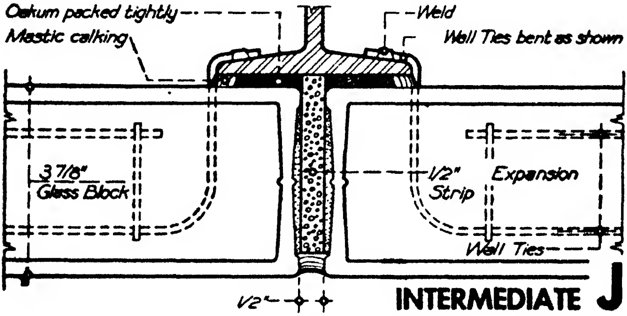
SCALE 1½" = 1'-0"

SCALE 3" = 1'-0"

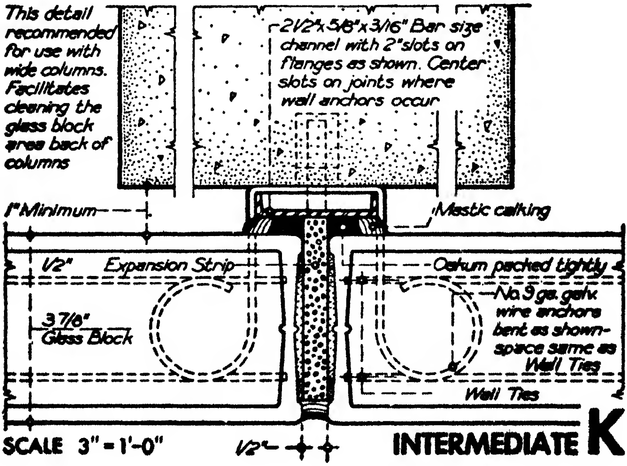
EXTERIOR PANELS
INTERMEDIATES H. J, K.



INTERMEDIATE H

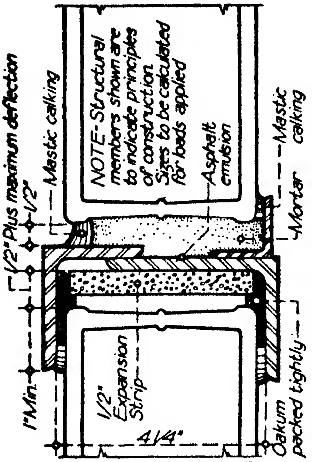


INTERMEDIATE J

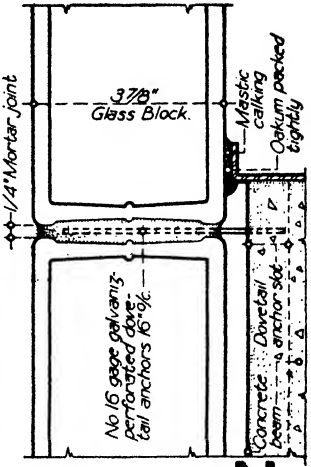


SCALE 3" = 1'-0" **INTERMEDIATE K**

EXTERIOR PANELS
INTERMEDIATES L, N, M, P.

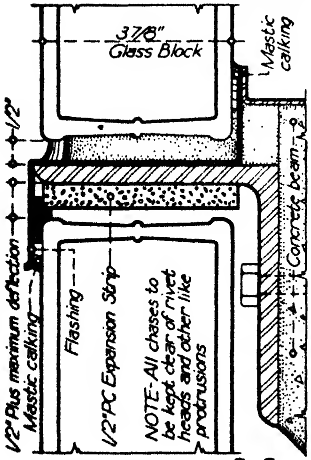


INTERMEDIATE L

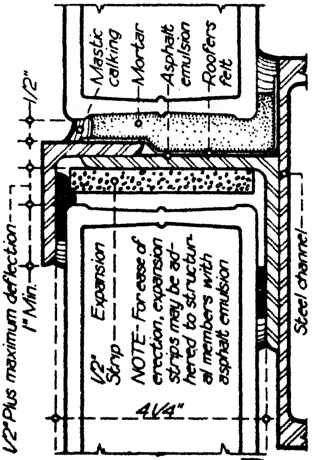


INTERMEDIATE N

SCALE 3" = 1'-0"

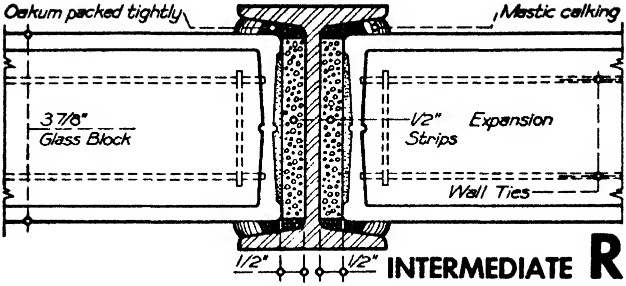


INTERMEDIATE M

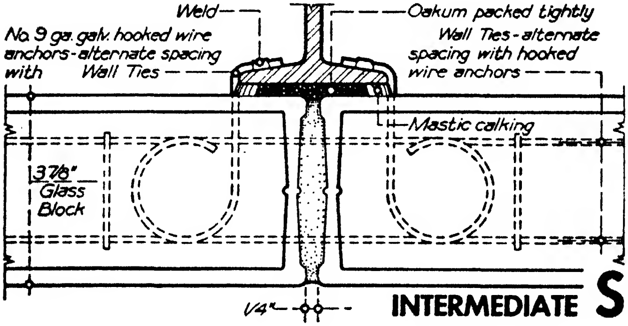


INTERMEDIATE P

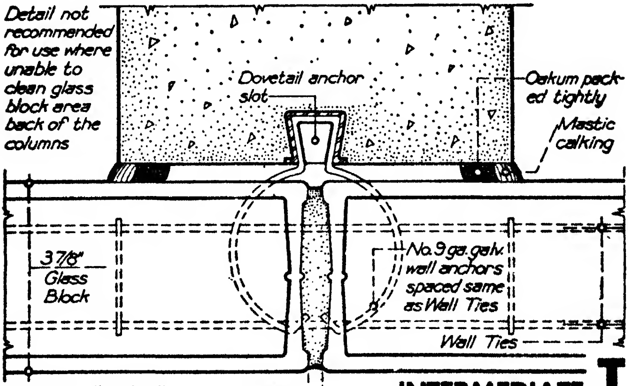
EXTERIOR PANELS
INTERMEDIATES R, S, T.



INTERMEDIATE **R**



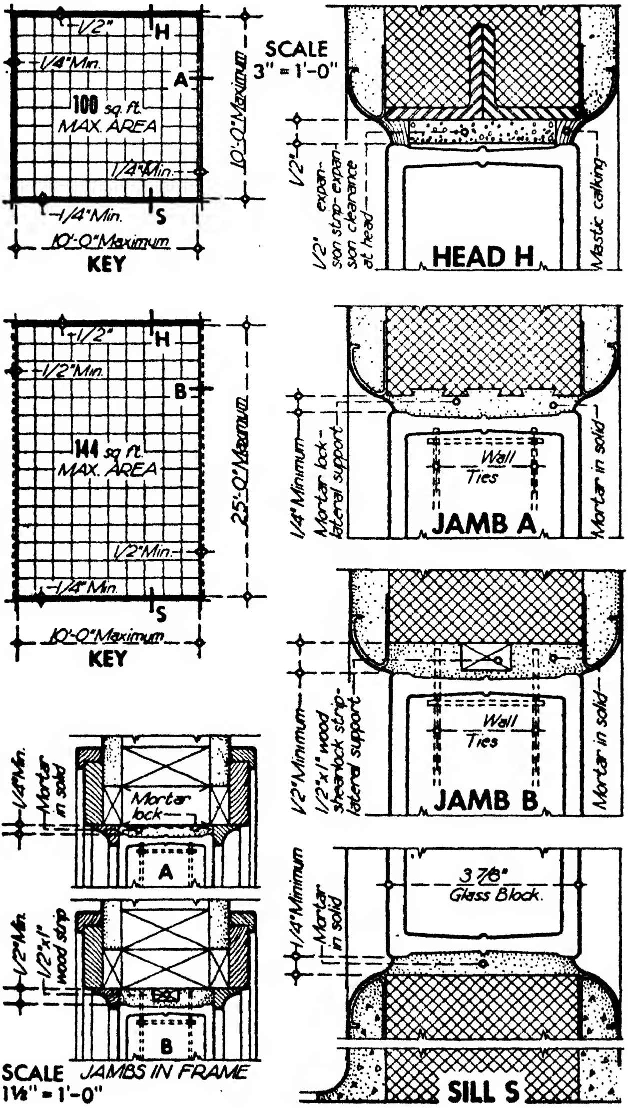
INTERMEDIATE **S**



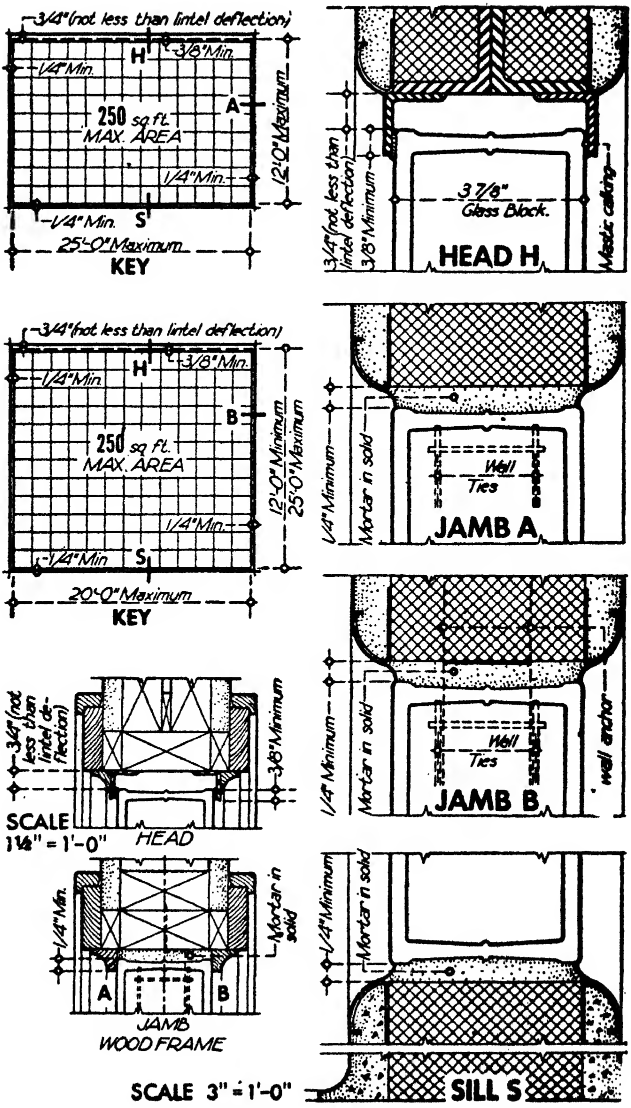
SCALE 3" = 1'-0"

INTERMEDIATE **T**

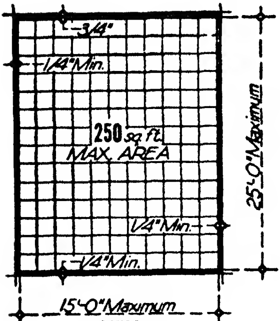
INTERIOR PANELS
100 AND 144 SQ.FT. MAX.



INTERIOR PANELS
250 SQ. FT. MAX.



INTERIOR PANELS
250 SQ. FT. MAX.



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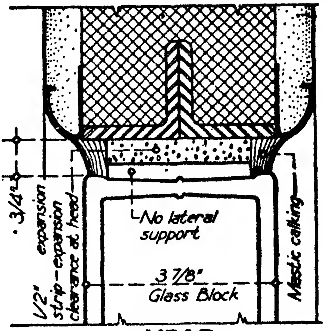
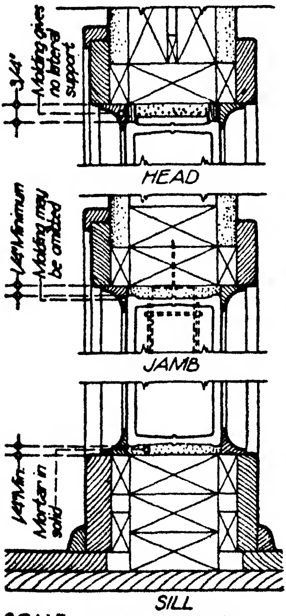
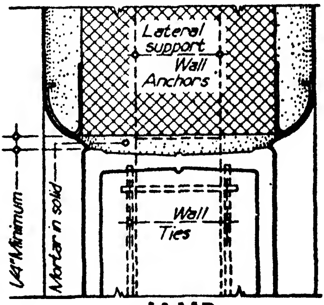


HEAD

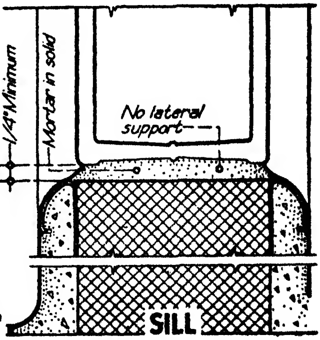


SCALE
1½" = 1'-0"

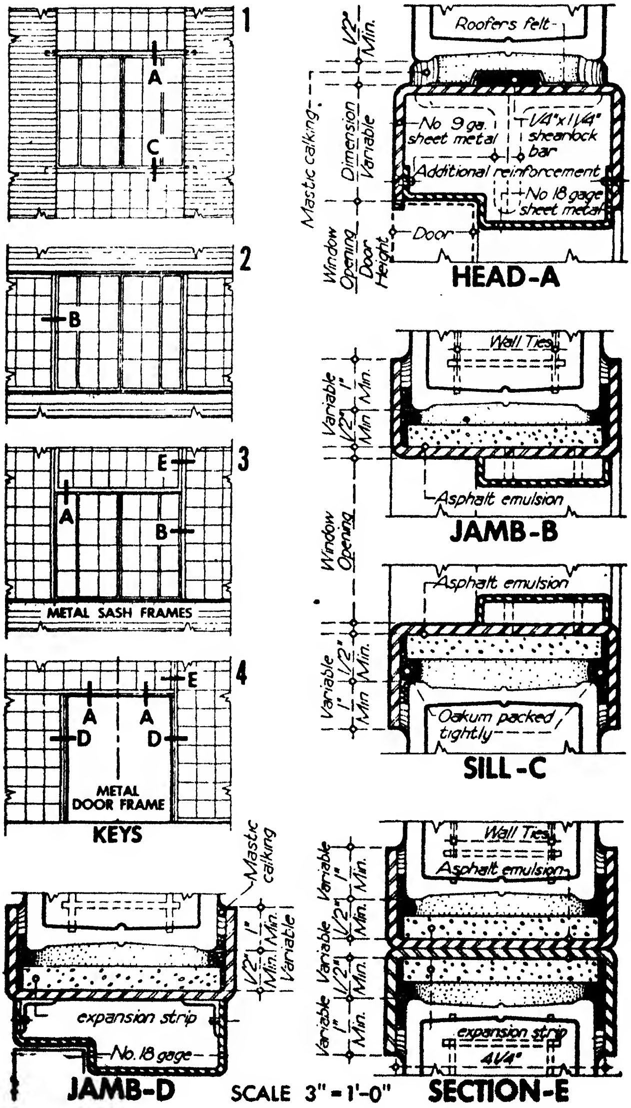


JAMB

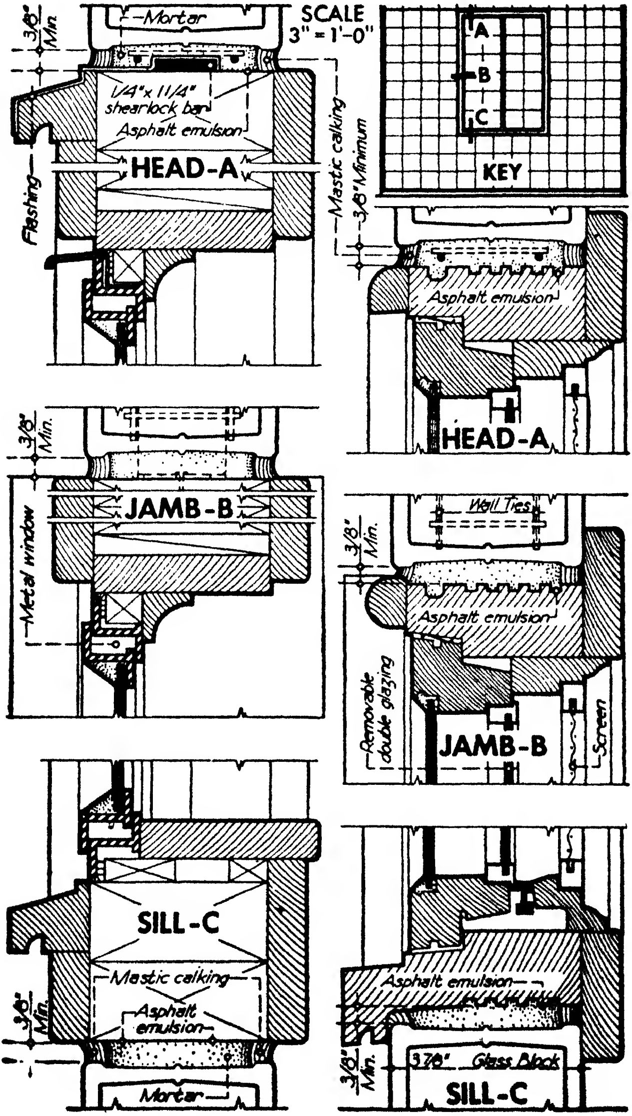
SCALE
3" = 1'-0"



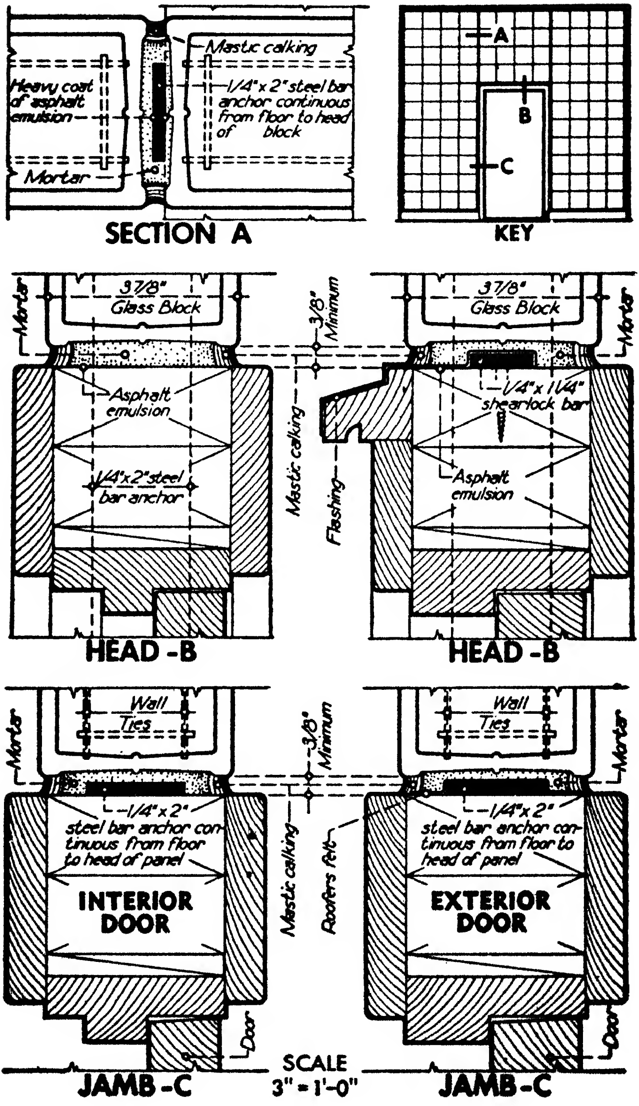
METAL FRAMES ADJACENT TO GLASS BLOCK PANELS



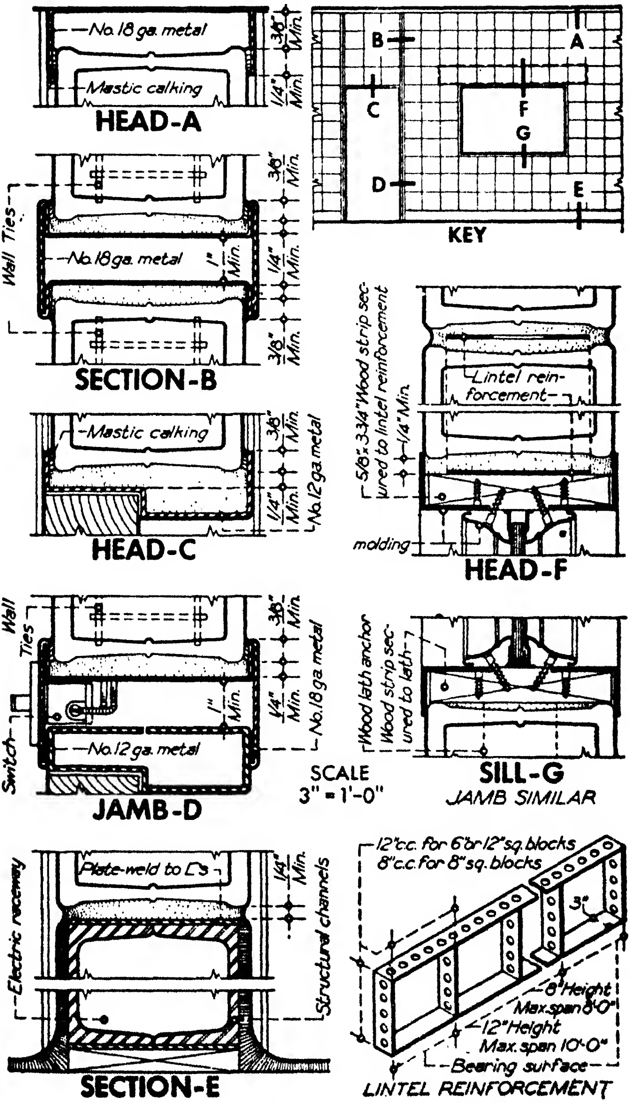
WOOD FRAMES IN GLASS BLOCK PANELS



WOOD FRAMES IN GLASS BLOCK PANELS



STEEL FRAMES IN INTERIOR PANELS



ROLLED FIGURED SHEET AND WIRE GLASS

There are 6 factors involved in the selection of the proper glass for a specific purpose. These factors are:

1. Obscurity
2. Glare reduction
3. Light transmission
4. Solar heat reduction
5. Fire and breakage protection
6. Appearance.

OBSCURE GLASS. For windows, partitions, and doors which must transmit daylight illumination, but where obscurity is required, the rolled figured sheet glasses offer a wide variety of patterns. The size of the pane and possible vibration will govern the thickness of glass to be used. If protection against fire and breakage is also desirable, a figured wire glass can be selected. If solar heat radiation is to be minimized, *Coolite* glass in *Hammered* and *Ribbed* is available, either wire or plain. Where reduction of glare is a problem, *Coolite* glass with G.R. (glare reducing) surface is recommended.

SAWTOOTH SKYLIGHTS. Ordinarily the skylights face north. As it is impossible to improve the thoroly diffused light from the north, a durable glass with relatively smooth surfaces, which will be easy to keep clean, such as *Hylite* or *Hammered* glass is recommended.

MONITOR SKYLIGHTS. These skylights are usually designed to run east and west so that one side receives light from the south and the other side receives north light. *Hylite* is excellent for the north side of a monitor skylight. If it is necessary to increase the distribution of the light, *Pentecor* glass has been especially designed to build up the light intensity on each side of a light source. At a point 50 feet from the light source the illumination with *Pentecor* is increased over 100% as compared with rough glass. On the south side of any skylight, glare and solar heat transmission may be critical factors. *Glare Reducing Coolite* glass has been developed for this use.

REGULAR SKYLIGHTS. These skylights may receive light from all directions. The selection of glass will depend upon the size of the skylight, the type of light it receives, and whether it is desirable to spread it over a wide area by using *Pentecor Wire Glass.* To reduce solar heat transmission by using *Coolite Wire Glass,* or to reduce heat and glare by using *G.R. Coolite Wire Glass.*

SIDEWALL SASH. Many buildings are relatively narrow units, not requiring overhead or skylight illumination. In buildings of this type it is desirable to cut down the illumination within a few feet of the window and build it up at points farther away, at the same time diffusing the light uniformly to reduce shadows and contrasts. *Factrolite* is especially designed for such windows having east, west and south exposures where the reduction of solar heat transmission and maximum glare reduction are not essential. Solar heat and glare problems would indicate the use of *Coolite* or *Glare Reducing Coolite.*

FIRE AND BREAKAGE PROTECTION. The object of wire glass is to afford constant fire protection at minimum cost. Windows, doors, transoms, skylights, and all places where fire or breakage is to be considered, will require wire glass. Wire glass may be fractured by severe heat or sudden shock. The wire mesh holds the shattered pieces in place, preventing serious injury or loss of life. It prevents draft and holds fire within the bounds of its origin. The regular *Mississippi* wire glass has borne the Underwriters' approval since 1906. For locations requiring the very finest appearance, *Misco* wire glass will be found suitable.

ROLLED FIGURED SHEET AND WIRE GLASS

ROLLED FIGURED SHEET. A flat glass in which the vision is more or less obscured by the impression of a design on one surface of the sheet in the rolling operation.

Pattern	*1/8"*	*7/32"*	*3/8" or 1/2"*
Aurora	48 x 132	60 x 136	....
Bandlite	48 x 132	54 x 136	....
Bandlite Softone	....	54 x 136	....
Bevelite	48 x 132	54 x 136	....
Bevelite Softone	....	54 x 136	....
Coolite Hammered	34 x 132	34 x 144	....
Dewlite	48 x 132	60 x 136	....
Factrolite	48 x 132	60 x 136	....
Florentine	48 x 132	....	....
Hammered	48 x 132	60 x 136	....
Hylite	48 x 132	60 x 136	....
Improved Structural Corrugated Flint	....	....	50 x 144
Luxlite	48 x 132	60 x 136	....
Magnalite "A," "B"	....	60 x 144	....
Pentecor	48 x 100	60 x 136	....
Pluralite	48 x 132	60 x 136	....
Polished Aurora	....	60 x 135	....
Polished Dewlite	....	60 x 135	....
Polished Syenite	....	60 x 135	....
Ribbed	48 x 132	60 x 136	60 x 132
Smooth Rough	48 x 132	60 x 136	....
Structuralite	....	....	50 x 144
Syenite	48 x 132	60 x 136	....

WIRE GLASS. Rolled flat glass having a layer of meshed wire incorporated in the sheet, with polished or figured surfaces.

Pattern	*1/4"*	*3/8"*	*1/2"*	*5/8" or 3/4"*
Coolite Hammered	34 x 144	....	....	....
Corrugated Flint	....	55 x 132	....	....
Factrolite	60 x 144	....	....	....
Hammered	60 x 144	....	....	....
Hylite	60 x 144	....	....	....
Magnalite "A," "B"	60 x 144	....	....	....
Misco Hammered	56 x 144	....	....	....
Misco Polished	58 x 132	....	....	....
Misco Polished Coolite	58 x 132	....	....	....
Pentecor	60 x 144	....	....	....
Polished	60 x 132	60 x 132	44 x 120	42 x 108
Ribbed	60 x 144	60 x 132	60 x 132	44 x 132
Smooth Rough	60 x 144	60 x 132	....	....
Syenite	60 x 144	....	....	....

OTHER TYPES OF GLASS. A wide range of cathedral glasses, corrugated wire glass, ultra-violet glass, ornamental plate and other types are also manufactured.

APPROXIMATE WEIGHT IN LBS. PER SQ. FT.

Type of Glass	*Thickness*						
	1/8	7/32	1/4	3/8	1/2	5/8	3/4
Figured Plain Glass	2	2 3/4	3 1/4	5	6 1/2	8 1/2	10
Figured Wire Glass	....	....	3 1/2	5	6 1/2	8 1/2	10
Polished Wire Glass	....	....	3 1/4	....	6 1/2	8 1/2	10

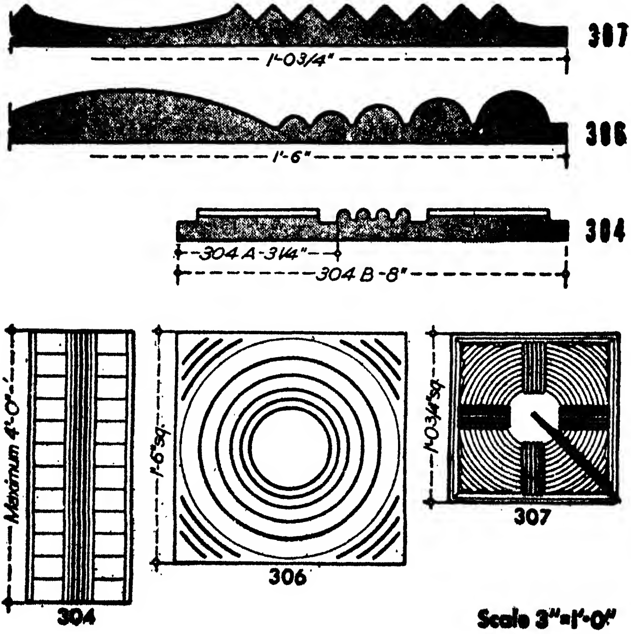
STOCK SHAPES
ARCHITECTURAL GLASS

STOCK AND SPECIAL SHAPES. A wide variety of *Architectural Glass* is carried in stock at all times and can be obtained promptly. These shapes numbered in the 300 series are shown on this and the following *Data Sheets*. Special shapes can be readily made up to suit the designer's requirements.

TYPES OF GLASS. Two types of glass are available: (1) *crystal,* a brilliant water white glass, and (2) *sea water,* a delicate transparent green glass (special shapes only).

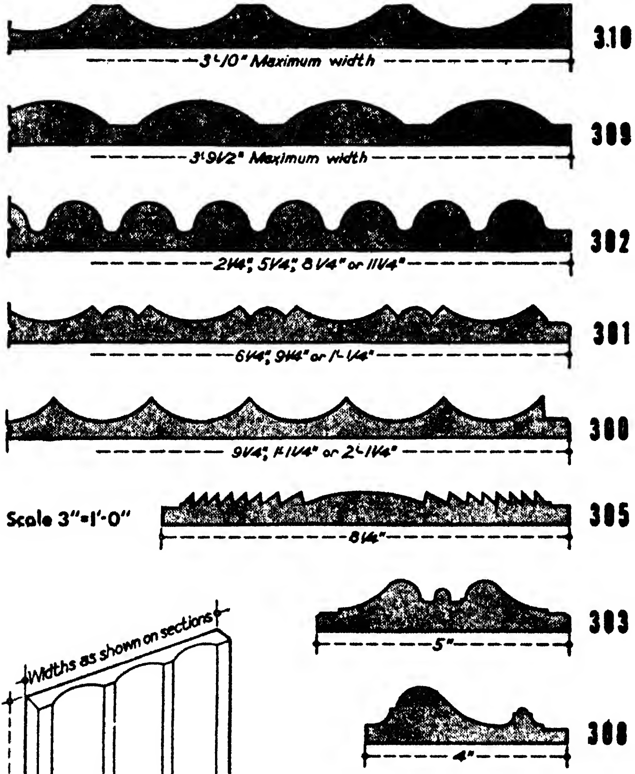
SURFACE FINISHES. The molded face of the architectural glass shapes has a clear or fire polished surface which can be, at times, quite wavy. The flat back surface may be finished in a variety of ways: (1) *Matted*: frosted; a surface usually obtained by sand-blasting. (2) *Polished*: a true plane, produced by mechanically grinding and then polishing to a high luster. (3) *Mirrored*: highest quality mirror silvering with an electrolytically-deposited film of copper over the back of the silvering for protection. On special shapes a wide variety of finishes are available on both the molded and back surfaces.

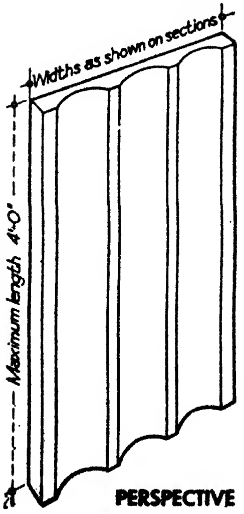
SPECIALLY CAST SCULPTURED GLASS. *Architectural Glass* can also be produced in specially cast, sculptured panels by a new process which has substantially lowered the cost of this exquisite treatment, making it available for far wider use by architects and designers than ever before.



Scale 3" = 1'-0"

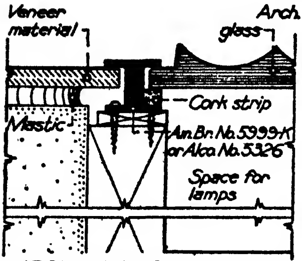
STOCK SHAPES
ARCHITECTURAL GLASS



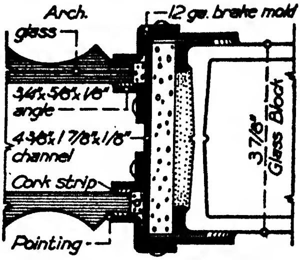


The standard shapes shown on these *Data Sheets* can be used to create interesting design effects for such purposes as illuminated bulkheads, friezes, spandrels, door and fireplace trim, band courses, decorative inserts, pilasters, interior screen and partitions. The sides and ends of the panels may be specified as *ground* or *polished*, depending upon the method of erection, whether or not the edges are to be exposed, and whether or not the joint is to be minimized.

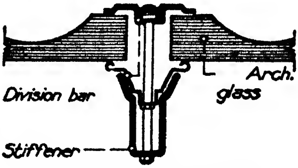
ARCHITECTURAL GLASS INSTALLATION DETAILS



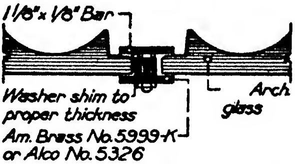
ARCHITECTURAL GLASS ADJOINING VENEER MATERIAL



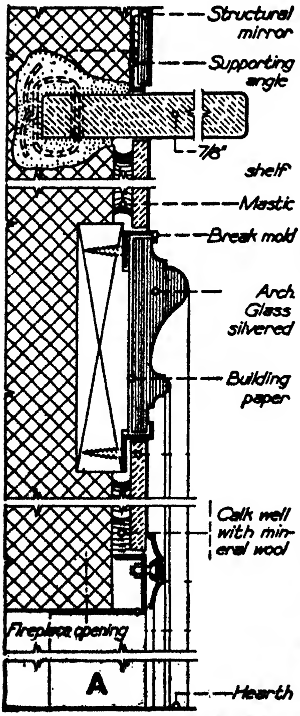
DOUBLE ARCHITECTURAL GLASS INSTALLATION

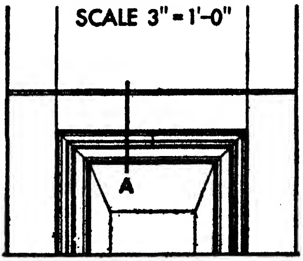


VERTICAL SEPARATION WITH STIFFENER



SEPARATION FOR HORIZONTAL AND VERTICAL JOINTS





FIREPLACE SURROUND OF ARCHITECTURAL GLASS

WEIGHTS OF MATERIALS

Substance	Weight, Pounds per Cubic Foot
Ashlar Masonry	
Granite, syenite, gneiss	165
Limestone, marble	160
Sandstone, bluestone	140
Mortar Rubble Masonry	
Granite, syenite, gneiss	155
Limestone, marble	150
Sandstone, bluestone	130
Dry Rubble Masonry	
Granite, syenite, gneiss	130
Limestone, marble	125
Sandstone, bluestone	110
Brick Masonry	
Pressed brick	140
Common Brick	120
Soft Brick	100
Concrete Masonry	
Cement, stone, sand	144
Cement, slag, etc	130
Cement, cinder, etc	100
Various Building Materials	
Ashes, cinders	40-45
Cement, P'rtl'd, loose	90
Cement, Portland, set	183
Lime, gypsum, loose	53-64
Mortar, set	103
Slags, bank slag	67-72
Slags, bank screenings	98-117
Slags, machine slag	96
Slags, slag sand	49-55
Earth, Etc., Excavated	
Clay, dry	63
Clay, damp, plastic	110
Clay and gravel, dry	100
Earth, dry, loose	76
Earth, dry, packed	95
Earth, moist, loose	78
Earth, moist, packed	96
Earth, mud, flowing	108
Earth, mud, packed	115
Riprap, limestone	80-115
Riprap, sandstone	90
Riprap, shale	105
Sand, gravel, dry, loose	90-105
Sand, gravel, dry, p'k'd	100-120
Sand, gravel, dry, wet	118-120
Minerals	
Asbestos	153
Barytes	281
Basalt	184
Bauxite	159
Borax	109
Chalk	137
Clay, marl	137
Dolomite	181
Feldspar, orthoclase	159
Gneiss, serpentine	159
Granite, syenite	175
Greenstone, trap	187
Gypsum, alabaster	159
Hornblende	187
Limestone, marble	165
Magnesite	187
Phosphate rock, apatite	200
Porphyry	172

Substance	Weight, Pounds per Cubic Foot
Minerals—Continued	
Pumice, natural	40
Quartz flint	165
Sandstone, bluestone	147
Shale, slate	175
Soapstone, talc	169
Stone, Quarried, Piled	
Basalt, granite, gneiss	96
Limestone, marble, quartz	95
Sandstone	82
Shale	92
Greenstone, hornblende	107
Bituminous Substances	
Asphaltum	81
Coal, anthracite	97
Coal, bituminous	84
Coal, lignite	78
Coal, peat, turf, dry	47
Coal, charcoal, pine	23
Coal, charcoal, oak	33
Coal, coke	75
Graphite	131
Paraffine	56
Petroleum	54
Petroleum refined	50
Petroleum benzine	46
Petroleum gasoline	42
Pitch	69
Tar, bituminous	75
Coal and Coke, Piled	
Coal, anthracite	47-58
Coal, bituminous, lignite	50-54
Coal, peat, turf	20-26
Coal, charcoal	10-14
Coal, coke	23-32
Metals, Alloys, Ores	
Aluminum, cast-hammered	165
Aluminum, bronze	481
Brass, cast-rolled	534
Bronze, 7 9 to 14% Sn	509
Copper, cast-rolled	556
Copper, ore pyrites	262
Gold, cast-hammered	1205
Iron, cast, pig	450
Iron, wrought	485
Iron, steel	490
Iron, speigel-eisen	468
Iron, ferro-silicon	437
Iron, ore, hematite	325
Iron, ore limonite	237
Iron, ore magnetite	315
Iron, slag	172
Lead	710
Lead, ore, galena	465
Manganese	475
Manganese ore, pyrolusite	259
Mercury	849
Nickel	565
Nickel monel metal	556
Platinum, cast-hammered	1330
Silver, cast-hammered	656
Tin, cast-hammered	459
Tin, ore, cassiterite	418
Zinc, cast-rolled	440
Zinc, ore, blende	253

Substance	Weight, Pounds per Cubic Foot
Various Solids	
Cereal, oats, bulk	32
Cereal, barley, bulk	39
Cereal, corn, rye, bulk	48
Cereal, wheat, bulk	48
Hay and Straw, bales	20
Cotton, Flax, Hemp	93
Fats	58
Flour, loose	28
Flour, pressed	47
Glass, common	156
Glass, plate or crown	161
Glass, crystal	184
Leather	59
Paper	58
Potatoes, piled	42
Rubber, caoutchouc	59
Rubber, goods	94
Salt, granulated, piled	48
Saltpeter	67
Starch	96
Sulphur	125
Wool	82
Timber, U. S. Seasoned	
Ash, white-red	40
Cedar, white-red	22
Chestnut	41
Cypress	30
Elm, White	45
Fir, Douglas spruce	32
Fir, eastern	25
Hemlock	29
Hickory	49
Locust	46
Maple, hard	43
Maple, white	33
Oak, chestnut	54
Oak, live	59
Oak, red, black	41
Oak, white	46
Pine, Oregon	32
Pine, red	30
Pine, white	26
Pine, yellow, long-leaf	44
Pine, yellow, short-leaf	38
Poplar	30
Redwood, California	26
Spruce, white, black	27
Walnut, black	38
Walnut, white	26
Moisture Contents: Seasoned timber 15 to 20% Green timber up to 50%	
Various Liquids	
Alcohol, 100%	49
Acids, muriatic, 40%	75
Acids, nitric, 91%	94
Acids, sulphuric, 87%	112
Lye, Soda, 66%	106
Oils, vegetable	58
Oils, mineral, lubricants	57
Water, 4°C, max. density	62.428
Water, 100°C	59.830
Water, ice	56
Water, snow, fresh fallen	8
Water, sea water	64
Gases, Air = 1	
Air, 0°C, 760 mm	.0807

DEAD LOADS OF BUILDING MATERIALS

ROOFS

5-ply felt and gravel	(pounds per sq. ft.)	6
4-ply felt and gravel		5
3-ply ready roofing, composition roofing		1
25/32" softwood sheathing		3
Wooden shingles		2
1/4" slate		10
Flat clay shingle tile		15
Clay Spanish tiles		10
Cement tile		16
2" book tile		12
3" book tile		20
Skylight, G. I. frame, glass		5
Sheet metal		2

Weight of trusses in pounds per square foot of horizontal projection of roof supported, according to Hool, "Elements of Structures" (McGraw-Hill), is equal to $C(1 + L/10)$, in which;
$C = 0.50$ for wood trusses, 0.75 for steel trusses.
L = Span of the truss in feet.

CEILINGS

Lath and 3/4" plaster	(pounds per sq. ft.)	8
Suspended metal lath and plaster		10
Painted sheet metal		3

FLOORS

25/32" hardwood finish flooring	(pounds per sq. ft.)	4
3/8" hardwood finish flooring		2
25/32" softwood underflooring		3
Cement or terrazzo finish per 1" of thickness		12
Floor tile per 1" of thickness		12
3" creosoted wood block flooring		15
Solid concrete slab, per foot of span		6
Dry cinder concrete fill per 1" of thickness		7
Cast iron radiation per sq. ft. of surface		7
Asphalt mastic flooring 1½" thick		18
Softwood joists, per foot of span		⅓
2 x 4 spruce sleepers and dry cinder concrete fill		10

WALLS AND PARTITIONS

Stone or gravel concrete	(pounds per cu. ft.)	144
Cinder concrete well tamped		108
Cinder concrete not tamped		60
Ordinary brickwork		120
Hollow tile masonry		48
Sandstone rubble		132
Sandstone ashlar		144
Limestone rubble		144
Limestone ashlar		156
Granite rubble		156
Granite ashlar		168
3" gypsum block	(pounds per sq. ft.)	10
4" gypsum block		12
5" gypsum block		14
1/2" plaster on masonry		5
3/4" lath and plaster		8
4" hollow plaster partition		22
2 x 4 studs with plates, average height		1⅔
2 x 6 studs with plates, average height		2½

MINIMUM ALLOWABLE LIVE LOADS

Floor Loads

(pounds per sq. ft.)

Dwelling attic floors for light storage only	20
Dwelling floors, solid or ribbed monolithic slab	30
Dwelling floors used for living purposes	40
Hospital rooms and wards	40
Hotel guest rooms	40
Lodging and tenement houses	40
Assembly rooms having fixed seats	50
Office floors should be designed to support either a concentrated load of 2000 lbs. located on any area of 2½ square feet, or a uniform load of	50
Light manufacturing	75
Retail salesrooms, light merchandise	75
Garages, passenger cars only	80
Printing plants	100
Spaces where crowds may collect	100
Fire escapes and exit passageways	100
Aisles, corridors, lobbies	100
Public spaces in hotels and public buildings	100
Assembly halls without fixed seats	100
Banquet rooms	100
Grandstands	100
Theater stages	100
Stairways	100
Gymnasiums	100
Wholesale stores, light merchandise	100
Garages, all types of vehicles	100
Special storage purposes	100
General storage purposes	250
Sidewalks should be designed to support either a concentrated load of 8000 lbs. located at any point, or a uniform load of	250

Roof Loads

(pounds per sq. ft.)

Rise 4" or less per foot, pounds per square foot of horizontal projection	30
Rise 4" to 12" per foot, pounds per square foot of horizontal projection	20
Rise over 12" per foot, allow for wind pressure acting at right angles to roof surface, per square foot of roof surface	20

These live loads are given as minimum in Bureau of Standards booklet called *Minimum Live Loads Allowable for Use in Design of Buildings,* obtainable from Government Printing Office, Washington, D. C., for 10c.

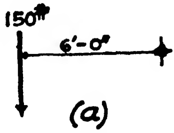
In the absence of local laws or code requirements, the above loads may be used as a basis for the engineering design.

A live load is defined as the weight resulting from furniture, persons, snow, wind, or other movable and varying loads which are not a permanent part of the structure.

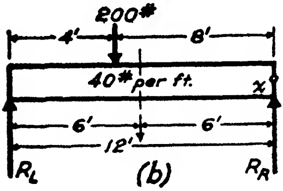
HOW TO FIGURE REACTIONS

Usually the first step in the design of a beam is to find the value of the reactions (the upward forces exerted by the supports), by applying the principle that *the sum of the clockwise moments equals the sum of the counter-clockwise moments, at any point.*

By "moment" is meant the product of a force and its perpendicular distance from the given point. In *Figure a* the moment is $150 \times 6 = 900$ ft. lbs. In this instance it is counter-clockwise as it tends to produce rotation opposite to the hands of a clock.



To find the reactions of a simple beam (beam with two supports, one at each end) loaded as in *Figure b,* take moments at point x. This eliminates the unknown R_R from our computation, as it passes through point x and hence its perpendicular distance is zero. The clockwise moment in the example is $R_L \times 12$. The moment of the concentrated load is 200×8 and is counter-clockwise. The uniform load of 40 lbs. per ft. acts as if its whole weight were exerted at its center of gravity as shown by the dotted arrow, and its moment is $(40 \times 12) \times 6$ and is counter-clockwise. Set the clockwise moments opposite the counter-clockwise moments and solve:—

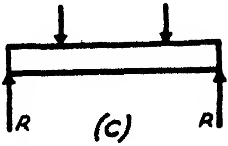


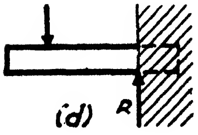
$$R_L \times 12 = 200 \times 8 + (40 \times 12) \times 6$$
$$R_L = (1600 + 2880)/12 = 373 \text{ lbs.}$$

Since in any beam, the sum of the upward forces exerted by the reactions must equal the sum of the downward forces exerted by the loads, we can find the value of R_R as follows:—

$$R_R = 200 + (40 \times 12) - 373 = 307 \text{ lbs.}$$

This procedure is typical for any simple beam, however loaded. It should be evident from *Figure c* that if the loads are symmetrical the reactions will be equal, each having a value equivalent to half the total load, making moment calculations needless.



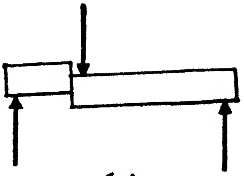


In cantilever beams *Figure d,* the one reaction at the wall is equal to the sum of all the loads, without the necessity of moment calculations. In continuous beams (beams with 3 or more supports), the computations to find the reactions are generally too involved for the architect to attempt.

VERTICAL SHEAR

Relatively short and heavily loaded beams sometimes fail by shearing. Vertical Shear is the measure of the tendency of the two parts of a beam on opposite sides of a given section to slide in opposite directions as in *Fig. a*, and is equal to the reaction on the left of the section minus the loads on the left of the section.

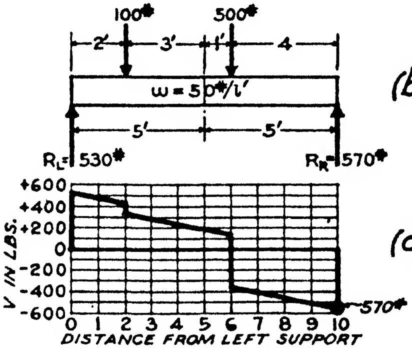
$$V = +R - \Sigma W$$



(a)

Applying this definition to a simple beam loaded as in *Fig. b* we can find the value of the vertical shear at any section. For example, the shear at a section 5′ from the left support will be equal to—

$$V_{5'} = +530 - (50 \times 5) - 100 = +180 \text{ lbs.}$$

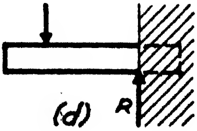


(b)

(c)

It is often necessary in unsymmetrically loaded beams to draw a shear diagram to show how the shear (V) varies. This is not only so that the beam may be designed to resist failure from shear, but because we will later have to determine from it where the maximum bending moment (another cause of failure) occurs. The diagram is constructed by calculating the shear at several sections along the beam and plotting the results as in *Fig. c*. V is positive when the reaction is greater, negative when the loads are greater. The maximum shear in the example occurs an infinitesimal distance to the left of R_R and is equal to 570 lbs.

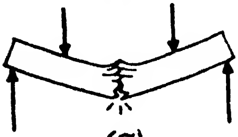
The maximum shear in a cantilever beam, *Fig. d*, is equal to the reaction, which is also equal to the sum of the loads. The maximum shear for continuous beams involves computations too complicated for the average architectural man.



(d)

BENDING MOMENTS

To determine the size that any beam must be to resist failure by "transverse rupture," see *Figure a,* under given loads we must investigate the Bending Moment, which is the measure of the tendency of external loads to cause such failure. The bending moment at any section of a simple beam is equal to the moment of the reaction to the left of the section, minus the moments of the loads to the left of the section. This definition may be expressed:



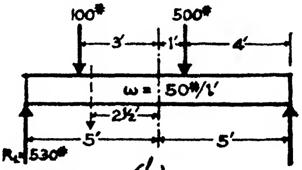
(a)

$$M_X = M_R - \Sigma M_W$$

The word "moment" alone will be used in referring both to bending moment and to moment of a force, the kind of moment meant being evident from the context of the discussion.

Applying the definition to a simple beam loaded as in *Figure b,* we can find the numerical value of the moment at any section. For example the moment at the section 5′ from the left support will be:

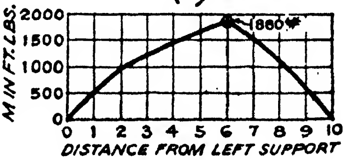
$M_5 = (530 \times 5) - (50 \times 5 \times 2.5) - (100 \times 3) = 2650 - 625 - 300 = 1725$ ft. lbs.



(b)

Since the usual calculations for design are made in inch pounds, we have:

1725 ft. lbs. $\times$ 12 = 20700 in. lbs.



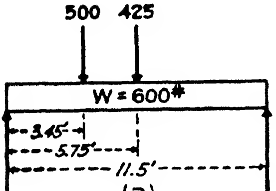
(c)

The Moment Diagram is made by calculating the moment at intervals along the beam and plotting the results as in *Figure c.* The position of the worst moment condition can be determined from the shear diagram without drawing a moment diagram, for *the maximum moment occurs where the shear is zero.* From an examination of the shear diagram we could have determined that the maximum moment would occur 6′ from the left support. One calculation would then have shown its value to be 1880 ft. lbs. The beam must be designed strong enuf to resist this maximum value.

The maximum moment for a cantilever beam occurs at the wall. It is calculated in exactly the same manner as for simple beams. Always view the drawing with the reaction at the right to eliminate it from the calculations so that its value need not be known.

The computation of maximum moments for continuous beams is somewhat complicated. For such beams having approximately equal spans *L,* and uniform loads per foot of beam *w,* the usual building code requirement of a maximum moment of $12wL^2/10$ inch lbs. for end spans, and wL^2 inch lbs. for interior spans, will generally be on the side of safety.

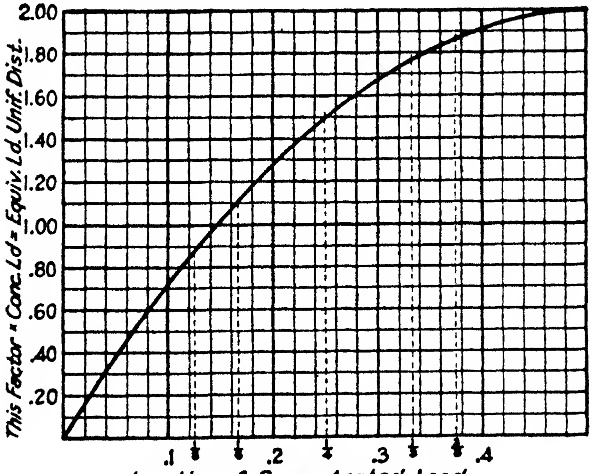
CHANGING CONCENTRATED INTO UNIFORM LOADS*



(a)

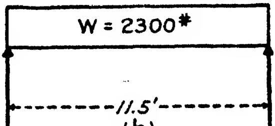
Handbooks which give sizes of beams to resist bending and deflection are based on *uniformly distributed* loads. To use such data for a beam with *concentrated* loads it is necessary to find the uniformly distributed load that produces an equivalent bending effect.

For example, in *Figure a*, the location of the 500 lbs. concentrated load with respect to the nearer support is 3.45/11.5 = .3 of the total span. Consulting the graph below it is found that the factor for a load in this location is about 1.70. This means that a uniformly distributed load of 1.70 × 500 lbs. or 850 lbs. produces approximately the same bending moment in the beam as the 500 lbs. concentrated load produces at the .3 position.



Similarly the equivalent uniformly distributed load for the 425 lbs. concentrated load at the center of the span is found to be 2.00 × 425 lbs. which equals 850 lbs.

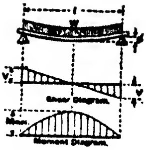
The *total* equivalent uniformly distributed load will be the sum of the separate uniform loads which have been found and are given, or 850 + 850 + 600 = 2300 lbs. (= 200 lbs./1' of span). The beam can be designed as if it were loaded as in *Figure b*. Note, however, that the reactions in the two cases are *not* the same.



(b)

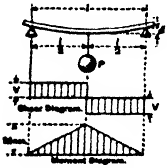
**For simply supported beams.*

STRESSES FOR USUAL LOADING CONDITIONS



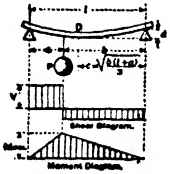
UNIFORMLY LOADED SIMPLE BEAM.

Maximum Shear at ends $= W/2$ lbs.
Maximum Moment at center $= Wl/8$ in. lbs.
Maximum Deflection $= 5Wl^3/384EI$ inches.



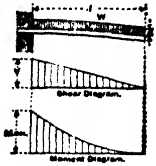
SIMPLE BEAM WITH CONCENTRATED LOAD AT CENTER.

Maximum Shear $= P/2$ lbs.
Maximum Moment at center $= Pl/4$ in. lbs.
Maximum Deflection $= Pl^3/48EI$ inches.



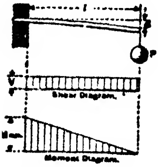
SIMPLE BEAM WITH CONCENTRATED LOAD AT ANY POINT.

Maximum Shear $= Pb/l$ lbs.
Maximum Moment at P $= Pab/l$ in. lbs.
Maximum Deflection at D $= Pabc(l+a)/9EIl$.
Note b is greater than a.



UNIFORMLY LOADED CANTILEVER BEAM.

Maximum Shear at wall $= Wx/l$ lbs.
Maximum Moment at wall $= Wl/2$ in. lbs.
Maximum Deflection at end $= Wl^3/8EI$ in. lbs



CANTILEVER BEAM WITH CONCENTRATED LOAD AT END.

Maximum Shear $= P$ lbs.
Maximum Moment at wall $= Pl$ in. lbs.
Maximum Deflection at end $= Pl^3/3EI$.

P = Concentrated Load in lbs.
W = Total Load in lbs. uniformly distributed.
l = Span of beam in inches.
I = Moment of Inertia in inches^4. (For rectangular beam $= bd^3/12$. For steel beams consult handbook.)
E = Modulus of Elasticity. (Steel = 29,000,000; other materials vary.)

STRESSES FOR NO. 1 DIMENSION AND TIMBERS

The following stresses should be used in the design of wood-framed buildings, for joists, rafters and beams, where No. 1 grade is to be used. This is a grade often employed for buildings, but if wood having higher stresses is desired, it is advisable to specify a higher grade in which the material is graded under the structural grading rules.

Continuously Dry

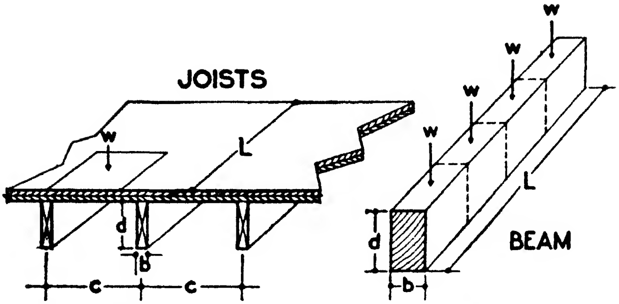
Species	*f*	*v*	*E*	*p*
CEDAR, Port Orford†	1100	80	1,200,000	250
CEDAR, Western Red†	1000	100	1,000,000	200
CYPRESS, Southern† (Tidewater Red)	1100	100	1,200,000	300
DOUGLAS FIR (Coast)†	1200	100	1,600,000	325
DOUGLAS FIR (Inland)†	1200	80	1,500,000	315
FIR, Balsam* (Eastern)	720	56	1,000,000	150
FIR, White*	880	56	1,100,000	300
HEMLOCK, Eastern*	880	56	1,100,000	300
HEMLOCK, Western* (West Coast)	1040	60	1,400,000	300
LARCH, Western†	1200	100	1,300,000	325
OAK, Red and White†	1100	100	1,500,000	500
PINE, Lodgepole*	720	68	1,000,000	250
PINE, Norway*	880	68	1,200,000	300
PINE, Northern White*	720	68	1,000,000	250
PINE, Ponderosa*	720	68	1,000,000	250
PINE, Dense Longleaf Southern†	1400	100	1,600,000	380
PINE, Dense Shortleaf Southern†	1200	100	1,600,000	380
PINE, Sugar*	720	68	1,000,000	250
PINE, Western White* (Idaho)	720	68	1,000,000	250
REDWOOD, Close-grained†	1200	70	1,200,000	267
SPRUCE, Eastern* (Red and White)	880	68	1,200,000	250
SPRUCE, Engelmann*	600	56	800,000	175
SPRUCE, Sitka*	880	68	1,200,000	250
TAMARACK*	960	76	1,300,000	300

f = extreme fibre stress; v = unit shear; E = Modulus of elasticity; p = compression perpendicular to the grain.

* Species graded under Yard Lumber Rules, but which are used in certain parts of the country for joists and rafters. The 60% strength ratio value used by the Forest Products Laboratory has been assigned to these species.

† No. 1 Dimension has been taken as practically equivalent to the lowest standard stress-grade in these species which are graded structurally, when the slope of grain is limited to 1" in a length of 12". It is fortunate that in these woods having structural stress-grades, the association rules are a little more particular in describing the grading of No. 1 Dimension. Thus the No. 1 Dimension, when slope of grain is limited, is entitled to practically the same stress as the lowest true structural grade.

WOOD BEAMS AND JOISTS
HORIZONTAL SHEAR



JOIST FORMULAE

(1) $vbd = .0625cwL$

(2) $c = \dfrac{vbd}{.0625wL}$

(3) $d = \dfrac{.0625cwL}{vb}$

(4) $w = \dfrac{vbd}{.0625cL}$

BEAM FORMULAE

(1) $vbd = .75wL$

(2) $d = \dfrac{.75wL}{vb}$

(3) $w = \dfrac{vbd}{.75L}$

c = Spacing of joists in inches on center.

v = Allowable Unit Shear,

b = Actual breadth of joists or beam unless code allows use of nominal breadth.

d = Actual depth of joists or beam unless code allows use of nominal depth. Actual d is ⅜" less than nominal d for sizes of 4" and 6". Actual d is ½" less than nominal d for sizes of 8" and over.

w = For *joists,* total dead and live load in lbs. per sq. ft. uniformly distributed. For *beams,* total dead and live load in lbs. per linear foot of beam uniformly distributed. To get the safe superimposed load, the weight of the joists or beam and other dead loads must be subtracted.

L = Span of joists or beam in feet.

EXAMPLE OF JOIST DESIGN

Given: w = 105 lbs. per sq. ft., L = 8.0′, Western larch, (v = 100).
To Find: Spacing required for 2 x 8's determined by horizontal shear.
Solution: Substituting proper values in (2) above,

$$c = \frac{100 \times 1.625 \times 7.5}{.0625 \times 105 \times 8} = 23'' \text{ o/c.}$$

Note: Cases of joist failure from horizontal shear are extremely rare and shear calculations are never necessary in ordinary work.

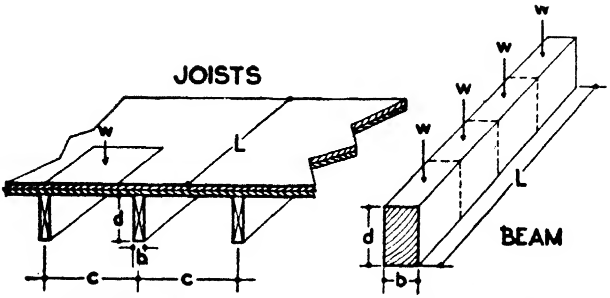
EXAMPLE OF BEAM DESIGN

Given: w = 500 lbs. per linear foot, L = 11.0′, nominal b = 6", Sitka spruce, (v = 68).

To Find: Depth of beam required as determined by horizontal shear.
Solution: Substituting proper values in (2) above,

$$d = \frac{.75 \times 500 \times 11}{68 \times 5.5} = 11'', \text{ say nominal } 12'' \text{ depth}$$

WOOD BEAMS AND JOISTS
BENDING



JOIST FORMULAE

(1) $fbd^2 = .75cwL^2$

(2) $c = \dfrac{fbd^2}{.75wL^2}$

(3) $d = \sqrt{\dfrac{.75cwL^2}{fb}}$

(4) $w = \dfrac{fbd^2}{.75cL^2}$

BEAM FORMULAE

(1) $fbd^2 = 9wL^2$

(2) $d = \sqrt{\dfrac{9wL^2}{fb}}$

(3) $w = \dfrac{fbd^2}{9L^2}$

c = Spacing of joists in inches on center.

f = Allowable Extreme Fiber Stress

b = Actual breadth of joists or beam unless code allows use of nominal breadth.

d = Actual depth of joists or beam unless code allows use of nominal depth. Actual d is ⅜" less than nominal d for sizes of 4" and 6". Actual d is ½" less than nominal d for sizes of 8" and over.

w = For *joists*, total dead and live load in lbs. per sq. ft. uniformly distributed. For *beams*, total dead and live load in lbs. per linear foot of beam uniformly distributed. To get the safe superimposed load, the weight of the joists or beam and other dead loads must be subtracted.

L = Span of joists or beam in feet.

EXAMPLE OF JOIST DESIGN

Given: w = 105 lbs. per sq. ft., L = 8.0', Western larch, (f = 1200).
To Find: Spacing required for 2 x 8's determined by Bending.
Solution: Substituting proper values in (2) above,

$$c = \frac{1200 \times 1.625 \times 7.5 \times 7.5}{.75 \times 105 \times 8.0 \times 8.0} = 22'' \text{ o/c.}$$

EXAMPLE OF BEAM DESIGN

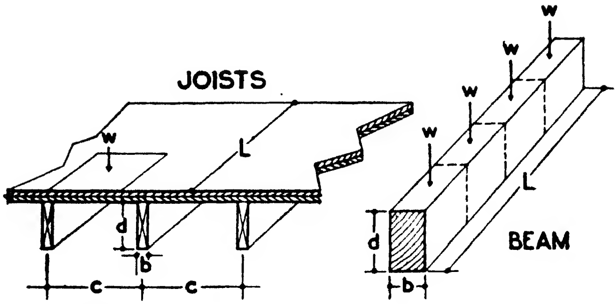
Given: w = 500 lbs. per linear foot, L = 11.0', nominal b = 6", Sitka spruce, (f = 880).

To Find: Depth of beam required as determined by Bending.

Solution: Substituting proper values in (2) above,

$$d = \sqrt{\frac{9 \times 500 \times 11.0 \times 11.0}{880 \times 5.5}} = 10.7'', \text{ say nominal } 12'' \text{ depth}$$

WOOD BEAMS AND JOISTS
DEFLECTION



JOIST FORMULAE

(1) $Ebd^3 = 675cwL^3$

(2) $c = \dfrac{Ebd^3}{675wL^3}$

(3) $d = \sqrt[3]{\dfrac{675cwL^3}{Eb}}$

(4) $w = \dfrac{Ebd^3}{675cL^3}$

BEAM FORMULAE

(1) $Ebd^3 = 8100wL^3$

(2) $d = \sqrt[3]{\dfrac{8100wL^3}{Eb}}$

(3) $w = \dfrac{Ebd^3}{8100L^3}$

c = Spacing of joists in inches on center.
E = Allowable Modulus of Elasticity,
b = Actual breadth of joists or beam.
d = Actual depth of joists or beam to limit deflection to 1/360th of the span.
w = For *joists,* total dead and live load in lbs. per sq. ft. uniformly distributed. For *beams,* total dead and live load in lbs. per linear foot of beam uniformly distributed. To get the allowable superimposed load, the weight of the joists or beam and other dead loads must be subtracted.
L = Span of joists or beam in feet.

EXAMPLE OF JOIST DESIGN

Given: w = 105 lbs. per sq. ft., L = 8.0′, Western larch, (E = 1,300,000).
To Find: Spacing required for 2 x 8's, to limit deflection to 1/360th of the span.
Solution: Substituting proper values in (2) above,

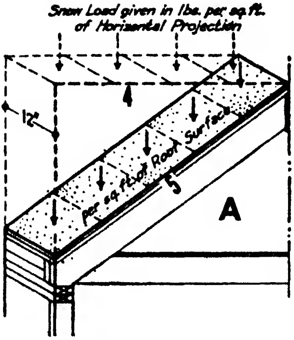
$$c = \frac{1,300,000 \times 1.625 \times 7.5 \times 7.5 \times 7.5}{675 \times 105 \times 8.0 \times 8.0 \times 8.0} = 24'' \text{ o/c.}$$

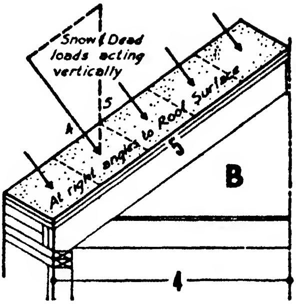
EXAMPLE OF BEAM DESIGN

Given: w = 500 lbs. per linear foot, L = 11.0′, nominal b = 6″, Sitka spruce, (E = 1,200,000).
To Find: Depth of beam required to limit deflection to span /360.
Solution: Substituting proper values in (2) above,

$$d = \sqrt[3]{\frac{8100 \times 500 \times 11.0 \times 11.0 \times 11.0}{1,200,000 \times 5.5}} = 10''$$

HOW TO DESIGN WOOD RAFTERS





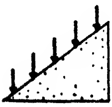
SNOW LOAD. Snow loads are usually given in codes in pounds per square foot of horizontal projection. To translate this figure into pounds per square foot of roof surface, consider the strip of roof 1'-0" wide, as shown in *Figure A*. If the horizontal projection were 4'-0" and the snow load 15 pounds, the total load on the section would be $4 \times 15 = 60$. If the length of the roof along the slope is 5'-0", the load per square foot of roof surface becomes $60 \div 5 = 12$ lbs., acting vertically.

WEIGHT OF CONSTRUCTION. Weights of roof construction materials are given in lbs. per square foot of roof surface. Suppose in this case that the weight of construction is 13 lbs. Adding this value to the snow load, we have a total of 25 lbs. per square foot of roof surface, acting vertically. We must find the component of this vertical load which acts at *right angles* to the roof surface. The component is found by similar triangles, as shown in *Figure B*, as follows:

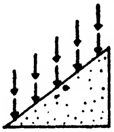
$$\frac{25 \times 4}{5} = 20 \text{ lbs. per sq. ft. acting at right angles to roof surface.}$$

WIND LOAD. Wind loads are ordinarily given in pounds per square foot acting at right angles to the roof surface. If the wind load is 10 lbs., it can be added to the component of the snow and dead loads, making a total of 30 lbs. per square foot.

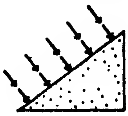
DESIGN OF RAFTERS. The span of rafters is taken to be their unsupported length measured on the slope. Plate, ridge and collar beams (if at every rafter) are regarded as supports. The design of rafters becomes an identical calculation to that of joists, using the greatest unsupported length as the span, and the load in pounds per square foot, acting at right angles to the roof surface, as explained in the foregoing.



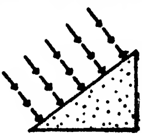
Snow load changed to lbs. per sq. ft. of roof surface.



Weight of materials added to snow load.



Normal component of combined loads calculated.



Wind load added to get total normal load.

SAFE LOADS ON EASTERN FIR* JOISTS

Span in feet	2 x 16's Actual 1⅝ x 15½					2 x 14's Actual 1⅝ x 13½				
	12	14	16	18	20	12	14	16	18	20
10	179	154	135	120	108	155	133	117	104	93
11	163	140	123	109	99	140	121	106	94	85
12	148	128	112	99	90	130	111	97	87	77
13	137	117	103	91	83	118	102	89	79	71
14	126	108	95	85	76	108	93	82	74	66
15	117	100	89	78	71	97	85	76	68	59
16	110	94	83	73	66	83	75	66	60	51
17	101	86	76	67	61	73	64	59	51	45
18	89	76	67	59	54	63	58	51	45	40
19	79	68	60	53	48	58	51	44	40	35
20	71	60	53	47	43	52	45	39	35	31
21	64	54	48	42	39	47	40	35	32	28
22	58	49	43	38	35	39	33	27	26	24

Span in feet	2 x 12's Actual 1⅝ x 11½					2 x 10's Actual 1⅝ x 9½				
	12	14	16	18	20	12	14	16	18	20
8	167	141	125	111	101	140	118	104	93	84
9	149	126	111	99	90	124	105	93	82	74
10	133	113	100	89	80	111	94	83	74	67
11	122	105	91	80	73	92	79	70	62	56
12	110	94	82	74	67	77	66	58	51	47
13	96	82	72	64	58	65	55	49	43	40
14	83	70	62	54	49	56	47	42	37	34
15	71	60	53	47	43	47	39	35	31	28
16	62	52	46	41	37	38	32	27	25	23
17	54	46	41	35	32	31	26	23		
18	47	39	35	30	28	25	21			
19	39	33	29	25	24	21				
20	33	27	24	21	20					

Span in feet	2 x 8's Actual 1⅝ x 7½					2 x 6's Actual 1⅝ x 5⅝				
	12	14	16	18	20	12	14	16	18	20
6	147	127	110	98	88	109	94	82	73	66
7	127	107	93	84	76	80	68	60	54	48
8	110	94	82	74	66	61	53	46	41	36
9	85	73	63	57	51	46	40	35	31	27
10	69	59	51	46	42	33	28	25	22	
11	57	48	42	38	34	24	21			
12	47	39	34	31	28					
13	36	30	26	24	21					
14	27	23	20							

Safe loads given are *net* safe loads per square foot, weight of joists themselves has been deducted from gross safe load to obtain values given. Stresses used are those recommended by the N.B.F.U. for *common grade* which is the grade ordinarily used for joists. Loads above the solid lines are determined by unit shear = 56. Loads between solid and dotted lines determined by extreme fibre stress = 720. Loads below dotted lines determined by modulus of elasticity = 1,000,000, and will produce deflections not greater than span"/360.

* Also called "Balsam Fir."

SAFE LOADS ON WHITE FIR & EASTERN HEMLOCK JOISTS

Span in feet	2 x 16's Actual 1⅝ x 15½					2 x 14's Actual 1⅝ x 13½				
	12	14	16	18	20	12	14	16	18	20
8	225	194	170	151	136	195	168	147	132	118
9	201	172	150	134	120	173	148	140	117	104
10	179	154	135	120	108	155	142	117	104	94
11	163	140	123	109	98	141	121	106	95	86
12	149	128	112	100	89	129	110	97	87	78
13	137	117	103	92	83	119	101	89	80	71
14	127	108	95	85	76	110	93	82	78	66
15	118	101	87	79	71	103	87	76	69	61
16	111	94	82	73	66	95	81	71	64	57
18	97	83	73	65	58	83	71	62	56	50
20	88	74	66	59	53	61	53	46	41	37
22	71	60	53	47	42	45	38	33	30	27
24	53	45	40	35	32	32	28	24	22	20
26	40	34	30	26	24	24	21			

Span in feet	2 x 12's Actual 1⅝ x 11½					2 x 10's Actual 1⅝ x 9½				
	12	14	16	18	20	12	14	16	18	20
7	192	164	144	137	116	160	136	119	106	96
8	168	143	126	111	101	140	119	104	92	84
9	149	127	111	99	90	123	106	93	82	75
10	143	113	100	88	80	111	94	83	73	67
11	121	105	91	80	73	101	86	75	67	61
12	111	94	83	73	67	92	78	69	61	56
13	102	87	76	68	61	81	69	61	54	49
14	94	80	70	64	57	64	54	48	43	39
16	77	65	58	50	46	42	35	31	28	26
18	52	44	39	34	31	28	24	21		
20	37	31	27	24	21	20				

Span in feet	2 x 8's Actual 1⅝ x 7½					2 x 6's Actual 1⅝ x 5⅝				
	12	14	16	18	20	12	14	16	18	20
6	146	125	109	98	88	110	94	82	73	65
7	125	107	93	84	75	94	80	70	62	56
8	109	93	81	73	65	73	65	56	50	45
9	97	83	72	64	58	51	45	39	35	31
10	86	73	64	57	52	36	32	28	25	22
12	51	43	37	34	30	20				
14	31	26	22	21						

Safe loads given are *net* safe loads per square foot, weight of joists themselves has been deducted from the total safe loads to obtain the values given. Stresses used are those recommended by the National Lumber Manufacturers Association for *No. 1 Dimension* which is the grade ordinarily used for joists and rafters. Loads above the solid lines are determined by shear = 56. Loads between solid and dotted lines determined by extreme fibre stress = 880. Loads below dotted lines determined by modulus of elasticity = 1,100,000, and will produce deflections less than 1/360 of the span.

DOUGLAS FIR[1], EASTERN[2] & SITKA SPRUCE, AND NORWAY PINE JOISTS

Span in feet	2 x 16's Actual 1⅝ x 15½					2 x 14's Actual 1⅝ x 13½				
	12	14	16	18	20	12	14	16	18	20
8	277	238	209	185	108	248	207	182	163	146
9	246	204	185	165	149	215	184	162	144	130
10	221	191	166	148	134	193	164	144	127	116
11	202	174	151	134	122	177	149	132	118	106
12	183	159	138	123	111	160	136	120	107	96
13	169	146	127	113	103	147	126	110	99	89
14	156	135	118	104	95	137	116	102	92	82
15	145	126	109	97	88	122	105	92	82	73
16	136	128	103	91	82	107	91	80	72	64
18	111	95	84	74	67	83	71	62	56	50
20	89	76	67	59	54	66	56	50	45	40
22	72	62	54	48	44	49	42	37	33	30
24	59	49	43	38	35	36	31	27	24	21
26	43	38	33	29	27	27	23			

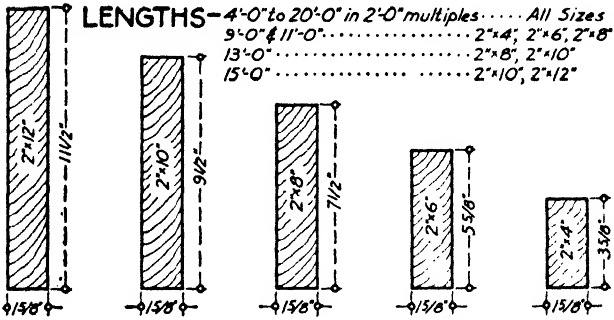
Span in feet	2 x 12's Actual 1⅝ x 11½					2 x 10's Actual 1⅝ x 9½				
	12	14	16	18	20	12	14	16	18	20
7	237	204	178	158	142	196	169	147	131	118
8	207	177	155	136	125	171	146	129	114	104
9	183	157	138	122	110	153	131	110	102	92
10	165	141	123	109	99	136	116	103	91	82
11	150	128	113	99	90	114	98	86	76	69
12	137	117	103	91	82	95	81	72	63	58
13	127	107	90	79	72	81	69	61	54	49
14	103	87	77	68	62	69	59	52	46	42
16	77	65	58	51	46	46	39	35	31	28
18	57	49	42	37	35	32	26	24	21	
20	41	34	31	26	24	22				

Span in feet	2 x 8's Actual 1⅝ x 7½					2 x 6's Actual 1⅝ x 5⅝				
	12	14	16	18	20	12	14	16	18	20
6	181	150	135	120	108	135	116	101	91	81
7	155	132	115	103	92	99	85	74	66	59
8	135	115	101	90	81	75	65	57	50	45
9	105	90	79	70	63	56	48	42	37	33
10	86	78	64	57	52	40	35	30	27	24
12	56	48	42	37	34	22	20			
14	34	29	25	23	20					

Safe loads given are *net* safe loads per square foot. Weight of joists themselves has been deducted from total safe loads to obtain values given. Stresses used are those recommended by the N.B.F.U. and the U.S.F.P.L. for *common grade,* which is the grade ordinarily used for joists. Loads above the solid lines are determined by shear = 68. Loads between solid and dotted lines determined by extreme fibre stress = 880. Loads below dotted lines determined by modulus of elasticity = 1,200,000, and will produce deflections less than span"/360.

[1]Rocky Mountain region.
[2]Also called Red, White, Black Spruce.

ARKANSAS SOFT PINE
STUDS, JOISTS AND RAFTERS



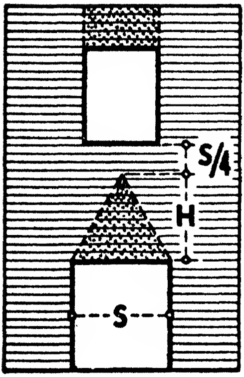
Moisture content for Kiln Dried No. 1 and No. 2 Dimension, including Dense, does not exceed 15%.

Span	**2 x 12's** *Spacing on Centers* 12"	14"	16"	18"	20"	**2 x 10's** *Spacing on Centers* 12"	14"	16"	18"	20"
10 ft.	279	238	209	186	168	190	162	143	127	113
11 ft.	230	196	172	153	138	156	133	119	104	93
12 ft.	192	165	144	128	116	131	111	109	87	78
13 ft.	163	140	122	109	99	111	94	84	74	66
14 ft.	140	120	105	93	84	92	81	72	63	57
15 ft.	121	102	90	80	72	82	70	61	54	49
16 ft.	98	83	73	65	59	67	56	50	44	40
17 ft.	81	69	61	54	49	55	47	41	36	33
18 ft.	67	57	50	44	41	46	39	34	30	27
19 ft.	57	48	42	37	34	39	32	29	25	22
20 ft.	48	40	36	31	29	32	27	24	21	..

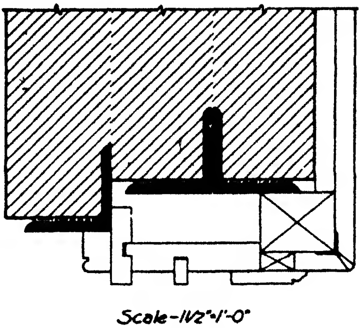
Span	**2 x 8's** *Spacing on Centers* 12"	14"	16"	18"	20"	**2 x 6's** *Spacing on Centers* 12"	14"	16"	18"	20"
6 ft.	198	170	148	132	120	110	95	83	74	66
7 ft.	169	145	127	112	102	94	81	71	63	56
8 ft.	147	127	111	98	89	82	71	62	55	49
9 ft.	131	113	98	87	79	73	63	55	49	44
10 ft.	116	110	88	77	71	66	55	49	44	39
11 ft.	95	83	72	63	58	54	45	40	36	32
12 ft.	80	69	60	53	49	45	37	33	30	26
13 ft.	67	59	51	45	41	38	31	28	25	22
14 ft.	58	50	44	38	35	32	27	24	21	...
15 ft.	49	43	37	32	30	27	23	20	...	...
16 ft.	40	34	30	26	24	22	...	...	...	...

Safe loads given are *net* safe loads per square foot—weight of joists themselves has been deducted. Stresses used are for *No. 1 Dimension.* Loads above the solid lines are governed by v = 100. Loads between the solid and dotted lines governed by f = 1200. Loads below dotted lines governed by E = 1,600,000, and will produce deflection less than span"/360.

ANGLE LINTELS IN BRICKWORK



DIAGRAM



SECTION THRU HEAD OF OPENING

CORBELING ACTION OF BRICK MASONRY. When brick masonry is laid on a lintel over an opening, the brickwork bond will have strength enuf to create a self-supporting corbeled arch. From the experience of wreckers and results of fire, many examples can be adduced to show that only a small triangular area of the wall over an opening is actually dependent upon the lintel for support. The size of this triangle is not susceptible to exact analysis for the stresses acting, and engineers variously assume the height of the triangle as 0.50, 0.67 or 0.865 times the span. Since headers or soldier courses do not bond to create corbeling effect, the height of the triangle should be taken from the top of such courses and not from the top of the opening.

WHEN CORBELING ACTION MAY BE ASSUMED. There must be a sufficient amount of brickwork over the triangle to permit the arch effect to act. One writer has given a minimum for this distance as ¼ of the opening span.

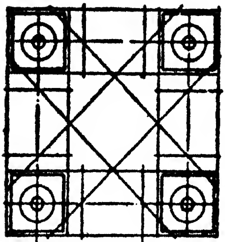
WHEN CORBELING ACTION MAY NOT BE ASSUMED. If the triangle over the opening does not have a sufficient amount of brickwork over it (as in the upper window in the illustration) then the lintel must carry the entire load within the dotted lines.

USE OF STEEL ANGLE LINTELS. Calculations can be made on the assumption of a wall thickness of 4" — 2 of the selected lintels would be used for an 8" wall, 3 for a 12" wall as shown in the illustration.

TABLE OF LINTEL SIZES. The following table assumes that the triangular space above the opening is equilateral, having a height of .865 times the span; the weight of brickwork, 120 lbs. per cu. ft.; there is sufficient brickwork above the triangle as to insure it acting as a corbeled arch to span the opening.

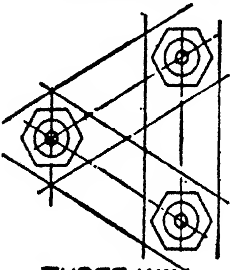
Span in Feet	*Total Triangular Load*	*Equivalent Uniformly Distributed Load*	*Angle to Use for Each 4" Thickness of Brickwork*
7'-0"	848#	1130#	3½ x 3½ x ¼
8'-0"	1106#	1475#	3½ x 3½ x 5/16
10'-0"	1730#	2307#	3½ x 5 x 5/16

TYPES OF FLAT SLAB REINFORCING

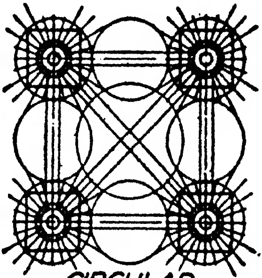


FOUR WAY

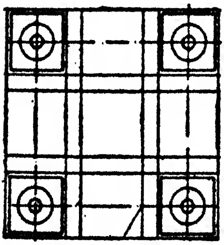
SECTION



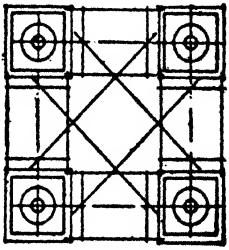
THREE WAY



CIRCULAR



TWO WAY



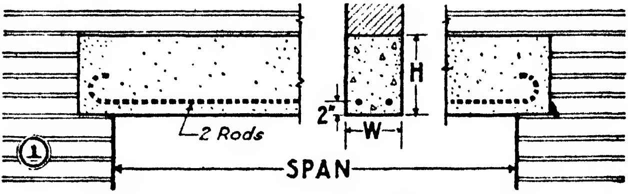
COMBINATION

The maximum economy for flat slabs occurs with spans approximately 20'-0" x 20'-0", and for heavy live loads. The relative economy de-creases as the spans increase and the live loads decrease.

ADVANTAGES. Smooth ceilings are good for lighting, ventilation, prinklers, and shafting. The construction is quite shallow, resulting n reduced story heights. Expensive stirrups are almost entirely liminated. The form cost is low. Very economical of material.

DISADVANTAGES. Enlarged column capitals are objectionable in ome types of buildings. Changes cannot readily be made after the ructure is completed. The solid slab does not provide much insulation gainst sound and heat.

CONCRETE LINTELS



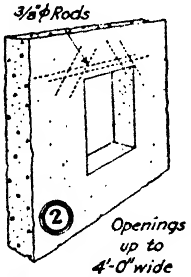
SUPPORTING 8-INCH MASONRY WALLS

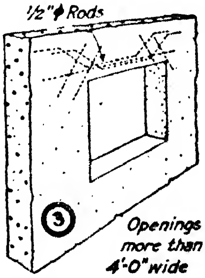
W x H	Span 2'-4"	3'-0"	3'-10"	4'-6"	5'-2"	6'-0"
8" x 8"	3/8"	1/2"	3/4"	...	...	...
8" x 10"	3/8"	3/8"	1/2"	5/8"	...	...
8" x 12"	...	3/8"	1/2"	1/2"	5/8"	7/8"
8" x 14"	...	...	3/8"	1/2"	5/8"	5/8"

SUPPORTING 12-INCH MASONRY WALLS

W x H	Span 2'-4"	3'-0"	3'-10"	4'-6"	5'-2"	6'-0"
8" x 8"	1/2"	3/4"	...	...	...	...
8" x 10"	3/8"	1/2"	3/4"	...	...	...
8" x 12"	...	1/2"	5/8"	5/8"	...	...
8" x 14"	...	3/8"	1/2"	5/8"	3/4"	1"

All bars specified are round bars, to be hooked at the ends, as shown. When the opening is between sizes shown in the tables, use the figures given for the next largest opening. Conservative assumptions have been used in preparing the tables which should be adequate for any average condition without concentrated load.





It will be found generally satisfactory, where no heavy or concentrated load occurs over an opening and the span is not more than 4', to place 2 rods 3/8" in diameter in the bottom of the lintel, so that there will be 1" of concrete below them. Two diagonal rods should be placed at each top corner of a window or door, as shown in *Fig. 2.* When the opening is between 4' and 8', the rods should be bent up as shown in *Fig. 3* and when between 8' and 12', three 1/2" rods should be used, 2 of them being bent.

R. C. SLAB

fc = 725, fs = 18,000

Total Thickness of Slab	Below Center of Steel	Rods and Spacing	Maximum "M" in Inch Pounds	Maximum "V" in Pounds	SAFE UNIFORMLY DISTRIBUTED SUPERIMPOSED LOAD IN POUNDS PER SQ. FT., SIMPLY SUPPORTED — SPAN IN FEET							
					4	5	6	7	8	9	10	11
3"	$\frac{3}{4}$"	$\frac{3}{8}$"φ $6\frac{1}{2}$" oc	7120	945	261	154	96	61				
$3\frac{1}{2}$"	$\frac{3}{4}$"	$\frac{3}{8}$"φ $5\frac{1}{2}$" oc	10460	1150	395	237	152	100	67	44		
4"	$\frac{3}{4}$"	$\frac{3}{8}$"φ $4\frac{1}{2}$" oc	14 900	1360	572	350	228	155	108	75	51	
$4\frac{1}{2}$"	1"	$\frac{1}{2}$"φ $7\frac{1}{2}$" oc	17 100	1470		401	262	178	124	87	60	40
5"	1"	$\frac{1}{2}$"φ $6\frac{1}{2}$" oc	22 640	1680		545	360	249	176	127	91	65
$5\frac{1}{2}$"	1"	$\frac{1}{2}$"φ 6" oc	27 600	1890			444	310	222	162	118	94
6"	$1\frac{1}{4}$"	$\frac{1}{2}$"φ $5\frac{1}{2}$" o.c	32 100	1990			523	360	263	194	142	105
$6\frac{1}{2}$"	$1\frac{1}{4}$"	$\frac{1}{2}$"φ 5" o.c.	38 800	2200				450	327	243	181	136
7"	$1\frac{1}{4}$"	$\frac{5}{8}$"φ 7" o.c.	48 000	2420					416	312	235	180
$7\frac{1}{2}$"	$1\frac{1}{4}$"	$\frac{5}{8}$"φ $6\frac{1}{2}$" oc	56 100	2620					495	374	284	220
8"	$1\frac{1}{4}$"	$\frac{5}{8}$"φ 6" oc	64 800	2840						440	336	262

This table is based on $n=15$, $f_c=725$, $f_s=18000$, $M=\frac{12wL^2}{8}$, $v=40$

The columns giving safe uniform loads are intended for use for single slabs such as occur under porch floors, residence garage roof slabs, etc.

For other than simple spans, or for other than uniform loads, the moment should be calculated and the slab selected from the column giving the maximum moment values. Shear is not important in solid slabs, except for very heavy loads on short spans. Deflection calculations are unnecessary in all usual cases.

Use temperature rods ¼" rounds—24" o.c. at right angles to reinforcement.

R. C. SLAB
$f_c = 800$, $f_s = 18{,}000$

TOTAL THICKNESS OF SLAB	BELOW CENTER OF STEEL	RODS AND SPACING	MAXIMUM M IN INCH POUNDS	MAXIMUM V IN POUNDS	SAFE UNIFORMLY DISTRIBUTED SUPERIMPOSED LOAD IN POUNDS PER SQ. FT., SIMPLY SUPPORTED. SPAN IN FEET: 4	5	6	7	8	9	10	11
3"	3/4"	3/8"φ-5 1/2" o/c	8 425	936	313	187	118	77	50	31		
3 1/2"	3/4"	3/8"φ-4 1/2" o/c	12 600	1 143	481	292	189	127	87	59	40	
4"	3/4"	1/2"φ-6" o/c	17 550	1 350	681	418	275	189	133	94	67	46
4 1/2"	1"	1/2"φ-5 1/2" o/c	20 350	1 455		486	319	220	155	111	79	55
5"	1"	1/2"φ-5 1/2" o/c	26 600	1 663		647	430	299	215	156	115	84
5 1/2"	1"	1/2"φ-4 1/2" o/c	33 600	1 870			553	388	281	207	155	116
6"	1 1/4"	1/2"φ-4 1/2" o/c	37 500	1 975			619	435	315	233	175	131
6 1/2"	1 1/4"	5/8"φ-6" o/c	45 800	2 180				541	396	295	223	170
7"	1 1/4"	5/8"φ-6" o/c	55 000	2 390					485	365	279	215
7 1/2"	1 1/4"	5/8"φ-5 1/2" o/c	65 000	2 600					583	441	339	264
8"	1 1/4"	5/8"φ-5" o/c	75 800	2 810						523	405	317

This table is based on $n = 15$, $f_c = 800$, $f_s = 18\,000$, $M = \frac{12wL^2}{8}$, $V = 40$

The columns giving safe uniform loads are intended for use for single slabs such as occur under porch floors, residence garage roof slabs, etc.

For other than simple spans, or for other than uniform loads, the moment should be calculated and the slab selected from the column giving the maximum moment values. Shear is not important in solid slabs, except for very heavy loads on short spans. Deflection calculations are unnecessary in all usual cases.

Use temperature rods ¼" rounds—24" o/c at right angles to reinforcement.

AREAS OF REINFORCING RODS

Spacing in Inches	Area of Steel in Square Inches per Foot Width of Slab					
	1/4	3/8	1/2	1/2	5/8	3/4
3	0.20	0.44	0.78	1.00	1.23	1.77
3½	0.17	0.38	0.67	0.86	1.05	1.51
4	0.15	0.33	0.59	0.75	0.92	1.33
4½	0.13	0.29	0.52	0.67	0.82	1.18
5	0.12	0.26	0.47	0.60	0.74	1.06
5½	0.11	0.24	0.43	0.55	0.67	0.96
6	0.10	0.22	0.39	0.50	0.61	0.88
6½	0.09	0.20	0.36	0.46	0.57	0.82
7	0.08	0.19	0.34	0.43	0.53	0.76
7½	0.08	0.18	0.31	0.40	0.49	0.71
8	0.07	0.17	0.29	0.38	0.46	0.66
8½	0.07	0.16	0.28	0.35	0.43	0.62
9	0.07	0.15	0.26	0.33	0.41	0.59
9½	0.06	0.14	0.25	0.32	0.39	0.56
10	0.06	0.13	0.24	0.30	0.37	0.53
10½	0.06	0.13	0.22	0.29	0.35	0.51
11	0.05	0.12	0.21	0.27	0.33	0.48
11½	0.05	0.11	0.20	0.26	0.32	0.46
12	0.05	0.11	0.20	0.25	0.31	0.44

Spacing in Inches	Area of Steel in Square Inches per Foot Width of Slab				
	7/8	1	1	1 1/8	1 1/4
3	2.40	3.14	4.00	5.06	6.25
3½	2.06	2.69	3.43	4.34	5.36
4	1.80	2.36	3.00	3.80	4.69
4½	1.60	2.09	2.67	3.37	4.17
5	1.44	1.88	2.40	3.04	3.75
5½	1.31	1.71	2.18	2.76	3.41
6	1.20	1.57	2.00	2.53	3.13
6½	1.11	1.45	1.85	2.34	2.89
7	1.03	1.35	1.71	2.17	2.68
7½	0.96	1.26	1.60	2.02	2.50
8	0.90	1.18	1.50	1.90	2.34
8½	0.85	1.11	1.41	1.79	2.21
9	0.80	1.05	1.33	1.69	2.08
9½	0.76	0.99	1.26	1.60	1.97
10	0.72	0.94	1.20	1.52	1.88
10½	0.69	0.90	1.14	1.45	1.79
11	0.66	0.86	1.09	1.38	1.70
11½	0.63	0.82	1.04	1.32	1.63
12	0.60	0.79	1.00	1.27	1.56

The 11 sizes of rods shown above have been approved through *Simplified Practice Recommendation R26* promulgated by the U. S. Department of Commerce

CONCRETE DWELLING CONSTRUCTION

Construction practice has developed 4 general types of concrete construction. City building codes do not, in general, provide for the construction of concrete houses of all 4 types. Some types are not permitted because they are not mentioned in city building codes. City building departments are prone to allow only just what is provided for in the code—regardless of the merit of any proposed new type of construction. Satisfactory, meritorious types of construction should be covered by general requirements for structural adequacy; and the building inspector should be clothed with the power of selection and should be furnished with the necessary means of investigation. 4 types are as follows:

1. CONCRETE STRUCTURAL FRAME WITH CURTAIN WALLS. This type has a structural frame of reinforced concrete columns, beams, and girders and floor slabs cast in place, and thin inclosure walls plastered and back plastered or shot with a cement gun on wire mesh or metal lath attached to columns and beams.

Dwellings constructed with monolithic reinforced concrete frames cast in metal lath or other forms, and with inclosing walls of concrete plastered or shot metal lath, or of precast units carried by such frames, or having reinforced concrete bearing walls, shall be designed in accordance with standard methods of reinforced concrete design to carry safely the dead weight of the structure and the live loads which may be imposed. Inclosure or panel walls shall be of sufficient strength and rigidity to resist lateral forces and transmit them to the framework.

The adequacy of a structural concrete frame proposed for dwelling houses is susceptible of analysis according to principles of reinforced concrete design, and building codes should specifically provide for the use of such a system. Inasmuch as the structural frame carries all the loads, the inclosure walls need have only such strength as is necessary to transmit wind loads to the structural frame. This has been successfully accomplished by a thickness of 1½" of cement mortar plastered and back plastered on metal lath which is attached to the structural frame of the building. The interior portion of exterior walls is formed by plastering on metal lath to a thickness of ⅞" to 1". An air space is thus provided for insulation. The total thickness of such exterior walls is governed by the width required for window and door frames, and is usually not less than 6".

Instead of constructing the inclosure or curtain walls by plastering on metal lath, the cement gun or other mechanical means of applying concrete or mortar may be used.

In view of the relatively light types of reinforcement customary for concrete dwelling construction, it is strongly recommended that the concrete covering over such reinforcement be of sufficient thickness for full protection against corrosion. Metal lath or other light-weight metal reinforcing fabric should be thoroly galvanized or painted.

CONCRETE DWELLING CONSTRUCTION

2. MASONRY. Blocks, brick, or tile of concrete laid into walls with mortar joints. Codes usually contain a table of wall thicknesses for such construction. Some codes refer to brick only.

3. MONOLITHIC CONCRETE WALLS. The vertical loads on bearing walls not more than 3 stories high are comparatively small. The stability of the completed structure as a whole should be considered in any analysis of wall thickness requirements for dwellings.

Experience in the construction of houses having plain concrete bearing walls has shown that a thickness of 6" is sufficient. Reinforcement not less than 2/10ths of 1%, computed on a vertical height of 12", shall be placed over all wall openings and at corners of the structure to prevent cracks.

Several systems of construction have been successfully used which produce double concrete walls. Usually these systems produce 2 walls, each 4" thick, with an air space (or rigid insulation—Ed.) between the 2 thicknesses. Wall openings and corners should be reinforced in the same manner as solid monolithic walls. The inner and outer parts of such walls should be securely braced and tied together with non-corrodible ties or other means to bring them into common action. Positive means should be provided to transmit floor and roof loads to both walls.

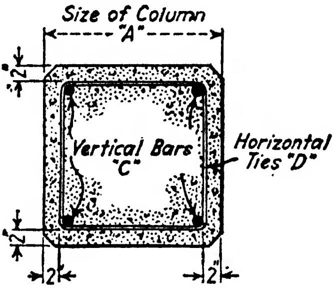
4. UNIT CONSTRUCTION. Unit construction, in which precast units different from ordinary concrete block or concrete tile are employed. These structural parts range from the special forms of small units, which serve merely as inclosure walls between members of a load-carrying framework, to large slabs forming an entire side wall of the building, or even to the members for an entire house which are precast and transported.

Precast concrete units for construction of dwellings shall be of sufficient strength, and where necessary shall be reinforced to carry safely the loads imposed. Connections between the several parts of such structures shall be sufficiently strong and rigid to resist the vertical and horizontal forces which may be imposed.

The strength of large precast concrete units can be computed and verified by tests. The structural adequacy of a system employing units of sufficient strength will depend largely on the details of the connections, the support afforded by adjacent units, and the stability of the structure as a whole. Systems that employ relatively small units should be judged on the basis of the structural adequacy of the framework carrying the units. If the units themselves are reinforced concrete structural members, they are susceptible of theoretical analysis, and a decision as to structural adequacy will therefore be based on engineering design.

The Building Code Committee of the U. S. Department of Commerce have recommended minimum requirements for small dwelling construction. The recommendations applying to residences built of concrete have been summarized as above. The requirements apply to small dwellings only and are not to be considered as general, or applicable to other and larger types of construction.

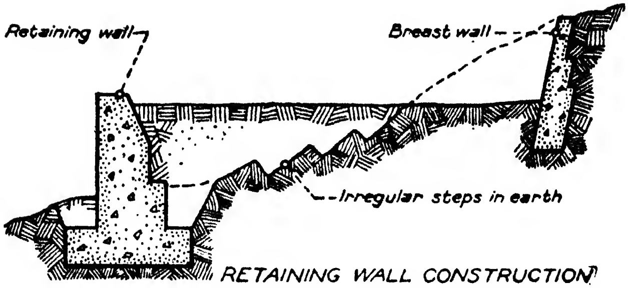
SAFE VERTICAL LOADS FOR CONCRETE COLUMNS



A Column Size	B† Safe Load Acting Vertically	C Size of 4 Vertical Bars	D Spacing of ¼ in. Horizontal Ties
8 in.	7,700 lbs.	⅜ in. rd.	6 in.
	8,300 lbs.	⅜ in. sq.	6 in.
	8,700 lbs.	½ in. rd.	8 in.
10 in.	16,400 lbs.	½ in. rd.	8 in.
	17,500 lbs.	½ in. sq.	8 in.
	18,600 lbs.	⅝ in. rd.	10 in.
12 in.	33,600 lbs.	½ in. rd.	8 in.
	35,000 lbs.	½ in. sq.	8 in.
	36,500 lbs.	⅝ in. rd.	10 in.
	38,600 lbs.	⅝ in. sq.	10 in.
	40,000 lbs.	¾ in. rd.	12 in.
	43,000 lbs.	¾ in. sq.	12 in.
	44,000 lbs.	⅞ in. rd.	12 in.
13 in.	42,800 lbs.	½ in. sq.	8 in.
	44,100 lbs.	⅝ in. rd.	10 in.
	46,200 lbs.	⅝ in. sq.	10 in.
	47,500 lbs.	¾ in. rd.	12 in.
	50,600 lbs.	¾ in. sq.	12 in.
	51,500 lbs.	⅞ in. rd.	12 in.
	55,600 lbs.	⅞ in. sq.	12 in.
14 in.	52,700 lbs.	⅝ in. rd.	10 in.
	54,700 lbs.	⅝ in. sq.	10 in.
	56,200 lbs.	¾ in. rd.	12 in.
	59,100 lbs.	¾ in. sq.	12 in.
	60,000 lbs.	⅞ in. rd.	12 in.
	64,200 lbs.	⅞ in. sq.	12 in.
	64,700 lbs.	1 in. rd.	12 in.
	70,000 lbs.	1 in. sq.	12 in.

† For conservative design the maximum height of column is 12 times the diameter, altho the Joint Committee allows a maximum height of 15 times the diameter. Safe Loads are loads acting vertically on a square reinforced column of 1:2:4 high quality concrete. For loads not acting thru the axis of the column a special calculation must be made.

BREAST AND RETAINING WALLS



RETAINING WALL CONSTRUCTION

BREAST WALLS. These are erected only to prevent weathering or disruption of earth or other material which is in its undisturbed natural position and which is sufficiently cohesive and stable to support itself unless disturbed. Obviously, breast walls cannot be used to support earth whose angle is greater than the natural angle of repose. The following table gives these values.

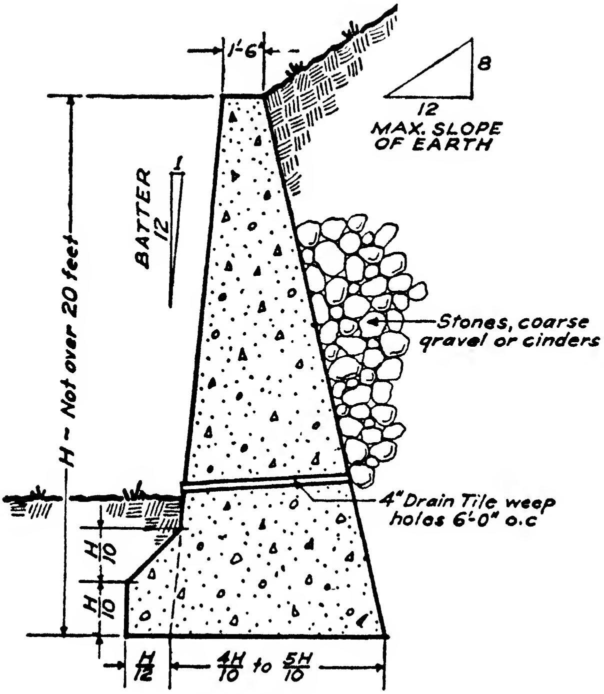
Kind of Earth	*Angle of Repose*	*Weight in lbs. per cu. ft.*
Sand, clean, dry	33° 41′	90
Sand & Clay	36° 53′	95
Clay, dry	36° 53′	100
Clay, plastic	26° 34′	100
Gravel, clean	36° 53′	100
Gravel & Clay, dry	36° 53′	100
Gravel, Sand & Clay, dry	36° 53′	100
Soil	36° 53′	100
Soft Rotten Rock	36° 53′	110
Hard Rotten Rock	45° 00′	100
Bituminous Cinders	45° 00′	45
Anthracite Ashes	45° 00′	30

Where the ground to be supported is firm and the strata are horizontal, breast walls are usually built more to protect than to sustain the earth. A trifling force skilfully applied to unbroken ground will keep in place a mass of material which, if once allowed to move, would crush a heavy wall. The strength of a breast wall must be increased when the strata to be supported incline down toward the wall.

RETAINING WALLS. These are constructed so that rotation or overturning due to the pressure of material behind the wall will be prevented. Where the ground freezes to an appreciable depth, the back of the wall should be sloped from below the frost line toward its top surface. This slope should be quite smooth to lessen the hold of the frost and prevent displacement. If the original ground is made irregular with steps and the earth well rammed in layers, the pressure will be less than where the earth is placed in layers sloping toward the earth.

WATERPROOFING. The action of acids or alkalis in the ground water is destructive to concrete and in such locations a standard waterproofing material should be applied. If finished brick parapets occur on top of retaining walls, a dampproof or waterproof course should be laid under them.

GRAVITY TYPE RETAINING WALL



SECTION

The Gravity retaining wall is perhaps the most common type and requires no complicated reinforcing. It depends upon its own shape and weight to resist earth pressure. It is the simplest to construct and for walls under 20 feet in height, it is often the most economical. Excavate to below frost line and to firm enough soil to withstand the pressure at the toe of the wall due to the tendency to overturn.

Since retaining walls do not withstand any pressure during construction the forms can be stripped as soon as the concrete has set enough to sustain its own weight. This allows the most economical and satisfactory finishing, which is accomplished by simply rubbing with a wooden float dipped in water and sand. In this way the form marks are rubbed off and a smooth surface obtained.

SUGGESTED VOLUMETRIC MIXES FOR CONCRETE

KIND OF CONCRETE WORK *	Mix by Volume Job Damp Materials			Workability or Consistency	Water Added at Mixer Per Bag, Gallons	A One Bag Batch Makes This Volume of Concrete Cu. Ft.	Materials for One Cubic Yard of Concrete			
	Cement Bags	Sand Cu. Ft.	Stone, Gravel Cu. Ft				Cement Bags	Sand Cu. Ft.	Stone, Gravel Cu. Ft.	Water Added at Mixer Gallons
Footings Heavy Foundations	1	3.75	5	stiff	6.4	6.2	4.3	16.3	21.7	27.6
Watertight Concrete for Cellar Walls and Walls Above Ground	1	2.5	3.5	medium	4.9	4.5	6.0	15.0	21.0	29.5
Driveways, Floors, Walks } One course	1	2.5	3	stiff	4.4	4.1	6.5	16.3	19.5	28.7
Driveways, Floors, Walks } Two course	1	Top 2	0	stiff	3.6	2.14	12.6	25.2		45.3
	1	Base 2.5	4	stiff	4.9	4.8	5.7	14.2	22.8	27.8
Pavements	1	2.2	3.5	stiff	4.3	4.2	6.4	14.1	22.4	27.5
Watertight Concrete for Tanks, Cisterns and Precast Units (piles, posts, thin reinforced slabs, etc.)	1	2	3	medium	4.1	3.8	7.1	14.2	21.3	29.3
				wet	4.9	3.9	6.9	13.8	20.7	33.7
Heavy Duty Floors	1	1.25	2	stiff	3.4	2.8	9.8	12.3	19.6	33.9
Mortar for Laying Concrete Building Units	1	6 plaster sand	1 sack 50 lbs. Hydrated Lime	medium	12.5	5.5	4.9	29.4	4.9 sacks of lime	61.2

**Many specifications require proportioning and measuring by weight with accurate control of a specified maximum allowable water content.*

STANDARD SYMBOLS FOR CONCRETE DESIGN

A_s = effective cross-sectional area of metal reinforcement in tension in beams.

A_v = total area of web reinforcement in tension in a section, or the total area of all bars bent up in any one plane.

b = width of rectangular beam.

b = width of flange of T-beam.

b' = width of stem of T-beam.

d = depth from compression surface of beam or slab to center of longitudinal tension reinforcement.

d' = depth from compression surface of beam or slab to center of compression reinforcement.

E_c = modulus of elasticity of concrete.

E_s = modulus of elasticity of steel.

f_c = compressive unit stress in extreme fiber of concrete.

f'_c = ultimate compressive strength of concrete at age of 28 days.

f_s = tensile unit stress in longitudinal reinforcement.

f'_s = compressive unit stress in longitudinal reinforcement.

f_v = tensile unit stress in web reinforcement.

j = ratio of lever arm of resisting couple to depth *d*.

k = ratio of depth of neutral axis to depth *d*.

m = bending moment or moment of resistance in general.

$n = E_s/E_c$—ratio of modulus of elasticity of steel to that of concrete.

p = ratio of effective area of tension reinforcement to effective area of concrete in beams $= A_s/bd$.

p' = ratio of effective area of compression reinforcement to effective area of concrete in beams.

s = spacing of stirrups measured perpendicular to the direction of the stirrups.

t = thickness of flange of T-beam.

V = total shear.

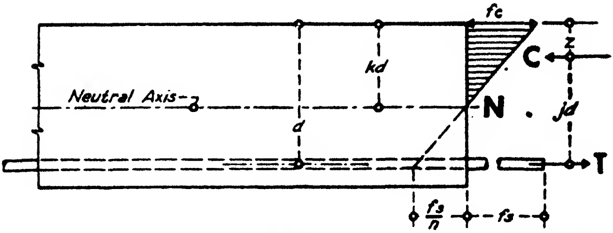
V' = excess of total shear over that permitted on the concrete.

v = shearing unit stress.

z = depth from compression surface of beam or slab of resultant of compressive stresses.

α = angle between inclined web bars and axis of beam.

RECTANGULAR BEAM AND SLAB FORMULAS



Computations of flexure in rectangular reinforced concrete beams and slabs, reinforced *for tension* only, are based on the following formulas.

Position of neutral axis,

$$k=\sqrt{2pn+(pn)^2}-pn \quad \text{.............(1)}$$

Arm of resisting couple,

$$j=1-\frac{k}{3} \quad \text{..................(2)}$$

Compressive unit stress in extreme fiber of concrete,

$$f_c=\frac{2M}{jkbd^2}=\frac{2pf_s}{k} \quad \text{...............(3)}$$

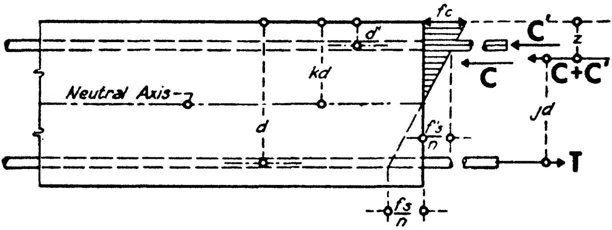
Tensile unit stress in longitudinal reinforcement,

$$f_s=\frac{M}{A_s jd}=\frac{M}{pjbd^2} \quad \text{..............(4)}$$

Steel ratio for balanced reinforcement,

$$p=\frac{1}{2}\,\frac{1}{\frac{f_s}{f_c}\left(\frac{f_s}{nf_c}+1\right)} \quad \text{..............(5)}$$

RECTANGULAR BEAM AND SLAB FORMULAS



Computations of flexure in rectangular reinforced concrete beams and slabs, *reinforced for both tension and compression*, are based on the following formulas.

Position of neutral axis,

$$k=\sqrt{2n\left(p+p'\frac{d'}{d}\right)+n^2(p+p')^2}-n(p+p')\,..(6)$$

Position of resultant compression,

$$z=\frac{\frac{1}{3}k^3d+2p'nd'\left(k-\frac{d'}{d}\right)}{k^2+2p'n\left(k-\frac{d'}{d}\right)}\,..........(7)$$

Arm of resisting couple,

$$jd=d-z\,.................(8)$$

Compressive unit stress in extreme fiber of concrete,

$$f_c=\frac{6M}{bd^2\left[3k-k^2+\frac{6p'n}{k}\left(k-\frac{d'}{d}\right)\left(1-\frac{d'}{d}\right)\right]}\,...(9)$$

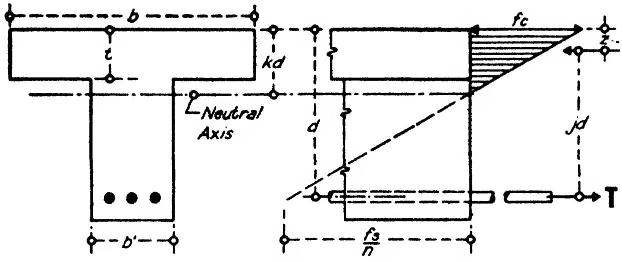
Tensile unit stress in longitudinal reinforcement,

$$f_s=\frac{M}{pjbd^2}=nf_c\frac{1-k}{k}\,...........(10)$$

Compressive unit stress in longitudinal reinforcement,

$$f'_s=nf_c\frac{k-\frac{d'}{d}}{k}\,..............(11)$$

T-BEAM FORMULAS



Computations of flexure in reinforced concrete *T-beams* are based on the following formulas.

The effective flange width to be used in the design of symmetrical T-beams should not exceed ¼th of the span length of the beam, its overhanging width on either side of the web should not exceed 8 times the thickness of the slab nor ½ the clear distance to the next beam. For beams having a flange on 1 side only, the effective overhanging flange width should not exceed $\frac{1}{12}$th of the span length of the beam, nor 6 times the thickness of the slab, nor ½ the clear distance to the next beam.

(a) NEUTRAL AXIS IN THE FLANGE.

Use formulas for rectangular beams and slabs.

(b) NEUTRAL AXIS BELOW THE FLANGE.

Position of neutral axis,

$$kd = \frac{2ndA_s + bt^2}{2nA_s + 2bt} \quad \ldots\ldots\ldots\ldots\ldots (12)$$

Position of resultant compression,

$$z = \left(\frac{3kd - 2t}{2kd - t}\right)\frac{t}{3} \quad \ldots\ldots\ldots\ldots\ldots (13)$$

Arm of resisting couple,

$$jd = d - z \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

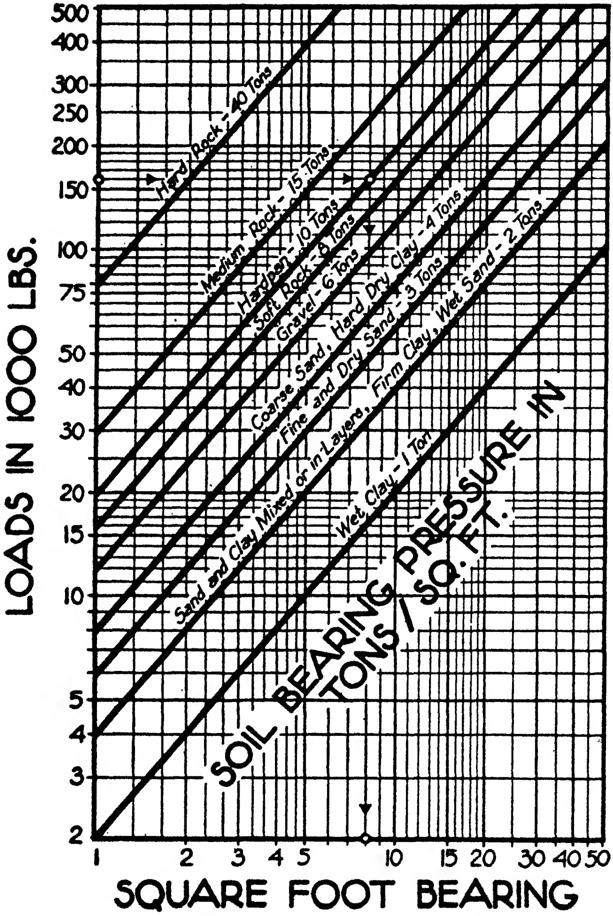
Compressive unit stress in extreme fiber of concrete,

$$f_c = \frac{Mkd}{bt(kd - \frac{1}{2}t)jd} = \frac{f_s}{n}\left(\frac{k}{1-k}\right) \quad \ldots\ldots (15)$$

Tensile unit stress in longitudinal reinforcement,

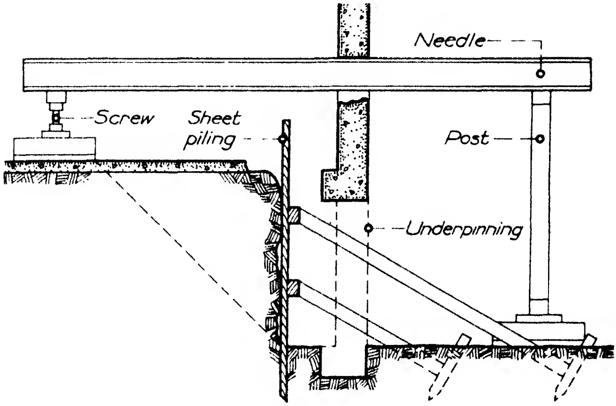
$$f_s = \frac{M}{A_s jd} \quad \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

FOUNDATION DESIGN CHART

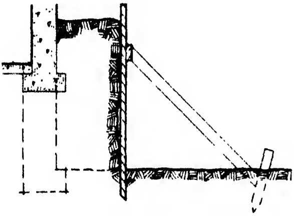


EXAMPLE. For a load of 160,000 lbs. on hardpan, the chart shows that a footing of 8 sq. ft. would be required. The values given for various soils are averages and may not agree with your local code. Be sure to check local requirements before using this chart. Values falling between the diagonal lines can be readily interpolated.

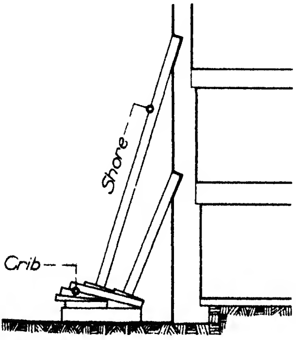
UNDERPINNING ABUTTING FOUNDATIONS



NEEDLING — Where old walls are in weak condition and/or the soil is not stable, the underpinning is accomplished with the aid of "needling." Shoring (*see below*) is usually necessary.

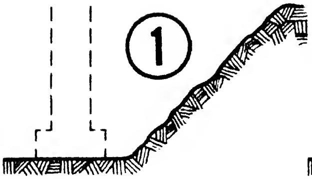


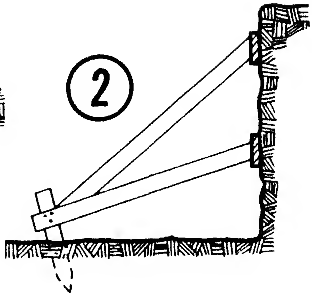
SHORING — Sockets are cut in the old wall and *shores*, also called *spur braces*, are inserted. These rest on a crib of timbering. Shores prevent slipping, bulging, and reduce the load to be supported while underpinning is placed.



SECTIONING — If the old walls are sound and the soil stable, a short excavation is made and a 6 ft. length of new wall is built under the old wall. When this new section will bear weight, another section is added, and so continued until the old wall has a continuous foundation under it.

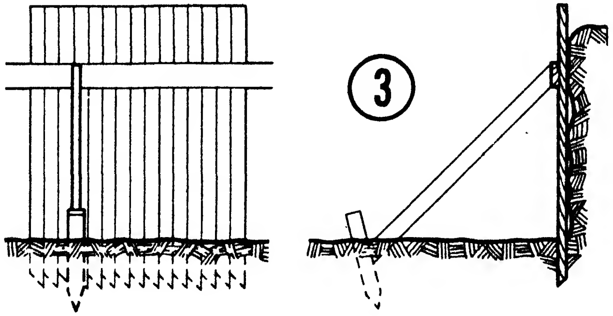
PREVENTING CAVE-INS IN EXCAVATIONS





1. SLOPED BANK — In this type the earth takes its natural angle of repose where the soil lacks the stability to stand vertically when cut. Such excavation is undesirable and is frequently forbidden in specifications because the undisturbed earth remaining creates a bowl for the collection of water (both before and after the backfilling is done) and an undesirably large amount of soil removal and backfill is required.

2. BRACED BANK — If the soil has some stability but will not stand unaided, very simple bracing may be sufficient.

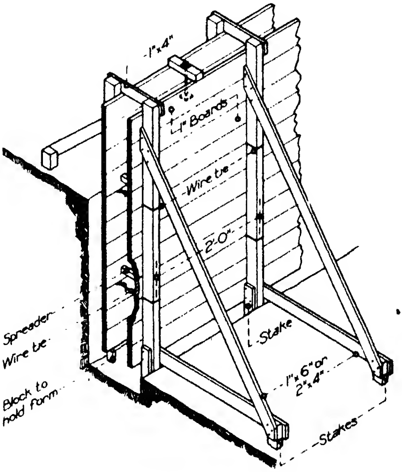


3. SHEET PILING — In very fluid soils sheet piling is driven and braced, and may be used as the outside form for poured foundations. Wood, steel, or concrete sheet piling are available.

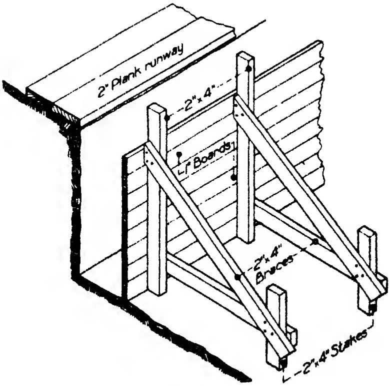
PREVENTING CAVE-INS IN EXCAVATIONS

4. VERTICAL BANK — In moist, clayey soil the earth may stand vertically without support. This makes it the most economical type where it is feasible. If no space is needed outside the foundation wall for inspection, waterproofing, piping, or other work, such earth may serve as an outside form for concrete as shown in the upper illustration. This procedure is not recommended, however, because in the pouring operation, earth particles may be too easily knocked off into the concrete. The absorption of the soil may draw water from the concrete and weaken it.

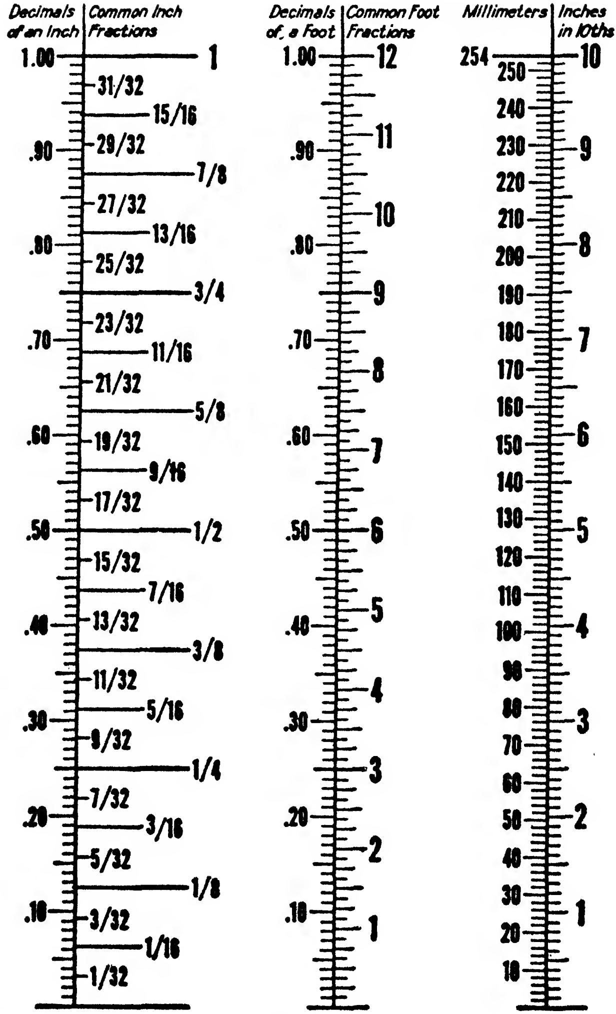
If poured concrete foundations are to be used, it is better to employ the method shown in the lower illustration, using an outside form.



5. TRENCH WALL — A trench is excavated and the encircling foundation wall is built. Then the general excavations are carried on inside the walls, which may require bracing.



INCH AND FOOT EQUIVALENTS



DECIMALS OF AN INCH | DECIMALS OF A FOOT | MILLIMETER EQUIVALENTS

DECIMALS OF A FOOT

0"	.0000	1"	.0833	2"	.166667	3"	.2500
1/16	.0052	1 1/16	.0885	2 1/16	.171875	3 1/16	.2552
1/8	.0104	1 1/8	.09375	2 1/8	.1771	3 1/8	.2604
3/16	.015625	1 3/16	.0990	2 3/16	.1823	3 3/16	.265625
1/4	.0208	1 1/4	.1042	2 1/4	.1875	3 1/4	.2708
5/16	.0260	1 5/16	.109375	2 5/16	.1927	3 5/16	.2760
3/8	.03125	1 3/8	.1146	2 3/8	.1979	3 3/8	.28125
7/16	.0365	1 7/16	.1198	2 7/16	.203125	3 7/16	.2865
1/2	.0417	1 1/2	.1250	2 1/2	.2083	3 1/2	.2917
9/16	.046875	1 9/16	.1302	2 9/16	.2135	3 9/16	.296875
5/8	.0521	1 5/8	.1354	2 5/8	.21875	3 5/8	.3021
11/16	.0573	1 11/16	.140625	2 11/16	.2240	3 11/16	.3073
3/4	.0625	1 3/4	.1458	2 3/4	.2292	3 3/4	.3125
13/16	.0677	1 13/16	.1510	2 13/16	.234375	3 13/16	.3177
7/8	.0729	1 7/8	.15625	2 7/8	.2396	3 7/8	.3229
15/16	.078125	1 15/16	.1615	2 15/16	.2448	3 15/16	.328125

4"	.3333	5"	.416667	6"	.5000	7"	.5833
4 1/16	.3385	5 1/16	.421875	6 1/16	.5052	7 1/16	.5885
4 1/8	.34375	5 1/8	.4271	6 1/8	.5104	7 1/8	.59375
4 3/16	.3490	5 3/16	.4323	6 3/16	.515625	7 3/16	.5990
4 1/4	.3542	5 1/4	.4375	6 1/4	.5208	7 1/4	.6042
4 5/16	.359375	5 5/16	.4427	6 5/16	.5260	7 5/16	.6093
4 3/8	.3646	5 3/8	.4479	6 3/8	.53125	7 3/8	.6146
4 7/16	.3698	5 7/16	.453125	6 7/16	.5365	7 7/16	.6198
4 1/2	.3750	5 1/2	.4583	6 1/2	.5417	7 1/2	.6250
4 9/16	.3802	5 9/16	.4635	6 9/16	.546875	7 9/16	.6302
4 5/8	.3854	5 5/8	.46875	6 5/8	.5521	7 5/8	.6354
4 11/16	.390625	5 11/16	.4740	6 11/16	.5573	7 11/16	.640625
4 3/4	.3958	5 3/4	.4792	6 3/4	.5625	7 3/4	.6458
4 13/16	.4010	5 13/16	.484375	6 13/16	.5677	7 13/16	.6510
4 7/8	.40625	5 7/8	.4896	6 7/8	.5729	7 7/8	.65625
4 15/16	.4115	5 15/16	.4948	6 15/16	.578125	7 15/16	.6615

8"	.666667	9"	.7500	10"	.8333	11"	.916667
8 1/16	.671875	9 1/16	.7552	10 1/16	.8385	11 1/16	.921875
8 1/8	.6771	9 1/8	.7604	10 1/8	.84375	11 1/8	.9271
8 3/16	.6823	9 3/16	.765625	10 3/16	.8490	11 3/16	.9323
8 1/4	.6875	9 1/4	.7708	10 1/4	.8542	11 1/4	.9375
8 5/16	.6927	9 5/16	.7760	10 5/16	.859375	11 5/16	.9427
8 3/8	.6979	9 3/8	.78125	10 3/8	.8646	11 3/8	.9479
8 7/16	.703125	9 7/16	.7865	10 7/16	.8698	11 7/16	.953125
8 1/2	.7083	9 1/2	.7917	10 1/2	.8750	11 1/2	.9583
8 9/16	.7135	9 9/16	.796875	10 9/16	.8802	11 9/16	.9635
8 5/8	.71875	9 5/8	.8021	10 5/8	.8854	11 5/8	.96875
8 11/16	.7240	9 11/16	.8073	10 11/16	.890625	11 11/16	.9740
8 3/4	.7292	9 3/4	.8125	10 3/4	.8958	11 3/4	.9792
8 13/16	.734375	9 13/16	.8177	10 13/16	.9010	11 13/16	.984375
8 7/8	.7396	9 7/8	.8229	10 7/8	.90625	11 7/8	.9896
8 15/16	.7448	9 15/16	.828125	10 15/16	.9115	11 15/16	.9948

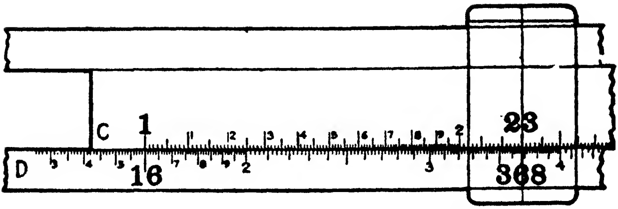
DECIMALS OF AN INCH

Fraction	64ths	Decimal	Fraction	64ths	Decimal
			1/2	32	.500
—	1	.015625	—	33	.515625
1/32	2	.03125	17/32	34	.53125
—	3	.046875	—	35	.546875
1/16	4	.0625	9/16	36	.5625
—	5	.078125	—	37	.578125
3/32	6	.09375	19/32	38	.59375
—	7	.109375	—	39	.609375
1/8	8	.125	5/8	40	.625
—	9	.140625	—	41	.640625
5/32	10	.15625	21/32	42	.65625
—	11	.171875	—	43	.671875
3/16	12	.1875	11/16	44	.6875
—	13	.203125	—	45	.703125
7/32	14	.21875	23/32	46	.71875
—	15	.234375	—	47	.734375
1/4	16	.250	3/4	48	.750
—	17	.265625	—	49	.765625
9/32	18	.28125	25/32	50	.78125
—	19	.296875	—	51	.796875
5/16	20	.3125	13/16	52	.8125
—	21	.328125	—	53	.828125
11/32	22	.34375	27/32	54	.84375
—	23	.359375	—	55	.859375
3/8	24	.375	7/8	56	.875
—	25	.390625	—	57	.890625
13/32	26	.40625	29/32	58	.90625
—	27	.421875	—	59	.921875
7/16	28	.4375	15/16	60	.9375
—	29	.453125	—	61	.953125
15/32	30	.46875	31/32	62	.96875
—	31	.484375	—	63	.984375

CONVERSION FACTORS

One board foot	=144	cubic inches
One centimeter	=0.3937	inches
One centimeter	=0.01	meters
One centimeter	=10	millimeters
One cubic centimeter	$=3.531 \times 10^{-5}$	cubic feet
One cubic centimeter	=0.06102	cubic inches
One cubic foot	=28317	cubic cms.
One cubic foot	=1728	cubic inches
One cubic foot	=7.481	gallons
One cubic foot	=28.32	liters
One cubic inch	=16.39	cubic cms.
One degree (angle)	=0.01745	radians
One foot per second	=0.6818	miles per hour
One gallon	=231	cubic inches
One gallon	=3.785	liters
One gram	$=2.205 \times 10^{-3}$	pounds
One gram per cu. cm.	=62.43	pounds per cubic foot
One horsepower	=550	foot-pounds per second
One horsepower	=0.7457	kilowatts
One inch	=2.540	centimeters
One kilogram	=1000	grams
One kilogram	=2.205	pounds
One kilogram per sq. mm.	=1422	pounds per square inch
One mile	=5280	feet
One pound	=453.6	grams
One pound per sq. in.	=0.068	atmospheres
One pound per sq. in.	=2.307	feet of water
One pound per sq. in.	=2.036	inches of mercury
One pound per sq. in.	$=7.031 \times 10^{-4}$	kilograms per sq. mm.
One radian	=57.30	degrees
One square inch	=6.452	square cms.
One ton (long)	=2240	pounds
One ton (long) per sq. in.	=1.575	kilograms per sq. mm.

MULTIPLICATION AND DIVISION



$1600 \times .23 = 368$

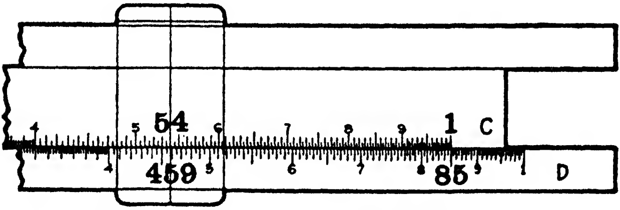
$\frac{36.8}{23} = 1.6$

MULTIPLICATION

In this problem the slide projects to the right, and the position of the decimal point in the result is found by taking one less than the sum of the whole digits in the two factors. Thus 1600 has 4 whole digits, .23 has 0 whole digits, so $(4+0)-1=3$, and there are 3 whole digits in the result.

DIVISION

Division is exactly the opposite of multiplication. The position of the decimal point in the result, when the slide projects to the right, is found by subtracting the number of whole digits in the divisor from the number of whole digits in the dividend and then adding one. Thus 36.8 has 2 whole digits, 23 has 2 whole digits, so $(2-2)+1=1$.



$850 \times .054 = 45.9$

$\frac{45\,900}{5.4} = 8\,500$

MULTIPLICATION

When the slide projects to the left as in this example, the decimal point is found by adding the whole digits in both factors. Thus 850 has 3 whole digits, .054 has -1 whole digits, so the result will have $3+(-1)=2$ whole digits.

DIVISION

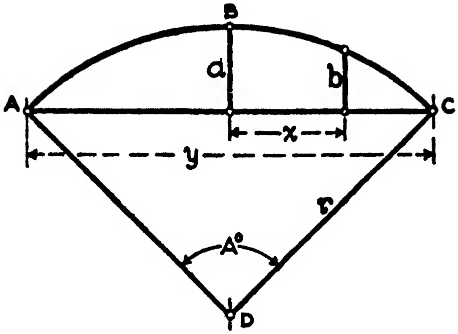
When the slide projects to the left in division, the number of whole digits in the result will be found to equal the number of whole digits in the dividend less the number of whole digits in the divisor. Thus 45900 has 5 whole digits, 5.4 has 1 whole digit, so the result will have $5-1=4$ whole digits in the result.

NOTE

321.9876 has 3 whole digits
32.1987 has 2 whole digits
3.2198 has 1 whole digit

.3219 has 0 whole digits
.0321 has -1 whole digits
.0032 has -2 whole digits

CIRCULAR ARCS, CHORDS AND SEGMENTS



Area of circular sector ABCD = arc $\times \frac{r}{2}$

Length of arc ABC $= \frac{\pi r A^0}{180} = 0.017453A^0 r$

$$r = \frac{y^2}{8a} + \frac{a}{2}$$

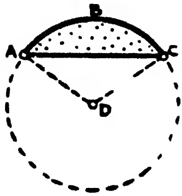
$$x = \sqrt{r^2 - (r + b - a)^2}$$

$$b = \sqrt{r^2 - x^2} - (r - a)$$

$$a = r - \sqrt{r^2 - \frac{y^2}{4}} = \frac{y}{2} \tan \frac{A}{4} = r + b - \sqrt{r^2 - x^2}$$

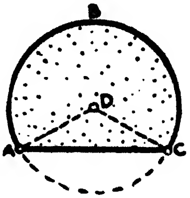
$$y = 2\sqrt{2ar - a^2} = 2r \sin \frac{A}{2}$$

$$A^0 = \frac{57.29578 \text{ arc}}{r}$$



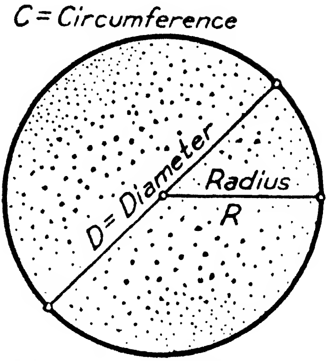
Area of the segment ABC = area of the sector ABCD minus the area of the triangle ACD.

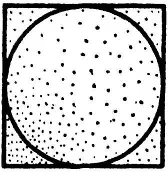
Area of the segment ABC = area of the sector ABCDA plus the area of the triangle ADC.



THE CIRCLE AND THE SQUARE

$\pi = 3.14159265+$
$C = \pi D = 2\pi R$
$C = 3.5446\sqrt{\text{area}}$
$D = 0.3183\,C = 2R$
$D = 1.1283\sqrt{\text{area}}$
$\text{Area} = \pi R^2 = 0.785398 D^2$
$\text{Area} = 0.07958 C^2 = \frac{\pi D^2}{4}$



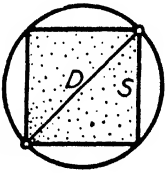


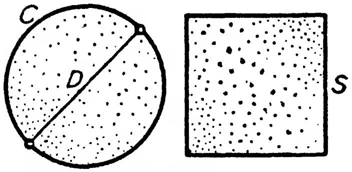
CIRCUMSCRIBED SQ.

Area of square = 1.2732 × area of circle

Area of square = 0.6366 × area of circle
$S = 0.7071\,D$
$D = 1.4142\,S$

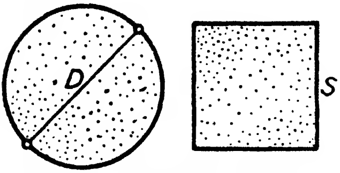
INSCRIBED SQUARE





EQUAL AREAS

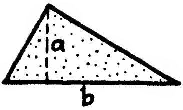
$S = 0.8862\,D$
$S = 0.2821\,C$
$D = 1.1284\,S$



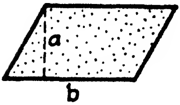
EQUAL PERIPHERIES

$S = 0.7854\,D$
$D = 1.2732\,S$

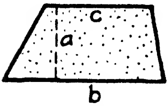
AREAS OF PLANE FIGURES



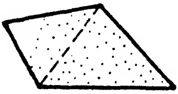
Area of triangle $= \frac{a\ b}{2}$



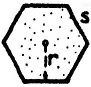
Area of parallelogram $= a\ b$



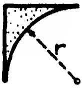
Area of trapezoid $= a \left(\frac{b + c}{2}\right)$



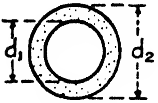
Area of trapezium = Divide into two triangles and find the area of each separately.



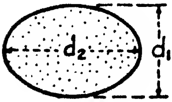
Area of regular polygon having n sides $= r \left(\frac{n\ s}{2}\right)$



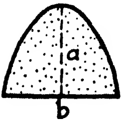
Area $= .2146\ r^2$



Area $= 0.7854\ (d_2^2 - d_1^2)$



Area of ellipse $= 0.7854\ d_1 d_2$



Area of parabola $= \frac{2\ a\ b}{3}$

SOLID, DRY AND LIQUID MEASURE

CUBIC OR SOLID MEASURE.

United States and British.

1 cubic inch = .0005787 cubic foot = .000021433 cubic yard.

1 cubic foot = 1728 cubic inches = .03703704 cubic yard.

1 cubic yard = 27 cubic feet = 46656 cubic inches.

1 cord of wood = 128 cubic feet = 4 feet by 4 feet by 8 feet.

1 perch of masonry = 24.75 cubic feet = 16.5 feet by 1.5 feet by 1 foot. It is usually taken as 25 cubic feet.

DRY MEASURE.

United States only.

Pints	*Quarts*	*Gallons*	*Pecks*	*Bushels*	*Cubic Inches*
1	.50	.125	.0625	.015625	33.6003125
2	1.	.25	.125	.03125	67.200625
8	4.	1.	.05	.125	268.8025
16	8.	2.	1.	.25	537.605
64	32.	8.	4.	1.	2150.42

1 heaped bushel = 1.25 struck bushel, and the cone must be not less than 6 inches high.

LIQUID MEASURE.

United States only.

Gills	*Pints*	*Quarts*	*Gallons*	*Barrels*	*Cubic Inches*
1	.25	.125	.03125	.000992	7.21875
4	1.	.5	.125	.003968	28.875
8	2.	1.	.25	.007937	57.75
32	8.	4.	1.	.031746	231.
1008	252.	126.	31.5	1.	7276.5

The British imperial gallon = 277.410 cubic inches or 10 pounds avoirdupois of pure water at 62° F. and barometer at 30 inches.

The British imperial gallon = 1.20091 United States gallons.

1 fluid drachm = 60 minims = .125 fluid ounce = .0078125 pint.

1 fluid ounce = 480 minims = 8 drachms = .0625 pint.

LAND, LINEAR AND MISC. MEASURE

LINEAR MEASURE

United States and British.

Inches	*Feet*	*Yards*	*Rods*	*Furlongs*	*Miles*
1	.08333	.02778	.0050505	.00012626	.00001578
12	1.	.33333	.0606061	.00151515	.00018939
36	3.	1.	.1818182	.00454545	.00056818
198	16.5	5.5	1.	.025	.003125
7920	660.	220.	40.	1.	.125
63360	5280.	1760.	320.	8.	1.

ROPE AND CABLE MEASURE.

1 inch = .111111 span = .013889 fathom = .0001157 cable's length.
1 span = 9 inches = .125 fathom = .00104167 cable's length.
1 fathom = 6 feet = 8 spans = 72 inches = .008333 cable's length.
1 cable's length = 120 fathoms = 720 feet = 960 spans = 8640 inches.

NAUTICAL MEASURE.

1 nautical mile, as adopted by the United States Coast and Geodetic Survey, equals the length of one minute of arc of a great circle of a sphere whose surface equals that of the earth = 6080.204 feet = 1.1516 statute miles.

1 league = 3 nautical miles = 18240.613 feet.

GUNTER'S CHAIN.

1 link = 7.92 inches = .01 chain = .000125 mile.
1 chain = 100 links = 66 feet = 4 rods = .0125 mile.
1 mile = 80 chains = 8000 links.

SQUARE OR LAND MEASURE.

United States and British.

Square Inches	*Square Feet*	*Square Yards*	*Square Rods*	*Acres*	*Square Miles*
1	.006944	.0007716	....	....	....
144	1.	.111111	....	....	....
1296	9.0	1.	.03306	.0002066	....
39204	272.25	30.25	1.	.00625	.00000977
6272640	43560.	4840.	160.	1.	.0015625
	27878400.	3097600.	102400.	640.	1.

1 square rood = 40 square rods.
1 acre = 4 square roods.
1 square acre = 208.71 feet square.

U. S. AND BRITISH WEIGHTS

AVOIRDUPOIS WEIGHT.

United States and British.

*Grains**	*Drams*	*Ounces*	*Pounds*	*Hundred-weight*	*Gross Tons*
1.	.03657	.002286	.000143	.00000128	.000000064
27.34375	1.	.0625	.003906	.00003488	.000001744
437.5	16.	1.	.0625	.00055804	.00002790
7000.	256.	16.	1.	.0089286	.0004464
784000.	28672	1792.	112.	1.	.05
15680000.	573440.	35840.	2240.	20.	1.

1 pound avoirdupois = 1.215278 pounds troy.
1 net ton = 2000 pounds = .892857 gross ton.

TROY WEIGHT.

United States and British.

Grains†*	*Pennyweight*	*Ounces†*	*Pounds†*
1	.041667	.0020833	.0001736
24	1.	.05	.0041667
480	20.	1.	.0833333
5760	240.	12.	1.

1 pound troy = .822857 pound avoirdupois.
175 ounces troy = 192 ounces avoirdupois.

APOTHECARIES' WEIGHT.

United States and British.

Grains†*	*Scruples*	*Drams*	*Ounces†*	*Pounds†*
1	.05	.016667	.0020833	.000173611
20	1.	.333333	.0416667	.0034722
60	3.	1.	.125	.0104167
480	24.	8.	1.	.0833333
5760	288.	96.	12.	1.

†The pound, ounce and grain are the same as in troy weight.
*The avoirdupois grain = troy grain = apothecaries' grain.

METRIC WEIGHTS AND MEASURE

LENGTH, CAPACITY AND WEIGHT.

Length	*Kilometre*	*Hecto-metre*	*Decametre*	*Metre*	*Decimetre*	*Centimetre*	*Millimetre*
Capacity	*Kilolitre or Stere*	*Hectolitre or Decistere*	*Decalitre or Centistere*	*Litre or Millistere*	*Decilitre*	*Centilitre*	*Millilitre*
Weight	*Kilo-gramme*	*Hecto-gramme*	*Deca-gramme*	*Gramme*	*Deci-gramme*	*Centi-gramme*	*Milli-gramme*
	1	10	100	1000	10000	100000	1000000
		1	10	100	1000	10000	100000
			1	10	100	1000	10000
				1	10	100	1000
				.1	1	10	100
				.01	.1	1	10
				.001	.01	.1	1

1 myriametre = 10 kilometres = 10000 metres.
1 tonne = 1000 kilogrammes = 100 quintals = 10 myriagrammes.
1 gramme = weight of 1 cubic centimetre of distilled water at its maximum density at sea level in latitude of Paris and barometer at 760 millimetres.
1 litre = 1 cubic decimetre.

SQUARE OR SURFACE MEASURE.

Square Kilometre	*Square Hectometre or Hectare*	*Square Decametre or Are*	*Square Metre or Centiare*	*Square Decimetre*	*Square Centimetre*	*Square Millimetre*
1	100	10000	1000000			
	1	100	10000	1000000		
	.01	1	100	10000	1000000	
	.0001	.01	1	100	10000	1000000
	.000001	.0001	.01	1	100	10000
		.000001	.0001	.01	1	100
			.000001	.0001	.01	1

1 square myriametre = 100 square kilometres = 100000000 square metres.

CUBIC MEASURE.

Cubic Decametre	*Cubic Metre*	*Cubic Decimetre*	*Cubic Centimetre*	*Cubic Millimetre*
1	1000	1000000	1000000000	
.001	1	1000	1000000	1000000000
.000001	.001	1	1000	1000000
.000000001	.000001	.001	1	1000
	.000000001	.000001	.001	1

1 cubic metre = 1 kilolitre = 1 stere.

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

ACRE equals:
a square 208.71 feet on a side
43,560 square feet
4,840 square yards
1/640th square mile
0.404687 hectare
4,046.87 square meters

BARREL (flour, US) equals:
196 pounds av, customary value

BARREL (liquid, US) equals:
No legal value
31 1/2 and 31 gallons (US), customary value to some extent
42 gallons (US—Standard Oil Co.), customary value to some extent

BOARD FOOT equals:
1 square foot X 1 inch thick.

BUSHEL (Br) equals:
4 pecks (Br)
8 gallons (Br)
32 quarts (Br)
64 pints (Br)
2,219.28 cu. inches
1.28431 cu. feet
1.03202 bushels (US)
36.3677048 liters or cu. decimeters

BUSHELS (US) equals:
4 pecks (US)
32 quarts (dry; US)
64 pints (dry; US)
2,150.420 cu. inches
1.24446 cu. feet
35.23928 liters or cu. decimeters
0.3523928 hectoliter
0.968972 bushels (Br)
7.75178 gallons (Br)

CABLE (cable length, Br) equals:
0.1 knot or nautical mile (Br)
608 feet (sometimes taken as 608.6 feet)

CABLE (cable length, US) equals:
720 feet
120 fathoms (US)
219.457 meters

CENTIMETER equals:
0.01 meter
0.0328083 foot
0.393700 inch
393.700 mils

CENTIMETER³ (cu. cm.) or milliliter, equals:
0.001 liter or cu. decimeter
0.0616234 cu. inch

CHAIN, engineer's, equals:
100 links
100 feet
30.480 meters

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

CHAIN, Gunter's or surveyor's, equals:
- 100 links
- 66 feet
- 4 rods, perches or poles
- 0.1 furlong
- 1/80 statute mile (US)
- 20.117 meters

CHAIN, metric, equals:
- 20 meters
- 100 links
- 65.61667 feet

CIRCULAR MIL, CIRCULAR INCH, CIRCULAR CENTIMETER, ETC.
See mil, inch, centimeter, etc.

CORD (of wood) equals:
- 4 feet x 4 x 8 feet
- 128 cu. feet
- 8 cord feet
- 3.62458 cu. meters

DRAM (av) equals:
- 1/16 ounce (av)
- 27.34375 grains
- 0.455729 dram (ap)
- 1.77185 grams

DRAM (ap) equals:
- 1/8 ounce (troy or ap)
- 3 scruples
- 60 grains
- 2.19429 drams (av)
- 3.887934 grams

FATHOM (US) equals:
- 6 feet
- 1.8288 meters

FOOT (US) equals:
- 12,000 mils
- 12 inches
- 1/3 yard
- 1/5280 or 0.000189394 statute mile (US)
- 30.4801 centimeters
- 1.0000029 feet (Br)

FOOT^2 (sq. ft.) (US) equals:
- 144 sq. inches
- 1/9 or 0.111111 sq. yard
- 183.346 cir. inches
- 1.27324 cir. feet
- 929.034 sq. centimeters
- 1.0000057 sq. feet (Br)

FOOT^3 (cu. ft.) equals:
- 1.728 cu. inches
- 0.0370370 cu. yard
- 28.3170 liters or cu. decimeters
- 7.48052 gallons (US)
- 0.803564 bushel (US)

GALLON (liquid; US) equals:
- 231 cu. inches
- 0.133681 cu. foot
- 3.78543 liters or cu. decimeters
- 3,785.43 cu. centimeters
- 32 gills (US)
- 8 pints (liquid; US)
- 4 quarts (liquid; US)
- 0.8327024 gallon (Br)

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

GILL (liquid; US) equals:
1/4 pint (liquid; US)
1/32 gallon (US)

GRAIN (same in av, troy and ap weights) equals:
1/7000 pound (av)
1/5760 pound (troy or ap)
0.00228571 ounce (av)
0.0647989 gram

GRAM equals:
0.001 kilogram
15.43235639 grains
0.564383 drams (av)
0.0352740 ounce (av)
0.00220462 pound (av)
0.771618 scruple
0.257206 drams (ap)
0.0321507 ounce (troy or ap)

HOGSHEAD (liquid; US) equals:
63 gallons (US)
2 barrels of 31 1/2 gallons (US)
238.48 liters

HUNDREDWEIGHT, short, equals:
100 pounds (av)
1/20 or 0.05 short or net ton
45.35924 kilograms

HUNDREDWEIGHT, long, equals:
112 pounds (av)
1/20 or 0.05 long or gross ton
50.8024 kilograms

INCH equals:
1,000 mils
1/12 foot
1/36 yard
2.540005 centimeters

INCH^2 (sq. in.) equals:
1/144 or 0.00694444 sq. foot
1,000,000 sq. mils
1,273,240 cir. mils
1.27324 circular inches
6.45163 sq. centimeters
8.21447 cir. centimeters

INCH^3 (cu. in.) equals:
1/1728 or 0.000578704 cu. foot
16.38716 cu. centimeters or milliliters
0.01638716 liter or cu. decimeter

KILOGRAM OR KILO equals:
1,000 grams
0.001 metric ton
15,432.35639 grains
35.2740 ounces (av)
2.20462 pounds (av)
0.0220462 hundredweight (short)
0.0196841 hundredweight (long)
0.00110231 short or net ton
0.000984206 long or gross ton
32.1507 ounces (troy or ap)

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

KILOMETER equals:
1,000 meters
3,280.83 feet
1,093.61 yards
0.621370 statute mile (US)
0.539593 knot or nautical mile (US)

KNOT (US) equals:
1 nautical mile (US) per hour

LEAGUE (US) equals:
15,840 feet
5,280 yards
3 statute miles (US)
4.82805 kilometers
Sometimes taken as 3 knots or nautical miles (US)

LINK equals:
0.01 of measuring chain (In the engineer's chain, each link is 12 inches long; in the Gunter's or surveyor's chain, each link is 7.92 inches long; in the metric chain, each link is 20 centimeters long.)

LITER equals:
1 cu. decimeter
10 deciliters
1,000 cu. centimeters
0.01 hectoliter
0.001 cu. meter
61.0234 cu. inches
0.0353145 cu. foot
2.11336 pints (liquid; US)
1.05668 quarts (liquid; US)
0.264170 gallon (US)
1.81616 pints (dry; US)
0.908078 quart (dry; US)
0.113510 peck (US)
0.0283774 bushel (US)
1.75980 pints (Br)
0.879902 quart (Br)
0.219975 gallon (Br)
0.109988 peck (Br)
0.0274969 bushel (Br)

METER (international) equals:
0.001 kilometer
0.01 hectometer
0.1 dekameter
10 decimeters
100 centimeters
1,000 millimeters
1,000,000 micrometers
39.370113 inches (Br)
39.37 inches exact legal value (US)
3.28083 feet (US)
1.09361 yards (US)
0.000621370 statute mile (US)

MIL, circular, equals:
0.000001 circular inch
0.785398 sq. mil
0.000000785398 sq. inch
0.000645163 cir. millimeter
.000506709 sq. millimeter

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

MILE, statute or land (US) equals:
5,280 feet
1.60935 kilometers

MILE² (sq. mile) equals:
640 acres
3,097,600 sq. yards
2.59000 sq. kilometers

MILLIMETER equals:
0.001 meter
39.370 mils
0.039370 inch

OUNCE (ap) same as troy ounce, equals:
480 grains
24 scruples
8 drams (ap)
1/12 or 0.0833333 pound (troy or ap)
31.1035 grams

OUNCE (av) equals:
16 drams (av)
1/16 or 0.062500 pound (av)
437.500 grains
28.3495 grams
0.911458 ounce (troy or ap)

OUNCE (troy, gold and silver) same as ap ounce, equals:
480 grains
20 pennyweights
1/12 or 0.0833333 pound (troy or ap)
0.6085714 pound (av)
31.1035 grams
1.09714 ounces (av)

OUNCE, fluid (ap US) equals:
480 minims (ap US)
8 fluid drams (ap US)
1/16 pint (ap US)
1.80469 cu. inches
0.0295737 liter

PECK (US) equals
8 quarts (dry; US)
0.25 bushel (US)
8.80982 liters

PENNYWEIGHT (troy) equals:
24 grains
1.55517 grams
1/20 ounce (troy or ap)

PERCH, linear, see rod

PERCH, of masonry, equals:
16 1/2 feet x 1 1/2 feet x 1 foot
24 3/4 cu. feet (generally taken as 25 cu. feet, sometimes 22 cu. feet)
0.70085 cu. meter

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

PINT (dry; US) equals:
0.5 quart (dry; US)
0.550614 liter

PINT (liquid; US) equals:
0.125 gallon (US)
0.473179 liter

PIPE or butt (liquid; US) equals:
126 gallons (US)
2 hogsheads (US)
476.96 liters

POLE, see rod

POUND (av) equals:
7,000 grains
16 ounces (av)
256 drams (av)
14.5833 ounces (troy or ap)
453.5924277 grams
0.4535924277 kilogram
7000/5760 or 0.21528 pounds (troy or ap)

POUND (troy or ap) equals:
5,760 grains 12 ounces (troy or ap)
0.373242 kilogram
5760/7000 or 1.21528 pound (av)

QUART (dry; US) equals:
2 pints (dry; US)
1/8 or 0.125 peck (US)
1/32 or 0.031250 bushel (US)
67.200625 cu. inches
0.0388893 cu. foot
1.10123 liters
1,101.23 cu. centimeters
11.0123 deciliters
1.16365 quarts (liquid; US)
0.968972 quart (Br)
0.242243 gallon (Br)

QUART (liquid; US) equals:
0.25 gallon (US)
0.946359 liter

ROD or perch or pole, equals:
16 1/2 feet
5 1/2 yards
1/40 furlong
1/320 statute mile (US)
5.0292 meters

ROOD equals:
1/4 acre
40 sq. rods, poles or perches
1,210 sq. yards
1,011.72 sq. meters

SECTION (of land) equals:
1 mile square
640 acres

EQUIVALENTS OF MEASUREMENT

ap = apothecary; av = avoirdupois; Br = British; US = United States.

SQUARE (building) equals:

100 sq. feet

TON (gross) displacement of water, equals:

35.8813 cu. feet
1.01605 cu. meters

TON register (shipping for whole vessels) equals:

100 cu. feet
2.8317 cu. meters

TON, long or gross, equals:

2,240 pounds (av)
1.12 short or net tons
1,016.05 kilograms
1.01605 metric tons

TON, short or net, equals:

2,000 pounds (av)
20 hundredweights (short)
907.185 kilograms
0.907185 metric ton
17.8571 hundredweights (long)
0.892857 long or gross ton

TON, metric, (tonne, tonneau, millier or bar) equals:

2,204.62 pounds (av)
1.10231 short or net tons
0.984206 long or gross ton
1,000 kilograms

YARD (US) equals:

36 inches
3 feet
1.0000029 yards (Br)
0.914402 meter

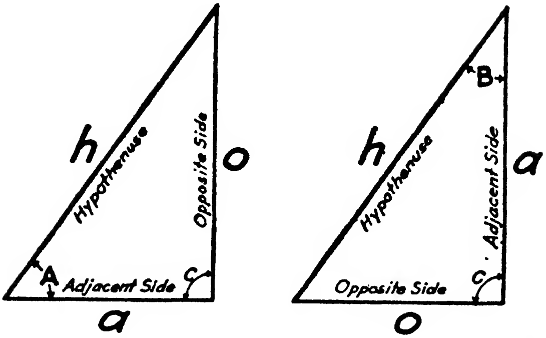
YARD². (sq. yd.) (US) equals:

1,296 sq. inches
9 sq. feet
1/4840 or 0.000206612 acre
0.836131 sq. meter
1.0000057 sq. yards (Br)

YARD³ (cu. yd.) equals:

27 cu. feet
46,656 cu. inches
0.764559 cu. meter

SOLUTION OF RIGHT TRIANGLES



In any right triangle, if the side o = 4, and the hypothenuse h = 5, the ratio of o/h will be 4/5, which equals 0.80, and is called the *sine* of the given angle. Regardless of the size of the triangle the sine will always be the same if the angle is the same, and vice versa. For instance, if the sides were o = 8 and h = 10, or if o = 1.12 and h = 1.40, the sine in either case would be 0.80 and the angle would be 53°-07′-48″.

This principle holds true for all of the six ratios, or *functions*, that can be made from the three sides. These functions with the usual abbreviations are as follows:

$\frac{o}{h}$ = Sine (sin) $\frac{h}{o}$ = Cosecant (csc)

$\frac{a}{h}$ = Cosine (cos) $\frac{h}{a}$ = Secant (sec)

$\frac{o}{a}$ = Tangent (tan) $\frac{a}{o}$ = Cotangent (cot)

Following *Data Sheets* give the numerical values of the various functions for different angles between 0° and 90° with which any unknown part of a right triangle can be found if two other parts are known. Knowing two of the three sides one of the functions is calculated and the corresponding angle can be found from the tables, or from geometry the third side can be computed. Knowing an angle, the proper function can be found from the tables to use as a multiplier of the known side to find the unknown side.

$$o = h \sin = a \tan = \sqrt{(h+a)(h-a)}$$

$$a = h \cos = o \cot = \sqrt{(h+o)(h-o)}$$

$$h = a \sec = o \csc = \sqrt{o^2 + a^2}$$

$$C = 90° = A + B$$

SINES 0° TO 45°
COSINES 45° TO 90°

COSINE		60′	50′	40′	30′	20′	10′	0′
	SINE	0′	10′	20′	30′	40′	50′	60′
89°	0°	.00000	.00291	.00582	.00873	.01164	.01454	.01745
88	1	.01745	.02036	.02327	.02618	.02908	.03199	.03490
87	2	.03490	.03781	.04071	.04362	.04653	.04943	.05234
86	3	.05234	.05524	.05814	.06105	.06395	.06685	.06976
85	4	.06976	.07266	.07556	.07846	.08136	.08426	.08716
84	5	.08716	.09005	.09295	.09585	.09874	.10164	.10453
83	6	.10453	.10742	.11031	.11320	.11609	.11898	.12187
82	7	.12187	.12476	.12764	.13053	.13341	.13629	.13917
81	8	.13917	.14205	.14493	.14781	.15069	.15356	.15643
80	9	.15643	.15931	.16218	.16505	.16792	.17078	.17365
79	10	.17365	.17651	.17937	.18224	.18509	.18795	.19081
78	11	.19081	.19366	.19652	.19937	.20222	.20507	.20791
77	12	.20791	.21076	.21360	.21644	.21928	.22212	.22495
76	13	.22495	.22778	.23062	.23345	.23627	.23910	.24192
75	14	.24192	.24474	.24756	.25038	.25320	.25601	.25882
74	15	.25882	.26163	.26443	.26724	.27004	.27284	.27564
73	16	.27564	.27843	.28123	.28402	.28680	.28959	.29237
72	17	.29237	.29515	.29793	.30071	.30348	.30625	.30902
71	18	.30902	.31178	.31454	.31730	.32006	.32282	.32557
70	19	.32557	.32832	.33106	.33381	.33655	.33929	.34202
69	20	.34202	.34475	.34748	.35021	.35293	.35565	.35837
68	21	.35837	.36108	.36379	.36650	.36921	.37191	.37461
67	22	.37461	.37730	.37999	.38268	.38537	.38805	.39073
66	23	.39073	.39341	.39608	.39875	.40142	.40408	.40674
65	24	.40674	.40939	.41204	.41469	.41734	.41998	.42262
64	25	.42262	.42525	.42788	.43051	.43313	.43575	.43837
63	26	.43837	.44098	.44359	.44620	.44880	.45140	.45399
62	27	.45399	.45658	.45917	.46175	.46433	.46690	.46947
61	28	.46947	.47204	.47460	.47716	.47971	.48226	.48481
60	29	.48481	.48735	.48989	.49242	.49495	.49748	.50000
59	30	.50000	.50252	.50503	.50754	.51004	.51254	.51504
58	31	.51504	.51753	.52002	.52250	.52498	.52745	.52992
57	32	.52992	.53238	.53484	.53730	.53975	.54220	.54464
56	33	.54464	.54708	.54951	.55194	.55436	.55678	.55919
55	34	.55919	.56160	.56401	.56641	.56880	.57119	.57358
54	35	.57358	.57596	.57833	.58070	.58307	.58543	.58779
53	36	.58779	.59014	.59248	.59482	.59716	.59949	.60182
52	37	.60182	.60414	.60645	.60876	.61107	.61337	.61566
51	38	.61566	.61795	.62024	.62251	.62479	.62706	.62932
50	39	.62932	.63158	.63383	.63608	.63832	.64056	.64279
49	40	.64279	.64501	.64723	.64945	.65166	.65386	.65606
48	41	.65606	.65825	.66044	.66262	.66480	.66697	.66913
47	42	.66913	.67129	.67344	.67559	.67773	.67987	.68200
46	43	.68200	.68412	.68624	.68835	.69046	.69256	.69466
45	44	.69466	.69675	.69883	.70091	.70298	.70505	.70711

SINES 45° TO 90°
COSINES 0° TO 45°

COSINE		60′	50′	40′	30′	20′	10′	0′
	SINE	0′	10′	20′	30′	40′	50′	60′
44°	45°	.70711	.70916	.71121	.71325	.71529	.71732	.71934
43	46	.71934	.72136	.72337	.72537	.72737	.72937	.73135
42	47	.73135	.73333	.73531	.73728	.73924	.74120	.74314
41	48	.74314	.74509	.74703	.74896	.75088	.75280	.75471
40	49	.75471	.75661	.75851	.76041	.76229	.76417	.76604
39	50	.76604	.76791	.76977	.77162	.77347	.77531	.77715
38	51	.77715	.77897	.78079	.78261	.78442	.78622	.78801
37	52	.78801	.78980	.79158	.79335	.79512	.79688	.79864
36	53	.79864	.80038	.80212	.80386	.80558	.80730	.80902
35	54	.80902	.81072	.81242	.81412	.81580	.81748	.81915
34	55	.81915	.82082	.82248	.82413	.82577	.82741	.82904
33	56	.82904	.83066	.83228	.83389	.83549	.83708	.83867
32	57	.83867	.84025	.84182	.84339	.84495	.84650	.84805
31	58	.84805	.84959	.85112	.85264	.85416	.85567	.85717
30	59	.85717	.85866	.86015	.86163	.86310	.86457	.86603
29	60	.86603	.86748	.86892	.87036	.87178	.87321	.87462
28	61	.87462	.87603	.87743	.87882	.88020	.88158	.88295
27	62	.88295	.88431	.88566	.88701	.88835	.88968	.89101
26	63	.89101	.89232	.89363	.89493	.89623	.89752	.89879
25	64	.89879	.90007	.90133	.90259	.90383	.90507	.90631
24	65	.90631	.90753	.90875	.90996	.91116	.91236	.91355
23	66	.91355	.91472	.91590	.91706	.91822	.91936	.92050
22	67	.92050	.92164	.92276	.92388	.92499	.92609	.92718
21	68	.92718	.92827	.92935	.93042	.93148	.93253	.93358
20	69	.93358	.93462	.93565	.93667	.93769	.93869	.93969
19	70	.93969	.94068	.94167	.94264	.94361	.94457	.94552
18	71	.94552	.94646	.94740	.94832	.94924	.95015	.95106
17	72	.95106	.95195	.95284	.95372	.95459	.95545	.95630
16	73	.95630	.95715	.95799	.95882	.95964	.96046	.96126
15	74	.96126	.96206	.96285	.96363	.96440	.96517	.96593
14	75	.96593	.96667	.96742	.96815	.96887	.96959	.97030
13	76	.97030	.97100	.97169	.97237	.97304	.97371	.97437
12	77	.97437	.97502	.97566	.97630	.97692	.97754	.97815
11	78	.97815	.97875	.97934	.97992	.98050	.98107	.98163
10	79	.98163	.98218	.98272	.98325	.98378	.98430	.98481
9	80	.98481	.98531	.98580	.98629	.98676	.98723	.98769
8	81	.98769	.98814	.98858	.98902	.98944	.98986	.99027
7	82	.99027	.99067	.99106	.99144	.99182	.99219	.99255
6	83	.99255	.99290	.99324	.99357	.99390	.99421	.99452
5	84	.99452	.99482	.99511	.99540	.99567	.99594	.99619
4	85	.99619	.99644	.99668	.99692	.99714	.99736	.99756
3	86	.99756	.99776	.99795	.99813	.99831	.99847	.99863
2	87	.99863	.99878	.99892	.99905	.99917	.99929	.99939
1	88	.99939	.99949	.99958	.99966	.99973	.99979	.99985
0	89	.99985	.99989	.99993	.99996	.99998	1.0000	1.0000

TANGENTS 0° TO 45°
COTANGENTS 45° TO 90°

COTAN		60′	50′	40′	30′	20′	10′	0′
	TAN	0′	10′	20′	30′	40′	50′	60′
89°	0°	.00000	.00291	.00582	.00873	.01164	.01455	.01746
88	1	.01746	.02036	.02328	.02619	.02910	.03201	.03492
87	2	.03492	.03783	.04075	.04366	.04658	.04949	.05241
86	3	.05241	.05533	.05824	.06116	.06408	.06700	.06993
85	4	.06993	.07285	.07578	.07870	.08163	.08456	.08749
84	5	.08749	.09042	.09335	.09629	.09923	.10216	.10510
83	6	.10510	.10805	.11099	.11394	.11688	.11983	.12278
82	7	.12278	.12574	.12869	.13165	.13461	.13758	.14054
81	8	.14054	.14351	.14648	.14945	.15243	.15540	.15838
80	9	.15838	.16137	.16435	.16734	.17033	.17333	.17633
79	10	.17633	.17933	.18233	.18534	.18835	.19136	.19438
78	11	.19438	.19740	.20042	.20345	.20648	.20952	.21256
77	12	.21256	.21560	.21864	.22169	.22475	.22781	.23087
76	13	.23087	.23393	.23700	.24008	.24316	.24624	.24933
75	14	.24933	.25242	.25552	.25862	.26172	.26483	.26795
74	15	.26795	.27107	.27419	.27732	.28046	.28360	.28675
73	16	.28675	.28990	.29305	.29621	.29938	.30255	.30573
72	17	.30573	.30891	.31210	.31530	.31850	.32171	.32492
71	18	.32492	.32814	.33136	.33460	.33783	.34108	.34433
70	19	.34433	.34758	.35085	.35412	.35740	.36068	.36397
69	20	.36397	.36727	.37057	.37388	.37720	.38053	.38386
68	21	.38386	.38721	.39055	.39391	.39727	.40065	.40403
67	22	.40403	.40741	.41081	.41421	.41763	.42105	.42447
66	23	.42447	.42791	.43136	.43481	.43828	.44175	.44523
65	24	.44523	.44872	.45222	.45573	.45924	.46277	.46631
64	25	.46631	.46985	.47341	.47698	.48055	.48414	.48773
63	26	.48773	.49134	.49495	.49858	.50222	.50587	.50953
62	27	.50953	.51320	.51688	.52057	.52427	.52798	.53171
61	28	.53171	.53545	.53920	.54296	.54674	.55051	.55431
60	29	.55431	.55812	.56194	.56577	.56962	.57348	.57735
59	30	.57735	.58124	.58513	.58905	.59297	.59691	.60086
58	31	.60086	.60483	.60881	.61280	.61681	.62083	.62487
57	32	.62487	.62892	.63299	.63707	.64117	.64528	.64941
56	33	.64941	.65355	.65771	.66189	.66608	.67028	.67451
55	34	.67451	.67875	.68301	.68728	.69157	.69588	.70021
54	35	.70021	.70455	.70891	.71329	.71769	.72211	.72654
53	36	.72654	.73100	.73547	.73996	.74447	.74900	.75355
52	37	.75355	.75812	.76272	.76733	.77196	.77661	.78129
51	38	.78129	.78598	.79070	.79544	.80020	.80498	.80978
50	39	.80978	.81461	.81946	.82434	.82923	.83415	.83910
49	40	.83910	.84407	.84906	.85408	.85912	.86419	.86929
48	41	.86929	.87441	.87955	.88473	.88992	.89515	.90040
47	42	.90040	.90569	.91099	.91633	.92170	.92709	.93252
46	43	.93252	.93797	.94345	.94896	.95451	.96008	.96569
45	4	.96569	.97133	.97700	.98270	.98843	.99420	1.0000

TANGENTS 45° TO 90°
COTANGENTS 0° TO 45°

COTAN		60′	50′	40′	30′	20′	10′	0′
	TAN	0′	10′	20′	30′	40′	50′	60′
44°	45°	1.0000	1.0058	1.0117	1.0176	1.0236	1.0295	1.0355
43	46	1.0355	1.0416	1.0477	1.0538	1.0599	1.0661	1.0724
42	47	1.0724	1.0786	1.0850	1.0913	1.0977	1.1041	1.1106
41	48	1.1106	1.1171	1.1237	1.1303	1.1369	1.1436	1.1504
40	49	1.1504	1.1572	1.1640	1.1709	1.1778	1.1847	1.1918
39	50	1.1918	1.1988	1.2059	1.2131	1.2203	1.2276	1.2349
38	51	1.2349	1.2423	1.2497	1.2572	1.2647	1.2723	1.2799
37	52	1.2799	1.2876	1.2954	1.3032	1.3111	1.3190	1.3270
36	53	1.3270	1.3351	1.3432	1.3514	1.3597	1.3680	1.3764
35	54	1.3764	1.3848	1.3934	1.4020	1.4106	1.4193	1.4282
34	55	1.4282	1.4370	1.4460	1.4550	1.4641	1.4733	1.4826
33	56	1.4826	1.4919	1.5013	1.5108	1.5204	1.5301	1.5399
32	57	1.5399	1.5497	1.5597	1.5697	1.5798	1.5900	1.6003
31	58	1.6003	1.6107	1.6213	1.6319	1.6426	1.6534	1.6643
30	59	1.6643	1.6753	1.6864	1.6977	1.7090	1.7205	1.7321
29	60	1.7321	1.7438	1.7556	1.7675	1.7796	1.7917	1.8041
28	61	1.8041	1.8165	1.8291	1.8418	1.8546	1.8676	1.8807
27	62	1.8807	1.8940	1.9074	1.9210	1.9347	1.9486	1.9626
26	63	1.9626	1.9768	1.9912	2.0057	2.0204	2.0353	2.0503
25	64	2.0503	2.0655	2.0809	2.0965	2.1123	2.1283	2.1445
24	65	2.1445	2.1609	2.1775	2.1943	2.2113	2.2286	2.2460
23	66	2.2460	2.2637	2.2817	2.2998	2.3183	2.3369	2.3559
22	67	2.3559	2.3750	2.3945	2.4142	2.4342	2.4545	2.4751
21	68	2.4751	2.4960	2.5172	2.5387	2.5605	2.5826	2.6051
20	69	2.6051	2.6279	2.6511	2.6746	2.6985	2.7228	2.7475
19	70	2.7475	2.7725	2.7980	2.8239	2.8502	2.8770	2.9042
18	71	2.9042	2.9319	2.9600	2.9887	3.0178	3.0475	3.0777
17	72	3.0777	3.1084	3.1397	3.1716	3.2041	3.2371	3.2709
16	73	3.2709	3.3052	3.3402	3.3759	3.4124	3.4495	3.4874
15	74	3.4874	3.5261	3.5656	3.6059	3.6471	3.6891	3.7321
14	75	3.7321	3.7760	3.8208	3.8667	3.9136	3.9617	4.0108
13	76	4.0108	4.0611	4.1126	4.1653	4.2193	4.2747	4.3315
12	77	4.3315	4.3897	4.4494	4.5107	4.5736	4.6383	4.7046
11	78	4.7046	4.7729	4.8430	4.9152	4.9894	5.0658	5.1446
10	79	5.1446	5.2257	5.3093	5.3955	5.4845	5.5764	5.6713
9	80	5.6713	5.7694	5.8708	5.9758	6.0844	6.1970	6.3138
8	81	6.3138	6.4348	6.5606	6.6912	6.8269	6.9682	7.1154
7	82	7.1154	7.2687	7.4287	7.5958	7.7704	7.9530	8.1444
6	83	8.1444	8.3450	8.5555	8.7769	9.0098	9.2553	9.5144
5	84	9.5144	9.7882	10.078	10.385	10.712	11.059	11.430
4	85	11.430	11.826	12.251	12.706	13.197	13.727	14.301
3	86	14.301	14.924	15.605	16.350	17.169	18.075	19.081
2	87	19.081	20.206	21.470	22.904	24.542	26.432	28.636
1	88	28.636	31.242	34.368	38.188	42.964	49.104	57.290
0	90	57.290	68.750	85.940	114.59	171.89	343.77	infin.

SECANTS 0° TO 45°
COSECANTS 45° TO 90°

COSEC		60′	50′	40′	30′	20′	10′	0′
	SEC	0′	10′	20′	30′	40′	50′	60′
89°	0°	1.0000	1.0000	1.0000	1.0000	1.0001	1.0001	1.0002
88	1	1.0002	1.0002	1.0003	1.0003	1.0004	1.0005	1.0006
87	2	1.0006	1.0007	1.0008	1.0010	1.0011	1.0012	1.0014
86	3	1.0014	1.0015	1.0017	1.0019	1.0021	1.0022	1.0024
85	4	1.0024	1.0027	1.0029	1.0031	1.0033	1.0036	1.0038
84	5	1.0038	1.0041	1.0044	1.0046	1.0049	1.0052	1.0055
83	6	1.0055	1.0058	1.0061	1.0065	1.0068	1.0072	1.0075
82	7	1.0075	1.0079	1.0083	1.0086	1.0090	1.0094	1.0098
81	8	1.0098	1.0102	1.0107	1.0111	1.0116	1.0120	1.0125
80	9	1.0125	1.0129	1.0134	1.0139	1.0144	1.0149	1.0154
79	10	1.0154	1.0160	1.0165	1.0170	1.0176	1.0182	1.0187
78	11	1.0187	1.0193	1.0199	1.0205	1.0211	1.0217	1.0223
77	12	1.0223	1.0230	1.0236	1.0243	1.0249	1.0256	1.0263
76	13	1.0263	1.0270	1.0277	1.0284	1.0291	1.0299	1.0306
75	14	1.0306	1.0314	1.0321	1.0329	1.0337	1.0345	1.0353
74	15	1.0353	1.0361	1.0369	1.0377	1.0386	1.0394	1.0403
73	16	1.0403	1.0412	1.0421	1.0430	1.0439	1.0448	1.0457
72	17	1.0457	1.0466	1.0476	1.0485	1.0495	1.0505	1.0515
71	18	1.0515	1.0525	1.0535	1.0545	1.0555	1.0566	1.0576
70	19	1.0576	1.0587	1.0598	1.0609	1.0620	1.0631	1.0642
69	20	1.0642	1.0653	1.0665	1.0676	1.0688	1.0700	1.0712
68	21	1.0712	1.0724	1.0736	1.0748	1.0760	1.0773	1.0785
67	22	1.0785	1.0798	1.0811	1.0824	1.0837	1.0850	1.0864
66	23	1.0864	1.0877	1.0891	1.0904	1.0918	1.0932	1.0946
65	24	1.0946	1.0961	1.0975	1.0990	1.1004	1.1019	1.1034
64	25	1.1034	1.1049	1.1064	1.1079	1.1095	1.1110	1.1126
63	26	1.1126	1.1142	1.1158	1.1174	1.1190	1.1207	1.1223
62	27	1.1223	1.1240	1.1257	1.1274	1.1291	1.1308	1.1326
61	28	1.1326	1.1343	1.1361	1.1379	1.1397	1.1415	1.1434
60	29	1.1434	1.1452	1.1471	1.1490	1.1509	1.1528	1.1547
59	30	1.1547	1.1567	1.1586	1.1606	1.1626	1.1646	1.1666
58	31	1.1666	1.1687	1.1708	1.1728	1.1749	1.1770	1.1792
57	32	1.1792	1.1813	1.1835	1.1857	1.1879	1.1901	1.1924
56	33	1.1924	1.1946	1.1969	1.1992	1.2015	1.2039	1.2062
55	34	1.2062	1.2086	1.2110	1.2134	1.2158	1.2183	1.2208
54	35	1.2208	1.2233	1.2258	1.2283	1.2309	1.2335	1.2361
53	36	1.2361	1.2387	1.2413	1.2440	1.2467	1.2494	1.2521
52	37	1.2521	1.2549	1.2577	1.2605	1.2633	1.2662	1.2690
51	38	1.2690	1.2719	1.2748	1.2778	1.2808	1.2837	1.2868
50	39	1.2868	1.2898	1.2929	1.2960	1.2991	1.3022	1.3054
49	40	1.3054	1.3086	1.3118	1.3151	1.3184	1.3217	1.3250
48	41	1.3250	1.3284	1.3318	1.3352	1.3386	1.3421	1.3456
47	42	1.3456	1.3492	1.3527	1.3563	1.3600	1.3636	1.3673
46	43	1.3673	1.3711	1.3748	1.3786	1.3824	1.3863	1.3902
45	44	1.3902	1.3941	1.3980	1.4020	1.4061	1.4101	1.4142

SECANTS 45° TO 90°
COSECANTS 0° TO 45°

COSEC		60′	50′	40′	30′	20′	10′	0′
	SEC	0′	10′	20′	30′	40′	50′	60′
44°	45°	1.4142	1.4184	1.4225	1.4267	1.4310	1.4352	1.4396
43	46	1.4396	1.4439	1.4483	1.4527	1.4572	1.4617	1.4663
42	47	1.4663	1.4709	1.4755	1.4802	1.4849	1.4897	1.4945
41	48	1.4945	1.4993	1.5042	1.5092	1.5142	1.5192	1.5243
40	49	1.5243	1.5294	1.5346	1.5398	1.5450	1.5504	1.5557
39	50	1.5557	1.5611	1.5666	1.5721	1.5777	1.5833	1.5890
38	51	1.5890	1.5948	1.6005	1.6064	1.6123	1.6183	1.6243
37	52	1.6243	1.6304	1.6365	1.6427	1.6489	1.6553	1.6616
36	53	1.6616	1.6681	1.6746	1.6812	1.6878	1.6945	1.7013
35	54	1.7013	1.7082	1.7151	1.7221	1.7291	1.7362	1.7435
34	55	1.7435	1.7507	1.7581	1.7655	1.7730	1.7806	1.7883
33	56	1.7883	1.7960	1.8039	1.8118	1.8198	1.8279	1.8361
32	57	1.8361	1.8444	1.8527	1.8612	1.8697	1.8783	1.8871
31	58	1.8871	1.8959	1.9049	1.9139	1.9230	1.9323	1.9416
30	59	1.9416	1.9511	1.9606	1.9703	1.9801	1.9900	2.0000
29	60	2.0000	2.0101	2.0204	2.0308	2.0413	2.0519	2.0627
28	61	2.0627	2.0736	2.0846	2.0957	2.1070	2.1185	2.1301
27	62	2.1301	2.1418	2.1537	2.1657	2.1779	2.1902	2.2027
26	63	2.2027	2.2154	2.2282	2.2412	2.2543	2.2677	2.2812
25	64	2.2812	2.2949	2.3088	2.3228	2.3371	2.3515	2.3662
24	65	2.3662	2.3811	2.3961	2.4114	2.4269	2.4426	2.4586
23	66	2.4586	2.4748	2.4912	2.5078	2.5247	2.5419	2.5593
22	67	2.5593	2.5770	2.5949	2.6131	2.6316	2.6504	2.6695
21	68	2.6695	2.6888	2.7085	2.7285	2.7488	2.7695	2.7904
20	69	2.7904	2.8118	2.8334	2.8555	2.8779	2.9006	2.9238
19	70	2.9238	2.9474	2.9714	2.9957	3.0206	3.0458	3.0716
18	71	3.0716	3.0977	3.1244	3.1516	3.1792	3.2074	3.2361
17	72	3.2361	3.2653	3.2951	3.3255	3.3565	3.3881	3.4203
16	73	3.4203	3.4532	3.4867	3.5209	3.5559	3.5915	3.6280
15	74	3.6280	3.6652	3.7032	3.7420	3.7817	3.8222	3.8637
14	75	3.8637	3.9061	3.9495	3.9939	4.0394	4.0859	4.1336
13	76	4.1336	4.1824	4.2324	4.2837	4.3362	4.3901	4.4454
12	77	4.4454	4.5022	4.5604	4.6202	4.6817	4.7448	4.8097
11	78	4.8097	4.8765	4.9452	5.0159	5.0886	5.1636	5.2408
10	79	5.2408	5.3205	5.4026	5.4874	5.5749	5.6653	5.7588
9	80	5.7588	5.8554	5.9554	6.0589	6.1661	6.2772	6.3925
8	81	6.3925	6.5121	6.6363	6.7655	6.8998	7.0396	7.1853
7	82	7.1853	7.3372	7.4957	7.6613	7.8344	8.0157	8.2055
6	83	8.2055	8.4047	8.6138	8.8337	9.0652	9.3092	9.5668
5	84	9.5668	9.8391	10.128	10.433	10.759	11.105	11.474
4	85	11.474	11.868	12.291	12.746	13.235	13.763	14.336
3	86	14.336	14.958	15.637	16.380	17.198	18.103	19.107
2	87	19.107	20.230	21.494	22.926	24.562	26.451	28.654
1	88	28.654	31.258	34.382	38.202	42.976	49.114	57.299
0	89	57.299	68.757	85.946	114.59	171.89	343.78	inf.

HOW TO USE LOGARITHMS

EXPONENT OF NUMBERS. An exponent, or power, or index, is a small number written slightly above and to the right of a number to indicate how many times the number is to be taken as a factor in the product. Suppose we assume that $a = 2$, then;

$$a^2 = aa = 2 \times 2 = 4$$
$$a^3 = aaa = 2 \times 2 \times 2 = 8$$

If we wish to multiply like numbers, we add the exponents, thus;

$$a^2 \times a^3 = aa \times aaa = a^{2+3} = a^5 = (2 \times 2) \times (2 \times 2 \times 2) = 32$$

If we wish to divide like numbers, we subtract exponents, thus;

$$\frac{a^3}{a^2} = \frac{aaa}{aa} = a^{3-2} = a^1 = \frac{2 \times 2 \times 2}{2 \times 2} = \frac{8}{4} = 2$$

LOGARITHMS ARE EXPONENTS OF 10. Any number can be expressed as a power of 10. This power, or exponent, consists of two parts known as the *characteristic* and the *mantissa.*

THE CHARACTERISTIC. The characteristic of a number that has one or more digits to the left of the decimal point will be one less than the number of digits, and will be positive.

The characteristic of a decimal fraction will be a number representing the position of the first significant figure to the right of the decimal point, and will be negative.

The exponents of 10 in the following table are the characteristics for the numbers given in the left column;

100,000.000	=	10^5
10,000.000	=	10^4
1,000.000	=	10^3
100.000	=	10^2
10.000	=	10^1
1.000	=	10^0
0.100	=	10^{-1} (also written $\overline{10}^1$, or 10^{9-10})
0.010	=	10^{-2} (also written $\overline{10}^2$, or 10^{8-10})
0.001	=	10^{-3} (also written $\overline{10}^3$, or 10^{7-10})

THE MANTISSA. Now, suppose we want to express some number such as 246 in terms of 10 raised to a power. The number 246 falls between 100 and 1,000, or between 10^2 and 10^3. In other words, the exponent will be 2 plus some fraction. Such a fraction is called a mantissa. So-called Tables of Logarithms are not tables of *Logarithms* at all—they are really Tables of Mantissas or that fractional part of the exponent of 10 for any number that is not an exact multiple of 10. Thus we find that the *mantissa* of the number 246 is 39094, which means that the *logarithm* is 2.39094. This is written;

$$\log 246 = 2.39094$$

The mantissa is always positive, depends only upon the sequence of the digits in the number without regard to the position of any decimal point. The mantissa for 2,460,000 is the same as for 246 or 0.0000246 or 2.46. But the characteristics are different;

$$\log 2{,}460{,}000 = 6.39094$$
$$\log 246 = 2.39094$$
$$\log 0.0000246 = 5.39094$$
$$\log 2.46 = 0.39094$$

Thus, in looking up the mantissa of a number in the tables, remember it is the same for 24 as for 2400. This eliminates the need for values below 100 in a table of 100 to 1,000. In a table from 1,000 to 10,000 values below 1,000 are not needed.

HOW TO USE LOGARITHMS

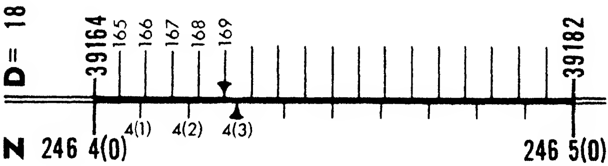
HOW TO USE THE TABLES. In the tables that follow, notice that under the column headed "O" there are some mantissas with 5 digits, while those under the remaining columns have but 3 digits. The first two digits of the 5-digit mantissas apply to all values reading across the page until reaching a series with asterisks, or until the next 5-digit mantissa is reached.

To find the mantissa of the number 1234: Read across from 123 to the column headed 4. You will find the value *132. In the next line under the "O" column you will find a 5-digit value whose 1st two figures are 09. Therefore the mantissa of the number 1234 is 09132.

USE OF THE "D" COLUMN. The mantissas in the tables are given for numbers with 4 significant figures. The 5th significant figure can be found by using the column of differences which gives the average numerical difference in each line between the values given for the 4-figure numbers.

To find the mantissa of the number 24643: This will fall between the mantissas for the numbers 2464 and 2465, which are 39164 and 39182. (*See Diagram*). The difference is 18. The 5th figure we want in the number is 3, so .3 x 18 = 5.4. 39164 + 5 = 39169, which is the mantissa of 24643.

To find the number whose mantissa is 39169: This is 5 more than the nearest lower mantissa 39164, for the number 2464. (*See Diagram*). Since the difference between this and the next higher mantissa is 18, take 5/18 x 10 = 2.78 which we car call 3. Therefore the number sought is 24643.



EXAMPLE OF MULTIPLICATION. What is the product of 246 x 10.43?

$$\begin{aligned} \log 246 &= 2.39094 \\ \log 10.43 &= 1.01828 \\ \hline \text{total} &= 3.40922 \end{aligned}$$

Since the characteristic is 3, we know there will be 4 integers in the result. The table shows that 40922 is the mantissa for 25658, and the number sought is therefore 2565.8.

EXAMPLE OF DIVISION. What is 246 divided by 10.43?

$$\begin{aligned} \log 246 &= 2.39094 \\ \log 10.43 &= 1.01828 \\ \hline \text{subtract} &= 1.37266 \end{aligned}$$

Since the characteristic is 1, we know there will be 2 integers in the quotient. The table shows that 37266 is the mantissa for 23586 and the number sought is 23.586.

ABSCISSA OF NUMBERS
1000 TO 1499

N	0	1	2	3	4	5	6	7	8	9	D
100	00000	043	087	130	173	217	260	303	346	389	43
101	432	475	518	561	604	647	689	732	775	817	43
102	860	903	945	988	*030	*072	*115	*157	*199	*242	42
103	01284	326	368	410	452	494	536	578	620	662	42
104	703	745	787	828	870	912	953	995	*036	*078	42
105	02119	160	202	243	284	325	366	407	449	490	41
106	531	572	612	653	694	735	776	816	857	898	41
107	938	979	*019	*060	*100	*141	*181	*222	*262	*302	40
108	03342	383	423	463	503	543	583	623	663	703	40
109	743	782	822	862	902	941	981	*021	*060	*100	40
110	04139	179	218	258	297	336	376	415	454	493	39
111	532	571	610	650	689	727	766	805	844	883	39
112	922	961	999	*038	*077	*115	*154	*192	*231	*269	39
113	05308	346	385	423	461	500	538	576	614	652	38
114	690	729	767	805	843	881	918	956	994	*032	38
115	06070	108	145	183	221	258	296	333	371	408	38
116	446	483	521	558	595	633	670	707	744	781	37
117	819	856	893	930	967	*004	*041	*078	*115	*151	37
118	07188	225	262	298	335	372	408	445	482	518	37
119	555	591	628	664	700	737	773	809	846	882	36
120	918	954	990	*027	*063	*099	*135	*171	*207	*243	36
121	08279	314	350	386	422	458	493	529	565	600	36
122	636	672	707	743	778	814	849	884	920	955	35
123	991	*026	*061	*096	*132	*167	*202	*237	*272	*307	35
124	09342	377	412	447	482	517	552	587	621	656	35
125	691	726	760	795	830	864	899	934	968	*003	35
126	10037	072	106	140	175	209	243	278	312	346	34
127	380	415	449	483	517	551	585	619	653	687	34
128	721	755	789	823	857	[illegible]	924	958	992	*025	34
129	11059	093	126	160	193	227	261	294	327	361	34
130	394	428	461	494	528	561	594	628	661	694	33
131	727	760	793	826	860	893	926	959	992	*024	33
132	12057	090	123	156	189	222	254	287	320	352	33
133	385	418	450	483	516	548	581	613	646	678	33
134	710	743	775	808	840	872	905	937	969	*001	32
135	13033	066	098	130	162	194	226	258	290	322	32
136	354	386	418	450	481	513	545	577	609	640	32
137	672	704	735	767	799	830	862	893	925	956	32
138	988	*019	*051	*082	*114	*145	*176	*208	*239	*270	31
139	14301	333	364	395	426	457	489	520	551	582	31
140	613	644	675	706	737	768	799	829	860	891	31
141	922	953	983	*014	*045	*076	*106	*137	*168	*198	31
142	15229	259	290	320	351	381	412	442	473	503	31
143	534	564	594	625	655	685	715	746	776	806	30
144	836	866	897	927	957	987	*017	*047	*077	*107	30
145	16137	167	197	227	256	286	316	346	376	406	30
146	435	465	495	524	554	584	613	643	673	702	30
147	732	761	791	820	850	879	909	938	967	997	29
148	17026	056	085	114	143	173	202	231	260	289	29
149	319	348	377	406	435	464	493	522	551	580	29
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
1500 TO 1999

N	0	1	2	3	4	5	6	7	8	9	D
150	17609	638	667	696	725	754	782	811	840	869	29
151	898	926	955	984	*013	*041	*070	*099	*127	*156	29
152	18184	213	241	270	298	327	355	384	412	441	29
153	469	498	526	554	583	611	639	667	696	724	28
154	752	780	808	837	865	893	921	949	977	*005	28
155	19033	061	089	117	145	173	201	229	257	285	28
156	312	340	368	396	424	451	479	507	535	562	28
157	590	618	645	673	700	728	756	783	811	838	28
158	866	893	921	948	976	*003	*030	*058	*085	*112	27
159	20140	167	194	222	249	276	303	330	358	385	27
160	412	439	466	493	520	548	575	602	629	656	27
161	683	710	737	763	790	817	844	871	898	925	27
162	952	978	*005	*032	*059	*085	*112	*139	*165	*192	27
163	21219	245	272	299	325	352	378	405	431	458	27
164	484	511	537	564	590	617	643	669	696	722	26
165	748	775	801	827	854	880	906	932	958	985	26
166	22011	037	063	089	115	141	167	194	220	246	26
167	272	298	324	350	376	401	427	453	479	505	26
168	531	557	583	608	634	660	686	712	737	763	26
169	789	814	840	866	891	917	943	968	994	*019	26
170	23045	070	096	121	147	172	198	223	249	274	25
171	300	325	350	376	401	426	452	477	502	528	25
172	553	578	603	629	654	679	704	729	754	779	25
173	805	830	855	880	905	930	955	980	*005	*030	25
174	24055	080	105	130	155	180	204	229	254	279	25
175	304	329	353	378	403	428	452	477	502	527	25
176	551	576	601	625	650	674	699	724	748	773	25
177	797	822	846	871	895	920	944	969	993	*018	25
178	25042	066	091	115	139	164	188	212	237	261	24
179	285	310	334	358	382	406	431	455	479	503	24
180	527	551	575	600	624	648	672	696	720	744	24
181	768	792	816	840	864	888	912	935	959	983	24
182	26007	031	055	079	102	126	150	174	198	221	24
183	245	269	293	316	340	364	387	411	435	458	24
184	482	505	529	553	576	600	623	647	670	694	24
185	717	741	764	788	811	834	858	881	905	928	23
186	951	975	998	*021	*045	*068	*091	*114	*138	*161	23
187	27184	207	231	254	277	300	323	346	370	393	23
188	416	439	462	485	508	531	554	577	600	623	23
189	646	669	692	715	738	761	784	807	830	852	23
190	875	898	921	944	967	989	*012	*035	*058	*081	23
191	28103	126	149	171	194	217	240	262	285	307	23
192	330	353	375	398	421	443	466	488	511	533	23
193	556	578	601	623	646	668	691	713	735	758	22
194	780	803	825	847	870	892	914	937	959	981	22
195	29003	026	048	070	092	115	137	159	181	203	22
196	226	248	270	292	314	336	358	380	403	425	22
197	447	469	491	513	535	557	579	601	623	645	22
198	667	688	710	732	754	776	798	820	842	863	22
199	885	907	929	951	973	994	*016	*038	*060	*081	22
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
2000 TO 2499

N	0	1	2	3	4	5	6	7	8	9	D
200	30103	125	146	168	190	211	233	255	276	298	22
201	320	341	363	384	406	428	449	471	492	514	22
202	535	557	578	600	621	643	664	685	707	728	21
203	750	771	792	814	835	856	878	899	920	942	21
204	963	984	*006	*027	*048	*069	*091	*112	*133	*154	21
205	31175	197	218	239	260	281	302	323	345	366	21
206	387	408	429	450	471	492	513	534	555	576	21
207	597	618	639	660	681	702	723	744	765	785	21
208	806	827	848	869	890	911	931	952	973	994	21
209	32015	035	056	077	098	118	139	160	181	201	21
210	222	243	263	284	305	325	346	366	387	408	21
211	428	449	469	490	510	531	552	572	593	613	20
212	634	654	675	695	715	736	756	777	797	818	20
213	838	858	879	899	919	940	960	980	*001	*021	20
214	33041	062	082	102	122	143	163	183	203	224	20
215	244	264	284	304	325	345	365	385	405	425	20
216	445	465	486	506	526	546	566	586	606	626	20
217	646	666	686	706	726	746	766	786	806	826	20
218	846	866	885	905	925	945	965	985	*005	*025	20
219	34044	064	084	104	124	143	163	183	203	223	20
220	242	262	282	301	321	341	361	380	400	420	20
221	439	459	479	498	518	537	557	577	596	616	20
222	635	655	674	694	713	733	753	772	792	811	19
223	830	850	869	889	908	928	947	967	986	*005	19
224	35025	044	064	083	102	122	141	160	180	199	19
225	218	238	257	276	295	315	334	353	372	392	19
226	411	430	449	468	488	507	526	545	564	583	19
227	603	622	641	660	679	698	717	736	755	774	19
228	793	813	832	851	870	889	908	927	946	965	19
229	984	*003	*021	*040	*059	*078	*097	*116	*135	*154	19
230	36173	192	211	229	248	267	286	305	324	342	19
231	361	380	399	418	436	455	474	493	511	530	19
232	549	568	586	605	624	642	661	680	698	717	19
233	736	754	773	791	810	829	847	866	884	903	19
234	922	940	959	977	996	*014	*033	*051	*070	*088	18
235	37107	125	144	162	181	199	218	236	254	273	18
236	291	310	328	346	365	383	401	420	438	457	18
237	475	493	511	530	548	566	585	603	621	639	18
238	658	676	694	712	731	749	767	785	803	822	18
239	840	858	876	894	912	931	949	967	985	*003	18
240	38021	039	057	075	093	112	130	148	166	184	18
241	202	220	238	256	274	292	310	328	346	364	18
242	382	399	417	435	453	471	489	507	525	543	18
243	561	578	596	614	632	650	668	686	703	721	18
244	739	757	775	792	810	828	846	863	881	899	18
245	917	934	952	970	987	*005	*023	*041	*058	*076	18
246	39094	111	129	146	164	182	199	217	235	252	18
247	270	287	305	322	340	358	375	393	410	428	18
248	445	463	480	498	515	533	550	568	585	602	18
249	620	637	655	672	690	707	724	742	759	777	17
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
2500 TO 2999

N	0	1	2	3	4	5	6	7	8	9	D
250	39794	811	829	846	863	881	898	915	933	950	17
251	967	985	*002	*019	*037	*054	*071	*088	*106	*123	17
252	40140	157	175	192	209	226	243	261	278	295	17
253	312	329	346	364	381	398	415	432	449	466	17
254	483	500	518	535	552	569	586	603	620	637	17
255	654	671	688	705	722	739	756	773	790	807	17
256	824	841	858	875	892	909	926	943	960	976	17
257	993	*010	*027	*044	*061	*078	*095	*111	*128	*145	17
258	41162	179	196	212	229	246	263	280	296	313	17
259	330	347	363	380	397	414	430	447	464	481	17
260	497	514	531	547	564	581	597	614	631	647	17
261	664	681	697	714	731	747	764	780	797	814	17
262	830	847	863	880	896	913	929	946	963	979	16
263	996	*012	*029	*045	*062	*078	*095	*111	*127	*144	16
264	42160	177	193	210	226	243	259	275	292	308	16
265	325	341	357	374	390	406	423	439	455	472	16
266	488	504	521	537	553	570	586	602	619	635	16
267	651	667	684	700	716	732	749	765	781	797	16
268	813	830	846	862	878	894	911	927	943	959	16
269	975	991	*008	*024	*040	*056	*072	*088	*104	*120	16
270	43136	152	169	185	201	217	233	249	265	281	16
271	297	313	329	345	361	377	393	409	425	441	16
272	457	473	489	505	521	537	553	569	584	600	16
273	616	632	648	664	680	696	712	727	743	759	16
274	775	791	807	823	838	854	870	886	902	917	16
275	933	949	965	981	996	*012	*028	*044	*059	*075	16
276	44091	107	122	138	154	170	185	201	217	232	16
277	248	264	279	295	311	326	342	358	373	389	16
278	404	420	436	451	467	483	498	514	529	545	16
279	560	576	592	607	623	638	654	669	685	700	16
280	716	731	747	762	778	793	809	824	840	855	15
281	871	886	902	917	932	948	963	979	994	*010	15
282	45025	040	056	071	086	102	117	133	148	163	15
283	179	194	209	225	240	255	271	286	301	317	15
284	332	347	362	378	393	408	423	439	454	469	15
285	484	500	515	530	545	561	576	591	606	621	15
286	637	652	667	682	697	712	728	743	758	773	15
287	788	803	818	834	849	864	879	894	909	924	15
288	939	954	969	984	*000	*015	*030	*045	*060	*075	15
289	46090	105	120	135	150	165	180	195	210	225	15
290	240	255	270	285	300	315	330	345	359	374	15
291	389	404	419	434	449	464	479	494	509	523	15
292	538	553	568	583	598	613	627	642	657	672	15
293	687	702	716	731	746	761	776	790	805	820	15
294	835	850	864	879	894	909	923	938	953	967	15
295	982	997	*012	*026	*041	*056	*070	*085	*100	*114	15
296	47129	144	159	173	188	202	217	232	246	261	15
297	276	290	305	319	334	349	363	378	392	407	15
298	422	436	451	465	480	494	509	524	538	553	15
299	567	582	596	611	625	640	654	669	683	698	15
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
3000 TO 3499

N	0	1	2	3	4	5	6	7	8	9	D
300	47712	727	741	756	770	784	799	813	828	842	14
301	857	871	885	900	914	929	943	958	972	986	14
302	48001	015	029	044	058	073	087	101	116	130	14
303	144	159	173	187	202	216	230	244	259	273	14
304	287	302	316	330	344	359	373	387	401	416	14
305	430	444	458	473	487	501	515	530	544	558	14
306	572	586	601	615	629	643	657	671	686	700	14
307	714	728	742	756	770	785	799	813	827	841	14
308	855	869	883	897	911	926	940	954	968	982	14
309	996	*010	*024	*038	*052	*066	*080	*094	*108	*122	14
310	49136	150	164	178	192	206	220	234	248	262	14
311	276	290	304	318	332	346	360	374	388	402	14
312	415	429	443	457	471	485	499	513	527	541	14
313	554	568	582	596	610	624	638	651	665	679	14
314	693	707	721	734	748	762	776	790	803	817	14
315	831	845	859	872	886	900	914	927	941	955	14
316	969	982	996	*010	*024	*037	*051	*065	*079	*092	14
317	50106	120	133	147	161	174	188	202	215	229	14
318	243	256	270	284	297	311	325	338	352	365	14
319	379	393	406	420	433	447	461	474	488	501	14
320	515	529	542	556	569	583	596	610	623	637	14
321	651	664	678	691	705	718	732	745	759	772	14
322	786	799	813	826	840	853	866	880	893	907	13
323	920	934	947	961	974	987	*001	*014	*028	*041	13
324	51055	068	081	095	108	121	135	148	162	175	13
325	188	202	215	228	242	255	268	282	295	308	13
326	322	335	348	362	375	388	402	415	428	441	13
327	455	468	481	495	508	521	534	548	561	574	13
328	587	601	614	627	640	654	667	680	693	706	13
329	720	733	746	759	772	786	799	812	825	838	13
330	851	865	878	891	904	917	930	943	957	970	13
331	983	996	*009	*022	*035	*048	*061	*075	*088	*101	13
332	52114	127	140	153	166	179	192	205	218	231	13
333	244	257	270	284	297	310	323	336	349	362	13
334	375	388	401	414	427	440	453	466	479	492	13
335	504	517	530	543	556	569	582	595	608	621	13
336	634	647	660	673	686	699	711	724	737	750	13
337	763	776	789	802	815	827	840	853	866	879	13
338	892	905	917	930	943	956	969	982	994	*007	13
339	53020	033	046	058	071	084	097	110	122	135	13
340	148	161	173	186	199	212	224	237	250	263	13
341	275	288	301	314	326	339	352	364	377	390	13
342	403	415	428	441	453	466	479	491	504	517	13
343	529	542	555	567	580	593	605	618	631	643	13
344	656	668	681	694	706	719	732	744	757	769	13
345	782	794	807	820	832	845	857	870	882	895	13
346	908	920	933	945	958	970	983	995	*008	*020	13
347	54033	045	058	070	083	095	108	120	133	145	13
348	158	170	183	195	208	220	233	245	258	270	12
349	283	295	307	320	332	345	357	370	382	394	12
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
3500 TO 3999

N	0	1	2	3	4	5	6	7	8	9	D
350	54407	419	432	444	456	469	481	494	506	518	12
351	531	543	555	568	580	593	605	617	630	642	12
352	654	667	679	691	704	716	728	741	753	765	12
353	777	790	802	814	827	839	851	864	876	888	12
354	900	913	925	937	949	962	974	986	998	*011	12
355	55023	035	047	060	072	084	096	108	121	133	12
356	145	157	169	182	194	206	218	230	242	255	12
357	267	279	291	303	315	328	340	352	364	376	12
358	388	400	413	425	437	449	461	473	485	497	12
359	509	522	534	546	558	570	582	594	606	618	12
360	630	642	654	666	678	691	703	715	727	739	12
361	751	763	775	787	799	811	823	835	847	859	12
362	871	883	895	907	919	931	943	955	967	979	12
363	991	*003	*015	*027	*038	*050	*062	*074	*086	*098	12
364	56110	122	134	146	158	170	182	194	205	217	12
365	229	241	253	265	277	289	301	312	324	336	12
366	348	360	372	384	396	407	419	431	443	455	12
367	467	478	490	502	514	526	538	549	561	573	12
368	585	597	608	620	632	644	656	667	679	691	12
369	703	714	726	738	750	761	773	785	797	808	12
370	820	832	844	855	867	879	891	902	914	926	12
371	937	949	961	972	984	996	*008	*019	*031	*043	12
372	57054	066	078	089	101	113	124	136	148	159	12
373	171	183	194	206	217	229	241	252	264	276	12
374	287	299	310	322	334	345	357	368	380	392	12
375	403	415	426	438	449	461	473	484	496	507	12
376	519	530	542	553	565	576	588	600	611	623	12
377	634	646	657	669	680	692	703	715	726	738	11
378	749	761	772	784	795	807	818	830	841	852	11
379	864	875	887	898	910	921	933	944	955	967	11
380	978	990	*001	*013	*024	*035	*047	*058	*070	*081	11
381	58092	104	115	127	138	149	161	172	184	195	11
382	206	218	229	240	252	263	274	286	297	309	11
383	320	331	343	354	365	377	388	399	410	422	11
384	433	444	456	467	478	490	501	512	524	535	11
385	546	557	569	580	591	602	614	625	636	647	11
386	659	670	681	692	704	715	726	737	749	760	11
387	771	782	794	805	816	827	838	850	861	872	11
388	883	894	906	917	928	939	950	961	973	984	11
389	995	*006	*017	*028	*040	*051	*062	*073	*084	*095	11
390	59106	118	129	140	151	162	173	184	195	207	11
391	218	229	240	251	262	273	284	295	306	318	11
392	329	340	351	362	373	384	395	406	417	428	11
393	439	450	461	472	483	494	506	517	528	539	11
394	550	561	572	583	594	605	616	627	638	649	11
395	660	671	682	693	704	715	726	737	748	759	11
396	770	780	791	802	813	824	835	846	857	868	11
397	879	890	901	912	923	934	945	956	966	977	11
398	988	999	*010	*021	*032	*043	*054	*065	*076	*086	11
399	60097	108	119	130	141	152	163	173	184	195	11
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
4000 TO 4499

N	0	1	2	3	4	5	6	7	8	9	D
400	60206	217	228	239	249	260	271	282	293	304	11
401	314	325	336	347	358	369	379	390	401	412	11
402	423	433	444	455	466	477	487	498	509	520	11
403	531	541	552	563	574	584	595	606	617	627	11
404	638	649	660	670	681	692	703	713	724	735	11
405	746	756	767	778	788	799	810	821	831	842	11
406	853	863	874	885	895	906	917	927	938	949	11
407	959	970	981	991	*002	*013	*023	*034	*045	*055	11
408	61066	077	087	098	109	119	130	140	151	162	11
409	172	183	194	204	215	225	236	247	257	268	11
410	278	289	300	310	321	331	342	352	363	374	11
411	384	395	405	416	426	437	448	458	469	479	11
412	490	500	511	521	532	542	553	563	574	584	11
413	595	606	616	627	637	648	658	669	679	690	11
414	700	711	721	731	742	752	763	773	784	794	10
415	805	815	826	836	847	857	868	878	888	899	10
416	909	920	930	941	951	962	972	982	993	*003	10
417	62014	024	034	045	055	066	076	086	097	107	10
418	118	128	138	149	159	170	180	190	201	211	10
419	221	232	242	252	263	273	284	294	304	315	10
420	325	335	346	356	366	377	387	397	408	418	10
421	428	439	449	459	469	480	490	500	511	521	10
422	531	542	552	562	572	583	593	603	613	624	10
423	634	644	655	665	675	685	696	706	716	726	10
424	737	747	757	767	778	788	798	808	818	829	10
425	839	849	859	870	880	890	900	910	921	931	10
426	941	951	961	972	982	992	*002	*012	*022	*033	10
427	63043	053	063	073	083	094	104	114	124	134	10
428	144	155	165	175	185	195	205	215	225	236	10
429	246	256	266	276	286	296	306	317	327	337	10
430	347	357	367	377	387	397	407	417	428	438	10
431	448	458	468	478	488	498	508	518	528	538	10
432	548	558	568	579	589	599	609	619	629	639	10
433	649	659	669	679	689	699	709	719	729	739	10
434	749	759	769	779	789	799	809	819	829	839	10
435	849	859	869	879	889	899	909	919	929	939	10
436	949	959	969	979	988	998	*008	*018	*028	*038	10
437	64048	058	068	078	088	098	108	118	128	137	10
438	147	157	167	177	187	197	207	217	227	237	10
439	246	256	266	276	286	296	306	316	326	335	10
440	345	355	365	375	385	395	404	414	424	434	10
441	444	454	464	473	483	493	503	513	523	532	10
442	542	552	562	572	582	591	601	611	621	631	10
443	640	650	660	670	680	689	699	709	719	729	10
444	738	748	758	768	777	787	797	807	816	826	10
445	836	846	856	865	875	885	895	904	914	924	10
446	933	943	953	963	972	982	992	*002	*011	*021	10
447	65031	040	050	060	070	079	089	099	108	118	10
448	128	137	147	157	167	176	186	196	205	215	10
449	225	234	244	254	263	273	283	292	302	312	10
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
4500 TO 4999

N	0	1	2	3	4	5	6	7	8	9	D
450	65321	331	341	350	360	369	379	389	398	408	10
451	418	427	437	447	456	466	475	485	495	504	10
452	514	523	533	543	552	562	571	581	591	600	10
453	610	619	629	639	648	658	667	677	686	696	10
454	706	715	725	734	744	753	763	772	782	792	9
455	801	811	820	830	839	849	858	868	877	887	9
456	896	906	916	925	935	944	954	963	973	982	9
457	992	*001	*011	*020	*030	*039	*049	*058	*068	*077	9
458	66087	096	106	115	124	134	143	153	162	172	9
459	181	191	200	210	219	229	238	247	257	266	9
460	276	285	295	304	314	323	332	342	351	361	9
461	370	380	389	398	408	417	427	436	445	455	9
462	464	474	483	492	502	511	521	530	539	549	9
463	558	567	577	586	596	605	614	624	633	642	9
464	652	661	671	680	689	699	708	717	727	736	9
465	745	755	764	773	783	792	801	811	820	829	9
466	839	848	857	867	876	885	894	904	913	922	9
467	932	941	950	960	969	978	987	997	*006	*015	9
468	67025	034	043	052	062	071	080	089	099	108	9
469	117	127	136	145	154	164	173	182	191	201	9
470	210	219	228	237	247	256	265	274	284	293	9
471	302	311	321	330	339	348	357	367	376	385	9
472	394	403	413	422	431	440	449	459	468	477	9
473	486	495	504	514	523	532	541	550	560	569	9
474	578	587	596	605	614	624	633	642	651	660	9
475	669	679	688	697	706	715	724	733	742	752	9
476	761	770	779	788	797	806	815	825	834	843	9
477	852	861	870	879	888	897	906	916	925	934	9
478	943	952	961	970	979	988	997	*006	*015	*024	9
479	68034	043	052	061	070	079	088	097	106	115	9
480	124	133	142	151	160	169	178	187	196	205	9
481	215	224	233	242	251	260	269	278	287	296	9
482	305	314	323	332	341	350	359	368	377	386	9
483	395	404	413	422	431	440	449	458	467	476	9
484	485	494	502	511	520	529	538	547	556	565	9
485	574	583	592	601	610	619	628	637	646	655	9
486	664	673	681	690	699	708	717	726	735	744	9
487	753	762	771	780	789	797	806	815	824	833	9
488	842	851	860	869	878	886	895	904	913	922	9
489	931	940	949	958	966	975	984	993	*002	*011	9
490	69020	028	037	046	055	064	073	082	090	099	9
491	108	117	126	135	144	152	161	170	179	188	9
492	197	205	214	223	232	241	249	258	267	276	9
493	285	294	302	311	320	329	338	346	355	364	9
494	373	381	390	399	408	417	425	434	443	452	9
495	461	469	478	487	496	504	513	522	531	539	9
496	548	557	566	574	583	592	601	609	618	627	9
497	636	644	653	662	671	679	688	697	705	714	9
498	723	732	740	749	758	767	775	784	793	801	9
499	810	819	827	836	845	854	862	871	880	888	9
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
5000 TO 5499

N	0	1	2	3	4	5	6	7	8	9	D
500	69897	906	914	923	932	940	949	958	966	975	9
501	984	992	*001	*010	*018	*027	*036	*044	*053	*062	9
502	70070	079	088	096	105	114	122	131	140	148	9
503	157	165	174	183	191	200	209	217	226	234	9
504	243	252	260	269	278	286	295	303	312	321	9
505	329	338	346	355	364	372	381	389	398	406	9
506	415	424	432	441	449	458	467	475	484	492	9
507	501	509	518	526	535	544	552	561	569	578	9
508	586	595	603	612	621	629	638	646	655	663	9
509	672	680	689	697	706	714	723	731	740	749	9
510	757	766	774	783	791	800	808	817	825	834	9
511	842	851	859	868	876	885	893	902	910	919	9
512	927	935	944	952	961	969	978	986	995	*003	9
513	71012	020	029	037	046	054	063	071	079	088	8
514	096	105	113	122	130	139	147	155	164	172	8
515	181	189	198	206	214	223	231	240	248	257	8
516	265	273	282	290	299	307	315	324	332	341	8
517	349	357	366	374	383	391	399	408	416	425	8
518	433	441	450	458	466	475	483	492	500	508	8
519	517	525	533	542	550	559	567	575	584	592	8
520	600	609	617	625	634	642	650	659	667	675	8
521	684	692	700	709	717	725	734	742	750	759	8
522	767	775	784	792	800	809	817	825	834	842	8
523	850	858	867	875	883	892	900	908	917	925	8
524	933	941	950	958	966	975	983	991	999	*008	8
525	72016	024	032	041	049	057	066	074	082	090	8
526	099	107	115	123	132	140	148	156	165	173	8
527	181	189	198	206	214	222	230	239	247	255	8
528	263	272	280	288	296	304	313	321	329	337	8
529	346	354	362	370	378	387	395	403	411	419	8
530	428	436	444	452	460	469	477	485	493	501	8
531	509	518	526	534	542	550	558	567	575	583	8
532	591	599	607	616	624	632	640	648	656	665	8
533	673	681	689	697	705	713	722	730	738	746	8
534	754	762	770	779	787	795	803	811	819	827	8
535	835	843	852	860	868	876	884	892	900	908	8
536	916	925	933	941	949	957	965	973	981	989	8
537	997	*006	*014	*022	*030	*038	*046	*054	*062	*070	8
538	73078	086	094	102	111	119	127	135	143	151	8
539	159	167	175	183	191	199	207	215	223	231	8
540	239	247	255	263	272	280	288	296	304	312	8
541	320	328	336	344	352	360	368	376	384	392	8
542	400	408	416	424	432	440	448	456	464	472	8
543	480	488	496	504	512	520	528	536	544	552	8
544	560	568	576	584	592	600	608	616	624	632	8
545	640	648	656	664	672	679	687	695	703	711	8
546	719	727	735	743	751	759	767	775	783	791	8
547	799	807	815	823	830	838	846	854	862	870	8
548	878	886	894	902	910	918	926	933	941	949	8
549	957	965	973	981	989	997	*005	*013	*020	*028	8
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
5500 TO 5999

N	0	1	2	3	4	5	6	7	8	9	D
550	74036	044	052	060	068	076	084	092	099	107	8
551	115	123	131	139	147	155	162	170	178	186	8
552	194	202	210	218	225	233	241	249	257	265	8
553	273	280	288	296	304	312	320	327	335	343	8
554	351	359	367	374	382	390	398	406	414	421	8
555	429	437	445	453	461	468	476	484	492	500	8
556	507	515	523	531	539	547	554	562	570	578	8
557	586	593	601	609	617	624	632	640	648	656	8
558	663	671	679	687	695	702	710	718	726	733	8
559	741	749	757	764	772	780	788	796	803	811	8
560	819	827	834	842	850	858	865	873	881	889	8
561	896	904	912	920	927	935	943	950	958	966	8
562	974	981	989	997	*005	*012	*020	*028	*035	*043	8
563	75051	059	066	074	082	089	097	105	113	120	8
564	128	136	143	151	159	166	174	182	189	197	8
565	205	213	220	228	236	243	251	259	266	274	8
566	282	289	297	305	312	320	328	335	343	351	8
567	358	366	374	381	389	397	404	412	420	427	8
568	435	442	450	458	465	473	481	488	496	504	8
569	511	519	526	534	542	549	557	565	572	580	8
570	587	595	603	610	618	626	633	641	648	656	8
571	664	671	679	686	694	702	709	717	724	732	8
572	740	747	755	762	770	778	785	793	800	808	8
573	815	823	831	838	846	853	861	868	876	884	8
574	891	899	906	914	921	929	937	944	952	959	8
575	967	974	982	989	997	*005	*012	*020	*027	*035	8
576	76042	050	057	065	072	080	087	095	103	110	8
577	118	125	133	140	148	155	163	170	178	185	8
578	193	200	208	215	223	230	238	245	253	260	8
579	268	275	283	290	298	305	313	320	328	335	8
580	343	350	358	365	373	380	388	395	403	410	8
581	418	425	433	440	448	455	462	470	477	485	7
582	492	500	507	515	522	530	537	545	552	559	7
583	567	574	582	589	597	604	612	619	626	634	7
584	641	649	656	664	671	678	686	693	701	708	7
585	716	723	730	738	745	753	760	768	775	782	7
586	790	797	805	812	819	827	834	842	849	856	7
587	864	871	879	886	893	901	908	916	923	930	7
588	938	945	953	960	967	975	982	989	997	*004	7
589	77012	019	026	034	041	048	056	063	070	078	7
590	085	093	100	107	115	122	129	137	144	151	7
591	159	166	173	181	188	195	203	210	217	225	7
592	232	240	247	254	262	269	276	283	291	298	7
593	305	313	320	327	335	342	349	357	364	371	7
594	379	386	393	401	408	415	422	430	437	444	7
595	452	459	466	474	481	488	495	503	510	517	7
596	525	532	539	546	554	561	568	576	583	590	7
597	597	605	612	619	627	634	641	648	656	663	7
598	670	677	685	692	699	706	714	721	728	735	7
599	743	750	757	764	772	779	786	793	801	808	7
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
6000 TO 6499

N	0	1	2	3	4	5	6	7	8	9	D
600	77815	822	830	837	844	851	859	866	873	880	7
601	887	895	902	909	916	924	931	938	945	952	7
602	960	967	974	981	988	996	*003	*010	*017	*025	7
603	78032	039	046	053	061	068	075	082	089	097	7
604	104	111	118	125	132	140	147	154	161	168	7
605	176	183	190	197	204	211	219	226	233	240	7
606	247	254	262	269	276	283	290	297	305	312	7
607	319	326	333	340	347	355	362	369	376	383	7
608	390	398	405	412	419	426	433	440	447	455	7
609	462	469	476	483	490	497	504	512	519	526	7
610	533	540	547	554	561	569	576	583	590	597	7
611	604	611	618	625	633	640	647	654	661	668	7
612	675	682	689	696	704	711	718	725	732	739	7
613	746	753	760	767	774	781	789	796	803	810	7
614	817	824	831	838	845	852	859	866	873	880	7
615	888	895	902	909	916	923	930	937	944	951	7
616	958	965	972	979	986	993	*000	*007	*014	*021	7
617	79029	036	043	050	057	064	071	078	085	092	7
618	099	106	113	120	127	134	141	148	155	162	7
619	169	176	183	190	197	204	211	218	225	232	7
620	239	246	253	260	267	274	281	288	295	302	7
621	309	316	323	330	337	344	351	358	365	372	7
622	379	386	393	400	407	414	421	428	435	442	7
623	449	456	463	470	477	484	491	498	505	511	7
624	518	525	532	539	546	553	560	567	574	581	7
625	588	595	602	609	616	623	630	637	644	650	7
626	657	664	671	678	685	692	699	706	713	720	7
627	727	734	741	748	754	761	768	775	782	789	7
628	796	803	810	817	824	831	837	844	851	858	7
629	865	872	879	886	893	900	906	913	920	927	7
630	934	941	948	955	962	969	975	982	989	996	7
631	80003	010	017	024	030	037	044	051	058	065	7
632	072	079	085	092	099	106	113	120	127	134	7
633	140	147	154	161	168	175	182	188	195	202	7
634	209	216	223	229	236	243	250	257	264	271	7
635	277	284	291	298	305	312	318	325	332	339	7
636	346	353	359	366	373	380	387	393	400	407	7
637	414	421	428	434	441	448	455	462	468	475	7
638	482	489	496	502	509	516	523	530	536	543	7
639	550	557	564	570	577	584	591	598	604	611	7
640	618	625	632	638	645	652	659	665	672	679	7
641	686	693	699	706	713	720	726	733	740	747	7
642	754	760	767	774	781	787	794	801	808	814	7
643	821	828	835	841	848	855	862	868	875	882	7
644	889	895	902	909	916	922	929	936	943	949	7
645	956	963	969	976	983	990	996	*003	*010	*017	7
646	81023	030	037	043	050	057	064	070	077	084	7
647	090	097	104	111	117	124	131	137	144	151	7
648	158	164	171	178	184	191	198	204	211	218	7
649	224	231	238	245	251	258	265	271	278	285	7
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
6500 TO 6999

N	0	1	2	3	4	5	6	7	8	9	D
650	81291	298	305	311	318	325	331	338	345	351	7
651	358	365	371	378	385	391	398	405	411	418	7
652	425	431	438	445	451	458	465	471	478	485	7
653	491	498	505	511	518	525	531	538	544	551	7
654	558	564	571	578	584	591	598	604	611	617	7
655	624	631	637	644	651	657	664	671	677	684	7
656	690	697	704	710	717	723	730	737	743	750	7
657	757	763	770	776	783	790	796	803	809	816	7
658	823	829	836	842	849	856	862	869	875	882	7
659	889	895	902	908	915	921	928	935	941	948	7
660	954	961	968	974	981	987	994	*000	*007	*014	7
661	82020	027	033	040	046	053	060	066	073	079	7
662	086	092	099	105	112	119	125	132	138	145	7
663	151	158	164	171	178	184	191	197	204	210	7
664	217	223	230	236	243	249	256	263	269	276	7
665	282	289	295	302	308	315	321	328	334	341	7
666	347	354	360	367	373	380	387	393	400	406	7
667	413	419	426	432	439	445	452	458	465	471	7
668	478	484	491	497	504	510	517	523	530	536	7
669	543	549	556	562	569	575	582	588	595	601	7
670	607	614	620	627	633	640	646	653	659	666	7
671	672	679	685	692	698	705	711	718	724	730	6
672	737	743	750	756	763	769	776	782	789	795	6
673	802	808	814	821	827	834	840	847	853	860	6
674	866	872	879	885	892	898	905	911	918	924	6
675	930	937	943	950	956	963	969	975	982	988	6
676	995	*001	*008	*014	*020	*027	*033	*040	*046	*052	6
677	83059	065	072	078	085	091	097	104	110	117	6
678	123	129	136	142	149	155	161	168	174	181	6
679	187	193	200	206	213	219	225	232	238	245	6
680	251	257	264	270	276	283	289	296	302	308	6
681	315	321	327	334	340	347	353	359	366	372	6
682	378	385	391	398	404	410	417	423	429	436	6
683	442	448	455	461	467	474	480	487	493	499	6
684	506	512	518	525	531	537	544	550	556	563	6
685	569	575	582	588	594	601	607	613	620	626	6
686	632	639	645	651	658	664	670	677	683	689	6
687	696	702	708	715	721	727	734	740	746	753	6
688	759	765	771	778	784	790	797	803	809	816	6
689	822	828	835	841	847	853	860	866	872	879	6
690	885	891	897	904	910	916	923	929	935	942	6
691	948	954	960	967	973	979	985	992	998	*004	6
692	84011	017	023	029	036	042	048	055	061	067	6
693	073	080	086	092	098	105	111	117	123	130	6
994	136	142	148	155	161	167	173	180	186	192	6
695	198	205	211	217	223	230	236	242	248	255	6
696	261	267	273	280	286	292	298	305	311	317	6
697	323	330	336	342	348	354	361	367	373	379	6
698	386	392	398	404	410	417	423	429	435	442	6
699	448	454	460	466	473	479	485	491	497	504	6
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
7000 TO 7499

N	0	1	2	3	4	5	6	7	8	9	D
700	84510	516	522	528	535	541	547	553	559	566	6
701	572	578	584	590	597	603	609	615	621	628	6
702	634	640	646	652	658	665	671	677	683	689	6
703	696	702	708	714	720	726	733	739	745	751	6
704	757	763	770	776	782	788	794	800	807	813	6
705	819	825	831	837	844	850	856	862	868	874	6
706	880	887	893	899	905	911	917	924	930	936	6
707	942	948	954	960	967	973	979	985	991	997	6
708	85003	009	016	022	028	034	040	046	052	058	6
709	065	071	077	083	089	095	101	107	114	120	6
710	126	132	138	144	150	156	163	169	175	181	6
711	187	193	199	205	211	217	224	230	236	242	6
712	248	254	260	266	272	278	285	291	297	303	6
713	309	315	321	327	333	339	345	352	358	364	6
714	370	376	382	388	394	400	406	412	418	425	6
715	431	437	443	449	455	461	467	473	479	485	6
716	491	497	503	509	516	522	528	534	540	546	6
717	552	558	564	570	576	582	588	594	600	606	6
718	612	618	625	631	637	643	649	655	661	667	6
719	673	679	685	691	697	703	709	715	721	727	6
720	733	739	745	751	757	763	769	775	781	788	6
721	794	800	806	812	818	824	830	836	842	848	6
722	854	860	866	872	878	884	890	896	902	908	6
723	914	920	926	932	938	944	950	956	962	968	6
724	974	980	986	992	998	*004	*010	*016	*022	*028	6
725	86034	040	046	052	058	064	070	076	082	088	6
726	094	100	106	112	118	124	130	136	141	147	6
727	153	159	165	171	177	183	189	195	201	207	6
728	213	219	225	231	237	243	249	255	261	267	6
729	273	279	285	291	297	303	308	314	320	326	6
730	332	338	344	350	356	362	368	374	380	386	6
731	392	398	404	410	415	421	427	433	439	445	6
732	451	457	463	469	475	481	487	493	499	504	6
733	510	516	522	528	534	540	546	552	558	564	6
734	570	576	581	587	593	599	605	611	617	623	6
735	629	635	641	646	652	658	664	670	676	682	6
736	688	694	700	705	711	717	723	729	735	741	6
737	747	753	759	764	770	776	782	788	794	800	6
738	806	812	817	823	829	835	841	847	853	859	6
739	864	870	876	882	888	894	900	906	911	917	6
740	923	929	935	941	947	953	958	964	970	976	6
741	982	988	994	999	*005	*011	*017	*023	*029	*035	6
742	87040	046	052	058	064	070	075	081	087	093	6
743	099	105	111	116	122	128	134	140	146	151	6
744	157	163	169	175	181	186	192	198	204	210	6
745	216	221	227	233	239	245	251	256	262	268	6
746	274	280	286	291	297	303	309	315	320	326	6
747	332	338	344	349	355	361	367	373	379	384	6
748	390	396	402	408	413	419	425	431	437	442	6
749	448	454	460	466	471	477	483	489	495	500	6
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
7500 TO 7999

N	0	1	2	3	4	5	6	7	8	9	D
750	87506	512	518	523	529	535	541	547	552	558	6
751	564	570	576	581	587	593	599	604	610	616	6
752	622	628	633	639	645	651	656	662	668	674	6
753	679	685	691	697	703	708	714	720	726	731	6
754	737	743	749	754	760	766	772	777	783	789	6
755	795	800	806	812	818	823	829	835	841	846	6
756	852	858	864	869	875	881	887	892	898	904	6
757	910	915	921	927	933	938	944	950	955	961	6
758	967	973	978	984	990	996	*001	*007	*013	*018	6
759	88024	030	036	041	047	053	058	064	070	076	6
760	081	087	093	098	104	110	116	121	127	133	6
761	138	144	150	156	161	167	173	178	184	190	6
762	195	201	207	213	218	224	230	235	241	247	6
763	252	258	264	270	275	281	287	292	298	304	6
764	309	315	321	326	332	338	343	349	355	360	6
765	366	372	377	383	389	395	400	406	412	417	6
766	423	429	434	440	446	451	457	463	468	474	6
767	480	485	491	497	502	508	513	519	525	530	6
768	536	542	547	553	559	564	570	576	581	587	6
769	593	598	604	610	615	621	627	632	638	643	6
770	649	655	660	666	672	677	683	689	694	700	6
771	705	711	717	722	728	734	739	745	750	756	6
772	762	767	773	779	784	790	795	801	807	812	6
773	818	824	829	835	840	846	852	857	863	868	6
774	874	880	885	891	897	902	908	913	919	925	6
775	930	936	941	947	953	958	964	969	975	981	6
776	986	992	997	*003	*009	*014	*020	*025	*031	*037	6
777	89042	048	053	059	064	070	076	081	087	092	6
778	098	104	109	115	120	126	131	137	143	148	6
779	154	159	165	170	176	182	187	193	198	204	6
780	209	215	221	226	232	237	243	248	254	260	6
781	265	271	276	282	287	293	298	304	310	315	6
782	321	326	332	337	343	348	354	360	365	371	6
783	376	382	387	393	398	404	409	415	421	426	6
784	432	437	443	448	454	459	465	470	476	481	6
785	487	492	498	504	509	515	520	526	531	537	6
786	542	548	553	559	564	570	575	581	586	592	6
787	597	603	609	614	620	625	631	636	642	647	6
788	653	658	664	669	675	680	686	691	697	702	6
789	708	713	719	724	730	735	741	746	752	757	6
790	763	768	774	779	785	790	796	801	807	812	5
791	818	823	829	834	840	845	851	856	862	867	5
792	873	878	883	889	894	900	905	911	916	922	5
793	927	933	938	944	949	955	960	966	971	977	5
794	982	988	993	998	*004	*009	*015	*020	*026	*031	5
795	90037	042	048	053	059	064	069	075	080	086	5
796	091	097	102	108	113	119	124	129	135	140	5
797	146	151	157	162	168	173	179	184	189	195	5
798	200	206	211	217	222	227	233	238	244	249	5
799	255	260	266	271	276	282	287	293	298	304	5
N	0	1	2	3	4	5	6	7	8	9	D

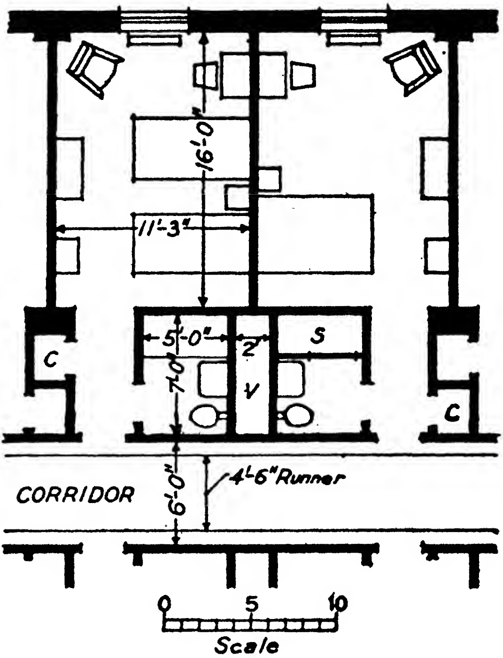
ABSCISSA OF NUMBERS
9000 TO 9499

N	0	1	2	3	4	5	6	7	8	9	D
900	95424	429	434	439	444	448	453	458	463	468	5
901	472	477	482	487	492	497	501	506	511	516	5
902	521	525	530	535	540	545	550	554	559	564	5
903	569	574	578	583	588	593	598	602	607	612	5
904	617	622	626	631	636	641	646	650	655	660	5
905	665	670	674	679	684	689	694	698	703	708	5
906	713	718	722	727	732	737	742	746	751	756	5
907	761	766	770	775	780	785	789	794	799	804	5
908	809	813	818	823	828	832	837	842	847	852	5
909	856	861	866	871	875	880	885	890	895	899	5
910	904	909	914	918	923	928	933	938	942	947	5
911	952	957	961	966	971	976	980	985	990	995	5
912	999	*004	*009	*014	*019	*023	*028	*033	*038	*042	5
913	96047	052	057	061	066	071	076	080	085	090	5
914	095	099	104	109	114	118	123	128	133	137	5
915	142	147	152	156	161	166	171	175	180	185	5
916	190	194	199	204	209	213	218	223	227	232	5
917	237	242	246	251	256	261	265	270	275	280	5
918	284	289	294	298	303	308	313	317	322	327	5
919	332	336	341	346	350	355	360	365	369	374	5
920	379	384	388	393	398	402	407	412	417	421	5
921	426	431	435	440	445	450	454	459	464	468	5
922	473	478	483	487	492	497	501	506	511	515	5
923	520	525	530	534	539	544	548	553	558	562	5
924	567	572	577	581	586	591	595	600	605	609	5
925	614	619	624	628	633	638	642	647	652	656	5
926	661	666	670	675	680	685	689	694	699	703	5
927	708	713	717	722	727	731	736	741	745	750	5
928	755	759	764	769	774	778	783	788	792	797	5
929	802	806	811	816	820	825	830	834	839	844	5
930	848	853	858	862	867	872	876	881	886	890	5
931	895	900	904	909	914	918	923	928	932	937	5
932	942	946	951	956	960	965	970	974	979	984	5
933	988	993	997	*002	*007	*011	*016	*021	*025	*030	5
934	97035	039	044	049	053	058	063	067	072	077	5
935	081	086	090	095	100	104	109	114	118	123	5
936	128	132	137	142	146	151	155	160	165	169	5
937	174	179	183	188	192	197	202	206	211	216	5
938	220	225	230	234	239	243	248	253	257	262	5
939	267	271	276	280	285	290	294	299	304	308	5
940	313	317	322	327	331	336	340	345	350	354	5
941	359	364	368	373	377	382	387	391	396	400	5
942	405	410	414	419	424	428	433	437	442	447	5
943	451	456	460	465	470	474	479	483	488	493	5
944	497	502	506	511	516	520	525	529	534	539	5
945	543	548	552	557	562	566	571	575	580	585	5
946	589	594	598	603	607	612	617	621	626	630	5
947	635	640	644	649	653	658	663	667	672	676	5
948	681	685	690	695	699	704	708	713	717	722	5
949	727	731	736	740	745	749	754	759	763	768	5
N	0	1	2	3	4	5	6	7	8	9	D

ABSCISSA OF NUMBERS
9500 TO 9999

N	0	1	2	3	4	5	6	7	8	9	D
950	97772	777	782	786	791	795	800	804	809	813	
951	818	823	827	832	836	841	845	850	855	859	
952	864	868	873	877	882	886	891	896	900	905	
953	909	914	918	923	928	932	937	941	946	950	
954	955	959	964	968	973	978	982	987	991	996	
955	98000	005	009	014	019	023	028	032	037	041	
956	046	050	055	059	064	068	073	078	082	087	
957	091	096	100	105	109	114	118	123	127	132	5
958	137	141	146	150	155	159	164	168	173	177	5
959	182	186	191	195	200	204	209	214	218	223	5
960	227	232	236	241	245	250	254	259	263	268	5
961	272	277	281	286	290	295	299	304	308	313	5
962	318	322	327	331	336	340	345	349	354	358	5
963	363	367	372	376	381	385	390	394	399	403	5
964	408	412	417	421	426	430	435	439	444	448	5
965	453	457	462	466	471	475	480	484	489	493	4
966	498	502	507	511	516	520	525	529	534	538	4
967	543	547	552	556	561	565	570	574	579	583	4
968	588	592	597	601	605	610	614	619	623	628	4
969	632	637	641	646	650	655	659	664	668	673	4
970	677	682	686	691	695	700	704	709	713	717	4
971	722	726	731	735	740	744	749	753	758	762	4
972	767	771	776	780	784	789	793	798	802	807	4
973	811	816	820	825	829	834	838	843	847	851	4
974	856	860	865	869	874	878	883	887	892	896	4
975	900	905	909	914	918	923	927	932	936	941	4
976	945	949	954	958	963	967	972	976	981	985	4
977	989	994	998	*003	*007	*012	*016	*021	*025	*029	4
978	99034	038	043	047	052	056	061	065	069	074	4
979	078	083	087	092	096	100	105	109	114	118	4
980	123	127	131	136	140	145	149	154	158	162	4
981	167	171	176	180	185	189	193	198	202	207	4
982	211	216	220	224	229	233	238	242	247	251	4
983	255	260	264	269	273	277	282	286	291	295	4
984	300	304	308	313	317	322	326	330	335	339	4
985	344	348	352	357	361	366	370	374	379	383	4
986	388	392	396	401	405	410	414	419	423	427	4
987	432	436	441	445	449	454	458	463	467	471	4
988	476	480	484	489	493	498	502	506	511	515	4
989	520	524	528	533	537	542	546	550	555	559	4
990	564	568	572	577	581	585	590	594	599	603	4
991	607	612	616	621	625	629	634	638	642	647	4
992	651	656	660	664	669	673	977	682	686	691	4
993	695	699	704	708	712	717	721	726	730	734	4
994	739	743	747	752	756	760	765	769	774	778	4
995	782	787	791	795	800	804	808	813	817	822	4
996	826	830	835	839	843	848	852	856	861	865	4
997	870	874	878	883	887	891	896	900	904	909	4
998	913	917	922	926	930	935	939	944	948	952	4
999	957	961	965	970	974	978	983	987	991	996	4
N	0	1	2	3	4	5	6	7	8	9	D

TYPICAL HOTEL GUEST ROOM



Width of bedroom may vary from 9' to 14', depending on the class of occupancy, beds to be used, and other factors. Width may be determined as a multiple of the standard 2'-3" wide carpet. Depth of bedroom may vary from 14' to 18'. Ceiling height may vary from 8'-8" to 9'-8".

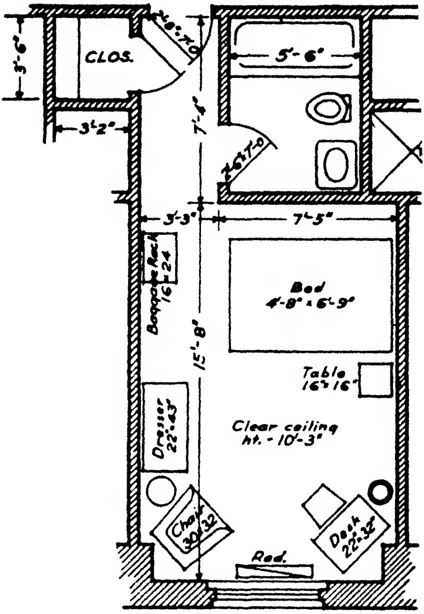
Bathroom width is determined by length of tub or shower stall. Length should not be less than 7' for fixture arrangement shown. Ceiling may be furred down over bathroom element to 7'-6", providing horizontal pipe duct in the furred space.

Closets should not be less than 2' deep to accommodate the standard coat hanger.

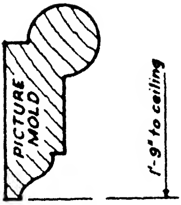
Vent shaft contains the plumbing piping and provides ventilation. It should be at least 2' wide, with access to it thru a hinged medicine cabinet in the bathroom.

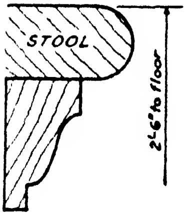
Plan arrangement shown is preferable to other schemes because—it gives protection to the bedroom from corridor noises; it results in a width of wing of good stability; it is economical of outside wall per unit; it results in a satisfactory column arrangement; a positive air circulation from bedroom to bathroom removes bathroom odors.

DOUBLE BED HOTEL ROOM

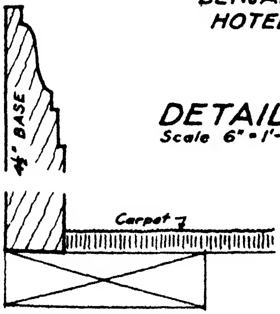


PLAN
Scale 1/8" = 1'-0"

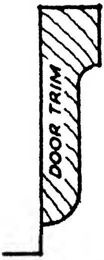




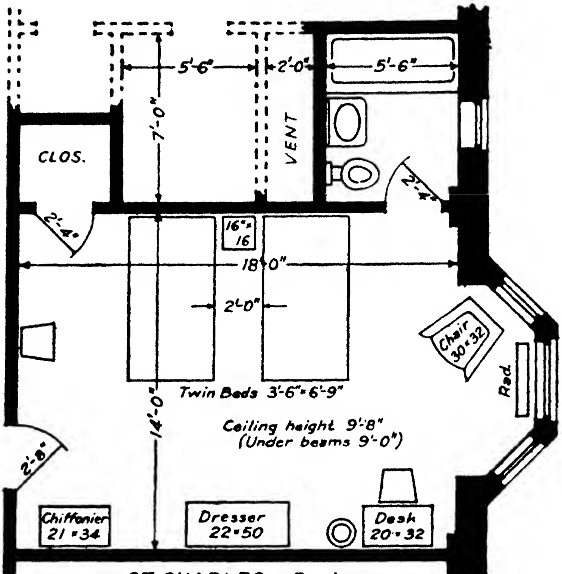
BENJAMIN FRANKLIN HOTEL - Philadelphia



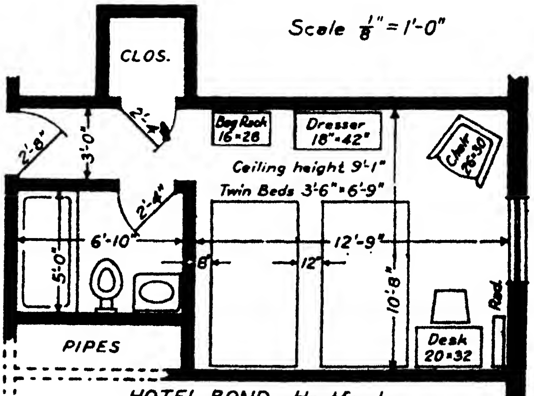
DETAILS
Scale 6" = 1'-0"



TWIN BED HOTEL ROOMS

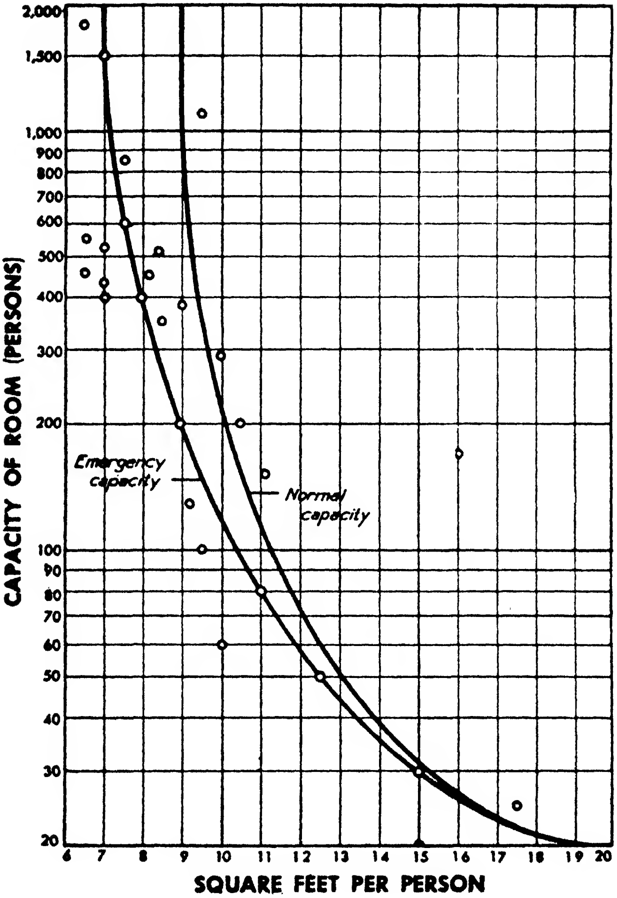


ST. CHARLES Boston



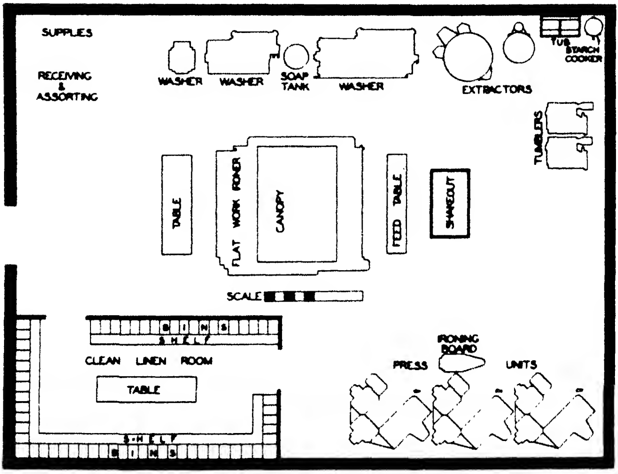
HOTEL BOND Hartford

HOTEL DINING ROOMS
SQUARE FOOT AREAS



For the preparation of the chart above, a large number of representative hotel dining rooms were measured. The capacity of these rooms was taken from actual hotel experience. Resulting positions on the graph are shown by the dots. It is extremely doubtful if 6½ square feet per person is adequate space even under emergency conditions. The normal capacity curve should always be used as a minimum, particularly where dining room is to be used for meetings at which the diners are to listen to speeches or entertainment following the meal without leaving their tables.

PLANNING THE 200-BED HOTEL LAUNDRY



Typical Laundry Plan for 200-Room Hotel

The inclusion of a laundry in a hotel assures continuous operating economies in the handling of hotel linen. Guests' laundry can be quickly and efficiently handled to provide an additional source of hotel income.

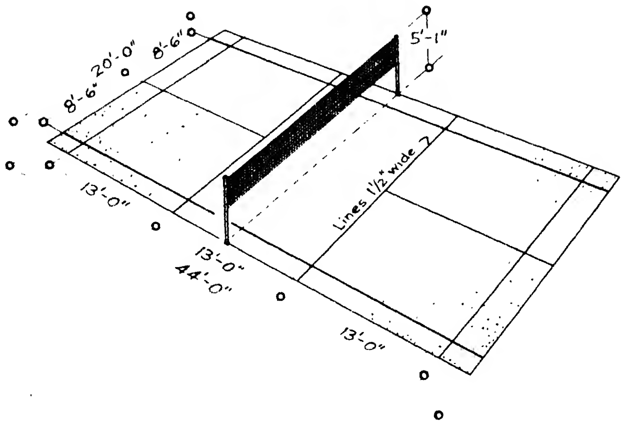
For the average condition 10 square feet of area should be allowed for the laundry room for each guest room in the hotel. This will provide sufficient space for the machinery necessary to take care of usual hotel linen. However, if special facilities of the hotel, such as swimming pools, barber shop and beauty parlor linen, are to be handled by the hotel laundry, the required area for the laundry room might have to be increased up to 20%.

The laundry should be out of sight and hearing of the guests. To locate it on the ground floor or in the basement is usually desirable. The laundry must have a supply of high pressure steam—100-pound pressure is usual for ironing machinery. If the equipment is to be heated by electricity rather than by steam, the laundry may be located without respect to the power plant. Where it is available at low cost, electricity is practical in conjunction with a low pressure steam system to provide hot water.

An entrance to the laundry room at least 6′-6″ wide and 7′-6″ high is recommended. The ceiling must be 12′-0″ above the level of the laundry room floor, 14′-0″ if line shafting is to be used instead of individual motor equipment. The individual motor drive is recommended for all machinery.

Architects should provide the proper room for the laundry but should not attempt the placing or selection of equipment without the advice of a Machinery Company representative.

BADMINTON COURTS



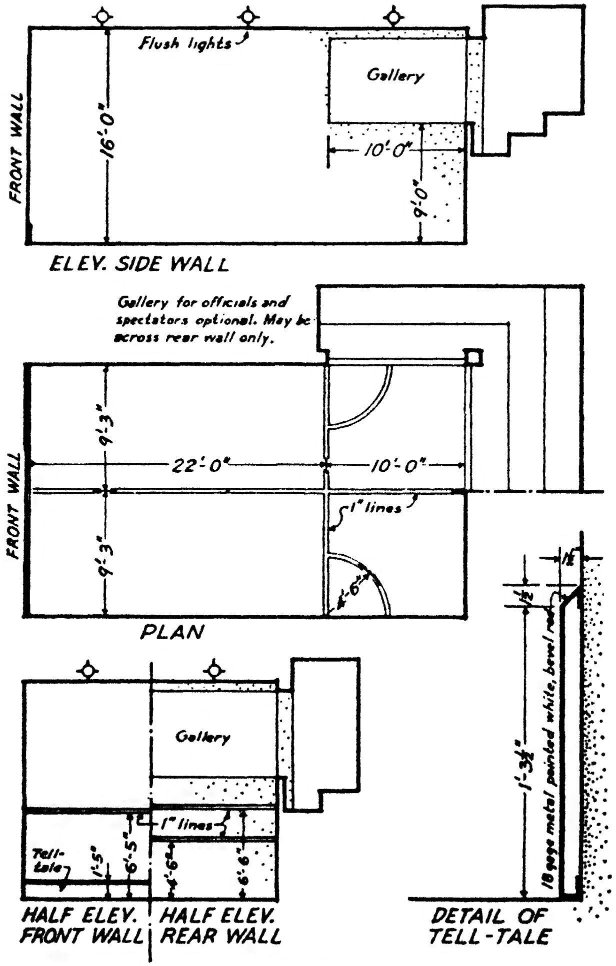
OUTDOOR COURTS. A level area of lawn 30 x 50 ft. may be used without special preparation. Since only volley shots are played, there is no need for the perfect turf required for lawn tennis. Cement, asphalt and clay surfaces provide about an equally secure footing. Provide a 1500-watt unit on a 25 ft. pole located 24" from net posts for night play.

INDOOR COURTS. An unobstructed space of 4 to 6 ft. should be allowed along both long sides of the court, and from 6 to 10 ft. at the ends. An area of 30 x 60 ft. provides ideal conditions for doubles court. Lockers, seats for spectators and other objects should not encroach on this unobstructed space.

The clear overhead space at the net line should be not less than 25 ft. and 30 ft. is preferable. End walls 20 ft. high will be adequate. This allows gable roof construction if desired.

Light green is the most desirable color for walls and ceiling. Artificial lighting consists of three units 5' o/c at each end of the net, 25 ft. high. A wood floor of British Columbia fir laid lengthwise of T&G boards is best. Skylight with diffusing and glare reducing glass will furnish daylight illumination.

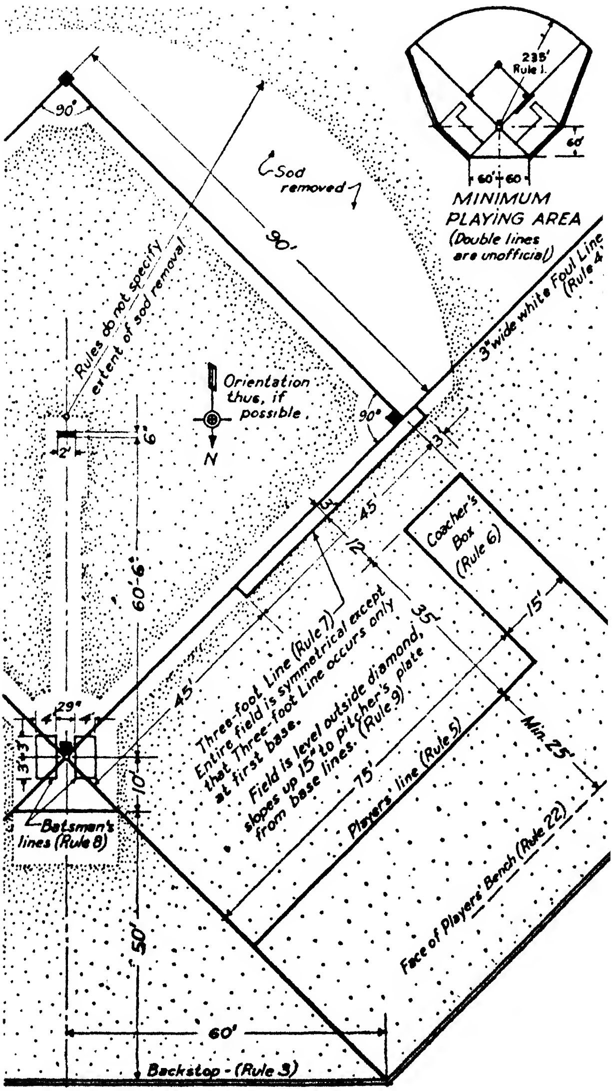
SQUASH COURTS



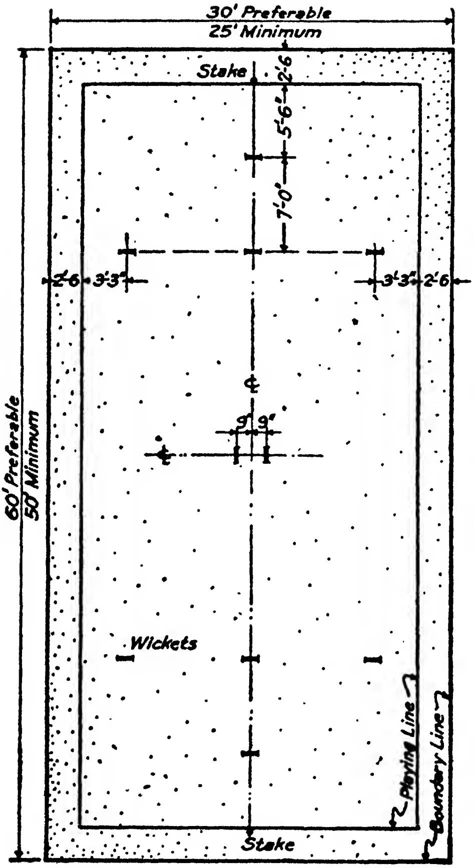
Floor and walls to be maple, secret nailed, white enamel finish, 25/32" x 2¼". Floor laid on edge, running lengthwise. Side walls laid flat, running horizontally. End walls laid flat, running vertically. Lines to be vivid red.

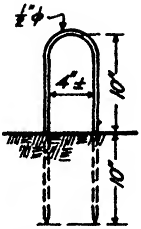
This court is used for Squash Racquets and Squash Tennis. With tell-tale removed it is adapted to Handball.

BASEBALL DIAMOND



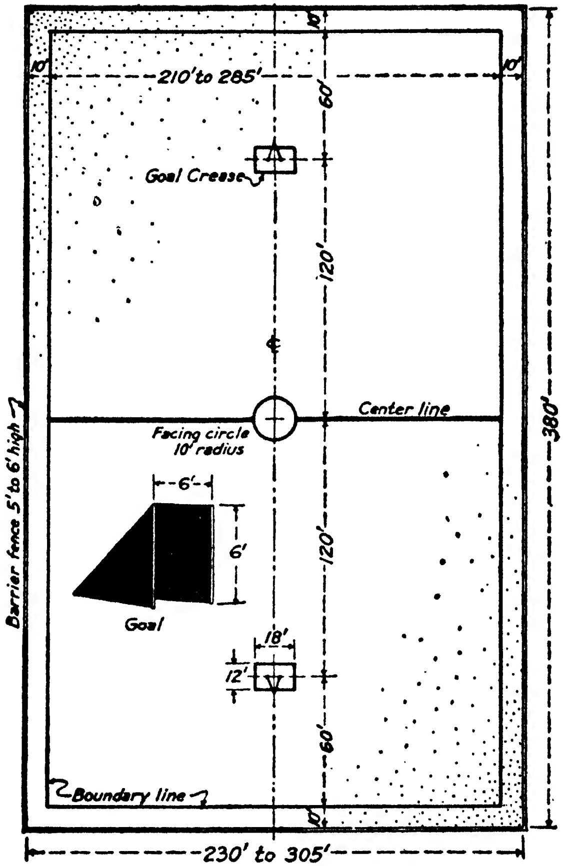
CROQUET COURTS





The court should consist of a level lawn closely cropped. The boundary line is a strong white cotton cord stapled in place, or a chalk line extending around the court. The playing line is a line (imaginary or otherwise) 2'-6" inside the boundary line. This may be marked or not by chalk or a smaller cord stapled in place. Some additional space is desirable around the outside of the boundary line. A total unobstructed area of 50' x 80' provides an ideal condition. Courts in batteries should have 10' or more between their boundary lines. For complete playing rules see Spaulding's Athletic Library handbook number 48R, *Lawn Sports*.

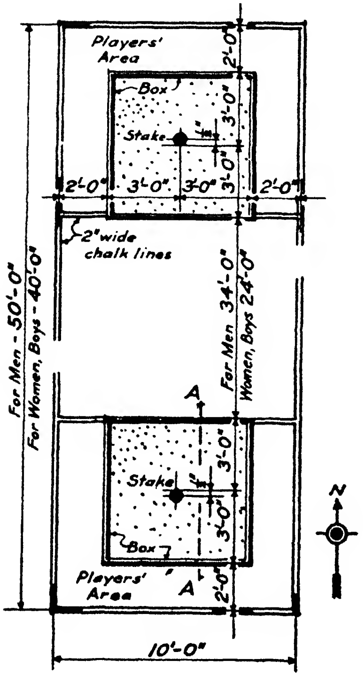
LACROSSE FIELD

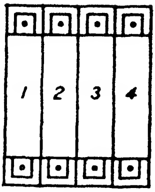


The boundaries of the field are marked with white lines and an extra heavy white line designates the Center Line. The official rules state that the barrier fence shown is "advisable."

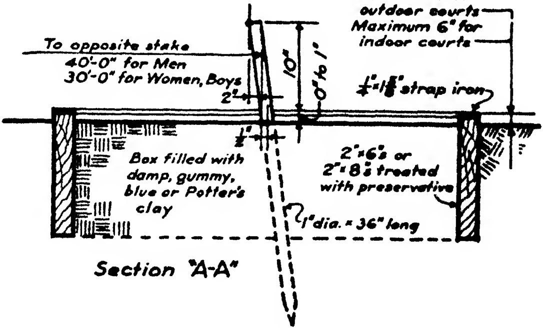
For complete playing rules see Spaulding's Athletic Library OFFICIAL LACROSSE GUIDE.

HORSESHOE COURTS
OFFICIAL STANDARD



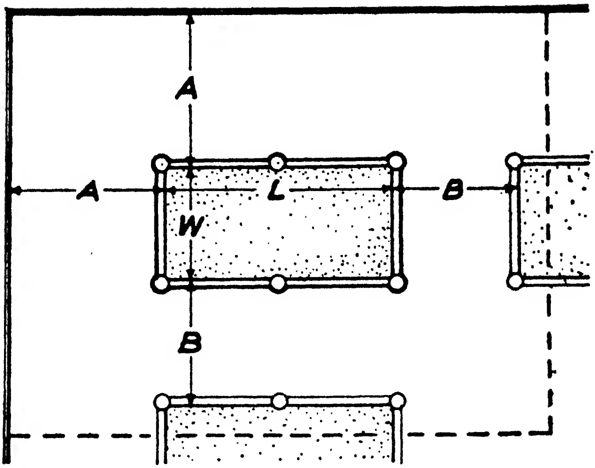


Multiple courts should be arranged in batteries of four, spaced 10'-0" o.c. 10'-0" or more should be allowed between the batteries.



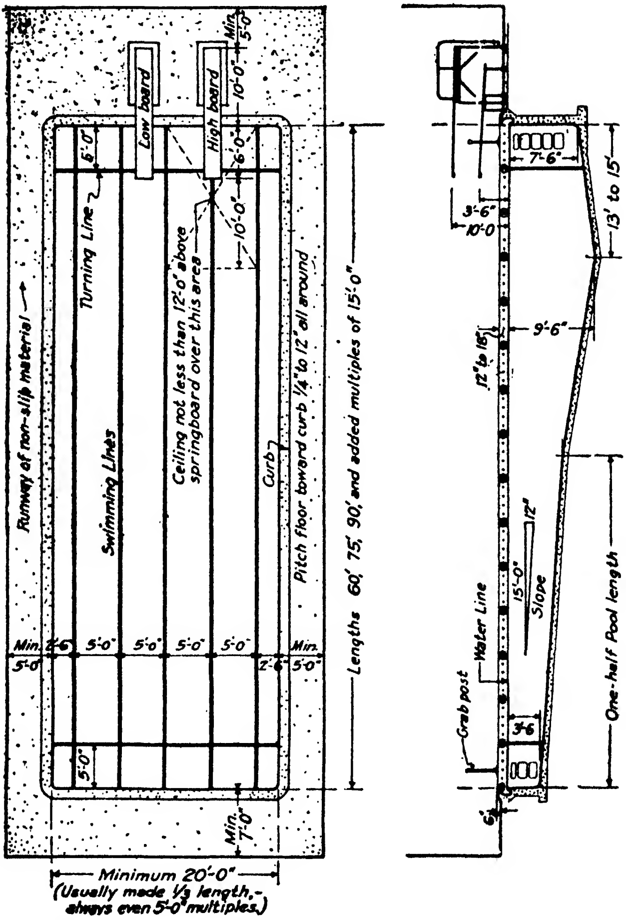
Section "A-A"

BILLIARD ROOMS



Size W x L	Where Used	Unobstructed Space A	Between Tables B
3x6	Home	4'-6"	....
3½x7	Home	5'-0"	....
4x8	Home Commercial standard in South America, Mexico, and Spain	5'-6"	4'-6"
4½x9	Popular U. S. commercial standard	6'-0"	5'-0"
5x10	U. S. professional standard	6'-0"	5'-0"
6x12	Commercial standard in Canada and England	6'-0"	5'-0"

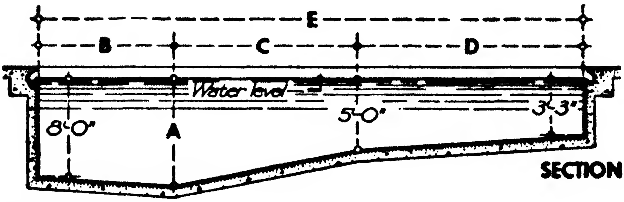
STANDARD SWIMMING POOL DIMENSIONS



The editor of Beach & Pool says, "A swimming lane must be 5'-0" wide, a pool must have a minimum of 4 lanes and be at least 60'-0" long. If a larger pool is required it is enlarged in multiples of 5 and 15 feet."

To meet championship requirements pools should be not less than 36' (permitting six 6' lanes) to 42' (permitting six 7' lanes) in width. Seventy-five feet is the ideal length for indoor pools and must be at least that length to comply with world record requirements.

SWIMMING POOL
SIZES AND CAPACITIES



F · *Width of pool*
Q · *Approximate number of people at one time*
8Q ·*Maximum daily load*

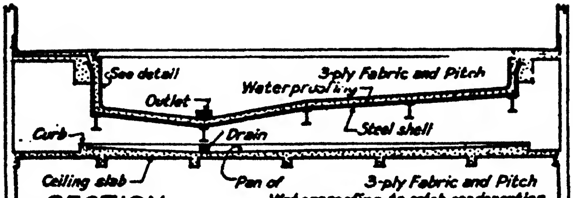
The number of people admitted to the pool at one time is given in the table and is subject to variation, depending upon ages of the swimmers. For simultaneous use by small active boys and dignified older persons, the limit could be very much lower than that given—since a sense of overcrowding would result. If all the swimmers are of the same age, a larger number of users at one time would be tolerable.

The maximum daily load and the capacity of the pool in gallons are given to facilitate calculations involving water purifications, drainage and supply.

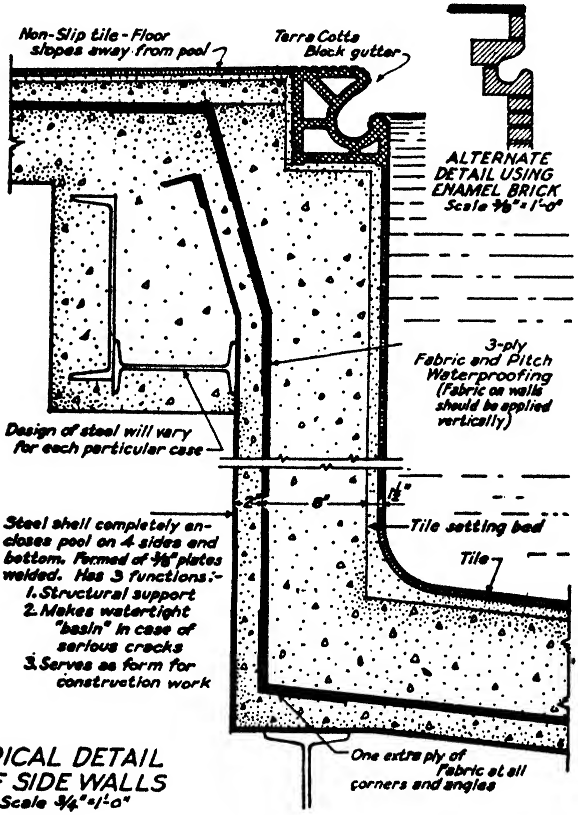
"STANDARD" SWIMMING POOL DIMENSIONS

A	*B*	*C*	*D*	*E*	*F*	*Gallons*	*Q*
9'	15'	20'	25'	60'	20'	55,000	32
9'	15'	20'	40'	75'	25'	80,000	42
9½'	18'	25'	47'	90'	30'	120,000	75
10'	18'	25'	62'	105'	35'	155,000	100
10'	20'	30'	70'	120'	40'	207,000	130
10'	20'	30'	85'	135'	45'	248,000	170
10'	20'	30'	100'	150'	50'	310,000	250
10'	20'	30'	130'	180'	60'	420,000	360
10'	20'	30'	160'	210'	70'	558,000	490

INDOOR SWIMMING POOL

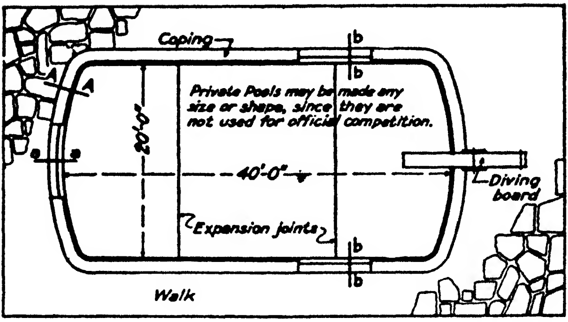


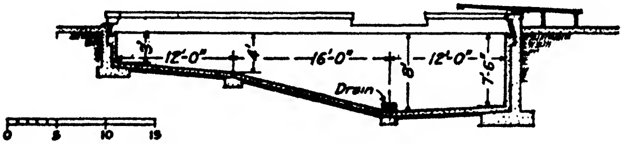
SECTION

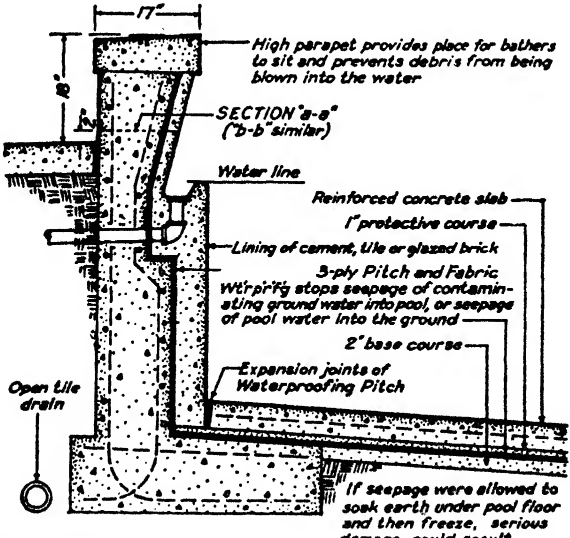


TYPICAL DETAIL OF SIDE WALLS
Scale 3/4" = 1'-0"

SMALL OUTDOOR SWIMMING POOL

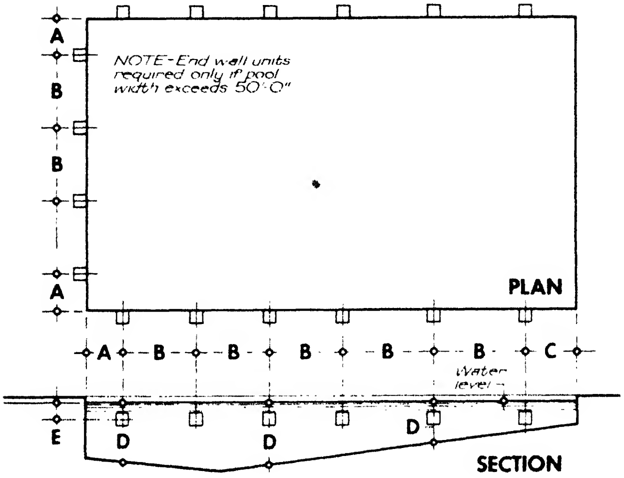






SECTION "A-A"
Scale 3/8"=1'-0"

UNDERWATER LIGHTING
SWIMMING POOLS



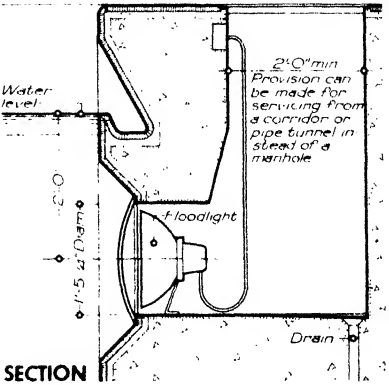
SIZE OF LAMP	A	B (Maximum) Where D is More Than 5' 0"	B (Maximum) Where D is Less Than 5'-0"	C	E Min	E Max.
250-watt	4'-0"	8'-0"	10'-0'	5'-0"	1'-0"	1'-3"
400-watt						
500-watt						
1000-watt	6'-0"	12' 0"	15'-0"	7'-6"	1'-6"	2'-0"
1500-watt						

Total wattage should equal pool length multiplied by watts per square foot as recommended in the table below. To determine correct lamp size, divide the total wattage thus found by the number of units. Choose the nearest standard lamp size and respace the number of units required. The A and C dimensions given in the table above should be maintained, and the B dimensions should not be exceeded. All floodlights should be equipped with lenses which give a horizontal spread of light.

LOCATION OF POOL	RECOMMENDED WATTS PER SQUARE FOOT. Good Practice	RECOMMENDED WATTS PER SQUARE FOOT. Minimum
OUTDOORS	3	1
INDOORS	5	2.5

UNDERWATER LIGHTING SWIMMING POOLS

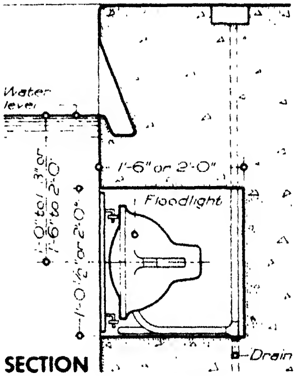
DRY NICHE METHOD. Recommended for brick or tile finished pools. Floodlights are mounted behind watertight portholes and are serviced from above thru manholes or a tunnel in the rear. A cast bronze niche lining is cast into the wall of the pool, to receive porthole ring and watertight door. Aluminum is lower priced but can be used only in fresh chemical-free water.



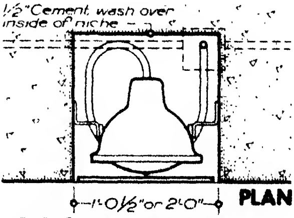
SECTION

WET NICHE METHOD. Less expensive and simpler than the Dry-niche method. The wet niche is commonly used for outdoor concrete pools. Doors cover the niche, and are opened when the lighting units need to be raised to the surface for servicing. Any construction that prevents free circulation of water behind the unit should be avoided.

Floodlights can be furnished in cast-aluminum casing and door parts at a lower price than bronze, but can be used only in fresh, chemical-free water.



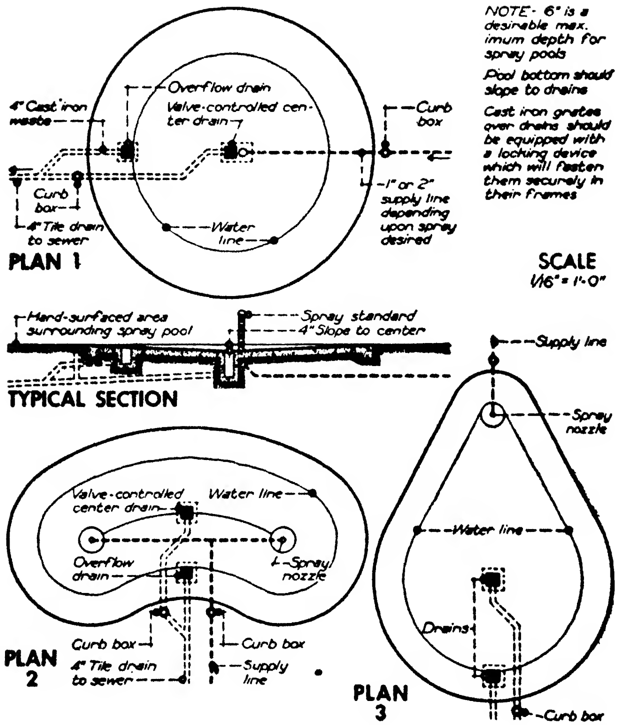
SECTION



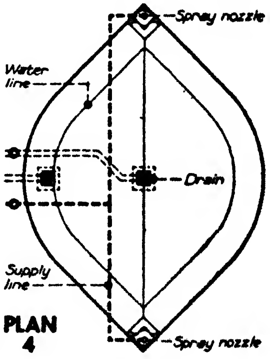
PLAN

NOTE—Size of niche varies according to the type of floodlight used.

PLAYGROUND POOLS



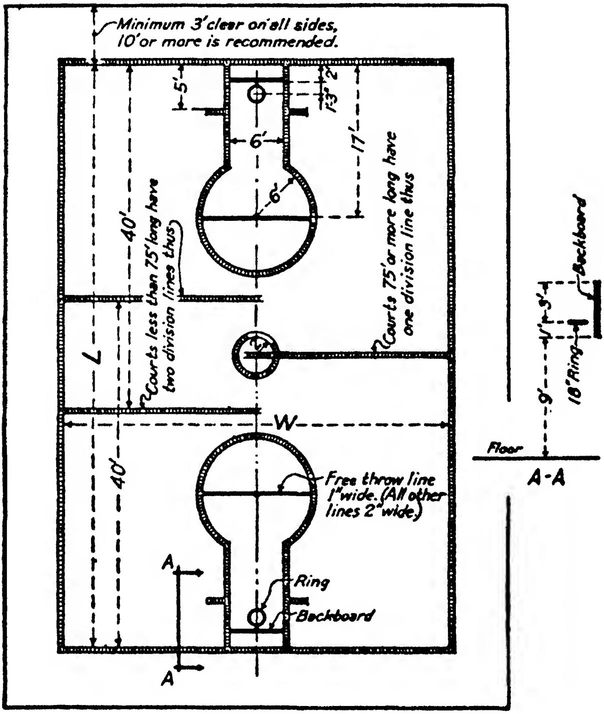
Water play should be provided in every playground. Pools may be small and need not be deep, 6" being a desirable maximum. Every pool should be equipped with some form of spray shower, with drains so arranged that for economy of operation approximately 3" of water can be retained in the basin after the shower is turned off.



The plans shown are important as design elements, for the shape of each pool is determined by the contour of the falling water.

The pool may be constructed of concrete or the bituminous material used in surrounding areas. A hard-surfaced area surrounding the pool defines it distinctly and makes proper maintenance easier.

BASKETBALL COURTS



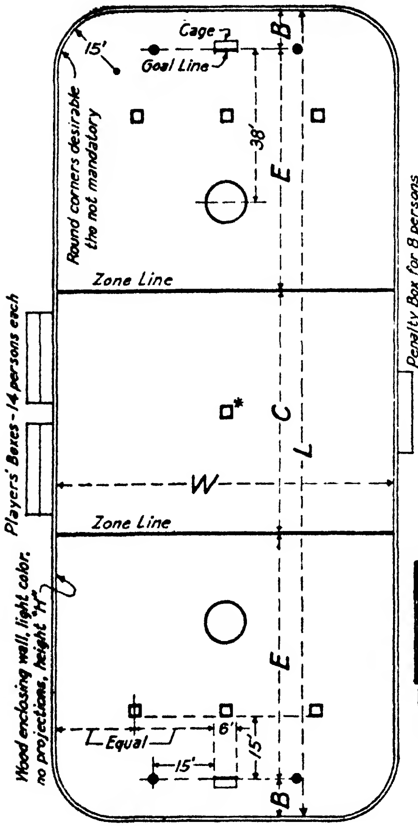
Minimum court size	35 x 60
Ideal for elementary school players	40 x 60
Ideal for high school players	48 x 75
Ideal for college players	48 x 84
Maximum court size	50 x 94

The information on this sheet conforms to the official basketball rules as adopted by the National Basketball Committee of the United States and Canada, representing the

National Collegiate Athletic Association,
National Federation of State High School Athletic Associations,
Amateur Athletic Union of the United States,
Young Men's Christian Association,
Canadian Amateur Basketball Association.

For complete playing rules see Spalding's Athletic Library *Basketball Guide*.

ICE HOCKEY RINKS



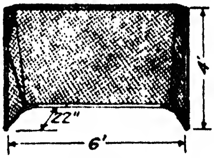
RINK MARKINGS

□ 12" Squares (inside) required by N.C.A.A. only

□* 12" Center Square required by N.C.A.A. and A.A.U.

● Spots required by N.C.A.A. only.

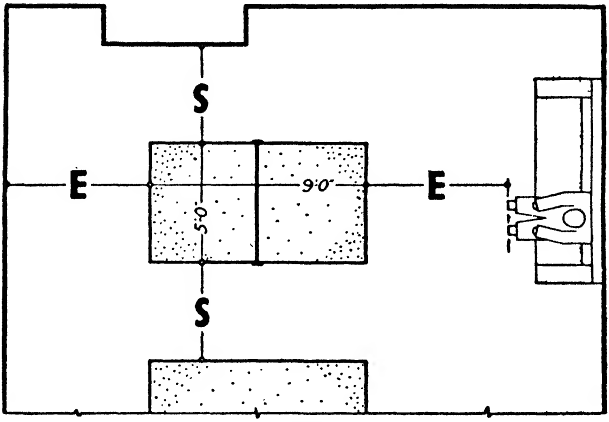
○ 10' Dia. circle required by N.H.L. only



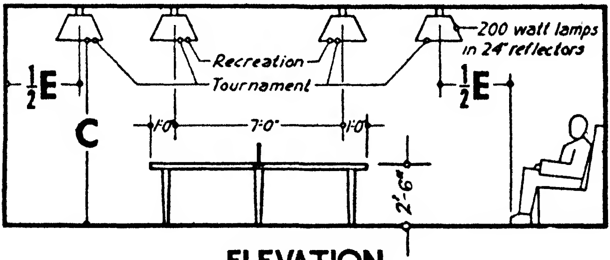
ONE TYPE OF CAGE

	National Hockey League (pro)			Amateur Athletic Union			National Collegiate A. A.		
	Min	*Pref*	*Max*	*Min*	*Pref*	*Max*	*Min*	*Pref*	*Max*
W	—	85	—	—	85	130	60	85	110
L	—	200	—	—	200	260	160	200	250
B	—	10	—	5	—	15	10	15	15
E	—	60	—	—	C	—	50	60	60
C	—	60	—	—	E	—	45	—	—
H	42"	—	48"	10"	—	—	36"	—	—

TABLE TENNIS



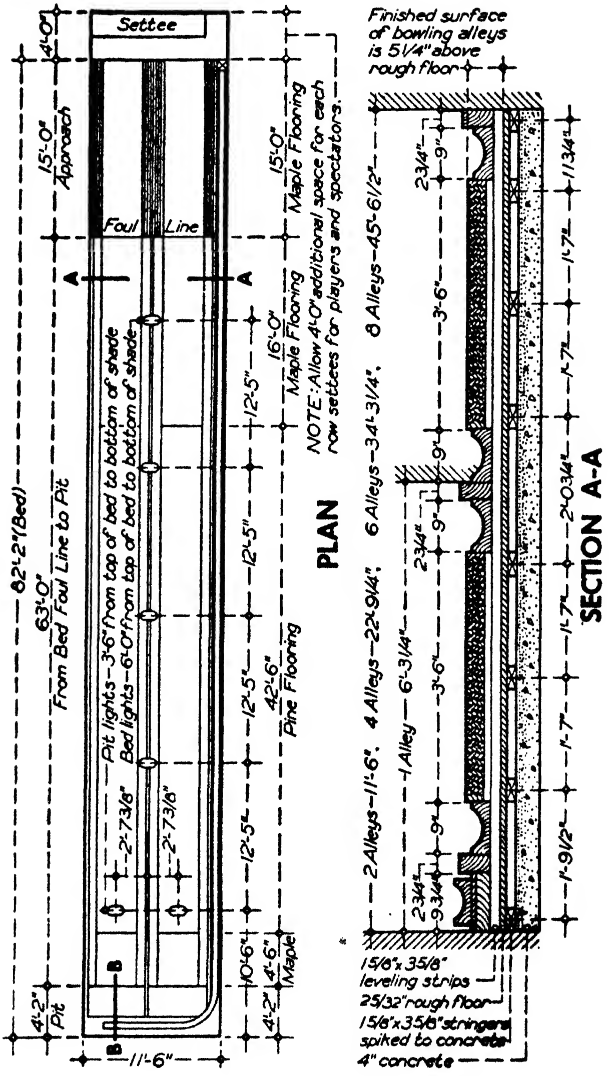
PLAN



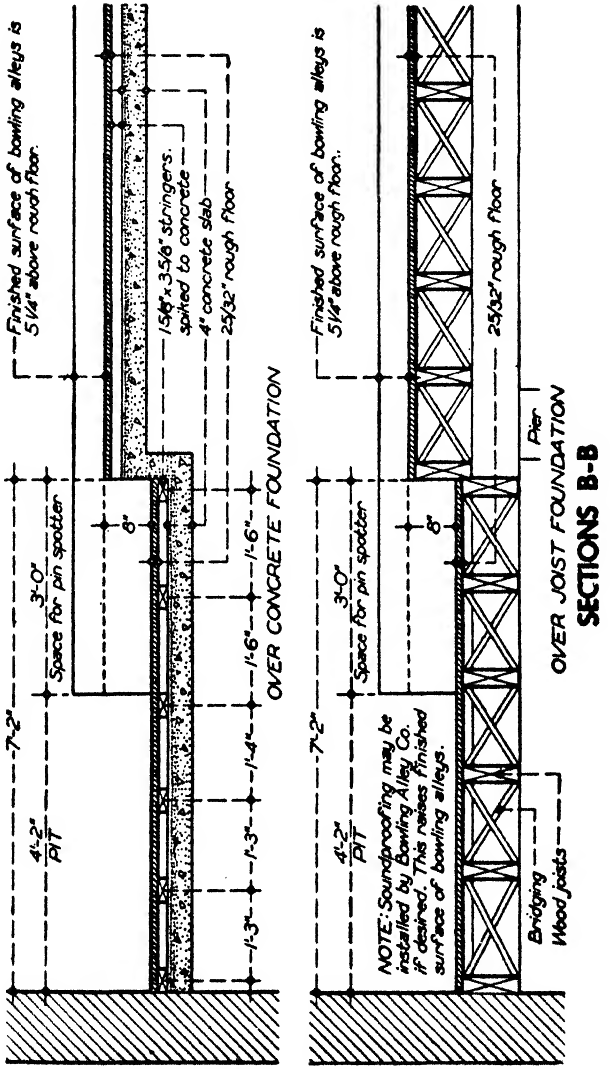
ELEVATION

	Unobstructed space		
	E	S	C
Advanced tournament play, late rounds	20'-0"	10'-0"	8'-6"
Advanced tournament play, early rounds	10'-0"	6'-0"	8'-6"
Beginners for tournament play	6'-0"	6'-0"	8'-6"
Advanced and average players for recreation	10'-0"	6'-0"	7'-6"
Dub players for recreation	5'-0"	3'-0"	6'-6"

BOWLING ALLEYS



BOWLING ALLEYS

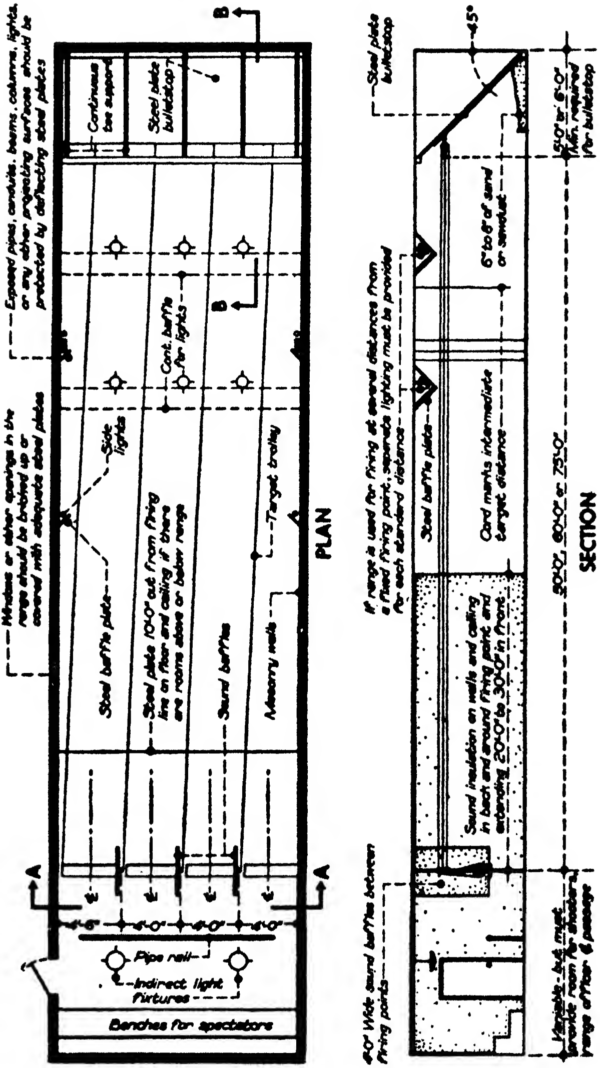


OVER CONCRETE FOUNDATION

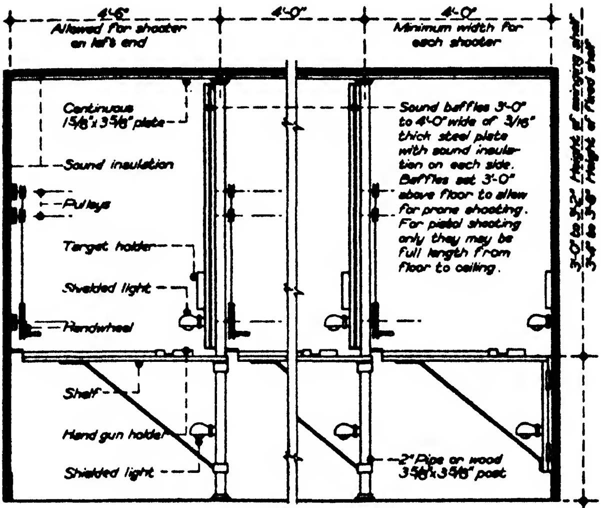
OVER JOIST FOUNDATION

SECTIONS B-B

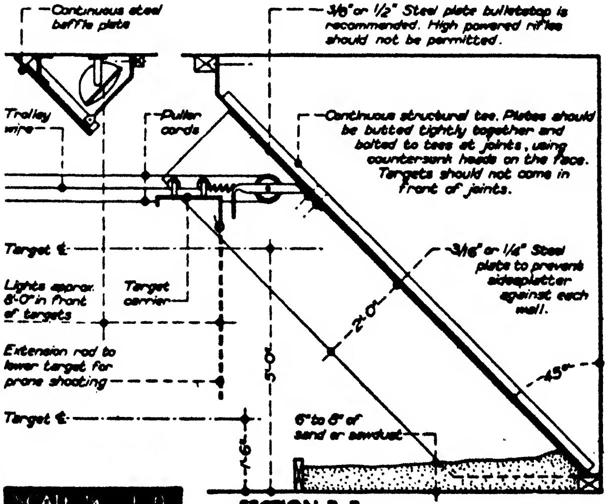
SHOOTING RANGE



SHOOTING RANGE



SECTION A-A



SECTION B-B

SIZES OF PLAYGROUND APPARATUS

In the following table are given the dimensions and approximate use areas of several types of apparatus frequently installed on children's playgrounds. Since the types of equipment made by the various manufacturers differ somewhat the dimensions and areas given are merely suggested. Furthermore, it is not likely that all of the apparatus listed will be found on a single playground. It is desirable to provide the safety zones around all apparatus, especially that which is movable.

Type of Apparatus	*Length of Apparatus*	*Height of Apparatus*	*Space Required*
Circular traveling rings	10′ dia.	12′	25′ dia.
Gang slide	16′	8′	20′x45′
Giant stride		12′	32′ dia
Horizontal bar	6′	8′ upright	12′x20′
Horizontal ladder	16′	7′-6″	8′x24′
Merry-go-round	10′ dia.		30′ dia.
Sand box on table	6′x10′ to 10′x20′		12′x16′ to 16′x30′
Slide	16′	8′	12′x30′
Slide-spiral	35′	18′	25′x35′
Swings—set of 3	15′ at top	12′	30′x35′
Swings—set of 6	30′ at top	12′	30′x50′
Teeters—set of 4	12′ to 15′	2′-6″	20′x20′
Traveling rings—set of 6	40′ at top	14′	20′x60′

The Jungles Gymn and other outdoor gymnasium outfits are manufactured in several sizes and combinations which occupy widely different areas. It is advisable to have all such equipment placed at least 15′ from the nearest fences, building or other apparatus.

The wading pool may be any desired size or shape altho it is usually rectangular or circular. The circular pools generally have a diameter of from 40′ to 75′.

The platform for dancing may be in any desired dimension. An average size would be 20′x30′ to 30′x40′. According to a number of authorities from 40 to 50 square feet per child is the amount of space which should be provided for apparatus play.

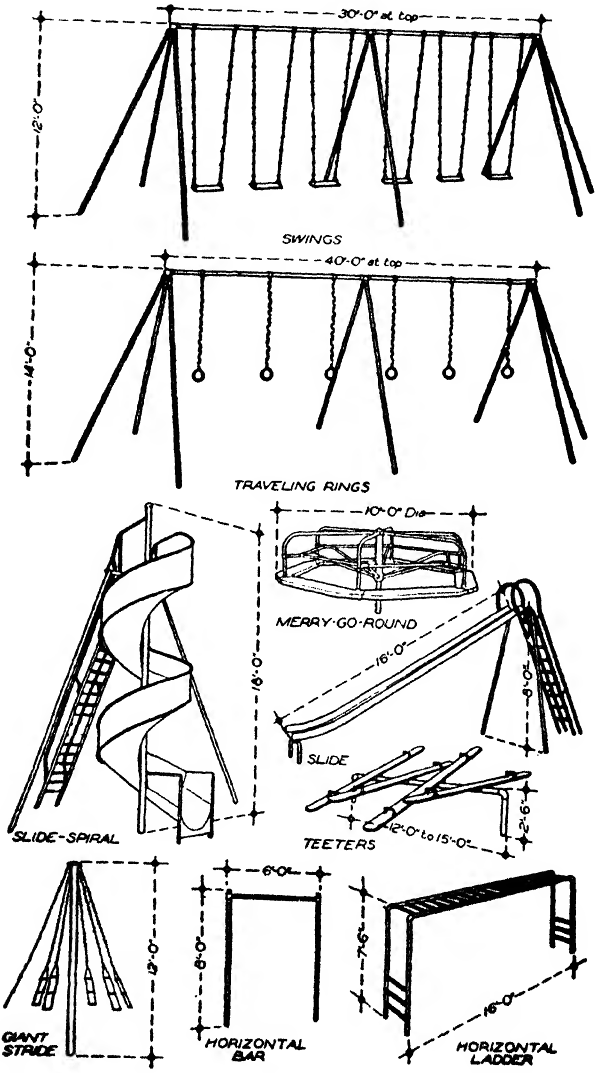
PLAYGROUND GAME AREAS

This table is reprinted (with slight revisions) from "New Play Areas, Their Design and Equipment," edited for the National Recreation Association by George D. Butler.

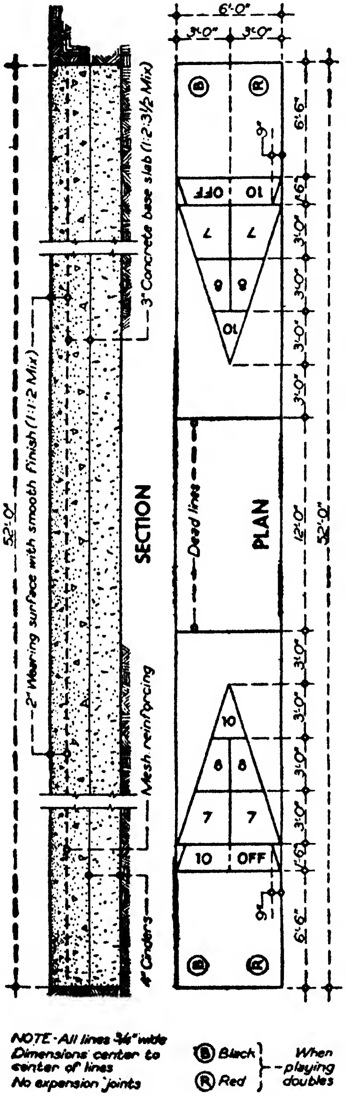
Name	*Size of Marked Area (in Feet)*	*Size Field Required*
Archery	90 to 300 in length	50 (min. width) x 450 (max. length)
Badminton	17 x 44 (single)	25 x 60
	20 x 44 (double)	30 x 60
*Baseball	90′ diamond	300 x 300 (min.)
		350 x 350 (aver.)
*Basketball (men)	35 x 60 (min.)	60 x 100 (aver.)
	50 x 94 (max.)	
Basketball (women)	45 x 90	55 x 100
Boccie	18 x 62	30 x 80
Bowling Green	14 x 110 (1 alley)	20 x 120
	110 x 110 (8 alleys)	120 x 120
Box Hockey	4 x 10	16 x 20
Clock Golf	Circle 20′ to 24′ in diameter	30′ Circle
Cricket	Wickets 66′ apart	420 x 420
*Croquet	30 x 60	30 x 60
Deck Tennis	12 x 40 (single)	20 x 50
	18 x 40 (double)	26 x 50
Field Ball	180 x 300	210 x 340
Field Hockey	150 x 270 (min.)	200 x 350 (aver.)
	180 x 300 (max.)	
Football	160 x 360	180 x 420
*Handball	20 x 34	30 x 45
Hand Tennis	16 x 40	25 x 60
*Horseshoes (men)	Stakes 40′ apart	12 x 50
*Horseshoes (women, boys)	Stakes 30′ apart	12 x 40
*Lacrosse	230 x 380 (min.)	
Paddle Tennis	16 x 44 (single)	28 x 60
	20 x 44 (double)	32 x 60
Polo	600 x 960 (max.)	600 x 960
Quoits	Stakes 54′ apart	25 x 80
Roque	30 x 60	30 x 60
Shuffleboard	6 x 52	10 x 64
Soccer (men)	150 x 300 (min.)	240 x 360 (aver.)
	300 x 390 (max.)	
Soccer (women)	120 x 240 (min.)	200 x 320 (aver.)
	180 x 300 (max.)	
Softball	60′ diamond	250 x 250 (min.)
Speedball (men)	160 x 240 (min.)	180 x 300
	160 x 360 (max.)	180 x 420
Speedball (women)	180 x 300	200 x 340
Table Tennis	5 x 9	12 x 20
*Tennis (ideal)	27 x 78 (single)	57 x 138
	36 x 78 (double)	66 x 138
Tether Tennis	Circle 6′ in diam.	20 x 20
Touch Football	160 x 300	175 x 330
Volley Ball	30 x 60	50 x 80

*Detailed drawings appear elsewhere in this book.

SIZES OF PLAYGROUND EQUIPMENT



SHUFFLEBOARD COURTS



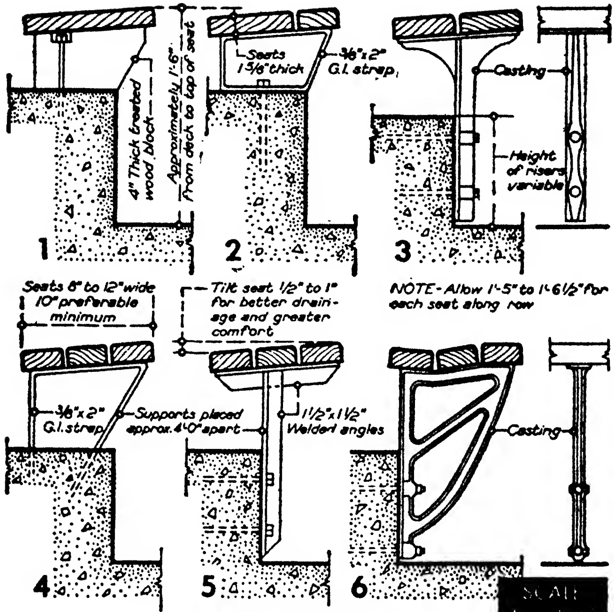
BASE COURSE. Well-drained level ground is the best site for a court. The site should be stripped of all sod down to uniformly firm ground and refilled with at least 4" of well tamped cinders. Where the sub-soil is firm sand, the cinder fill may be omitted. The base layer of concrete should be struck off to grade.

WEARING COURSE. Expanded metal or wire mesh weighing not less than 60 pounds per 100 square feet should be put down on the base course. The wearing or playing layer should be mixed and placed within 45 minutes after the base layer is struck off. It should be carefully brought to grade with a straightedge and wood floated. Grinding the surface with a machine shod with free, rapid cutting abrasive stones will give the smoothest and most satisfactory playing surface.

Curing is very important and the surface should be kept continually wet for 7 days. Since no expansion joints are used, careful curing will prevent surface checking or cracks. After curing the court should dry for 4 or 5 days before the playing lines are painted on.

MARKING. All lines are 3/4" wide and the dimensions on the drawing are from center to center of lines. A high quality paint made with an oil or varnish base is satisfactory for use on concrete surfaces. For new construction less than 6 months old, a zinc sulphate wash consisting of 3 pounds of crystals to 1 gallon of water should be applied to the concrete surface to be painted. Allow 48 hours for the zinc sulphate treatment to dry. Remove any crystals that appear on the surface before painting lines.

STADIUM SEATING



TYPICAL SECTIONS

TREADS. The dimensions of treads will have to be an economic compromise between the 2 conflicting factors: (1) Increasing the width of tread increases comfort by providing more leg room, but (2) reduces the sight line clearance. Treads vary from 2'-0" to 2'-6" with 2'-2" as an average.

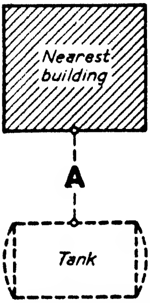
RISERS. Increasing the riser height increases the total height of the structure and its cost. The number of rows of seats and the assumed sight line clearance produce dimensions of 6" to 1'-6" for risers.

WIDTH ALLOWED PER SPECTATOR. The complete disregard of spectator comfort is nowhere better shown than in the allotment of from 1'-5" to 1'-6½" in width to each spectator. Even the cheapest movie theater usually allows 19" and the better theaters have a substantial proportion of 20", 21" and 22" wide seat spacings.

SEATS AND SUPPORTS. Seats of 2 or 3 pieces are recommended as being less likely to warp than a single plank. Comfort and drainage are improved by tilting the seats slightly. Douglas fir, redwood, and Southern cypress which are free of pitch and kiln-dried or air-seasoned are most commonly used. Painting and preservative treatment increase the life of the wood. Supports attached to the risers facilitate cleaning, are easily placed. Supports are spaced 4'-0" o/c. Seats should be cut at expansion joints.

BIBLIOGRAPHY. See Portland Cement Association "Concrete Grandstands."

NBFU RULES ON GASOLINE STORAGE

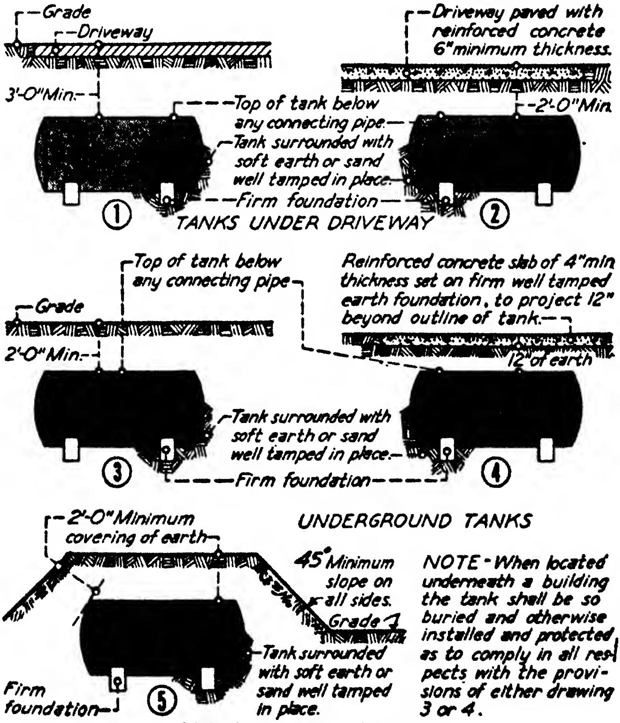


A If top of tank is below all floors, basements, cellars or pits of buildings.	MAXIMUM CAPACITY OF TANK
Within 50'-0"	Unlimited
Within 40'-0"	50,000 gals.
Within 30'-0"	20,000 gals.
Within 25'-0"	15,000 gals.
Within 20'-0"	5,000 gals.
Within 10'-0"	2,000 gals.

NOTE-When within 10'-0" of any building and the top of the tank is above the lowest floor, basement, cellar or pit of the building, the maximum tank capacity is 550 gals.

Where necessary to prevent floating, tanks shall be securely anchored or weighted.

MAXIMUM CAPACITY OF TANKS FOR UNDERGROUND STORAGE



SETTING OF TANKS

GASOLINE FILLING STATION REQUIREMENTS

SITE. Minimum frontage on corner lot should be at least 80 feet. Minimum frontage on inside lot should be at least 100 feet. A lot with streets on 3 sides is ideal, and triangular lots with streets on 2 sides are also highly desirable. Where the station site lends itself to landscaping, hardy shrubbery and lawn areas do much to minimize the undesirability of an oil station, particularly in a residential neighborhood.

DRIVEWAYS. Two 30-foot approaches are obviously a minimum in all cases. If the station fronts on more than one street, two 30-foot approaches are desirable from each contiguous street.

PLOT PLAN REQUIREMENTS. The lot will contain the station building, pump islands, gasoline tanks, space for inflating tires, and an area for outside greasing, washing and gas delivery. Typical arrangements of these facilities are shown on the following 2 *Data Sheets.*

MATERIALS FOR STATION BUILDING. Materials commonly used in oil station construction are:

Metal lath and stucco on frame or concrete
Monolithic reinforced concrete
Brick or stone masonry
Porcelain enamel on steel, masonry, concrete or frame
Glass block
Precast concrete slabs as a veneer
Stainless steel, aluminum or sheet metal over frame, steel or masonry

REQUIREMENTS FOR STATION BUILDING. Average areas for the parts of the station are about as follows:

Sales office, 11′ x 13′
Lavatories for men and women, about 5′ x 6′
Storage room, about 70 sq. ft.
One or more lubritorium bays, 14′ x 25′ each

HEATING. The location of heating apparatus in a basement is dangerous and should never be attempted. A heater room may be added on the ground floor if a central system is desired. Entrance to the heater room should be from the outside only. If unit heaters are used, they should be of a direct fired type listed by Underwriters Laboratories, Inc. and installed at least eight feet above the floor. Gravity warm air heating systems should not be used.

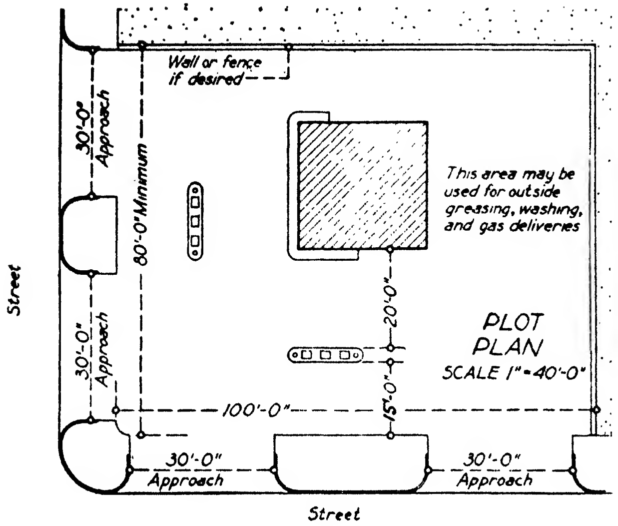
YARD SURFACING. The smaller stations usually have a crushed stone yard surfacing. The larger stations have the entire driveway area of asphalt or concrete. Driveway areas are important because they speed up the traffic and hard surfacing adds much to the station's attractiveness.

INSPECTION AND REPAIR PITS. Elevated trestles or hoists are preferable for this service. If pits are used, they should be continuously ventilated. Gasoline vapor forms explosive mixtures with air and being heavier than air, may create a serious fire hazard if adequate ventilation is not provided. Exhaust gases are also heavier than air and may react seriously on the health of workers continuously employed in pits, busied at greasing operations.

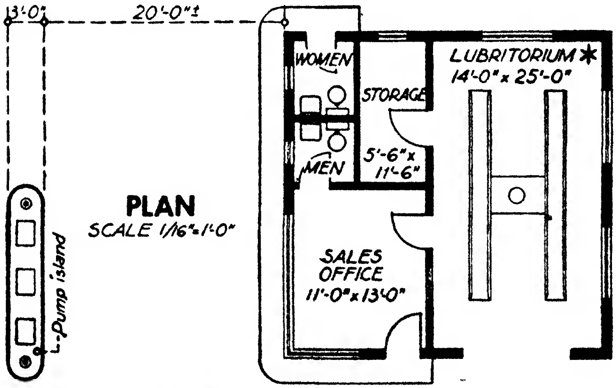
OTHER SERVICES. Tire and battery service, car washing, motor tune-up, and accessory installation service may require additional bays similar in size to the lubritorium bays.

COST. For building, driveway, equipment, architectural service and permits, a neighborhood station would cost about $12,000; a large super service station, about $20,000. These figures will vary greatly with locality and quality of construction.

FILLING STATION ON CORNER LOT



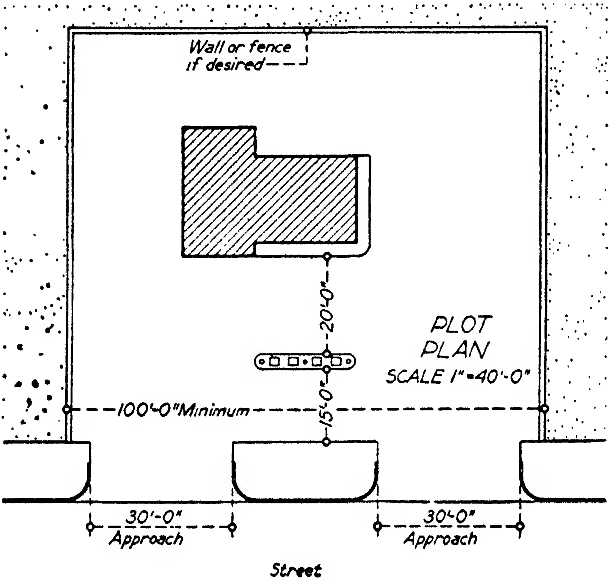
PLOT PLAN
SCALE 1" = 40'-0"

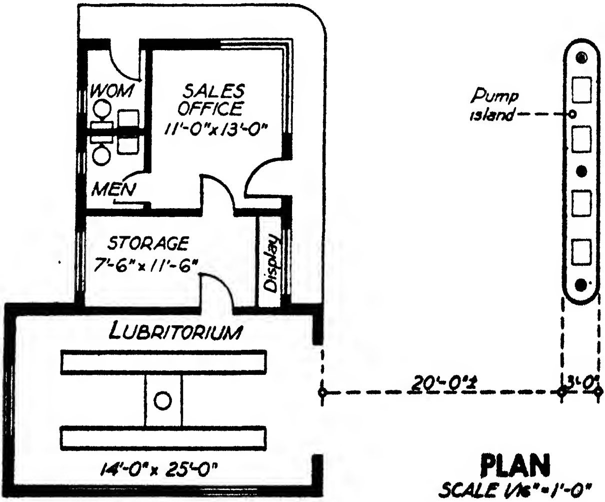


PLAN
SCALE 1/16" = 1'-0"

***NOTE** For monthly sales volume of 6,000 to 10,000 gallons of gasoline have one-bay lubritorium, for 10,000 to 15,000 gallons, two bays; for 15,000 to 20,000 gallons, three bays

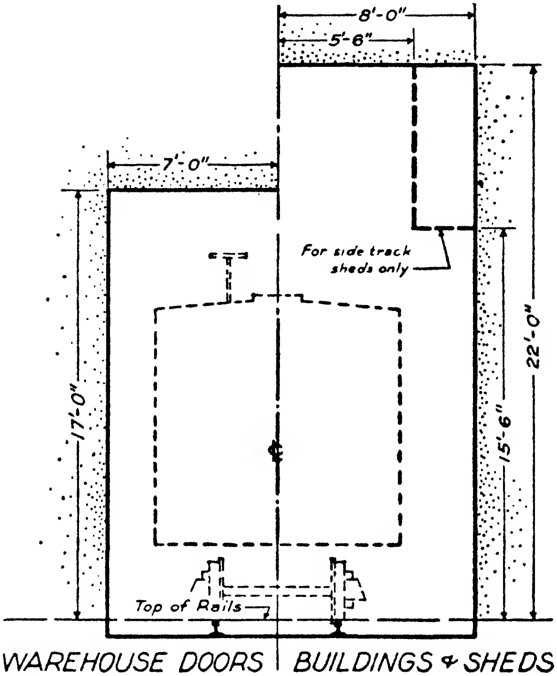
FILLING STATION ON INSIDE LOT

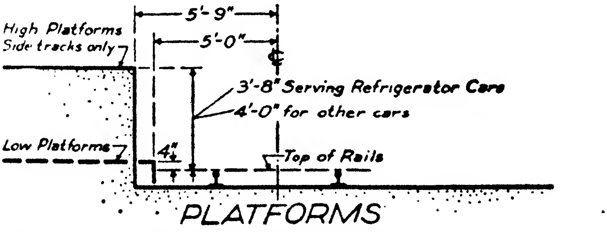




PLAN
SCALE 1/16"=1'-0"

FREIGHT TRAIN CLEARANCE DIAGRAM





Clearances shown are minimum for straight track. Increase clearances on curved track for the overhang and tilting of a car 80′ long, 14′ high, 60′ c. to c. of trucks, the super-elevation of outer rail conforming to A. R. E. A. recommendations. The distance from top of rail to top of ties to be 8″. Legal requirements should govern when in excess of those shown.

AIRPORT DESIGN CHECK LIST

LANDING AREA
- Size and Design
- Grades
- Drainage
- Surfaces
- Runways

APPROACHES
- Zoned Area
- Freedom from Obstructions

MARKING
- Boundary Markers
- Obstruction Marking
- Identification Marker
- Runway Marking

LIGHTING
- Beacons
- Boundary and Range Lights
- Obstruction Lights
- Floodlighting
- Contact Lights
- Instrument-landing Lighting
- Course Light
- Building Interior Lighting
- Instrument Lighting
- Emergency Power Supply
- Remote Control
- Miscellaneous Requirements

AIRCRAFT SERVICING FACILITIES
- Fuel
- Repairs
- Storage

TRAFFIC CONTROL FACILITIES
- Control Tower
- Airport Traffic Control Room Equipment

BUILDINGS
- Terminal
- Passenger & Administration
    - Waiting Room
    - Rest Rooms
    - Dining Rooms
    - Ticket Office
    - Post Office
    - U. S. Weather Bureau
    - Airways Communication Office
    - Administration Offices
    - Employee Facilities
- Hangars
- Additional Buildings

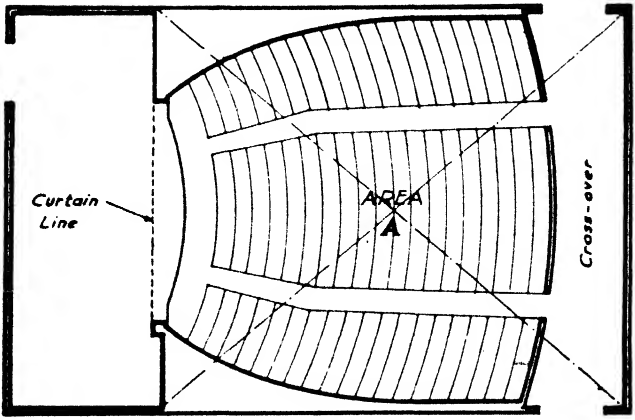
OTHER FACILITIES
- Aprons, Taxiways and Loading Areas
- Road, Parking Lot, and Fence
- Facilities for Visiting Public
- Fire Protection Equipment
- First-aid Facilities
- Wreckage Equipment

JUDGING LAND FOR PRIVATE AIR FIELDS

Some fields provide natural landing facilities for private planes. Some can be utilized with just a little preparation. Others need so much processing, that expense puts them out of consideration. However, modern bulldozers are equipped to level land and vegetation in a matter of hours. The table below rates land on its possible use as a private air field.

Factors of Land	**GOOD** *Little cost to process*	**AVERAGE** *Medium cost to process*	**POOR** *Highest cost to process*
LEVEL	Flat. Gentle rise. Long gentle swells	Slightly uneven, no more than 3′ difference. Not over a 2% grade. (2′ rise per 100′.)	Uneven, over 3′ in difference. A grade in excess of 2%.
TYPE OF SOIL	Sandy or clay mixture. Rock-free.	Moderately rocky. Small rocks that can be scraped off easily.	Excessively rocky, with large, loose rocks. Rock ledge that needs grading.
VEGETATION	Tough, low grass.	Small shrubs, grass, and small trees.	Thick shrubs. Many large trees.
DRAINAGE	Natural drainage with gentle slope, rounded center rise, or flat top of plateau.	Absolutely flat, or low-lying, necessitating tiles to carry off water.	Hollow field, needing leveling, or tiles with possible pumping.
TYPE OF FINISH ON FIELD	Short, natural grass to help drainage and hold soil. A field previously used for agriculture needs less special drainage.	Seeded sod, attractive, needs occasional mowing. Clay needs no upkeep, but is dusty in Summer, muddy in wet seasons.	Concrete, good for heavy traffic, but expensive and unnecessary for private field.

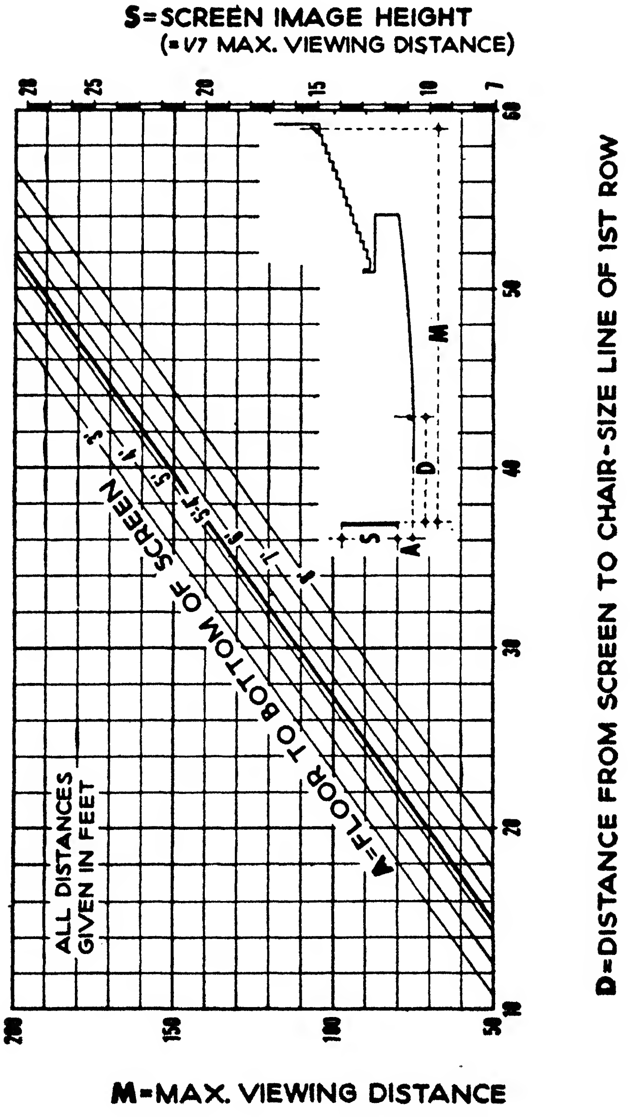
AREA PER SEAT FOR THEATERS



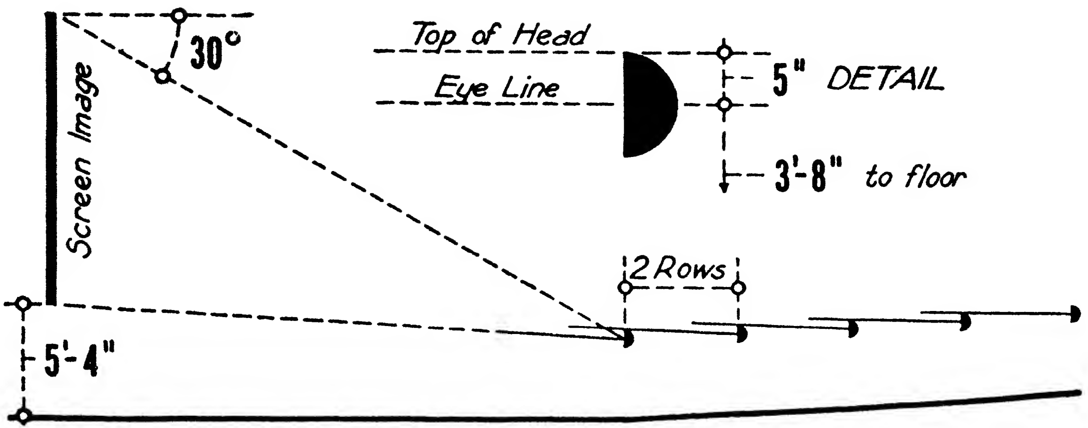
The following table gives the seating area of a number of auditoriums. It will be seen that the square feet to be allowed for each seat varies between fairly wide limits. The highest figure shown represents a 25% increase over the lowest. In making rough seating calculations it would be safer to allow 7 square feet per seat than the usual 6 square feet that is recommended by some authorities. Note that the seating area has been taken as the distance from the curtain line to the rear wall of the cross-over.

Name of Theater	*Floor*	*Area "A"*	*No. of Seats*	*Sq. Ft. per Seat*
Fred W. Wehrenburg Theater, St. Louis, Mo.	Main Floor	8,549	1,308	6.53
Ritz Theater, Baltimore, Md.	Main Floor	7,484	1,004	7.45
25th St. Theater, Newport News, Va.	Main Floor	3,278	549	5.97
Teatro de Comedia, Mexico	Mn. Fl. Balcony	3,662 2,134	490 349	7.47 6.11
Junior and Senior High School, Dobbs Ferry, N. Y.	Mn. Fl. Balcony	4,666 1,737	627 257	7.44 6.75
Ritz Theater, Columbus, Ohio	Main Floor	4,669	702	6.65
Virginia Polytechnic Institute, Blacksburg, Va.	Main Floor	21,098	3,003	7.02

LOCATION OF FIRST ROW OF SEATS



DETERMINING THE MAIN FLOOR SLOPE



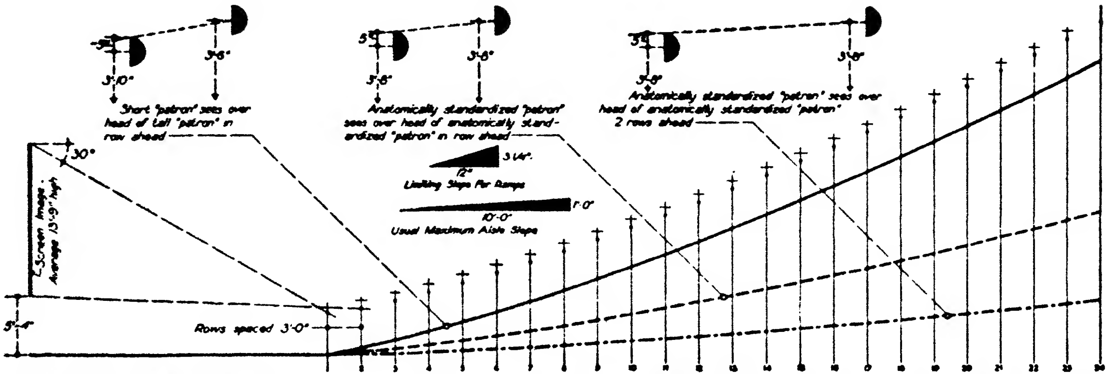
The slope of a theater floor depends upon the position of the first row of seats, the position of the screen-image and the sight-line clearance.

To preserve the illusion of reality, the screen-image must not be too high with respect to first row of spectators. The stage level in American theaters has been, almost without exception, taken as 3'-4" above the level of the first row of seats; the bottom of the screen-image being 2'-0" above the level of the stage. Therefore, a point 5'-4" above the floor is the focus of all eye lines for determining the main floor.

The height of the screen-image itself may be assumed equal to 1/7th of the distance from the screen-image to the last row of seats. A 30° angle with the horizontal from the top of the screen-image will intersect the horizontal eye line 3'-8" above the floor, and this will determine first row of seats.

The conditions for sight-line clearance should allow any seat occupant of anatomically average dimensions to see over the head of a spectator sitting in the second row ahead. A distance from eye to top of head of 5" is a safe assumption.

CONVENTIONAL VS. IDEAL THEATER FLOOR SLOPE



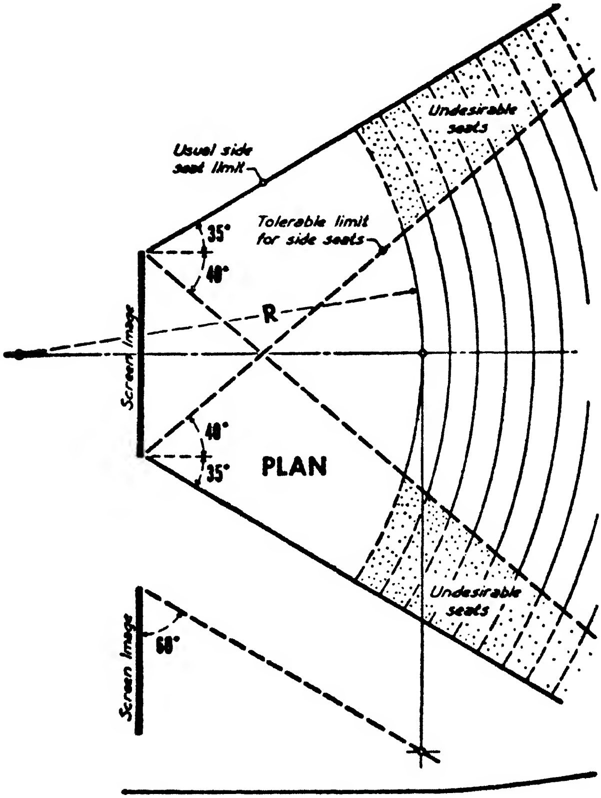
THE QUEST FOR THE IDEAL. An ideal situation implies that a short "patron" should be able to see over the head of a tall "patron" in the row immediately ahead. The chart above shows the resulting floor slope from this condition, for a theater representing the average of United States movie houses.

DIFFICULTIES WITH THE IDEAL. The theoretically ideal floor slope is steeper than the usual building code limit for aisle slopes—and also exceeds the inclination beyond which the aisle is no longer a ramp. The National Fire Protective Association, International, say, "The risers of steps in aisles, where practicable, shall be uniform in height for any floor or tier." If this recommendation is observed, it effectively prohibits the theoretically ideal slope.

A QUALIFIED IDEAL. By assuming that all theater patrons are of anatomically average dimensions but still retaining the premise that first-row sight-line clearance is desirable, we get the second curve shown above. This, too, presents the same difficulties as the first case, altho to a lesser degree.

USUAL COMPROMISE. The third curve shows the floor slope designed as recommended in "The Design of the Cinema," Part 2, which appeared in PENCIL POINTS in June 1938. This floor slope becomes legally acceptable and at the same time represents precedent which has been followed in the past in the design of theaters where motion-picture entertainment is daily enjoyed by millions of patrons.

SIDE SEAT LIMITS FOR SATISFACTORY VIEWING

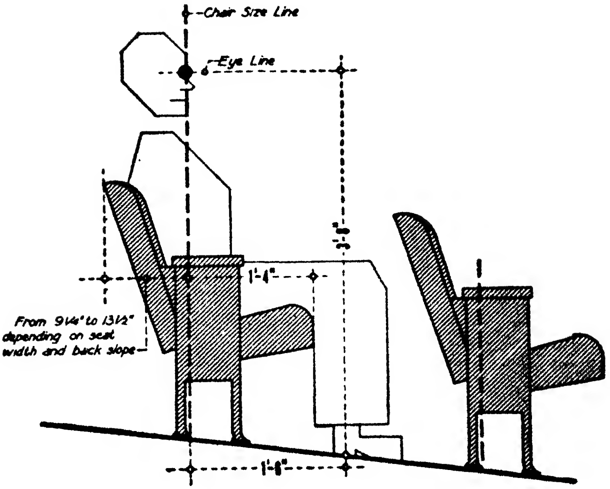


SECTION

SIDE SEAT DISTORTION. Side seats from which the observer sees any part of the screen-image at an angle greater than 40° have been found, in a limited test, to destroy the illusion of reality. The usual side seat limit employed in motion-picture theater design has been a 35° line from the near edge of the screen, as shown. The hatched area indicates undesirable seats and this portion should be kept to an absolute minimum.

RADIUS OF SEATS. The seats in both the balcony and on the main floor follow a series of concentric circular segments so that the observers may sit approximately facing the action taking place on the stage or screen. The smallest usual radius for the chair size line of the first row is about 30′-0″. So far as is known to this author, no logical rule exists for locating the center of the concentric circular segments.

THEATER CHAIRS FOR MAIN FLOOR



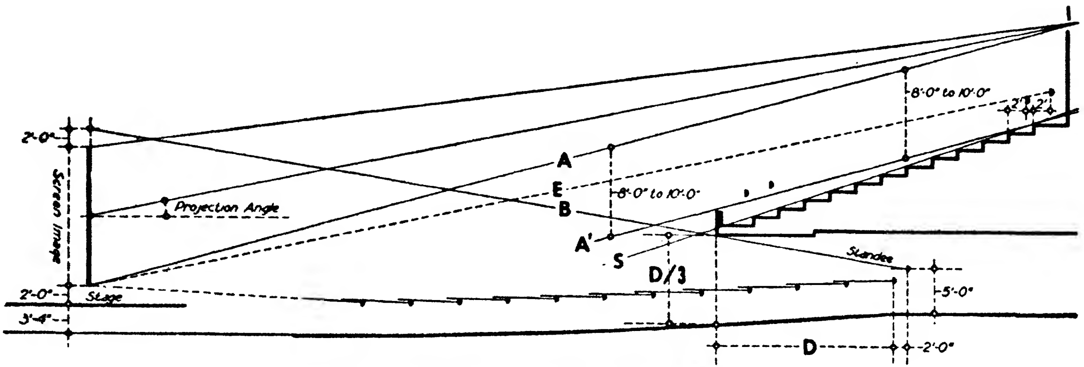
Theater chairs are arranged with legs to fit all floor slopes in ¼" intervals from 0" to 2¼" per foot for conventional inclines, and from 0" to minus 2½" for reversed inclines. The legs are shortened or lengthened so that the theoretical eye-level will come 3'-8" above the level of the heel, as shown in the drawing above.

In calculating the floor slope, the eye is assumed as 3'-8" above the floor on a vertical line thru the eye, involving an apparent discrepancy. However, no important error results since it is only the equivalent of moving the entire floor as designed a distance of 1'-6" nearer the screen. Lines in plan and section to indicate seat rows should represent "chair-size" lines rather than the backs of the seats as is customary, because on this line nominal chair width coincides with actual width.

Many building laws specify 2'-6" from back to back of seats as the minimum allowed. For extremely-low-admission-price theaters equipped with veneer-wood-back seats, this distance probably represents an economic feasibility. However, for the average theater employing padded-back seats and enjoying an average to high-class clientele, the back-to-back spacing of 2'-8" is little enuf, 2'-10" would represent a better normal condition, and 3'-0" might be regarded as an att[illegible]nable ideal.

The width of seats on the "chair-size line" will vary from 18" to 24" in 1" intervals. 1½" is allowed for each end standard. 18" and 19" wide seats are uncomfortable and their use should be limited. Since row lengths vary in any given seating layout, the variation in seat widths allows adjustment to fit.

DETERMINING THE BALCONY SLOPE

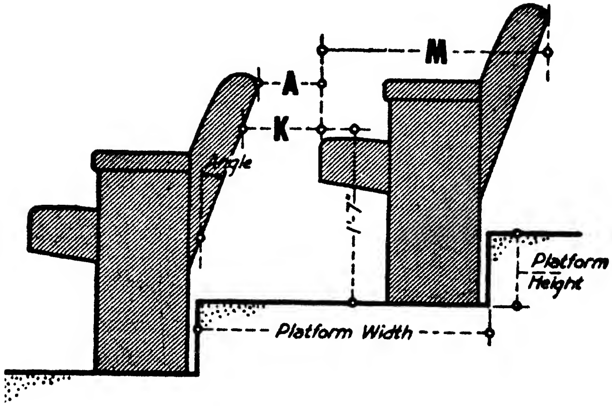


DETERMINING BALCONY PLATFORMS

The capacity of the balcony is most often between 33⅓ % to 50% of that of the main floor. The balcony section will be the result of a number of limiting conditions: *First,* the projection angle should not exceed 12° with the horizontal for ideal conditions. However, many theaters use a 20° angle and projectors allow up to about 30°. The balcony steps should fall below A'. *Second,* sight-line B of a standee should clear the bottom front edge of the balcony. *Third,* the balcony should not overhang the last row of main floor seats by more than 3 times the height, as indicated by D/3, for acoustical reasons. *Fourth,* the slope S should not necessitate aisle steps that are illegal or uncomfortable. *Fifth,* the sight-line E must clear the head of the occupant of the seat in the next row in front, to a focus at the bottom of the screen-image.

The common method of determining the balcony slope by projecting the line S to a point 7'-6" below stage level at the curtain line has resulted in highly unsatisfactory balcony vision, and the method should be avoided.

THEATER CHAIRS FOR BALCONY



Steps upon which the balcony seats are placed are usually referred to as *platforms*. In the balcony aisles steps are introduced to make circulation possible. Building laws usually limit the height of a single step to 7½" or 8". With 2 such risers for each balcony seat platform, the maximum slope of the balcony would be between 15" and 16" in height for each 32" to 36" horizontally.

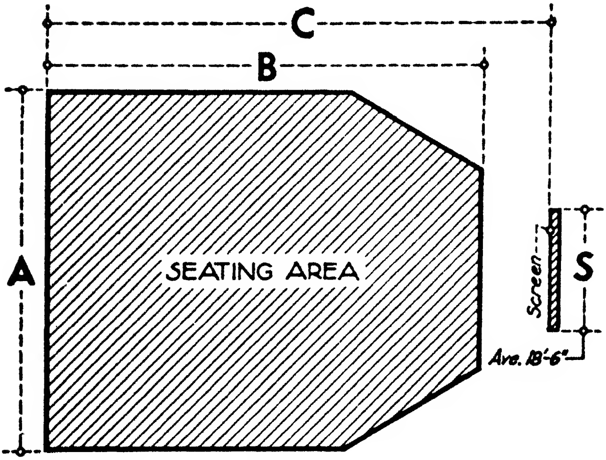
Older theaters for legitimate productions often have 3 steps for each seat platform, making a rise of 21" to 24" per platform. Such a pitch results in discomfort.

The knee room for balcony seats is measured on a line 1'-7" above the platform. Whereas raising the platform height does not affect the aisle width "A" for any given platform width, it does reduce the knee room "K". Thus it becomes important to have definite chair dimensions in mind before deciding on the platform width. The platform width is established so that "A" will be not less than 6½" nor "K" less than 8½".

The usual chair-back slope for the platform seats is 5¼" in the height of the seat-back, making an angle of 14°-8'. This requires that platforms from 2" to 11" high should be not less than 31" wide; platforms 11⅛" to 16" high should have 33" as a minimum platform width. The overall dimension "M" and the slope of the seat-back should be known before the balcony platforms are decided upon.

The first row in the balcony should have from 2" to 6" wider platform, so that toe room is provided and also so that people passing between the balcony rail and the seat occupants will not feel any danger of tripping and falling. If there is no rear cross-over, the platform width for the last row of seats against the rear wall will have to be from 6¼" to 9½" greater to accommodate the pitch of the back seat.

EXISTING PROPORTIONS SCREEN-TO-SEATING

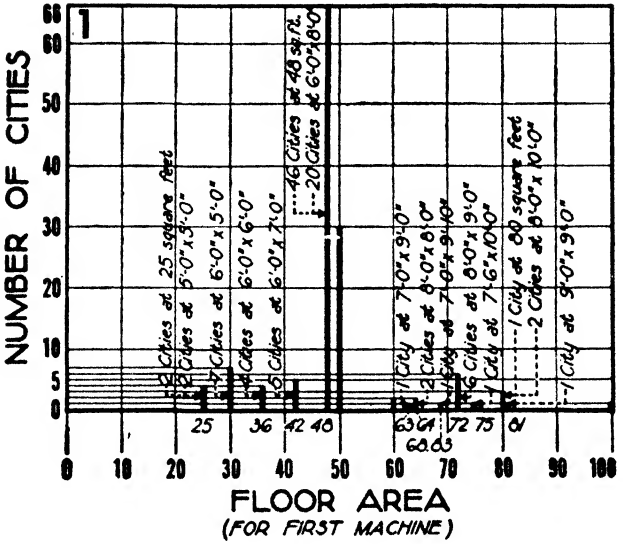


RATIO	MINIMUM	AVERAGE	MAXIMUM
B/A	1.52	1.98	2.35
A/S	2.50	3.00	3.50
C/S	4.65	5.20	5.85

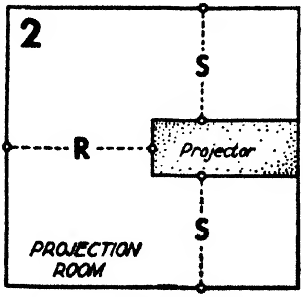
EXISTING MOVIE THEATERS. A survey conducted by the Society of Motion Picture Engineers, covering about 600 theaters thruout the United States, was undertaken to determine the existing conditions under which many millions of persons enjoy and pay for motion-picture entertainment. The value of the survey lies upon the entirely safe assumption that characteristics of the 50% group centering about the gross average represent tolerable practice at the present time. Care was taken that the theaters covered would represent a fair cross-section of all the theaters operating in the country. The survey points the way to further research to determine the improvements that can be made to arrive at more nearly ideal moving-picture theater design conditions.

SURVEY RESULTS. The results of the SMPE survey are shown above diagrammatically and represent the limits of the 50% group of theaters falling about the total group average. A disparity will be noted if the A or S values are calculated from the 2 ratios in which they both appear. In a statistical compilation of this type such a disparity is natural. The shape of the seating area shown is for diagrammatic purposes only—it does not necessarily represent the forms encountered in the survey.

MOVIE PROJECTION ROOM AREAS



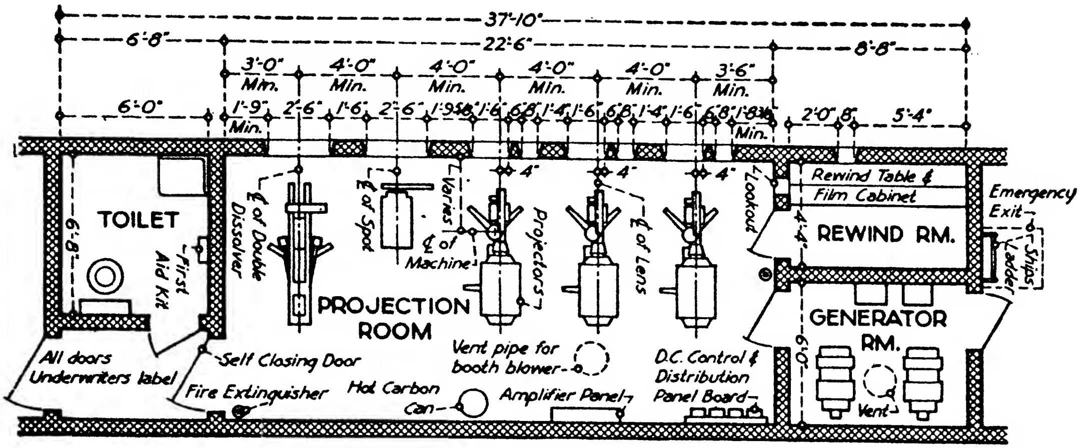
The standards proposed by the National Board of Fire Underwriters and the Travelers Insurance Company—a floor area of 48 square feet for the first machine and 24 square feet additional for each added machine—are generally enforced in the large group of cities conforming to the 48 square feet minimum for the first machine. The chart above shows the tabulation for 186 cities over 50,000 population which specify either square areas or width-by-length dimensions. A number of codes base the requirements on space around the projection machine, require sufficient space to permit operator free movement or make no provision, as shown below.



PLAN

Number of Cities.	R	S
1	4'-0"	3'-0"
14	3'-6"	3'-6"
2	2'-6"	3'-0"
8	2'-0"	2'-0"
14	Sufficient to permit operator free movement.	
13	No provision.	

PROJECTION ROOM PLAN

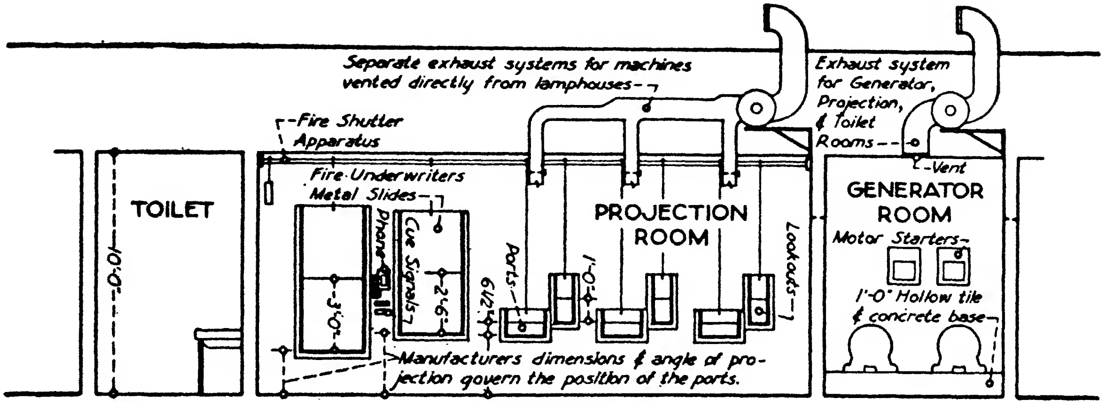


PLAN

SCALE 0 1 2 3 4 5 FEET

The above plan makes provisions far in excess of the usual legal requirements which are in some cases merely impractical and in other cases impossible. Altho some laws allow rewinding in the projection room, it is desirable to allot a separate space for handling the highly inflammable film. Toilet facilities are mandatory in a minority of cases but are desirable for the comfort of persons who work at a difficult, hazardous and confining vocation. Only a limited number of localities require 2 means of egress from the projection-room but an auxiliary exit should be provided on account of the danger to operators in case of fire. Rewind room should be furnished with observation ports, toward the screen and toward the projection-room. Doors should be of the automatic closing type, opening toward the principal means of exit and should bear the Underwriters Label.

PROJECTION ROOM ELEVATION

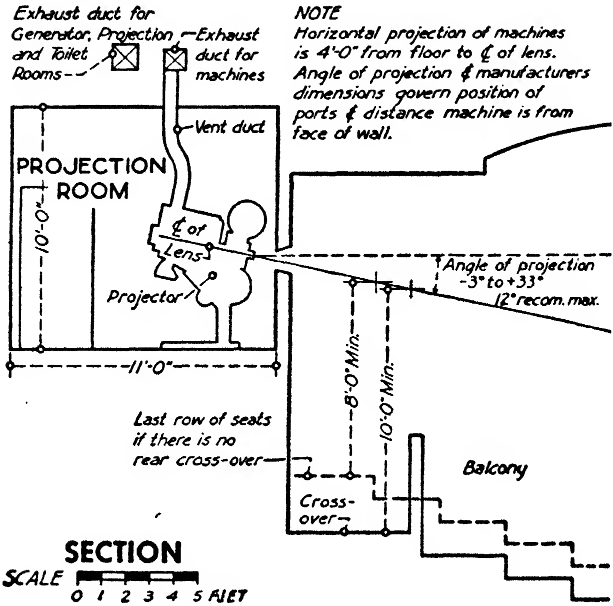


ELEVATION

SCALE 0 1 2 3 4 5 FEET

The architect will best handle the question of ports in the projection-room by finding out at the earliest possible moment what company is to furnish the projection apparatus. Such a company will cooperate with him in the proper placing of the openings and will have a full knowledge of the building regulations which apply in his locality. The heights of projection ports is a matter which depends upon both the type of projector and the angle of projection and is nothing for the architect to fool around with by himself.

PROJECTION ROOM SECTION

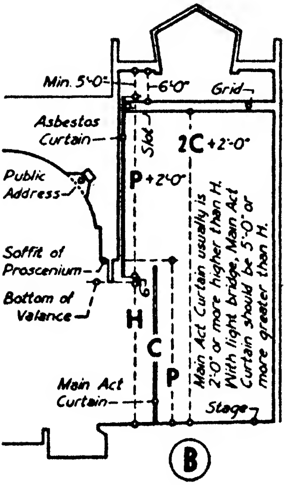


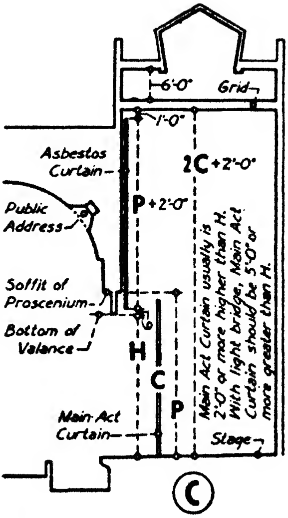
Some building laws allow ceiling heights as low as 5'-6" but this is ridiculously inadequate both as a room in which normal size operators are expected to work and is also insufficient to house some of the more modern projection machines. A ceiling height of 8'-0" may well be taken as a practical working minimum and can be increased to 10'-0" or 12'-0" if construction allows.

The general lack of legal requirements for proper ventilation is fully as startling as the lack of consistency in those requirements which have been established. Complete lamp-house ventilation, projection-room exhaust capacity which will change the air not less than 6 times per hour, the venting of the generator room by mechanical means—all should be considered as practical minimum conditions whether or not they are legally mandatory. Satisfactory ventilation of the projection-room itself presupposes the placing of fresh air inlets near the floor on at least 3 sides of the projection-room.

To prevent willful obstruction of the light beam from the projector to the screen, sufficient height must be allowed to the last row of balcony seats so that a full-grown rowdie cannot reach high enuf to intercept the light, as shown on the drawing above.

STAGE HEIGHT AND GRID LOCATION





STAGE HEIGHT. The height of the stage is a matter of real importance and one that cannot be given too much consideration. The height of the gridiron above the stage floor depends upon the treatment of the proscenium arch.

SIMPLEST CASE. When the soffit of the proscenium construction is also the top of the clear stage opening, the bottom of the grid needs to be twice the proscenium height plus 3'-6".

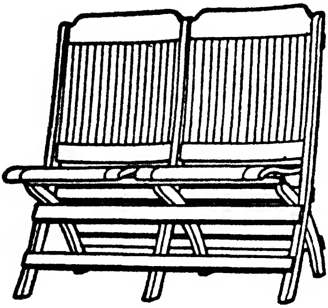
SLOTTED GRID. Many architects, however, prefer to build the arch high—especially on a wide stage, to give it a more graceful effect. A wide valance is then hung in the archway to cut the proscenium opening down to a suitable height. This arrangement is the most common one and produces a pleasing effect. If the valance is a fabric or other non-structural material, the asbestos curtain must lap the actual proscenium soffit 2'-0" in the down position.

A saving can be effected, as shown in Figure B, by slotting the gridiron to allow passage of the asbestos curtain. Usually 3'-0" or 4'-0" in the height of the building can be saved and by this method the weight of the asbestos curtain is carried by the proscenium wall instead of the gridiron. With deep stages this is particularly important.

GRID NOT SLOTTED. In Figure C is shown the gridiron without slotting for the asbestos curtain, necessitating added height of the stage construction.

PUBLIC ADDRESS SPEAKER. Notice particularly in the diagrams that the public address speakers are placed in front of the proscenium arch. Oftentimes they are put backstage so that the performers using the microphone on the stage apron will be in front of the loud speaker. This creates a feed-back of energy which completely destroys the intelligibility of the voice and creates an unpleasant effect. By following the suggestion in the diagram this difficulty is obviated.

SEATING CAPACITY WITH PORTABLE CHAIRS



DOUBLE UNIT

ROWS	DEPTH
10	32'-6"
12	37'-6"
16	47'-6"
18	52'-6"
20	57'-6"
22	62'-6"
24	67'-6"
26	72'-6"
28	77'-6"
30	82'-6"

Figuring 2'-6" back to back: 3'-6" cross aisle at rear and 4'-0" cross aisle at front.

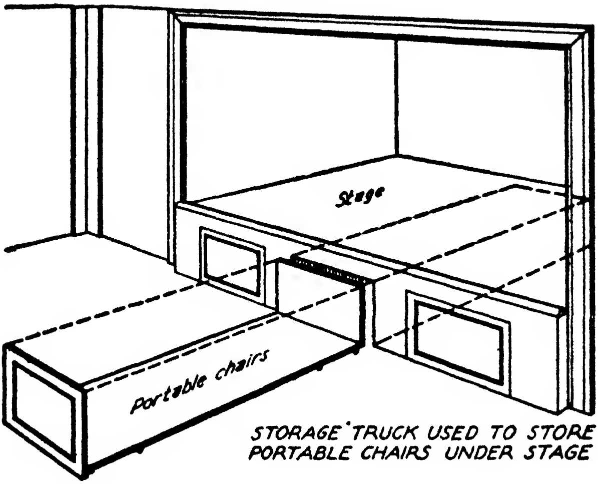
Table A

Table B

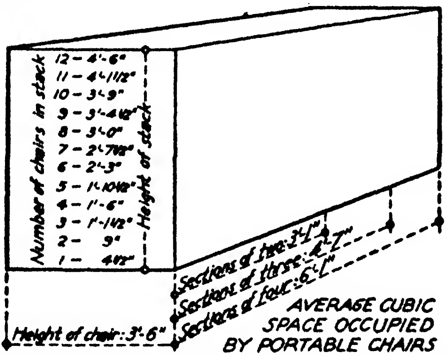
WIDTH	ARRANGEMENT	CHAIRS
18'-4"	Aisle 3'-0"	10
21'-4"	Aisle 3'-0"	12
24'-4"	Aisle 3'-0"	14
30'-4"	Aisle 3'-0" Aisle 3'-0"	16
33'-6"	Aisle 3'-0" Aisle 3'-0"	18
33'-4"	Aisle 3'-0" Aisle 3'-0" Aisle 3'-0"	16
36'-6"	Aisle 3'-0" Aisle 3'-0"	20
39'-7"	Aisle 3'-0" Aisle 3'-0"	22
39'-6"	Aisle 3'-0" Aisle 3'-0" Aisle 3'-0"	20
46'-0"	Aisle 3'-0" Aisle 3'-6" Aisle 3'-0"	24
56'-4"	Aisle 3'-6" Aisle 3'-6" Aisle 3'-6"	30
65'-4"	Aisle 3'-6" Aisle 3'-6" Aisle 3'-6"	36

The tables above will help you to determine the seating capacity of your auditorium. They show the most popular grouping and spacing arrangement of the various widths of auditoriums. Table *B* shows the total number of chairs which can be placed across the width of the room, the grouping arrangement, and the size and location of the aisles. Table *A* shows the number of rows in the depth of the room. By multiplying the number of chairs in the width of the room by the number of rows in the depth of the room, the total seating capacity is obtained. These tables makes no allowance for posts, obstructions, etc.

PORTABLE CHAIRS
CLEARING AND STORAGE



STORAGE TRUCK USED TO STORE PORTABLE CHAIRS UNDER STAGE



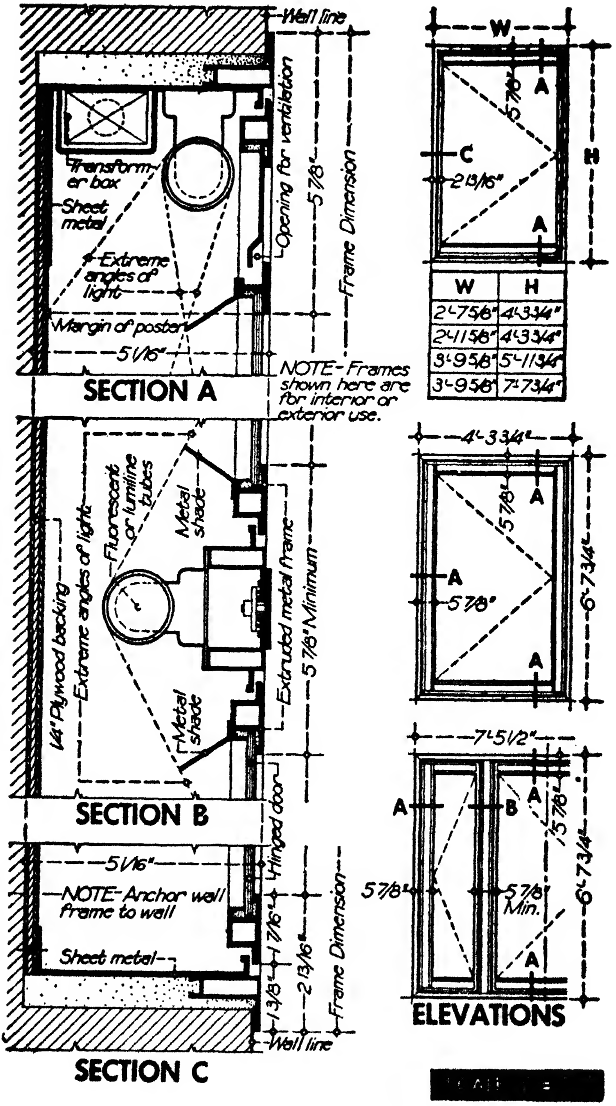
AVERAGE CUBIC SPACE OCCUPIED BY PORTABLE CHAIRS

TIME REQUIRED TO CLEAR FLOOR OF PORTABLE CHAIRS.

No. CHAIRS	NUMBER OF MEN									
	1	2	3	4	5	6	7	8	9	10
100	12	6	4							
200	24	12	8	6						
300	36	18	12	9	7					
400	48	24	16	12	10	8	7			
500	60	30	20	15	12	10	9			
600	72	36	24	18	14	12	10			
700	84	42	28	21	18	14	12	11		
800	96	48	32	24	20	16	14	12		
900	108	54	36	27	22	18	16	14	12	
1000	120	60	40	30	25	20	18	16	14	12

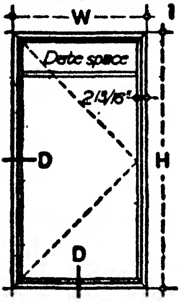
This table, while purely theoretical, will prove of assistance in figuring the approximate time for clearing an auditorium of portable chairs. It is made up on the basis that one man can fold and move one section in 15 seconds or 8 chairs per minute.

DISPLAY FRAMES WITH CONCEALED LIGHTING



FLUSH AND SURFACE DISPLAY FRAMES

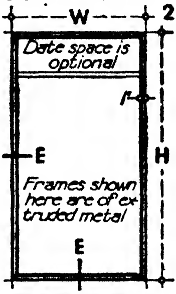
FRAMES WITH GLAZED DOORS



W	H
2'-11 5/8"	3'-9 5/8"
3'-9 5/8"	5'-5 5/8"
3'-9 5/8"	7'-1 5/8"

NOTE-Actual poster size is the same as glass opening.

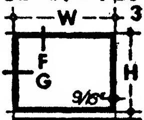
FRAMES WITH SLIP-IN PANELS



W	H
1'-4"	1'-1"
2'-8"	3'-6"
3'-6"	5'-2"
3'-6"	6'-10"

NOTE-Wall Frames 1 & 2 to be used for interiors and exteriors.

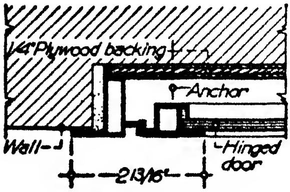
FRAMES FOR SLIP-IN CARDS



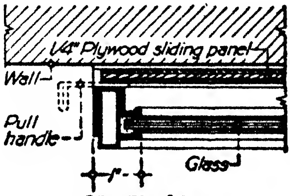
W	H
1'-3 1/8"	4 1/8"
1'-3 1/8"	5 1/8"
11 1/8"	9 1/8"
1'-3 1/8"	9 1/8"
1'-3 1/8"	1'-0 1/8"
1'-6 1/8"	1'-3 1/8"
1'-11 1/8"	1'-3 1/8"
3'-1 1/8"	1'-3 1/8"
2'-5 1/8"	1'-11 1/8"
2'-7 1/8"	3'-5 1/8"
3'-5 1/8"	5'-1 1/8"
3'-5 1/8"	6'-9 1/8"

NOTE-For interior use only.

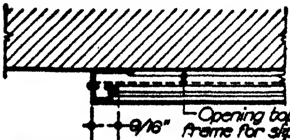
ELEVATIONS



SECTION D

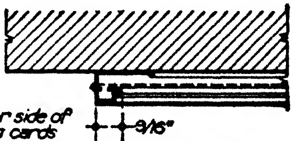


SECTION E



This size frame used on display frames under 2'-7 1/8"x3'-5 1/8".

SECTION F

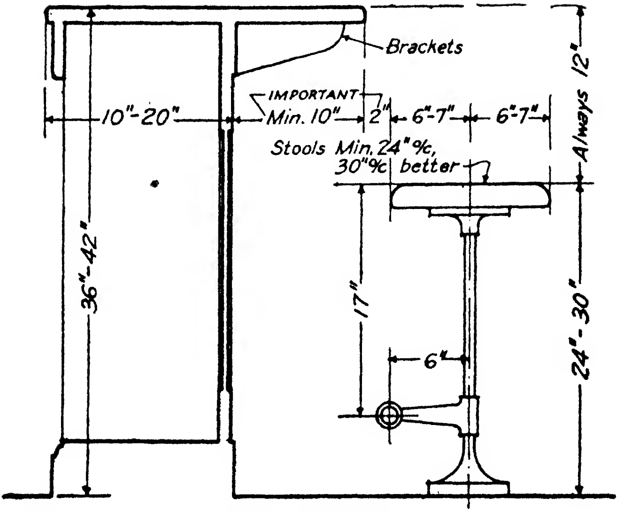


This size frame used on display frames over 2'-7 1/8"x3'-5 1/8".

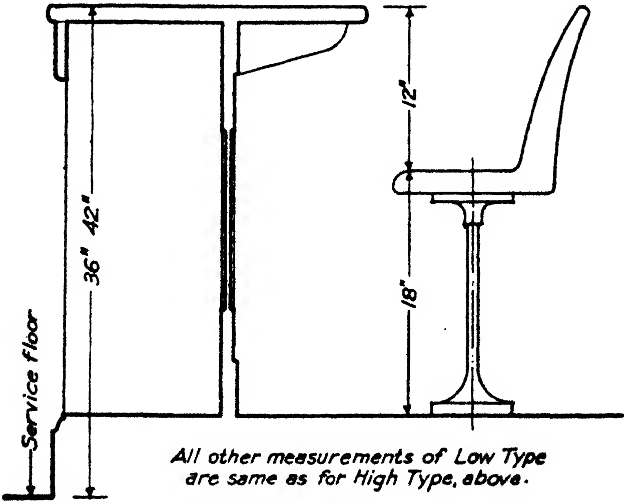
SECTION G

[redacted]

LUNCH COUNTERS



HIGH TYPE



All other measurements of Low Type are same as for High Type, above.

LOW TYPE

CAFÉ DOORS, WINDOWS, STORAGE

STORAGE AND DISPLAY OF FOOD AND DRINK. *All food and drink shall be so stored and displayed as to be protected from dust, flies, vermin, handling, droplet infection, overhead leakage and other contamination. All means necessary for the elimination of flies shall be used.*

Public-health reason. Food or drink not properly protected from contamination may become a public-health hazard.

Satisfactory compliance. The following requirements are implied conditions of satisfactory compliance:

(1) The presence of rodents, roaches, ants or other vermin shall be considered as violating this item. Food or drink shall not be stored on floors which are subject to flooding from sewage back-flow, such as those below street level.

(2) All unwrapped or unenclosed food and drink on display are protected by glass or otherwise from public handling or other contamination, except that approved hand openings may be permitted on counter fronts.

(3) All supplementary means necessary for the elimination of flies, such as fly-repellant fans, fly paper, fly traps or fly-killing sprays or powders are employed.

(4) All enclosed spaces within double walls, between ceilings and floors, in fixtures and equipment which provide harborage for rodents have been eliminated by the removal of the sheathing which forms the enclosed space; or all exposed edges of such walls, floors, and sheathing have been protected against gnawing by rats by the installation of approved ratproof material, and all openings in walls, floors, and ceilings through which pipes, cables, and other conduits pass have been properly sealed with snugly fitting collars of metal or other approved ratproof material securely fastened in place.

DOORS AND WINDOWS. *When flies are prevalent, all openings into the outer air shall be effectively screened and doors shall be self-closing, unless other effective means are provided to prevent the entrance of flies.*

Public-health reason. Flies may contaminate the food with disease organisms, thus nullifying the effectiveness of all other public health safeguards.

Satisfactory compliance. The following requirements are implied conditions of satisfactory compliance.

(1) All openings to the outer air are effectively screened with not less than 16-mesh wire cloth, and

(2) All doors are self-closing and screen doors to the outer air open outward; or

(3) Fans of sufficient power to prevent the entrance of flies are in use at all ineffectively protected openings; or

(4) Flies are absent.

(5) Window and door screens must be tight-fitting and free of holes. This includes the screens for skylights and transoms.

Condensed recommendations from tentative "Ordinance and Code Regulating Eating and Drinking Establishments" *by U. S. Public Health Service.*

CAFÉ FLOORS, WALLS, CEILINGS, VENTILATION, LIGHTING

FLOORS. *The floors of all rooms in which food or drink is stored, prepared, or served, or in which utensils are washed, shall be of such construction as to be easily cleaned, shall be smooth, and shall be kept clean and in good repair. Kitchen floors shall be impervious to water.*

Public-health reason. Properly constructed floors which are in good repair can be more easily kept clean than improperly constructed floors. Kitchen floors having an impervious surface can be cleaned more easily than floors constructed of wood or other pervious or easily disintegrated material, will not absorb organic matter, and are, therefore, more likely to be kept clean and free of odors. Clean floors are conducive to clean food-handling methods.

Satisfactory compliance. The following requirements are implied conditions of satisfactory compliance:

(1) The floors of all rooms in which food or drink is stored, prepared, or served are of such construction as to be easily cleaned, are smooth, and are in good repair. Floors may be of concrete, terrazzo, tile, etc., or wood covered with linoleum, or tight wood floors.

(2) The floors of all rooms in which food is prepared or utensils are washed are constructed of concrete, tile or other impervious material, in good repair and provided with drains. However, where floors of such rooms are kept clean without flushing, a linoleum or similarly impervious surfacing in good repair shall be accepted in lieu thereof and the drain requirement shall be waived. If floor drains are used they shall be provided with proper traps so constructed as to minimize clogging.

WALLS AND CEILINGS. *Walls and ceilings of all rooms in which food or drink is stored, prepared, or served shall be kept clean and in good repair; shall be finished in light color; shall have a smooth, washable surface up to the level reached by splash or spray.*

Public-health reason. Painted or otherwise properly finished walls and ceilings are more easily kept clean and are therefore more likely to be kept clean. A light-colored paint or finish aids in the even distribution of light and the detection of unclean conditions. Clean walls and ceilings are conducive to clean food-handling operations.

LIGHTING. *All rooms in which food or drink is stored or prepared or in which utensils are washed shall be well lighted.*

Public-health reason. Ample light promotes cleanliness.

Satisfactory compliance. Satisfactory if artificial light sources furnish 10 footcandles on all working surfaces in rooms in which food or drink is prepared, or utensils washed, as measured by a light meter; and are in use except when equivalent natural light is present. Storage rooms sufficiently well lighted with 4 footcandles at a distance of 30″ from the floor.

VENTILATION. *All rooms in which food or drink is stored, prepared, or served, or in which utensils are washed, shall be well ventilated.*

Public-health reason. Proper ventilation reduces odors and prevents condensation upon interior surfaces.

Satisfactory compliance. This item shall be deemed to have been satisfied if all rooms are adequately ventilated so as to be reasonably free of disagreeable odors and condensation. Ventilation equipment supplementary to windows and doors, such as adequate exhaust fans or stove-hoods, shall be provided if necessary.

CAFÉ LAVATORIES, TOILETS, WATER SUPPLY

LAVATORY FACILITIES. *Adequate and convenient hand-washing facilities shall be provided, including warm running water, soap and approved sanitary towels. The use of a common towel is prohibited. No employee shall return from a toilet room without washing his hands.*

Public-health reason. The use of washing facilities and sanitary towels are essential to the personal cleanliness of food handlers.

Satisfactory compliance. This item shall be deemed to have been satisfied if hand-washing facilities, including warm running water, soap and individual cloth or paper towels are provided. Washing facilities must be adequate and convenient to the toilet rooms. Dish-washing vats shall not be accepted as washing facilities for personnel. Warm water must be on hand at all times or within a reasonable time after opening the faucets. Soap and towels should be provided by the management. No employee shall return from a toilet to a room where food, drink or utensils are handled or stored without first having washed his hands.

TOILET FACILITIES. *Every restaurant shall be provided with adequate toilet facilities conveniently located and conforming with the ordinance of the city. Toilet rooms shall not open directly into any room in which food, drink or utensils are handled or stored. The doors of all toilet rooms shall be self-closing. Toilet rooms shall be kept in a clean condition, in good repair, and well lighted and ventilated. Hand-washing signs shall be posted in each toilet room used by employees. In case privies or earth closets are permitted and used, they shall be separate from the building, and shall be of a sanitary type constructed and operated in conformity with the standards of the State board of health.*

Public-health reason. The need for toilet facilities and the necessity for protecting the food from toilet-contaminated flies are obvious.

Satisfactory compliance. The following requirements are implied conditions of satisfactory compliance:

(1) The toilet room, stool, etc., are kept clean, sanitary, in good repair and free from flies.

(2) Durable, legible signs are posted conspicuously in each toilet room directing employees to wash their hands before returning to work. Such signs may be stenciled on the wall to prevent removal.

(3) A booth open at the top shall not qualify as a toilet room.

WATER SUPPLY. *The water supply shall be easily accessible to all rooms in which food is prepared or utensils are washed, and shall be adequate and of a safe sanitary quality.*

Public-health reason. The water supply should be accessible so as to encourage its use in cleaning operations; it should be adequate so that cleaning and rinsing will be thoro; and it should be of safe, sanitary quality in order to be suitable for drinking and to avoid the contamination of food and utensils.

Condensed recommendations from tentative "Ordinance and Code Regulating Eating and Drinking Establishments" *by U. S. Public Health Service.*

CAFÉ EQUIPMENT, WASTE DISPOSAL, ETC.

CONSTRUCTION OF UTENSILS AND EQUIPMENT. *All eating and cooking utensils and all show and display cases or windows, counters, shelves, tables, refrigerating equipment, sinks and other equipment or utensils used in connection with the operation of a restaurant shall be so constructed as to be easily cleaned and shall be kept in good repair.*

Public-health reason. If the equipment is not so constructed that it can easily be cleaned, and is not kept in good repair, it is unlikely that it will be properly cleaned.

Satisfactory compliance. The following requirements are implied conditions of satisfactory compliance!

(1) All surfaces with which food or drink comes in contact consist of smooth, not readily corrodible material.

(2) All surfaces with which food or drink comes in contact are in good repair, free of breaks, corrosion, open seams, cracks and chipped places.

(3) All surfaces with which food or drink comes in contact are easily accessible for cleaning, and are self-draining.

(4) All display cases, windows, counters, shelves, tables, refrigeration equipment, stoves, hoods and other equipment are so constructed as to be easily cleaned, and are in good repair.

(5) The above requirement precludes the use of any type of equipment so designed as to permit food or drink routinely to come in contact with threaded surfaces.

(6) In all cases where a rotating shaft is inserted thru a surface with which food or drink comes in contact, the inspector shall assure himself that the joint between the moving and stationary surfaces is close fitting.

DISPOSAL OF WASTES. *All wastes shall be properly disposed of, and all garbage and trash shall be kept in suitable receptacles in such manner as not to become a nuisance.*

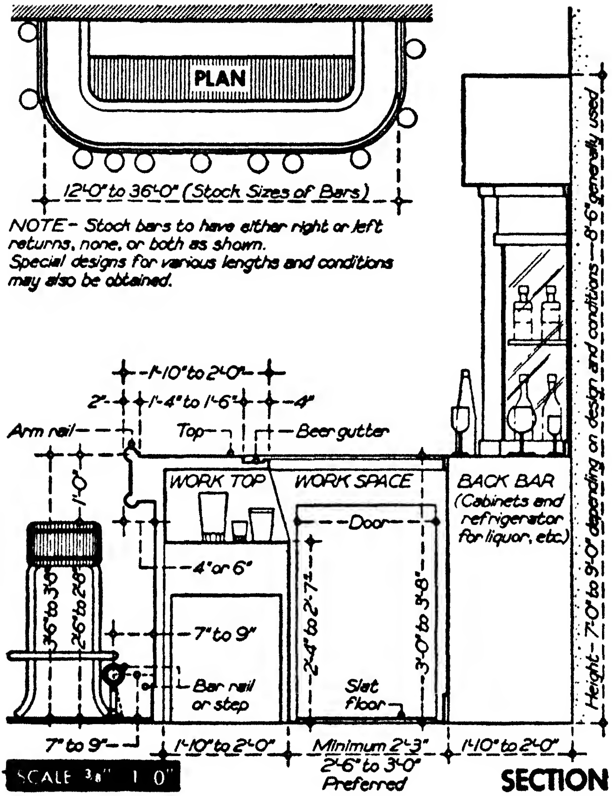
Public-health reason. All garbage, refuse and liquid wastes resulting from the normal operation of a food or drink establishment should be properly disposed of so as not to become a nuisance or a public-health menace.

REFRIGERATION. *Waste water from refrigeration equipment shall discharge into an open sink or drain, properly trapped and sewer connected, provided that where sewer connections are not available, clean adequate water-tight drip pans may be used.*

MISCELLANEOUS. *The surroundings of all restaurants shall be kept clean and free of litter or rubbish. None of the operations connected with a restaurant shall be conducted in any room used for domestic purposes. Adequate lockers or dressing rooms shall be provided for employees' clothing. Soiled linens, coats, and aprons shall be kept in containers provided for this purpose.*

Condensed recommendations from tentative "Ordinance and Code Regulating Eating and Drinking Establishments" *by U. S. Public Health Service.*

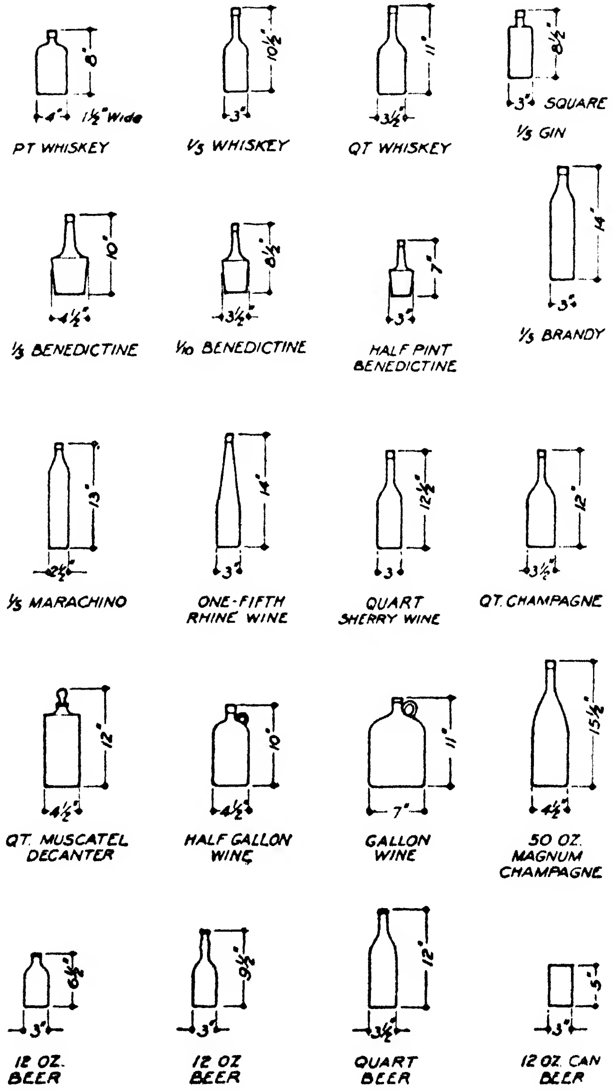
LIQUOR BARS



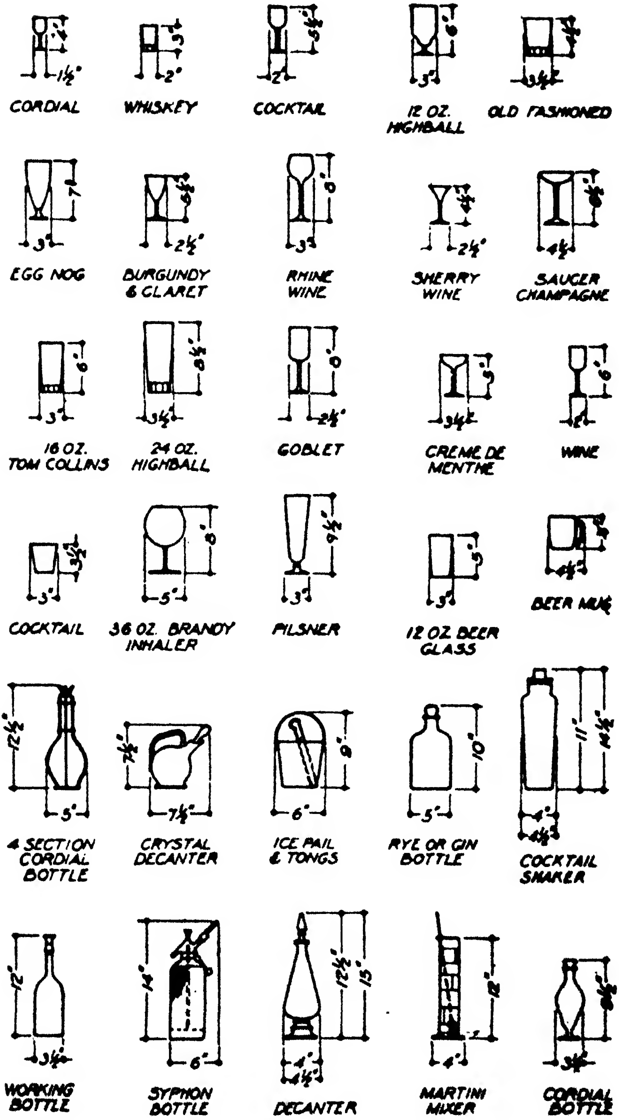
STOCK BARS. There is properly no such thing as a stock bar for dispensing liquor. The general measurements have been thoroly well established and if the section shown above is followed, it will be found that such fittings as cabinets, refrigerators, sinks and other similar equipment can be readily fitted into any special design. The handling of the bar front and the back bar offers wide scope for the imagination of the designer and we find bars constructed of practically all decorative material such as glass blocks, bakelite, structural glass, bricks, field stone, wood, marble, etc.

VARIATIONS. One serious item of discomfort to bar patrons arises from the projection of the work top being too little and from having a too deep apron. The section above would be vastly improved if the projection was increased from 4" or 6" to 8" or 10", and the vertical thickness reduced to a minimum. Patrons using bar stools would find this an improvement in comfort. If more than one bartender is to work, the aisle space between front and back bars should not be less than 3'-0"

SIZES OF LIQUOR BOTTLES



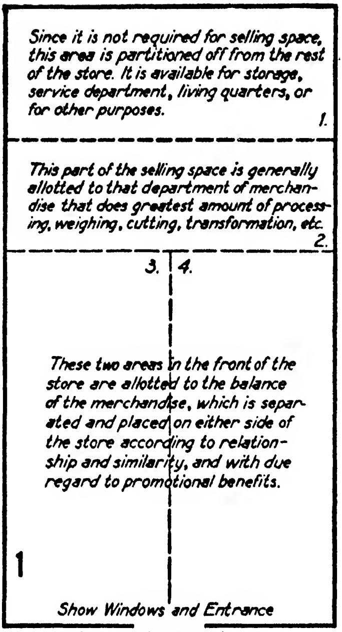
SIZES OF LIQUOR GLASSES, ETC.



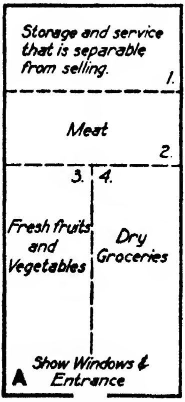
SMALL STORE PLANNING PRINCIPLES

IN GENERAL. Store design is constantly adjusting itself to changing needs of the time and location insofar as merchants have been able to determine the wants of the customers and have been in a position to make desirable changes. To set down a specific plan for *any* kind of retail store is impossible. However, the basic principle of *departmentization* can be established to assist in planning.

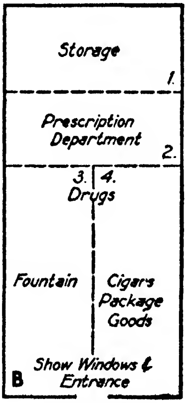
SELLING AREAS. All merchants divide their stock and activities into departmental groups. Small businesses can be conveniently set up in 3 departments. The location of the departments will depend upon the special skill of the merchant and the local market demand for various goods. For example, the drawing shows the meat department to occupy the rear of the grocery store, yet a merchant wishing to lay heavier stress on meat because of profit potentialities or because of special skill in handling meat, might place this department forward at the side of the store.



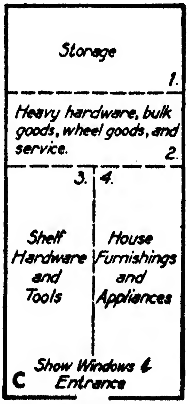
BASIC USE OF SPACE IN RETAIL STORES



GROCERY STORE

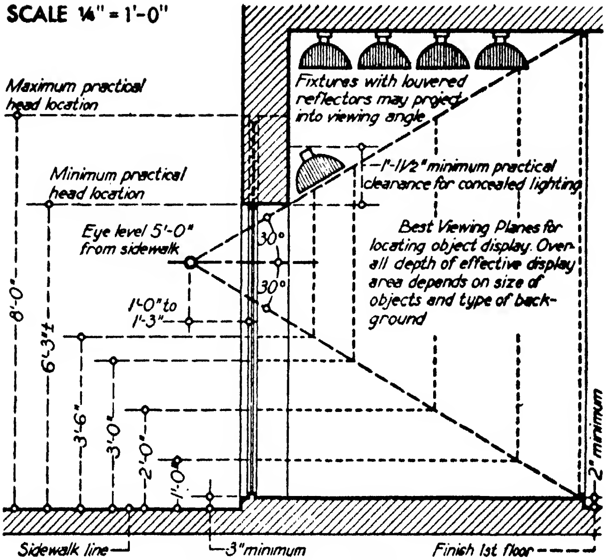


DRUG STORE



HARDWARE STORE

SHOW WINDOW
DESIGN PRINCIPLES

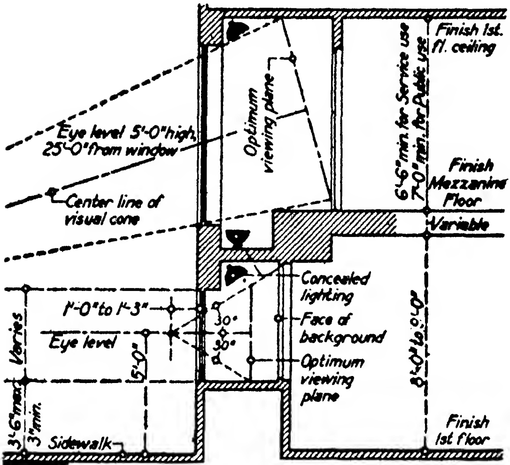


BEST VIEWING PLANES
SECTION

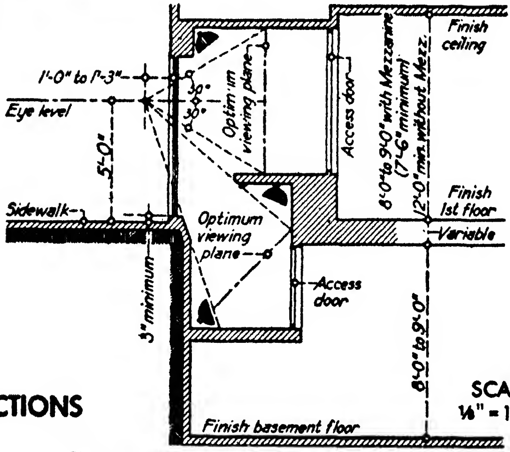
In general, the smaller the objects are which must be displayed, the higher the bulkhead becomes and the shallower the display space becomes — to bring the objects closer to the observer's eye. Large objects such as automobiles and house furnishings will have a very low bulkhead and a relatively deep display area. In the diagram above is shown a method of locating the most favorable viewing plane for locating the objects on display. Obviously, the show-window back should be located sufficiently in the rear of this plane to furnish a proper background.

SIGHT LINES. The normal cone of human vision is approximately 60° — 30° in all directions from the optical center. Eye levels have been incorrectly suggested in various printed articles as 5'-3". Consumer Research says that women influence the majority of retail purchases so a 5'-3" sight line is incorrect as an average for prospective buyers. An eye level of 5'-0" or even 4'-10" more closely approximates true conditions. For bulkheads of various heights, the optimum viewing plane will be found at the intersection of the floor and the sight lines.

MULTIPLE SHOW WINDOWS



A SIGHT LINES – Ground and Mezzanine Windows.



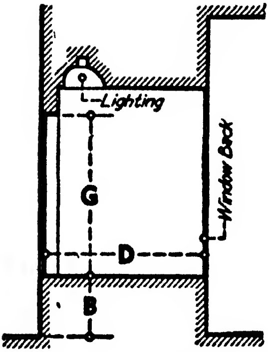
SECTIONS

SCALE
⅛" = 1'-0"

B SIGHT LINES – Ground and Basement Windows.

A comfortable viewing angle is 30° in all directions from the optical axis. Within this 60° cone, the eye sees quickly and without any appreciable physical effort of focusing. Thus it is practical to plan show windows which encompass two or more "viewing angle areas."

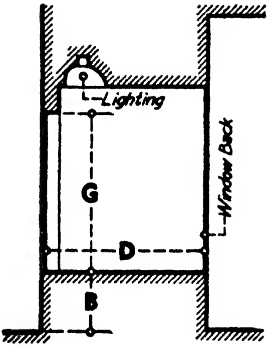
DIMENSIONS OF SHOW WINDOWS



NO STANDARDS POSSIBLE. In analyzing the figures which are presented below, the designer is cautioned not to regard these as hard and fast standards which must not be varied. The figures given only represent reasonable averages for the types of stores listed. They will, however, provide a starting place since they take into consideration the basic principle of store front heights which dictates that the smaller the object displayed, the higher must be the display window floor.

Store	*Bulkhead Height* **(B)**	*Glass Height* **(G)**	*Window Depth* **(D)**	*Lighting in Watts per Lin Ft. Outlets 12"-15"*	*Window Backs*
Artists' Materials	2'-2" to 3'-0"	4'-6" to 6'-0"	3'-0" to 4-0"	100 to 200	Neutral color, suitable for tacking; no portion of window more than 3'-6" from access door
Automobile Machinery (large)	0'-0" to 1'-0" (access window sometimes needed)	8'-0" to 10'-0"	6'-0" to 10'-0"	300 to 500 (special lighting effects; ceiling lights lowered, recessed spotlights)	Open into store
Machinery (small)	0'-0" to 1'-0"	6'-0" to 10'-0"	5'-0" to 10'-0"	250 to 300	Closed
Bakery Confectionery	2'-0" to 2'-6"	5'-0" to 6'-0"	2'-0" to 3'-6"	150	Glass or wood, closed. Screened vent ducts to outer air
Banks (branch store type)	3'-0"	6'-0"	2'-6"	200	Preferably open or low; interior appearance important
Bars, Cafes, Restaurants	1'-8" to 2'-4"	6'-0" to 8'-0"	0'-0" to 5'-0"		
Real Estate Agencies	2'-0"	6'-0"	4'-0"		
Books or Stationery Tobacco	2'-0" to 3'-0"	4'-6" to 6'-0"	2'-0" to 1'-6"	100	Closed or low railing, wood; possibly with shelving for displays
Cameras and Photography	1'-8" to 3'-0"	4'-0" to 6'-0"	2'-0" to 3'-0"	200	Open or closed.
China and Glassware	2'-0"	5'-6"	3'-0"	200	Closed
Musical Instruments Pictures and Frames	1'-4" to 2'-0"	5'-0" to 7'-0"	3'-0" to 5'-0"		
Toys	1'-0"	7'-0"	6'-0"		
Clothing (Men's)	1'-4" to 2'-0"	6'-6" to 8'-0" Allow 4 sq. ft. per "torso" form; 3'-4" to 4'-2" high	3'-0" to 6'-0"	200 Additional spotlights and base outlets	Closed; partitions or screens often divide window into 4'-0" to 6'-0" units
Clothing (Women's)	1'-0" to 2'-6"	7'-0" to 9'-0" Allow 4 sq. ft. by 5'-10" per form	3'-0" to 6'-6"	200 Additional spotlights and base outlets	Closed
Cutlery, Novelties, Silverware	1'-10" to 2'-6"	4'-6" to 6'-0"	2'-0" to 3'-0"	150	Closed, removable

DIMENSIONS OF SHOW WINDOWS

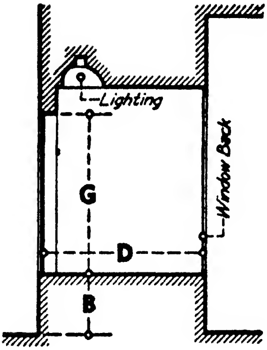


NO STANDARDS POSSIBLE. In analyzing the figures which are presented below, the designer is cautioned not to regard these as hard and fast standards which must not be varied. The figures given only represent reasonable averages for the types of stores listed. They will, however, provide a starting place since they take into consideration the basic principle of store front heights which dictates that the smaller the object displayed, the higher must be the display window floor.

Store	*Bulkhead Height* **(B)**	*Glass Height* **(G)**	*Window Depth* **(D)**	*Lighting in Watts per Lin. Ft. Outlets 12"-15"*	*Window Backs*
Dairies, Delicatessen Meat and Fish	1'-8" to 2'-4"	5'-0" to 7'-0"	2'-6" to 4'-0"	150	Closed or partially open. Vent unless refrigerated
Birds and Pets	1'-6"	7'-0"	4'-0"		
Department Store	1'-0" to 2'-6"	8'-0" to 10'-0"	7'-0" to 10'-0"	250	Closed. Interior wall valuable
Drug	1'-8" to 3'-0"	6'-0" to 8'-0"	2'-0" to 4'-0"	200	Partially closed or open; show interior
Dry Goods Hosiery and Lingerie	1'-4" to 2'-0"	6'-0" to 8'-0"	3'-0" to 5'-0"	200	Closed
Rugs and Linoleum*					Open or closed.
Electric Equipment Typewriters	1'-8" to 2'-4"	6'-0" to 8'-0"	3'-0" to 4'-0"	200	Closed
Florist (General)	1'-0" Waterproof floor; drainage	6'-0" to 8'-0"	3'-0" to 6'-0"	150	Open or glass—additional glass and metal shelving—ventilated
Florist (Hotel, Cut Flowers)	3'-0"	4'-0" to 5'-0"	3'-0" to 4'-0"	100	Closed—additional glass and metal shelving—Vent unless refrigerated
Furniture	0'-0" to 1'-2"	9'-0" to 11'-0" Room size, 9' x 12' rug, wall space	7'-0" to 12'-0"	250 to 350 Convenience outlets	Closed; access doors, 4'-0" x 6'-8". Period background
Furrier	1'-8" to 2'-4"	6'-0" to 8'-0"	3'-0" to 6'-0"	200 Spotlights and/or footlights; lenses necessary to protect furs	Semi-closed or closed, rich wood preferred
Grocery Liquor	1'-8" to 2'-6"	5'-0" to 7'-0"	3'-0" to 6'-0"	150	Open or low rail—clear view into store
Haberdasher (Varied Stock)	1'-4" to 2'-6"	6'-0" to 7'-0"	3'-0" to 5'-0"	200	Closed
Haberdasher (Limited Stock)	2'-6" to 2'-8"	5'-0" to 6'-0"	2'-6" to 3'-0"	150	Closed

*Large enough for room setups and usually sold with furniture.

DIMENSIONS OF SHOW WINDOWS



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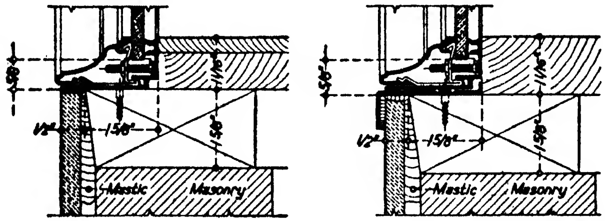
Store	*Bulkhead Height* **(B)**	*Glass Height* **(G)**	*Window Depth* **(D)**	*Lighting in Watts per Lin. Ft. Outlets 12"-18"*	*Window Backs*
HARDWARE OR PAINTS HOUSE FURNISHINGS	1'-0" to 2'-6"	6'-0" to 10'-0"	2'-6" to 6'-0"	200 Additional spot-lights and outlets for mechanical contrivances	Closed
HATS (Men's)	1'-4" to 2'-4"	6'-0" to 8'-0"	3'-0" to 5'-0"	200	Closed
HATS (Women's Millinery)	1'-4" to 2'-8"	5'-0" to 7'-0" 1 sq. ft. area x 1'-3" to 1'-8" height per hat	3'-0" to 5'-0"	200	Closed
JEWELRY (Inexpensive)	2'-4" to 3'-0"	4'-6" to 6'-0"	2'-0" to 3'-6"	150	Low or closed, removable; provide access passage
JEWELRY (High Quality)	3'-2" to 4'-0"	3'-0"	1'-0" to 3'-0"	100 "Daylight" lenses preferred	Low or closed, removable; provide access passage. Miniature stage
LEATHER GOODS LUGGAGE	1'-4" to 2'-0"	6'-6" to 7'-6"	3'-0" to 8'-0"	200	Closed, provide shelves 1'-3" to 2'-0" apart for luggage displays
OPTICAL	3'-0" to 3'-6"	4'-0" to 5'-0"	2'-0" to 3'-0"	150	Closed or partially open; whole window free in design
PIANOS RADIOS (floor cabinets)	0'-0" to 1'-0"	7'-0" to 10'-0"	5'-0" to 10'-0"	200	Open or closed
RADIO ACCESSORIES (not many floor models) AUTOMOBILE ACCESSORIES REFRIGERATORS SPORTING GOODS	1'-4" to 2'-0"	6'-0" to 8'-0"	3'-0" to 6'-0"	200	Open or closed
SERVICE: BARBER SHOP, BEAUTY SHOP, CLEANER & DYER, LAUNDRY, TAILOR	1'-6" to 2'-4"	6'-6" to 8'-0"	1'-6" to 5'-0"	200	Preferably open; interior appearance important
SHOES (Men's)	1'-4" to 2'-2"	6'-0" to 7'-0"	2'-0" to 5'-0"	150	Closed
SHOES (Women's; Men's and Women's)	2'-0" to 2'-4" 4'-0" †	5'-0" to 6'-0" 3'-0"† 1½ sq. ft. per pair shoes	2'-0" to 5'-0"	150	Closed † (Exclusive shops may feature individual models in small windows)

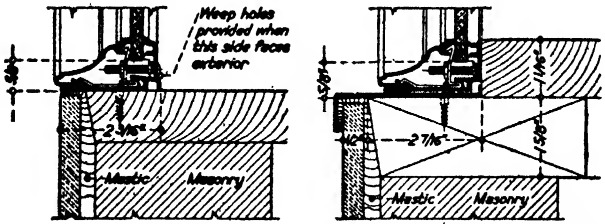
STORE FRONT SILL DETAILS

On this and the Data Sheets immediately following are shown details of store front construction that are typical. Details of the moldings to be used should, of course, be obtained from the manufacturer's representative before making drawings. The details given here will, however serve to visualize the store front construction and will serve as a guide.

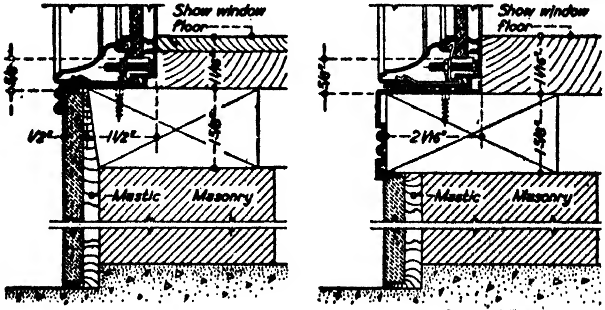
Store front setting moldings are variously available in aluminum, Alumilited aluminum, copper and bronze. Sash may be provided with weep holes for drainage if specified.



SILL OR JAMB

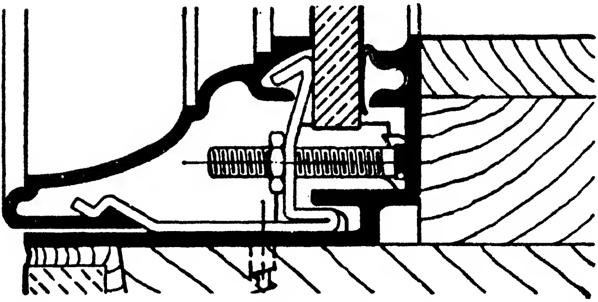


SILL OR JAMB

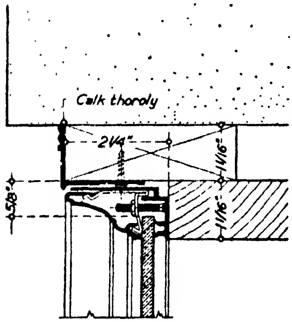


SILL OR JAMB

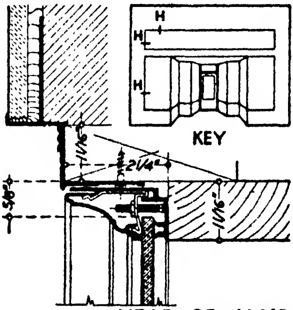
STORE FRONT
HEAD AND JAMB DETAILS



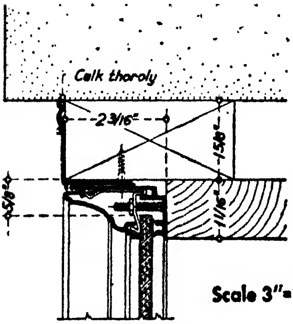
FULL SIZE



HEAD OR JAMB

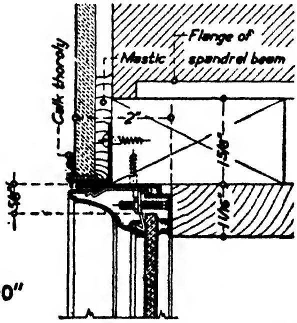


HEAD OR JAMB



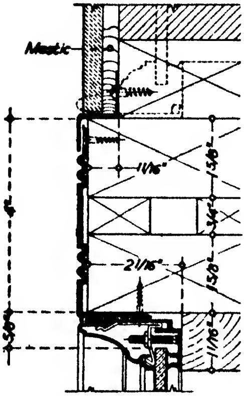
Scale 3"=1'-0"

HEAD OR JAMB

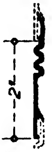


HEAD OR JAMB

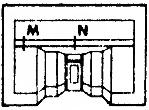
STORE FRONT
TRANSOM BAR DETAILS



"M"
TRANSOM BAR

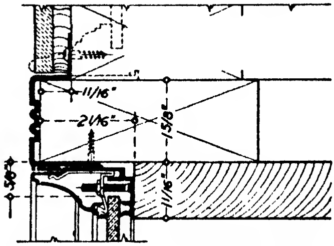


FOR 2"
EXTENSION

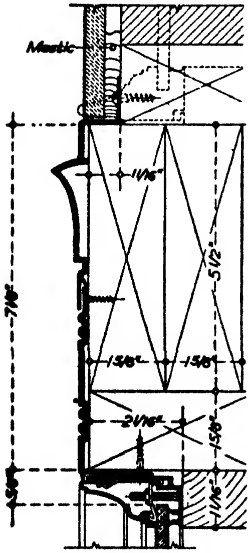


KEY

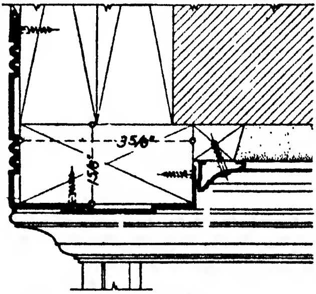
Scale 3"=1'-0"



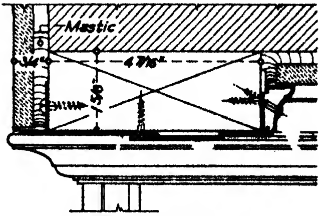
"M" TRANSOM BAR



"M"
TRANSOM BAR

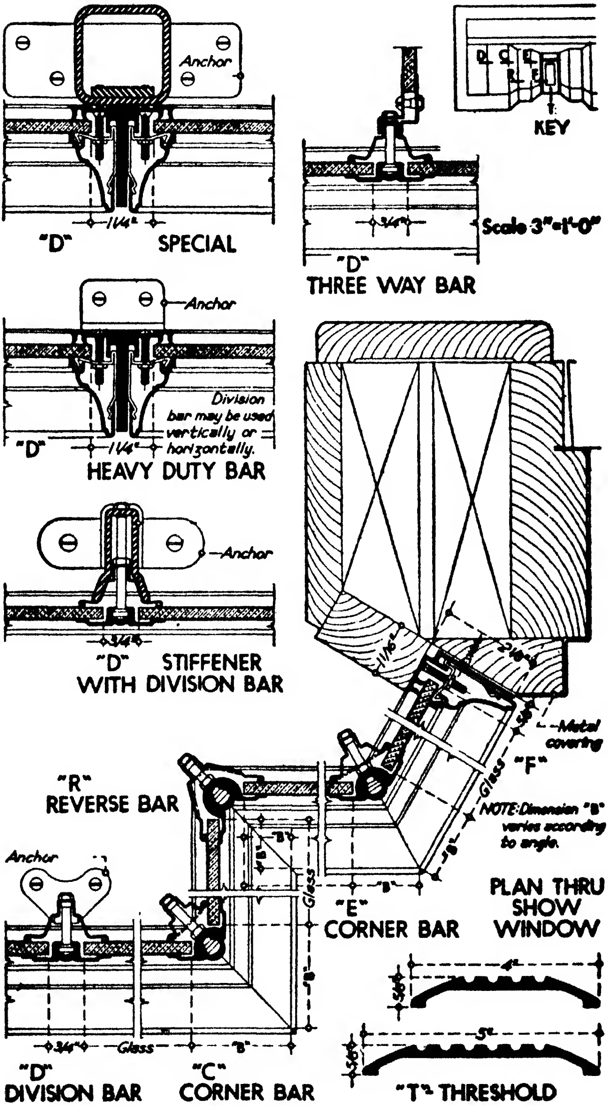


"N"- UNDERCOVERING

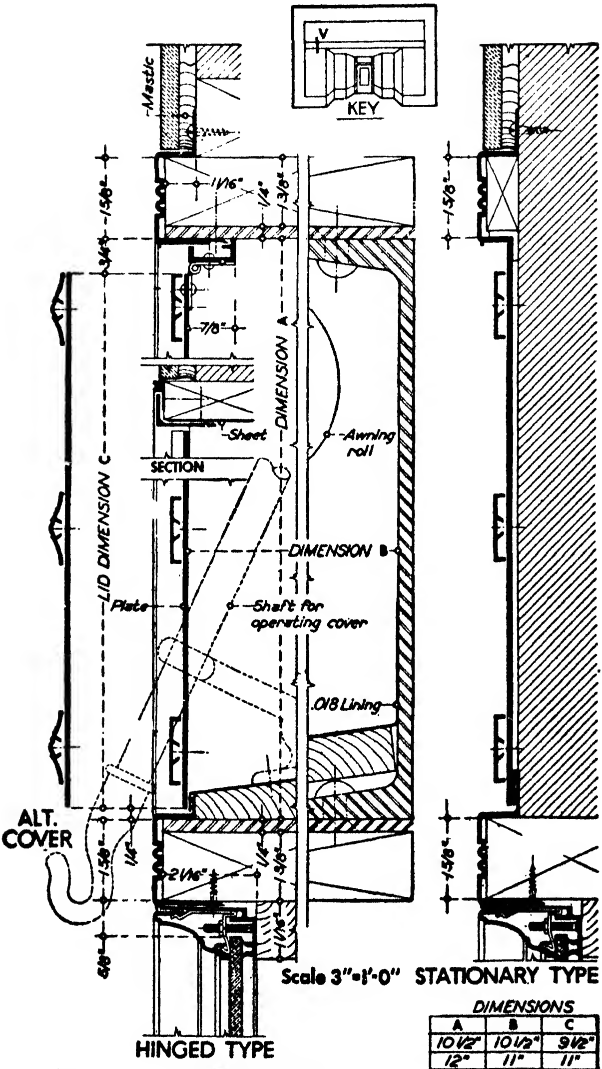


"N"- ALTERNATE
UNDERCOVERING

STORE FRONT
DIVISION BAR DETAILS



STORE FRONT
AWNING BAR DETAILS

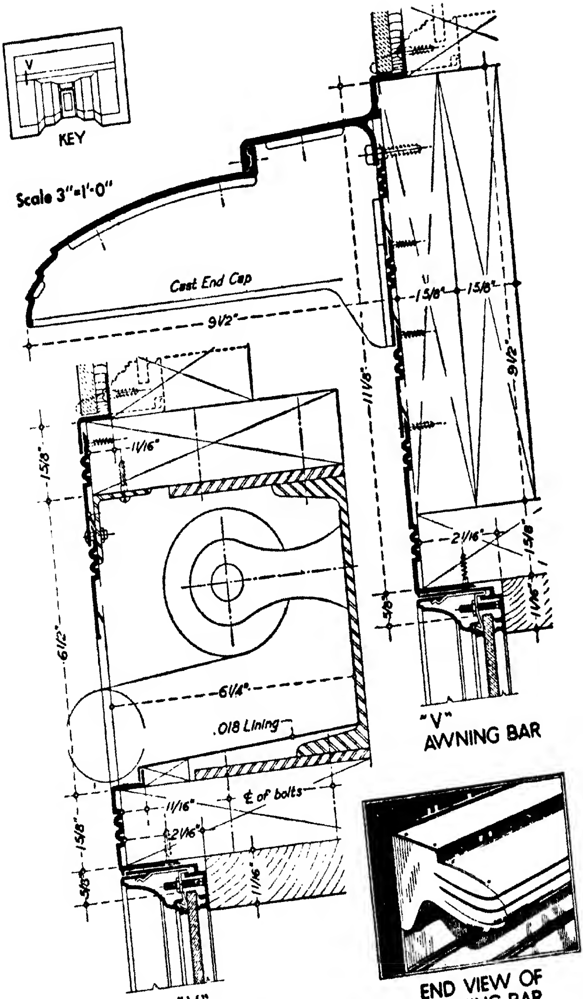


"V" AWNING BAR

DIMENSIONS

A	B	C
10 1/2"	10 1/2"	9 1/2"
12"	11"	11"
13 1/2"	11"	12 1/2"

STORE FRONT AWNING BAR DETAILS

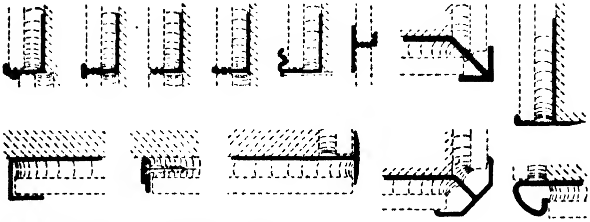


"V" AWNING BAR

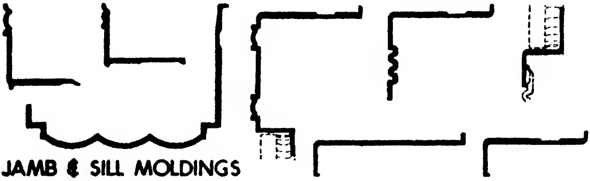
"V" AWNING BAR

END VIEW OF AWNING BAR

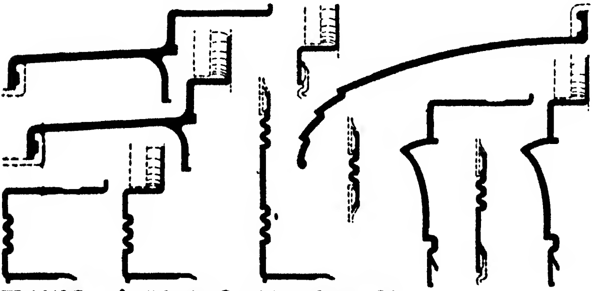
STORE FRONT EXTRUDED MOLDINGS



FOR USE WITH STRUCTURAL GLASS

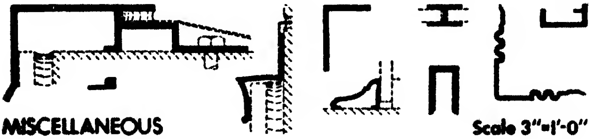


JAMB & SILL MOLDINGS



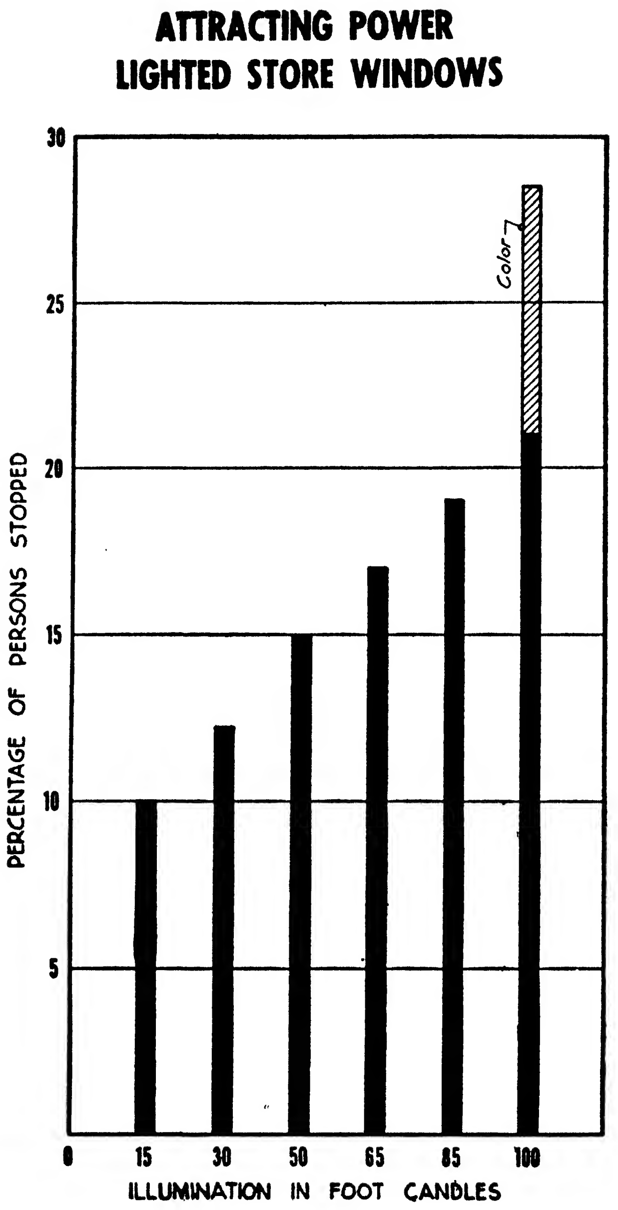
TRANSOM & AWNING BAR MOLDINGS

REEDS & EMBELLISHMENT

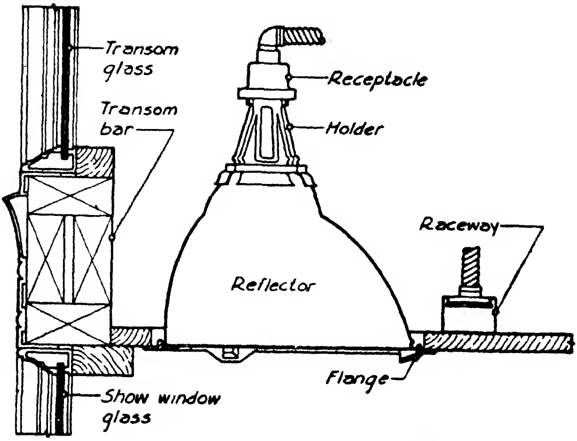


MISCELLANEOUS

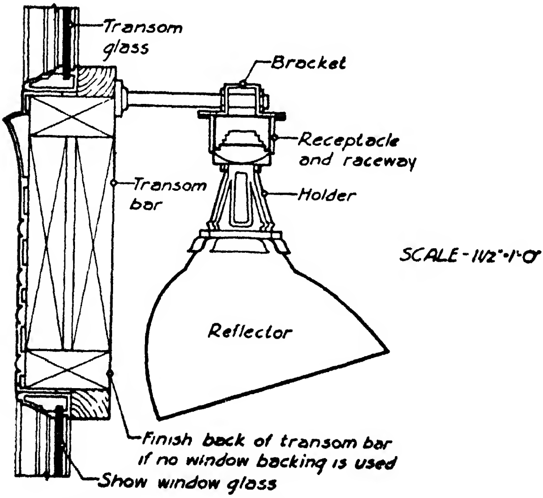
Scale 3"=1'-0"


ATTRACTING POWER
LIGHTED STORE WINDOWS
30
25
20
15
10
5
0
15
30
50
65
85
100
PERCENTAGE OF PERSONS STOPPED
ILLUMINATION IN FOOT CANDLES
Color

SHOW WINDOW LIGHTING

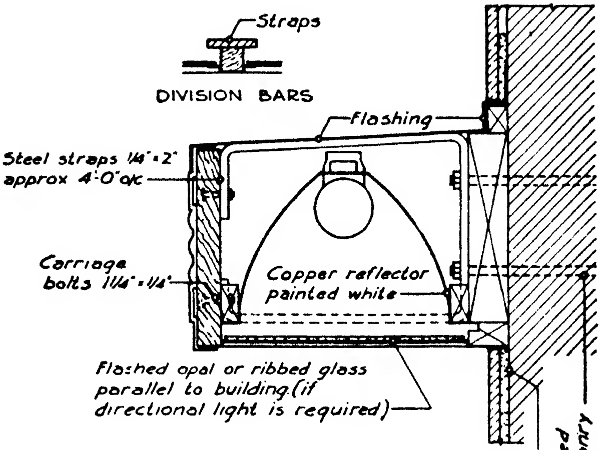


FLUSH CEILING REFLECTOR

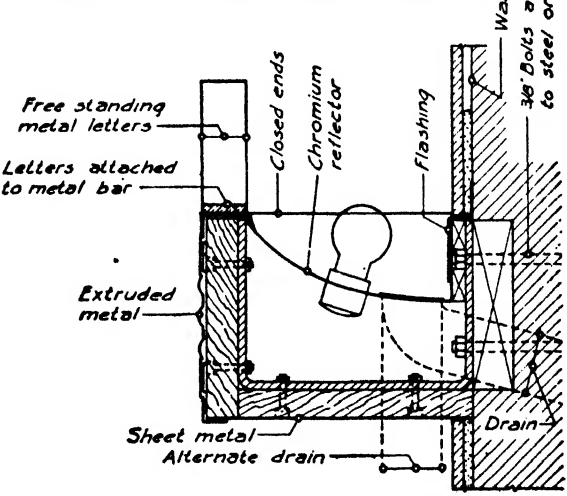


BRACKET TYPE REFLECTOR

STORE FRONT LIGHTING



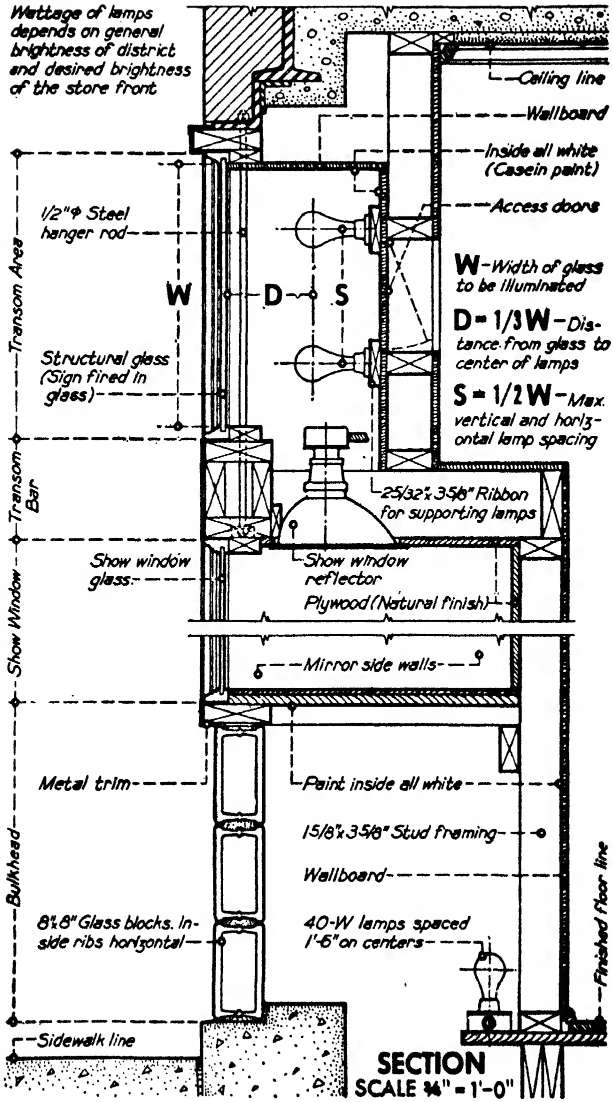
TROUGH LIGHTING DOWN



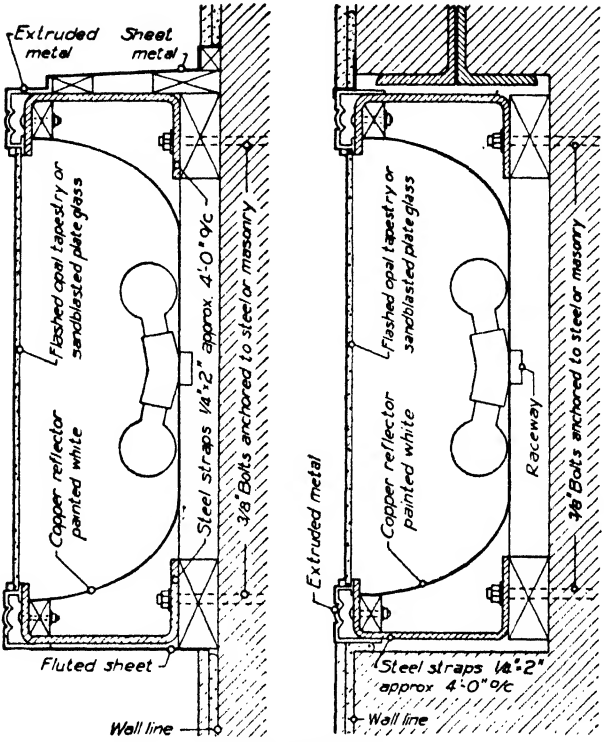
TROUGH LIGHTING UP

SCALE-1 1/2"=1'-0"

ILLUMINATED STORE FRONT

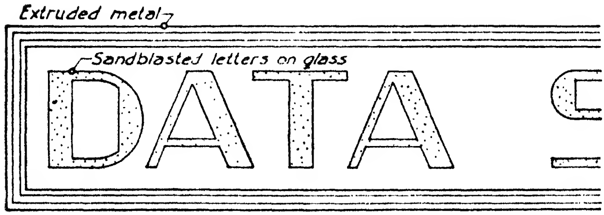


STORE FRONT LIGHTING



SECTIONS

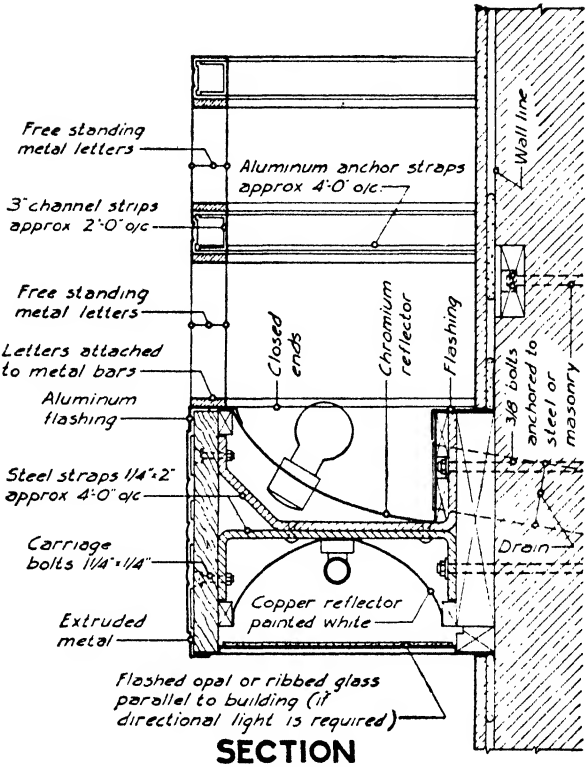
SCALE-1½"-1'-0"



ELEVATION

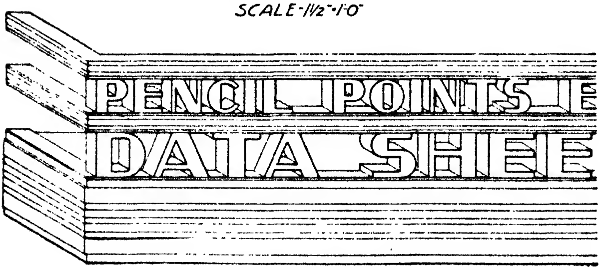
SCALE-½"-1'-0"

STORE FRONT LIGHTING



SECTION

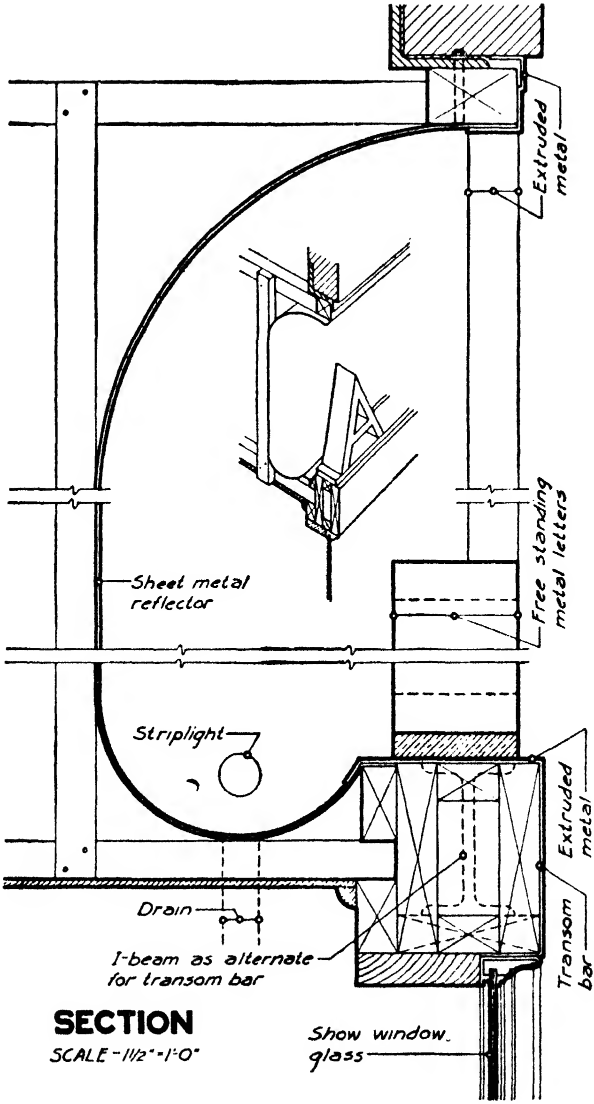
SCALE-1½"-1'-0"



ELEVATION

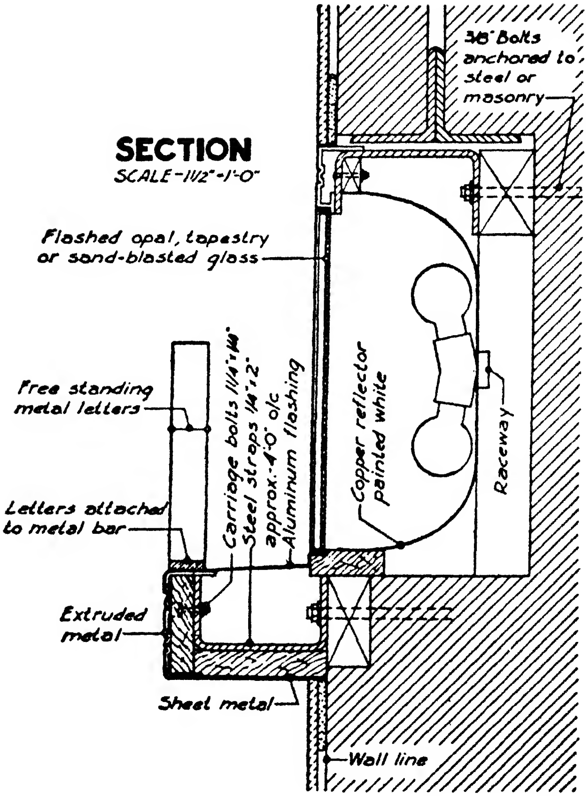
SCALE-½"-1'-0"

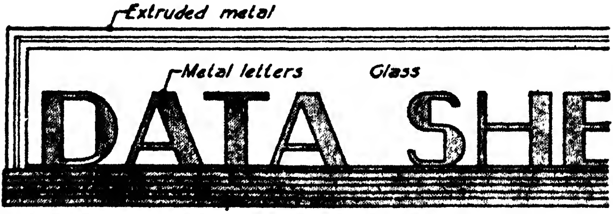
STORE FRONT LIGHTING



SECTION
SCALE - 1 1/2" = 1'-0"

STORE FRONT LIGHTING





ELEVATION

SCALE-1/2"=1'-0"

PORCELAIN ENAMEL LETTERS FOR SIGNS

SIGN LETTERS. Letters are available in 2 materials; All porcelain enamel and porcelain faces inlaid in stainless steel side flanges. They are used for identification on store fronts, roofs, marquees, or in any other position where permanent architectural lettering is required. All letters are made strictly to the architect's patterns—no stock alphabets are used. The letters can be produced in Gothic, Roman, thick and thin, modern, angular, or script. An accurate scaled drawing must be supplied, showing the design required. Simple or complicated trade marks or logotypes can be supplied to the architect's design.

Permanent materials and finishes are used thruout. Both types of letters have a distinctive roll beaded edge, resulting in better definition and readability.

Thirty-five standard colors are available. Special color matches involve a slight delay in delivery, and an extra charge is made.

Letters falling within 4'-0" x 10'-0" can be fabricated in one unit. If made in sections, sizes are unlimited. Backs can be furnished to enclose electrical work.

METHODS OF MOUNTING. The letters may be attached in a number of ways, as follows:

1. Attached to the face of a building.
2. Attached to the face of a building but setting away from the wall.
3. Free-standing letters, base-attached on marquees, copings or projecting parts.

For the all-porcelain enameled letters, the attachment methods shown are applicable. For porcelain inlaid stainless steel letters, essentially the same methods are used with the exception that where possible the letters are supported from the heavy porcelain face rather than from the side flanges.

NEON LIGHTING. Letters will be provided with electrode holes, tube support holes. The neon tubing can be installed on the face of the letters to be directly visible at night, or it can be placed in the back of a free-standing letter to create a silhouette effect when illuminated. The local electrical sign contractor should be consulted as to code requirements. One important Underwriter requirement is that both high tension wiring and neon tubing must be 1 1/2" from any metal unless shielded by an approved insulator. In all cases neon tubing is set 1 1/2" from the face or background on which it is mounted. A porcelain or pyrex bushing for a 1 3/8" to 1 3/4" hole allows the passage of the tubing thru any metal parts.

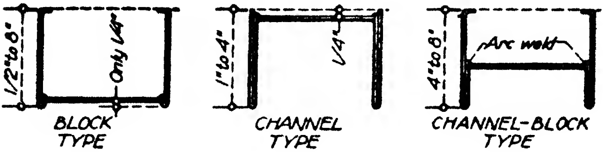
Transformers for letter installations are placed inside the building as close as possible to the letters, where accessible; or in a curb or transformer box under the letters; or in the letter itself if it is large enuf. Transformer sizes vary with different manufacturers and the capacity will vary with the length and diameter of the run of tubing. Several transformers are usually used on the average job.

BULB LIGHTING. Letters will be provided with lamp socket holes at a small extra charge. Bulb lighting can be installed on the face of the letters, as shown in the detail; or thru the use of an intermediate back to support the electrical work, the bulbs may be mounted on the backs of the letters to create a silhouette effect. Intermediate bases accommodate 6 and 10 watt bulbs, medium bases are a standard size and accommodate 6, 10, 15, and 25 watt bulbs.

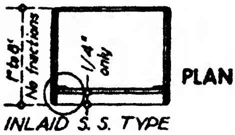
CAUTION. Wherever possible, method of attaching letters to background should be entirely concealed; also, attachments should be designed not to interfere wtih installations and servicing of electrical work.

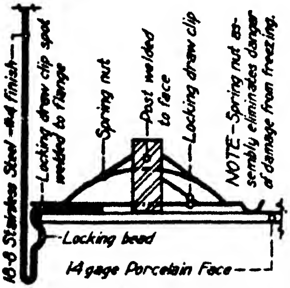
TWO TYPES OF PORCELAIN ENAMEL LETTERS

ALL-PORCELAIN LETTERS. Letters are made with 14 gage faces and 18 gage side flanges completely arc welded and completely covered with porcelain enamel inside and out. Fold back construction obviates all exposed metal edges. Faces and flanges can be made in different colors. All porcelain letters are available in 3 types, as shown below. 1/4" recess face is used for non-illuminated installations and deep recess is used for illuminated installations if desired.

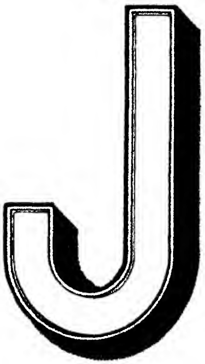


ALL-PORCELAIN LETTERS



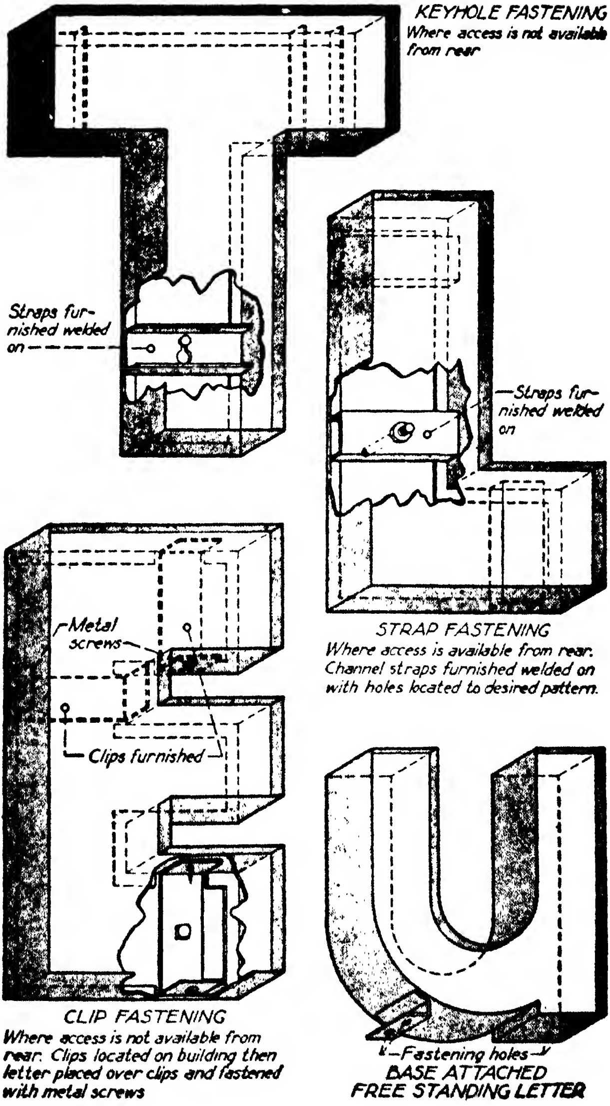


DETAIL AT JOINT OF PORCELAIN AND STAINLESS STEEL

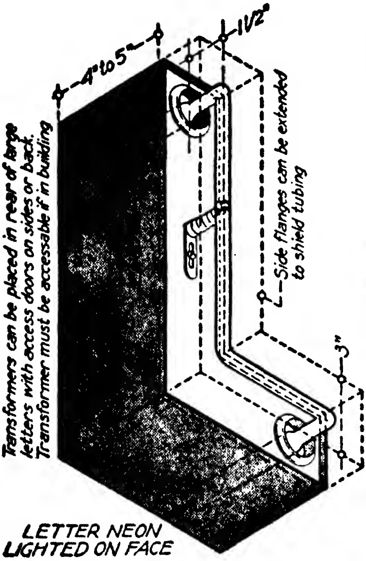


PORCELAIN INLAID STAINLESS STEEL LETTERS

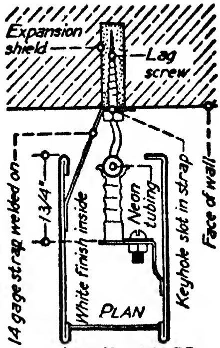
PORCELAIN ENAMEL LETTERS FOR SIGNS



PORCELAIN ENAMEL LETTERS FOR SIGNS

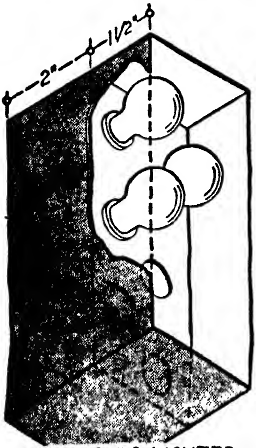


LETTER NEON LIGHTED ON FACE

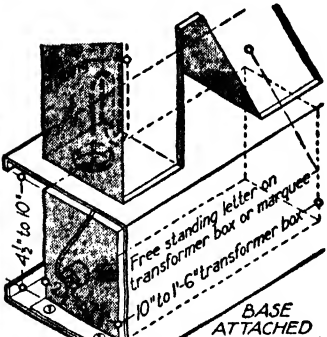


WALL ATTACHED SILHOUETTE LETTER

For servicing this Silhouette Neon Installation lift letter and tube assembly, held in place by 14 gage strap with keyhole attachment, off projecting lag screws. Next detach high tension cables.



LETTER BULB LIGHTED ON FACE

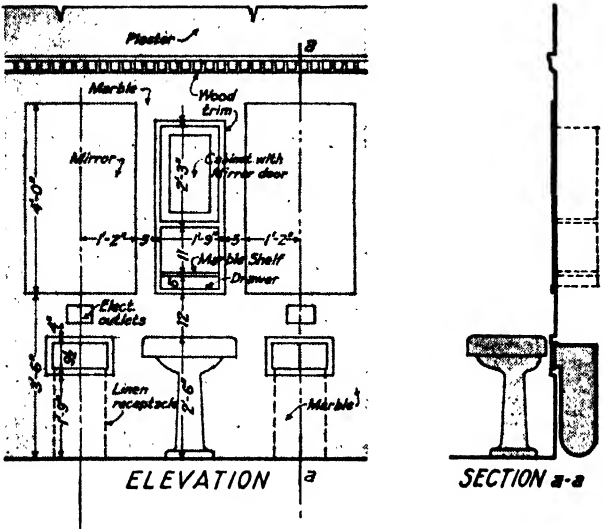


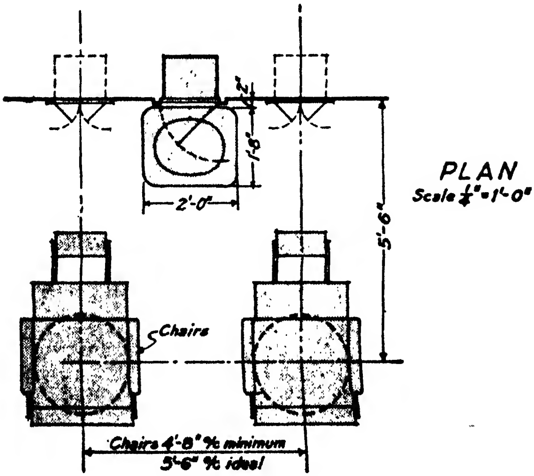
BASE ATTACHED SILHOUETTE LETTER

NOTE– Spacing between bulbs is 1/4". Bulbs used are 6, 10, 15, and 25 watts.

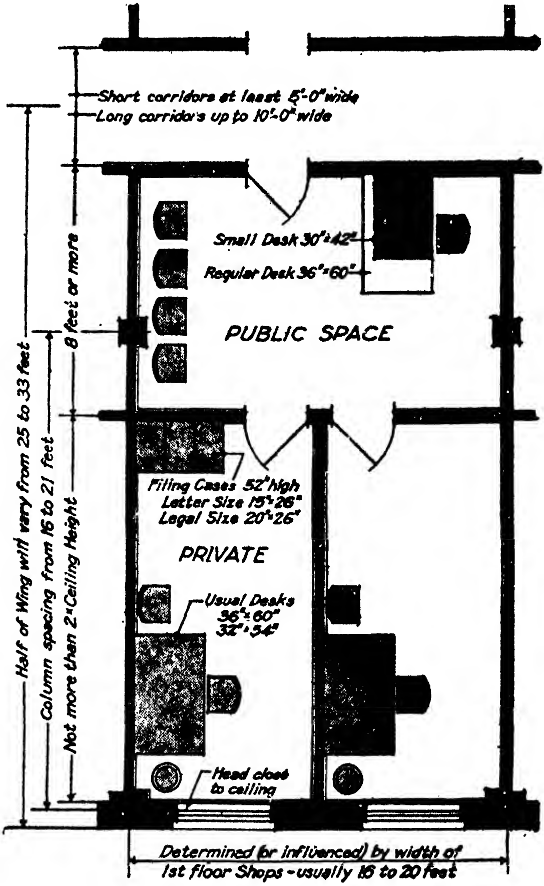
Sockets and wiring enclosed in backs of letters.

BARBER SHOP
PLAN





TYPICAL OFFICE BUILDING UNIT



FLOOR TO FLOOR HEIGHT. From 10 to 13 feet. Floors having large undivided areas for general offices will require greater heights than small private units as shown here.

SIZE OF UNIT. Sizes recommended here are for usual city office buildings. They will vary with cost of land, kind of floor and beam construction adopted, whims of owner, shape of lot, etc. Structural requirements are extremely important if the office building is to be economically constructed.

PLANNING SCHOOL CLASSROOMS

The following Data Sheets on schoolhouse requirements are presented only as suggested practice for preliminary sketches. Regional and local variations make rigid standards on a national scale impossible to attempt.

REFERENCE.

The *Bulletin of the A.I.A.* for March 1947 pp. 25 et seq., presents a general outline of the problem of school design together with a complete and excellent bibliography.

A voluntary association with an interest in bettering the physical condition of school buildings, known as the *National Council on Schoolhouse Construction* publishes a "guide" for $1.00, obtainable from W. D. McClurkin, George Peabody College, Nashville, Tenn. Material taken from this book should be checked with laws, codes, and regulations of the place, as well as with recommendations of recognized authorities.

CONDITIONS ENTERING INTO THE PLANNING OF CLASSROOMS.

In addition to mere classroom space, provide for heating and ventilation, chalkboards, bulletin boards, supply cabinets, bookcases, and means for the hanging of children's, students', and teachers' clothing.

Other desirable features, depending upon the character of the school, include such items as provisions for room clock, temperature control, electric outlets for lighting, projection, and vacuum cleaning, interphone connections, radio connections, lavatory and drinking facilities, project lockers, and such other special features as the school organization may require.

COLOR OF WALLS AND CEILINGS.

All walls should be of a color with a light reflecting factor of not less than 30% nor more than 50%.

The ceiling should be ivory white or light cream with a high reflecting factor of not less than 70%.

Avoid glossy finish.

COLOR OF SHADES.

Use translucent shades, the color of which harmonizes with walls.

COATROOMS, WARDROBES, AND LOCKERS.

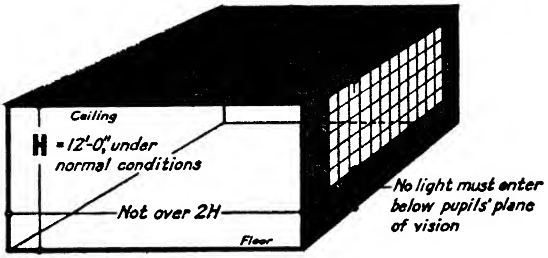
Provide each elementary classroom with suitable space for the children's outer garments in one of 3 ways:

(1) Ventilated coatrooms approximately 5 ft. wide, with an outside window having a glass area of not less than 1 sq. ft. to every 10 sq. ft. of floor area; also with 2 hook strips placed respectively 3'-6" and 5'-0" above floor, each to be equipped with a sufficient number of hooks staggered 18" apart on each strip. A pole equipped with hangers may be substituted for hook strips. Coatrooms as described above with a classroom wall in the form of a stationary screen are acceptable when the area behind the screen is properly ventilated.

(2) Ventilated wardrobes easy of access and convenient for use, opening preferably into the classroom.

(3) Ventilated lockers in corridors, providing ample space for outer garments and placed so as to be convenient for use.

PLANNING SCHOOL CLASSROOMS



DIMENSIONS OF CLASSROOMS.

The width of a classroom, unilaterally lighted, should be not more than twice its height.

Under normal conditions the height of a classroom should be 12 feet.

The length of a classroom is determined by the desired seating capacity and activity spaces of the room.

Provide in the front end of the classroom approximately 8 feet between the first row of seats and the front wall.

In the rear of the classroom provide at least 3 feet between the last row of seats and the rear wall.

SEATING CAPACITY OF CLASSROOMS.

The normal seating capacity of classrooms is determined by allowing 16 sq. ft. average, up to 30 sq. ft. for primary rooms, depending on the method of instruction. High school lecture rooms may need only 7 sq. ft. in theater arrangement, up to 20 sq. ft. with other types of seating and seats.

AISLES.

For safety and convenience in passing up and down classroom, aisles next to walls should be at least 30" wide.

Intermediate aisles should be at least 18" wide.

DOORS TO CLASSROOMS.

Classroom doors should be at least 3'-0" x 7'-0" x 1 3/4". A clear wireglass pane in the upper part of the door is desirable.

LOCATION OF WINDOWS.

Bilateral daylight sources clerestory windows, and variations of skylights, may contribute materially to visual comfort and efficiency when properly controlled by shielding devices or orientation.

East and west fenestration is preferable to north and south.

The top of the upper sash of windows should be 6" or less below the ceiling.

No windowpanes should be placed so low that light enters the room below the plane of vision of pupils seated next to the windows.

GLASS AREA OF WINDOWS.

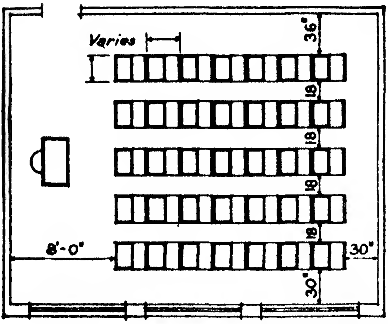
Natural daylight illumination should be adequate at the desks of all pupils.

The ratio of window area to floor area is governed by the intensity of illumination necessary for a proper distribution of a sufficient amount of light at each desk. For different regions of the country the actual ratio of required glass area to floor area will vary between one-fourth and one-sixth.

ARTIFICIAL ILLUMINATION.

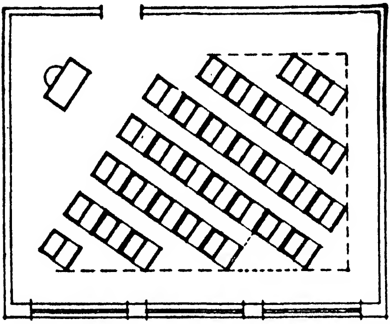
Intensities of from 20 to 40 ft. candles are satisfactory in a balanced brightness environment.

SCHOOL SEATING SCHEMES



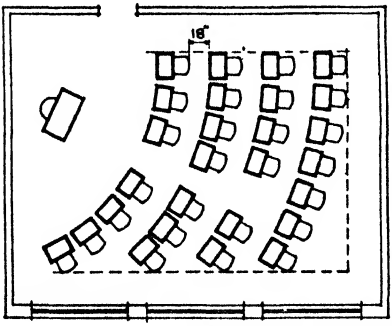
This is the usual arrangement of desks, especially the fixed type. The pupils at the rear and near the windows are facing a glare of light. The focus of attention on the teacher's desk is difficult for pupils at the sides near the front. It is the most economical arrangement. The local laws shoud govern the dimensions of aisles.

RECTANGULAR SCHEME



In this plan the desks are turned away from the glare of the windows, resulting in excellent lighting for all desks. The focus of attention is as difficult as in the rectangular scheme. Suitable to fixed or movable seating. Not particularly economical of floor space. Surrounding aisle sometime reduced in width.

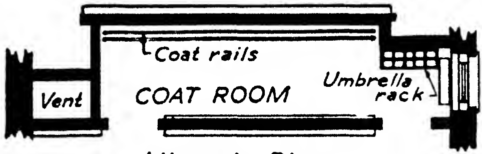
OBLIQUE SCHEME



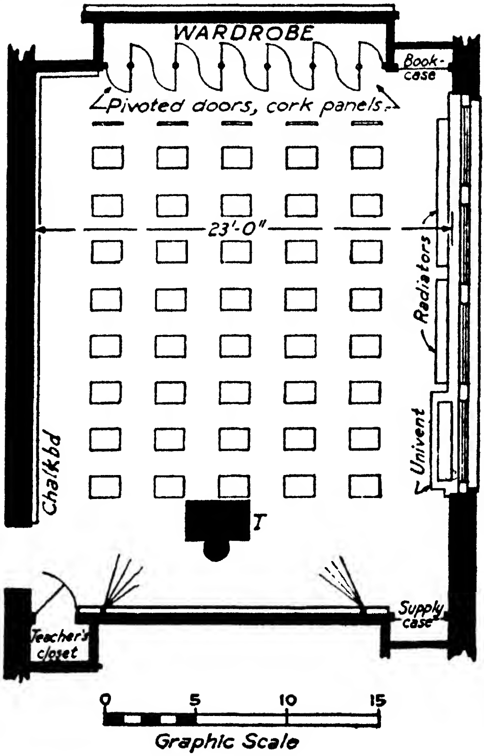
A scheme particularly adaptable to movable seating. Excellent light is secured on all desks, and the attention of the pupils is easily focused on the teacher's desk without turning in the seats. Difficult to lay out in plan. Somewhat wasteful unless the rear and window aisles are utilized for seating.

RADIAL SCHEME

PLAN OF ELEMENTARY SCHOOL CLASSROOM

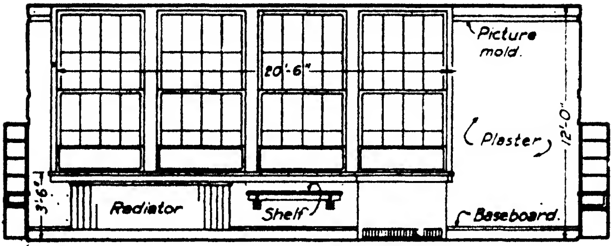


Alternate Plan

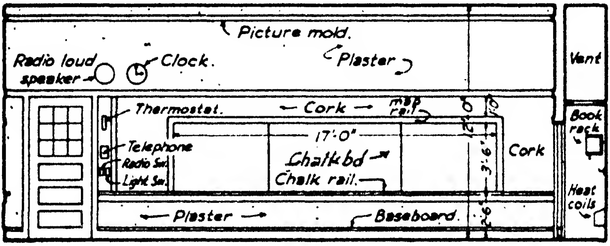


The alternate plan is for the rear of classrooms in schools where the State Laws require a coat room instead of the wardrobe unit. When the State Laws require two doors to each classroom the additional door should be placed near the rear of the room on the left-hand wall.

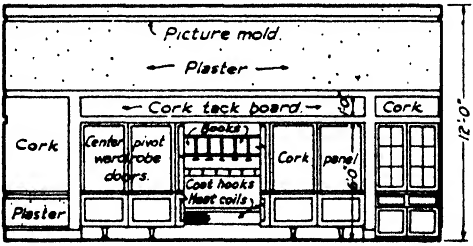
ELEVATIONS OF ELEMENTARY CLASSROOM



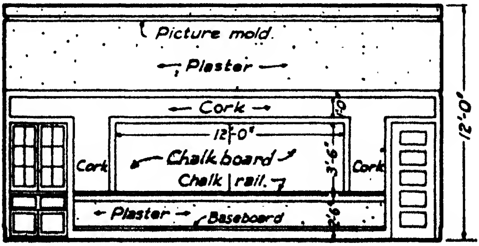
WINDOW WALL



WALL OPPOSITE WINDOWS

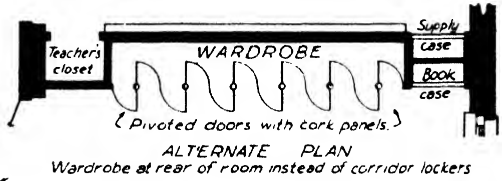


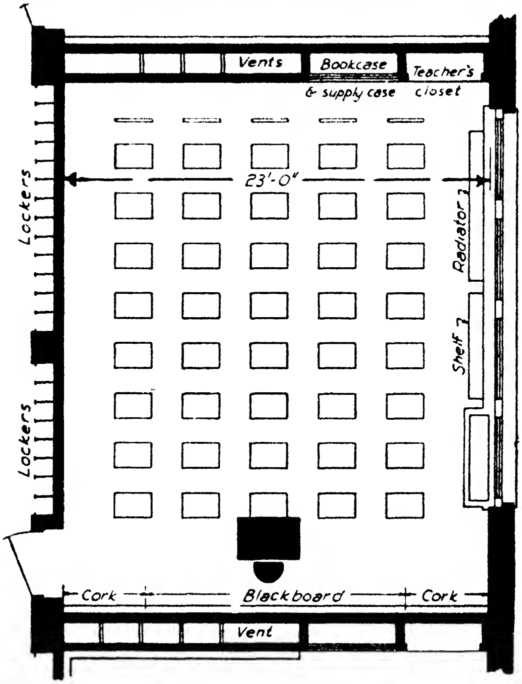
REAR OF ROOM



FRONT OF ROOM

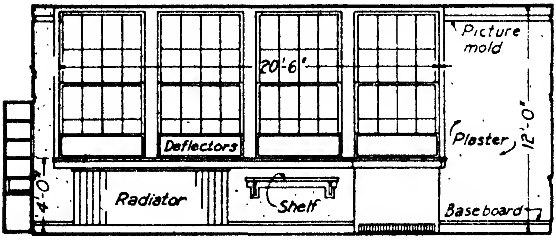
PLAN OF JUNIOR OR SENIOR HIGH SCHOOL CLASSROOM



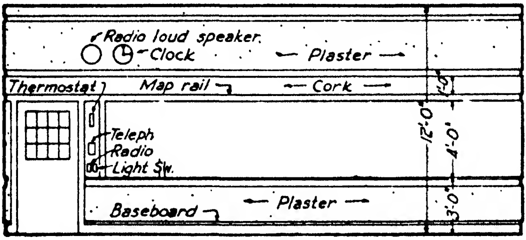


The alternate plan is for the rear of classrooms where lockers are not desired. When the state laws require two doors to each classroom, the additional door should be placed near the rear of the room on the left-hand wall.

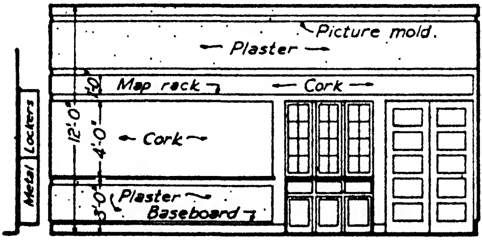
ELEVATIONS OF JUNIOR OR SENIOR HIGH SCHOOL CLASSROOM



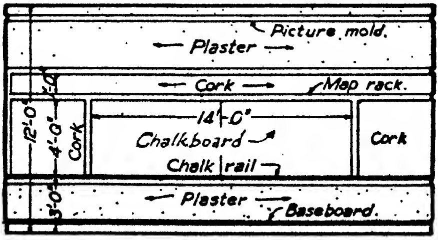
WINDOW WALL



WALL OPPOSITE WINDOWS



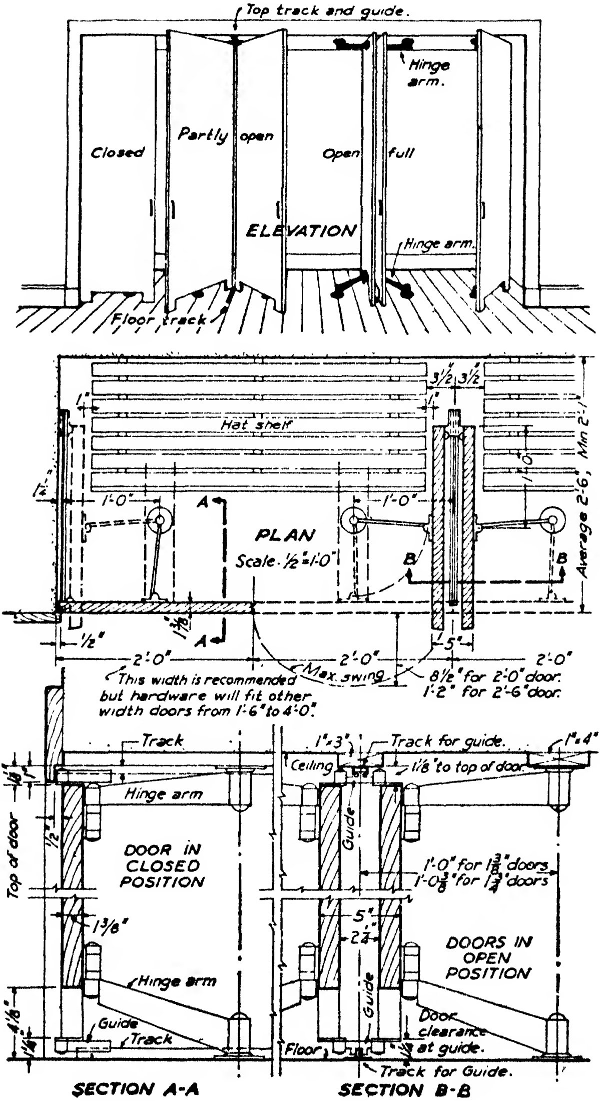
REAR OF ROOM



FRONT OF ROOM

Scale

DETAIL OF SCHOOL WARDROBE



AREA AND LOCATION OF CHALKBOARDS

Many states have specific requirements as to the position of the light-colored or conventional black chalkboard in the schoolroom and its area. The chalkboard area may vary with the type of classroom and the number of pupils to be served. Some classrooms require more chalkboard area than others.

Kindergarten and primary rooms should be adequately equipped with cork bulletin boards to accommodate the display of pupils' work as well as pictures and diagrams that are used extensively in these grades. Bulletin boards should be installed along the top of the chalkboard in practically all elementary classrooms so that work can be displayed without interfering with the chalkboard work.

From a survey on the use of chalkboards it seems that 34 linear feet of board is the *minimum*. The survey indicates the typical classroom *should have* a total length of 45.7 linear feet of chalkboard to take care of (1) teachers' activity which averages 17.5 linear feet, and (2) the pupils' activity with a maximum of 28.2 linear feet. The survey figures are based on an analysis on the use of chalkboards in 6,000 schools, grades 1 to 8 inclusive—some grades requiring less and some requiring more. It may not always be easily possible to secure the chalkboard areas indicated as desirable in the survey because of window areas, doors, wardrobes, etc. Swinging leaf chalkboards are sometimes necessary to make up the desirable area.

Extensive tests made in schools where conditions were considered representative, show the length of chalkboards to be as in the following table:

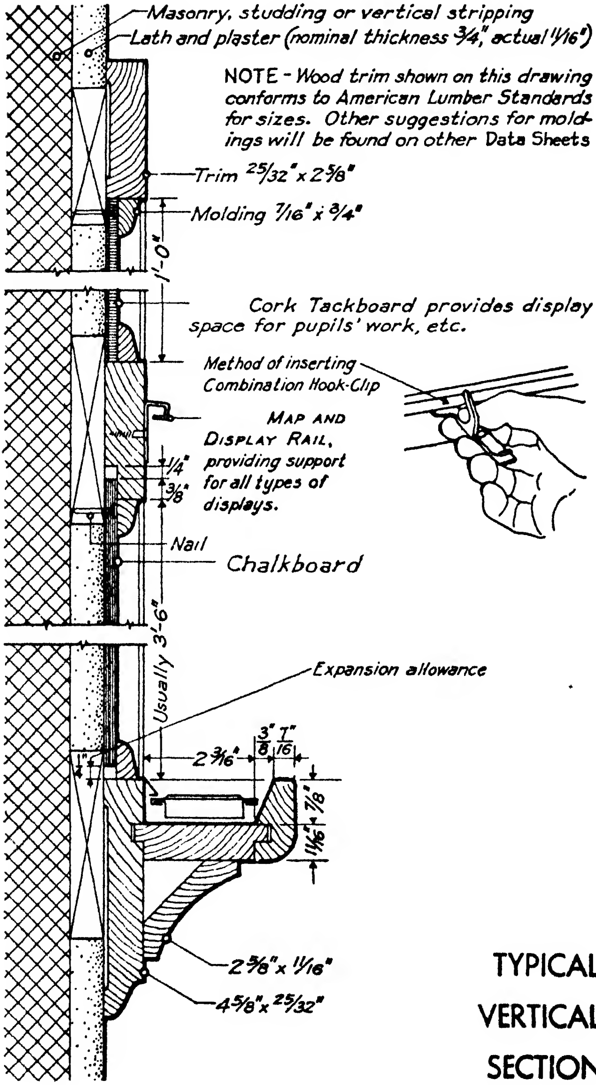
	Elementary Grades 1, 2, 3	*Grade School Grades 4, 5, 6*	*7, 8*	*High School*
Width of room	18′-6″	18′-9″	21′-0″	26′-0″ to 33′-8″
Length of room	27′-4″	30′-0″	31′-4″	32′-0″ to 43′-0″

In rural schools the chalkboard which is placed with its lower edge 26″ above the floor and is 42″ wide, is serviceable. It provides chalkboard which the majority of children can conveniently reach. The top of such a board is 5′-8″ above the floor. A board 48″ wide, would give a permanent writing space at the top which is very desirable in many cases.

Chalkboards are now available with a reflection factor of 30%, which is practical when the level of illumination is sufficiently high to overcome the loss in visibility due to the reduced brightness difference between the white chalk and the light-colored board, as compared to the white chalk on the conventional blackboard. Where conventional blackboards are installed, a convenient means such as sliding panels should be available for covering the blackboard with lighter-colored surfaces when it is not in use.

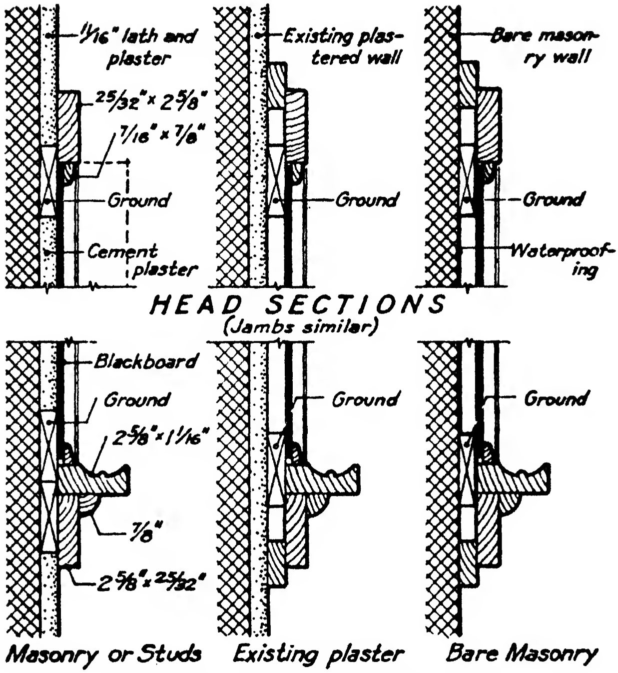
A trend is evident in some sections toward reducing the area of chalkboard to an 8 to 12-ft. panel on the front wall, to be used by the teacher for demonstration purposes.

TYPICAL CHALKBOARD CONSTRUCTION



TYPICAL VERTICAL SECTION

SUB-CHALKBOARD CONSTRUCTION

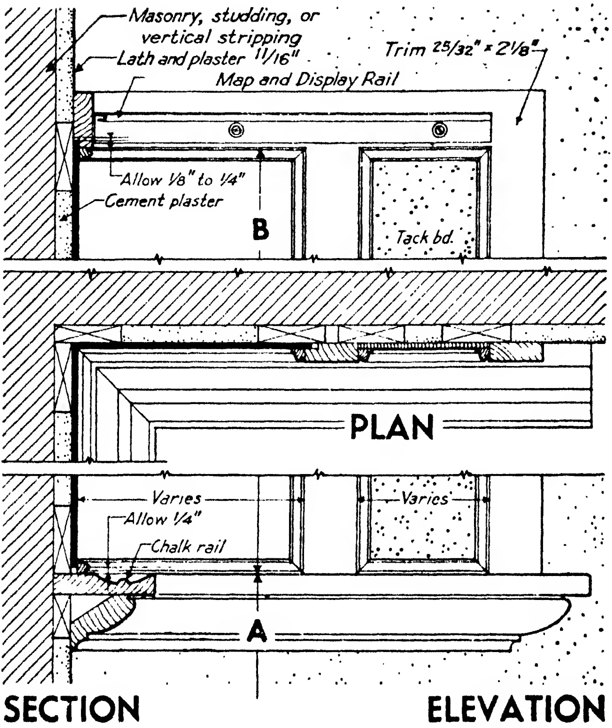


TYPICAL VERTICAL SECTIONS

WOOD BACKING —In addition to the methods of installing chalkboards over plaster and bare masonry as shown *above*, an excellent base can be installed of wood. Nominal 1 in. T & G flooring, kiln-dried, S1S is considered ideal. A backing of 5-ply Exterior Type plywood, or kiln-dried V-jointed or CV-jointed ceiling are also highly satisfactory. These backings are secure and easy to install, no grounds are required for nailing of trim and trough. Mastic is used to cement the board to the backing.

VENTILATED CONSTRUCTION —In unusually humid climates, there is a tendency for chalkboards to sweat. To prevent sweating, one manufacturer recommends a method of ventilating the space behind the chalkboard so that free circulation of air takes place. This construction consists merely of vertical furring strips 25/32nds in. by 1 5/8 in., approximately 16″ o/c. These are placed over and fastened to the horizontal grounds and the chalkboard, trough and trim is fastened to the vertical grounds.

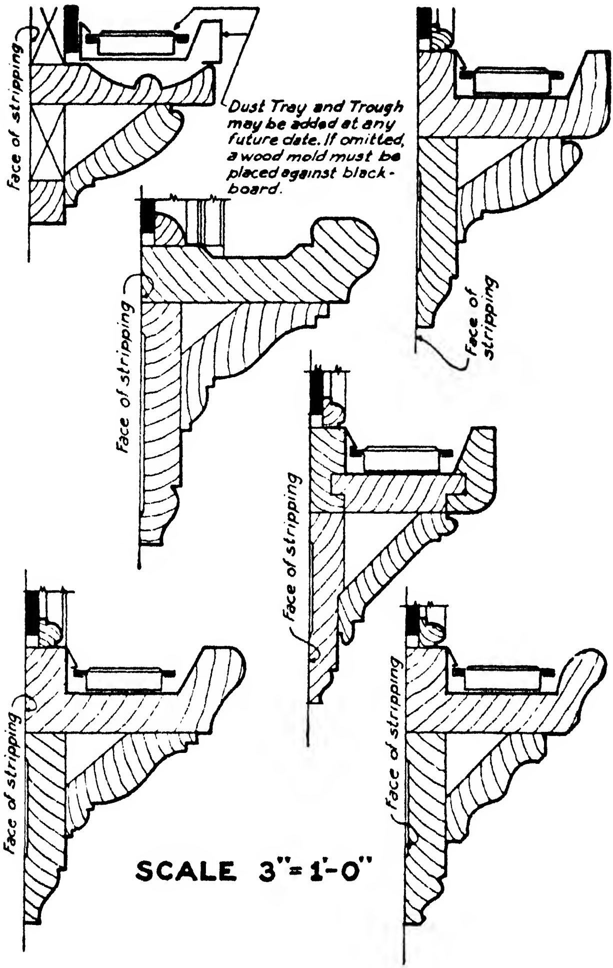
CHALK RAILS AND CHALKBOARD HEIGHTS



Simplified Practice Recommendation No. 75 of the U. S. Bureau of Standards recommends that the heights of blackboards be 3′-6″ and 4′-0″. The 3′-6″ height serves pupils with varying ability to "reach." The 4′-0″ height is used extensively for teachers' blackboards and for rural schools where pupils of all grades must use the same blackboard.

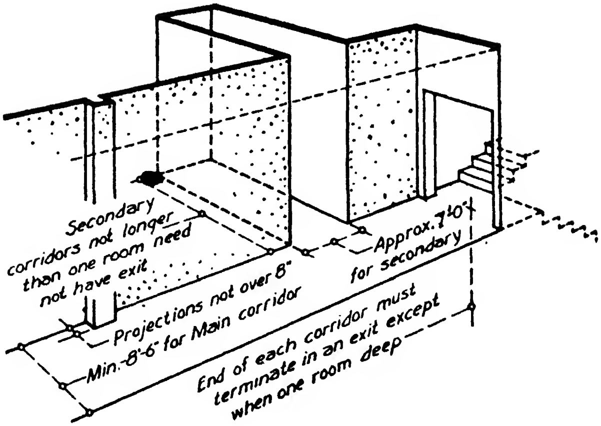
Grade	A *Chalk-Rail Above Floor*	B *Height of Blackboard*
Kindergarten	1′-9″ to 2′-2″	3′-6″
First and Second Grades	2′-0″ to 2′-4″	3′-6″
Third and Fourth Grades	2′-2″ to 2′-6″	3′-6″
Fifth and Sixth Grades	2′-4″ to 2′-8″	3′-6″
Junior and Senior High Schools	2′-6″ to 3′-0″	4′-0″
Back of Teacher 1st to 8th Grade incl.	3′-0″	to height of doors
Rural Schools	2′-2″	4′-0″

SUGGESTED CHALK-RAIL DETAILS



This page of details is offered only as suggestions for trough details. The drawings shown all illustrate actual installations. Other chalk rail details using lumber of standard dimensions and of simpler section will be found on others of these *Data Sheets*.

SCHOOL BUILDING CORRIDORS



CORRIDOR CONSTRUCTION.

In buildings of more than 2 stories high, construct corridors of "fire-proof construction" with walls of approved masonry or reinforced concrete. Structural members must have a fire resistance of not less than a 4-hour rating for bearing walls, isolated piers, columns and wall-supporting girders; a 3-hour rating for other walls and girders than those already specified, and for beams, floors, roofs, and floor-fillings; a 2-hour rating for fire partitions.

WIDTH OF CORRIDORS.

The minimum clear passage-way of the main corridor or corridors of any school building containing 4 classrooms or more, should be 8′-6″.

The minimum clear corridor width of secondary corridors will vary with the length of such corridors and the number of classroom doors leading to them, but such secondary corridors should be approximately 7′-0″ wide.

TERMINATION.

Each end of each corridor should terminate on an egress or stairway, excepting that "pockets" not to exceed the length of 1 classroom may be planned when conditions dictate.

LIGHTING.

Corridors and passage-ways should be well lighted. Outside windows are always desirable. Artificial illumination of 3 foot-candles intensity is recommended.

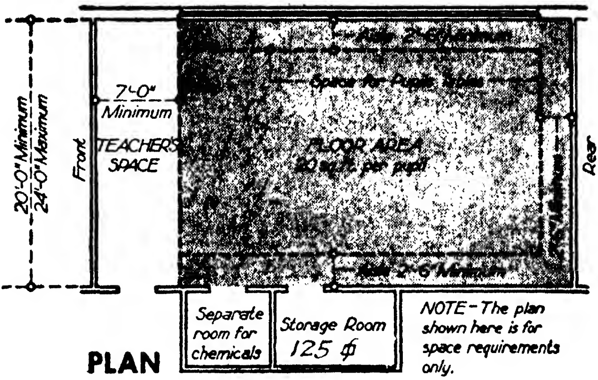
WALL PROJECTIONS.

No projections should extend beyond the face of the corridor walls in excess of 8″.

CORRIDOR EQUIPMENT.

No radiators, drinking fountains, wash basins or other equipment should be placed on corridor walls unless the walls are recessed to receive them.

SCIENCE LABORATORIES



PLAN

DIMENSIONS OF LABORATORIES

Laboratories should be not less than 20'-0" wide and not more than 24'-0" wide.

Laboratories should be standard as to light, heat and ventilation.

At the front end of the laboratory, provide a minimum of 7'-0" between the first student's table and the front wall for teacher's space.

Allow 2'-6" for aisle space on both sides and rear of the room.

For each pupil, allow a minimum of 20 square feet of floor area in addition to the 7 feet of teacher's space.

DEPENDENCIES

Provide a separate room which is vented, for the storage of chemicals.

One storage room for apparatus and equipment and another for chemical storage may be placed between 2 laboratories to serve them both.

TEACHER'S TABLE

The teacher's table should have an acid-resisting top, acid-resisting sink and drain.

Each table should be provided with an electrical connection and a direct current supply is desirable.

Cold water is mandatory at the sink, and hot water is desirable.

A gas connection should be provided.

STUDENTS' TABLES

Allow a minimum of 2'-6" of table length for each pupil's station.

Gas, water, electric connections should be convenient to each station.

Table tops should be acid-resisting.

OTHER REQUIREMENTS

Provide both translucent and opaque window shades of approved type.

Provide an electrical outlet which is suitable for a projection machine.

A bulletin board of at least 15 square feet should be provided.

A notebook case is desirable.

A minimum of 20 linear feet of blackboard with at least 10 linear feet in the teacher's end of the room should be provided.

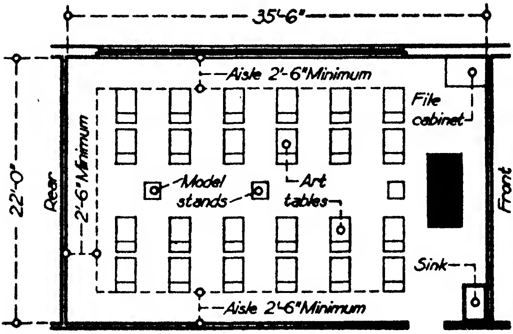
SPECIAL REQUIREMENTS

For chemistry, provide a fume hood for light and heavy gases.

For biology, provide an aquarium with a water supply and drain.

For general science and biology, a germinating bed is desirable.

ART AND MECHANICAL DRAWING



PLAN

ART ROOMS

Rooms devoted to art instruction should be so located as to receive north light.

Not less than 30 square feet of floor area per student should be provided.

Provide adequate arrangements for electric connections, water supply, ventilation, display spaces and storage facilities.

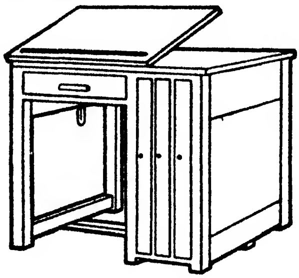
A typical art room plan is shown above.

MECHANICAL DRAWING ROOMS

The provisions for mechanical drawing rooms are practically identical with those of art rooms and where class schedules allow, the same room can be and often is used for both purposes.

Rooms devoted to mechanical drawing should be so located as to receive north light, and artificial lighting should be provided to correspond with the standard set by the lighting code of the American Engineering Standards Committee.

At least 30 square feet in gross floor area per student should be provided.



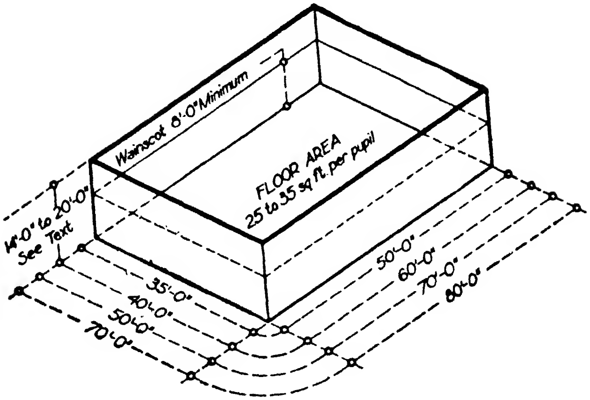
Special rooms suitably equipped should be considered for the purpose of duplicating or blue printing.

TABLES

Illustrated at the left is a typical drawing table with adjustable top. Boards, instruments and materials are stored in the compartments. A general drawer is provided for class room equipment.

Dimensions of the table shown are 2'-10" long, 1'-8" wide, and 2'-6" high.

PHYSICAL EDUCATION



DIMENSIONS OF GYMNASIUMS

The floor dimensions should be computed on the basis of 25 to 35 square feet per pupil and will depend upon the enrollment, the school organization and the age of the children.

Recommended dimensions are shown on the drawing above.

In elementary schools, the ceiling should be not less than 14 feet for floor areas of 2400 square feet or less; the ceiling to be 16 feet for floor areas over 2400 square feet and less than 3500 square feet.

High school gymnasiums should have a ceiling height of 18 to 20 feet.

SPECTATOR PROVISIONS

Seats along sides, which begin at or near the floor level, are to be preferred over other means of seating.

VENTILATION

Mechanical ventilation should be provided.

ORIENTATION

Southern exposure is desirable.

LIGHTING

Locate window sills at least 6 feet from the floor. Bilateral lighting is preferred.

Equip windows with suitable shades.

Artificial lighting should correspond with the standards established by the American Engineering Standards Committee.

FLOORS, WALLS AND CEILING

Finish floor should be marked with painted or stained lines for games.

Floors should be of such material and so installed as to provide suitable resiliency, freedom from slipperiness and splintering.

Provide a wainscot to the height of at least 8 feet, of brick, glazed structural tile, wood, linoleum, cork tile or other suitable material.

The ceiling and areas above the wainscoting should receive acoustical treatment to keep the time of reverberation to a reasonable limit.

DEPENDENCIES

Necessary rooms for instructors of both sexes should be provided.

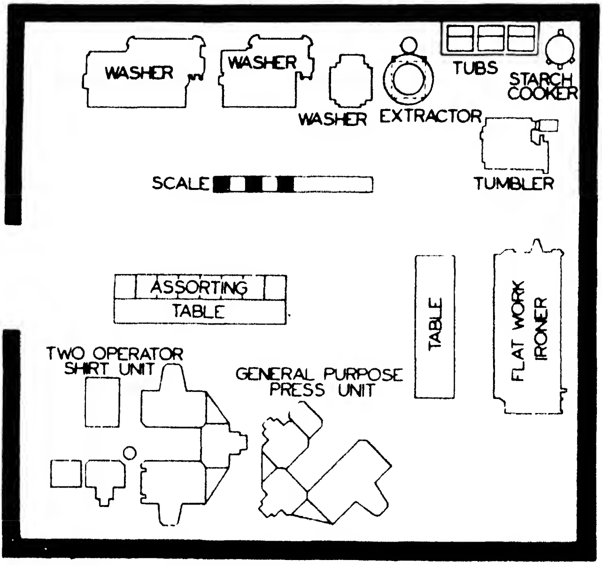
Storage and apparatus room of such required dimensions as to carry out the physical education program should be provided.

SANITARY PROVISIONS

Provide one or more drinking fountains of the recessed wall type.

Place sanitary water-flushed cuspidors near drinking fountains.

BOYS' PRIVATE SCHOOL LAUNDRY



Typical Laundry Room for Boys' Private School

Boards of Education have found laundry installations economical for the handling of bathing suits, bath towels, gymnasium uniforms and linens from the cafeteria. Having the laundry under the direct control of school authorities enables the school to operate with a smaller stock of linen supply.

The linen requirements of a school are subject to wide variation and no rule of thumb can be formulated. An experienced laundry engineer can determine the laundry requirements either by an estimate of the weekly laundry load or by his experience with other similar projects, or both.

The laundry must have a supply of high pressure steam—100-pound pressure is usual for ironing machinery. If the equipment is to be heated by electricity rather than by steam, the laundry may be located without respect to the power plant. Where it is available at low cost, electricity is practical in conjunction with a low pressure steam system to provide hot water.

An entrance to the laundry room at least 6'-6" wide and 7'-6" high is recommended. The ceiling must be 12'-0" above the level of the laundry room floor, 14'-0" if line shafting is to be used instead of individual motor equipment. The individual motor drive is recommended for all machinery.

Architects should provide the proper room for the laundry but should not attempt the placing or selection of equipment without the advice of a Machinery Company representative.

SCHOOL BUILDING LIBRARIES

LIBRARY ROOM FOR ELEMENTARY SCHOOLS.

The minimum desirable floor area is approximately the same as the size of a standard classroom.

The pupil capacity of a library room is computed on a basis of from 15 to 25 square feet of net usable floor area per pupil.

LIBRARY ROOM FOR HIGH SCHOOLS.

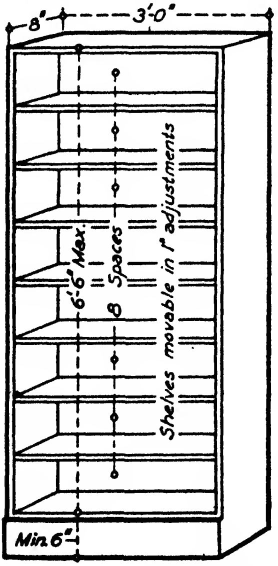
For high schools having an enrollment of less than 200 pupils, a separate classroom or an end of a study hall should be fitted with shelving, tables and chairs.

For an enrollment of from 200 to 500 high school pupils, there should be a separate library room equipped with shelving, tables and chairs. In addition thereto, there should be a charging desk, bulletin board, and other essential office equipment.

As the enrollment increases, work rooms should be provided. A work room is very desirable, and, whenever provided, lavatory facilities should constitute a part of the equipment. Whenever the enrollment and the use of a library justify it, separate small conference spaces should be added.

ACOUSTICS.

Careful attention should be paid to the acoustics of the library and a noiseless type of floor should be selected.



BOOK-CASES.

Book shelving in library rooms should be the open type, as shown in the illustration at the left.

Shelves should be movable with 1-inch adjustments.

Provide 1 shelf for each 10 inches in height.

Allow 8 books to the shelf foot in computing capacity.

A limited number of sections should be provided which are 10 inches and 12 inches deep in addition to the 8-inch deep sections.

EQUIPMENT

Reading tables should not have glossy surfaces.

Suitable chairs, librarian's desk, card catalog case, magazine rack, and closets should be provided as needed.

A bulletin board at least 4'-0" x 3'-0" should be provided.

LIGHTING.

Provision for natural lighting should be made on the same basis as for classrooms.

Artificial lighting should correspond with the standards established by the American Standards Assn.

Tables and desks should be so planned that pupils will not be obliged to face the windows,

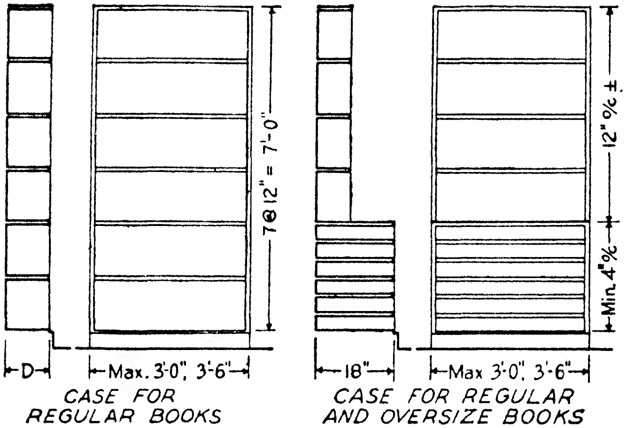
CLASSROOM LIBRARY FACILITIES.

In elementary school buildings in which a separate library room is provided, and in cases where the educational program requires it, book reference facilities should be made available in each classroom.

The minimum shelf space should be determined by the requirements. Such classroom shelving should be made readily accessible to pupils and should be of the closed, locking type.

A reading table should be placed in the elementary classroom.

BOOKSHELVES



SHELF DEPTH (D). Shelves deeper than necessary collect dirt and waste space. An analysis of a college library shows that the variation in book sizes requires shelving proportioned as follows:

85%— 8" shelves
10%—10" shelves
5%—12" shelves

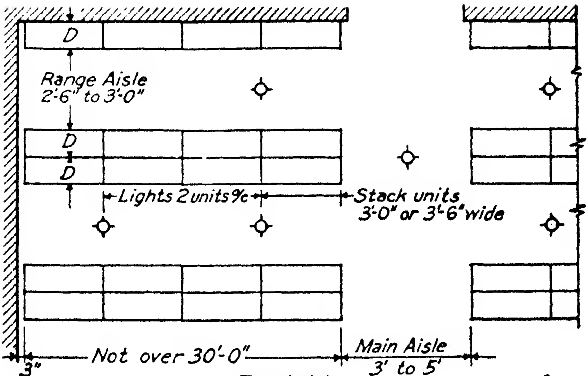
The following table gives recommended shelf depths for various types of books and data for estimating the capacity of shelving. In general libraries about one-third extra shelf space is usually allowed for expansion.

Kind of Books	Vols. per ft. of shelf	D
Fiction	10	8"
Economics	9	8
General Literature	8	8
History	8	8
Law	4½	8
Public Documents	6	8
Reference	8	10
Technical	7	10
Medical	6½	10
Bound Periodicals	5½	12

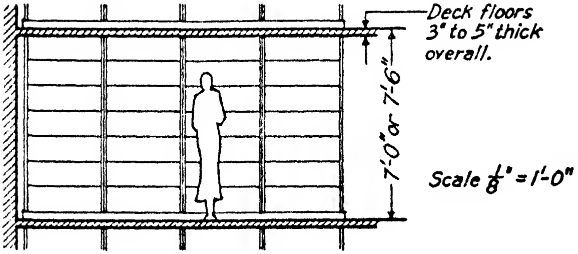
OVERSIZE BOOKS. Periodicals, atlases and other large books should preferably be shelved flat on account of their bulk and the consequent damage to their bindings in removing and replacing them on the shelves. Shelves 18" deep x 28" or more wide x 4" or more on center vertically are recommended. A collection of books on art or architecture will require a larger proportion of shelves for oversize books.

HEIGHT AND WIDTH OF UNITS. 7'-0" is a practical limit for height, and 3'-0" or 3'-6" for widths of units. All shelves should be adjustable, the number being based on a vertical spacing of 12" on center.

LIBRARY STACKS



PLAN



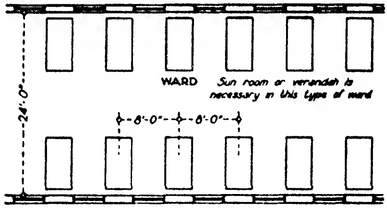
ELEVATION

Depths (D) for books = 8", 9", 10", 12". For newspapers 18" and 22". No definite rules can be laid down for the depth of shelves required, as this dimension depends upon the method of classification, space available, and the nature of the library. Where economy and compactness of storage are important, 85% of the shelves could be planned for 8" depth in a general library. Most books are 6" or less in depth, and extra shelf width collects dust as well as wasting space which would be valuable if added to the width of range aisles.

For small multi-deck stacks a hand-power book dumb-waiter 16" x 20" x 30" is adequate. It may be built into a stack unit near the center of the stack room. For larger stack rooms an automatic push-button-control electric elevator car 3'-4" x 4'-4" (clear shaft 4'-9" x 5'-3") will accommodate a book truck and attendant.

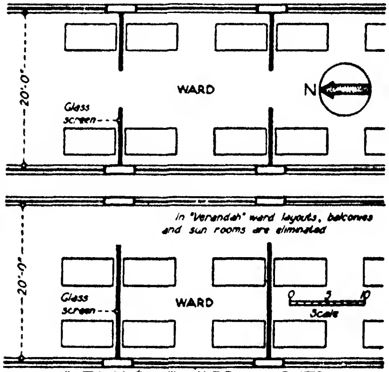
No columns are necessary as the stack units are designed to act as supports for the floors and stacks above.

BASIC WARD LAYOUTS



USUAL WARD LAYOUT

Patients so placed, receive a minimum of sunshine on their bodies and a scanty maximum on their feet. Only one bed receives partial insolation at A.M. or P.M.



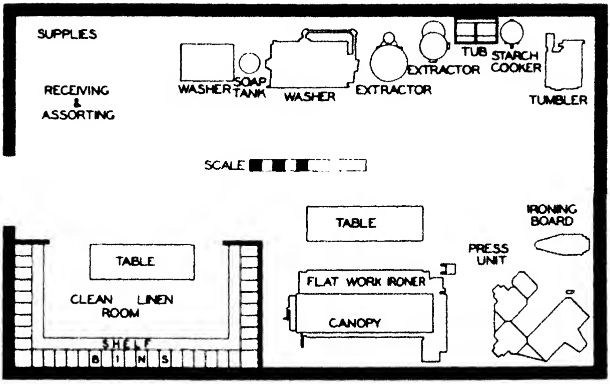
"VERANDAH" WARD LAYOUTS

Patients have a better outlook and receive complete insolation at A.M. or P.M. Supervision is not interfered with. Slightly higher cost of maintaining the necessary minimum temperature.

USUAL WARD LAYOUT. In this type the long axis of the ward runs north and south with narrow windows and a large amount of wall surface. The percentage of light in this wall is only about 30% so that a sunroom is a necessary addition.

VERANDAH WARD LAYOUT. Hospital wards with the beds placed parallel to the long axis of the ward were first developed in Copenhagen. The percentage of light in this wall is 66%. The long sliding windows may be swung back giving a complete open-air effect. The width of the ward is reduced and this decrease in span for floors and roofs will offset the 3% increase in the total cube necessitated by the extra length. The amount of sunshine will average fully 3 times as much in the verandah ward as in the older type. Balconies are eliminated which would shade the windows of lower floors. Supervision of the wards is no more difficult since the upper panels of the partitions are glazed. The patient has the advantage of being in a cubicle with only 3 other people instead of in an open ward exposed to the gaze of 19 other patients.

PLANNING THE 100-BED HOSPITAL LAUNDRY



Typical Laundry Plan for 100-Bed Hospital

For an average condition 12 square feet should be allowed for the laundry room for each patient bed in the hospital. 10 square feet of laundry area per patient bed is a practical minimum. 14 square feet of laundry per patient bed may be taken as a practical maximum. Hospitals in which there are a large percentage of surgical cases and insane hospitals have high laundry consumption. If insane patients are used as operators, machinery gives only 50% efficiency—requiring double equipment and double floor space.

The laundry should be out of sight and hearing of patients. To locate it on the ground floor or in the basement is usually desirable, altho a separate building may be advisable. The laundry must be located close to a source of high-pressure steam. 100-lb. steam pressure is usual for ironing machinery. If the equipment is to be heated electrically, the laundry may be located anywhere, irrespective of the power plant. It is practical for a hospital to purchase low cost electricity and to install a low-pressure steam system to provide hot water.

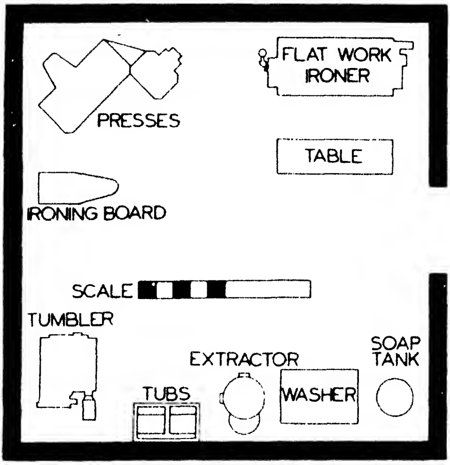
An entrance to the laundry room 6′-6″ wide by 7′6″ high is usually sufficient unless the largest machines are being used.

The ceiling must be 12′-0″ above the level of the laundry room—14′0″ if line shafting is to be used instead of individual motor equipment. The individual motor drive is recommended for all machinery.

Ventilating hoods should be provided over flat-work ironers. This reduces the humidity in the work room. Some architects require washing machines to have hoods or require them to be placed in separate rooms, but this is impractical.

Architects should provide adequate space for the laundry room but should not attempt the placing or selection of equipment without the advice of a Company representative.

PLANNING THE CLUB LAUNDRY



Typical Laundry Room for Small Country Club

In the modern social or athletic club where the highest standards of comfort and of service are attained, a laundry is essential. A laundry department in the city or country club has proved to be the most efficient and economical way of handling daily wash. Napkins, table cloths, bed linen and garments from the locker room are washed, ironed and returned to service promptly. With the laundry under the direct supervision of the club officials a smaller supply of linen is required.

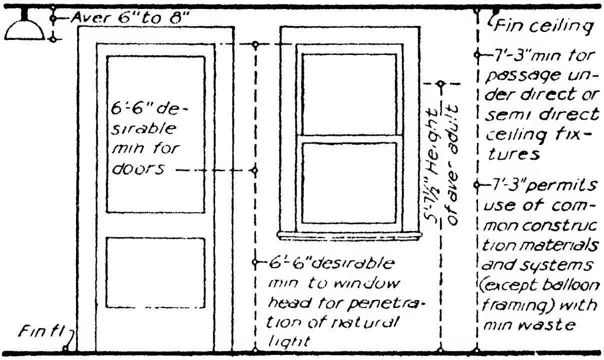
The residential city club requirements are analogous to those of the hotel problem. Linen requirements of a hotel can be handled in a laundry room whose area is equal to 10 square feet for each guest room. If the club has a swimming pool, gymnasium or other facilities requiring additional laundry, this area will have to be increased.

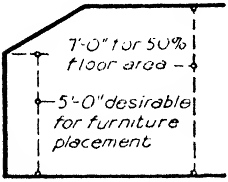
The linen requirements of a country club are subject to wide variation and no rule of thumb can be formulated. An experienced laundry engineer can determine the laundry requirements either by an estimate of the weekly laundry load or by his experience with other similar projects, or both.

The laundry must have a supply of high pressure steam—100-pound pressure is usual for ironing machinery. If the equipment is to be heated by electricity rather than by steam, the laundry may be located without respect to the power plant. Where it is available at low cost, electricity is practical in conjunction with a low pressure steam system to provide hot water.

Architects should provide the proper room for the laundry but should not attempt the placing or selection of equipment without the advice of a Machinery Company representative.

MINIMUM CEILING HEIGHTS FOR HOUSES AND HOUSING





CEILING HEIGHT FOR ATTIC ROOM

MINIMUM CEILING HEIGHTS—PUBLIC HOUSING ADMINISTRATION REQUIREMENTS

Dwelling unit ceiling heights shall not be less than 7'-10", except that for sloped ceilings of top floors of 2- or 3-story dwellings the average height shall not be less than 7'-6" and minimum head room at wall 6'-6". Basement rooms shall not be less than 7'-0" in the clear, and higher as may be required by their purpose be required by their purpose.

HEIGHTS REQUIRED BY CONSTRUCTION
to avoid waste of building materials

Wall Construction	Ceiling Height[1]
Masonry—	
Brick[2]	
40 courses	8'- 1 13/16"
39 courses	7'-11 1/16"
38 courses	7'- 8 5/16"
37 courses	7'- 5 9/16"
36 courses	7'- 2 13/16"
35 courses	7'- 0 1/16"
34 courses	6'- 9 5/16"
Concrete Block[3]	
14 courses	8'- 3 13/16"
13 courses	7'- 7 13/16"
12 courses	6'-11 13/16"
Frame—	
Western Platform	
8'-0" studs	8'- 3 23/32"
7'-0" studs	7'- 3 23/32"
Balloon	
18'-0" studs	8'- 1 7/16"
16'-0" studs	7'- 1 7/16"

1—Finish floor to finish ceiling, joists assumed 9⅝", flooring double, both finish and subflooring 25/32" thick, plaster on ceiling 1" thick.

2—Brick assumed 2¼" x 3¾" x 8" with ½" joints.

3—Concrete block assumed 7¾" high with ¼" joints.

MINIMUM WINDOW AREAS FOR HOUSES AND HOUSING

Suggested minimum window areas contained herein are based on natural illumination requirements as determined by data on average daylight illumination and brightness of the sky for different regions of the United States. The Committee on the Hygiene of Housing of the American Public Health Association recommends a minimum of 6 footcandles of natural light. This necessitates, at Washington, D.C. (lat. 39°) a ratio (glass to floor area) of 15 per cent, or 1:6.7, if walls and ceiling are light in color. However, since exacting eye work can usually be moved close to windows in residences, it seems reasonable to relax this standard. U. S. Public Health and Weather Bureau reports show that Plains states average 25 per cent higher, Western mountain states 46 per cent higher, than Northeastern states in daylight illumination. To facilitate adapting the table to local conditions, governing physical conditions for each region are listed.

MINIMUM RATIO—WINDOW AREA TO FLOOR AREA

	Region	I North-eastern States	II South-eastern States	III North-western States	IV South-western States
Physical Condition	Latitude	high	low	high	low
	Altitude	low	low	high	high
	Air Pollution	high	moderate	low	low
Desirable Ratio Window Area to Floor Area		1:7	1:8	1:8	1:10
Minimum Openable Area Per Window		1/3	1/2	1/3	1/2

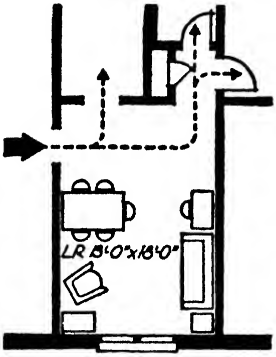
SPECIAL CASES

Location	Min. Ratio Glass to Floor Area
Bathroom and water closet compartments	1:8 (not less than 3 sq. ft.)
Kitchen	1:8 (not less than 9 sq. ft.)
Basement and Cellar	1:40
Stairways in multiple family buildings (more than 2 stories)	12 sq. ft. minimum per story height
Hallways in multiple family buildings	1:20

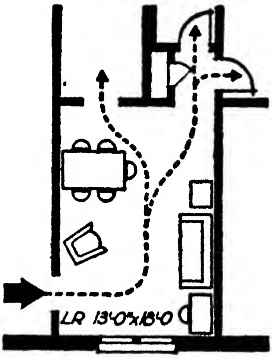
CURRENT PRACTICE

American Standards Association (tentative)	1:8
National Board of Fire Underwriters	1:10
Uniform Building Code (Pacific Coast)	1:8
U. S. H. A. — F. H. A. — P. B. A.	1:10
Michigan State Housing	1:8
New York, N. Y. — Washington, D. C. — Chicago, Ill	1:10
Boston, Mass. — Miami, Fla.	1:8

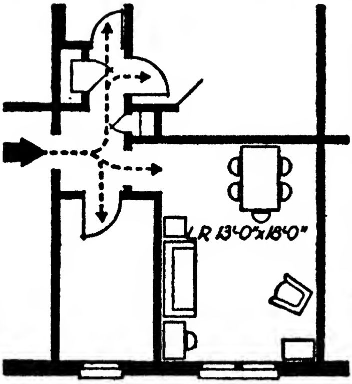
LIVING ROOMS IN MULTIPLE HOUSING



FAIR



POOR



GOOD

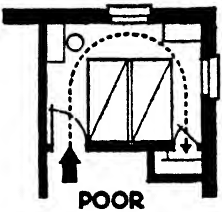
USE OF DATA. The comments on this *Data Sheet* apply specifically to multi - family housing. Nevertheless, many of the suggestions are equally applicable to detached dwellings. The material has been taken in part from the FHA booklet entitled "Architectural Presentation and Desirable Physical Characteristics of Projects Submitted to the Rental Housing Division under Sections 207 and 210 of the National Housing Act."

SIZE. Will vary with the size of the family, their economic status and the contemplated use of the room. It should be not less than 11'-0" in width. If standard length lumber is used with 4" end bearing for joists, the width will usually work out 11'4", 13'-4", 15'-4", etc., to avoid waste in cutting. The average living room size for detached bungalows has been found to be 12'-5" x 17'-4", equal to 216 square feet. In multiple housing, the rooms are usually smaller than in detached dwellings.

ASPECT. It is generally desirable for the living room to receive sun during the periods of the day when it is occupied. For this reason south or west exposures are good. The living room should be given a favorable location with respect to attractive views. Cross-ventilation should be provided, if possible.

CIRCULATION. Living rooms should be entered thru a small foyer in which outer garments can be removed. The foyer acts as a buffer against direct intrusion into the living space. In no case should the necessity of passing diagonally thru the living room to reach other rooms of the dwelling be tolerated.

BED ROOMS IN MULTIPLE HOUSING



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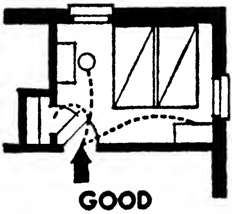
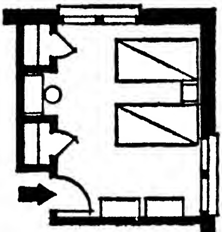


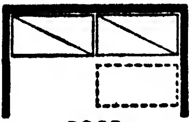
GOOD

TWO SMALL BEDROOMS (13'-0"x10'-0")-Illustrating the need of careful study of wall spaces.

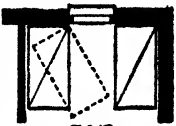


GENEROUS

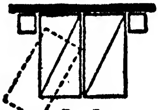
A LARGE BEDROOM (16'-0" x12'-0")-affording space for study, sewing, or play.



POOR



FAIR



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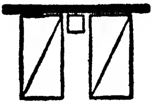


GOOD

Arrangements of TWIN BEDS rated for facility of housekeeping.

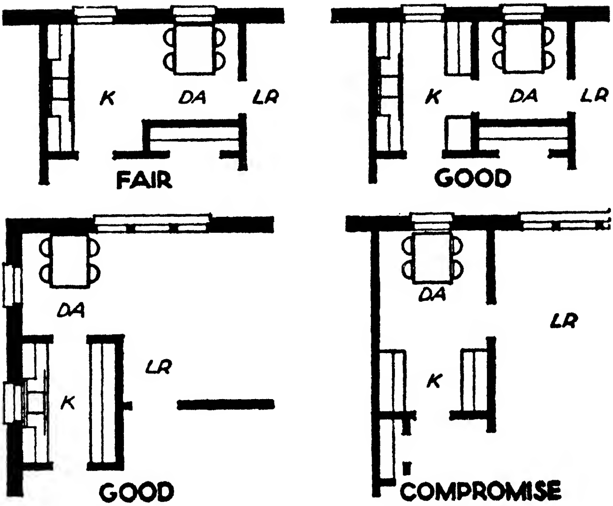
USE OF DATA. The comments on this *Data Sheet* apply specifically to multi-family housing. Nevertheless, many of the suggestions are equally applicable to detached dwellings. The material has been taken in part from the FHA booklet entitled "Architectural Presentation and Desirable Physical Characteristics of Projects Submitted to the Rental Housing Division under Sections 207 and 210 of the National Housing Act."

BEDROOMS IN LOW-INCOME HOUSING. It is desirable to have at least 1 bedroom that will accommodate twin beds. Where space-saving is essential to very low rentals, observance of this recommendation may not be imperative. Persons who must economize in the rent they pay, have the parallel problem of reduced household expense. A double bed costs less than a pair of twin beds and the recurrent cost of laundry is less.

SIZE AND SHAPE OF ROOM. Careful study of wall spaces for required furniture will largely determine the room size. It has been found that detached bungalows have an average bedroom size of 10'-5" to 10'-8" wide by 11'-8" to 12'-7" long.

PLANNING REQUIREMENTS. Privacy, ventilation, adequate storage space, quiet, and some sunlight during each day are desirable. Bedrooms must frequently serve as places for study, sewing or play, especially in small dwelling units, hence there should be adequate space for these activities. Facility of cleaning and bed-making is of special importance. Added time and labor are required to move beds or to make them up from 1 side only.

KITCHENS IN MULTIPLE HOUSING



USE OF DATA. The comments on this *Data Sheet* apply specifically to multi-family housing. Nevertheless, many of the suggestions are equally applicable to detached dwellings. The material has been taken in part from the FHA booklet entitled "Architectural Presentation and Desirable Physical Characteristics of Projects Submitted to the Rental Housing Division under Sections 207 and 210 of the National Housing Act." Where FHA recommendations have seemed incompatible with good architectural planning, changes have been deliberately made.

KITCHENS IN LOW-INCOME HOUSING. In housing for the lower-income groups, kitchen equipment must be adequate but not over-liberal. Limited cupboard and storage space would be allowable. If the cost of gas or electricity is prohibitive, mechanical refrigeration would be useless.

SIZE AND SHAPE OF ROOM. In general, the oblong room, wide enuf to accommodate fixtures on both long sides, is more efficient than a square room. The minimum is 6'-6" for kitchens with fixtures on both walls; 5'-6" for fixtures on one side only. The minimum should be amplified if possible. In detached bungalows, the average kitchen was found to be 8'-3" x 11'-3", equal to 92½ sq. ft. In the large urban centers there are a great many childless families in which both husband and wife have gainful occupations and usually "eat out." For such people, the small kitchen may be entirely appropriate.

STRIP KITCHENETTE. The kitchen installed in a niche or closet off the living room is to be condemned without exception. It is inadequate in equipment. It fills the room with cooking odors. If the living room is used for sleeping, the strip kitchenette can and has caused asphyxiation by the escape of cooking gas or refrigerants. Wall space is sacrificed.

LIGHT AND VENTILATION. The kitchen should face east or northeast, if possible. An east aspect is particularly desirable if a dining alcove is incorporated. Ample light and good ventilation to remove hot air and odors are important. An exhaust fan is highly desirable.

DINING SPACE. Dining alcove should be located so it does not interfere with food preparation.

AVERAGE ROOM SIZES

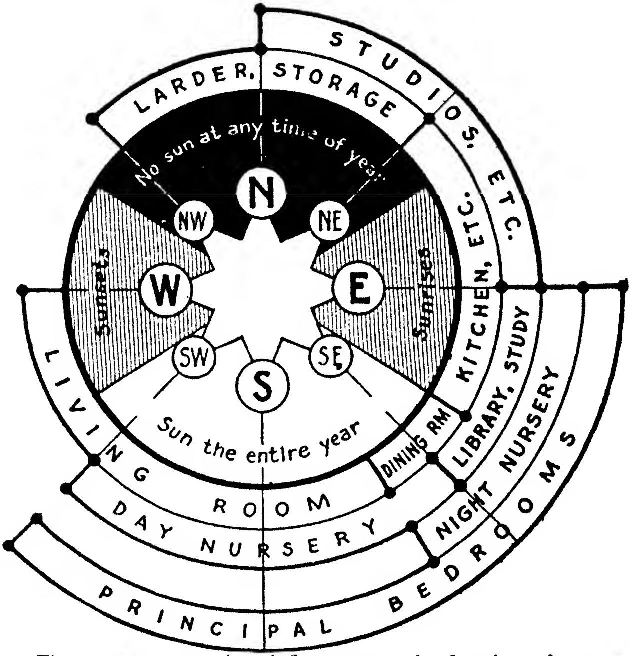
Rooms	Bungalows	2-Story Detached	Row Houses
KITCHEN	8'-3" x 11'-3", 92½#	9'-1" x 11'-8", 107#	8'-0" x 12'-0", 96#
DINING ROOM	12'-4" x 10'-7", 131#	13'-10" x 12'-0", 166#	14'-1" x 11'-1", 156#
LIVING ROOM	17'-4" x 12'-5", 216#	21'-4" x 13'-2", 281#	16'-0" x 13'-6", 216#
BED ROOM #1	12'-7" x 10'-8", 134#	16'-5" x 12'-8", 208#	14'-0" x 11'-11", 166#
BED ROOM #2	11'-8" x 10'-5", 122#	13'-5" x 11'-5", 153#	12'-11" x 9'-10", 127#
BED ROOM #3		12'-7" x 10'-0", 126#	11'-6" x 8'-5", 97#

SOURCE OF INFORMATION. Houses were inspected in 31 cities during a survey conducted by staff members of the Division of Building and Housing of the U. S. Department of Commerce. The price range of the houses inspected was from $1950 to $9850.

ROOM SIZE VARIATIONS. *Kitchens* were found more nearly alike in size than any other room. Most of them contained about 100 square feet with the width about three-quarters of the length, so that 8'-10" x 11'-8" would be typical. The variation in *Living Rooms* was from 11'-0" to 15'-0" in width, and 15'-0" to 22'-0" in length. The width was commonly about two-thirds of the length. The width of *Dining Rooms* tended to be about three-quarters of the length with an area about half again as large as the kitchen. *Bedrooms* ran noticeably larger in 2-story houses than in 1-story houses. The owner's bedroom in many 2-story houses was over the living room and about the same size.

CEILING HEIGHTS. Ceiling heights were usually greater in the South than in the North, presumably because they are more comfortable in warmer climates and also on account of custom. In houses above the lowest price range there was an increasing tendency to obtain a higher living room ceiling by dropping its floor 1 or 2 steps lower than the rest of the first floor.

ASPECT OF ROOMS



There are many other influences on the location of rooms besides their aspect with regard to the sun. Prevailing winds in both winter and summer, the range of temperature, natural obstructions influencing light and air, the number of sunny days per year, desirable vistas and personal preferences all have a bearing on the direction in which rooms face.

LIVING ROOM. The living room should generally receive sun during the periods of the day when it is occupied. For this reason the south or west (or both) exposures are desirable.

DINING ROOM. It is thought that the morning sun has a cheerful influence on the day's activities, so dining rooms should have an easterly exposure where possible.

KITCHEN. The housewife usually spends an appreciable part of her morning in the kitchen so that an easterly exposure is desirable. In the opinion of some experts, a northern exposure for the kitchen is desirable because of the diffused quality of the light to work by as well as the coolness.

BEDROOM. The location of the bedroom is largely a matter of personal preference, some people objecting to being awakened by the morning sun and its resulting heat in the summertime. A room exposed to the west receives the heat of the afternoon and is often unpleasantly warm at bedtime. A bedroom exposed to the north, if adequately heated, is preferred by many.

KITCHEN PLANNING

POSITION OF KITCHEN IN THE HOUSE PLAN

Easy access to front door, rear door and deliveries, telephone, toilet, stairs to second floor, stairs to basement.

Not a part of circulation. Should not have to pass thru kitchen to go from house to garage, basement to outdoors, house to broom closet.

As few doors in kitchen walls as possible, two is minimum and ideal. Sunny exposure not desirable, north light is ideal. View over children's play area sometimes advisable.

SIZE AND SHAPE OF KITCHEN

Preferably oblong, good average width is 8'-0" to 9'-0".

Small as possible. "90 to 108 sq. ft."—U. S. Govt. Bul. 1513.

ROUTING

"Should proceed from right to left"—Jury of a national competition.

"Should proceed from left to right"—U. S. Govt. Bul. 1513.

ELECTRIC WORK

Outlets for refrigerator, toaster, percolator, dishwasher, grill.

General illumination from center ceiling outlet. Local illumination at sink, range, work table, serving plane, 12" from wall near ceiling.

VENTILATION

Cross draft important. Windows close to ceiling. 4'-0" to stool.

LAUNDRY

Kitchen plan efficiency impaired by inclusion of laundry. Built-in ironing board useful for occasional emergency use.

BROOM CLOSET

Under no circumstances should this dirt-removing equipment be in Kitchen.

STORAGE PANTRY

Materials and equipment should be stored where they are used, not in a separate room or closet. The doorway to the storage pantry often takes as much kitchen wall space as the required storage facilities would have taken.

SERVING PANTRY

Has no place in the small servantless home.

BREAKFAST NOOK

Should be located so not to increase the distance from the Kitchen to the Dining Room.

THE RANGE

Locate to obviate cross-draft. Working plane 34" to 36".

THE SINK

Not under a window. Wall space over sink very valuable for storing equipment needed there. Work without facing bright light. Sink can be near Dining Room door for easy clearing away of dishes which is often impossible with sink under a window. Rim from 34" to 39" above floor.

THE WORK TABLE

Toe space 5" high and 3" to 4" deep, cove molding at the floor. Working plane 34" to 36" above floor.

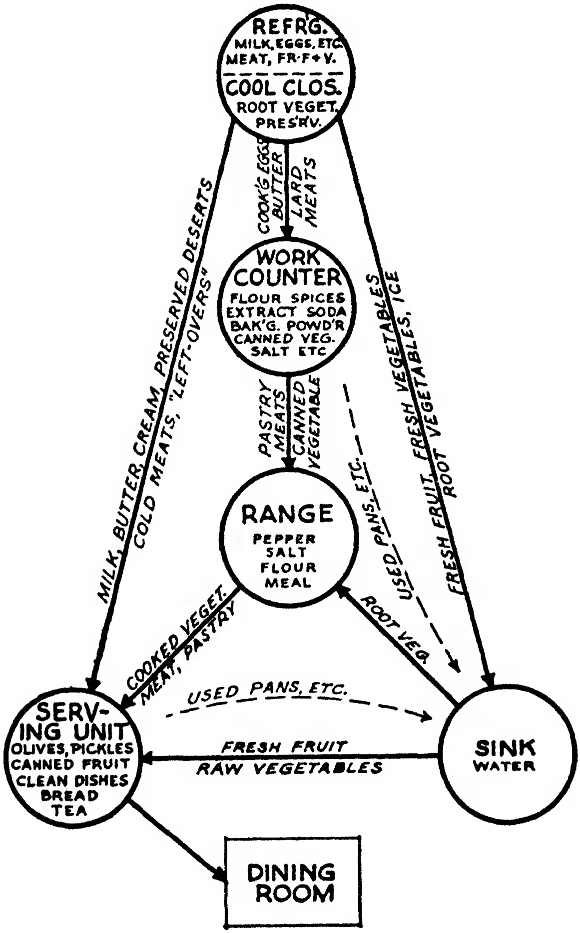
Cabinet doors removable, for easy cleaning at the sink. Sliding, so worker doesn't have to step away to open them and to obviate cracking skulls in arising under swing door left open. Glass panel, so articles are visible without searching. No muntins, for easy cleaning, and better vision.

No live storage space over 7'-0" from floor.

GREAT CONVENIENCES

Linen chute hopper, incinerator hopper, desk for keeping kitchen records, exhaust fan for ventilation, adequate linen storage for table linen, dish towels, etc.

KITCHEN ROUTING



This diagram indicates the relation of the various units of kitchen equipment as used in the preparation of most frequently served foods. In each circle is given a few of the typical food materials stored at that location.

Clearing away process is: soiled dishes from dining room to sink, to dish storage; cream, butter, etc., from dining room to refrigerator.

KITCHEN CABINET REQUIREMENTS

SOURCE OF INFORMATION. Several years ago a small group of men measured over 5,000 existing kitchens and pantries and ascertained whether or not sufficient storage space had been provided. From this mass of data it was possible to formulate simple rules for the amount of storage space necessary in a home or apartment.

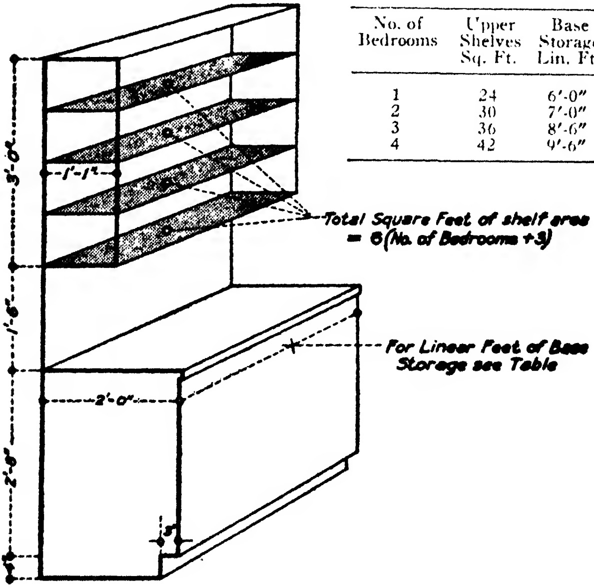
NORMAL OCCUPANCY. The amount of kitchen storage space required is a function of the normal occupancy of the dwelling. Normal occupancy is determined by allowing 2 persons for the first or master bedroom, 1 person for each additional bedroom and 2 persons are added for accumulation and entertaining. In other words, the normal occupancy is taken as the number of bedrooms plus 3.

RESIDENCE STORAGE SPACE. Six square feet of shelf area should be allowed per person. Since the base storage cabinet may contain both drawers and shelves, this is measured in linear feet as shown in the diagram. The storage space over refrigerators and broom closets is disregarded in making calculations, as it is not particularly accessible and acts as a factor of safety.

APARTMENT STORAGE SPACE. Allow 10 to 14 square feet of upper shelves, and 3 to 4 linear feet of base storage for one-room studio apartments having alcove kitchens. Allow 14 to 20 square feet of upper shelves and 4 to 6 linear feet of base storage for apartments with 1 bedroom. Use the residence table for apartments of 2 or more bedrooms. It shows minimum requirements.

MINIMUM FOR RESIDENCE

No. of Bedrooms	Upper Shelves Sq. Ft.	Base Storage Lin. Ft.
1	24	6'-0"
2	30	7'-0"
3	36	8'-6"
4	42	9'-6"

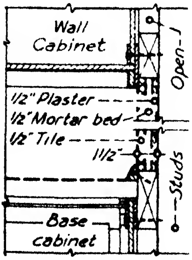


KITCHEN CABINET, USUAL DIMENSIONS

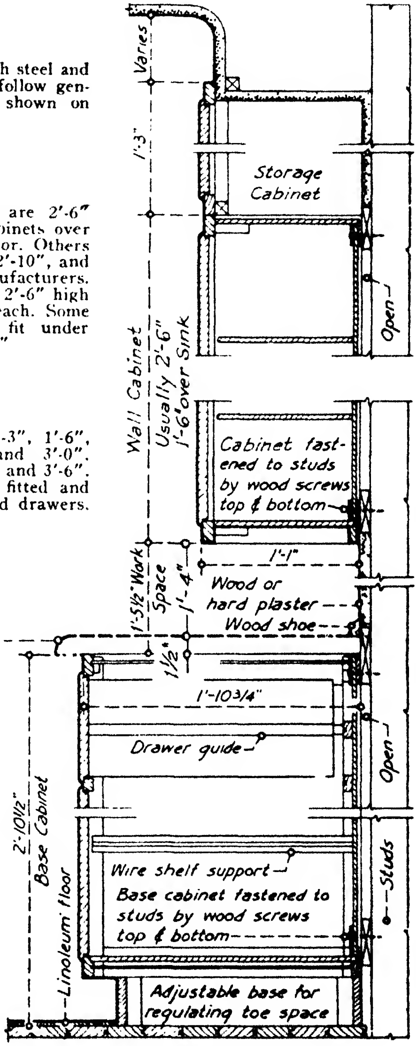
Manufacturers of both steel and wood kitchen cabinets follow generally the dimensions shown on this drawing.

Usual wall cabinets are 2'-6" high, and 1'-6" for cabinets over the sink and refrigerator. Others are made 2'-0", 2'-9", 2'-10", and 3'-0" high by a few manufacturers. Top shelf on units over 2'-6" high are less accessible to reach. Some refrigerators will not fit under cabinets more than 1'-6"

Usual widths are 1'-3", 1'-6", 1'-9", 2'-0", 2'-6" and 3'-0". Others are 2'-3", 2'-9", and 3'-6". Sections are variously fitted and provided with doors and drawers.

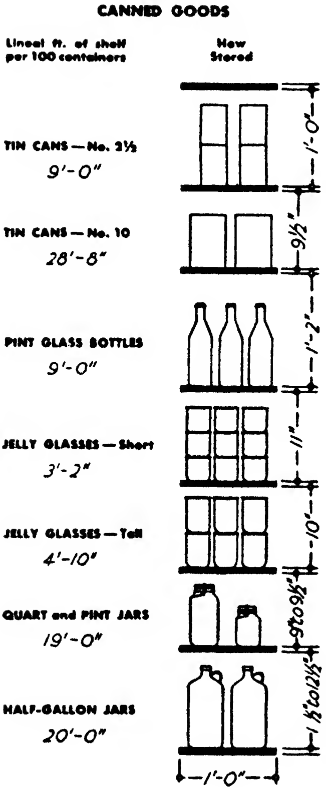


ALTERNATE FOR COUNTER BACK

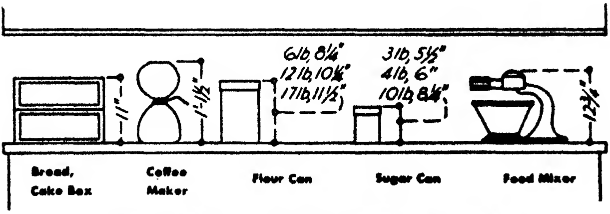


SECTION THRU WALL UNITS
Scale - 3/4" = 1'-0"

KITCHEN STORAGE REQUIREMENTS



The amount of canned goods stored differs so with family habits that it is impossible to determine the amount of storage space needed. For rural families extra storage space must be provided outside the kitchen. On the basis of studies of shelf space needed for different sized containers and an Indiana study of the average amounts of canned goods stored by rural families, 63 feet of shelving 12" wide, with shelves 9" apart, is needed for home canned foods, and 14 feet, with shelves 12" to 18" apart, for food in tin cans. With a ceiling 7'-3" high this requires a wall space 9 to 10 feet wide; a closet 4' x 4' with shelves on 3 sides is adequate.



AVERAGE HEIGHTS OF ARTICLES STORED ON COUNTERS

CHECK LIST OF CULINARY EQUIPMENT

SINK EQUIPMENT

1 waste basket
1 towel rack
1 dishpan, about 12-qt. capacity
1 vegetable brush
1 garbage can
1 dish dryer (if no electric dishwasher)
6 dishcloths (if no dishwasher)
12 dish towels and glass towels
6 pot holders
1 case paper towels (for hands)

GLASSWARE AND CHINA

8 service plates
8 dinner plates
8 dessert or salad plates
8 cereal dishes
8 breakfast or luncheon plates
8 soup plates
8 bouillon cups
8 cups and saucers
8 egg cups
8 sherbet glasses
2 vegetable dishes
1 sauce or gravy bowl
16 glasses (water and iced tea)
Relish, candy and nut dishes
1 teapot and stand
1 cream pitcher
1 water pitcher
1 sugar bowl
Salts and peppers
1 large platter
1 medium platter
Other glasses for wines, cocktails and beer may be added according to needs.

FOR KITCHEN CABINET OR WORK TABLE

1 coffee-making device (percolator, filter, etc.)
1 set storage jars (spices, cereals, teas, coffee, etc.)
5 mixing bowls, nested, ½-pt. to 2-quart capacity
2 standard measuring cups (1 glass, 1 aluminum)
6 custard cups
1 grater
1 dough blender
1 fruit juice extractor
1 set cookie cutters
1 set muffin pans (6 or 8 in set)
2 or 3 casseroles or baking dishes, 1 quart, 2 quarts
1 egg beater
1 set kitchen cutlery
2 teaspoons for tasting
2 wooden spoons (10-inch and 14-inch)
1 corkscrew and bottle opener
1 chopping bowl and knife
1 cake turner (if no broad spatula in cutlery set)
1 breadboard
1 utility tray
1 colander
1 rolling pin
1 potato ricer
1 flour sifter
1 bread box
1 cake box
(last three items only if they are not part of the cabinet)
2 wire strainers (3-inch and 6-inch)
2 sets measuring spoons

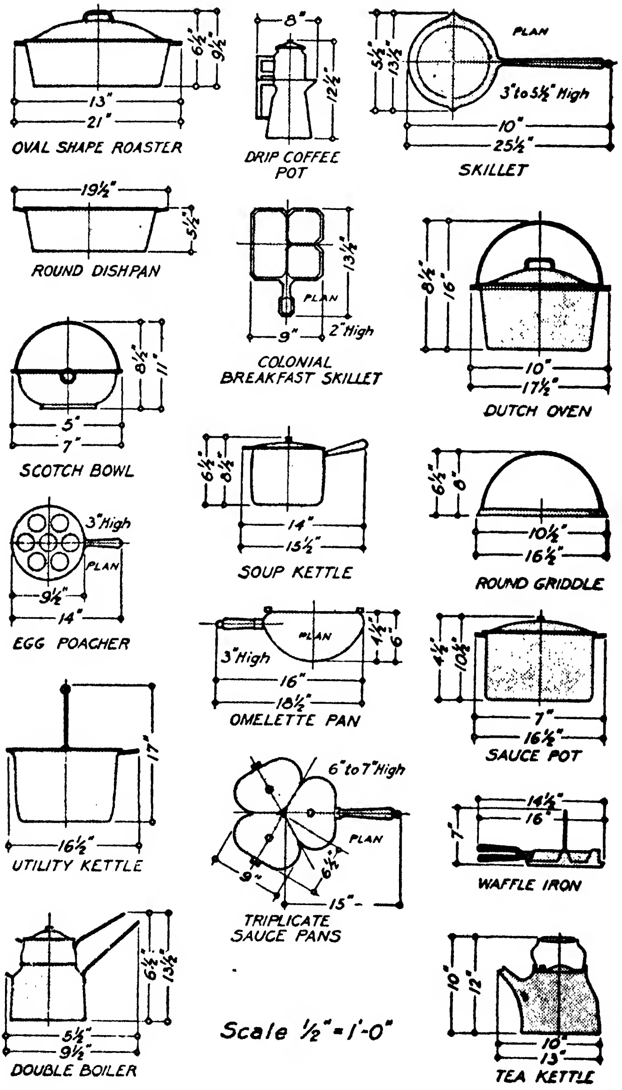
FOR STORAGE CABINET

1 Dutch oven
1 square cake pan, 10 x 10 inches
1 oblong loaf-cake pan, 10 x 5 inches
2 layer cake pans, 9-inch
1 griddle, 10-inch
1 cookie sheet, 12 x 12 inches
2 pie plates, 10 inches
1 roasting pan, 15 x 10 inches
1 saucepan, straight or convex (covered), 6 to 10 quarts
2 wire cake coolers
1 food chopper
1 steamer or waterless cooker
1 roll waxed paper
2 or 3 saucepans (covered) 2 to 4 quarts
1 funnel
1 beater (whip)
1 toaster
1 set refrigerator dishes (including 1 large covered vegetable container)

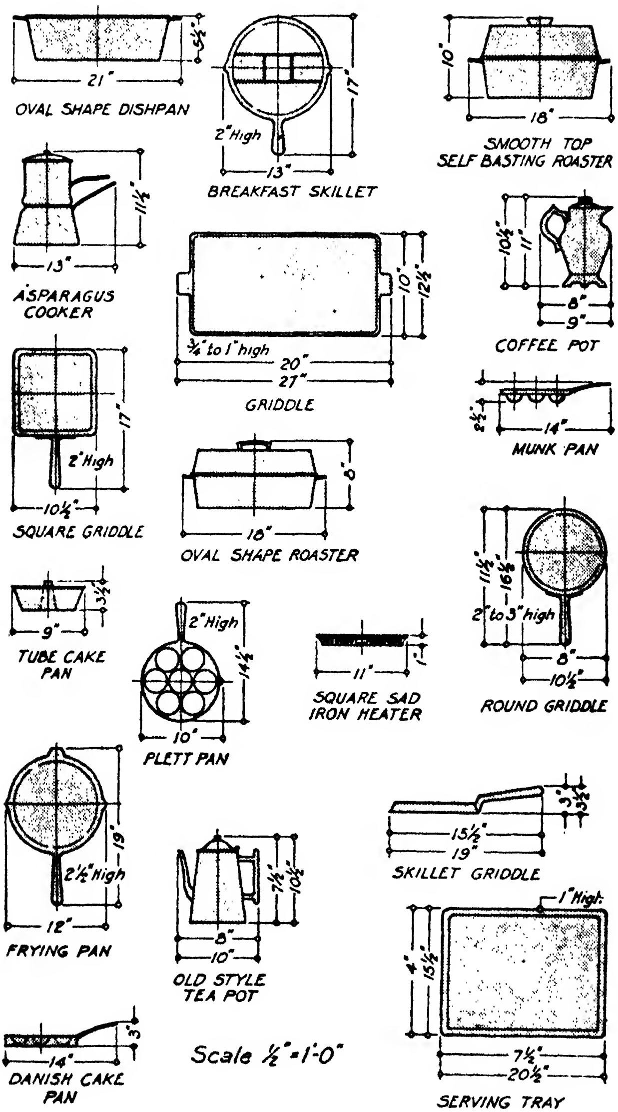
TO KEEP NEAR RANGE

1 salt and pepper and flour shaker
1 potato masher
2 frying pans, 4 inches and 8 or 10 inches
1 double boiler, 1½ quarts
1 basting spoon
3 lipped saucepans, 1 pint, 1½ pints, 1 quart
1 tea kettle

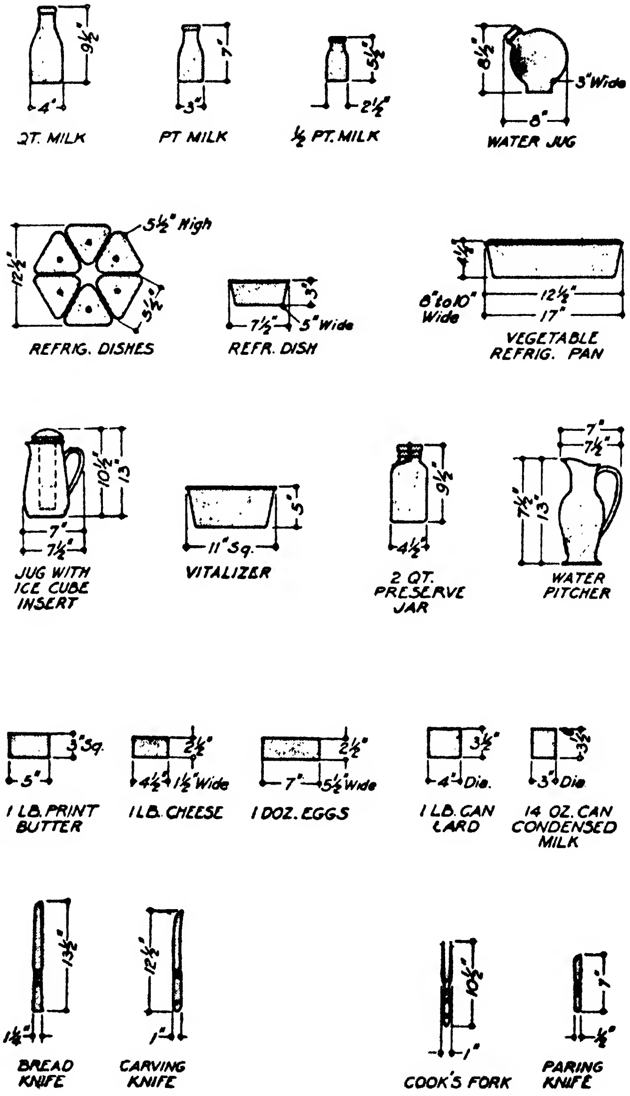
SIZES OF KITCHENWARE



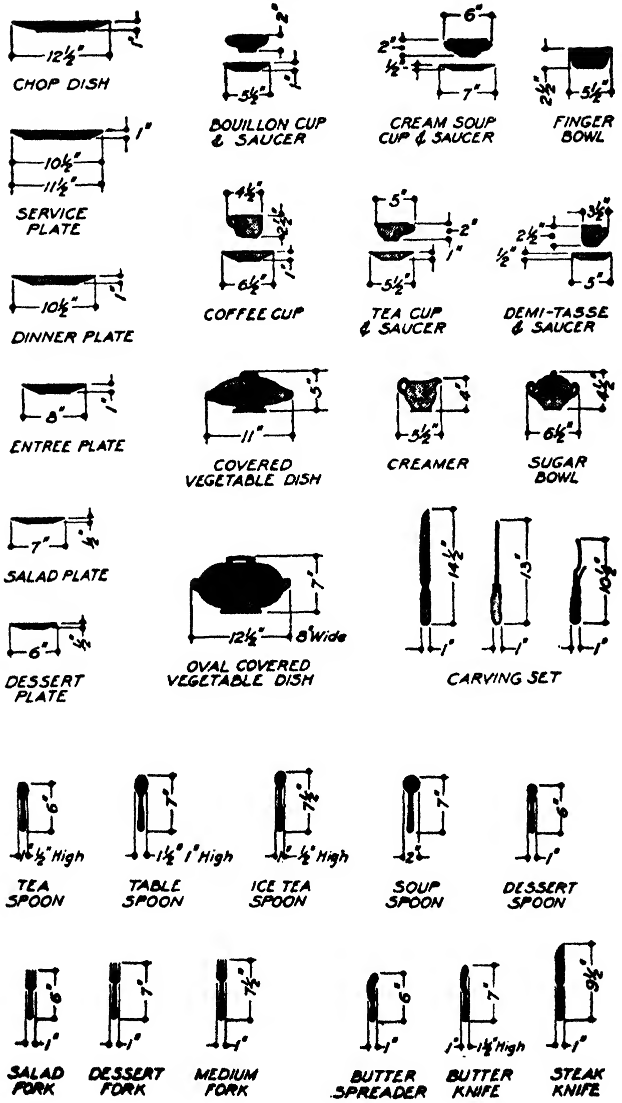
SIZES OF KITCHENWARE



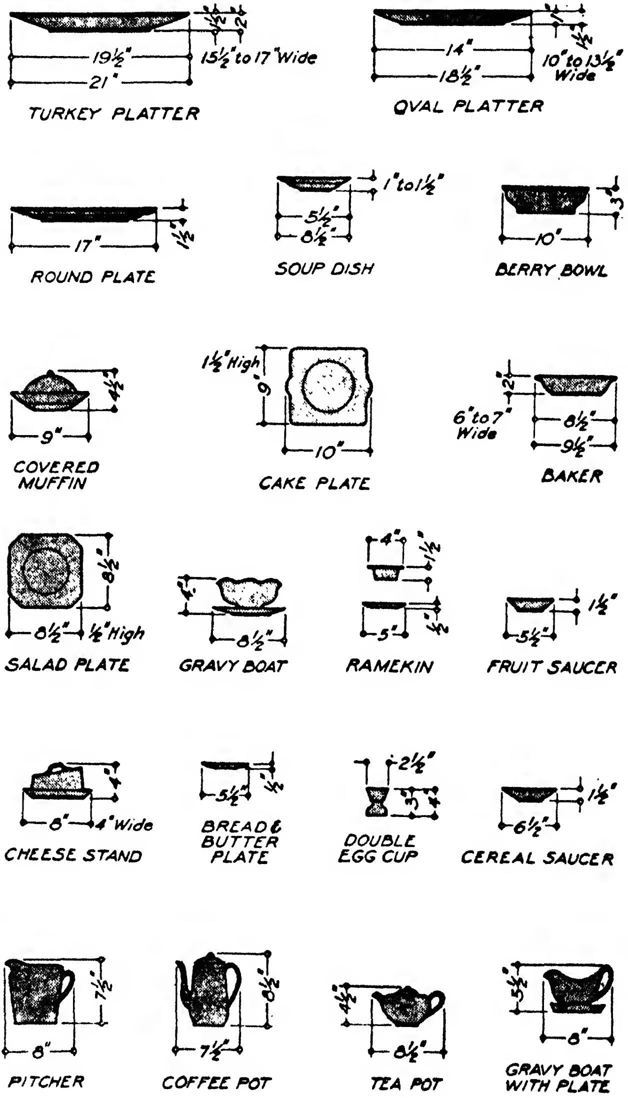
SIZES OF KITCHENWARE



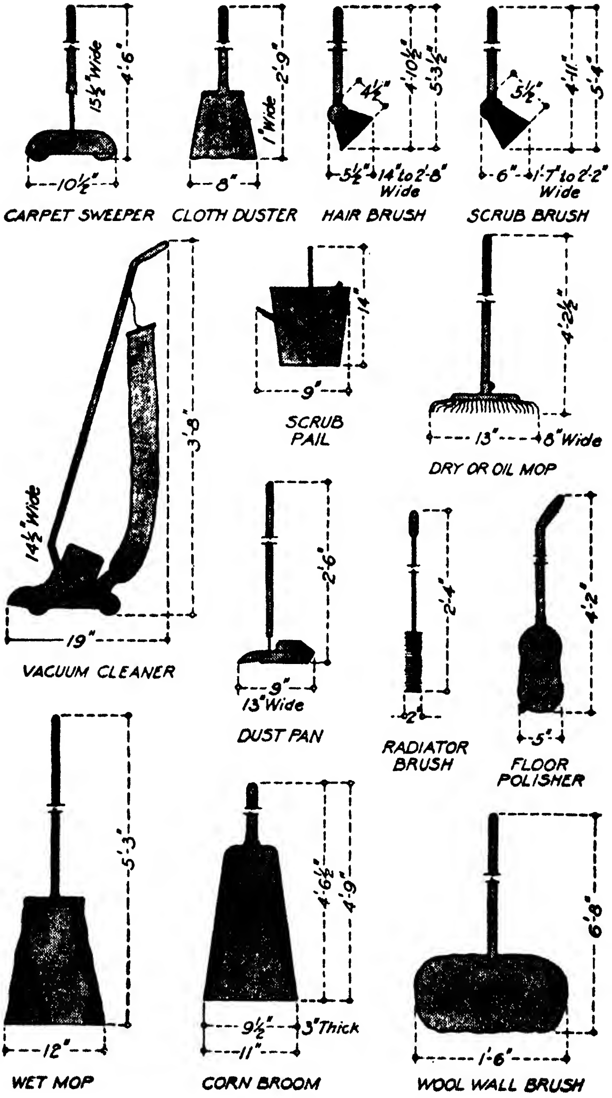
SIZES OF TABLEWARE



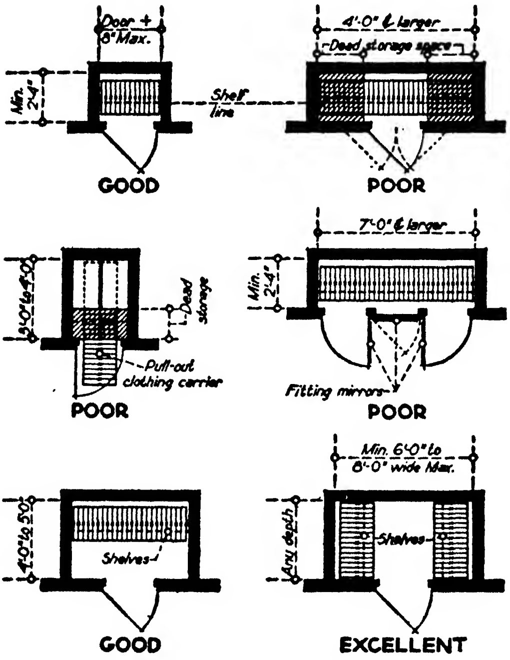
SIZES OF TABLEWARE



HOUSE CLEANING EQUIPMENT



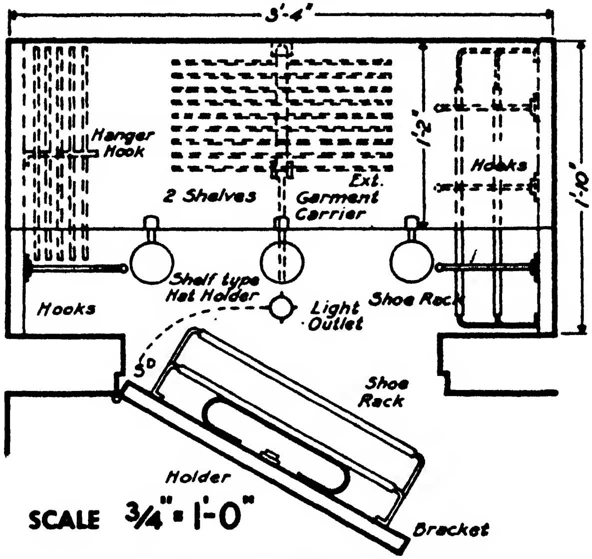
BASIC REQUIREMENTS FOR CLOSETS



FUNCTION OF CLOSET. Bedroom closets should be classed as "live storage." More erroneous and misleading information has been printed on closets than on any other space in the house. The following requirements are basic in the arrangement of desirable closet space:

1. Hanging space that does not permit the easy removal and examination of garments is useless.
2. Excess wall space devoted to doors, so that garments are visible and accessible, is undesirable.
3. Mothproof bags for the protection of infrequently used garments are 2'-1½" wide, making the usual closet recommendation of 22" entirely inadequate. No closet should be less than 2'-4" in the clear, if garments are not to rub and brush against the closet walls. A man's overcoat will measure 24" as a minimum in width.
4. 1¼" gas pipe is infinitely preferable to wooden poles, for easy manipulation of the hangers.
5. 5 linear feet of hanging space is a minimum for each person. Systems based on floor area or cubage for closets are not true indexes of the available hanging space and should not be employed in determining closet sizes.
6. The hanging pole for adults' use should be 5'-8" above the floor to accommodate long coats and long evening dresses—hanging poles are invariably located too low.

WIDE, SHALLOW CLOSET, AND CLOSET DESIGN DATA



SCALE 3/4" = 1'-0"

CAPACITY OF HANGER BAR. Heavy garments for adults require 2'-0" in width so that they will not brush against the wall — meaning that the hanger bar should be 12" from the wall. Capacity of the bar will depend upon the type of garments hung. The following table gives the length of bar required for various types of garments on hangers:

Men's suits	2"
Overcoats	5"
Women's dresses	1½"
Skirts	2"
Women's coats	5"
Fur-collared coats	6"

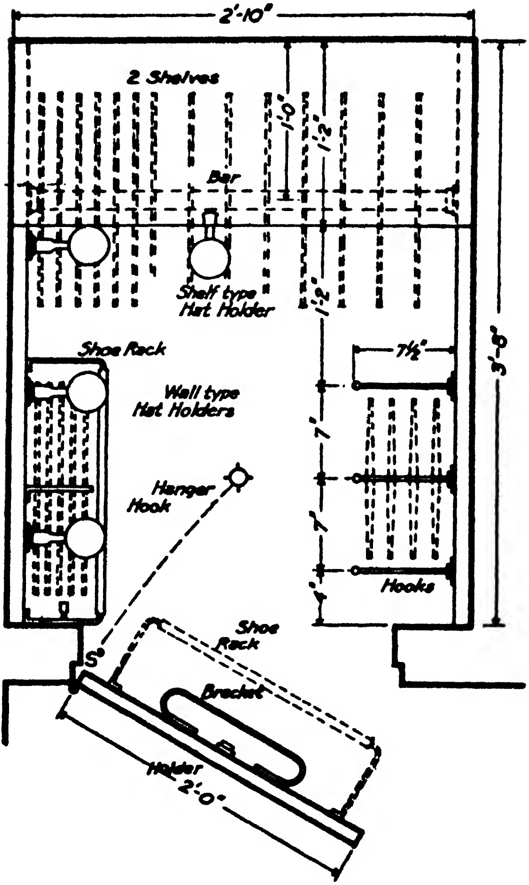
SHOE RACK. The adjustable shoe rack may be extended from 1'-8" to 2'-4". At its 1'-8" position, it is suitable for a 24" closet door and will hold 2 pairs of men's shoes or 3 pairs of women's shoes. Width required for storing shoes is as follows:

Per pair of men's shoes	8"
Per pair of women's shoes	6"

HANGING BAR HEIGHT. An extra cleat may be placed at a lower level for the installation of hooks and hanging rod—to be convenient for children. The following table gives the height of the hanging pole for children of various ages:

From 3 to 6 years	3'-0"
From 6 to 9 years	4'-0"
From 9 to 12 years	4'-6"
From 12 to 14 years	5'-0"
From 14 years up	5'-6"

MINIMUM PLAN FOR DEEP, NARROW CLOSETS

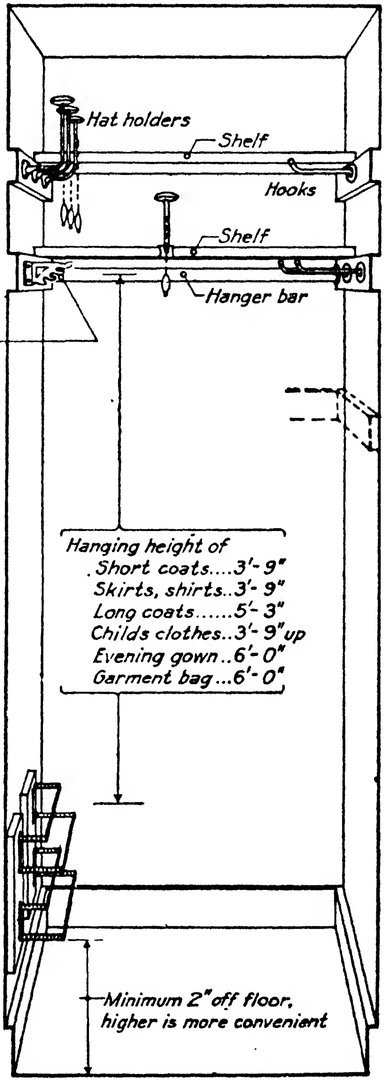


The plan shown above for a deep but narrow closet provides at least 3 times the accommodation in the limited space that can normally be obtained with the usual haphazard supply of coat hooks ordinarily provided. Yet easy access is provided to all parts of the closet.

The top shelf can be used for the storage of seasonal or seldom used articles. The lower shelf is used for hats and boxes, etc.

One or more shelf type hat holders can be used on the edge of the lower shelf without preventing easy access to the material behind.

INTERIOR VIEW
DEEP, NARROW CLOSETS



Continue shelf cleats for hardware support

Wall type hat holders keep hats out of the way, yet readily accessible

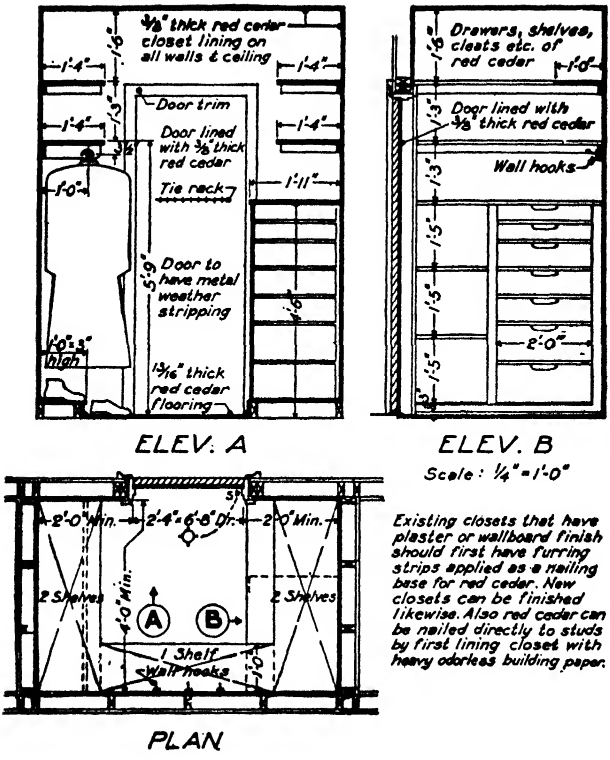
Hanger hook will accommodate 5 garments on hangers

An extra cleat at a lower level can be used for hardware convenient for a child.

Adjustable shoe racks keep shoes in order off the floor. Racks may be installed on door if hanging garments interfere.

INTERIOR VIEW

CEDAR CLOSETS

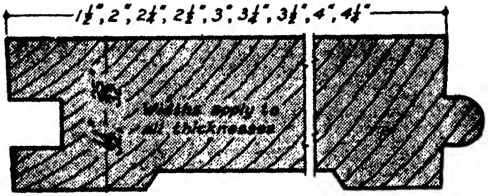


The value of cedar in protecting clothing lies in the fact that it kills the newly hatched or young larvae of clothes moths. Well-made chests (or closets) of red cedar, *juniperus virginiana,* heartwood, can be depended upon for protection against clothes moths — provided the articles to be placed in them are first thoroly brushed, combed or otherwise treated to remove the older clothes moth larvae.

The aroma, or the persistent characteristic of red cedar heartwood, is due to a volatile oil present in the wood. As it is the aroma from this volatile oil that protects the clothing, the closets should remain tightly closed at all times, except when clothing is being removed or placed in them.

A lined closet will give off its aroma indefinitely. Red cedar when exposed to the air for long periods of time tends to seal itself on the surface. The closet can be kept efficient by scraping the surface lightly, at long intervals.

CEDAR CLOSET LINING STANDARDS



COMMERCIAL STANDARD. The commercial standard for aromatic red cedar closet lining was adopted at a conference to which all producer and consumer interests were invited. The industry has since accepted and approved for promulgation by the Department of Commerce the specifications as follows:

SCOPE. This commercial standard is a minimum specification for clothes closet lining made only from genuine aromatic red cedar (*Juniperus virginiana*). It covers width, thickness, minimum length, matching, heartwood requirements, and permissible defects.

GENERAL REQUIREMENTS. All commercial standard aromatic red cedar closet lining shall be straight, well milled, and of such a nature as to make a sound finished job without cutting to eliminate defects.

DIMENSIONS. Standard nominal thicknesses shall be 3/8" (actual thickness 11/32") and 13/16" (actual thickness 25/32"). Standard lengths shall be 8" and longer and of fair average to make an economical and satisfactory finished job. Standard face widths shall be as shown in the drawing above. It is optional with each manufacturer as to the number of face widths he desires to make.

MATCHING. Each piece shall be side and end matched. Hollow backing shall be optional with each manufacturer.

HEARTWOOD REQUIREMENTS. The face side of each piece shall grade not less than 75 per cent red heartwood, surface measurement. Sapwood extending entirely across the face of any piece shall not be permitted.

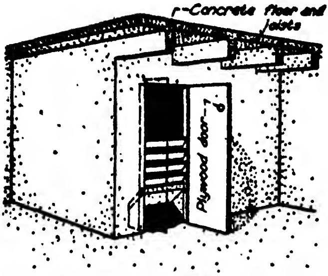
PERMISSIBLE DEFECTS. Slight imperfections in dressing, such as machine burns, "pick-up" of grain around knots, etc. Small breaks on the edges that will be closed by the tongue and groove. Sound knots. White streaks in the heartwood and slight shakes shown therein.

GUARANTEE. The following or a similar guarantee shall be used in connection with sales of commercial standard aromatic red cedar closet lining. The label may be used on either or both package and invoice.

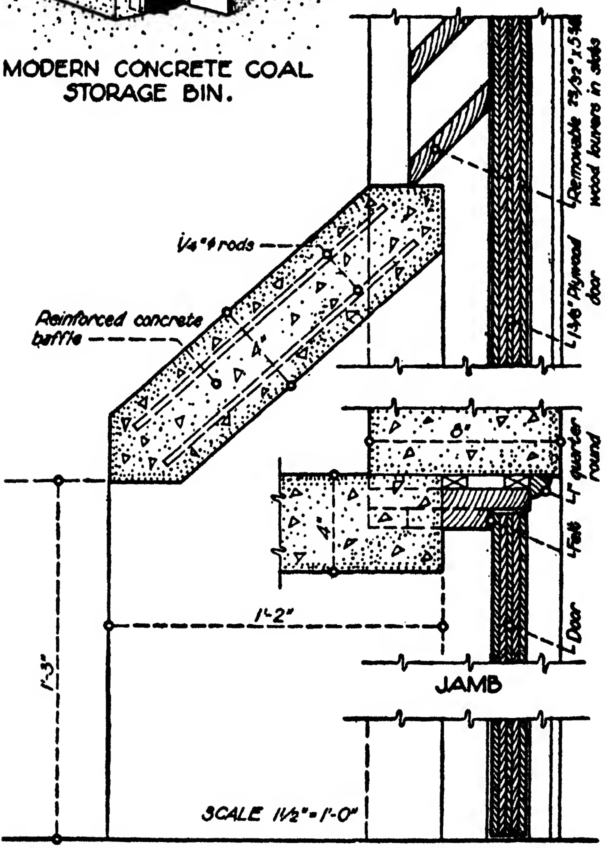
The manufacturer guarantees this genuine aromatic red cedar closet lining to conform to the standard grading rules as published in Department of Commerce, Commercial Standard CS26-30, for Aromatic Red Cedar Closet Lining.

....
Name of manufacturer

COAL STORAGE BIN MADE OF CONCRETE

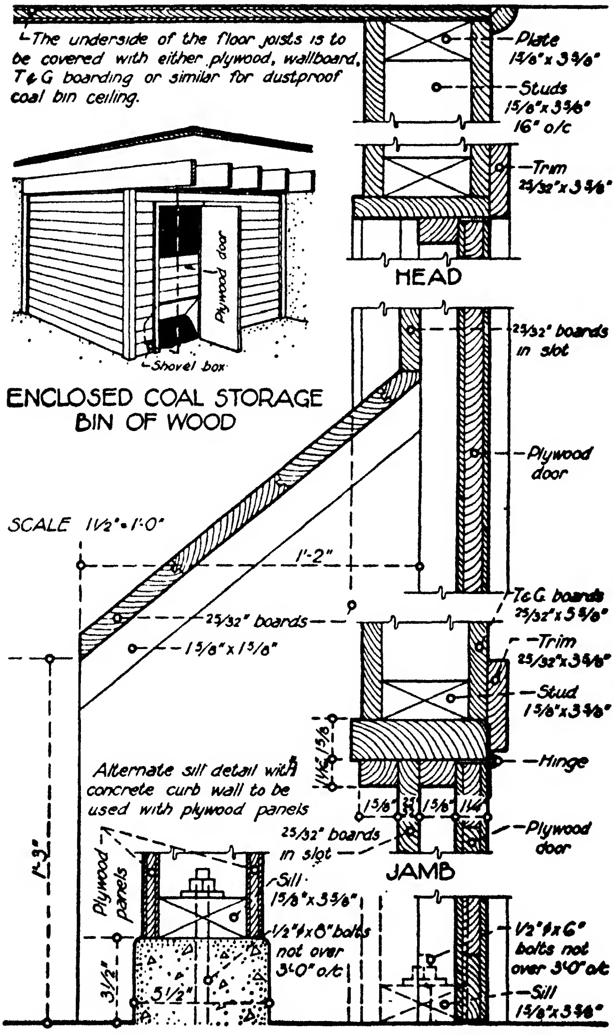


MODERN CONCRETE COAL STORAGE BIN.



DETAIL OF CONCRETE SHOVEL BOX CONSTRUCTION.

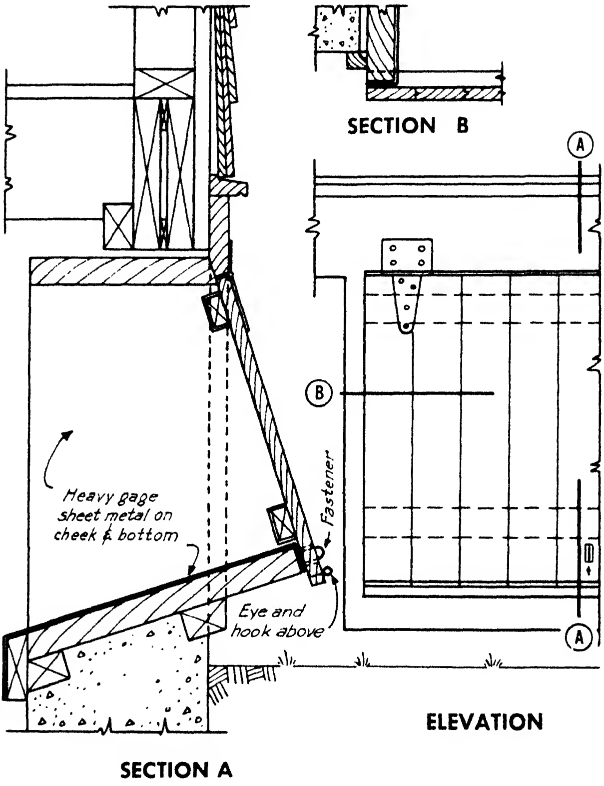
COAL STORAGE BIN OF WOOD



ENCLOSED COAL STORAGE BIN OF WOOD

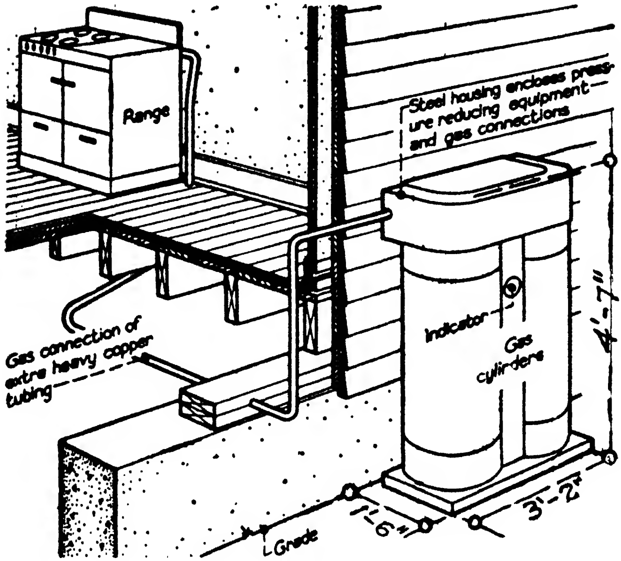
DETAIL OF WOODEN SHOVEL BOX CONSTRUCTION

COAL CHUTE MADE OF WOOD



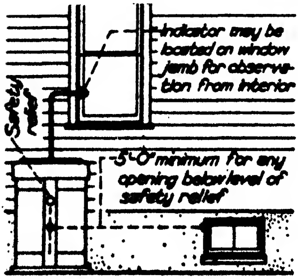
Any planking may be used to construct the wood coal chute shown in the drawing. One of the best materials for the four sides of the chute is standard T & G soft-wood flooring in 1⅝"x5⅛" or better yet 2⅝"x5⅛" size. The door can be made of the same material in 1-5/16"x2⅜" size. The clear opening should be not less than 18"x24"—and can be up to 24"x30". Heavy sheet metal lining inside cheeks Hair cracks can be puttied with oil and whiting putty.

LIQUEFIED PETROLEUM GAS INSTALLATION



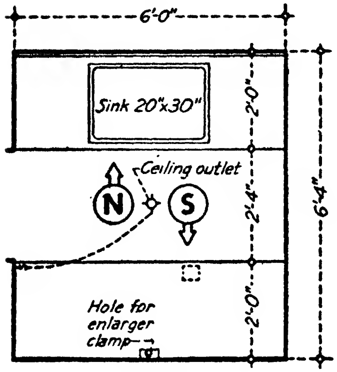
BOTTLED GAS. Propane (C_3H_8) is delivered in steel cylinders containing 100 lbs. having a heating value of 21,500 Btu per lb. Used in cold climates because it flows freely at sub-zero temperatures. There is also a cash-and-carry 40-lb. cylinder that contains 20 lbs. of gas, and is attached by the user.

TANK GAS. Butane (C_4H_{10}) is used in warm climate, requires lighter equipment. Usually metered from a delivery tank truck to the permanent storage tank of the building.

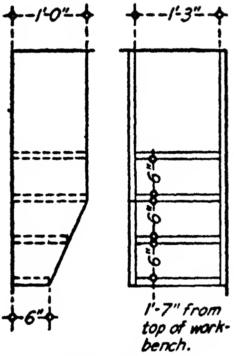


USES. Equipment is available for the use of L-P gas for room heaters, emergency lighting, incinerators, laundry driers and ironers, cooking, water heating, refrigeration, orchard smudge-pots, poultry brooders, etc.

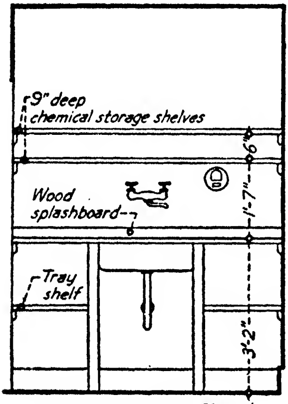
ECONOMICAL AMATEUR DARKROOM



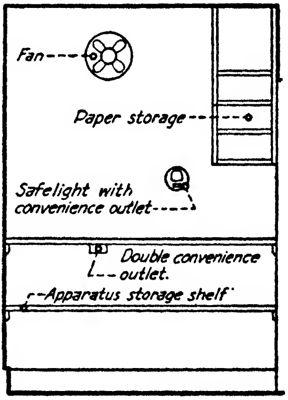
PLAN



DETAIL OF PAPER STORAGE



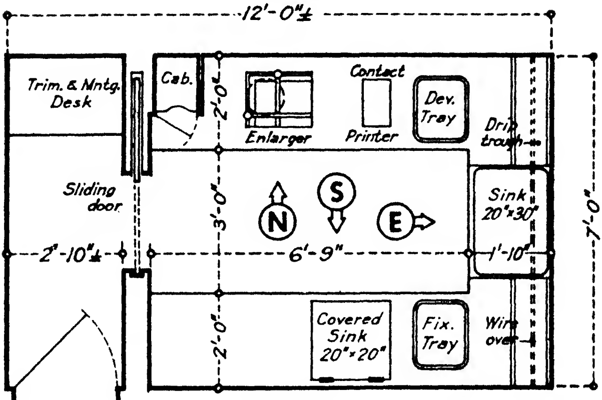
ELEVATION "N"



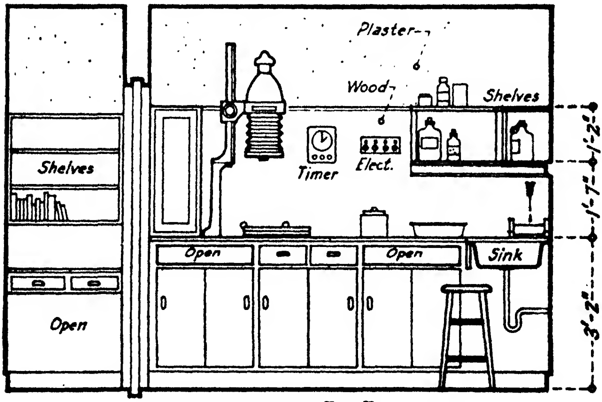
ELEVATION "S"

In the plan the *wet* operations have been separated from the *dry*. The mixing of chemicals, development, washing, and fixing can all take place on the sink side of the room. The exposure in the enlarger or contact printer as well as the drying and trimming can be confined to the other side of the darkroom. The door should have a lock, and a ventilating fan is an absolute necessity. The door can be weather-stripped to make it light-tight.

AMATEUR DARKROOM



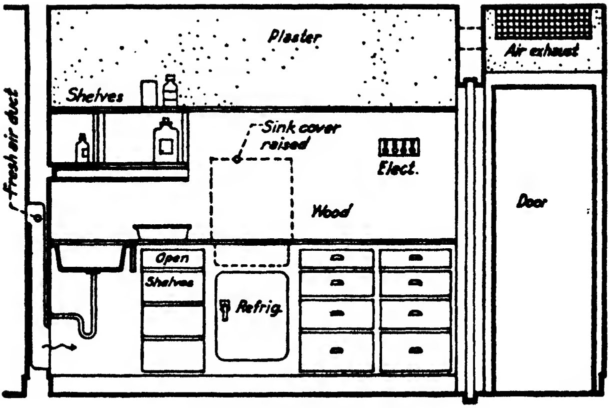
PLAN



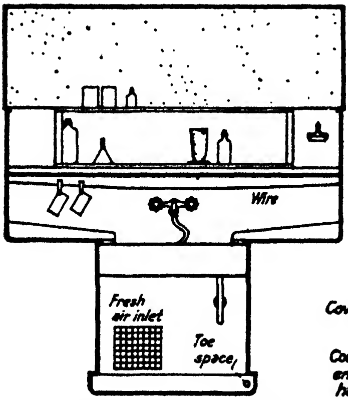
ELEVATION "N"

For right handed persons, a clockwise sequence of operations will be most efficient. The sink at the end of the room serves as a rinse between development and fixing and will also be the location for mixing of chemicals. The covered sink is for the final washing of films or prints. The hinged cover, when closed, results in no loss of work space. Counter area is provided alongside this covered sink for ferrotyping, a print drier or other apparatus. The cabinet beside the enlarger is for printing paper up to 11" x 14", and other light-sensitive supplies.

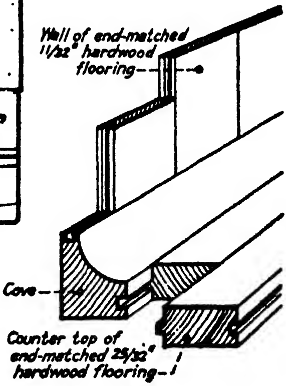
AMATEUR DARKROOM



ELEVATION "S"



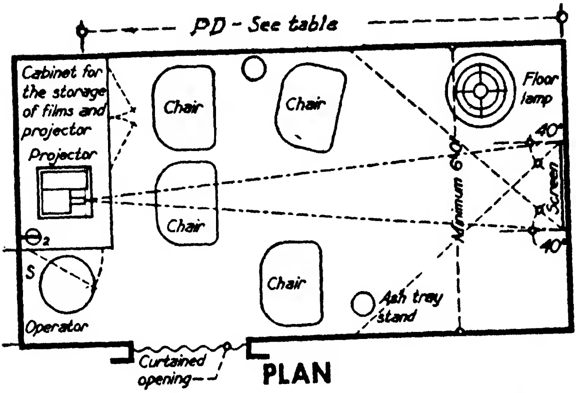
ELEVATION "E"



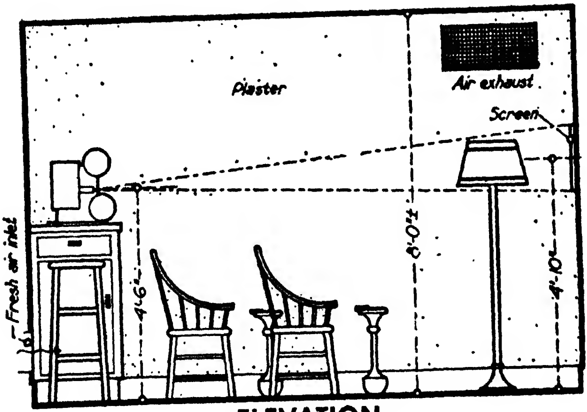
DETAIL

Acid, alkali and water-resisting black paint is obtainable for the counter top. The ceiling should be fitted with orange, red and green safe lights for the various dark room operations. Five-ply plywood in the heavier thicknesses would make an ideal material for the wood wall, counter front and the sliding doors. A small refrigerator unit which will maintain a dry temperature of 68° is desirable, tho not essential.

AMATEUR HOME MOVIE THEATER



PLAN



ELEVATION

The plan and elevation above show a room required for an audience of 4 or 5 people and the operator. In general, principles of commercial movie theaters apply to the projection of home movies. The line of sight from the nearest spectator to the top of the screen should not exceed 30° with the horizontal. Side seats from which the observer sees any part of the screen image at an angle greater than 40° are undesirable. Home projectors do not allow an angle of projection that deviates more than a few degrees from the horizontal.

AMATEUR HOME MOVIE THEATER

HOME MOVIE PROJECTORS. Amateur home movie machines are constructed to take 8 mm. or 16 mm. film. Depending on the size of the lamp used for illumination, the model of the projector and the lens, various screen-image sizes and projection distances or *throws* may be obtained to provide entertainment in rooms varying thru a wide range of seating capacities. The following tables are presented thru the courtesy of the Eastman Kodak Company.

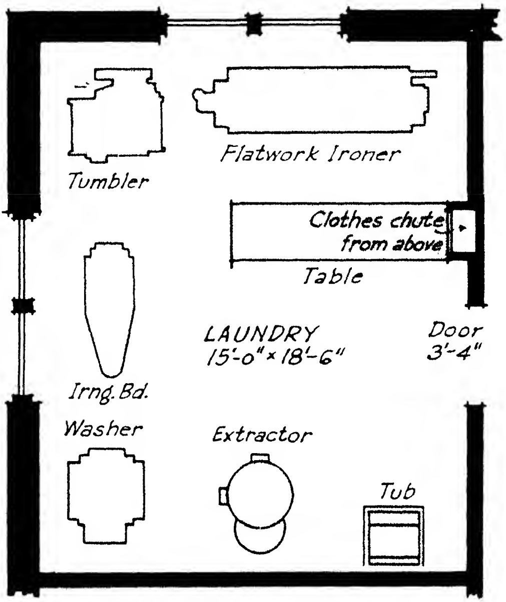
PD Projection Distance for 16-mm. Kodascopes						Same, 8-mm.
Size of Screen (inches)	1-inch Lens (feet)	1½-inch Lens (feet)	2-inch Lens (feet)	3-inch Lens (feet)	4-inch Lens (feet)	1-inch lens only (feet)
16½ x 22	5	7½	10	..	..	11
22 x 30	6¾	10	13½	..	.	14½
30 x 40	9	13½	18	26½	36	19½
39 x 52	11½	17	23	34½	46	25
45 x 60	13	19½	26½	40	53	..
54 x 72	16	24	32	48	64	..
63 x 84	19	28½	37	56	74	..
72 x 96	21	31½	42	63	84	..

Long Dimension of Projected Picture	PD Distance From Projector Lens to Screen			
	35-mm. (24x36-mm.) Kodaslides		Bantam (28x40-mm.) Kodaslides	
	5-inch Lens	7½-inch Lens	5-inch Lens	7½-inch Lens
18 inches	6 ft.	9 ft.	5½ ft.	8 ft.
22 inches	7 ft.	11 ft.	6½ ft.	10 ft.
24 inches	8 ft.	12 ft.	7 ft.	10½ ft.
30 inches	10 ft.	15 ft.	8½ ft.	13 ft.
40 inches	13 ft.	20 ft.	11½ ft.	17 ft.
48 inches	15½ ft.	23½ ft.	13½ ft.	20½ ft.
52 inches	16½ ft.	25½ ft.	14½ ft.	22 ft.
60 inches	19 ft.	29 ft.	17 ft.	25½ ft.
72 inches	23 ft.	35 ft.	20 ft.	31 ft.
84 inches	26½ ft.	41 ft.	23 ft.	36 ft.

FITTINGS. The projection room should have a table, or cabinet, upon which the projector is placed. The space underneath can contain a compartment to house the projector when not in use. Space for the storage of films and extra lamps, tools, etc.

MECHANICAL CONVENIENCES. The room should have facilities for changing the air by forced ventilation at least 6 times per hour. The light switches for the room illumination should be located near the operator's table and might very well be put on a rheostat so that the lights can be dimmed and brought up slowly to prevent ocular shock. An outlet of sufficient capacity for the projector itself should be conveniently located.

PLANNING THE LARGE RESIDENCE LAUNDRY



Typical Laundry Room for Large Residence

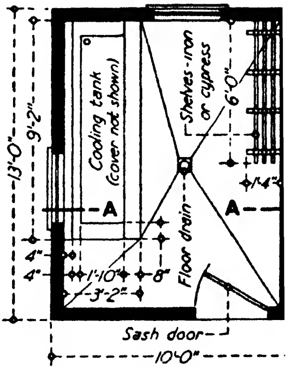
For the larger residence a number of smaller substantially built machines have been developed. The linen requirements of the large residence are subject to wide variation and no rule of thumb can be formulated. An experienced laundry engineer can determine the laundry requirements by an estimate of the weekly laundry load or by his experience with other similar projects, or both.

The equipment for the large residence laundry may be heated by electricity since high pressure steam would not be available. The heating and plumbing system should be designed to supply an adequate amount of hot water. An entrance to the laundry room 4'-0" wide and 7'-0" high will usually be ample. The ceiling should be as high as possible to allow the rise of heat and moisture above the breathing line of the operators.

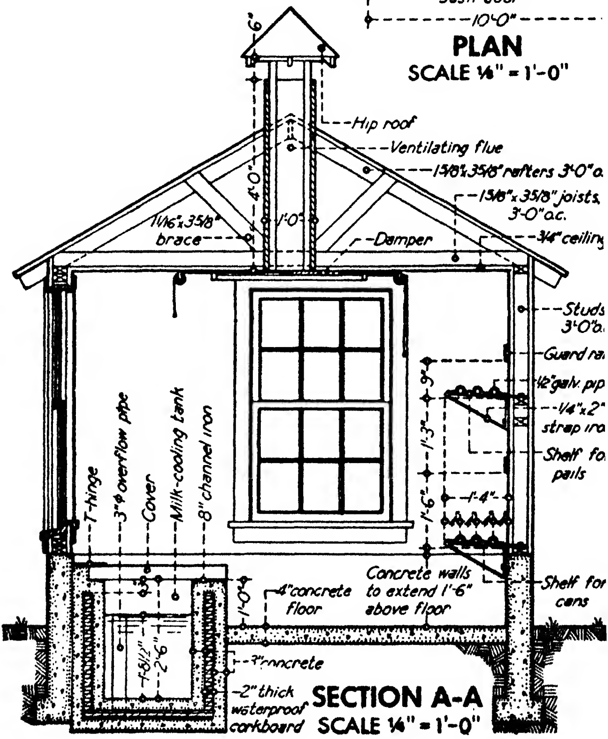
Architects should provide adequate space for the laundry room but should not attempt the placing or selection of equipment without the advice of a Machinery Company representative.

DETAILS OF A MILK HOUSE

The milk house should contain the tank for cooling, the rack for holding dairy utensils, space for an attendant to work conveniently. For electrical refrigeration, the corkboard insulation should be 4" thick and the building should be 4'-0" longer than shown. The milk house should be convenient to the ice house and located so that trucks can be driven to it. A loading platform is a great convenience. A supply of pure water that is as cold as possible should be available for filling the tank and flushing the floor.

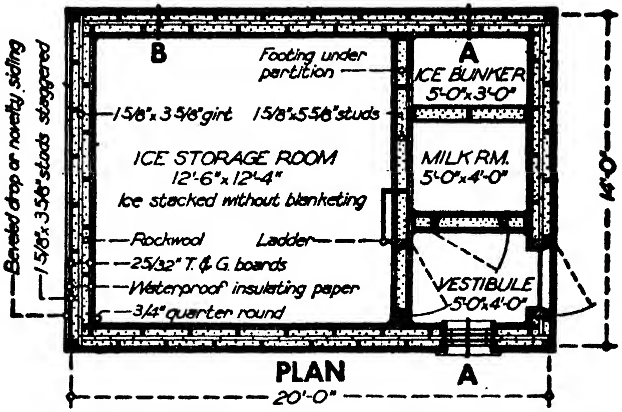


PLAN
SCALE ¼" = 1'-0"



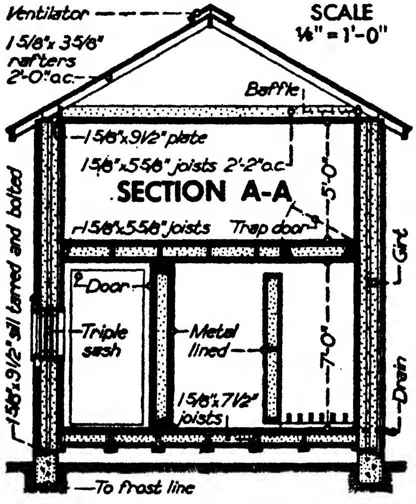
SECTION A-A
SCALE ¼" = 1'-0"

DETAILS OF AN ICE HOUSE

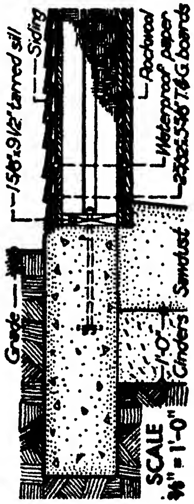


Tons of Ice	Length	Width	Height	Tons of Ice	Length	Width	Height
10	10'-0"	7'-0"	7'-0"	30	14'-0"	10'-0"	10'-0"
20	14'-0"	8'-0"	8'-0"	40	18'-0"	10'-0"	10'-0"
25	14'-0"	10'-0"	8'-0"	50	16'-0"	12'-0"	12'-0"

INSIDE DIMENSIONS OF ICE HOUSES

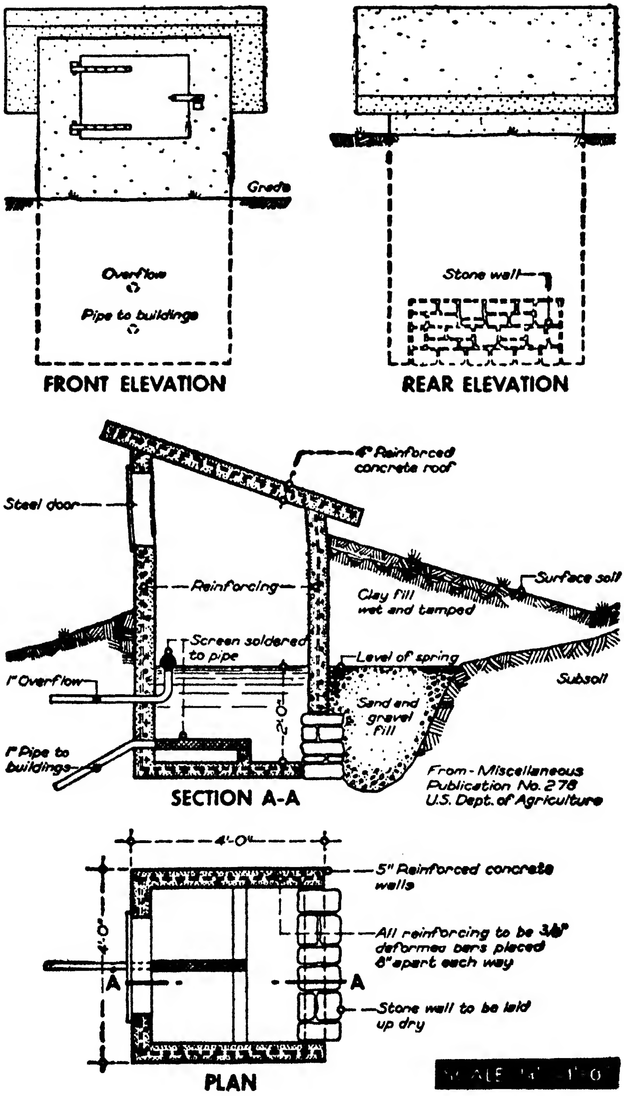


FARMERS BULLETIN 1078 U.S. Dept. of Agri.



DETAIL B

FARM SPRING HOUSE



STANDARD PLUMBING SYMBOLS

PIPING

CHARACTER	BAND INITIAL	BAND COLOR
Sanitary Sewerage	SAN	Blue
Soil Stack	SS	"
Waste Stack	WS	"
Vent Stack	VS	"
Combined Sewerage	CS	"
Storm Sewerage	STORM	Green
Roof Leader	RL	"
Indirect Waste	IW	"
Industrial Sewerage	IS	"
Acid or Chemical Waste	AW	"
Cold City Water	CW	White
Hot City Water	HW	"
Cir. Hot City Water	Ch	"
Chilled Drinking Water	[illegible]	"
Fire Line	FL	Red
Cold Industrial Water	CI	Yellow
Hot Industrial Water	HI	"
Cir Hot Industrial Water	IR	"
Air	A	Gray
Gas	G	Brown
Oil	O	Black
Vacuum Cleaner	V	Cream
Local or Surface Vent	LV	Tan

DRAINS

Cleanout		Refrigerator Dr.	DR.	Floor Drain	DR.
Grease Separator	G.S.	Roof Sump	S.	Shower Drain	DR.
Oil Separator	O.S.	Floor Drain with Backwater Valve	DR.	Garage Drain	DR.

BATHROOM PLANNING

POSITION OF BATHROOMS IN HOUSE PLAN. The location of bathrooms over each other, adjacent to each other, and over the kitchen and laundry plumbing, results in the greatest economy. However, it is not suggested that convenience and utility be sacrificed for the economy of piping. Usually good planning and piping economy are natural complements.

It is desirable to locate the bathrooms so that soil stacks do not come in partitions adjacent to rooms used for entertainment since bathroom sounds may be heard. Where this condition is impossible to avoid, piping should be heavily wrapped with hair felt, using studs large enuf so that the hubs of the pipe do not touch the lathing.

SIZE AND SHAPE OF BATHROOM. Bathrooms somewhat larger than those ordinarily regarded as minimum are desirable. The care of children and invalids often requires greater space for convenience than the minimum.

CHECK LIST OF EQUIPMENT.

- Lavatory
- Toilet
- Bathtub
- Tub with shower over
- Separate shower compartment
- Bidet
- Separate toilet compartment
- Dressing table
- Dental basin
- Manicure table
- Exerciser
- Sun lamp
- Sun lamp and couch
- Scale

BUILT-IN CONVENIENCES.

- Medicine cabinet over lavatory
- Medicine storage cabinet
- Linen cabinet
- Towel bars
- Soap dish with draining lip
- Paper holder
- Toothbrush and glass holder
- Grab bars at tub
- Hooks for strop, douche, clothing
- Electric heater
- Clothes chute or hamper
- Full length mirror
- General illumination fixture
- Fixtures for local illumination at mirror, in shower, at dressing table
- Outlets for curling iron, electric razor, water heater, vibrator, razor blade sharpener, hair dryer, etc.
- Exhaust fan if no other means of ventilation is provided (fan may be in attic, controlled from bathroom)

WINDOWS AND DOORS. Never locate a window over a bathtub nor in a shower enclosure, nor behind the toilet. The window should be located on a clear wall so that it may be approached for opening and closing. The stool of bathroom windows should never be less than 4'-0" from the floor. Glazing should be obscure glass.

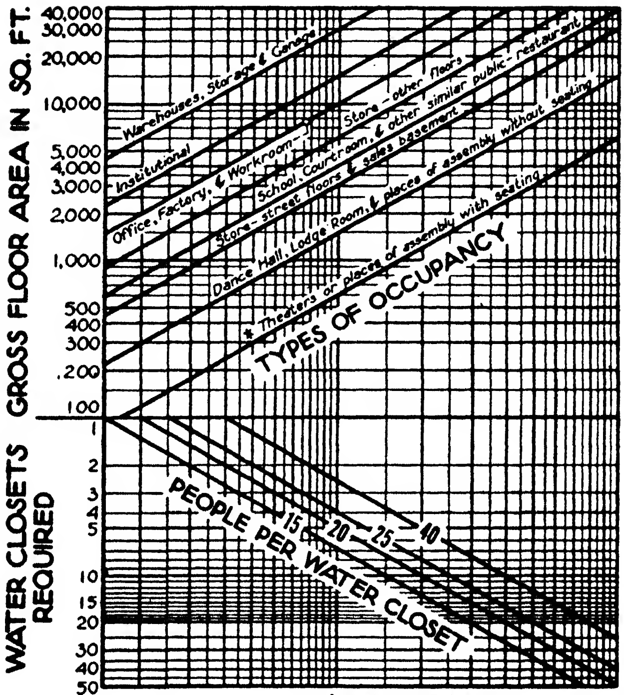
No bathroom should ever have more than one door. If it is to serve more than one bedroom, it should be entered from a common hall.

TYPES OF FIXTURES. There are 4 basic materials used in the manufacture of bathroom fixtures.

1. Porcelain
2. Vitreous china
3. Enameled cast iron
4. Porcelain enameled steel

BATHROOM HEATING. Radiators should be under the window, enclosed in such a way as to eliminate any possibility of burns—bare radiators should never be used in bathrooms. The heating should be designed to take care of at least 2 air changes per hour and should be able to provide an inside dry bulb temperature of 80° F.

TO DETERMINE FIXTURES FROM FLOOR AREA



* Use actual seating area

First—read across from floor area to curve for type of building.

Second—at intersection read down to curve for number of persons per toilet as specified in the local code or as judged desirable. (15 persons per toilet represents generous conditions.)

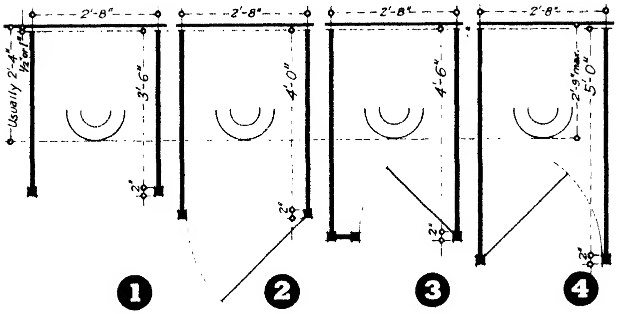
Third—from this intersection read to the left for the number of water closets required.

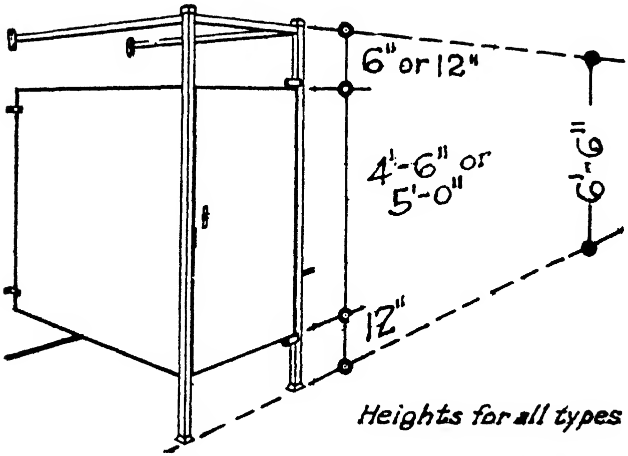
Fourth—determine the probable sex proportion and divide the number of toilets found, in a suitable ratio, remembering that urinals in the men's toilet room augment the facilities offered by the water closets and makes relatively fewer water closets necessary for men than for women. For schools, allow 1 toilet to 25 girls, and 1 toilet to 40 boys.

Fifth—apportion urinals and lavatories as follows:

Type of Building	*Urinals to 1 Closet*	*Lavatories to 1 Closet*
Theaters	1½	½ to 1
Office Buildings	½ to 1	1 to 1½
Schools (boys' room)	1	1
Schools (girls' room)	—	½
Other Buildings	1	½ to 2

METAL
TOILET PARTITIONS

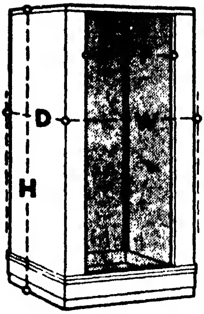




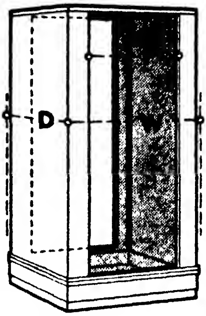
For additional data on the subject given on this page, see *Simplified Practice Recommendation R101-40* as promulgated by the U. S. Dep't. of Commerce, and available from the Superintendent of Documents, Washington, D.C. for 5 cents. Since this document is incomplete and anything but simplified, it is suggested that data required for anything more definite than rough sketch drawings be obtained from an informed representative of a manufacturer. Plans above show:

1. **NO DOORS, OR THE INFORMAL TYPE**
2. **FULL-WIDTH DOORS SWINGING OUT, IN CASE OF FIRE**
3. **"L" FRONTS WITH NARROW DOORS SWINGING IN.** Experience has shown that this type is fraught with the possibility of adventure, and these dimensions are recommended for use where special conditions do not make other dimensions preferable. "L" fronts are recommended for rigidity, permanence, space economy.
4. **FULL-WIDTH DOORS SWINGING IN.** Space wasting and completely disconcerting to a user in entering or leaving; hence the type most used.

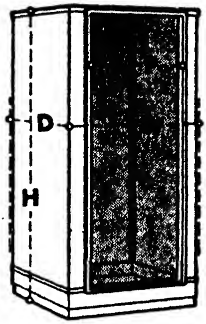
SIZES OF SHOWER INCLOSURES



SINGLE ENTRANCE CABINET



DOUBLE ENTRANCE CABINET



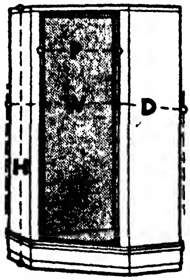
IN A WALL CABINET

W	2'6"			2'8"					3'0"						3'6"			
D	2'6"	2'8"	3'0"	2'6"	2'8"			3'0"	2'6"	2'8"	3'0"		3'6"		2'6"	2'8"	3'0"	3'6"
↓ P	2'0"	1'8"	1'8"	1'10"	1'10"	2'0"	2'2"	1'10"	2'0"	2'0"	2'0"	2'2"	2'0"	2'2"	2'2"	2'2"	2'2"	2'2"
H = 6'-8"		●	●	●	✱	●		●	●	●	▣	●	●	●	●	●	✱	▣
H = 6'-6"	●						●		●		□	●					●	

● *Manufactured standards*

✱ *Recommended*

□ *Corner shower sizes*



CORNER ENTRANCE CABINET

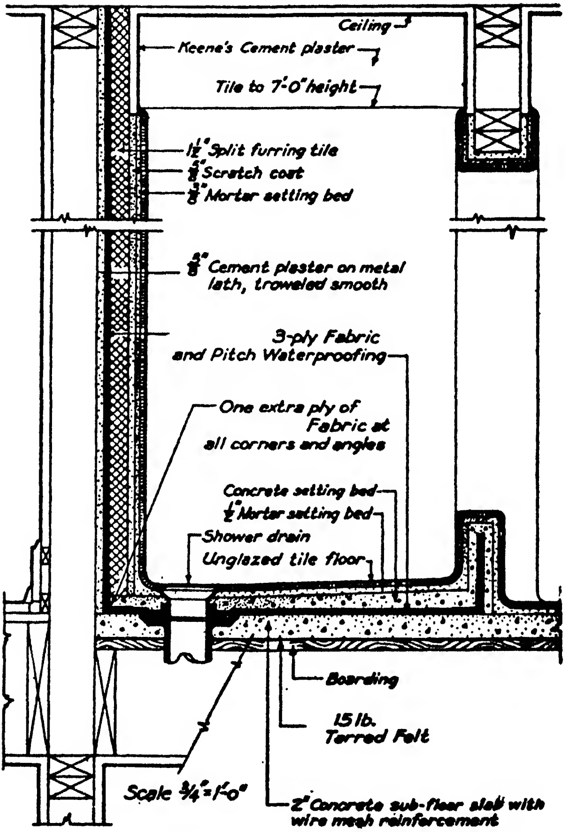
The dimensions given above apply to factory-made metal types of job-constructed enclosures of tile or other material having a waterproof membrane or receptor. The following pages show details for adaptation to exposed or built-in installations.

Where space permits, the so-called combination shower consisting of valves and head over a bathtub, should be avoided because of:

1. Danger of slipping
2. Inadequate space for free movement
3. Discomfort from flapping curtain
4. Slopping of water around edges of shower curtain
5. Duplication of built-in wall accessories for standing and seated positions

The designer may choose between curtain or glass door; between factory-made enameled enclosures in standard colors or selected colors in a job-constructed enclosure; between a dome light and no light (switch should always be beyond reach of the bather's wet hands and grounded feet); between exposed or built-in construction.

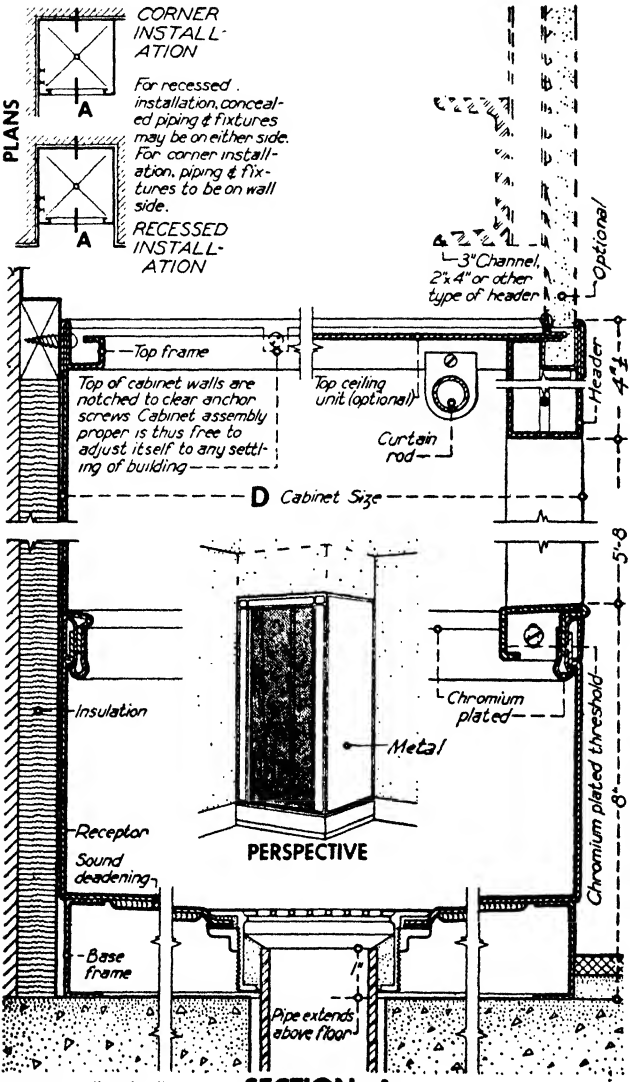
SHOWER BATH CONSTRUCTION



Showers less than 36 x 36 in the clear should only be planned when space conditions make it mandatory. The door opening may be closed either with a water-proof curtain or any of the standard shower stall doors having ventilating panels.

The floor of the shower should be of an unglazed or abrasive tile, to prevent slipping. Glazed or unglazed tiles may be used for the walls at the discretion of the designer. Floor drains vary from 1½" to 3" wastes. The larger the better.

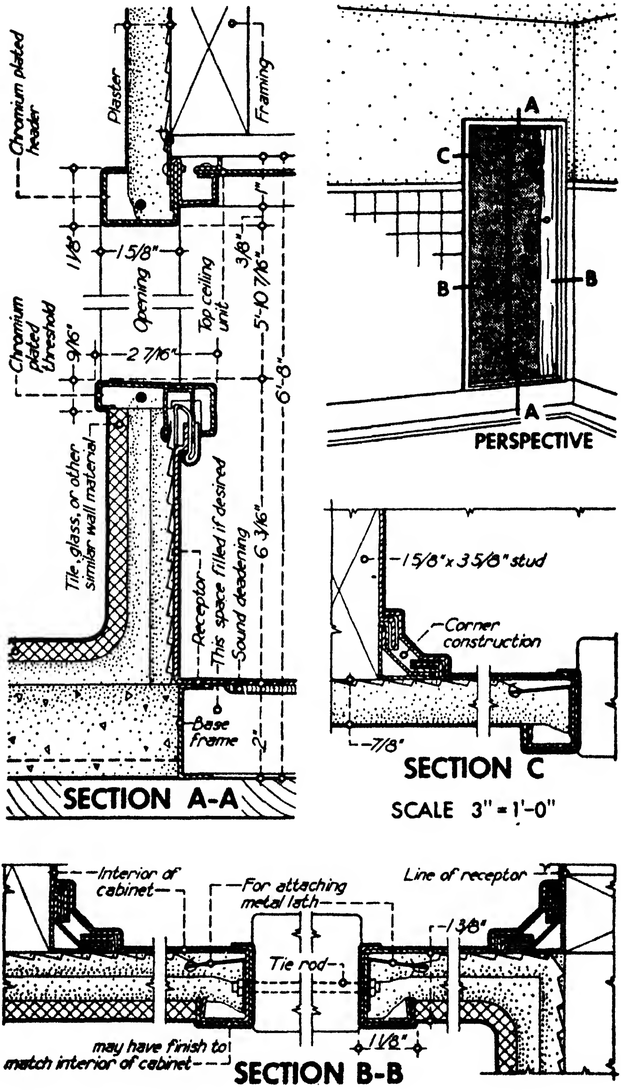
EXPOSED TYPE
METAL SHOWER INCLOSURES



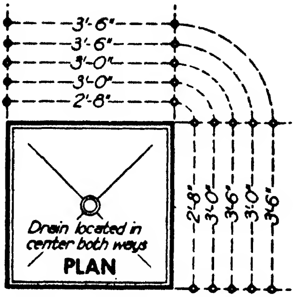
SCALE 3" = 1'-0"

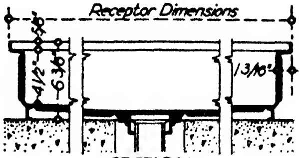
SECTION A

BUILT-IN TYPE
METAL SHOWER INCLOSURES

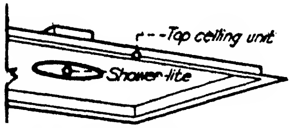


RECEPTORS & CEILINGS FOR METAL SHOWER INCLOSURES

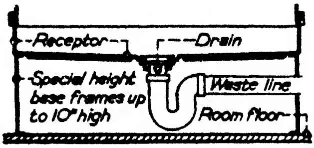




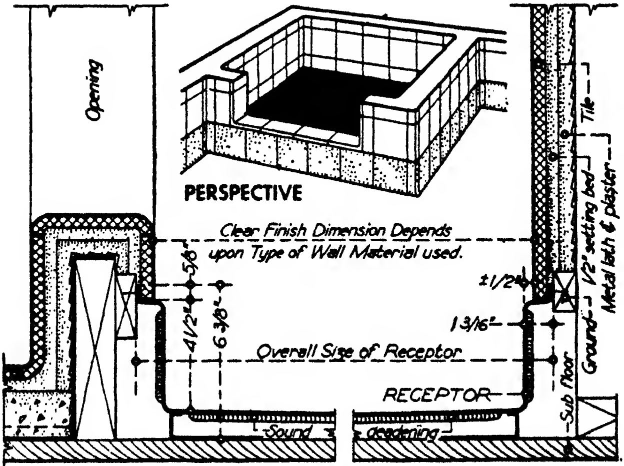
SECTION



CEILING UNIT. Should be used on all models when built-in.



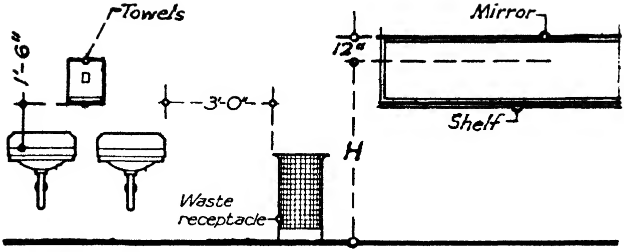
HIGH-BASE FRAME. Available to accommodate waste line or trap between receptor and room floor. This special frame is particularly useful in remodeling work.



SCALE 1½" = 1'-0"

SECTION

WASHROOM PLANNING



EFFICIENT PLANNING. Each fixture should be placed where it is handiest for the user and so that traffic moves rapidly at all times. This principle involves both the horizontal and vertical placement of equipment.

USED BY		H	H_1
MEN		5'-0"	2'-11"
WOMEN		4'-6"	2'-11"
CHILDREN	5 to 6 Years	3'-1"	2'-0"
	6 to 11 Years	3'-8"	2'-6"
	11 to 14 Years	4'-4"	2'-11"

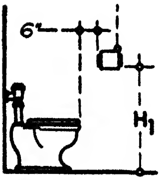
Efficiency, however, can be carried to the point where (a) the person is inconvenienced, or (b) architectural dimensions become greater to attain the flow of traffic than a less "efficient" room would require. Lavatories spaced too close together will only be used alternately—half as many fixtures a few extra inches apart will take care of the same number of persons. No one who wants to wash his face should be forced to travel to another part of the room where the towels are located.

TOWEL CABINETS. There should be one towel cabinet above each alternate space between lavatories, located as low as possible so that water from wet hands does not run up the arm or sleeve.

LAVATORIES. The height of a lavatory rim should be ONE HALF of the users height. Invariably lavatories are placed TOO LOW in all types of buildings including residences. A six-foot man will find a 3-ft. height of rim most convenient, e.g.

The spacing of lavatories should be ONE HALF of the users height. A six-foot man will spread his elbows to about 2'-6" in washing so lavatories 3-ft. on center will allow clearance.

WASTE RECEPTACLE. Waste receptacle should not be located beneath the towel cabinet. Its position, as shown in the illustration, will lead the user away from the towel cabinet.

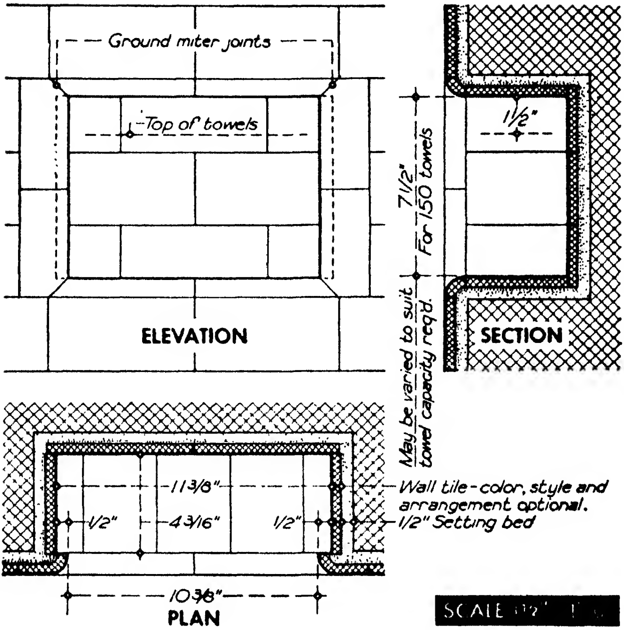


MIRRORS AND SHELVES. Mirrors over lavatories lead users to loiter in front of basins except where face-washing is essential to cleaning up as in some factories. Mirrors on towel cabinets create congestion and unnecessary use of more than 1 towel. In washrooms used by women, shelves need to be provided under mirrors for cosmetics, eyeglasses and handbags.

SOAP. Some states require the provision of soap. Liquid or powdered soap dispensers for correct types of soap to meet particular requirements are available from leading manufacturers.

OTHER EQUIPMENT. Consideration should be given to the necessity for and the placing of sand urns, cuspidors, hand lotion dispensers, sanitary napkin dispensers and receptacles, medicine or first-aid cabinets.

BUILT-IN TOWEL HOLDER RECESS



Where a recessed type holder is desirable for dispensing standard folded paper towels, it may be constructed as shown in the drawing above. Towels are retained in the wall recess by the 1/2" lips projecting from the right and left sides. Replenishment of the supply is accomplished easily by adding towels to the pile to with 1 1/2" from the soffit of the niche.

Users simply remove towels as needed from the top of this pile. There is no restraint over the removal of towels and therefore, this recessed type will be most frequently found in buildings where a certain extravagance is not a serious consideration, such as clubs, homes, higher class hotels, private office suites.

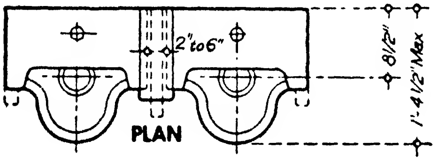
By following the dimensions shown in the drawings, details can be worked out for recessed holders in any type of wall finish such as linoleum, porcelain enameled iron panels, laminated sheet materials, marble, glass, or other interior wall materials. The recess shown is for 150 towel capacity. Greater or lesser capacity can be obtained by allowing about 1" of towel height for 25 towels.

The drawing showing the recess in tile makes use of 3"x6" tile shapes. The only precaution that should be especially noted is that the miter joints at the four corners should be carefully ground from the standard tile stretcher cap member.

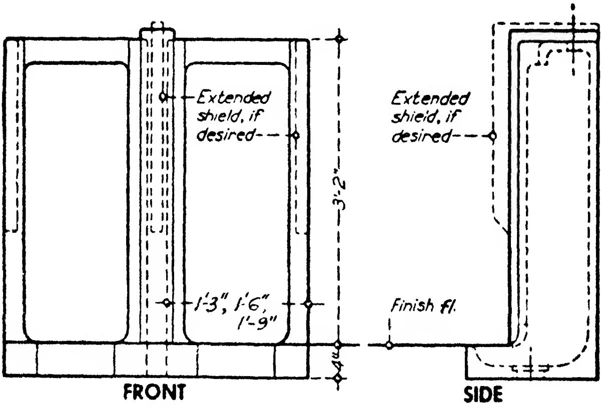
SIZES OF STALL URINALS

GENERAL. Urinals are made of vitreous china, excepting the trough type which is of enameled iron. The stall type is most commonly used; wall-hung urinals are second in popularity; the pedestal type third. In these *Data Sheets* exclusive designs are not shown—only those types made by two or more manufacturers are represented. Dimensions are given to the nearest half-inch above fractions.

SPACING. The usual spacing is 24" o/c, and is entirely too little. Extended observation will reveal that with the customary spacing, men will wait rather than crowd into a space between two urinals which are in use. Only alternate urinals will tend to be used when the spacing is less than about 30" o/c. A 36" o/c spacing may be regarded as ideal. It is believed that 10 urinals on a 36" spacing is much to be preferred to 15 urinals on a 24" spacing, under normal conditions and with the exception of toilet rooms in legitimate theaters where some inconvenience can be tolerated because of rush conditions between acts.

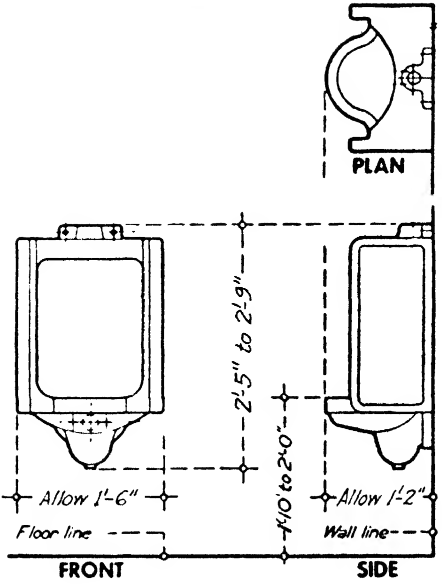


NOTE: The drawings shown are diagrammatic and do not represent the design of any manufacturer

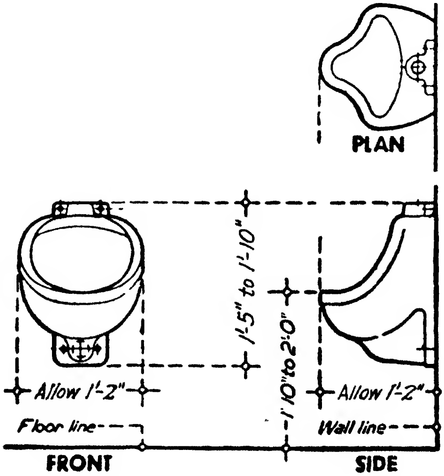


SIZES OF WALL-HUNG URINALS

NOTE: The drawings shown are diagrammatic and do not represent the design of any manufacturer

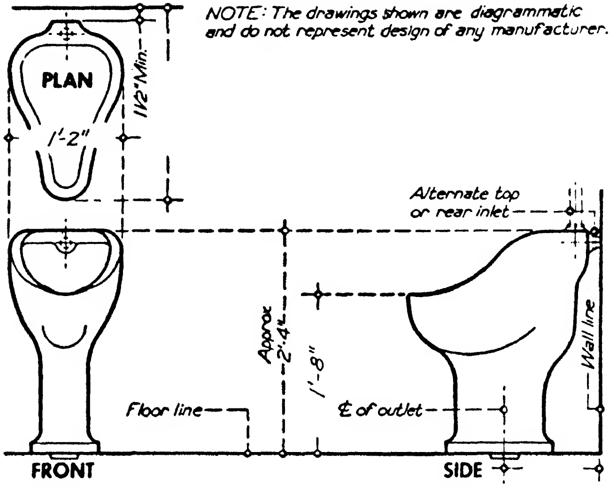


WALL HUNG STALL URINAL

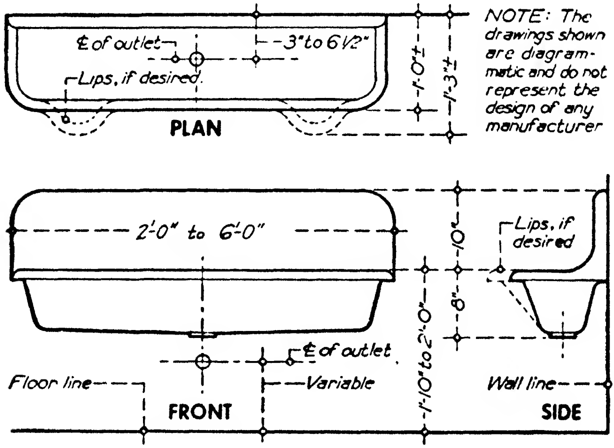


WALL HUNG URINAL

PEDESTAL AND TROUGH URINALS

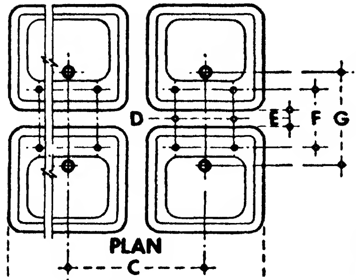


PEDESTAL URINAL



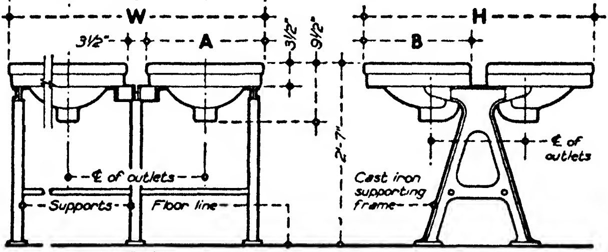
E. I. TROUGH

BATTERY LAVATORIES



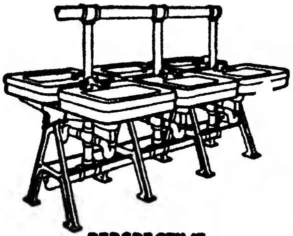
NUMBER DOUBLE BATTERIES	W 20"x18" Lavatories	W 24"x21" Lavatories
1	1'-8"	2'-0"
2	3'-7½"	4'-3½"
3	5'-7"	6'-7"
4	7'-6½"	8'-10½"
5	9'-6"	11'-2"
6	11'-5½"	13'-5½"

Dimensions may vary slightly according to the different manufacturers.

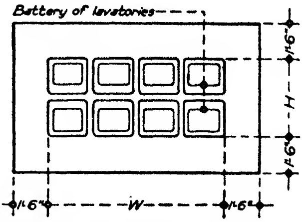


FRONT **SIDE**

SIZE OF LAVATORY		DIMENSIONS									
A	B	C	D	E		F		G		H	
				Min.	Max.	Min	Max	Min.	Max.	Min.	Max
20"	18"	1'-11½"	10"	2"	4"	8¼"	10¼"	1'-3¾"	1'-5¾"	3'-2"	3'-4"
24"	21"	2'-3½"	1'-0"	2"	4"	1'-0"	1'-2"	1'-7½"	1'-9½"	3'-8"	3'-10"



PERSPECTIVE
SHOWING BATTERY INSTALLATION



NOTE- Allow 1'-6" clear space all around a battery of lavatories

COLD WATER DISTRIBUTION

NOTE- For average one or two family dwelling with flush tanks for water closets a 5/8" tap in water main and a 3/4" service pipe will be satisfactory with water pressure 30 lbs. per sq. in. or over. If water pressure is less, then service pipe should be 1". Where flush valves are used on water closets install a 1" tap in water main, and service pipe into building not less than 1 1/4" or 1 1/2" if pressure is below 30 lbs. per square inch.
Most desirable pressure for domestic service is between 20 lbs. and 40 lbs per sq. in.
Entire water supply system controlled by main gate shut-off valve within building.

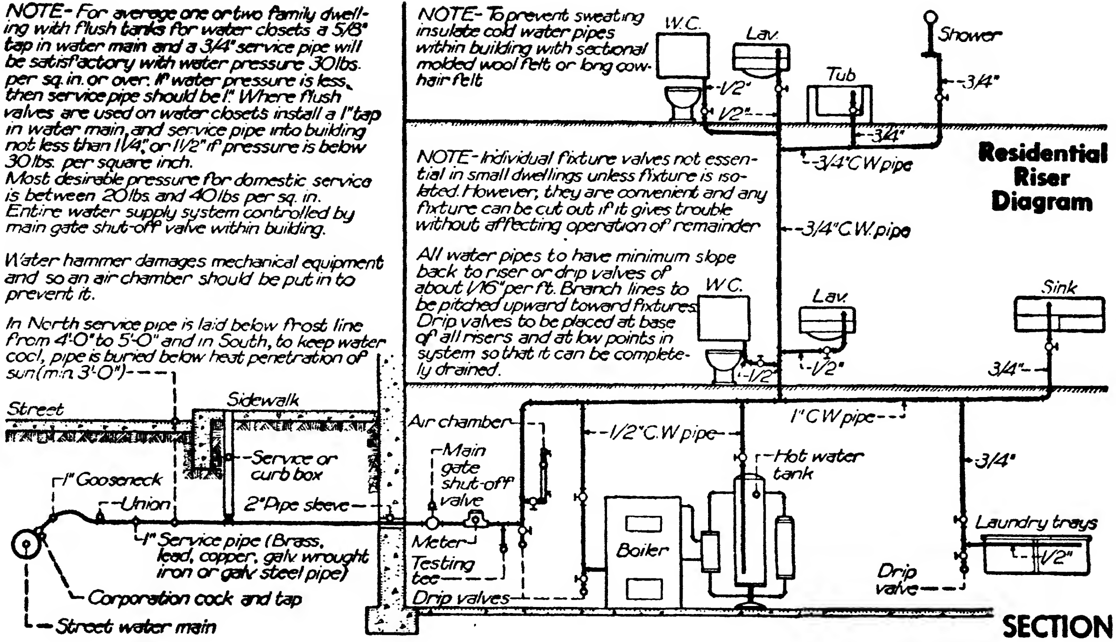
Water hammer damages mechanical equipment and so an air chamber should be put in to prevent it.

In North service pipe is laid below frost line from 4'-0" to 5'-0" and in South, to keep water cool, pipe is buried below heat penetration of sun (min. 3'-0").

NOTE- To prevent sweating insulate cold water pipes within building with sectional molded wool felt or long cow-hair felt

NOTE- Individual fixture valves not essential in small dwellings unless fixture is isolated. However, they are convenient and any fixture can be cut out if it gives trouble without affecting operation of remainder

All water pipes to have minimum slope back to riser or drip valves of about 1/16" per ft. Branch lines to be pitched upward toward fixtures. Drip valves to be placed at base of all risers and at low points in system so that it can be completely drained.

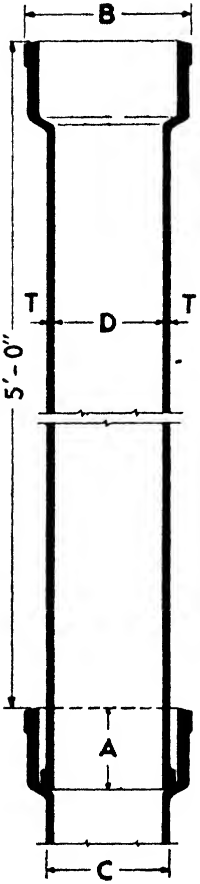


INSIDE DIAMETERS OF PLUMBING PIPE

Nominal diameters in inches	Actual inside diameters in inches						
	Types of copper tubing			*Steel* [1]		*Brass (I. P. S.)*	
	K	L	M	Standard	Extra Strong	Standard	Extra Strong
3/8	0.40	0.43	0.45	0.49	0.42	0.49	0.42
1/2	.53	.55	.57	.62	.55	.63	.54
3/4	.75	.79	.81	.82	.74	.82	.74
1	1.00	1.03	1.06	1.05	.96	1.06	.95
1 1/4	1.25	1.27	1.29	1.38	1.28	1.37	1.27
1 1/2	1.48	1.51	1.53	1.61	1.50	1.60	1.49
2	1.96	1.99	2.01	2.07	1.94	2.06	1.93
2 1/2	2.44	2.47	2.50	2.47	2.32	2.50	2.32
3	2.91	2.95	2.98	3.07	2.90	3.06	2.89
3 1/2	3.39	3.43	3.47	3.53	3.36	3.50	3.36
4	3.86	3.91	3.94	4.03	3.83	4.00	3.82
5	4.81	4.88	4.91	5.05	4.81	5.06	4.81
6	5.74	5.85	5.88	6.07	5.76	6.13	5.75

[1] For the most part, wrought-iron pipe corresponds in size to the corresponding weights of steel pipe, differing by not more than 0.01 inch in diameter for nominal diameters of 2 1/2 inches and smaller and by not more than 0.02 inch for nominal diameters of from 3 to 6 inches.

CAST IRON SOIL PIPE



STANDARD

Diameter Inside D	Diameter Outside C	Wall Thickness T	Hub Dimensions B	Hub Dimensions A
2	2¼	⅛	3 11/16	2½
3	3¼	⅛	4 11/16	2¾
4	4¼	⅛	5 11/16	3
5	5¼	⅛	6 11/16	3
6	6¼	⅛	7 11/16	3
8*	8⅜	7/32	10⅛	3¼

MEDIUM

Diameter Inside D	Diameter Outside C	Wall Thickness T	Hub Dimensions B	Hub Dimensions A
2*	2¼	3/16	3⅞	2½
3*	3¼	3/16	4⅞	2¾
4*	4¼	3/16	5⅞	3
5*	5¼	3/16	6⅞	3
6*	6¼	3/16	7⅞	3
8*	8⅜	11/32	10⅛	3¼

EXTRA HEAVY

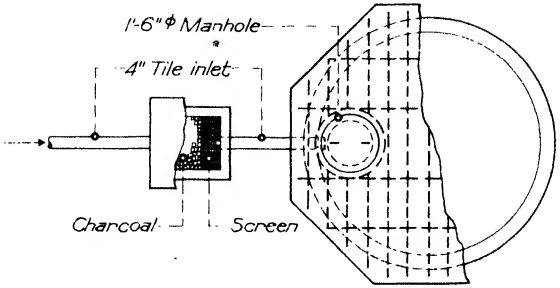
Diameter Inside D	Diameter Outside C	Wall Thickness T	Hub Dimensions B	Hub Dimensions A
2	2½	¼	4 3/16	2½
3	3½	¼	5 3/16	2¾
4	4½	¼	6 3/16	3
5	5½	¼	7 3/16	3
6	6½	¼	8 3/16	3
8*	8¾	13/32	10⅞	3¼

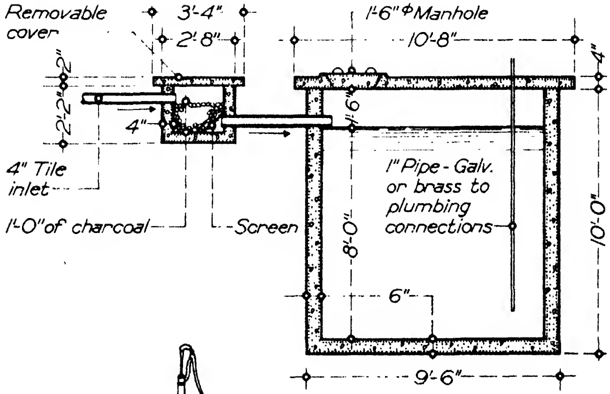
** Nominal size, not actual size.*
All dimensions are in inches.

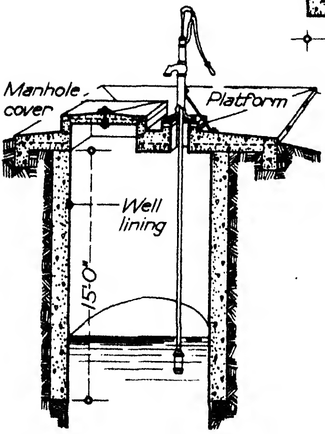
Cast iron hub and spigot drainage pipe is made in three weights — "standard," "medium," and "extra heavy." Fittings are made in medium and extra heavy weights, the medium weight being used with standard weight piping. Usually the local building codes specify the weight permissible.

Cast iron drainage pipe and fittings are also furnished with a coating of coal tar pitch. This give the pipe a smooth surface and protects the iron from chemical action. Some codes do not permit coated pipe because flaws in the iron cannot be detected.

CISTERNS AND WELLS







CISTERNS — Rainwater from roof leaders can be used for washing and cleaning, but not for drinking. One shown holds 3,400 gals.

WELLS — A natural spring should be protected by a well "curb" or lining to exclude seepage and burrowing animals. Diameter usually about 6 ft.

DETERMINING WATER DEMAND

In order to select an electric water system which will operate satisfactorily, certain facts must be known. WATER DEMAND is the amount of water to be supplied. TYPE OF SOURCE may be *shallow* if from a cistern, lake, stream or dug or driven well where the maximum lift from working water level to pump inlet does not exceed 22′-0″; or *deep* if the lift exceeds 22′-0″. YIELD of the well is the flow of water in gallons per hour (gph).

MAXIMUM WATER DEMAND occurs when all water-using devices flow at one time. Since this seldom occurs, it is ordinarily an impractical design basis, and short-cuts are commonly used.

1. RULE OF THUMB, based on accumulated experience, is embodied in Table 1. Requirements are approximate; in every case they should be checked to make certain that no unusually heavy demands will occur.

2. RATE OF FLOW method, more satisfactory when unusual conditions exist, is based on requirenents of fixtures, livestock, etc., listed in Table 2. Minima shown are absolute; use of average requirements is preferred for calculations in order to maintain reserve water for fire-protection and other abnormal demands. EXAMPLE: For residences, assume fixtures having greatest demand in every bath, kitchen, laundry, etc., are flowing concurrently. For 2 baths and kitchen:

[2x200 (shower)] + [5 (kitchen sink)] = 405 gph

For farms, large herds of stock may determine maximum demand. However, peak loads occur at determinable intervals, and the supply can be replenished comparatively slowly. For a farm which must supply 10 cows in milk, 2 horses, 400 fowl, 2 hogs, and 5 people:

(10x35) + (2x10) +(4x2) + (2x2.5) + (5x35) = 558 gph

NOTE: To the above figures must be added special requirements such as water for heating system, irrigation, etc. Base calculations on water consumption in summer. Each electric water system is unique; installations vary accordingly.

TABLE 1—WATER DEMAND BY RULE OF THUMB

TYPE OF INSTALLATION	PUMP CAPACITY (gph)*
Small home, cottage, small service stat'n	200 to 250
Large homes,-more than 1 lavatory or bath	300 to 375
Average farm (normal quantity of stock)	300 to 400

*To accommodate normal demand

TABLE 2—WATER DEMAND BY RATE OF FLOW.

USE OR FIXTURE For Each:	DEMAND IN GAL. PER HOUR (H) OR PER DAY (D) Min.	Average
Person (1)	25 D	35 to 50 D (100 D Max.)
Horse	5 D	10 D
Cow, dry	7 D	12 D
Cow, in milk	25 D	35 D
Hog	1 D	2 to 2.5 D
Sheep	1 D	2 D
100 Chickens	......	2 D
½" Hose Nozzle (2)	75 H	200 H
¾" Hose Nozzle	100 H	275 to 300 H
Lawn Sprinkler	125 H	200 H
Shower, hourly rate	100 H	200 H
Shower, per bath	....	30
Bath, Tub (1 filling)	....	30
Lavatory (1 filling)	....	1.5
Toilet (1 filling)	....	6
Sink, laundry (1 filling)	....	10
Sink, kitchen	....	75 D

Notes: 1. When using quantity demanded per person per day, it is not necessary to add individual fixtures listed below; these are for use when unusual conditions exist. 2. Eight gallons will sprinkle 100 sq. ft. of lawn; 16-20 gal. will soak it.

LOCATING THE WELL is not a precise matter, nor can its rate of flow be predetermined. Advice should be obtained from reputable local well-drillers, owners of adjacent wells and the State Department of Health. Unknown geological formations, drought and number of adjacent wells affect the depth at which water may be found. Avoid locations close to barns, sewage disposal fields, etc., and if possible check rock formations, to eliminate chances of penetrating strata which will carry polluted surface water into the well. High elevations are usually preferable. It is advisable to submit water samples to competent authorities to determine its purity.

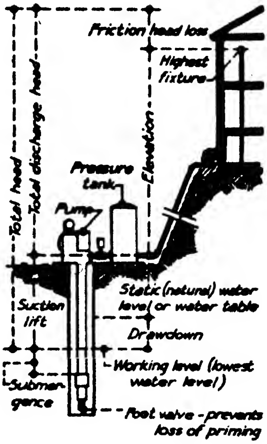
TYPES OF WATER SOURCES AND SYSTEMS

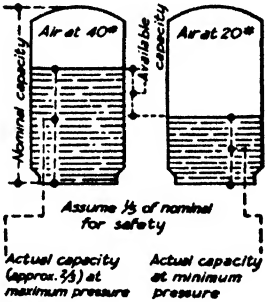
SHALLOW WELLS (dug or driven wells, cisterns, lakes, streams, etc.) are those in which the *working level* of water does not descend more than 22′-0″ below pump inlet level when the pump operates, during droughts, etc. For these, *Shallow Well Pumps* are available in 2 types: (1) *Piston* and (2) *Centrifugal* or *Ejector*. Both types operate by creating vacuum in the well piping and thus enabling atmospheric pressure to raise water to pump level.

DEEP WELLS (drilled and cased) are those in which the working level is more than 22′-0″ below pump inlet level. *Deep Well Pumps* are of 3 types: (1) *Piston;* (2) *Centrifugal* (*Ejector*), available with 1 or 2 well pipes; (3) *Turbine*. If the working level is at or very close to 22′-0″, it is preferable to use a deep well pump.

SELECTING THE SYSTEM. 1. *The pump* should have, ideally, capacity in gals. per hr. to enable it to pump a day's water demand in 1 hr. However, yield of well (rate of flow in gph) must at least equal pump capacity. If yield is limited, a smaller pump and larger tank may be more satisfactory. *Peak water demand* (maximum demand occurring at any one period) may be used as the design basis.

2. *Tank size* should be sufficient to prevent too frequent starting and stopping of the pump, to avoid undue wear and excess current consumption, and to maintain adequate water reserves. For average homes, *available* tank capacity, shown diagrammatically, should be at least 5 to 10 gals. Average *nominal* tank capacity is 1/8 to 1/4 the hourly pumping capacity. *Waterlogging* occurs when tank air is absorbed by water under pressure. To overcome this, an air control should be specified.



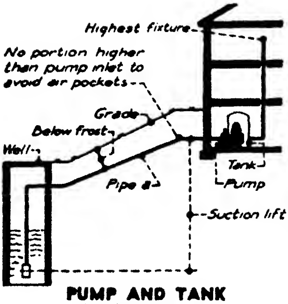


TANK CAPACITIES

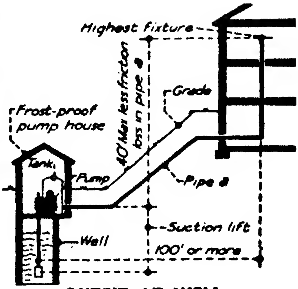
Capacity (Gals.)	Standard Tank Sizes (″) Dia.	Lgth.
18	12	36
42	16	48
82	20	60
120	24	60
220	30	60
315	36	72
365	30	120

tank sizes may vary 10%

SHALLOW WELL SYSTEMS



PUMP AND TANK IN BASEMENT
Well not over 100'-0" distant



OUTFIT AT WELL LOCATION
Over 100'-0" from house

Shallow well pumps operate by lowering air pressure in the well piping and allowing atmospheric pressure at water level to force water up to the pump. The practical maximum vertical lift from working level to pump inlet is 22'-0" at sea level. As altitude increases, maximum lift decreases as shown in table below.

ALTITUDE, FT.	*Sea*	*1000*	*2500*	*4000*	*5000*	*6500*	*8000*
MAX. PRACTICAL SUCTION LIFT, FT.	22	21	20	18	17	16	15

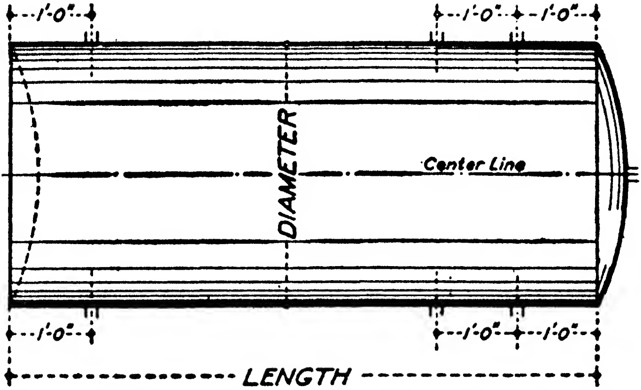
Friction loss occurs in all pipe runs; and, by reducing the head, may materially affect choice of type of system and of location of units. Amount of loss depends on: (1) pipe size; (2) length of run; (3) water pressure. Examples: In 100'-0" of ¾"-pipe head is reduced 1'-11" at 2-lb. pressure, 136'-0" at 20-lb. For 2" pipe, head is reduced 6" per 100'-0" at 10-lb., 6'-7" at 40-lb. Sharp elbows increase friction loss. If friction loss is unavoidable, any of several means of overcoming it may be used, depending on local conditions. Pipe sizes or pump size may be increased; or a high pressure pump may be installed.

The casing is the lining of a driven well, or a supplementary lining in a dug well, which houses well piping. In old wells, its diameter may limit pump size. In new wells, 4" casings (minimum) are advisable; 6" diameter is preferred. Well seal is a sanitary ground level cap, required by some states.

PISTON PUMP. On its forward stroke, the piston creates vacuum which draws in water; the back stroke forces accumulated water into a discharge chamber. Most are double-acting; a single stroke forces water out of one chamber while drawing fresh water into the other, thus producing a more constant flow. Piston pumps deliver rated capacities at any stage of lift (0'-0" to 22'-0"), at normal pressures (20 to 40 lb.). Piston pumps are slightly less quiet and compact than ejectors.

EJECTOR PUMP is centrifugal; a motor-driven impeller scoops up water, forces it outward into discharge lines, and by thus creating vacuum draws in more water. In addition, ejector pumps have built into them a Venturi, or device for increasing their capacity. Ejectors operate most satisfactorily when suction lift approximates 15'-0", and discharge head (pump to highest fixture) is 40'-0" maximum.

HOT WATER STORAGE TANKS



In accordance with unanimous action of 2 general conferences of manufacturers, distributors and users of hot water storage tanks, the U. S. Department of Commerce recommends that simplified dimensions and capacities of hot water storage tanks be established as follows: The tanks to be made in 2 working pressures; 65 pounds classified as *standard*, 100 pounds classified as *extra heavy*. Each tank is to be stenciled with its classification, working pressure, and name and address of its manufacturer. There are 6 tappings in each tank, placed as shown in the diagram above. 11x15-inch manholes may be placed either in the shell or the convex end. 4x6-inch hand holes may be located as desired. The tanks are interchangeable for either horizontal or vertical installation.

STANDARD TANK SIZES

Diameter	*Length*	*Gallons*	*Diameter*	*Length*	*Gallons*
20"	5 ft.	82	42"	7 ft.	504
24"	5 ft.	118	42"	8 ft.	576
24"	6 ft.	141	42"	10 ft.	720
30"	6 ft.	220	42"	14 ft.	1,008
30"	8 ft.	294	48"	10 ft.	940
36"	6 ft.	318	48"	16 ft.	1,504
36"	8 ft.	423	48"	20 ft.	1,880

MINIMUM SIZE HEATING COILS

Tank dimensions		*Size of pipe*	*Minimum length of heating coil*	*Tank dimensions*		*Size of pipe*	*Minimum length of heating coil*
Diameter	*Length*			*Diameter*	*Length*		
20"	5 ft.	1"	14 ft.	42"	7 ft.	1½"	22 ft.
24"	5 ft.	1¼"	14 ft.	42"	8 ft.	1½"	26 ft.
24"	6 ft.	1¼"	18 ft.	42"	10 ft.	1½"	34 ft.
30"	6 ft.	1¼"	18 ft.	42"	14 ft.	1½"	50 ft.
30"	8 ft.	1¼"	26 ft.	48"	10 ft.	2"	34 ft.
36"	6 ft.	1½"	18 ft.	48"	16 ft.	2"	58 ft.
36"	8 ft.	1½"	26 ft.	48"	20 ft.	2"	74 ft.

CAPACITY OF TANKS

CYLINDRICAL TANKS

Depth or Length	DIAMETER 18-in.	24-in.	30-in.	36-in.	42-in.	48-in.	54-in.	60-in.
1 Inch	1.10	1.96	3.06	4.41	5.99	7.83	9.91	12.24
1 ft.	13.	23.	37.	53.	72.	94.	119.	147.
1½ ft.	20.	35.	55.	79.	108.	141.	179.	220.
2 ft.	26.	47.	73.	106.	144.	188.	238.	294.
2½ ft.	33.	59.	92.	132.	180.	235.	298.	367.
3 ft.	40.	71.	110.	159.	216.	282.	357.	441.
3½ ft.	46.	82.	129.	185.	252.	329.	417.	514.
4 ft.	53.	94.	147.	211.	288.	376.	476.	587.
4½ ft.	59.	106.	165.	238.	324.	423.	536.	661.
5 ft.	66.	117.	183.	264.	360.	470.	595.	734.
5½ ft.	73.	129.	202.	291.	396.	517.	657.	808.
6 ft.	79.	141.	221.	317.	432.	564.	714.	881.
7 ft.	92.	164.	257.	370.	504.	658.	833.	1028.
8 ft.	106.	188.	294.	424.	576.	755.	952.	1175.
9 ft.	119.	212.	330.	476.	644.	846.	1071.	1322.
10 ft.	132.	235.	372.	530.	720.	940.	1190.	1475.
12 ft.	157.	282.	440.	634.	864.	1128.	1428.	1755.
14 ft.	185.	329.	514.	740.	1000.	1316.	1665.	2056.
16 ft.	211.	376.	587.	846.	1152.	1500.	1904.	2350.
18 ft.	238.	423.	661.	952.	1296.	1692.	2142.	2644.
20 ft.	264.	470.	734.	1057.	1440.	1880.	2430.	2940.

To find how many U. S. gallons a cylindrical tank will hold: Multiply the square of the inside diameter by 0.7854, which gives the area; multiply that result by the depth and this gives the cubic contents of the tank. If measurements are in inches, divide the cubic contents by 1728 and you then have contents expressed in cubic feet; then multiply by 7.4805 (U. S. gallons in each cubic foot of water) and the final result is the number of U. S. gallons the tank will contain.

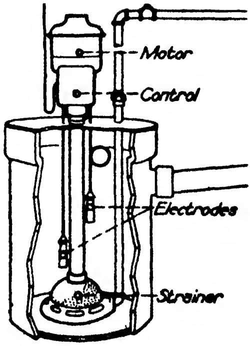
RECTANGULAR TANKS

To find how many U. S. gallons any rectangular tank will hold: Multiply the inside length, depth and width, which gives the contents of the tank in cubic inches, or in cubic feet, as case may be. If in inches, divide by 1728 and you have the contents in cubic feet. Then multiply that result by 7.4805 (U. S. gallons in each cubic foot of water) and the final result is the number of U. S. gallons the tank will contain.

A gallon of water (U. S. standard) weighs 8 1/3 lbs. and contains 231 cubic inches.

A cubic foot of water contains 7 1/2 gallons, 1728 cubic inches, and weighs 62 1/2 lbs.

DESCRIPTION OF SUMP PUMPS



GENERAL CHARACTERISTICS. Every part of the floatless sump pump is built to assure dependable service under the most severe operating conditions, as shown by service records of many thousands of installations Pump is simple and rugged in construction and carefully engineered by Imperial.

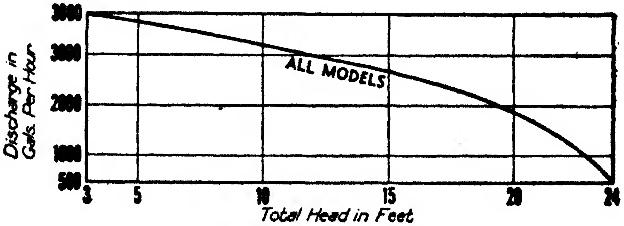
MOTOR. Motor has oil-sealed ball thrust bearing for vertical operation. Will not cause radio interference. 115-volts, 60 cycles, A.C., std. 230-volts optional. Wide range of cycle frequencies available.

ELECTRIC CONTROL. Motor on sump pump is started and stopped automatically by 2 adjustable electrodes which hang down into the sump pit. Electrodes are attached to an electrical relay. Motor starts when water reaches upper electrode; stops when water drops below lower electrode. Positive in action; no moving parts in water. No float to stick, clog or become damaged due to mud, debris or corrosion.

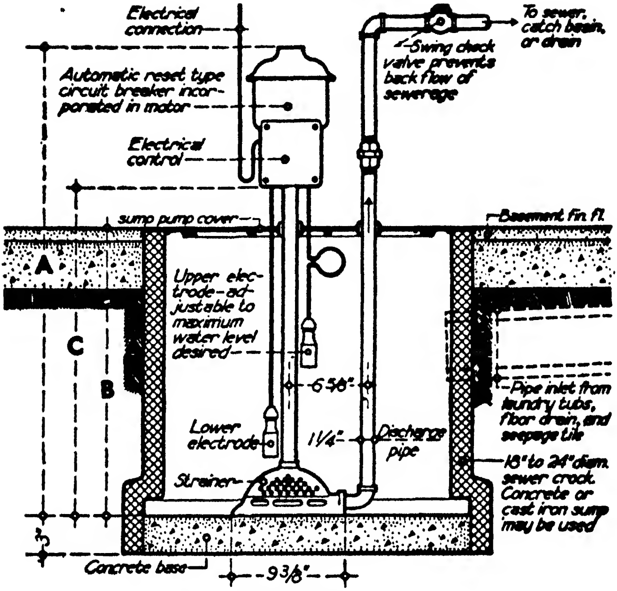
BRASS AND BRONZE CONSTRUCTION. All parts of pump which come in contact with water are brass or bronze construction. This assures long service; no rusting.

HOW TO SELECT PUMP SIZE. Made in 5 models for sumps from 2′-0″ to 8′-0″ deep. Sump depth determines model required. All models have same high pumping capacity.

Chart below gives discharge capacities against various discharge heads. To determine approx. total discharge head on average job (where total head is approx. 20′-0″), measure vertical distance or elevation in feet from bottom of sump to highest point in discharge line, and add ¼ ft. for each foot of pipe and ¾ ft. for each elbow.



DIMENSIONS OF SUMP PUMPS



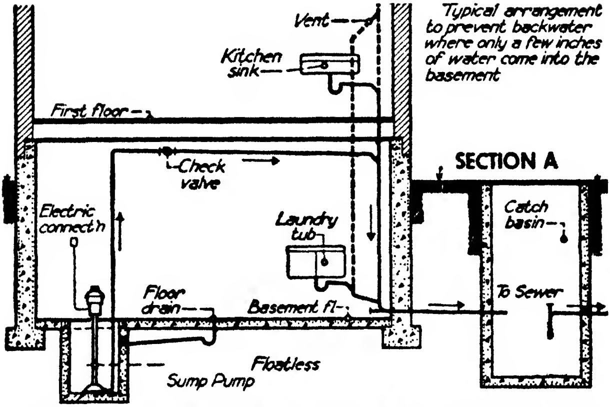
FLOATLESS SUMP PUMP

MODEL	A Height of Pump	B Depth of Sump	C Base to Motor	Motor H.P.
BA-2	3'-3 3/4"	2'-0"	2'-4"	1/4
C-3	4'-3 3/4"	3'-0"	3'-4"	
C-4	5'-3 3/4"	4'-0"	4'-4"	
C-6	7'-3 3/4"	6'-0"	6'-4"	
C-8	9'-3 3/4"	8'-0"	8'-4"	

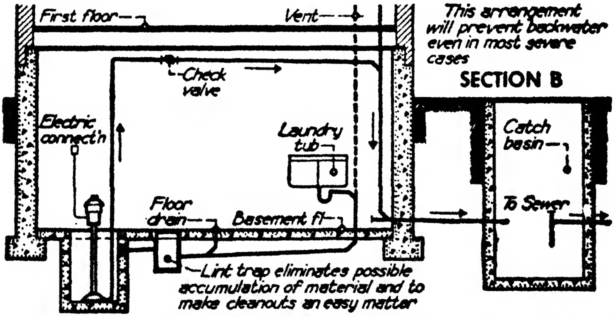
SUMP PUMP COVERS		
NO.	Size of Crock	Outside Diameter
1	1'-3" to 1'-6"	1'-7 3/4"
2	1'-9" to 1'-10"	2'-0"
3	2'-0"	2'-3 1/2"

Installation of the floatless sump pump is simple. The pit can be made by sinking an 18- or a 24-inch length of sewer crock into the earth. Sump pump covers are available to prevent dirt from the floor washing into the pit. Special mountings for suspending pump on cover can be supplied for unusual conditions.

DIAGRAMS OF SUMP PUMP INSTALLATIONS

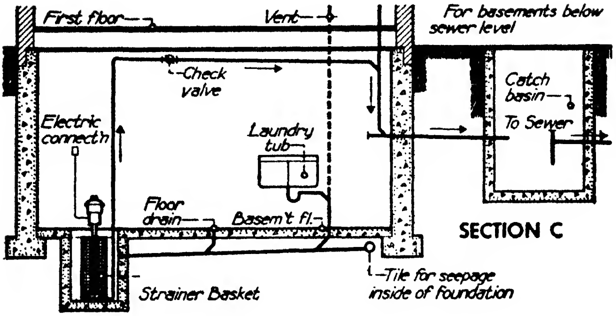


BACKWATER PREVENTION FOR ORDINARY CONDITIONS. Overloading of the city sewer often results in the flooding of basements. This diagram shows how the basement may be entirely cut off from drain connections thru which backwater may enter. It would be necessary for the water in the sewer (and catch basin) to reach the height of the laundry tub rim to become a hazard. The catch basin is shown since certain localities make it mandatory. The catch basin acts as a large size grease trap, allowing only clear water to enter the sewer. It should be noted that fixtures discharging solid wastes are not drained to the sump pit nor to the catch basin. Therefore, they must be above the level of the sewer and connected directly to it thru the usual house drain trap.



BACKWATER PREVENTION FOR SEVERE CONDITIONS. By also draining the laundry tubs into the sump pit, thru a lint trap, the height which is safe against backwater becomes sufficient to provide for the most severe conditions. Otherwise *Section B* corresponds to *Section A* above. The lint trap prevents the accumulation of material which might clog the sump pump strainer. See also Section C

DIAGRAM OF SUMP PUMP INSTALLATION



SECTION C

DRAINAGE FOR FIXTURES BELOW SEWER LEVEL. Because the basement floor is considerably below the level of the city sewer does not mean that the occupant must be denied the conveniences of plumbing in the basement. The floor drain for convenience in cleaning, laundry tubs, or other fixtures not discharging solid wastes, may be utilized in connection with a floatless sump pump. In *Section C* is shown such a piping diagram. The backing up of the sewer due to storms and other causes cannot flood a basement having such an arrangement of waste lines.

The catch basin is required in many localities, to prevent grease and soap from sinks and tubs from reaching the sewer.

In this diagram is shown an alternate method of preventing lint from entering the sump pit, thru the use of a strainer basket.

Notice the foundation drain tile to pick up seepage of ground water from around footings. Ground water can be kept from entering the basement in this manner with any of the diagrams shown.

WHERE THERE IS NO SEWER. Buildings on level sites, having no city sewer for wastes, often make use of a septic tank disposal system. Since the drain field of such a system must be close to the surface of the ground to make use of the bacteria which attack and purify the outflow, the entrance to the septic tank system may be well above the basement level (on sloping sites this would not be true). The condition becomes, therefore, similar to that shown in *Section C* above, except that a grease trap might be substituted for the catch basin. The grease trap, if used, should not receive waste from cellar drains, or other waste.

BASEMENT WALL LEAKAGE. Occasionally, buildings are built in soil which does not allow ground water from storms to soak away and a poor foundation permits this waten to seep into the building periodically. Such conditions frequently occur during the spring thaws and rains. If the foundation is porous, it is practically impossible to render it water-tight from the inside—and it is too late to attack the problem from the exterior. The use of a sump pump can often be made to alleviate such conditions by removing the water as fast as it accumulates, by trenching radially from a sump pit, under the basement floor. Open drain tile are laid, the trench is backfilled with coarse stones. Of course, the basement floor construction must be cut and patched for such an operation.

OTHER USES. Boiler pits, settling basins, flywheel and elevator pits and similar places may develop seepage problems or may require means of removing drainage when the sewer is at a higher elevation.

SEPTIC TANK
SEWAGE DISPOSAL

CAST IRON SOIL PIPE. Should extend 5′ outside the foundation wall, where the tile line should begin. If a well or other water supply is located nearer than 50′ from this point, the cast iron pipe should be extended. The water supply should not be on the down-hill side of the sewage disposal system.

GREASE TRAP. The septic tank may give trouble or a sewer line may clog from the collection of grease, most of which comes from the kitchen. There should be a grease trap in the kitchen line.

SEPTIC TANK ACTION. In a septic tank some of the solid matter floats on the surface as scum or "mat" and the heavier solids settle to form sludge. The septic tank causes the retained scum and sludge to decompose by biochemical action in the absence of oxygen, materially reducing the volume of the solids.

SEPTIC TANK. The septic tank should be watertight. Walls, top, and floor should be reinforced. The inlet and outlet of the first or settling chamber are arranged so as not to disturb the sludge or scum and carry solid particles to clog the following part of the system. An automatic siphon discharges the contents of its chamber normally about every eight hours, flooding the drain field pipes. The tank should be tightly covered to prevent spread of odors, transmission of disease germs by flies, and accidents to children. It should have a foot or two of earth covering to secure uniformity of temperature and warmth in winter to aid the biochemical action.

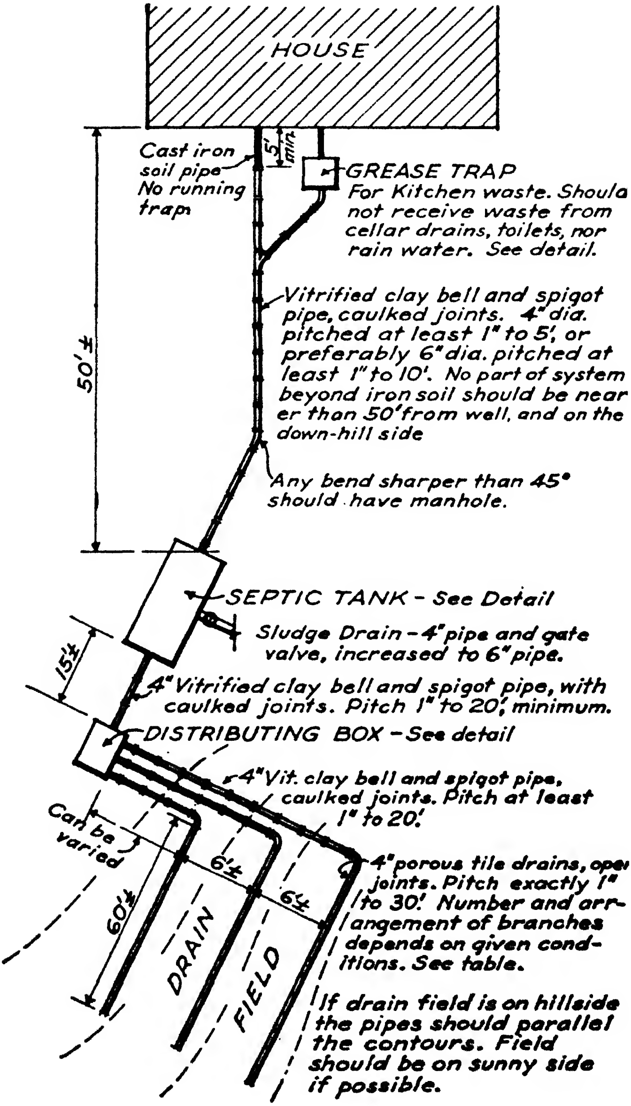
DISTRIBUTING BOX. This device insures the equal distribution of the outflow to each of the drain field branches, and is recommended in preference to the scheme of branching directly from a main pipe with the leeching pipes.

DRAIN FIELD. The outflow of the septic tank, which contains disease germs and foul smelling matter in liquid form, soaks through the top soil from the subsurface drain pipes. The top 10 or 20″ of soil contains friendly bacteria which attack and purify the outflow. The siphon acting intermittently allows a rest period between discharges to better handle this process. The whole system should be watertight except these drain field pipes, which are meant to leak.

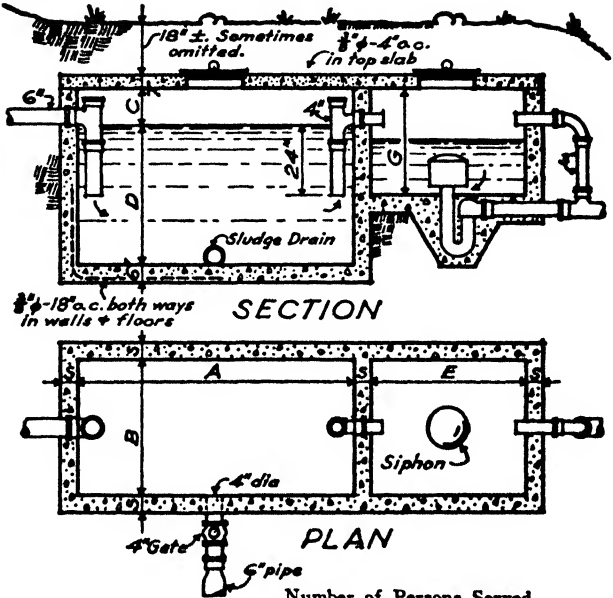
MAINTENANCE. Some tanks need cleaning every year, while some experimental tanks built in New Hampshire were working satisfactorily after eleven years without cleaning. When both scum and sludge together have accumulated to a thickness of 2′ the tank should be cleaned. The 6″ sludge drain pipe should lead to a shallow pit in the ground, located more than 100′ away and down the slope from any well or spring. The pit should be about 2′-6″ deep and large enough to hold the contents of the septic tank and covered over the top with boards and earth. The contents of the tank may be drawn off into this pit and there allowed to leech and dry out until the next cleaning is necessary. Just before the next cleaning the pit should be opened and the dried-out sludge disposed of as manure.

BIBLIOGRAPHY. U. S. Government publications: *"Sewage Disposal for Suburban and Country Homes,"* supplement No. 58 to the Public Health Reports; *"Sanitary Disposal of Sewage Through a Septic Tank,"* by H. R. Crohurst, reprint No. 625 of the Public Health Reports: *"Sewage Disposal on the Farm,"* by George M. Warren, Dept. of Agriculture No. 712.

SEPTIC TANK SEWAGE DISPOSAL



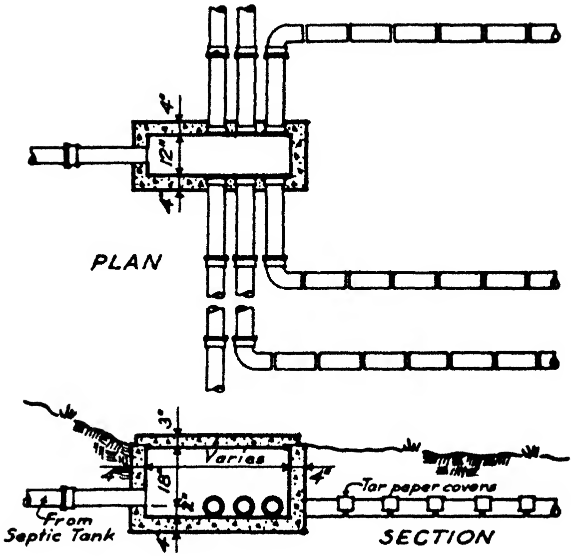
SEPTIC TANK
SEWAGE DISPOSAL



	Number of Persons Served						
SEPTIC TANK DIMENSIONS	1-9	10-14	15-20	21-25	26-30	31-35	36-40
A—Length	6'-0"	7'-0"	8'-0"	9'-0"	9'-6"	10'-0"	10'-6"
B—Width	2'-6"	3'-6"	4'-0"	4'-6"	4'-8"	5'-0"	5'-3"
C—Air Space ...	1'-0"	1'-0"	1'-0"	1'-0"	1'-3"	1'-3"	1'-3"
D—Liquid Depth..	4'-0"	4'-0"	4'-0"	4'-3"	4'-6"	4'-8"	4'-9"
E—Length	3'-0"	3'-6"	4'-0"	4'-6"	4'-8"	5'-0"	5'-3"
G—Depth	3'-0"	3'-0"	3'-0"	3'-0"	3'-6"	3'-6"	3'-6"
THICKNESS OF CONCRETE							
S—Walls	6"	6"	6"	7"	8"	8"	9"
T—Top	4"	4"	4"	5"	5"	5"	5"
SIPHON DIMENSIONS							
Size	*4"	4"	4"	4"	5"	5"	5"
Drawing Depth ..	17"	17"	17"	17"	23"	23"	23"
LINEAR FEET of 4" DRAIN TILE IN FIELD							
Sandy Soil	200	340	475	600	725	850	975
Medium Soil	350	500	650	800	1025	1150	1300
Clay Soil	700	1000	1250	1500	1800	2100	2400
MIN. NO. OF DRAIN FIELD BRANCHES							
Sandy Soil	3	5	6	8	10	11	12
Medium Soil	4	6	7	9	11	12	13
Clay Soil	7	10	12	14	16	18	20

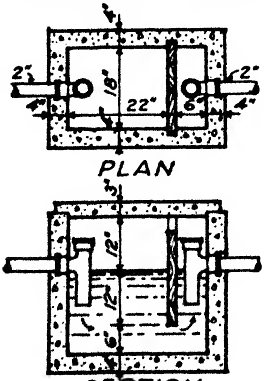
* In this smallest size the siphon is sometimes omitted.

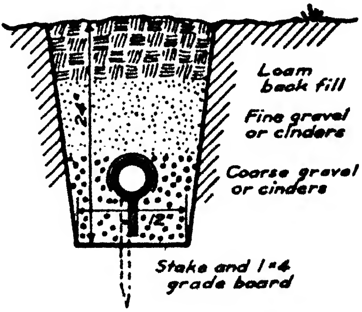
SEPTIC TANK SEWAGE DISPOSAL



DISTRIBUTING BOX

GREASE TRAP





DRAIN TILE TRENCH

Except in very dry, porous soils this detail should be followed.

HEAT LOSS BY Btu METHOD

Heat flows from substances of higher temperature to substances of lower temperature. To maintain the warmth of a room when the adjacent temperatures are lower, we must add to the air in the room an amount of heat equal to that which is constantly flowing away.

Calculation of a heating installation is divided into 2 parts. *First,* the Heat Loss must be determined. *Second,* the conditions required to balance that loss must be calculated. This may be expressed simply thus:

Heat to Be Supplied = Heat Loss

Quantities of heat are measured in British thermal units, called "Btu's." A Btu is the amount of heat required to raise the temperature of 1 lb. of water 1°F. Heating calculations are made on the basis of one hour as the unit of time.

Heat is lost from a room in 3 ways, viz.: (1) heat loss thru glass; (2) heat loss thru outside walls, floors, and ceilings; heat loss thru walls, floors, and ceilings adjacent to unheated spaces; (3) heat loss by infiltration. This may be simply expressed thus:

$$\textit{Heat to Be Supplied} = HL_G + HL_W + HL_I$$

The following *Data Sheets* will be devoted to the calculation of the 3 quantities involved.

To make heat loss calculations it is necessary to arrive at the temperature at which the room is to be maintained, known as the "inside temperature," indicated as t_i.

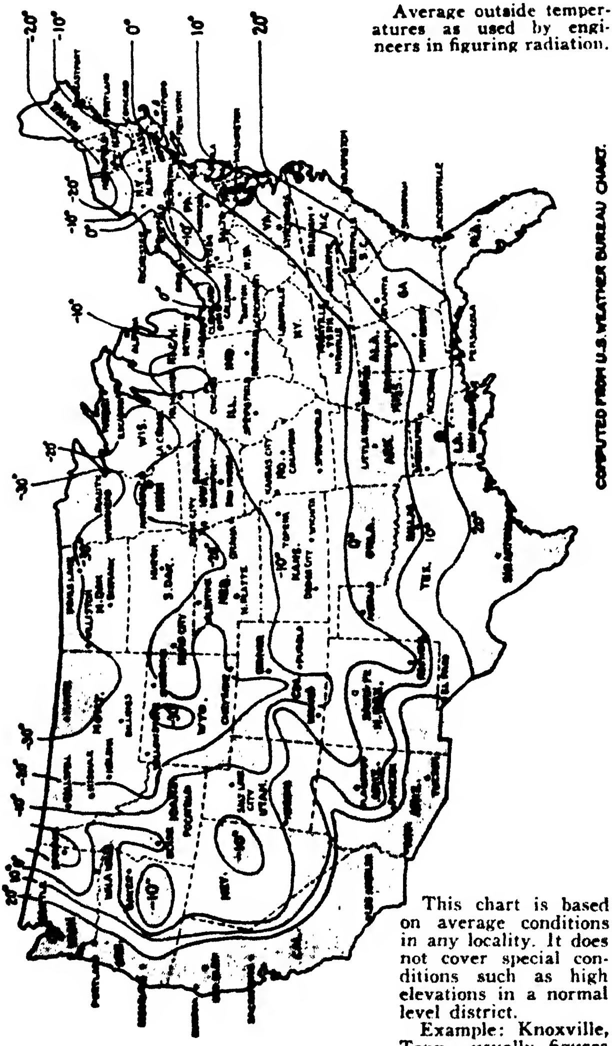
TABLE A. t_i VALUES USUALLY SPECIFIED

Schools	
Classrooms	70-72° F.
Assembly Rooms	68-72° F.
Gymnasiums	55-65° F.
Toilets and Baths	70° F.
Wardrobe and Locker Rooms	65-68° F.
Kitchens	66° F.
Dining and Lunch Rooms	65-70° F.
Playrooms	60-65° F.
Natatoriums	75° F.
Hospitals	
Private Rooms	70-72° F.
Private Rooms (surgical)	70-80° F.
Operating Rooms	70-95° F.
Wards	68° F.
Kitchens and Laundries	66° F.
Toilets	68° F.
Bathrooms	70-80° F.
Theaters	
Seating Space	68-72° F.
Lounge Rooms	68-72° F.
Toilets	68° F.
Hotels	
Bedrooms and Baths	70° F.
Dining Rooms	70° F.
Kitchens and Laundries	66° F.
Ballrooms	65-68° F.
Toilet Service Rooms	68° F.
Homes	70-72° F.
Stores	65-68° F.
Public Buildings	68-72° F.
Warm Air Baths	120° F.
Steam Baths	110° F.
Factories, Machine Shops	60-65° F.
Foundries and Boiler Shops	50-60° F.
Paint Shops	80° F.

It is also necessary to determine the "outside temperature," called t_o. A temperature of 15° above the lowest on record is usually assumed — since extremely low temperatures are usually of short duration and are rarely repeated in successive years.

t_0 = OUTSIDE TEMPERATURES

Average outside temperatures as used by engineers in figuring radiation.



This chart is based on average conditions in any locality. It does not cover special conditions such as high elevations in a normal level district.

Example: Knoxville, Tenn., usually figures 0° to desired inside temp.

HL_G = HEAT LOSS THRU GLASS

The amount of heat in Btu which is lost per square foot per hour per degree difference in temperature is called the *coefficient of heat transmission*. These coefficients which apply to glass and glazing are indicated by the symbol k_G. It should be obvious from the definition that the total heat loss thru a window or skylight would be its area in square feet *times* the coefficient *times* the difference in temperature. This can be expressed as follows:

$$\textit{Total Loss thru Glass} = A_G \, k_G \, (t_i - t_o)$$

The areas of windows, skylights and other glazed areas are calculated from the architectural drawings. Doors with thin panels of veneer wood or similar material are calculated as glass areas. The coefficients of transmission will appear on following *Data Sheets.*

Assume that a room contains 2 windows measuring 3′ x 5′. The total area would be 30 square feet. The coefficient for a single glazed window is 1.13. With a difference in temperature of 70° F. the calculation would be thus:

$$\textit{Heat Loss thru Windows} = 30 \textit{ sq. ft.} \times 1.13 \textit{ Btu's} \times 70^\circ \textit{ diff.} = 2{,}370 \textit{ Btu}$$

The loss thus obtained is considered the *heat loss thru glass,*

FULL AREA OF TWO-PANE WINDOWS

Giving the total area of two-pane windows, including the sash

Width Glass	*Width of Opening*	*Height Glass* 18″ / *Height of Opening* 3′-6″	24″ / 4′-6″	30″ / 5′-6″	36″ / 6′-6″	42″ / 7′-6″	48″ / 8′-6″
24″	2′-4″	8.2	10.5	12.8	15.1	17.4	19.8
26″	2′-6″	8.7	11.2	13.7	16.2	18.7	21.2
28″	2′-8″	9.3	12.0	14.7	17.3	20.0	22.6
30″	2′-10″	10.0	12.8	15.6	18.4	21.2	24.0
32″	3′-0″	10.5	13.5	16.5	19.5	22.5	25.5
34″	3′-2″	11.0	14.3	17.4	20.6	23.7	27.0
36″	3′-4″	11.7	15.0	18.3	21.6	25.0	28.3
38″	3′-6″	12.2	15.8	19.2	22.7	26.2	29.8
40″	3′-8″	12.8	16.5	20.1	23.8	27.4	31.2
42″	3′-10″	13.4	17.3	21.0	24.9	28.6	32.6
44″	4′-0″	14.0	18.0	22.0	26.0	30.0	34.0
46″	4′-2″	14.6	18.8	23.0	27.1	31.2	35.5
48″	4′-4″	15.2	19.5	23.8	28.1	32.4	36.8
50″	4′-6″	15.7	20.3	24.8	29.2	33.7	38.2
52″	4′-8″	16.3	21.0	25.6	30.3	35.0	39.6
54″	4′-10″	16.9	21.8	26.6	31.4	36.2	41.0
56″	5′-0″	17.5	22.5	27.5	32.5	37.5	42.5

HL_W = HEAT LOSS THRU WALLS

The amount of heat in Btu which is lost per square foot per hour per degree difference in temperature is called the *coefficient of heat transmission.* The coefficients which apply to walls, floors, and ceilings are indicated by the symbol k_W. It should be obvious from the definition that the total heat loss thru outside wall, floor, or ceiling, or thru a wall, floor, or ceiling adjacent to an unheated space would be the area of the wall in square feet *times* the coefficient *times* the difference in temperature. This can be expressed as follows:

$$\textit{Total Loss thru Wall} = A_W \; k_W \; (t_i - t_o)$$

The areas of walls, floors, or ceilings are calculated from the architectural drawings. The coefficients of transmission will appear on following *Data Sheets.*

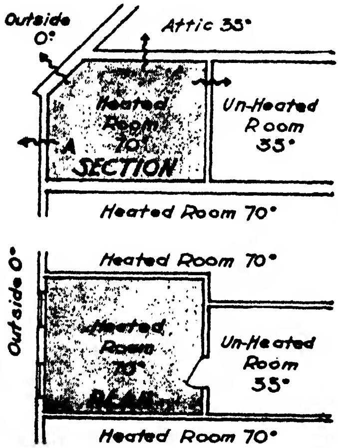


Figure 1

The temperature of unheated spaces in a building is usually taken as the mean between the room and the outside design temperature. For instance, if the outside design temperature has been taken as 0°F., and the temperature of the room has been taken as 70°F.—the temperature of unheated spaces in the building would be assumed as 35° F. It is also possible that a basement room might have part of its outside wall below grade and part above grade. In such a case the t_o of the ground is taken at 50°F.

Reference to *Figure 1* will serve as an illustrated example. From the drawing the total area of the wall exposed to the outside *(Arrow A)* may be calculated as 96 square feet, from which we subtract the area of the windows, 30 square feet, giving an actual wall area of 66 square feet. We will assume the coefficient for this type of wall construction to be 0.25 with a difference in temperature of 70°F. The calculation would be thus:

Heat Loss thru Wall = *66 sq. ft. x 0.25 Btu x 70° diff.*
= *1,155 Btu*

A single room may have a wall which is exposed to the outside, a portion of the roof may be similarly exposed, the floor, ceiling, or inside partitions may be exposed to adjacent unheated spaces. Separate calculation is necessary for each condition, as marked by arrows on *Figure 1.* The sum of the losses thus obtained is considered the *heat loss thru walls.*

HL_I = HEAT LOSS BY INFILTRATION

Cold air from the outside enters a building thru cracks in the construction and sometimes through the walls themselves. Some engineers calculate the exact length of all cracks around windows, doors, etc., and arrive at a theoretical volume of air admitted. For most cases, however, it has become practice to assume a certain number of complete changes of air in a room per hour.

The usual number of air changes used in heating work will be found in *Table C* below. Whether or not the actual infiltration of air amounts to the number of air changes shown in the table, it has been found that the heating system should allow for the number given. Doors and windows are opened for ventilation purposes, thus changing the air in the room, even though there is actually a very small infiltration. In rooms having forced systems of ventilation part of the heat loss may be supplied by the warmed air and part by the radiation in the room.

The cubic contents of the room *times* the number of air changes per hour will give the volume of air which must be heated. It requires .018 Btu to raise one cubic foot of air 1° F. Therefore, if we multiply the total volume of air by .018 we will have the number of Btu's required to raise this air in temperature 1° F. Then, if this quantity is multiplied by the number of degrees it is required to raise the temperature, we will have the total heat required to balance the infiltration loss. This may be expressed as follows:

$$HL_I = .018\ n\ C\ (t_i - t_o)$$

Assume a room having a floor area of 10 feet by 12 feet with a ceiling height of 9 feet. The cubic contents will be 1,080 cubic feet. If two air changes an hour are desirable, the calculation then becomes:

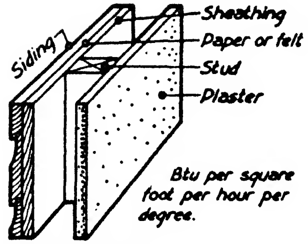
$$HL_I = .018 \times 2 \times 1080 \times 70$$
$$= 2{,}720\ Btu$$

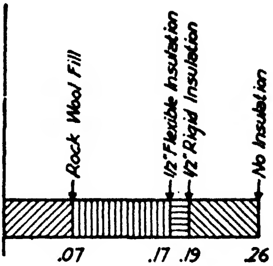
The loss thus obtained is considered the *heat loss by infiltration*

TABLE C. n VALUES

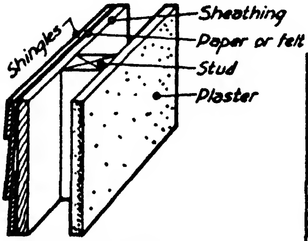
Type or exposure	*Number*
Rooms, no windows or outside doors	½
Rooms, exposure 1 side	1
Rooms, exposure 2 sides	1½
Rooms, exposure 3 sides	2
Rooms, exposure 4 sides	2
Living Rooms in Residences	1 to 2
Stairways and Halls	½ to 1
Bedrooms	1½
Small Convention Halls	4
General Offices	3
Private Offices	4
Public Dining Rooms	4
Banquet Halls	5
Basement Restaurants	8 to 12
Hotel Kitchens	4 to 6
Public Libraries	3

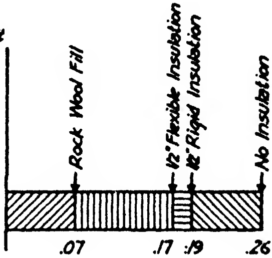
"U" VALUES
FOR FRAME WALLS



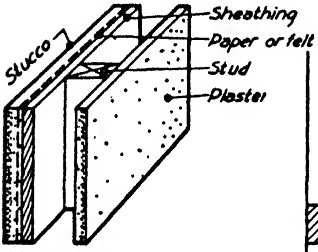


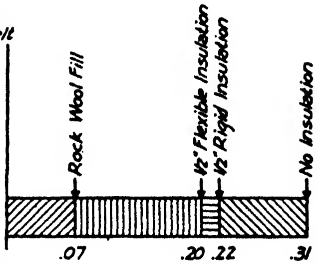
WOOD SIDING



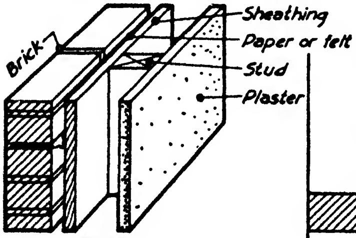


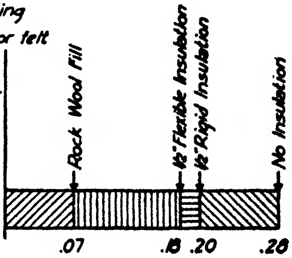
WOOD SHINGLES





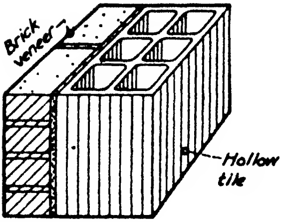
STUCCO

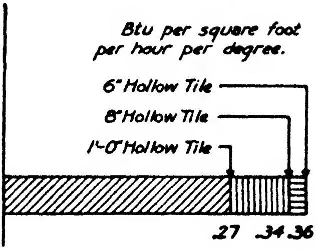




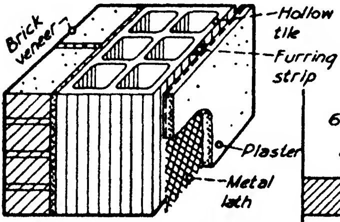
BRICK VENEER

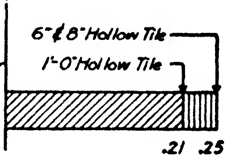
"U" VALUES FOR MASONRY WALLS



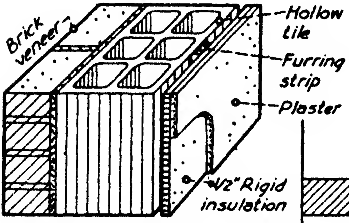


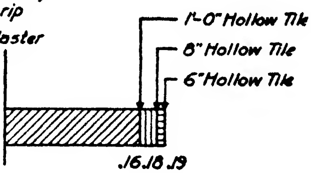
NO INTERIOR FINISH



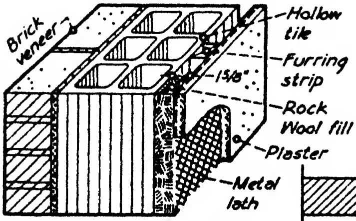


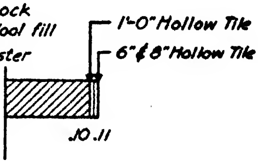
METAL LATH AND PLASTER





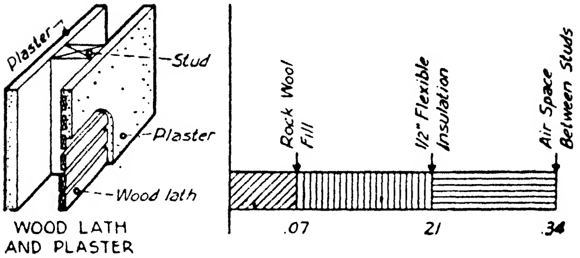
1/2" RIGID INSULATION AND PLASTER

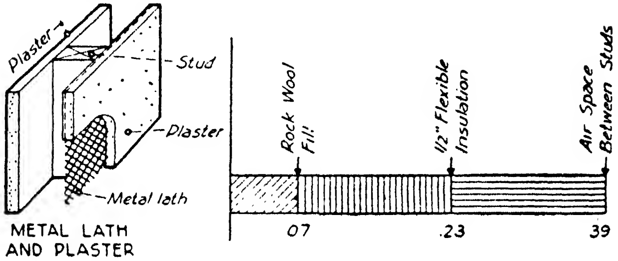


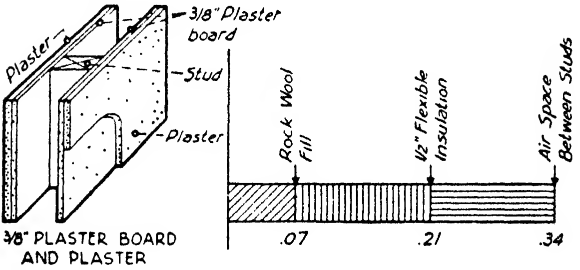


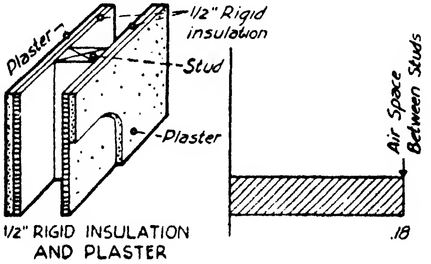
ROCK WOOL FILL, METAL LATH AND PLASTER

"U" VALUES FOR INTERIOR PARTITIONS



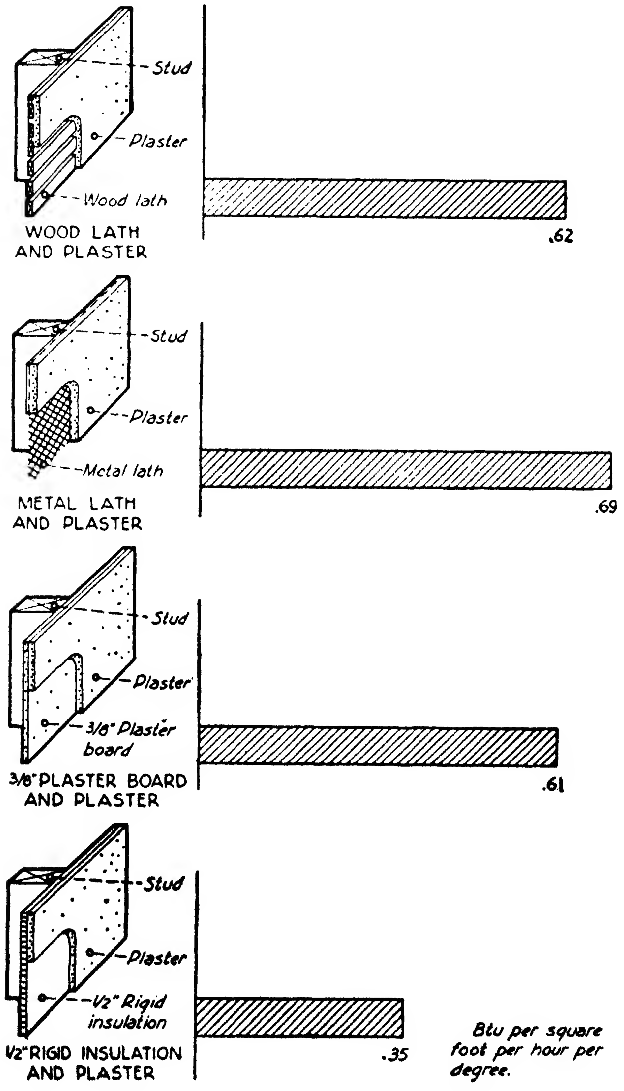




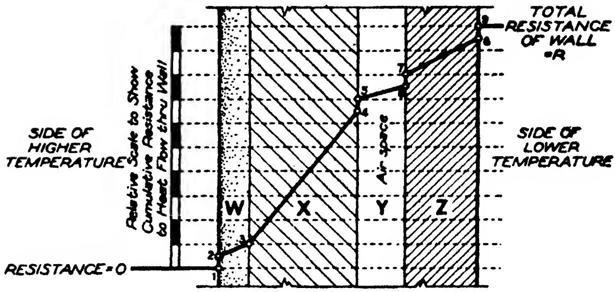


Btu per square foot per hour per degree.

"U" VALUES FOR INTERIOR PARTITIONS



HOW TO FIGURE HEAT LOSS COEFFICIENTS



The heat loss thru a wall, floor or roof depends upon the over-all resistance of the construction to heat flow.

In the drawing above is shown graphically how the over-all resistance of a heterogeneous wall is made up of the numerical sum of the resistances of the various parts. The total resistance to heat flow increases as we proceed thru the wall from the side of higher temperature toward the side of lower temperature. There are 4 types of resistance which may go to make up the total over-all resistance (R) of a given wall.

F = The surface or film resistances.

M = The resistances of the solid materials.

A = The resistance of the air space, or spaces.

I = Resistance of insulating materials.

F = FILM RESISTANCE. The surface of a material exposed to air offers a resistance to heat flow which is called the film resistance and is indicated here by the letter F, with a subscript for identification in case there are several. In the illustration, F_{1-2} is the film resistance of the wall face on the side of higher temperature. F_{4-5} and F_{6-7} are the film resistances of the surfaces facing air space and are included in the value of A_{4-7} in making calculations. F_{8-9} is the resistance of the surface on the side of lower temperature.

In still air the film resistance of a vertical surface, such as the interior plastered wall of a house, would have a value of 0.66. The exterior film would be different since these are usually determined experimentally upon the assumption of an air movement of 15 miles per hour. The sum of F_{1-2} plus F_{8-9} can be indicated by the symbol ΣF.

Where 2 different materials are in contact as at 3, there is no film resistance.

The film resistance of a horizontal surface will be different than that for the same material in a vertical position and the direction of the heat flow also affects the resistance value. The following table presents typical resistance values for various types of surfaces.

Ordinary Surfaces	*Values of F*
Vertical surfaces, still air, heat flow horizontal	0.66
Horizontal surfaces, still air, heat flow upward	0.51
Horizontal surfaces, still air, heat flow downward	0.83
Outside vertical surfaces, air 15 mph	0.17

HOW TO FIGURE HEAT LOSS COEFFICIENTS

M = RESISTANCE OF SOLID MATERIALS. Different materials used for wall construction have different resistances. Material W in the illustration, for instance, might have considerably less resistance than material X. The resistance of the body of a material is indicated by the letter M with a subscript for identification where several materials are used.

In the illustration, the resistance of material W is shown by the line 2-3 and the vertical distance would indicate the amount of the resistance. The sum of Mw plus Mx plus Mz can be indicated by the symbol ΣM. The following table presents typical resistance values for various types of materials.

The resistance of *heterogeneous* materials, such as hollow tile or plasterboard made of gypsum between layers of heavy paper, do not vary directly as the thickness—and values for each thickness have to be determined experimentally. However, when the resistance of a *homogeneous* material for 1" thickness is known, the resistance for other thicknesses are found by direct proportion, i.e., 2" thickness has twice the resistance of a 1" thickness.

Type of Material	*Thickness*	*Values of M*
Average Brickwork	1"	0.15
"	4"	0.60
"	8"	1.20
"	12"	1.80
Typical Stone Masonry or Concrete Work	1"	0.08
"	4"	0.32
"	8"	0.64
"	12"	0.96
"	16"	1.28
Hollow Clay Tile Masonry	4"	1.00
"	6"	1.60
"	8"	1.70
"	12"	2.50
Gypsum, Solid	1"	0.50
Sand and Gravel Hollow Core Concrete Blocks	12"	1.30
Cinder Hollow Core Concrete Blocks	1"	1.75
Gypsum between Layers of Heavy Paper	3/8"	0.26
"	1/2"	0.35
"	1"	0.70
Cement and Asbestos Building Board	1"	0.37
Cement Plaster (Stucco)	1"	0.08
Metal Lath and Gypsum Plaster	23/32"	0.23
Wood Lath and Gypsum Plaster	23/32"	0.40
Fir Sheathing and Building Paper	25/32"	1.16
Fir Sheathing, Building Paper and Yellow Pine Siding		2.00
Fir Sheathing, Building Paper and Stucco		1.22
Maple Flooring	25/32"	0.65
"	1"	0.83
Battleship Linoleum	1/4"	0.74
Cement and Asbestos Building Boards	1"	0.37
Asphalt Roofing		0.15
Tile or Terrazzo Flooring	1"	0.08

HOW TO FIGURE HEAT LOSS COEFFICIENTS

A = AIR SPACE RESISTANCE. Heat is conducted across an air space by a combination of radiation, conduction and convection. The resistance of an air space increases with the air space width until about ¾" has been reached—after which the width has but little effect.

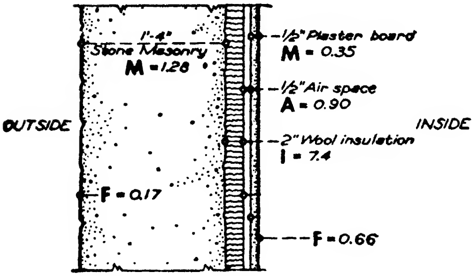
In the illustration the resistance of air space Y is shown by the line 5-6 and the vertical distance indicates the air space resistance which can be identified by the symbol A_Y. In a wall having several air spaces their total resistance can be identified by the symbol ΣA. Air spaces bounded by very smooth reflective or rough surfaces vary somewhat from the resistance of air spaces bounded by such ordinary materials as paper, wood, plaster, etc. The following table gives typical resistance values for spaces bounded by ordinary materials and will serve as approximations which are accurate enough for usual calculations. The value of film resistances which bound such air spaces is included in the A values below.

Type of Air Space	*Width of Air Space*	*Values of A*
Vertical space, heat flow horizontal	¾"	0.90
Joist space, horizontal, heat flow upward	3⅝"	0.75
Stud space, vertical, heat flow horizontal	3⅝"	0.85
Joist space, horizontal, heat flow downward	3⅝"	1.05

I = RESISTANCE OF INSULATION. Resistance values per inch of thickness do not afford a true basis for comparison between insulating materials as applied altho they are frequently used for that purpose. The value of an insulating material is measured in terms of its heat resistance which depends not only upon the resistance per inch but upon the thickness as installed and the presence of air spaces which produce film resistances. In the illustration no insulation material is shown. The symbol I is used to designate the resistance of an insulation material, and in the case of several occurring in the same construction, the symbol ΣI would be employed. The following table gives typical resistance values for I.

Type of Insulation	*Thickness*	*Values of I*
Typical flexible blankets	1"	3.70
Blanket of wood fibers between layers of paper	1"	4.00
Hair felt blanket between layers of paper	1"	4.00
Glass wool, loose fill or bat	1"	3.70
"	2"	7.40
"	3⅝"	13.45
Loose cellular dry gypsum	1"	1.00
Typical mineral wool, loose fill or bat	1"	3.70
Loose sawdust and shavings	1"	2.44
Typical rigid cork board	1"	3.33
"	1½"	5.00
Typical rigid fiber board	1"	3.03

HOW TO FIGURE HEAT LOSS COEFFICIENTS



TYPICAL EXAMPLE. In the illustration is shown a 16" masonry wall with 2" of wool insulation, an air space and ½" plaster board. It is desired to find the heat loss coefficient for this construction.

From our original statement we find that:

$$\text{Total resistance } (\mathbf{R}) = \Sigma F + \Sigma M + \Sigma A + \Sigma$$

An examination of the drawing shows 3 film resistances (F) in still air. Consulting the foregoing tables, the value is 0.66. The outside film resistance is 0.17.

$$\Sigma \mathbf{F} = 0.66 + 0.17 = 0.83$$

The resistance of the masonry and the ½" plaster board are found from the foregoing tables and we have:

$$\Sigma \mathbf{M} = 1.28 + 0.35 = 1.63$$

In a similar manner we have the resistance of the air space:

$$\Sigma \mathbf{A} = 0.90$$

In a similar manner we find:

$$\Sigma \mathbf{I} = 7.4$$

The total overall resistance of the wall becomes:

$$\mathbf{R} = 0.83 + 1.63 + 0.90 + 7.4 = 10.76$$

TRANSMISSION COEFFICIENT. The transmission of a square foot of construction is equal to the reciprocal of the resistance—which is a fancy way of saying:

$$\mathbf{U} = \frac{1}{R}, \text{ or}$$

$$\mathbf{U} = \frac{1}{10.76} = 0.093$$

This means that each square foot of the wall construction will transmit 83-thousandths of a Btu per hour per degree difference in temperature between the inside and outside of the construction.

PRINCIPLES OF HEAT INSULATION

Heat may be transmitted in three ways—conduction, convection and and radiation. (1) *Conduction.* If one part of a body is at a higher temperature than another part, there will be a flow of heat toward the part at lower temperature. One end of a metal bar may be held in a fire and heat will flow to the opposite end. (2) *Convection.* When a body is in contact with a cooler fluid (such as a liquid or a gas), heat leaves the hot body by *conduction* from its surface to the fluid in contact with it. The heated fluid will rise, giving place to cooler fluid from below. The essential characteristic of convection is this continuous renewal of the fluid layer at the surface of contact. (3) *Radiation.* Radiant heat is transmitted thru space by wave motion. It does not appreciably affect the air thru which it passes. Radiant heat behaves like light. We may have heat shadows. The intensity of radiant heat is inversely proportional to the square of the distance from the source. Gases are almost perfectly transparent to radiant heat. Such substances as wood, hair felt, granular fills, and wool types of wood fiber, glass, or mineral *are almost perfectly opaque to it.*

Heat is lost thru a wall in the following manner: the inside surface of the wall becomes warmed by its contact with the warm air of the room. The heat in the materials composing the inside face of the wall tends to flow to the colder outside face by conduction. If the wall contains an air space, part of the heat will cross or bridge the air space by radiation.

The remaining part of the heat bridges the air space by convection, that is, by the fluid motion of the air in the air space. Effective insulation stops this heat loss by interposing a barrier material of low conductivity.

The ability to minimize all kinds of heat transmission is the basis of an efficient insulation. This can be proved conclusively by comparing the heat loss thru walls which are insulated with various types of insulation, using any standard text giving heat transmission coefficients. Insulation should be of a material that cannot decompose, is non-inflammable, is vermin proof, is not water soluble.

HEAT LOSS COEFFICIENTS IN Btu

Type of Wall	*Uninsulated*	*Insulated*
(1) Frame (wood siding and sheathing, wood lath and plaster)	.250	.055
(2) Frame Stucco (stucco, sheathing, wood lath and plaster)	.300	.056
(3) Brick Veneer Frame (4-inch brick sheathing, wood lath and plaster)	.250	.056
Type of Roof		
(1) Wood Shingle Roof (wood lath and plaster ceiling)	.290	.058
(2) Asphalt Shingle Roof (or Slate on wood sheathing)	.320	.062

STRUCTURAL INSULATING BOARD STANDARDS

In February 1941 the Insulation Board Institute, the members of which produce approximately 90 percent of the vegetable fiber type of structural insulating board, requested the Division of Simplified Practice, National Bureau of Standards, to make available its cooperative procedure for the establishment of a simplified practice recommendation for this product.

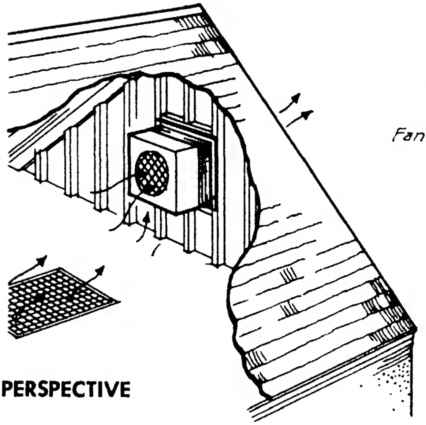
The proposed recommendation was submitted, for approval, to manufacturers, distributors, architects, contractors, and others interested in the product, and was accorded sufficient support to warrant its promulgation as Simplified Practice Recommendation R179-46.

Product	*Sizes*	*Thicknesses*	*Edges*
Building Board[2]	4′-0″ x 6′-0″ 4′-0″ x 7′-0″ 4′-0″ x 8′-0″ 4′-0″ x 9′-0″ 4′-0″ x 10′-0″ 4′-0″ x 12′-0″	½″, 1″	Square
Sheathing	4′-0″ x 8′-0″ 4′-0″ x 9′-0″ 4′-0″ x 10′-0″ 4′-0″ x 12′-0″	½″, 25/32″	Do.
	2′-0″ x 8′-0″	25/32″	Long edges fabricated, ends square
Interior boards factory-finished	4′-0″ x 6′-0″ 4′-0″ x 7′-0″ 4′-0″ x 8′-0″ 4′-0″ x 9′-0″ 4′-0″ x 10′-0″ 4′-0″ x 12′-0″	5/16″	Square
Insulating Plaster lath	1′-6″ x 4′-0″	½″, 1″	Fabricated
Roof insulation board	1′11″ x 3′-11″ 2′-0″ x 4′-0″	½″, 1″, 1½″, 2″	Square
Tileboard Panels	12″ x 12″ 12″ x 24″ 16″ x 16″ 16″ x 32″	½″, ¾″, 1″	Fabricated edges.
Plank	8″, 10″, 12″, 16″ x 8′, 10′, 12′	½″	Fabricated long edges.

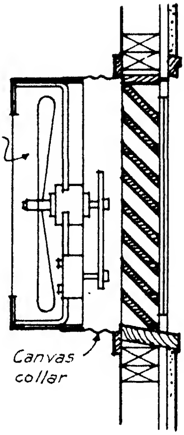
[1] Fabricated edges refers to any type of edge treatment other than square edges, without reinforcement.

[2] Building board in natural finish only. Tileboard and plank in nat. finish and 4 colors; interior board in 1 color.

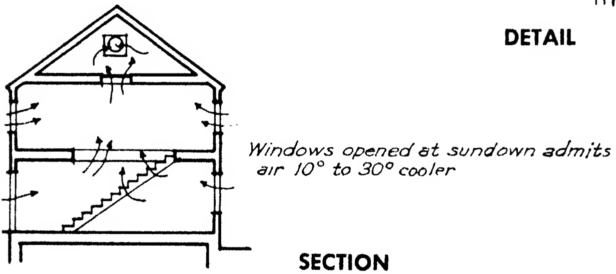
FANS FOR SUMMER COOLING



PERSPECTIVE



DETAIL



SECTION

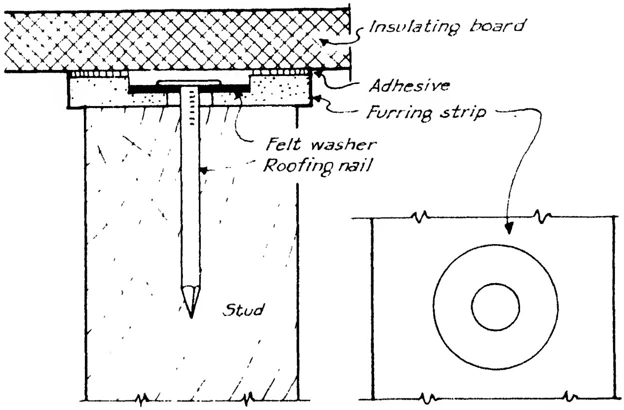
The noise of a fan may be worse than the heat. The same principle of attic arrangement can be reversed, the fan being located in the BASEMENT to exhaust thru an areaway or bulkhead. The basement fan can be securely anchored to a concrete base with cushioning to eliminate vibration. Generally this scheme is better than the attic type which was cooked up because hot air rises—but it can also be made to flow in the opposite direction with fan-created pressure.

By dividing the volume of the house in cubic feet by the number of minutes in which a complete air change is desired, you will get the size fan you should have. For example, a house of 15,000 cubic feet to have a complete air change in 3 minutes would require a fan of 5,000 cu. ft. per min.

The ceiling grille and the outside louver should have one square foot of FREE AREA for each 500 cubic feet of air per minute discharged by the fan. In the case above this would mean a free area of 10 sq. ft.

During summer months outside air temperatures are 10 to 30 degrees cooler than the daytime inside house temperature. The fan system shown with 3-minute air changes in northern areas will cool a house at night.

FLOATING ATTACHMENT FOR INSULATING BOARD



SECTION AT NAILING

ELEVATION SHOWING SINKAGE IN STRIP

The relatively high expansivity of fiber insulating boards with variations in humidity has made paneling necessary to conceal unsightly joints. The National Bureau of Standards has developed several methods, of which the method described herewith is one, to eliminate the usual nailing. These attachment methods allow the entire surface of the wall to expand or contract as a unit, permitting the successful application of any decorative treatment normally applied to a plaster wall without restriction as to surface design because of the ultimate certainty of cracks appearing at the junction of the wall board units.

The furring strips occur on each stud and are made of pressed fiberboard. The insulating boards are fastened to the furring strips with adhesive, using temporary nailing to hold them until the adhesive sets.

It is essential to keep the boards unrestricted at the edges, which should be concealed with trim fitting snugly against the board but NOT FASTENED TO IT.

Swedish putty works well as a crack filler for following painting or papering.

1-PIPE GRAVITY SYSTEM

The 1-pipe gravity system is the simplest and most economical to install for small and moderate sized buildings. It requires less piping, fewer fittings, and less labor to install than other systems. The system would operate equally well on large installations, except that such large piping would be necessary that it would no longer be economical.

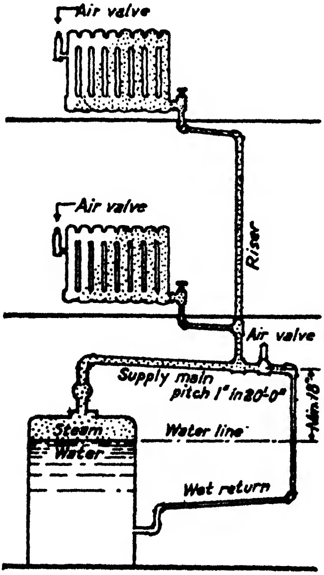
The system consists of a main pipe, above the water line of the boiler, extending horizontally from the boiler to the most remote radiator, known as the *supply main*. From the main there are branch pipes known as *risers*, extending vertically to the radiators above. In the 1-pipe system steam travels up and the condensate from the radiators travels down in the same pipe.

From the end of the supply main a pipe is brought back to the boiler which is known as the *return*. The return may be above the water line until it connects with the boiler, in which case it is known as a *dry return*. If the return is below the water line it will contain water, and it is known as a *wet return*. The type of return does not affect the operating principle of the system.

To be satisfactory the 1-pipe gravity steam system must perform 3 functions, as follows:

1. Carry steam uniformly to all radiators.
2. Return the condensate properly.
3. Vent the air in piping and radiators.

The successful performance of the first two functions depends upon proper design and installation. The third function depends upon efficient air valves. Hoffman Specialty Company manufacture reliable valves for this purpose.



Air must be eliminated from the radiators and piping to allow the entrance of steam. Air valves allow air to be pushed out by the entering steam, but do not allow steam or condensate to pass. As the radiators cool, air is again drawn into them thru the valve. This is one disadvantage of the system. The inflowing air causes a more rapid cooling of the radiators, mitigating against uniform temperatures.

A valve to rid the piping of air is placed near the end of the supply main, at the point where the main is "dripped" into the return.

No modulation is possible with a 1-pipe system.

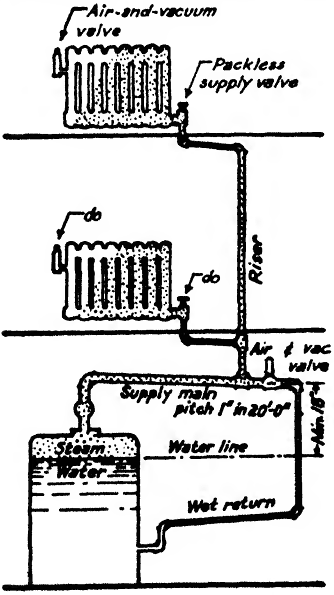
1-PIPE GRAVITY VACUUM SYSTEM

The piping of this system is the same as that of the 1-pipe gravity system. The difference consists in the use of *air-and-vacuum-valves* on the radiators and mains to correct one of the basic shortcomings of the straight gravity system.

The air-and-vacuum-valve may be described as a "one-way" valve. It allows the elimination of air (but not the escape of steam or condensate) and does not allow the air to reenter the radiator as the radiator cools. When the steam pressure drops, due to a lowering of the fire, the condensing steam in the radiator forms a partial vacuum in the radiator—permitting the reentry of steam into the radiators against practically no resistance. Thus, the radiators will re-heat quickly, will remain heated with a sub-atmospheric boiler pressure, and will maintain a much more even heat.

In order that the vacuum in the system may be retained as long as possible, it is necessary that all fittings and connections be tight against the in-leakage of air. Not only the piping, but also the radiators and boiler must be made air-tight. Because it is difficult to prevent some in-leakage of air around the stem of the ordinary radiator supply valve, the bellows type of packless supply valve is recommended.

All boilers with this type of system require a *compound pressure and vacuum gage.* Such a gage is necessary to tell the user how the system is operating so that he may get the greatest efficiency and comfort from it. Certain movements of the gage indicator show that there is air in-leakage.



The installation cost of this system is very slightly more than the regular 1-pipe gravity system—and is fully justified by the increased economy and comfort resulting.

Any 1-pipe gravity system can easily be converted into a vacuum system by substituting air-and-vacuum valves for the air valves, substituting packless supply valves for the ordinary type used to control the radiators. At the same time the system must be made tight against air in-leakage.

2-PIPE GRAVITY SYSTEMS

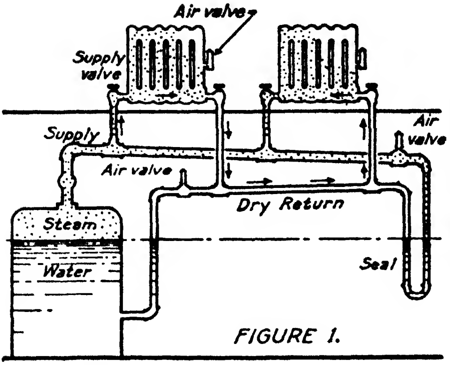


FIGURE 1.

The obvious cure for the defects of the 1-pipe system was to provide separate paths for the supply of steam and the return of the condensate. This is the basis of all 2-pipe systems.

If a *dry return* were used in a 2-pipe system, however, the steam flowed completely thru a radiator into the return piping. The steam might thus enter a following radiator from both the supply and return ends, trapping air in the center of the radiator. (See arrows on *Fig.* 1.) This air, being unable to reach the air valve, lessened the heat output of the radiator. The return was protected against the entrance of steam from the supply by a water seal.

If a *wet return* were used, the return main was below the water line. This sealed each return pipe so that steam could not enter any radiator from the return pipes. The low point of the supply main was dripped into the return as shown by dotted lines on *Fig.* 2.

Both the supply and the return in such 2-pipe systems had to have control or shut-off valves at each radiator. It was found that occupants of rooms tried to control the radiators by the operation of only one valve. If the supply valve (A) were closed, the condensing steam in the radiator sucked it full of air thru the air valve, or full of water if an air-and-vacuum valve were used. If the return valve (B) were closed, we had that particular radiator operating on a 1-pipe system, the condensate having been forced to run back thru the supply riser, which caused hammer.

To overcome the difficulty of having two shut-off valves, *the radiator trap* was used at the return end of each radiator. The trap allowed air and condensate to pass, but not steam.

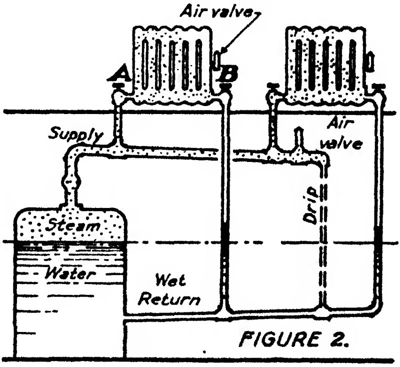


FIGURE 2.

2-PIPE GRAVITY SYSTEM WITH CONDENSATION PUMP

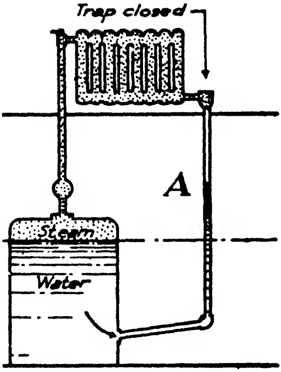


FIGURE 3

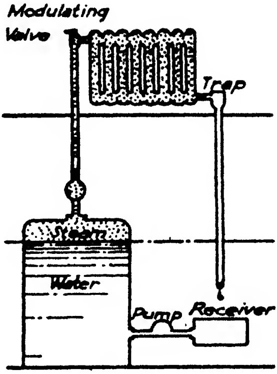


FIGURE 4

To overcome the inconvenience of having two shut off valves at each radiator, the *radiator trap* may be used at the return ends. The trap allows air and condensate to pass, but not steam. It is only necessary with such an arrangement to operate the supply valve to control the radiator. Since no condensate exits thru this orifice, it is possible to use a modulating valve which controls the supply of steam to the radiator.

The radiator trap closes upon the approach of steam. When it has closed it shuts off the boiler pressure thru the supply main and the radiator, which is otherwise exerted on the return. Therefore, the water in the return would rise as at *A* in *Fig.* 3, until its weight balances the pressure in the boiler which is exerted thru the return main as indicated by the arrow in *Fig.* 3. This "reversed" pressure might force water from the boiler into the return piping, lowering the level of the water in the boiler, thus causing serious damage.

There are 3 devices in common use to overcome this defect of the 2-pipe system using radiator traps. They are as follows:

1. Differential loop. (Used on coal-fired systems with a boiler pressure of 8 oz. or less.)
2. Boiler return trap. (Used on small systems up to approximately 8,000 square feet of radiation.)
3. Condensation pump. (Has its widest application on relatively large installations.)

Methods 1 and 2 are based on the principle of equalizing the pressure exerted on the return water to prevent forcing water from the boiler into the return piping.

Method 3—the condensation pump is illustrated diagrammatically in *Fig.* 4. When the radiator trap closes there is no tendency for any condensing steam in the return to suck water up into the pipe, it being open to the air. An automatic float in the receiver actuates the water pump, returning the condensate to the boiler.

The Hoffman Specialty Company manufacture condensation pumps, modulating supply valves, radiator traps, for this system. No air valves are used since the air is eliminated thru the condensation pump and receiver.

2-PIPE VACUUM RETURN LINE SYSTEM

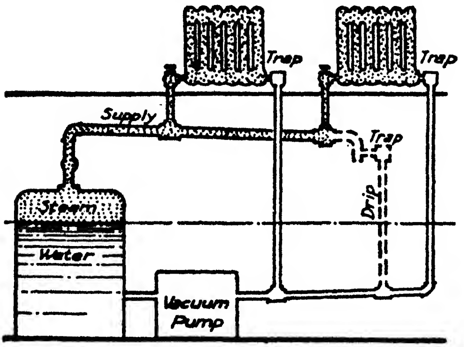
Steam traveling in the supply pipes is subjected to a loss in its initial pressure because of pipe friction and fittings. In a large steam system this loss of pressure results in sluggish circulation if gravity alone is depended upon to create the distribution of steam to the radiators. In large installations the boiler pressure must frequently be increased to unreasonably high pressures in order to force the steam to circulate against the pipe friction and the air resistance.

A method of overcoming this difficulty was sought and found in the creation of a vacuum in the return line of 2-pipe systems, increasing the pressure differential between the supply and the return to such an extent that the system operates satisfactorily on pressures of no more than 2 pounds. The circulation of the 2-pipe system thus becomes a positive mechanical operation which eliminates the forcing, noise, and difficulty of obtaining equal distribution of steam to the radiators.

The arrangement of boiler, piping and radiators in the 2-pipe vacuum return line system is practically identical with the 2-pipe gravity system with radiator trap except for the addition of the vacuum pump. The steam enters the radiators thru modulating supply valves. At the return end of the radiators the steam is prevented from passing into the return piping by radiator traps. The traps allow air and condensate to escape. The return leads to a vacuum pump which vents the air from the system, pumps the condensate back into the boiler, and creates a vacuum in the return piping. Steam is prevented from entering the return piping by the use of drip traps.

For the successful operation of the system it is essential that the radiator traps function properly. Any leakage of steam thru the traps into the return pipes makes it difficult to maintain the proper vacuum—and proper vacuum is a vital requisite in maintaining positive circulation.

A more rapid warming up of the system, better removal of air from the system, and better circulation in return lines having air or water pockets—are advantages of the 2-pipe vacuum return line system. Radiators may be located below the water line of the boiler. Vacuum systems are somewhat more economical to operate because of the lower radiator temperatures which can be carried in mild weather when little heat is needed. Vacuum return line systems are best suited to large buildings where the advantages to be gained will justify their slightly higher initial cost.



The Hoffman Specialty Company manufacture modulating valves, radiator return traps and vacuum pumps, designed for such systems.

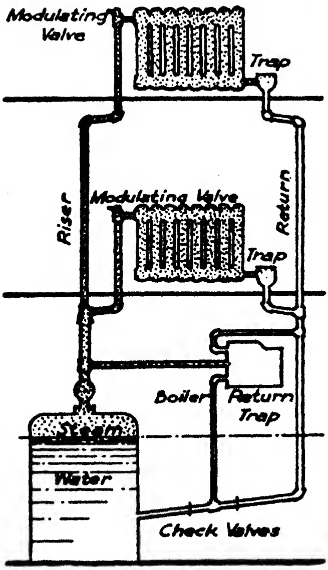
2-PIPE VAPOR-VACUUM SYSTEM

The boiling point of water depends upon the pressure. Water boils at 212° F. under atmospheric pressure. As the pressure is reduced below atmospheric the boiling point of water becomes lower. For instance, the temperature of steam at 20 inches of vacuum is 161° F. The vapor vacuum system utilizes this principle of physics by circulating vapor, which is steam at a pressure at or below atmospheric. Steam, at this lowered pressure, is lower in temperature and gives the vapor vacuum system an increased flexibility to take care of very mild weather.

First, enuf steam is produced by firing the boiler to fill the entire system with steam above atmospheric pressure. This steam enters the supply pipes and the radiators. The thermostatic traps at the return ends of the radiators close upon the approach of steam.

The supply and the radiators being full of steam above atmospheric pressure, the fire is now banked and steam is produced more slowly. This system is air-tight so that as the steam in the radiator condenses, the pressure is lowered below atmospheric. As the pressure is lowered the boiling point of the boiler water is lowered, and steam continues to be formed. This process will continue at constantly lower temperatures and pressures as long as there is sufficient heat in the boiler water to generate steam at the pressure thus created, or until the fire is again accelerated. When the temperature of the steam falls somewhat below 212° F. the radiator traps open, allowing the escape of water and air.

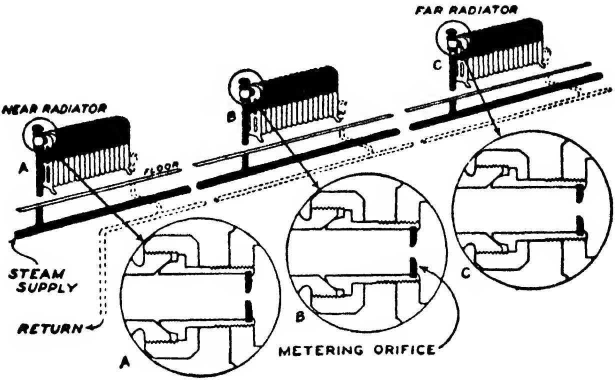
A device called a *boiler return trap* is used in connection with check valves. This arrangement is used to return the boiler water to the boiler, and to prevent the boiler water from entering the return piping when the thermostatic radiator traps are closed during the pressure period of the cycle.



This cycle, consisting of alternate operation under pressure above atmospheric and then under pressure below atmospheric, is repeated as the heat demands of the building are met thru manual or thermostatic operation of the fuel supply and dampers.

This system is particularly adapted to hand or stoker firing. It is widely and most commonly used with gas or oil firing.

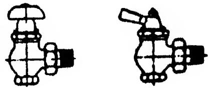
DISTRIBUTING STEAM EVENLY TO RADIATORS



UNEVEN STEAM DISTRIBUTION. When the boiler is fired, a steam pressure is built up in the supply header of the boiler. The steam flows to the various radiators in the building against the resistance offered by the supply piping and fittings. The nearest radiator will offer comparatively little resistance against the flow of steam to it. The most remote radiator, because of the length of piping, the number of elbows, etc., will offer comparatively great resistance against the flow of steam to it. The steam will take the easiest path, so that the nearest radiators will be filled most quickly.

In extremely mild weather when the boiler pressure is low, the steam may never reach the most remote radiators. If the steam pressure is increased to a point which will overcome the resistance to the most remote radiators, overheating will result.

HOW EVEN DISTRIBUTION IS ACCOMPLISHED. Metering Orifices, when properly selected and installed, effect even distribution of steam to all parts of the heating system. In the illustration it can be seen that the metering orifice in near radiator *A* is quite small. Radiator *B*, being more remote, offers comparatively greater resistance against the flow of steam to it, so the metering orifice is slightly larger. In other words, the resistance against the flow of steam to each radiator has been equalized or balanced by the installation of the correctly sized metering orifice. The result is that each radiator receives a proportionate amount of steam regardless of pressure. In large buildings, intermediate Metering Orifices are used where needed in the branch mains to assist in primary distribution. They are placed in pipe lines between union flanges or between companion flange and gate valve.



SUPPLY VALVES. Supply Valves are furnished in both the wheel and lever handle type. Steam flow to the radiators can be varied from an *off* position to a full *on* position, but cannot be increased over the amount determined by the metering orifice.

PRINCIPLES OF RADIANT HEATING

DESIGN PRINCIPLES. The first step is to *forget* all the nonsense about skiing at Sun Valley in your wickies. The second step is to *remember* that the heat loss from a room (see pp 389 et seq.) must be balanced by the heat supplied to that room. The ratio of radiant to convected heat in any given installation is so full of unpredictable variables that it intrigues the minds of physicists and advertising men. The question should be relegated to them.

The burning of one pound of 12,500 Btu coal in a system operating at 60% efficiency will deliver 7,500 Btu to a room, and it makes not the slightest difference what *species* of heat it is. Millions of people are completely comfortable because a radiator full of steam at 215°F will deliver 240 Btu per hour per square foot. Nobody ever worried particularly in the designing of such satisfactory systems, how much of the heat was radiant and how much was convected. Experience showed that humidity, air motion, and location of the heat sources should be considered carefully—but 240 Btu were looked upon simply as 240 Btu.

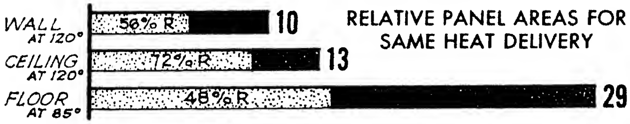
Any "panel" performs largely as an air heating device. In the design of a radiant system, the SQUARE FEET, LOCATION, and the EMISSIVITY of the wall, floor of ceiling area are the basis of the design. Find out what heat loss must be balanced by supply, divide this by the emissivity of the heated surface, and you will know how many square feet are required. Locate this area to result in "even" heating.

EXTERIOR WALLS. Radiation of bodily heat to masses at lower temperature is a prime cause of discomfort. The idea of locating radiant surfaces in interior partitions as a method of "saving" fuel is ridiculous. The loss from radiant panels in outside walls to the outside can be reduced with proper insulation to a value consistent with that to be found if the panels were located elsewhere. The extra cost of such insulation is probably not excessive if comfort is the objective. For a surface temperature of 120° the heat transfer rate to the room will be 90 heat units per hour.

CEILINGS. Ceilings adjacent to the outside or to unheated spaces follow the same principle proposed above, unless they are so high as to have no noticeable radiant cooling effect. Using the ceiling-floor construction to heat the rooms both below and above may lead to serious control problems unless the loads are practically constant. For a surface temperature of 120° the heat transfer to the room will be 70 heat units per hour.

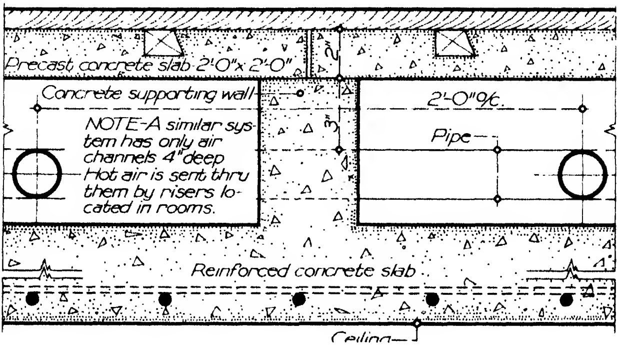
FLOORS. Floor slabs on fill are often assumed to reach temperature equilibrium but the locality and slab construction should be analyzed to establish the probable need for insulation. A floor slab at 85° will transfer 31.5 heat units per hour.

SOURCES OF HEAT. In the following pages are shown some methods of installing pipes or tubing for steam or hot water. In localities where the cost of electricity is favorable the type of rubber, plastic or glass panels with resistance wire embedded makes the heating system as simple as turning on the lights. Hot air may be used as a medium in floor, wall, or ceiling channels. Baseboards, with and without convective paths, provide another method that in many cases is adaptable to remodelling as well as in new work where the requirement of simplicity of construction outlaws built-in piping.

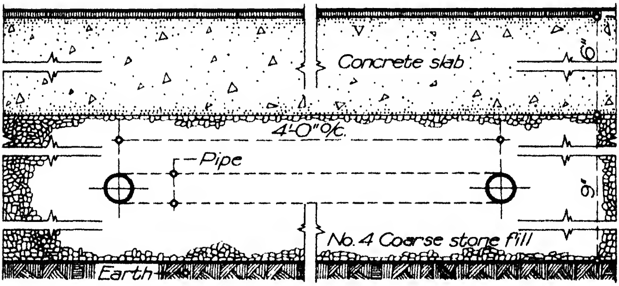


In the bar chart above, the percentage figures for radiant heating effect shows that no panel system does more than provide an approach to radiant heating. The dark part of the bars represent the air heating effect which is in all locations, a considerable part of the total.

RADIANT HEATING CONSTRUCTION

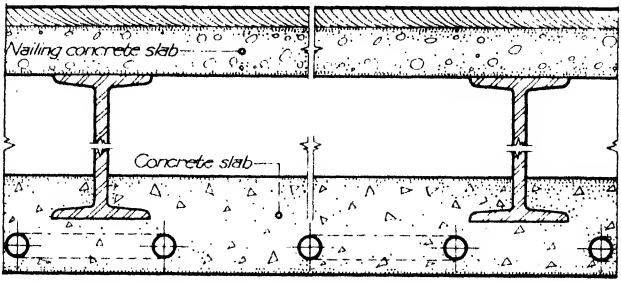


A special case of concrete floor slab construction where the heating effect is attained either by pipe coils in the air spaces or by circulation of hot air through these spaces. Note that this construction permits access to the pipes without cutting major structural parts. This construction can also be used where the floor is on the ground.

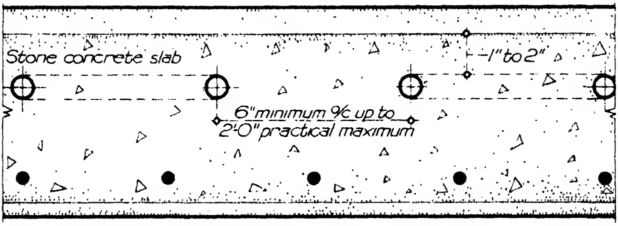


Typical concrete floor on ground with the coils located below the slab in the stone fill. This method can only be used where the fill is always dry. Note that no insulation is indicated below the coils as dry earth is a fairly good insulator but will absorb large quantities of heat at the start and return it at the end of the season, thus introducing considerable time lag when any attempt is made to change the floor temperature.

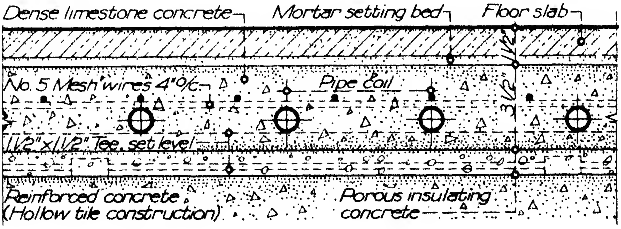
RADIANT HEATING CONSTRUCTION



A special case of concrete ceiling slab construction in which the air space acts as insulation and materially limits upward heat flow to the floor above. Note that no plaster is indicated in this figure and that radiation will take place directly from the concrete ceiling surface.

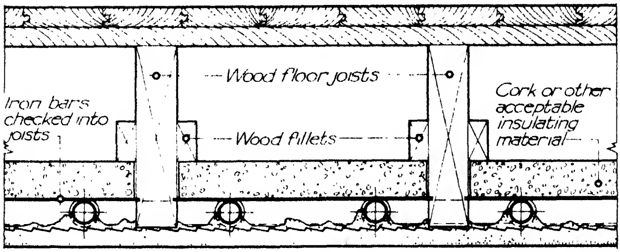


Typical concrete floor construction with the coils in top of slab for greater heating effect to the floor above.

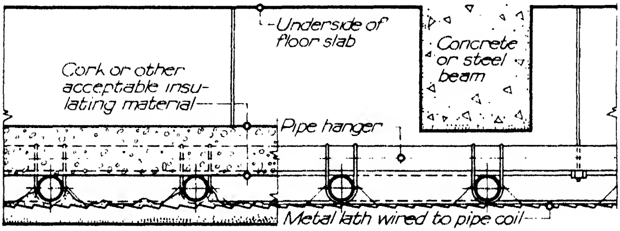


Typical fireproof floor construction using floor fill and coils in the fill. Note the use of insulating concrete to prevent heat flowing to the space below. This construction can also be used where the floor is on the ground.

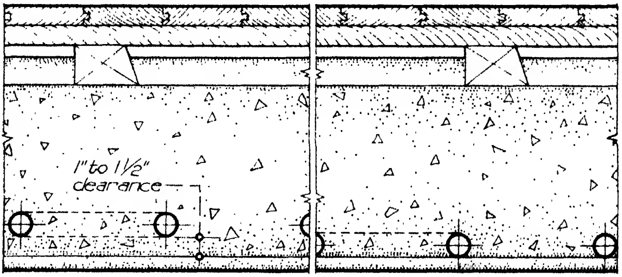
RADIANT HEATING CONSTRUCTION



Typical wood joist ceiling construction with coils in plaster ceiling and with insulation to prevent heating the floor above. Scrim should be worked into the finished white plaster coat to prevent cracks. Pipes are generally spaced 6" to 9" apart although if uniform surface temperatures are not important, the spacing may be as much as 24".



Typical fireproof ceiling construction with coils in plaster hung ceiling with insulation, scrim and pipe spacing as noted above.



Typical floor-ceiling concrete construction. While wood flooring is indicated this method may be used with practically any floor finish such as cement, terrazzo, tile, linoleum, etc. Note that no insulation is indicated and therefore the heating effect is both up and down in proportion to the thermal values above and below the coils. The left hand section of this figure indicates the pipe coil being used as slab reinforcement.

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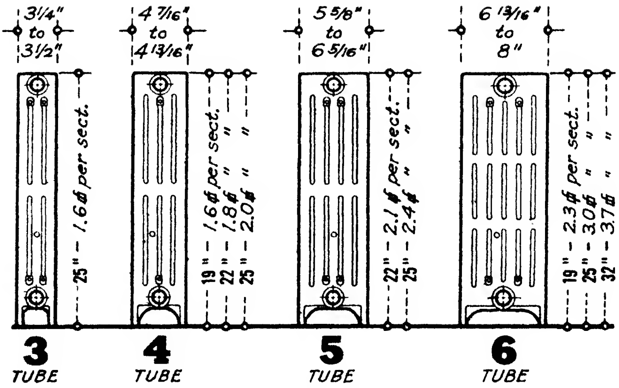
CAST IRON RADIATORS



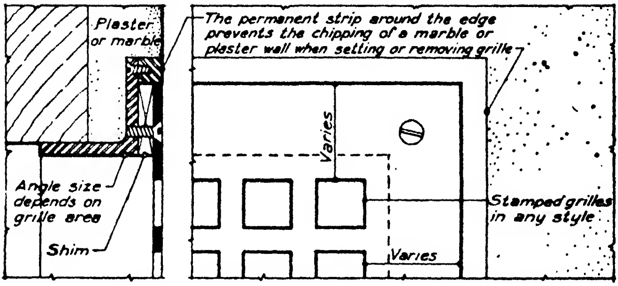
HEATING CAPACITY OF RADIATORS

Height	3 Tubes	25″	—	—	—	—	—	—	—
and	4 Tubes	19″	22″	25″	—	—	—	—	—
Number	5 Tubes	—	—	—	22″	—	25″	—	—
of Tubes	6 Tubes	—	—	—	—	19″	—	25″	32″
Sections	*Length*	*Square Feet of Heating Surface*							
6	10½″	9.6	10.8	12.0	12.6		14.4	18.0	22.2
10	1 – 5½″	16.0	18.0	20.0	21.0	23.0	24.0	30.0	37.0
14	2 – 0½″	22.4	25.2	28.0	29.4	32.2	33.6	42.0	51.8
18	2 – 7½″	28.8	32.4	36.0	37.8	41.4	43.2	54.0	66.6
22	3 – 2½″	35.2	39.6	44.0	46.2	50.6	52.8	66.0	81.4
26	3 – 9½″	41.6	46.8	52.0	54.6	59.8	62.4	78.0	96.2
30	4 – 4½″	48.0	54.0	60.0	63.0	69.0	72.0	90.0	
38	5′– 6½″	60.8	68.4	76.0	79.8	87.4	91.2		

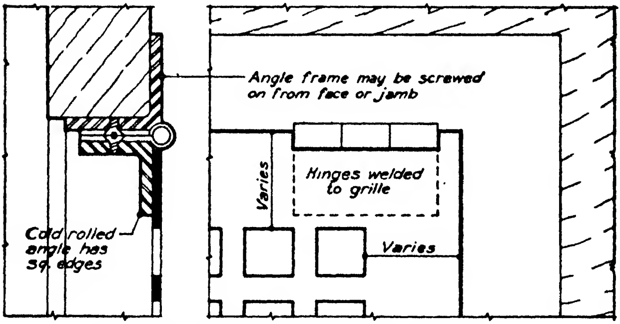
Small-tube radiators are available in assemblies of any number of even sections up to 56. The list of assemblies shown in the table includes those which past experience has shown to be in most demand. Therefore, to facilitate prompt delivery under normal conditions, the assemblies listed are considered stock assemblies, and other assemblies are available as required.

Over-all height and leg height of radiator as made by some manufacturers is 1 inch greater than shown. Radiators may be furnished without legs. Where greater than this leg height is required, the radiator height is 2 inches greater than shown.

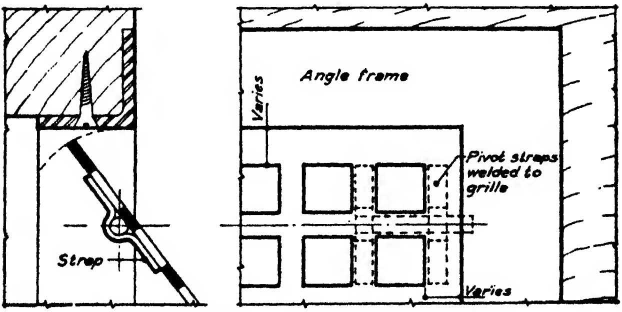
METAL GRILLES FOR HEATING



GRILLE IN PLASTER OR MARBLE FINISH



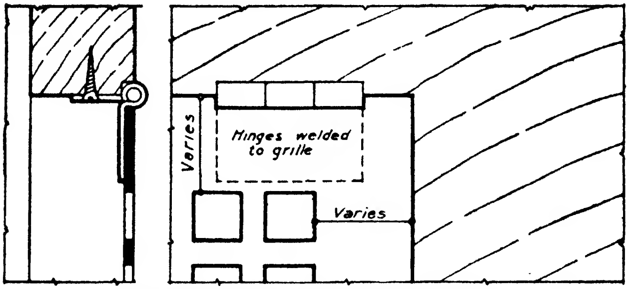
HINGED GRILLE IN WOOD FINISH



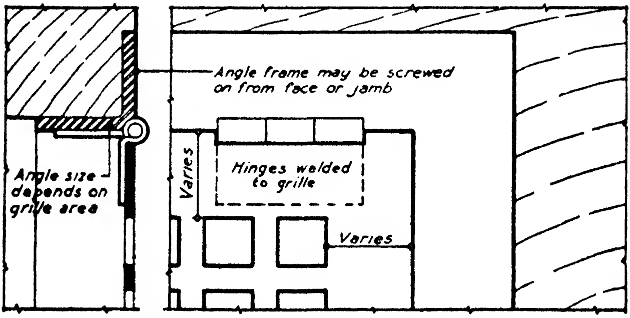
PIVOTED GRILLE IN WOOD FINISH

Scale Half Size

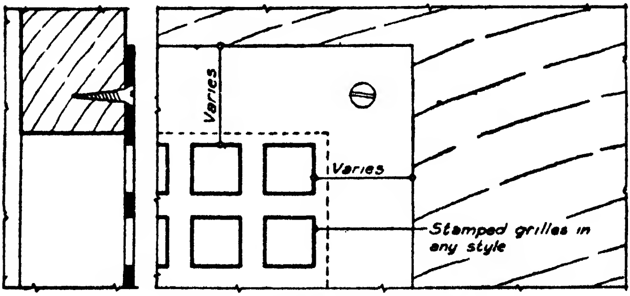
METAL GRILLES FOR HEATING



HINGED GRILLE IN WOOD FINISH



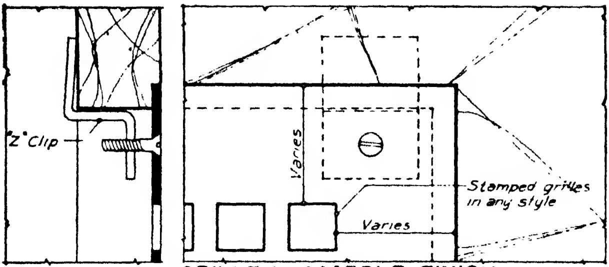
HINGED GRILLE IN WOOD FINISH



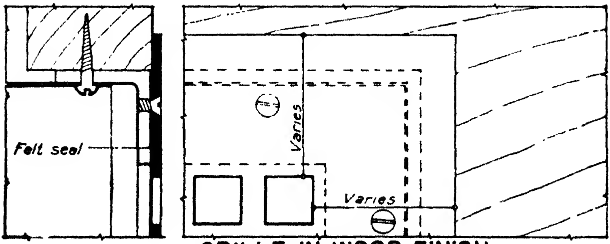
GRILLE IN WOOD FINISH

Scale Half Size

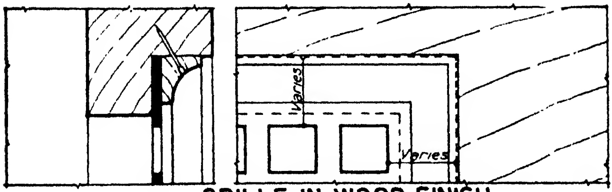
METAL GRILLES FOR HEATING



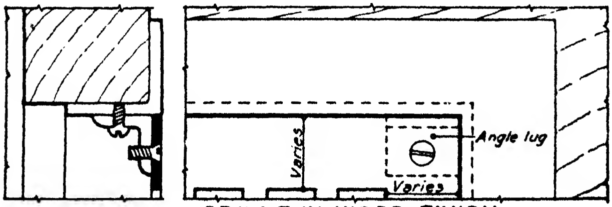
GRILLE IN MARBLE FINISH



GRILLE IN WOOD FINISH



GRILLE IN WOOD FINISH



GRILLE IN WOOD FINISH

Scale Half Size

COST OF 100,000 Btu

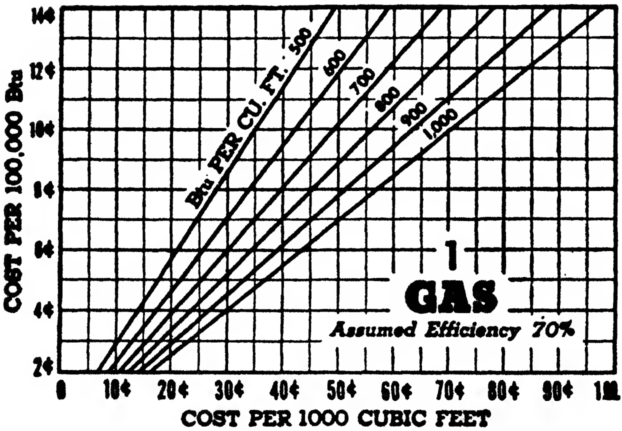
The charts on this and the following *Data Sheet* will permit rapid comparisons of heating costs.

FUEL COMPARISON. At $10.00 a ton, Chart 2 shows that 12,000 Btu coal produces 100,000 Btu's for 7¢. To obtain the same cost using 110,000 Btu oil, it would have to be available for 5¢ per gallon, as shown on Chart 3.

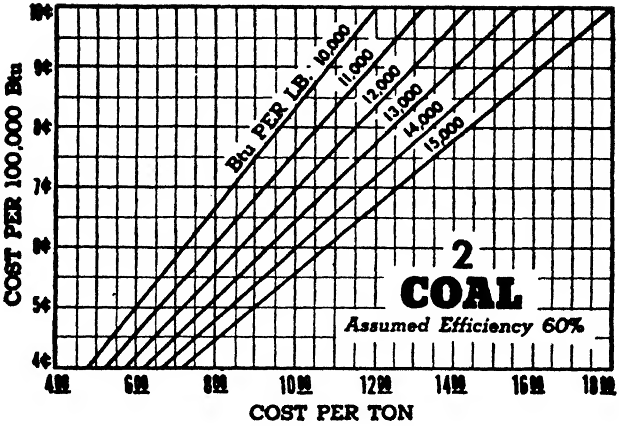
An analysis of local fuel costs and the calorific value of these fuels will provide a useful method of determining possible economies. It should be remembered, however, that each fuel has distinctive characteristics and advantages which must form a part of any such analysis.

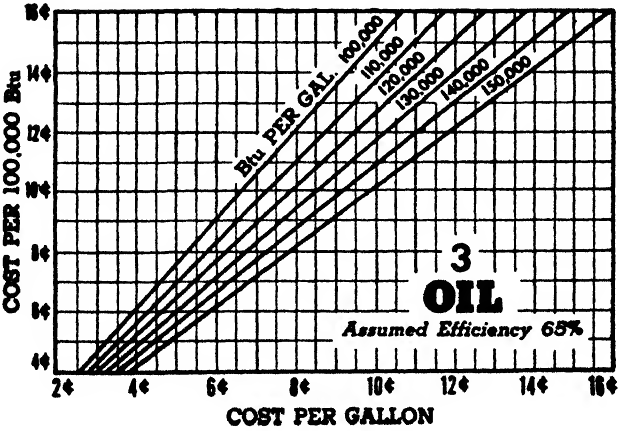
EFFICIENCIES. The efficiency assumed in preparing the charts appears on each one. If a different efficiency is to be used the cost per 100,000 Btu will be equal to:

$$\text{Cost per 100,000 Btu, shown by chart } x \ \frac{\text{efficiency shown on chart}}{\text{revised efficiency}}$$

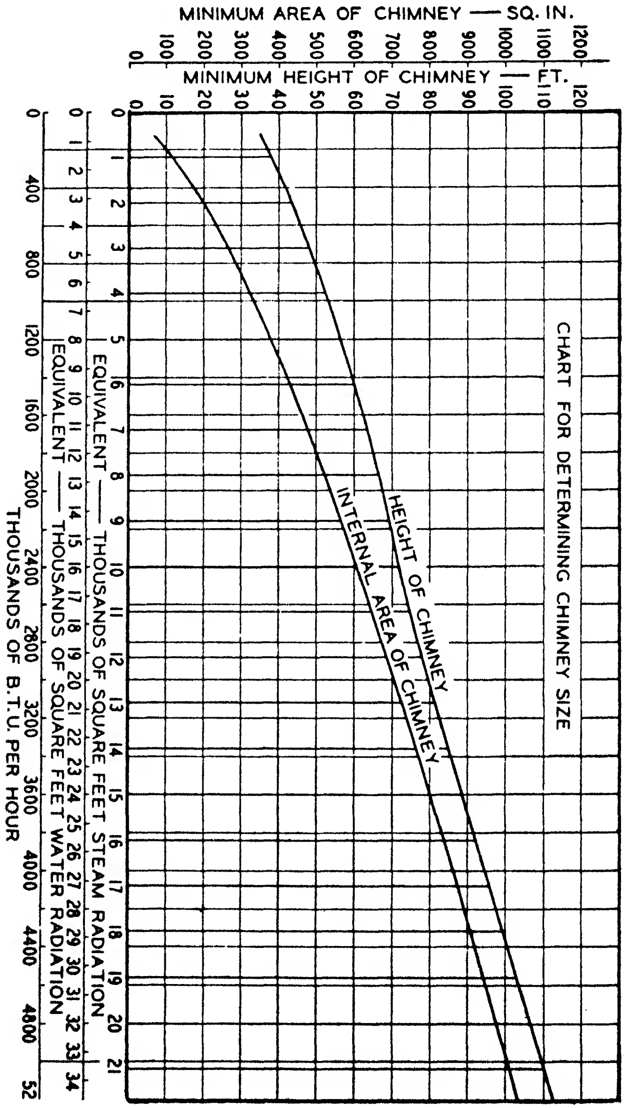


COST OF 100,000 Btu

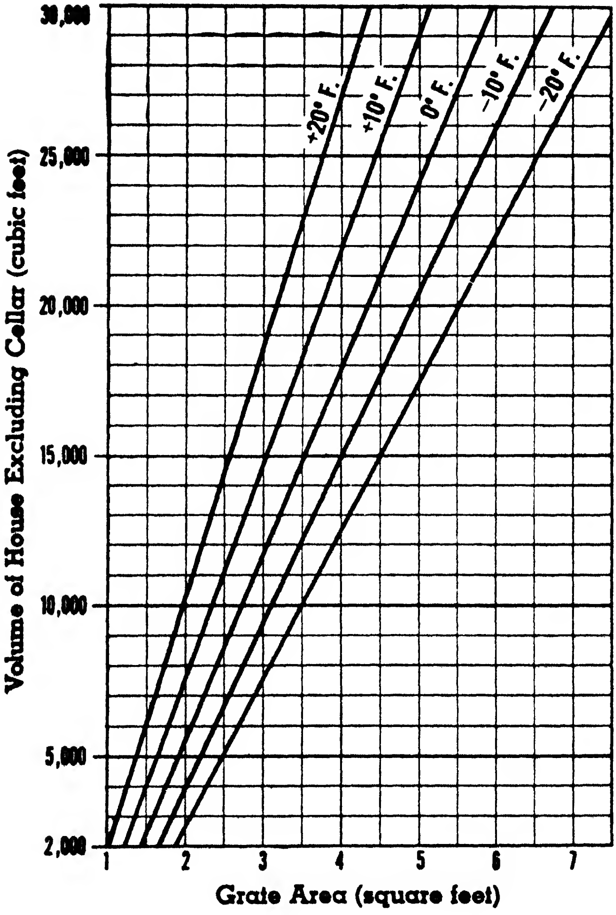




CHIMNEY SIZE FROM HEAT DEMANDS OF BUILDING



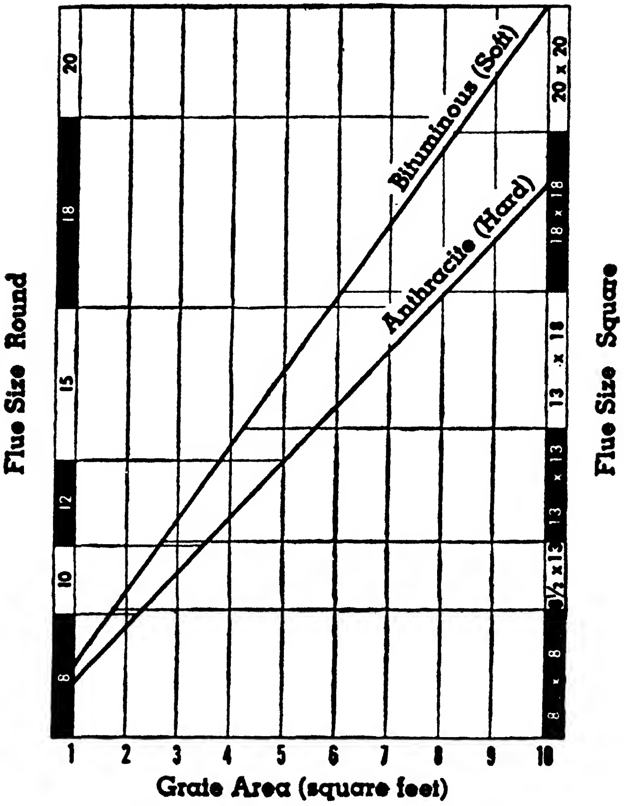
GRATE REQUIRED FROM HOUSE VOLUME



This chart may be used to determine the approximate sizes of furnaces, boilers or heaters from sketch drawings, before plans have progressed to a stage where accurate heating calculations are possible. The table should be used with discretion since a poorly built house will require a larger heating unit than that indicated.

Example. The chart shows that to heat a house of 19,000 cubic feet to 70° in —10°F. weather, a grate area of 4¼ square feet is required.

SIZE OF CHIMNEY FLUE FROM GRATE AREA



This chart will permit the determination of approximate chimney sizes from sketch drawings when the plans have not progressed to a stage where accurate heating calculations are possible. The chart is calculated from the formula:

$$A = \frac{182G}{\sqrt{H}}, \text{ in which:}$$

A = the area of the flue in square inches
G = Grate area in sq. ft.
H = Height of chimney in feet, above the grate level

The chart has been calculated for a chimney 36 feet high — an average for most residential construction.

EXAMPLE. A furnace, boiler or heater having a grate area of 6½ square feet would require a 15-inch round flue or a 13x18 rectangular flue for anthracite; an 18-inch round or an 18x18 rectangular for bituminous.

STANDARD SIZES OF CLAY FLUE LININGS

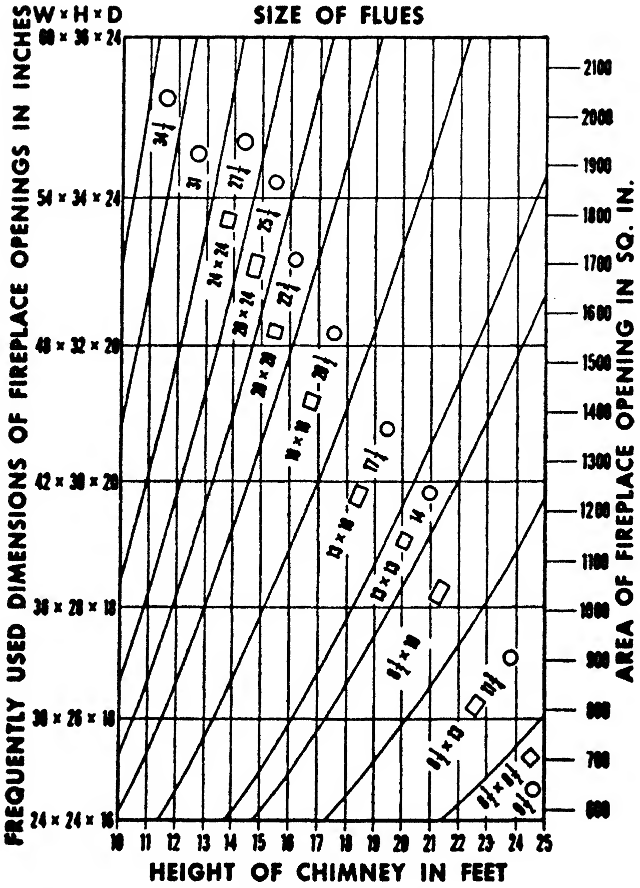
RECTANGULAR

Outside Dimensions of Flue Linings, Inches	Inside Dimensions of Flue Linings, Inches	Inside Cross Sectional Area of Flue Linings, Sq. Ins.	Thickness of Shell, Inches	Length, Feet
4½x 8½	3¼x 7¼	23.56	⅝	2
4½x13	3¼x11¾	38.19	⅝	2
7½x 7½	6¼x 6¼	39.06	⅝	2
8½x 8½	7¼x 7¼	52.56	⅝	2
8½x13	7 x11½	80.5	¾	2
8½x18	6¾x16¼	109.69	⅞	2
13 x13	11¼x11¼	126.56	⅞	2
13 x18	11¼x16¼	182.84	⅞	2
18 x18	15¾x15¾	248.06	1⅛	2
20 x20	17¼x17¼	297.56	1⅜	2
20 x24	17 x21	357.0	1½	2
24 x24	21 x21	441.0	1½	2

ROUND

Outside Diameter of Flue Linings, Inches	Inside Diameter of Flue Linings, Inches	Inside Cross Sectional Area of Flue Linings, Sq. Ins.	Thickness of Shell, Inches	Length, Feet
7¼	6	28.27	⅝	2
9½	8	50.26	¾	2
11¾	10	78.54	⅞	2
14	12	113.0	1	2
17¼	15	176.7	1⅛	2
20½	18	254.4	1¼	2
22¾	20	314.1	1⅜	2
25¼	22	380.13	1⅝	2
27¼	24	452.3	1⅝	2
31	27	572.5	2	2½
34¼	30	706.8	2⅛	2½
37½	33	855.3	2¼	2½
41.0	36	1017.9	2½	2½

FIREPLACE FLUE SIZES

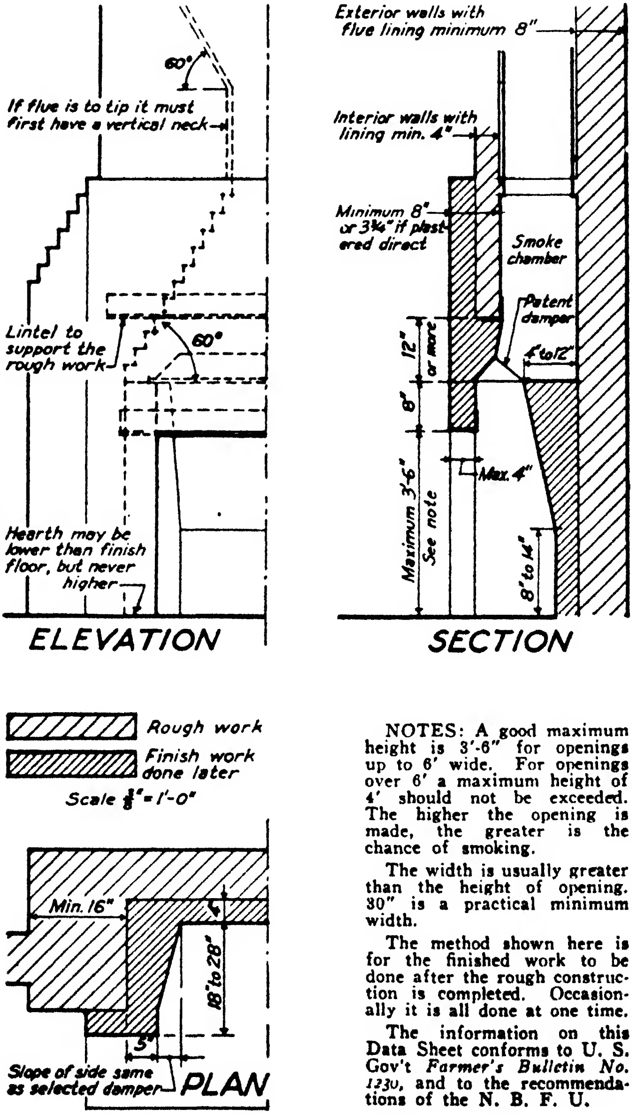


The commonly used rules of thumb for proportioning fireplace flues are very inaccurate methods since the draft of a flue may be said to vary inversely as the square root of the height. If we take a chimney 25'-0" from the top of the fireplace opening to the top of the flue as being satisfactory, on the basis of flue area equal to 1/12th the opening area we can derive the following formula from which the above chart has been plotted:

$$\text{Flue area in sq. ins.} = \frac{.41 \times \text{opening width}'' \times \text{opening height}''}{\sqrt{\text{chimney height}'}}$$

This chart should provide proper flue area for fireplaces having less than usual height.

FIREPLACE CONSTRUCTION



NOTES: A good maximum height is 3'-6" for openings up to 6' wide. For openings over 6' a maximum height of 4' should not be exceeded. The higher the opening is made, the greater is the chance of smoking.

The width is usually greater than the height of opening. 30" is a practical minimum width.

The method shown here is for the finished work to be done after the rough construction is completed. Occasionally it is all done at one time.

The information on this Data Sheet conforms to U. S. Gov't *Farmer's Bulletin No. 1230*, and to the recommendations of the N. B. F. U.

SIZE OF CHIMNEY FLUE BASED ON HEATING SYSTEM

Warm air sq. in. leader pipe	RADIATION		*Round lining inside dimen.*	*Rectangular lining outside dimen.*
	Steam sq. ft.	*Hot Water sq. ft.*		
790	590	973	10″	* 8 1/2″x13″
1000	690	1140	*10″	13″ x13″
	900	1490	12″	*13″ x13″
	1100	1820	*12″	13″ x18″
	1700	2800	15″	*13″ x18″
	1940	3200	*15″	18″ x18″
	2130	3520		18″ x18″
	2480	4090	18″	20″ x20″
	3150	5200	*18″	20″ x24″
	4300	7100	20″	24″ x24″
	5000	8250		24″ x24″

**These sizes produce the exact minimum required areas of flue for heights of 25 ft. or greater. The other sizes without the asterisk will furnish slightly in excess of the required minimum.*

In selecting the size of flue for a furnace, boiler or heater, an 8 1/2″ x 13″ should be considered the minimum. Chimneys for small units such as a laundry stove or kitchen range that are coal fired require an 8 1/2″ x 8 1/2″ flue.

The most common error found in chimney construction is the relation of sectional area and height. A chimney may be high enough yet have too small an area to carry off the necessary volume of gases. Or the area may be sufficient, but to little height to produce a draft that will draw enuf air thru the fuel bed for correct combustion. For chimneys lower than 25 ft. high, the following formula can be used to get the approximate sectional area of the lower flue:

$$A_L = \frac{5\ A_H}{\sqrt{H_L}}, \text{ in which:}$$

A_L = Sectional area of low flue

A_H = Sectional area of 25 ft. high flue

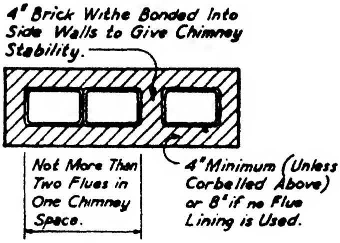
H_L = Height of low flue

No flue should ever be built without flue linings. It is best to have a width of 4″ thick brickwork between adjoining flues in the same chimney. Every flue in a chimney must be separate and have separate ash pits and clean-outs.

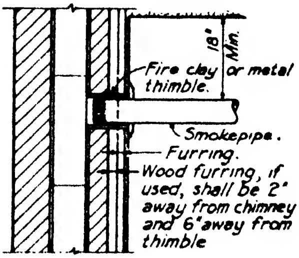
Even tho a house is to be heated with gas or oil, a flue large enuf for coal should be installed. The uncertainty of supply of all types of fuels may dictate a conversion later, as well as considerations of economy, or lowered pressure.

The best location for the chimney is near the center of the house. It will not be cooled by outside temperatures, and it aids in heating the building.

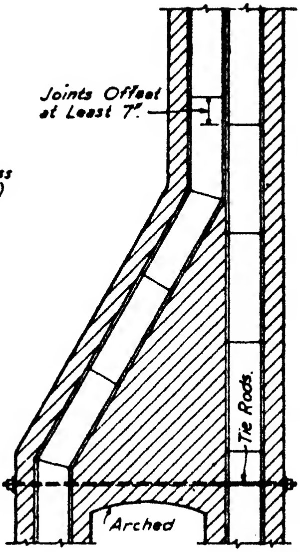
CHIMNEY CONSTRUCTION



USE OF WITHES



BOILER OR STOVE CONNECTION TO FLUE



ARCHED CHIMNEY WITH FLUE OFFSET

*Not more than two lined flues shall be permitted in the same flue space, and the joints of any such adjoining flue linings shall be staggered at least seven inches.

*Flue spaces shall be separated by smoke-tight withes of masonry, not less than 3¾" thick, bonded into chimney walls.

*Flues used for heating furnace, boilers or for fireplaces shall be separated from other flues by means of withes.

*There shall be but one connection to a flue irrespective of whether the flue be used for coal, coke, wood or oil.

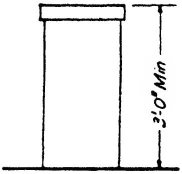
*Smokepipes shall enter chimney through a fire clay or metal thimble or flue ring of masonry. The top of smokepipe intakes shall not be less than 18 inches below sheet metal ceilings, wood lath and plaster, or exposed wood joists. Neither the intake pipe nor the thimble shall project into the flue. No woodwork shall be placed within 6 inches of the thimble.

*It is important that flues be constructed as nearly vertical as possible since each offset retards draft and offers a lodging place for the accumulation of soot. When the direction of the flue must change, it should preferably not depart more than 30° from the vertical but in no case more than 45°.

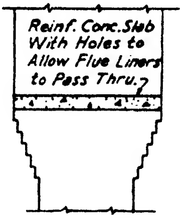
Chimneys that have openings within their width or depth shall have tie rods located over the opening to relieve thrust.

**Text from "A Standard Ordinance for Chimney Construction" as recommended by the National Board of Fire Underwriters.*

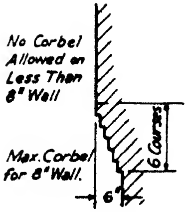
CHIMNEY CONSTRUCTION



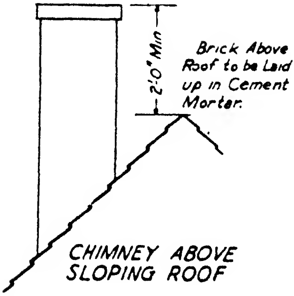
CHIMNEY ABOVE FLAT ROOF



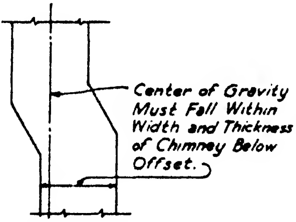
ENLARGING CHIMNEYS



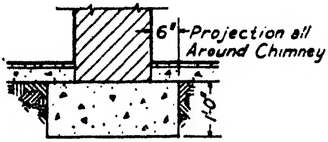
CORBEL



CHIMNEY ABOVE SLOPING ROOF



CHIMNEY OFFSET



CHIMNEY FOOTING

Chimneys shall be built at least 3'-0" above flat roofs, and not less than 2'-0" above the ridge of gable and hip roofs or the high point of mansards—irrespective of the distance of the chimney from such obstruction to draft. Unless provided with a stone, terra cotta, concrete, or other special cap or top, the chimney lining shall project at least 4".

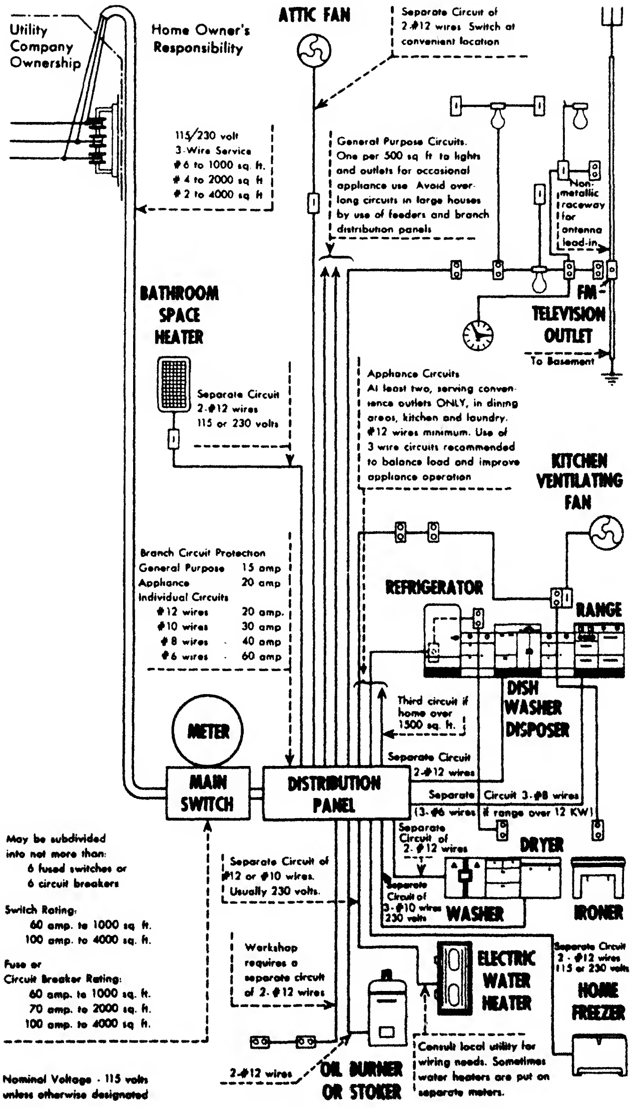
The total offset, overhang or corbel of an independent chimney shall not exceed ¼ the width of the chimney in the direction of the offset.

Corbeled chimneys shall not be supported by hollow walls or walls of hollow units. Solid walls supporting corbeled chimneys shall be not less than 12" thick, and corbeling shall not project more than 1" per course and not more than 6" in any case.

Chimneys shall be built upon concrete or solid masonry foundations properly proportioned to carry the weight imposed without settlement or cracking. The footing for an exterior chimney shall start below the frost line.

Text from "A Standard Ordinance for Chimney Construction" as recommended by the National Board of Fire Underwriters.

ELECTRIC WIRING ADEQUACY



ELECTRIC WIRING SYMBOLS

CEILING OUTLETS

Outlet for light	
Blanked outlet	B
Drop cord	D
To indicate electric outlet when circle used alone might be confused with columns or other symbols	E
Fan outlet	F
Junction box	J
Lamp holder	L
Lamp holder with pull switch	L PS
Vapor discharge lamp outlet	V

WALL OUTLETS

Outlet for light	
Blanked outlet	B
To indicate electric outlet when circle used alone might be confused with columns or other symbols	E
Fan outlet	F
Junction box	J
Lamp holder	L
Lamp holder with pull switch	L PS
Vapor discharge lamp outlet	V
Exit light outlet	X
Clock outlet (*specify voltage*)	C

ELECTRIC WIRING SYMBOLS

SWITCHES

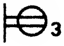
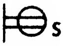
Single pole switch	S
Double pole switch	S_2
Three-way switch	S_3
Four-way switch	S_4
Automatic door switch	S_D
Electrolier switch	S_E
Key-operated switch	S_K
Switch with pilot lamp	S_P
Circuit breaker	S_{CB}
Weatherproof circuit breaker	S_{WCB}
Momentary contact switch	S_{MC}
Remote control switch	S_{RC}
Weatherproof switch	S_{WP}
Fused switch	S_F
Weatherproof fused switch	S_{WF}
Pull switch from ceiling	$\circledS$
Pull switch from wall	$\vdash\!\circledS$

SPECIAL PURPOSE OUTLETS

Special purpose, convenience outlet described in the plans or specifications.	
Any standard symbol with the addition of a subscript letter may be used to designate some special variation of standard equipment, and should be explained in the Key or Legend of Symbols.	$\bigcirc$ a, b,

ELECTRIC WIRING SYMBOLS

CONVENIENCE OUTLETS

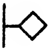
Duplex outlet (without subscript numeral)	
Outlet other than duplex: 1 = single, 3 = triplex	
Weatherproof outlet	
Range outlet	
Switch and outlet	
Radio and outlet	
Floor outlet	

PANELS, CIRCUITS, AND MISCELLANEOUS

Lighting panel	
Power panel	
Branch circuit concealed in ceiling or wall	————
Branch circuit concealed in floor	—·—·—·
Branch circuit exposed	------
Home run to panel board with number of circuits indicated by number of arrows	
Generator	
Motor	
Instrument	
Power transformer. (*Or draw to scale*)	
Controller	
Isolating switch	

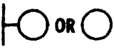
ELECTRIC WIRING SYMBOLS

AUXILIARY SYSTEMS

Push button	
Buzzer	
Bell	
Annunciator	
Public utility telephone	
Interconnecting telephone	
Telephone switchboard (*or draw to scale*)	
Bell-ringing transformer	
Electric door operator	
Fire alarm bell	
City fire alarm station	
Fire alarm central station	
Automatic fire alarm device	
Watchman's station	
Watchman's central station	
Horn	
Nurse's signal plug	
Maid's signal plug	
Signal central station	
Interconnection box	
Battery	
Special auxiliary outlet	

CHECK LIST FOR RESIDENCE ELECTRIC OUTLETS

FRONT AND OTHER ENTRANCES



To conform with architectural style.

Near door to front entrance for decorative lighting.


At front and trades entrances.


Bell or chimes at interior location, usually kitchen.


Illuminated house number.

S — Just inside door to control entrance lighting.

RECEPTION HALL

Central ceiling light may be replaced by wall, cove, or valance lighting, which should have switch.


One in each usable wall space 3 ft. or more in length, and not more than 12 ft. apart.

LIVING ROOM, LIBRARY, SUNROOM, BEDROOMS


Usually one required. Long and narrow rooms, rooms over 400 sq. ft., or rooms with low ceilings may require two.


For better decorative effect, valance, cove, or wall lighting may replace ceiling light.


One in each wall space 3 ft. or more in length with others located so that no point in any wall space (unbroken by doorways) is more than 6 ft. from an outlet. At least two such outlets should be switch controlled.

Radio and outlet

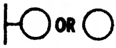
CLOSETS


Required in all closets and storage spaces.

S_D — Automatic door switches are an added convenience.

CHECK LIST FOR RESIDENCE ELECTRIC OUTLETS

HALLS



One per 15 ft. of length of hall, and at turns in direction or intersections. Use multiple switching for convenience.


One per 20 ft. of hall length and not less than one, for vacuum cleaners, console table lights, etc.

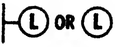
RECREATION ROOM


One for each 150 sq. ft. or major fraction.


Valence, cove, or wall bracket lights to supplement or take the place of ceiling light, depending on use of room.


One in each usable wall space 3 ft. or more in length with others located so that no point of the room periphery is more than 6 ft. from an outlet.

LAUNDRY OR LAUNDRY SPACE



One at each work center, washer, ironer, etc.

For hand iron.


One for each work center.


For washer.

GARAGE


One over hood location at each car space.


Exterior light for illuminating path to house for detached garages, with multiple switch control from garage and house. Same light may flood driveway.


One for every two car spaces.

S_{WP3} Exterior switch to turn on garage lights, with 3-way control from house.

CHECK LIST FOR RESIDENCE ELECTRIC OUTLETS

KITCHEN, KITCHENETTE, PANTRY

 Centrally located for general illumination.

Over Sink and range, choice depending upon window and cabinet arrangement. Additional undercabinet lights may be desirable.

 One for each 4 ft. or work counter frontage. Minimum one to each countertop.

For electric refrigerator.

At high visibility location for electric clock.

For kitchen ventilating fan.

For electric range, and separate broilers or ovens.

 For special equipment such as dishwasher, electric sink, home freezer, provide individual outlets.

 Annunciator.

DINING ROOM, DINETTE, OR NOOK

 One over table center.

 Valence or cove light with switch may replace or supplement ceiling light.

 No point of wall periphery more than 6 ft. from an outlet. Wall spaces 3 ft. or more to have outlet. Outlet at 36" from floor in any wall space accommodating serving table or buffet, or table used against wall.

 At hostess' chair.

TERRACES AND PATIOS

One for each 15 ft. or major fraction of adjoining house wall. May be switched from inside door.

CHECK LIST FOR RESIDENCE ELECTRIC OUTLETS

BATHROOMS AND WASHROOMS


One if floor area is 60 sq. ft. or more. Enclosed shower compartment requires a ceiling light in vaporproof fixture, switched from outside compartment.


One on each side or a single light above mirror.


One near and at level of bottom edge of mirror for immersion heaters, electric shavers, etc.

BOILER ROOM OR UTILITY ROOM

One in each inclosed space, one over work bench, one in front of furnace. Additional lights for a minimum of one to each 150 sq. ft. of open space.


At work bench.

For automatic fired heating equipment.

For electric water heater.

ATTIC

One in each inclosed space.


For general use.

S_P One at foot of attic stairs to control stairway and attic lights, with pilot.

STAIRWAYS

One at head and foot of each flight between active floors, or a single light on straight, short flights.

S_3 Multiple control switches to provide convenient switching of lights on two floors from either floor.

CHECK-LIST OF ELECTRIC EQUIPMENT

FRONT HALL

Doorbell Chimes	
Lighted House Number	20
Ceiling Fixture	
Bracket Fixtures	
Table Lamps	
Vacuum Cleaner	300
Telephone	

LIVING ROOM OR LIBRARY

Ceiling Fixture	
Bracket Fixtures	
Floor Lamps	
Table Lamps	
Electric Fan	50
Vacuum Cleaner	300-375
Unit Air Conditioner	
Radio	100
Electric Clock	2
Sun Lamp	250
Telephone	
Maid Signal	

DINING ROOM

Ceiling Fixture	
Bracket Fixtures	
Vacuum Cleaner	300
Electric Fan	50
Radiant Heater	1000
Waffle Iron	660
Toaster	600
Percolator	400
Egg Cooker	660
Chafing Dish	660
Electric Clock	2
Telephone	

KITCHEN

Ceiling Fixture	
Bracket Fixtures	
Kitchen Desk Lamp	
Electric Range	7000-12500
Refrigerator	90-180
Dish Washer	200
Electric Clock	2
Ventilating Fan	50
Orange Juice Extractor	60
Toaster	600
Percolator	400
Grill	

KITCHEN —Continued

Single Disc Hotplate	600
Double Disc Hotplate	1000
Waffle Iron	660
Tea Kettle	400
Chafing Dish	660
Electric Mixer	125
Popcorn Popper	600
Electric Flat Iron	660
Egg Cooker	660
Telephone	

BASEMENT

Ceiling Fixture	
Oil Burner	
Washing Machine	200
Electric Flat Iron	660-1000
Flat Plate Iron	1320
Drier	
Ventilating Fan	50
Electric Clock	2

BEDROOM

Ceiling Fixture	
Bracket Fixtures	
Floor Lamps	
Table Lamps	
Electric Alarm Clock	2
Vacuum Cleaner	300
Radiant Heater	600
Sun Lamp	250
Infra Red Lamp	500
Electric Fan	50
Medicinal Vaporizer	
Heating Pad	65
Radio	100
Exerciser	
Hair Drier	250
Telephone	
Fan Heater	1000-1320

BATHROOM

Ceiling Fixture	
Bracket Fixtures	
Ventilating Fan	50
Razor Blade Sharpener	50
Immersion Water Heater	
Radiant Heater	600
Hair Curler	25
Hair Drier	250

Note—This check-list may be used to insure completeness of plans, as a questionnaire for the owner to determine the electric conveniences desired, and as a guide in determining the capacities of circuit. The figures given are for the wattage of the equipment and are subject to some variation but will represent a usual average.

WATTAGE OF ELECTRIC OUTLETS

(1.) Locate the outlets in plan, as nearly as possible according to the following rule: Using direct lighting the units should be spaced not to exceed the distance from floor to outlet; using indirect or semi-indirect lighting the spacing of the units should not exceed the ceiling height; from wall to unit should not exceed ½ the regular spacing.

(2.) Determine number of square feet of floor lighted by unit.

(3.) Select proper wattage per square foot for given class of occupancy from following table.

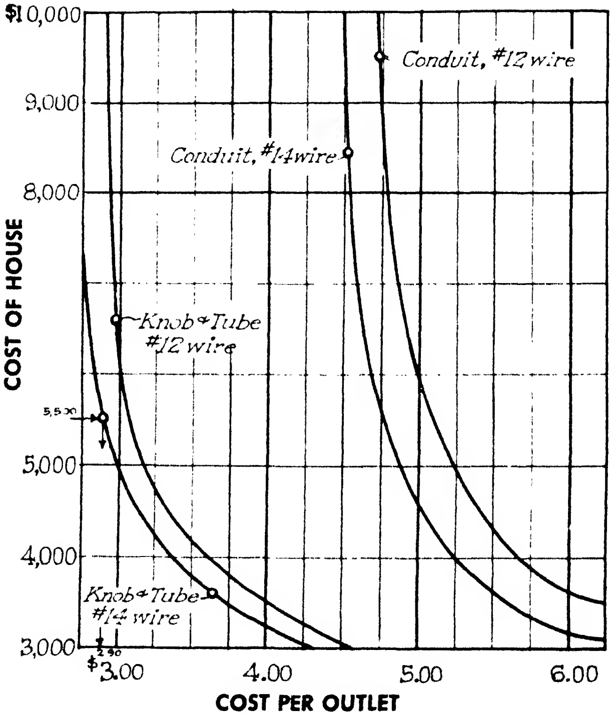
WATTS PER SQUARE FOOT FOR GENERAL ILLUMINATION

Class of occupancy		Good practice	Min.
Auditoriums		1.0	0.6
Auto Parking Spaces		0.2	0.1
Banking Room, with additional local illum.		2.0	1.2
Churches	Auditorium	0.6	0.4
	Sunday School Room	1.6	1.0
Drafting Room, no local illumination		5.0	3.0
Factory, with additional bench illumination		2.4	1.2
Garage	Dead storage	0.6	0.4
	Live storage	1.6	1.0
	Repair dept., wash racks	3.0	2.0
	Filling station yards	0.8	0.4
Hospitals	Wards	1.0	0.6
	Private Rooms	1.6	1.0
	Laboratories	3.0	2.0
Hotels	Lobby	1.6	1.0
	Dining Room	1.2	0.8
	Bedrooms	1.6	1.0
Library	Reading Room	2.4	1.6
	Stack Room	1.2	0.8
Offices, general		2.4	1.6
Recreation	Gymnasiums	2.4	1.6
	Swimming Pools	1.6	1.0
	Shower Rooms	1.2	0.8
Restaurants		1.6	1.0
Schools	Class Rooms, man. training	2.4	1.6
	Sewing Rooms	5.0	3.0
Stores		2.4	1.2

(4.) Find wattage of outlet required = Area per outlet x watts per sq. ft.

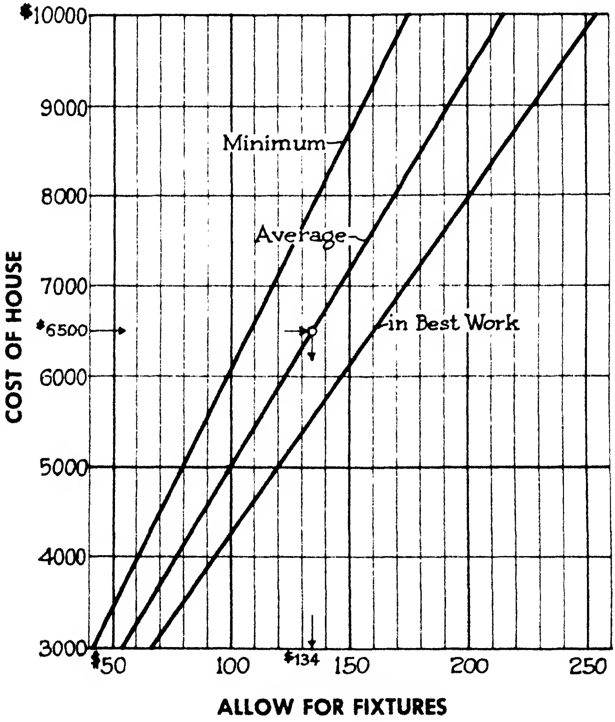
It is doubtful if a more accurate method than the above would be consistent with the indeterminate factors of maintenance, adherence by the tenant to the design assumptions, factor of safety in the wiring installation, variation in foot-candle intensities recommended by various authorities, etc., etc. The foregoing method may be used with absolute assurance of providing sufficient capacity at the outlets for the service required. A good explanation of the longer and presumably more accurate "Flux of Light Method" will be found in Edison Lamp Works' *Lighting Data Bulletin LD*-117*D* entitled "Calculation of the Lighting Installation."

ESTIMATING
ELECTRIC WIRING



Figures given in this chart are based on the minimum number of outlets. For more adequate wiring more outlets would be required and the cost per outlet would be somewhat lower. Armored cable or BX is approximately the same price as knob and tube. It must be remembered that the figures given here are only approximations based on averages. Before using the chart for any locality, and during periods of fluctuating costs especially, these figures should be checked against local conditions.

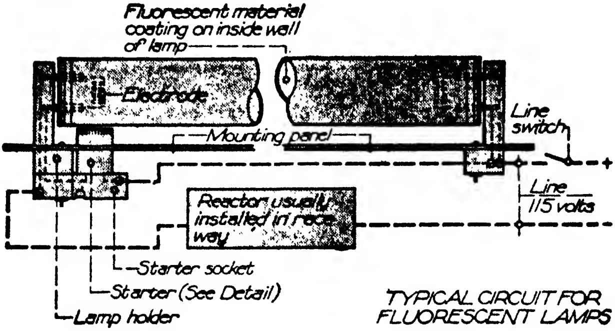
ESTIMATED COST OF ELECTRIC FIXTURES



The modern, efficient light sources, the mazda and fluorescent lamps, provide inexpensive light for seeing. When proper shades and fixtures are chosen, the lighting devices become an important part of the decorative scheme as well.

The chart shows quickly the allowance that should be included for lighting fixtures. For example, a $6,500 house, having average quality and number of light fixtures, would require $134 allowance. If the same house was to have best quality fixtures, the chart shows that $160 should be allowed.

ELEMENTS OF FLUORESCENT LIGHTING



TYPICAL CIRCUIT FOR FLUORESCENT LAMPS

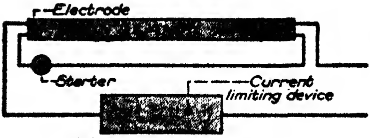
FLUORESCENT PRINCIPLE. Fluorescence is a natural phenomenon by which short wave-lengths of radiant energy are converted to longer waves. The term is applied to a group of light sources first made available in 1938, in which invisible ultra-violet radiations are changed to visible light. By coating the inside of low pressure mercury lamps with materials known as *phosphors* a large percentage of the energy input of the lamps is radiated as visible light.

Phosphors used are of many types, many hundreds being known. The actual choice of a phosphor depends on the color of light desired and the range of ultra-violet which they utilize.

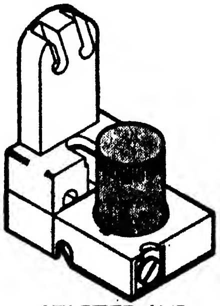
OPERATION. At each end of the lamp there is an electrode in the form of a small coil of wire, coated with a material which freely emits electrons when heated. Electrons are necessary to carry the arc current which passes thru the vaporized mercury. Since mercury is a liquid at normal temperatures, a slight amount of argon gas is used to facilitate starting.

1. THE STARTER. A self-timing device in the starter preheats the lamp electrodes and then automatically switches the circuit in such a way as to provide a high voltage surge to start normal lamp operation. If the lamp arc fails to strike, the cycle is repeated. The starter is in the form of a small aluminum cylinder having bayonet type contacts and is readily replaceable.

2. REACTOR. This prevents the arc current from increasing beyond the limit set for each size of lamp. Essentially it is a choke. The reactor is also called the *Ballast* or *Current Limiting Device.*

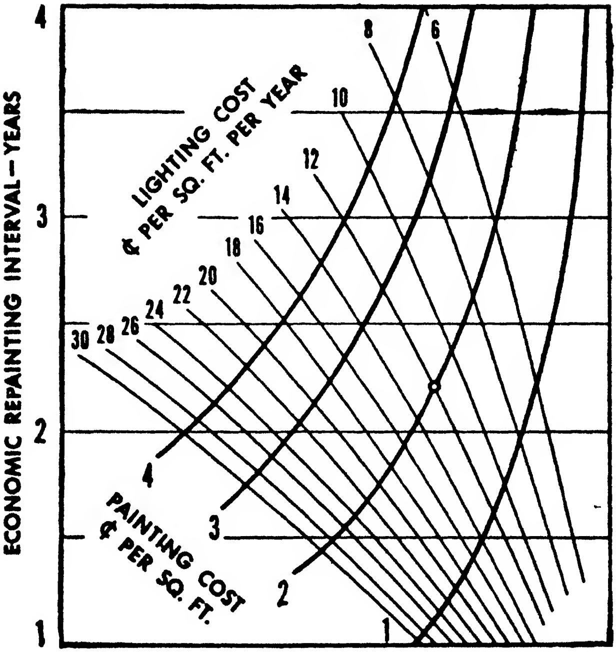


ESSENTIAL ELEMENTS IN CIRCUIT



STARTER AND SOCKET WITH LAMPHOLDER

CEILING REPAINTING FOR INDIRECT LIGHTING



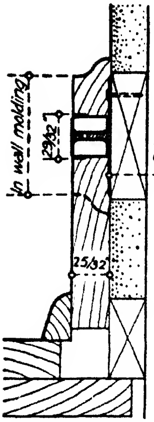
This is a cost calculator to show how often ceilings of offices and institutional buildings should be repainted to secure maximum lighting efficiency at lowest cost.

This chart was developed by the General Electric Company, and takes into account the economical balance between the cost of light absorbed by *dirty and darkened* ceilings and the cost of maintenance. *Knowing* the cost of repainting per square foot and the yearly cost of light per square foot, the intersection of the lines representing these values should be carried horizontally to the time scale at the left side to get the economical repainting period where indirect lighting is employed for illumination. For instance, the chart shows that a ceiling should be repainted in about 2¼ years if the lighting cost is 12c. per square foot per year and the painting cost is 2c. per square foot.

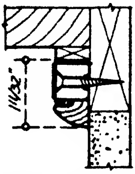
It must be noted that the chart is based on an average accumulation of dirt and darkening from age, with a ceiling of usual materials.

If the dirt accumulation is lessened by means of air conditioning or if the darkening is retarded by the employment of more permanent surfaces, ***the chart will not apply***. It is reproduced here as an illustration of the principle involved rather than as a quantitative basis for design calculations.

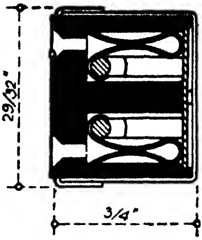
RACEWAY TYPE OF ELECTRIC CONVENIENCE OUTLET

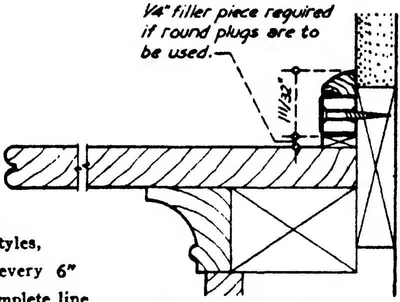


IN WOOD BASE



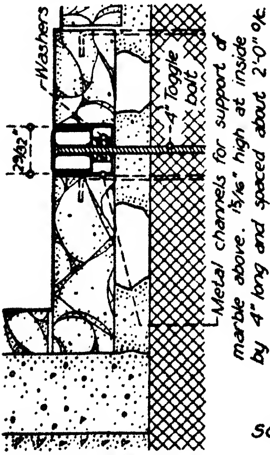
UNDER KITCHEN CABINET



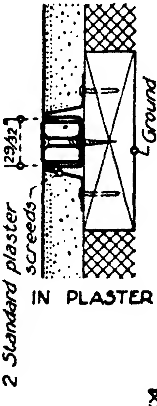


ON FIREPLACE MANTEL

Strip is available in 2 styles, providing outlets either every 6" or every 18", with a complete line of accessory fittings.

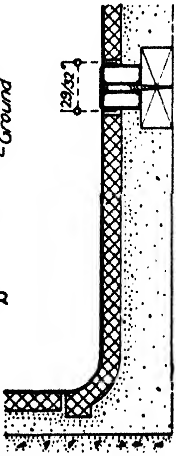


IN MARBLE BASE



IN PLASTER

SCALE 3" = 1'-0"



OVER TILE BASE

FLOODLIGHTING OF BUILDINGS

Buildings and Monuments

Representative Building Materials	Approx. Reflection Factors. Per Cent	Footcandles for Downtown* Buildings in Cities of:		
		Over 50,000	50,000 to 5,000	Under 5,000
White Terra Cotta Cream Terra Cotta Light Marble	75	15	10	5
Light Gray Limestone Bedford Limestone Buff Limestone Smooth Buff Face Brick	50	20	15	10
Briar Hill Sandstone Smooth Gray Brick Medium Gray Limestone Common Tan Brick	35	30	20	15
Dark Field Gray Brick Common Red Brick Brown Stone	20	50	30	20

* For buildings in outlying districts use the footcandles recommended for downtown buildings in cities of the next smaller classification.

NOTE—Buildings composed of material having a reflection factor much below 20 per cent cannot economically be floodlighted unless there is a large amount of light trim.

Utilitarian and Protective Purposes

Construction Work	5
Dredging	2
Gasoline Service Stations	
Buildings and Pumps	20
Yard and Driveways	5
Parking Spaces	1
Protective Industrial	0.2
Quarries	2
Shipyards (construction)	5

Special Applications

Trees	5–20
Flags	30
Loading Docks	5
Loading Platforms	5
Signs	30
Smokestacks	15
Art Glass Windows	20–200
Waterfalls	10
Water Tanks	15

NUMBER OF PROJECTORS. Use the following formula to determine the number of projectors which will produce the required level of illumination—

$$\text{Number of projectors} = \frac{(\text{Area in Square Feet}) \times (\text{Footcandles})}{0.7 \times (\text{Beam lumens})}$$

Area—area of surface to be lighted, in square feet.

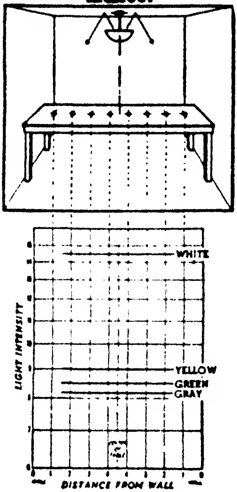
Footcandles—from Table above.

0.7—This is the *Maintenance Factor* and represents an allowance of 30 per cent for depreciation in service.

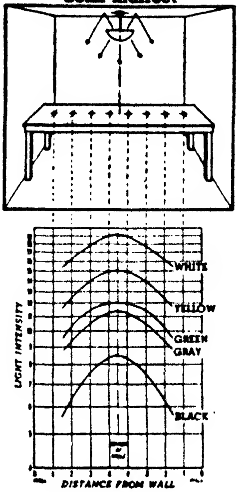
Beam lumens—This figure will be obtained from manufacturers' catalogs for the specific equipment under consideration.

ROOM COLORS AFFECT LIGHTING

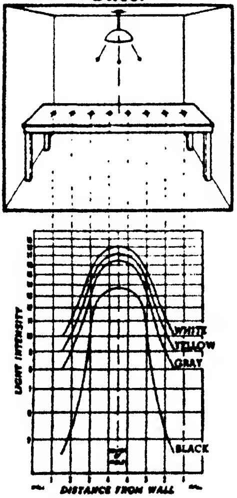
Indirect



Semi-indirect



Direct



It must be noted that these charts are to indicate the principle involved rather than to serve as quantitative guides for design.

All surfaces absorb some of the light that strikes them. Consequently, the architect will take this factor into consideration when selecting a surfacing material. A black surface absorbs practically all the light that strikes it while a white surface absorbs practically none. An ideal white would reflect 100% of all the light that is directed upon it. Magnesium oxide, reflecting about 98%, generally is used as a *standard white* by scientific investigators. As this condition is not obtainable in common practice, maximum efficiency must be tempered with a consideration of commercial availability.

The charts in *Figures 1* and *2* are indicative of the wide variation resulting from the use of different colors in reflecting surfaces of a room. The colors selected for test are those having an adaptability to business and industrial use under various types of illumination. Basis for the diagrams is a series of tests conducted by the New Jersey Zinc Company technologists, contained in a 16-page booklet titled *Using Paint As Light.*

IMPORTANCE OF LIGHTNING PROTECTION

The fundamental theory of lightning protection for buildings is to provide a means by which a discharge may enter or leave the earth without passing thru a nonconducting part of the structure such as wood, brick, tile or concrete. Damage is caused by the heat and mechanical force generated in such nonconducting portions by the discharge, whereas, in metal parts the heat and mechanical forces are of negligible effect if the metal has sufficient cross-sectional area. There is a strong tendency for lightning discharges on structures to travel on those metal parts which extend in the general direction of the discharge. Hence, if metal parts are provided, of proper proportions and distributions, and adequately grounded, damage can be prevented.

REASONS FOR LIGHTNING PROTECTION. That lightning involves a very real personal hazard and is the cause of tremendous financial loss is conclusively proven by the statistics compiled by the United States Government and the National Board of Fire Underwriters. The reasons for installing lightning protection equipment on any building may be outlined as follows:

1. LOSS OF LIFE AND PHYSICAL INJURY. The lives of the occupants of a building are in danger during every electrical storm. Many people are killed each year by lightning strokes and many others are injured. The after effects of even a minor shock are extremely unpleasant.

2. TERROR OF LIGHTNING. It is said that Napoleon feared lightning more than he did the enemy's fire. Children and animals display their fear but it is no more acute than that of many adults. A great many persons experience real terror during an electrical storm, which can be eliminated by the feeling of security resulting from lightning protection.

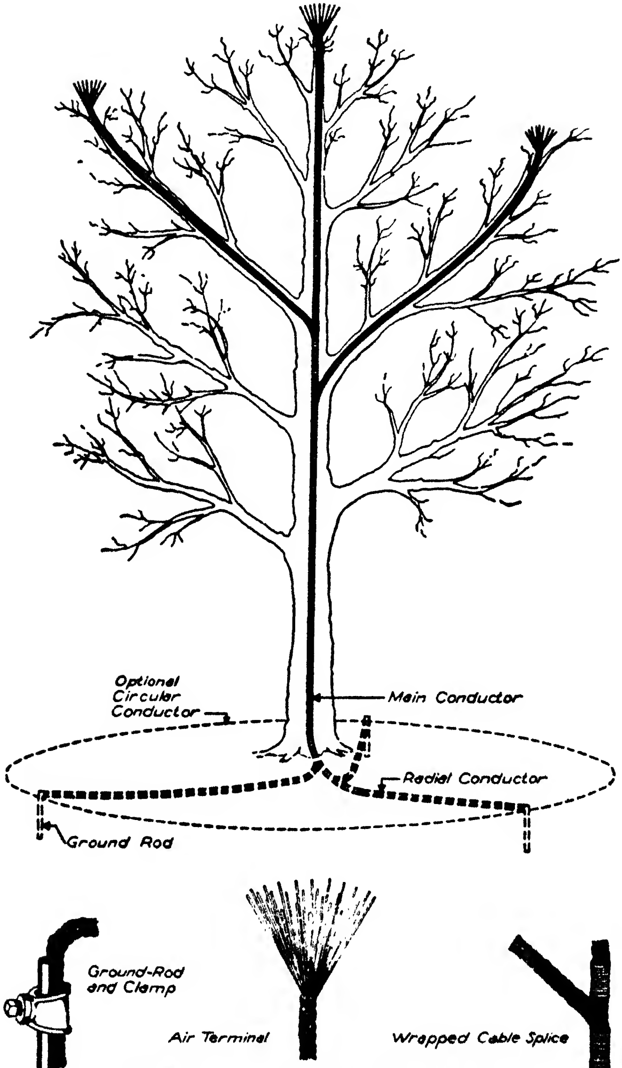
3. DAMAGE TO BUILDING FROM STROKE. Many costly buildings have been entirely demolished as a result of a direct stroke. In other cases the resultant fire has finished the job which was started by lightning. The modern trend in building construction toward many disconnected metal parts increases the lightning hazard to property.

4. DAMAGE TO BUILDING FROM FLICKERS. An enormous amount of damage is done to buildings all over the United States that occurs without the knowledge of the building owners. When lightning strikes a building directly, there is plenty of evidence left to record its visit, but many times only a minor part of a nearby stroke "flickers" onto the building. These minor strokes are responsible for injury to gutters, downspouts, flashings; tile, slate and other roofing material is often cracked; well-built chimneys apparently disintegrate rapidly with broken caps and cracked chimney walls; foundation walls may be cracked and caused to leak; cracks in ceilings and inside walls are frequently attributed to building settlement whereas lightning flickers are the cause.

5. DAMAGE TO BUILDING CONTENTS. Furniture, equipment, personal belongings and treasures, valuable papers and other building contents having value far in excess of the cost of an adequate lightning protection installation, may be destroyed by a lightning stroke.

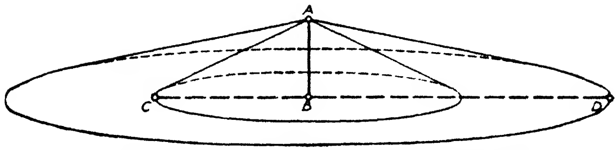
6. ELECTRICAL INSTALLATION AND EQUIPMENT. Cost of replacement in case of damage is high today. As a rule, insurance is inadequate. The only method of insuring against such a loss is by eliminating the hazard thru the installation of proper lightning protection because in many cases there is no fire, or prompt action reduces the extent of the fire loss to a negligible proportion.

LIGHTNING PROTECTION FOR TREES



APPROVED LIGHTNING PROTECTION MATERIALS

LIGHTNING PROTECTION FOR TREES



Minimum Cone BC = 2AB   Maximum Cone BD = 4AB.

CONE OF INFLUENCE. The National Fire Protection Association *Code for Protection Against Lightning*, 1934, points out that "experiments have indicated under certain assumed test conditions that a vertical conductor will generally divert to itself all direct hits which otherwise might fall in a cone shaped space, of which the apex is the top of the conductor and the base a circle whose radius is 2 to 4 times the height of the conductor."

Thus a lightning protected tree will tend to protect nearby structures or trees which are totally within the cone shaped space represented above. However, as Dr. M. G. Lloyd has shown, the *cone of influence* is not a zone of complete protection and lightning occasionally strikes within such a zone.

INFLUENCE OF LOCATION. Trees standing alone or above their neighbors and trees along avenues, streams and lakes, are struck more frequently than others.

SPECIES SUSCEPTIBILITY. There is considerable difference in susceptibility to lightning attack among trees of different species. Studies made abroad tend to show the following are relatively free of lightning attack:

beech	birch
horse chestnut	holly

The same studies indicate that the following are struck frequently:

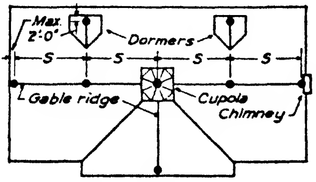
oak	maple
elm	ash
pine	spruce
poplar	

As a general rule decayed or rotten trees are greater sufferers from lightning than sound, undecayed specimens. Deep-rooted trees are generally believed to be more liable to lightning injury than those with shallow and widespreading root systems.

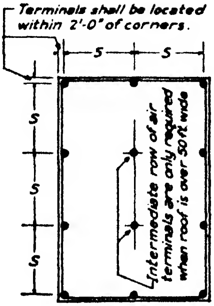
PRINCIPLES OF TREE PROTECTION. Air terminals should be placed at the highest point or points in a tree. It is unnecessary to place air terminals on lateral branches where such terminals would fall within the cone of influence. Copper cable may be attached to trees with copper nails—never with steel nails—in order to avoid electrolysis. The use of insulated fasteners is never recommended. Three ground terminals should be provided for each conductor.

LOCATION OF AIR TERMINALS

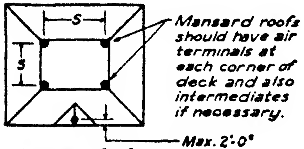
Prominent dormers, cupolas, wood flag poles, chimneys, spires, monitors and other similar projections, and all gables should have air terminals.



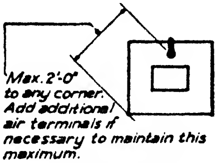
Gable Roof with Cupola and Dormers



Flat Roof or low pitch roof

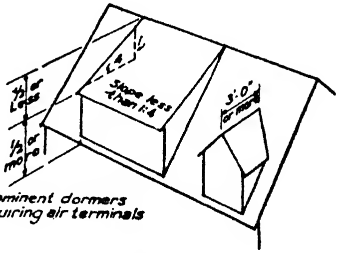


Mansard Roof

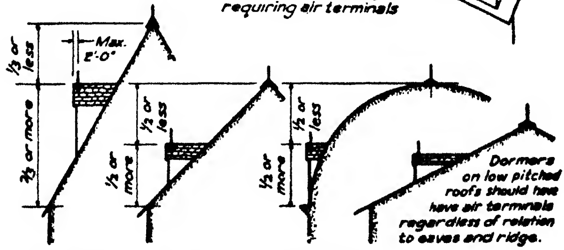


Chimney Cap

(S) Spacing of air terminals on roofs and roof projections should not exceed 20 feet.

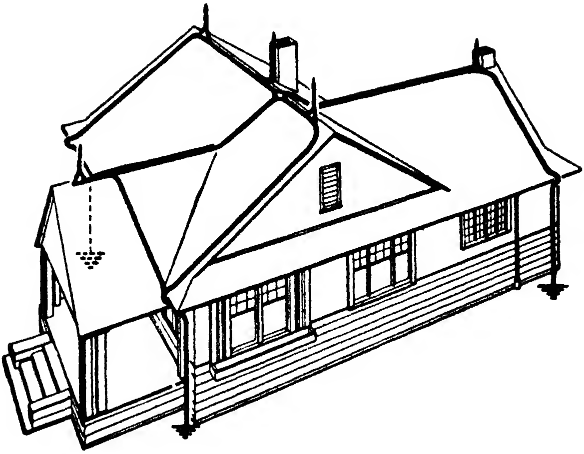


Prominent dormers requiring air terminals



HEIGHT OF DORMER RIDGE IN RELATION TO EAVES AND RIDGE OF ROOF WILL DETERMINE WHETHER AIR TERMINALS ARE NEEDED

LIGHTNING PROTECTION



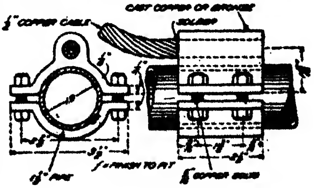
EFFICACY OF LIGHTNING RODS. An analysis of lightning fires showed that only 5 out of 100 occurred in rodded structures, some of these having old or defective systems.

AIR TERMINALS. Single-pointed heavy rods are most satisfactory. Rods should be placed on upward projections like chimneys, towers, etc.; on flat roofs 50′ o/c; and on the edges of flat roofs and ridges of pitched roofs 25′ o/c. Rods should be from 10″ to 60″ above flat roofs and ridges; from 10″ to 14″ above upward projections.

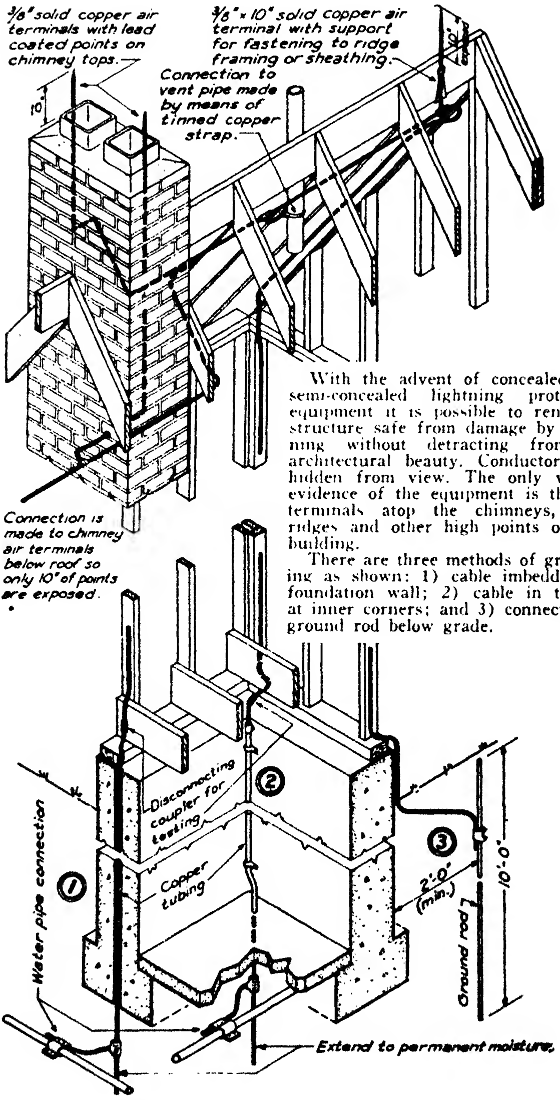
CONDUCTORS. There must be 2 paths from each rod to ground, *outside* the building. Stranded copper cable or twisted square bars (star section) are the best forms of conductors. Conductors should be in straight runs without sharp bends. Painting conductors above the ground does not affect their value.

FASTENERS. These hold the conductor securely about 1″ away from the surface of walls or roofs. Insulators are not required. Holes made in roofing or walls by the fasteners should be made water-tight.

GROUND. A good, permanent electrical connection must be made from conductors to moist earth, below the foundations. There must be ample area of contact. The corrosion of the metal used in the earth must be slight. A metal rod driven in the earth is satisfactory when the soil is wet and clayey. But where moist earth is deep, a ⅛″ copper plate 10 sq. ft. in area should be buried and backfilled with charcoal; or the cable may be unbraided and the strands fanned out in a deep trench and backfilled with charcoal. Connections to the water pipe outside the building makes one of the best grounds available. See Figure.



CONCEALED LIGHTNING PROTECTION SYSTEM



With the advent of concealed and semi-concealed lightning protection equipment it is possible to render a structure safe from damage by lightning without detracting from its architectural beauty. Conductors are hidden from view. The only visible evidence of the equipment is the air terminals atop the chimneys, roof ridges and other high points on the building.

There are three methods of grounding as shown: 1) cable imbedded in foundation wall; 2) cable in tubing at inner corners; and 3) connected to ground rod below grade.

OPEN SPECIFICATION FOR LIGHTNING PROTECTION

Architects will find that it best serves the interests of their clients to exclude Lightning Protecion from the General Contract and to take separate bids. The following short form specification is suggested. The science of Lightning Protection and its correct installation is a highly technical and specialized field. The Architect's best guarantee of an effective and honest installation is to deal with a manufacturer whose integrity and record are beyond reproach. The National Lightning Protection Company is national in scope and the justified confidence reposed in this company by the national leaders in all fire prevention and safety fields is the best recommendation that the Architect can demand.

Lightning protection is an absolute necessity for many types of buildings—and a desirable precaution for buildings of all kinds. A lightning stroke invariably deadens telephones and renders private electric pumping systems inoperative on country estates. Churches, schools, hospitals and public or semi-public buildings with spires, chimneys, domes or projecting gable ends almost invariably require lightning protection. Low, flat buildings may require lightning protection more seriously than higher buildings in more favorable locations. Metal-roofed or metal-clad buildings used for manufacturing where explosive gases, dangerous fumes or dust are created require an "excess" lightning protection system. Country club buildings as a rule occupy exposed locations and are ideal lightning targets.

1. WORK INCLUDED. This Contract includes the furnishing of all labor and materials for complete protection of the building from lightning damage and the installation of lightning protection equipment on trees which have been noted on the plot plan.

> *Notes.* Valuable trees should be protected since it takes a generation to grow a beautiful shade tree. Each tree adds hundreds of dollars to the value of grounds. Trees overhanging the building itself or in close proximity to it may attract lightning to the building even tho the building is properly rodded. Trees can be protected with a simple, inexpensive and practically invisible system.
>
> The Owner should be advised by the Architect that his cooperation is required for his continued protection in the future. The location of a new building in close proximity to the protected structure, the growth of a tree so that it commands or overhangs the protected building, the addition of metal vents and pipes which project upward from the roof's surface, the addition of dormers or wings and porches, the installation of radio antennae or electric and telephone wiring, the addition of a flagpole, the reroofing of a building in which the conductor system is reapplied by the roofers in a haphazard manner—all these things affect the efficiency of the lightning protection system as originally installed. Such changes may require the addition of lightning protection equipment to again render the building lightning-proof.

2. SHOP DRAWINGS. Furnish a complete layout of the lightning protective system for the Architect's approval before starting the installation of materials.

3. COOPERATION OF OTHER TRADES. Instruct the mason contractor and any other sub-contractors on the work, allowing sufficient time for their requirements, so that chimney anchors, cable fastenings or any other devices may be placed at the time of construction.

OPEN SPECIFICATION FOR LIGHTNING PROTECTION

4. **MATERIALS AND WORKMANSHIP.** Furnish and install materials in accordance with the "Code for Protection Against Lightning" as adopted by the American Standards Association. Use no materials nor devices which do not bear Underwriters' Laboratories Labels. Full compliance with the manufacturer's rules and regulations for the installation system on this particular building, is also a requirement. Upon completion of the installation of the lightning protective equipment, furnish the Owner with the "Master Label Plate of Approval" of the Underwriters' Laboratories Incorporated.

> INSPECTED—TESTED—APPROVED
>
> **FACTORY INSPECTION LABEL No.......**
>
> This label evidences that this material has been inspected and tested for conformity to "National Quality" requirements and found to fully comply. It evidences also full accord with the requirements of the U. S. Bureau of Standards, American Institute of Electrical Engineers, National Fire Protection Association, Underwriters Laboratories, Inc., and the American Institute of Architects.
>
> It is the most perfect material of its type that the combination of Science and Mechanical Skill can effect.
>
> The installation of this material entitles the purchaser to the benefit and protection of the "National Quality" Guaranty Plan and Program.
>
> Inspected and Tested by . . . .
>
> Checked by . . . .

Label for Materials

5. **SAMPLES AND SCHEDULE OF MATERIALS.** Submit samples of terminals, anchors, conductors and other visible parts of the system to the Architect for his selection and approval at the time and place which the Architect designates. At the same time submit a typewritten schedule of the materials to be used, giving catalog numbers and complete description, to the Architect for his approval.

6. **INSTALLATION.** Employ only specially trained and thoroly competent workmen who are experienced in the installation of lightning protection equipment. Make the entire installation in an inconspicuous manner so as not to mar the architectural design of the structure. Provide an adequate number of air terminals. Firmly anchor all air terminals. Course the conductors properly and run them straight when they are supposed to be straight; make proper bends where bends are required. Use the proper attachment for each building, or building surface. Attach conductors to the building firmly so that they can't and won't come loose. See that all joints and connections are well made and will stay that way. Make all required metal work connections in a permanent and durable manner. The course of all conductors must be horizontal or downward, never upward. No branch leads may be longer than 16 ft. without an additional ground.

Notes. Lightning protection systems may be planned in such a way that they do not detract from the appearance of the building. Conductors may be run down in corners, behind downspouts or inside the downspouts. A fully concealed system may also be specified in which the only visible parts of the installation are the air terminals, the conductors being run inside the building during construction.

OPEN SPECIFICATION FOR LIGHTNING PROTECTION

7. PROMINENT PARTS. Spires, cupolas, ventilators, chimneys, high dormers, gable ends, water tanks, flagpoles, stair and elevator penthouses and other vertical projections, must be protected by air terminals.

8. AIR TERMINALS FOR PITCHED ROOFS. On pitched roofs install air terminals not more than 20 feet on centers along all ridges. There must be an air terminal within 2 feet of the ends of all ridges whether they occur on the main roof or on dormers. On flat roofs or pitched roofs having a slope less than 30°, install air terminals at the corners and edges so that they are spaced not greater than 20 feet on centers. Provide 2 conductors to ground for straight ridge-line building 70 feet or less in length, providing 1 additional conductor to ground for each additional 40 feet of length. Provide whatever additional conductors to ground that are required to relieve low-positioned air terminals or to avoid a branch lead of over 16 feet, on pitched roofs of irregular arrangement.

9. AIR TERMINALS FOR FLAT ROOFS. Install air terminals at the corners of all flat roofs and not more than 20 feet on centers around the entire perimeter. Install an additional row of air terminals spaced 20 feet on center for each 50 feet of roof width over 50 feet. For the first 200 feet of perimeter of flat or flat pitched roofs, install 2 conductors to ground. Install 1 additional conductor to ground for each additional 100 feet of perimeter or fractional part thereof.

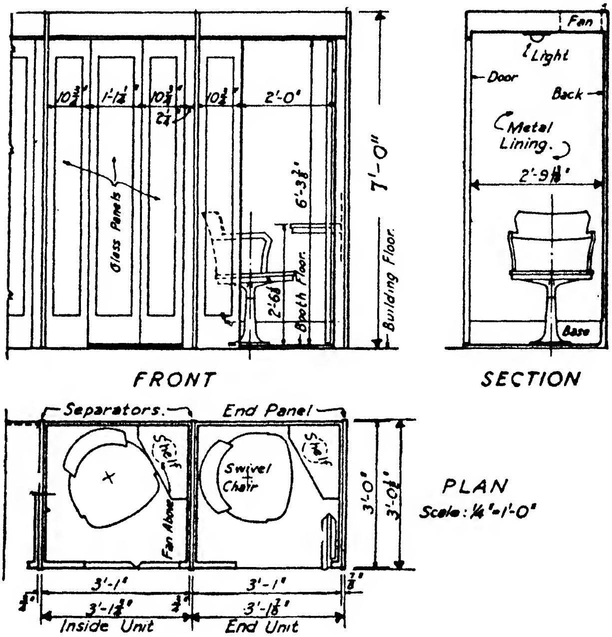
10. CHIMNEYS. Provide lead covered air terminals on chimneys, so located that no chimney corner is more than 2 feet distant from an air terminal. Air terminals must extend at least 10 inches above the highest part of the chimney construction.

11. GROUNDING. Provide an adequate number of effective grounds. For the purposes of estimating and bidding, it will be assumed that the earth is permanently moist to within 3 feet from finish grade. If, during the excavation, conditions are encountered which are at variance with this assumption, an adjustment will be made between the Owner and this Contractor for the greater expense that is involved in establishing the proper ground connections for the lightning protection system, each as a rule extending into the earth to a depth of 10 ft. or equivalent. Install ground conductor guards where necessary to prevent mechanical injury.

> *Note.* To terminate a conductor in a few feet of dry, non-conducting earth, so limits its capacity as to greatly interfere with, if not totally destroy, the protecting power of the lightning protection system. Groundings in sand, gravel and stony soil should be made by adding metal in the form of driven rods, or strips, plates or lengths of rod buried in trenches extending radially from the building.

12. CONNECTING METAL WORK. Connect metal ventilators, metal stacks, vent pipes or other metallic objects which project above the rodded structure to the system so that they will thus serve as additional terminals. Connect metal roofing, ridge rolls, valleys, guy wires and other metal bodies of conductance, to the lightning conductor or ground them independently. Electric wires, radio wires and telephone wires entering buildings must be properly protected so that lightning cannot enter the building by these means.

STANDARD TELEPHONE BOOTH NO. 7

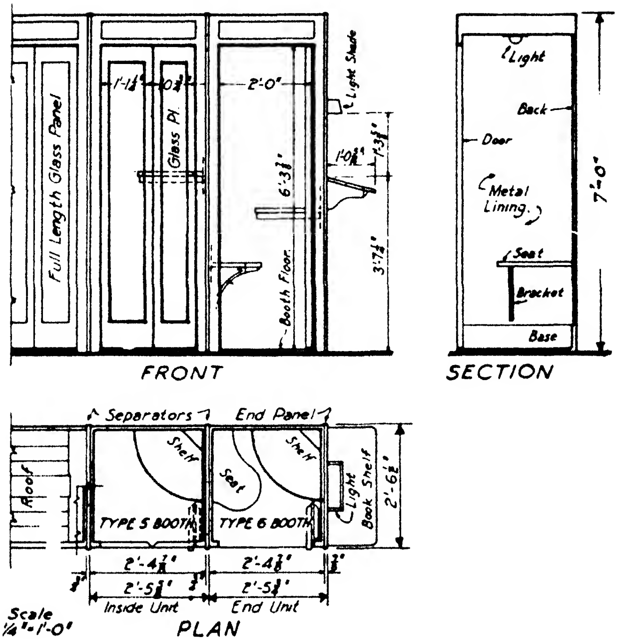


This large type of booth, No. 7, is installed in locations where persons may be expected to make several successive telephone calls, thereby using the booth for a comparatively long period of time, requiring greater comfort and more space. Its use is usually confined to railway stations, hotels and such places where there is an operator in attendance.

Both the electric light and fan in each booth are controlled by an automatic door switch. The fan may also be controlled by a wall switch. Fan and light are on the house current.

Local telephone companies supply these booths in oak and birch with light mahogany, dark mahogany and walnut finishes. Booths in unfinished mahogany or other woods finished to match special samples for decorative purposes may be obtained from the local company on "$pecial" ba$i$.

STANDARD TELEPHONE BOOTHS NOS. 5 AND 6



SPACE REQUIRED FOR GROUPS OF BOOTHS

No. of Units	*Overall Widths**
1	2'- 6¾"
2	5'- 0¼"
3	7'- 5⅞"
4	9'-11½"
5	12'- 5⅛"
6	14'-10¾"
7	17'- 4⅜"
8	19'-10"
9	22'- 8⅝"
10	24'- 9¼"
11	27'- 2⅞"
12	29'- 8½"

***Overall widths include two end panels and one less separator than number of units.**

Booths 5 and 6 are similar, the only difference being in the height of shelf and that booth 6 is furnished with a seat. The book shelf and light fixture above are not a part of the booth unit and if they are to be located at end panel as shown, sufficient space must be provided for reader.

These booths are furnished and installed by the telephone companies and remain their property unless they are to be "built-in." In that case they must be bought by the owner. The electric light in each booth uses house current and is controlled by a door switch.

Telephone companies supply these booths in oak and birch woods with oak, mahogany and walnut finishes. Other woods and finishes may be obtained on "$pecial" ba$i$.

GENERAL REQUIREMENTS OF EMERGENCY LIGHTING

Several kinds of storage battery-operated emergency lighting systems are available to satisfy varying requirements. *Low voltage models* are for areas up to 10,000 square feet. Fully automatic models are available for protection of 2-wire, 115 volt lighting circuits. For 3-wire systems models are available.

Emergency lighting protection should be included in all places where continuous light must be insured to prevent:

1. Panic or injury to patrons or employees.
2. Damage to property.
3. Theft.
4. Interruption of business activities or industrial processes.
5. Loss of good-will.
6. The fire hazard of substitute lighting.

HOSPITALS. The same storm, fire or accident which puts out the lights may cause injuries requiring the immediate use of the operating room or accident dispensary. The danger of a light failure during operations is extremely serious.

THEATERS, AUDITORIUMS. Most building codes require emergency lights for panics. These should have an independent light source.

INDUSTRIAL PLANTS. Many industries conduct dangerous or delicate processes, the control of which might be lost if lights fail. Ample light should be available instantly to make quick repairs so that production can be resumed and losses minimized.

BANKS. Emergency lighting permits the continuation of business during light failures, and is important in the prevention of theft and holdups.

STORES AND MARKETS. Emergency lighting protection enables the store to continue business, prevent theft or shoplifting, protect cashier or cash registers, eliminate the fire hazard of substitute lighting, especially candles, and prevent loss of good-will.

ENGINE ROOMS. Lighting troubles are apt to originate in the boiler, engine or transformer room. Lighting is necessary to find the trouble quickly to make repairs.

LARGE HOMES. Large homes are often located in the suburbs where the electric supply is overhead with more frequent lighting failures than in the business districts. Emergency lighting protection provides a definite sense of security and convenience.

SUITABILITY OF WOODS FOR FLOORING

SUBFLOORS (HOUSE)

Usual requirements: Requirements are not exacting, but high stiffness, medium shrinkage and warp, and ease of working are desired.

Highly suitable: Commonly used—Douglas fir, western larch, southern yellow pine. Seldom used because of adaptability to more exacting uses—cypress, redwood, ash, yellow poplar.

Good suitability: Commonly used—hemlocks, ponderosa pine, spruces, white fir. Seldom used because of adaptability to more exacting uses—northern white pine, sugar pine, western white pine. Seldom used since not readily available and hard to work—beech, birch, chestnut, elm, hackberry, maple, oak, tupelo.

Grades used: No. 2 boards are used extensively in higher type homes. In more economical construction both No. 2 and No. 3 are used. No. 3 is serviceable but not so tight as No. 2. No. 4 and No. 5 are available in some species but entail waste in cutting. When hardwoods are used, No. 2 Common is adapted to the better class houses and No. 3 Common to the more economical.

LIVING ROOM AND BEDROOM FLOORING

Usual requirements : High resistance to wear, attractive figure or color, minimum warp and shrinkage.

Highly suitable: Most commonly used hardwoods—hard maple, red and white oak. Not commonly used—ash (white), beech, birch, walnut. Not commonly available, hard to work and nail—hickory, black locust, pecan.

Good suitability: Cypress, Douglas fir, western hemlock, western larch, redwood, southern yellow pine. (Vertical grain.) Cherry, red gum, sycamore (quartered). (Not commonly available. Highly decorative and suitable where wear is light and maintenance good.)

Grades used: In beech, birch, and maple flooring the grade of Firsts is ordinarily used for the better class of homes, and Seconds and sometimes Thirds in low-cost jobs. In oak the grade of Clear (either plain or quartered) is used in better class work and Selects and sometimes No. 1 Common in low-cost work. Other hardwoods are ordinarily used in the same grades as oak. When softwood flooring is used (without covering) in better class homes, grade A or B and Better vertical grain us used. Grade D or C (vertical grain) is used in more economical and low-cost homes.

KITCHEN FLOORING (UNCOVERED)

Usual requirements: Resistance to wear, fine texture, ability to withstand washing and wear without discoloring and slivering, minimum warp and shrinkage.

Highly suitable: Fine textured—beech, birch, hard maple. Open textured—ash, red and white oak. Soft maple.

Good suitability: Cypress, Douglas fir, western hemlock, western larch, redwood, southen yellow pine. (Vertical grain preferred.) Elm, hackberry, sycamore.

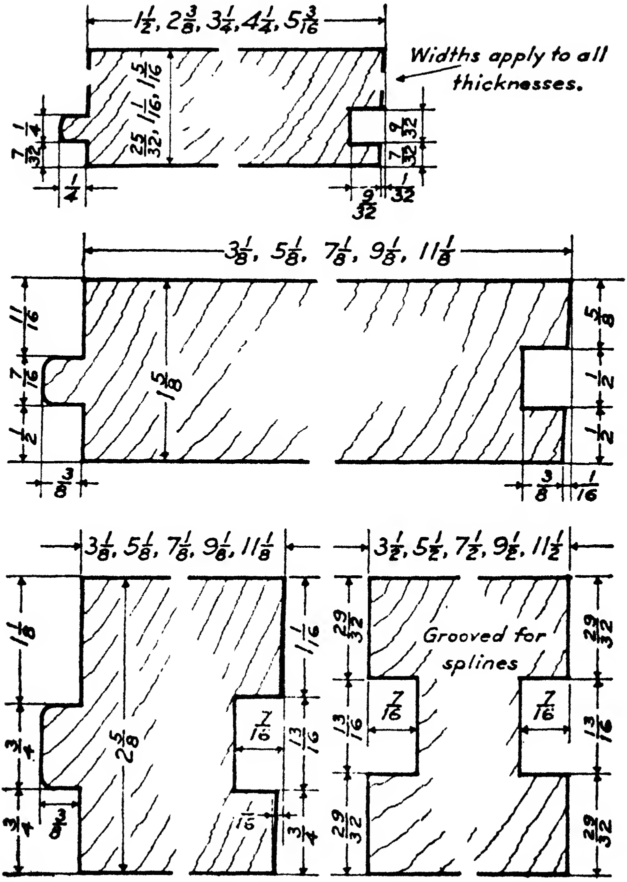
Grades used: The flooring grades, Seconds in beech, birch, and hard maple, and Selects in the oaks are used in high-priced houses. In more economical construction Thirds in beech, birch, and hard maple, and No. 1 Common or No. 2 Common in the oaks are used. D (vertical grain) is the lowest grade of softwood that proves thoroly satisfactory in high-class construction. A grade and B and Better grade (vertical grain) are used most extensively. No. 1 and No. 2 are serviceable in low-cost construction but wear unevenly around knots.

PORCH FLOORING

Usual requirements: Medium to good decay resistance, medium wear resistance, nonsplintering, freedom from warping.

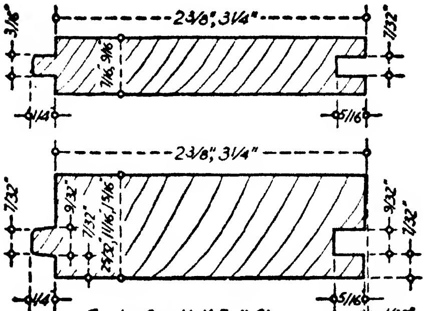
Highly suitable: Cypress, Douglas fir (vertical grain), western larch (vertical grain), southern yellow pine (vertical grain), redwood, white oak. (If full drainage is not obtainable only the heartwood of cypress, redwood, and white oak can be given a high rating.) Black locust, walnut. (Usually impractical except when cut from homegrown timber.)

STANDARDS* FOR SOFTWOOD FLOORING



*The patterns shown are those known as "Standard" according to the U. S. Dept. of Commerce *"Simplified Practice Recommendation No. R16-29"* and accepted by the A.I.A., Associated General Contractors of America, American Railway Association, National Lumber Manufacturers Association, and over one hundred and fifty other manufacturers and consumers of lumber. They apply to flooring of Western Red Cedar, Sitka Spruce, West Coast Hemlock, Coast Region Douglas Fir, Redwood, Red Cypress, Southern Yellow Pine, North Carolina Pine, Eastern Hemlock, and Tamarack, as produced by the principal lumber manufacturers of the United States.

FINISH FLOORING
OF ARKANSAS SOFT PINE



Scale - One Half Full Size

PINE FLOORING. It is from the heavier butt logs that flooring stock is cut in order to take advantage of the more dense growth which, in the finished product, will stand up under hard wear. Heart face, edge grain ARKANSAS PINE flooring is practically indestructible.

ARCHITECT'S SPECIFICATIONS. The specifications to be complete must clearly state a choice in the following items:

1. Plain end or End-matched.
2. Grade.
3. Method of sawing.
4. Proportion of Heart Face.
5. Face width and thickness.
6. Scratched or hollow-backed if 25/32" thick or thicker.

GRADES OF PLAIN END FLOORING. Grades usually specified in good construction are either *A* or *B*. *A* grade consists of pieces practically free of defects on the face side. *B* admits a very limited number of minor defects on the face side which do not detract from a smooth, well groomed surface. *C* admits slight defects none of which affect the soundness of the wood. It is suitable under carpets or linoleum, and in closets, etc. Moisture content in *C* or higher grade, kiln dried flooring does not exceed 12 per cent in 90 per cent of the pieces delivered. *D* is suitable for low cost, utility construction. It can be trimmed as laid, to eliminate most defects without loss of more than 10 per cent of the length of any piece. Moisture content in *D* grade, kiln dried, does not exceed 15 per cent. Standard lengths in all grades are 4 to 20 feet.

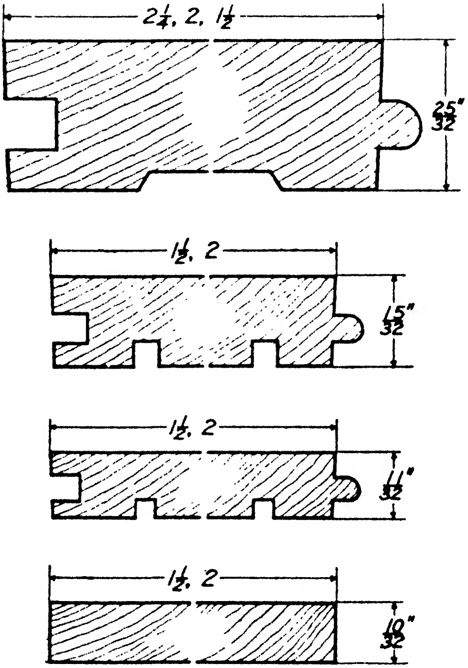
GRADES OF END-MATCHED. In using End-matched material, the carpenter does not need to trim except when he reaches the side of a room. Thus, practically 100 per cent of the flooring material is used and a large part of waste labor is eliminated. Where end joints occur, they are permanently maintained flush with each other and adjoining pieces. Grades are the same as in Plain end flooring, above. Standard lengths are 2 to 16 feet, nested in bundles 8 feet and longer in multiples of 1 foot.

EDGE GRAIN FLOORING. *Edge Grain, Rift Grain, Vertical Grain* or *Quarter Sawn* flooring receives painter's finish evenly, is most durable.

FLAT GRAIN FLOORING. *Flat Grain, Plain Sawn* or *Slash Grain* flooring is suitable for general flooring use where strict economy is necessary.

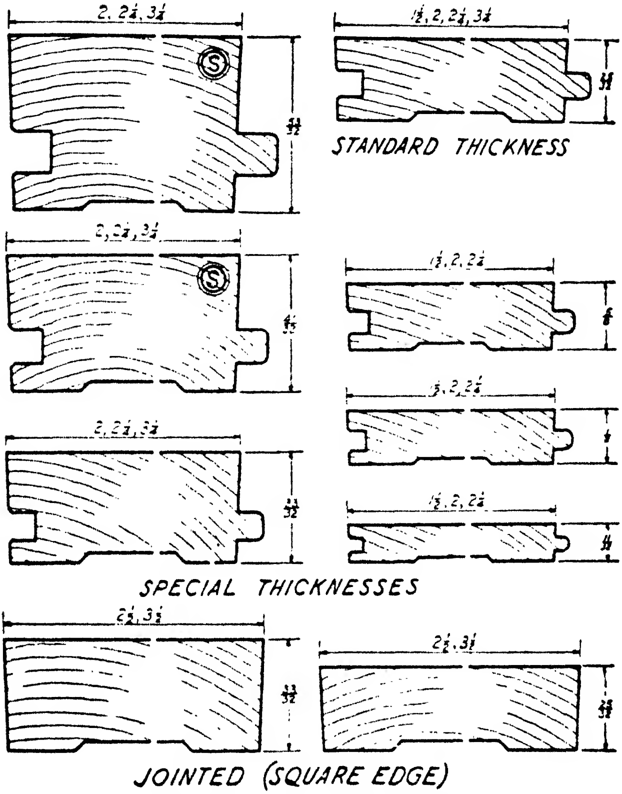
HEART FACE FLOORING. If unusual durability and *uniform color* are required, *Heart Face* flooring should be specified. *Heart Face* flooring is free from sapwood on the face side. It is unusually decay-resistant.

OAK FLOORING STANDARDS



Actual	*Nominal*	*Counted as*
25/32 x 2¼	13/16 x 2¼	1 x 3
25/32 x 2	13/16 x 2	1 x 2¾
25/32 x 1½	13/16 x 1½	1 x 2¼
15/32 x 2	½ x 2	1 x 2½
15/32 x 1½	½ x 1½	1 x 2
11/32 x 2	3/8 x 2	1 x 2½
11/32 x 1½	3/8 x 1½	1 x 2
10/32 x 2	5/16 x 2	1 x 2
10/32 x 1½	5/16 x 1½	1 x 1½

FLOORING STANDARDS
MAPLE, BIRCH, AND BEECH



The $^{25}/_{32}$" thickness is most commonly used for general purposes. The $^{53}/_{32}$" and $^{41}/_{32}$" thicknesses are marked "S" on the drawing to indicate that they are seldom carried in stock and are usually made only to fill special orders. The $^{33}/_{32}$" thickness has $^{1}/_{4}$" more depth of wearing surface than the Standard Thickness, and is recommended where floors are to be subjected to extraordinary strain and wear. The $^{5}/_{8}$" and $^{1}/_{2}$" thicknesses are manufactured for special purposes and can be obtained on special order if desired.

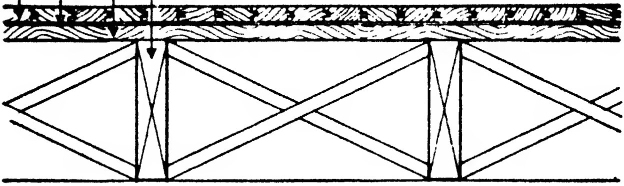
The $^{11}/_{32}$" thickness is used over old floors, but care should be taken that the underfloor is dry, sound, and of uniformly even surface.

Square edge or "Jointed" flooring possesses the advantage of easy replacement in industrial floors.

In the $3^{1}/_{4}$" and $3^{1}/_{2}$" face widths two channels in the back are usual, the other face widths having one channel as shown.

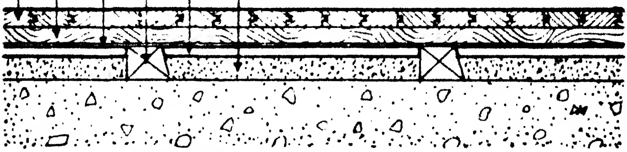
WOOD FINISH FLOORING

Finish flooring laid either parallel or at right angles to joists. Thickness varies.
Building Paper lapped 4"
Sub-flooring $\frac{25}{32}$" thick S4S 4" or 6" wide, laid diagonally with $\frac{1}{8}$" spaces between boards
Joists spaced 12" to 18" o.c. - designed to limit deflection. Bridging at least every 8'-0" of span, and two rows at least in spans of 12'-0" or over.

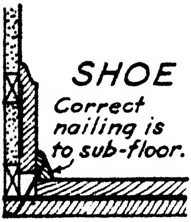


OVER WOOD JOISTS

Finish flooring laid either parallel or at right angles to sleepers. Thickness varies.
Sub-flooring $\frac{25}{32}$" thick S4S 4" or 6" wide, laid diagonally with $\frac{1}{8}$" spaces between boards.
Building paper lapped 4".
Sleepers 2"x3" or 2"x4" ripped to give beveled edge. Space 16" o.c. or 18" o.c. If sub-floor is omitted (not advised) space sleepers 12" o.c.
Space of $\frac{1}{2}$" for ventilation.
Cinder concrete fill.



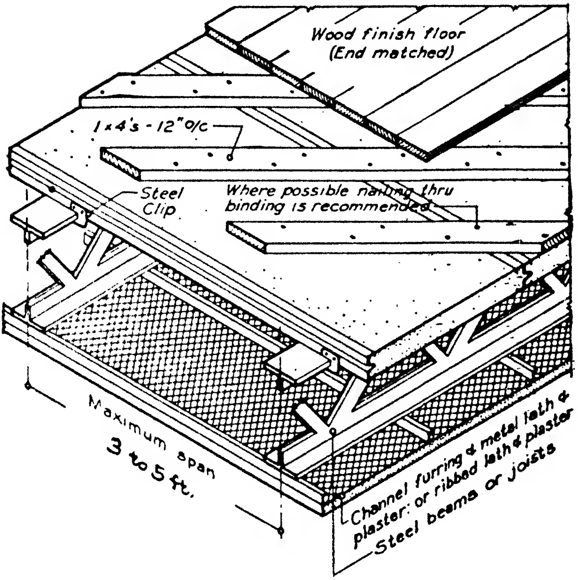
*OVER CONCRETE



SHOE
Correct nailing is to sub-floor.

*Good Nailing Concrete permits omission of both sleepers and sub floor, when properly applied and given several weeks to dry. Concrete floors on earth should have an effective damp-prfg. applied under wood

WOOD FINISH FLOORS OVER GYPSUM PLANK



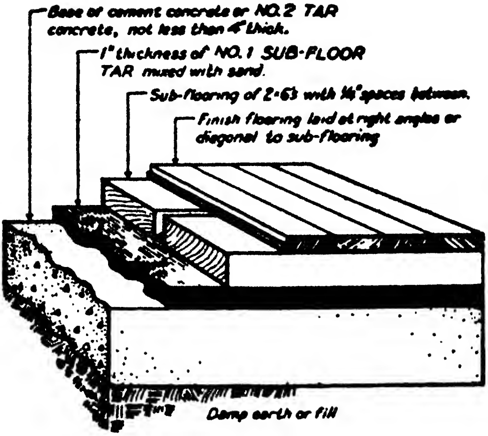
WOOD FINISH OVER WOOD STRIPS. A satisfactory and economical method is shown in the drawing above. 1 x 4's spaced 12" o/c may be laid either diagonally or at right angles to the direction of the gypsum plank. These strips are face-nailed to the plank, about 8" o/c on opposite edges with the nails driven on the slant. The finish must be end matched, and is nailed to the strips at each bearing.

WOOD FINISH OVER BOARDING. A finished wood floor can be installed over gypsum plank in the conventional manner. Sub-flooring 25/32" thick, S4S, 4 or 6 inches wide, is laid either diagonally or at right angles to the plank with 1/8" spaces between boards. Sub-flooring should be face-nailed on opposite edges 12" o/c, driving the nails to slant toward each other.

WOOD PARQUETRY BLOCK FLOORS. Ordinary wood parquetry block floors are laid directly over plank as they would be over concrete.

THICK FLOOR FINISHES. For terrazzo, granolithic, ceramic tile, or other poured finishes, plank should first be coated with tar, asphalt, or gypsum sealer. From the top of the plank to the finish floor line, should be not less than 1 1/2" thick. For best results, a minimum of 2" is recommended. The poured finish should be provided with adequate expansion joints and mesh reinforcing.

WOOD FINISH FLOORS OVER GYPSUM PLANK



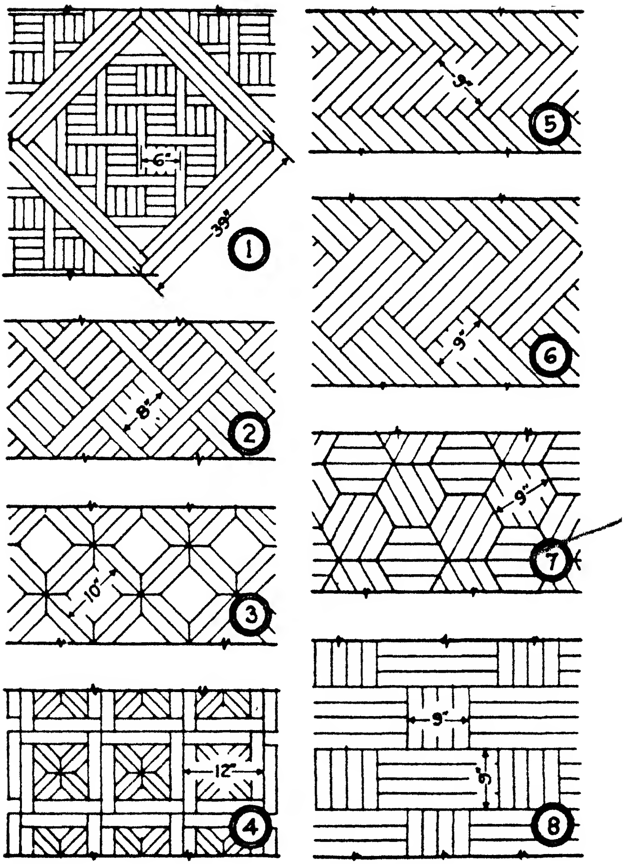
In basements where the ground is damp and it is desired to use a wood finish floor, an effective dampproofing is necessary, The earth should be leveled off to proper grade. If earth or cinder fill is used it should be puddled and rolled or tamped to thoroughly compact it. The sub-base may be either a cement-concrete slab installed in the usual way, or a slab of No. 2 sub-floor tar concrete. A cubic yard of crushed stone or gravel passing a 2¼" sieve but retained on a ¼" sieve is mixed with approximately 10 gallons of No. 2 sub-floor tar which has been heated. This should be thoroughly rolled or tamped and brought to accurate grade.

Over the slab the dampproofing course is placed. One cubic yard of clean torpedo sand is heated (210° to 250°F) and mixed with 25 to 30 gallons of No. 1 sub-floor tar at the same temperature. The mixture is spread evenly over the slab to a thickness of from 1¼" to 1½" and leveled with a straight edge.

Well dried or treated planks are laid on this soft mixture before it cools and bedded by hammering, so that the coating compacts to a thickness of 1". If any plank is hammered below level, it is raised and more of the mixture applied beneath it. After the planks have been brought to proper level they are toe-nailed together. The sub-floor planks are preferably pressure treated with coal tar creosote meeting the Grade 1 specifications of the American Wood Preservers' Association. In food factories, creameries, etc., where the odor of creosote might be objectionable, the planks should be treated with a suitable salt preservative such as zinc chloride or Wolman salts. Planks to be creosoted should be dried before treatment. When a salt preservative is used, the planks should be dried after treatment, whether or not they were dried before treatment.

The finish floor is then laid at right angles or diagonal to the planks in the usual manner.

PARQUETRY PATTERNS

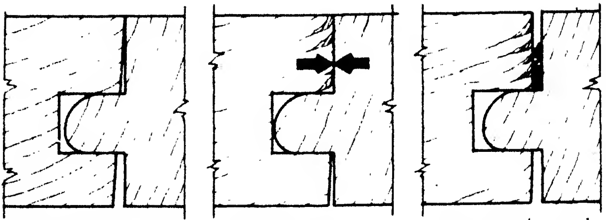


1. Design used in Palace at Fontainebleau.
2. From the Library of Marie Antoinette, Versailles.
3. From Thos. Jefferson's own house at Monticello.
4. In Melbury House, Dorset.
5. Butted Herringbone.
6. Clustered Herringbone.
7. Hexagons.
8. Basket Weave.

All drawings are made to the same scale of ⅛" = 1'-0".

Usual thickness for parquetry floors is 13/16". The sizes of the patterns may be varied to suit the dimensions of the room and standard sizes of wood flooring to be used.

CAUSE OF CRACKS IN WOOD FLOORS



Flooring dry when laid — Swelling crushes top fibers — Permanent crack results later

When flooring with a high moisture content is laid tight, it dries out with the building, and as it shrinks from drying, cracks appear. Why cracks appear when the flooring is dry and carefully put down is not so well understood, however. These diagrams show what happens.

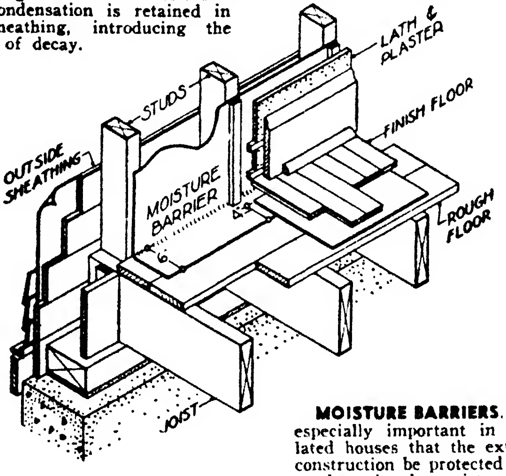
A succession of damp days, high humidities from the drying of wet plaster, or other cause, will allow the dry flooring to absorb moisture. The swelling of the flooring often causes a perceptible bulging of some boards. A crushing of the wood fiber on the sloped female edge is bound to take place—and we are then face to face with the most common cause of all cracking, known as "compression set." The subsequent drying of the house to a state of moisture equilibrium simply causes each board to shrink away from its neighbor, and the width of the crack is roughly equal to the amount of crushing or set that has taken place. Foreign matter or particles in such cracks will still farther open them during subsequent damp and dry cycles of swelling and shrinking.

Cracking can be prevented if the following precautions are carefully observed: 1) Use dry flooring to begin with, 2) Edge-grain flooring, even in lower grades, is to be preferred to mixed or flat-grain, 3) Building must be dried out, 4) Apply painters finish to floors as soon as laid, and 5) Maintain a dry temperature until building is occupied.

PROTECTING CONSTRUCTION AGAINST CONDENSATION

HOW CONDENSATION OCCURS. The average relative humidity in a house during the heating season is about 20%. As moisture is added to the air by air conditioning, home laundry operations, cooking, water pans on radiators, etc., the relative humidity is increased and may reach 40% or even more. The humidified air passes readily thru the plaster and insulation in its attempt to reach the outside atmosphere where the humidity is lower. The temperature of the wall construction decreases from the room temperature on the inside to outside temperatures on the exterior face. If the humidified air in its passage outward reaches the inside face of the sheathing, and the sheathing is at or below dewpoint temperature, condensation will occur.

RESULT OF CONDENSATION. Some tests of sheathing have shown a moisture content as high as 35%. Instances of ice in the walls have been found. Insulation of various types have been reported as wet in a number of cases. Condensation has also been found on the roof sheathing, forming as frost during the cold weather. Warmer weather causes the frost to melt and drop off, soaking thru the ceiling plaster and producing the effect of roof leaks. The condensation is retained in the sheathing, introducing the hazard of decay.

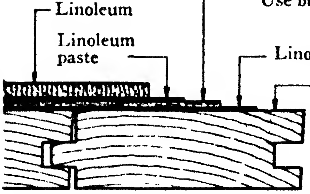


MOISTURE BARRIERS. It is especially important in insulated houses that the exterior construction be protected from condensation by moisture barriers. Fiber-reinforced paper has the qualities which make it uniquely suitable for this use. It is highly vapor-resistant. Its special asphalt is flexible in cold weather. The asphalt is protected from oxidation by the dense kraft paper. A moisture barrier must form an unbroken surface to be effective and the 2-way sisal fiber reinforcement of this paper guarantees its application without cracks, rips or tears.

APPLICATION OF PAPER. Beginning with a 3" lap on the ribbon or plate, apply 36" fiber-reinforced paper vertically, lapping it over the face of the studs. Allow about 6" of paper to fold out at the bottom of walls over sub-flooring, so that floor lining paper may lap at least 4" minimum. Apply paper similarly under the joists of all insulated ceilings. Allow ceiling paper to fold down on side walls to provide a lap of 2". Batten the paper at every stud and joist if wood or metal lath is used. Laps may be sealed with mastic before the battens are applied, as an extra precaution against leakage. All openings around electrical and other outlets and joints at fire-stops must be made tight.

LINOLEUM
STANDARDS

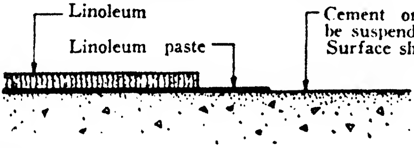
Lining felt shall be semi-saturated, weighing approximately 1 lb. per sq. yd. Use butt joints.



T. & G. wood flooring of dry and well-seasoned hard or softwood lumber. Floor boards not more than 3 1/4″ wide, preferably laid diagonally and toe nailed with all joints tight.

Old wood flooring shall have defective and badly worn boards replaced. These and any loose boards shall be face nailed. Any unevenness in the boards shall be planed or sanded to a smooth and even surface. Floors should be sized with a suitable floor or wall size after sanding. Paint or varnish on old floors shall be removed before applying linoleum paste.

LINOLEUM ON WOOD FLOORING



Cement or concrete floors shall be suspended and thoroughly dry. Surface shall be smooth and even.

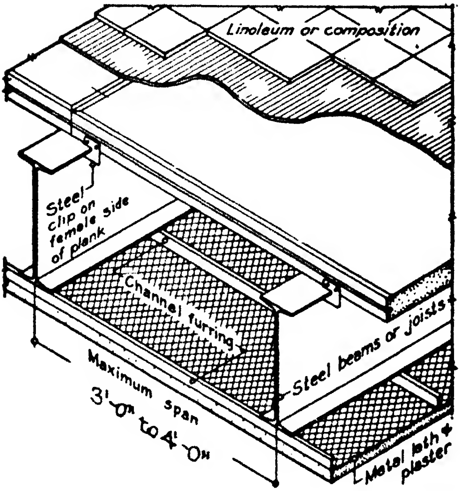
Scored expansion joints, cracks, etc., are to be filled with plaster of Paris or other suitable material to prevent them from showing on the the linoleum surface.

LINOLEUM ON SUSPENDED CONCRETE FLOOR

PROPERTIES OF LINOLEUM

Type of Linoleum	*Approx. Thickness in Inches*	*Finished Gage*	*Average Net Weight per Sq. Ft. in Lbs.*
BATTLESHIP			
3/16″ gage	3/16″	.187	1.45
Heavy gage	1/8″	.125	1.0
EMBOSSED INLAID			
Heavy gage	1/8″	.125	.88
Standard gage	3/32″	.0925	.62
JASPE			
Heavy gage	1/8″	.125	1.0
Standard gage	3/32″	.0925	.68
MARBELLE			
Heavy gage	1/8″	.125	1.0
Standard gage	3/32″	.0925	.63
Light gage	1/16″	.070	.44
PLAIN			
Heavy gage	1/8″	.125	1.0
Standard gage	3/32″	.0925	.68
STRAIGHT LINE INLAID			
Heavy gage	1/8″	.125	1.0
Standard gage	3/32″	.0925	.63
Light gage	1/16″	.070	.44

THIN FLOOR FINISHES OVER GYPSUM PLANK



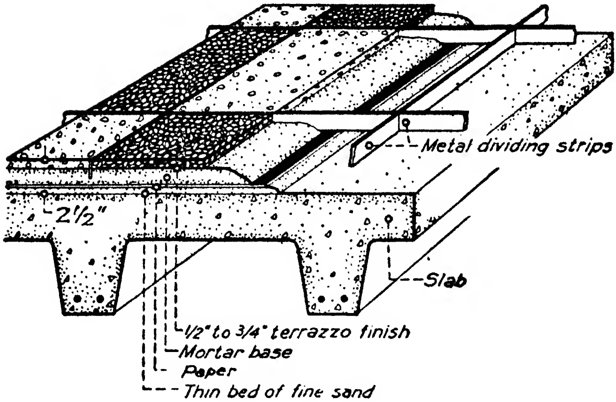
THIN FLOOR FINISHES. Where a thin finish flooring, such as linoleum, rubber tile, asphalt tile, etc., is to be applied over plank, a leveling coat shall first be used. Spacing of joists or beams shall be limited to 3 or 4 ft., depending on the manufacturer's recommendations, in order to maintain a ratio between the overall thickness of the floors and the spans that will assure adequate stiffness.

LEVELING COAT. This composition bonds with gypsum, sets quickly and firmly, and is easily troweled to a smooth, hard finish. The first step in its application is to sweep the plank floor thoroughly, to remove any loose material or debris.

The plank is dampened with water and the leveling coat is applied in 2 coats. It sets hard in from 1 to 3 hours. It must not be retempered in mixing. The finish flooring should be applied after the leveling coat is thoroly dry.

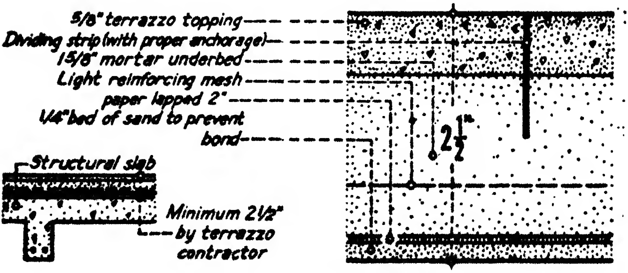
OVER LIGHT STEEL JOISTS. Clips are attached alternately to the opposite flanges of the joists, thus allowing the plank itself to act as a series of struts. Clips are used at every intersection of the plank with the joists. Steel clips are securely nailed to the female side of the plank with 2 four-penny galvanized slater's nails.

TERRAZZO FLOORS ON SAND CUSHION

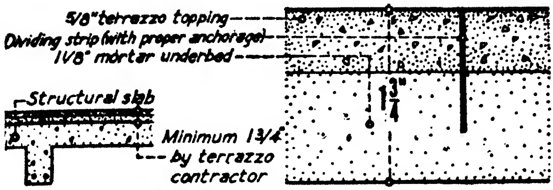


CRACKS IN TERRAZZO FLOORS. Shrinkage cracks are largely eliminated or localized by the brass dividing strips that form the pattern of the floor. Structural cracks are usually caused by the cracking of the base slab. Structural cracks may be eliminated by constructing the floor finish without bond with the base. This is accomplished by separating the base slab from the finish with a layer of sand, covered with fiber-reinforced paper. The sand provides a cushion and cracks originating in the base slab from settlement, contraction or vibration do not appear on the surface.

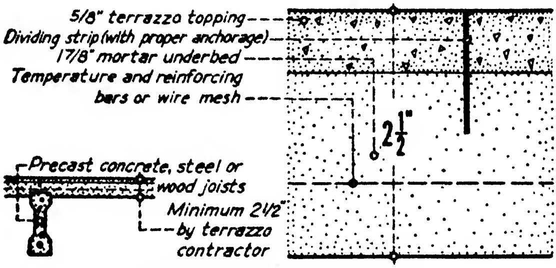
WHY FIBER-REINFORCED PAPER? Obviously, any rupture in the paper used over the sand bed will allow the wet mortar mixture to get thru when the terrazzo under-bed is placed and rolled down. Solid "points of support" might be formed in this manner—utterly destroying the function of the sand cushion. Because of its great strength, fiber-reinforced paper is not broken by workmen walking over it or cut by the planks upon which heavy loads are wheeled.



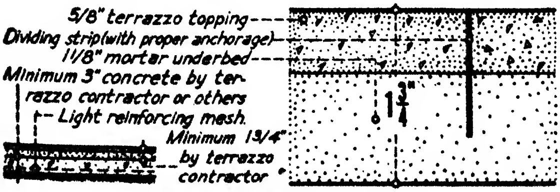
TERRAZZO FLOORS



BONDED TO CONCRETE



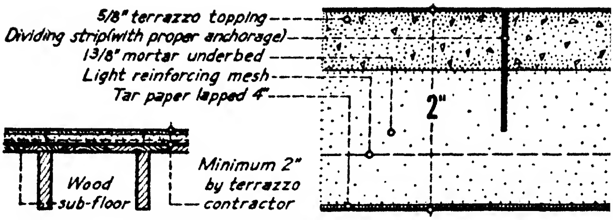
DIRECTLY OVER JOISTS



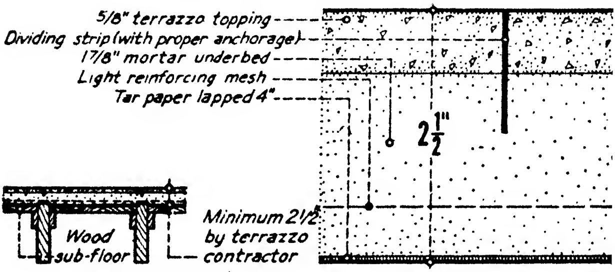
DIRECTLY OVER EARTH

Terrazzo topping - 200 lbs. marble granule to not less than 100 lbs. white or gray portland cement. Mortar underbed 1 cement: 4 sand. Dividing strips to be indicated on plans and/or specified to show: 1). Depth: (1 1/4" is standard). 2). Gage or face thickness 3). Material: Brass, White Metal (zinc or nickel silver) or composition 4). Spacing and arrangement.

TERRAZZO FLOORS



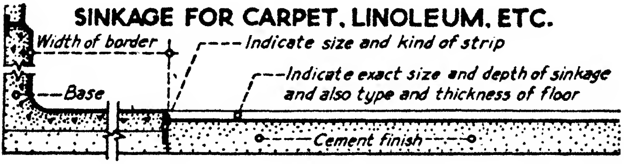
WOOD CONSTRUCTION

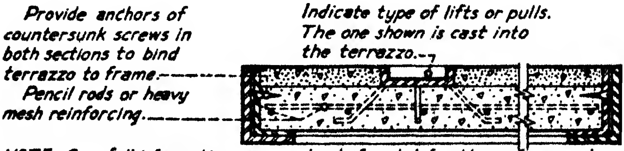


NEW OR OLD WOOD CONSTRUCTION

Terrazzo topping-200lbs. marble granule to not less than 100lbs. white or gray portland cement. Mortar underbed 1cement:4 sand. Dividing strips to be indicated on plans and/or specified to show: 1). Depth (1 1/4" is standard). 2). Gage or face thickness 3). Material: Brass, White Metal (zinc or nickel silver) or composition. 4). Spacing and arrangement.

SINKAGE FOR CARPET, LINOLEUM, ETC.

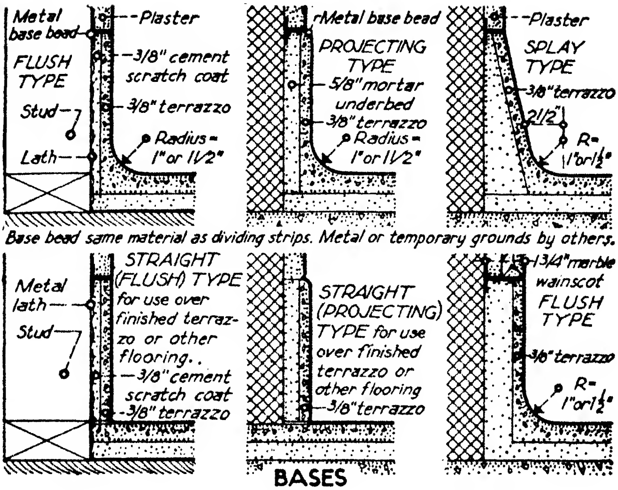




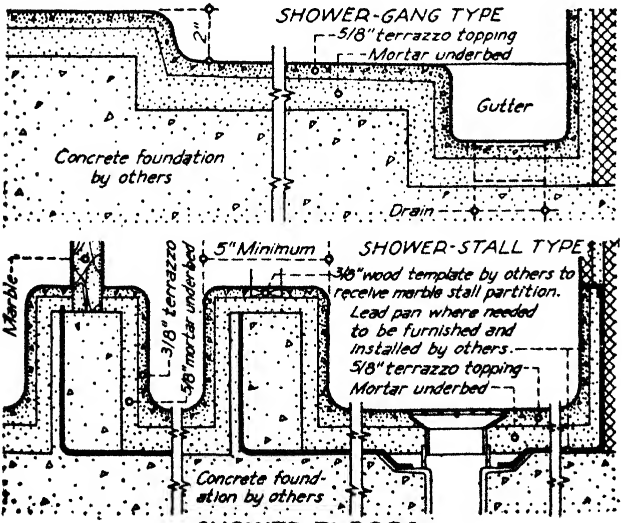
NOTE- Give full information on size, kind of metal for these frames to be furnished and set by the terrazzo contractor.

TRENCH COVER

TERRAZZO BASES AND SHOWER STALLS



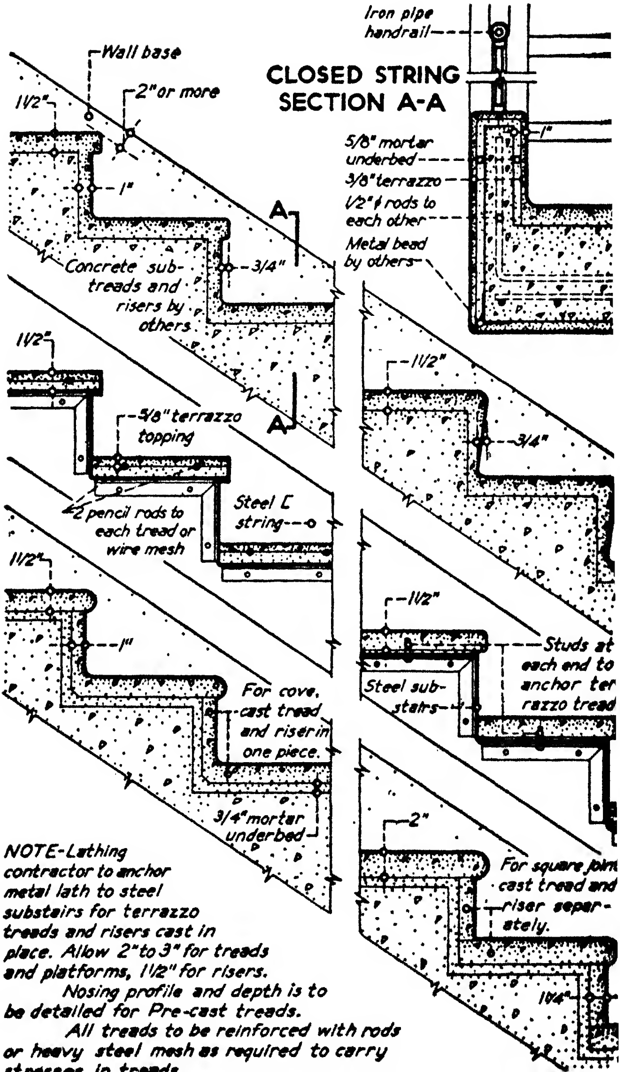
BASES



SHOWER FLOORS

SCALE OF DETAILS - 1½" = 1'-0"

TERRAZZO STAIR CONSTRUCTION



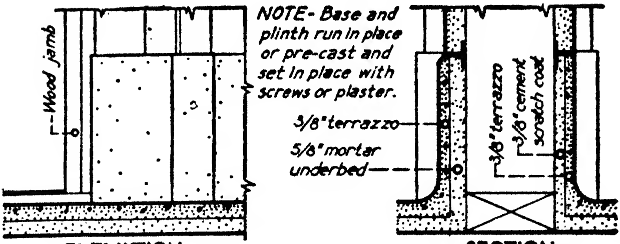
NOTE—Lathing contractor to anchor metal lath to steel substairs for terrazzo treads and risers cast in place. Allow 2" to 3" for treads and platforms, 1 1/2" for risers.

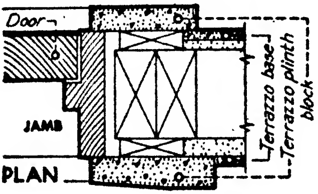
Nosing profile and depth is to be detailed for Pre-cast treads.

All treads to be reinforced with rods or heavy steel mesh as required to carry stresses in treads.

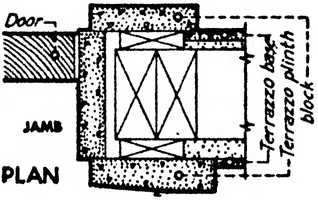
SCALE ¾" = 1'-0"

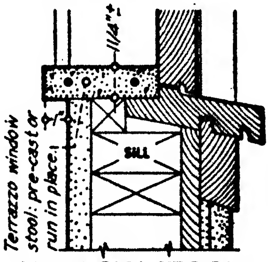
TERRAZZO DOOR TRIM AND WINDOW STOOL





BASE AND PLINTH

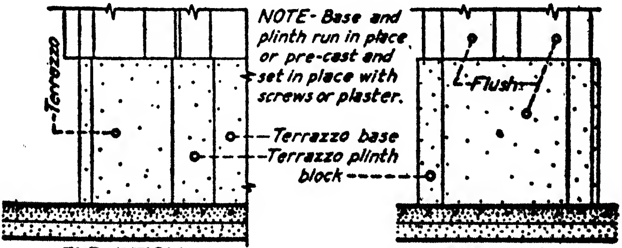




WINDOW STOOL

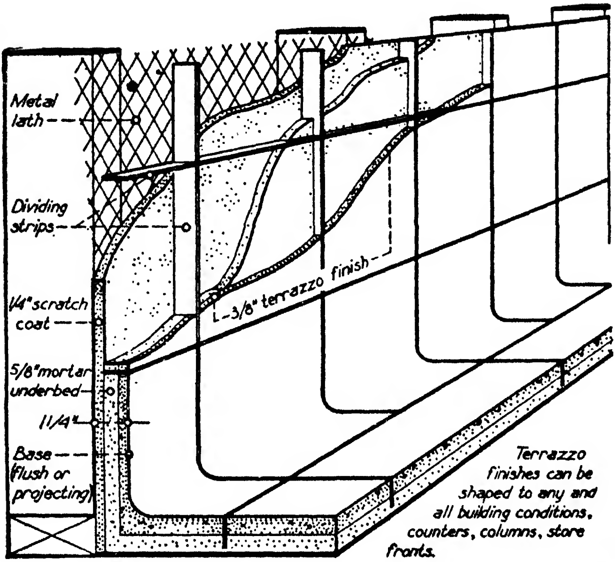
Ornamental terrazzo, tho usually job made is sometimes pre-cast. It may take any desired form - from statuary to table tops. It is often used in connection with terrazzo flooring, being designed and colored to harmonize with floor.

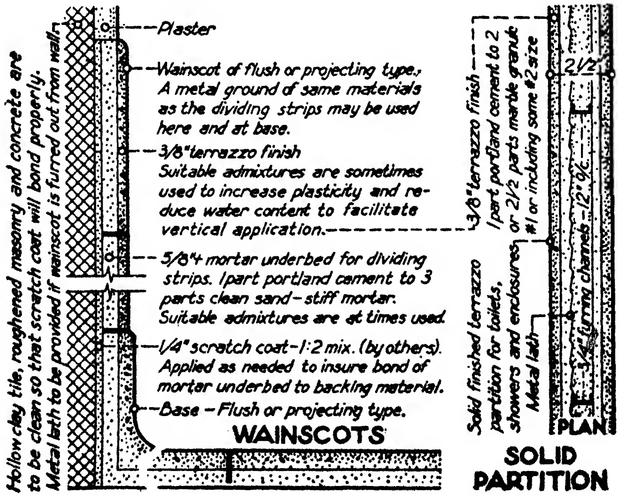
SCALE 1½" = 1'-0"



HOSPITAL TYPE

TERRAZZO
WAINSCOTS & PARTITIONS





SHORT FORM
TERRAZZO SPECIFICATION

AVAILABLE REFERENCE MATERIAL. *The following publications are available from the Association, prepared especially for architectural needs in designing, detailing and specifying:*

Specification for Terrazo Work and for Mosaics
Terrazo Maintenance Bulletin
Dividing Strip Location and Data
Reducing Explosion Hazards in Operating Rooms
Terrazo Streamlined Bathroom
Resiliency Tests
Outdoor Terrazo

1. WORK INCLUDED. This Contract includes the furnishing of all labor and materials for terrazzo work including topping, underbed, dividing strips, sand bed, paper, and reinforcing mesh, as hereinafter specified and/or shown on the drawings.

2. MATERIALS AND WORKMANSHIP. Furnish and install materials in accordance with the current edition of "Specifications for Terrazzo Work," as published by the NATIONAL TERRAZZO & MOSAIC ASSOCIATION, 1420 New York Avenue N.W., Washington, D. C.

3. SAMPLES. Submit samples of dividing strips and of the terrazzo as required by the Architect for his selection and approval.

4. PREPARATION OF CONCRETE SURFACE. Clean the concrete floor thoroly of plaster droppings, wood chips and other debris, where terrazzo floors are to be installed over concrete. Slush the concrete with neat cement grout to insure a good bond.

5. PREPARATION OF WOOD SUB-FLOORS. Cover wood sub-floors that are to receive terrazzo with . . . (*brand*) . . . building paper, over which nail a reinforcing wire fabric.

6. PREPARATION OF SAND CUSHION. Cover the structural slab with a ¼" bed of dry sand, over which lay . . . (*brand*) . . . paper. The surface of the structural slab must be smooth and must have no points of support to destroy the function of the sand cushion. Lap building paper 2" on the sides and 2" on the ends.

7. MOTAR UNDERBED. Mix the underbed in the proportions of 1 part Portland cement and 4 parts coarse screened sand by volume. Spread the mixture evenly and bring to a level ⅝" below the finish floor grade.

8. DIVIDING STRIPS. While the underbed is still plastic, install . . . (*brass, nickel silver, zinc alloy, composition, etc.*) . . . dividing strips in . . . (*specify gage**) . . . B&S gage by 1¼" deep to conform with pattern shown on plans.

9. TERRAZZO TOPPING. Proportion the terrazzo mixture for topping in the ratio of 200 pounds of . . . (*give color and sizes of granule, whether domestic or imported, see catalogs*) . . . marble granules to 100 pounds . . . (*gray or white*) . . . Portland cement with the addition of . . . (*give quantity and color*) . . . non-fading and lime-proof mineral pigment. Mix ingredients dry. Add water after the mixing to make the mix plastic but not flowing. Use the same marble granule that appears on the surface for the entire thickness so that the topping shall be uniform in composition.

**Metal strips less than ⅛" thick are made of uniform thickness for their entire depth. Strips ⅛" thick or more are of the "heavy top" type, having the top member not less than ⅜" deep. Composition strips are available in colors.*

SHORT FORM
TERRAZZO SPECIFICATION

10. INSTALLATION OF TERRAZZO. Place the mix in the spaces formed by the dividing strips. Roll into a compact mass by means of heavy stone or metal rollers until all the superfluous cement and water is extracted. Hand-trowel to an even surface, disclosing the lines of the strips on a level with the terrazzo topping. A minimum of 70% marble granule must show in the finished surface.

11. CURING. Keep floor moist for not less than 6 days.

12. SURFACING. Machine rub the surface with No. 24 grit abrasive stone for the initial rubbing. Follow with No. 80 grit abrasive stone rubbing. Apply a light grouting of neat Portland cement of the same kind and color as the matrix, to fill the voids. Allow this grouting to remain until the time of final cleaning.

13. FINISHING. Allow at least 72 hours after the floor has been grouted before removing the grouting coat by machines, using a stone not coarser than No. 80 grit. Wash thoroly and leave in condition acceptable to the Architect. Acids are injurious to terrazzo and must not be used in cleaning.

14. HEAVY DUTY NON-SLIP FLOORS. Proportion the terrazzo mixture for topping in the ratio of 150 pounds of . . . (*give color and sizes of granule, whether domestic or imported, see catalogs*) . . . marble granules to 50 pounds of abrasive aggregate and 100 pounds . . . (*gray or white*) . . . Portland cement with the addition of . . . (*give quantity and color*) . . . non-fading and lime-proof mineral pigment. Mix ingredients dry and add water after the mixing to make the mix plastic but not flowing. Use the same marble granule and abrasive aggregate that appears on the surface for the entire thickness so that the topping shall be uniform in composition thruout.

15. LIGHT DUTY NON-SLIP FLOORS. Sprinkle abrasive aggregate on the surface only, so that the finished floor shows 4 parts marble granule and 1 part abrasive aggregate.

16. TERRAZZO BASES. Provide a base as detailed with . . . (*specify gage*) . . . B&S gage dividing strips every 5 feet and finish in the same manner as specified for floors. Base screeds, temporary grounds, or metal lath required for bases on stud walls to be furnished and set by others. Apply a scratch coat of cement and sand mortar to the walls back of the base and bring to a line ⅜" back of the finished base face. Set base dividing strips into scratch coat.

17. TERRAZZO STAIRS. Metal lath securely anchored to steel substairs by others. Reinforce pan treads and platforms with steel pencil rods. Install treads, platforms and landings that are to be made non-slip in conformity with Paragraph 14.

SHORT FORM
TERRAZZO SPECIFICATION

18. TERRAZZO WAINSCOTS. **A suitable sub-surface will be provided by others. Apply a ⅝" setting bed composed of 1 part cement and 3 parts sand with . . . (*specify gage*) . . . B&S gage dividing strips, as shown on drawings. Apply ⅜" finish to match approved sample. Bring wainscot to a . . . (*hone or polished*) . . . finish.**

19. TERRAZZO PARTITIONS. **A cement plastered sub-base will be supplied by others. Install terrazzo on both sides to a total partition thickness of 2½". as specified under wainscots.**

20. PRE-CAST TERRAZZO. **Pre-cast terrazzo shall conform to the specifications for cast-in-place terrazzo but in addition, reinforce pre-cast pieces for eliminating breaks and cracks in handling and placing.**

21. WORKING CONDITIONS. The following facilities are to be provided free of charge to the terrazzo and mosaic contractor to enable him to carry out his work most economically and with efficiency:

Space for storing his materials and equipment.
Water, light, and heat above freezing point.
Use of elevator or other hoisting facilities and gangways.
Suitable electric current and connections for Terrazzo Grinding Machines, shall be furnished as directed.

Rubbish caused in doing his work will be collected by the terrazzo contractor and placed where designated on each floor, for removal and disposal by others.

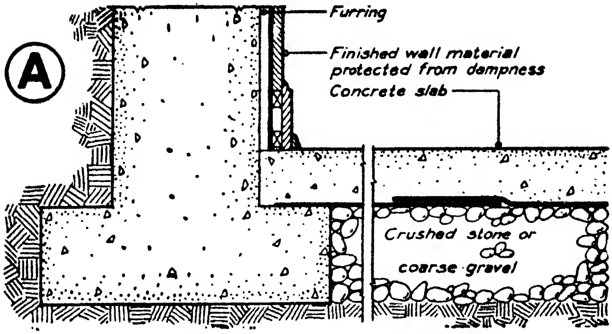
22. GUARANTEE FOR TERRAZZO AND MOSAIC. All work shall be guaranteed for a period of one year against defects caused by the use of inferior materials or workmanship.

MAINTENANCE OF TERRAZZO AND MOSAIC. Consult your terrazzo contractor for "sealers" and treatments suitable for terrazzo. Soaps and scrubbing powders containing caustic alkali should never be used in the maintenance of terrazzo and mosaic surfaces. To properly care for new terrazzo and mosaic floors, they should be scrubbed two or three times a week, and mopped on alternate days. Use a neutral soap, free from alkali, acids, or other strong ingredients, as they may ruin the floor. The floor must be rinsed after each washing, so as to prevent it from becoming slippery.

After two or three months of this treatment, the floor will acquire a beautiful natural sheen, and will require less work for its upkeep. Additional information in bulletin "Terrazzo Maintenance," from The National Terrazzo & Mosaic Association, 1420 New York Ave., Washington 5, D.C.

FINISH FLOORS
AT OR BELOW GRADE

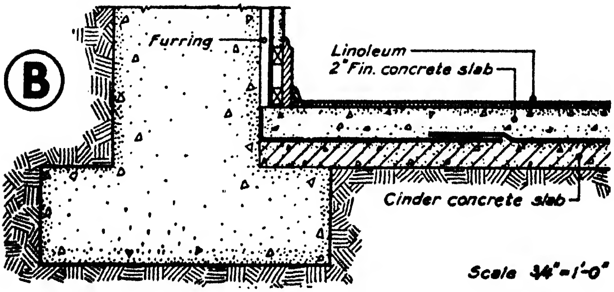
A



MONOLITHIC FLOORS. In clay, heavy loam or other soils which hold moisture, special precautions must be taken to protect the basement rooms from dampness. Under the floor a bed of crushed stone or coarse gravel is commonly used in such conditions, providing a layer of material which does not readily hold moisture. Over this *plain* fiber-reinforced paper should be laid, as shown in Figure A above, lapping the joints at least 9 inches. The paper maintains an even thickness in the fill against displacement caused by workmen walking over it during the pouring operation. It also prevents the wet mixture from flowing into the filling voids in the layer of crushed stone which depends for its value upon the existence of such voids.

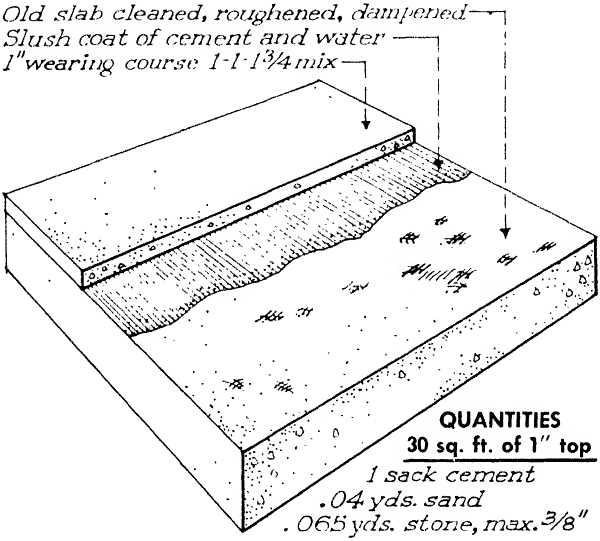
WALL PROTECTION. In such cases, wood paneling, plaster or finish walls of any type should be protected from dampness with *treated* fiber-reinforced paper.

B



FLOORS HAVING A FINISH. Wood, linoleum, rubber tile and other floor finishes should not be laid on concrete where dampness is present. A very dry mix cinder concrete slab should first be installed. Copper-covered fiber-reinforced paper should be laid over the cinder concrete, lapping the joints 6 inches and mopping them with hot asphalt. Finish walls should be protected with *treated paper*.

CONCRETE FLOOR RESURFACING



Old concrete slab to be resurfaced must be clean of loose particles, grease, oil, paint, or other material which interferes with bonding of the new top.

Saturate slab with water overnight. Then allow to dry 2 hours. No pools should be left standing.

Brush on a thin coat of cement mixed with water to the consistency of heavy cream or thick paint.

Place the wearing surface before the slush coat has dried or set.

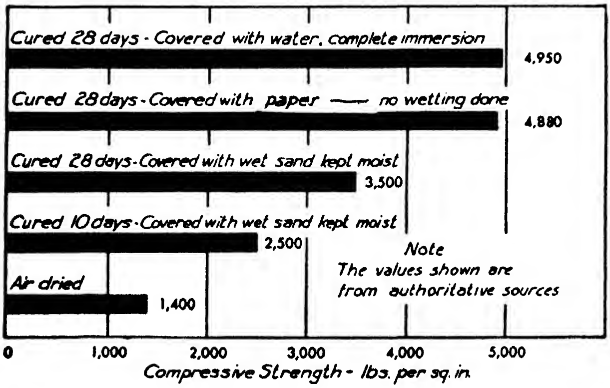
Screed to proper true level, float with wood float, and trowel to desired smoothness.

Careful curing will determine the amount of wear the new top will withstand. Protect carefully with wet sand, wet burlap, or waterproof paper as soon as new surface can be sprinkled and walked on.

Not more than 5 gallons of water should be used in the mix for each sack of cement. Screeding, floating and troweling should not bring free water to the surface. Do not dust top with dry cement, or sand and cement, to take up excess water.

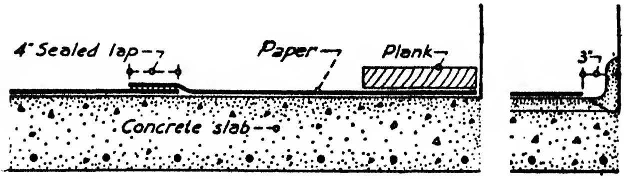
CURING AND PROTECTION OF CONCRETE AND TERRAZZO FLOORS

EFFECTIVENESS OF CURING AND PROTECTION WITH PAPER. Moisture is known to be a requisite for proper curing of concrete. The chart below shows the effectiveness of covering the concrete surface with waterproof and airproof fiber-reinforced paper to retain the original moisture automatically—entirely eliminating the human element. In addition to this, the paper protects floors against stains and construction dirt right up to the completion of the building.



CURING MONOLITHIC CONCRETE FLOORS. Monolithic slabs are generally placed before the building is closed in. Planks or other weights are used to hold the edge of paper in place on the slab.

CURING GRANOLITHIC FLOORS. Concrete slabs which receive a granolithic finish are not ordinarily poured until the building is closed in. For such floors which are to have a granolithic cove, the paper should be stopped 3" from the wall to allow the placing of the cove without disturbing the paper covering of the floor. If no cove is to be used, the paper is to be run right up to the wall.



BASIC RULES FOR MASTIC

1. Mastic will not withstand oils, greases, gasoline, animal or butter fats, solvents such as naphtha, carbon tetrachloride, etc.

2. Mastic will not stand temperatures above the normal atmospheric, unless special construction and special mixes are used.

3. Mastic will not remain on vertical surfaces over 3" high unless reinforced with expanded metal.

4. Mastic will support the heaviest type of *moving* load, but is incapable of sustaining exceptionally heavy *standing* loads over prolonged periods without indenting, unless a special mix or metal floor grids are used.

5. Mastic must be applied over a firm, suitable base as it possesses little structural strength.

6. Edges of mastic, such as at elevator wells, stair treads, etc., must be protected by metal strips, angle irons or other means to prevent the mastic from fraying.

7. Mastic must be troweled on—it cannot be screeded unless an unusually soft mix is used.

8. Do not rely upon mastic to form a bond with the base over which it is applied. This is the reason for establishing a minimum thickness of 1". Mastic will creep or shove under trucking when applied less than 1" thick.

9. If a mastic floor is to be installed above the first floor, it is advisable to allow the mastic contractor the exclusive use of an elevator. The mastic mixture must not be allowed to cool as might be the case if delay were caused from a joint use of hoist or elevator.

10. Red rosin sized paper or insulating paper must be applied over boards before receiving mastic. Resinous or green unseasoned boards must not be used.

11. Mastic is impractieal for roof gardens unless special precautions are taken by an experienced contractor.

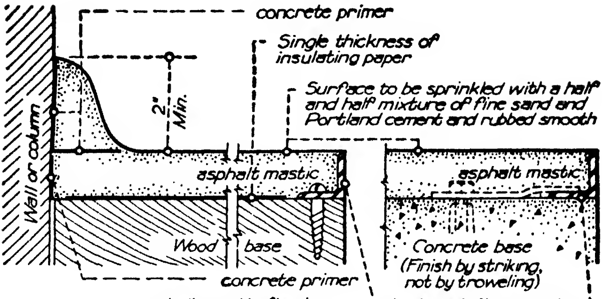
12. Where mastic is to be applied over a waterproofing membrane, apply 2 layers of dry waxed craft paper before applying mastic.

13. Mastic mixtures must be applied while hot and cannot be applied over wet or damp surfaces without blistering.

Mastic properly used, has many advantages for use in flooring. It is resilient and decreases fatigue due to standing at work; it is quickly and easily laid; it is sanitary, odorless, non-dusting, non-absorbent and non-glaring; it is easy to maintain; it is waterproof and can be washed as often as desired without injury to the floor or danger of leakage to floors below. It is easily installed over any old floor that is solid; mastic floors are ready for use 3 hours after being laid.

Mastic is an ideal industrial flooring and is also used in the construction of sidewalks, tennis courts, swimming pools. It is suitable for cold storage floors and floors subjected to acid liquors.

MASTIC FLOORING FOR ORDINARY CONDITIONS

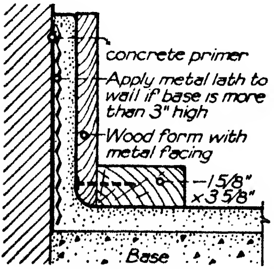


asphalt mastic flooring shall be of uniform thickness. If surface is to be sloped to drain, the base shall have a similar slope if possible,— otherwise lay mastic on a fill of sand and cement mortar

Angles at floor openings to hold edge of mastic in place. Surface in contact with mastic to be painted with hot asphalt

SCALE 3" = 1'-0"

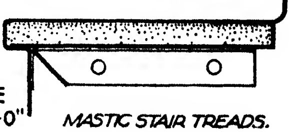
Location	*Base*	*Mastic Thickness (Min.)*
Outdoor foot and light traffic	Concrete or firm base	1"
	Wood	1"
Indoor foot and light traffic	Concrete or firm base	1"
	Wood	1¼"
Cold storage spaces	Concrete or firm base	1"



METHOD OF APPLYING BASE.

SCALE 1½" = 1'-0"

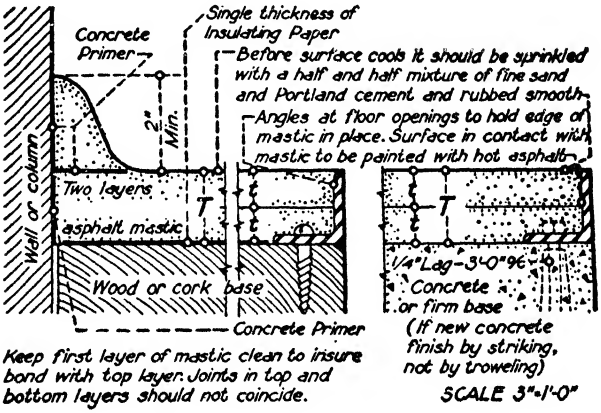
asphalt mastic is an excellent surface material for stair treads and landings, especially in schools and industrial buildings. It is resilient, noiseless and slip proof. It may be applied on a base of wood, metal, concrete or other firm construction. No separate anti-slip nosings are necessary. Asphalt thickness should not be less than 1".



MASTIC STAIR TREADS.

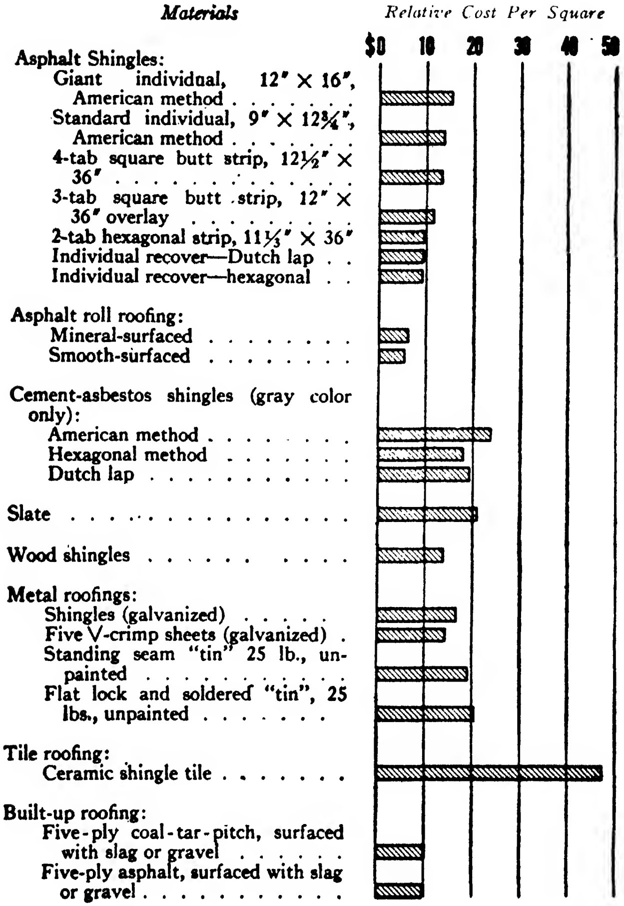
MASTIC FLOORING FOR SEVERE CONDITIONS

Mastic is a bituminous mixture of asphalt, asphalt flux, filler, sand and gravel. When hot it is sufficiently plastic for spreading with wooden trowel or float. It hardens as it cools and is ready for use two or three hours after laying. This mastic mixture is waterproof, acid-resisting, non-dusting, sanitary, slip-proof, sound absorbent and noiseless. It is also resilient and therefore less tiring to workers. These features make it an excellent flooring material for all types of industrial buildings, canneries and bottling plants, chemical and acid plants, railroad platforms, loading platforms, sidewalks, roofing, tennis courts and other outdoor game areas. It can be made exceptionally hard to withstand heavy trucking and heavy loads by the addition of a special hardener.



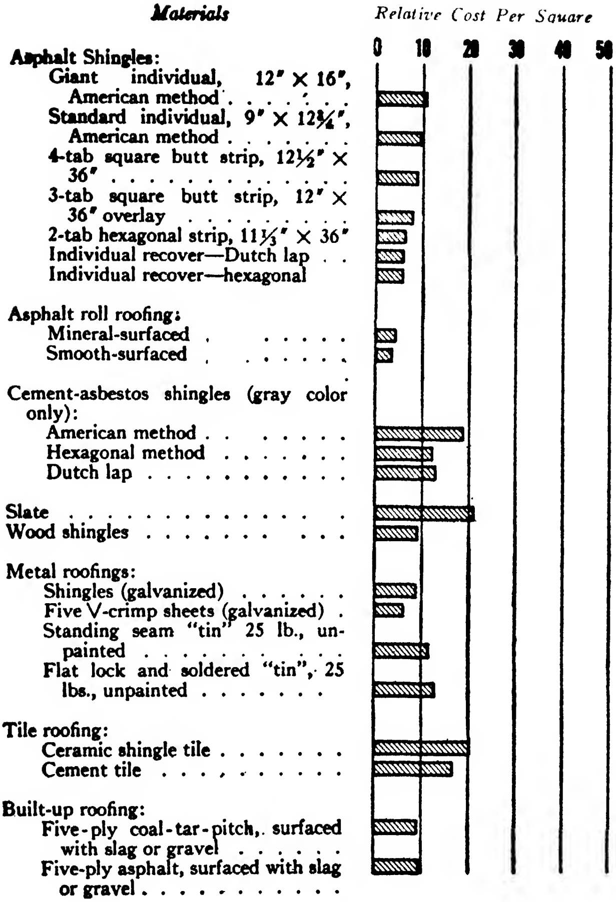
Location	Base	Mastic Thickness	
		t	*T (Min.)*
Outdoor heavy trucking and traffic	Concrete or firm base	¾"	1½"
	Wood	¾"	1½"
Indoor heavy traffic	Concrete or firm base	¾"	1½"
	Wood	¾"	1½"
Cold storage spaces	Wood or cork	⅝"	1¼"
Plating rooms, acid tank rooms and floors subject to liquid acids	Concrete or firm base	⅝"	1¼"
	Wood	⅝"	1¼"

ROOFING COSTS
NORTHEASTERN U. S.



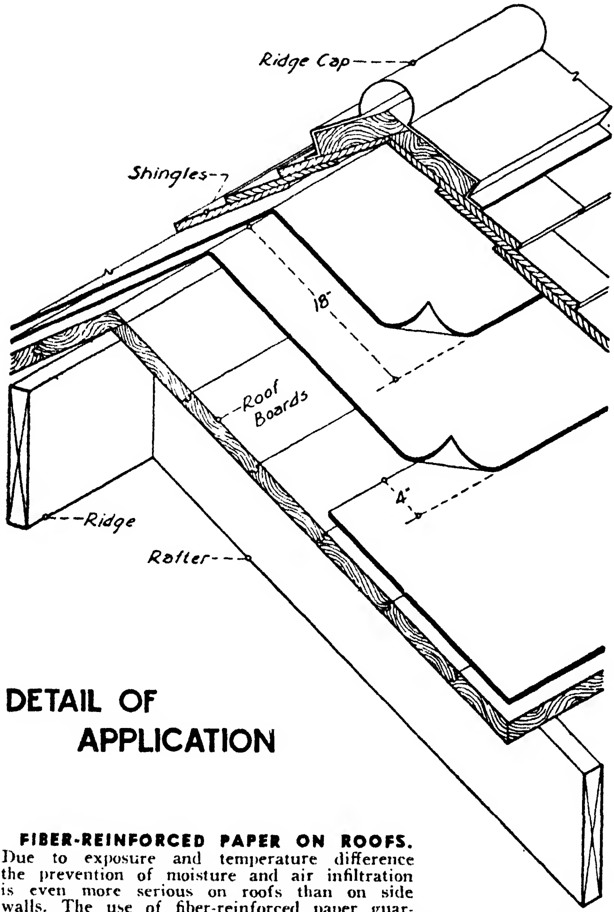
The bar chart DOES NOT SHOW ACTUAL COSTS. The figures are relative and the scale for the bars are indices—NOT DOLLARS. The cost of application was included with the cost of the materials in making the calculations for the averages shown. Roofing cost in place is only one factor in the choice of a type—appearance, availability, and life expectancy need consideration.

ROOFING COSTS
SOUTHEASTERN U. S.



The bar chart DOES NOT SHOW ACTUAL COSTS. The figures are relative and the scale for the bars are indices—NOT DOLLARS. The cost of application was included with the cost of the materials in making the calculations for the averages shown. Roofing cost in place is only one factor in the choice of a type—appearance, availability, and life expectancy need consideration.

FIBER-REINFORCED PAPER ON ROOFS



DETAIL OF APPLICATION

FIBER-REINFORCED PAPER ON ROOFS. Due to exposure and temperature difference the prevention of moisture and air infiltration is even more serious on roofs than on side walls. The use of fiber-reinforced paper guarantees an undamaged covering even with careless handling or under high winds. The great strength of this paper makes it desirable in preference to ordinary building paper. The fact that the asphalt always remains tacky and clings tightly to the shanks of the nails, prevents seepage around them. The paper should be applied in the 36″ width lapping it horizontally at least 4″, using large-head galvanized roofing nails. It should be carried 18″ beyond all hips, ridges and valleys from both directions, as shown in the detail. If stained shingles are to be used as a roof covering, they must be thoroly dry before application.

WOOD SHINGLES

Shingles covered by this standard are known as "No. 1 Grade" and are from the following species which constitute the highest class of decay resistance: Western Red Cedar *(Thuja plicata)*, Southern Cypress *(Taxodium distichum)*, Redwood *(Sequoia sempervirens)*. Their high durability, close grain and even texture make them especially suitable for roofing shingles.

WIDTH. Maximum width shall be 14″. The minimum width for shingles 16″ long and 18″ long shall be 4″. Shingles shall have parallel sides.

THICKNESS. Shingles are measured for thickness at the butt ends and designated according to the number of pieces necessary to make up a specific unit of thickness. For example: 4/2 indicates that 4 butts measure 2″ in thickness.

Length in inches	*Thickness in inches*	*Maximum exposure to weather on roofs*	*Maximum exposure to weather on walls*
16″	5/2	5″	6 3/4″
18″	5/2¼	5 1/2″	7 1/2″
24″	4/2	7 1/2″	10″

Adapted from *Commercial Standard CS 31-38*

MINIMUM ROOF PITCH. Wood shingles should not be used on a roof with a slope of less than 6″ rise in 12″ run. 8″ in 12″ is a better minimum.

WOOD SHINGLE ROOF CONSTRUCTION. Shingles are applied either to wood sheathing or strips. When 1 x 3 or 1 x 4 strips are used they are spaced the same distance apart on centers as the shingles are exposed to the weather. Such construction without tight sheathing should be used only when heating costs are not a consideration, or when special precautions have been taken to insulate the building. Laying shingles on strips allows free circulation of air, and is thought to retard their decomposition.

Roof sheathing or boarding laid tight and covered with good building paper is considered a better base for shingles, providing a desirable degree of heat insulation. The individual boards which make up the roof-boarding are called "roofers." The roofers may be either square edge or matched boards. A double course of shingles should start the roof at the eaves.

WOOD SHINGLE SIDE WALL CONSTRUCTION. The shingles may be laid on either strips or tight sheathing as for roofs, with the same advantages and disadvantages for the two methods.

CHARACTERISTICS OF SHINGLE ROOFS. The wooden shingle is light in weight, has excellent insulating value, can be easily applied, results in pleasing architectural effects, and high-grade shingles properly applied have great durability. The main objection to their use is the fire hazard. Sparks or flying embers are more likely to roll off the smooth surface of a newly shingled roof than from an old roof having shingles with curled edges. For this reason any treatment of shingles, such as staining or creosoting, which will tend to maintain a smooth surface incidentally improves their fire resistance. If rain water for household purposes is to be collected from the roof, care must be taken to select treated shingles that will not contaminate the water.

STANDARD SLATE SIZES

In accordance with the unanimous action of a general conference of representative manufacturers, distributors and users of roofing slate, the industry has adopted and approved for promulgation by the U. S. Department of Commerce, the *Simplified Practice Recommendation No. R*14-28, establishing the following schedule of sizes (in inches):

SLATE SHINGLES FOR SLOPING ROOFS

Lengths	*Widths*	*Exposure*	*Thicknesses*
10	6 7 8	3½	3/16, ¼, ⅜.
12	6 7 8 9 10	4½	
14	7 8 9 10 12	5½	
16	8 9 10 12	6½	3/16, ¼, ⅜, ½, ¾, 1, 1¼, 1½, 1¾, 2.
18	9 10 11 12	7½	
20	10 11 12 14	8½	
22	11 12 14	9½	
24	12 14	10½	

NATURAL SLATE TILES FOR FLAT ROOFS

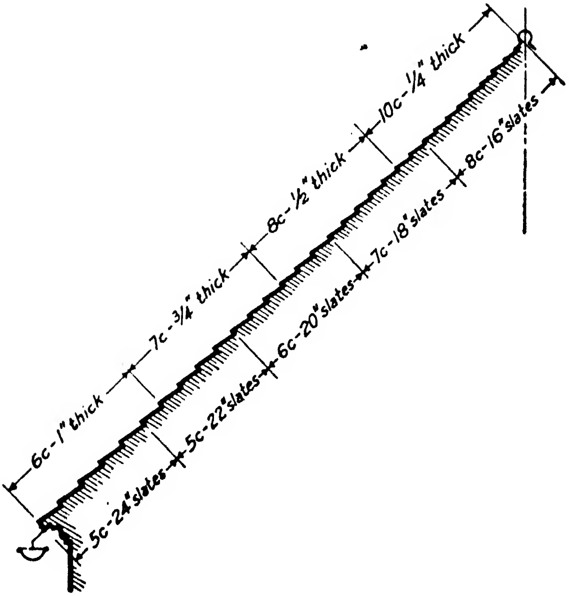
Face Dimension	*Thicknesses for all sizes*
6 x 6	For ordinary service 3/16"
6 x 8	
6 x 9	
10 x 6	
10 x 7	For promenade or extraordinary service ¼" or ⅜"
10 x 8	
12 x 6	
12 x 7	
12 x 8	

In carrying out a desired design on special roofs it is sometimes necessary to make shingles longer than 24" in which case the thicker slates are used. It is recommended that smaller shingles such as 12 or 14" lengths be used for pents, porch and dormer roofs and cheeks, garages or other low buildings—even where the main roof is of larger slates as a means of maintaining proper scale.

Particular attention is called to the increasing use of random widths of the desired lengths. While slate is plentiful such practice will bring about the elimination of waste of an important natural resource. It also will often obviate the necessity of waiting for specified widths while an accumulated finished stock of other usable sizes is available.

Commercial Standard is the quarry run of 3/16" slate. It shows tolerable variations above and below 3/16". The terms "3/16" slate," or "full 3/16" slate," or "not less than 3/16" slate" indicate a desire for a hand-picked selection regardless of cost. For slates ¼" or more in thickness, plus tolerances only are permissible.

GRADUATED SLATE ROOFS



To lay out a graduated slate roof, first divide the rafter length from ridge to eaves into the same number of equal parts as there are to be different *thicknesses* of slate used.

Next divide the distance again into the same number of equal parts as there are to be *lengths* of slate used. A greater number of lengths should be used than thicknesses.

Then lay out the courses to correspond as nearly as possible with the divisions made, as shown in the drawing. The exposure for each length is found by subtracting 3" for the "head lap" from the length, and dividing the remainder by two.

With a graduated slate roof random widths should always be used.

SUGGESTED GRADUATIONS

Thicknesses	*Lengths*
¼, ⅜, ½, ¾, 1	14, 16, 18, 20, 22, 24
3/16, ¼, ⅜, ½, ¾	14, 16, 18, 20, 22, 24
3/16, ¼, ⅜, ½	12, 14, 16, 18, 20
3/16, ¼, ⅜	12, 14, 16, 18, 20
½, ¾, 1, 1¼, 1½	16, 18, 20, 22, 24, 26, 28, 30

GENERAL INFORMATION ON ASBESTOS SHINGLES

PROCESS OF MANUFACTURE. Asbestos shingles are made by a combination of asbestos fiber and Portland cement formed under great hydraulic pressure. A variety of colors is available. These colors are obtained by the addition of the highest quality, pure mineral pigments. The range of colors makes it possible to obtain an effective harmony between the house, the roof and the surrounding landscape. These shingles offer a carefree permanence and attractive appearance.

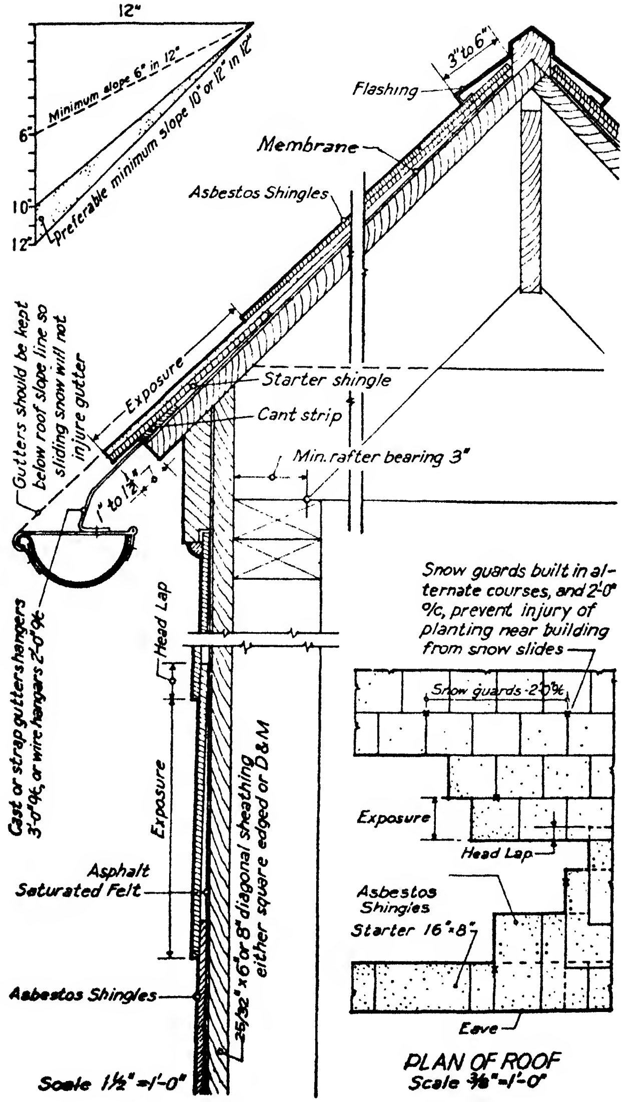
ACCESSORIES. Eave starters, ridge and hip shingles, and ridge roll are available for various methods of application.

APPLICATION. The roof boarding should be of narrow width, well seasoned lumber. It should be laid with broken joints with at least 2 nails at each rafter. Unless end-matched lumber is used, the ends of every board should be securely nailed at a bearing. Before applying the shingles, the roof boarding should be covered with a membrane. Complete directions to the builder for proper application are included in every bundle shingles.

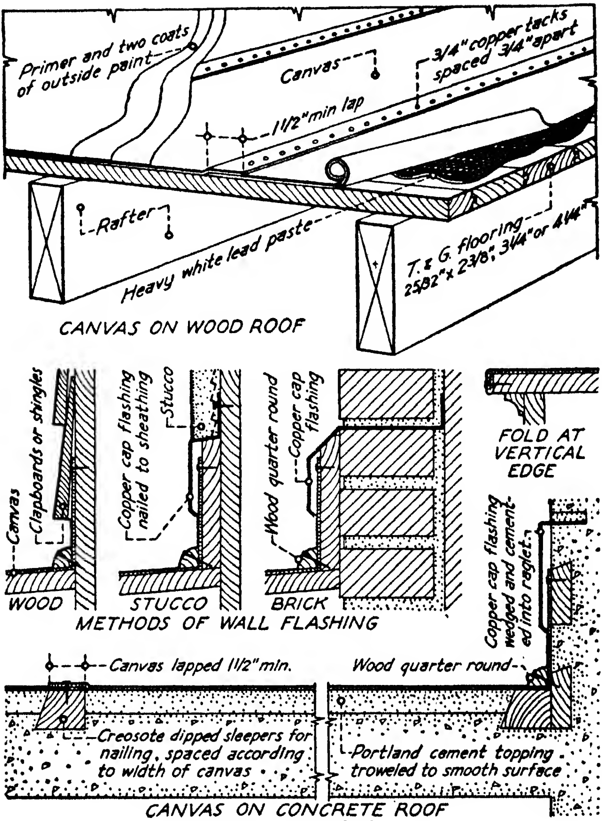
NAILS. On new roofs, concealed nails should be needle-pointed, copper or galvanized iron roofing nails 1 1/4″ long. Each shingle should be fastened with at least 2 nails, not too tightly driven. Exposed face nails for broadsiding shingles on new construction should be 1-inch alloy face nails. These are furnished by the manufactures in the proper amounts for the shingles ordered.

FLASHING. The materials used for flashing and their method of application for an asbestos shingle roof are identical to that of a roof covered with slate or wood shingles.

ESSENTIALS OF ASBESTOS SHINGLE CONSTRUCTION



CANVAS ROOFING



Canvas roofing has been used for years where a flat roof must be walked upon. It is light in weight, not readily broken under light traffic, easy to lay. If kept well painted, a canvas roof should last 25 or 30 years.

Wood sheathing should first be painted, using 100 lbs. white lead in oil heavy paste, 4 gals, raw linseed oil, 2 gals. turpentine, 1 pt. liquid drier. When this is thoroly dry, apply a heavy coat of the white lead heavy paste and press the canvas into the wet paste with rollers. Nail canvas with ¾" copper tacks ¾" o/c.

The canvas surface should receive 3 coats of paint. Mix priming coat 100 lbs. white lead in oil heavy paste, 3 gals. raw linseed oil, 2 gals. turpentine, 1 pt. liquid drier. Second and finishing coats may be any good paint designed for outside use.

KINDS OF BUILT-UP ROOFING

Built-up roofing is either smooth-surfaced, or finished with slag or gravel. Roofs may be classified thus:—

Slag or Gravel Finish

1. Coal-Tar Pitch and Tarred Rag Felt.
2. Asphalt and Asphalt Rag Felt.

Smooth Finish

3. Asphalt and Asphalt-impregnated Asbestos Felt.
4. Asphalt with Asphalt Rag Felt and Asphalt-impregnated Asbestos Felt.
5. Asphalt with Asphalt Felt and Mineral Surfaced Roll Roofing.

SLAG OR GRAVEL . The gravel or slag protects the pitch or asphalt from drying out due to the evaporation of natural oils. The gravel or slag prevents ignition from burning embers. The slag or gravel provides a wearing surface and makes possible the application of a much heavier coat of bitumen, which is permanently anchored in place, than would otherwise be possible. The choice between the use of gravel or slag depends upon the price and availability in any given locality.

COAL-TAR PITCH This is a hydrocarbon obtained by the distillation of coal or from blast furnaces. It is loosely referred to as "tar" or "pitch." Coal-tar pitch has high resistance to the penetration of water.

COAL-TAR PITCH ROOFING Due to the relatively low melting point of coal-tar pitch it is used only on slopes from dead level up to 2" per foot. On steeper slopes the materials are likely to slip under the heat of the sun. Water and moisture has a preservative effect on coal-tar pitch which also favors relatively flat or dead level slopes for this material. The coal-tar pitch roofing has high resistance to acid fumes and corrosive gases. Experience indicates that coal-tar pitch roofs are extremely long-lived under conditions not antagonistic to their use.

ASPHALT Asphalt is a bitumen, i.e. a natural mixture of hydrocarbons. It is found in superficial deposits in various parts of the world, and is obtained as a by-product in the distillation of petroleum, refined for commercial use.

ASPHALT ROOFING Due to the higher melting point of asphalt, it is used on slopes up to 6" per foot. Asphalt is less impervious to moisture than coal-tar pitch, and hence must not be used on slopes of less than 1" per foot, to insure proper drainage. In climates having exceptionally hot sunshine, asphalt is thought by some to be particularly suitable because of its relatively high melting point.

SMOOTH FINISH ROOFINGS. Smooth finish roofings have the advantage of light weight. They may be used on slopes from 1" to a maximum of 6" per foot, depending on the specification. Asbestos felt is recommended for the final layers for its fire-resisting qualities and since it has the property of preventing the rapid drying out of the asphalt, which is unprotected by slag or gravel. Asphalt loses its oils less quickly than coal-tar pitch, so it is employed for smooth surface roofing. Mineral surfaced roll roofing is also used as a final course in certain specifications on steep slopes.

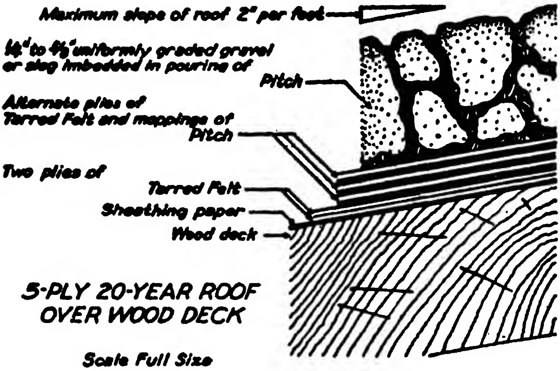
CONSOLIDATED ROOFING TABLE

Type of Deck	Bond Years	No. of Plies	Maximum Slope of Deck, In. per Ft.	Surface Finish	Insulation	Sheathing Paper No. of Plies	No. of Plies, Tarred Felt	Weight of Tarred Felt, Lbs. per Sq.	Mineral Surfaced Roofing, No. of Plies	Weight of Mineral Surfaced Roofing, Lbs. per Sq.	Asphalt Primer	Pitch, Lbs. per Sq.	Asphalt, Lbs. per Sq.	Gravel, Lbs. per Sq.	Slag, Lbs. per Sq.
Wood	20	5	2	S. or G.	Optional	1	5	75	...	...	...	150	...	300	400
	15	4	2	S. or G.	Optional	1	4	60	...	...	...	125	...	300	400
	20	5	5 max. 2 min.	Slag	Optional	1	5	75	...	...	...	140	40–50	250	...
	10	4	Over 3 in.	Mineral Surfaced	Optional	...	2	30	2	110	...	...	60	...	...
Poured Concrete or Gypsum	20	4	2	S. or G.	Optional	...	4	60	...	...	...	200	...	300	400
	20	4	1/4	S. or G.	Optional	...	4	60	...	...	...	200	...	300	400
	15	3	2	S. or G.	Optional	...	3	45	...	...	...	175	...	300	400
	20	4	5 max. 2 min.	Slag	Optional	...	4	60	...	...	...	160	...	250	...
	10	3	Over 3 in.	Mineral Surfaced	Optional	...	1	15	2	110	Yes	...	90	...	...
	...	5	1	Promenade Tile	Optional	...	5	75	...	...	...	200	...	...	...

CONSOLIDATED ROOFING TABLE

Type of Deck	Precast Concrete		Precast Gypsum			Spray Pond Over Concrete or gypsum		Steel		
Slag, Lbs. per Sq.	400	400	400	400	....	700	700	400	400	....
or Gravel, Lbs. per Sq.	300	300	300	300	250	500	500	300	300	250
Asphalt, Lbs. per Sq.	....	....	....	....	....	....	....	35	35	35
Pitch, Lbs. per Sq.	200	175	150	125	140	300	275	{200 35}	{175 35}	{60 35}
Asphalt Primer	....	....	....	....	....	....	....	Yes	Yes	Yes
Weight of Mineral Surfaced Roofing, Lbs. per Sq.	....	....	....	....	....	....	....	....	....	....
Mineral Surfaced Roofing, No. of Plies	....	....	....	....	....	....	....	....	....	....
Weight of Tarred Felt, Lbs. per Sq.	60	45	75	60	75	60	45	60	45	60
No. of Plies, Tarred Felt	4	3	5	4	5	4	3	4	3	4
Sheathing Paper No. of Plies	....	....	....	....	....	....	....	....	....	....
Insulation	Optional	Optional	Optional	Optional	Optional	No	No	Yes	Yes	Yes
Surface Finish	S. or G.	S. or G.	S. or G.	S. or G.	Slag	S. or G.	S. or G.	S. or G.	S. or G.	Slag
Maximum Slope of Deck, In. per Ft.	2	2	2	2	{5 max. 2 min.}	1	1	1	1	{4 max. 2 min.}
No. of Plies	4	3	5	4	5	4	3	4	3	4
Bond Years	20	15	20	15	20	20	15	20	15	10

5-PLY 20 YEAR ROOF OVER WOOD DECK



5-PLY 20-YEAR ROOF OVER WOOD DECK

Scale Full Size

DECK. The roof deck is made of clean, smooth lumber that is free from knot holes, large cracks or loose boards. The lumber should be well-seasoned or treated.

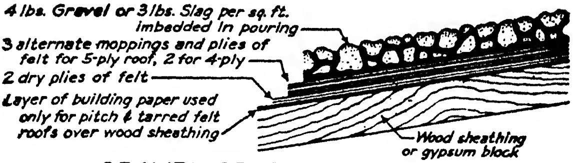
CONSTRUCTION. One thickness of sheathing paper is laid over the deck with 1″ laps. Over this are laid two thicknesses of tarred felt, each 36″ strip or "course" overlapping the preceding one 19″ in clap-board fashion, nailed where necessary to hold the plies in place.

Over this surface a mopping of pitch is applied. Another thickness of tarred felt is laid with laps of 24 2/3″, leaving 11 1/3″ to the weather. Each lap is mopped so that nowhere does felt touch felt. Two more plies are added in this same way, alternating with moppings over the entire surface. Each strip of felt is nailed every two feet along the upper edge. All nails must be covered by two plies of felt.

Over the last ply is poured a uniform coating of pitch. While the pitch is hot, gravel or slag is imbedded into it.

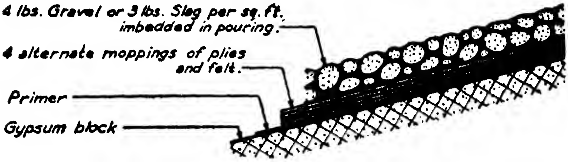
INSULATION. When insulation is applied on the wood deck it must be thoroughly dry and of approved type. It is nailed to the deck, and must be able to retain the roofing nails used in applying the roofing. When one layer of insulation is used, the roofing is applied as above. When more than one layer is used the sheathing paper may be omitted.

ROOFS OVER WOOD OR GYPSUM BLOCK, 0" TO 3" SLOPE



GRAVEL OR SLAG SURFACING

Total Plies	Bond Years	Base	Type of Roofing	Roof Slope	Wt. Per Sq. Ft.*
5	20	Wood	Pitch and Tarred Felt	0" to 2"	6.32
5	20	Gyp. Bl.	Pitch and Tarred Felt	0" to 2"	6.32
4	15	Wood	Pitch and Tarred Felt	0" to 2"	5.91
4	15	Gyp. Bl.	Pitch and Tarred Felt	0" to 2"	5.91
5	20	Wood	Asphalt and Asphalt Felt............	1/2" to 3"	6.07
4	15	Wood	Asphalt and Asphalt Felt............	1/2" to 3"	5.66



GRAVEL OR SLAG SURFACING

Total Plies	Bond Years	Base	Type of Roofing	Spec. No.	Roof Slope	Wt. Per Sq. Ft.*
4	20	Gyp. Bl.	Asphalt and Asphalt Felt............	205	1" to 4"	6.20

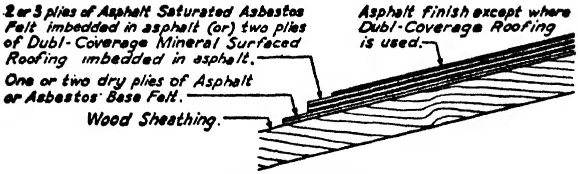
** Weight given is in pounds per square foot, with gravel surfacing; for slag surfacing the weight is 1# less All roofs in table are Underwriters Class A.*

CHOICE OF ROOFING. The selection of the proper specification will depend upon the slope of the deck, number of plies desired, and whether a Pitch or Asphalt type is preferred, as shown in the table. See *Data Sheet* entitled "Kinds of Built-Up Roofing."

CONSTRUCTION OF WOOD DECKS. The roof deck should be built of 6" or 8" wide boards, 25/32" thick, laid diagonally. All boards must have a bearing on rafters at each end, and must be nailed securely at each bearing. The boards must not deflect perceptibly under an average man's weight. Cracks wider than 1/4" or knot holes over 1" must be covered with sheet metal, securely nailed. Thoroughly seasoned lumber must be used to eliminate tearing of the plies from movement of the wood. The deck must be smooth, carefully graded to drains, and swept clean of all loose material.

CONSTRUCTION OF GYPSUM BLOCK DECK. The blocks must be dry. If pronounced ridges or depressions are present they must be leveled off before the roofing operation is begun.

ROOFS FOR WOOD DECKS
SLOPE 1" TO 6" PER FT.



SMOOTH SURFACING

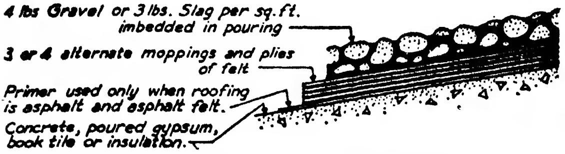
Total Plies	3	4	3	3	4	4
Bond Years	10	10	15	15	20	20
Roof Slope, per ft.	1"-6"	over 3"	1"-6"	1"-6"	1"-6"	1"-6"
Wt. in lbs. per sq. ft.	1.37	1.92	1.87	1.60	2.07	1.95
Dry Plies Asphalt Felt	1	1	1	1	1	1
Mopped Plies Ash. Felt	2	—	2	2	3	3
Mopped Plies Dubl-Cov.	—	2	—	—	—	—
Total Moppings	3	2	3	3	3	4
Cold Coating Surface Finish	x	—	x	x	x	x
Surface Fin. Dubl-Cov.	—	x	—	—	—	—

CHOICE OF ROOFING. The selection of the proper specification will depend upon the slope of the deck, number of plies desired, and whether an asphalt surface finish or a mineral surfaced roll roofing ("Dubl-Coverage") is preferred. See *Data Sheet* entitled "Kinds of Built-Up Roofing."

CONSTRUCTION OF WOOD DECK. The roof deck is usually built of 6" to 8" wide boards, 25/32" thick, square edged or T & G laid diagonally. All boards must have a bearing on rafters at each end, and must be nailed securely to each rafter. The boards must not deflect perceptibly under an average man's weight. Cracks wider than 1/4" or knot holes over 1" must be covered with sheet metal, securely nailed. Thoroughly seasoned lumber must be used to eliminate tearing of the fabric from movement of the wood. The deck must be smooth, carefully graded to drains, and swept clean of all loose material.

VARIETIES OF SMOOTH FINISH ROOFING. On the *Data Sheet* giving the "Kinds of Built-Up Roofing" there were three types of smooth surface roofing tabulated. By referring to the table above it will be seen that roofings in columns 1, 3, 4, 5 and 6 belong to the class *Asphalt with Asphalt Rag Felt and Asphalt-impregnated Asbestos Felt.* The use of asbestos felt prevents the rapid drying out of the oils in the waterproofing material. In column 2, a mineral surfaced roll roofing, with an asphalt felt, is utilized, placing it in the classification *Asphalt with Asphalt Felt and Mineral Surfaced Roll Roofing.*

ROOFS OVER CONCRETE, GYPSUM, BOOK TILE, OR INSULATION, 0″ TO 3″ SLOPE



GRAVEL OR SLAG SURFACING

Total Plies	*Bond Years*	*Base*	*Type of Roofing*	*Roof Slope*	*Wt. Per Sq. Ft.*†
3	15	Pd.Con.*	Pitch and Tarred Felt	0″ to 1″	6.20
4	20	Pd.Con.*	Pitch and Tarred Felt	0″ to 1″	6.60
3	15	Pd.Con.*	Asphalt and As. Rag Felt.............	1″ to 4″	5.80
4	20	Pd.Con.*	Asphalt and As. Rag Felt............	1″ to 4″	6.20

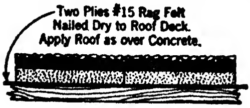
** Pd.Con. refers to poured concrete, poured gypsum, precast concrete, book tile, approved rigid insulation. † Weight given is in pounds per square foot with gravel surfacing; for slag surfacing the weight is 1 # less. All roofs in table are Underwriters Class A.*

CHOICE OF ROOFING. The selection of the proper specification will depend upon the slope of the deck, number of plies desired, and whether a Pitch or Asphalt type is preferred, as shown in the table. See *Data Sheet* in this set entitled "Kinds of Built-Up Roofing."

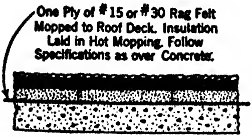
CONSTRUCTION OF POURED CONCRETE AND POURED GYPSUM DECKS. This type of deck must not be either wet or frozen. Sharp or abrupt ridges or depressions must be made smooth by filling with mortar or hammering down the high spots. The deck must be swept clean of all loose material. *If the deck is of poured gypsum, felts must be nailed as over boards.*

CONSTRUCTION OF PRECAST CONCRETE DECKS. The blocks must be dry. If pronounced ridges or depressions occur, they must be levelled off before applying the roofing.

CONSTRUCTION OF BOOK TILE DECKS. These must be covered with a brush coat of cement mortar, which is allowed to set and dry, so that a smooth, even surface is obtained to receive the roof.



Board Deck - Gravel Roof

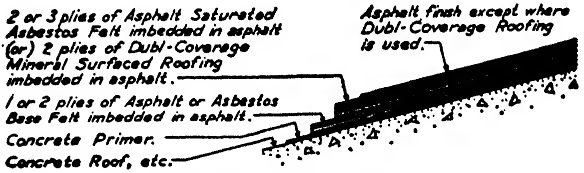


Concrete Deck - Gravel Roof

INSULATION. Insulation must be of a type that will retain nails and must be able to withstand foot traffic. It must be thoroughly dry. Insulation thicknesses vary usually from ½″ to 2½″. The illustrations at the left show the application of the insulation to different types of decks.

STEEL DECK INSULATED. Roofing may be applied to insulation over a steel deck. For slopes of less than 2″ per ft. the insulation is held by mopping; over 3″, by screws or clips.

ROOFS OVER CONCRETE, GYPSUM, BOOK TILE, OR INSULATION, 1" TO 6" SLOPE



SMOOTH SURFACING

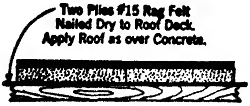
Total Plies	3	3	4	3	5
Bond Years	10	10	15	20	20
Roof Slope, in ins. per ft.	1"-6"	3"-6"	1"-6"	1"-6"	1"-6"
Wt. in lbs. per sq. ft.	1.70	2.18	2.00	2.10	2.15
Mopped Plies Asphalt Felt	1	1	2	1	2
Mopped Plies Asbestos Felt	2	—	2	2	3
Mopped Plies Dubl-Coverage	—	2	—	—	—
Total Moppings	4	2	5	4	6
Cold Coating Surface Finish	x	—	x	x	x
Surface Fin. Dubl-Coverage	—	x	—	—	—

CHOICE OF ROOFING. The selection of the proper specification will depend upon the number of plies desired, and whether an asphalt surface finish or a mineral surface roll roofing ("Dubl-Coverage") is preferred. See *Data Sheet* entitled "Kinds of Built-Up Roofing."

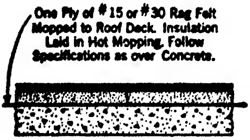
POURED CONCRETE AND POURED GYPSUM DECKS. This type of deck must not be either wet or frozen. Sharp or abrupt ridges or depressions must be made smooth by filling with mortar or hammering down the high spots. The deck must be swept clean of all loose material.

PRECAST CONCRETE AND PRECAST GYPSUM DECKS. The blocks must be dry. Pronounced ridges or depressions must be levelled off before applying the roofing.

BOOK TILE DECKS. These must be covered with a brush coat of cement mortar, which is allowed to set and dry, so that a smooth, even surface is obtained to receive the roof.



Board Deck - Smooth Roof

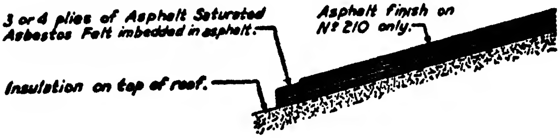


Concrete Deck - Smooth Roof

INSULATION. Insulation must be of a type that will retain nails and must be able to withstand foot traffic. It must be thoroughly dry. Insulation thicknesses vary usually from ½" to 2½". The illustrations at the left show the application of the insulation to different types of decks.

STEEL DECK INSULATED. Roofing may be applied to insulation over a steel deck. For slopes of less than 2" per ft., the insulation is held by mopping; over 2", by screws or clips.

ROOFS OVER INSULATION SLOPES 1" TO 6" PER FT., UNDER PROMENADE DECKS



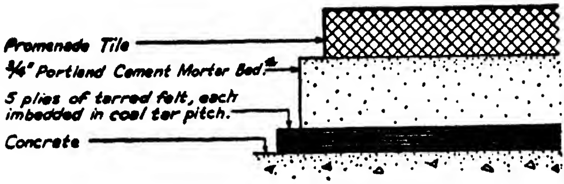
SMOOTH SURFACING

3-PLY 15-YEAR SPECIFICATION. This is a roof especially developed for use only over insulation, for slopes of 1" to 6" per foot. It consists of 3 plies of asphalt-impregnated asbestos felt and three moppings of asphalt. The felt itself constitutes the surface finish, no final mopping being applied. The insulation to which the roofing is applied may be over any type of deck—wood, steel, concrete, gypsum, book tile, etc., but must be held securely to its base material.

4-PLY 20-YEAR SPECIFICATION. This is a roofing especially developed for use only over insulation, for slopes of 1" to 6" per foot. It consists of 4 plies of asphalt-impregnated asbestos felt and five moppings of asphalt. The last mopping of asphalt constitutes the surface finish. The insulation to which the roofing is applied may be over any type of deck—wood, steel, concrete gypsum, book tile, etc., but must be securely held to its base material.

INSULATION. See other *Data Sheets* in this section.

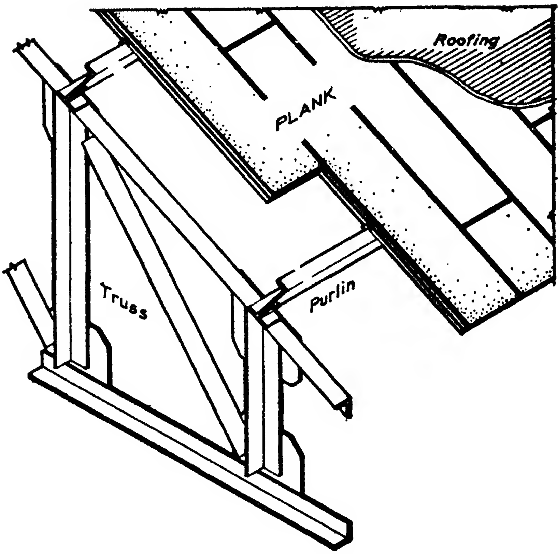
PROMENADE DECKS



**Or Pitch Base Plastic Cement.*

5-PLY 20-YEAR SPECIFICATION. This is a special type of roofing for use under promenade tile, having slopes from 0" to 1" per foot. It consists of 5 plies of tarred felt and 6 moppings of coal tar pitch. This roof has Underwriters Classification A. If rigid insulation is placed on the concrete slab, the roofing may be applied to the insulation in the same manner as it would be if directly on concrete.

SLOPED ROOFS
OVER GYPSUM PLANK



STRUCTURAL SYSTEM OF ROOF. Gypsum plank is laid directly over the purlins of a truss roof, over beams acting as rafters on either sloping or flat decks. When the supporting members run horizontally, the courses of plank run up the slope. When the supporting members run with the slope, the plank is coursed horizontally.

PITCHED ROOFS. On steep roofs, provision must be made to prevent the sliding action of the construction. A stop angle should be used at the eave. It may also be necessary to bolt the plank thru rafters or purlins as the pitch of the roof requires. Clips are used at every intersection of the plank with a support.

EAVES AND RAKES. Plank may overhang up to 18 inches beyond support at the eave and up to 6 inches at the rake, where the courses of plank run up the slope (as shown above). If the plank runs horizontally, these overhangs will be reversed. All openings, except for small pipes, vents or downspouts should be framed out.

VALLEYS, GUSSETS AND COVES. These are readily formed from gypsum, poured and screeded to the desired contours.

BUILT-UP ROOFING. Application is same as over wood decks—nailing the first layer of paper or felt and spot-mopping if desired, but not mopping the entire area.

SHINGLE OR SLATE. Roofing of this type may be nailed directly to the plank. Nails should be square cut, preferably hard copper, penetrating 1 1/2 inches.

GALVANIZED IRON
SHEETS FOR PAINTING

Galvanized Sheet Gage	**Approx. thickness in ins.*	*Lbs. per sq. ft.*
14 gage	.078	3.281
16 gage.	.064	2.656
18 gage.	.052	2.156
20 gage.	.040	1.656
22 gage.	.034	1.406
24 gage.	.028	1.156
26 gage.	.022	0.906
28 gage	.019	0.781

**Galv. sheet metal is specified by weight per sq. ft. Only approximate equivalent thicknesses are given for comparison*

Standard Widths	*Gages for sheets 8 ft. & 10 ft. long*
2′-0″, 2′-6″, 3′-0″	10, 12, 14, 16, 18, 20, 22, 24, 26, 27, 28.
4′-0″	10, 12, 14, 16, 18, 20, 22, 24, 26.

DIFFICULTY OF PAINTING GALVANIZED IRON. Because of the character of its surface, especially when new, galvanized iron is a very difficult material to paint.

Solutions of copper acetate or copper sulfate roughen the surface of the galvanized iron and give it a blackened appearance. Other chemicals are variously employed—all having in common an etching effect on the galvanized coating to provide a surface to which paint will adhere. Part of the galvanized coating is destroyed, thus decreasing the protection of the base metal. Neither weathering nor etching counteracts the tendency of certain zinc compounds remaining on the surface to dry up the essential elastic ingredients of paints and lacquers.

GALVANIZED SHEETS FOR PAINTING. These sheets have a finely crystaline phosphate coating that is an integral part of the sheet. It is neutral to paint. It keeps the paint from direct contact with the zinc coating. The results of this treatment are:

1. A finely textured surface providing good mechanical adhesion, that may be immediately painted.
2. Chemical neutrality that retards aging and failure of the paint.
3. Full weight pure zinc galvanized coating.

CLEANING. When it is necessary to clean these sheets that have been factory-treated to receive paint, organic cleaners such as naphtha, benzine and lacquer thinners are preferred. Alkali cleaners attack and partly remove the paint adherent surface, and are difficult to remove.

PAINT APPLICATION. Lacquer base primers are not recommended. Most paint manufacturers make good oil base primers, and their use with these sheets is recommended for lacquer or oil paint finishes.

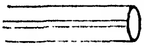
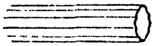
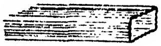
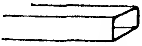
Asphaltic base paints, commonly used for industrial painting, can be applied to these sheets with excellent results.

Recommended Gages	*Commercial and Public Buildings*	*Residential Buildings*
Roofing (Corrugated)	26-18	
Roofing (V-Crimp)	26-24	28-26
Roofing (Other Types)	26	28-26
Gutter and Eaves Trough	24	26-24
Conductor Pipe & Valleys	24	26-24
Flashings & Ridge Roll	26-24	28-26

DETERMINATION OF ROOF LEADERS

$$\text{Required area in } \square'' \text{ of leaders} = \frac{\text{Area of roof surface*}}{\text{Constant shown in table**}}$$

Arizona	500	Maine	400	Oklahoma	264
Alabama	68	Maryland	345	Ohio	370
Arkansas	208	Massachusetts	416	Oregon	400
California	400	Michigan	238	Pennsylvania	263
Colorado	303	Minnesota	294	Rhode Island	435
Connecticut	370	Mississippi	345	South Carolina	294
Delaware	330	Missouri	56	South Dakota	275
Florida	244	Montana	285	Tennessee	181
Georgia	222	Nebraska	200	Texas	322
Idaho	285	Nevada	285	Utah	1000
Illinois	345	New Hampshire	500	Vermont	345
Indiana	303	New York	312	Virginia	275
Iowa	135	North Carolina	232	Washington	400
Kansas	345	North Dakota	312	West Virginia	384
Kentucky	454	New Mexico	200	Wisconsin	244
Louisiana	208	New Jersey	222	Wyoming	910

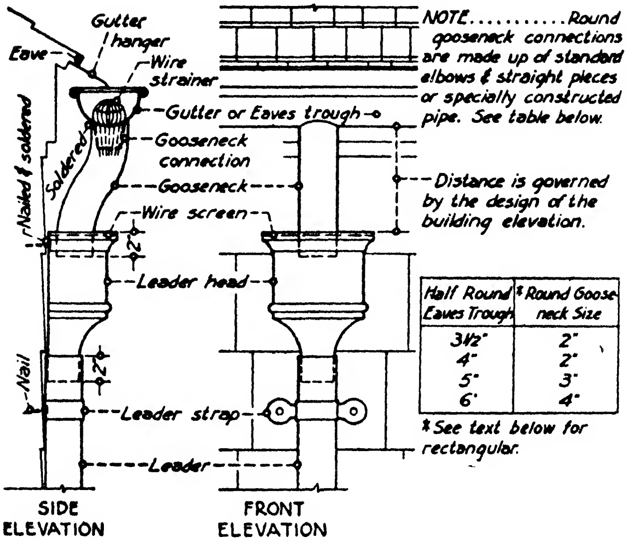
Type of Leader	Leader Size	Area in square ins.
 Plain Round Leader	3" 4" 5" 6"	7.07 12.57 19.63 28.27
 Corrugated Round Leader	3" 4" 5" 6"	5.94 11.04 17.72 25.97
 Square Corrugated Leader	1¾" x 2¼" (2") 2⅜" x 3¼" (3") 2¾" x 4¼" (4") 3¾" x 5" (5")	3.80 7.73 11.70 18.75
 Plain Rectangular Leader	1¾" x 2¼" 2" x 3" 2" x 4" 3" x 4" 4" x 5" 4" x 6"	3.94 6.00 8.00 12.00 20.00 24.00

Seventy-five feet is the maximum spacing for leaders.
All outlets should be provided with screens or strainers.
Scuppers should be provided for all roofs with encircling parapets.
Round leaders should not be less than 3" in diameter.
Rectangular leaders should not be less than 1¾" x 2¼".

*This is square feet of actual roof surface, not horizontal proj'n.

**Table calculated on the basis of 1□" of leader per 1" of rainfall per 1200 □ feet per hour for maximum rate in different localities as shown by report of Chief of Weather Bureau.

GOOSENECKS, LEADER HEADS AND STRAPS



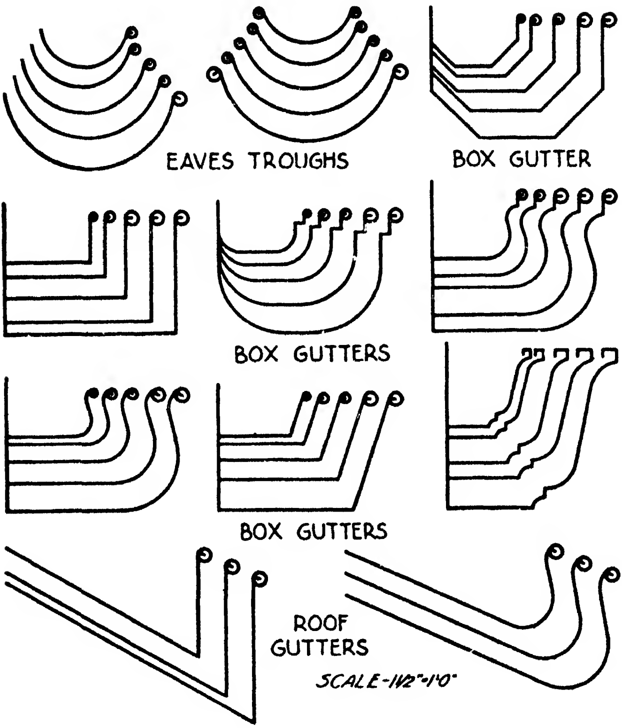
Half Round Eaves Trough	* Round Goose neck Size
3½"	2"
4"	2"
5"	3"
6"	4"

RECTANGULAR GOOSE NECK CONNECTIONS. The rectangular goose neck is much more efficient than the standard round type, in handling the water flowing thru it. In section, it should be as long as the gutter width and the goose neck width should 2/3rds of the gutter width.

LEADER HEADS. Leader heads are primarily ornamental. They also effect the transition between goose necks and leaders of different cross sectional shape, as well as provide a "magazine" space for the collection of water. Because of a limited range of standard leader heads, many architects use special designs. The dimensions of a leader head are entirely at the discretion of the designer—no rules of hydraulics entering the problem other than that of providing a smooth path for the water.

LEADER STRAPS. Leader straps are available in many stock designs but vary from locality to locality. The architect will do well to either use his own designs or to require his successful bidder on the sheet metal work to submit samples of available styles.

STANDARD SHEET METAL GUTTERS AND EAVES TROUGHS

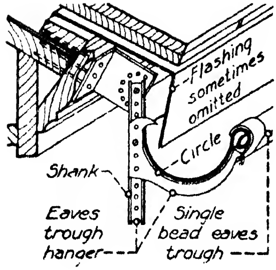


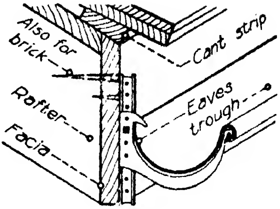
GUTTER SIZES. All standard gutters are made in overall widths of 3 1/2″, 4″, 5″, 6″, 7″ and 8″, except gutter shown at lower left which is made in depths of 4 1/2″, 5 3/4″ and 6 1/4″ overall, and the gutter shown at the lower right which is made in depths of 4″, 5″ and 6″ overall.

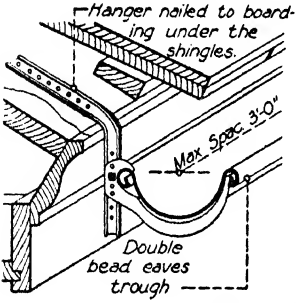
GUTTER DESIGN. Gutters smaller than 4″ should not ordinarily be used unless demanded by architectural design. The size of the gutters are determined by the leaders and their spacing. Use a gutter not less than the equivalent circular diameter of the leader for leader spacings up to 50 ft. For leader spacings from 50 to 70 ft., use a gutter 1″ wider than the equivalent circular diameter of the leader. From 70 to 90 ft., use a gutter 2″ wider than the equivalent circular diameter of the leader.

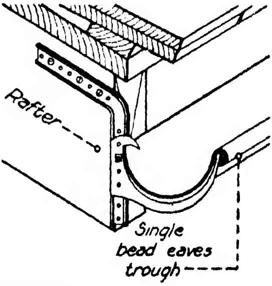
DEAD-LEVEL GUTTERS. Accurately installed dead-level gutters drain readily and are usually more desirable than sloping gutters from an architectural design standpoint.

GUTTER HANGERS



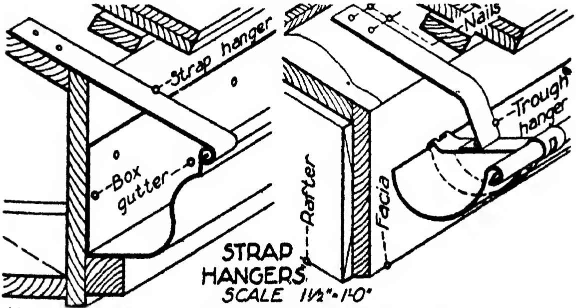






CAST HANGERS

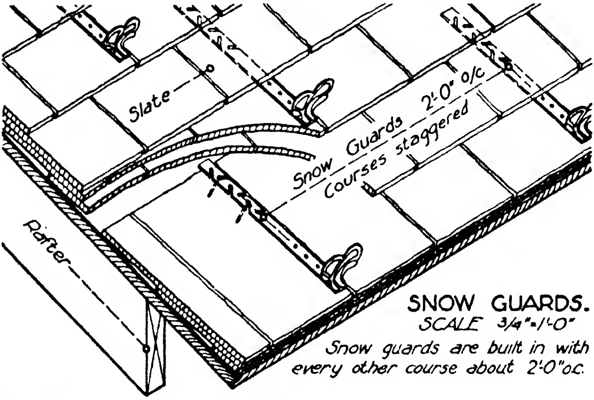
For hanging gutters, the half round eaves trough in single or double bead is used. Other gutter types are for box construction.



STRAP HANGERS
SCALE 1½" = 1'-0"

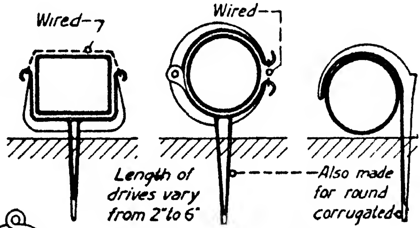
Maximum spacing for cast and strap hangers is 3'-0". Good practice is 2'-6".

SNOW GUARDS, LEADER HOOKS, STRAINERS

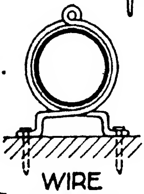


SNOW GUARDS.
SCALE 3/4"=1'-0"
Snow guards are built in with every other course about 2'-0"o.c.

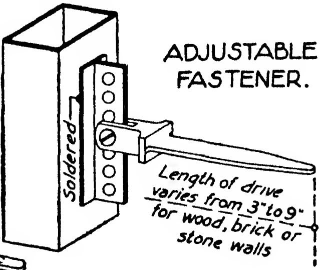
WIRE STRAINER.



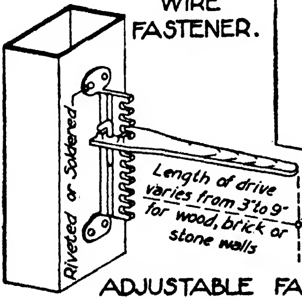
LEADER HOOKS.
SCALE 1½"=1'-0"



WIRE FASTENER.



ADJUSTABLE FASTENER.



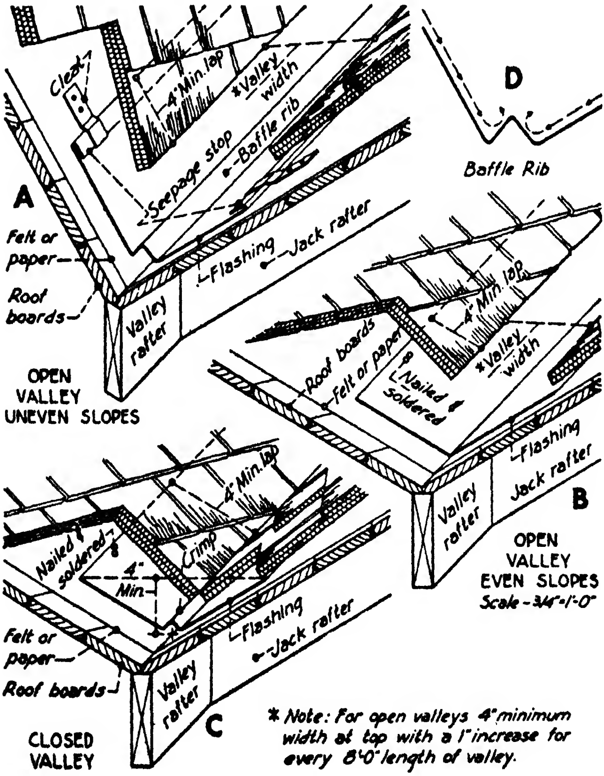
Note - Adjustable fasteners are for all types of leaders.

ADJUSTABLE FASTENER.

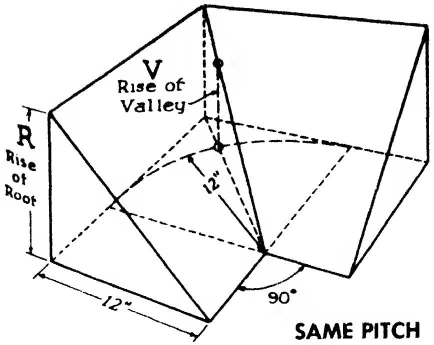
OPEN AND CLOSED VALLEYS

OPEN VALLEYS. Where the adjacent roof surfaces are of different areas or different slopes, a baffle rib prevents the larger or faster descending volume of water from forcing its way up under the roofing on the opposite side, as shown at *A* and *D*. If the slopes and areas are the same, a smooth valley may be used, as shown at *B*. Separate sheets lapped 2" provide for expansion and contraction. It is preferred by many to the usual locked and soldered cross seams in the valleys.

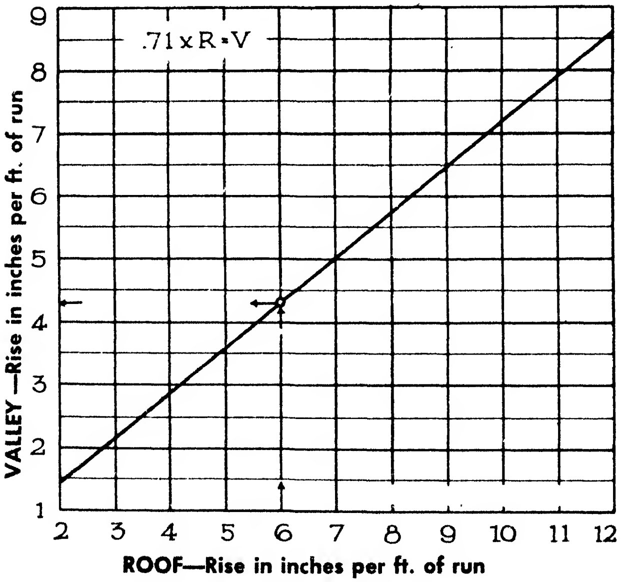
CLOSED VALLEYS. The closed valley may be used for slopes of 45° or steeper where adjacent roof surfaces are of similar slopes and areas. One of several methods is shown at *C* where the sheets are laid in long pieces directly on the paper or felt which covers the roof sheathing. They may be of any length and should lap 4". The center crimp stiffens the valley flashing and forms a straight line to which the slates or shingles are set.



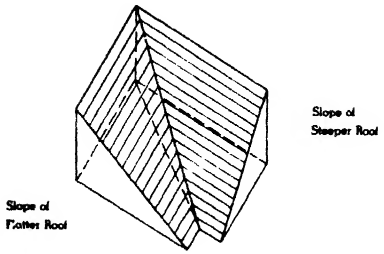
SLOPE OF ROOF VALLEYS



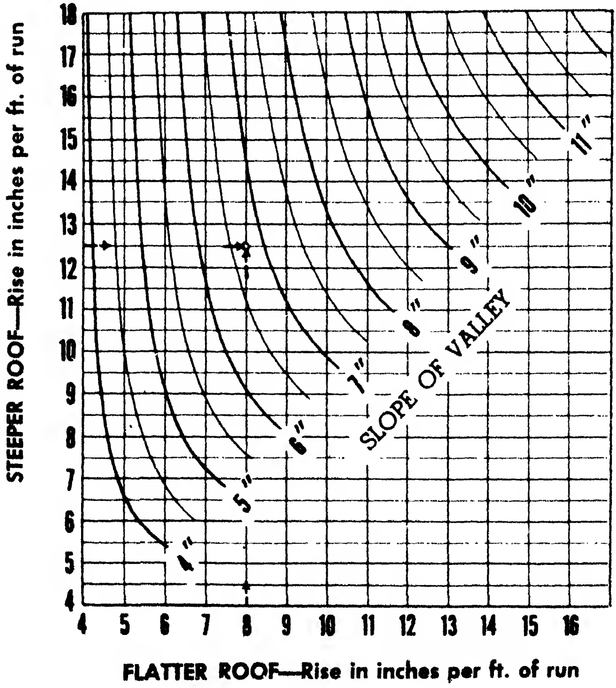
It is frequently necessary to find the slope of a gutter between two roofs of the same pitch intersecting at right angles. The chart below shows that two intersecting roofs having 6" rise per foot will have a gutter whose rise is about 4¼" per foot.



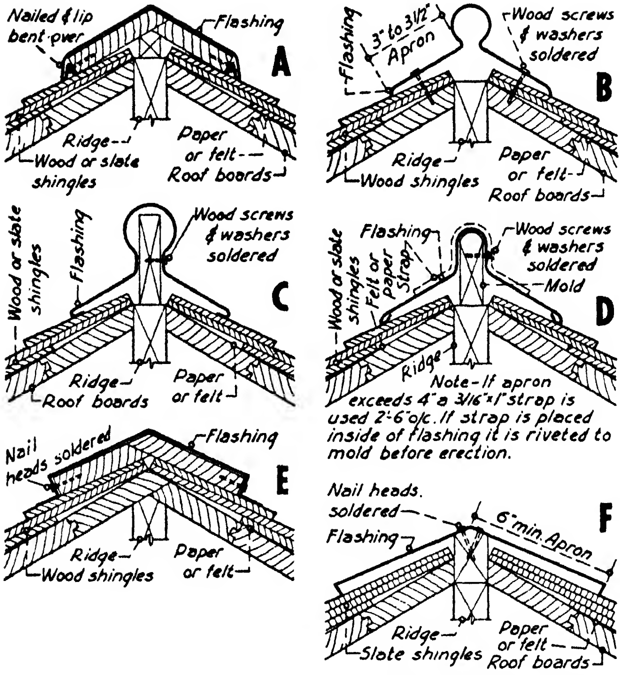
SLOPE OF ROOF VALLEYS



The slope of a valley (or hip) formed by roofs intersecting at right angles, but having different slopes, can be roughly determined from the chart below. EXAMPLE: A roof having a slope of 8" rise per foot of run intersects at right angles with a roof having a slope of 12½" per foot of run; the chart shows that the ridge or hip will slope at about 6¾" per foot of run.

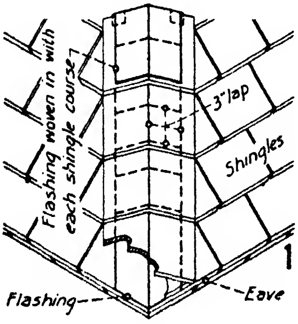


SHEET METAL RIDGES AND HIPS

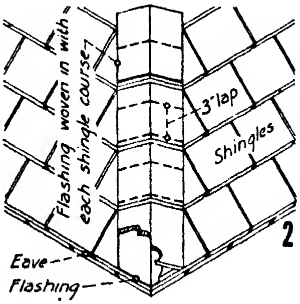


RIDGES
Scale-1 1/2"=1'-0"

Note: The above ridges are sometimes used as hips.



SADDLE HIP

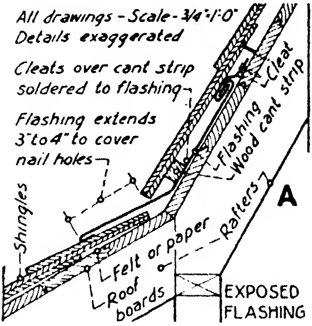


BOSTON HIP

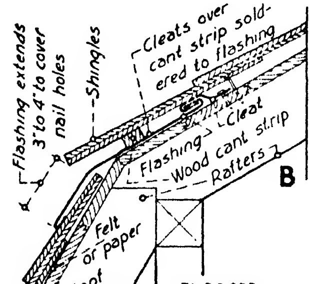
CHANGE OF ROOF SLOPE

Figure *A* shows a method of flashing where a shed roof meets a steeper slope. This method is adaptable to slate, wood or asbestos shingles. The great stiffness of iron makes it unnecessary to fasten down the exposed end of the flashing.

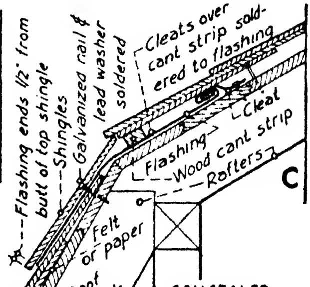
Figures *B* and *C* are 2 methods of handling the change of slope on a mansard or gambrel roof. The method shown at *C* is less desirable since it is necessary to penetrate the flashing with nails.



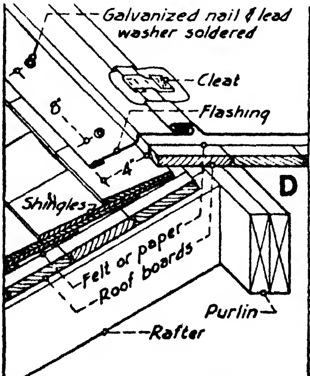
EXPOSED FLASHING



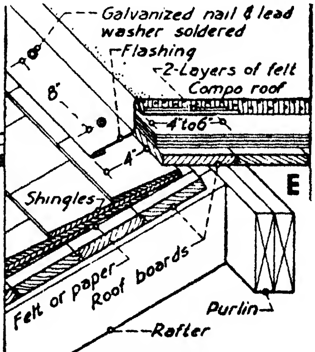
EXPOSED FLASHING



CONCEALED FLASHING

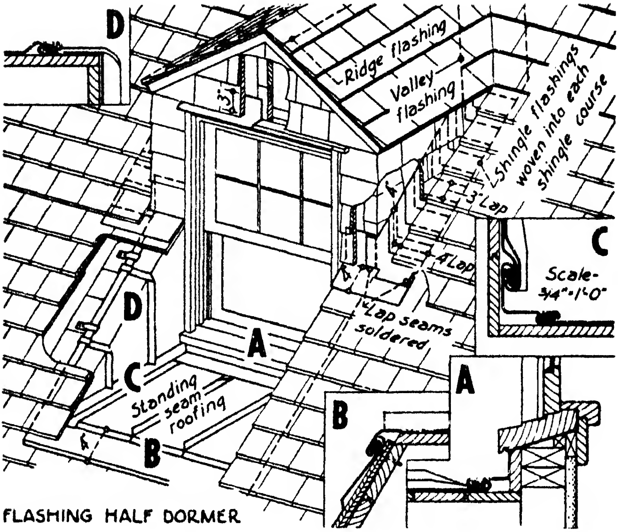


SHEET METAL DECK ABOVE SHINGLE ROOF

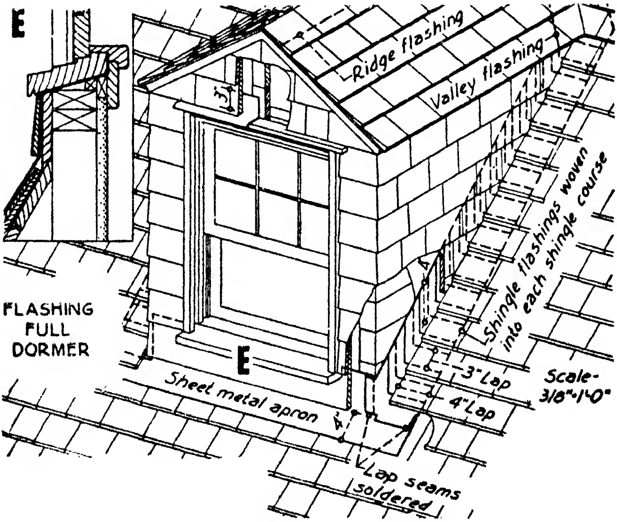


COMPOSITION ROOF ABOVE SHINGLE ROOF

DORMER FLASHING

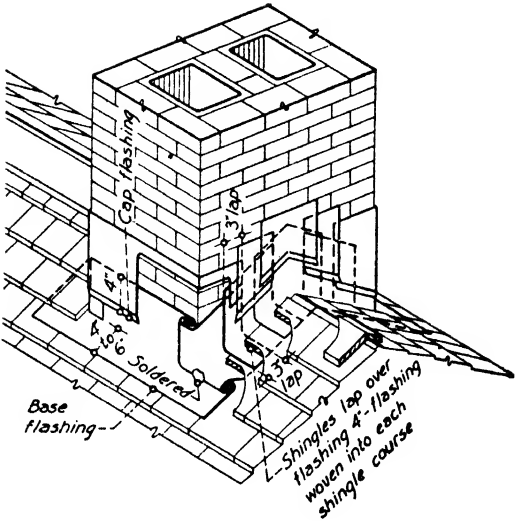


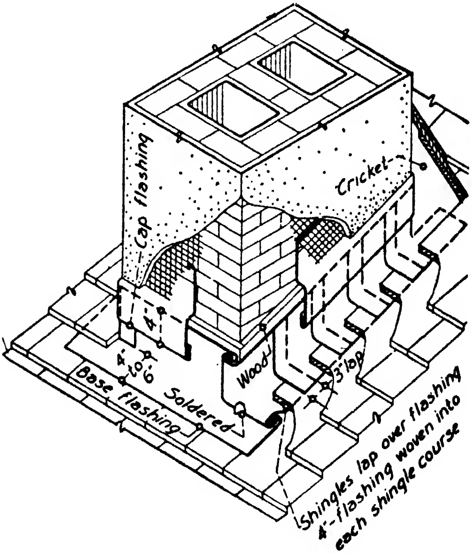
FLASHING HALF DORMER



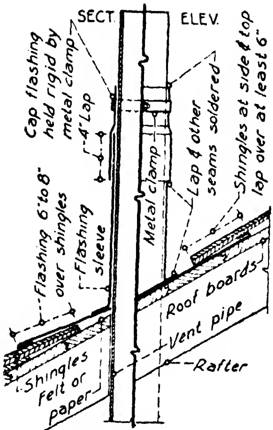
FLASHING FULL DORMER

CHIMNEY FLASHING

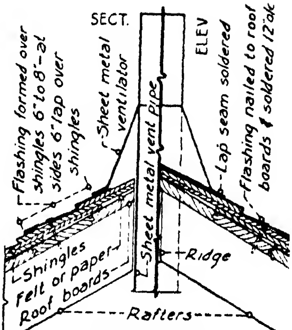




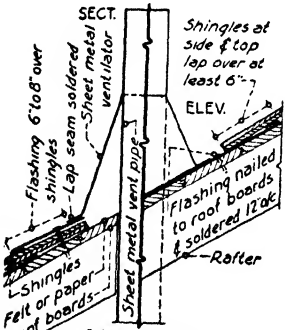
FLASHING ROOF PENETRATIONS



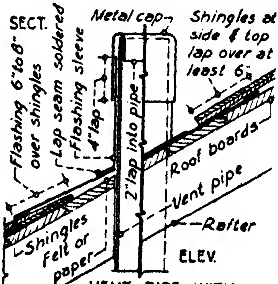
LONG VENT PIPE FLASHING



SHEET METAL VENTILATOR ON RIDGE

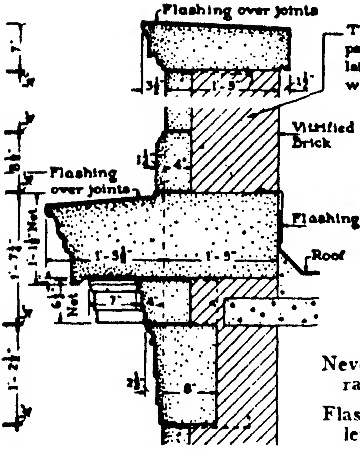


SHEET METAL VENTILATOR ON SLOPE

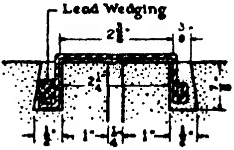


VENT PIPE WITH SHEET METAL CAP

FLASHING OF STONE JOINTS



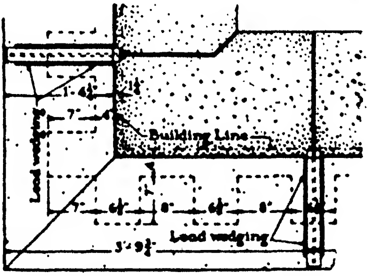
SECTION



SECTION OF RAGLET
(with flashing in place.)

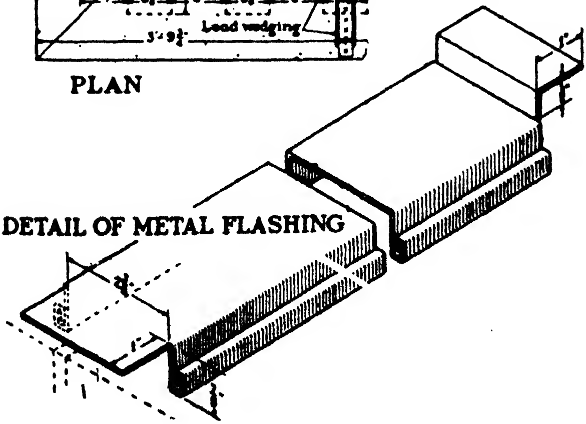
Never use molten lead in raglets.

Flashing is fastened into raglets with soft lead wedging, and joints filled with elastic caulking compound.



PLAN

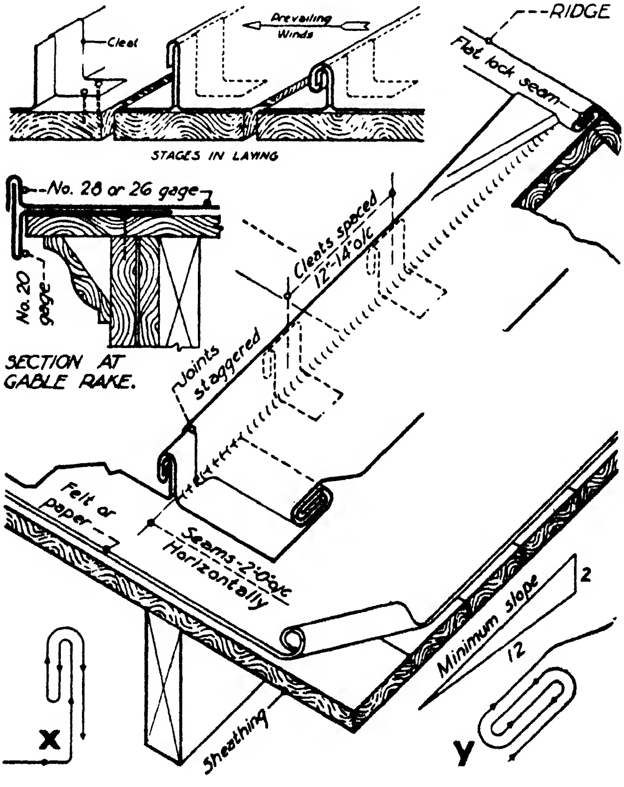
DETAIL OF METAL FLASHING



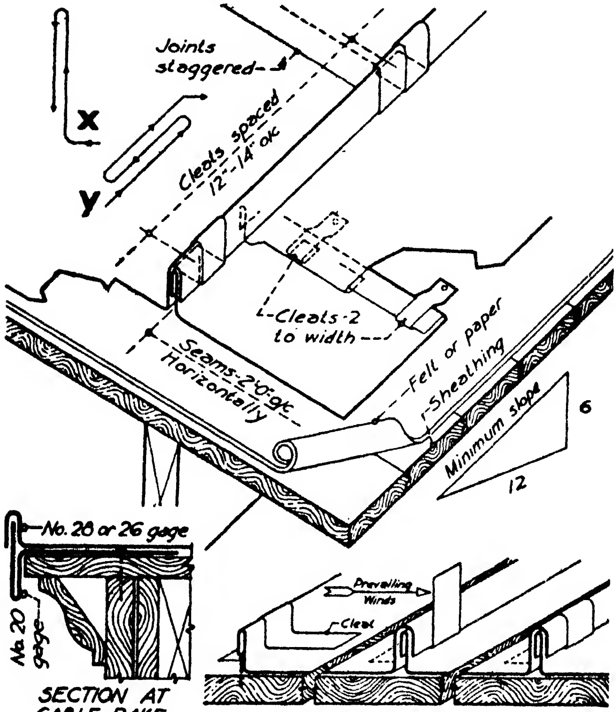
STANDING SEAM ROOFING

STANDING SEAM. Because it makes the most water-tight sheet metal roof, this style should be used for roof slopes below 4″ in 12″, and may be used for slopes as flat as 2″ in 12″. Water would have to take the course shown at x and y to get thru the tightly swaged standing seams and end locks. This roofing comes in rolls consisting of 5 sheets 2′-2½″ wide, joined end to end by a double cross lock, totaling 50′-0″ long. Nails are not driven thru the sheets at any exposed point. The sheets are held in place by cleats.

COST. It costs more to lay Standing Seam roofing than other styles of sheet metal roofs, due to the forming operations required in turning the double lock on the standing seam. Where 2 workmen could lay 5 or 6 squares of Standing Seam roofing, they could lay about 8 to 10 squares of Pressed Standing Seam or V-crimp roofing.



PRESSED STANDING SEAM ROOFING



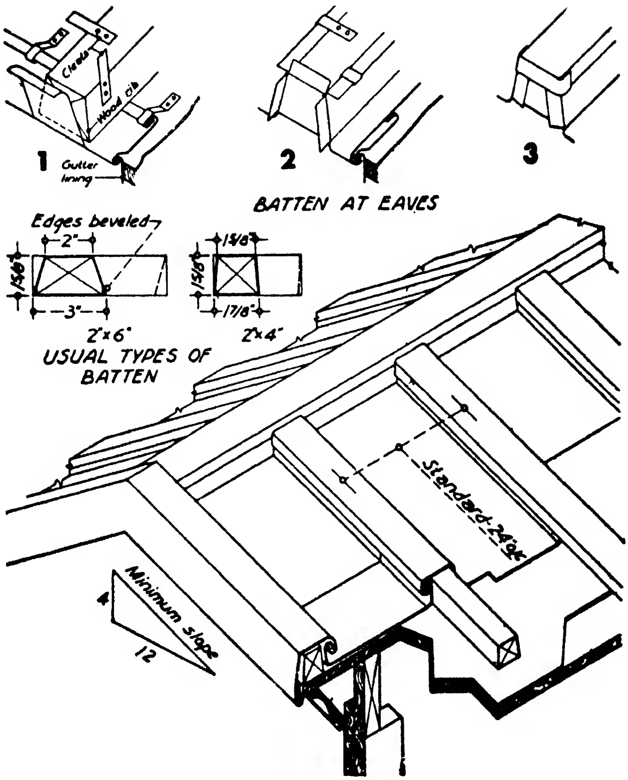
SECTION AT GABLE RAKE.

STAGES IN LAYING

PRESSED STANDING SEAM. For roofs having a slope of 6" in 12" or steeper, this type provides a completely tignt covering. Water is forced to take the paths shown at *x* and *y* to get thru the seams and end locks. This roofing comes to the job in sheets with the standing seams ready formed. Each sheet has a covering width of 2'-0" in lengths of 5'-0", 6'-0", 7'-0", 8'-0", 9'-0", 10'-0", 11'-0" and 12'-0". Cleats nailed to the roof boarding are locked into the side and end seams to hold the sheets in place. Nails are not driven thru the sheets at any exposed point.

COST. The Pressed Standing Seam roofing costs less for material and is less expensive to lay than Standing Seam roofing. This roofing lays up very simply and quickly due to the preforming of the seams. The mechanics have only to form the end joints and fasten the cleats at the job. It may be removed and re-applied with simply the loss of the cleats.

RIBBED SEAM ROOFING



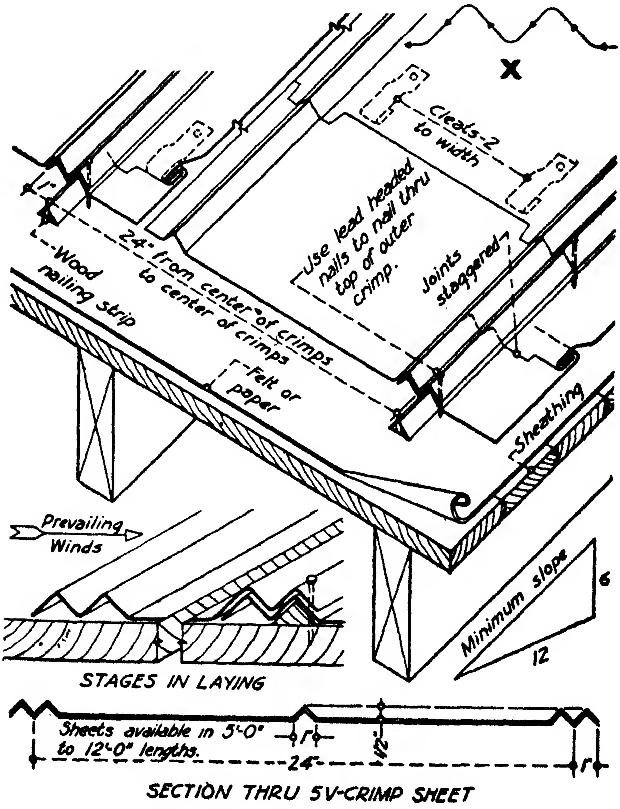
RIBBED SEAM ROOFING. This style roofing is formed by the sheet metal contractor, over wood battens placed by the carpenter. Adaptable to roofs of steep slope, Ribbed Seam Roofing should not be used on slopes flatter than 4" in 12" and preferably 6" in 12". This roofing is formed from flat sheet metal, therefore the battens may be spaced any distance apart up to the limits of a 48" wide sheet. The size and shape of the battens used are at the designer's option, triangular, semi-circular and other sections sometimes being employed.

CONSTRUCTION. Roofing sheets are secured to the wood battens by cleats as shown at 1. spaced 12" to 14" apart and alternating on top and side of batten.

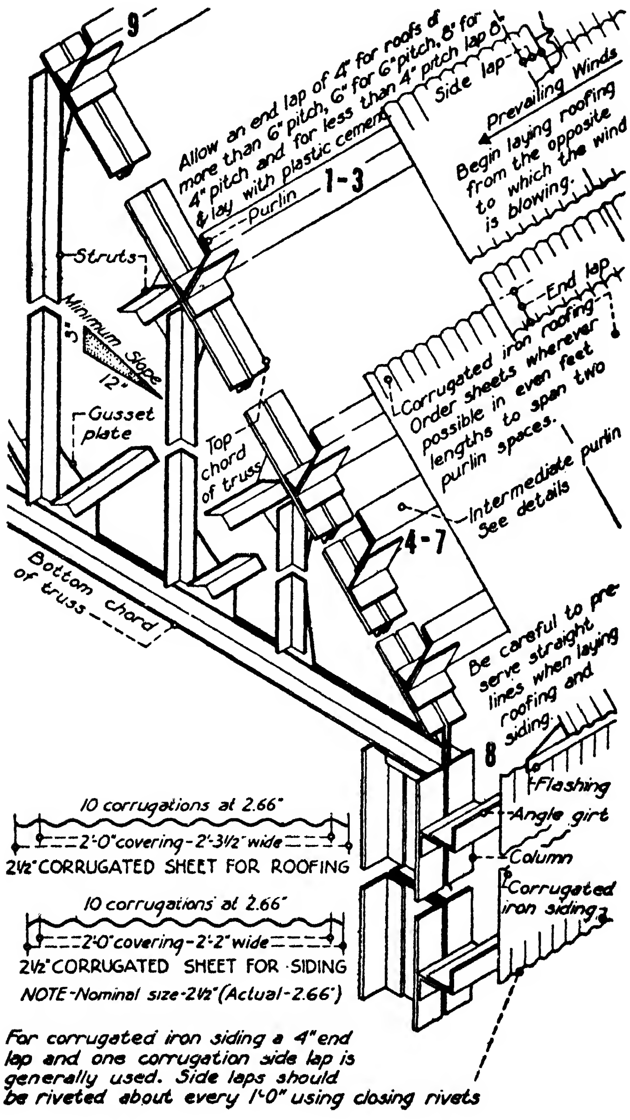
5V-CRIMP ROOFING

5V-CRIMP ROOFING. The water-tightness of this roofing may be increased by applying roofing cement to the laps as the roofing is laid. The 26 and 28 gage weights can be applied without the wood nailing strips, but good practice requires the wood strip as shown in the drawing. This style may be used on open sheathing provided that when the end seams fall over an open space a sheathing board be inserted.

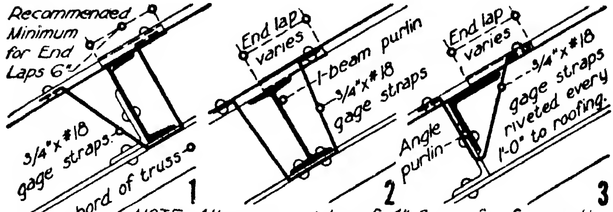
V-Crimp roofing is also available in 2V and 3V types which are not recommended for permanent construction as they do not provide, with a single lap, the water-tightness obtained with the 5V types altho they are cheaper.



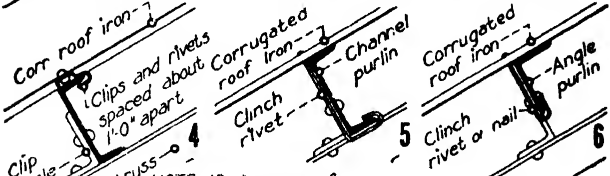
CORRUGATED IRON FOR ROOFS AND WALLS



CORRUGATED IRON CONNECTION DETAILS



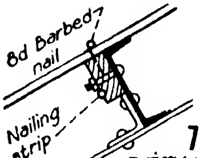
NOTE- Allow an end lap of 4" for roofs of more than 6" pitch, 6" for 6" pitch, 8" for 4" pitch and for roofs of less than 4" pitch lap 8" and lay with plastic cement.



NOTE- If side laps of roofing are to be riveted, use closing rivets spaced about 1'-0" apart

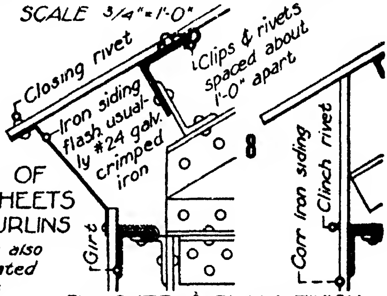
NOTE- Clinch rivets to be spaced every other corrugation. Rivet always to go thru top of corrugation

SCALE 3/4" = 1'-0"

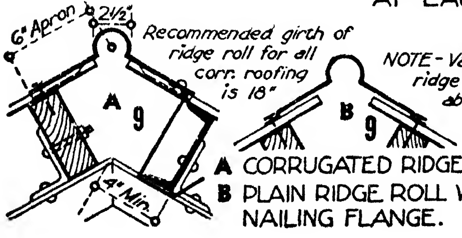


DETAILS OF ROOFING SHEETS SECURED TO PURLINS

The above methods are also used to tie the corrugated iron siding to the girts



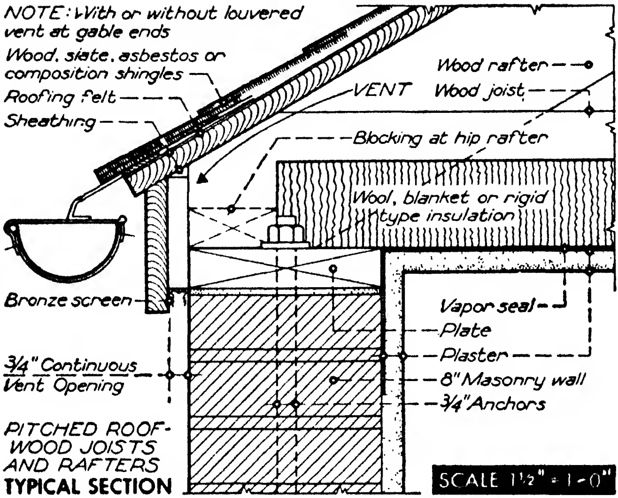
FLASHED & PLAIN FINISH AT EAVES.



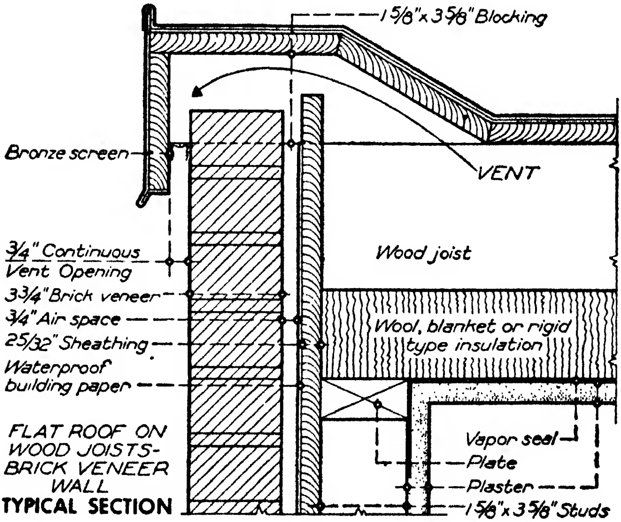
NOTE - Various standard ridge rolls are available for different requirements.

A CORRUGATED RIDGE ROLL.
B PLAIN RIDGE ROLL WITH NAILING FLANGE.

ATTIC VENTILATION

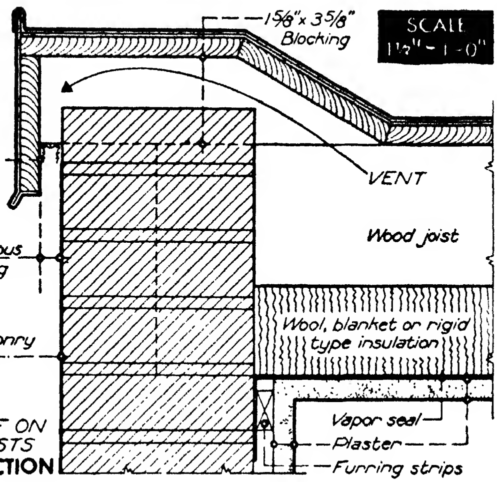


PITCHED ROOF-WOOD JOISTS AND RAFTERS
TYPICAL SECTION

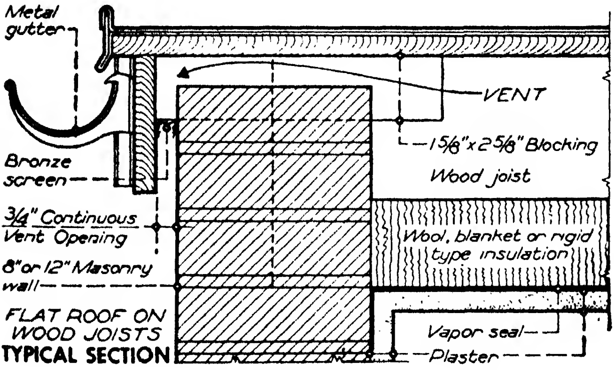


FLAT ROOF ON WOOD JOISTS-BRICK VENEER WALL
TYPICAL SECTION

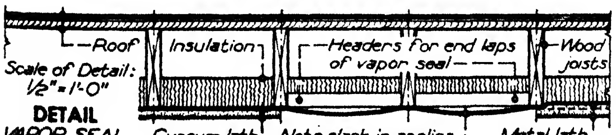
ATTIC VENTILATION



FLAT ROOF ON WOOD JOISTS
TYPICAL SECTION



FLAT ROOF ON WOOD JOISTS
TYPICAL SECTION

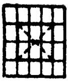


Scale of Detail: ½" = 1'-0"
DETAIL
VAPOR SEAL APPLICATION

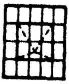
SYMBOLS FOR SOLID ROLLED WINDOWS AND DOORS

(Viewed in elevation from outside)

WINDOWS


Horizontally Pivoted

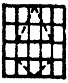

Top Pivoted


Bottom Pivoted


Vertically Pivoted

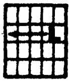

Hinged at Left (Casement)


Hinged at Right (Casement)


Top Hinged to project out at bottom

Bottom Hinged to project in at top

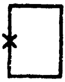

Counterbalanced Window (Double Hung)



Horizontally Rolling toward left

Horizontally Rolling toward right

DOORS

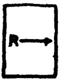

Hinged Side


Left Hand to open in

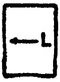

Left Hand to open out


Right Hand to open in


Right Hand to open out



Horizontally Rolling toward right

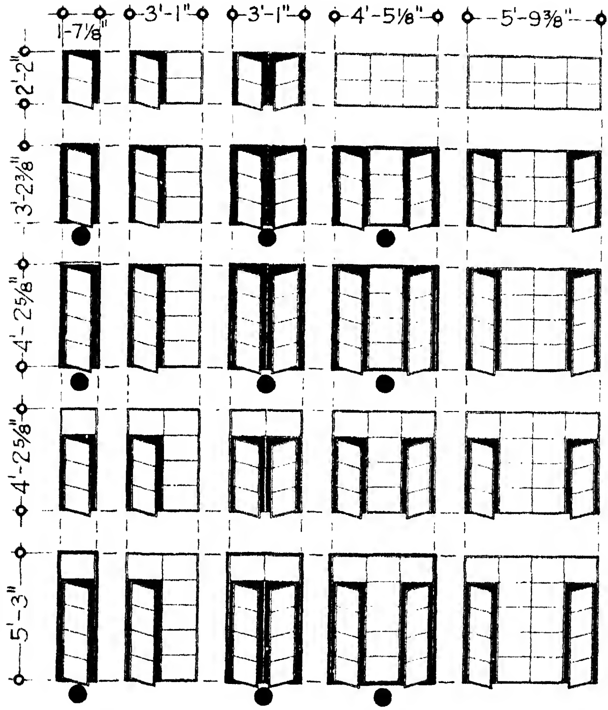


Horizontally Rolling toward left

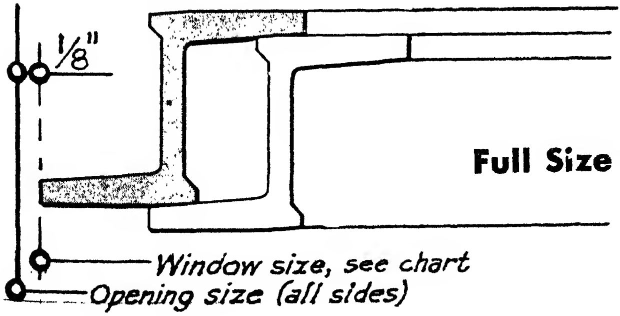
Door and Window indications in plan are made in the usual manner, but since the heights and widths can only be determined on the elevations it is convenient to indicate the motion of vents or doors as shown here.

These Symbols conform to the U. S. Department of Commerce *Simplified Practice Recommendation No. 72.* — "Solid Section Steel Windows"

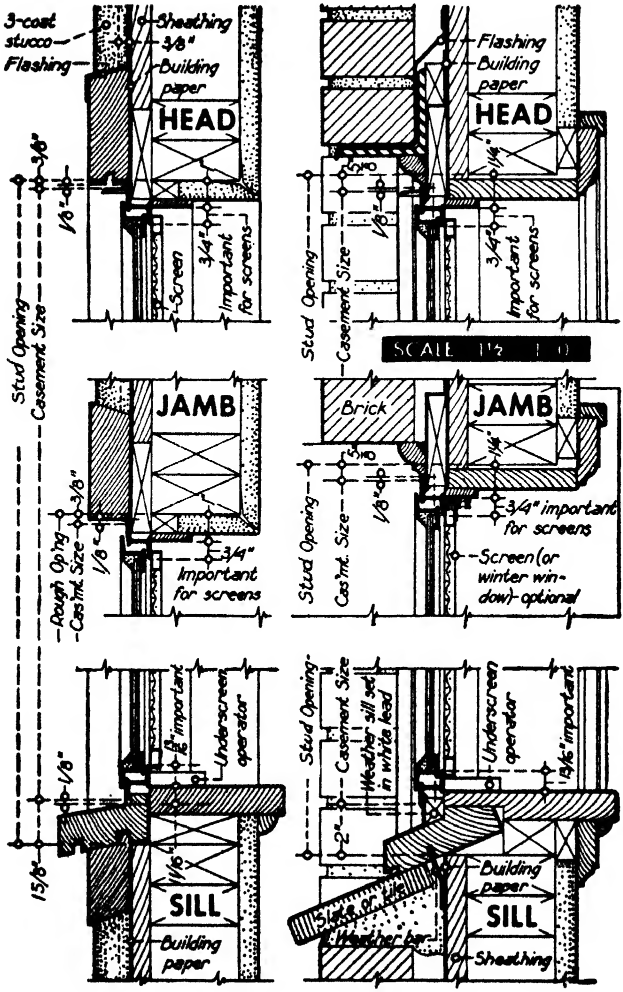
STANDARD DIMENSIONS OF RESIDENTIAL CASEMENTS



Sizes are recommended by Metal Window Inst. Units with single ventilator may swing from right or left jamb. Units with black dots are "package" standards. All units warehouse sizes. Fixed types furnished in all sizes shown.



WINDOW IN STUCCO OR BRICK VENEER WALL



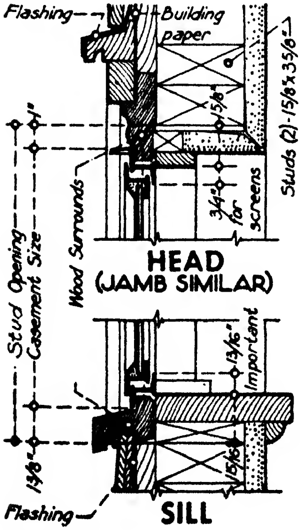
Calking, mastic, wood strips, flashings, trim, structural steel, glass, putty, glazing, and wire glazing clips are not furnished by the steel window manufacturer. Anchor clips at sill are furnished when required. Continuous metal fins at head and jambs, and head drips, are furnished when specified at extra cost.

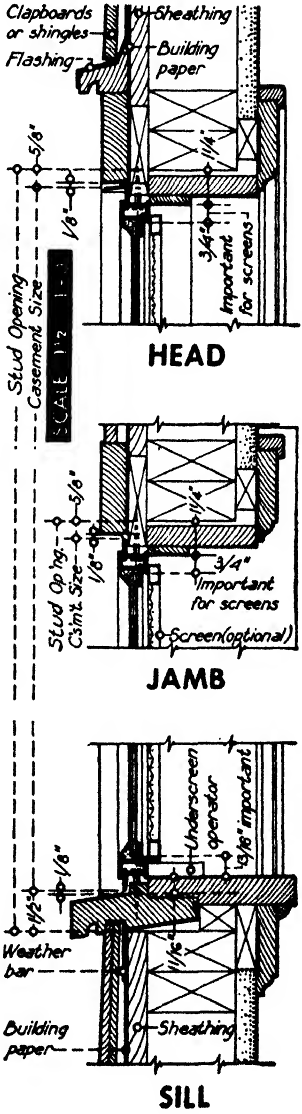
WINDOW IN SHINGLE OR CLAPBOARD WALL

WOOD SURROUNDS. Various forms of specially milled shapes provide a time and trouble-saving short-cut to better window installation. Any durable close-grained wood may be used. California redwood makes an ideal material. These surrounds must be milled to exact size, and should be provided with interlocking joints mitered at the upper corners and dovetailed or tennoned into the sill. Assembly is recommended at the mill where frames should be accurately squared, waterproof glued, and shipped with temporary diagonal braces to insure their squareness in transit. Windows are best mounted in the surrounds on the flat and then the frame and window together put into place. This procedure avoids racking of the steel window which is the cause of most air leakage in this type of fenestration.

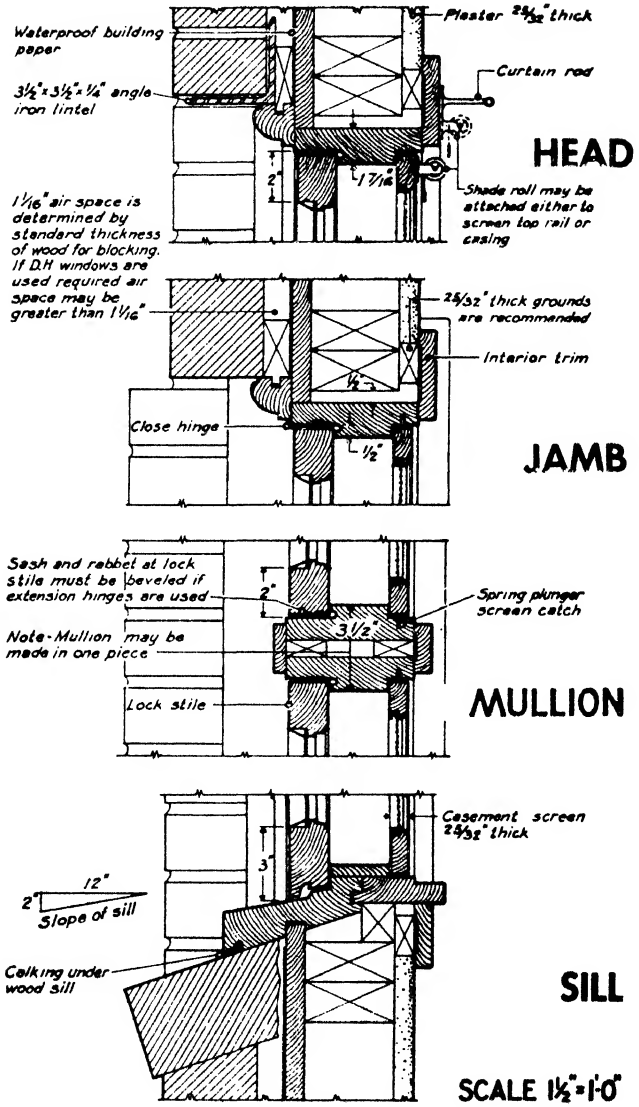
Wood surrounds may be used with brick veneer and stucco to completely frame the casement units.

Mullions are frequently detailed to be cut from 4″ nominal width stock, actual 3 5/8″.

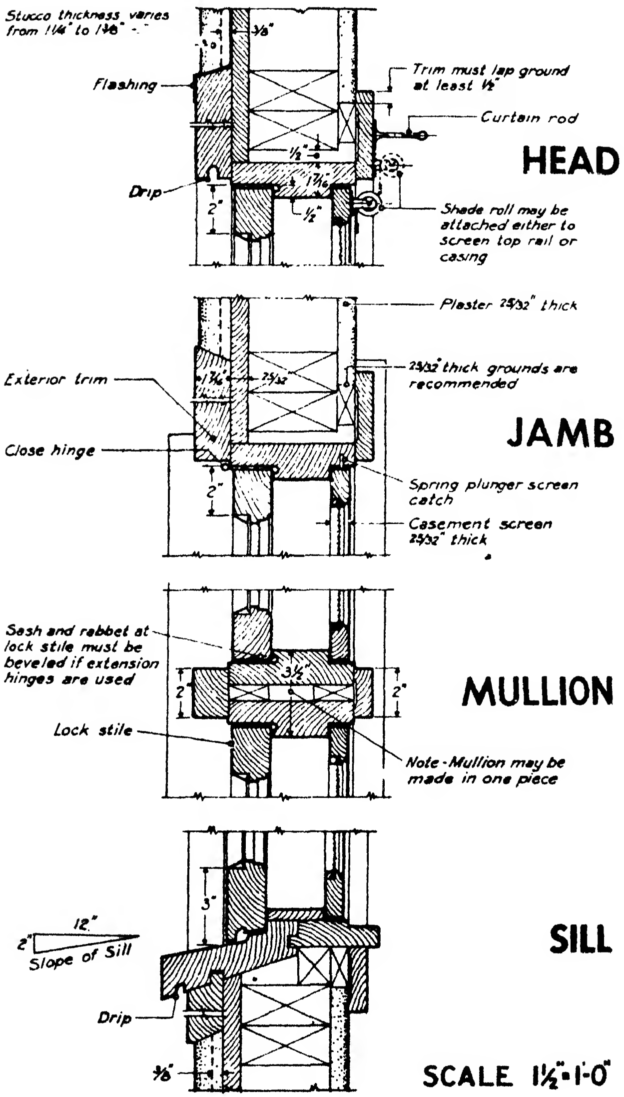




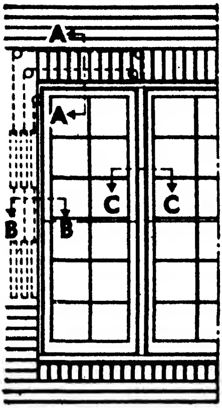
OUTSWINGING WOOD CASEMENT IN BRICK VENEER



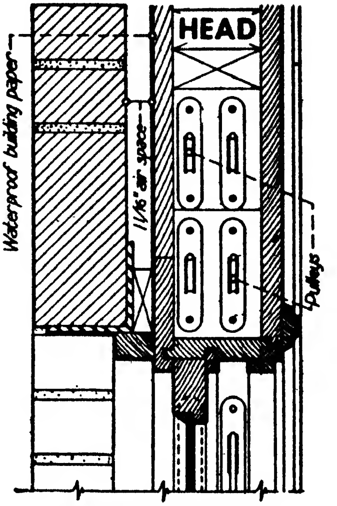
OUTSWINGING WOOD CASEMENT IN STUCCO FRAME WALL



NO WEIGHT IN D.H. WINDOW MULLION



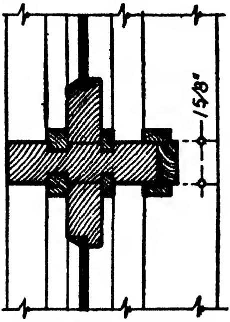
1/2 ELEVATION



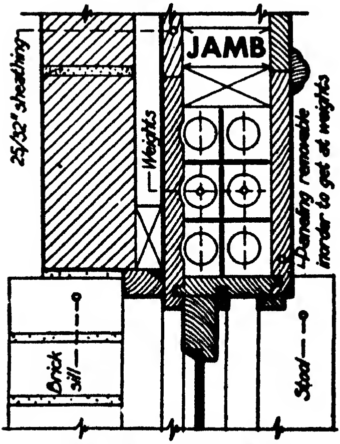
SECTION "A-A"

SCALE of DETAILS
1 1/2"=1'-0"

NOTE – The slender lines of this mullion makes it very desirable for residential work. The frame is so constructed as to eliminate the weight box in the mullion.

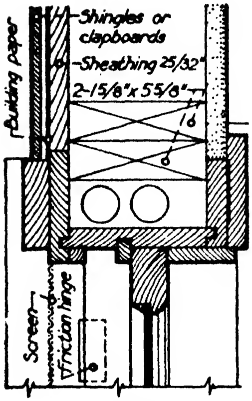


SECTION "C-C"



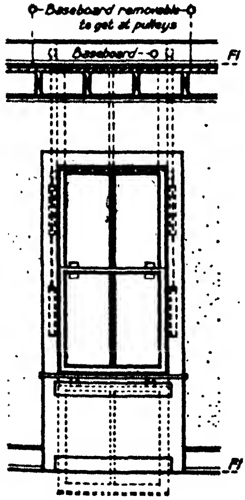
SECTION "B-B"

D.H. WINDOW WITH 100% OPENING

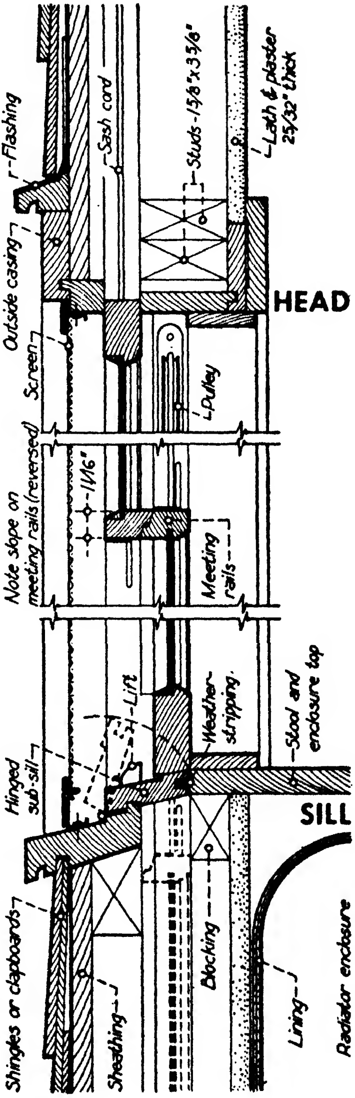


JAMB

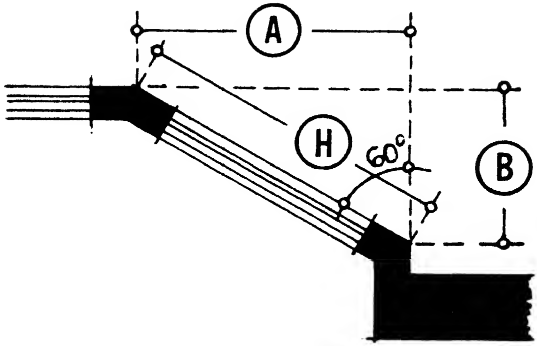
SCALE of DETAILS
1 1/2" = 1'-0"



ELEVATION

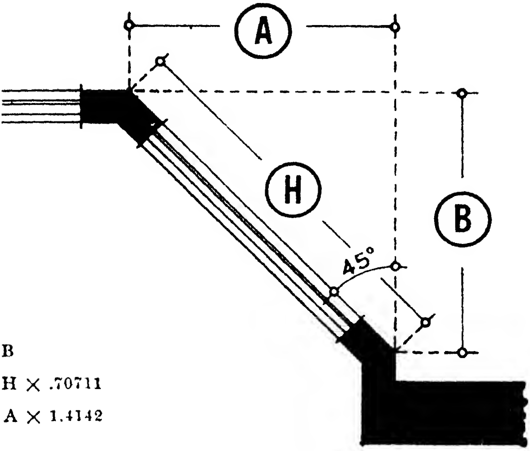


LENGTH OF SIDES OF 30°—60° BAYS



A	B	H	A	B	H
2'- 7 3/16"	1'- 6"	3'- 0"	4'-10 7/8"	2'-10"	5'- 8"
2'- 8 15/16"	1'- 7"	3'- 2"	5'- 0 5/8"	2'-11"	5'-10"
2'-10 5/8"	1'- 8"	3'- 4"	5'- 2 3/8"	3'- 0"	6'- 0"
3'- 0 3/8"	1'- 9"	3'- 6"	5'- 4 1/16"	3'- 1"	6'- 2"
3'- 2 1/8"	1'-10"	3'- 8"	5'- 5 13/16"	3'- 2"	6'- 4"
3'- 3 13/16"	1'-11"	3'-10"	5'- 7 9/16"	3'- 3"	6'- 6"
3'- 5 9/16"	2'- 0"	4'- 0"	5'- 9 15/16"	3'- 4"	6'- 8"
3'- 7 5/16"	2'- 1"	4'- 2"	5'-11"	3'- 5"	6'-10"
3'- 9 1/16"	2'- 2"	4'- 4"	6'- 0 3/4"	3'- 6"	7'- 0"
3'-10 3/4"	2'- 3"	4'- 6"	6'- 2 1/2"	3'- 7"	7'- 2"
4'- 0 1/2"	2'- 4"	4'- 8"	6'- 4 3/16"	3'- 8"	7'- 4"
4'- 2 1/4"	2'- 5"	4'-10"	6'- 5 5/16"	3'- 9"	7'- 6"
4'- 3 15/16"	2'- 6"	5'- 0"	6'- 7 11/16"	3'-10"	7'- 8"
4'- 5 11/16"	2'- 7"	5'- 2"	6'- 9 7/16"	3'-11"	7'-10"
4'- 7 7/16"	2'- 8"	5'- 4"	6'-11 1/8"	4'- 0"	8'- 0"
4'- 9 3/16"	2'- 9"	5'- 6"	7'- 0 13/16"	4'- 1"	8'- 2"

LENGTH OF SIDES OF 45° ANGLE BAYS



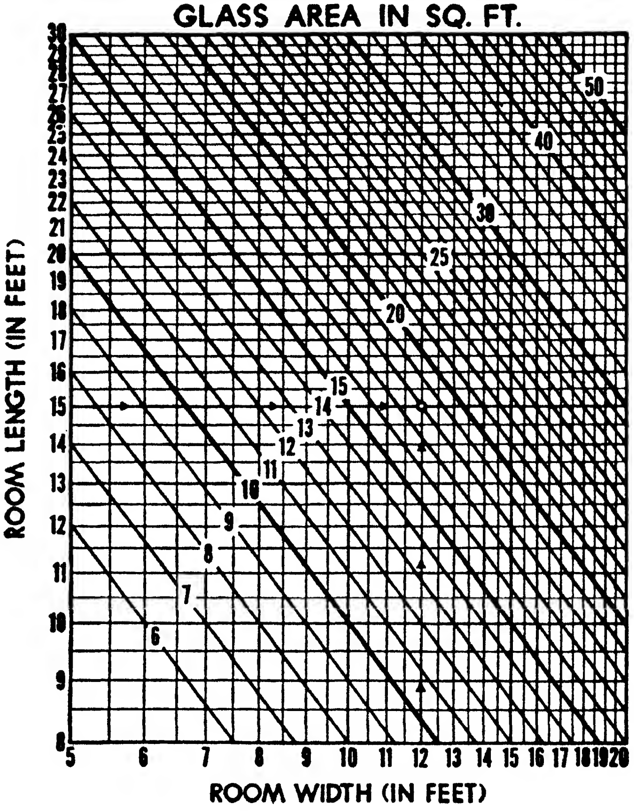
A = B

A = H × .70711

H = A × 1.4142

A	B	H	A	B	H
1'- 6"	1'- 6"	2'- 1 7/16"	2'-10"	2'-10"	4'- 0 1/16"
1'- 7"	1'- 7"	2'- 2 7/8"	2'-11"	2'-11"	4'- 1 1/2"
1'- 8"	1'- 8"	2'- 4 1/4"	3'- 0"	3'- 0"	4'- 2 15/16"
1'- 9"	1'- 9"	2'- 5 11/16"	3'- 1"	3'- 1"	4'- 4 5/16"
1'-10"	1'-10"	2'- 7 1/8"	3'- 2"	3'- 2"	4'- 5 3/4"
1'-11"	1'-11"	2'- 8 1/2"	3'- 3"	3'- 3"	4'- 7 1/8"
2'- 0"	2'- 0"	2'- 9 15/16"	3'- 4"	3'- 4"	4'- 8 9/16"
2'- 1"	2'- 1"	2'-11 3/8"	3'- 5"	3'- 5"	4'-10"
2'- 2"	2'- 2"	3'- 0 3/4"	3'- 6"	3'- 6"	4'-11 3/8"
2'- 3"	2'- 3"	3'- 2 3/16"	3'- 7"	3'- 7"	5'- 1 5/16"
2'- 4"	2'- 4"	3'- 3 5/8"	3'- 8"	3'- 8"	5'- 2 1/4"
2'- 5"	2'- 5"	3'- 5"	3'- 9"	3'- 9"	5'- 3 5/8"
2'- 6"	2'- 6"	3'- 6 7/16"	3'-10"	3'-10"	5'- 5 1/16"
2'- 7"	2'- 7"	3'- 7 7/8"	3'-11"	3'-11"	5'- 6 1/2"
2'- 8"	2'- 8"	3'- 9 1/4"	4'- 0"	4'- 0"	5'- 7 7/8"
2'- 9"	2'- 9"	3'-10 11/16"			

MINIMUM GLASS AREAS FOR ROOMS



GLASS AREA. The recommended Building Code of the NBFU is typical of most requirements for window glass area: "The glass area of windows shall be not less than 1/10th of the floor area of the room served by them; provided that in habitable rooms such glass area shall not be less than 10 square feet, and in bathrooms not less than 6 square feet."

PROPORTION OF OPENING. The FHA require that 40% of the glass area must be capable of opening for ventilation; the NBFU recommend 50%.

GLAZED DOORS. The FHA provide that the glazed portions of doors opening on yard, court or street may be considered as windows. The NBFU do not make this provision.

HOW TO USE THE CHART. A room 15 feet long by 12 feet wide is shown by the chart to require 18 square feet of glass area.

LIFE OF NON-FERROUS INSECT-SCREEN CLOTH

SCREEN MATERIAL	TIME OF FAILURE*	AT END OF NINE YEARS
98% Copper 2% Silicon	7 5/6 yrs.	Dark color, a number of small holes near the top.
Copper (Unalloyed)	7 1/2 yrs.	Dark color; considerable corrosion; wires thin with number of holes near the top.
90% Copper 10% Zinc	7 1/2 yrs.	Uniform dark color; holes at top and edge. Over half of cloth torn out by a slate in storm.
75% Copper 20% Nickel 5% Zinc	7 1/4 yrs.	Dark color; badly corroded, several holes.
80% Copper 20% Zinc	6 1/3 yrs.	Dark color; heavy corrosion products on some areas; other areas, the wires are thin, many holes; brittle.
95% Copper 5% Aluminum	5 7/12 yrs.	Entirely failed most of the cloth corroded away.
70% Nickel 30% Copper (Approx.)	4 2/3 yrs.	Dark color; badly corroded most of the cloth gone.

**Failure was deemed to have occurred when there was a break in the wire in at least 1 place, as a result of corrosion.*

ATMOSPHERIC-EXPOSURE TESTS. Research Paper RP803 of the National Bureau of Standards records the results of atmospheric exposure tests on 7 compositions of non-ferrous screen wire cloth, made by the National Bureau of Standards in cooperation with the A.S.T.M. over a period of about 9 years. The specimens were exposed at Pittsburgh, Pa., a heavy-industrial atmosphere; at Portsmouth, Va., and Cristobal, Canal Zone, a temperate and tropical sea-coast atmosphere, respectively, with some industrial contamination; and at Washington, D. C., a normal inland atmosphere. The bar chart above gives results of the tests at Pittsburgh.

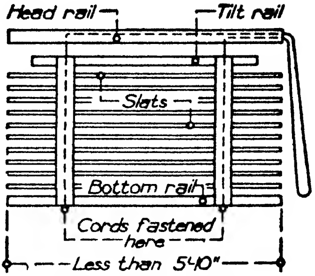
MATERIALS. Seven non-ferrous materials in the form of 16-mesh insect-screen cloth woven from wire 0.0113" in diameter were used. Of the 7 compositions, unalloyed copper and the 90-copper 10-zinc alloy were commercially available at the time the program was started and have continued to be since. The other alloys were not on the market at the time.

LABORATORY TESTS. Accelerated-corrosion tests were also made to determine the relative corrodibility of the different materials. The accelerated-corrosion tests consisted of salt spray and intermittent-immersion tests in salt solutions and dilute acid. The results were not consistent with the results of the exposure tests in any of the 4 locations and could not have been used to predict the behavior of the screen material in actual service.

STANDARD WOOD-SLAT VENETIAN BLINDS

These *Data Sheets* give in part the requirements of U. S. Dept. of Commerce *Commercial Standard CS61*. Wood slat Venetian blinds *not* conforming to this standard may be obtained, as well as blinds with metal slats or slats of other materials.

Referring to the table at the bottom of the page, the 2⅜" width slats are usually used in commercial buildings, since they have fewer slats per foot of blind and are, consequently, more economical. The 2" and 1¾" widths are used for residential work. Any of the 3 widths of blinds may be specified for any window area up to the practical listed maximum of 250 sq. ft.



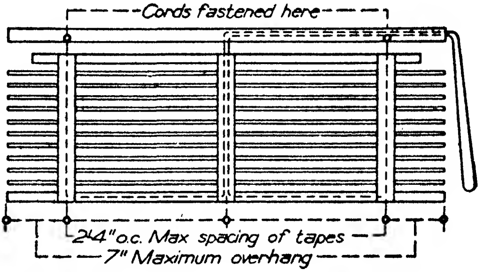
SINGLE PULL BLIND

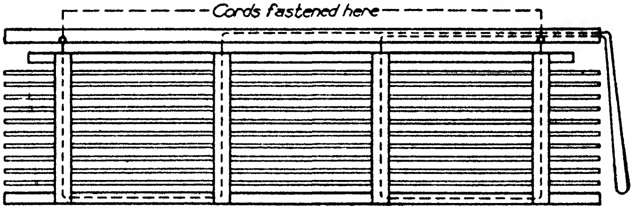
35 Sq. Ft. Maximum

Compound pull blinds have from three to eight tapes depending on the width.

Maximum width of blinds is 15'-6".

A tilt rail center support is to be used for each tape in excess of two tapes.





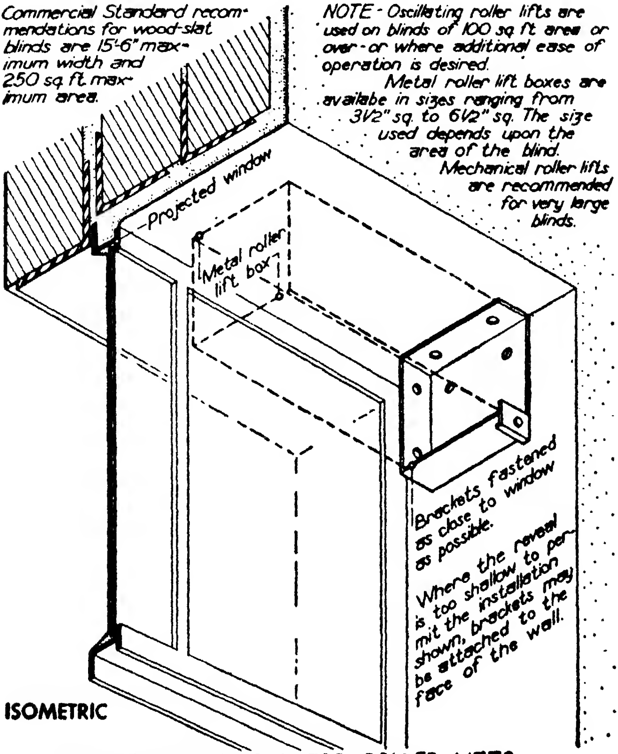
COMPOUND PULL BLINDS

35 to 100 Sq. Ft.

PARTS		2 3/8" WIDTH	2" WIDTH	1 3/4" WIDTH
		Thickness	Thickness	Thickness
HEAD RAIL		1 1/8"	7/8"	7/8"
TILT RAIL		3/4"	5/8"	5/8"
BOTTOM RAIL	Single Pull	3/4"	5/8"	5/8"
	Compound Pull	1 1/8"	7/8"	7/8"
SLATS		1/8"	1/8"	1/8"

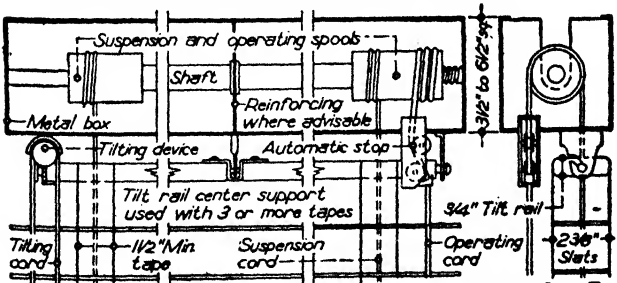
MINIMUM DIMENSIONS OF RAILS AND SLATS

STANDARD WOOD-SLAT VENETIAN BLINDS



ISOMETRIC

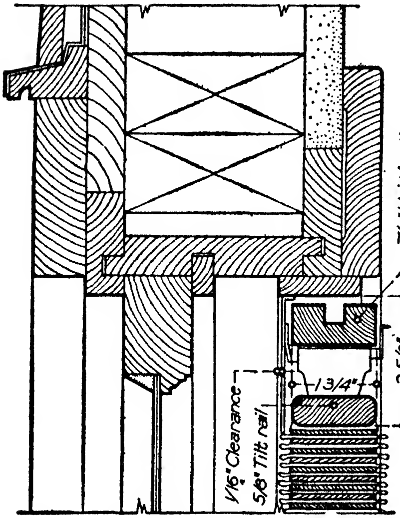
BRACKET INSTALLATION FOR ROLLER LIFTS



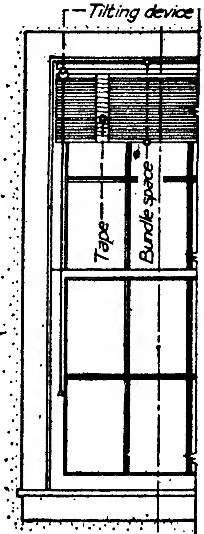
OSCILLATING ROLLER LIFT

100 to 250 Sq. Ft.

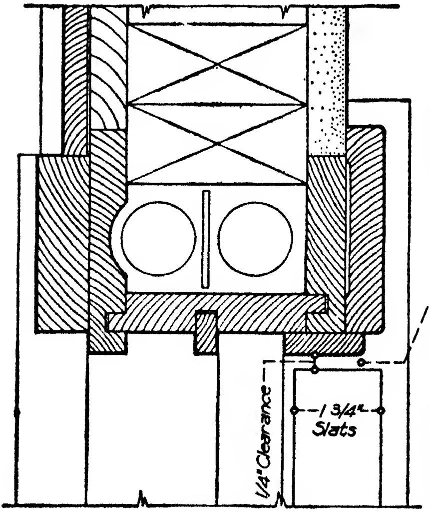
VENETIAN BLIND INSTALLATION



HEAD



ELEVATION



JAMB

NOTES

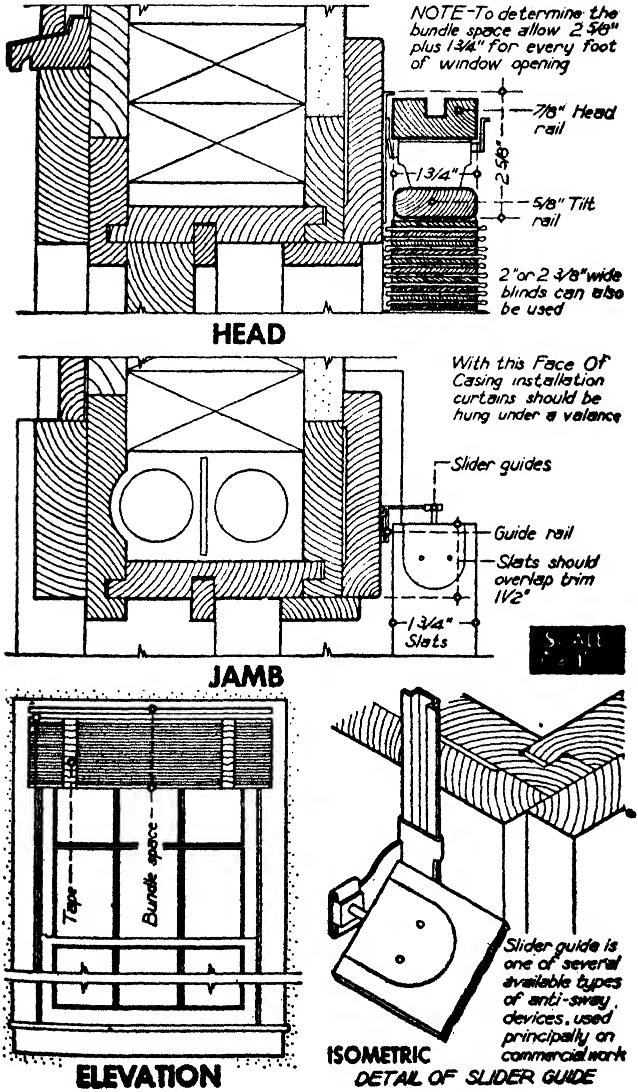
To determine the bundle space for wood-slat blinds allow 2 5/8" plus 1 3/4" for every foot of window opening

Curtains may be hung in the usual way or under a valance

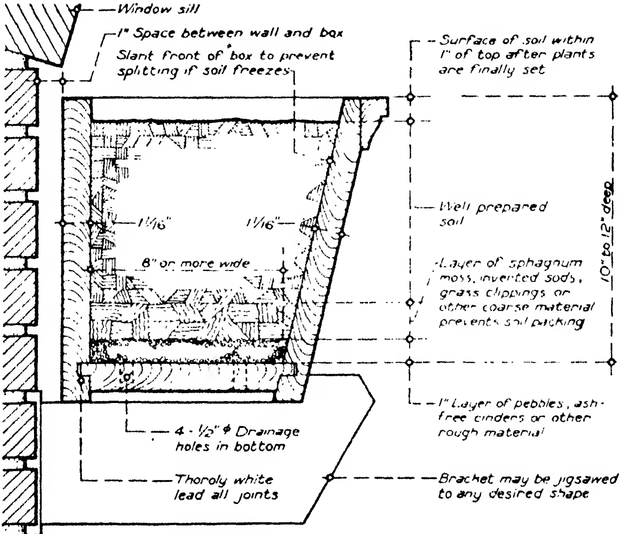
Various types of hold-down devices available, used principally on residential work

This method of Stop Bead installation is recommended for use where economy is the foremost consideration

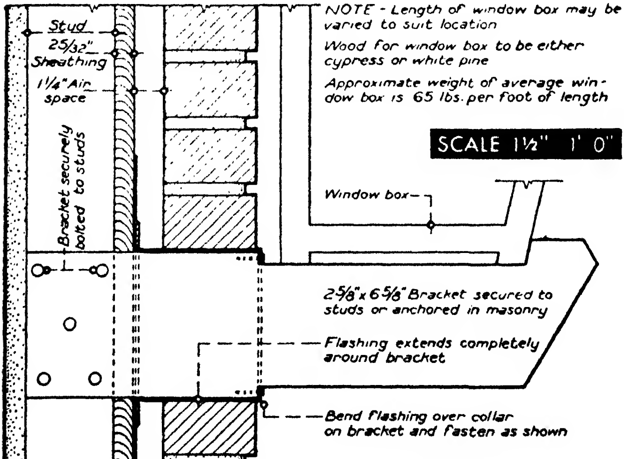
VENETIAN BLIND INSTALLATION



DETAILS OF WINDOW BOXES

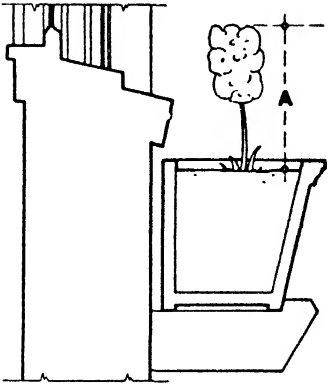


SECTION *THRU WINDOW BOX*



DETAIL
OF BRACKET ATTACHMENT

PLANTING FOR WINDOW BOXES



Ageratum grows 12 inches or less high, compact with white, blue or purple flowers.

Chinese pink grows about 12 inches high with single or double flowers of white or shades of red.

Sweet alyssum is a spreading plant with white, sweet scented flowers, varying in height from 4 to 8 inches. It blooms continually, covering the surface of the box and trailing over its edge.

Candytuft attains a height of 12 inches and more with upright stalks of white or purplish flowers. It is not a continuous bloomer.

Lobelia grows from 6 to 12 inches high with flowers that are white or shades of blue. It is upright and compact with good foliage; when given plenty of water in hot weather it blooms continually during a long season.

Mignonette grows to a height of 15 inches and more. It is chiefly valuable for its sweet fragrance, altho its greenish-yellow to brownish flowers are attractive though not showy.

Dwarf nasturtiums grow about 12 inches high with large, showy yellow, orange or red flowers. Manure should not be added to the soil for these plants.

Petunias will grow about 12 inches high without support, altho the branches will grow several feet long and if permitted to droop over the edge of the box, make a beautiful showing. They grow best in a warm sunny situation. There are many varieties from white to a rich royal purple.

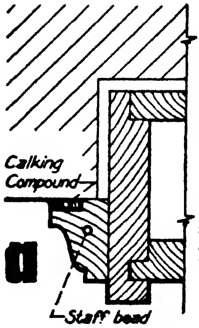
Verbenas grow less than 12 inches high but the long stems will droop gracefully over the edges of the box. There are white, scarlet and purple varieties which thrive in full sunshine and bloom freely for a long season.

Calliopsis, snapdragon, and *helichrysum* or *strawflower* are upright, easily grown annuals that attain a height of 18 inches.

Vines or trailing plants adapted to use in window boxes are *kenisworth, ivy, wandering Jew, Vinca major, climbing nasturtiums, Ageratum rostrata, Asparagus sprengeri, Ficus pumila* and *English ivy*.

Porch and outdoor window boxes planted with evergreens may be used effectively. More permanent appearing and dignified summer effects may often be obtained by evergreens, especially in connection with more formal buildings. They are the only plants that can be widely used for winter effects.

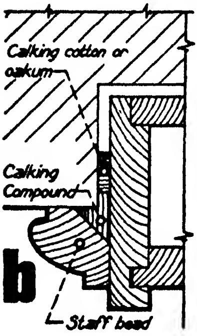
CALKING OF MASONRY JOINTS AND OPENINGS



CALKING COMPOUND. This is a plastic material composed of elastic oils and gums. It is impervious to heat, cold, moisture or acid fumes. When set, it forms a tough skin on the surface but remains permanently pliable and elastic underneath. It adheres tenaciously to wood, stone, terra cotta, concrete, iron, glass or any other building material.

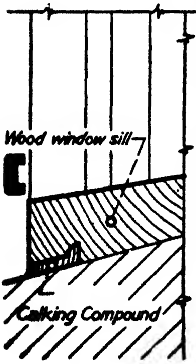
PREVENTING INFILTRATION, ETC. *Calking Compound* is used as a plastic filler for spaces between exterior window and door frames and the surrounding masonry to prevent the leakage of water, air and dust into the building, and the leakage of heated air from the building.

WINDOW AND DOOR FRAME CALKING. Staff beads are sometimes detailed to receive calking without removal, as shown in *Figue a.* The calking rabbet should be ⅛″ to ¼″ wide by ½″ to ¾″ deep. The calking compound adjusts itself to the movements of the materials, insuring a permanently sealed joint.



If the staff beads are removable, as shown at *Figure b,* the mortar of masonry joints behind frames should be raked out to a depth of ½″ to ¾″. The joint between frame and masonry should be filled with plumber's oakum or calking cotton. Fill the space with calking compound and form a fillet corner in the angle. The staff bead is then replaced, nail holes puttied and the frame painted.

CALKING MASONRY. The joints in cast stone, natural stone, terra cotta, provide a point of attack for the entrance of moisture, particularly in copings, corners, gutters, belt courses, base courses or other projecting members. *Calking Compound* is finding increasing use as a material for pointing because it provides a permanently sealed masonry joint. *Calking Compound* will not stain the masonry, will not run or melt, shrink or crack from extreme temperature or movement of the construction. Joints to be calked should be kept back or raked out not less than 1″ nor more than 1½″ to receive the calking compound.



APPLICATION. Power gun calking in which the compound is forced into the joint under pneumatic pressure, is the most efficient method. On large projects, this method should be specified. On smaller work, hand calking guns will result in a good job if care is taken to force the compound back into the joint. A hand tool such as a putty knife, small trowel or calking key may be used to force the compound into the joints.

TYPES OF COMPOUND. Two consistencies are available—*knife* grade and *gun* grade. Stock colors are battleship gray and cream white. Special shades can be furnished if ordered in not less than 30-gallon lots.

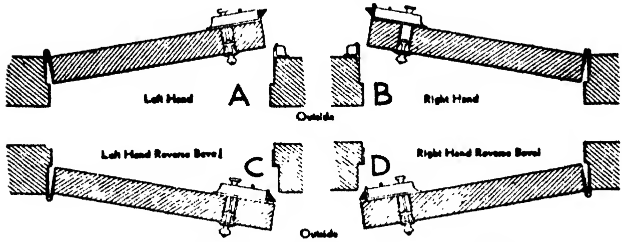
HAND AND BEVEL OF DOORS

Bevel of Door—The free edge of doors over $1\frac{3}{8}''$ thick is bevelled $\frac{1}{8}''$ in $2''$ to clear the rabbet. If a mortise lock is used its front must be bevelled to correspond.

Bevel of Lock—Term used to describe the direction in which the latch bolt is inclined, for either mortise or rim locks, and corresponds to the door bevel always.

"Outside"—If the key functions from one side only, that is the "outside." It is usually the exterior side of an entrance door, the hall side of a room door, and the room side of a closet door.

Hand and Bevel of Doors and Locks

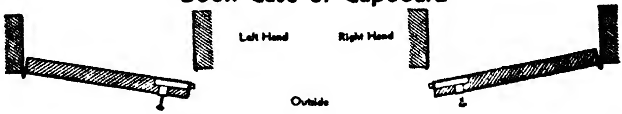


Hand of a Lock—With either mortise or rim locks if the key functions from one side only, stand on that side and if the butts are on the right it is a right hand lock. If on the left it is a left hand lock. If it is a mortise lock having the key function the same on both sides, determine the hand from the side from which the butts are not seen, as at A and B.

Bevel of a Lock—Standing as for determining hand, if the door opens toward you it requires a reverse bevel. If it opens away from you it requires a regular bevel. If no bevel is designated it is understood as regular bevel.

Hand of Door Itself—Determined by the side that is hinged, standing on the side from which the butts are not seen. A and D are left hand doors, and B and C are right hand doors.

Book Case or Cupboard

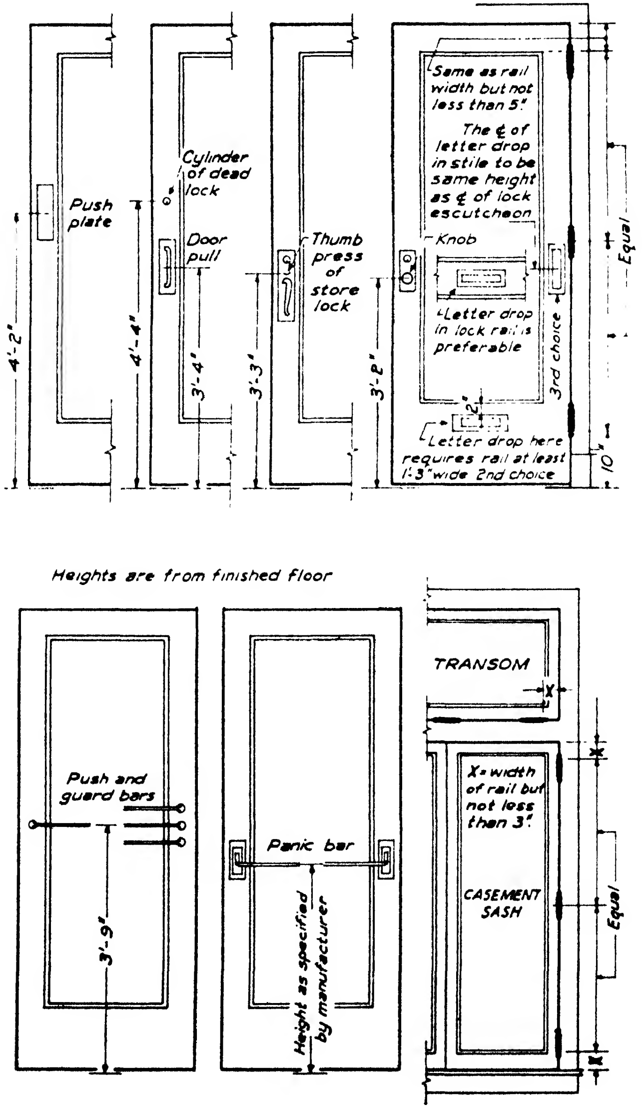


Book Case or Cabinet Locks are made with reverse bevel bolts as such doors regularly open outwards. Designated as "right hand" or "left hand" only.

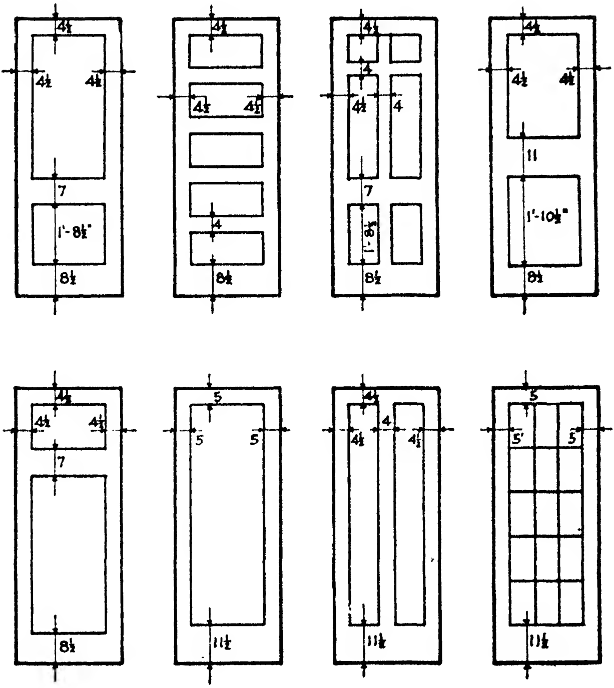
Casement Windows

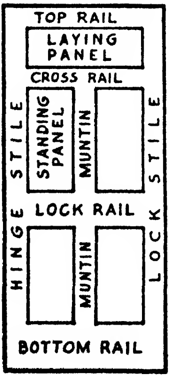
Casements and French Doors—Hand taken from the *inside*, which is the side on which casement fasteners or cremone bolts are applied.

LOCATION OF HARDWARE



STOCK WOOD DOOR PATTERNS





Dimensions shown are exclusive of moldings and vary with each manufacturer. The molds on stock doors are ½" or less in width.

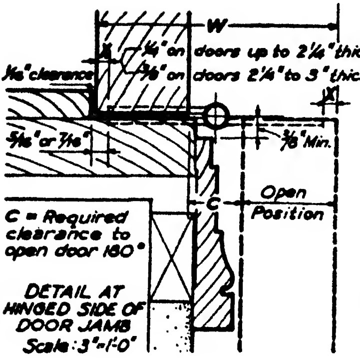
One-panel doors should not be less than 1¾" thick, with panel not less than ½" thick.

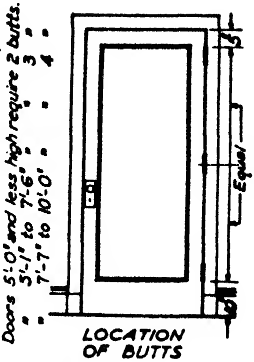
Doors over 2'-8" wide or over 7'-0" high should be not less than 1¾" thick.

Doors veneered with two kinds of wood should be not less than 1¾" thick.

Flush doors should be at least 1¾" thick.

BUTTS AND HINGES



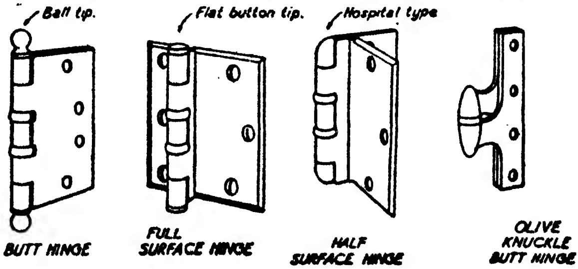


WIDTH OF BUTTS = W — 2X. Butts come in multiples of ½" widths, fractional sizes resulting from formula take next higher width.

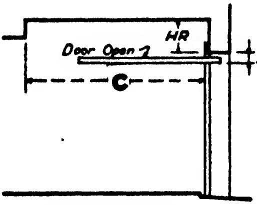
Type of Door	Door Thickness	Door Width	Height of Butt
Cupboard Doors..........	¾" to ⅞"	up to 2'-0"	2½"
Screen Doors..............	⅞" to 1⅛"	up to 3'-0"	3"
Wood Doors...............	1⅛"	up to 3'-0"	3½"
Steel Doors...............	1⅛"	up to 3'-0"	4½"
Wood Doors...............	1¼" to 1⅜"	up to 2'-8"	3½"
Wood Doors...............	1¼" to 1⅜"	2'-9" to 3'-1"	4"
Steel Doors...............	1¼" to 1⅜"	up to 2'-8"	4½"
Steel Doors...............	1¼" to 1⅜"	2'-9" to 3'-1"	5"
Steel or Wood Doors......	1⅝" to 1⅞"	up to 2'-8"	4½"
Steel or Wood Doors......	1⅝" to 1⅞"	2'-9" to 3'-1"	5"
Steel or Wood Doors......	1⅝" to 1⅞"	3'-2" to 3'-7"	5"*
Steel or Wood Doors......	1⅝" to 1⅞"	3'-8" to 4'-2"	6"*
Steel or Wood Doors......	2" to 2½"	up to 3'-7"	5"*
Steel or Wood Doors......	2" to 2½"	3'-8" to 4'-2"	6"*

* = Extra Heavy.

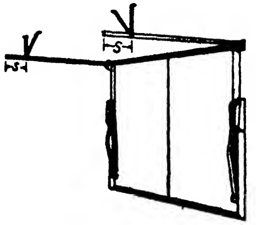
HINGES AND BUTTS. A *hinge* is a device that allows a door to swing. That type of hinge in which the leaves close together when the door is closed, is called a *butt hinge* or *butt*.



DETAILS OF "SWING-UP" GARAGE DOORS



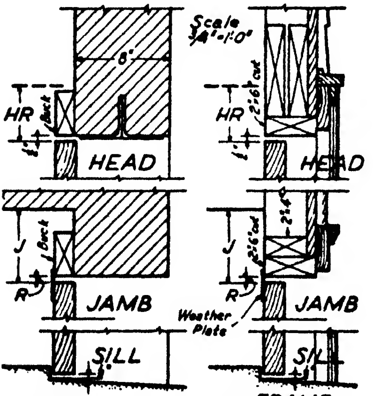
SECTION



Max. Weight of Door	150#	250#	500#
Rear Hanger, S	0"	0"	0" to 18"
Jamb Space, J	2½"	3"	3½"
Buck Size	2 x 4	2 x 4	2 x 4
Side Clearance, R	⅜"	⅜"	½"
Height Reduction, X	3½"	3½"	7½"
Headroom, H.R	1⅝"	2"	2¼"

C FOR DOORS

6'-6" to 7'- 0" high	6'-10"	6'-10"	6'-10"
7'-1" to 8'- 0" high	....	7'-10"	7'-10"
8'-1" to 9'- 0" high	....	....	8'-10"
9'-1" to 10'- 0" high	....	....	9'-10"
10'-1" to 10'-11" high	....	....	9'-10"
11'-0" to 12'- 0" high	....	....	11'-10"

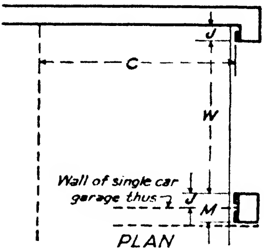


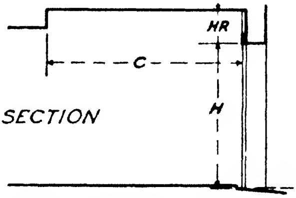
BRICK CONSTRUCTION

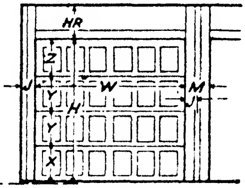
FRAME CONSTRUCTION

With "swing-up" doors, a slight pull on the bottom floats it quietly open. A car can rest nearly against door and not be touched in opening it. The "swing-up" door is quiet, well weathered, requires a minimum of height, depth and side-room. The heavier types are provided with safety devices to prevent accidental closing. "Swing-up" hardware can be used on doors up to 16' wide, providing a wide, clear opening for 2 cars. They are also suitable for roadside stand enclosures and, provided with wire mesh panels, for market stalls, gates, etc. Electric operators available.

DIMENSIONS FOR "ROLL-UP" GARAGE DOORS







INSIDE ELEVATION

HOW TO DETAIL GARAGE OPENINGS. Decide from sketch elevations the size of openings necessary for utility and desired design effect. Refer to Table 1 for the dimensions to be observed. Table 2 gives vertical section measurements for all types. Bucks must be securely bolted (counter sunk) to wall. Jamb bucks 2x6 or 4x4 steel angles. Avoid special designs, woods, glass, molds, etc.

Width of doors	*No. panels wide*
8'-0½" to 9'-11"	4
10'-0" to 14'-11"	6
15'-0" to 18'-11"	8
19'-0" to 21'-11"	10
22'-0" to 24'-0"	12

TABLE 1.

Max. size	*Used for*	*Th*	*H.R.*	*J*	*J'*	*C*
8' x 8'	Residences	1⅜"	9½"	4"	....	10'-5"
8' x 8'	Residences	1⅜"	12" fr 16" rr	3"	....	10'-5"
8' x 8'	Residences	1⅜"	6½"	5"	....	10'-5"
8' x 8'	Residences	1¾"	9½"	4"	....	10'-5"
300 sq. ft.	Ex. Heavy doors	1¾"	22"	6½"	8"	H 25½"
175 sq. ft.	Comm. doors	1¾"	13" fr 24" rr	3"	....	H+29"
175 sq. ft.	Comm. doors	1¾"	13"	5"	....	H+29"
10' x 10'	Over car lift	1¾"	60" max.	6"	....	H—HR+29"

Th=door thickness. HR=head room, see drawing. J=jamb clearance. J'=jamb clearance on chain side. C=unobstructed ceiling. fr=front. rr=rear. M=min. mullion. Width=2J. The residence doors are carried in two other stock sizes: 8'-0" x 7'-0", 8'-0" x 7'-6".

TABLE 2.

Door heights	*No. of secs.*	*Heights of sections* X	Y	Z
7'-0" to 7'-2"	4	21¼"	21"	20 13/16" to 22 13/16"
7'-3" to 7'-6"	4	24¼"	21"	20 13/16" to 23 13/16"
7'-7" to 8'-5"	4	24¼"	24"	18 13/16" to 28 13/16"
8'-6" to 9'-3"	4	27¼"	27"	20 13/16" to 29 13/16"
9'-4" to 9'-6"	5	22¾"	22½"	21 13/16" to 23 13/16"
9'-7" to 10'-5"	5	24¼"	24"	18 13/16" to 28 13/16"
10'-6" to 10'-9"	5	27¼"	24"	26 13/16" to 29 13/16"
10'-10" to 11'-6"	5	27¼"	27"	21 13/16" to 29 13/16"
11'-7" to 12'-3"	6	24¼"	24"	18 13/16" to 26 13/16"
12'-4" to 12'-9"	6	27¼"	24"	24 13/16" to 29 13/16"
12'-10" to 13'-9"	6	27¼"	27"	18 13/16" to 29 13/16"

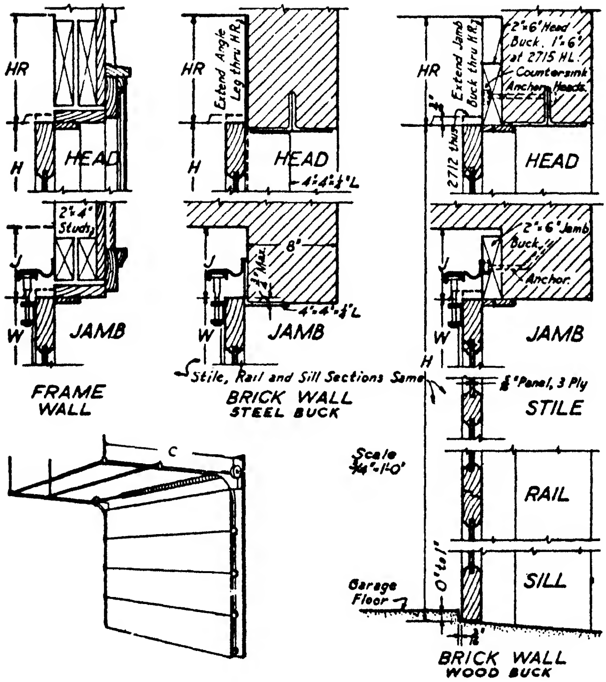
DETAILS OF "ROLL-UP" GARAGE DOORS

Doors roll up vertical tracks and rest on horizontal tracks when fully open. See illustration, Figure 1, below, which shows a typical "roll-up" Door. Doors are made of three or more horizontal sections. The hardware, with the exception of the handles, is inside, out of the weather. The proper size and type of spring is furnished at the factory. The operation of the door allows the garage to be practically the same depth inside as the car is long, thus saving plan space. Doors are securely locked by a heavy cylinder sliding bolt engaging in track. The opening and closing of the door is easy, smooth and quiet.

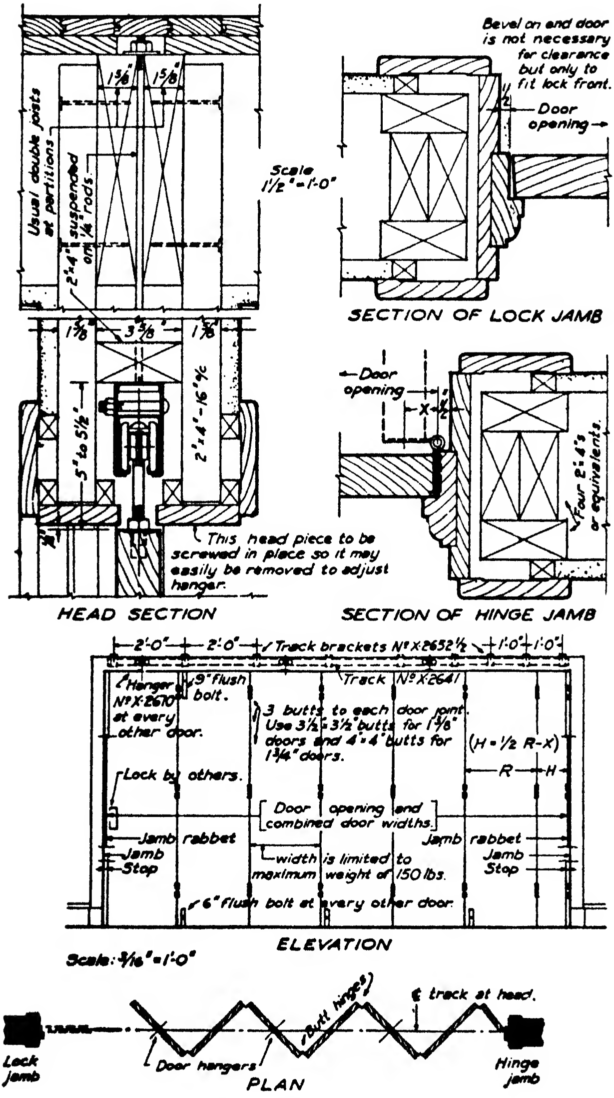
Doors are regularly furnished unpainted and unglazed, but can be furnished primed, if specified. V-joint doors and special designs, tin clad and steel doors can be had to order.

Angle hangars for suspending horizontal track are standard. Provide support for hangars. In planning, avoid posts, beams, pipes, angle walls, truss braces, gables, or other obstructions that cut down apparent side or head room.

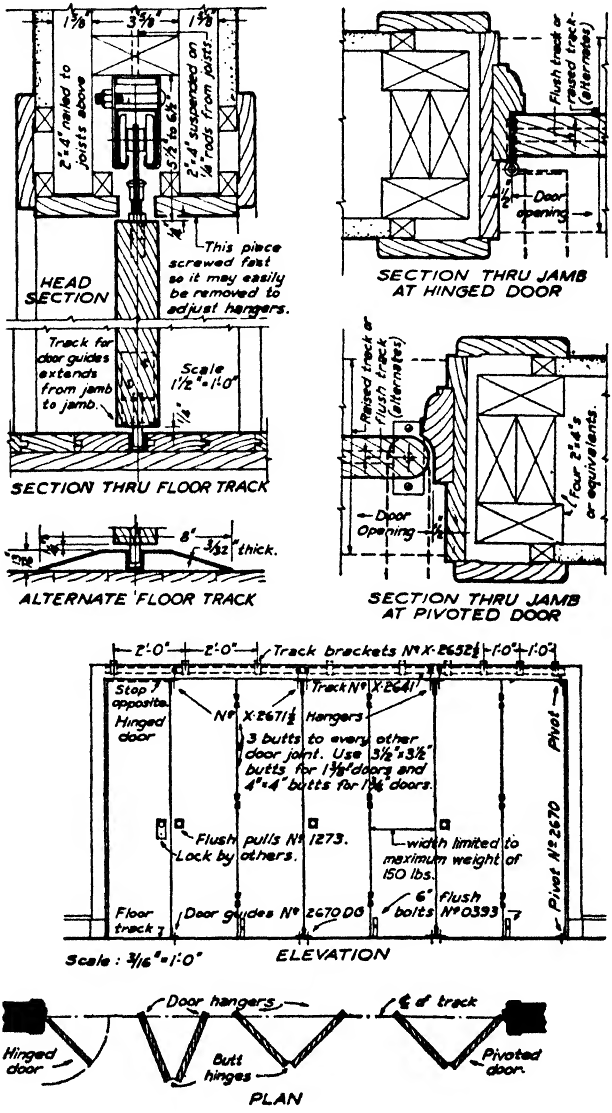
Service doors can be had in any type door. Electric operators are also available for all doors.



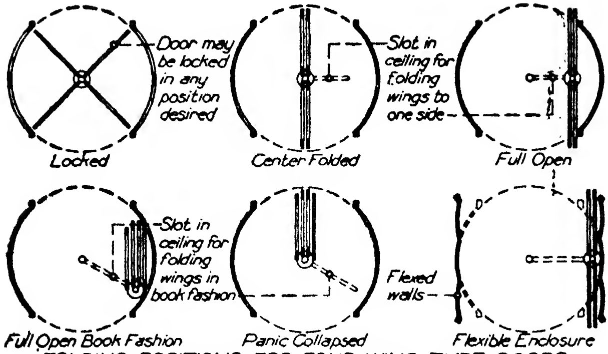
ACCORDION DOORS



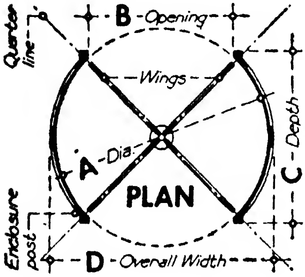
ACCORDION DOORS



SIZES AND CAPACITIES
REVOLVING DOORS



FOLDING POSITIONS FOR FOUR WING TYPE DOORS



A 6'-6" Dia door is recommended for average use. At entrances accommodating people with luggage use 7'-0" Dia. to 8'-0" Dia doors.

Based on 10 to 12 revolutions per minute the capacity per hour both in and out of a revolving door with four wings is about 2600 persons.

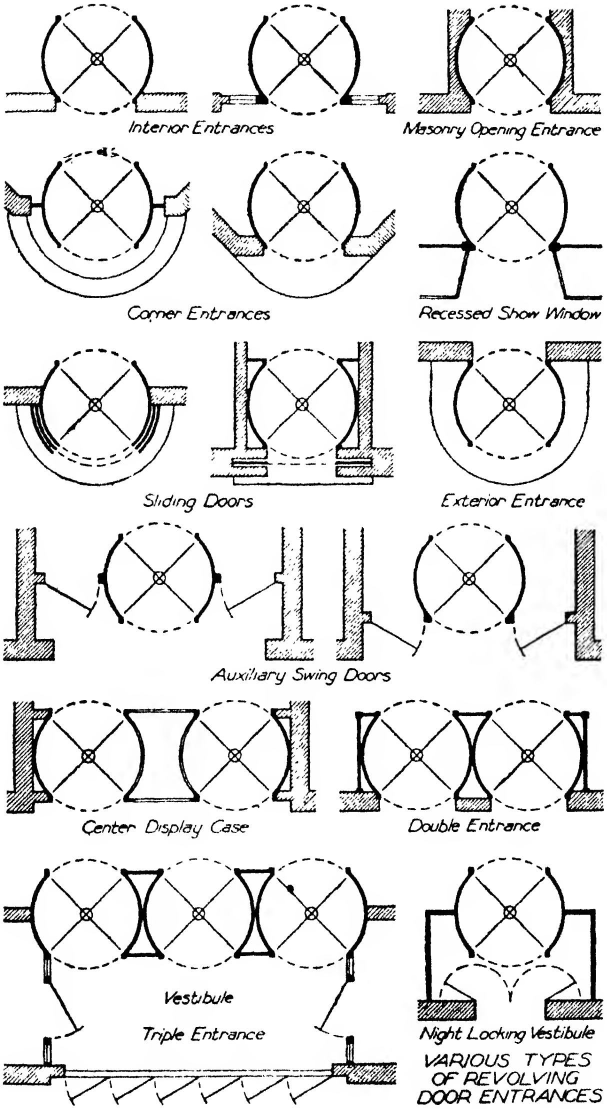
Dimensions of doors of different manufacturers may vary 1" from those given in table.

All manufacturers may not regard all diameters given as standard

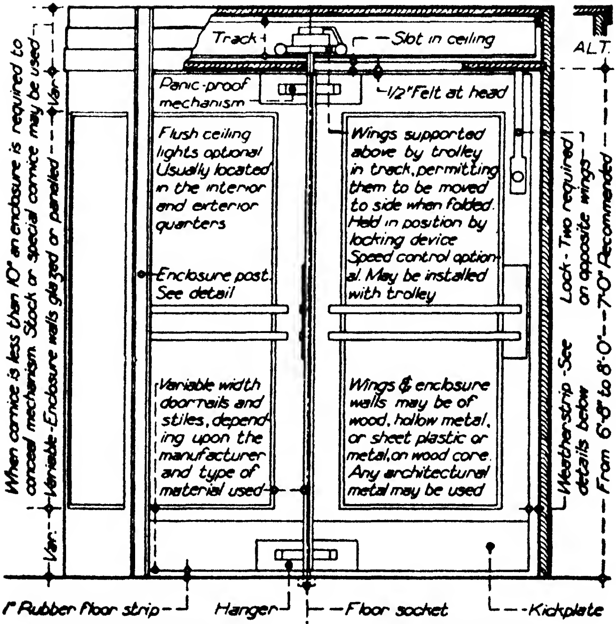
A-DIAMETER	B	C	D
5'-6"	3'-8 1/2"	4'-5"	5'-9"
5'-8"	3'-10 1/2"	4'-6"	5'-11"
5'-10"	3'-11 1/2"	4'-7 1/2"	6'-1"
6'-0"	4'-1"	4'-9"	6'-3"
6'-2"	4'-2 1/2"	4'-10 1/2"	6'-5"
6'-4"	4'-4"	4'-11 1/2"	6'-7"
6'-6"	4'-5"	5'-1"	6'-9"
6'-8"	4'-6 1/2"	5'-2 1/2"	6'-11"
6'-10"	4'-8"	5'-4"	7'-1"
7'-0"	4'-9 1/2"	5'-5 1/2"	7'-3"
7'-2"	4'-10 3/4"	5'-7"	7'-5"
7'-4"	5'-0"	5'-8"	7'-7"
7'-6"	5'-1 1/2"	5'-9 1/2"	7'-9"
7'-8"	5'-3"	5'-11"	7'-11"
7'-10"	5'-4 1/2"	6'-0 1/2"	8'-1"
8'-0"	5'-6"	6'-1 1/2"	8'-3"

TABLE OF DIMENSIONS

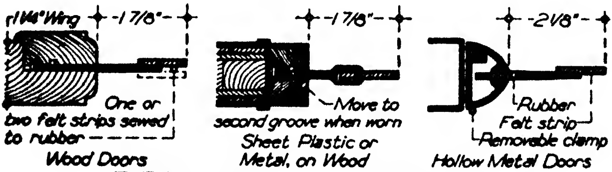
VARIOUS PLANS FOR REVOLVING DOORS



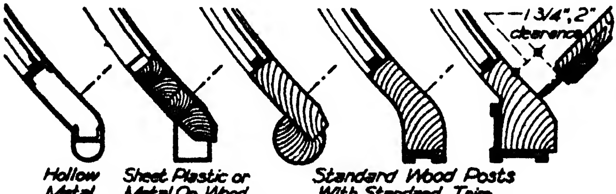
SECTION AND DETAILS
REVOLVING DOORS



1/2 ELEVATION | **1/2 SECTION**



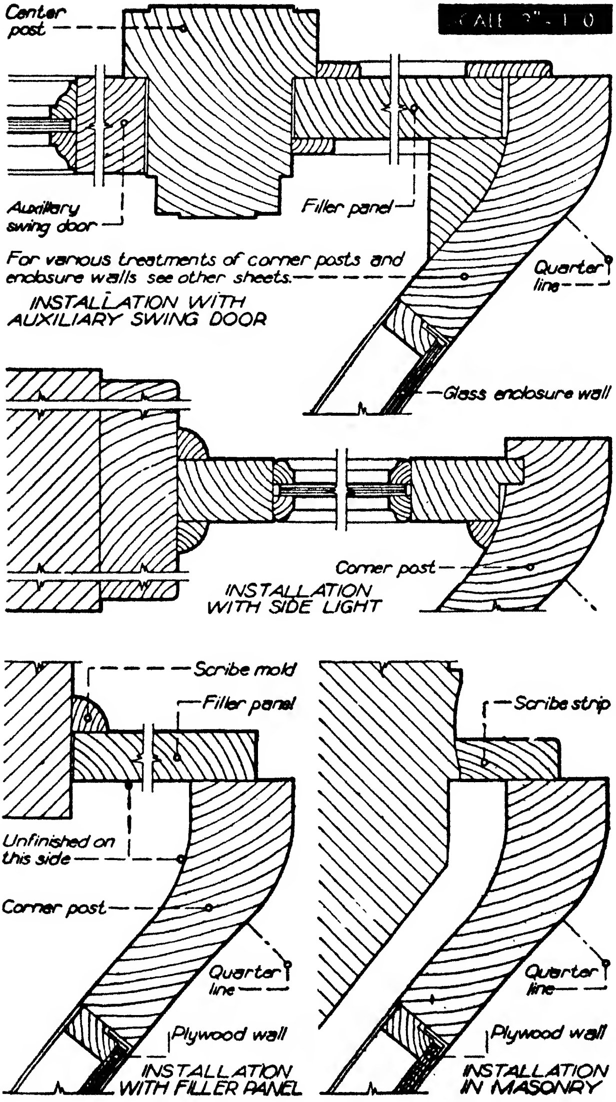
TYPES OF WEATHERSTRIP CLAMPS



Hollow Metal | Sheet Plastic or Metal, On Wood | Standard Wood Posts With Standard Trim

VARIOUS TYPES OF ENCLOSURE POSTS

CORNER POST DETAILS
REVOLVING DOORS

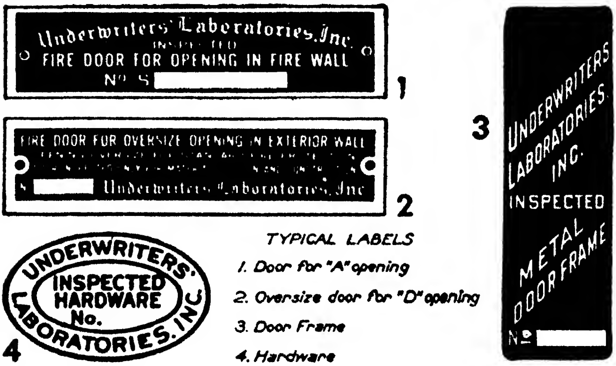


SIGNIFICANCE OF UNDERWRITERS' LABEL

UNDERWRITERS' REQUIREMENTS. Construction and installation not in accordance with Underwriters' requirements may be covered by fire insurance—but a higher yearly premium will be exacted. The NBFU maintains the Underwriters' Laboratories, who have established the following procedure with respect to fire doors:

1. PROMULGATION OF REGULATIONS. These classify the openings in the walls of buildings according to the importance of their locations in the prevention of property damage as a result of fire; and describe the manufacture and installation of doors, frames and hardware for such openings.

2. FACTORY INSPECTION. Doors, frames, and hardware are inspected during manufacture. *Inspection manifests* (so-called "Underwriters' Labels") are affixed to those complying with the Regulations,



TYPICAL LABELS

1. Door for "A" opening
2. Oversize door for "D" opening
3. Door Frame
4. Hardware

The door for an opening greater in area than prescribed in the Regulations would be constructed to the same standards as tho it were regulation size. Such an opening would bear a special label as shown at (2). The local field inspector will then exercise his discretion as to the amount of protection offered by such an oversize door.

Frames may be labeled. Only 1 type of label is used. Frames for Class A openings, where required for flush swing doors are structural channels not less than 4". For other class openings unit steel frames are available.

Hardware undergoes a factory inspection and that which meets the Regulations is identified by a decalcomania label shown at (4). Only 1 type of label is used on hardware for any fire door.

3. FIELD INSPECTION. The local Rating Bureau of the Underwriters is the final judge of the fire risk involved in a building, and the resulting insurance rate. The local inspector may, at his own discretion, (a) honor the factory-affixed labels, or (b) change the classification of the completed installation from that shown by the labels. The local inspector will temper his rating by local conditions.

LEGAL REQUIREMENTS. State and municipal building codes may require the use of doors meeting their own regulations. They usually conform in general to the NBFU Regulations altho there may be exceptions involving minor modifications in hardware and exit requirements. In New York City, the Board of Standards and Appeals requires tests on which procedure and regulations for the manufacture and labeling of fire doors in New York City are based.

UNDERWRITERS' FIRE DOOR REQUIREMENTS

CLASS A OPENINGS. These occur in division walls separating buildings, or in division walls dividing a single building into fire sections. Doors protecting such openings in "Fire Walls" are required on both sides of the wall. No glass permitted. No transoms permitted.

These doors must be equipped with automatic closing devices. Frequently it is found desirable to install a gravity sliding door on 1 side which would be normally open, and a swinging door on the opposite side which would be normally closed. Thus, traffic thru the doorway would require the opening of 1 door only. These doors must be 3-ply construction, hung with approved fire door hardware only.

Type of Door	Maximum Opening Metal Clad, Tin Clad, Corrugated		
	Area in sq. ft.	*Width*	*Height*
Single Slide	120	12′	12′
Single Swing	72	6′	12′
Swing in Pairs	120	10′	12′

CLASS B OPENINGS. These occur in enclosures to vertical communications thru buildings—such as stairs, elevators and hatchways. Doors required on 1 side of the wall only. Not more than 100 sq.ins. of glass per opening, and longer dimension not over 12″. No transoms.

These doors may be equipped with automatic closing devices. May be hung on either fire door or builder's hardware. Tinclad doors are 2-ply.

Type of Door	Maximum Opening Metal Clad, Tin Clad, Corrugated			Max. Opening Kalamein
	Area in sq. ft.	*Width*	*Height*	
Single Slide	80	10′	10′	4′ x 8′
Single Swing	60	6′	10′	4′ x 8′
Swing in Pairs	80	10′	10′	8′ x 8′

CLASS C OPENINGS. These occur in corridor and room partitions. Doors are required on 1 side of the wall only. Exposed area of any individual wired glass light must not exceed 1296 square inches and not over 4′-6″ in width or height. Transoms permitted with maximum height of 2′-0″ over *Kalamein* doors having pressed steel frames only.

Automatic closing devices are optional. Either fire door or builder's hardware. Tinclad doors are 2-ply.

Type of Door	Maximum Opening Metal Clad, Tin Clad, Corrugated			Max. Opening Kalamein
	Area in sq. ft.	*Width*	*Height*	
Single Slide	80	10′	10′	4′ x 8′
Single Swing	60	10′	6′	4′ x 8′
Swing in Pairs	80	10′	10′	8′ x 8′

CLASS D AND E OPENINGS. These occur in exterior walls which have severe or moderate fire exposure on outside of the building. Doors are required on 1 side only. These openings are usually equipped with normally closed swing doors. No glass permitted in D openings. In E openings wired glass must not exceed 720 square inches per light, with a maximum dimension of 4′-6″. No transoms permitted in D or E.

Automatic closing devices are optional. Either fire door or builder's hardware. Tinclad doors are 2-ply.

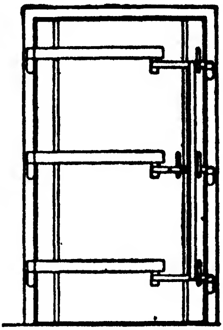
Type of Door	Maximum Opening Metal Clad, Tin Clad, Corrugated			Max. Opening Kalamein
	Area in sq. ft.	*Width*	*Height*	
Single Swing	40	4′	10′	4′ x 8′
Swing in Pairs	60	6′	10′	6′ x 8′

HOW TO SELECT FIRE DOORS

DEFINITION OF FIRE DOOR. **A fire door is a door of limited size, constructed and intended for proper installation in a suitable wall so as to resist the passage of heat, flame and smoke for not less than a specified length of time. (The term "fire door" is sometimes loosely used by the trade to refer to a door in a fire wall or class A opening.)**

DESIGN PROCEDURE. Since the local inspector is given considerable latitude, the architect will find it to his advantage to consult an expert during planning and specifying. The Company representative can be of great service in such a capacity since he will, without obligation, give the architect freely of advice based on an intimate knowledge of local Underwriters' interpretations as well as a familiarity with costs and manufacture. Selection will depend on the desired appearance, amount of protection required, and the plan will dictate whether a single swing door, a pair of swinging doors, or a sliding door is to be used.

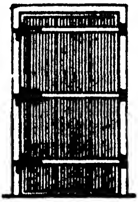
METAL CLAD DOORS. **The 24 gage galvanized steel covering of the metal clad door is considerably more durable than the 30 gage terne-plate applied to tin clad. Therefore, the door is not as liable to damage by careless truckdrivers and workmen. The galvanized steel sheets are *preformed* to precisely fit the wood core. The entire design and construction were developed with the idea that increased Underwriters and New York City code requirements necessitated a stronger fireproof door construction than that offered by the conventional tin clad door. The appearance is very much improved since continuous flush sheets are used to eliminate the horiontal seams.** Metal Clad doors receive finish painting readily. In many localities 1 metal clad door can replace the use of 2 doors of other types where 1 is normally required on each side of an opening in a fire wall. Metal Clad fire doors can also be furnished in seamless flush design when specified.



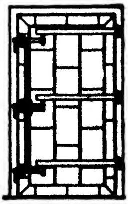
METAL CLAD

TIN CLAD DOORS. **These are made of 20-pound fire door standard terne-plate, equal to 30 gage. Terneplate consists of steel sheets coated with an alloy of lead and tin called "terne mixture." Joints are laid with ½" seams and nailed under seams.**

CORRUGATED DOORS. **These are made of 2 layers of not less than 24-gage galvanized steel with 1/16" asbestos insulation between layers. The layer on the exposed side is laid with corrugations vertical and on the unexposed side horizontal.**



CORRUGATED

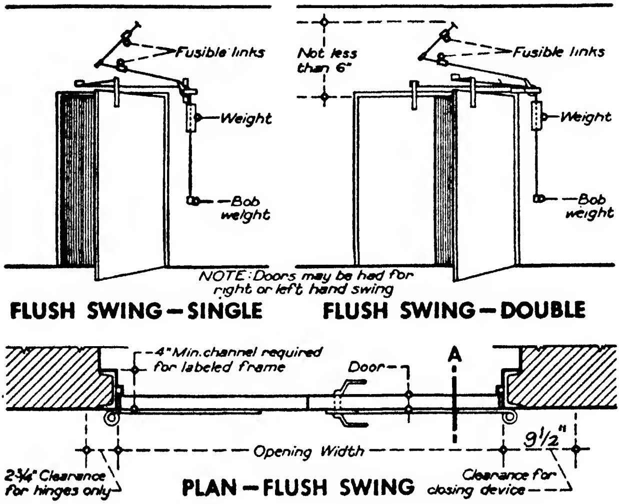


TIN CLAD

KALAMEIN DOORS. *Kalamein* doors are made of 24-gage galvanized sheets or sheet copper over wood cores with hollow metal moldings. Doors are primed to receive paint finish at the job.

THICKNESSES. **Three-ply *Metal Clad* and *Tin Clad* doors are 2 7/16" thick. Two-ply *Metal Clad* and *Tin Clad* are 1¾" thick. *Corrugated Iron* doors are 2½" thick over door panel angles. *Kalamein* doors are not less than 1¾" thick with 5/16" thick panels.**

FLUSH SWING
AUTOMATIC CLOSING

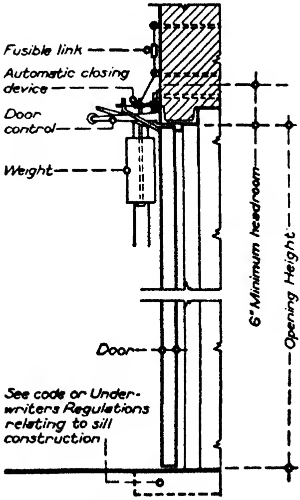


PLAN—FLUSH SWING

USES. The installation shown would normally be employed where a neat appearing door and frame is required. The channel iron frame which is used offers protection to the jamb. The flush swing installation is suitable for class A or lower openings, utilizing a properly labeled Metal Clad, Tin Clad or Corrugated Iron door. Class A openings require doors on both sides of the wall.

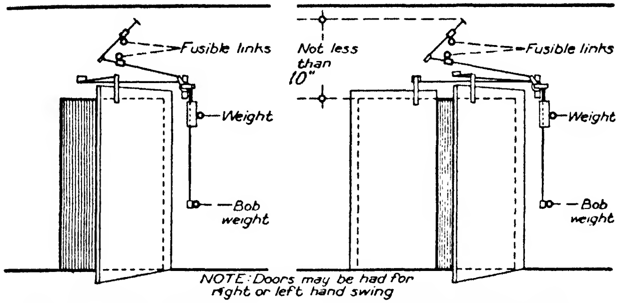
FLUSH SWING OPERATION. A cable or chain is so arranged over pulleys that the melting of a fusible link drops the weight and closes the door. The weight should be enclosed in suitable boxing for the entire length of its travel. One link occurs near the head where flames coming thru the opening can release it and the other link is near the ceiling where heat would be the greatest.

Automatic swinging doors in pairs are so arranged that the standing door must close before the active door.

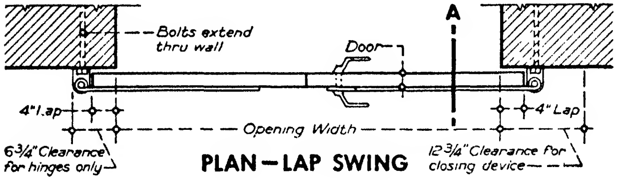


SECTION A

LAP SWING AUTOMATIC CLOSING



LAP SWING—SINGLE **LAP SWING—DOUBLE**

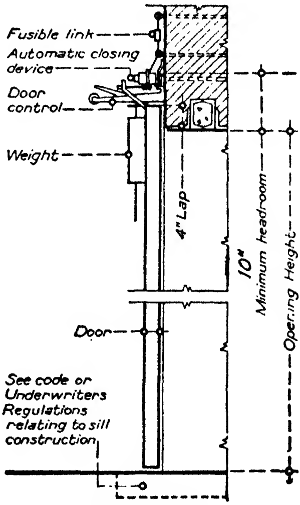


PLAN—LAP SWING

USES. The lap swing installation is suitable for Class A or lower class openings, utilizing a Metal Clad, Tin Clad or Corrugated Iron door properly labeled. Class A openings require doors on both sides of the wall.

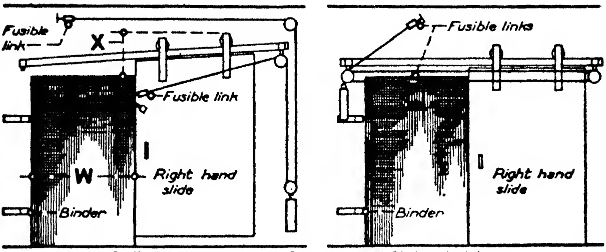
LAP SWING OPERATION. A cable or chain is so arranged over pulleys that the melting of a fusible link drops the weight and closes the door. The weight should be enclosed in suitable boxing for the entire length of its travel. One link occurs near the head where flames coming thru the opening can release it and the other link is near the ceiling where heat would be the greatest.

Automatic swinging doors in pairs are so arranged that the standing door must close before the active door.



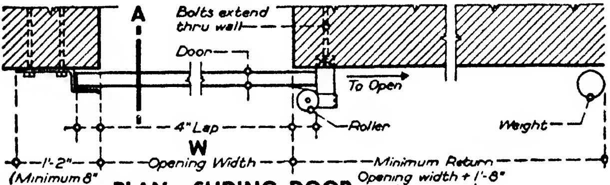
SECTION A

SLIDING DOORS
AUTOMATIC CLOSING



NOTE: Doors may be had for right or left hand slides

INCLINED TRACK **LEVEL TRACK**



PLAN — SLIDING DOOR

USES. The installation shown would be employed for class A or lower class openings, utilizing a Metal-Clad, Tin-Clad or Corrugated Iron door bearing a suitable label. Class A openings require doors on both sides of the wall.

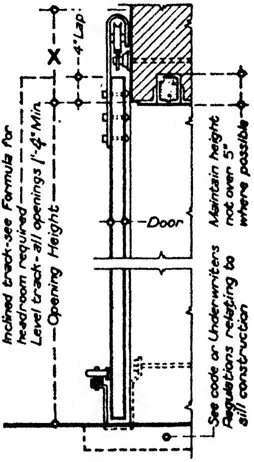
INCLINED TRACK. The mechanism for sliding doors generally consists of a counter balance weight so that the door will remain stationary in any position of its travel. The melting of a fusible link disengages the weight and the door rolls shut by gravity.

LEVEL TRACK. The weight is arranged to pull the door shut after the fusible link has been released. The weight used to close the door should be enclosed in a suitable boxing (not shown) for its entire travel.

HEADROOM X. The space in inches required for the inclined track with 4" lap may be found from the following formula in which W is the width in *feet:*

$$1\tfrac{1}{2}\ W' + 14\tfrac{1}{4}'' = X''$$

Any increase in lintel over 5" requires a corresponding increase in lap and headroom.



SECTION A

MAXIMUM SIZES AND GLASS AREAS FOR KALAMEIN DOORS

PANELED KALAMEIN DOORS

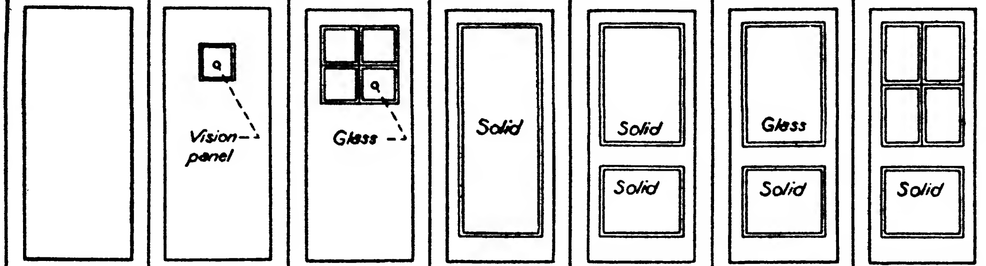
Class	Maximum Glass	Maximum Opening	
		Single	*Pairs*
B	100 sq. in. per opening. 12″ max. dim.	All	7′-0″ x 7′-6″
C	1296 sq. in. per light	3′-6″*	7′-0″ x 7′-6″
D	No glass permitted	x	7′-0″ x 7′-6″
E	720 sq. in. per light. 4′-6″ high max.	7′-6″*	6′-0″ x 7′-6″

* 3′-10″ max. width permitted for doors with two or more panels.

FLUSH KALAMEIN DOOR

Class	Maximum Glass	Maximum Opening with Builders Hardware		Maximum Opening with Firedoor Hardware	
		Single	*Pairs*	*Single*	*Pairs*
B	100 sq. in. per opening. 10″ max. dim.	All	All	All	All
C	100 sq. in. per opening. 10″ max. dim.	4′-0″	8′-0″	4′-0″	8′-0″
D	No glass permitted	x	x	x	x
E	100 sq. in. per opening. 10″ max. dim.	8′-0″	8′-0″	10′-0″	10′-0″

KALAMEIN DOORS FOR B, C, D & E OPENINGS

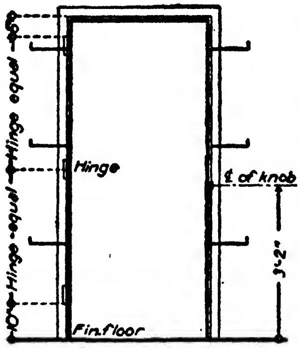


Class of Opening	FLUSH	FLUSH	FLUSH	1-PANEL	2-PANEL	2-PANEL	2-PANEL
B	Yes	Yes	—	Yes	Yes	—	—
C	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D	Yes	—	—	Yes	Yes	—	—
E	Yes	Yes	Yes	Yes	Yes	Yes	Yes

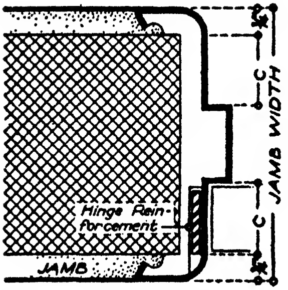
Max. area Flush Doors 26 sq.ft., others 32 sq.ft.

Kalamein was first applied to iron, coated with an anti-corrosive alloy of lead, tin, antimony and nickel. Now, any kind of iron put onto wood to effect fireproofing, is taken as kalamein. *Kalamein Doors* are made of 24-gage galvanized sheets over wood cores with hollow metal moldings. Doors are primed to receive paint finish at the job.

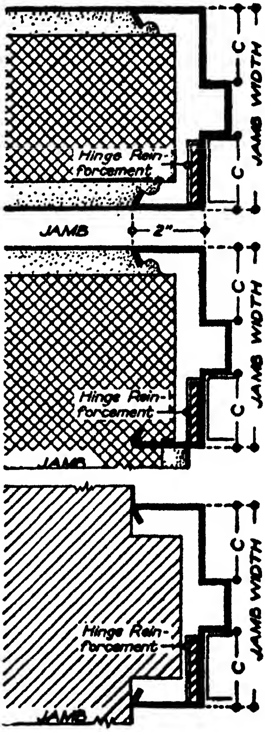
STEEL FRAMES
B, C, D, E & F OPENINGS



ELEVATION OF FRAME



C = DOOR THICKNESS + 3/16"



NOTE 4" Jamb Width Minimum For Label

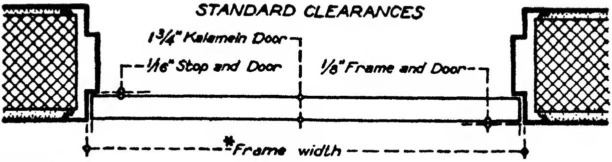
MOST FREQUENTLY USED SIZES		
JAMB WIDTH	4½" 5¾" 8½"	
FRAME SIZES		
	Width	Height
SINGLE DOOR	2-8 3-0	6-8 7-0
PAIR OF DOORS	5-4 6-0	6-8 7-0

Steel frames may bear the label of the Underwriters' Laboratories when necessary for insurance requirements. They are suitable for use in class B openings or those with lesser requirements.

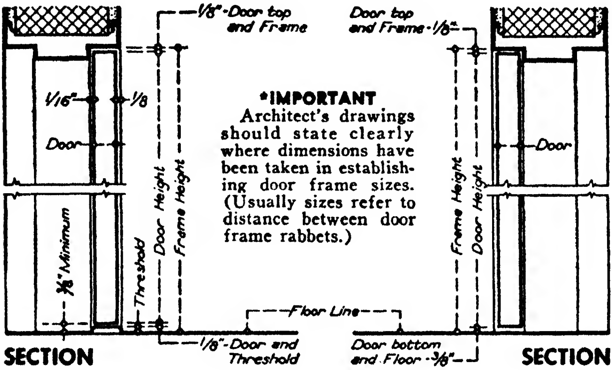
Frames are made of 16-gage cold rolled steel with all angles, moldings, returns and the miters neatly welded and ground smooth.

Unit-Steel Frames are made to any finished wall dimension and for any size of opening, the usual sizes being shown in the table.

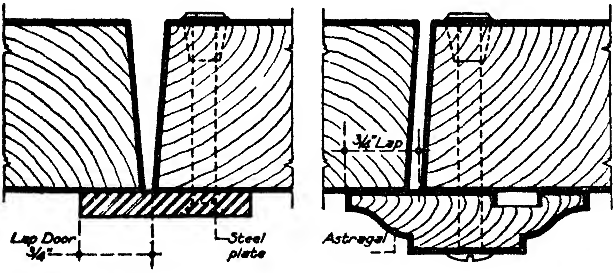
STANDARD CLEARANCES FOR KALAMEIN DOORS



PLAN



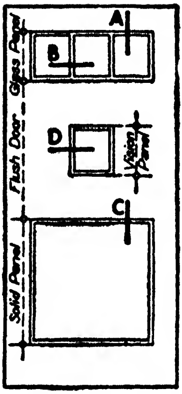
SECTION SECTION



SCALE HALF SIZE "V" BEVEL REGULAR BEVEL
REQUIRED ON LABELED DOORS

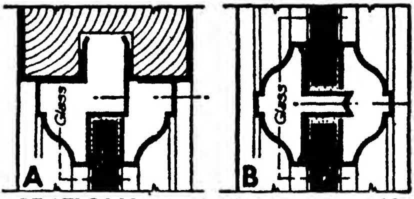
The standard clearances shown above have been adopted by most door and frame manufacturers for wood, kalamein and steel units. It is of utmost importance that exact clearances be maintained for kalamein and steel materials. The preferable procedure is to specify kalamein doors and unit steel frames to be furnished by one manufacturer.

LABELED KALAMEIN DOOR DETAILS

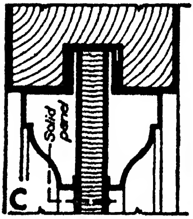


At the discretion of the designer a *Kalamein* fire door may represent many desired combination of flush areas, solid panels, glazed panels, or vision panels. Sections A and B are not used for labeled flush doors.

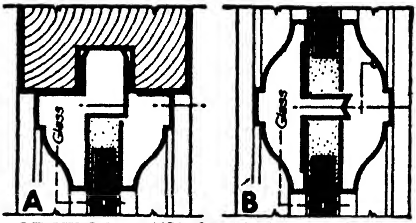
Typical molding sections are presented below for labeled construction. Other moldings with the same coverage may be obtained on special order.



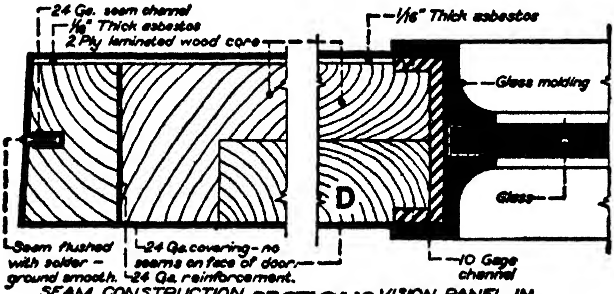
SECTIONS HOLLOW METAL MOLDINGS USED FOR GLASS UNDER 300 Sq. In. IN AREA



HOLLOW METAL MOLDINGS FOR SOLID PANEL

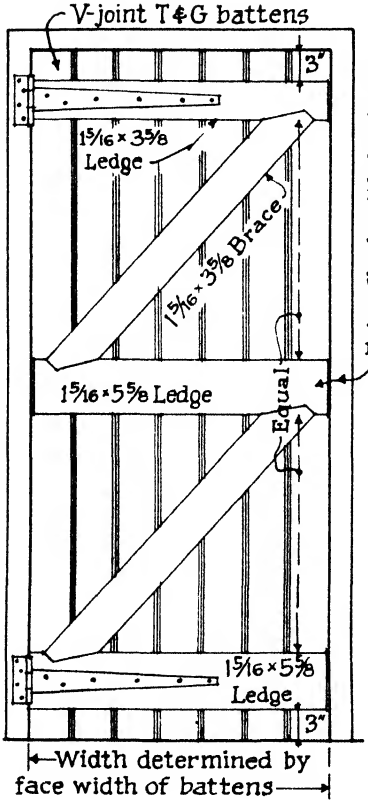


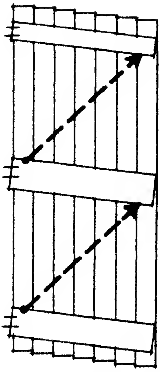
SECTIONS HOLLOW METAL MOLDINGS USED FOR GLASS OVER 300 Sq. In. IN AREA

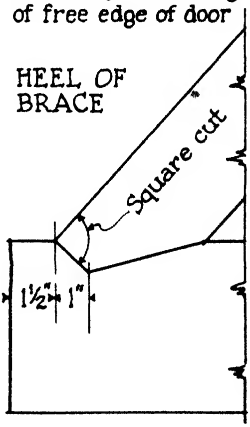


SEAM CONSTRUCTION FLUSH DOOR SECTIONS VISION PANEL IN FLUSH DOOR

BATTEN DOOR CONSTRUCTION



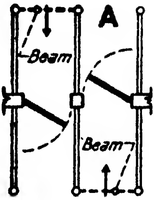




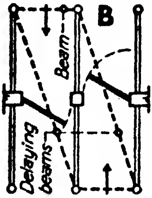
Ledged and battened doors will sag out of square unless braced with braces slanting upwards from the hinged edge. For best appearance, the slope of the braces should be the same, requiring the center ledge to be midway between the top and bottom ledges. Properly constructed, these doors may be used for openings of almost any width, so long as the height is slightly greater than twice the width. Strap hinges are generally used with doors of this type.

ELECTRIC DOOR CONTROL AND APPROACHES

GENERAL CONSIDERATIONS. On this page are shown typical approach arrangements likely to be encountered in practice. The light beam should be approximately 3'-6" from the door if opposite the hinged side; approximately 3'-0" from the edge of the door in the 90° open position if on the hinged side. This is to allow enuf time after the light beam is broken so that the doors will be fully open when the individual reaches them. There are 3 distinct types of photo-electric controls:

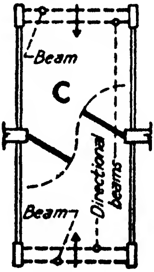


1. ADJUSTABLE TIME DELAY. The breaking of a single light beam actuates the door opening mechanism and allows an *adjustable period* of 2 to 11 seconds for the individual to pass thru. The *adjustable time delay* is generally used on service doors where the users are familiar with electric operation. This type of control is adaptable to any door arrangement. See *Fig. A.*

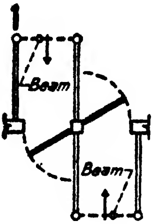


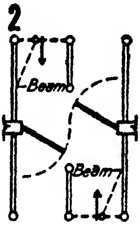
2. DELAYING BEAM. The breaking of a light beam actuates the operating mechanism. The door or doors will remain open as long as the *delaying beam* is obstructed by an individual passing thru. The *delaying beam* is suitable for the control of doors used by the general public. See *Fig. B.*

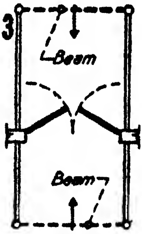
3. DIRECTIONAL BEAM AND TIME DELAY. This is *only used* for 2-way traffic thru a *single doorway.* When the first 2 beams are broken in approaching the door, the door opens and closes after the time delay; but the breaking of the second pair of beams does not re-open the door. The directional beam is desirable as an aid to air conditioning and is used where the users are familiar with the door operation. See *Fig. C.*

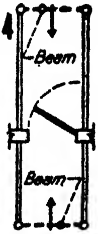


TRAFFIC ARRANGEMENTS. For simplicity, the Figures below are indicated with single beam control. In the ideal arrangement of circulation, the *in* and *out* traffic is separated, *Figures 1* and *2* being typical. *In* and *out* traffic separation is particularly recommended for all doors automatically operated. However, where it is not possible to separate the *in* and *out* traffic, single doorways for 2-way traffic are sometimes used, as shown in *Figures 3* and *4.*

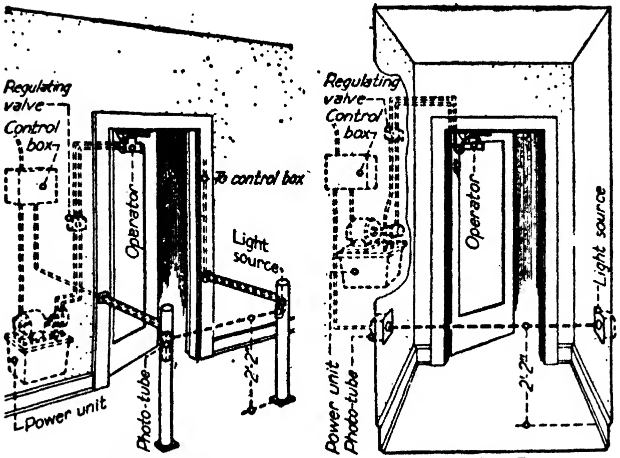








GENERAL INFORMATION
ELECTRIC DOOR OPERATION



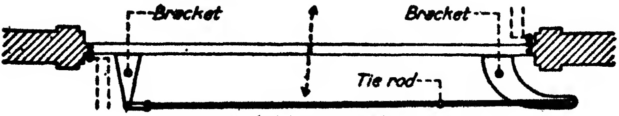
POST TYPE WALL TYPE

PURPOSE. Electric operation is a simple, safe and reliable means of opening and closing doors automatically in restaurants, hotels, shops, hospitals, factories, office buildings, shipping rooms, and in many other places, for a moderate first cost and a power consumption of approximately 1 kilowatt per day per door. Automatic door operation increases efficiency, promotes good will with the public and employees. Air conditioning and humidity control are made more efficient and economical when doors are automatically controlled.

OPERATION. The opening and closing of a door or a pair of doors may be controlled by a light beam, a push button, a floor treadle, a pull switch or a combination of these. The light beam is usually 26" above the floor so that dogs or cats will not break the beam.

The control device actuates the *Power Unit* which supplies hydraulic pressure directly to the piston of the *Operator*. The door is opened by this pressure and remains open for a predetermined (and adjustable) time interval. The pressure is then relieved and the door closer closes the door in the regular manner. Should the electric power fail, the door is not blocked—it will operate manually. Should the door touch an individual passing thru, a slight manual pressure will open the door without danger of personal injury or injury to the apparatus.

BALANCED DRAFT OPERATION. Below is shown a tie rod, linking a pair of doors to open simultaneously in opposite directions, either or both having an *Operator*. Doors difficult to control because of strong air currents, can be operated easily by balancing the pressure in this manner.



BALANCED DRAFT OPERATION

SUITABILITY OF WOODS FOR FRAMING, BOARDING

FRAMING (HOUSE)

Usual Requirements: High stiffness, good bending strength, good nail-holding power, hardness, freedom from pronounced warp. For this use dryness and size are more important factors than inherent properties of the different woods.

Highly Suitable: Extensively used—Douglas fir, western larch, southern yellow pine. Sometimes used, but more difficult to obtain in straight pieces and harder to nail and saw—ash, beech, birch, maple, oak. Seldom used—cypress, redwood.

Good Suitability: Extensively used—eastern hemlock, western hemlock, eastern spruce, Sitka spruce, white fir. Seldom used because of adaptability to more exacting uses—northern white pine, ponderosa pine, sugar pine, western white pine. (Low strength may be compensated for by the use of larger members.) Seldom used—chestnut, yellow poplar.

Grades Used: No. 1 Dimension is the usual softwood grade for all framing items in both high and medium-class construction. No. 2 Dimension renders satisfactory service once it is in place, but is not so straight or easily fabricated as No. 1. No. 3 Dimension is serviceable for studs and joists in the more economical and low-cost homes, especially when warped pieces and short lengths resulting from cutting out defects can be used to advantage. When hardwoods are used for framing, sound square edge is used in the better types of construction and for such items as joists, rafters, and sills. Hardwood Common Dimension is used in the more economical type of buildings and for studding in all types.

ROOF BOARDS (HOUSE)

Usual Requirements: High stiffness, good nail holding, small tendency to warp, ease of working.

Highly Suitable: Commonly used—Douglas fir, western larch, southern yellow pine. Not commonly used because of adaptability to more exacting uses—cypress. Seldom used because not readily available and hard to work—ash, beech, birch, chestnut, elm, hackberry, maple, oak, tupelo.

Good Suitability: Commonly used—hemlocks, ponderosa pine, spruces, white fir. Seldom used because of adaptability to more exacting uses—northern white pine, sugar pine, western white pine, redwood, yellow poplar.

Grades Used: No. 2 boards are used extensively in higher type homes. In more economical construction both No. 2 and No. 3 are used. No. 3 is serviceable but no so tight as No. 2. No. 4 and No. 5 are available in some species but entail waste in cutting. When hardwoods are used, No. 2 Common is adapted to the better class houses and No. 3 Common to the more economical.

WALL SHEATHING (HOUSE)

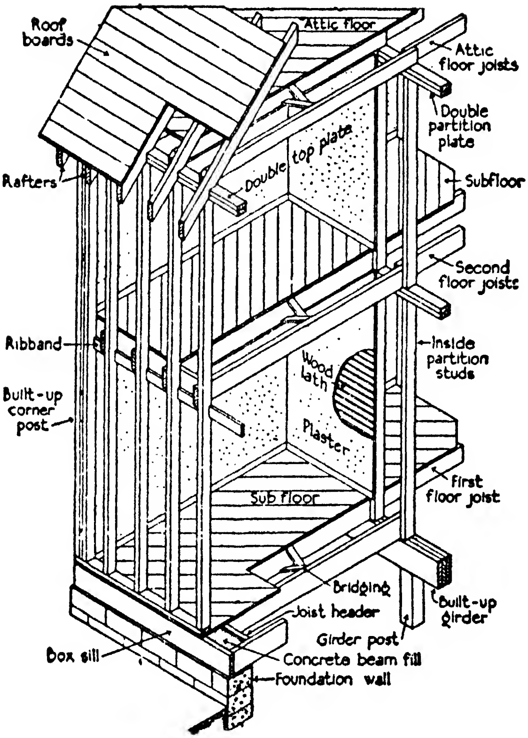
Usual Requirements: Easy working, easy nailing, moderate shrinkage. All woods can be used for sheathing with satisfactory results altho some woods are less time-consuming to work than are others.

Highly Suitable: Cedar, cypress, hemlocks, northern white pine, ponderosa pine, sugar pine, western white pine, redwood, spruce, white fir, basswood, chestnut, yellow poplar.

Good Suitability: Douglas fir, western larch, southern yellow pine, cottonwood.

Grades Used: No. 3 grade of softwoods makes a serviceable sheathing when covered with good building paper. No. 1 and No. 2 make a tighter coverage but do not warrant omitting use of building paper. No. 4 and No. 5 are used in low-cost homes but are not generally available. They both entail some waste in cutting. When a hardwood is used for sheathing, No. 2 Common is adapted to the better type homes, and No. 3 Common to the more economical.

BALLOON FRAMING

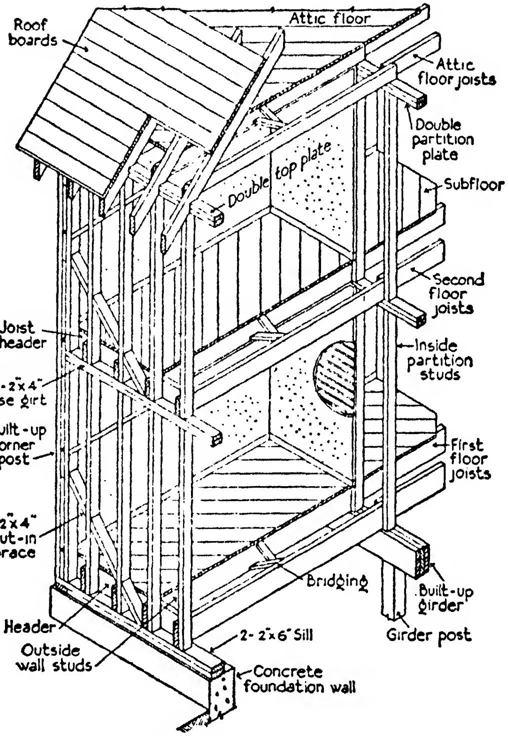


This type of frame has many things to recommend it. The one-piece studs, extending the full height of the wall and tied together by the ribband at the second floor line, reduce to a minimum the shrinkage factor. It is strong and rigid. For this reason it is particularly to be preferred for stucco construction, altho the same advantages are important to any type of wall covering.

This frame requires careful fire-stopping. It is more efficient when the interior studding is set directly on top of girders or bearing partitions.

Studs, joists, and rafters are spaced 16″ on centers for proper nailing. If the stud spacing is changed, for example to 12″ o.c. as required for back-plastered stucco, then the joists and rafters must correspond. Rough floors laid diagonally give added strength, but where laid at right angles economy of materials is obtained. Diagonal sheathing aids in tying the superstructure to the sill.

BRACED FRAME

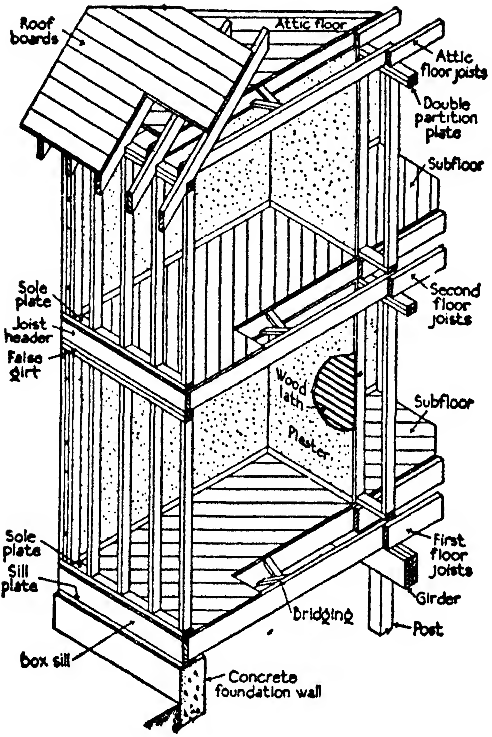


The Braced Frame is an outgrowth of the Elizabethan half-timber construction. The original type used heavy posts at the corners with intermediate posts between, heavy sill and plate, and a mortised and tenoned girt at the 2nd floor.

This old method of framing has been gradually modified and is still undergoing change. Built-up members are now used making it lighter than formerly, but it remains the heaviest of all framing methods. The present girts are too light to act as beams. The studs have become an integral part of the structure instead of merely forming a curtain wall as formerly. The studs support the floors and roof about as they do in other types.

The Braced Frame makes use of short length studs, and has good provision for fire-stopping both at the sill and 2nd floor line. However it is wasteful of both labor and materials. It presents a line of shrinkage at the 2nd floor girt which is a bad fault when stucco or brick veneer are to be used. This method has been generally discarded except in New England where it still persists.

PLATFORM FRAMING

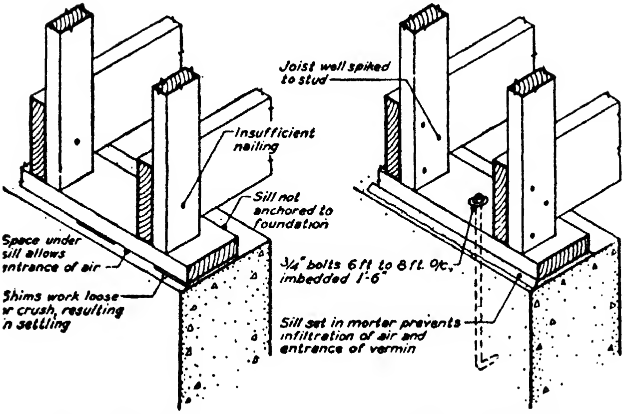


The Platform Frame is also known as Western Frame. This type is distinguished by floor platforms independently framed. The 2nd and 3rd floors are supported by studs which are one story in height. In this type the studs and floor joists need not be spaced the same distance apart. Any spacing other than 16" o/c may be furred with wood strips properly spaced to take standard lath.

The chief merit of this type is that shrinkage is fairly equal, altho it is greater than with other types because of the boxed sill construction at each floor line.

The Platform Frame should be used only with all-wood construction. It should be avoided with masonry veneer or stucco. The firestopping is well taken care of without any further precautions by this type of frame. However, the frame is relatively weak, and the disadvantages outweigh the virtues. Diagonal sheathing should always be used with this type, as it furnishes almost the only tie from one story to another.

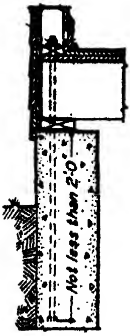
SILLS IN FRAME CONSTRUCTION



POOR PRACTICE *GOOD PRACTICE*

SIZE OF SILL. For small buildings of light frame construction, a 2"x6" sill is large enuf under most conditions. For 2-story structures, and in localities subject to earthquakes or high winds, a sill 4" in (nominal) thickness is desirable. It affords more nailing surface for the diagonal sheathing. A 4" sill permits a much more satisfactory lap splice.

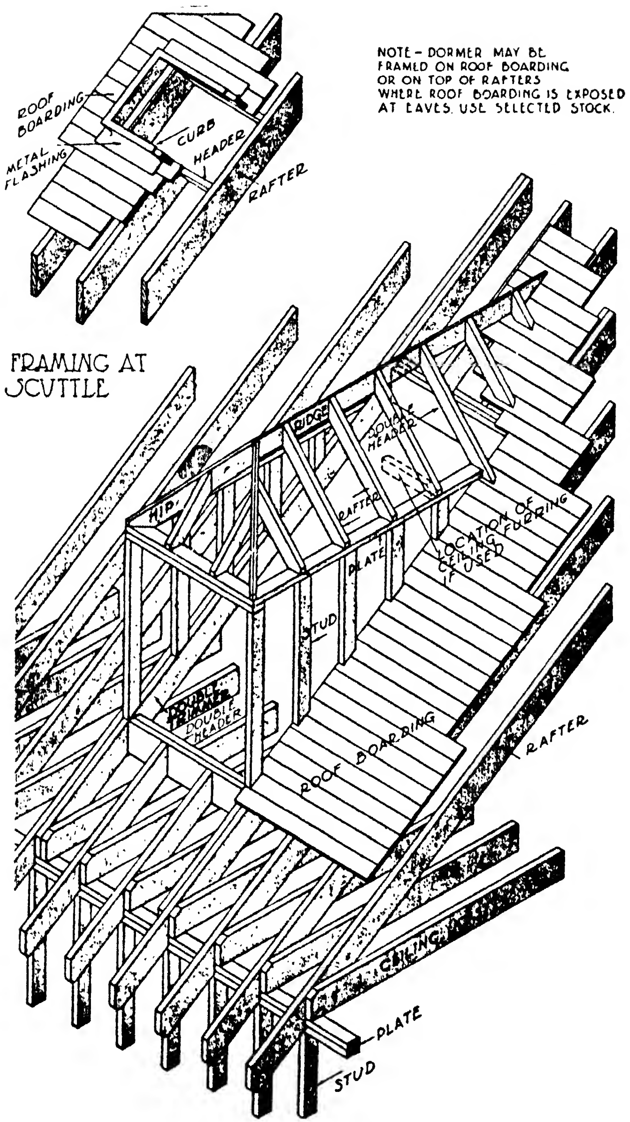
ANCHORING. Where high winds are at all probable, it is important that the building be thoroly anchored to the foundation. In fact, anchoring is desirable and good practice in all localities. It is best accomplished by imbedding ¾" bolts, 6 to 8 ft. o/c, to a depth of 1'-6". They should project sufficiently thru the sill to receive a good sized washer and nut. Severe wind conditions may require anchoring as shown at the left.



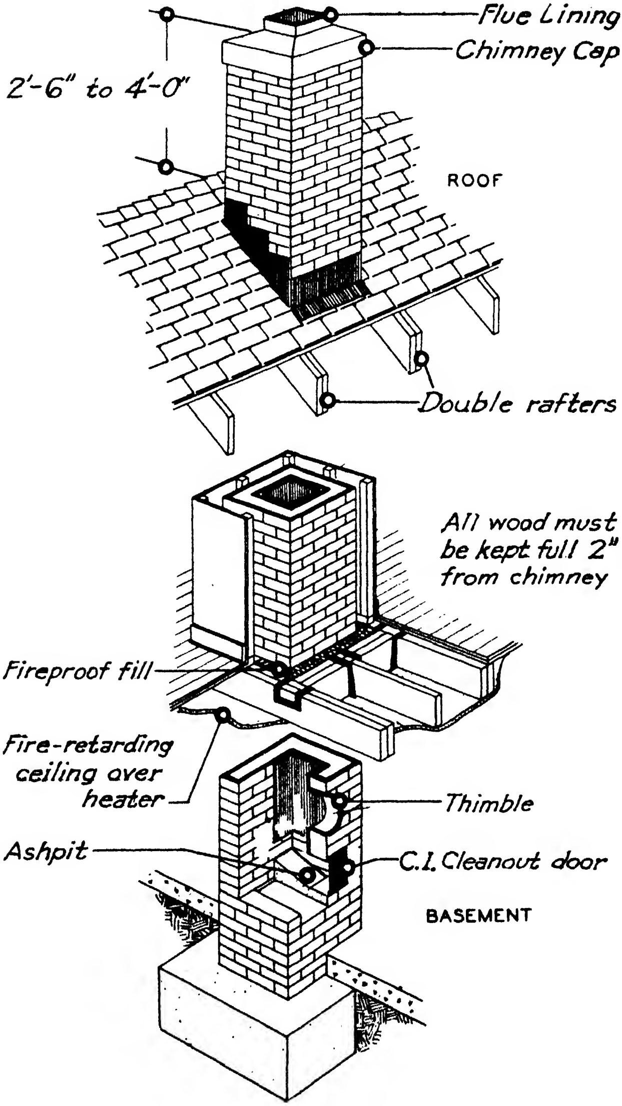
SHEATHING. That the full advantages of anchoring may be obtained, especially where wind storms occur, it is essential to put sheathing on diagonally and to nail it securely to the sill and wall plates. This provides a tie between the sill and the structure above.

SPLICING THE SILL. Where a 2"x6" is used as a sill, it is entirely satisfactory to butt the ends if it is properly anchored. Where the sill is built of two 2"x6" pieces, the joints in the 2 courses should be broken. A solid sill 4" thick may be halved, or butted where properly anchored.

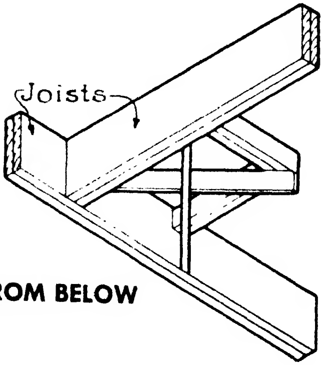
DORMERS IN WOOD FRAMING



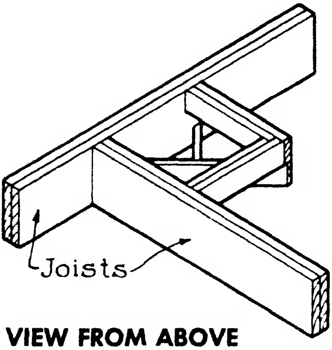
FRAMING AROUND CHIMNEYS



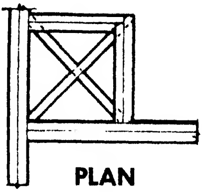
FRAMING FOR CANTILEVER PLATFORMS



VIEW FROM BELOW



VIEW FROM ABOVE



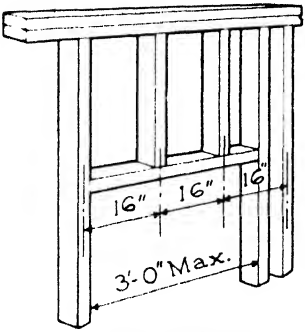
PLAN

There are many locations in framing where a cantilever platform is required. These places occur in fireplace hearths, at turning of stairways, particularly. The same principle of support may also be applied to shelves which must support relatively heavy weights, occuring in inside corners.

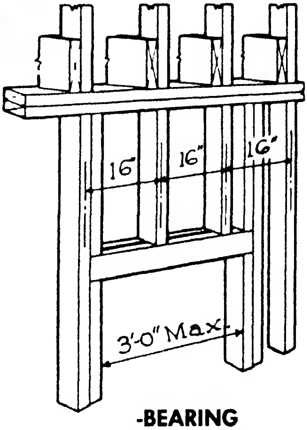
The trimmers which form the nailing for the sub-flooring are doubled, as shown in the drawing, but they do not need to be as deep as the two supporting members beneath since they do not actually carry the load themselves. The lower diagonal member must be a sound piece of wood since it carries a concentrated load at its middle.

Resting on the lowest member we have the cantilever piece which carries the corner of the platform. The end of this piece should be nailed in the corner with nails sloping upward since this end will tend to move up. The size of all the members will depend upon the depth of joists and the size of the platform which must be supported.

FRAMING OVER 3 FT. MAX. OPENINGS



NON-BEARING PARTITION



-BEARING PARTITION

a

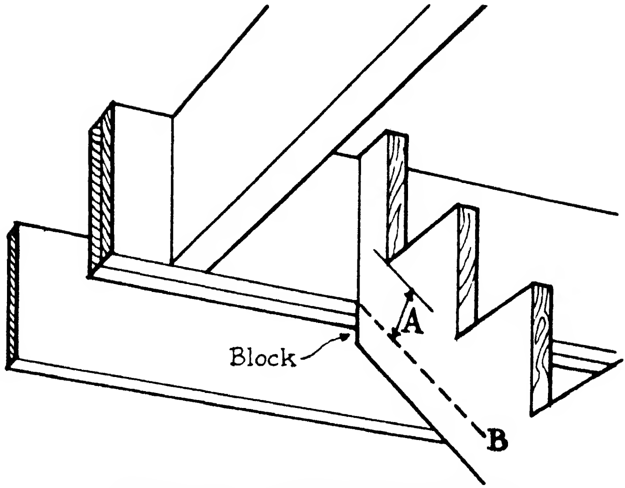
b

The framing of an opening depends on two things: the width oı the opening, and whether the partition in which it occurs is bearing or non-bearing. The illustrations show the proper method of framing openings 3′x0″ or less in width.

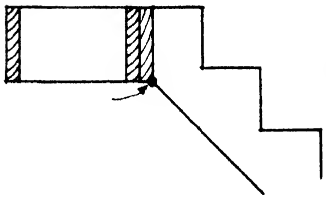
In a non-bearing partition a single 2x4 is satisfactory as a header. It is sufficiently strong and lessens the likelihood of plaster cracks due to movement of a double member. However, it often happens that the use of wide trim requires doubled 2x4s to provide nailing.

In load-bearing partitions or walls the header should be doubled and should rest on doubled studs, as shown. 2x4s placed horizontally, as at *a,* do not provide the strength of studs laid vertically as at *b.* The strength of double horizontal studs depends upon very secure nailing together. Vertical studs require lath spacers to bring their thickness to 3⅝″.

STAIR CARRIAGE FRAMING



PERSPECTIVE TO SHOW WEAK FRAMING



SECTION TO SHOW CORRECT FRAMING

The weakness lies in the small effective depth marked *A* on the drawing together with the low resistance of wood to splitting along the dotted line *B*. This error could be corrected in some measure by nailing a substantial block under the double joists at the heel of the stringer so that the vertical face of the stringer would have bearing.

The only correct way to frame the stairs, however, is shown in the small section. The double joists should be placed far enough from the face of the top riser so that the line of the underside of the stringer intersects the lowest corner of the double joists.

FIBER-REINFORCED PAPER OVER SHEATHING

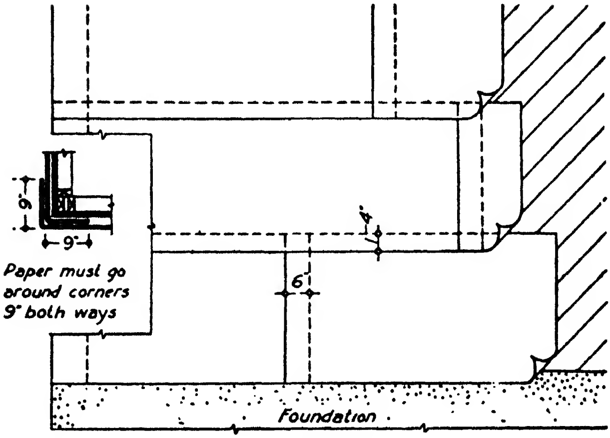


Figure-1 Scale-1/4"=1'-0"

OVER SHEATHING. Air infiltration must be controlled in any structure to prevent expensive losses thru the outer walls. Moisture cannot penetrate the double layer of special quality asphalt in fiber-reinforced paper. The exclusion of moisture and air cannot be realized if the paper tears in application or disintegrates after the building is completed. This extra-strength paper affords the architect a product which fulfills the purposes for which building paper is used.

The paper should be applied loosely, shingle-fashion, using large-head galvanized nails with laps of at least 4" and end laps of at least 6". Since the corners of a building offer the easiest point of attack for air and moisture infiltration, it is important that the paper be turned around the corner for a distance of 9" from both directions, as shown in the drawing.

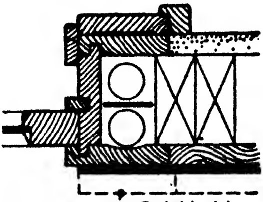


Figure-2

FLASHING OF FRAMES. When the frames for openings are in place at the time the paper is applied, it should be carried over to the frame as shown in *Figure 2*—creating an effective "wind break."

When the window frames are set after the application of the paper, a strip of sufficient width should be tacked around the frame, as shown in *Figures 3*, to cover the joint between the frame and the wall construction.

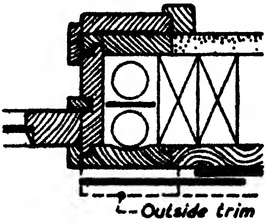
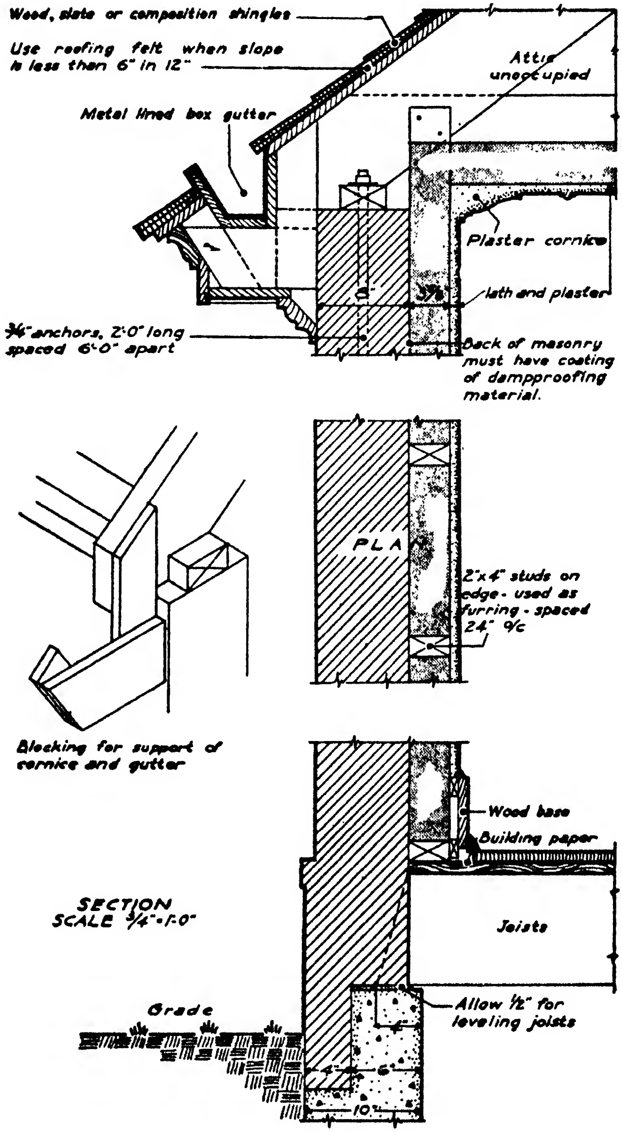


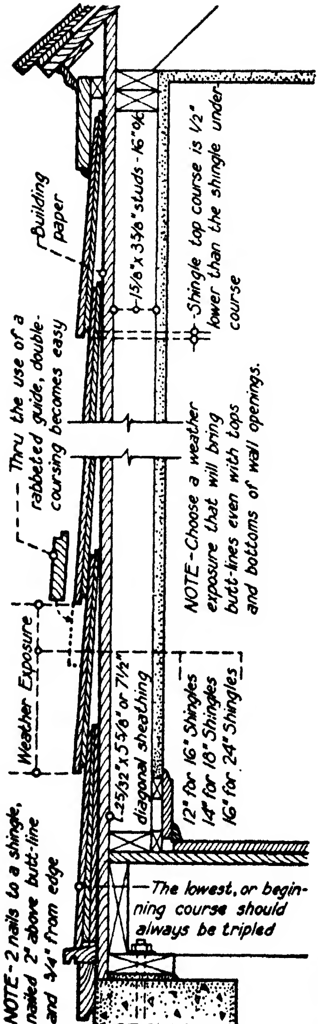
Figure-3

Scale-1 1/2"=1'-0"

MASONRY WALL CONSTRUCTION



WOOD SHINGLE SIDEWALLS



SECTION
SCALE 3/4" = 1'-0"

DOUBLE COURSES. Sidewalls covered with shingles that are given a very wide exposure create a strikingly attractive appearance. It is particularly adaptable to modern interpretation of the Colonial styles as well as lending individuality to the designer's treatment of other architectural periods. The wide exposure requires deep butt shadows to be effective—both being readily obtainable with standard shingles at surprisingly low cost.

APPLICATION. The weather exposure of shingles in single courses should not exceed half the shingle length minus ½". When double coursing is employed with "butt-nailing" much longer exposures become possible, greatly reducing the cost of application. Use 5d small head hot dipped zinc coated nails, 2 nails per shingle, placed near the edges of the shingles and not more than 3" above the butts.

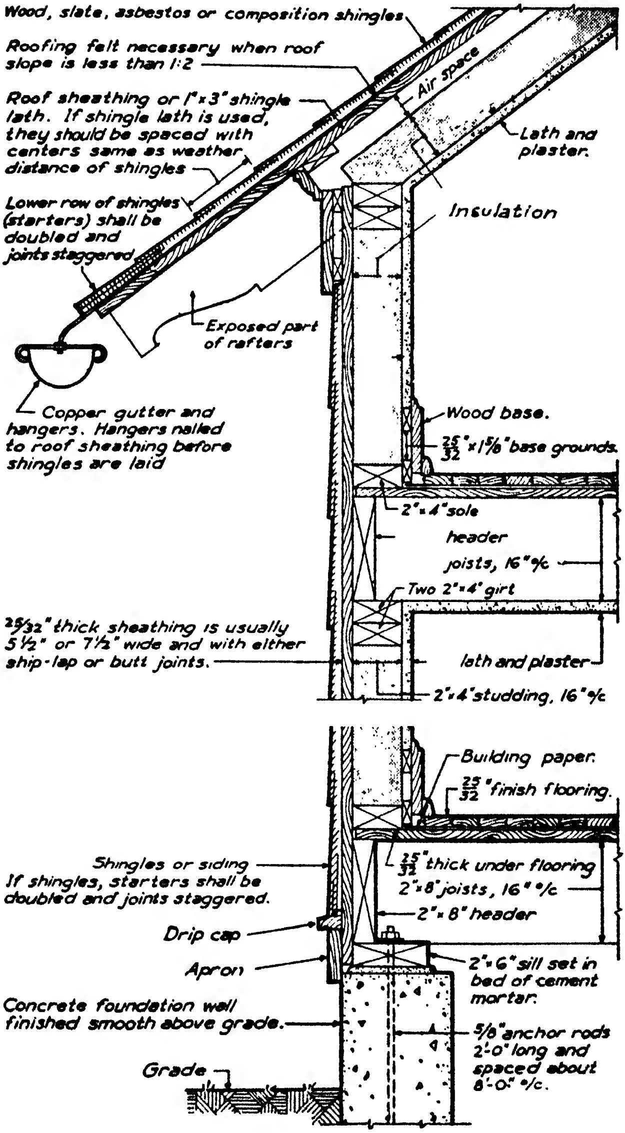
The following table shows the reason why the double coursing is economical due to the greater allowable exposure of the shingles.

Length of Shingles (in inches)	*Exposure of Shingles (in inches)*	
	Single Course	*Double Course**
16"	6" to 7½"	8" to 12"
18"	6" to 8½"	8" to 14"
24"	8" to 11½"	12" to 16"

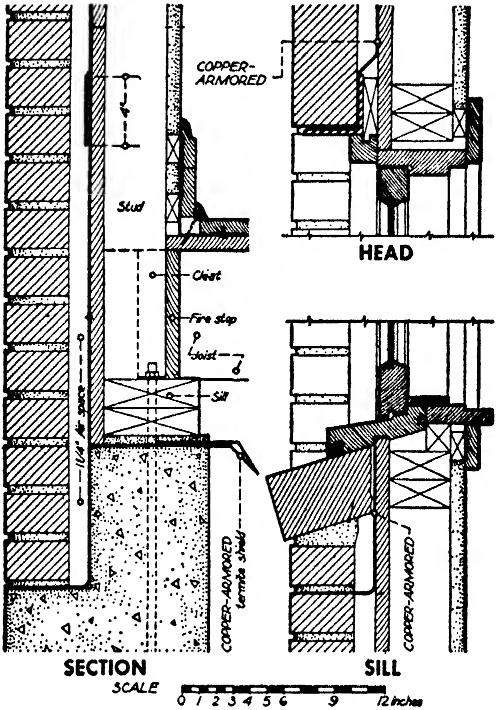
**Assuming exposed course is face or butt-nailed.*

GRADES. The exposed shingles in each course should be Grade 1 which are all clear Edge Grain shingles. The under courses may be Grade 2 or 3. When stained shingles are applied, unstained shingles may be used with entire satisfaction in the concealed courses.

SHINGLE, SIDING, OR CLAPBOARD WALL CONSTRUCTION



FIBER-REINFORCED PAPER IN BRICK VENEER

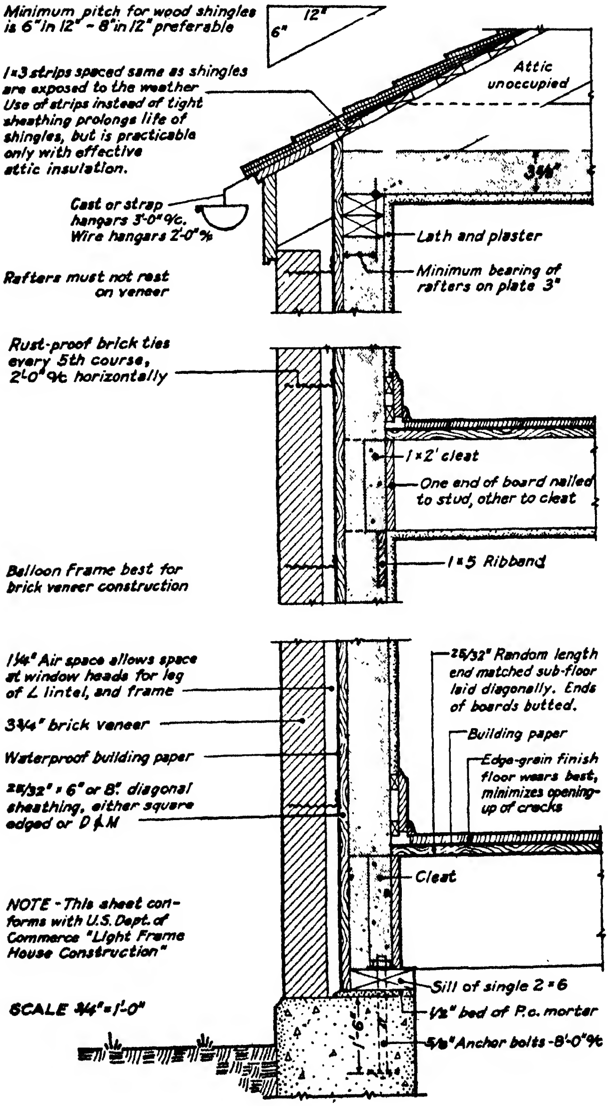


PROTECTING FOUNDATION SILLS. Mortar droppings sometimes fill the dead air space to a height of 15". Moisture is readily conducted from the brick veneer by the mortar. Rotting can take place as a result with serious damage to the sill of the building. A 30" strip of copper-covered fiber-reinforced paper, installed as shown above, all around the building will obviate this hazard. On the corners the laps should be sealed with mastic and nailed 2" o/c with copper roofing nails.

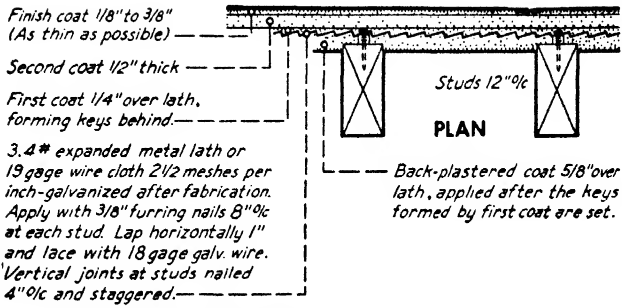
DAMP COURSE OR TERMITE SHIELD. Where foundation sills are 24" or less above outside grade level, a single thickness of copper-covered fiber-reinforced paper should be laid over the top of the foundation to prevent capillary action from conducting moisture to the sill. If termite protection is necessary, the copper is doubled over part way and turned down at a 45° angle, as shown above.

WINDOW FLASHING. The entrance of water, moisture, and air infiltration around the perifery of a window and at the sill can cause rotting and warping of the frame, which can be obviated by the use of copper-covered fiber-reinforced paper flashing, as shown in the details above. This flashing is light and flexible, making it easy and economical to install.

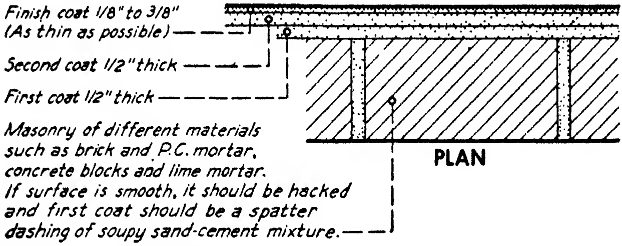
BRICK VENEER CONSTRUCTION



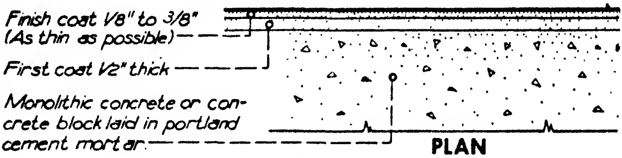
CORRECT STUCCO CONSTRUCTION



BACK-PLASTERED CONSTRUCTION



OVER HETEROGENEOUS MASONRY



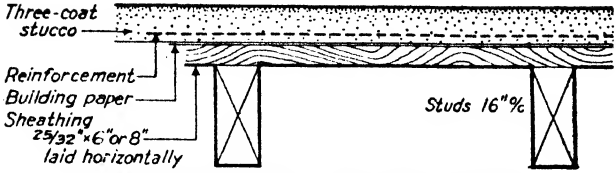
Three coat work should always be used except on masonry walls of homogeneous materials, which present a true, even, clean, sound surface, where the second or leveling coat may be omitted.

Where the wall surface is too smooth to provide proper bond it should be hacked and dashed with a coat of soupy sand-cement mixture.

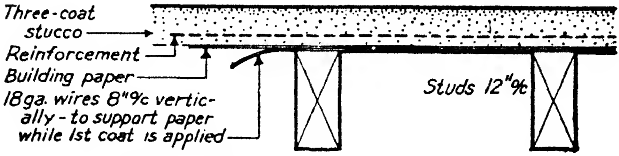
Due to its rough texture and the similarity of its composition to that of stucco, concrete masonry is well adapted as a stucco base.

OVER HOMOGENEOUS MASONRY

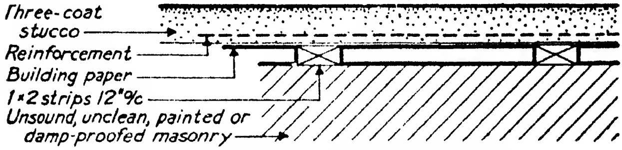
CORRECT STUCCO CONSTRUCTION



SHEATHED FRAME CONSTRUCTION



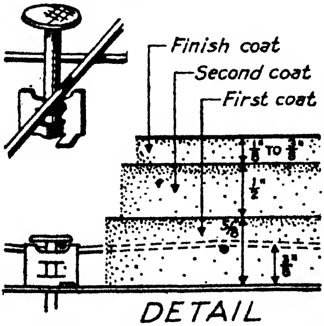
OPEN FRAME CONSTRUCTION



OVER UNSUITABLE OLD MASONRY

FINISH COAT—should be thin as possible consistent with the desired texture effect.

REINFORCEMENT—large open mesh type insures complete imbedment, making stucco a reinforced slab. 1.8 lb. expanded 20 gage sheets with openings from 1"x2" to 1½"x4"; or 14 gage wire fabric with openings 2"x2"; or 18 gage wire fabric with openings from 1"x1" to 1½"x1½". Galvanized *after* fabrication.



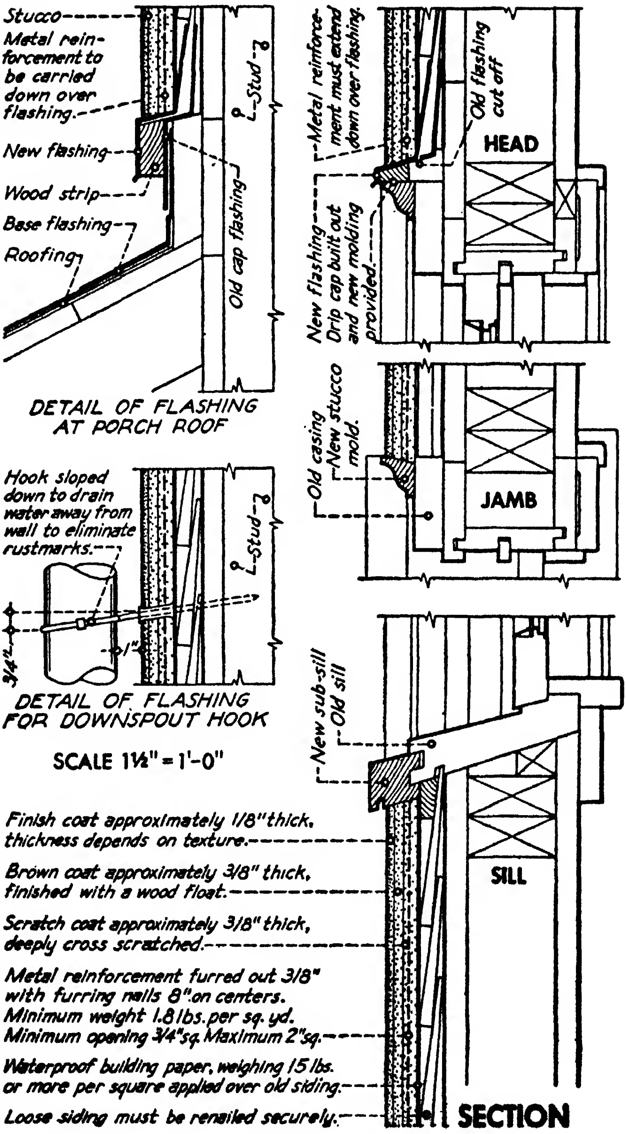
DETAIL

FURRING NAILS — these locate the reinforcement in the stucco slab without reducing the thickness at the points of support, which causes cracks. Reinforcement should be nailed at each bearing 8" o/c vertically.

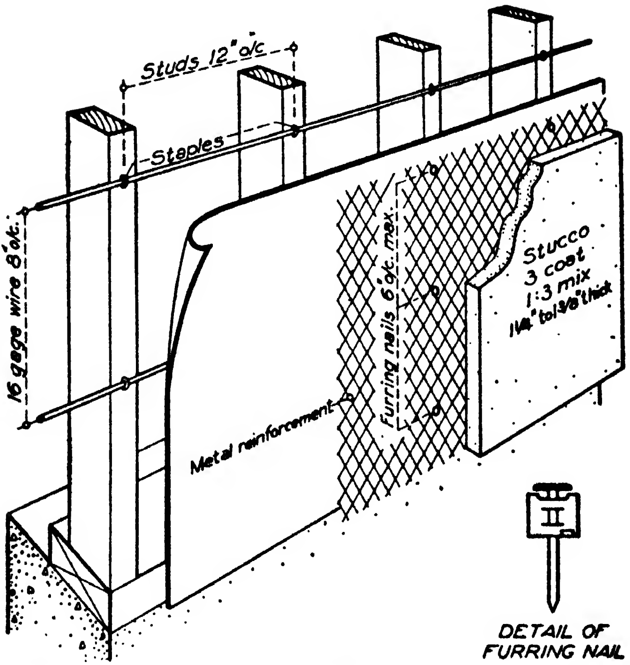
BUILDING PAPER—15 lb. roofing felt or heavy waterproof paper.

FRAMING — balloon type, well braced and bridged.

STUCCO OVER OLD CLAPBOARD WALLS



OPEN FRAME STUCCO CONSTRUCTION



OPEN FRAME CONSTRUCTION. So-called "open frame" construction has been widely used in various parts of the country because of its economy. With wood lath and plaster interior finish and stud spaces filled with rock wool, the heat transmission coefficient is 0.10.

BRACING REQUIREMENTS. The corners of exterior walls should be braced diagonally with 1" x 6" pieces let into the studs on the interior face. The studding should be bridged with 2" x 4" braces at least once in every story height.

BUILDING PAPER. The dryness of the frame and the air leakage of the open frame stucco wall depends in a large measure upon the quality of the building paper which is used. Fiber-reinforced paper should be applied weather-board fashion directly over the studs, lapping horizontal joints 4" and vertical joints lapped over studs. The paper is held temporarily with occasional tacks. The furring nails used in the following application of the metal reinforcing hold it permanently. When the stucco is applied, this paper does not belly back, thereby effecting a considerable saving in the quantity of stucco used.

METAL REINFORCING. Use expanded metal lath or wire fabric with relatively large openings (¾" to 2") so that the stucco will completely imbed the metal, forming a reinforced concrete slab. No form of metal or wood strips or rods should be used since they reduce the thickness of the stucco section with resulting cracks and discoloration. Horizontal and vertical joints of the metal reinforcing must be lapped 1 full mesh. Horizontal joints should be tied in each stud space with No. 18 annealed tie wire.

LOG CABIN WALLS

SUITABLE SPECIES. Balsam, hemlock, tamarack and pine make very good trees for the construction of log houses. Cottonwood, willow, aspen, birch and basswood are not so suitable. Cedar and white pine are excellent. Other species can be used, but it is advisable to choose the more durable woods.

SIZE OF LOGS. Logs from 4 to 10 inches in diameter are usually employed. Logs should have only a slight taper, if possible. Logs should be longer than the length of the room to allow for intermembering. Tree trunks longer than 20 feet are heavy and difficult to handle. Logs used in a wall can be spliced by halving the abutting ends, but is not considered good practice as it weakens the wall and detracts from the appearance. Short lengths can be utilized for panels between wall openings.

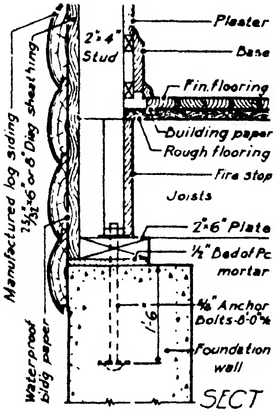
TIME OF CUTTING. If the logs are to be peeled, winter is the best time for felling the trees. If felled in the spring while the sap is running, the logs deteriorate thru the development of stain and decay organisms. Bark will adhere to the logs if the trees are cut in the late summer. To avoid insect injury, the cutting should be postponed until about the time of the first frost. To increase the adhesion of the bark, a narrow strip or score should be cut off on 2 sides of the entire length. The logs should then be seasoned by piling in the shade to allow the thoro circulation of air until the following spring. The scores, ends and notches should be painted with coal-tar creosote a few days after felling and again just before the timbers are used. Peeled logs are less subject to rotting and can be better protected against insect attack.

FINISHING. Sometimes logs are stained, creosoted or painted. Staining is preferable, since the odor of creosote is persistent and penetrating. The cuts made by notching should always have a protective coating.

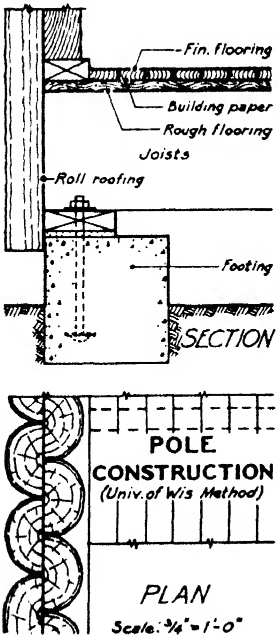
INSECT PROTECTION. See *Farmer's Bulletin* 1582, "Protection of Log Cabins from Injurious Insects," also *Farmer's Bulletin* 1472, "Preventing Damage by Termites or White Ants." from the Supt. of Documents, Washington, D.C

CHINKING. The cracks or spaces between the logs must be sealed, but this operation should be delayed as long as possible so that the logs will dry out. Narrow cracks may be calked with cotton waste, oakum or sphagnum moss (the moss found in swamps and used by florists in wrapping plant roots). If the joints are wide, they may be closed with short lengths of quartered logs to fit the cracks, bedded in mortar and nailed in place. Nails may be driven into the logs with heads protruding to form a key for cement mortar which protects the calking. Before filling wide spaces between the logs with mortar, narrow strips of expanded metal lath may be fitted and nailed between the logs to serve as reinforcement and as a background for the mortar. Clay for chinking is mixed like mortar, to the consistency of putty and pushed into the joints. When well done clay chinking will last from 10 to 12 years and may be used as filling in minor buildings.

POLE AND SIDING LOG CABIN WALLS



LOG SIDING CONSTRUCTION



Manufactured shiplapped log siding may be used horizontally, as illustrated, over sheathing in the same manner as any other siding. This material may also be used to simulate pole construction, if a proper waterproof building paper or roll roofing is placed between the logs and sheathing.

Buildings with walls made by placing logs on end are referred to as *pole houses.* Such structures are easier to build than those in which the logs are horizontal because one man can handle the logs, which generally are of short length and small diameter. Moreover, the labor of notching at the corners is not required as with horizontal log construction using real logs.

The poles should be not less than 4 to 5 inches in diameter. If full round logs are to be used for pole construction, the logs should be hewn on the sides and matched to fit closely to insure a weathertight wall. The cracks are chinked in the same manner as in horizontal log construction. A good foundation should be provided, upon which square sill logs should be bolted. The sill logs should equal in diameter, or hewn dimension, that of the wall poles. The top surface of the sill must be level to provide proper bearing for the sawed ends of the poles. Similar logs must be used for plates over the tops of the verticals. The sills and plates should be halved and lapped at the corners. The corner uprights should be set first and the plates then placed on top of them. The wall uprights are then matched and fitted between the sills and plates and spiked in place.

Split logs and slabs are sometimes used in the manner illustrated, in which 2 layers of logs or slabs are used, with staggered joints and roll roofing or heavy building paper between. Edges of slabs should be cut to make close joints.

FACTS ON TERMITE DAMAGE

EXTENT OF DAMAGE. Damage to buildings by termites is constantly becoming a more serious problem because remedial measures have not been generally adopted. Destruction by termites is estimated to involve a loss of $40,000,000 annually. Wood treated under pressure with creosote or certain salt preservatives is termite-proof. Its liberal use together with proper construction methods will definitely prevent termite attack.

While damage to buildings by termites is serious, decay of wood causes a far greater loss. Untreated wood that is subjected to moisture tends to decay.

EXAGGERATED REPORTS OF INJURY. The United States Department of Agriculture, in 1931, issued a Press Bulletin which is quoted in part as follows:

"Home owners should beware of overdrawn and alarming reports of injuries to buildings by termites. The Bureau of Entomology says that there has been no change in the situation in the South and West as to termite damage. Conditions are substantially the same now as they have been for the last 50 to 100 years. The records indicate that the collapse of a building on account of termite damage is so rare as to be for practical purposes a negligible risk. It is true that where termites have been in buildings for many years—as indicated by emerging swarms of the winged forms—the foundation timbers, and even the floors and adjacent woodwork, may have become so weakened as to make necessary some replacement.*

REPAIR OF DAMAGED BUILDINGS. *"The entomologists point out that an experience of 35 years in termite control indicates that radical reconstruction of the foundations is the only permanent and effective remedy for buildings which, because of original faulty construction, have become heavily infested. Such remedial measures as spraying and fumigation, or even the removal of the worst-infested timbers, without other protection, are at best temporary. Spraying and fumigation are practically useless.*

"Another exploited remedy is poisoning of the soil near the foundation walls or supporting columns underneath the buildings. Such treatment is very much in the experimental stage. On present information the Federal Entomologists cannot recommend it as a permanent remedy."

EFFECTIVE REMEDIES FOR TERMITE DAMAGE. The only effective remedy for termite damage is to observe the essentials of termite-proofing that would be used in new construction. These precautions are fully described in this series of *Data Sheets.* Architects are cautioned not to accept any new or easy methods, until they have assured themselves of the effectiveness of the method. Advice can be obtained from the local State Department of Agriculture, or from the Bureau of Entomology, Washington, D. C.

BIBLIOGRAPHY. *Preventing Damage by Termites or White Ants,* U. S. Department of Agriculture Farmer's Bulletin No. 1911, for sale by the Superintendent of Documents, Washington, D. C., 5c. *Injury to Buildings by Termites,* U. S. Department of Agriculture Leaflet No. 101, for sale by Superintendent of Documents, Washington, D. C., 5c. *Our Enemy the Termite,* by Thomas E. Snyder, Comstock Publishing Co., Ithaca, N. Y. *Termites and Termite Control,* edited by Charles A. Kofoid, University of California Press, Berkeley, Calif., 734 pp.

* It is not now so certain that there has been *no* change.

BIOLOGY OF TERMITES

TYPES AND RANGE. Termites superficially resemble ants in size, general appearance, and habit of living in colonies. Hence, they are frequently called "white ants." They are not true ants but are more closely related to cockroaches. Termites are of 2 main classes: (1) the ground-inhabiting or subterranean termites and, (2) the dry wood termites. Subterranean termites are found in nearly every state and are responsible for most of the termite damage to wood structures. Dry wood termites are found only in a narrow strip of territory along the southern edge of the United States. The diagram, prepared by the United States Bureau of Entomology and Plant Quarantine, shows the approximate range of each group.

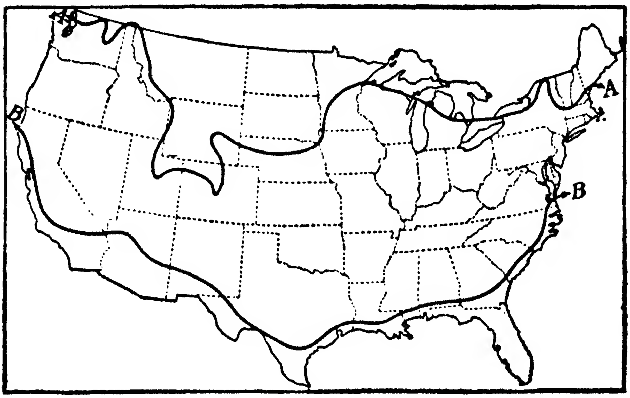


FIGURE 1.—*Map showing approximately (line A-A) the northern limit of damage done by subterranean termites in the United States and (line B-B) the northern limit of damage done by dry-wood or non-subterranean termites.*

HABITS OF LIFE. The subterranean termites develop their colonies in the ground. They live habitually in the dark and shun the light—that is, they are cryptobiotic. The invasion of buildings is accomplished thru foraging tunnels made by the workers under the surface of the ground. Chance contacts made with buildings lead to entry thru crevices or by means of shelter tubes to reach the wood they need for food without exposure to light. The shelter tubes may be attached to the walls of the building and have been known to extend for 14 or 15 feet vertically. The workers are also able to build buttressed tubes reaching, without support, up from the ground for a distance of a foot, in the effort to contact with structural timbers. The shelter tubes are constructed by the workers of earth and wood particles. The termite colony has its habitat in moist earth. Termites must have a constant source of moisture or they will die. If the connection between the earth and their source of food supply in the wood is destroyed, the termites in the wood will die.

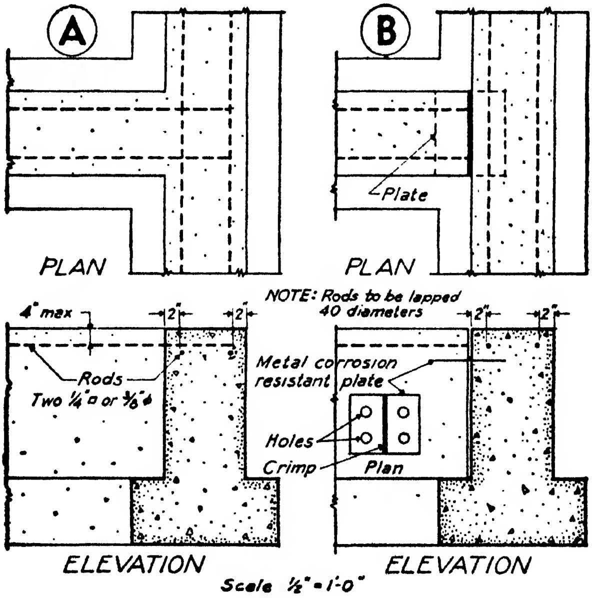
SWARMING. Winged fertile termites (called "alates") appear once or twice a year. When favorable external conditions arrive, the alates (temporarily losing their aversion to light) push their way into the open and take wing for a brief flight. At the end of the swarming flight, the alates drop their wings, burrow into the earth in pairs and found new colonies.

TERMITE CONTROL METHODS

Food and moisture are the factors to be controlled in seeking to prevent damage by termites. Protective measures are designed (1) to prevent termites from reaching wood which they need as their food supply, (2) to render wood which is subject to attack, inedible to the termites, and (3) to force the termites to build visible shelter tubes so that their presence in the vicinity can be known and the tubes destroyed. All of the following precautions should be carried out to give the maximum protection to buildings against damage by subterranean termites.

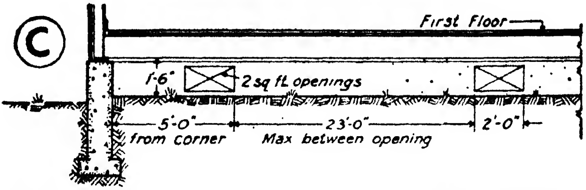
1. WOOD DEBRIS. Remove all stumps, roots and wood debris in the vicinity of the building. Remove all wood forms which have been used in concrete below a plane 18" above the ground. Special precautions should be used to see that no spreaders, used in concrete form work for basement foundations, are left in place. Do not bury any waste wood in the fill or back fill.

2. FOUNDATIONS. Construct foundation walls and piers of concrete. Reinforce foundation walls with not less than two ⅜" steel rods placed not more than 4" below the top of the wall. Reinforcing should be continuous thruout the length of every wall, and around all corners. Lap rods not less than 40 diameters. Interior foundation walls abutting exterior walls must be joined with special care, as shown at A and B. The tops of foundation walls should not be less than 5" above the finish grade.



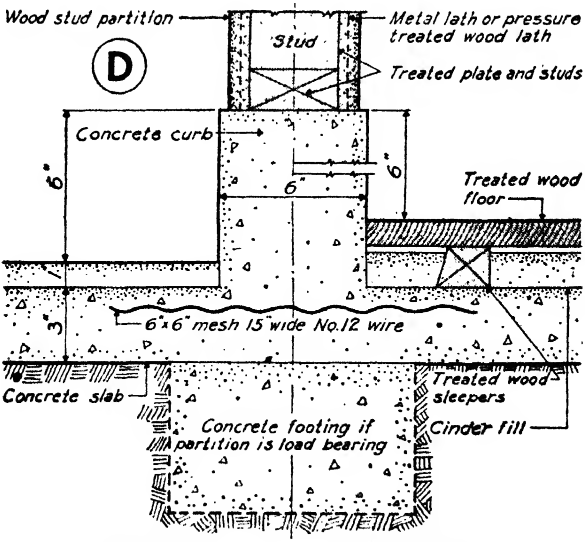
TERMITE CONTROL METHODS

3. VENTILATION. For buildings without basements, openings must be provided thru foundation walls for (a) cross ventilation, (b) access for inspection, and (c) to light the area. See drawing C.



FOUNDATION OPENINGS FOR BUILDINGS WITHOUT BASEMENT
Scale 1/8" = 1'-0"

4. BASEMENT FLOORS. The basement floor should be of concrete 3" thick of 1:3:6 mixture. While wooden columns, partitions, door casings, stairs, sleepers, wood flooring, etc., may generally be safely installed on a good concrete floor, the safest practice is not to depend upon perfection in the concrete. Pressure treated wood should be used. Place partitions on curbs 6" high, which should be poured monolithically with the rough floor slab. See drawing D. Columns and stair carriages should rest on similar 6" high bases.

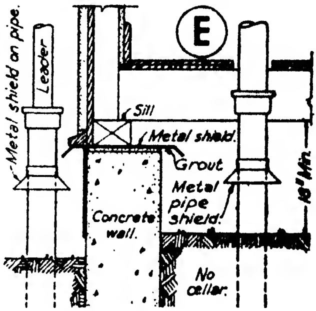


BASEMENT FLOOR CONSTRUCTION
Scale 1½" = 1'-0"

TERMITE CONTROL METHODS

5. WINDOWS AND DOORS. Window and door frames with their trim, occurring in the basement, should be made of pressure treated wood.

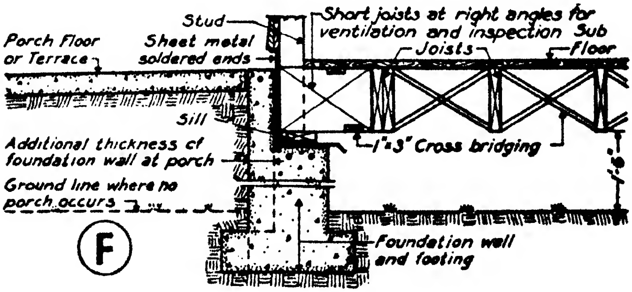
6. TERMITE BARRIER. Non-corroding metal termite barriers or "shields" may be constructed so as to completely cut off all access of termites from the ground to untreated wood, as shown on drawing E. However, attack in more than 90 per cent of cases of termite damage can be traced to contact of wood with the ground. Authorities consulted are not in agreement as to the proven value of termite shields in this country, altho their effectiveness has been reported favorably in tropical countries. Pipes which could serve as support for termite tubes from the ground to wood parts of the building should be protected with termite barriers, as shown on drawing E. Shields should project 2" horizontally, with an additional 2" turned down at a 45° angle.



7. DRAINAGE. Provide adequate drainage of soil beneath and around the structure.

8. JOINT RECESSES. Do not seal the ends of first-floor wood members entering masonry or concrete. Provide recesses which allow an air space of not less than 1" at each side of the member.

9. PRESSURE TREATED LUMBER. Use pressure treated wood for all lumber up to and including the first sub-floor for protection against rot as well as against termites.



10. PORCHES. Patios, porches and steps should not be higher than the top of the foundation wall. Failure to observe this protection has been the largest single cause of termite damage. Where patio, porch or steps are not resting on earth fill, provision must be made for the removal of concrete form work from underneath them and ventilating openings should be left—even under reinforced concrete slabs. See drawing F.

11. EXTERIOR FINISH. Wood siding should not be closer than 6" to ground level. Stucco should be stopped at least 3" above the ground line.

WHAT ARE STANDARD TERMITE SHIELDS

SUBTERRANEAN TERMITE ATTACK. Subterranean termites must have moisture and food in order to survive. Termites live in the ground where they find an unfailing source of moisture. To reach food in the form of cellulose above the ground, they construct shelter tubes in which to travel, or work in runways tunneled thru a material. They successfully erect vertical shelter tubes of earth and wood particles for an unsupported height of about 12″. Shelter tubes attached to foundation walls, pipes, etc., can be constructed to almost any height unless obstructed by a shield with a minimum horizontal projection of 2″ and with an additional 2″ turned down at 45°. The termites are unable to build shelter tubes around such a shield that is properly installed.

Termites are not brought into a building in either new or old lumber. Wooden framed buildings properly protected and constructed are in no danger of being attacked by termites.

STANDARD TERMITE SHIELDS. These shields consist of a series of diepressed sizes and shapes. These standardized shields are scientifically designed to conform with the Bureau of Entomology, U. S. Department of Agriculture, recommendations for termite shields. Shields are inexpensive, easily installed, neat appearing. Two types are available—pan type and strip type—for installation at the building site with a minimum of cutting and in most cases without soldering. These shields have stamped indentations to indicate the positioning on the wall. Labor for assembly and installation is extremely economical.

MATERIALS. The shields are made of 26-gage sheet steel, zinc-coated by the hot dipped process. Shields made of 16-ounce copper are available on special order.

PAN TYPE SHIELDS. When both faces of an 8″ masonry foundation wall or pier are not exposed to easy and frequent inspection, or for 8″ walls of brick, tile, stone or block construction without reinforced concrete caps, and pan type (P) shield is recommended. This type extends across the entire width of 8″ masonry foundation walls.

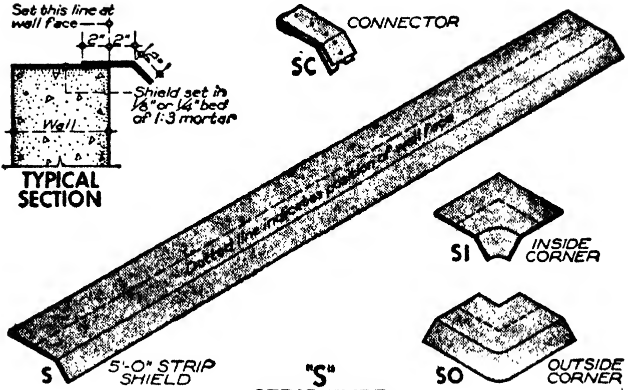
STRIP TYPE SHIELDS. The strip type (S) shield is used where 1 face of the wall is open to inspection and only the opposite face requires protection. This type is also used for monolithic concrete or capped unit construction walls wider than 8″ where 1 or both faces require protection. They are also used where shields on opposite faces are at different levels, around porches, chimneys, fireplaces, and for making special shields with large sheets.

CONNECTOR. With the Connector, strip and pan shields are interconnectable and interchangeable.

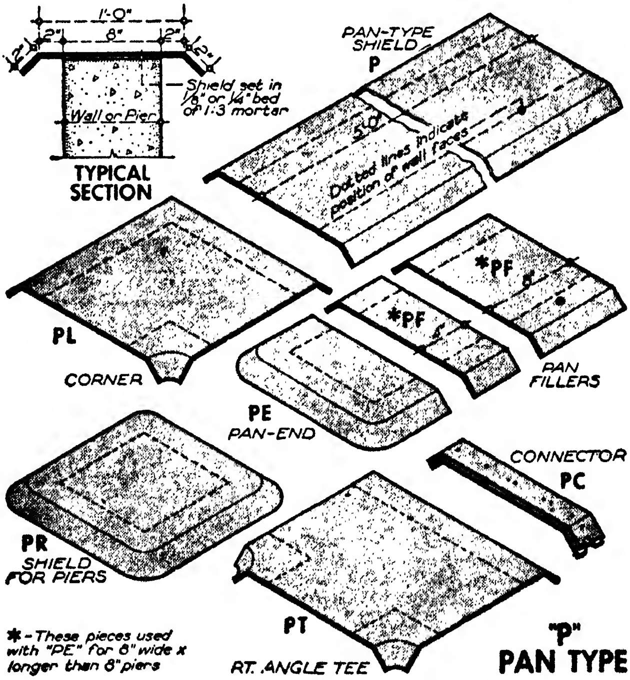
APPEARANCE. Because of the stiffening effect of the Connector, the installed shields are strong, durable and rigid with no raw or wavy edges. All curved corners are formed by die pressing and have no soldered joints.

INSTALLATION. Shields should be set simultaneously with the sill in a mortar bed not less than 1/8″ thick of 1:3 Portland cement to which may be added *not more than 15%* by volume of lime. Shields may be set in concrete forms at time of pouring, set in mortar joints as wall is laid up, or may be wedged and pointed in to a reglet. Holes for sill anchor bolts should be not over 1/4″ larger than the bolt and should be well surrounded with mortar or coal-tar-pitch as a seal when sill is set. If soldering is found necessary it should be done on the top side of the shield. Do not paint the underside of the shield which extends from the face of the wall.

STANDARD
TERMITE SHIELDS



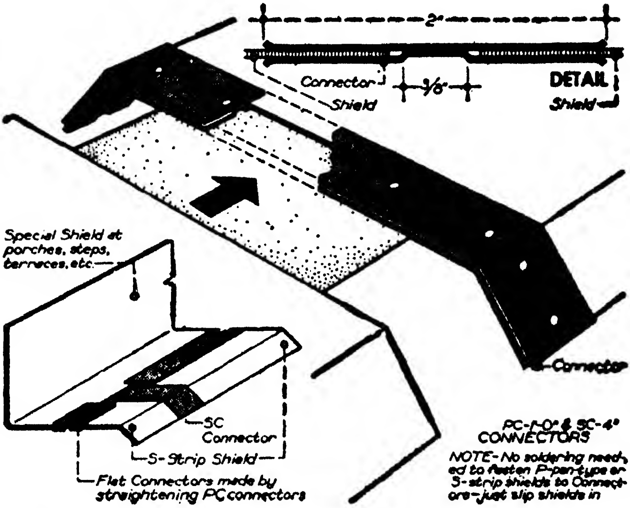
"S"
STRIP TYPE



* - These pieces used with "PE" for 8" wide x longer than 8" piers

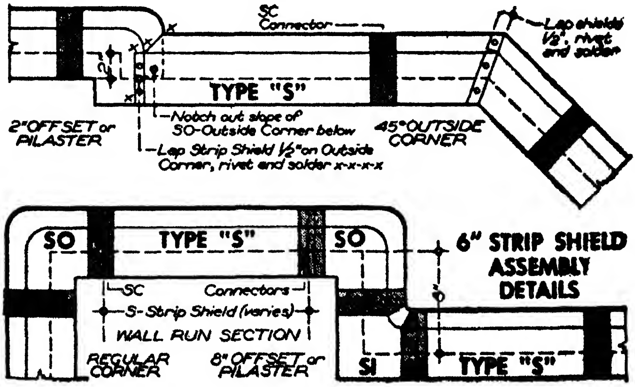
"P"
PAN TYPE

TERMITE SHIELD CONNECTOR

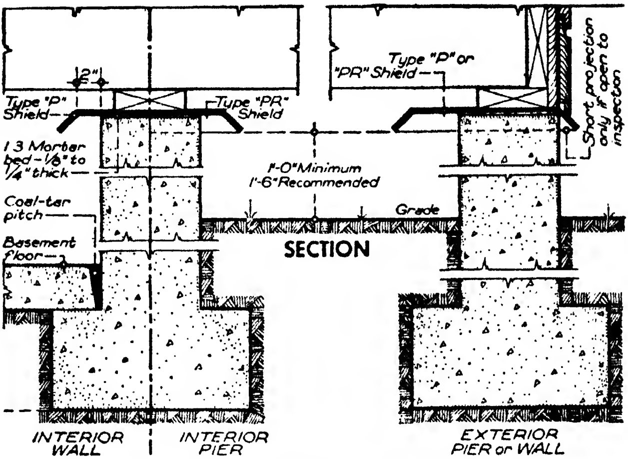


TERMITE SHIELD CONNECTOR. The great economy in installing termite shields is made possible by a patented Connector. This Connector makes tight joints between lengths of shields without the need for tools. In job-fabricated shields with soldered seams there is usually no provision made for expansion and contraction. This may result in broken joints and wavy edges. Termite shields provide app. 1" at each joint for temperature changes and settlement.

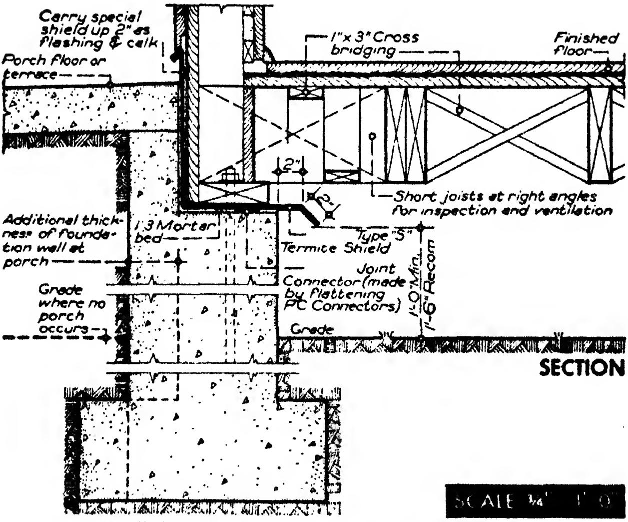
With the Connector, shields go together quickly and joints remain termite-tight. The Connector adds stiffening to the installation. They make possible the interconnection of the various shield shapes to meet practically any job condition with a minimum of cutting and fitting at the site.



DETAILS OF TERMITE SHIELD INSTALLATION

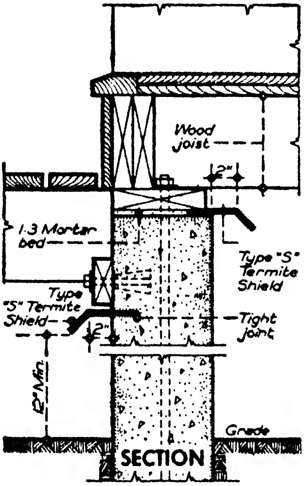


TYPE "P" TERMITE SHIELD ON PIERS AND WALLS

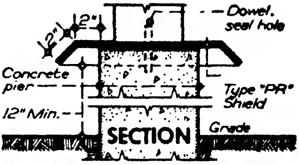


TYPE "S" TERMITE SHIELD WITH SPECIAL SHIELD AT PORCH OR TERRACE

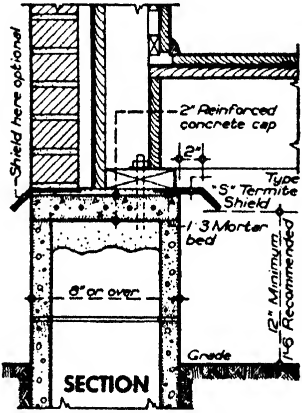
DETAILS OF TERMITE SHIELD INSTALLATION



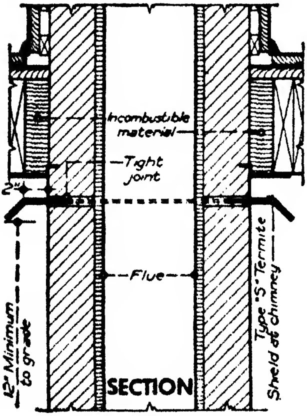
TYPE "S" SHIELD FOR ENTRANCE WITH WOOD PLATFORM AND STEPS



TYPE "PR" SHIELD ON 8"x8" CONCRETE PIER WITH WOOD POST



CONCRETE CAP ON BRICK, TILE, STONE OR BLOCK FOUNDATIONS



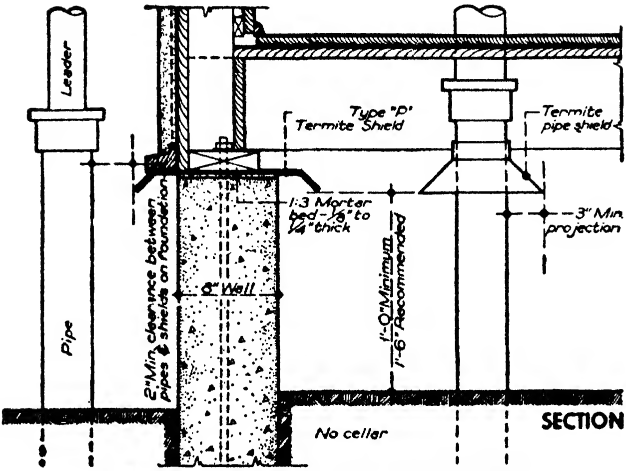
AT CHIMNEY

SCALE 1/4" = 1'-0"

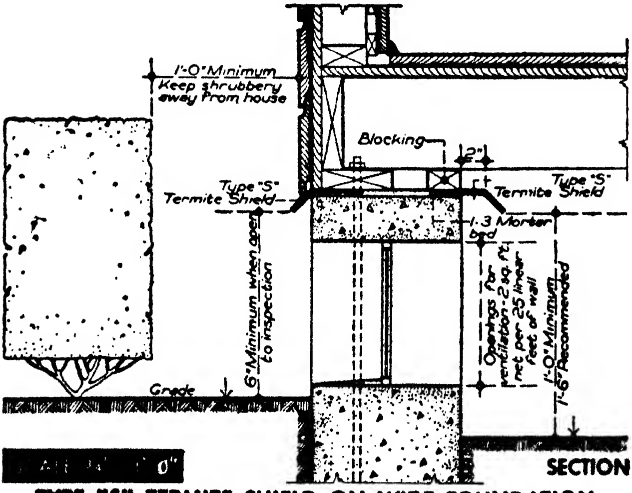
Foundation walls having well-filled joints in the top 3 courses present an effective barrier to prevent termites from reaching the wood sill by traveling thru the mortar joints of the masonry wall.

Brick, stone or other unit masonry with poor joints, or end construction tile require a 2" reinforced concrete cap for protection of the wood superstructure. End construction tiles may be placed on a smooth surface and filled with 2" or 3" of mortar, allowed to harden, then inverted to form the top course of the wall. The cap is cast in place on these partially filled blocks.

DETAILS OF TERMITE SHIELD INSTALLATION



TYPE "P" TERMITE SHIELD ON 8" WALL AND PIPE PROTECTION



TYPE "S" TERMITE SHIELD ON WIDE FOUNDATION AND THE LOCATION OF SHRUBBERY

PRESSURE-TREATED WOOD FOR TERMITE PROTECTION

PRESSURE TREATED WOOD. The proper use of pressure treated wood below the first floor in residences and other buildings will give protection against termites. Its use is practical and low in cost. The primary requisites of a good wood preservative are toxicity, permanence and freedom from damaging effects upon the wood. Other special requirements are often made of treated wood, such as the ability to accept and retain paint, low electrical conductivity, small fire hazard, ability to be worked with edged tools, absence of danger from the preservative to the health of workmen, the weight of the timber must not be unduly increased to the extent that handling costs become excessive, and, above all, the treated wood must give a service which will eventually save the consumer money.

EFFECTIVE PREPARATIONS. Coal-tar creosote is effective in preventing damage by subterranean termites, dry wood termites and decay. The odor and color resulting from the treatment of wood with creosote may be objectionable. Creosote treated lumber does not accept or retain paint. It is the most economical protection that can be used. Wolman Salts (and creosote and chromated zinc chloride) are accepted by the City of Los Angeles for the treatment of wood under pressure.

METHODS OF APPLICATION. Several methods of application of protective treatments are in use: *Brush and spray treatments* result in only a thin coating on protected wood being created. The protection is of short duration. Nailholes, checks, etc., provide passages for the entrance of termites to the untreated wood. *The open tank method of treatment*, when carefully and properly applied, will usually show a full penetration of the sapwood. *Pressure treatments* are the most effective method of securing maximum impregnation of the timber by the preservative. Pressure treatments are applicable only to the full-length treatment of timbers. All wood should be sized, framed and bored before treatment. If further shaping of the treated wood on the job is unavoidable, the freshly cut surface should be treated with several generous coats of the preservative.

FOR BUILDINGS, PORCHES AND EXTENSIONS WITHOUT BASEMENTS.

(a) Pressure Creosote Treatment of:
- Foundation timbers in contact with ground.
- Supporting posts, pillars and footings in contact with ground.

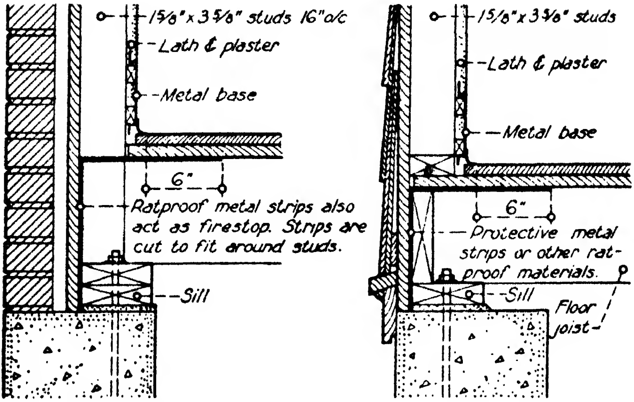
(b) Pressure Salt Treatment of:
- Siding up to 18" above ground.
- Lattices.
- First floor joists.
- First sub-floor.
- Sleepers, leaders and plates embedded in or laid on concrete or concrete-masonry foundations or walls.
- All other structural timbers within 18" of the ground.

FOR BUILDINGS WITH BASEMENTS HAVING CONCRETE FOUNDATIONS.

Pressure Salt Treatment:

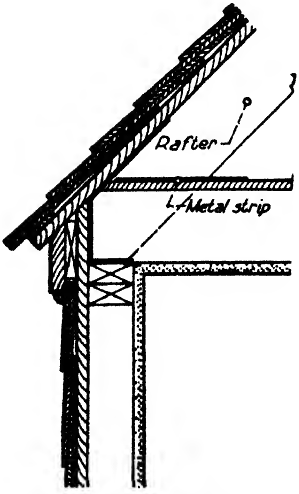
All wood used in basement, stairs, door and window casings, partitions, coal bins, studding, lath sleepers, leaders, plates and joists imbedded in or laid on concrete or masonry, all structural timbers within 18" of the ground.

RAT PROOFING
FRAME BUILDINGS



SOLID SILL BOX SILL

SCALE ¾"=1'-0"



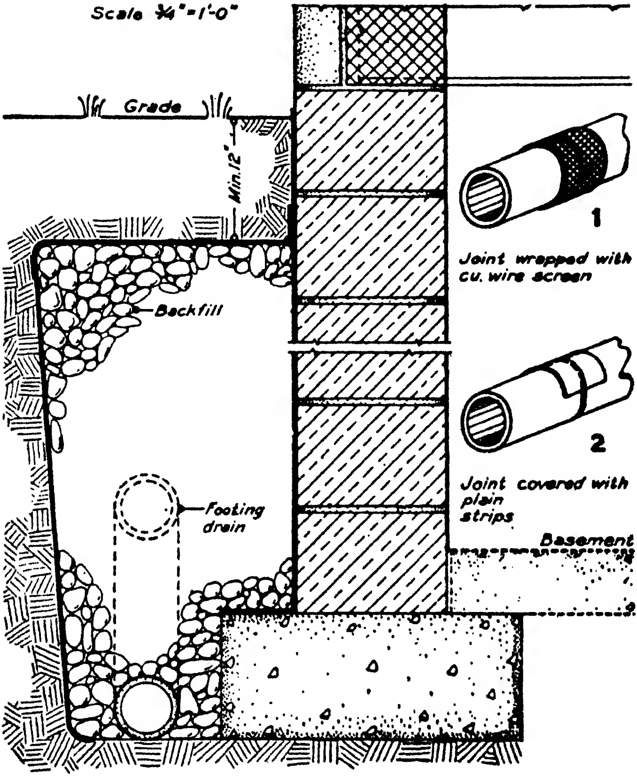
EAVE DETAIL

The following precautions, in addition to usual good construction, should be employed to render a building ratproof. *Cellar steps*—should be of open type. *Hollow walls above cellar*—must be protected from invasion from cellar, intermediate floors or attic. (See drawings herewith.) *Pipe lines*—should have ratproof metal collars. *Decorative grilles* — should have no openings greater than ½" and if openings exceed this amount, a metal screen should be installed behind grille.

Rats require large and constant amounts of food as well as quiet and well-protected places for hiding and breeding. Interfere with these requirements and the rats' existence becomes perilous. The elimination of rat hiding places exposes the animals to the attack of man and domestic cats and dogs.

Reference: See Supplement No. 131 to the Public Health Reports entitled "The Rat and Ratproof Construction of Buildings," for sale by the Superintendent of Documents, Washington, D. C.,

FOUNDATION FOOTING DRAINS



FOOTING DRAIN. All well-constructed basements should have footing drains. This drain should lead to an outlet to dispose of the collected water. The 4-inch draintile, as shown in the figure above, is laid either dead level or with very slight slope along the footing. The joints should be kept open, and a strip of copper wire screen or fiber-reinforced building paper 6″ x 9″ should be placed over the top of each joint.

BACKFILL. The trench is then filled with screened gravel or broken stone graded from 1/4″ to 1″, cinders or other coarse material. By lining the trench with fiber-reinforced building paper, loose dirt is prevented from being carried in when the backfill is placed. By the time the paper has rotted, the soil is compacted and little dirt will wash into the backfill voids.

WALL DAMPPROOFING. Added protection against dampness is provided by a mopping of bituminous material. To keep this mopping from injury when the backfill is placed, a layer of fiber-reinforced building paper should be mopped in place.

DAMPPROOFING OF RESIDENCE FOUNDATIONS

DAMPPROOFING VS. WATERPROOFING. Dampness appearing on the inside of basement surfaces may be from two causes: 1) Condensation, and 2) Capillarity. In neither case is there a static head to cause water to enter under pressure which is a condition that requires waterproofing.

CONDENSATION. If walls, floors or ceiling are below the dewpoint for the relative humidity of the air, droplets will be condensed on these surfaces. The cure is either adequate air movement, absorption of the air vapor with chemicals, or insulation of the surfaces to raise their surface temperature above the dewpoint. Condensation is most prevalent during relatively warm and humid times of the year.

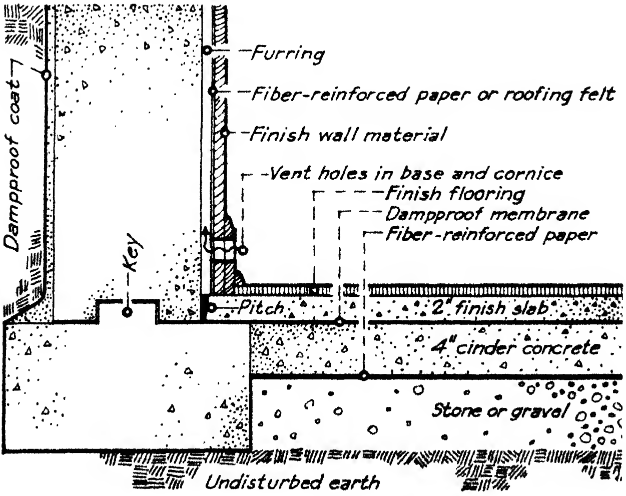
CAPILLARITY. Water will climb by capillarity in coarse sands 2 or 3 ft., and in fine sands, silts, loams, and clays, from 5 to 8 ft. Borings should be made in doubtful soils to be sure that the permanent ground water level is a safe distance below the basement floor. If there is the slightest question, the precautions shown in the drawing should be taken . . . because after the building is up, corrective measures are prohibitive in cost.

WATERPROOFING. Where the permanent (or intermittent, due to rains) ground water level is above the foundations, complete membrane *waterproofing* is needed as shown on the next page.

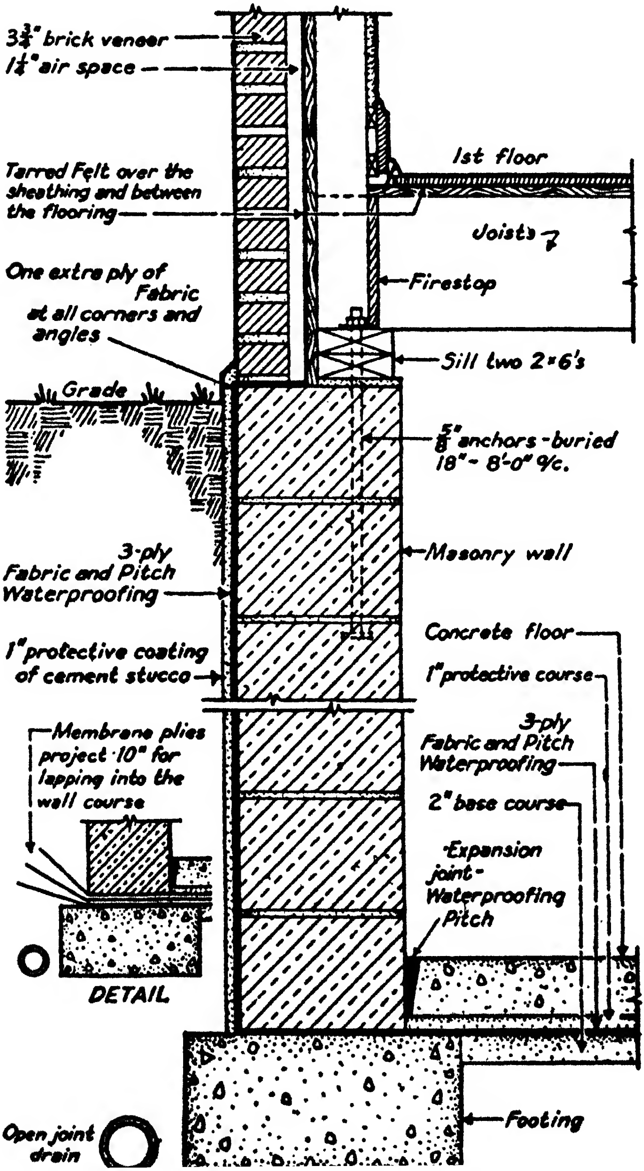
EXCAVATIONS. Footings should always rest on undisturbed earth. If a dampness condition is foreseen, special care should be exercised in mixing the concrete for the footings so that they will be as impermeable as possible. Under the floor area there should be a well-tamped layer of broken stone, coarse gravel or cinders. Capillary action will be broken by the voids in this type of underlayment.

ROUGH SLAB. Over the underlayment should be laid a fiber-reinforced building paper with generous laps to maintain an even thickness of the fill against displacement and leakage of the liquid from the concrete during the pouring of the slab. Light reinforcing is advisable, such as 1/4″ rods 18″ o/c both ways.

MEMBRANE. A copper-clad fiber-reinforced building paper lapped 9″ both ways in a mopping of coal-tar pitch (not asphalt) will be adequate for most conditions.



WATERPROOFING OF RESIDENCE FOUNDATIONS



MEMBRANE WATERPROOFING

MEMBRANE WATERPROOFING is constructed in place by building up a strong, waterproof, and impermeable blanket with overlapping plies of tar-saturated open mesh cotton fabric or rag felt. The plies are coated and cemented together with hot coal tar pitch. There is always one more application of pitch than plies except when it is necessary to lay a dry sheet on a wet surface in order to start work. Properly constructed membrane waterproofing is superior to all other types of waterproofing as it prevents the entrance of water regardless of hydrostatic head, capillary attraction, concrete cracks, and expansion joints.

FABRIC. Tar Saturated Waterproofiing Fabric is made by thoroughly saturating an open mesh cotton fabric with a pure coal tar pitch compound. This compound contains a high percentage of coal tar creosote which is the best known commercial preservative of plant fibres. As this treatment makes the fabric unusually resistant to subsoil conditions, it insures the life of the fabric for many years.

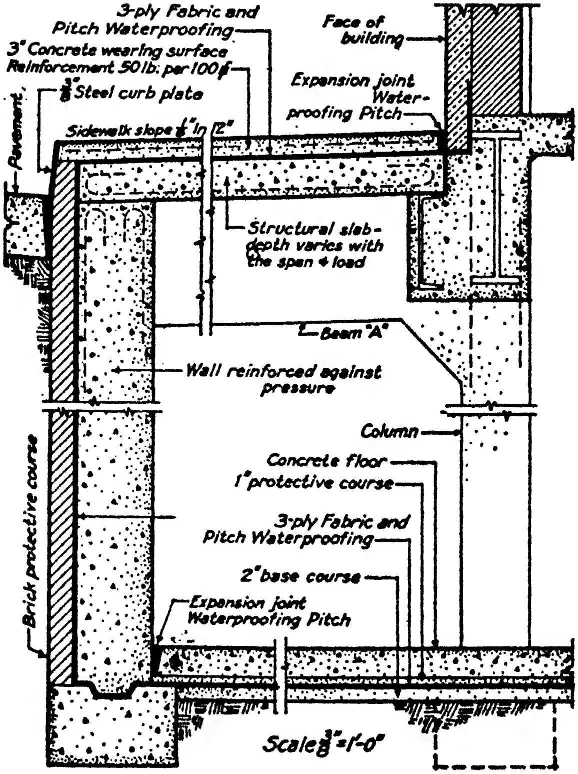
FELT. Approved Tarred Felt is less costly than fabric and it has been used in the membrane waterproofing of many important structures. Fabric is much stronger than felt and it should be specified exclusively for bridges and tunnels, track and machine isolation, irregular surfaces, structures exposed to vibration and under heavily loaded columns. With these exceptions felt may be used either alone or with alternate plies of fabric.

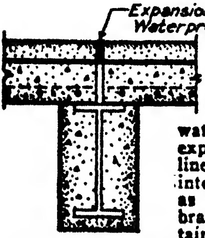
PITCH. Waterproofing Pitch contains only coal tar products. It is unaffected by prolonged submersion in water; resistant to attack by termites; self-healing and self-sealing when fractured; and possesses great ductility which permits it to conform to irregularities caused by unequal settlement of the structure.

Recommended Number of Thicknesses of Membrane Waterproofiing Materials for Different Water Pressures

Head of Water (Feet)	Felt and Pitch or Fabric and Pitch	
	Plies of Tarred Felt or Tar Saturated Fabric	Mopping of Waterproofing Pitch
1-3	2	3
3-6	3	4
6-9	4	5
9-12	5	6
12-18	6	7
18-25	7	8
25-35	10	11
35-50	11	12
50-75	13	14
75-100	14	15

WATERPROOFING OF SIDEWALK VAULT

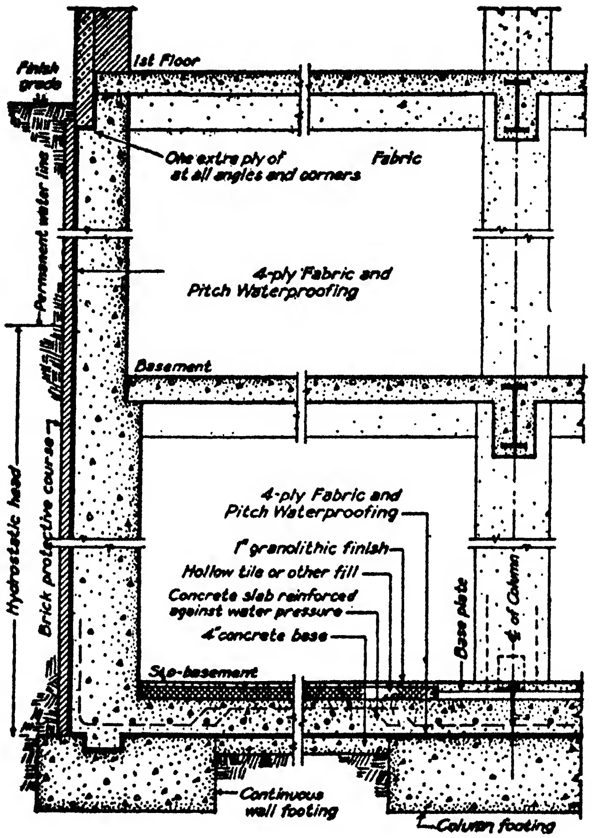




SECTION THRU BEAM "A"

The problem involved in constructing sidewalk vaults is to provide for movement of the concrete to eliminate cracking, and at the same time to exclude water so that the space may be usable. A 1" expansion joint should occur at the building line as shown. Others should occur at proper intervals at right angles to the building face as shown in the detail at the left. The membrane acts as a flexible dam in the joint, retaining the filling of pitch. To facilitate the movement of the slabs, 2 dry plies of Approved Tarred Felt are placed between the bottom of the slab and its bearing surface on beams or wall, thus breaking the joint.

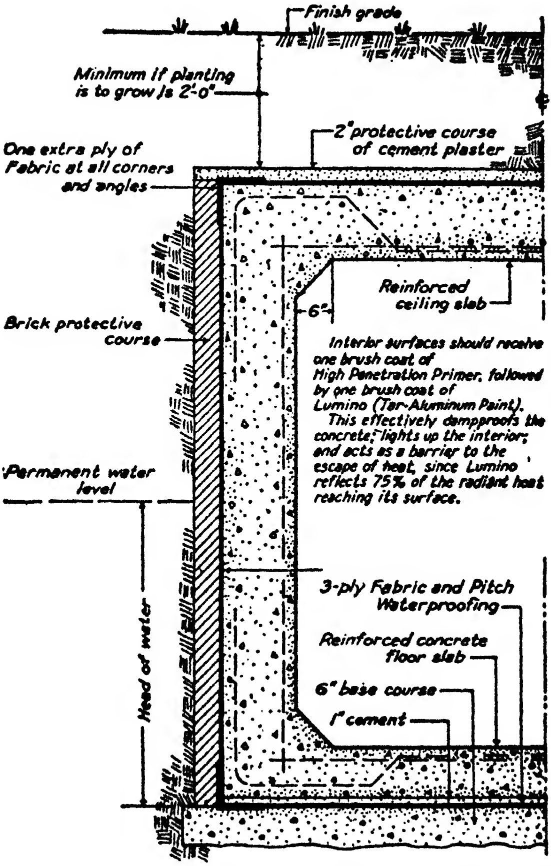
WATERPROOFING OF DEEP FOUNDATIONS



In the construction of deep basements having unfavorable water conditions, the waterproofing method is shown here. 4-ply Fabric and Pitch Waterproofing membrane will withstand a hydrostatic head up to 9′. From 9′ to 12′ 5 plies are used. A sheet of 20-oz. soft rolled copper should be placed between the plies beneath all columns, posts or walls under which the pressure exceeds 400 lbs. per sq. inch.

The sub-basement floor is reinforced as a flat slab to resist the upward pressure of the water. Inverted beams may be used, but these necessitate a greater amount of fill to bring the construction to a level to receive the wearing surface. If piles are used, the footings shown above become the pile cappings. No dowels need be run through the membrane.

SUBTERRANEAN TUNNEL TO CONNECT BUILDINGS



Frequently it is necessary to construct subterranean tunnels from one building to another, either for a passageway for circulation of people, or as a conduit to contain pipes and ducts. If the soil will retain ground water, or if the passage extends below the permanent water level, an effective waterproofing is necessary as shown above. This forms an unbroken envelope through which moisture is unable to penetrate.

The thickness of the floor slab and the reinforcing will depend upon the span and the head of water to be resisted. The thickness and reinforcing of the walls depend upon the height and the water head. The detail of the roof or ceiling slab will depend upon the span and the weight of earth to be sustained.

DEPTHS FOR FOUNDATIONS

The depth generally considered safe in various regions is given in the table. However, it is best to check with local builders or county agricultural agents because safe depth varies to a great extent, depending usually on the depth to which frost penetrates and the effect of frost in the soil. Dry soils ordinarily do not heave when freezing, but damp clay may heave enough to cause serious damage to the building unless the footings are below frost depth.

The depths given in the table are based on recommendations made by state agricultural colleges and are considered sufficient to prevent damage by frost but are not the total depths to which frost penetrates. Note the soil conditions at these depths; if not firm or if subject to change of volume due to alternate wetting and drying, footings must be made wider, reinforced, or carried deeper than indicated in the table.

In regions having little frost set footings below the topsoil on firm ground, because if they are placed too close to the surface, rats can burrow under them and wind, rains, or floods may erode the soil from beneath, causing the building to settle. In some localities the firm soil is a relatively thin layer overlaying soft ground. If the firm soil is cut thru, a secure bearing is almost impossible. Under such conditions shallow footings may be protected from erosion by banking soil against the foundations. This fill requires sodding and protection from erosion caused by drip from the roof, which has been provided with rain gutters and downspouts.

All footings of buildings are preferably set on the same type of soil and must be level but not necessarily at the same elevation. Where the ground slopes or where there is a basement under only a portion of the building, step the footing down gradually to avoid undermining the higher portion. The ratio in which the stepping can be done safely varies with the type of soil, but for average conditions a vertical rise of not more than 2'-0" in a horizontal distance of 4'-0" is generally satisfactory.

When 1 part of the foundation rests on rock and another on soil make the footing of the portion on soil twice as wide as called for by the normal soil bearing area Under such circumstances some building codes require the rock surface to be cut so a 6" layer of sand can be placed on top of the rock. Occasionally a relatively thin rock stratum overlays soft clay or loose sand; such a bed is unsafe for heavy buildings or concentrated pier loads. Care must be taken to see that the rock is not merely a large boulder that might be loosened by the weight of the building.

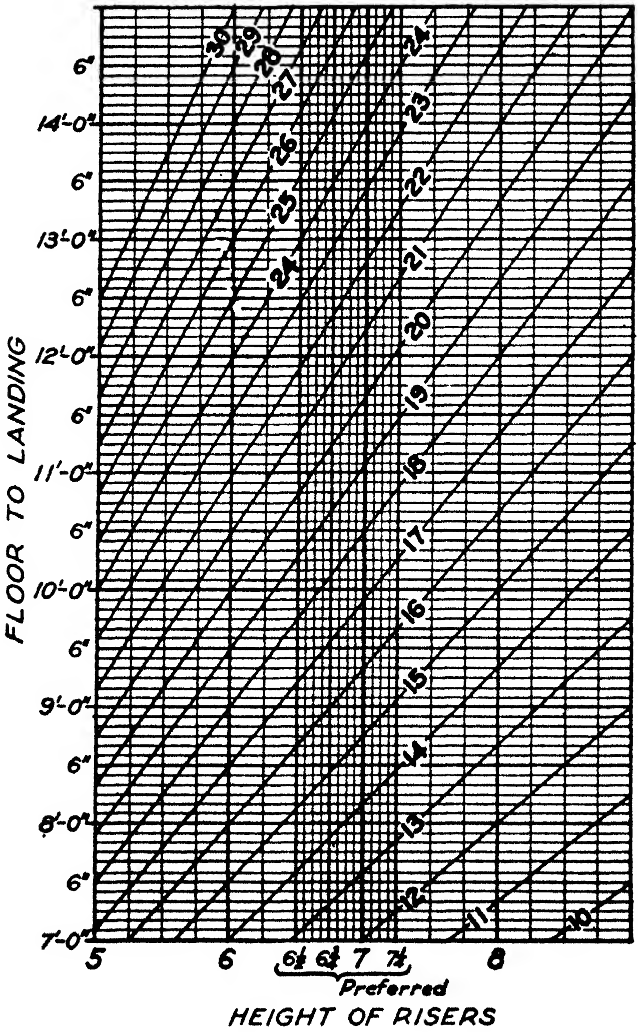
When the rock stratum slopes, the surface may be cut to form level steps to prevent the footing from sliding. Sometimes slight slopes are merely heavily chipped; at times the surfaces are doweled. Where out-croppings of rock strata have been exposed to weathering from some time and the surfaces are likely to be rotten or loose, cut the rotten layers away to solid material.

State	*Mild Areas*	*Colder Areas*	*Local Consideration*
Alabama	1'-6"	1'-6"	Reinforce footings and floor, and use piles in Blackbelt area
Arizona	1'-6"	3'-0"	Closeness of irrigation a factor
Arkansas	1'-4"	1'-4"	Continuous foundations preferred
California	0'-6"—1'-0"	1'-6"—2'-0"	——
Connecticut	2'-0"—3'-6"	2'-6"—4'-0"	——
Florida	surface	0'-6"—1'-0"	Wide footings near surface; sandy soil
Georgia	——	——	Conditions variable; seek local advice

DEPTHS FOR FOUNDATIONS

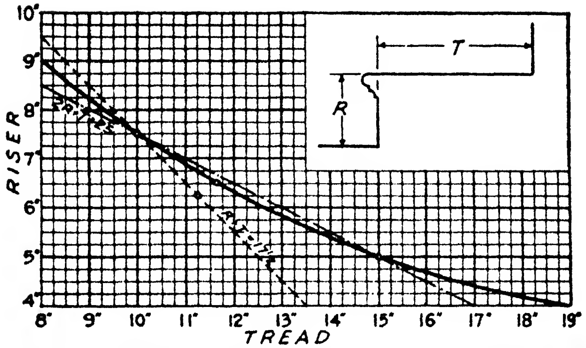
State	*Mild Areas*	*Colder Areas*	*Local Consideration*
Idaho	2′-0″	3′-0″	—
Illinois	3′-6″	5′-6″	Reinforcement advised
Indiana	2′-0″—3′-0″	2′-0″—3′-0″	—
Iowa	3′-0″	3′-6″	—
Kansas	5′-0″	5′-0″	Reinforce; heavy footings needed on swelling and shrinkage soils
Kentucky	1′-6″—2′-0″	2′-6″	—
Louisiana	0′-2″—1′-0″	0′-2″—1′-0″	Wide footings on alluvial soils
Maine	4′-0″—5′-0″	5′-0″—6′-0″	Use batter on outside face of wall or use a footing; less depth is required in gravelly soils
Maryland	—	—	Conditions variable; seek local advice
Massachusetts	2′-0″—4′-0″	2′-0″—4′-0″	Soil conditions fairly uniform
Michigan	3′-0″	3′-0″	—
Minnesota	5′-0″	5′-0″	—
Mississippi	Depth to uniform soil	Depth to uniform soil	—
Missouri	1′-6″	2′-0″	—
Montana	—	—	Seek local advice
Nebraska	1′-6″	2′-0″	Guard against roof water and rooting animals
Nevada	0′-0″—0′-6″	1′-6″	—
New Hampshire	6′-0″—8′-0″	6′-0″—8′-0″	—
New Jersey	1′-4″	3′-0″	—
New Mexico	0′-9″—1′-0″	1′-0″—1′-3″	—
New York	4′-0″	4′-0″	—
North Carolina	2′-0″	2′-6″—3′-0″	—
North Dakota	5′-0″—8′-0″	5′-0″—8′-0″	Reinforce
Ohio	1′-6″	1′-6″	Reinforce
Oklahoma	1′-6″	2′-0″	—
Oregon	1′-0″	2′-0″	—
Pennsylvania	4′-0″—6′-0″	4′-0″—6′-0″	—
South Carolina	1′-2″	1′-6″	—
South Dakota	4′-6″—5′-0″	4′-6″—5′-0″	Use continuous foundations
Tennessee	2′-0″	2′-0″	Guard against termites
Texas	1′-0″	2′-6″	Guard against erosion
Utah	1′-8″	2′-6″	—
Vermont	5′-0″	5′-0″	Conditions vary widely; carry to firm soil
Virginia	2′-0″	2′-0″	—
Washington	—	—	Conditions variable; seek local advice
West Virginia	1′-6″—2′-0″	2′-0″—2′-6″	—
Wisconsin	3′-0″	4′-0″	—

HOW MANY RISERS?



Read across on the proper horizontal line to whichever intersection with a slanting line showing the number of risers gives a desirable riser height. For example a 10′-0″ story height requires 17 risers at approximately 7 1/16″. Twelve risers of this same height would give 7′-1″ from floor to an intermediate landing, for determining head room, or thirteen would give 7′-8″.

PROPORTIONING
RISERS AND TREADS



The graph shows a comparison between the two best known stair "laws" and a curve based on actual stairs that have been tested for comfort.

Because it is the easiest to use, architects have generally adopted the rule that the sum of a riser and a tread should equal 17½. Actual test demonstrates that this rule gives steps that are too large for steep stairs and steps too small for gradual stairs.

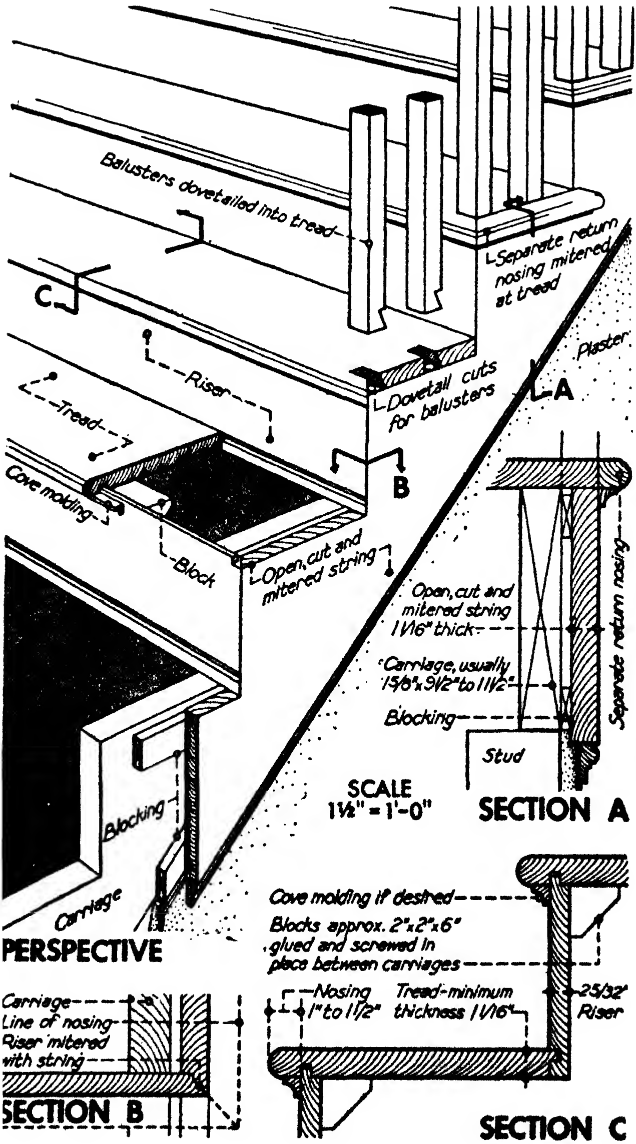
The rule that the sum of two risers and one tread should equal 25 results in a very good stairs when the risers are less than 7½". But for steeper stairs than this the steps become too small for comfort.

The curve shown by the heavy solid line follows very closely to the old rule that the product of a riser and a tread should equal 75. This curve gives a proportion of riser and tread that is most comfortable for the resulting angle of climb. By reference to the chart it will be seen that a 6½-11⅝ proportion is better than a 6¼-11¼ proportion, altho both will occupy approximately the same space in plan and section.

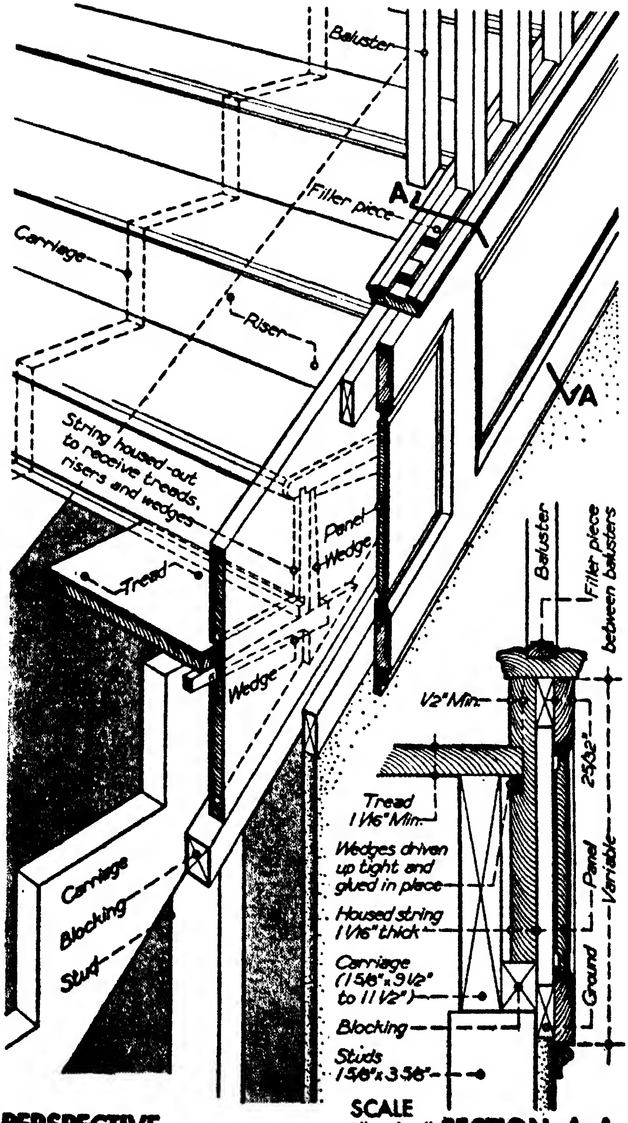
The following table gives the correct proportion of riser and tread as determined from the recommended curve:

Riser	*Tread*	*Riser*	*Tread*	*Riser*	*Tread*
4	19	5	15	6	12⅝
4⅛	18¼	5⅛	14⅝	6⅛	12⅜
4¼	17⅝	5¼	14⅜	6¼	12⅛
4⅜	17	5⅜	14	6⅜	11⅞
4½	16⅝	5½	13¾	6½	11⅝
4⅝	16⅛	5⅝	13⅜	6⅝	11½
4¾	15¾	5¾	13⅛	6¾	11¼
4⅞	15⅜	5⅞	12⅞	6⅞	11
7	10¾	8	9¼	9	8
7⅛	10⅝	8⅛	9⅛		
7¼	10⅜	8¼	9		
7⅜	10¼	8⅜	8¾		
7½	10	8½	8⅝		
7⅝	9⅞	8⅝	8½		
7¾	9⅝	8¾	8⅜		
7⅞	9½	8⅞	8⅛		

WOOD STAIR CONSTRUCTION



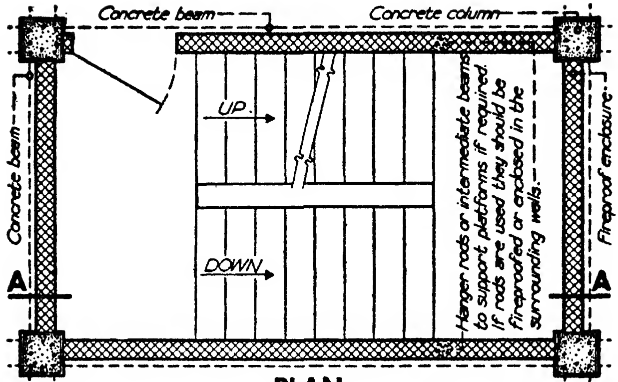
CLOSED STRING STAIRS



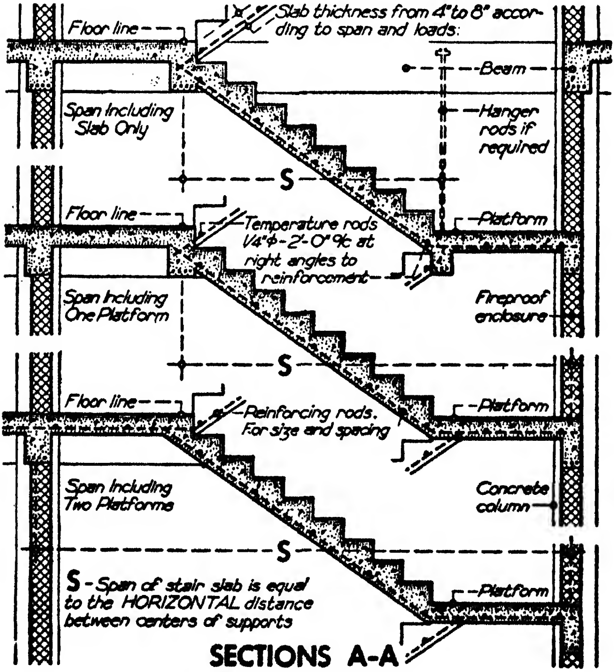
PERSPECTIVE

SCALE 1½" = 1'-0" SECTION A-A

CONCRETE STAIR CONSTRUCTION

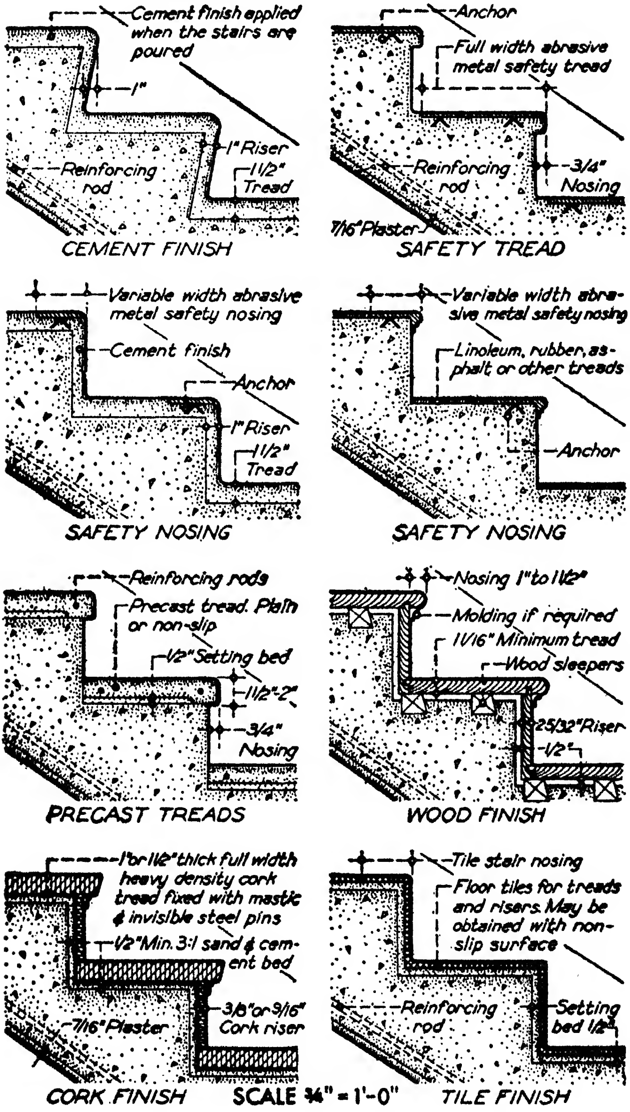


PLAN

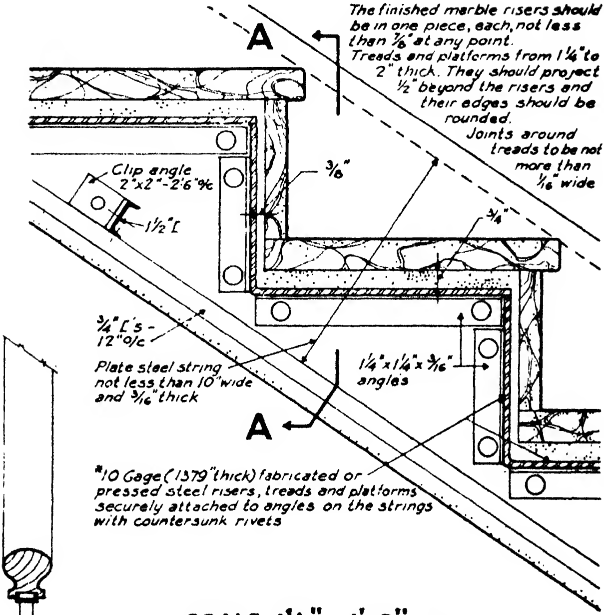


SECTIONS A-A

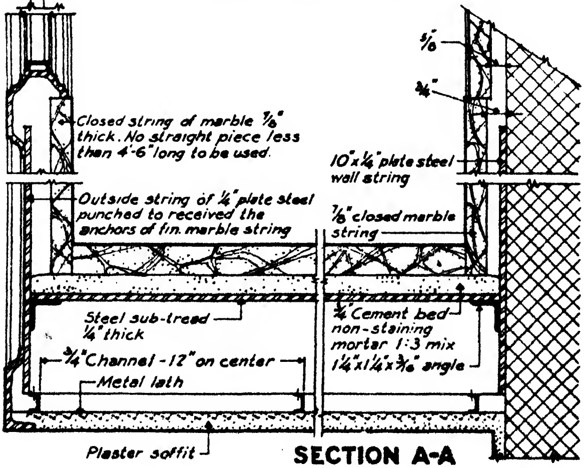
FINISHES FOR CONCRETE STAIRS



MARBLE STAIR OVER STEEL

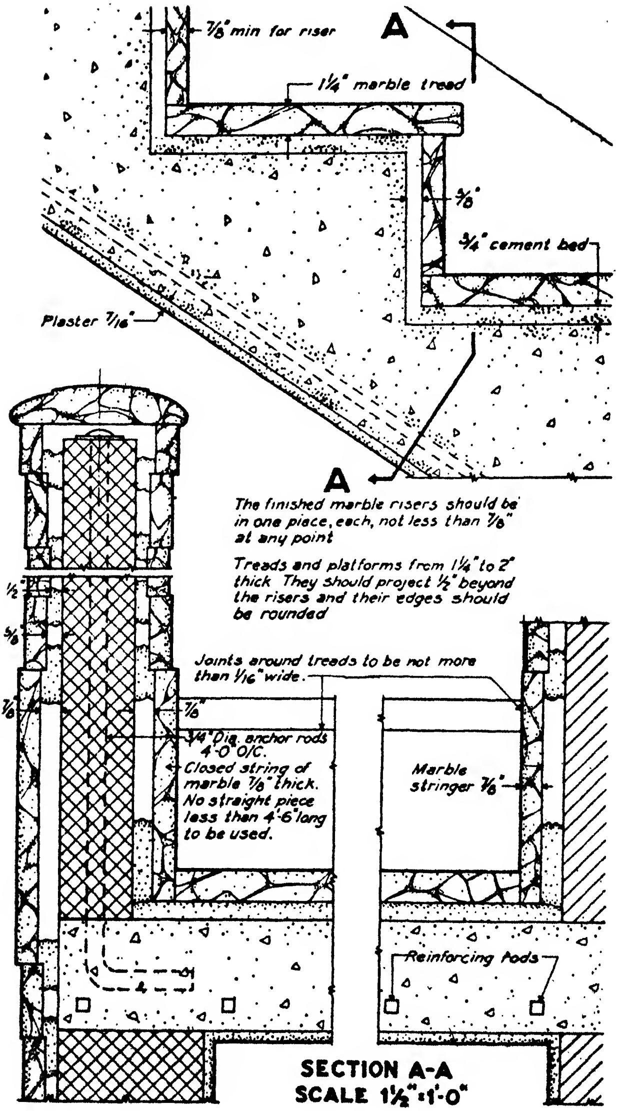


SCALE 1½" = 1'-0"

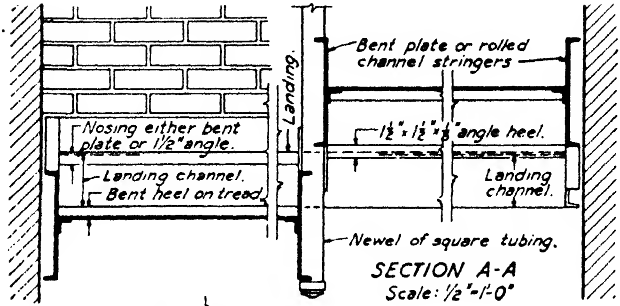


SECTION A-A

MARBLE STAIR
OVER CONCRETE



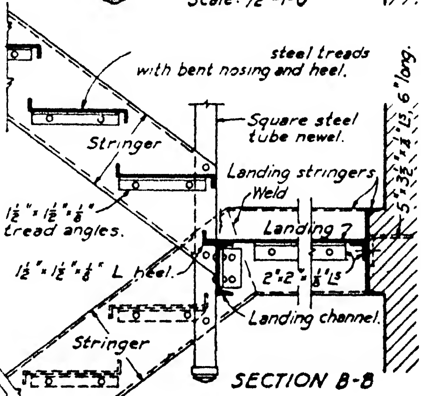
TYPICAL ALL-STEEL STAIR SECTIONS WITH BRICK ENCLOSING WALLS

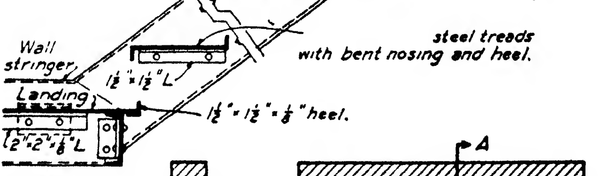


Thickness of treads and landing plates will depend upon span and the required safe load and can be determined from table

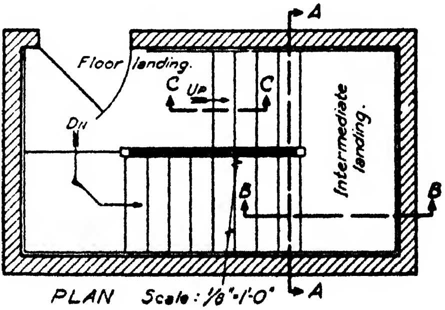
Large landing plates usually have stiffner angles or intermediate supports in order that plate thickness may be reduced to an economical minimum.

Wall stringers are supported by means of angle clips which are either built into brick supporting wall or else suspended on rods.

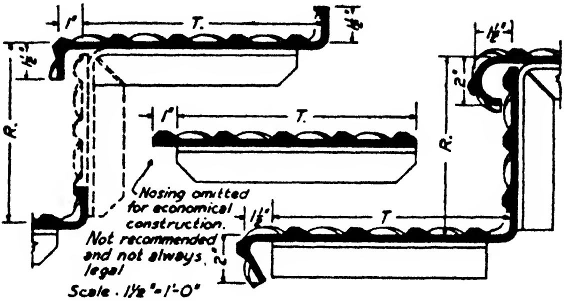




steel plates have pattern in three sizes. The small size pattern is recommended for stair treads, especially those with bent nosing

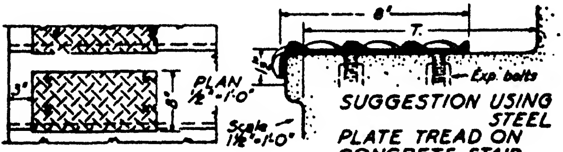


STAIR TREADS OF STEEL FLOOR PLATES



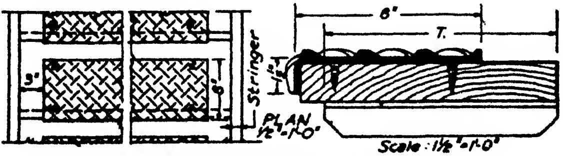
TREAD SUGGESTIONS USING STEEL PLATE WITH BENT NOSING AND HEEL

The use of checkered steel plate treads and landings in stair construction is both safe and economical because the slip-proof projections extend in two directions, at right angles to each other, and are so arranged that the plates may be easily cleaned and drained. Plates are cut to size and bent to form nosing and heel by the stair contractor.



SUGGESTION USING STEEL PLATE TREAD ON CONCRETE STAIR.

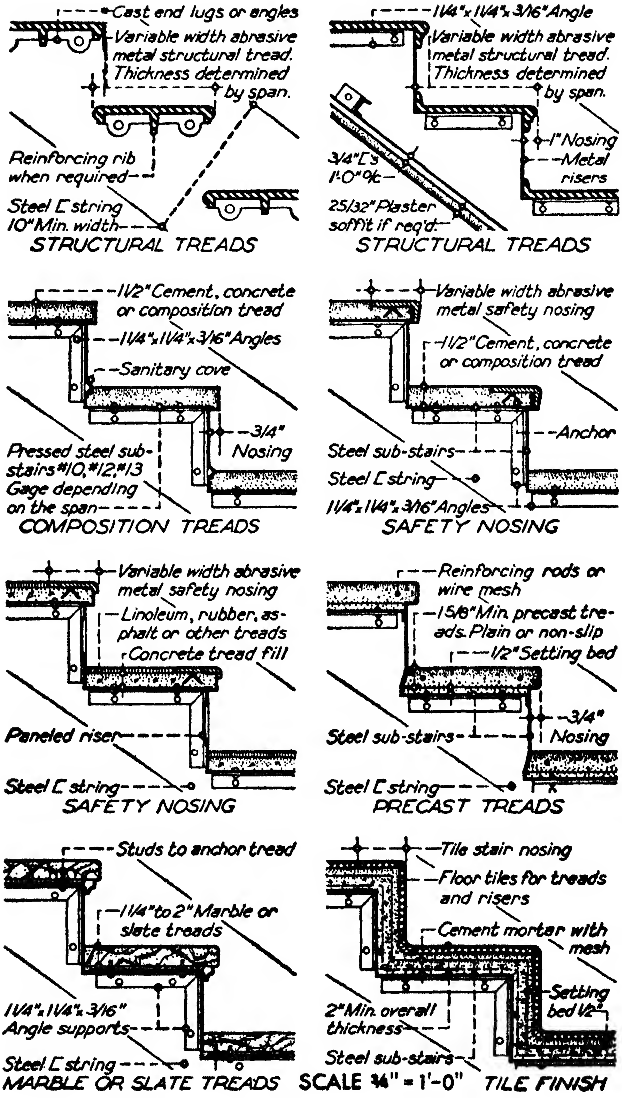
Treads with turned down nosing makes an ideal wearing and slip-proof surface for concrete stairs. They are easily secured, either by means of expansion bolts or anchors set in concrete when poured.



SUGGESTION USING STEEL PLATE TREAD ON WOOD STAIR.

Wood treads can be made to last for a long time when protected with the hard wearing surface of steel plate. Treads which have been worn down should be blocked out to a true level before steel plate is applied, otherwise the wood screws may work loose.

FINISHES FOR STEEL STAIRS

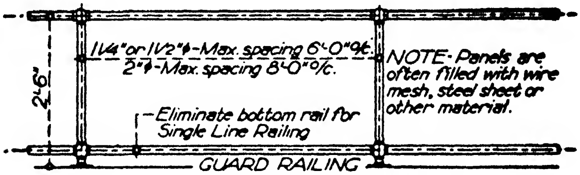


PIPE RAILINGS

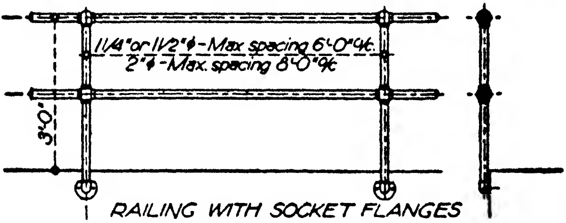
STANDARD WEIGHT & EXTRA STRONG PIPE SIZES

Nominal Size Pipe	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"
Approximate Outside Diameter	1 1/16"	1 5/16"	1 11/16"	1 15/16"	2 3/8"	2 7/8"	3 1/2"

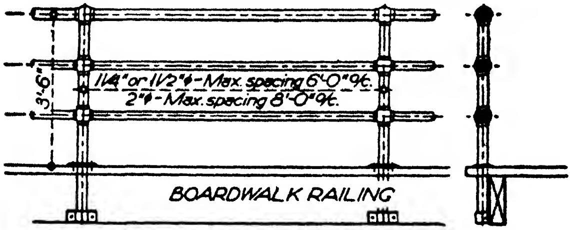
NOTE – When conditions necessitate use of heavier pipe than Standard Weight Wrought Steel Pipe, specify Extra Strong W.S. Pipe. Inside diameter of Extra Strong is smaller.
If Copper Bearing Steel or Genuine Wrought Iron is to be used, then specify it as such.
Railing finish to be black or galvanized.



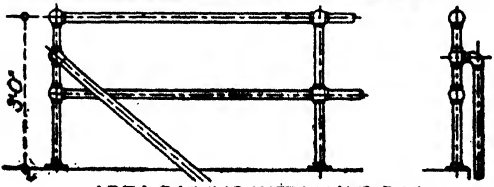
GUARD RAILING



RAILING WITH SOCKET FLANGES

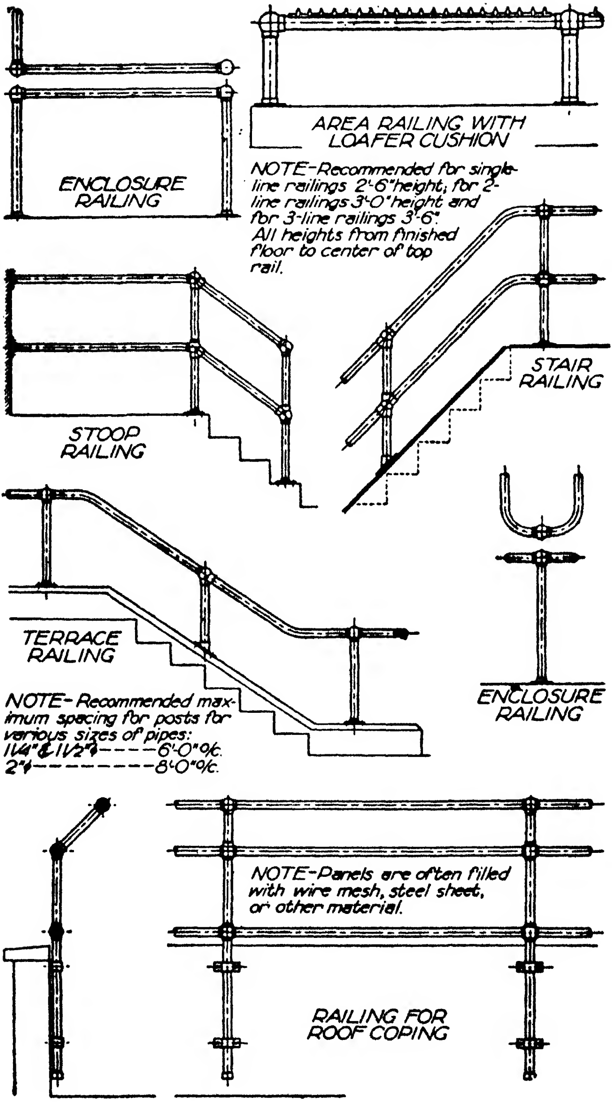


BOARDWALK RAILING

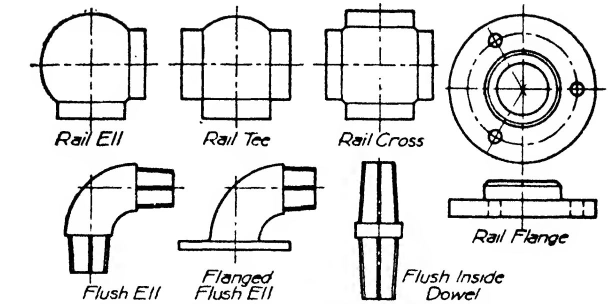


AREA RAILING WITH HAND RAIL

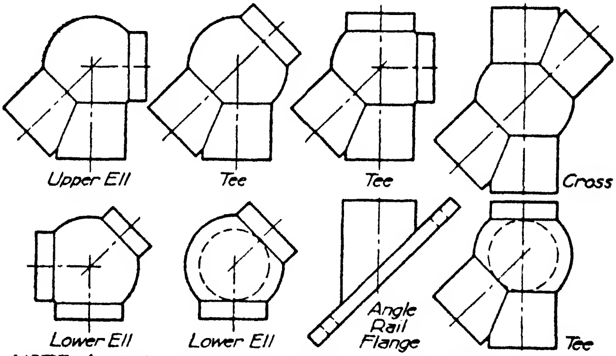
PIPE RAILINGS



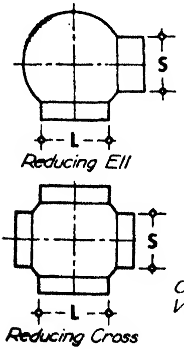
PIPE RAIL FITTINGS



NOTE- Rail Fittings are used with 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", and 3" pipes. Flush Fittings are used with 1 1/4" and 1 1/2" pipes.



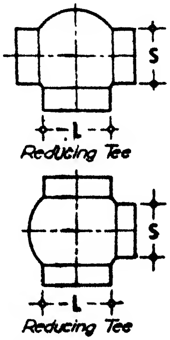
NOTE- Angle Rail Fittings are used with 1 1/4", 1 1/2", and 2" pipes and for all angles from 27 1/2° to 46 1/2°



REDUCING FITTINGS

L	S
1 1/4"	1"
1 1/2"	1"
1 1/2"	1 1/4"
2"	1 1/4"
2"	1 1/2"
2 1/2"	1 1/2"
2 1/2"	2"
3"	2"
3"	2 1/2"

Courtesy
Vulcan Rail & Construction Co.



HOW PORCELAIN ENAMEL PANELS ARE MADE

MANUFACTURER'S PROCEDURE. Eight steps are required to result in a finished porcelain enamel installation. Some manufacturers perform only one of these operations while others undertake several of the steps.

1. Manufacture of the frit
2. Grinding of the frit
3. Manufacture of the enameling sheets
4. Production of shop drawings to show jointing and attachment of each piece to conform with the architect's design
5. Forming of the panels
6. Enameling the panels
7. Backing of the enameled panels, if specified
8. Job installation of the finished pieces.

MANUFACTURE OF THE FRIT. Two types of frit are required. Both types consist essentially of an opaque glass, composed entirely from minerals, having no organic ingredients.

Frit for the *ground coat* contains *adherence oxides* which are so compounded that they have an affinity for the metal and will fuse with it. The mineral ingredients for the ground coat are melted together at temperatures up to 2500° F. By sudden immersion into water, it is shattered by thermal action into light, airy granules called *frit*.

Frit for the *cover coat* is produced in a similar manner but the composition is different. It is composed principally of feldspar (aluminum silicate), cryolite (sodium aluminum fluoride), and fluorspar (calcium fluoride). Feldspar is commonly used in making artificial teeth and opalescent glass. Cryolite produces opacity in glass.

GRINDING OF FRIT. The frit is ground with plain water and clay to make a liquid which passes a 200-mesh screen, comparable to the fineness of flour or face powder. The mixture for cover coats may contain color pigments in the form of mineral oxides. For use, the aqueous mixture is about the consistency of thin cream.

ENAMELING SHEETS. Sheets of special composition have all the metallurgical properties necessary for fine porcelain enamel work. These sheets are very different from the usual sheet iron or sheet steel being uniform in composition; absolutely flat; with a proper ductility for drawing, forming or stamping. The composition is such as to provide a tenacious bond between the porcelain enamel and the metal when the porcelain is fired. As a general rule, 16 or 18 gage sheets are used but 20 gage is sometimes utilized if the finished panel is small in area or is carefully backed up to provide rigidity

SHOP DRAWINGS. There are many methods of attachment in common use for fixing the porcelain enameled panels to the rough walls of the building. Some of these attachment methods are patented and others are not. Some require certain forming of the edges of the panels. If the architect attempts to detail the attachment of every panel before taking figures, he may automatically be limiting himself to a small group of manufacturers or even to a single manufacturer.

For work which requires competitive bidding, it is, therefore, usual for the architect to indicate on his quarter scale drawings only the design, dimensions, desired jointing, and the extent of the various colors to be used. Provisions should be made in the specifications for furring strips of wood or metal if required. A sample should be required of each bidder, to show the attachment device he proposes for use. The specifications should also require in competitive bidding that the successful contractor is to furnish complete shop drawings to show his recommended jointing and attachment methods for the architect's approval.

HOW PORCELAIN ENAMEL PANELS ARE MADE

FORMING THE PANELS. Before enameling, the sheets are sheared, bent, drawn, punched or formed to meet the conditions of the design. Fluting, reeding, louvers (not *louvres*) or other special forming may be required. Flanges, clips and pieces for installation connections are welded in place and filed smooth. Holes are punched or cut preferably at this time—altho a portable electric ceramic hole-saw can be used on the job in emergencies to make holes in the finished porcelain enameled sheets; raw edges should be painted.

The fabricated sheets are cleaned of all dirt and grease and then *pickled* in an acid bath. The pickling removes rust and scale and etches the metal. The result of the etching is not visible to the naked eye, but a magnifying glass will show a roughening of the surface which provides a bond for the adhesion of the ground coat of enamel.

ENAMELING THE PANELS. The metal is dipped or sprayed on both front and back with the liquid mixture of frit. The pieces are then dried at about 200° F. Water is driven off, leaving a layer of powder. The sheets are fired at about 1500° F., fusing the powder. A dark-colored glass-like coating is created, which is bonded intimately with the metal.

For monochrome panels, two thin cover coats are generally agreed to produce the most desirable result for architectural use. The cover coats are applied to face side in a similar manner to the ground coat. The fusing temperature of the cover coats is lower than that of the ground coat, to prevent the second and subsequent firings from loosening the ground coat from the metal.

Panels of porcelain enamel in polychrome generally require that the lightest color in the design be applied over the entire piece. After firing, the next lightest color is dipped or sprayed on and dried. A stencil is then imposed over the piece and the unwanted areas are brushed off. The piece is fired, and the process repeated until all the colors of the design have been applied.

BACKING OF THE SHEETS. Plywood or rigid insulating board may be used to back up the panels for one or more of the following reasons:

1. To reduce the heat transfer thru the wall
2. To deaden the metallic ring of the assembled sheets when struck
3. To increase the rigidity of the panels
4. To reduce or eliminate any waviness in the panel as a result of forming or firing.

Backing materials are usually at least ½″ thick. The material should not disintegrate from water or moisture. When used for sound deadening only, pressure sufficient to make a good joint with adhesive is required. If the backing is to act as mechanical reinforcement, the 2 parts are joined in a press which produces evenly distributed pressures up to 75 lbs. per square inch or more. One manufacturer has developed a sprayed on backing material for sound deadening and to reduce heat transfer, and is applied in ⅛″ thickness.

JOB INSTALLATION. Labor experienced in the erection of porcelain enamel should be used when available. Skilled mechanics should always be employed—unskilled labor never. The craft from which the labor is selected will vary with the method of attachment as well as with local building codes and labor regulations.

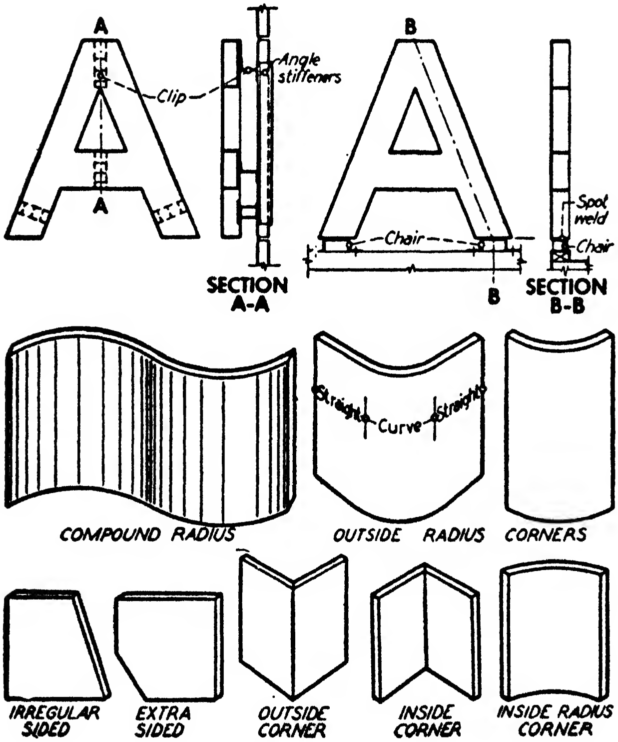
Porcelain enamel panels are usually erected by a sub-contractor under the general contract, from the enameler's shop drawings. Sometimes the work is installed by the enameler or the enamel jobber.

Particular attention should be paid to the erection of the first or lower course of panels. Calking should be forced into the joints on exterior work or watertight interior work, to the full depth of the calking recess. Smears of calking material may be removed with soap and water or gasoline. Soap and water are usually sufficient for the cleaning of the enamel.

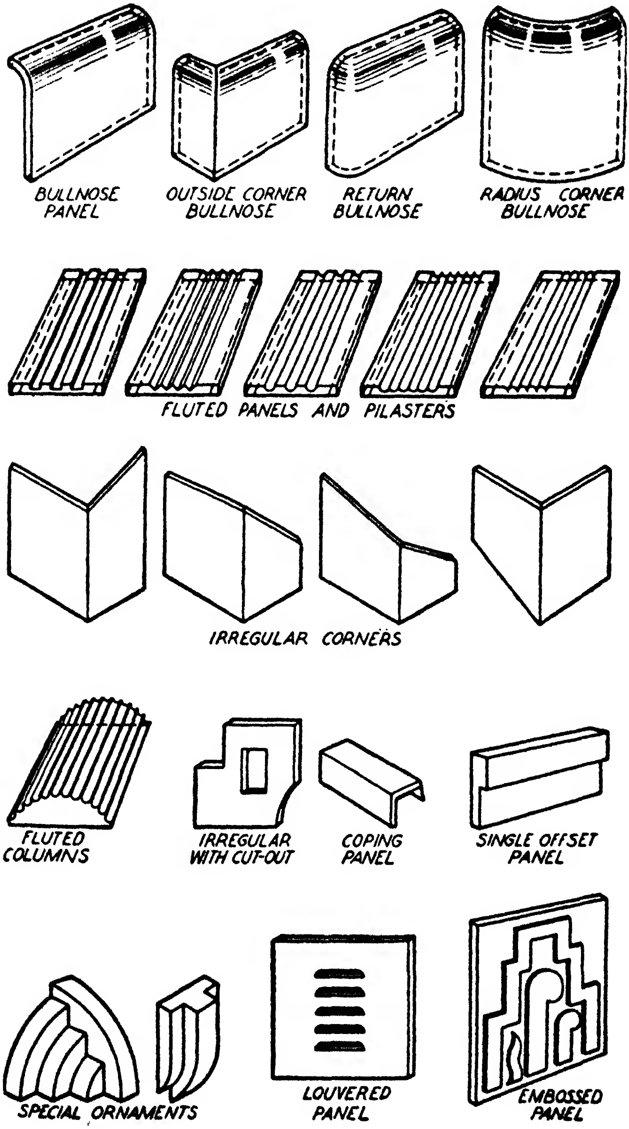
CONTOUR OF SURFACES FOR PORCELAIN ENAMEL

FABRICATING COMPLEX PARTS. Any shape which can be made in sheet metal by rolling, stamping, braking, spinning, or cutting and welding, can be porcelain enameled. If there is a repetition of special parts sufficient to justify the making of dies, the price of a complicated piece may be brought to an economical level.

Some manufacturers have stock dies for certain contours. The designer would do well to consult the manufacturer with whom he is working, to determine the dimensions of such pieces. Die stamped pieces are easier to enamel satisfactorily than welded pieces. It often happens that a manufacturer can suggest a small change in dimensions to make possible a more economical method of fabrication (and erection) than if the original design were insisted upon. It should be noted, however, that since the industry is not standardized, one manufacturer may be at variance with another as a result of differences in their equipment for fabrication. It will often be best to take figures on the original design and then call in selected bidders for their advice after figures are in.



CONTOUR OF SURFACES FOR PORCELAIN ENAMEL



METHODS OF ATTACHING PORCELAIN SHEETS

ATTACHMENT SYSTEMS IN GENERAL. There are a great number of available methods of attaching porcelain enameled sheets to create a finished interior or exterior wall surface. Each attachment method is adaptable to, or requires, a particular type of edge for installation. On the following *Data Sheets* in this series will be shown construction details of representative attachment systems.

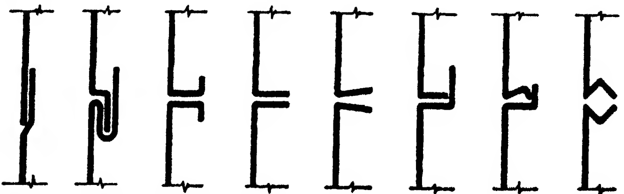
PROVISION FOR FASTENING. Porcelain enamel panels can be installed over any type of rough wall, be it frame, steel skeleton with or without curtain walls, or masonry of any type. It is necessary to provide some means of receiving the screws from the selected attachment device and holding the screws firmly. If furring strips are to be used over masonry, it is advisable to build wood strips into the joints so that furring strips can be nailed to the rough wall. The wood furring strip is the most widely used method of receiving the attachment screws. It is usually necessary to have a furring strip beneath each joint and it is important to introduce additional strips so spaced that the material will be supported from behind at least every 18". In some methods of attachment, the furring strips run only in one direction—either vertically or horizontally. In other systems of attachment they must run in both directions, forming a grid of furring strips.

FLAT SHEETS. In *Figure 1A* is shown the meeting of 2 plain flat sheets. The use of flat sheets is generally confined to interior surfaces. Because the flat sheet does not have the stiffness or rigidity possessed by the flanged types, it is necessary to observe one or more of 3 possible precautions:

1. Use sheet of relatively smaller area
2. Use a heavier gage metal
3. Back the sheet with a rigid insulation or plywood.

1A

SHEETS WITH FORMED EDGES. A typical group of the better known methods of flanging or forming is shown in the figures below. The turning or bending of the edges adds rigidity to the panel as well as creating a contour which lends itself to a particular attachment method. The joint created by most of these systems allows and requires pointing or calking. The calked joints make the resulting wall weatherproof and provide for the expansion and contraction of the enameled panels under the natural changes of temperature to be expected in exterior construction. The backing of the panels with rigid board is optional with most of the attachment systems.

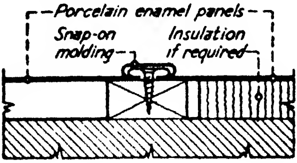


2A 2B 2C 2D 2E 2F 2G 2H

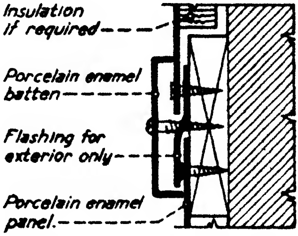
MASONRY BACKED SHEETS. A third classification of porcelain enameled sheets for finished wall surfaces consists of masonry backed sheets. The porcelain enameled sheets and the backing material form an integral unit obtainable in total thicknesses of 1" up to 8" or more. Due to the nature of the masonry backing and the rigidity of the units, the material is installed in exactly the same manner that comparable thicknesses of slate, marble, cut stone or other masonry would be handled.

ATTACHMENT OF FLAT SHEET PANELS

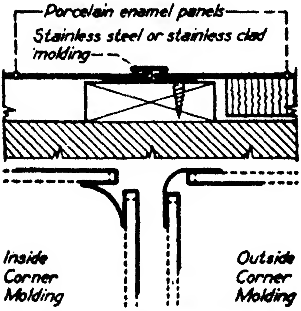
ATTACHMENT OF FLAT SHEETS. The flat panel is most frequently used on interior work, under dry conditions, for decorative purposes. For sound deadening or heat transfer prevention, these attachment methods allow the use of a rigid board if desired. Some are patented, as noted.



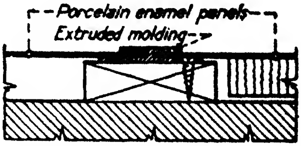
SNAP-ON MOLDINGS. The panels can be removed. A number of manufacturers make suitable snap-on moldings in various metals. Molding covered joints may run horizontally, vertically, or both, depending upon shape and size of panels and their arrangement. It is only necessary to hold 2 opposite edges of any flat porcelain enameled sheet panel. The other 2 edges can be butted and calked. By calking under the snap-on molding track and using the snap-on molding over vertical joints, a sanitary interior wall surface is created, which may be washed down. Not patented.



FLASHING AND BATTENS. This is a flat sheet panel method which can be used for exterior work. The horizontal joints have a small bent piece which acts as flashing. Panels and flashing are screwed into wood furring strips, as shown in the drawing above. The joint is then covered with a batten of porcelain enamel or other metal. The vertical joints are assembled from the back with blind fastenings so that an entire horizontal course is placed at one time. Not patented.

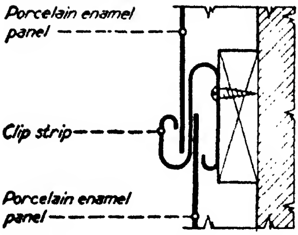


ROLLED MOLDINGS. A patented series of stainless steel moldings is shown above. These moldings allow for the expansion and contraction of the enameled sheets. An edge trim molding (not shown) is also available.

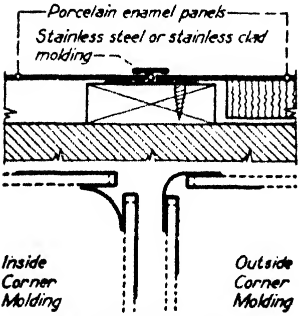


EXTRUDED MOLDINGS. A wide variety of extruded moldings in various metals are available for the attachment of flat sheet panels. The panels are installed progressively with the moldings, as shown. Horizontal or vertical courses can be assembled with blind fastenings so that the moldings occur only in one direction, if desired. For interior use. Some patented, others not.

ATTACHMENT OF FLAT SHEET PANELS



CLIP STRIP. This device is made of stainless steel. Clip strips are screwed to the wall or furring in a horizontal direction, one above the other, the proper distance apart. The top edge of a porcelain enameled sheet is inserted in the deep rear groove of the clip strip. Then with a downward motion the bottom edge of the same sheet is slipped into the outer groove of the next lower strip. The ends of the porcelain enameled sheets are overlapped. Holes at proper intervals in the middle leg of the strip allow the introduction of a screwdriver for attaching the strips to the furring. This is a proprietary product of Steel Buildings, Inc., Middletown, Ohio.



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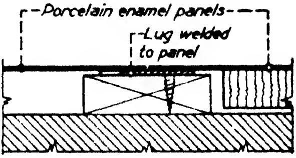
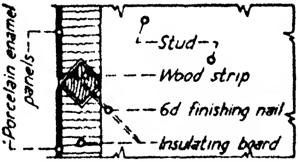
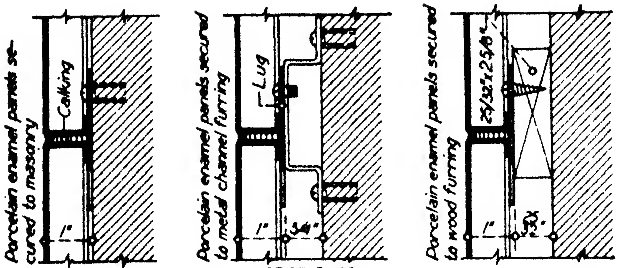


WELDED LUG. This is the same system as used in the lug and pan attachment as applied to formed edge panels. This method of attachment is not patented. It is an interlocking system, the panels being erected in sequence from the lower left of the facade upward and to the right. Furring strips are placed horizontally and vertically behind the joints. No intermediate strips are needed. This system is adaptable to interior use. With careful installation, the joints can be made very fine.



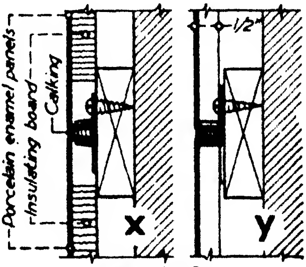
VEE CLAMP. A rigid insulation is cemented as a backing for flat panels. The edge of the insulation is grooved. The lower edge of the panels in a horizontal course is fitted over the top edge of a continuous square wood strip. At the top of the course another wood strip is installed and nailed into the studding or furring, and the process repeated. The joints are subsequently calked with mastic. The vertical joints may be handled in the same way as horizontal joints, thus holding the panels on all 4 sides. Vertical joints may also be calked or covered with molding. May be used on interior or exterior. Proprietary method of Ferro Enameling Co., Oakland, California.

PAN-AND-LUG ATTACHMENT

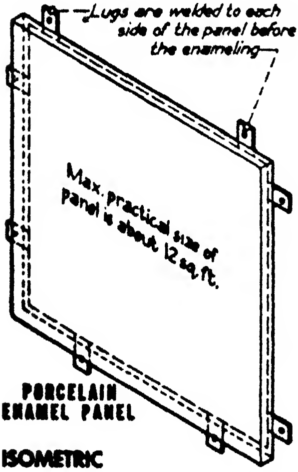


SECTIONS

One of the common methods of attachment for sheets having formed edges is known as the *pan and lug system*. This method of attachment is not patented. The depths of the pans may vary from ½" up to 2"—1" representing the majority of cases. This is an interlocking method as shown at the lower right, the panels proceeding from the lower left of the facade upward and to the right. If a masonry wall is extremely smooth and plumb, plugs may be used to receive the attachment screws. Usually metal or wood furring strips are used, which allow shimming to arrive at a plane wall. In *X* and *Y* are shown 2 variations of the formed edge. The method *X* forms a key for the calking so that it cannot work out of the joint.

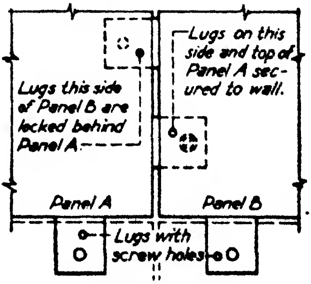


SECTIONS



PORCELAIN ENAMEL PANEL

ISOMETRIC



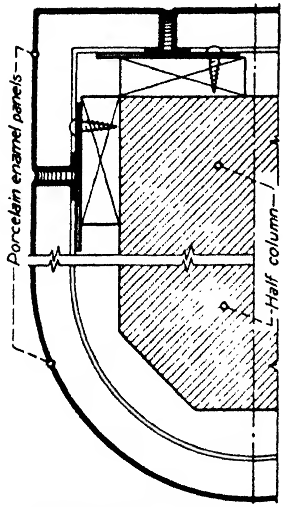
ELEVATION

NOTE– On exterior work the joints are filled with calking. On interior work the joints may be made so narrow that no filler is required.

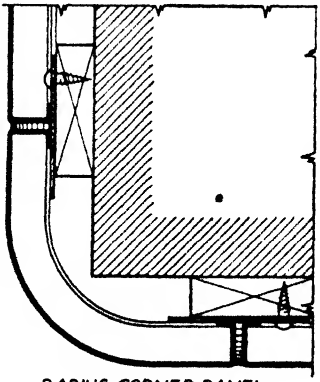
DETAILS OF PAN-AND-LUG ATTACHMENT

It is not necessary tor the architect to work out all these attachment details since the porcelain enamel fabricator is more experienced and familiar with the details of the attachment method. The architect should show the design and jointing he desires and provide for adequate furring. The details should be left to the manufacturer to work out and submit for approval.

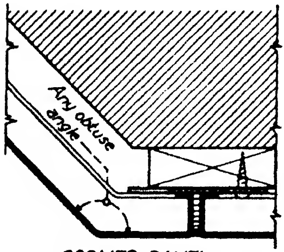
It must be remembered that almost any shape or contour which can be formed in sheet metal can be porcelain enameled and erected. The manufacturer may suggest slight changes in the jointing which will result in a simpler and more economical attachment.



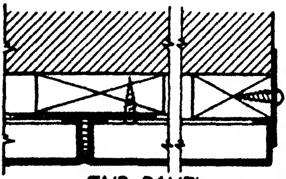
HALF ROUND COLUMN



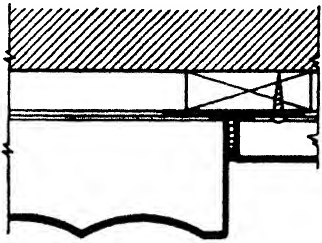
RADIUS CORNER PANEL



CORNER PANEL

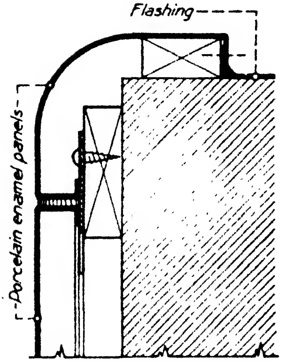


END PANEL
Detail showing porcelain enamel panels secured to wood furring strips

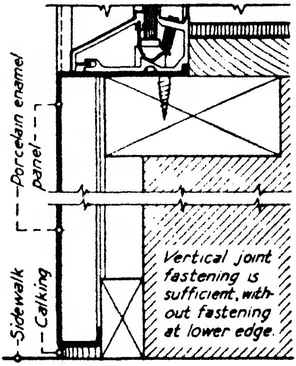


FLUTED PILASTER

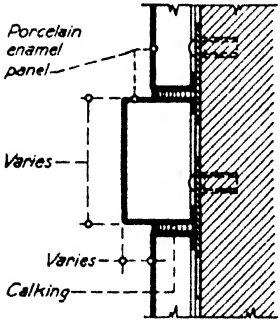
DETAILS OF PAN-AND-LUG ATTACHMENT



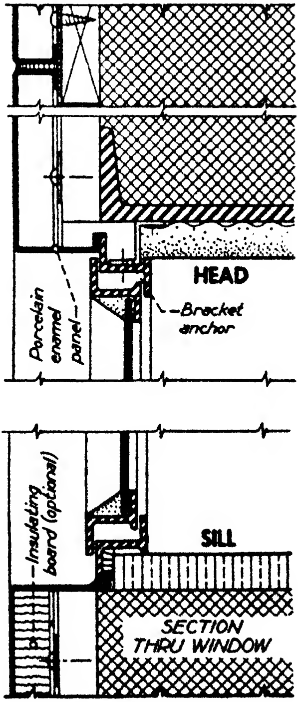
RADIUS COPING



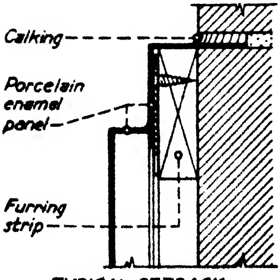
PANEL AT SIDEWALK



PROJECTING BAND

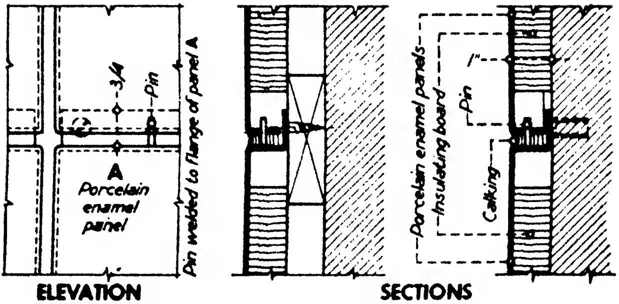


SECTION THRU WINDOW



TYPICAL SETBACK

ATTACHMENT METHODS FOR FORMED EDGE PANELS



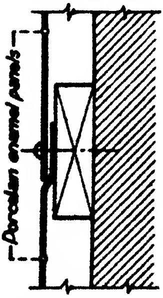
PINS AND HOLES METHOD

PINS AND HOLES METHOD. The bottom and 2 sides of the panel have a plain flange. The top edges have turned-up flanges which flash the horizontal joints. This flashing can be made continuous by adding a small piece of light gage metal at each vertical joint. The top edge should be screwed 18" o/c to wood or metal furring strips, or directly to the masonry. Pins in the top flange engage holes in the bottom flange of the next course above. Installation is begun at the bottom and proceeds in vertical rows. Patent rights in doubt.

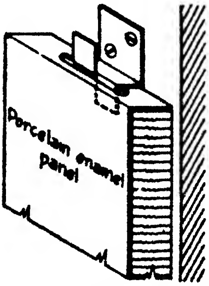
LAP JOINT. For interior work with exposed fastenings. Panels should be backed if placed where people may lean or push on the panels. Two adjacent edges are formed, the other 2 being flat. Not patented.

LOCK CLIP. A slot in the edge of the porcelain enameled panel is engaged by the flanges of a clip, as shown below. The panels are placed, the clips are then fastened to masonry plugs or furring strips and the next panel is placed to engage the free clip leg. Proprietary product of Frank Allen, San Francisco, Calif.

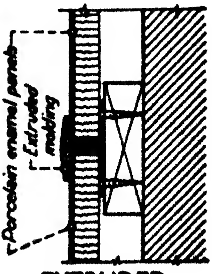
EXTRUDED MOLDING. A number of manufacturers make extruded moldings which are suitable for panels of various thicknesses, for interior use. Panels may be held by the moldings in horizontal joints, or vertical joints, or both. Panels can be made to touch where joints have no molding. The pan-shaped panels may be used with or without backing. Some patented, others are not.



LAP JOINT

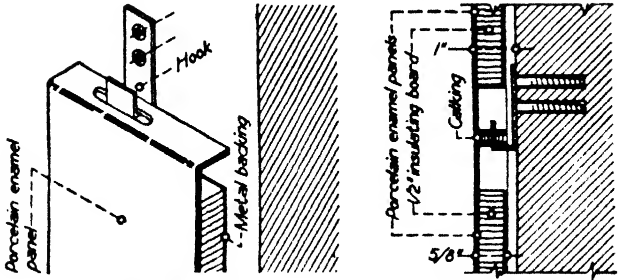


LOCK CLIP



EXTRUDED MOLDING

ATTACHMENT METHODS FOR FORMED EDGE PANELS



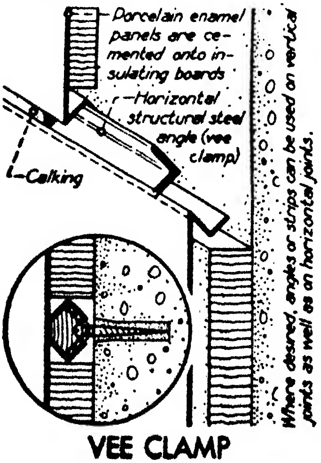
ISOMETRIC SECTION

HANGING HOOK METHOD

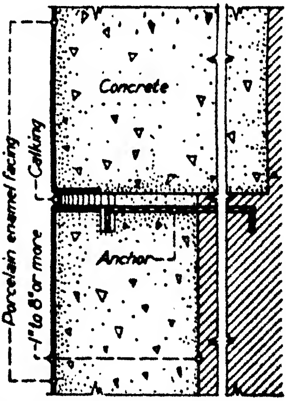
HANGING HOOK. The flanges of the pan shaped panels have slotted holes. The hooks, attached to the wall or to furring strips, allow the independent removal of any panel. Device used by Porcelain Products Co., Cicero, Ill.

VEE CLAMP. The lower edge of the panels in a horizontal course are fitted over the top edge of the continuous horizontal angle. At the top of the course another angle is installed and the process repeated. Angles, strips, or calking can be used on the vertical joints as desired. Proprietary product of Ferro Enameling Company, Oakland, Calif.

MASONRY-BACKED PANELS. Panels are anchored to the light weight concrete backing. Larger units have steel lifting hooks to facilitate handling. The units are load-bearing and are set on a mortar bed similar to other masonry. Stainless steel edgings are also available. Proprietary product of Maul Macotta Corp., Detroit, Mich.

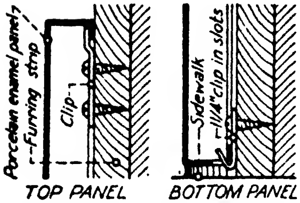


VEE CLAMP

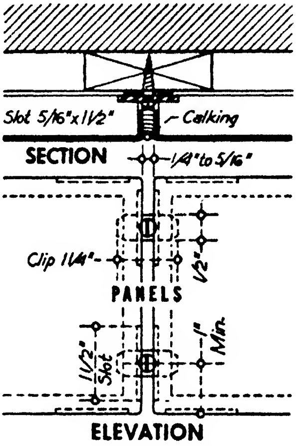


MASONRY-BACKED PANELS

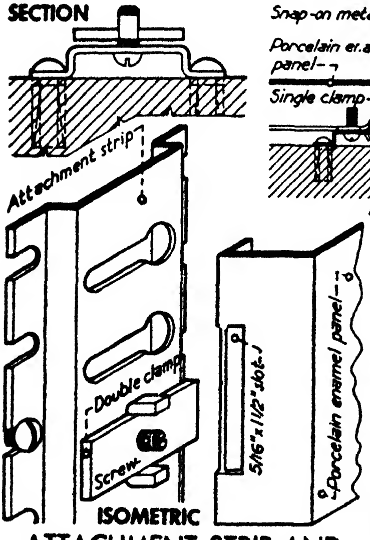
ATTACHMENT METHODS FOR FORMED EDGE PANELS



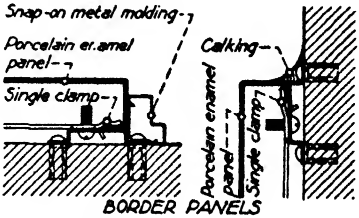
SLOT CLIP METHOD. This method allows removal of any individual panel. The bottom row of panels is attached with a simple hook engaging the slots on the bottom edge. Work proceeds from bottom upward and from left to right, or right to left. When one panel is in place, adjoining panels are slipped into place so that the clips engage the slots. Clips are then placed in the slots on the exposed edges of the last panel and the process repeated. Proprietary product of the Enamel Products Company, Cleveland, Ohio.



SLOT – CLIP METHOD

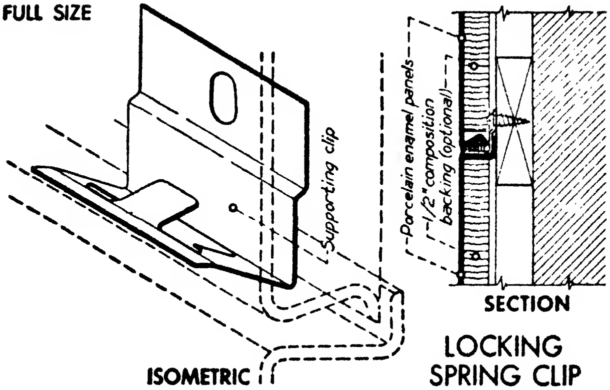


ATTACHMENT STRIP AND SCREW CLAMP METHOD



STRIP AND SCREW CLAMP. A continuous metal strip is designed to act both as furring and as part of the attachment device. These strips are secured to the wall under the vertical joints. The clamps engage slots on the edges of the panels. Lugs on the clamps space the panels to create uniform joint widths. The clamp is tightened with a machine screw. Joints are calked. Single clamps are available for edge panels. Must be ordered in not less than 1000 ft. lots. Proprietary device of the Grabler Manufacturing Co., Cleveland, Ohio.

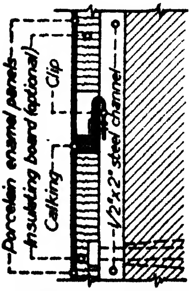
ATTACHMENT METHODS FOR FORMED EDGE PANELS



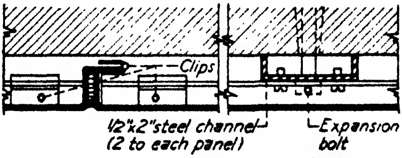
LOCKING SPRING CLIP

LOCKING SPRING CLIP. Steel furring strips are recommended altho wood furring strips may be used. Bottom clips are applied first, then the panel is placed in position and the top clips applied. Clips are applied to metal furring with self-tapping screws, to wood furring with wood screws. The ⅛" joints are calked after panels are in place. Calking is keyed by the shape of the flanges. Each panel is individually suspended, any panel being removable without disturbing the adjacent panels. Proprietary product of Kawneer Co., Niles, Mich.

HANGING CLIP. In this method channels (or wood furring strips) are applied vertically, 2 to each panel. The upstanding flange on the top edge of a horizontal course of panels is attached to the steel channels with self-tapping screws. The bottom and left-hand edges of the next row of panels has a hanging clip welded to the flange. The panel is dropped over the upstanding flange, engaging the hanging clips. Then the top edge of this panel is again fastened and the process is repeated. The joint is self-flashing and is calked. Proprietary device of Wolverine Porcelain Enameling Co., Detroit, Mich.



TYPICAL HORIZONTAL JOINT FOR STEEL CHANNEL FURRING

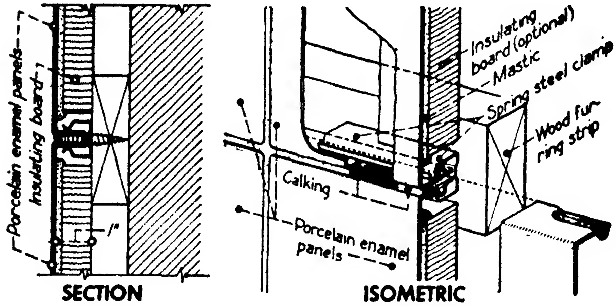


HORIZONTAL SECTION SHOWING TYPICAL VERTICAL JOINT

SECTIONS

HANGING CLIP METHOD

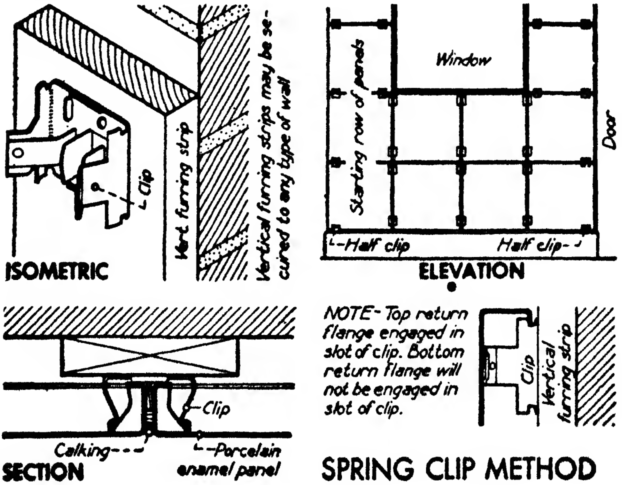
ATTACHMENT METHODS FOR FORMED EDGE PANELS



SPRING CLAMP METHOD

SPRING CLAMP. The "clips" or clamps are attached to the wall or to furring strips and the flanges of the panels have hollows which engage the spring clamps. Each panel can be independently removed and does not rest or depend on adjacent panels. For interior work the joints can be made extremely narrow and left without calking. For exterior work the joints are calked. Proprietary method of General Porcelain Enameling & Mfg. Co., Chicago, Ill.

SPRING CLIP. Furring is placed on the building at the center lines of vertical joints and on horizontal joints where needed around windows and at the edges of walls. Work may start at any point. The clips at the top of each panel act as hangers to support the weight of the panel, as well as a holding device. Proprietary device of the Toledo Porcelain Enamel Products Co., Toledo, Ohio.



SPRING CLIP METHOD

PORCELAIN ENAMEL CHARACTERISTICS AND FINISHES

CHARACTERISTICS. Porcelain enamel is a completely versatile material which can be applied to supporting framework of wood, steel, or any form of masonry. Porcelain enameled sheets are durable, have unusual resistance to abrasion. The material has almost unlimited possibilities of surface contours. Being a vitreous material, it is non-porous, non-absorbent, and is as easily cleaned as an enameled kitchen pot. It is light in weight, the finished product usually weighing less than 3 lbs. to the square foot. Porcelain enamel requires practically no maintenance. The panels are not generally damaged by fire or violent changes in temperature. No other material offers a more favorable group of properties and characteristics at so low a cost.

USES. Porcelain enamel is particularly adapted to uses where rigid sanitation is a requisite, where the appearance of absolute cleanness is a commercial asset, and where the character of the building demands the high attention value contributed by the color and brilliance of porcelain.

COLOR AND DECORATIVE PATTERNS. Porcelain enamel is essentially an opaque glass. It should not be confused with either brushed or baked organic enamels, belonging in the category of painter's materials. Porcelain enamel is composed entirely from minerals having no organic ingredients. History records no permanent colors except in the field of glass and ceramics. Porcelain enamel offers a complete range of lasting colors of any value or intensity. The complexity of polychrome designs is limited only by the designer's ingenuity and the building budget available. Stippled effects can be produced readily. Designs of diversified character can be printed by a screen process and fired.

COVER COAT ENAMELS. Cover coats should be selected on the basis of the severity of exposure. Three general types of cover coat enamels are available:

1. Regular
2. Weather-resisting
3. Acid-resisting.

Enamel surfaces should withstand the Porcelain Enamel Institute's standard tests for specified properties and classification. Weather-resisting enamel should be specified for outside exposure. Regular enamels may be used for interiors when not subjected to corrosive conditions. Acid-resisting enamel should be specified for especially corrosive locations. Acid-resisting porcelain enamel is a comparatively recent development. It is non-porous to a degree that repels the attack of all ordinary acids that are encountered in building service. A number of the enameling manufacturers recommend it for all exterior uses.

ENAMEL FINISHES. Two general types of finishes may be specified. The first is variously termed *glossy, glaze* or *lustrous*. This finish has been most used up to this time because of applications demanding a brilliant surface and, consequently, high attention value. The second type is known as *matte* finish. A dead matte surface is not practicable in porcelain enamel because such a surface would readily collect dirt and would not have good weathering properties. Therefore, even the so-called matte enamel produces a fair image of reflection in a flat area.

SURFACE TEXTURES. The breaking up of flat surfaces by means of corrugations and other embossed over-all patterns presents many interesting decorative possibilities. Narrow corrugations or reeding about $\frac{3}{16}$" o/c produces a surface not unlike the tooling of stone. The corrugations create a dull or matte effect and correct the tendency of slight waves in the panels to be accentuated. Great stiffness is added to the metal by this corrugating or reeding, making it possible to use lighter gages of metal.

2-INCH SOLID
PLASTER PARTITION

COST. Two-inch solid metal lath and plaster partitions have been widely used in many hospitals, offices, hotels and apartments, and many other types of buildings. Favor is shown for this system by Federal housing authorities who require low initial cost with structural soundness and minimum repair and replacement costs during a long period of amortization. Simplicity of erection allows, in some sections of the country, a cost lower than that of wood stud, lath and plaster walls.

USEFUL FLOOR AREA. Space economy is secured by the exceptionally small amount of floor area required, as compared with other thicker partitions, resulting in up to 7% more rentable space. Or, if the number and size of rooms are to remain constant, construction costs can be considerably reduced thru a diminished gross building area.

SOUND INSULATION. 2-Inch solid partitions with a noise reduction factor of 37.7 decibels is effective as a noise insulator, and as a result of scientific tests has been found satisfactory for use in apartments, schools, offices, hotels and similar buildings. Generally the reduction in sound depends on the comparative weights of partitions. The solid structure of this system is superior to 4″ or 5″ wood stud walls of the same weight.

The reason for the exceptional sound insulation properties of the 2-Inch solid partition is believed to lie in its great density. Its steel core provides unusual resistance to the transmission of sound, much as comparatively thin plate glass does in telephone booths, radio studios and the like.

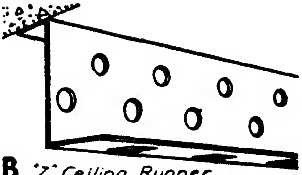
FIRE PROTECTION. Composed entirely of solid metal and gypsum, the 2-Inch solid partition is an excellent fire barrier, making possible the heading-off of a fire with resulting safety to life and property. In recent official tests, a 2″ partition system was subjected to intense heat and flame for 4 hours without failure. At the end of these tests the temperature had reached 2000°— hot enuf to melt glass and destroy certain types of masonry—but the solid partition continued to stand up. Securely attached and 2-way reinforced from floor to ceiling, it provides a continuous, unbroken fire barrier.

CRACK AND IMPACT RESISTANCE. The 2-Inch solid partition is a system built from steel and gypsum to form a monolithic unit, rigidly anchored from floor and ceiling. Its plaster base is a 2-way reinforcement of metal lath securely attached over sturdy metal channel studs. The final 2″ slab is resistant alike to shear, tension, impact and vibration. This resistance to shocks and cracks and resulting absence of repairs account for the choice of 2″ solid partitions by Federal housing authorities.

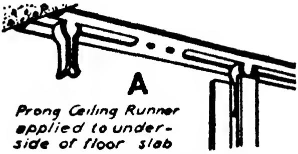
WEIGHT REDUCTION. 2-Inch solid partitions weigh only 17.5 pounds per square foot as compared with 27.5 pounds for 3″ clay tile and plaster walls. Thus, large savings can be effected in the steel or concrete framework of modern buildings. It should be noted that this increased weight effects the cost of steel columns as the *square* of the height.

ADAPTABILITY. 2-Inch solid plaster partitions are admirably suited for use as non-bearing partitions or enclosures such as office partitions which may be frequently altered to meet tenant requirements; partitions in apartments between tenants and around corridors; as enclosures around elevators and stairways; and as separations in schools, factories and homes.

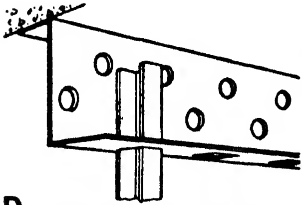
2-INCH SOLID PLASTER PARTITION



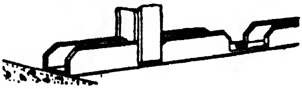
B "Z" Ceiling Runner applied to under-side of floor slab

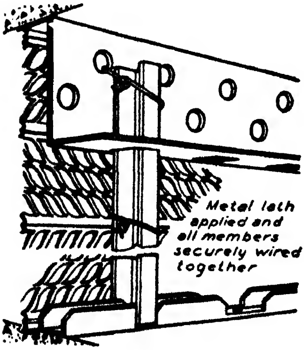


C Channel Floor Runner applied to floor



D Channel Stud slipped into "Z" Ceiling Runner holes and held by Floor Runner Slots





A. PRONG CEILING RUNNERS. These give utmost flexibility and speed of erection. Nailing surface is flat for rapid and accurate attachment to concrete ceilings with stub nails. Vertical prong is rigid, and long enuf to "take up" variations in ceiling height. Top runner fabricated from No. 20 gage black steel sheets. Vertical prongs spaced at the factory for any job.

B. "Z" CEILING RUNNERS. Attached with concrete stub nails or rawl drives. Lower horizontal surface perforated for steel channel studs. Variations up to 2" in ceiling height are automatically taken care of. No cutting or reshaping on the job.

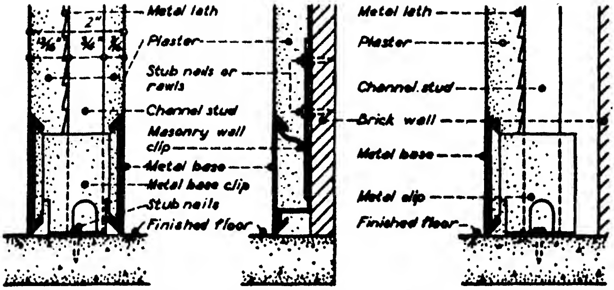
C. CHANNEL STUDS. 3/4" cold rolled channel fabricated from best quality open hearth 16 gage steel. Available in either 16'-0" or 20'-0" lengths.

D. CHANNEL FLOOR RUNNERS. Side flanges are punched every 2" to receive vertical studs. Flat section contains holes 12" o/c for direct attachment to floor. Studs drop securely in place, no wiring is necessary. Channel floor runners may be used at door and window frames.

WEIGHTS OF METAL LATH

Type of Lath	*Weight Lbs. per Sq. Yard*	*Spacing of Supports*
Diamond Mesh Lath	2.5	16"
	3.4	16"
Flat Rib Lath	2.75	16"
	3.4	24"
3/8" Rib Lath	3.4	24"
	4.0	24"

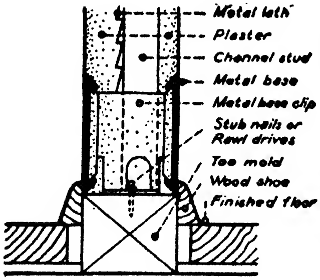
BASE DETAILS



DOUBLE BASE CLIP AND METAL BASE ON CONCRETE FLOOR

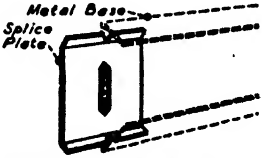
MASONRY WALL CLIP AND METAL BASE ON CONCRETE FLOOR

FURRED WALL CLIP AND METAL BASE ON CONCRETE FLOOR

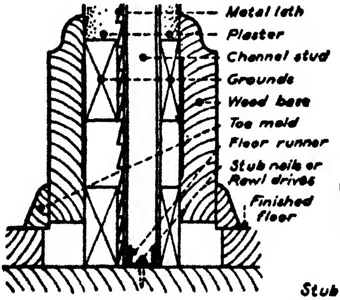


METAL BASE ON WOODEN FLOORS

The metal base shown allows economical installation. Base may be cut or bent to fit job conditions. Costly ends or angle units are not required. Metal base clip is nailed to the floor and metal base set and locked to it. Furred and masonry wall clips available for adjacent walls. Lengths of base are joined with splice plates. Cutting and bending equipment is available at low rental.

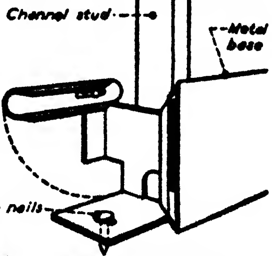


SPLICE PLATE FOR JOINING BASE



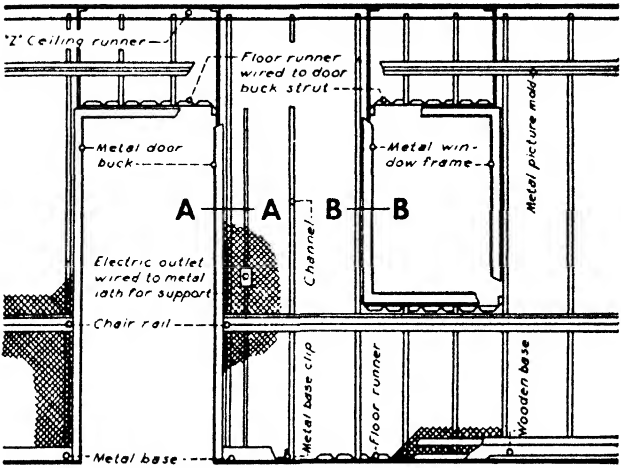
WOOD BASE
Showing channel floor runner applied to wood sub-floor

SCALE
3" = 1'-0"

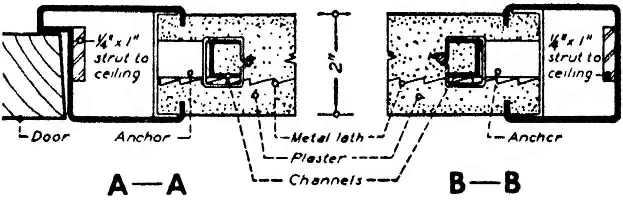


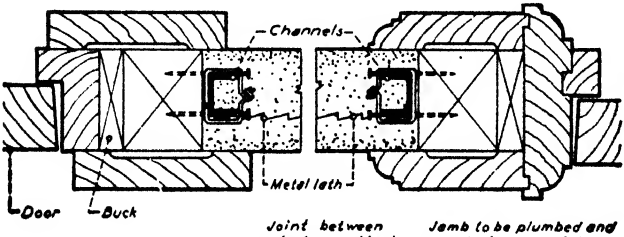
DOUBLE BASE CLIP

TREATMENT OF OPENINGS IN 2 INCH SOLID PARTITION



NOTE Erect steel channel with recommended spacing which depends on type and weight of metal lath





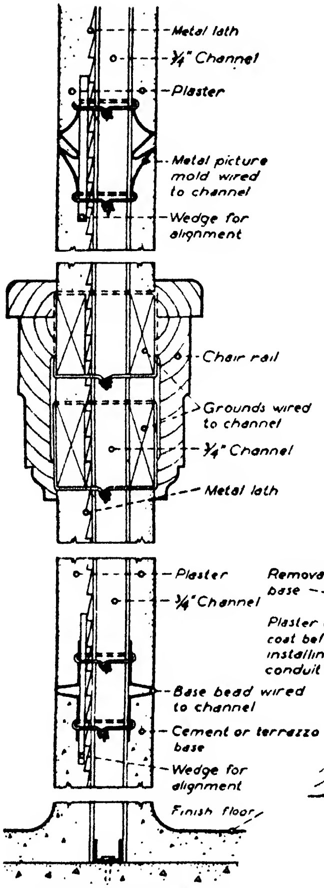
Joint between plaster and buck to be covered at least 1" by trim

Jamb to be plumbed and erected separately after which casings are applied

NOTE: This one-piece jamb recommended because width provides maximum resistance to impact of door

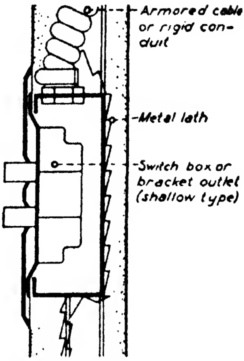
SCALE 3" = 1'-0"

INSTALLATION OF TRIM AND ELECTRICAL WORK

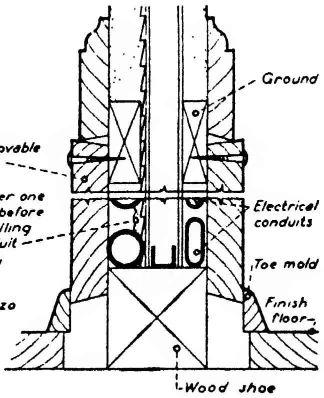


TYPICAL WALL SECTION

showing channel floor runner applied to top of rough slab



SWITCH BOX can be set either on channel side or lath side of partition



WOOD BASE

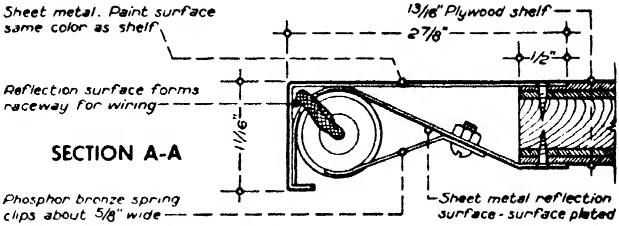
Showing removable parts to allow access to space housing electrical conduit

SCALE 3" = 1'-0"

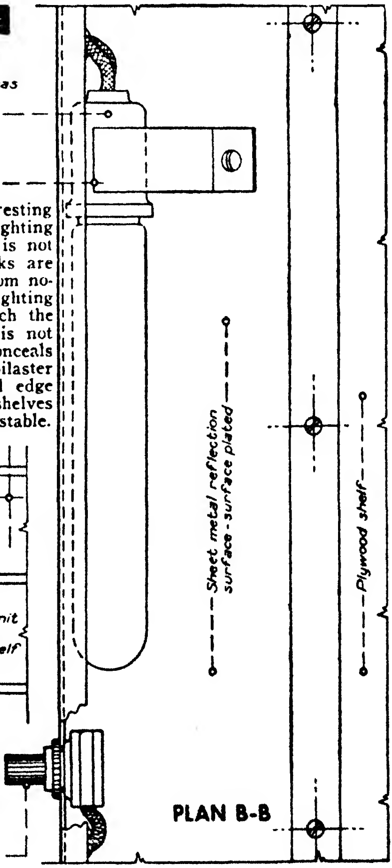
ELECTRIC. To assure a satisfactory installation, specify switches and receptacles as "shallow" devices and install in shallow boxes.

PLUMBING. It is recommended that no pipe exceeding 1" be installed in a 2" solid partition. Run any work other than short, simple runs in pipe chases of 2" solid partition construction and fit with access doors. Approved hangers on substantial construction must be used for any fixtures and must be installed before the final plaster coat is applied.

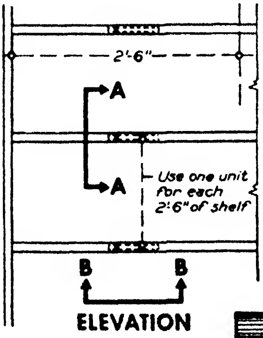
MYSTERY LIGHTING FOR BOOKCASE



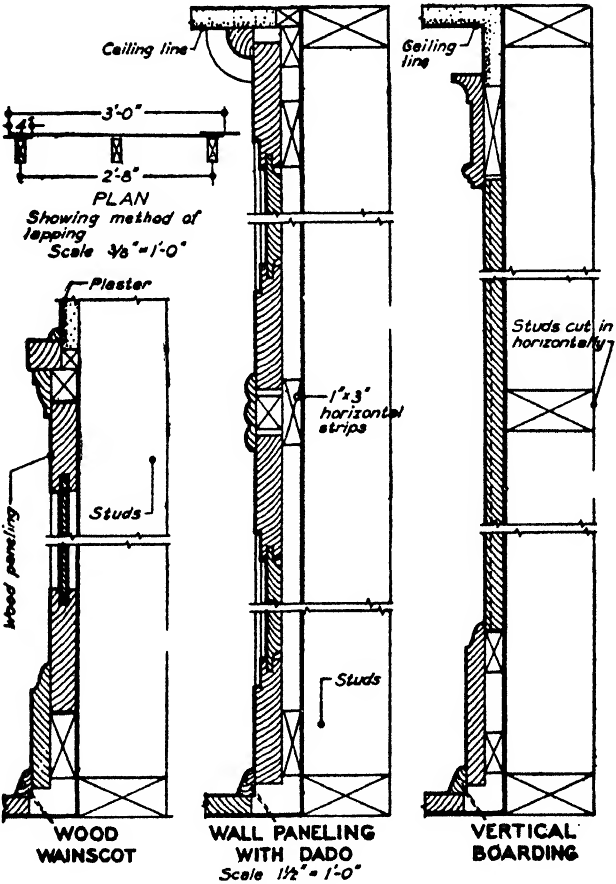
SCALE—HALF FULL SIZE



This is a very interesting method of bookcase lighting since the source of light is not visible and the book backs are apparently illuminated from nowhere. The edge of the lighting trough is finished to match the rest of the case and it is not apparent that this edge conceals the light sources. With a pilaster or return on the vertical edge to conceal the wiring the shelves may even be made adjustable.

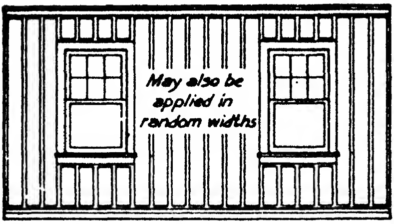


WOOD FINISHED INTERIOR WALLS



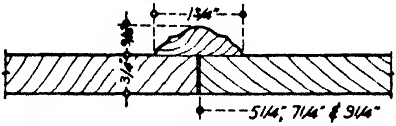
Plaster may safely be omitted from behind wood wainscots, paneling or vertical boarding by following the construction shown in the drawings above. The use of fiber-reinforced paper behind the wood effectively stops air movement, protects the wood from moisture which makes the joints open and which often makes the paneling warp. A further advantage is that wood grounds for nailing may be eliminated entirely or kept to a minimum. Where the horizontal members are cut between the studs, the room dimensions are increased by the thickness ordinarily occupied by the plaster. In the case of wood wainscots, the plane of the finish wood projects less from the plane of the plaster above, minimizing the width of the cap member.

INTERIOR WALLS OF ARKANSAS SOFT PINE

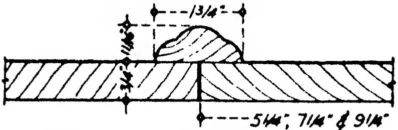


ELEVATION OF CAPE COD OR SALEM VERTICAL WAINSCOTING

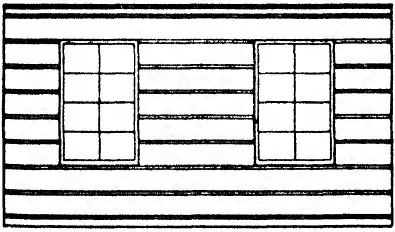
ELEVATIONS - Scale 1/8" = 1'-0"
DETAILS - Scale 3" = 1'-0"



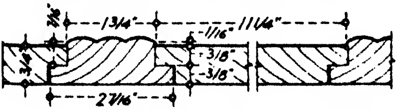
DETAIL OF CAPE COD MOLDING



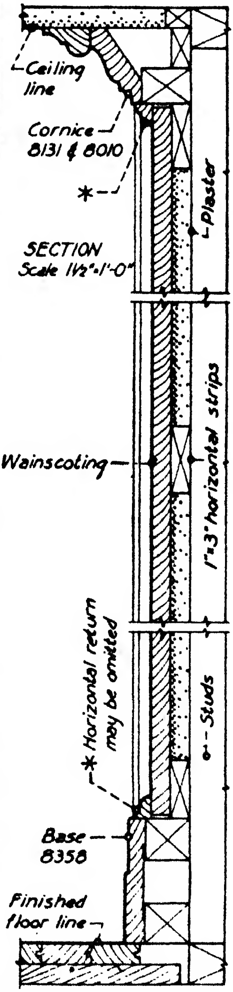
DETAIL OF SALEM MOLDING



ELEVATION OF STREAMLINE HORIZONTAL WAINSCOTING

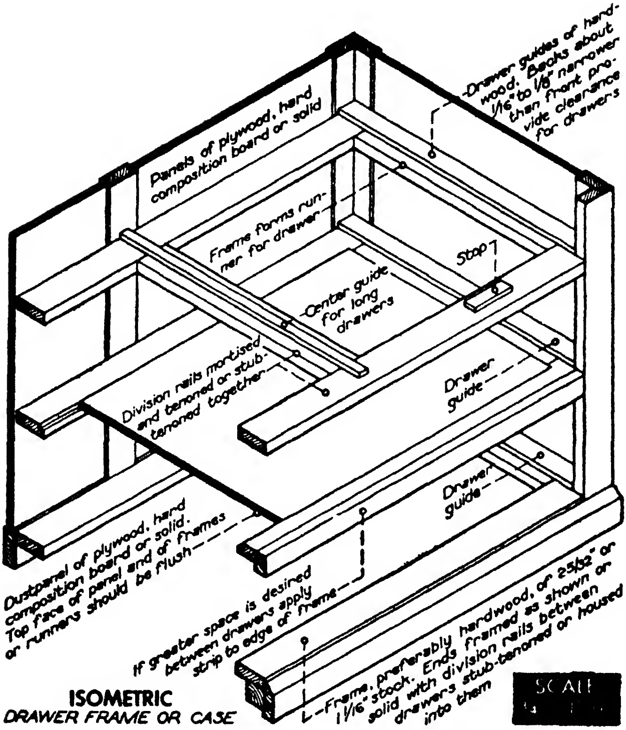


DETAIL OF STREAMLINE MOLDING



TYPICAL SECTION THRU WOOD WAINSCOTING

CABINETWORK ESSENTIALS



ISOMETRIC
DRAWER FRAME OR CASE

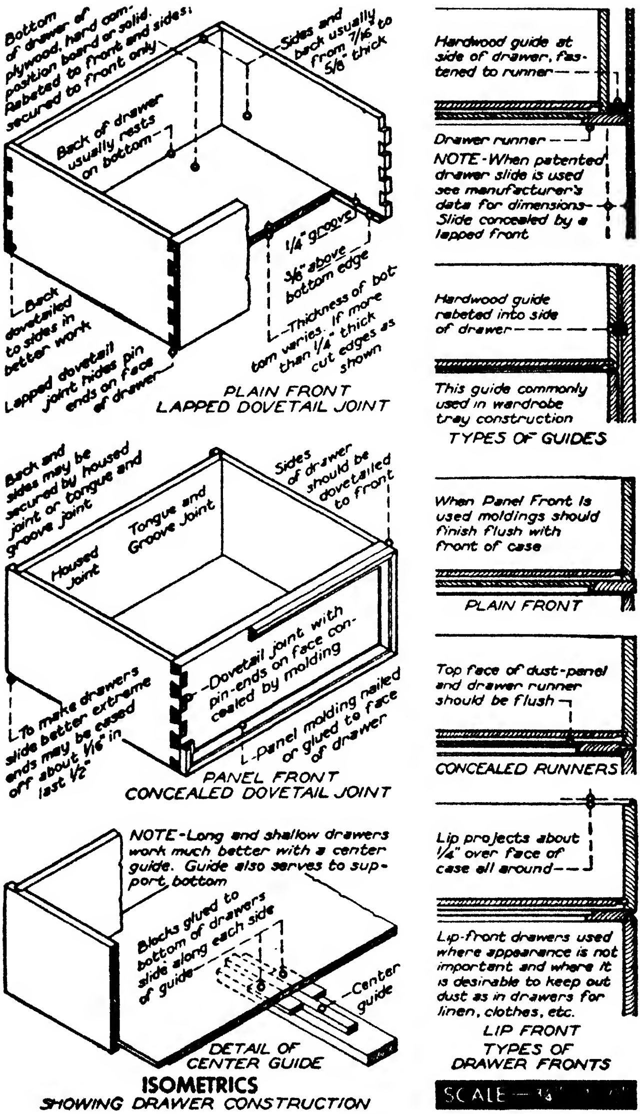
Wood selected for use in cabinet work must be thoroly seasoned and should be without defects in any exposed parts. The use of well-seasoned material reduces warping, shrinking or swelling to a minimum. Installation of cabinet work should be left until all the moisture within the building has evaporated and the plaster is dry.

The frame or case forms the containing framework of all typical cabinet construction, whether used to contain drawers or as a cupboard. The successful operation of drawers depends upon the construction of both drawer and the frame in which it works.

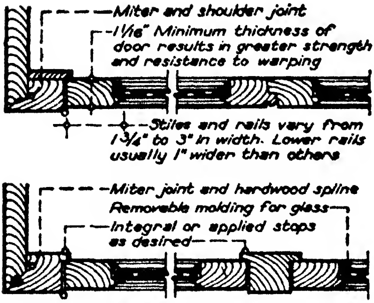
The drawing above shows the usual construction of a drawer frame, which should be so made that there will be only sufficient contact with the drawers to support and guide them. The frame is usually mortised and tenoned together with division rails between drawers added as required. In better work a dust-panel is installed in the frame between the drawers. It is important that if drawers are to operate properly, without sticking, that the guides at sides be narrower at the back than the front to provide necessary clearance.

The drawer itself consists of a box constructed in a special manner. Drawers slide on bottoms of side pieces which should be dovetailed to the front, and in better work to the back also. Dovetails should be fairly small with very little taper, fit snugly and be closely spaced to form perfectly secure glued joints.

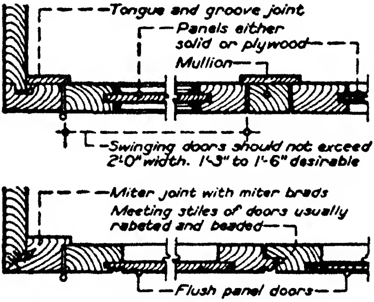
CABINET DRAWER DETAILS



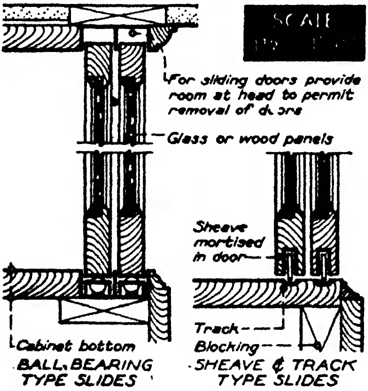
CABINET DOOR DETAILS



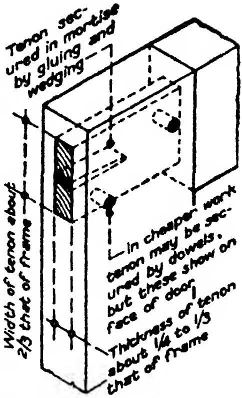
TYPICAL DETAILS *FOR GLAZED DOORS*



TYPICAL DETAILS *FOR PANELED DOORS*

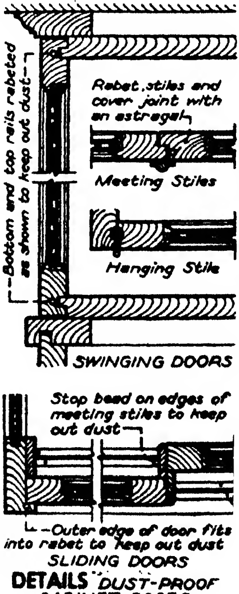


TYPICAL DETAILS *FOR SLIDING DOORS*



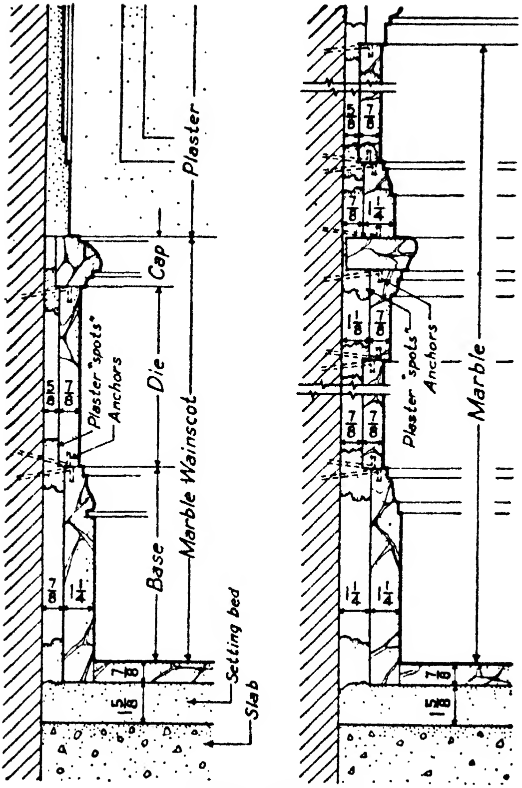
ISOMETRIC *SHOWING MORTISE AND TENON*

This joint should be used in constructing cabinet doors



DETAILS *DUST-PROOF CABINET DOORS*

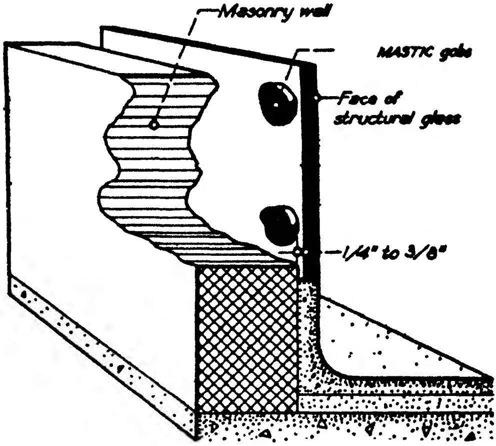
MARBLE WAINSCOTS



Scale 1½" = 1'-0"

1½" is the very least space that should be figured from rough wall face to finish marble face for wainscot or ashlar. Some of the marbles containing a large number of natural faults require reinforcing liners and need a minimum of 2½". Concealed anchors are used for fastening the marble to the rough wall. These are usually of 9 gage copper, brass, or aluminum wire. The number of anchors to be used should be left to the discretion of the marble contractor. The space behind the marble should never be filled solid with plaster of paris, spots only allowing for contraction and expansion and thus preventing cracks.

MASTIC SETTING OF STRUCTURAL GLASS



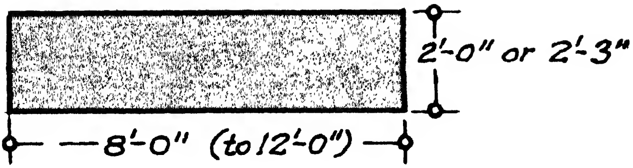
STRUCTURAL GLASS SETTING MATERIALS. Three types of materials are required for the setting of structural glass. First, a primer must be applied to the backing wall to provide a bond for the mastic. Second, a permanently elastic adhesive is required to hold the structural glass to the wall. Third, the joints in the glass require a pointing compound.

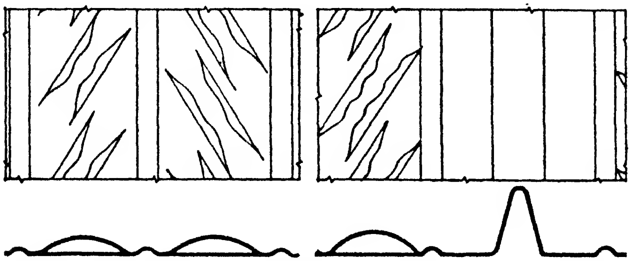
WALL PREPARATION. Masonry of almost any kind or cement-plastered metal lath on frame provide the necessary rigidity and strength required to receive structural glass. Wood sub-surfaces should be avoided. The wall should be thoroly dry and free from grease, oil, dust, dirt and loose material. Two thin coats of a black asphaltic priming paint should be applied to the wall and allowed to dry thoroly. This allows the mastic to adhere to the wall and also serves as a waterproofing.

STRUCTURAL GLASS POINTING COMPOUND. This material is made in black and white. For tints, it has been found economical to use the white base and tint with oil tube colors. If required in sufficient quantities, the manufacturer will supply tints to match structural glass. Compounds are available in "buttery" consistency for pointing after installation of glass is complete; and "heavy" for spreading on joints as glass is installed.

HOW TO SPECIFY. *Install structural glass where shown on drawings, using 2 thin coats of priming paint, mastic, and pointing compound, in strict accordance with recommendations and instructions of the manufacturer.*

SHEET LATH





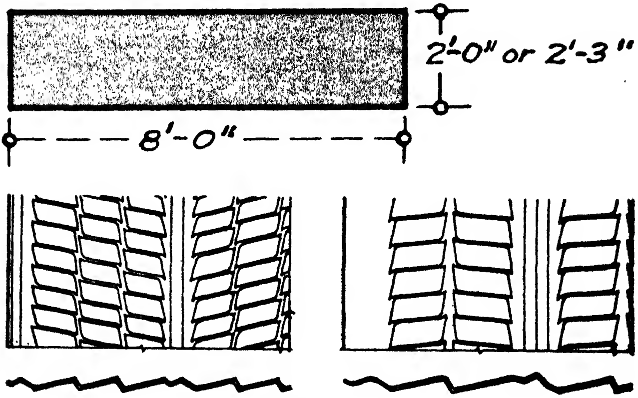
SHEET LATH.

SHEET LATH. A metal lath that is made by slitting, punching, or otherwise forming from copper-bearing steel sheets.

USES. Sheet Lath is used as a combination of keying and formwork for concrete floor and roof construction. It is also used for solid plaster partitions, ceiling work, and makes an excellent lath in the foundation bed for ceramic tile floors or walls.

STANDARDS OF THE INDUSTRY. The individual members of the industry have generally accepted the weight of Sheet Lath as not less than 4.5 lbs. per sq. yd., to consist only of painted copper-bearing sheet steel. Various manufacturers also produce Sheet Lath weighing 5.0, 5.6, 6.3, 7.2, 7.5, 8.5, and 11.25 lbs. per sq. yd.

FLAT RIB EXPANDED METAL LATH



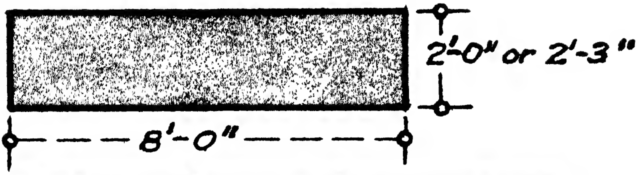
FLAT RIB EXPANDED LATH.

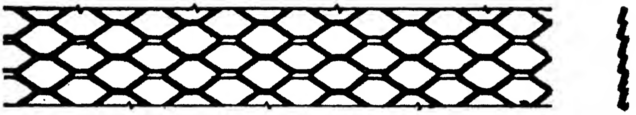
FLAT RIB EXPANDED LATH. The combination of expanded metal lath and ribs in which the rib has a total depth of less than 3/16" measured from the top inside of the lath to the top side of the rib.

USES. Flat rib laths are so-called "economy laths," having been designed to cut down on the amount of plaster squeezing thru the keys because of the flat rib. They are more rigid in the direction of the ribs which makes them particularly suitable for furred and suspended ceilings or plain wall areas, the weight to be used depending upon the spacing of the supports. No flat rib lath is ordinarily recommended for cornice or special detail work.

STANDARDS OF THE INDUSTRY. The individual members of the industry have generally accepted 2.75 and 3.4 lbs per sq. yd. as stock weights in painted copper-bearing steel, for Flat Rib Expanded Metal Lath. Approved for promulgation by the U. S. Department of Commerce, through the National Bureau of Standards.

FLAT EXPANDED METAL LATH





FLAT EXPANDED LATH

FLAT EXPANDED CORRUGATED LATH

FLAT EXPANDED METAL LATH. This is the term used to indicate a metal lath that is fabricated from copper-bearing or galvanized steel sheets by slitting and expanding so that a uniform diamond mesh is formed.

FLAT EXPANDED SELF-FURRING METAL LATH. This lath is similar to the Flat Expanded Metal Lath except that it has been made self-furring by indenting, dimpling, or crimping.

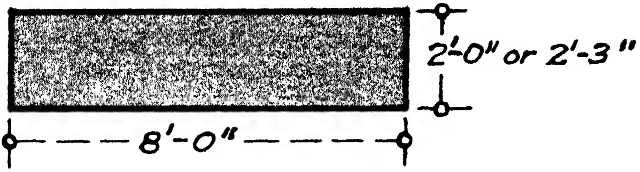
USES. Flat Expanded Metal Lath is the most widely used of all metal lath types. It is a general utility lath suited to all ordinary lathing needs. It can be readily bent or formed for furred or ornamental work, and is used in the fireproofing of steel members.

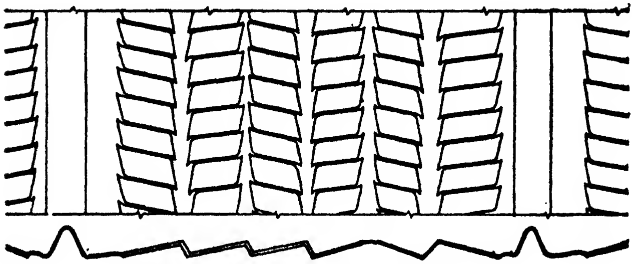
CAUTION. In the opinion of the author, this type of lath is not suitable for stucco work where the metal is to act as reinforcing. (*See pp 600 to 603*). In back-plastered stucco construction the 3.4# lath is the proper type.

STANDARDS OF THE INDUSTRY. The individual members of the industry have generally accepted the following schedule of weights in lbs. per sq. yd., and varieties of Flat Expanded Metal Laths as approved by the U. S. Dep't. of Commerce thru the National Bureau of Standards.

Painted Copper Bearing Steel	*Galvanized Steel Sheets*	*Specific Uses*
2.5# per sq. yd.	....	Solid & hollow partitions, wall furring, formed work, and back-plastered stucco.
3.4# per sq. yd.	3.4# per sq. yd.	Partitions, wall furring, ceilings, and formed work

3/8" RIB EXPANDED METAL LATH





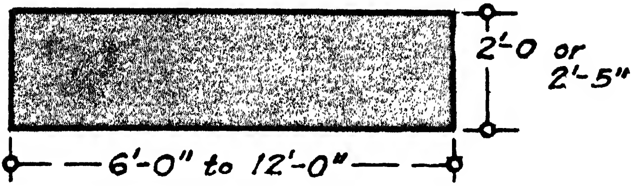
3/8" RIB EXPANDED LATH.

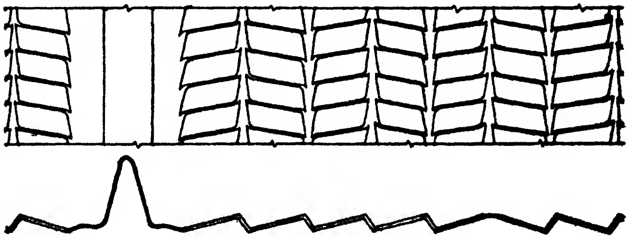
3/8 RIB EXPANDED LATH. The combination of expanded metal lath and ribs with a total depth of approximately 3/8", measured from the top inside of the lath to the top side of the rib, or rod-stiffened metal lath of equal rigidity.

USES. 3/8" rib expanded lath is exceptionally rigid. It is widely used as a form for concrete when attached to the top of the joists, and as a plastering base when attached to the underside of the joists. Because of its rigidity, 3/8" rib metal lath can be attached directly to steel joists or other horizontal steel members up to a spacing of 24" and up to 27" under concrete joists. It also may be used for partitions or furring.

STANDARDS OF THE INDUSTRY. The individual members of the industry have generally accepted 3.4 and 4.0 lbs. per sq. yd. in painted copper-bearing steel as stock varieties. Approved for promulgation by the U. S. Dep't. of Commerce thru the National Bureau of Standards. (One manufacturer makes this lath in 4.6 lbs. per sq. yd. weight.)

3/4" RIB EXPANDED METAL LATH





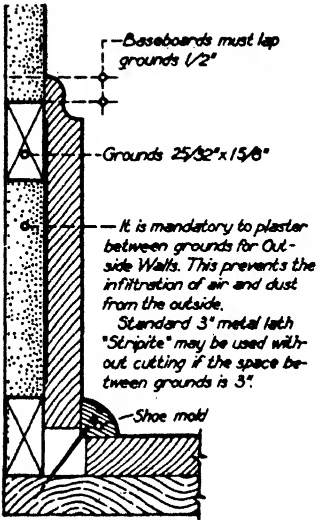
3/4" RIB EXPANDED LATH.

3/4" RIB EXPANDED LATH. The combination of expanded metal lath and ribs has a total depth of approximately ¾", measured from the top inside of the lath to the top side of the rib.

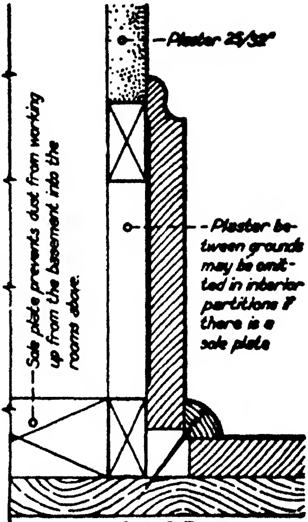
USES. This lath is designed primarily as reinforcement for concrete floors and roofs, serving, in addition, as a form upon which wet concrete is poured. Laid over wood joists, it is ideal as reinforcing for the concrete base for tile, terrazzo or composition flooring. Solid plaster partitions may be constructed with ¾" lath, requiring no studs since the rigidity of the ribs allows the lath to span from floor to ceiling.

STANDARDS OF THE INDUSTRY. The individual members of the industry have generally accepted 0.60 and 0.75 lbs. per sq. yd. in painter copper-bearing steel as stock varieties. Approved for promulgation by the U. S. Dep't. of Commerce thru the National Bureau of Standards.

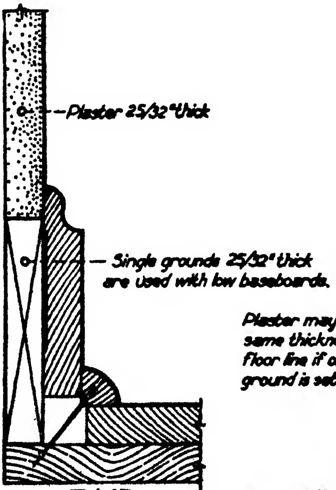
PLASTER GROUNDS FOR BASEBOARDS



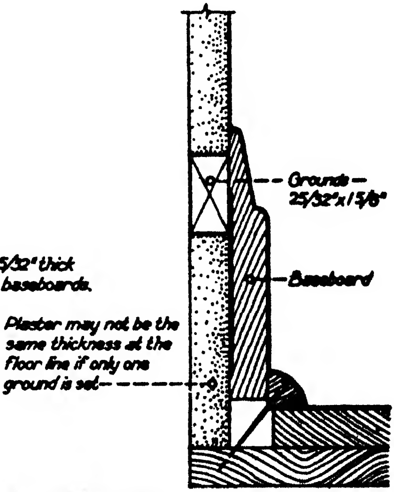
EXCELLENT



GOOD



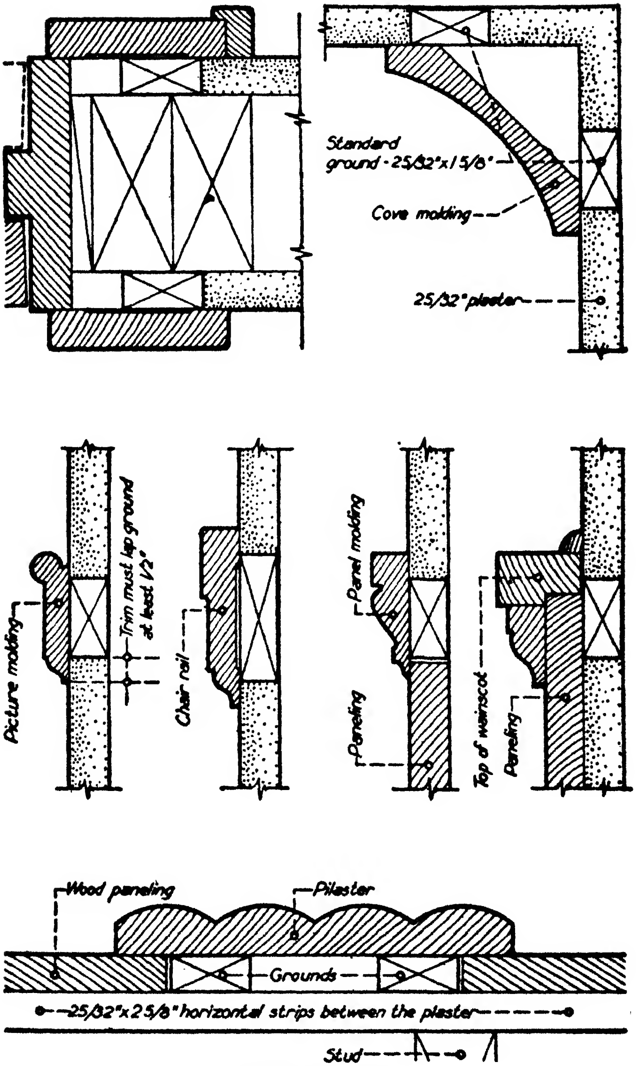
FAIR



POOR

Scale 3"=1'-0"

PLASTER GROUNDS FOR TRIM



Scale 3"=1'-0"

SIX
ACOUSTIC DEFECTS

USUAL ACOUSTICAL DEFECTS. There are six defects normally to be considered in acoustic design:

1. Echo
2. Sound Foci
3. Insufficient Loudness
4. Reverberation Time
5. Noise Quieting
6. Sound Transference

In the customary sense of the term, *Echo* results from the reflection of sound in such a way as to cause a definite or articulate repetition of the sound after an interval at least equal to the total duration of the original sound. *Sound Foci* result from a concentration or convergence of sound rays reflected from an extended concave surface, exactly in the manner that a headlight reflector concentrates light rays. Echo and sound foci are both defects wherever encountered, although they are of relatively infrequent occurrence in buildings. *Insufficient Loudness* is a problem of supplying more sound energy so that speech (and music, less often) will be intelligible. *Reverberation* is a confused or inarticulate prolongation of the original sound and up to a certain point is desirable. *Noise quieting* is required where the generated sound reaches high intensities. *Sound Transference* is the audibility of sounds generated in some other room of the building, thru walls, ducts, floors, or ceilings.

ECHO arises by regular reflection of sound from smooth walls, ceilings or other surfaces, just as a mirror may reflect a beam ot light without either focusing or scattering it. Echo generally is produced by the reflection from pain surfaces. If, however, the surface of the mirror is roughened, the reflected light will be reflected or diffused in all directions. If the walls and ceiling of a room be similarly irregular (on a sufficiently large scale) reflected sound will be scattered and broken up and its articulate character destroyed. In this case echo has been changed to reverberation.

The lapse of time before an echo is heard is due to the fact that the reflected sound has travelled a longer path than the sound which comes directly from the source. The longer this path difference the greater the time lapse. The shortest path difference for an echo to be audible is about 75 feet.

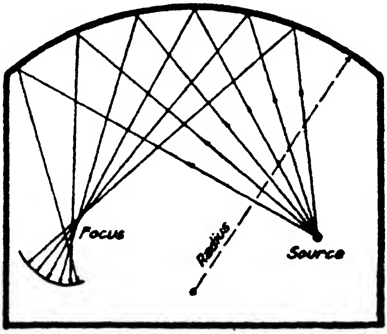
Echoes usually occur only in large rooms. They are caused by high ceilings and great distance to rear walls. They seldom cause serious difficulty in hearing but are regarded as a distinct annoyance. Echoes may be reduced or eliminated by either of two methods:

(1) Provide for large irregularities on the surface causing the echo in order to scatter or diffuse the reflected sound; thus preventing regular reflection. This is frequently done by coffering in the case of ceilings. The dimensions which should be assigned to such coffering are not a matter of taste or accident. If the wave length of the incident sound is very large, compared with the size of the irregularities it encounters, there will be little dispersive effect; if very small, the smooth surface inside the coffering may act as regular reflectors. Depressions about 4 feet square containing a succession of steps, totalling a depth of about 8 or 10 inches, provide the proper treatment for an average wave length between the male and female voice.

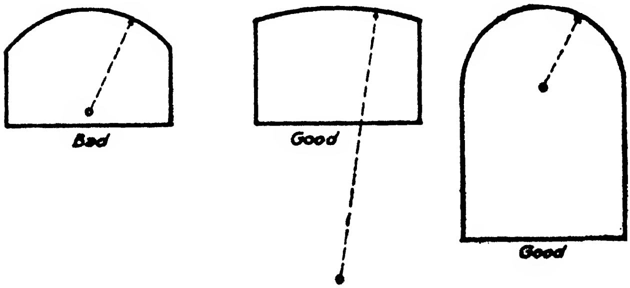
(2) Treat the surface with a highly sound absorptive material which absorbs at least 75 per cent of the sound incident upon it.

SOUND FOCI

SOUND FOCI. A sound focus is caused by reflection from a curved surface, which concentrates the sound rays in the same manner as a headlight reflector concentrates light rays. Depending on the curvature of the surface and the relative positions of the sound source and listener, focussing action may be heard as an abnormally loud echo, or as sound apparently coming from a source quite remote from its true source. These effects, when noticeable, are at least distracting and disturbing, and may sometimes cause serious difficulty in hearing. In a few extreme cases auditoriums have been rendered *totally useless* by this one defect.



Trouble of this kind is usually caused when barreled or domed ceilings are laid out with the center of curvature near the floor line, or when the center of curvature of a rear wall is near the front of the stage. An empirical rule for curved surfaces is; *The radius of curvature of ceiling surfaces should be less than half or more than twice the perpendicular distance to the source of sound: the radius of curvature for walls should be very small, as a coved corner, or more than twice the distance to the source of sound.*



The best cure for focussing action is to change the curvature of the offending surface in accord with the above rule. In extreme cases this is the only possible means to a complete elimination of the difficulty. Occasionally sound foci may be overcome by breaking up the offending surface by means of coffering, or by the use of a highly efficient sound-absorptive material, as described for the reduction of echoes.

INSUFFICIENT LOUDNESS

Insufficient Loudness is more serious for speech than music, since adequate loudness thruout an auditorium is necessary for speech to be understood. The larger an auditorium, the louder a speaker must talk to make himself heard. Since the average speaker's voice power is limited, it is necessary to use loud speakers in auditoriums larger than about 500,000 cubic feet in volume. In rooms this large, electrical amplification is necessary even though all other acoustical conditions are perfect. On the other hand, loud speakers are of little or no help in any auditorium unless other acoustical conditions are satisfactory.

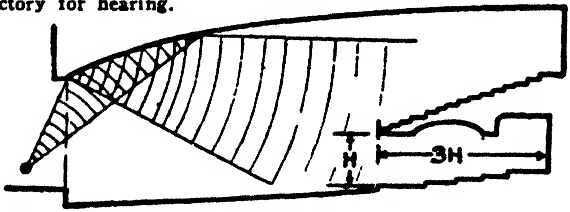
For legitimate theater productions, the distance from the curtain line to the last row of seats will be limited so that delicate voice shading may be audible. One authority has established this distance as 75'-0" for a theater with a balcony, and 100'-0" for a theater without a balcony.

The volume of an auditorium also has a bearing on the number of instruments that are suitable for musical renditions. In Circular No. 380 of the Bureau of Standards an empirical rule is given as follows:

Volume of Room	*Number of Instruments*
50,000	10
100,000	20
200,000	30
500,000	60
800,000	90

Loudness may be somewhat increased by locating the speaker or musicians near hard, sound-reflecting surfaces which reinforce the direct sound. A stage should be furnished with veneer "flats" or similar surfaces rather than heavy, sound-absorbing curtains. Musicians particularly prefer a sound reflecting stage.

Loudness is sometimes insufficient because of an excessively wide seating area. Auditors in the front corners do not receive the full loudness because the speaker's voice is directed away from them at a wide angle. If the seats are arranged within the proper angle for correct vision, they will generally be satisfactory for hearing.



Loudness is sometimes inadequate in excessively deep underbalcony spaces. The depth of such spaces should not be more than three times the height of the opening, as shown in the illustration. In the average auditorium loudness is usually adequate in the front and center of the seating area, but insufficient at the sides and rear. The use of a fan-shaped floor plan and a ceiling sloping up from the stage will help to overcome this defect. Sound from the stage is reflected by the walls and ceiling to the sides and rear, where it increases the loudness by reinforcing the direct sound. If such a design is impractical, a proscenium having soffit and sides at a 45° angle is of benefit.

TIME OF REVERBERATION

A sound produced in a room is reflected back and forth from the walls, floors, and ceilings, losing part of its energy by absorption at each reflection. These reflections continue after the sound source is stopped, and are heard as a prolongation of the original sound, which gradually dies out to inaudibility. This effect is called *"reverberation,"* and the length of time required for a sound of standard intensity to die out to inaudibility is termed *"reverberation time."*

Excessive reverberation causes an overlapping and confusion of spoken syllables and musical tones which renders hearing unsatisfactory. A working rule may be stated as follows:

Reverberation Time	*Hearing Conditions*
Over 3 seconds	Poor
2 to 3 seconds	Fair
1 to 2 seconds	Good

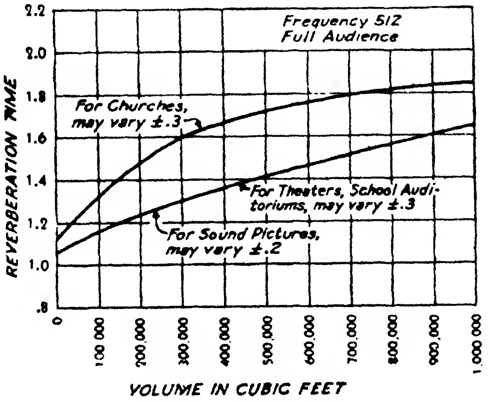
The most desirable reverberation time for a given room depends on its size and purpose. A chart of the optimum values proposed by the Acoustical Materials Association is given below.

The most commonly used formula for computing the reverberation time of a room is that given by W. C. Sabine:

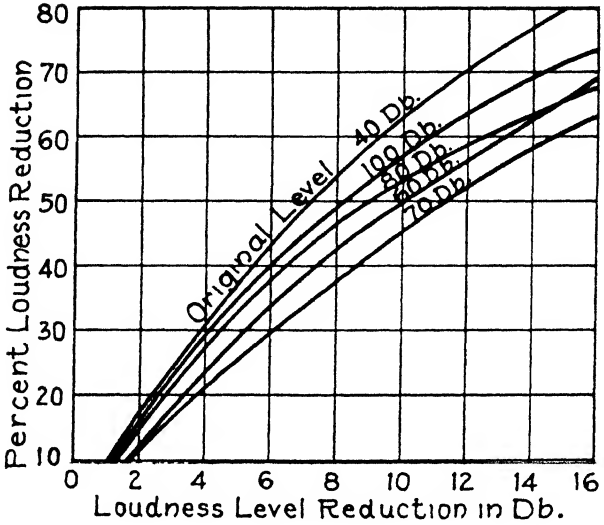
$$T = 5V/100a$$

in which, T = reverberation time in seconds, V = volume of room in cubic feet, a = total absorption of the room (which is the sum of the number of units absorbed by the walls, floor, ceiling, seats, furnishings, the audience itself, etc.).

The number of units absorbed by a given wall or other surface is the product of its area in square feet and its absorption coefficient. The *absorption coefficient* of a material is the percentage of sound absorbed by the surface when sound strikes it. If it may be said that an open window "absorbs" all the sound that falls upon it, its coefficient of absorption is unity, or 1 unit per square foot. A material absorbing half the sound that falls upon its surface would have an absorption coefficient of 0.50, or ½ unit per square foot. 100 square feet of a surface having an absorption coefficient of 0.50 would absorb 100 x 0.50 or 50 units.



NOISE REDUCTION



NOISE REDUCTION CALCULATIONS. The ear does not judge loudness in direct proportion to the physical intensity expressed in decibels. The Bell Telephone Laboratories have determined a relation between apparent loudness and the intensity level which is shown in the chart opposite.

The reduction of sound intensity expressed in decibels can be easily determined by the following formula, after which a reference to the graph will indicate the reduction in loudness as judged by the human ear:

$$\text{Reduction in db} = 10 \log \frac{\text{treated room absorption}}{\text{untreated room absorption}}$$

In determining the absorption for quieting noisy offices, restaurants, etc., the numerical averages of the coefficients from 256 to 2,048 cycles is recommended for use, and is called the "noise reduction coefficient."

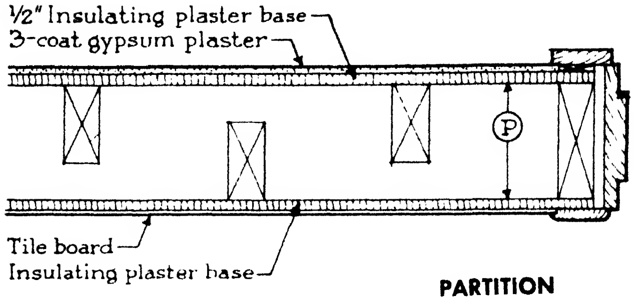
DESIGN PROCEDURE. It is good practice in noise quieting to treat enough area to give a reduction of at least 6 decibels. From the graph it will be seen that this means an apparent loudness reduction of from 30% to about 44% — depending upon the original noise level. Having calculated the total absorption of the room before treatment, the desirable absorption after treatment can be found from the formula.

APPLYING THE FORMULA. Let it be assumed that the calculation indicates 4,000 absorption units are required in a room to reduce the noise to a desired level. A further calculation reveals that the room without treatment, using plastered walls and ceiling, has a total absorption of 1,900 units. Therefore, the difference, or 2,100, units must be supplied by replacing plaster with a sound absorbing material

SOUND INTENSITIES

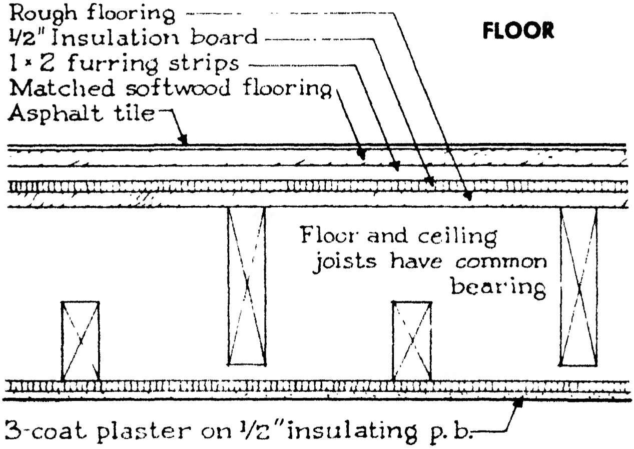
	Decibels	Relative Energy	
Deafening Noise			Threshold of painful feeling Thunder Artillery firing Unmuffled airplane engine
	110	100,000,000,000	Large steam whistle Boiler factory Structural steel riveter at 15 ft. In subway car
	100	10,000,000,000	Pneumatic Jackhammer drill 10 ft. away Newspaper press room Noise in untreated airplane cabin Elevated trains from street
Distracting Noise	90	1,000,000,000	Automobile horn at 23 ft. Noisiest street corner, New York Fire siren at 75 ft. Large public address system Police whistle at 15 ft.
	80	100,000,000	Average machine shop Interior of electric interurban train Snow shoveling on cement walk Motor truck without muffler Noise in a stenographic room
	70	10,000,000	Average factory Busy street traffic Full volume of modern home radio Noisy ventilating system, grille 3 ft. away Average busy street
Range of Conversation	60	1,000,000	Conjested department stores Average public building Church bells at 1200 ft. Average store Moderate restaurant clatter
	50	100,000	Noisy residence Average office Quiet automobile Satisfactory high school ventilating system Ordinary school class room
	40	10,000	Public library Average residence Quiet office Silent-movie theatre Quiet residence
Extreme Quiet	30	1,000	Legitimate theatre Private office acoustically treated Planetarium Rustling paper Average whisper
Sound Proof Chambers	20	100	Quiet church Underground vault Broadcasting studio Sound-film studio Breathing through nose
	10	10	Very quiet studio for making sound pictures
	0	1	Threshold of audibility

SOUND TRANSFERENCE



PARTITION

FLOOR



The problem of sound transference is susceptible to analysis in advance of construction, or as a corrective measure in existing buildings. It is recommended that publications issued by the National Bureau of Standards be consulted, as listed in Letter Circular LC-778, available free.

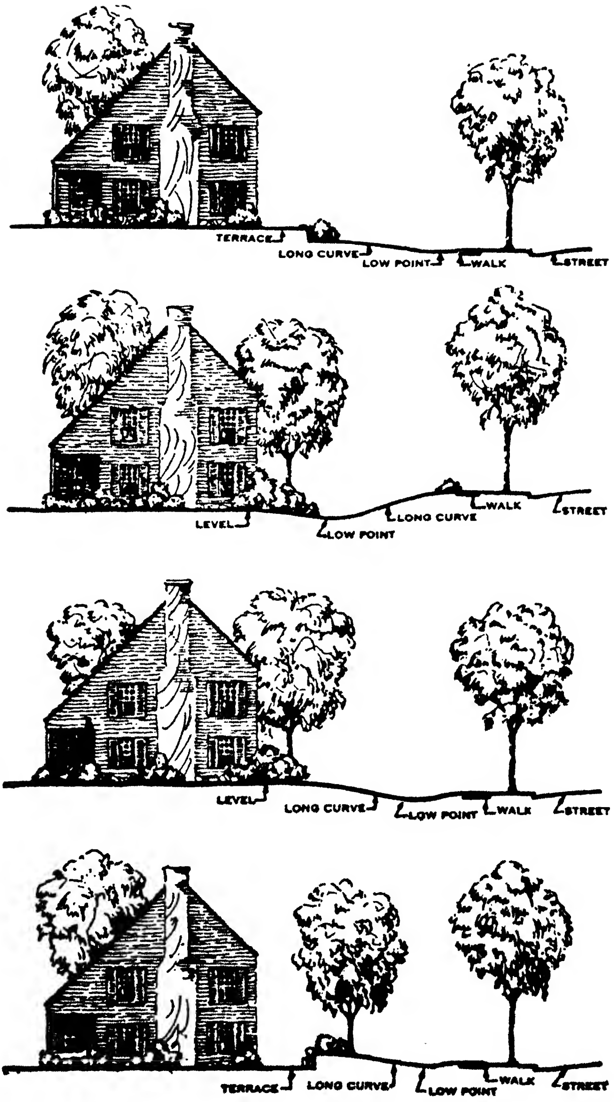
Recent tests at the U. S. Bureau of Standards indicate the effectiveness of staggered studs and floor joists in reducing the transmission of room noises. The location of the bathroom will determine which walls and/or the floor require this treatment. (A bath over the kitchen, e. g., would not require the floor treatment, but over the dining or living room, it would.) Soil stacks should be wrapped with hair felt, so that the dimension "P" for a partition with a 4" standard weight pipe would have to be at least 7½".

COEFFICIENTS OF ORDINARY MATERIALS

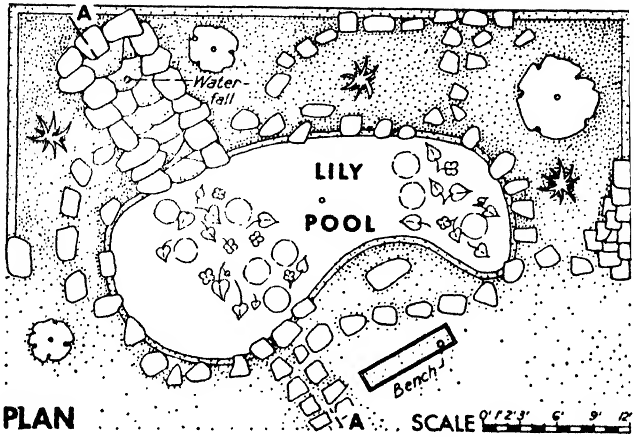
Material	*Coefficient 512 cycles*
Brick wall, painted	.017
Same, unpainted	.03
Carpet, unlined	.15- .20
Same, felt lined	.20- .35
Fabrics, hung straight	
Light, 10 oz. per sq. yd.	.11
Medium, 14 oz. per sq. yd.	.13
Heavy, draped, 18 oz. per sq. yd.	.50
Openings	
Stage, depending on furnishings	.25- .75
Deep balcony, upholstered seats	.50-1.00
Grills, ventilating	.15- .50
Plaster, gypsum or lime, smooth finish on tile or brick	.025
Same, on lath	.03- .04
Plaster, gypsum or lime, rough finish on lath	.06
Glass	.03
Marble or Glazed Tile	.01
Wood Panelling	.06
Floors	
Concrete or terrazzo	.015
Wood	.03
Linoleum, asphalt, rubber or cork tile on concrete	.03- .08
Metal or wood chairs (units per seat)	.17
Auditorium chair, wood veneer seat and back	.25
Wood Pews	.4
Pew Cushions	1.45-1.90
Theater chairs, upholstered in leatherette	1.6
Theater chair, heavily upholstered, plush or mohair	2.6 -3.00
Seated audience, per person (depending on character of seats)	3.0 -4.3

Complete tables of coefficients of the various materials that normally constitute the interior finish of rooms may be found in the various books on architectural acoustics. This short list will be useful in making simple calculations of the reverberation in rooms.

GRADING BETWEEN HOUSE AND SIDEWALK



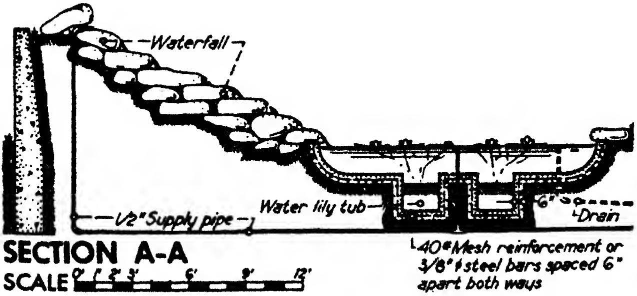
WATER LILY GARDEN POOL



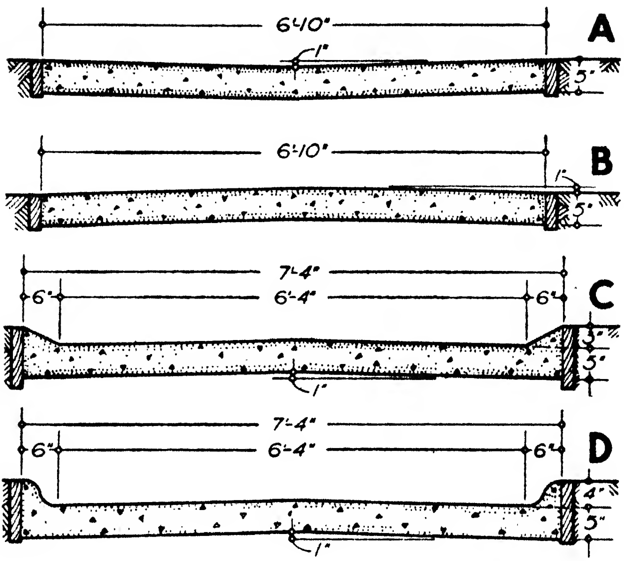
CHARACTER OF POOL. The general style of the garden—whether it is formal or informal—will suggest the pool treatment and its size. Colorful fish and aquatic plants make a garden pool a focal point of interest for the "outdoor living room."

SIZE AND CONSTRUCTION. Small species of water lilies require a pool 3'–0" or more across in least dimension. Larger varieties require 6'–0". From water line to top of soil in tubs should be 22" as a minimum. Pools with vertical sides can be built with wood or 20 gage sheet metal forms. Pools with sloping or curved sides can be made in firm soil by plastering a stiff mixture against the earth, placing the reinforcement and then completing the slab by further plastering. Floor and walls, in any case, should be placed in one operation to avoid joints.

WATERFALL. It may be advisable to set the stones for the waterfall in concrete so that the surrounding earth will not become soggy and form stagnant puddles for the breeding of mosquitoes.



SLAB-TYPE CONCRETE DRIVES



SLAB-TYPE CONCRETE DRIVES. The slab-type drive is less frightening to a timid driver than the ribbon type. When this type is used with curbs it becomes practically impossible for a careless driver to run over the adjoining planting. The slab-type drive is somewhat more expensive than the ribbon-type but there is no other choice for driveways which curve sharply or which require turn-around areas. Combinations of colored concrete and brick may often be used to bring the driveway into greater harmony with the landscape.

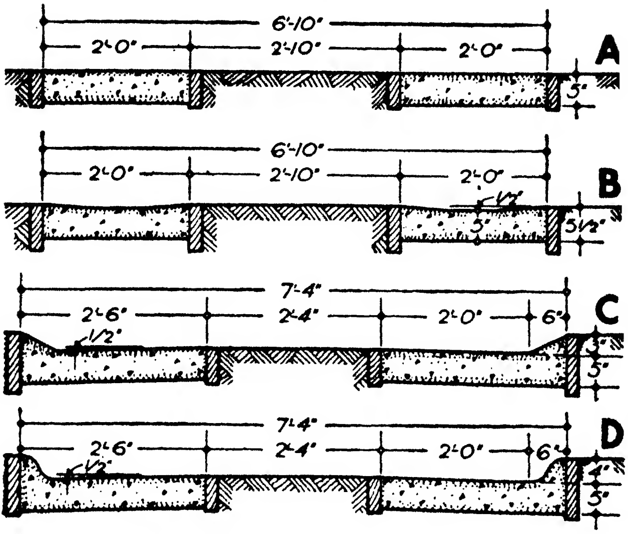
SUB-GRADE. The area upon which the slab is to lay should be brought to grade and well compacted before concreting. All soft and yielding material and all loose rocks or boulders must be removed or broken off to a depth several inches below the sub-grade and the holes refilled with tamped material. Settlement of the sub-grade is likely to cause cracking. Construction on ground that has recently been filled should be postponed for at least 12 months. If the soil is gravelly and porous, no sub-base is required. However, if the soil is clayey, a 6" course of gravel, crushed stone or cinders should first be placed.

FORMS. 2x6 or 2x8 lumber is used for forms. In ground likely to be infested with termites, care should be taken to remove all form lumber after the concrete has set.

EXPANSION JOINTS. No expansion joints are needed for drives less than 40'-0" long. On longer drives a 1" expansion joint should occur every 20'-0" to 30'-0".

THICKNESS OF SLAB. Drives that may be used by heavy coal or other trucks, should be increased in thickness to 6".

RIBBON-TYPE CONCRETE DRIVES



RIBBON-TYPE DRIVES. For straight drives the ribbon type is often considered more in keeping with the landscape treatment because of the area of turf which breaks up the driveway area. The ribbon-type is also more economical than solid full-width pavements. Ribbon drives without curbs should not be used on curves, no matter how slight. The dimensions given in the drawings above may be taken as entirely adequate. Ribbons as narrow as 1'-6" with 3'-4" between them represent an irreducible minimum for straight drives.

SUB-GRADE. The area upon which the slab is to lay should be brought to grade and well compacted before concreting. All soft and yielding material and all loose rocks or boulders must be removed or broken off to a depth several inches below the sub-grade and the holes refilled with tamped material. Settlement of the sub-grade is particularly likely to cause cracking with ribbon-type drives. Construction on ground that has recently been filled should be postponed for at least 12 months. If the soil is gravelly and porous, no sub-base is required. However, if the soil is clayey, a 6" course of gravel, crushed stone or cinders should first be placed.

FORMS. 2x6 or 2x8 lumber is used for forms. In ground likely to be infested with termites, care should be taken to remove all form lumber after the concrete has set.

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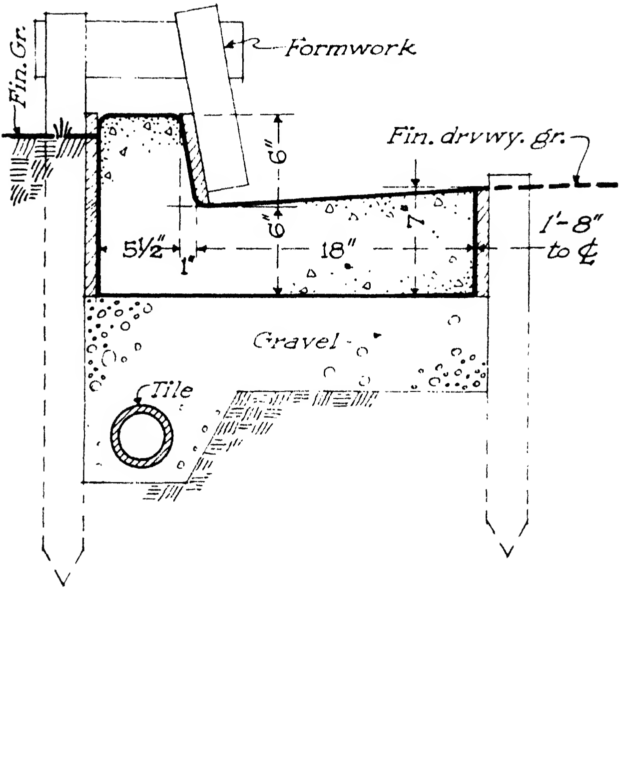
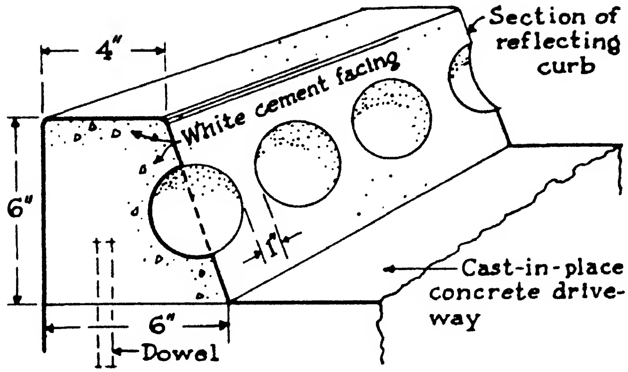
CONSTRUCTION OF DRIVEWAY CURBS

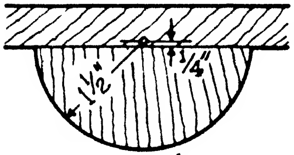


QUANTITIES REQUIRED FOR 100 FT.
7.8 barrels of cement (use *white* for night visibility).
2.6 cubic yards of sand
3.5 cubic yards of stone (1½" max.)

PROCEDURE—If soil requires a sub-base, gravel or cinders to a thickness of 6" should be used. If the nature of either the soil or the slope makes it necessary, provide open 4" clay drain tile, as shown. On curves, the distance to the center line (CL) of the roadway should be increased to 3'-9". Provide expansion joints of asphaltic felt at least every 50 linear feet, which separate the sections from top to bottom. A good finish can be obtained by removing the forms as soon as possible and troweling and rubbing the surface.

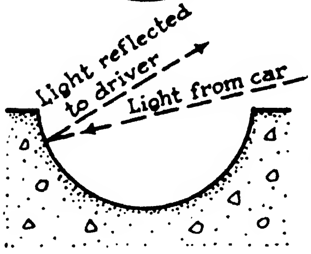
NIGHT-SAFE DRIVEWAY CURB





FORM FOR HOLLOWS

Any wooden sphere, such as a croquet ball, which is 3" to 4" in diameter, should be cut to ¼" less than half to make the reflecting hollows in the curb.



SECTION THRU HOLLOW

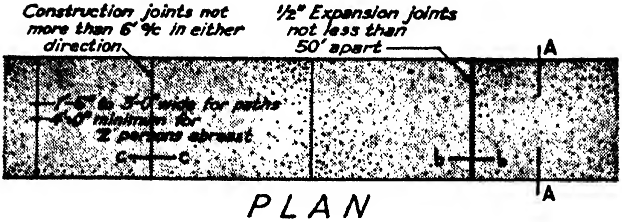
Note that light from the headlamps of the car will be reflected to the driver's eyes from <u>some</u> part of the spherical surface, no matter from what angle it strikes either horizontally or vertically.

This is a simple adaptation for private driveways of the reflective highway curb used with great success in New Jersey. This curb is visible at night because (1) it is a good reflector of light and (2) it is designed to reflect light to the driver's eyes.

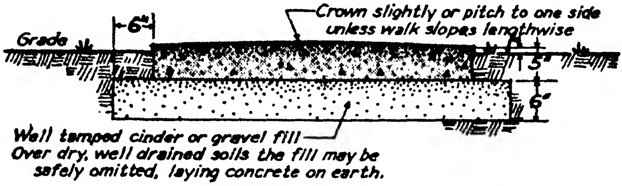
The curb may be precast or cast in place. White concrete should be used for the top and reflecting side in a 1 : 2 : 3½ mix with white quartz sand as a fine aggregate.

In rainy weather, when ordinary curbs are difficult or impossible to see, the reflective curb becomes a better reflector than when dry and its visibility is increased.

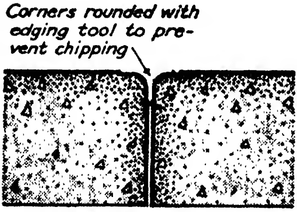
CONCRETE SIDEWALKS



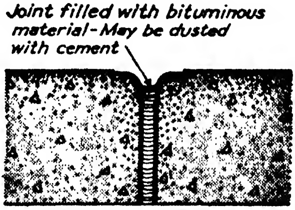
PLAN



SECTION A-A



DETAIL c-c



DETAIL b-b

NOTES

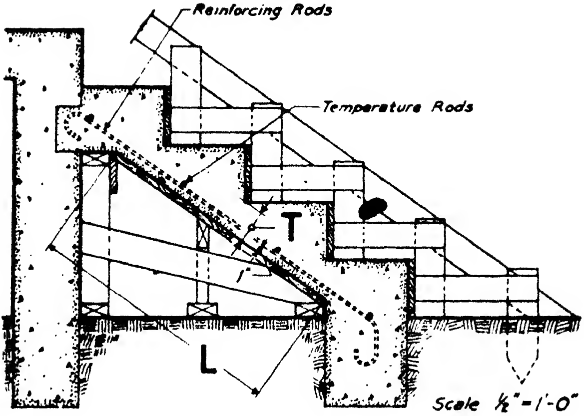
In building walks around trees provision must be made for the growth of the tree to prevent it from raising or cracking the walk.

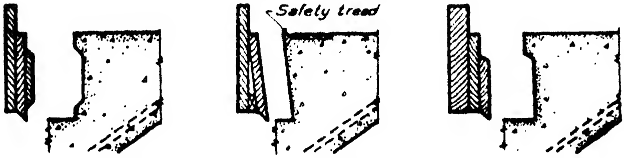
Plain concrete sidewalk slabs are not designed to act as bridges. Therefore the sub-grade must be of uniform bearing power. If the slab is to be laid directly on the ground, all soft spots must be dug out and filled with solid material, and exceptionally well compacted spots must be loosened and tamped.

Construction joints are made by placing metal division plates between the side forms and then removing them after the concrete has taken its initial set; or by cutting the partially hardened concrete completely thru to the sub-grade with a steel trowel. In hot weather these joints tend to close, in cold weather they tend to open, thus preventing irregular cracks.

The expansion joints allow movement of the walk, providing a cushion to absorb movements too great for the construction joints.

CONCRETE STEPS



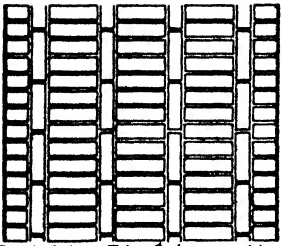


TYPES OF RISER FORMS
Scale ¾"=1'-0"

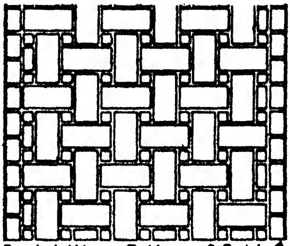
Reinforced concrete steps that are independent of the ground beneath can be depended upon not to crack if properly constructed. The entire slab should be concreted at one time. The longitudinal reinforcement should be placed before the forms for the risers are attached. The mixture used should be 1:2:4. The side and riser forms can be removed 24 hours after concreting, but the forms and shoring supporting the stair slab should be left in place at least 4 weeks unless high-early-strength concrete is used.

L	T	*Reinforcing rods*		*Temperature rods*	
Length of Slab	*Thickness*	*Dia.*	*Spacing*	*Dia.*	*Spacing*
2 to 3 feet	4"	¼"	10"	¼"	12" to 18"
3 to 4 feet	4"	¼"	7"	¼"	12" to 18"
4 to 5 feet	5"	¼"	6"	¼"	18" to 24"
5 to 6 feet	5"	¼"	5½"	¼"	18" to 24"
6 to 7 feet	6"	¼"	5"	¼"	18" to 24"
7 to 8 feet	6"	⅜"	4"	¼"	18" to 24"
8 to 9 feet	7"	½"	5"	¼"	18" to 24"

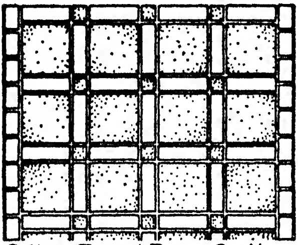
GARDEN WALKS



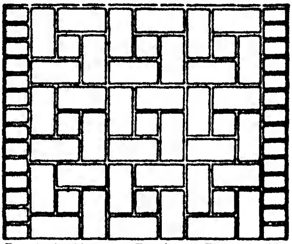
Brick Set on Edge & Arranged in Rows so as to Emphasize Direction of Walk.



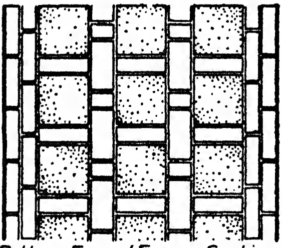
Basket-Weave Pattern of Brick & Small Inserts of Broken Brick or Small Square Tile.



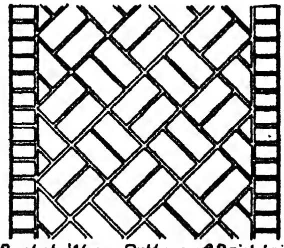
Pattern Formed From a Combination of Brick & Square Tile.



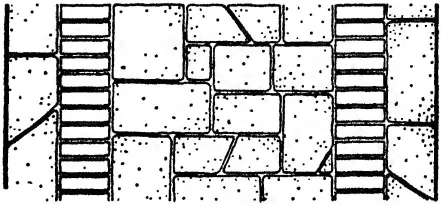
Basket-Weave Pattern Frequently Used in Spanish Gardens.



Pattern Formed From a Combination of Brick & Square Tile.



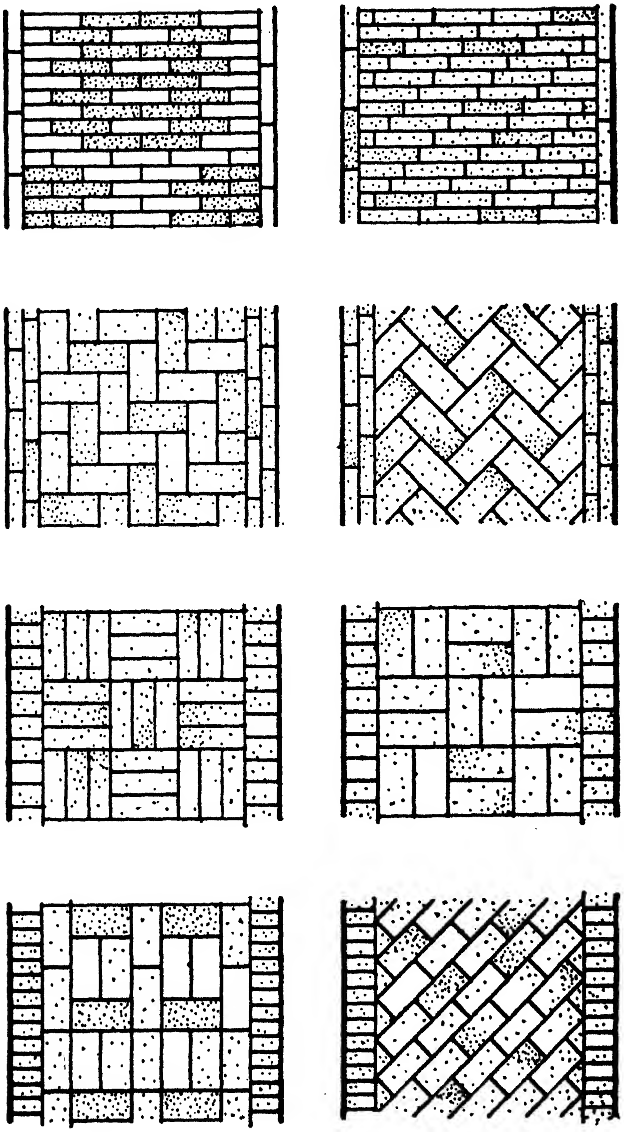
Basket-Weave Pattern of Brick Laid Flat & Diagonally.



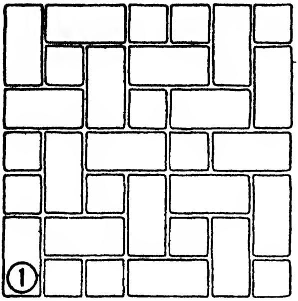
A great variety of patterns & color schemes are possible in the combination of brick & stone.

Wide Flagstone Walk or Terrace Pavement with Border of Brick.

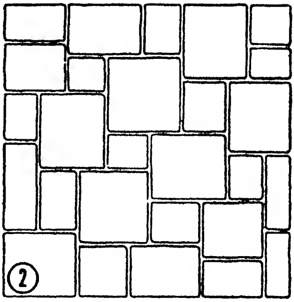
BRICK PATTERNS FOR WALKS



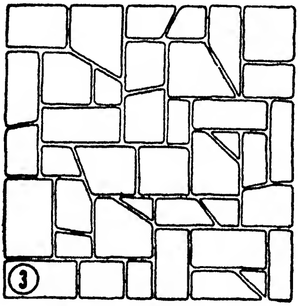
FLAGSTONE PAVING



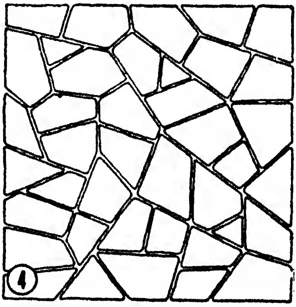
RECTANGULAR (Limited Sizes)



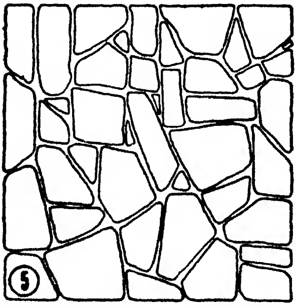
RANDOM RECTANGULAR



RANDOM SEMI-IRREGULAR



RANDOM IRREGULAR (Fitted)

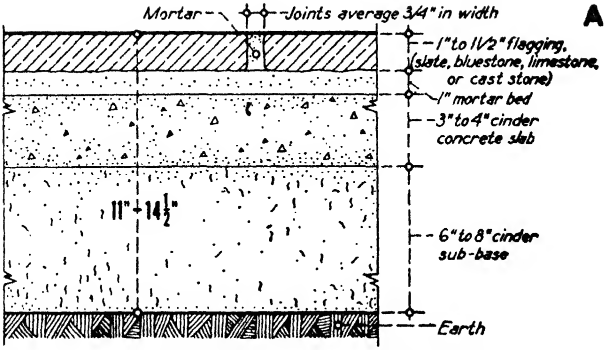


RANDOM IRREGULAR (Not Fitted)

The paving of walks and terraces with flagstones furnishes a desirable transition from the man-made geometrical formality of the building to the freedom and naturalness of the lawn and garden. Bluestone, limestone, stratified natural stones from the vicinity, cast stone and slate are commonly used materials. For terraces, it is important that the stones have level surfaces and that they be laid on concrete if furniture is to be used —see *Detail A* on following *Data Sheet*. The method shown in *Detail C* on the following *Data Sheet* may eventually result in tipping and movement of the stones out of level.

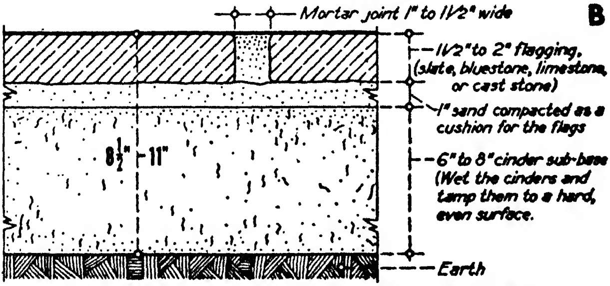
FLAGSTONE PAVING

A



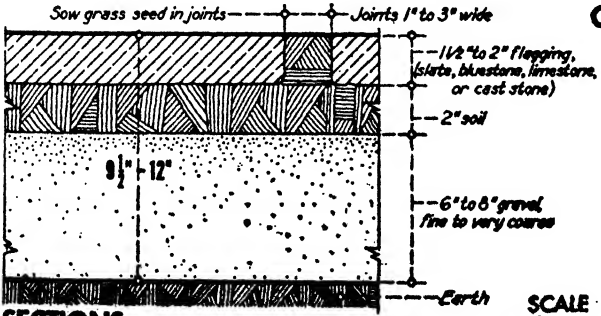
FLAGSTONES ON CONCRETE SLAB

B



FLAGSTONES DIRECTLY ON CINDER SUB-BASE

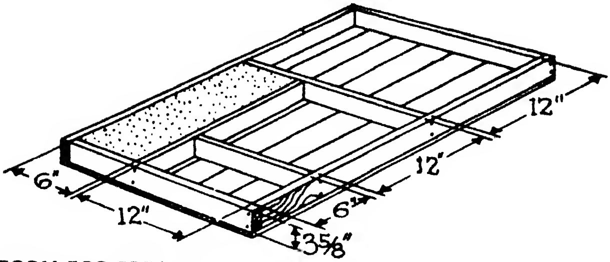
C



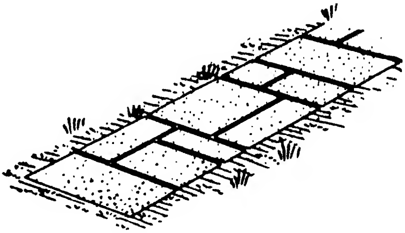
SECTIONS WITH EARTH JOINTS

SCALE 1½" = 1'-0"

CONCRETE FLAGSTONES



FORM FOR PRECAST FLAGSTONES

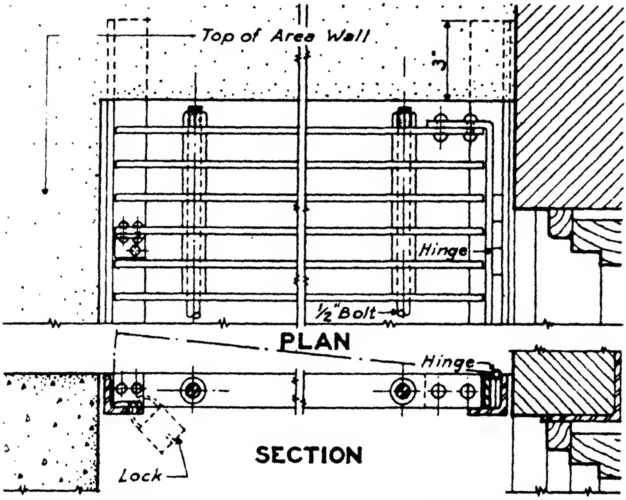


PATTERNS IN AN 18" WIDE WALK

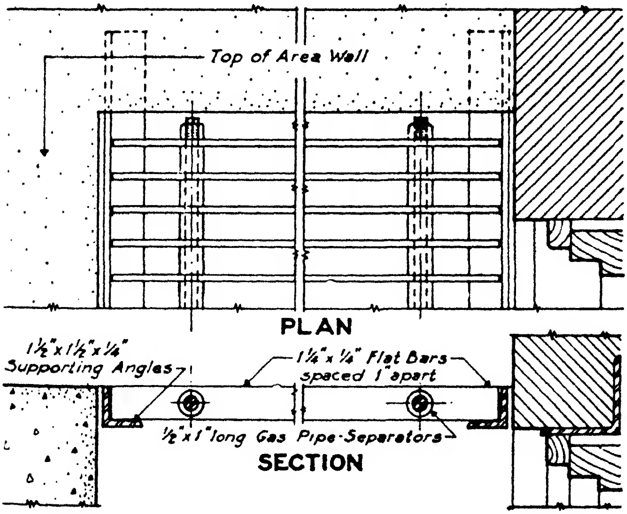
The sizes of flagstones obtained by using the simple forms shown, may be placed in a number of interesting designs. The forms should be made so they may be easily taken down for removal of the cast pieces and re-use. The wood should be well oiled each time before concreting.

Mineral pigments are often introduced in several shades to produce flagstones of different shades so that they vary not only in pattern but in color as well. The stones may be laid on a concrete base or on cinders with earth joints so that grass may grow between them. A number of different textures can be given to the stones by brooming, troweling, patting with a wire brush, etc. A 1:2¼:3 mix with maximum aggregate 1½" will produce a good quality concrete. Using very wet sand and pebbles, about 4¼ gallons of water should be used in the mix to each 1-sack batch. Using damp sand and pebbles, 5½ gallons should give a workable mixture.

SIDEWALK
AREA GRATINGS

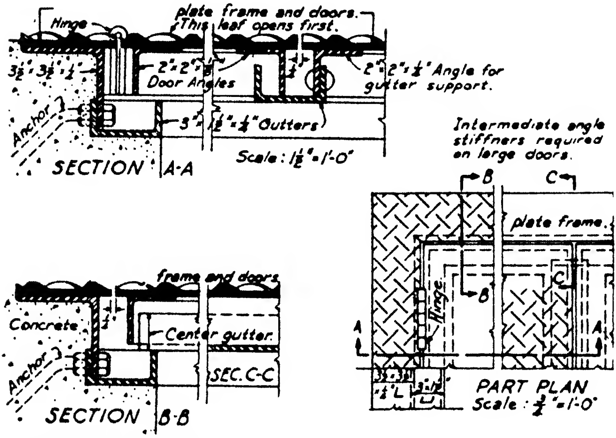


DETAILS OF HINGED GRATING
Scale 1½" = 1'-0"

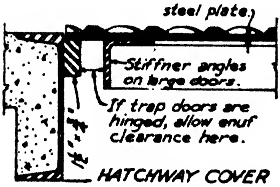


DETAILS OF GRAVITY TYPE GRATING
Scale 1½" = 1'-0"

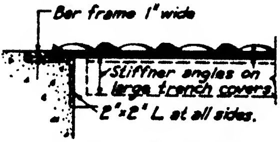
SIDEWALK COVERS, HATCHWAY COVERS AND SUMP PIT COVERS



SIDEWALK DOOR & FRAME WITH GUTTER CONSTRUCTED OF COMMON STEEL SHAPES.



HATCHWAY COVER
Scale: 1½"=1'-0"



PIPE TRENCH AND SUMP PIT COVERS
Scale: 1½"=1'-0"

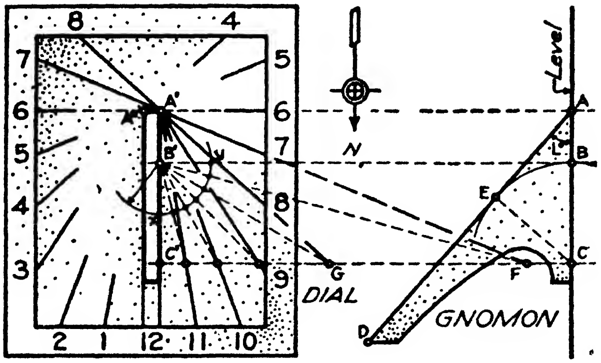
The need of safety precautions is as important outside of building as it is within. Steel plate with slip-proof projections extending in two directions is ideal for sidewalk doors. The above illustrates an economical method of constructing an all-steel sidewalk door using plates and common size structural steel shapes.

Hatchway, manhole and sump pit covers, etc., are easily constructed of slip-proof plates and standard size steel bars and structural shapes. The plates can be scribed by means of hack saw to fit irregular surface or openings.

Plates of large area should have stiffner angles in order that plate thickness may be reduced to an economical thickness.

Special slip-proof steel plates are well adapted for industrial buildings as a slip-proof floor surface, especially at furnaces; machines, etc., and also at trucking areas and loading platforms.

HORIZONTAL SUNDIAL



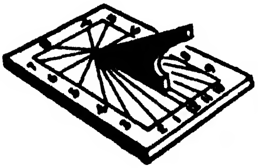
Draw a line *AC* of any convenient length. Draw *AD*, making the included angle *L°* equal to the latitude of the place. These two lines form the outline of the Gnomon, Stile, or Rod, as it is variously termed. *AC* represents the plane of the dial plate and *AD* is the plane of the two edges of the Gnomon which cast the time-telling shadow. The Gnomon may be cut away underneath to any desired shape as long as these two planes are not violated.

About point *C* describe an arc with radius *CE* equal to the perpendicular distance from *C* to line *AD*, cutting *AC* at *B*. Draw lines thru *A*, *B*, *C*, at right angles to *AC*. These will intersect a convenient line parallel to *AC* at points *A'*, *B'*, *C'*. Line *A'A* becomes the *6* o'clock mark on the dial.

From point *B'* describe a quadrant of convenient radius as *xy*. Divide the quadrant into six equal parts of 15° each. From *B'* draw lines thru the five division marks until they intersect *C'C*. Lines connecting the points on *C'C* thus found to point *A'* are the *7, 8, 9, 10,* and *11* o'clock dial marks.

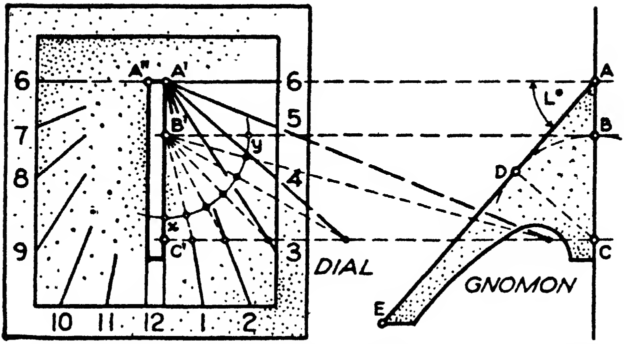
If it is desired to show half- or quarter-hour marks, the quadrant is divided into 12 or 24 equal parts, the procedure being the same. Five- or one-minute divisions can then be made accurately enuf on the dial face by eye.

The intersection of the planes of the sides of the Gnomon with the dial plate become the 12 o'clock marks. Continuation of the lines *FA'* and *GA'* become the *7* and *8* o'clock P. M. marks.



Since the dial is symmetrical the 4 and 5 A. M. and the 1 to 5 P. M. marks which converge at A" are easily found. The sundial must be set with the Gnomon in a true north and south direction, and the plate absolutely level.

SOUTH VERTICAL SUNDIAL

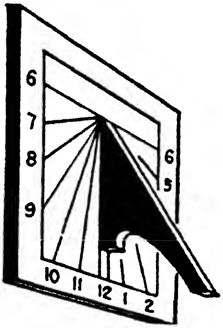


Draw a line AC of any convenient length. Draw AE, making the included angle CAE equal to the complement of the angle of latitude (90°—lat.) of the place. These two lines form the outline of the gnomon. AC represents the plane of the dial plate, and AE is the plane of the two edges of the gnomon which cast the time-telling shadow. The gnomon may be cut away underneath to any desired design as long as these two planes are not violated.

About point C describe an arc with radius CD equal to the perpendicular distance from point C to line AE, cutting AC at B. Draw lines thru A, B, C, at right angles to AC. These will intersect a convenient line parallel to AC at points A', B', C'. Line $A'A$ becomes the 6 o'clock mark on the dial.

From point B' describe a quadrant of convenient radius as xy. Divide the quadrant into six equal parts of 15° each. From B' draw lines thru the five division marks until they intersect $C'C$. Lines connecting the points on $C'C$ thus found to point A' are the 1 to 5 o'clock marks on the dial.

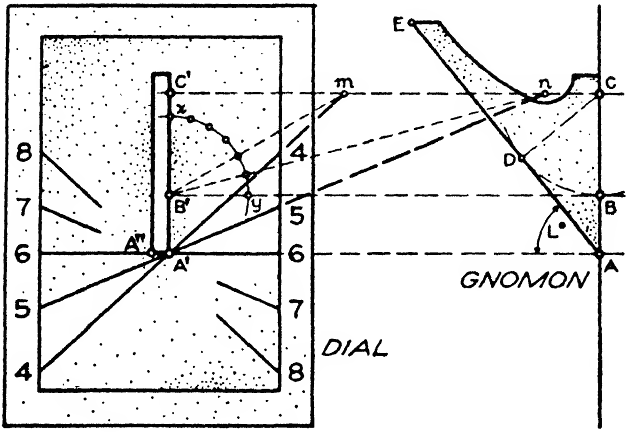
If it is desirable to show half or quarter hours, the quadrant is divided into 12 or 24 equal parts, the procedure then being the same. Five or one minute divisions can be then made accurately enuf on the dial face by eye.



The intersections of the planes of the sides of the gnomon with the dial plate become the 12 o'clock marks. Hours after 6 P. M. or before 6 A. M. cannot be shown on a south vertical dial.

Since the dial is symmetrical the 7 to 11 A. M. marks which converge at A'' are easily found. The sundial must be set exactly vertical and facing true (not magnetic) south.

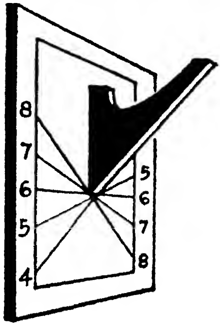
NORTH VERTICAL SUNDIAL



Draw a line AC of any convenient length. Draw AE, making the included angle CAE equal to the complement of the angle of latitude of the place (90°-latitude°). AC represents the plane of the dial plate and AE is the plane of the two edges of the gnomon which cast the time-telling shadow. The gnomon may be cut away as shown to any desired shape so long as these two planes are not violated.

About point C describe an arc with radius CD equal to the perpendicular distance from C to line AE, cutting AC at B. Draw lines thru A, B, C, at right angles to AC. These will intersect a convenient line parallel to AC at points A', B', C'. Line AA' becomes the 6 o'clock mark on the dial.

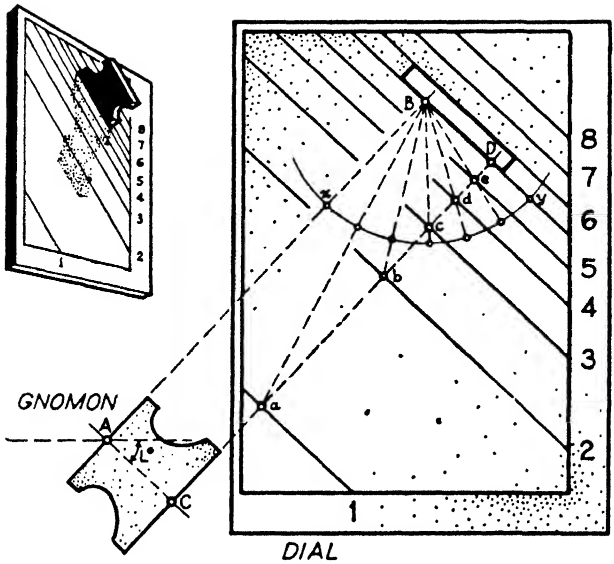
From point B' describe a quadrant of convenient radius as xy. Divide the quadrant into six equal parts of 15° each. From B' draw lines thru the two lower division marks until they intersect CC' at m and n. Lines from m and n continued thru A' become the 4 and 5 o'clock dial marks.



If it is desired to show half- or quarter-hour marks, the quadrant is divided into 12 or 24 equal parts, the procedure then being the same. Five- or one-minute divisions can then be made accurately enuf on the dial face by eye.

Since the dial is symmetrical the 7 and 8 o'clock marks which converge at A'' are easily found. The sundial must be set with the plate vertically plumb, and the gnomon in a true (not magnetic) north direction.

WEST VERTICAL SUNDIAL



Through a convenient point *A* draw the line *AC* making an angle *L°* with the horizontal which is equal to the latitude of the place. The distance *AC* is the height of the gnomon, which may be of any desired design so long as the top and bottom edges remain as parallel planes.

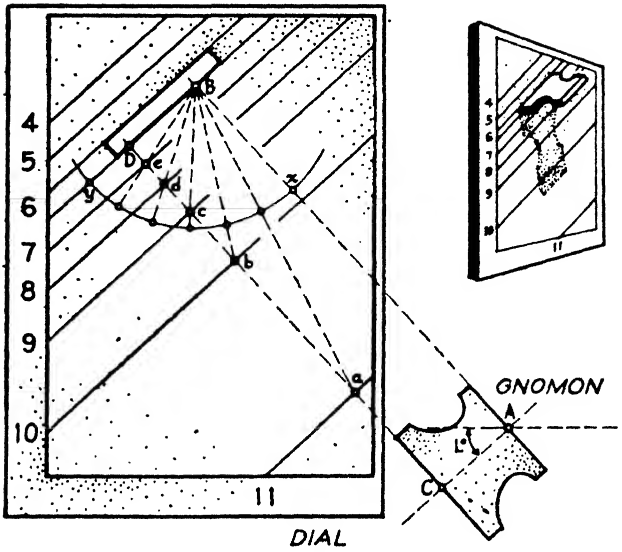
Draw parallel lines *AB* and *CD* at right angles to *AC*, making *BD* parallel to *AC*. Draw a line parallel to *BD* at a distance from it equal to the thickness of the gnomon. These two lines are the six o'clock marks on the dial, and locate the position of the gnomon.

From point *B* describe a quadrant of convenient radius as *xy*. Divide the quadrant into six equal parts of 15° each. From point *B* draw lines to the five division marks until they intersect line *CD*. Lines drawn parallel to *BD* through points *a, b, c, d,* and *e,* thus found, on *CD,* are the 1 to 5 o'clock dial marks.

If it is desirable to show half or quarter hour marks the quadrant is divided into 12 or 24 equal parts, these intermediate dial marks then being found in the same manner as the hours. Five- or one-minute divisions can then be made accurately enough on the dial face by eye.

The 8 and 7 o'clock marks are symmetrical about the gnomon with the 4 and 5 o'clock marks. The dial plate must be set exactly vertical and facing true west.

EAST VERTICAL SUNDIAL



Through a convenient point A draw the line AC making an angle $L°$ with the horizontal which is equal to the latitude of the place. The distance AC is the height of the gnomon, which may be of any desired design so long as the top and bottom edges remain as parallel planes.

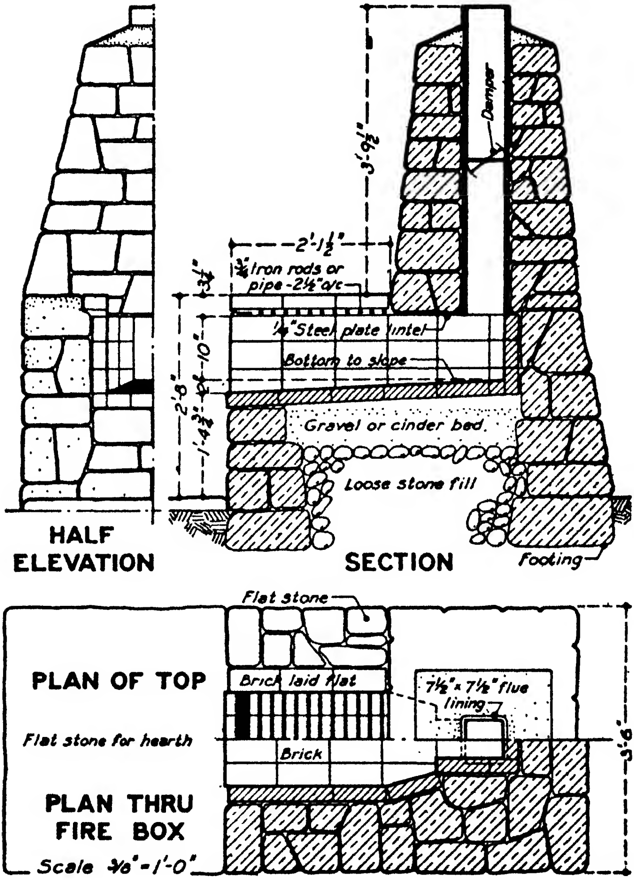
Draw parallel lines AB and CD at right angles to AC, making BD parallel to AC. Draw a line parallel to BD at a distance from it equal to the thickness of the gnomon. These two lines are the six o'clock marks on the dial, and locate the position of the gnomon.

From point B describe a quadrant of convenient radius as xy. Divide the quadrant into six equal parts of 15° each. From point B draw lines to the five division marks until they intersect line CD. Lines drawn parallel to BD through points a, b, c, d, and e, thus found on CD, are the 7 to 11 o'clock dial marks.

If it is desirable to show half or quarter hour marks the quadrant is divided into 12 or 24 equal parts, these intermediate dial marks then being found in the same manner as the hours. Five- or one-minute divisions can then be made accurately enough on the dial face by eye.

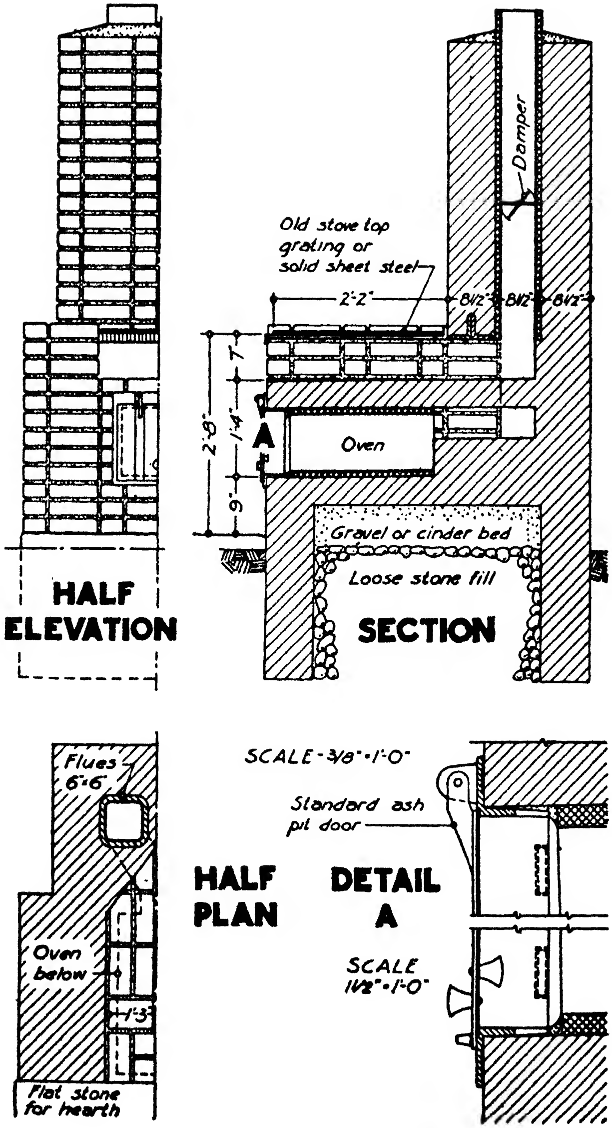
The 5 and 4 o'clock marks are symmetrical about the gnomon with the 7 and 8 o'clock marks. The dial plate must be set exactly vertical and facing due east.

OUTDOOR GRILL

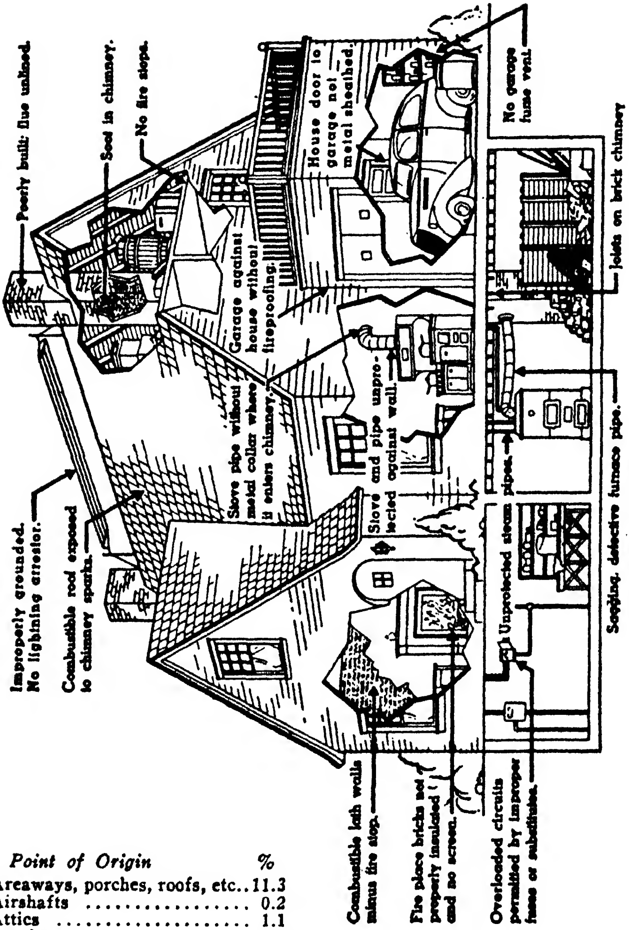


A simple type of outdoor fireplace is shown above. The footings should be carried below frost to prevent heaving. Rubble, ashlar, brick or other masonry are all equally suitable. The firebox should be lined with well-burned brick—it is not necessary to use fire brick. Cooking grill can be formed out of round or square iron rods, steel pipe or sidewalk grating, set into the mortar joint. An angle or plate lintel should be used to carry the chimney wall over the firebox opening. The masonry should be laid up in Portland cement mortar made of 1 part Portland cement, 1 part putty or hydrated lime and 6 parts of sand. Pleasing effects may be obtained by using colored mortar joints. The flue should be lined and only 2 lengths of standard 7½" x 7½" square flue lining are required.

OUTDOOR GRILL



ORIGIN OF FIRES IN RESIDENCES



Point of Origin	%
Areaways, porches, roofs, etc.	11.3
Airshafts	0.2
Attics	1.1
Awnings	2.7
Bathrooms and toilets	0.8
Bedrooms	10.1
Boiler and furnace rooms	2.2
Cellars	16.3
Chimney fires	2.3
Closets	4.2
Defective flues	5.3
Dining rooms	5.5
Dumbwaiter and elevator shafts	0.5
Hallways and corridors	2.5

Point of Origin	%
Kitchens	13.4
Parlors	7.5
Partitions, under floors, etc.	1.1
Storerooms	0.7
Stoves	10.5
Vacant floors	1.4
Miscellaneous	0.4

LOCAL NBFU INSPECTION AND RATING BUREAUS

Alabama: Alabama Inspection and Rating Bureau................Montgomery
Arizona: Arizona Equitable Rating Office..Phoenix
Arkansas: Arkansas Inspection and Rating Bureau................Little Rock
California: Board of Fire Underwriters of the Pacific......San Francisco
Colorado: Mountain States Inspection Bureau................................Denver
Connecticut: New England Fire Insurance Rating Assn,..Boston, Mass.
Delaware: Middle Dept. Assoc. of Fire Underwriters..Philadelphia, Pa.
District of Columbia: Underwriters Assn. of D. C...............Washington
Florida: Florida Inspection and Rating Bureau.......................Jacksonville
Georgia: Georgia Inspection and Rating Bureau.............................Atlanta
Idaho: Idaho Surveying and Rating Bureau...Boise
Illinois: Cook County Inspection Bureau...Chicago
Illinois Inspection Bureau (for rest of State)................Chicago
Indiana: Indiana Inspection Bureau...Indianapolis
Iowa: Iowa Insurance Service Bureau.......................................Des Moines
Kansas: Kansas Inspection Bureau...Topeka
Kentucky: Kentucky Inspection Bureau...Louisville
Louisiana: Louisiana Rating and Fire Prevention Bureau...New Orleans
Maine: New England Fire Insurance Rating Assn...........Boston, Mass.
Maryland: Md. Fire Underwriters Rating Bureau......................Baltimore
Massachusetts: New England Fire Insurance Rating Assn.........Boston
Michigan: Michigan Inspection Bureau...Detroit
Minnesota: Fire Underwriters Inspection Bureau.................Minneapolis
Mississippi: Mississippi State Rating Bureau................................Jackson
Missouri: Missouri Inspection Bureau..St. Louis
Montana: Board of Fire Underwriters of the Pacific
Butte, Mont. and San Francisco, Calif.
Nebraska: Nebraska Inspection Bureau...Omaha
Nevada: Board of Fire Underwriters of the Pacific, San Francisco, Calif.
New Hampshire: New Hampshire Board of Underwriters........Concord
New Jersey: Fire Insurance Rating Organization of N. J.........Newark
New York: New York Fire Insurance Rating Organization
New York, Syracuse and Buffalo
North Carolina: North Carolina Inspection and Rating Bureau..Raleigh
North Dakota: Fire Underwriters Inspection Bureau
Fargo, N. D., and Minneapolis, Minn.
Ohio: Ohio Inspection Bureau..Columbus
Oklahoma: Oklahoma Inspection Bureau...........................Oklahoma City
Oregon: Oregon Insurance Rating Bureau....................................Portland
Pennsylvania: Middle Department Rating Assn.
Philadelphia and Pittsburgh
Rhode Island: New England Fire Insurance Rating Assn., Boston, Mass.
South Carolina: South Carolina Inspection and Rating Bureau, Columbia
South Dakota: Fire Underwriters Inspection Bureau
Sioux Falls, S. D., and Minneapolis, Minn.
Tennessee: Tennessee Inspection Bureau.......................................Nashville
Texas: Texas State Fire Insurance Comm. (State maintained rating body) ....Austin
Fire Prevention and Engineering Bureau of Texas (inspection organization of insurance companies) ....Dallas
Utah: Board of Fire Underwriters of the Pacific
Salt Lake City, and San Francisco, Calif.
Vermont: New England Fire Insurance Rating Assn.......Boston, Mass.
Virginia: Virginia Insurance Rating Bureau...............................Richmond
Washington: Washington Surveying and Rating Bureau..............Seattle
West Virginia: West Virginia Inspection Bureau
Charleston, W. Va., and Columbus, Ohio
Wisconsin: Fire Insurance Rating Bureau................................Milwaukee
Wyoming: Mountain States Inspection Bureau..................Denver, Colo.

FIRE RESISTIVE VAULTS

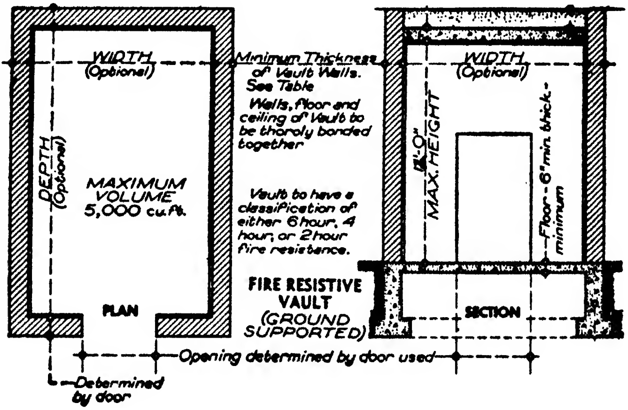
FUNDAMENTAL REQUIREMENTS. In the design of a fire-resistive vault a number of requirements must not be overlooked if the structure is to withstand successfully the effects of a severe fire and is to protect the records which it contains.

1. Wall, floor and roof construction of materials having sufficient fire resistance to resist the action of the most severe fire and also having adequate heat insulating resistance to prevent destruction of contents from high temperatures due to heat transmitted to the interior of the vault. Floors not less than 6" thick and greater if necessary to support the full load; or if exposed to fire from outside the vault, equivalent to that required for walls. Roofs at least 6" thick and greater if subject to unusual impact; or if exposed to fire from outside the vault, equivalent to that required for walls
2. Foundations and other supporting members of such design and construction that they will safely carry the weight of the vault and its contents when these supports are subjected to fire.
3. Provision against the impact of failing building members and building contents such as machinery and other heavy objects.
4. Independence of the vault structure from the building members, at least to such an extent that failure of the building will not cause failure of the vault.
5. Proper protection of door openings.
6. Vault shall be ventilated only thru door openings. Walls, floors, and roofs shall not be pierced. Not more than 2 door openings.

VAULT CLASSIFICATION. Vaults are classified in 2 groups according to the type of support—ground supported vaults and structure supported vaults. Each has a sub-division based upon the resistance periods to fire—6-hour, 4-hour, and 2-hour vaults.

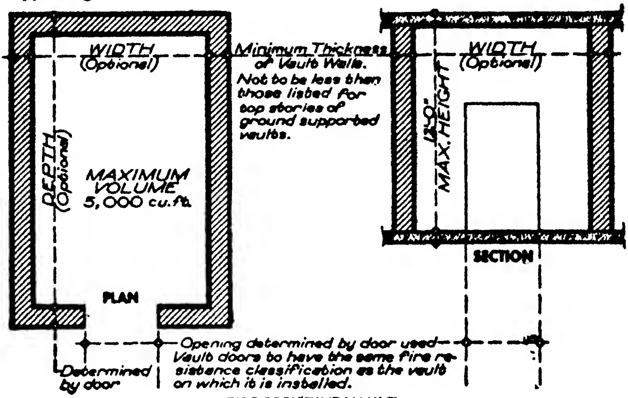
GROUND SUPPORTED VAULTS. Ground supported vaults are supported directly on the ground and independent of the building in which they are located. They afford full protection to their contents even in the event of complete destruction of building.

Foundations to be of reinforced concrete. Structural members supporting vaults shall have steel work protected by at least 4" of fireproofing.



FIRE RESISTIVE VAULTS

STRUCTURE SUPPORTED VAULTS. Structure supported vaults are supported by the framework of buildings of fire resistive construction. These vaults may be located individually on any floor and are designed to afford full protection to their contents, assuming the integrity of the supporting structure.



FIRE RESISTIVE VAULT
(STRUCTURE SUPPORTED)

Structure supporting vault shall be of adequate strength to carry full building load as well as entire weight of vault structure and contents. Structural members which support vault shall have steel protected by at least 4 inches of fire-proofing.

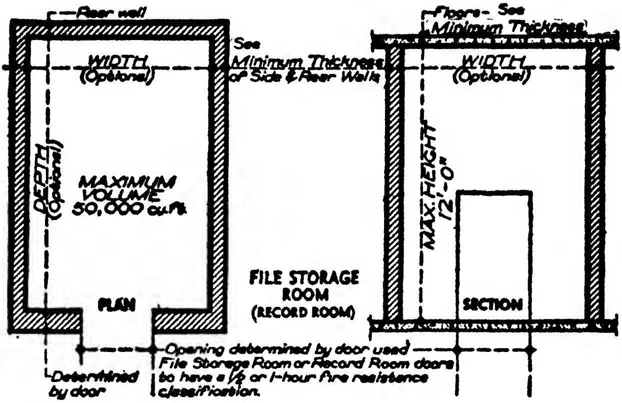
SUGGESTED MINIMUM THICKNESS OF WALLS FOR GROUND-SUPPORTED VAULTS

The following table suggests minimum thicknesses to take care of ordinary structural conditions and ordinary vault loads. The line for the "Top" floor may be considered as minimum wall thicknesses for Structural Supported Vaults.

Floor No.	*Thickness of Wall*						*Hollow Concrete Masonry*
	Reinforced Concrete			*Brick*			
	6 hr.	*4 hr.*	*2 hr.*	*6 hr.*	*4 hr.*	*2 hr.*	*2 hr.*
Top	10"	8"	6"	12"	12"	8"	8"
2nd from top	10"	8"*	8"	12"	12"	12"	12"
3rd from top	10"	10"	10"	12"	12"	12"	12"
4th from top	12"*	10"	10"	16"†	16"†	16"†	16"†
5th from top	12"	12"	12"	16"	16"	16"	16"
6th from top	12"	12"	12"	16"	16"	16"	16"
7th from top	12"‡	12"‡	12"‡	16"‡	16"‡	16"‡	16"‡
8th from top	12"	12"	12"	16"	16"	16"	16"
9th from top	12"	12"	12"	16"	16"	16"	16"
10th from top	14"	12"	12"	16"	16"	16"	16"

* Thickness in panel construction may be 2" less.
† Thickness in panel construction may be 4" less.
‡ These thicknesses apply to panel construction.

FILE STORAGE VAULT



A file storage room (record room) is an enclosure of fire-resistive construction intended for use where the volume of records is too large and not of sufficient importance to justify economically the provision of vaults or safes, but where values warrant a certain amount of special protection.

Storage rooms shall be located within buildings of fire-resistive construction. The protection specified for file storage room doors and window openings is a ½ to 1-hour fire-resistance classification. Practical structural requirements necessitate wall thicknesses having a higher fire-resistance classification.

MINIMUM THICKNESSES. *Side and rear walls*: reinforced concrete, 6"; brick, solid or hollow, 8"; hollow concrete masonry units, plastered 1/2" on each side, 8". *Floor and roof*: not less than 6" thick and greater if necessary to support the full load or resist unusual impact; or if exposed to fire from outside the room, equivalent to that required for wall.

OPENINGS. The openings in interior walls shall be restricted to doorways. Window and door openings are permitted in exterior walls. The door and window area should be kept to a minimum. All window openings shall be fitted with wired glass in metal frames, with fire actuated releases for closing. In addition, where exposed to adjoining buildings or structures within 50′, all window openings shall be protected with fire shutters or outside sprinklers.

VENTILATION. Ventilation of file storage rooms shall be thru door openings. Walls, floors, or ceilings shall not be pierced.

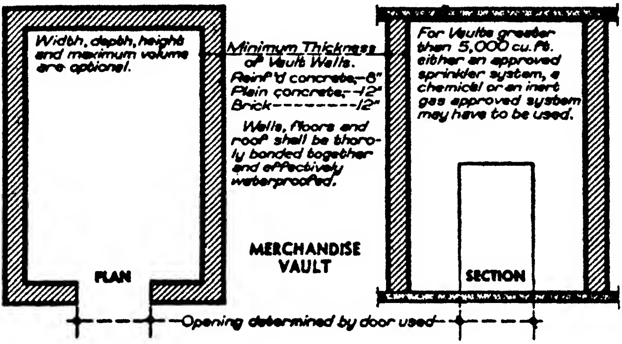
HEATING. Heating shall be by hot water or steam. When heated by steam the coils or radiators shall be located preferably overhead or shall be so arranged at the side to avoid the likelihood of records being in contact with the piping.

LIGHTING. File storage rooms shall be lighted by electricity with wiring in conduit and installed in accordance with National Electric Code. There shall be no pendant or extension cords. Main switches shall be outside the room and provided with a red pilot light.

REFERENCE. See "Protection of Records," 1947, by National Fire Protection Association, Boston.

MERCHANDISE VAULT

Floors and ceilings shall be of a construction equivalent in strength and fire resistance to the walls. Doors to be of 4-hour or longer fire-resistance classification.



Merchandise vaults are for the storage of soft goods and other merchandise. They are not intended to apply to vaults for the storage of film, pyroxylin plastics or other similar highly inflammable materials.

SUPPORTS. Vaults shall be supported from the ground up by a properly protected steel or reinforced concrete framework having a minimum 4-hour fire-resistance classification. The supporting walls or framework shall be of adequate strength to carry the weight of vault structure and contents together with any building loads they will be called upon to bear.

Vaults shall be structurally independent of non-fireproof buildings and any connection shall be so made that in event of collapse of the building, the stability and fire-resistive qualities of the vault shall not be endangered.

VENTILATION. Some means for ventilation may be required by the inspection department and in such a manner as to prevent fire passing thru the opening.

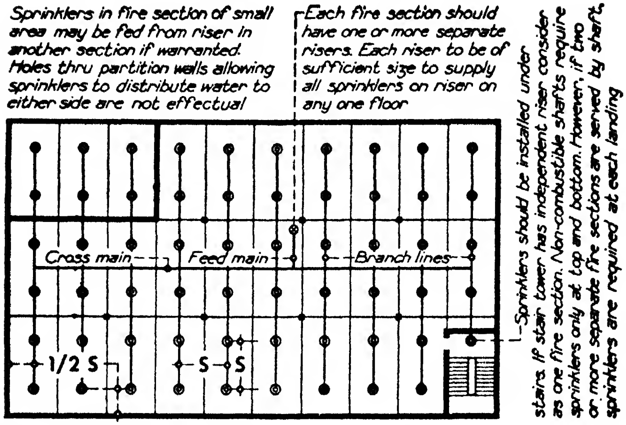
LIGHTING. Vaults shall be adequately lighted by electricity. Wiring shall be installed in accordance with the National Electric Code; all exposed wiring shall be in conduit. Pendant or extension cords shall not be used inside the vault.

REFRIGERATION. Refrigeration systems, if used, shall conform to the recommendations of the National Board of Fire Underwriters.

FIRE EXTINGUISHING EQUIPMENT. Where the vault contains high values which are subject to water damage, a system using an inert gas is recommended. Vaults protected by automatic sprinklers should, where practical, be provided with suitable floor drains.

REFERENCE. See NBFU pamphlet No. 84.

AUTOMATIC SPRINKLER LOCATION



S—Maximum distance between lines and between sprinklers on lines

A—Maximum square foot protection area allotted per sprinkler

1/2 S—Maximum distance from wall or partition to first sprinkler is 1/2 allowable distance between sprinklers in the same direction. With OPEN JOIST construction end sprinklers on alternate lines are spaced 2'-0" max. & end sprinklers on other lines are spaced 4'-0" max. from walls or partitions

TYPES OF CONSTRUCTION

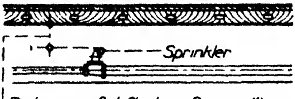
OCCUPANCY HAZARD	FIRE-RESISTIVE		MILL		SEMI-MILL		OPEN JOIST (Lines placed at right angles to the joists)		
	S	A SQ FT	S	A SQ FT.	S	A SQ FT.	S Distances between sprinklers: Right angle to joists	S Distances between sprinklers: Parallel to joists	A SQ FT.
LIGHT	14'-0"	196	14'-0"	168	14'-0"	144	8'-0"	10'-0"	80
ORDINARY	12'-0"	100	12'-0"	100	10'-0"	90	8'-0"	10'-0"	80
EXTRA	10'-0"	90	10'-0"	80	10'-0"	80	7'-0"	10'-0"	70

JOIST CONSTRUCTION WITH SHEATHED OR PLASTERED CEILING

OCCUPANCY HAZARD	TYPES OF SHEATHING: 1/2" Minimum thick plaster board, metal, or wood lath & plaster		Matched boarding or combustible fiber board		Cement or gypsum plaster on metal lath	
	S	A SQ FT.	S	A SQ FT.	S	A SQ FT.
LIGHT	14'-0"	168	12'-0"	120		
ORDINARY	10'-0"	80	Same as for OPEN JOIST		12'-0"	100
EXTRA	Same as for OPEN JOIST		Same as for OPEN JOIST		10'-0"	80

TABLES FOR MAXIMUM SPRINKLER SPACING

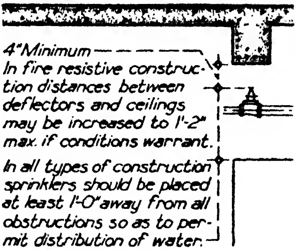
AUTOMATIC SPRINKLER INSTALLATION



Distances of deflectors from ceilings of mill or other smooth construction, or bottom of joists of open joist construction, should be 4" minimum, 10" maximum, with 5" to 8" preferred.

Ordinarily sprinklers are installed in upright position. Pendent position requires type approved for purpose.

MILL OR OTHER SMOOTH CONSTRUCTION



4" Minimum

In fire resistive construction distances between deflectors and ceilings may be increased to 1'-2" max. if conditions warrant.

In all types of construction sprinklers should be placed at least 1'-0" away from all obstructions so as to permit distribution of water.

FIRE-RESISTIVE CONSTRUCTION

Sprinkler deflectors installed parallel to ceilings, roofs, or incline of stairs. When in peak of pitched roof sprinklers should be horizontal.

Dimensions given above should be adhered to so as to insure proper distribution of water on ceilings; proper protection of area below sprinklers, and quick response to early heat waves from a fire.

INSTALLATION OF SPRINKLERS

RISERS to be adequately supported by attachments direct to riser or by hangers located on horizontal connections close to riser.

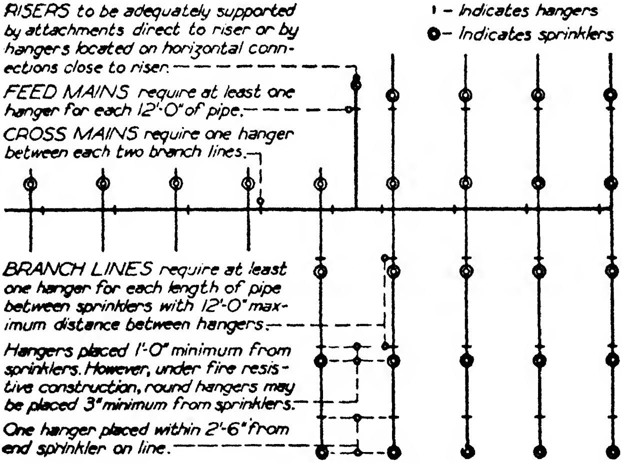
FEED MAINS require at least one hanger for each 12'-0" of pipe.

CROSS MAINS require one hanger between each two branch lines.

BRANCH LINES require at least one hanger for each length of pipe between sprinklers with 12'-0" maximum distance between hangers.

Hangers placed 1'-0" minimum from sprinklers. However, under fire resistive construction, round hangers may be placed 3" minimum from sprinklers.

One hanger placed within 2'-6" from end sprinkler on line.



LOCATION OF HANGERS

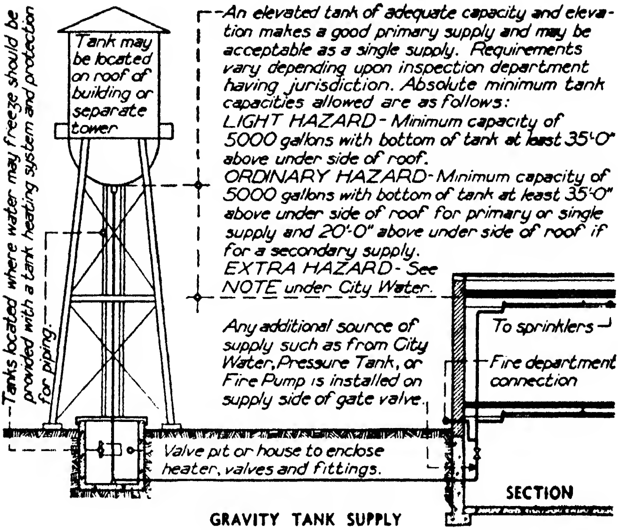
Hangers should be of round wrought iron U-type or approved adjustable type. Cast iron hangers or parts of hangers should be malleableized.

Pipes should be supported by hangers attached directly to structural members, by means of floor plates and thru bolts, or by approved inserts set in concrete when the suitability of the concrete has been definitely determined.

Where pipes are run thru concrete beams proper sleeves should be provided. Such sleeves should not be used for support of pipes.

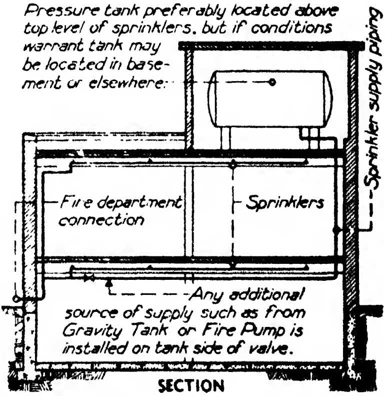
AUTOMATIC SPRINKLER WATER SUPPLIES

An elevated tank of adequate capacity and elevation makes a good primary supply and may be acceptable as a single supply. Requirements vary depending upon inspection department having jurisdiction. Absolute minimum tank capacities allowed are as follows:
LIGHT HAZARD - Minimum capacity of 5000 gallons with bottom of tank at least 35'-0" above under side of roof.
ORDINARY HAZARD - Minimum capacity of 5000 gallons with bottom of tank at least 35'-0" above under side of roof for primary or single supply and 20'-0" above under side of roof if for a secondary supply.
EXTRA HAZARD - See NOTE under City Water.



GRAVITY TANK SUPPLY

A pressure tank makes a good primary supply and in some cases may be acceptable as a single supply. Minimum requirements are as follows:
LIGHT HAZARD - 2000 gallons minimum amount of available water.
ORDINARY HAZARD - 3000 gallons minimum amount of available water.
EXTRA HAZARD - See NOTE under City Water.
Pressure tank ordinarily kept 2/3 full of water and an air pressure of 75 lbs. maintained.
Pressure tank should not be used to supply other than sprinklers or hand hose attached to sprinkler piping.



PRESSURE TANK SUPPLY

FIRE PUMP SUPPLY

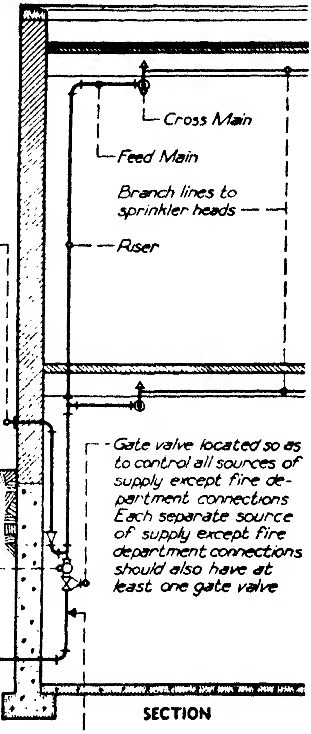
A properly located fire pump of adequate capacity and reliability makes a good secondary supply. An electrically driven and automatically controlled fire pump, taking water from an adequate source, may be acceptable as a single supply.
LIGHT HAZARD - 250 G.P.M. min. pump capacity. ORDINARY HAZARD - 500 G.P.M. min. pump capacity. EXTRA HAZARD - See NOTE under City Water.

AUTOMATIC SPRINKLER WATER SUPPLIES

Fire department connection thru which water can be pumped into the sprinkler system makes a desirable auxiliary supply. Number and location of connections determined according to specific requirements. On wet pipe systems with single riser connection made on system side of gate, check and alarm valves in riser. On systems with two or more risers connection made on system side of the shut-off valves controlling other water supplies but on supply side of separate riser shut-off valves.

Piping from water supply to sprinkler riser should be at least as large as riser. All main water supplies to connect with sprinkler system at foot of riser.

Grade line



Gate valve located so as to control all sources of supply except fire department connections. Each separate source of supply except fire department connections should also have at least one gate valve

Sprinkler alarm valve or other water flow detecting alarm device installed if required.

City supply main preferably not any smaller than 6". Connections to dead end mains should be avoided.

A connection from a reliable water works system is preferable as a primary or single supply. Minimum requirements are as follows:
LIGHT HAZARD - Supply to provide a residual pressure when delivering 250 G.P.M. of not less than 15 lbs. under the roof.
ORDINARY HAZARD - Supply to provide a residual pressure when delivering 500 G.P.M. of not less than 15 lbs. under the roof.
EXTRA HAZARD - See NOTE below.

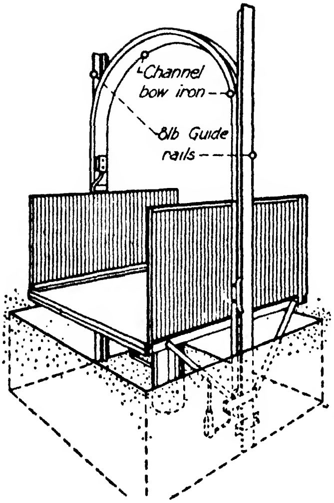
Any additional source of supply such as from a Gravity Tank, Pressure Tank, or Fire Pump is installed on supply side of gate valve controlling the sprinkler system.

CITY WATER SUPPLY

NOTE *Supply needed for EXTRA HAZARD and other various occupancies must be determined by a study of the conditions in each case. Consideration should be given to number of sprinklers that may operate.*

Every automatic sprinkler system should have at least one automatic water supply of adequate pressure, capacity and reliability. The necessity for a second independent supply, which is desirable, should be determined by a study of conditions in each case and consultation with the inspection department having jurisdiction.

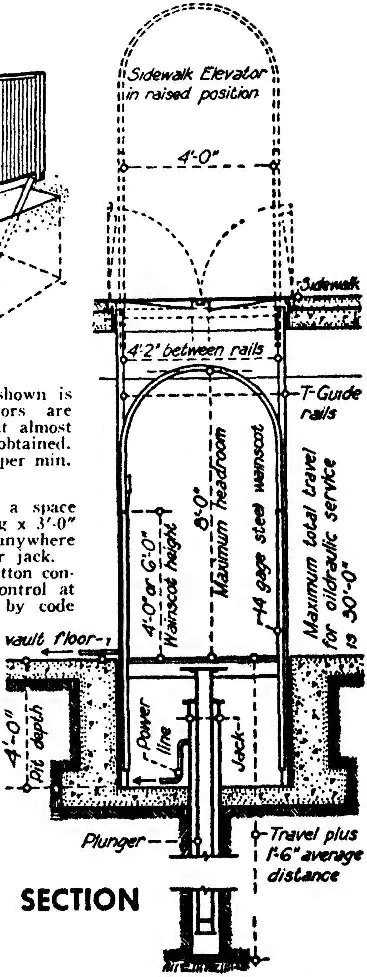
SIDEWALK ELEVATORS



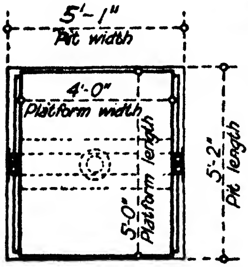
The capacity of the car shown is 2000 lbs. Sidewalk elevators are usually custom made, so that almost any size or capacity may be obtained. A maximum speed of 30 ft. per min. is suggested

The power unit occupies a space about 3'-4" wide x 4'-2" long x 3'-0" high, and may be located anywhere within 75 ft. of the elevator jack.

Constant pressure push button control, with a key operated control at sidewalk level, is required by code in most areas.



SECTION



PLAN

FACTORS IN ELEVATOR DESIGN

SELECTION OF PROPER EQUIPMENT. The selection of the proper number of elevators, capacity, speed, type of control, size of cars, type of doors, etc., is dependent on a number of factors requiring careful analysis of each building.

In general, it is desirable to include at least 2 passenger elevators in the ordinary building where the elevators are essential to the proper functioning of the building.

In larger and higher buildings, the number of passenger elevators, their arrangement and control can be determined only after careful study and analysis of all the factors involved.

Selection of freight elevator capacities, speed, size of platforms and proper controls must be determined by the type of goods or materials to be handled and the proposed flow thru the building. It is desirable to anticipate increased demands on freight elevators by specifying larger capacities than those which will be demanded immediately.

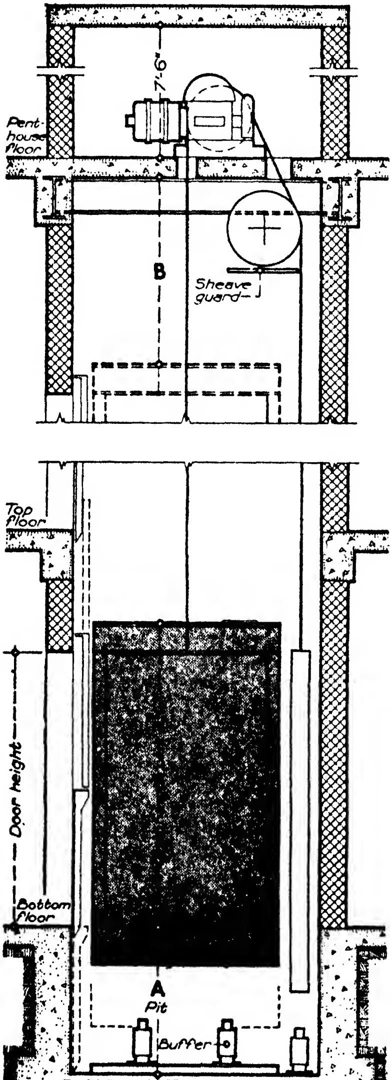
For *final* information necessary to draw up *detailed specifications* for the elevator equipment, consult elevator manufacturer. Their engineers are fully trained, competent and familiar with architectural problems. They will be pleased to honor architects' requests for expert engineering assistance.

FREQUENTLY USED DESIGN SPEEDS AND LOADS. The speeds, loads and platform sizes given are subject to variance. Those given in this table represent values frequently employed.

Type Building	*Speed*	*Load*	*Car Size*
Office			
Up to 5 stories	100–150	2000	6′–4″ x 4′–6″
Up to 15 stories†	150–600	2500	7′–0″ x 5′–0″
Small Apartments	100–150	1500	5′–0″ x 4′–6″
Small Hotels	100–150	2000	6′–4″ x 4′–6″
Apartment Houses	150–450	2500	7′–0″ x 5′–0″
Hotels			
Up to 15 stories	150–450	2000	6′–4″ x 4′–6″
15 Stories and Up	450–800	2500	7′–0″ x 5′–0″
Hospitals	100—450	4000	5′-8″ x 8′4″
Department Stores			
Small	100–150	2500	7′–0″ x 5′–0″
Large	150–300	4000	8′–0″ x 6′–0″
Freight	50–150	3000	60 sq. ft.

† Above 15 stories, consult elevator company.

SECTION DIMENSIONS ELEVATOR HATCHWAYS



TYPICAL VERTICAL SECTION

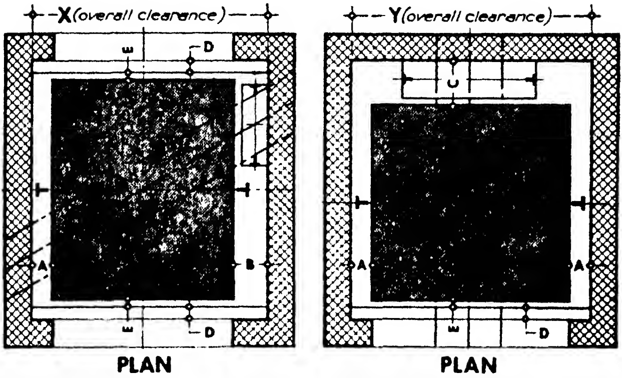
The section shown here illustrates the essential parts of any passenger or freight elevator installation, which influence the space which must be allowed vertically: The car, the elevator machinery and the pit.

Feet per min.	*A*	*B*
to 200	4'-0"	4'-0"
to 300	6'-9"	5'-0"
to 400	7'-6"	5'-6"
to 550	8'-2"	6'-3"
to 700	12'-6"	6'-9"
to 800	13'-10"	8'-8"

The *Safety Code for Elevators* requires that freight elevators having a travel of more than 2 floors above the main street floor and all passenger elevators shall be installed in fire-resistant hatchways.

Local laws or ordinances should be consulted before proceeding with the erection of hoistways, to determine legally acceptable construction which satisfies local fire-resistance requirement.

PLAN CLEARANCES
ELEVATOR HATCHWAYS



D -Depends on doors
E -Depends on elevators "E" is 1" for Passenger Elev. and 1¼" for Freight Elev.

Speed of car NOT over 200 ft. per min.

	Weight of Car Tee in lbs.	*A*	**B*	**C*
Up to 10,000 lbs. capacity and 100 sq. ft. platform area.. ...	15	7″	1′-1″	1′-0½″
Up to 20,000 lbs. capacity and 150 sq. ft. platform area......	22	8″	1′-1″	1′-0½″
Over 20,000 lbs. or over 150 sq. ft. of platform area, or both .	30	9″	1′-1″	1′-0½″

* *For speed over 200′ per min., B or C must be 1′-2″.*

Size of guide rails that must be used determines the clearances in the horizontal plane. The *Safety Code for Elevators* indicates the guide rails that are required for cars of different weights and capacities.

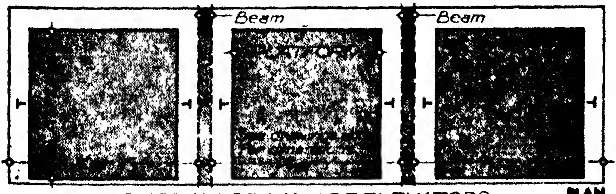
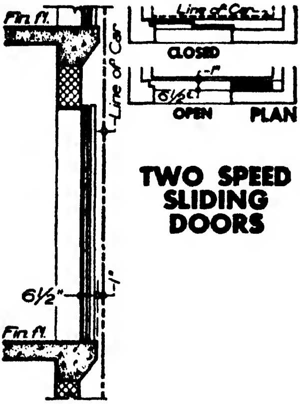


DIAGRAM OF BANK OF ELEVATORS PLAN

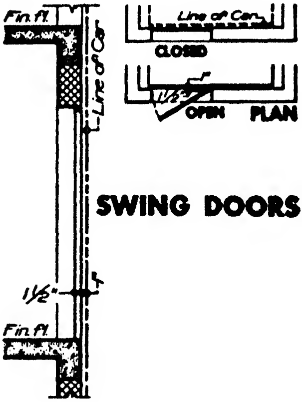
PASSENGER ELEVATOR DOOR TYPES

PASSENGER ELEVATOR DOORS. The nature of the traffic, space available, and architectural effect will govern the selection of the doors. It should be observed that the type of door selected will govern the detail of the door sill.



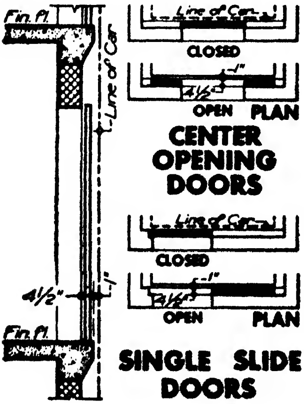
TWO SPEED SLIDING DOORS

2-Speed Sliding Doors. These are used where a wider opening into the car is desirable. They allow an opening equal to about 2/3rds the width of the car. These are probably the most commonly used, especially where doors are power operated.



SWING DOORS

Single Swing Doors. Swing doors are specified for passenger elevators for apartments, hospitals, small office buildings, etc., because they are easy to operate, quiet, and have very little equipment to be maintained or get out of order. They are also the least expensive.



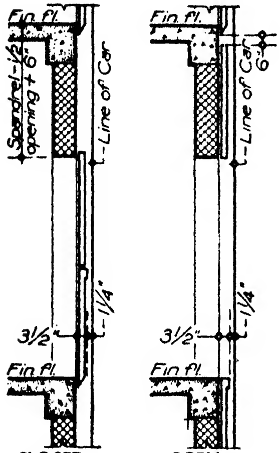
CENTER OPENING DOORS

SINGLE SLIDE DOORS

Center Opening Doors. These doors usually allow an opening about ½ the width of the car but more readily permit a successful architectural treatment since both doors are in the same plane. Center opening doors are sometimes advantageous because they operate faster than the other types.

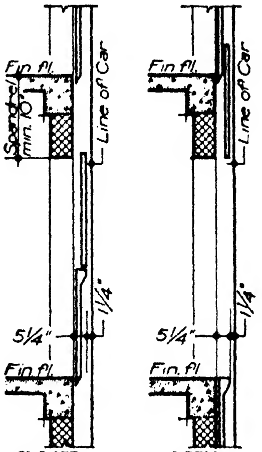
Single Slide Doors. These are used where a door opening about ½ the width of the car is acceptable.

FREIGHT ELEVATOR DOOR TYPES



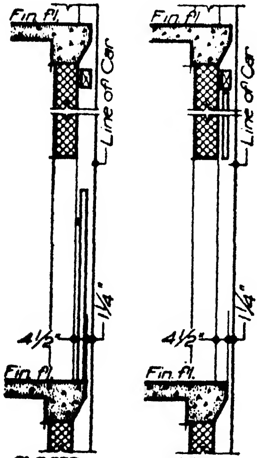
CLOSED POSITION   OPEN POSITION

REGULAR DOORS



CLOSED POSITION   OPEN POSITION

PASS DOORS



CLOSED POSITION   OPEN POSITION

VERTICAL GATES

REGULAR DOORS. This type is for general use in freight elevator openings in commercial or industrial buildings. Examination of the sections at the upper left show that the spandrel height must be equal to half the door opening height plus 6".

PASS DOORS. Where the spandrel height is not sufficient to accommodate regular type doors, pass type doors may be utilized. Pass doors may be installed where the spandrel height is as little as 10". This type is suitable for general use in freight elevator openings in commercial, industrial, and other types of buildings.

VERTICAL GATES. This type of elevator opening protection is used where local laws do not demand fireproof door protection, because it is least expensive.

STOCK GARAGE DOORS
SWINGING OR ROLLING

DESCRIPTION—Stock doors are made of old growth Douglas fir (Pseudotsuga taxifolia), intended for paint finish, in accordance with the provisions of Commercial Standard CS73, as promulgated by the Bureau of Standards and adopted by a representative group of door manufacturers.

These standard stock doors in pairs are hung by hinges—usually to swing outward. Sets of three doors may be hung on a track to slide around the corner, or one leaf may be hinged with the remaining two on a track hanger to fold in accordion fashion. It should be obvious that doors in sets of two or three leaves are not adaptable to overhead hardware.

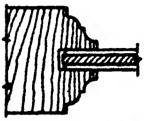
THICKNESS—Although CS73 permits the manufacture of garage doors in three thicknesses, the 1 1/8″ thickness is not manufactured. The 1 3/8″ thick garage doors are available from some manufacturers but are not generally used except in low-cost housing projects.

The 1 3/4″ thick garage doors are most widely used and most likely to be found in warehouse stocks.

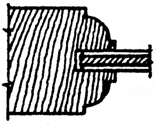
STANDARD SIZES—There are 8 widths and 3 heights listed as standard, as follows:

Widths	*Heights*
2′-0″	7′-0″
2′-4″	7′-6″
2′-6″	8′-0″
2′-8″	
3′-0″	
3′-6″	
3′-9″	
4′-0″	

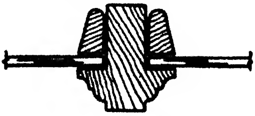
DESIGN—The standardized designs, as shown in the illustrations, suggest the use of these doors where appearance is not of special importance. Some of these designs have not been changed materially in 25 years or perhaps even longer. However, the information given here on dimensions and other properties of these standard doors may be useful to the designer in designing special doors.



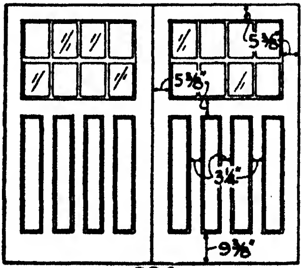
BEAD & COVE



OVOLO



GLASS BEAD



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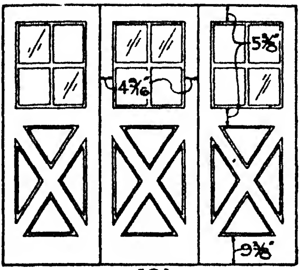
STOCK GARAGE DOORS
SWINGING OR ROLLING



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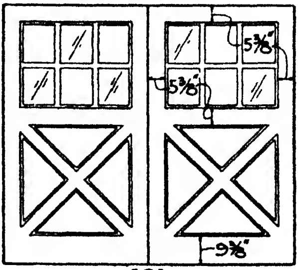

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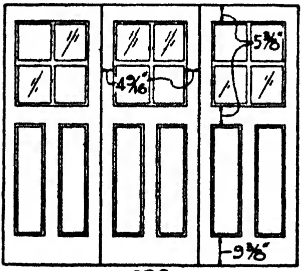

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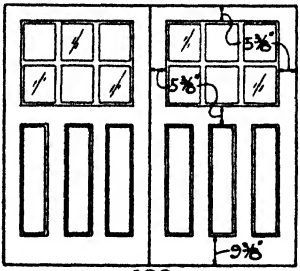

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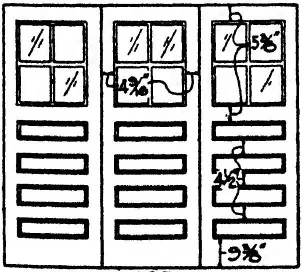

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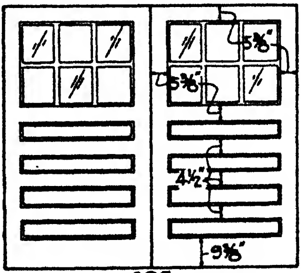

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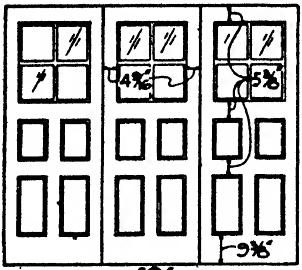
STOCK GARAGE DOORS
SWINGING OR ROLLING



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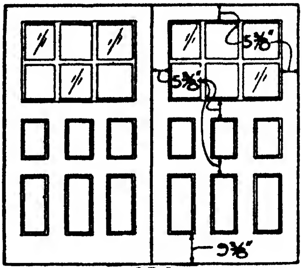

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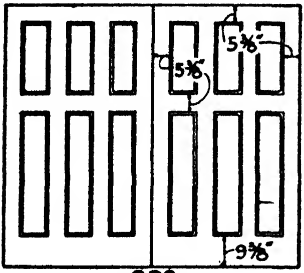

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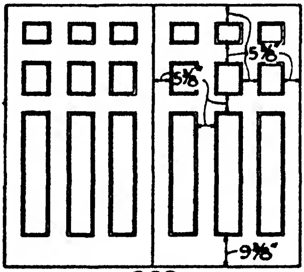

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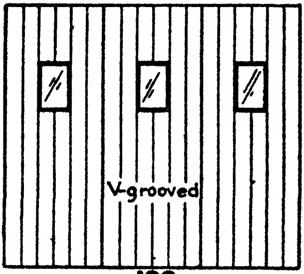

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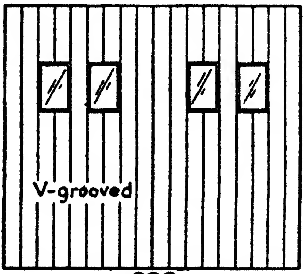

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PRESERVATIVES FOR WOOD

PRESSURE TREATMENTS have been definitely established by experience covering a long period of years as superior in obtaining maximum service against decay and insect attack. Pressure treatments consist of empty-cell and full-cell processes. Empty-cell treatment should be used with oil preservatives except when the retention specified is greater than can be obtained by an empty-cell process. Preservatives in water solution may be injected by either a full-cell or an empty-cell process.

NON-PRESSURE TREATMENTS should not be used for maximum service when it is practicable to use pressure treatments. Hot-and-cold-bath open-tank treatment gives the best penetration of the non-pressure methods.

BRUSH TREATMENT AND SPRAYING should be applied in at least 2 coats. Penetrations obtained will usually be less than 1/16″. Brush and spray treatments are used on surfaces cut after treatment. However, it is more practical than is commonly supposed to design wood structures so that all cutting, framing and boring of holes may be done before treatment.

RECOMMENDED PRACTICE—For protection against decay and against subterranean termites and dry-wood termites, the following recommendations are those of the Wood Preservers Association, according to location and use:

1. IN CONTACT WITH THE GROUND

Footings	*Mud sills*	*Plates*
Foundation timbers	*Pillars*	*Posts*

These and other members should be pressure treated with coal-tar creosote by the empty-cell process with a net retention of not less than 8 lbs. per cu. ft.

2. NOT IN CONTACT WITH THE GROUND

Bridging	*Partitions*	*Sills*
Coal bins	*Pillars*	*Sleepers*
Door casings	*Plates*	*Stairs*
Door frames	*Porches*	*Steps*
Footings	*Posts*	*Studding*
Foundation timbers	*Rails*	*Sub-flooring*
Headers	*Sheathing*	*Window casings*
Joists	*Siding*	*Window frames*

These and other members up to and including the first floor subfloor should be pressure treated with one of the following approved preservatives:

Preservative	*Minimum Retention lb. cu. ft.*
Coal-tar creosote	8.00
Chromated zinc chloride	0.75
Wolman salts (Tanalith)	0.35
Zinc chloride	1.00
Zinc meta arsenite	0.35

Where decay exposure is unusually severe, or where drywood termites prevail, the protection of these and additional members above the first floor subfloor may be necessary through the extended use of pressure treated lumber.

3. NAILING STRIPS

All nailing strips embedded in concrete or masonry should be pressure treated. Retentions of the various preservatives should be in accordance with Paragraph 2, except that for coal-tar creosote the retention should be not less than 6 lbs. per cu. ft.

PRESERVATIVES FOR WOOD

DESCRIPTION—The life of wood placed under conditions favorable to decay, attack of insects or marine borers, can be considerably extended by treatment with suitable preservatives. The penetrability of preservative varies considerably with various species. Sapwood is more easily penetrated than hardwood. Treatment does not appreciably affect the ultimate strength of woods. Some few woods, such as all heartwood of Southern cypress and the butt section of redwood, have a natural decay resistance without preservative treatment.

Some preservatives are more effective than others. All possess certain disadvantages that limit their use, as well as advantages that make them especially suitable for specific purposes. The preservatives fall into 3 general classes:

1. Those commonly called "preservative oils," which are relatively insoluble in water.
2. Salts injected into the wood in the form of water solutions.
3. Toxic material combined with a solvent, usually volatile, other than water.

1. PRESERVATIVE OILS—Preservative oils are ordinarily used in posts, poles, ties, and any material that will be in water, in contact with the soil, or in any other situation where high-moisture conditions prevail. If oil-treated material is to be used in buildings or where bleeding is especially undesirable, only straight creosote should be used.

Coal-tar creosote is the most important and most generally useful wood preservative. Coal-tar creosote is a black or brownish oil made by distilling coal-tar. The character of the various coal-tar creosotes available may vary considerably but satisfactory results may be expected from any good grade.

The advantages of coal-tar creosote are: (1) its toxicity to wood destroying fungi and insects, (2) its relative insolubility in water and its low volatility which impart to it a great degree of permanence under the most varied conditions, (3) its ease of application, (4) the ease with which its depth of penetration can be determined, and (5) its general availability and low cost.

For some purposes coal-tar creosote has properties that are a disadvantage. Freshly creosoted timber can be ignited and will burn, producing a dense smoke. After seasoning, however, the creosoted wood usually is but little, if any, easier to ignite than sound untreated wood, and less flammable than untreated but decayed wood.

Creosoted wood can be used in sills and foundation timbers, floor sleepers embedded in or resting on concrete, and even sub-flooring, with little danger of objection to the slight odor when freshly treated. Foodstuffs that are easily affected by odors should not be stored near creosoted wood.

Workmen sometimes object to the handling of creosoted wood because it soils clothes and may burn the skin, causing an effect similar to sunburn. Gloves and/or grease furnish protection against creosote burn.

It has been regarded as impossible to paint over creosoted wood but recent investigations indicate that some type of aluminum paint primer may be developed to secure satisfactory paint receptivity.

Other preservative oils consist of coal-tar and creosote solutions, creosote petroleum solutions, coal-tar distillates and various toxics in oils. These have not found wide use in building construction because of cost, lack of effectiveness, lack of service test records, or other reasons.

PRESERVATIVES FOR WOOD

2. WATER SOLUBLE SALTS—Inorganic salts and similar materials that are used in water solutions as wood preservatives are zinc chloride, acid cupric chromate, chromated zinc chloride, Wolman salts Tanalith, zinc meta arsenite and others. Preservative salts are ordinarily used in buildings where oil-treated wood is unacceptable because of odor, color, oily surface or unsatisfactory paintability. Salt preservatives are not to be used where marine borers are present and their use should be avoided for wood that will be in contact with the ground, in fresh water, or under other high-moisture conditions.

All salt-treated lumber for use in building or other places where high moisture content or shrinkage after installation would be a disadvantage, should be air dried or kiln dried after treatment and before use, to a suitable moisture content.

Zinc chloride was at one time the most largely used water soluble preservative but the poundage has decreased in favor of other types. It is not patented, it is inexpensive, it is uniform in quality, readily available. Wood treated with it can be painted. Like other water soluble salts, zinc chloride will leach out of treated timber if exposed to the soil moisture or rain and is, therefore, not recommended for timbers in contact with the ground. For outdoor use it is less effective than coal-tar creosote, but when painted it gives excellent results.

Chromated zinc chloride consists of approximately 18% of sodium bi-chromate and 82% commercial zinc chloride. It is not a patented preservative although there is a patent covering a method of preparing it. Like zinc chloride, chromated zinc chloride is intended for timber used above ground where it will not be wet or where it must be painted. Chromated zinc chloride reduces flammability in wood and the reduction is increased as higher concentrations are used.

Wolman salts comprise a group of patented preservatives, all essentially fluoride-phenol mixtures which vary considerably in composition, one of which is Tanalith U. This is said to consist of sodium fluoride, sodium chromate, di-sodium arsenate and dinitrophenol. Treatment leaves the wood odorless, clean and paintable.

Zinc meta-arsenite is a patented wood preservative sold under the name of ZMA. Treated wood is odorless, clean and paintable. It has given good service in the tropics when used above ground.

Other water-soluble preservatives include sodium fluoride, mercuric chloride, copper sulfate, and patented mixtures called Ac-zol and Celcure, all of which are toxic.

3. TOXIC MATERIAL IN NON-AQUEOUS VOLATILE SOLVENTS—This group of preservatives meets the need for a clean treatment that will not swell the wood but will leave it odorless and paintable. Many are sold under trade names.

Some of these preservatives are used for window sash, frames, and doors, and in the treatment of flooring, furniture and millwork exposed to fungus and termite attack.

COST—Cost of treatment will vary with the size of the job, distance from a source of supply and various other factors. The following prices for pressure impregnation must be regarded only as approximations.

Salt treatment, 1 lb. per cu. ft............$20 to $25 per M bd. ft.

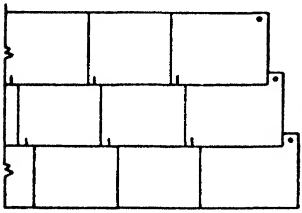
Creosote, 6 to 8 lbs. per cu. ft............$30 to $33 per M bd. ft.

Piles, ASTM 12-lb. treatment.............................25¢ per linear ft.

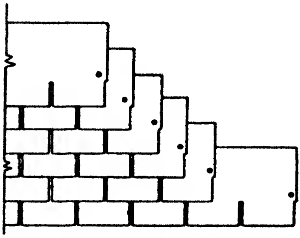
Some preserving companies do not accept orders in small amounts.

MINERAL SURFACED ASPHALT SHINGLES

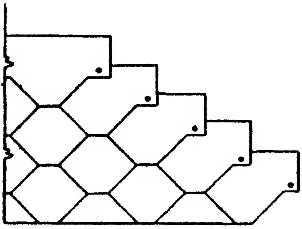
The multiplicity of designs and weights of individual and strip shingles that are available, the various methods of laying both types and the colors offered, create almost infinite permutations. In the accompanying table are listed these combinations of method, grade, and size most generally used.



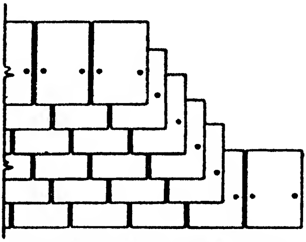
DUTCH LAP METHOD



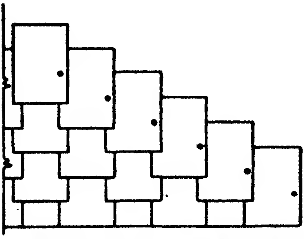
SQUARE TAB STRIP



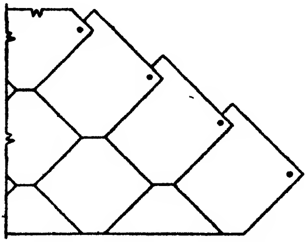
HEXAGONAL STRIP



AMERICAN METHOD
(1st & 4th Courses in Line)



WIDE SPACE METHOD



FRENCH METHOD

MINERAL SURFACED ASPHALT SHINGLES

	Method of Laying	Grade	Size in Inches	Exposure Inches	Head Lap Inches	Side Lap Inches	Wt. per sq. of Shingles only	Coverage in percent 1-ply	2-ply	3-ply	4-ply	Average Cost Range from HOLC Figures
INDIVIDUAL	American (alternate courses in line)	Heavy	12x16	5	6	—	325	—	15	68	17	$10.65-15.50
		Heavy	10x16	5	6	—	250	—	18	66	16	—
		Standard	9x12¾	4	4¾	—	244	—	14	70	16	$9.45-13.70
		Standard	8x12¾	4	4¾	—	250	—	15	69	16	$9.00-13.35
	American (1st & 4th courses in line)	Standard	9x12¾	4	4¾	—	250	4	6	73	17	—
	Wide Space (6″ between)	Standard	9x12¾	4	4¾	1½	165	32	48	16	4	—
		Standard	9x16	4	6	1½	165	32	48	16	4	—
	French	Standard	12x12	—	2½	2½	147	47	34	19	—	—
		Standard	14x14	—	2½	2½	134	57	31	12	—	—
		Standard	16x16	—	2½	2½	125	63	28	9	—	$5.90-9.60
	Dutch	Heavy	12x16	10	2	3	162	62	29	9	—	—
		Standard	13x18	11	3	3	134	56	32	12	—	$5.85-9.70
STRIP	Square Tab	Standard	12½x36	4	4½	—	265	—	5	83	12	—
		Standard	10x36	4	2	—	210	3	50	47	—	—
		Heavy	12x36	5	2	—	257	4	59	37	—	$8.00-11.55
		Thick Butt	15x36	5	5	—	254	—	6	94	—	—
		Thick Butt	12x36	5	2	—	210	4	59	37	—	—
	Hexagonal	Standard	12½x36	4	4½	—	227	13	60	27	—	—
		Standard	11⅓x36	4⅔	2	—	167	22	63	15	—	$6.35-9.75
		Standard	12⅓x36	4⅔	3	—	185	13	60	27	—	—

MINERAL SURFACED ASPHALT SHINGLES

DESCRIPTION—Asphalt shingles are made with a felt base impregnated with asphalt, coated with a more viscous asphalt, and surfaced with mineral granules embedded in the asphalt coating on that surface to be exposed to the weather, and mica or talc on the underside to prevent sticking.

Asphalt shingles are variously described as composition shingles, slate surfaced shingles, and frequently, confusedly called asbestos shingles although commonly they contain no asbestos fibers. The felts used in the manufacture of asphalt shingles are usually of organic fibers. Originally, materials other than rags (particularly wood fibers) were considered as adulterants. Research has shown, however, that roofings made from felts containing as much as 50% of certain materials other than rags may resist weathering as well as, if not better than, those made with all-rag felts.

The asphalts used are mainly of petroleum origin although some natural asphalts are also used. The asphalt coating usually contains fine mineral filler in proper proportions to definitely increase the resistance of the material to the weather.

Surfacing materials consisting of several types of colored granules are now in general use. Natural, fired, glazed, silicated and cemented granules provide a wide variation in color.

FIRE RESISTANCE—Shingles made and applied according to the specifications of the Underwriters Laboratories Inc. are eligible to receive the Class C label which identifies them as being "effective against light, fire, exposure." That is, they are "not readily flammable and do not readily carry or communicate fire; they afford at least a slight degree of heat insulation to the roof deck; they do not slip from position; they possess no flying brand hazard; they may require occasional repairs or renewals in order to maintain their fire-resistance properties."

INSTALLATION—The minimum roof slope should be 6″ per foot. The deck should consist of dry 25/32″ x 5 1/2″ T&G No. 2 (or 3) Douglas fir, western larch, southern yellow pine, hemlock, ponderosa pine, spruce or white fir boards, laid across or diagonal to rafters, nailed with 8d nails twice at each bearing.

Before shingles are laid in new construction, chimneys should be completed, flashings on upper side of chimney should be in place, vent pipes should be in place, gutters should be hung. Valley flashing consists of a lower course of half-width strip of slate roll roofing with surfacing down, nailed every 18″ along edges, and an upper course of full-width roll roofing with surfacing up, not nailed. Eaves and rakes should be flashed with a 1″ x 4″ angle formed of sheet metal, nailed so that the 1″ leg projects 1/2″ beyond the edge of the roof boards to form a drip.

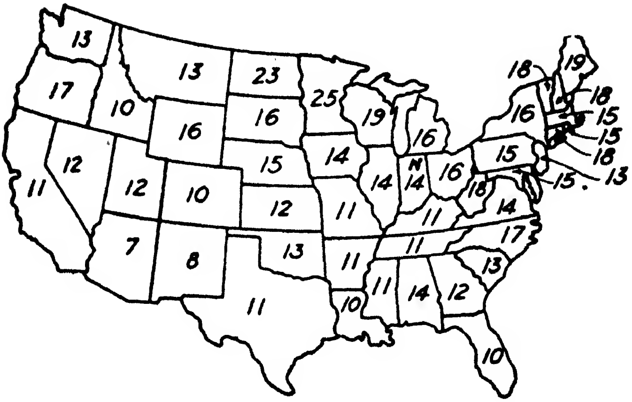
Where roofs abut vertical masonry, metal cap flashing should be in place. Wood cant strips should be placed where the roof abuts any vertical surface.

The deck is first covered with a 15 lb. saturated felt or a light smooth-surface roll roofing, lapped 2″ and nailed 18″ along the top edge. An 18″ wide starter strip of smooth-surface roll roofing is laid parallel with the eaves, with its lower edge projecting exactly 1/8″ beyond the edge of the eave flashing. Nail 6″ o/c on a line 4″ above the lower edge.

Either full-width roll roofing or sheet metal is used as base flashing, applied as the shingles are laid.

The shingles are laid as shown in the accompanying drawings. Ridges and hips are formed of individual shingles, lapped to conform with joint pattern of roof, and nailed.

MINERAL SURFACED ASPHALT SHINGLES



WEATHER RESISTANCE—In a survey conducted by the Bureau of Standards prior to 1940, the average years of service were reported for each State, and are shown in the accompanying map. It should be noted that these averages are composite for all types of asphalt shingles—differing in weight, manufacturing source, and method of laying. It can be safely assumed that the heavier weights and laying to increase the lap would produce a life expectancy exceeding the survey averages. Use of the lightest weights and laying to minimize the lap might reduce the life of a given installation below that of the survey average.

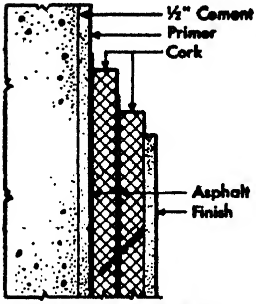
Multiple-layered methods of laying have higher first cost, because they require more material and more labor to apply them. Numerous observations in the field have shown that the oldest roofs are almost invariably of shingles laid to produce multiple-layers.

COLD WEATHER PRECAUTIONS—Spaces under the roof boarding should be ventilated to prevent warping. It is not advisable to attempt installation at temperatures below 40° F, and if outside temperatures are below 60° F, the roofing should be stored in a warm place for 24 hours before application. It is poor practice to walk on asphalt roofing at any time, but never in very cold weather.

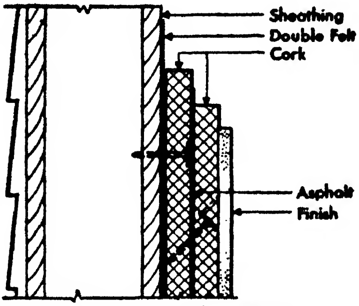
AVAILABILITY—There are more than 90 plants, located in 25 states, that manufacture asphalt shingles, making them readily available anywhere in the country.

LOW TEMPERATURE BLOCK INSULATION

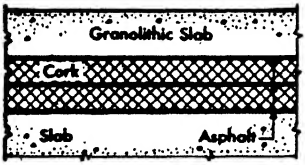
FINISHES—Glass type block is finished with asphalt emulsion. Other insulations may be finished with fibered or unfibered asphalt emulsion, mastic, or two 1/4" coats of Portland cement plaster jointed to localize cracking. Various types of special paint for cold storage work may then be applied to any of the foregoing finish materials. Wearing surface of floors can be wood on treated sleepers in the final course of insulation, or Portland cement, or mastic.



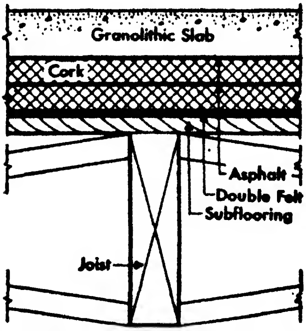
MASONRY WALL



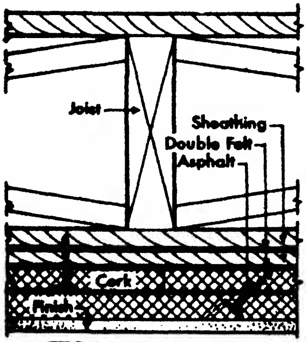
WOOD FRAME WALL



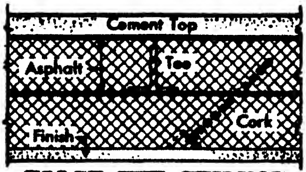
CONCRETE SUBFLOOR



WOOD SUBFLOOR



WOOD CEILING



FALSE TEE CEILING

LOW TEMPERATURE BLOCK INSULATION

DESCRIPTION—The rigid low temperature insulations are variously referred to as sheets, boards and blocks. Neither the word "sheet" nor "board" seems to describe accurately the material in the dimensions in which it is manufactured. A "board" is defined as a piece of rigid material of little thickness, and of length greatly exceeding the width.

CORK block is manufactured from ground cork which is molded and baked. The baking melts the natural resinous gums surrounding the cells, binding them together.

FIBER block is made of partially refined vegetable fibers obtained principally from crop plant wastes or wood. The blocks are fabricated from the pulp, suitable sizing material being incorporated in the product to render it water resistant. The drying temperature is such as to destroy rot-producing fungi.

GLASS block consists of true glass which has been cellulated in manufacture so that a section reveals a structure of tiny (5 million per cubic foot) sealed air chambers which are completely impervious to moisture.

MINERAL WOOL block consists of compressed loose wool with suitable binders to form a rigid material. Mineral wool is a generic term covering a number of similar products differentiated chiefly by the raw materials from which they are made, and being composed of very fine interlaced mineral fibers having the appearance of loose wool or cotton.

STRUCTURAL SHELL—Walls, floors and ceilings should be preferably of solid construction. Monolithic concrete or solid brick with flush joints are recommended.

All masonry walls, except excellent monolithic concrete surfaces, should receive a coat of 1:2 Portland cement plaster (manufacturers' literature on insulation refers to this plaster coat as "black-plaster" which, of course, *it is not*) floated to a true surface to fill the voids and to provide a true surface to receive the block. When dry it should receive an approved asphalt primer.

Construction with air spaces such as occur in hollow masonry or sheathed frame should be avoided but if used, the spaces should be left open to provide free air circulation. Sheathing should be treated T&G hemlock, pine, spruce or fir.

Self-sustaining partitions and interior walls can be constructed by utilizing temporary studs for alignment.

INSTALLATION—Some manufacturers maintain their own installation crews. Other manufacturers supply their materials to independent contract installers.

It is generally recommended that walls, floors and ceilings be constructed of 2 layers, both applied with hot asphalt (except for surfaces where 3 layers or more are required to obtain the thickness called for by heat loss calculation). Both transverse and longitudinal joints are staggered to prevent infiltration.

The 2nd (and any succeeding) layer of blocks is nailed or skewered to the preceding layer and on wood construction the 1st layer is nailed to the wood backing. The glass type of block, however, is not nailable but the bond of the glass surface with the asphalt provides satisfactory adhesion. The bottom layer of block in glass type ceilings is laid on T-irons.

The use of cold asphalt or the application of the 1st layer against masonry with Portland cement grout instead of hot asphalt is not recommended in the best practice.

LOW TEMPERATURE BLOCK INSULATION

SIZE							THICKNESSES (Thicknesses apply to all sizes)								Wt. Lbs. per Bd. Ft.	k Btu per Inch Thick
12 x 18	12 x 36	18 x 18	18 x 36	24 x 36	24 x 48	36 x 36	1/2	1	1 1/2	2	3	4	4 1/2	6		
	x		x	x		x		x	x	x	x	x		x	.65	0.27
	x							x	x	x	x	x			1.25	0.33
x										x	x		x	x	.90	0.45
		x	x						x	x	x				1.50	0.30
	x							x	x	x	x	x		x	.62	0.27
	x							x	x	x	x	x			1.25	0.33
	x			x				x	x	x	x	x				0.27
	x		x		x			x	x	x	x				1.00	0.28
			x					x	x	x	x	x			1.25	0.32
x	x	x	x	x			x	x	x	x	x	x			.65	0.27
	x		x	x				x	x	x	x	x				0.27

The table gives properties of various forms of low temperature block insulation, as compiled from a complete listing of manufacturers. The thermal coefficients given in the table were furnished from each one's own independent laboratory work. The temperatures at which the coefficients were determined were not necessarily the same for all the different products given.

GENERAL PRINCIPLES—Three forces attempt to drive moisture from the warm to cold side of a barrier: (1) Wind or air current pressures, (2) atmospheric pressures due to difference in the density of air at the different temperatures, (3) vapor pressure due to the difference in the absolute humidity at the different temperatures.

A cold room with one or more walls exposed to extremely low outside temperatures in the wintertime might have heat, air and vapor differentials tending to create a flow from the inside of the cold room to the exterior, instead of the other way around as would occur in the summer.

The basic principle of low temperature installations which utilize organic or fibrous insulation is the protection of the insulating material from the damaging effects of moisture permeation on the material itself and on its performance. The joints between any type of rigid blocks must be sealed against the infiltration of air and moisture which would make it uneconomical to maintain the interior temperature and would create a deposit of frost on coils, pipes or plates.

In addition to a satisfactory thermal coefficient, low temperature insulation may be examined for strength, freedom from odors, workability with tools, bond strength with asphalt, incombustibility, moisture resistance, susceptibility to rot, likelihood of attack from vermin.

LOW TEMPERATURE BLOCK INSULATION

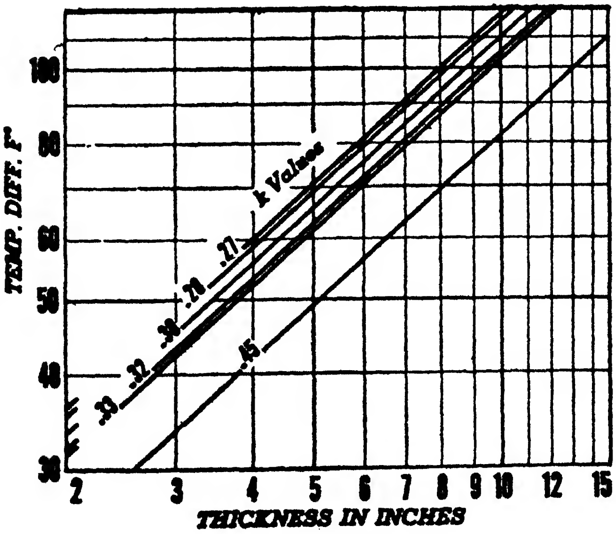
USES—Cold rooms are used for the cold storage of meat, fruit, vegetables, candy, dairy products, ice, furs, beer, etc., and for the processing of foods, ice cream, beer and other products. Locker plants, air conditioned ducts and apparatus require a low temperature type of insulation. One feature of the better class homes of the future will undoubtedly be a walk-in cold storage room with a fast freezer compartment.

THICKNESS OF INSULATION REQUIRED—The correct temperatures of cold rooms for different purposes will vary between quite wide limits. Most manufacturers' catalogs and various government specifications carry suggested minimum thicknesses of insulation based only on such cold room temperatures, irrespective of average outside temperatures during the period of peak refrigerating load. This is ridiculous because the total heat leakage through the walls, floor and ceiling is a function of the temperature difference—not the interior temperature only. The heat leakage establishes the original cost of the refrigeration plant and maintenance.

The dewpoint temperature of the exterior surface of cold rooms might be a factor in insulation thickness where spaces adjoining the cold room were at high humidity.

A complete analysis of required thickness of insulation would involve the cost of electric current and interest on the plant investment balanced against the interest on the cost of added inches of insulating material so that the most favorable economic balance is obtained.

The graph given on this BPF for insulation thickness will be found, under average conditions, to economically maintain the interior design temperature of the cold room. If the supporting construction contributes to the overall coefficient, its value would be credited in the selection of the insulation thickness.



LUMINESCENT PAINTS

DESCRIPTION—Any emission of light not ascribable directly to incandescence, and therefore occuring at low temperatures, is luminescence. (The word *luminous* includes all classes of objects which emit light, whether or not as the result of incandescence, and hence is not as accurate an adjective for coldlight emitting materials as *luminescent*.) Luminescent paints are coatings applied variously by dipping, spraying or brushing, which will emit light during or after excitation by a light source, called photoluminescent; or which will emit light without any form of external excitation, called autoluminescent. Commonly used luminescent paints fall into the following 3 classes:

1. Phosphorescent paints are non-toxic, photoluminescent and exhibit a glow for a considerable time after exposure to an external source of either "near" ultra-violet or visible light. All phosphorescent paints are also fluorescent. However, phosphorescent pigments do not fluoresce as brilliantly as fluorescent paints.
2. Fluorescent paints are non-toxic, photoluminescent and for all practical purposes emit light only during the period of excitation by an external source such as ultra-violet energy (popularly known as "black light") or some other light source.
3. Radioactive paints are autoluminescent and require no excitation from external sources. Radioactive paints are both phosphorescent for brief periods as well as fluorescent.

LUMINESCENT INTENSITY—To the uninitiated the intensity of light emitted from luminescent paints is frequently disappointing. Optical adaptation to darkness is subject to wide variation among persons as a result of differences in many complex contributing factors such as the observer's supply of vitamin A, the Purkinje effect, etc.

Immediately after blackout, at dusk, or on a moonlit night, the eyes may find difficulty in seeing the light emission of luminescent paints. After complete darkness-adaptation of the eyes a light intensity of 2/100th of a microlambert can be distinguished. (This is about equal to 1 twenty-five-millionth the brightness of an ordinary sperm candle.)

REFERENCES—A.I.A. File No. 25 for Paint Materials.

Luminescent and Fluorescent Paints, Bureau of Commerce Letter Circular 678.

Safe Handling of Radioactive Luminous Compound, Bureau of Standards Handbook 27, Government Printing Office, Washington, D. C., 10¢.

Luminous Paints and Colors, by E. R. Raaland, American Paint Journal, St. Louis, Mo., June 9, 1930, page 18.

Some Notes on Luminous Paints, Circular No. 272, by Gardner and Van Heuckeroth, Paint Manufacturers Association of the U. S., Washington, D. C.

Luminous Paints, by J. C. Bearn, Paint and Varnish Production Manager, New York City, Volume 5, Nos. 4, 5, and 6.

Luminescent Pigments and Paint, by H. Courtney Bryson, the Paint Industry Magazine, 1524 Chestnut Street, Philadelphia, February, March and April 1940.

Luminescent Paints, by J. Mitchell Fain, News Edition of Industrial and Engineering Chemistry, American Chemical Society, Washington, D. C., Volume 19, No. 22, page 1252.

PHOSPHORESCENT PAINTS

USES—The use of this material ordinarily should be confined to objects which are to be seen in complete or nearly complete darkness, and for such uses as would normally occur after dark-adaptation of the eyes had taken place.

Because the surface as well as the application of the paint can be controlled better in a factory than on the site, materials such as oilcloth, paper, cardboard, wallboard, adhesive tape, and decalcomanias which are factory coated with the phosphorescent paint, are available. Likewise, markers of transparent plastics impregnated with phosphorescent pigments are available.

Murals, decorative designs and ornaments, directional markers and safety warning signs, switch plates, kick plates, door knobs, furniture trim, light shades, are uses for phosphorescent paints which are already well known. Phosphorescent materials will act as an emergency light source in the case of power failure, to permit movement in a room, place of assembly or factory. Many new decorative, convenience and safety applications of phosphorescent materials are possible.

EXCITATION OF PHOSPHORESCENT PAINT—Daylight, visible artificial light and "near" ultra-violet light (3200-3900 AU) will activate phosphorescent paint. Mercury vapor and standard fluorescent lamps are probably most efficient excitation sources. The greater the intensity of light falling on the pigment, the greater will be its initial emission of afterglow.

COLOR—The daylight color of phosphorescent pigments is generally a light gray or light yellow. Attempts to change the daylight color by the addition of non-luminescent pigments will adversely affect the luminescence through screening out the activating light or absorbing the emitted light. Very small amounts of transparent synthetic dyes may be added to change the daylight color with only slight loss of phosphorescence.

APPLICATION—Surface for paint should be clean and dry. It is good practice to use two coats of an undercoater prepared with zinc sulfide (regular white pigment, not the luminescent pigment), lithopone, high strength lithopone, titanated lithopone or titanium dioxide. Lead or other metallic base paints should not be used. The same vehicle used in the luminescent coating should be employed in the undercoat. The white base coat provides a good light-reflecting background and protects the paint from the destructive effects, if any, of the surface to be painted.

After the undercoat is dry, the phosphorescent paint is applied with an absolutely clean, dry brush, stirring the paint with a wooden stick or glass rod just prior and during application. Being of a coarse, crystalline structure, phosphorescent pigments provide relatively poor brushing or spraying characteristics. Uniform covering, however, can be obtained by the application of two coats. For maximum phosphorescence these paints should be spread so that a total of one gallon of paint is applied to 50 or 60 yards of surface.

The calcium and strontium pigments are particularly susceptible to deterioration by moisture and if such paint films are to stand up under high humidities or exposure they must be protected by a coating of protective vehicle. In fact, a protective coating is a desirable precaution for *all* phosphorescent paints.

DURABILITY OF PHOSPHORESCENT PAINT — Phosphorescent pigments will eventually deteriorate, although none of the pigments fail because of continued re-excitation. Zinc and cadmium pigments are quite stable and some have been in continuous use for 2 and 3 years during the war. Calcium and strontium pigments properly protected from moisture can be expected to give service for 6 to 12 months or more under severe outdoor exposure and longer indoor service can be anticipated.

FLUORESCENT PAINTS

USES—Fluorescent pigments are used in plastics, paints, dyes, printing inks and paper. Fluorescent pigments have no useful afterglow and their uses are confined to those applications where it is possible and desirable to have a special black light source which can supply invisible light to the pigments when luminescence is required. Thus, fluorescent pigments are electrically dependent.

Impregnated plastics have been used for luminescent electric lamp shades, costume jewelry, etc.

Fluorescent pigments have been used in the preparation of printing inks and paper for use in airplane instruments, maps, wall-paper, decalcomanias, theater programs, etc.

Fluorescent dyes have been used for draperies, upholstery, wall and floor coverings, theater seats, arm rests and aisle carpeting.

EXCITATION OF FLUORESCENT PAINT—Fluorescent materials require a light source which contains little or no visible energy if their fluorescent light is to show to best advantage.

An ultra-violet, or so-called "black" light is such a light, but any bulb equipped with a suitable nickel oxide glass filter is a satisfactory, although not always an efficient, activating light source. Ultra-violet sources include the argon glow lamp, the high pressure mercury arc and the fluorescent lamp suitable filtered, and the new 360BL tubular lamp.

Some pigments respond immediately to activation, others require several seconds.

COLOR—The daylight colors are available in considerable range of pale to fairly vivid colors and do not correspond exactly to the fluorescent colors. Under activation the fluorescent pigments display an amazing brilliance and strength of color throughout a wide color range. Attempts to change the daylight color by the addition of non-fluorescent pigments adversely affects the luminescence through screening out the activating light or absorbing the emitted light. Synthetic dyes may be added by the manufacturer in small quantities to alter the daylight color with only slight loss in the fluorescence.

APPLICATION—Fluorescent paints are governed by the same general considerations as those which apply to phosphorescent paints. The particle sizes of fluorescent pigments correspond to those of ordinary paint pigments so that finished fluorescent paint can be applied readily by brushing or spray gun. To provide satisfactory fluorescence a zinc-cadmium paint should be applied so as to spread 120 yards to the gallon.

DURABILITY—Fluorescent paints vary considerably in their resistance to exposure to visible light and weather. Some are relatively unaffected by water, weak acids or alkalis or exposure to strong sunlight. Many have been exposed to outdoor weathering for months and even years with little loss of fluorescence. In certain vehicles the pigments are subjected to a photochemical darkening under some conditions of exposure to sunlight in the presence of water.

COST—Mixed paint for brushing or spraying is currently quoted by manufacturers at $40 to $60 a gallon. Future prices may be substantially lower.

RADIOACTIVE PAINTS

GENERAL—Radioactive paints contain a minute amount of radium, mesothorium, thorium, or radiothorium, in a luminescent base such as zinc sulfide. Experience in applying the paint during the last 15 years has shown that when due precautions are taken to prevent the radioactive compound from entering the mouth or lungs of workers no detectable injuries have resulted.

USES—Up to this time radioactive pigments have been employed chiefly as a paint for the marking of instruments and dials. Radioactive pigment has sometimes been placed between two discs of transparent plastic in the form of buttons to be used as guide markers. However, full advantage has not been taken of this material in architecture and building. The marking of danger spots in buildings, fuse boxes and light switches and other controls which are normally in darkness, so that phosphorescent paints would not be activated, opens up an interesting functional field for radioactive pigments.

The range of visibility in hairline markings and small numerals is from 5 to 20 feet in darkness. Areas of 10 square inches are visible for about 200 feet. Areas of 25 square inches are visible up to 500 or 600 feet. The range of visibility depends upon the grade of compound, the area to which it is applied, and the dark-adaptation of the observer's eyes.

EXCITATION—Luminescence in radioactive pigments is caused by the bombardment of the particles of the phosphorescent responsive base and no external excitation is required.

COLOR—The daylight color is a slightly yellowish white and the luminescent color is bluish or greenish white. No other pigment or dyestuff may be added to change the daylight color.

APPLICATION—Special precautions and equipment are needed for the applying of radioactive paints. For satisfactory results, 1 gram (about 1/28th of an ounce) of pigment should be made to cover an area of not more than 4 square inches. A heavier application will give increased brightness.

The surface to be treated must be clean and free from grease or finger marks. An undercoat of zinc oxide or titanium dioxide white lacquer is recommended.

DURABILITY—Radioactive compounds can be formulated and applied so as to be stable under outdoor conditions. The amount of radioactive material present should be sufficient to yield optimum brightness but if used in excess of this amount, it will accelerate the more rapid breakdown of the sensitive base without yielding more light. The luminosity lasts from 6 to 8 years.

COST—Prices range from 50¢ to $3 a gram, depending upon the amount and character of radioactive material.

STEEL PIPE
FOR ORDINARY USES

DESCRIPTION OF STEEL PIPE FOR SPECIAL USES—Different types of steel pipe are made for a wide variety of special requirements such as close coiling, bending, high pressure service, compression, tension, unusual corrosion resistance, flanging, impact, low temperature, plating, and many others. Standard specifications covering these types of pipe for special uses have been formulated by many organizations, among which are:

American Society for Testing Materials
Association of American Railroads
American Petroleum Institute
American Standards Association
American Society of Mechanical Engineers
American Waterworks Association
Director of Procurement of the U. S.
U. S. Navy

Both physical and chemical tests are usually described in such specifications. Any of these special pipes are normally made by pipe manufacturers on order to conform to the specifications. Pipe meeting such specifications may or may not be regularly found in jobbers' warehouses.

DESCRIPTION OF STEEL PIPE FOR ORDINARY USES — should conform to ASTM Specification A120 which covers black and hot-dipped galvanized, welded and seamless, unalloyed steel pipe from 1/8" to 12" nominal inside diameter, purchased mainly from jobbers' warehouse stocks. Hydrostatic pressure tests are the only physical tests made on pipe conforming to ASTM A120 because the pipe is intended for ordinary uses where special properties are not required. Steel Pipe for Ordinary Uses is manufactured from mild, ductile steel made by the open hearth or Bessemer process.

Steel Pipe for Ordinary Uses is available in a range of diameters, wall thicknesses, surface treatments and methods of manufacture.

LENGTHS—Standard weight pipe comes in random lengths from 16 to 22 feet. Not more than 5% of the total number of lengths may be "jointers," which are two pieces tightly coupled together. Continuously welded pipe comes in 21 ft. lengths.

Extra strong and double extra strong pipe comes in random lengths of 12 to 22 feet. Five per cent may be in lengths of 6 to 12 feet.

WELDED AND SEAMLESS TYPES—Steel pipe 3" and less in diameter is usually butt-welded, sizes 3 1/2" and over being lap-welded. In the *butt-welding* process the skelp with square or slightly beveled edges is drawn from the furnace through a funnel-shaped welding die or through welding rolls during which operation it is bent into tubular form and the edges are brought together with sufficient pressure to weld them.

In the *lap-welding* process the skelp, with scarfed or beveled edges is heated and bent to tubular form with the edges overlapping, and is then reheated and passed over a mandrel between rolls which compress and weld the lapping edges.

Seamless pipe conforming to A120 is made by piercing solid round steel billets and rolling.

STEEL PIPE
FOR ORDINARY USES

PHYSICAL PROPERTIES—Since warehouse stocks of steel pipe conforming to A120 are not manufactured to meet physical tests, the following figures are approximate.

Tensile strength, minimum pounds per square inch	45,000
Yield point or elastic limit, minimum pounds per square inch	25,000
Coefficient of thermal expansion, ins./in./F°....	.00000674

USES FOR BLACK STEEL PIPE—Black pipe is the term commonly applied to uncoated pipe and to pipe given an ordinary air-drying lacquer coating for protection against rust in shipment. The application of the lacquer coating is regular mill practice. Pipe for natural and manufactured gas for cooking and illumination; for low pressure steam heating systems; for air lines and ammonia; is generally furnished black.

USES FOR GALVANIZED PIPE—Zinc, applied by the hot dipped galvanizing process is widely used for protection against corrosion. As regular practice, galvanized steel and couplings are hot galvanized prior to threading. The threading operation, of course, removes the coating from the threaded areas. Regular practice is to furnish galvanized pipe in accordance with the galvanizing requirements given in ASTM Specification A120 and the test procedure given in that specification for determining weight of coating is standard in the industry. Galvanized steel pipe is used for hot and cold water supply lines, plumbing vent lines, and waste lines above ground.

Pipe meeting the same dimensional and hydrostatic requirements as specified in A120 but with special coatings is available from the mills for underground service.

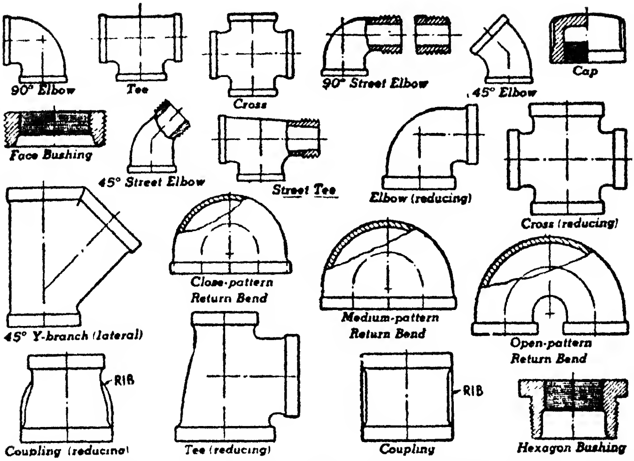
SPECIAL TREATMENTS—Special treatments are not described in ASTM A120 and pipe with special treatments is not normally to be found in jobbers' warehouse stocks. Special treatments consist of galvanizing after cutting to lengths, galvanizing on outside only, galvanizing on inside only, pipe and couplings galvanized after threading, galvanized coatings heavier than standard, tar base or asphalt base coatings on either inside or outside or both, addition of saturated fabrics over bituminous coatings, primer coatings, cement linings, pickling or mechanical cleaning followed by oiling. Steel pipe treated with these special finishes are normally available only on special order from the mill and frequently involve an additional cost and a longer time for delivery.

SPECIAL ALLOYS—Although ASTM Specification No. A120 does not cover wrought iron or alloyed steel pipe, they should be mentioned here. The addition of from 0.20% to 0.35% of copper provides increased resistance to atmospheric corrosion and various other types as well. The addition of copper and molybdenum increases both resistance to various types of corrosion as well as increasing the tensile strength. The corrosion resistance of wrought iron pipe is well established. The first cost of these types of pipe is higher than steel. They are made in standard, extra heavy and double extra heavy in dimensions the same as steel pipe. Fittings for the alloyed pipe are usually required to be of the same analysis as the pipe.

STEEL PIPE
FOR ORDINARY USES

Size (Nominal Inside Diameter)	O. D. to nearest 1/16th	STANDARD WEIGHT PIPE			EXTRA STRONG PIPE			DOUBLE EXTRA STRONG PIPE		
		Thickness in.	Wt. in lbs. per L. Ft., Threaded and with Couplings	Hydro-static Test Pressures	Thickness in.	Wt. in lbs. per L. Ft., Plain Ends	Hydro-static Test Pressures	Thickness in.	Wt. in lbs. per L. Ft., Plain Ends	Hydro-static Test Pressures
		BUTT WELDED								
1/8	7/16	0.068	0.24	700	0.095	0.31	850	—	—	1,000
1/4	9/16	0.088	0.42		0.119	0.54		—	—	
3/8	11/16	0.091	0.57		0.126	0.74		—	—	
1/2	13/16	0.109	0.85		0.147	1.09		0.294	1.71	
3/4	1 1/16	0.113	1.13		0.154	1.47		0.308	2.44	
1	1 5/16	0.133	1.68		0.179	2.17		0.358	3.66	
		LAP-WELDED, ELECTRIC-WELDED AND SEAMLESS GRADE A								
1 1/4	1 11/16	0.140	2.28	800	0.191	3.00	1,100	0.382	5.21	1,200
1 1/2	1 15/16	0.145	2.73		0.200	3.63		0.400	6.41	
2	2 3/8	0.154	3.68		0.218	5.02		0.436	9.03	
2 1/2	2 7/8	0.203	5.82		0.276	7.66		0.552	13.70	
3	3 1/2	0.126	7.62		0.300	10.25		0.600	18.58	
3 1/2	4	0.226	9.20	1,200	0.318	12.51	1,700	—	—	2,000
4	4 1/2	0.237	10.89		0.337	14.98		0.674	27.54	
5	5 9/16	0.258	14.81		0.375	20.78		0.750	38.55	
6	6 5/8	0.280	19.18		0.432	28.57		0.864	53.16	
8	8 5/8	0.322	28.81		0.500	43.39		0.875	72.42	2,800
10	10 3/4	0.365	41.13	1,000	—	—	—	—	—	—
12	12 3/4	0.375	50.71		—	—	—	—	—	—

STEEL PIPE
FOR ORDINARY USES



SOME FITTINGS USED WITH STEEL PIPE

FITTINGS FOR STEEL PIPE—Standard weight pipe is furnished with threaded ends and couplings made of wrought iron or steel by the pipe manufacturer. Each length of pipe 2" and smaller in diameter is furnished with a straight tapped coupling. Each length of pipe 2 1/2" in diameter and larger is furnished with one taper tapped coupling. All other fittings are made by companies other than the pipe manufacturers.

Any fitting can be *standard* or *heavy* in weight—the heavy weight withstanding pressures greater than the standard weight. Sometimes local building codes require the use of heavy weight fittings with standard weight pipe while others permit the lighter standard fittings to be used.

Fittings are made of either *cast iron* or *malleable iron*. The *cast iron* fittings are less expensive, somewhat more brittle, and slightly heavier in weight of metal. Cast iron fittings are commonly used with steel pipe for steam lines. *Malleable* fittings are less brittle and are somewhat easier to handle because of their lighter weight of metal and are commonly used in water, gas, and air lines.

Fittings may be either *black* or *galvanized*, the choice following type of steel pipe that is used.

INSTALLATION—Joint compound should be used to facilitate assembly and to render pipe connections tight and leakproof. The ends of all threaded pipe should be thoroughly reamed to eliminate burrs. Where water is to be heated for domestic or other uses it is desirable to employ an open or deaerating type of heater which permits dissolved gases in the water to escape, to minimize corrosion. Only ferrous fittings should be used. Pipe covering should be installed so as to prevent air from reaching the pipe surface. Where air gets beneath insulation, condensation can occur on the metal where it becomes acid due to absorption of atmospheric gases.

MAGNESIUM OXYCHLORIDE PLASTIC FLOORING

DESCRIPTION—Plastic magnesium oxychloride cement is known variously as composition, sorel cement, magnesia cement, plastic magnesia cement, magnesite, and by various trade names which may or may not suggest the ingredients or appearance of the finished floor.

These floors may be laid over old or new floors and sub-bases. Bases, wainscots, and carpet strips can be formed of the same material. Plastic magnesium oxychloride floors are permanent, warm, quiet, resilient, dustproof, relatively non-slip, incombustible, inhibiting to bacteria and fungus, and have good wearing qualities. A wide range of exceptionally clear, brilliant colors is available to the designer.

Because of the inherent resilience of magnesium oxychloride floors it may be applied monolithically to areas of large extent without cracking, provided there is no excessive structural movement. This property has led to its widespread use in ships, street railway cars, railway cars and subway cars, where the vibration and racking imposes serious demands.

Aggregates may be incorporated to form terrazzo. Metal or plastic strips may be used for design purposes. Ingredients may be controlled to produce a floor which will not spark from friction or static. Floors are sometimes scored to represent tiles or blocks with the dubious idea that such grooving of an inherently sanitary monolithic surface will improve either its function or its appearance!

COMPOSITION IN GENERAL—The plastic cement is made by adding about a 22° Baumé solution of magnesium chloride hexahydrate termed magnesium chloride ($MgCl_2+6H_2O$), to magnesium oxide (MgO) which is a fine white powder. Magnesium oxide is also referred to as calcined magnesia and calcined caustic magnesia. The resulting plastic paste is magnesium oxychloride (approx. $3\ MgO+MgCl_2+11H_2O$).

Fillers such as wood flour, hardwood fiber, cork, talc, asbestos, sand, silex, marble flour, limestone fines, as well as color pigments and aggregates if desired, are mixed into this paste. The paste sets to a hard mass comparable to Portland cement in strength. After setting the cement takes a high wax polish.

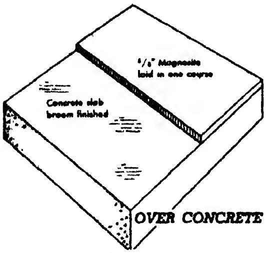
RESISTANCE TO LIQUIDS, ETC.—The floor is attacked by caustics and sulphuric acid but not by ordinary chemicals in the concentrations which would usually be encountered. Alcohol, grease, naphtha and other solvents do not attack this flooring.

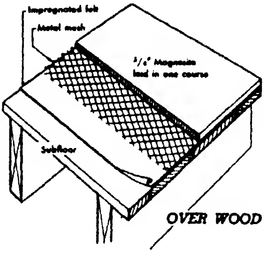
Magnesium oxychloride flooring is not waterproof in that it will not withstand complete immersion over a long period or constant dampness. However, experience in public transit cars as well as in many industrial and other building installations indicates that under normal conditions in dry locations the floors will withstand any wetting incidental to use or maintenance with affecting the normal life expectancy of the installation.

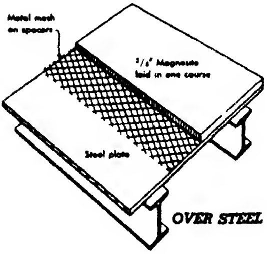
The choice of fillers, aggregates, and the grading of aggregates affect the solubility and absorption of the flooring. It has been found that the addition of copper powder in compositions that contain no fillers which are in themselves affected by water, will reduce the solubility of the flooring. The use of copper powder is a proprietary process owned by one company.

Washing soda and water, especially scalding water, will ordinarily attack almost any finish flooring whether it be linoleum, wood, terrazzo or even marble—depending on the strength of the solution Magnesium chloride is a salt and is water soluble even after it is crystallized in the solid flooring. While ordinarily, even daily mopping of floor is not harmful to it, constant water without intermittent periods for drying and recovery of the salt is harmful. Therefore, magnesite flooring is not recommended for unprotected sub-grade or exterior work.

MAGNESIUM OXYCHLORIDE PLASTIC FLOORING







INSTALLATION—The present trend is to apply flooring in one coat to a thickness of 5/8″ over-all. Where floors of 1″ or more in thickness are required for increased fire resistance, to meet grade, for greater impact strength under severe service, or for some other reason, two coats may be used with the finish surface coat *not less than* 1/2″.

The material is furnished to the site in two parts. The first consists of magnesium oxide, aggregates, colors and fillers which have been proportioned and dry-premixed by the installer. The second is magnesium chloride which is furnished in flake form and is reduced to a liquid on the job by the addition of water to the required specific gravity. These are combined to a mortar which is spread on the job, leveled and finished by troweling or grinding.

Flooring can be laid over subfloors of steel, wood or concrete. Cove bases can be laid against wood, hard cement plaster, brick, concrete or stone but should not be laid against glazed brick, gypsum tile or lime plaster.

Fairly even room temperature must be maintained. In cold weather a 65° to 70° temperature should be maintained day and night for 48 hours. A sudden drop of 15° or more may cause cracking by shrinkage. A sudden rise in temperature can cause buckling by expansion. Within 24 hours after the final troweling any roughness can be smoothed by dry rubbing with steel wool. Floors are then given a light coat of wax or a mixture of boiled linseed oil and turpentine or benzene, well rubbed in. New floors should be protected for 72 hours with sawdust or building paper.

WOOD SUB-FLOORS—The wood must be clean, sound, and firmly nailed. Painted or galvanized expanded metal lath or 1″ wire *mesh* galvanized after weaving is nailed 6″ both ways over good quality waterproof building paper.

CONCRETE SUB-FLOORS—The concrete must be sound, dry and not less than 30 days old. The surface should be short-tooth raked, broomed or picked. No wooden sleepers should occur. No lime fattener should be used in the concrete. Concrete on fill should be waterproofed.

STEEL SUB-FLOORS—Steel must be clean. The plates may be preformed to provide a key for the magnesite flooring or a metal mesh should be bolted or spot welded over the entire surface. Various types of bituminous coats, paints and enamels are used over the steel plate and anchoring mesh before the oxychloride cement is installed.

MAGNESIUM OXYCHLORIDE PLASTIC FLOORING

TYPES OF FLOORING—A wide latitude in properties of the flooring is possible through the control of the ingredients. When a flooring possessing certain qualities is desired, it is essential that the contractor be allowed to use the combination of ingredients that will produce the stated physical properties. Magnesium oxychloride floors can be grouped into 8 basic types as follows:

1. GENERAL PURPOSE TYPE—No coarse aggregates are used. This type may be installed in solid colors, pigmented to match flat paint shades and they may have contrasting colors, designs, borders and base.
Physical characteristics make the general purpose type suitable for school rooms, hospital rooms and wards, ships, corridors and lobbies other than those subjected to extremely heavy traffic conditions, light industrial plants, retail stores and shops. Flooring is finished by troweling.

2. HEAVY DUTY TYPE—Coarser aggregates are used and a smaller amount of filler than Type 1. Type 2 will meet more severe service conditions such as institutional and restaurant kitchens, intermediate industrial plants, corridors, lobbies and business establishments having hard usage. Finished same as Type 1.

3. NON-SPARKING AND STATIC DISCHARGING TYPE — There must be no silicious aggregate in this type. The flooring should be laid over a mat formed by lacing bare No. 14 copper wire 12" o/c both ways. The ends of these wires are soldered to a No. 8 copper wire which is grounded.
This type of floor prevents either mechanical or static sparking. Non-sparking floors are used in operating rooms, dope or paint spray shops, ammunition plants, or wherever explosions, flashes or fire present a hazard. Finish is by troweling or grinding.

4. NON-SLIP ABRASIVE TYPE—Abrasive aggregate may be either sprinkled and troweled into the finish surface or may be used as an integral aggregate to form a highly non-slip surface suitable for stair treads, ramps, elevator floors, etc. This type may be pigmented but is usually installed in a black color. Finish is by rubbing.

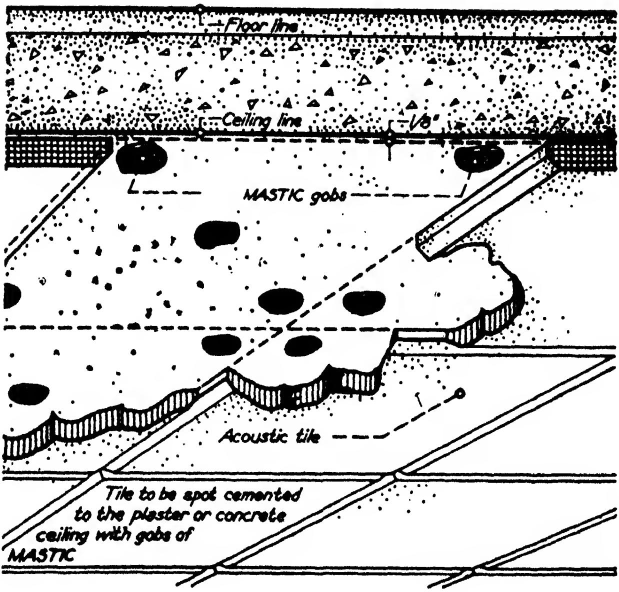
5. TERRAZZO TYPE—Marble chips, colored stone and pigment provide a practically unlimited range of color combinations. Division strips of brass, white metal, hard rubber or plastic may be used but aluminum strips are not suitable. Strips are not necessary for division into small units but are used only for the segregation of colors, the creation of design patterns or for localizing cracks over anticipated lines of structural stress. The floor is finished by grinding.

6. INDUSTRIAL TYPE—Crushed granite or trap rock chips are incorporated to create an extremely durable floor comparable to granite. It is installed with a power float of the vibrating type, hard troweled and lightly ground.
Another variety of industrial floor for the most severe use is formed by the installation of a Type 2 bedding, a cast iron or steel grid filled with Type 2 cement, and finished with steel wool.

7. CORK TERRAZZO TYPE—An extremely resilient and quiet floor is obtained by using 1/8" granulated cork. This type is suitable for libraries, hospital wards and corridors, apartment house corridors, schools and in front of work benches in industrial work. Finish is by grinding.

8. UNDERBED TYPE—This is an uncolored fibrous base coat material for leveling uneven sub-floors prior to surfacing with rubber tile, asphalt tile, linoleum or 1/2" magnesite finish.

MASTIC SETTING OF ACOUSTICAL TILE



ACOUSTICAL TILE MASTIC. Acoustical tile for noise quieting or for acoustical correction is made by a number of manufacturers in sizes usually varying from 6" x 12" or 9" x 9" to 18" x 36" and 24" x 24". This can be applied to masonry walls and ceilings by acoustical tile mastic, a very easy-working, buttery-like mastic of putty color. It is made from a combination of kettle-treated oils and neutral pigments. Because it contains no alcohol, it has no detrimental effect on painted surfaces.

PREPARATION OF SURFACE. Masonry of almost any kind or cement-plastered metal lath on frame provide the necessary rigidity and strength required to support acoustical tile. Wood sub-surfaces should be avoided. The wall should be thoroly dry and free from grease, oil, dust, dirt and loose material. Before the acoustical tile is applied, the surface should first be thoroly wire-brushed and a coat of primer wall sealer applied. At least 24 hours should be allowed for this coating to dry.

APPLICATION OF TILE. Acoustical tile mastic is applied to the back of each tile in pats of 3" diameter at each corner. If the surface is smooth, the pats should be only of sufficient thickness to leave a small space between the tile and the surface when the tile is pressed into place. If the wall or background is uneven, the thickness of the pat must be regulated accordingly so that the completed job will show a true even finish without irregularity.

STRUCTURAL FIBERBOARD INSULATING SHEATHING

DESCRIPTION—Structural Fiber Insulating Boards are made of partially refined vegetable fibers obtained principally from crop plant wastes or wood. The boards are made of fibers from at least 5 quite different raw materials—wood, bagasse (extracted sugar cane), corn stalks, licorice roots. and waste paper. However, the general properties of the finished products from the different sources are essentially the same. The basic materials are reduced to fibers by mechanical means or by exploding them with steam, usually after softening them with chemicals or by steaming them. The boards are fabricated from the pulp by a felting or molding process, suitable sizing material being incorporated in the product to render it water-resistant. The drying temperature is such as to destroy rot-producing fungi.

Sheathing is one of a group of 5 products made by the same process, which are similar in composition and properties:

Class A: Building Board
Class B: Lath (for plaster base)
Class C: Roof-Insulating Board
Class D: Interior Board (factory finished)
Class E: Sheathing

The sheathing boards are given a surface treatment consisting of one or more coatings of asphalt and some manufacturers use additional surfacings consisting of kraft paper, and aluminum paint for reflective insulation.

THERMAL PROPERTIES—The average thermal values for this material are as follows:

Thermal conductivity	k = .324
Thermal conductance C for 1/2″	= .648
Thermal conductance C for 25/32″	= .415

STRENGTH—All tests of fiberboard sheathing listed in the bibliography are incomplete, impractical, and inconclusive in arriving at any data which would make direct strength comparisons possible with completed walls utilizing either horizontal or diagonal wood sheathing. *However,* from ***multitudes of actual installations it is unquestionably evident that fiberboard sheathing contributes adequate strength to a complete and properly constructed frame wall.*** One manufacturer states that the 4′ width of 25/32″ fiberboard sheathing applied vertically has strength comparable to that contributed by diagonal wood sheathing; horizontally applied it compares with horizontal wood sheathing. Under accelerated aging tests conducted by the B. of S., the samples showed "excellent stability" of all their critical properties.

COST—The cost of 25/32″ insulating board sheathing per M square feet is normally higher than the same coverage of wood sheathing. The application cost is usually somewhat lower, making the cost in place about the same or slightly higher than wood sheathing.

STRUCTURAL FIBERBOARD INSULATING SHEATHING

INSTALLATION—Square-edged 4′ wide boards are designed for vertical installation and should be nailed 6″ on the intermediate supports and 3″ on the four edges, using nails which will insure not less than 1″ to 1 1/4″ penetration into the wood support.

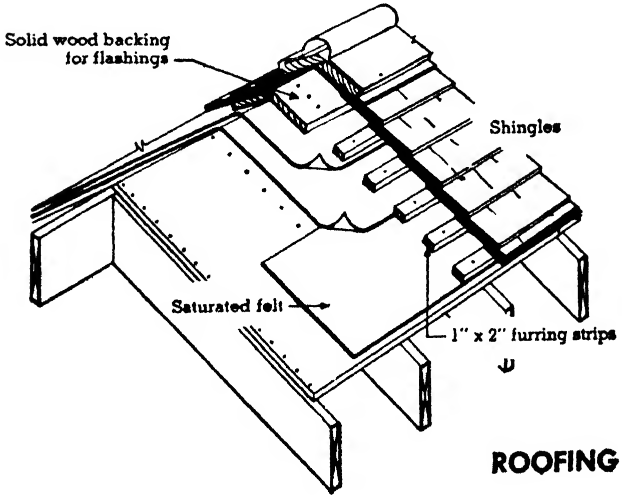
The 2′ wide boards are designed for horizontal installations, the fabricated long edges eliminating the need for headers behind horizontal joints. Boards should be nailed to supports 4 1/2″ o/c using nails which provide a penetration of 1″ to 1 1/4″. At the sill, plate, and girts the horizontal edge should be nailed 3″ o/c.

Since the maximum coefficient of expansion is 1/2 of 1% it is necessary to allow 1/8″ joints between boards.

Building paper is not required except under exterior stucco although the FHA may require it in some sections.

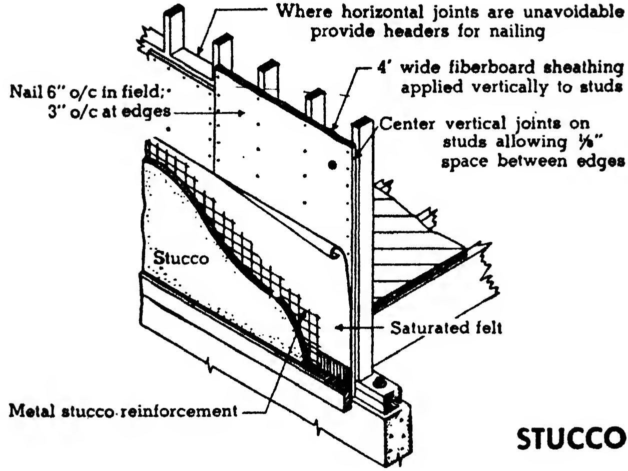
USES—Fiberboard sheathing is used as structural insulating wall sheathing under siding, shingles, stucco, masonry veneer. It is also used as roof sheathing on pitched roofs with wood stripping or solid wood sheathing under various types of roofing. The square-edged sheathing 4′ wide has been found suitable for the exterior of temporary structures. It can be painted with aluminum paint or other paint suitable for use over asphalt to reduce absorption of solar heat.

SIZES—Lengths generally available are from 8 ft. to 12 ft. long in square-edged 25/32″ or 1/2″ thicknesses, 4 ft. wide. A 2 ft. wide board that is 8 ft. long is made in 25/32″ thickness with long edges T & G, shiplapped, or V-grooved.

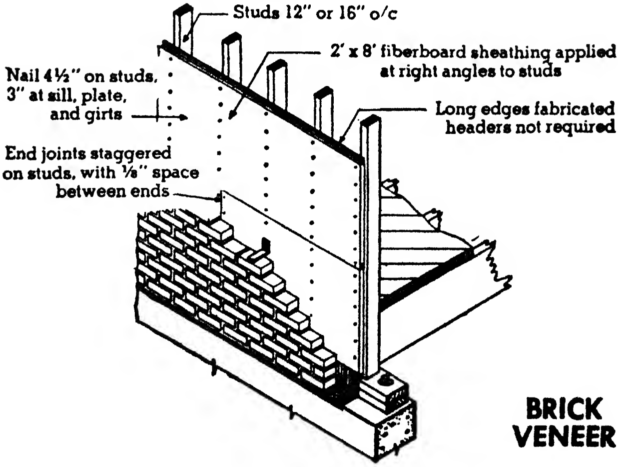


ROOFING

STRUCTURAL FIBERBOARD INSULATING SHEATHING

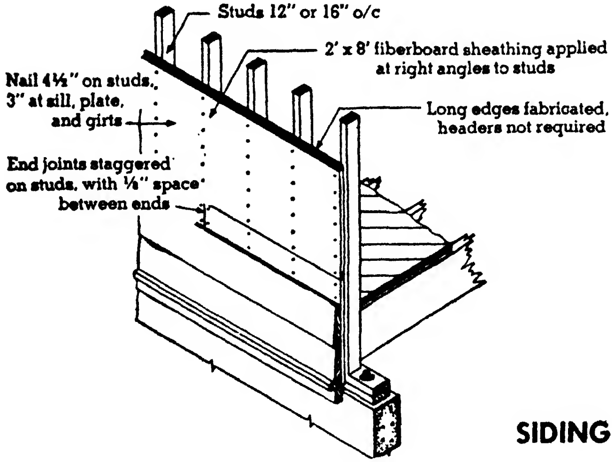


STUCCO

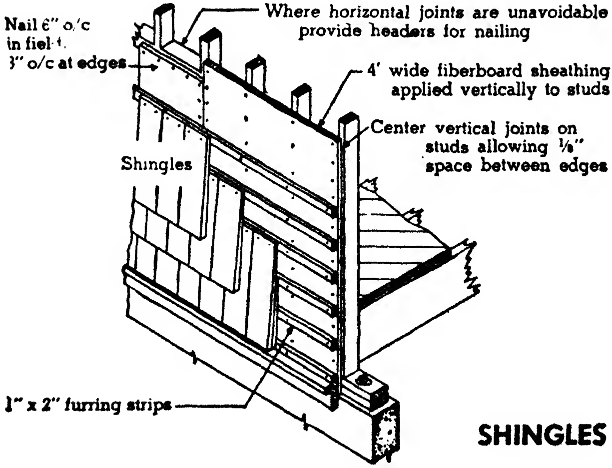


BRICK VENEER

STRUCTURAL FIBERBOARD INSULATING SHEATHING



SIDING



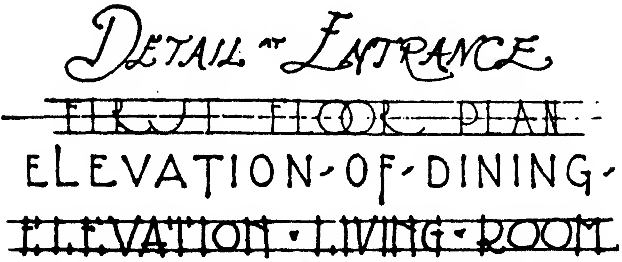
SHINGLES

SPELL IT RIGHT

The spelling that is recommended in conflicting cases is preferable for use on drawings because of brevity, modernity, or patriotism.

acoustic—adj., use instead of ***acoustical.***
abutment, abutted, abutting—watch your *t*'s.
balustrade.
barrel, barreled—shorter than ***barrelled.***
bat—the spelling *batt* is obsolete.
beveled, beveling—shorter than ***bevelled, bevelling.***
bridging.
Btu—not *B.t.u.*, not *B.T.U.*, not *BTU*. Use Btu for both singular and plural.
calking— *u* isn't indispensable.
center—American form of *centre.*
cleaned—were you ever *cleansed* in a poker game?
colonnade.
conduit—pronounced *kon-dit*, not *kon-doo-it.*
cupola.
draft, drafting, draftsman—if you get paid on a mileage basis, use ***draught, draughting, draughtsman, draughting-room, etc., ad nauseam.***
enameled, enameling.
enuf—accepted by the American Philological Association and the Philological Society of England, which should be enuf.
escalator.
fiber—not *fibre.*
gage—shorter than *gauge.*
grill—a gridiron for cooking.
grille—a grating or screen, especially of decorative intent.
hangars—indoor parking for aircraft.
hangers—supports.
leveled, leveling—no need for extra *l*'s.
louver—a slatted opening, pronounced *loo'-ver.*
Louvre—an art museum in Paris, pronounced *loov* (approx.).
mantel—the facing about a fireplace including the shelf above it. *Mantle* is a cloak, covering, or gas mantle.
marquee—better stick with Webster who says this is a hood over a door, the word probably originating from the tent or canopy set up to protect a *Marquise* from the elements.
miter—not mitre.
modillion.
mold, molded, molding—modern and shorter than ***mould, -ed, -ing.***
movable—no "*e*."
paneled, paneling—shorter than ***panelled, panelling.***
parallel, paralleled, paralleling—shorter than ***parallelled, parallelling.***
pavilion—compare "modillion."
pinnacle.
precede, preceding.
program—eschew ***programme.***
rabbet—means the same as ***rebate,*** and pronounced ***rabbet.***
rebate—say *ri-bate'*, not *ree'-bate.* Don't spell it ***rebate*** and pronounce it ***rabbet,*** they are two separate tho synonymous words.
receptacle—the *a* is the hard part of this word.
removable—not "removeable."
Renaissance.
stile—of a door, ***style*** of the lady I seen y. w. l. n.
supersede.
templet—shorter and more phonetic than ***template.***
terrazzo—say *ter-rat-so*, not *ter-rat-zzo.*
theater—preferable to the affected spelling ***theatre.***
thru, thoro—recommended by the Simplified Spelling Board.
transept—modern form of the archaic ***transcept.***

LETTERING FOR WORKING DRAWINGS



The four examples above were taken from actual published architectural drawings. They all violate one or more of the principles of sane lettering, which are:

1. LEGIBILITY—Most important requirement, both for direct prints and for reductions, in ink or pencil.
2. SPEED—Next most important requirement, necessitating simplicity of letter forms.
3. APPEARANCE—Should result from uniformity, not from doo-dads, swashes, or time-wasting tricks.
4. CHARACTER—Should be in keeping with the legal and business nature of the working drawings, which again outlaws freak spacing and letter forms.

The American Standards Association brochure *Drawings and Drafting Room Practice* says: "The single stroke commercial gothic letter is now in almost universal use thruout the world. It is recommended that only capitals be used in the vertical style. The letters may be all caps or caps and lower case if the inclined style is used." The A.I.A. cooperated in the formulation of this document.

DRAWING MATERIALS

HANDMADE PAPER. Made in two weights—regular and "extra heavy," the thickness of the paper varying within each classification according to the size of the sheet. Three surfaces are available, as follows:

Hot Pressed has a smooth surface and is used principally for fine line and pencil drawings. In regular weight it comes in all of the sizes listed below. In extra heavy it is available in Imperial and Double Elephant.

Cold Pressed has a finely grained surface and is used for water color work. In regular weight, it comes in all of the sizes listed below. In extra heavy it is available in Imperial and Double Elephant.

Rough (Torchon paper) has a coarsely grained surface and is used for water color, sketching, and very bold drawings. In regular weight it comes in Royal, Imperial and Double Elephant. In extra heavy it is available in Imperial and Double Elephant.

Cap	13 x 17 inches
Demy	15 x 20 "
Medium	17 x 22 "
Royal	19 x 24 "
Super-Royal	19 x 27 "
Imperial	22 x 30 "
Double Elephant	27 x 40 "
Antiquarian	31 x 53 "

WHITE, CREAM, BUFF, OR GREEN DRAWING PAPER. Used principally for pencil drawings. Has a smooth or slightly grained surface. It is a rag stock, and has high erasing quality. Various types are available in Cap (14 x 17), Demy, Medium, Royal, Imperial and Double Elephant. Other sheets are made in sizes 9 x 12, 12 x 18, 18 x 24, 24 x 36. 10 and 50 yard rolls are available in widths of 30, 36, 42, 54, and 62 inches.

DETAIL PAPER. Made of Manilla stock in a variety of surfaces from smooth to slightly grained. Used for ink or pencil drawings—does not take water color well. Erasing quality will vary from poor to good in different grades. Comes in rolls of 50 or 100 yards, in widths of 36, 42, 48, 54 inches.

TRACING PAPER. There is a wide variety of qualities, varying in transparency, life, erasing quality, and surface. Some tracing papers are available in sheets 8 1/2 x 11, 8 1/2 x 13, 9 x 12, 12 x 18, 18 x 24, 24 x 36. Rolls are either 20 or 50 yards long and come in widths 18, 24, 30, 36, 42, 57, 60, 62 inches.

TRACING CLOTH. Varies widely in quality. Comes in 24-yard rolls, in widths of 24, 30, 36, 38, 42, 48, 54 inches, for both ink and pencil.

BRISTOL BOARD. Has a hard, white surface. Withstands erasing well. Comes in sizes of 8 x 13 (Trade Mark), 10 x 15 (Patent Office), 12 1/2 x 15 1/4, 14 5/8 x 18 1/4, 15 x 20, 16 1/2 x 20 3/4, 18 1/4 x 22 3/8, 21 1/2 x 28 3/4, 22 1/2 x 28 1/2. Available in 2 and 3 ply thicknesses.

ILLUSTRATION BOARD. Comes with hot and cold pressed surfaces for pen, pencil or water color drawings. Made in light and heavy weights. Sizes available are 22 x 30, 22 1/2 x 28 1/2, 23 x 29, 30 x 40.

CHARCOAL PAPERS. Come in all colors. Have a rough surface. Usual size is 19 x 25.

BLUE PRINT INKS AND FIXATIF

BLUE PRINT INKS

Use a fine pen when using these inks to prevent blots and spreading. By soaking a clean uninked stamp pad or blotter with any one of the inks given below, blue prints may be stamped with the ordinary rubber stamp, which should also be clean of old ink before using.

(1.) Add 2 ounces of potassium oxalate (cost 25c at a drug or chemical store) to ½ pint of warm water. The mixture makes clear white lines which will appear quickly. If it has a tendency to run, thicken slightly with mucilage. For producing colored lines add ink of the desired color in quantity sufficient to produce the desired tint. Bottle should be marked "Poison."

(2.) Mix equal parts by volume of sal soda and warm water, to which add enough gum arabic to prevent spreading. This is slower acting than (1.).

(3.) Mix equal parts by volume of bicarbonate of soda (baking soda) and warm water. This is slow acting.

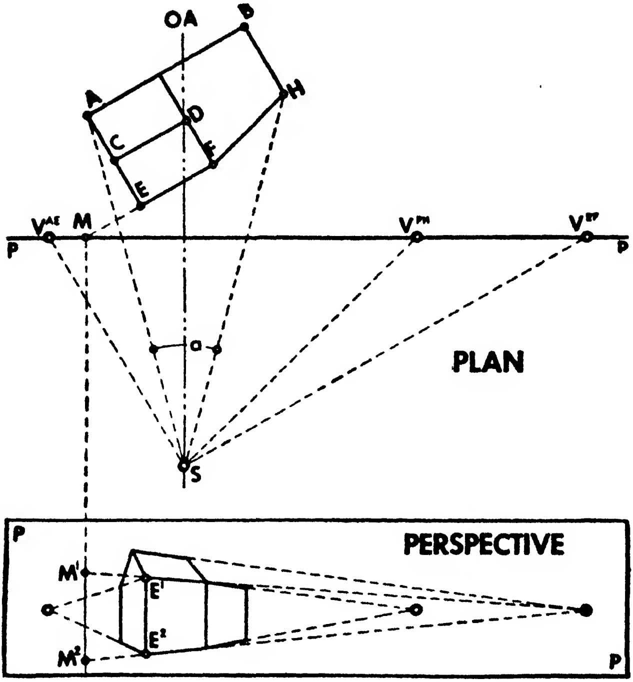
FIXATIF

The small insect spray guns for sale at five-and-ten cent stores are ideal for blowing fixatif. Don't blow too much on at one time, nor stand too close to the drawing, or the fixatif will collect in spots and is likely to run.

(1.) Add 2 ounces of powdered white shellac (cost about 10c at a paint store) and 1 ounce of gum sandarac (cost 15c at drug or chemical store) to 1 pint of denatured alcohol. Shake well and allow to settle. Pour off into clean bottle. Thin with more alcohol if necessary.

(2.) Pencil drawings may be fixed by dipping them in skim milk. Cold water also acts as a fixatif for pencil drawings to a limited extent.

FIVE BASIC RULES OF PERSPECTIVE



1. ANGLE OF VISION. *The area of the picture embraced by the eye should not represent an angle of greater than 45° in plan.* In the diagram the angle *a* is the angle of vision. Some authorities set a maximum of 60°, but this often results in distortion at the edge of the picture. The angle *a* should not be much less than 30° if a full perspective effect is to be realized.

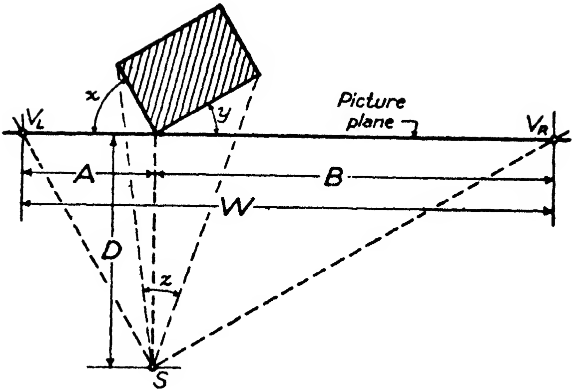
2. OPTICAL AXIS. *The optical axis should bisect the angle of vision.* When we look at a picture we naturally hold it directly in front of us—perspective drawing should be made as it is going to be looked at. The line *OA* should bisect angle *a*.

3. PICTURE PLANE. *The picture plane is taken perpendicular to the optical axis.* When a drawing is examined it is held in this position—therefore it should be drawn so that *PP* is normal to *OA*.

4. VANISHING POINTS. *The vanishing point for any system of lines is the intersection with the picture plane of a line parallel to the system, thru the observer's eye.* Lines *AB*, *CD*, and *EF*, together with all other lines parallel to them comprise a "system." These lines all vanish at *VEF*.

5. TRUE HEIGHTS. *Points, or projections of points, on lines of the object parallel to the picture plane, which fall in the picture plane will be their true distance apart.* Two points such as E^1 and E^2, (represented by *E* in plan) may be projected to the picture plane at *M*. The length M^1, M^2 on the picture plane will equal the true length of E^1, E^2 on the object.

PERSPECTIVE LAYOUT MADE EASY



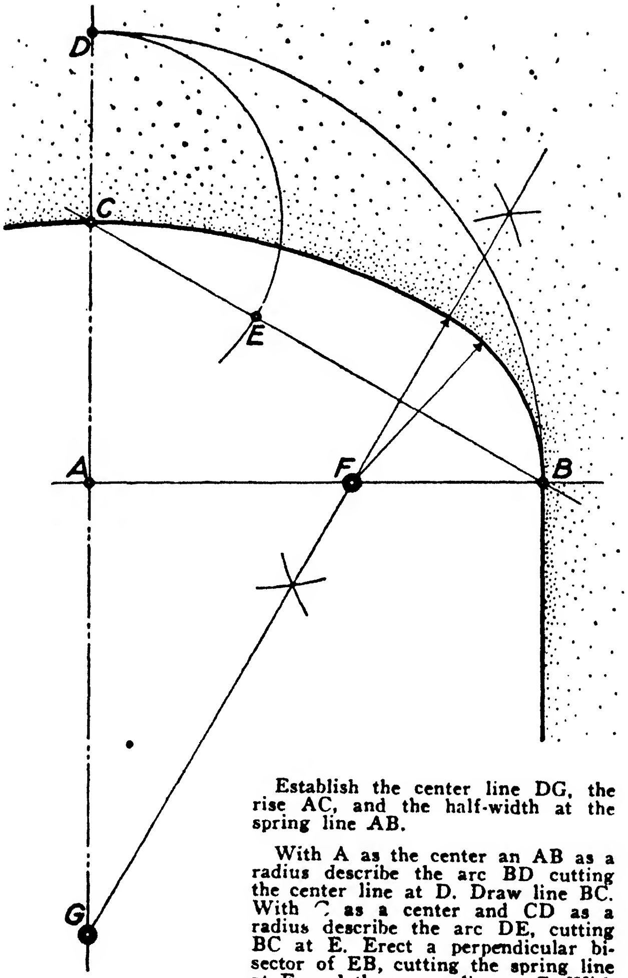
Angle		For W = 41"			For W = Any Measurement		
y	x	A"	B"	D"	A"	B"	D"
10°	80°	1¼	39¾	7	.0303xW	.9697xW	.1709xW
15	75	2¾	38¼	10¼	.0669xW	.9330xW	.2500xW
20	70	4¾	36¼	13¼	.1178xW	.8822xW	.3211xW
25	65	7¼	33¾	16	.1796xW	.8211xW	.3826xW
30	60	10¼	30¾	17¾	.2500xW	.7500xW	.4326xW
35	55	13½	27½	19¼	.3292xW	.6708xW	.4695xW
40	50	17	24	20⅛	.4134xW	.5866xW	.4911xW
45	45	20½	20½	20½	.5000xW	.5000xW	5000xW

The location of the vanishing points V_L, V_R and the station point S must be such that angle z is not greater than 45° in order to prevent distortion of the perspective.

The first A, B, D columns give the location in inches for the vanishing and station points for a standard 42" drawing board, the total width being 41".

The last A, B, D columns give the multiplier of any other width that may be used for larger or smaller perspectives, in order to locate the vanishing and station points. For example; *Given* W = 60", x = 30°. *Solution,* A = .25 × 60" = 15", B = .75 × 60" = 45", D = .4326 × 60" = 26".

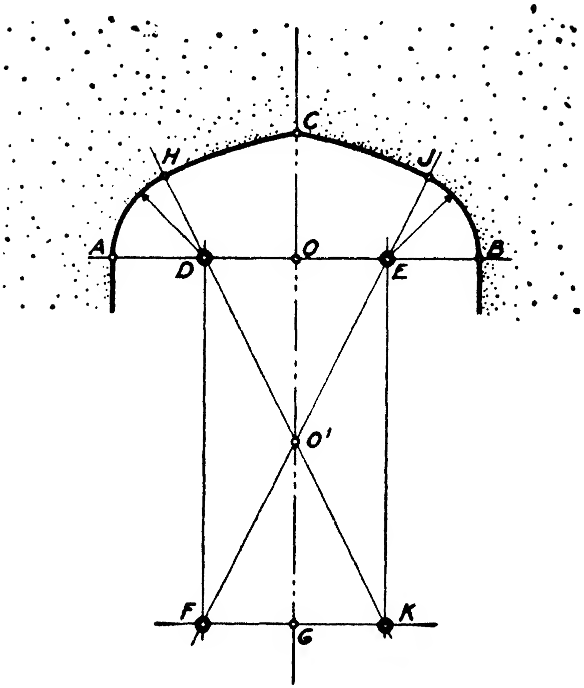
THREE-CENTERED ARCH



Establish the center line DG, the rise AC, and the half-width at the spring line AB.

With A as the center an AB as a radius describe the arc BD cutting the center line at D. Draw line BC. With C as a center and CD as a radius describe the arc DE, cutting BC at E. Erect a perpendicular bisector of EB, cutting the spring line at F, and the center line at G. With A as a center and AF as a radius describe an arc cutting the spring line at F' on the left-hand half of the drawing (which is not shown here). With the centers G, F, and F' construct the three-centered arch.

FOUR-CENTERED ARCH



Establish center line CG and spring line AB.

Bisect AO at D.

Bisect OB at E.

Make OO' equal to DE.

Drop perpendiculars DF and EK.

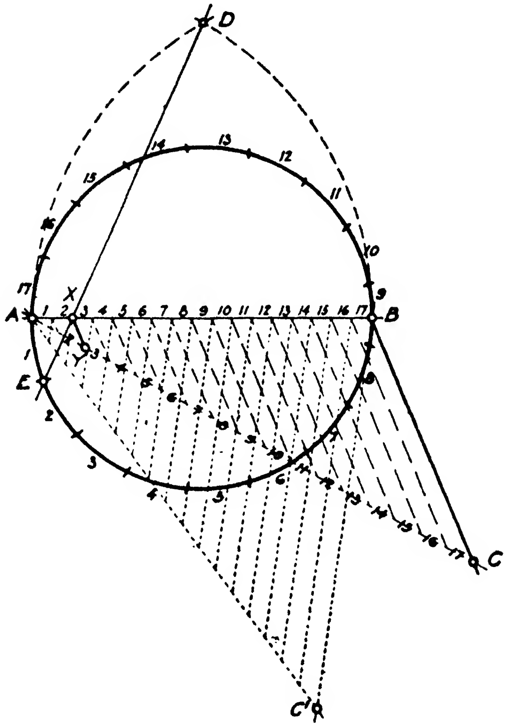
Produce DO' to K.

Produce EO' to F.

Using D and E as centers, describe arcs AH and JB.

With F and K as centers, describe arcs CJ and HC.

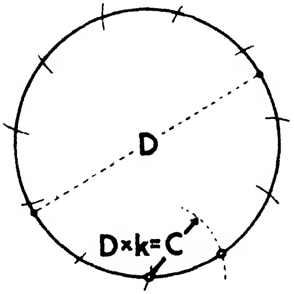
DIVIDING A CIRCUMFERENCE



PROBLEM: To divide the circumference of a circle into any number of equal spaces.

SOLUTION: Draw diameter of circle AB. Draw a line from A in any convenient location as AC or AC′. Connect B and C. Divide AC into desired number of spaces. Parallel to BC draw XY thru *second* division. With B as a center, draw the arc AD. With A as a center, draw the arc BD. From D draw a line thru X intersecting the circle at E. AE is the desired spacing.

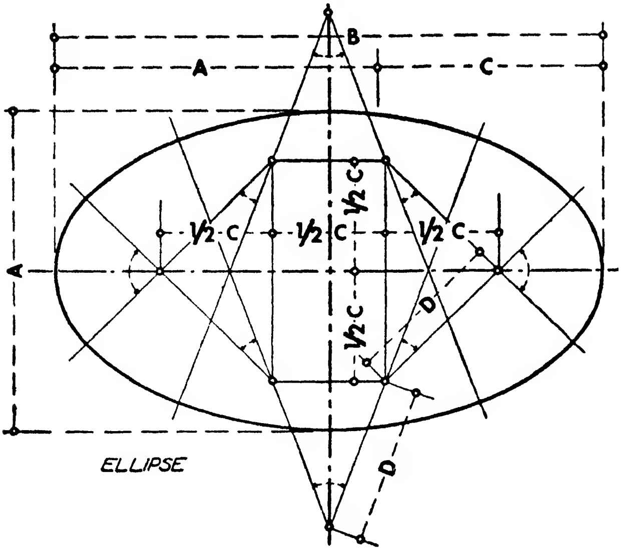
DIVIDING A CIRCUMFERENCE

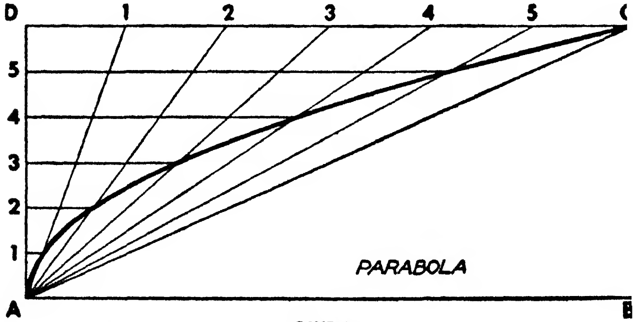


No. of Spaces *n*	*k*	No. of Spaces *n*	*k*	No. of Spaces *n*	*k*
..	.....	35	.0896	68	.0462
3	.8660	36	.0872	69	.0455
4	.7071	37	.0848	70	.0449
5	.5878	38	.0826	71	.0442
6	.5000	39	.0805	72	.0436
7	.4339	40	.0785	73	.0430
8	.3827	41	.0765	74	.0424
9	.3420	42	.0747	75	.0419
10	.3090	43	.0730	76	.0413
11	.2817	44	.0713	77	.0408
12	.2588	45	.0698	78	.0403
13	.2393	46	.0682	79	.0398
14	.2225	47	.0668	80	.0393
15	.2079	48	.0654	81	.0388
16	.1951	49	.0641	82	.0383
17	.1838	50	.0628	83	.0378
18	.1736	51	.0616	84	.0374
19	.1646	52	.0604	85	.0370
20	.1564	53	.0592	86	.0365
21	.1490	54	.0581	87	.0361
22	.1423	55	.0571	88	.0357
23	.1362	56	.0561	89	.0353
24	.1305	57	.0551	90	.0349
25	.1253	58	.0541	91	.0345
26	.1205	59	.0532	92	.0341
27	.1161	60	.0523	93	.0338
28	.1120	61	.0515	94	.0334
29	.1081	62	.0507	95	.0331
30	.1045	63	.0499	96	.0327
31	.1012	64	.0491	97	.0324
32	.0980	65	.0483	98	.0321
33	.0951	66	.0476	99	.0317
34	.0923	67	.0469	100	.0314

To divide a circle into any number of equal spaces, find the proper *k* factor in the table above. Multiply the diameter times this factor to get the length of the chord, as shown in the illustration.

ELLIPSE AND PARABOLA





GIVEN

Directions of axis AB and point C on the parabola.

TO CONSTRUCT

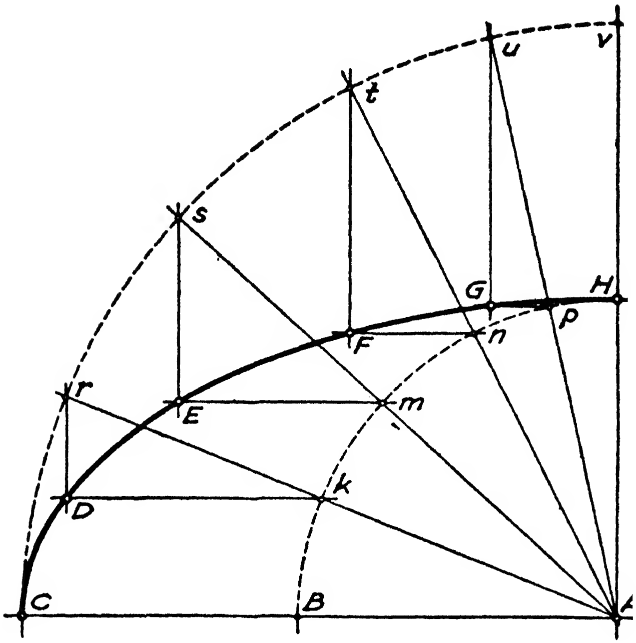
Draw Line AD thru A perpendicular to AB and a line parallel to AB thru C.

Divide lines AD and DC into same number of equal parts.

Connect A with division points on DC; draw lines thru division points on AD parallel to AB.

Intersections of lines of the same number are points on parabola.

HOW TO DRAW AN ELLIPSE



With A as a center and half the minor axis AH as a radius, draw the circle BH.

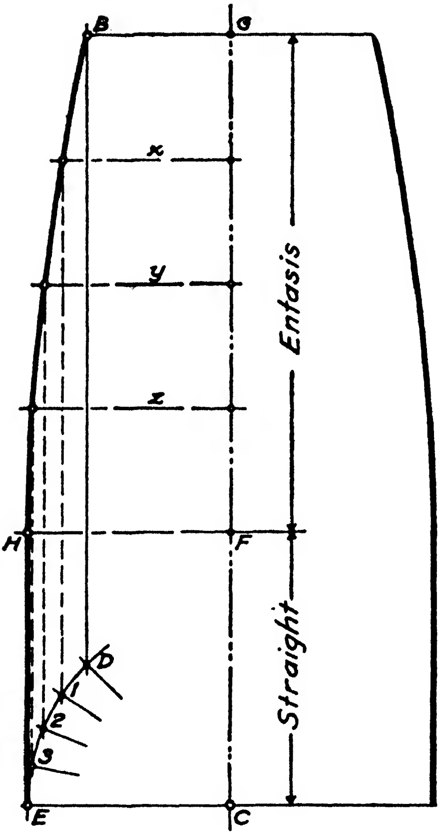
With A as a center and half the major axis AC as a radius, draw the circle Cv.

Draw any number of radii at random, as Akr, Ams, Ant, Apu.

Drop a vertical from r to intersect a horizontal from its corresponding point k, at D. In a similar manner find points E, F, and G.

Draw the ellipse thru the points thus found as CDEFGH.

ENTASIS OF COLUMNS



Given:—Radius BG at neck, and radius EC at bottom.

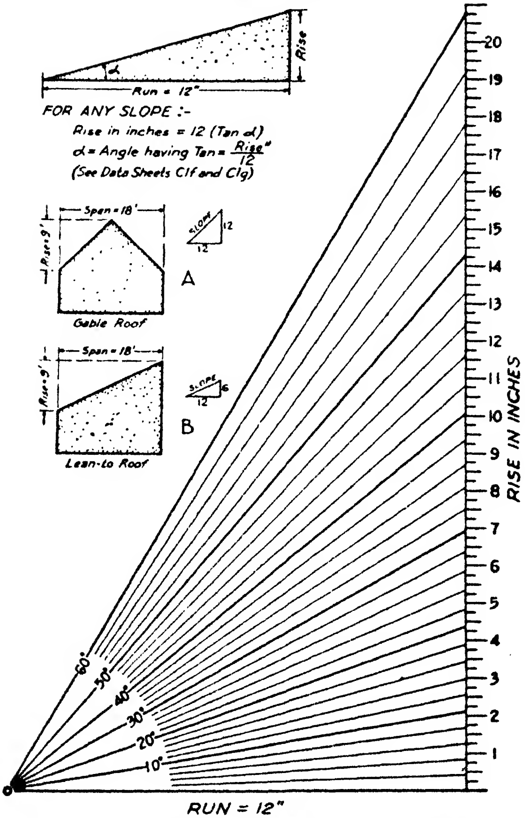
With C as center, draw arc ED to intersect vertical dropped from B at point D.

Divide arc ED into any number of equal parts by points 1, 2, 3.

Divide FG into a corresponding number of equal parts by the lines x, y, z.

The intersections of the lines x, y, z, with the corresponding vertical projections of the points 1, 2, 3, determines the entasis line HB.

SLOPE OF INCLINES



The amount of incline is measured in four ways. The *slope* may be given in inches of rise per 12" of run. The *pitch* may be given—the rise divided by the span. The *percentage* of the incline may be given—the rise in feet (or inches) divided by the run of 100 feet (or inches). The *angle* may be given in degrees.

Architectural drawings should always indicate the incline in inches of rise per 12" of run, using a small triangle as shown at "A" and "B." Use the above diagram as a templet under your tracing to get the slope, or use the trigonometric formulae given above.

The term "pitch" is misleading and ambiguous and should *never* be used except for gable roofs as at "A." The confusion may be appreciated best by noting the two roofs illustrated. Both have the same pitch of "one-half" but they have quite different *slopes* (12 to 12 and 6 to 12).

ROMAN NUMERALS

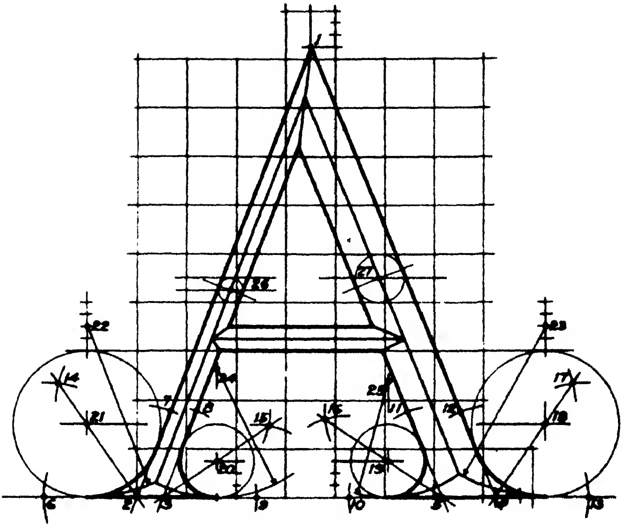
Arabic	*Roman*	*Arabic*	*Roman*
1	I	60	LX
2	II	70	LXX
3	III	80	LXXX
4	IV (IIII)	90	XC
5	V	100	C
6	VI	200	CC
7	VII	300	CCC
8	VIII	400	CCCC
9	IX	500	IƆ or D
10	X	600	DC
11	XI	700	DCC
12	XII	800	DCCC
13	XIII	900	DCCCC or CM
14	XIV	1,000	M or CIƆ
15	XV	2,000	MM
16	XVI	3,000	MMM
17	XVII	4,000	MMMM
18	XVIII	5,000	IƆƆ or $\overline{\mathrm{V}}$
19	XIX	10,000	CCIƆƆ or $\overline{\mathrm{X}}$
20	XX	50,000	IƆƆƆ or $\overline{\mathrm{L}}$
30	XXX	100,000	CCCIƆƆƆ or $\overline{\mathrm{C}}$
40	XL	500,000	IƆƆƆƆ or $\overline{\mathrm{D}}$
50	L	1,000,000	CCCCIƆƆƆƆ or $\overline{\mathrm{M}}$

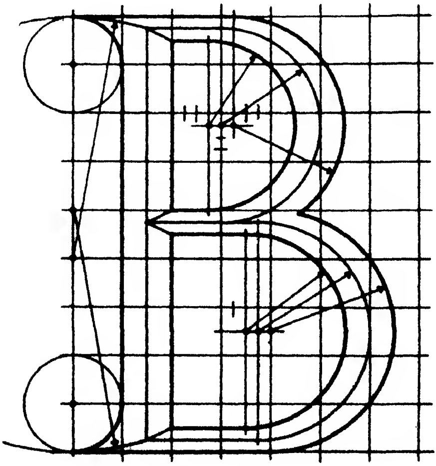
If the lesser number is placed before the greater, the lesser is to be deducted from the greater: thus IV signifies 1 less than 5, i.e., 4; IX = 9; XC = 90.

If the lesser number be placed after the greater, the lesser is to be added to the greater; thus VI signifies 1 more than 5, i.e., 6; XI = 11; CX = 110.

A horizontal stroke over a numeral denotes 1,000; thus $\overline{\mathrm{V}}$ ignifies 5,000; $\overline{\mathrm{L}}$ = 50,000; $\overline{\mathrm{M}}$ = 1,000 × 1,000 = 1,000,000.

INCISED CLASSIC ALPHABET





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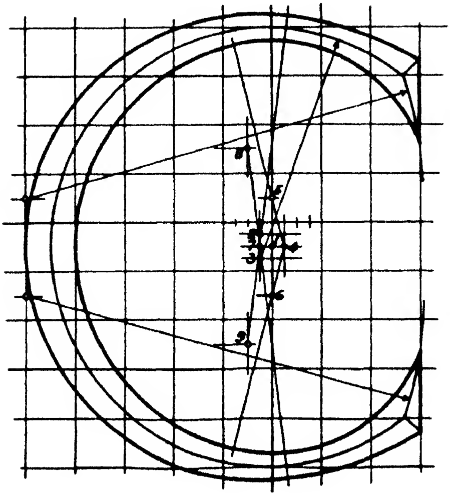

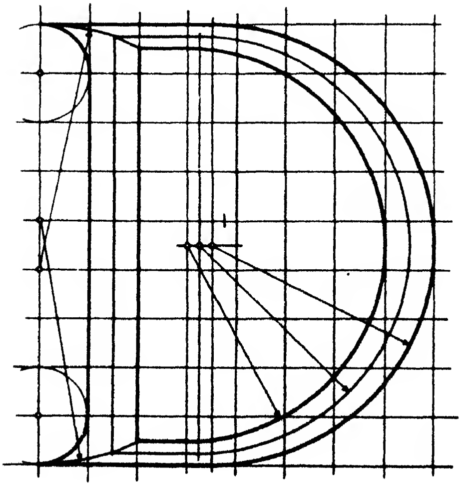

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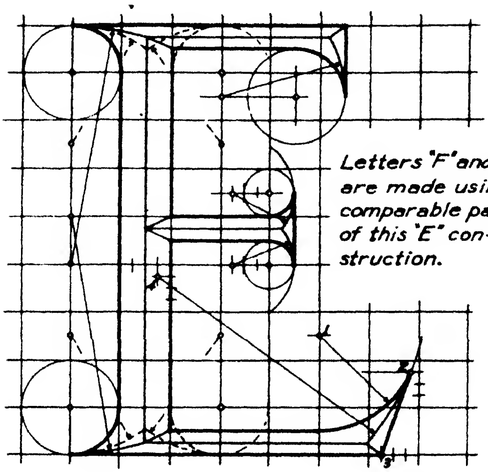
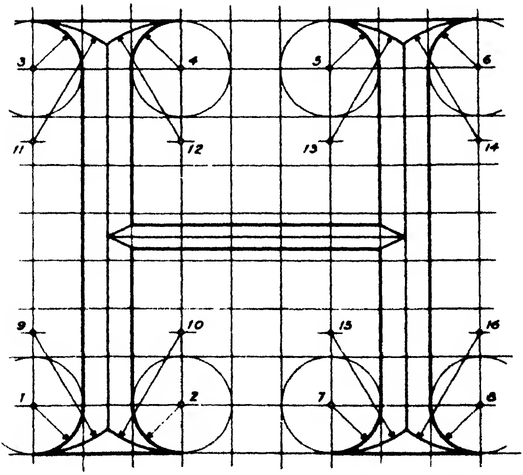


Letters "F" and "L" are made using comparable parts of this "E" construction.



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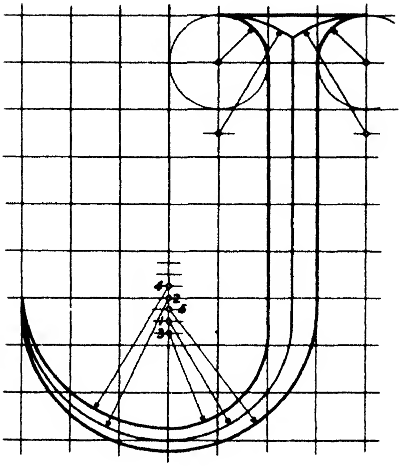

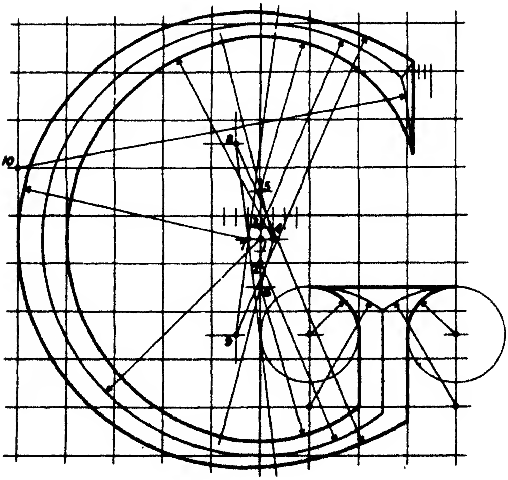

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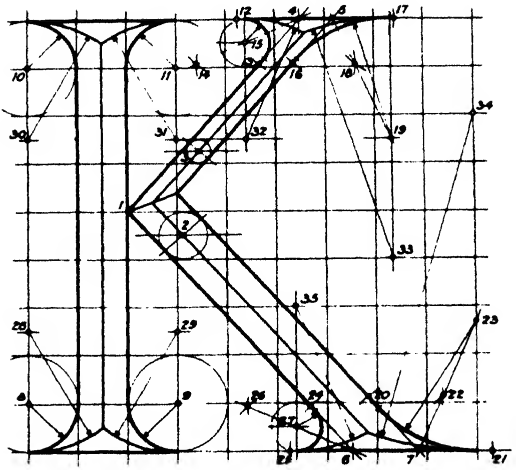

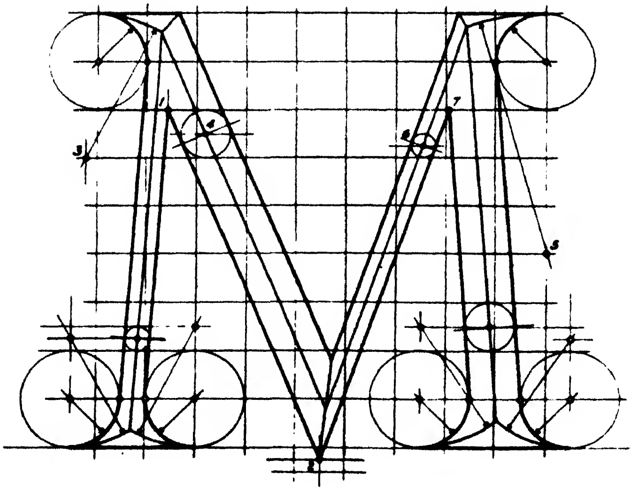

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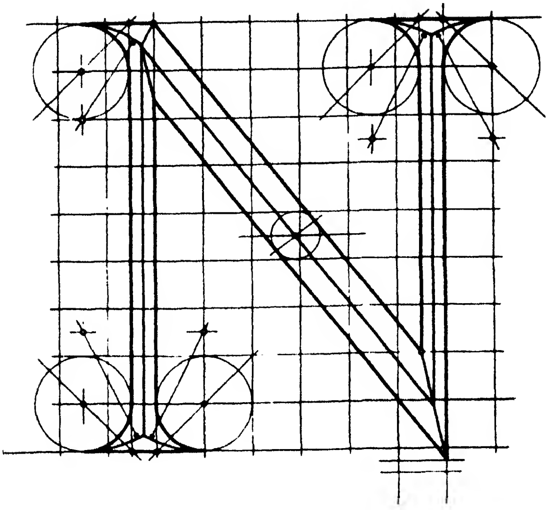

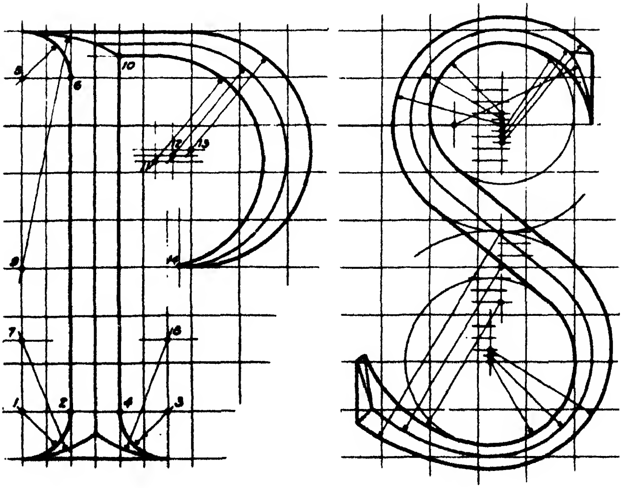

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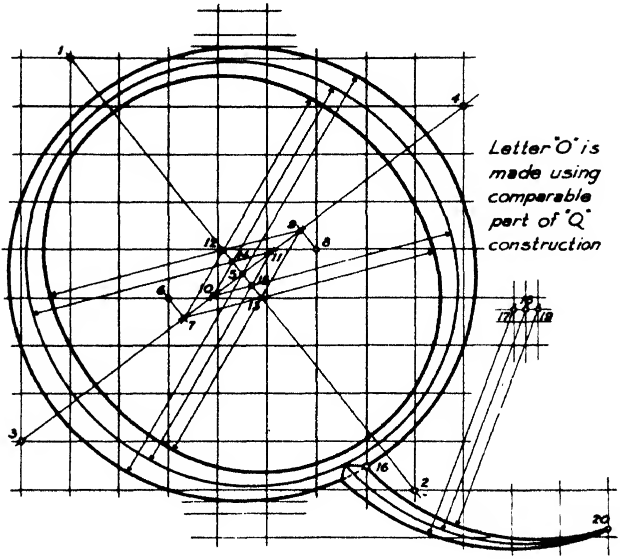

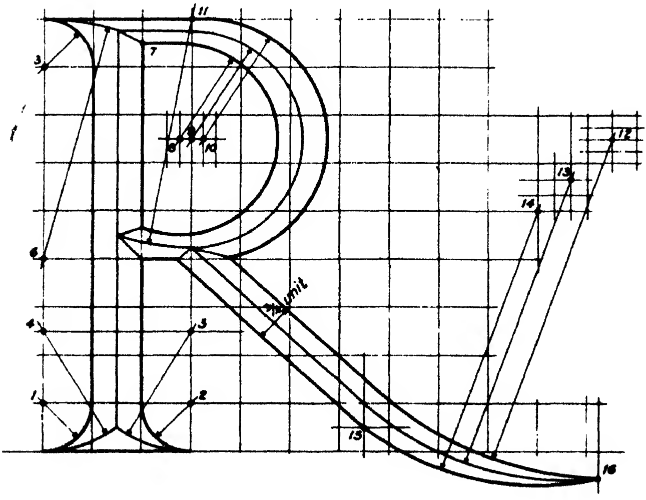

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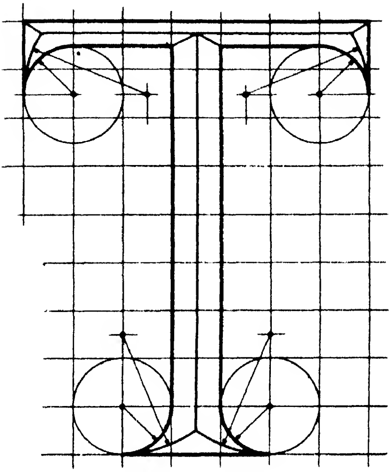

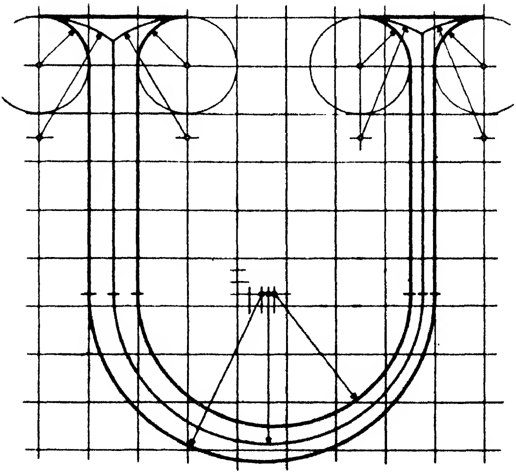

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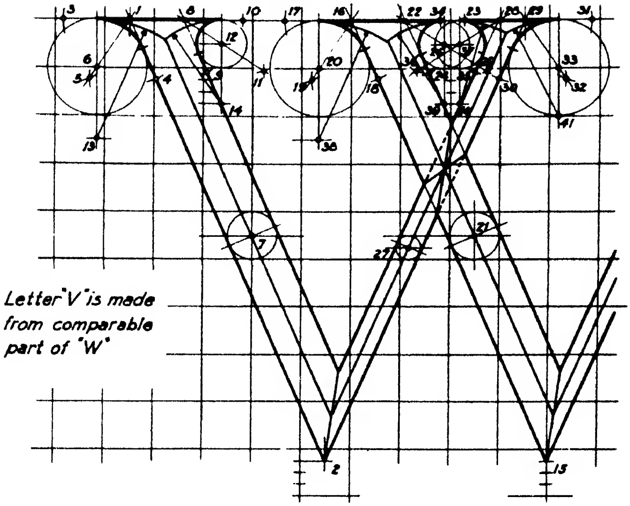

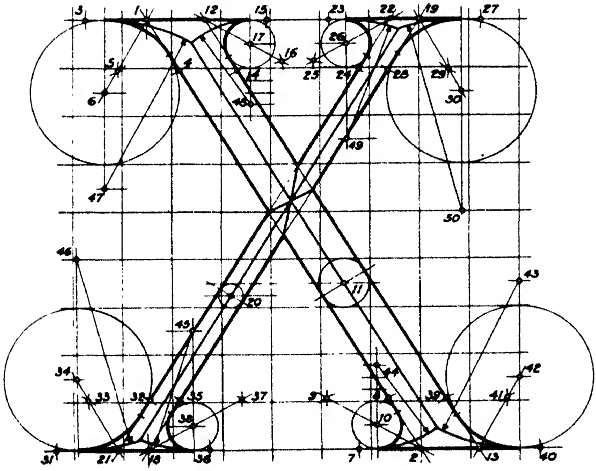

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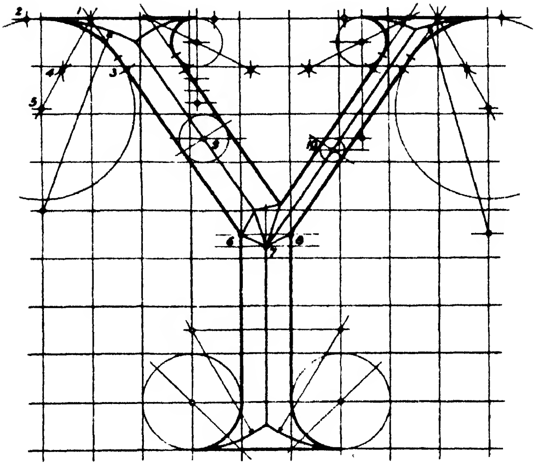
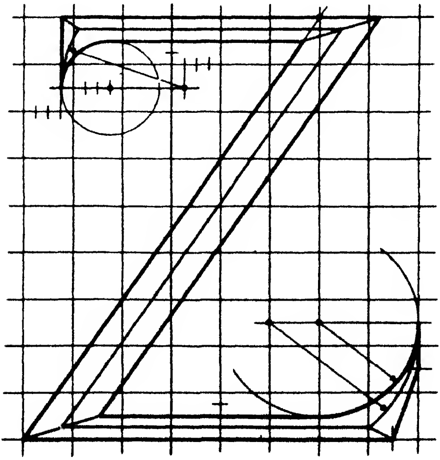
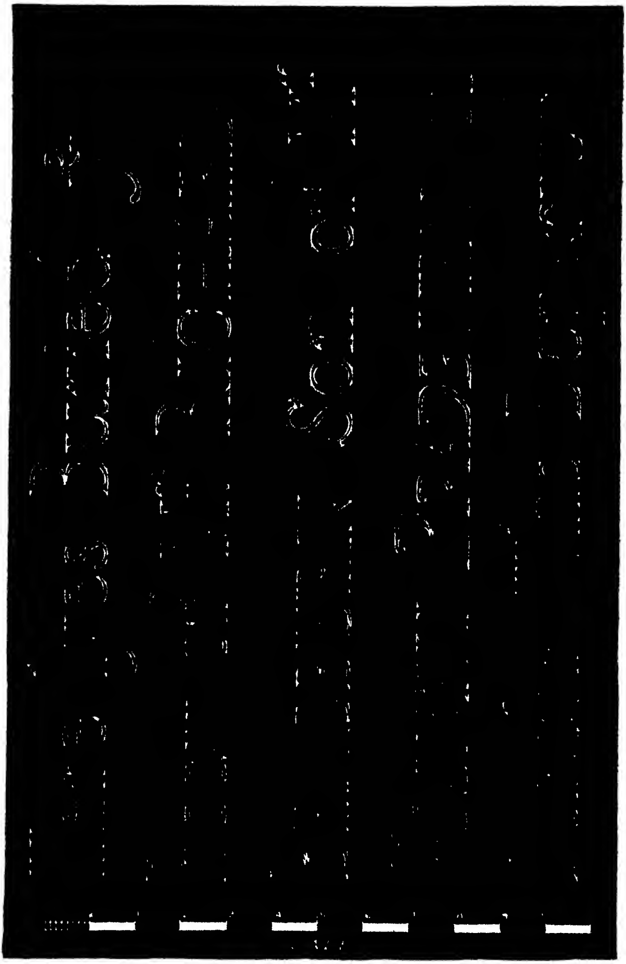




COLONIAL LETTERING



This lettering appears on a slate marker dating from about 1740. From 1725 to 1776 the Colonial lettering reached its greatest development, of which this is a typical example. The use of lowercase, small caps, italics and scratched guide-lines gives the composition its interest and flavor. The letters are incised with a V-cut of about 45° with the plane of the surface.

OLD ENGLISH LETTERING

A B C D E F
G H I J K L
M N O P Q R
S T U V W X Y
Z abcdefgh
ijklmnopqr
stuvwxyy
z ct ffi fi fl ff 1
2 3 4 5 6 7 8 9 0

JEWISH ALPHABET

A B C D E

F G H I J K

L M N O P

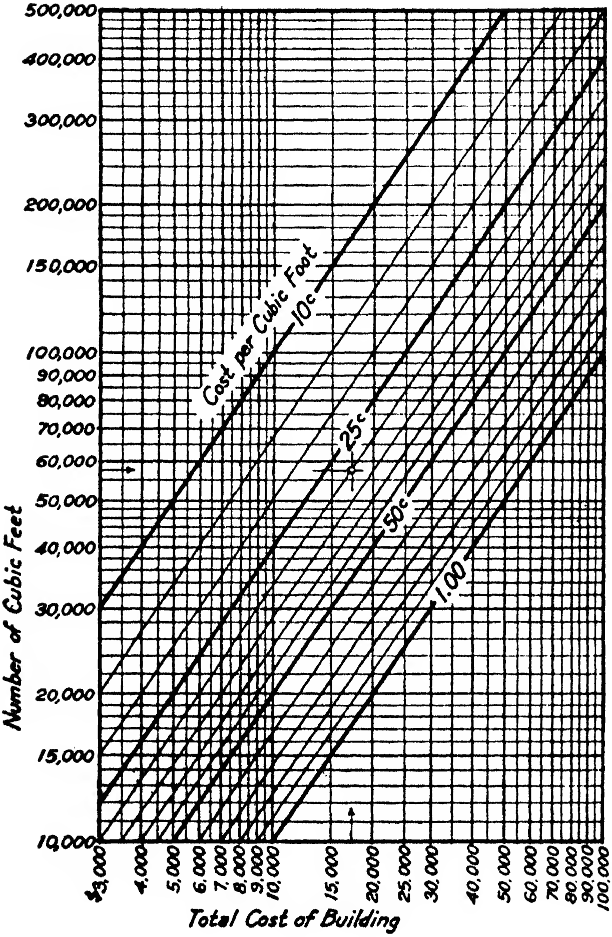
Q R S T U

V W X Y

Z מאָרגען

-טאגעבלאט

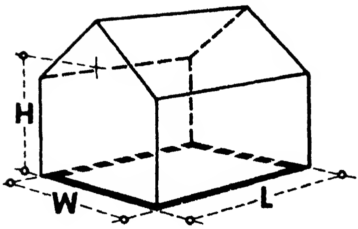
CUBIC COST CALCULATOR



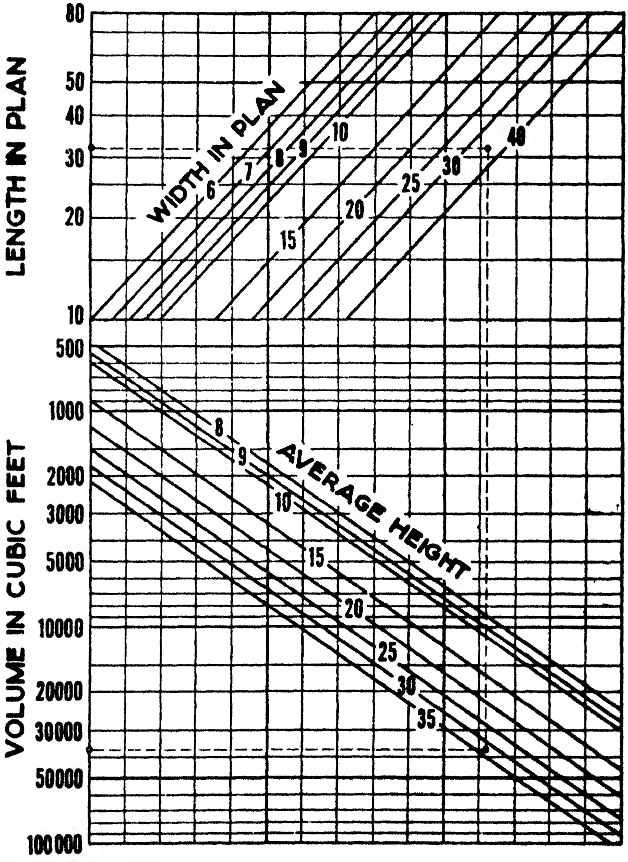
Example: If a building contains 57,500 cubic feet and costs 30 cents per cubic foot (follow the arrows), the chart shows the total cost of the building will be $17,250.

Similarly, if the drawings call for a building of 57,500 cubic feet and there is $17,250 available, the chart shows that the cost per cubic foot must not exceed 30 cents.

CHART FOR FINDING CUBAGE



The approximate cubic contents of a solid can be quickly found with this chart. For example, for a house measuring 32′ x 35′ in plan by an average height of 33′, the volume scale shows the cubic contents to be approximately 37,000 cubic feet.



COST BREAKDOWN OF HOUSE CONSTRUCTION

Divisions of work	*Per cent*	*Cost of House* $4000	$5000	$6000	$10000
Excavating, Grading	1.8	$72	$90	$108	$180
Concrete Walks, Steps	0.6	24	30	36	60
Chimney, Fireplace	3.0	120	150	180	300
Doors installed	4.2	168	210	252	420
Windows installed	5.9	236	295	354	590
Cabinets installed	2.2	88	110	132	220
Lumber (Material)	16.0	640	800	960	1600
Carpenter Labor	12.5	500	625	750	1250
Roofing	2.4	96	120	144	240
Flashings, etc.	1.1	44	55	66	110
Insulation	3.0	120	150	180	300
Glazing	1.0	40	50	60	100
Linoleum Floors	1.5	60	75	90	150
Tilework	1.5	60	75	90	150
Lath and Plaster	5.6	224	280	336	560
Paint, Decorating	6.3	252	315	378	630
Plumbing	8.5	340	425	510	850
Heating	10.5	420	525	630	1050
Electrical	2.1	84	105	126	210
Planting, Lawn	2.1	84	105	126	210
Miscellaneous	2.3	92	115	138	230
TOTAL	100.0	4000	5000	6000	10000

This table represents a fair average for the proportionate cost of the various divisions of the work for a frame house. If a prospect has a fixed budget of say $5000, for instance, to build a house whose material list is known, the quality of materials can be determined. Suppose 20 D. H. windows are to be glazed. The table shows $50 for glazing, or $1.25 each light. At the market price for the different grades of glass in place, therefore, it can be quickly determined whether to use DS or SS, in A, B, or other quality.

COST OF MATERIALS AND LABOR

Contract price	$1,875,178	100.0%
Pay rolls on the job	505,134	26.9%
Cost of materials on the job	1,055,130	56.3%
Overhead and miscellaneous*	314,914	16.8%

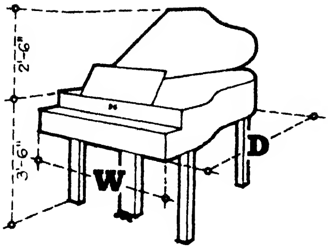
* *Includes such items as office work, rent, insurance, workmen's compensation, depreciation of equipment, etc.*

Data compiled from reports by contractors on 54 small and medium sized buildings erected in various parts of the U. S. Types of buildings covered were schools, office buildings, barracks, officers' quarters, Coast Guard stations, etc.

VALUE OF MATERIALS USED IN 54 BUILDINGS

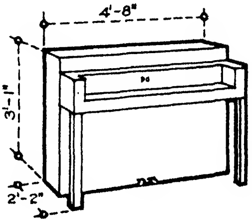
All materials	100.00%
Aluminum manufacturers	.19%
Brick, hollow tile, and other clay products	11.01%
Cast-iron pipe and fittings	.76%
Cement	7.35%
Coal	.12%
Concrete products	2.93%
Copper products	.81%
Crushed stone	.29%
Doors, windows, molding and trim	1.59%
Electric wiring and fixtures	3.68%
Electrical machinery, apparatus, and supplies	.08%
Elevators and elevator equipment	.05%
Explosives	.07%
Foundry and machine-shop products	1.25%
Furniture	2.63%
Glass	.56%
Hardware, miscellaneous	2.46%
Heating and ventilating equipment	6.66%
Linoleum	.26%
Lumber and timber products, not elsewhere classified	11.08%
Marble, granite, slate, and other stone products	3.36%
Nails and spikes	.19%
Nonferrous-metal alloys and products	.10%
Packing, pipe and boiler covering and gaskets	.16%
Paints and varnishes	1.39%
Paving materials and mixtures	.09%
Petroleum products	.26%
Planing-mill products	6.27%
Plumbing supplies, not elsewhere classified	6.78%
Pumps and pumping equipment	.36%
Roofing materials, not elsewhere classified	2.82%
Sand and gravel	3.80%
Sheet-metal work	1.21%
Steel products, not elsewhere classified	2.51%
Structural steel and ornamental metal work	11.68%
Stoves and ranges, other than electric	.05%
Tiling, floor and wall, and terrazzo	1.39%
Wall plaster, wall board, and floor composition	1.87%
Window and door screens and weatherstrip	.01%
Window shades and fixtures	.02%
Wire products, not elsewhere classified	.44%
Other	1.41%

SIZES OF PIANOS

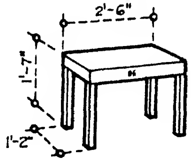


	W	D
Apartment ..	3'- 8"	4'- 0"
Baby	4'-10"	5'- 1"
Baby	4'-11"	5'- 4"
Parlor	5'- 0"	5'-10"
Parlor Concert	5'- 0"	7'- 7"
Concert	5'- 4"	9'- 0"

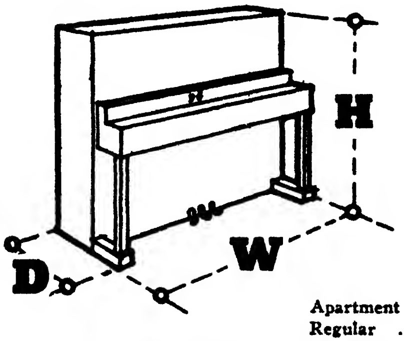
GRAND



BENCH



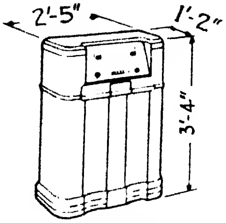
CONSOLE



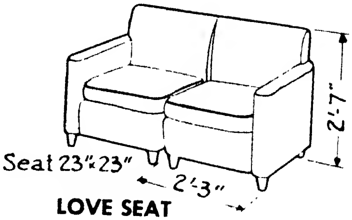
	H	D	L
Apartment .	3'-6"	1'-11"	3'-9"
Regular	4'-3"	2'- 0"	5'-0"
Regular	4'-5"	2'- 2"	5'-0"
Regular	4'-7"	2'- 4"	5'-2"

UPRIGHT

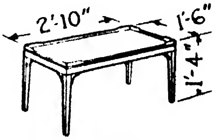
LIVING ROOM
FURNITURE SIZES



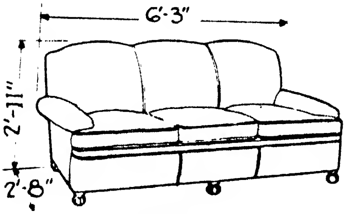
RADIO



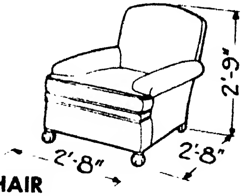
LOVE SEAT



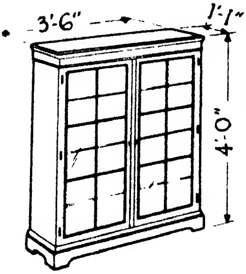
COFFEE TABLE



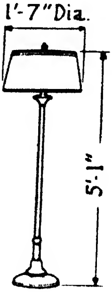
SOFA



CHAIR

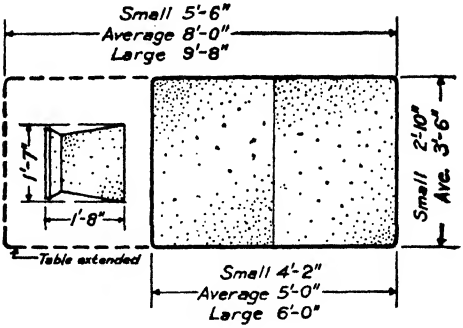


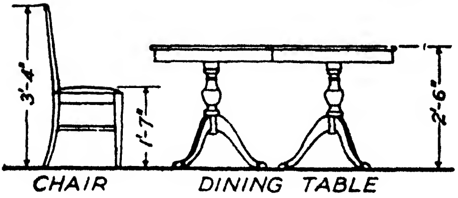
BOOK CASE

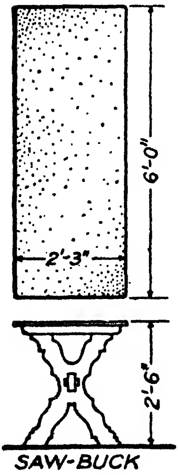


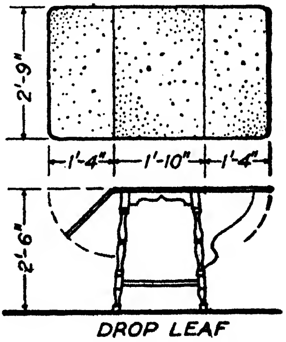
LAMP

SIZES OF DINING TABLES



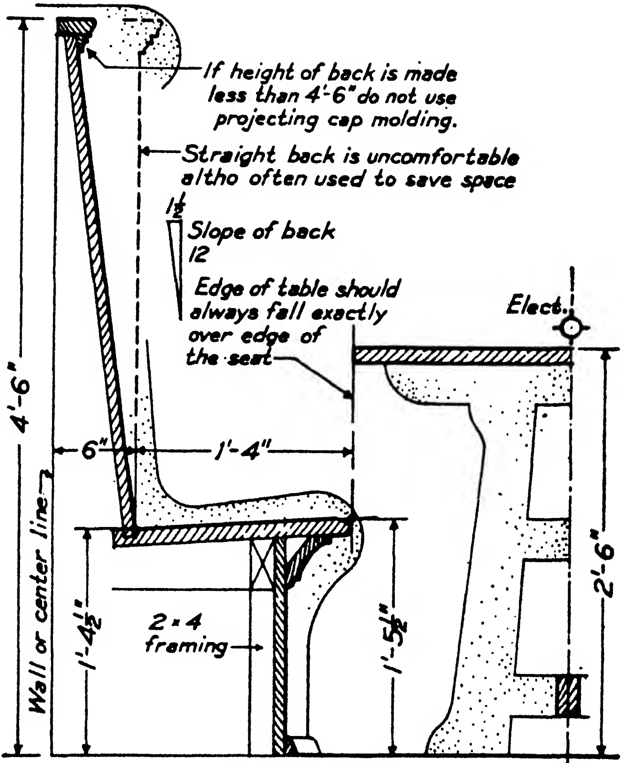




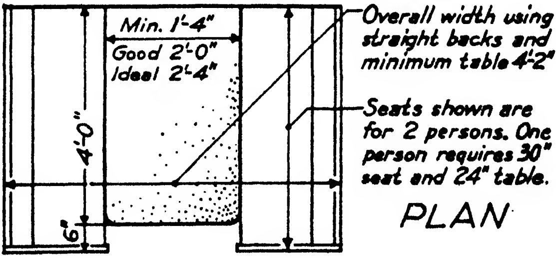


Other Drop Leaf Tables
Square 4'-0" × 4'-0"
Oval from –
1'-8" to 3'-0" wide
2'-8" to 4'-0" long

DINING ALCOVE

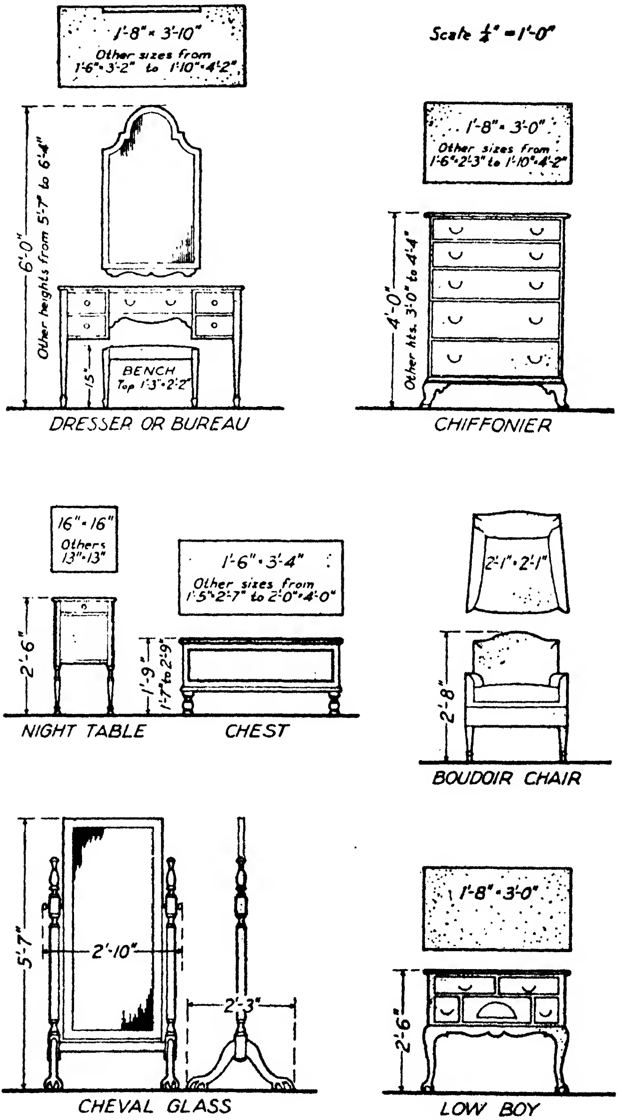


SECTION

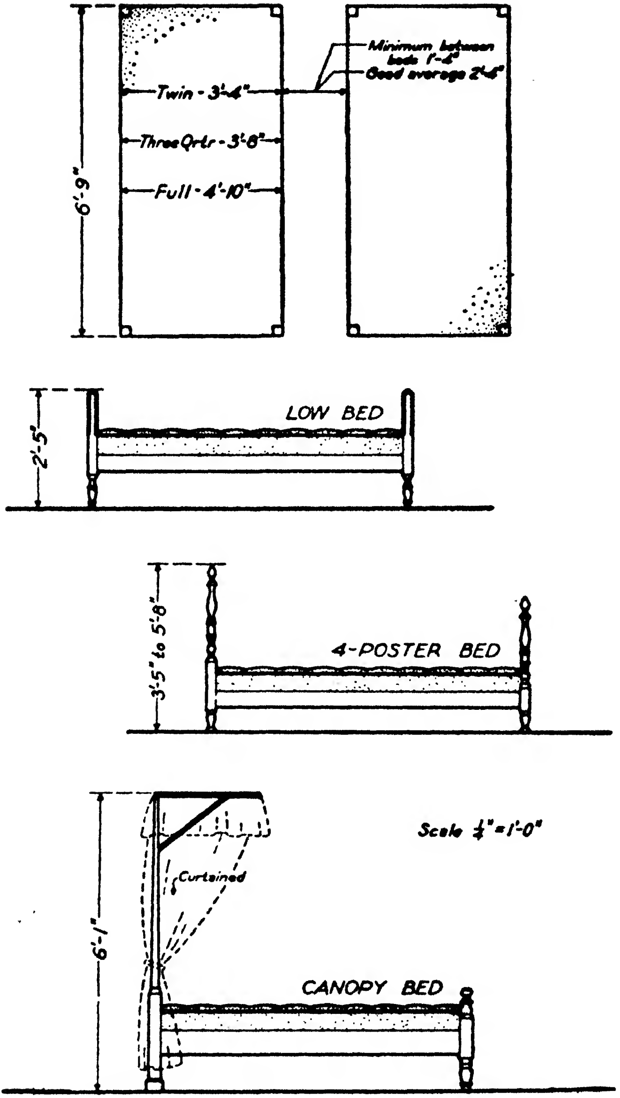


PLAN

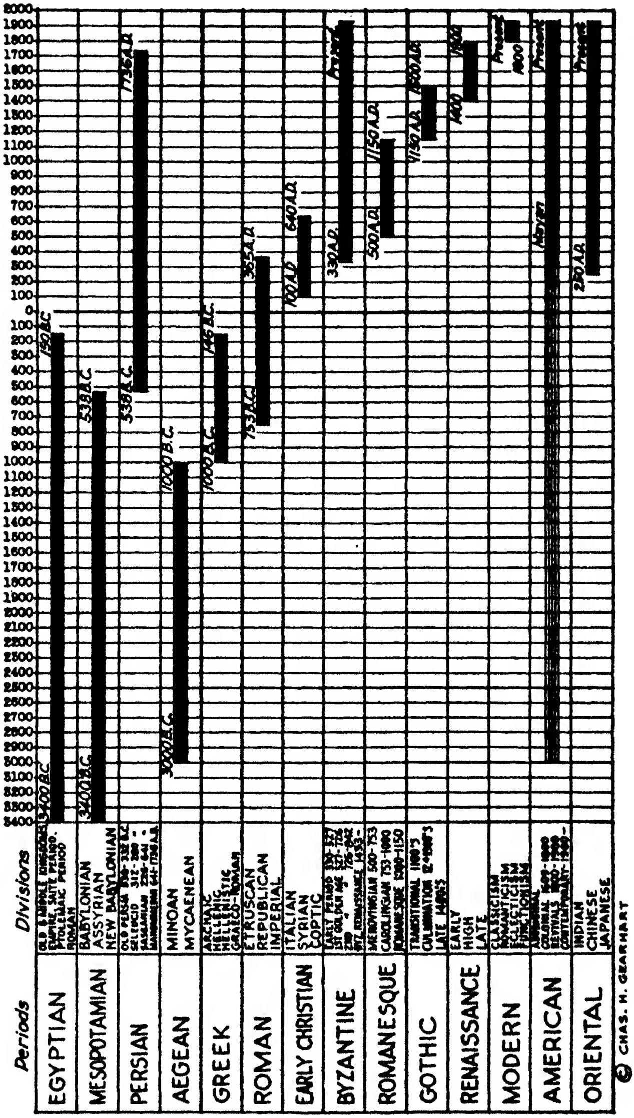
SIZES OF BEDROOM FURNITURE



SIZES OF BEDS



APPROXIMATE DURATION OF ARCHITECTURAL PERIODS



PERIOD FURNITURE

Showing the order of the period styles from the beginning of the Renaissance to the nineteenth century.

ENGLAND

Sovereign	Style	Period
Henry VIII 1509-1557	TUDOR	
Elizabeth 1558-1603	ELIZABETHAN	
James I 1603-1625	JACOBEAN	
Charles I 1625-1649		
Common-wealth 1649-1660		
Charles II 1660-1685		
James II 1685-1688		
William and Mary 1688-1702	WILLIAM AND MARY	
Anne 1702-1714	QUEEN ANNE	
George I 1714-1727	CHIPPENDALE	GEORGIAN PERIOD
George II 1727-1760	HEPPLEWHITE ADAM	
George III 1760-1820	SHERATON	

FRANCE

Period	Style	Sovereign
	FRANCOIS PREMIER	Francis I 1515-1547
	HENRI DEUX	Henry II 1547-1559
		Francis II 1559-1560
		Charles IX 1560-1574
		Henry III 1574-1589
	HENRI QUATRE	Henry IV 1589-1610
	LOUIS TREIZE	Louis XIII 1610-1643
ROCOCO	LOUIS QUATORZE	Louis XIV 1643-1715
	LOUIS QUINZE	Louis XV 1715-1747
CLASSIC REVIVAL	LOUIS SEIZE	Louis XVI 1747-1793
	EMPIRE	Napoleon 1793-1814

The duration of the Renaissance in other countries is about as follows: Italy 1443-1546; Germany 1525-1620; Flemish and Dutch 1520-1634; Spain and Portugal 1500-1620; other European countries 1500-1620. The Rococo begins at about the dates given for the end of the Renaissance.

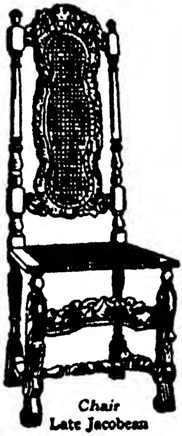
ENGLISH FURNITURE
(1560 - 1690)

TUDOR-ELIZABETHAN, JACOBEAN. Massive, sturdy furniture replaced the stark pieces of feudal days in early England. The Tudor-Elizabethan era was the Renaissance in Britain.

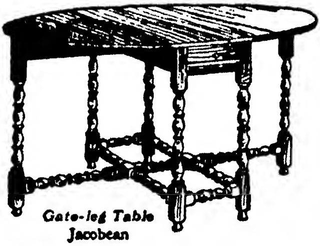
Oak in simple wax finish was carved elaborately in extravagant and forceful forms. Some dining room suites and occasional pieces are reproduced today, but interest in Tudor styles is chiefly because they represent the first swing toward decorative furniture and buildings. When this style is used, it properly belongs in large Gothic rooms.

Early Jacobean furniture, sometimes called Stuart, was particularly sturdy. It utilized the same oak that was employed in Queen Elizabeth's day. It was the style of furniture that inspired early American styles in the colonies. In the middle Jacobean the gateleg table evolved.

Late Jacobean, or Charles 2nd, furniture is increasingly used today; the severity of the Cromwellian morality having been replaced by a merry monarch's love of luxury, the designs reflected this lighter attitude toward life. Both oak and walnut were used in that period.

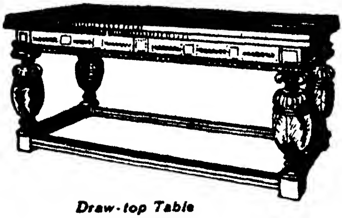


Chair
Late Jacobean



Gate-leg Table
Jacobean

Armchair
Elizabethan



Draw-top Table
Elizabethan

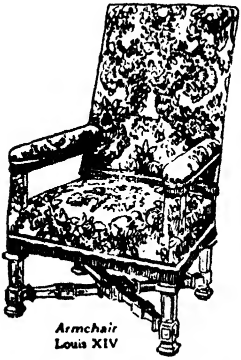
Armchair
Late Jacobean

FRENCH FURNITURE
(1500 - 1750)

LOUIS 14TH. This period marked the evolution of the straight line toward the curve which was to predominate in the following epoch. The straight line was usual. Proportions were large, massive, dignified and formal. Louis 14th furniture is seldom used today except in large and luxurious quarters. Its purpose was for show—comfort was not considered of great importance.

THE REGENCY. This era marked the beginning of a newer and lighter vein in furniture design. The curved line replaced rectilinear forms.

LOUIS 15TH. Probably the outstanding age of the world in decorative furniture, this period is notable for its rich and luxurious creations. The style is distinctly feminine. Walnut, mahogany and ebony were used effectively. Lacquers and gilding covered much of the woods to good advantage. The cabriolet leg was used almost exclusively and scroll feet were usual. Reproductions are suited to homes where fastidious elegance is desired. Careful selection is necessary to blend Louis 15th furniture with other styles.



Armchair
Louis XIV

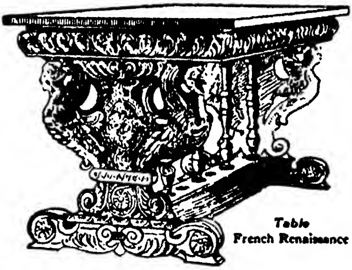
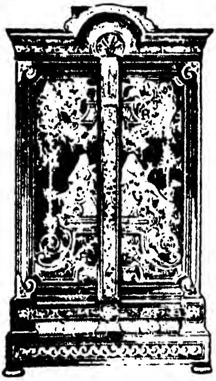
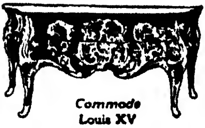


Table
French Renaissance

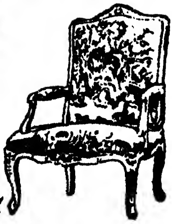
Writing Desk
Louis XV



Armoire
Louis XIV



Commode
Louis XV



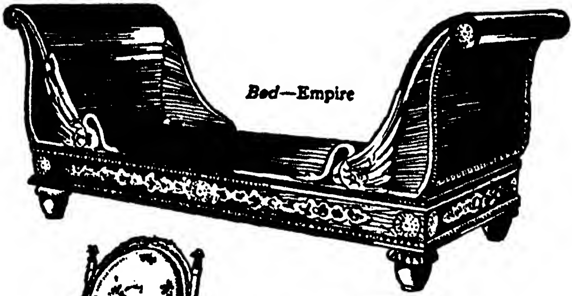
Armchair
Louis XV

FRENCH FURNITURE
(1750 - 1815)

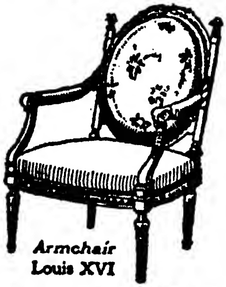
LOUIS 16TH. The furniture is a slender, straight line style with a return to classicism. It is a direct and vigorous reaction against the rococo ornamentation and excessive curves of the previous reign. Cherubs, love birds, garlands of flowers and love knots were some of the motifs employed. Round medallions, ovals, heads, busts, human figures, fluting, reeding and beading are features of the style. Mahogany finished either in natural grain or enameled, walnut, and satinwood were much used. Silks, figured satins, brocades, damasks, muslins and velvets in pastoral and floral designs with later extensive use of stripes are all typical. Simple and feminine, the style is used where a marked effect of delicacy and daintiness is desired.

THE DIRECTOIRE. Simple classical forms were substituted for monarchial ornament.

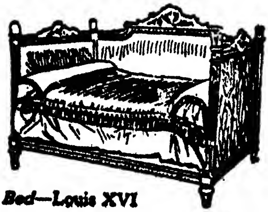
EMPIRE. A militaristic masculine stylistic reaction from the preceding femininity, the furniture was heavy and ponderous. Frequently Empire furniture is adapted to use with modern designs.



Bed—Empire



Armchair
Louis XVI



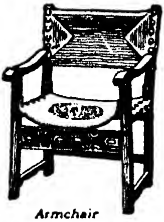
Bed—Louis XVI

Armchair—Empire

ITALIAN AND SPANISH FURNITURE (1453 - 1560)

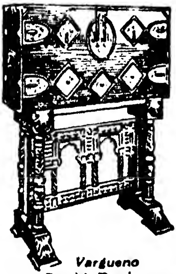
After the medieval ages, the Renaissance brought renewed interest in furniture as well as art and literature. In Italy, ornate carved pieces were used in formal halls of princes of church and state. The principal wood was walnut; the decoration was classical with fine restraint; rich, colorful dignity was expressed in the upholstery. Italian Renaissance reproductions today are scaled to the large home and would be incongruous in a bungalow.

In Spain, walnut and oak furniture were studded with brass and iron, and metal mounts were freely used. Bright red and rich green velvets were used in the trimmed and fringed upholstering, and decorated leather was also employed. Modern reproductions are well suited to many modern homes, particularly to those of Spanish architecture. Spanish furniture is massive, rugged, masculine, square, and sturdy. It is suited to use with Italian and French Renaissance furniture, as well as some early English designs.



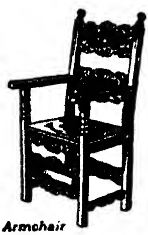
Armchair
Spanish Renaissance

Table
Spanish Renaissance

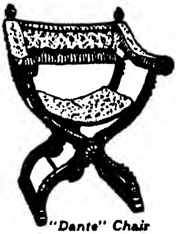


Vargueno
Spanish Renaissance

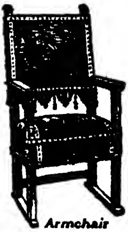
Painted Commode
18th Century Venetian



Armchair
Italian Renaissance



"Dante" Chair
Italian Renaissance



Armchair
Italian Renaissance

SIZES OF RUGS AND CARPETS

DOMESTIC RUGS

Usual sizes are in boldface and represent the standards of the wool carpet industry.

1'-10 1/2"x 3'-0"	9'-0" x 9'-0"
2'-2" x 4'-4"	9'-0" x 10'-6"
2'-3" x 3'-4"	**9'-0" x 12'-0"**
2'-3" x 4'-0"	**9'-0" x 15'-0"**
2'-3" x 4'-4"	9'-0" x 18'-0"
2'-3" x 4'-6"	9'-0" x 21'-0"
2'-3" x 5'-0"	10'-6" x 10'-6"
3'-0" x 3'-0"	10'-6" x 12'-0"
3'-0" x 5'-2"	10'-6" x 13'-6"
3'-0" x 5'-10"	10'-6" x 15'-0"
3'-0" x 6'-0"	**11'-3" x 12'-0"**
4'-6" x 6'-6"	11'-3" x 13'-6"
4'-6" x 7'-6"	**11'-3" x 15'-0"**
6'-0" x 9'-0"	11'-3" x 18'-0"
6'-9" x 9'-0"	11'-3" x 21'-0"
7'-6" x 9'-0"	12'-0" x 13'-6"
8'-3" x10'-6"	12'-0" x 15'-0"

HALL RUNNER RUGS

2'-3" x 9'-0"	3'-0" x 9'-0"
2'-3" x 12'-0"	3'-0" x 12'-0"
2'-3" x 15'-0"	3'-0" x 15'-0"

WIDTH OF CARPETS

Lengths of rolls vary, usual sizes are in boldface. New developments in seaming make possible the use of narrow widths with invisible joining. This is more economical than buying wider widths and sacrificing pieces, particularly in wall-to-wall installations. Custom jobs can be woven to order in almost any width.

1'-6"	10'-6"
2'-3"	**12'-0"**
3'-0"	**15'-0"**
4'-6"	**18'-0"**
6'-0"	30'-0"
9'-0"	

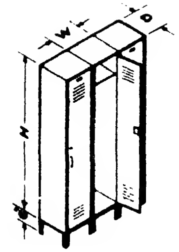
HALL RUNNER CARPETS

Available in rolls about 50 yds. long, 2'-3" and 3'-0" widths.

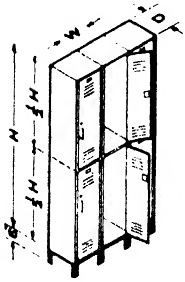
ORIENTAL RUGS

These are made on hand looms, and their sizes follow no established standard dimensions. In planning rooms for orientals, the particular rugs to be used must be actually measured.

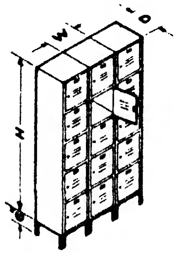
STANDARD STEEL LOCKER SIZES



SINGLE TIER LOCKERS		
W	D	H
1'-0"	1'-0"	5'-0"
1'-0"	1'-3"	5'-0"
1'-0"	1'-6"	5'-0"
1'-3"	1'-3"	5'-0"
1'-3"	1'-6"	5'-0"
1'-6"	1'-9"	5'-0"
1'-0"	1'-0"	6'-0"
1'-0"	1'-3"	6'-0"
1'-0"	1'-6"	6'-0"
1'-3"	1'-3"	6'-0"
1'-3"	1'-6"	6'-0"
1'-6"	1'-6"	6'-0"
1'-6"	1'-9"	6'-0"



DOUBLE TIER LOCKERS		
W	D	H
1'-0"	1'-0"	5'-0"
1'-0"	1'-0"	6'-0"
1'-0"	1'-3"	6'-0"
1'-3"	1'-3"	6'-0"
1'-0"	1'-3"	7'-0"
1'-3"	1'-3"	7'-0"



BOX LOCKERS			
TIERS HIGH	W	D	H
5	1'-0"	1'-0"	5'-0"
6	1'-0"	1'-0"	6'-0"
5	1'-0"	1'-3"	5'-0"
6	1'-0"	1'-3"	6'-0"
5	1'-3"	1'-3"	6'-0"
4	1'-3"	1'-3"	5'-0"

*Sizes shown are those adopted by leading manufacturers and users, promulgated in *Simplified Practice Recommendation No. 35* of the U. S. Department of Commerce. Some Steel Lockers are manufactured which do not exactly conform to this "Standard," the leg heights varying from 5" to 7½", and the height (H) varying up to ⅝" more than that shown above. Lockers to be recessed should be ordered without the legs. The Locker Mfrs. Assn. recommend that lockers only be included in locker contracts to get best competitive bidding.

COMMERCIAL STANDARDS

GENERAL INFORMATION. Commercial Standards from the National Bureau of Standards, U.S. Department of Commerce, establish standard quality requirements, methods of test, rating, certification, and labeling of commodities, and provide uniform bases for fair competition. They are developed by voluntary cooperation among manufacturers, distributors, consumers, and other interests, upon the initiative of any of these groups, through a regular procedure of the National Bureau of Standards established for that purpose.

Copies of *printed* Commercial Standards may be consulted in public or college libraries. Or they may be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. *Mimeographed* copies may be obtained without charge from the Commodity Standards Division, National Bureau of Standards, Washington 25, D.C.

Below is a list of Standards of particular interest to the construction industry. Those marked "OP" are out of print, but may be obtained in mimeographed form, unless marked "NM." Those that are both out of print, and not mimeographed should be consulted in libraries. "MO" means mimeographed only at the time this book is published. When ordering, give title and full order number. Remittance is required in advance of shipment. A discount of 25% is allowed on orders totalling 100 or more copies. The prices quoted are for publications which are to be delivered to addresses in the United States and its possessions, and to countries extending the franking privilege.

TITLE	CS NO.	PRICE
Bathroom accessories; colors for	63-38	5¢
Blankets, hospital; wool, and wool and cotton	136-46	5¢
Blinds, Venetian; wood-slat	61-37	5¢
Boilers, hand-fired, hot water supply; testing and rating	145-47	10¢
Burners, domestic, underfeed type; for Pennsylvania anthracite (second edition)	48-40	5¢
Burners, oil; automatic, mechanical-draft, for domestic installations (second edition)	75-42	10¢
Calking, lead	94-41	5¢
Closet lining; aromatic red cedar	26-30	OP
Compressors. air; tank-mounted	126-45	10¢
Convectors, steam and hot water; methods of testing and rating	140-47	10¢
Coolers, drinking water; self-contained mechanically refrigerated	127-45	10¢
Doors, entrance; factory-fitted, Douglas fir	91-41	5¢
Doors, standard-stock, Douglas fir, (old growth), Sitka spruce and Western hemlock (fourth edition)	73-48	15¢
Doors; standard stock ponderosa pine (second edition)	120-46	10¢
Fiber-board; structural, insulating (third edition)	42-43	5¢
Flooring; oak (second edition)	56-41	5¢
Furnaces; forced-air, solid fuel burning	109-44	10¢
Furnaces, gas; floor, gravity-circulating types	99-42	5¢
Furnaces, oil-burning; floor, equipped with vaporizing pot-type burners	113-44	10¢
Furnaces, warm-air equipped with oil-burners, vaporizing pot-type (second edition)	104-46	15¢

COMMERCIAL STANDARDS

TITLE	CS NO.	PRICE
Hardware; builders', nontemplate (second edition)....	22-40	10¢
Hardware; builders', template (second edition)	9-33	10¢
Hardware Cloth	132-46	5¢
Heaters, space; oil-burning, flue-connected, with vaporizing pot-type burners	101-43	10¢
Insect wire screening	138-47	5¢
Insecticide, household; liquid spray type	72-38	OP
Kitchen accessories; colors for	62-38	OP
Lifts, automotive	142-47	10¢
Lumber; hardwood, dimension (second edition)	60-48	10¢
Lumber, tank stock; cedar, cypress, and redwood	92-41	5¢
Mineral wool; blankets, blocks, insulating cement, pipe insulation for heated industrial equipment	117-44	10¢
Mineral wool; loose, granulated, or felted form, in low-temperature installations	105-43	10¢
Mineral wool products; all types, testing; reporting....	131-46	10¢
Mirrors (second edition)	27-36	10¢
Molding and trim; hardwood, interior	76-39	5¢
Netting; woven wire	133-46	5¢
Oils, fuel (sixth edition)	12-48	MO
Paints, oil; artists'	98-42	5¢
Pipe, bituminized-fiber; drain and sewer	116-44	5¢
Pipe, clay; perforated (standard and extra strength ..	143-47	10¢
Pipe, lead	95-41	5¢
Pipe, nipples; brass, copper, steel, and wrought iron (second edition)	5-46	5¢
Plumbing fixtures; cast iron, enameled (second ed.) ..	77-48	MO
Plumbing fixtures; earthenware (vitreous-glazed)	111-43	5¢
Plumbing fixtures, formed metal, porcelain-enameled ..	144-47	10¢
Plumbing fixtures, staple porcelain	4-29	NM-OP
Plumbing fixtures; vitreous china, staple (fourth ed.)	20-47	10¢
Plywood; Douglas fir (seventh edition)	45-47	10¢
Plywood; hardwood (third edition)	35-47	10¢
Plywood; hemlock, western	122-45	5¢
Prefabricated homes (second edition)	125-47	10¢
Shingles, wood; red cedar, tidewater red cypress, California redwood (fourth edition)	31-38	5¢
Stair treads and risers; hardwood	89-40	5¢
Staple seats for water-closet bowls	29-31	OP
Stone, cast; colors and finishes	53-35	5¢
Tanks; porcelain-enameled, for domestic use	115-44	MO
Traps and bends, lead	96-41	5¢
Unions; standard weight, malleable iron or steel screwed	7-29	OP
Veneers, walnut	64-37	5¢
Wall-paneling; solid, hardwood	74-39	5¢
Wall paper	16-29	5¢
Wallboard; fiber, homogeneous	112-43	5¢

OWNER AND ARCHITECT
6 PERCENT AGREEMENT

......(*Name and Address*)......, hereinafter called the Owner, and TOM THUMBTACK, hereinafter called the Architect, hereby agree as follows;

WHEREAS, the Owner intends to construct .....(*type building*)..... on the following described premises, viz:..........................; and whereas the Owner has employed the Architect to render professional services in connection with said proposed work:

NOW, THEREFORE, in consideration of the payment of the fees hereinafter provided to be paid by the Owner, the Architect agrees to furnish and perform the following professional services in connection with said proposed building, for the general, structural and mechanical work, viz:

1. PRELIMINARY WORK. Prepare preliminary sketches and secure for the Owner preliminary estimates. No such estimates can be regarded as other than approximations, and the Architect assumes no responsibility for their accuracy.
2. CONTRACT DRAWINGS. Prepare general working drawings, specifications and proposal forms.
3. LETTING CONTRACTS. Draft advertisements, if necessary; receive and tabulate bids, advise as to letting contracts, draft forms of contracts.
4. DETAILS AND SHOP DRAWINGS. Prepare necessary full size details and check shop drawings.
5. SUPERVISION. Supervise the work generally, issue certificates of payment to contractors; make final inspection for acceptance of the work. The Architect will endeavor to guard the Owner against defects and deficiencies of the work of contractors, but he does not guarantee the performance of their contracts.

ARCHITECT'S FEE. The owner agrees to pay the Architect for the above named services a sum equal to *six per cent* (6%) of the total cost of said building, in connection with which such services have been performed, including cost of all mechanical equipment and all fixtures, whether fixed or movable, made from the Architect's drawings, or purchased under the Architect's supervision; provided that the Architect's fees shall not be included in computing the cost of said building.

PAYMENTS. Whether the work be entirely executed or whether its execution be suspended or abandoned in part or in whole, payments to the Architect on his fee are to be made as follows, for service rendered in execution or up to the time of such suspension or abandonment:

A sum equal to 20% of the basic rate computed upon a reasonable estimated cost, upon completion of the Preliminary Work.

Upon completion of Contract Drawings and Specifications, a sum sufficient to increase payments on the fee to 60%, computed upon a reasonable estimated cost, or if bids have been received, upon the lowest bona fide bid or bids.

As the work progresses, payments shall be made in proportion to the amount of service rendered, computed upon the final cost of the work.

SURVEYS, BORINGS, AND TESTS. The Owner agrees to furnish, at his own expense, complete and accurate surveys, borings, and tests as required by Architect.

DRAWINGS. The drawings and specifications to be prepared and furnished by the Architect pursuant to this agreement shall be the property of the Architect. Copies thereof shall be furnished the owner, but for the purpose of this building only.

Dated....................193... ....*Owner*

........................*Architect*

OWNER AND ARCHITECT COST - PLUS AGREEMENT

......(*Name and Address*)......, hereinafter called the Owner, and TOM THUMBTACK, hereinafter called the Architect, hereby agree as follows;

WHEREAS, the Owner intends to construct .....(*type building*)..... on the following described premises, viz:..........................; and whereas the Owner has employed the Architect to render professional services in connection with said proposed work:

NOW, THEREFORE, in consideration of the payment of the fees hereinafter provided to be paid by the Owner, the Architect agrees to furnish and perform the following professional services in connection with said proposed building, for the general, structural and mechanical work, viz:

1. PRELIMINARY WORK. Prepare preliminary sketches and secure for the Owner preliminary estimates. No such estimates can be regarded as other than approximations, and the Architect assumes no responsibility for their accuracy.
2. CONTRACT DRAWINGS. Prepare general working drawings, specifications and proposal forms.
3. LETTING CONTRACTS. Draft advertisements, if necessary; receive and tabulate bids, advise as to letting contracts, draft forms of contracts.
4. DETAILS AND SHOP DRAWINGS. Prepare necessary full size details and check shop drawings.
5. SUPERVISION. Supervise the work generally, issue certificates of payment to contractors; make final inspection for acceptance of the work. The Architect will endeavor to guard the Owner against defects and deficiencies of the work of contractors, but he does not guarantee the performance of their contracts.

ARCHITECT'S FEE. The owner agrees to pay the Architect for the above named services a sum equal to the *total cost* to the Architect of performing and furnishing such services, plus *33⅓%* of such total cost.

PAYMENTS. On or about the first day of each month during the time when such services are being performed, the Architect shall render to the Owner a statement showing the services, performed and furnished during the preceding month, and the cost thereto as above mentioned, plus 33⅓% of such cost. The total amount of such statement shall be due and payable immediately upon the rendering of each statement. The Owner can terminate this agreement at any time by notifying the Architect in writing to that effect, and paying him in full for all services performed and furnished to date, upon the basis heretofore described.

SURVEYS, BORINGS, AND TESTS. The Owner agrees to furnish, at his own expense, complete and accurate surveys, borings, and tests as required by Architect.

DRAWINGS. The drawings and specifications to be prepared and furnished by the Architect pursuant to this agreement shall be the property of the Architect. Copies thereof shall be furnished the Owner, but for the purpose of this building only.

Dated...................193... ....*Owner*

......................*Architect*

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