MACHINE DRAWING

BY

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AND

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(Central Technological Institute, Bombay State)
BOMBAY

GEOFFREY CUMBERLEGE

OXFORD UNIVERSITY PRESS

Rs 3-12

Oxford University Press, Amen House, London E.C.4
GLASGOW NEW YORK TORONTO MELBOURNE WELLINGTON
BOMBAY CALCUTTA MADRAS CAPE TOWN
Geoffrey Cumberlege, Publisher to the University

First published 1940
Second edition 1943
Third edition 1945
Fourth edition 1950

PRINTED IN INDIA BY V. V. BAMBARDEKAR AT THE INDIA PRINTING WORKS, FORT, BOMBAY, AND PUBLISHED BY GEOFFREY CUMBERLEGE, OXFORD UNIVERSITY PRESS, APOLLO BUNDER, BOMBAY

FOREWORD

The representation of ideas by means of lines, or what we know as drawing, is an art which has been practised from the time when thinking man first sought a medium whereby he could communicate his ideas to others, however rudimentary those ideas may have been. In fact, it is more than likely that the first language of man was in the form of drawings, and that what we call writing today is nothing more or less than a peculiarly developed form of drawing, though judging from the appearance of the handwriting of the average individual the connexion between the two appears to be very remote.

Modern drawing generally is of two distinctly different forms, namely, Freehand Drawing, which is practised without the aid of any instrument, and Mechanical Drawing, which, as its name implies, is of a mechanical nature inasmuch as the lines, both straight and curved, which form the drawing, are drawn by mechanical means through the medium of instruments such as straight-edges, rules, compasses and set-squares.

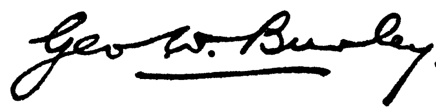
Mechanical Drawing is essentially the engineer's language—and, it may be said, a universal language—as by means of it complex ideas and conceptions, relating to things to be made or which have been made, can be much more readily, clearly and accurately represented than by means of words. A skilled reader of a mechanical drawing can, almost at a glance, comprehend the appearance and construction of the thing represented, whereas a verbal description would take considerable time to read and would in all probability be incomplete in regard to all the points covered by the drawing and, furthermore, would be lacking in that sense of accuracy which is the true basis of Mechanical Drawing.

Machine Drawing, which is the subject with which this book is concerned, is a branch of Mechanical Drawing, and, as its name implies, deals chiefly with machines and parts of machines and mechanical apparatus of all kinds, and a training in it is a necessary part of the technical education of every mechanical and electrical engineering student or apprentice, since the only way in which such student or apprentice can acquire the necessary knowledge to enable him to read a drawing is through the medium of actual training in the making of drawings in order, as it were, to learn the language, without a knowledge of which, of course, drawings cannot be read. The value of training in Machine Drawing cannot be over-emphasized since the training has an educational value in addition to its practical feature whereby experience in the technique of the art (that is, practical draughtsmanship) is acquired.

As with every other educational subject, the teaching of Machine Drawing must proceed from the simple to the complex or less obvious, and the authors of this book have kept this educational principle before them, though at the same time they have also kept before them the necessity of keeping abreast of the modern developments so far as draughtsmanship is concerned, so that the methods and conventions which they have adopted are the generally accepted ones and in line with standard practice. This latter point is of considerable importance since the value of a mechanical drawing lies chiefly in the ease with which it can be read.

As a textbook for use in connexion with first and second year classes in Machine Drawing this book is eminently suitable, and I can strongly recommend its use in all technical educational institutions in which engineering and allied subjects are taught.

PRINCIPAL
V. J. T. I.
June 1940



NOTE TO THE FOURTH EDITION

This edition has been completely revised and we have added some new figures. Alterations and additions to existing drawings have been made wherever necessary.

BOMBAY, H. A. D.
August 1950. C. E. K.

NOTE TO THE THIRD EDITION

This edition has been fully revised, and many changes made in text and figures.

BOMBAY, H. A. D.
May 1945. C. E. K.

PREFACE TO THE SECOND EDITION

In this second edition many new exercises have been added and the book completely revised and enlarged to suit the needs of other Engineering Colleges.

The authors acknowledge with thanks the many valuable suggestions, received since the book was first published, to create a wider sphere of use for the book, and they hope that they have achieved this to a large measure in the present edition.

BOMBAY, H. A. D.
July 1943. C. E. K.

PREFACE TO THE FIRST EDITION

In preparing this book on Machine Drawing, the authors have used their many years of experience in teaching and examining engineering students for the benefit of students in Engineering Colleges and Technical Institutions. Knowing the difficulties of engineering students, the authors have prepared these drawings with careful attention to the standard of their understanding capacity from start to finish.

The difficulty of students in visualizing the objects they are to draw, will be minimized if the earlier part of the book is thoroughly worked over. Every student must endeavour to picture in his mind's eye the part, or whole, of the object he has to draw. Models of machine parts can be exhibited to students in the earlier stages to help them understand the drawings. Later, when students are more familiar with machines and machine parts, they should be able to get a mental picture when they see a drawing. In the later stages students should be guided to read and interpret drawings without the aid of models or sample parts.

Since in modern engineering practice everything is made according to drawings the authors have not overlooked the idea of giving data for guiding the practical student in the course of his workshop training. Limitations of space, however, have prevented the authors from presenting more than a few tables of practical data in so small a book. Any standard engineering pocket book [1] will, however, be a valuable guide to the practical student and provide any data not given here. Complete worked out drawings have been taken from practice, and the drawings presented in this volume are complete in themselves. If the burden of the Indian Engineering student who has not got big workshops to visit like students in more industrial countries, and who has to learn theoretically, is in any way lightened by this book, the authors will feel well rewarded.

BOMBAY, H. A. D.
May 1940. C. E. K.

[1] The 'Practical Engineer' Pocket Book is published annually, price 6s.

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SECTION I

INTRODUCTION AND GENERAL PRINCIPLES

Place of Machine Drawing in Engineering Institutions

According to Dr Johnson, 'Knowledge is of two kinds. We may know it ourselves, or we may know where we can find information about it. To know it ourselves, our information must be through books, and to have the skill to extract the essence from books, we must know what books to read.' The school, college, or institution directs the student to develop the will and capacity to learn for himself; and neither dictated notes nor a series of lectures, nor the possession of a personal library, will help anybody, unless he has enthusiasm coupled with initiative. 'Knowledge is power', and we should try to know more than we are expected to know. Machine drawing or engineering drawing has to be studied in a more practical way than a host of other subjects that a student has to learn through books. Machine drawing and an engineer have to go together. There is no line of division between them. Machine drawing in engineering institutions, therefore, prepares the student to express his ideas in a methodical and systematic way.

Machine Design

This consists in expressing original ideas based on scientific principles—the practical constructive art of engineering. The designer must have a fair knowledge of mechanics, mechanisms, strength of materials, metallurgy, workshop processes and many other engineering standards and specifications. The subject of machine design has not been dealt with in this book, but in some chapters empirical formulae or other data based on a standard are given to enable students to calculate the necessary dimensions not given either on the drawings or in the texts.

Machine Drawing

Machine drawing deals with the application of practical geometry to the representation of machines or parts of machines. Practical geometry, plane or solid geometry, deals with simple projections of plane figures, such as a triangle, a square, a circle, etc., or the projections of solids, such as a cylinder, a cube, a cone, etc., which are regular in shape and size.

By the adoption of certain conventions, the ordinary geometrical projections, supplemented with notes and symbols, indicate much more than the mere shape of the objects, however intricate and complex they are. This graphic language expresses the shape and form of the objects legibly and intelligibly to the ordinary man in a workshop. Machine drawing is language to the engineer and workman. It speaks silently the systematized rules of production in a workshop, for a finished drawing carries with it a wealth of information from the drawing office to the workshop, where it is read and the contents brought out in three dimensional objects.

Machine drawing can be divided under two heads—

(i) Assembly drawings.—Drawings which show the general arrangement, or indicate the function of a machine.

(ii) Working drawings.—Drawings which express the processes for the manufacture of a machine or its parts—also called detail drawings.[1]

Instruments and their Use

Good equipment is no extravagance. For machine drawing a good set of instruments, with one or more pairs of set squares, pencils, rubber, pins, paper and a drawing board and T-square are essential. The size of the drawing board for all practical purposes may be Imperial (32″ × 23″) or half Imperial (23″ × 16″) with a T-square to match. It is wise to invest in a box of good quality instruments even in the early stages. Cheap ones will not only be of no use, but will greatly reduce speed and accuracy. The drawing board should be tilted at a suitable angle of 15° to 30°. This will be less tiring to the worker, as a flat board on a horizontal table is apt to cause severe strain, especially on the neck. A pair of good quality celluloid set squares, either six inches and eight inches, or eight inches and ten inches, will serve a host of purposes. The pair should be 45° and 60°. A box of cardboard scales of good make will satisfy the young student. As he advances, a wooden scale or a set of such scales will be found useful. Besides being rigid, a wooden scale will generally have eight different scales marked on it. Good quality pencils of H and 2H grades should be used. The H pencil should have a conical point and the other a chisel point. The chisel pointed pencil is used to draw straight lines, while the other is used for inserting or marking off dimensions and lettering. Students must be encouraged to use such pencils from the beginning. It will be found handy to carry with the instruments a piece of NO. 0 glass paper, or a smooth flat file about four inches long, for sharpening the pencil points.

[1] See blue prints at the end of the book.

Types of Lines for Drawings

There are many accepted standards and conventions for representing on finished drawings the different materials with which the parts are to be made. But the authors

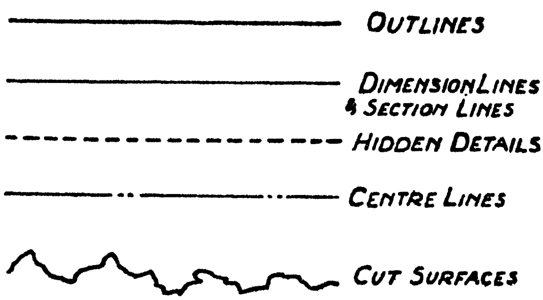


FIG. 1

are of the opinion that it is best to have one type of section lines to indicate a majority of materials, except brass, gun-metal, leather, or white metal, which may be indicated in the conventional way. Fig. 2 indicates some of the accepted standards of representing different materials.

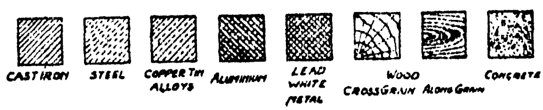


FIG. 2

It will be a saving of time in the workshop if the different materials are indicated as shown in the blue prints at the end of this book.

Lines of Projection

These lines indicate on a drawing how another view is evolved from an already drawn view. These lines may be faint continuous lines or chain lines. Projection lines are not ordinarily shown on working drawings, but will be found useful in interpreting drawings in which certain sections are projected at odd angles.

Fig. 3 shows how the different views of an ordinary hexagonal pyramid are evolved

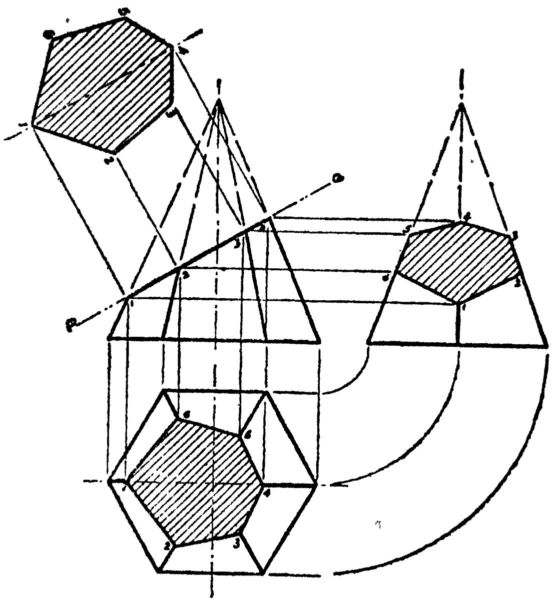


FIG. 3

and the projection lines indicate how the true form of section is obtained when the solid is cut by the plane PQ. Fig. 28 shows how the different views of an ordinary hexagonal nut are drawn by projecting the lines from selected points in the plan.

Parts to be Machined

Where some side or face has to be machined it will always be better to indicate it clearly on the drawing either by putting the letter '*f*' along the surface, or by marking the surface with a red line. Other shop processes can be indicated by short notes on the drawing against each part.[1]

Tapers and Angles

The accepted standards, Morse or Brown and Sharpe Standard tapers, are to be used except in cases where other tapers are to be taken. The following method of drawing tapers on drawings will be more accurate than calculated values. A common taper for shaft keys is 1 in 96 or $\frac{1}{8}$ inch per foot length.

In the rectangle EFGH (Fig. 4) let FG denote the maximum thickness of key, and let G be the point through which the requisite taper of 1 in 96 has to be drawn. Draw a straight line AB parallel to EF and make it equal to 6 inches. At B draw BC perpendicular to AB and let BC be made equal to $\frac{1}{16}$ inch. Join AC; a parallel GK to CA, gives the requisite taper. The same process repeated on both sides gives a

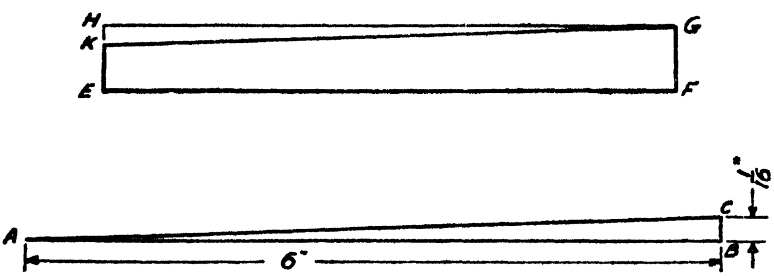


FIG. 4

double taper as in piston rod ends of steam engines. (Fig. 71).

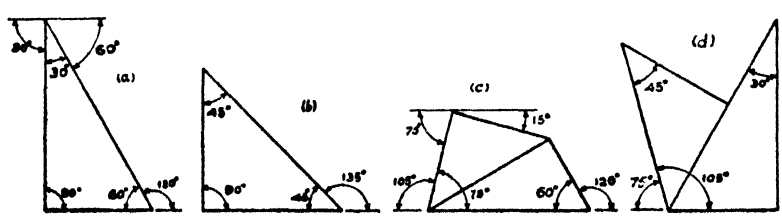


FIG. 5

Many common angles can be set off with the two set squares and compasses. Fig. 5 shows how with the aid of set squares some of the common angles can be set off. Except

[1] See blue prints.

to mark half a degree or so, the use of a protractor in machine drawing should be avoided as far as possible.

Dimensioning and Lettering

The value of a drawing, whether for workshop use or otherwise, greatly depends upon the clearness and accuracy of the figures and dimensions, and the skilful way in which they are arranged. Uniformity in lines, dimensions and letters, greatly improves the appearance of a drawing. On the other hand, bad lettering and dimensions will introduce costly errors in the process of manufacture. Duplication or repetition should be avoided as far as possible. Plainness moves more than eloquence. Single stroke lettering, either sloping or upright, will speak much more than flourishes and ornamentations. Proper lettering and dimensioning is a matter of practice and unless the student aims at perfection, instruction alone cannot pave the way. The following style of lettering and dimensioning (Fig. 6) can be followed. Most of the drawings in this book are dimensioned in the best possible way, and therefore, will enable the student to understand the value of proper dimensioning. It is important that the line dividing the figures in a vulgar fraction, be parallel to the dimension line.

The scale to which a drawing is made, should be clearly written, not to enable workmen to scale the drawing, but to enable the manufacture or measurement of a particular part or set of parts to a different system of measurement, such as the metric system. The title of a drawing, the drawing number, date, etc., are to be shown clearly. The index tables on the blue prints indicate how to arrange the above, in addition to the other particulars to be given on a drawing.

Copying Drawings

Original drawings are kept in the drawing office for reference, and copies are sent to workshops. A drawing is first copied by tracing on cloth or paper, and the tracing used to produce blue prints or photo copies.

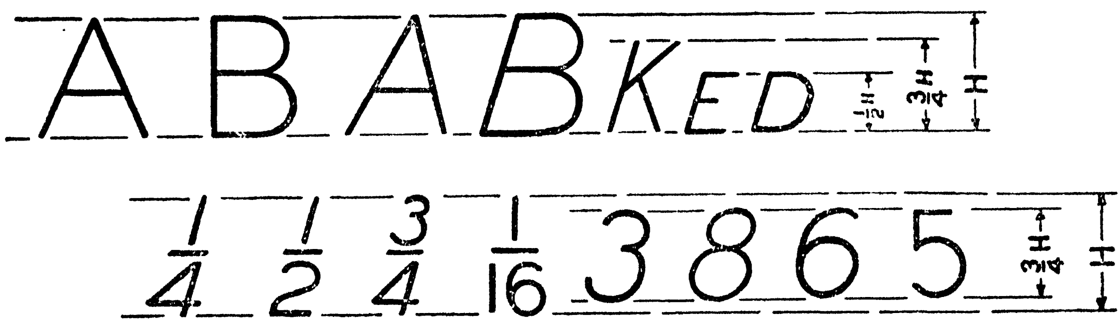


FIG. 6

Tracing

In copying a drawing by tracing, the drawing is set on the board and a tracing paper or cloth of the required size to cover the entire drawing sheet is spread over it. The instruments required for tracing are the bow pen and bow compasses. Good quality drawing ink (black) is put in the spring bow so that it stands in between the jaws upto a length of about a quarter of an inch. The jaws are adjusted to the required thickness of lines and all the curves or arcs are drawn first. The curves or arcs are joined by straight lines using the bow pen. Dotted lines, generally are shown slightly thinner than the outlines to have some contrast. It should be borne in mind that one particular view should be completed before tracing another unless it is desired to complete all the views at one sitting. Dimensions are inserted next, either with the bow pen or with a pen having a fine point steel nib. Dimension lines are drawn next and arrows are inserted. Section lines are drawn last. Note that the dimension lines and section lines should be as thin as possible. The dimension lines should not connect the figures but a gap should be left. Where some dimension is inserted in a sectioned portion, section lines are not carried over it.

Duplicating Drawings

The tracing so produced can be used to obtain blue prints or photo copies. Heliography or sun-printing is employed for making blue prints from sensitized paper, which is suitably exposed to the sun with the tracing, and washed in water, and certain solutions, to remove the unaffected sensitizing matter. The various processes are: Ferro-Cyanide, Ferro-Gallic, Ferro-Prussiate, Platinotype and Zincographic. The sun-printing has the drawback that it is mainly dependent upon weather conditions and the character of the sunlight. The electrical photo copying process overcomes the above difficulty and, besides, has many advantages. A drawing can be enlarged or reduced to any requisite size; the details in a drawing can be separated to suit a purpose; or several drawings can be combined into one. Except for the initial cost, the electrical photo copying process stands supreme.

Sections

Whenever hidden details are to be shown in one or more views, the particular object is supposed to be cut by planes at suitable places and at suitable angles, and the surfaces so exposed are shown by suitable lines drawn sufficiently close to one another, at 45° to the horizontal.

Fig. 3 shows how the object, when it is cut by the plane PQ will appear in plan and end elevation. In the case of ribs or webs which are put on to strengthen castings, although a longitudinal section may pass through them, they are not shown by section lines in order to avoid the appearance of solidity.[1] Similarly, bolts, nuts, shafts, cotters, keys, pins, etc. are not shown in section when the plane of section is along their lengths. Transverse sections or cross sections are shown in the usual way.

Revolved Sections

Whenever round bars, angles, tees, channels, etc. are to be represented, it is not necessary to draw a separate view to show the cross section. Such parts can be represented as shown in Fig. 7.

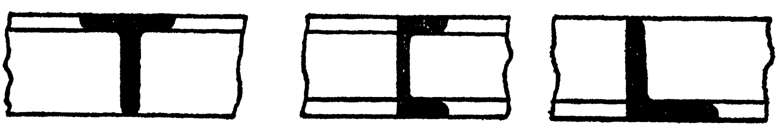


FIG. 7

Limits to Views and Lines

By a judicious selection of aspect, many parts of a machine can be represented clearly in one or two views. Too many views and lines will not only mar the appearance of a drawing, but will also introduce confusion.

[1] See worm wheel in blue prints at the end of the book.

Geometrical Construction

In Fig. 8 some of the common constructions are given.

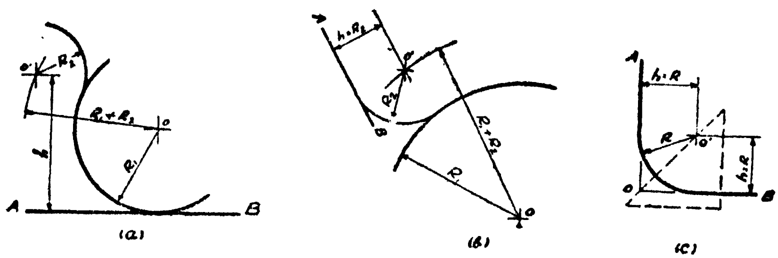


FIG. 8

Fig. 8 (*a*) gives the construction for drawing a circle of radius R_1 tangential to a straight line AB and another circle of radius R_2. Fig. 8 (*b*) shows the same, but the straight line AB is inclined to the horizontal. Fig. 8 (*c*) is common in machine drawing, where two lines AO and BO meeting at right angles can be joined by an arc of radius R as shown.

Scales and their Sub-Divisions

There are several scales to which a drawing can be prepared. Of these the full size, gives the dimensions in inches or feet. The scale is usually stated as 12 inches = foot. Other scales are sub-divisions of the full size scale, and they comprise the following, besides many others, which may be chosen to suit a particular purpose.

$9'' =$ foot or $\frac{3}{4}$ size
$6'' =$ „ „ $\frac{1}{2}$ „
$4\frac{1}{2}'' =$ „ „ $\frac{3}{8}$ „
$4'' =$ „ „ $\frac{1}{3}$ „
$3'' =$ „ „ $\frac{1}{4}$ „
$2'' =$ „ „ $\frac{1}{6}$ „
$1\frac{1}{2}'' =$ „ „ $\frac{1}{8}$ „
$1'' =$ „ „ $\frac{1}{12}$ „
$\frac{1}{2}'' =$ „ „ $\frac{1}{24}$ „

Where a drawing cannot be finished in a reasonable time, or where a drawing is continued for a few days, it will be advantageous to construct the particular scale, to which the drawing is made, on the paper itself. This, in particular, will give uniformity in dimensions, should the paper contract or expand. In drawings where the views are to be scaled, this method is the best.

Symbols and Abbreviations

Al. Aluminium.
B.A. British Association.
C.I. Cast Iron.
Circ. Circular.
C.L. Centre Line.
CRS. Centres.
C'Sunk *or* C.S.K. Countersunk.
D_1. Diameter at bottom of threads or Core Diameter.
Dia. *or* D. Diameter.
Ft. Foot (*also as* 1'-0").
G.M. Gun Metal.
H. Height.
Hex. Hexagon.
Ins. Inches (*also as* 3").
M.S. Mild Steel.
Pc. Circular Pitch or Circumferential Pitch.
P.C.D. Pitch Circle Diameter.
Pd. Diametrical Pitch.
Rad. *or* R. Radius.
Rt. Right.
Sq. Square.
T. Thickness.
Thds. Threads.
T.P.I. Threads per inch.
W. Width.
Whit. Whitworth.
W.I. Wrought Iron.

SECTION II

REPRESENTING OBJECTS IN THREE DIMENSIONS

Principles of Projection

- Orthographic
  - First angle method [1]
- Perspective

Orthographic and Perspective Projection

If lines are drawn from selected points on the contour of an object to meet a plane, the outline given on the plane is called the projection of the object on the plane. The lines are called projection lines or projectors. If the projectors are perpendicular to the plane, an orthographic projection is the result. When the projectors converge to a point, they give a perspective projection. In Fig. 9 there is a rectangular block, and from selected points, A, B, C and D projectors are drawn to meet the plane EG. The projectors meet the plane at points A′, B′, C′, D′. By joining these points the projection of the block is obtained on the plane. In order to minimize confusion in later stages, it will be better to follow one standard way of thought from the beginning. Generally when the projection of an object is required on a plane, the object is viewed away from the plane, so that the object comes between the eye and the plane.

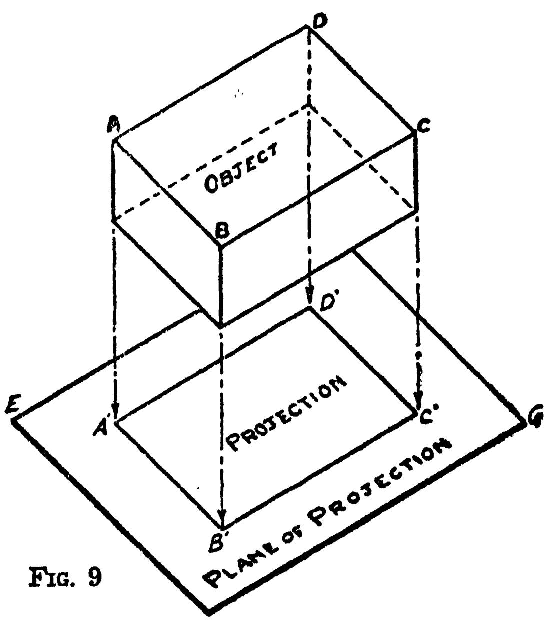


FIG. 9

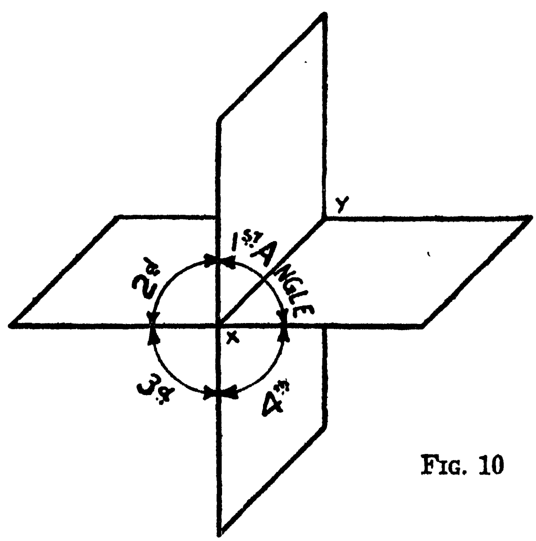


FIG. 10

The projectors from points clearly seen on the object are drawn to meet the plane always at right angles.

In machine drawing, orthographic projection is almost exclusively used. This method enables the views to be easily drawn and scaled. Unlike pictorial projection, it has

[1] B.E.S.A. Report No. 308-1927.

the disadvantage that views are not easily interpreted. [Fig. 12 (*a*) shows a shaped block in pictorial projection.]

Planes of Projection

Two principal planes are used in orthographic projection, one horizontal, and one vertical, intersecting and dividing space into four angles or quadrants as in Fig. 10. The orthographic projections of an object, situated in one of these angles, on the horizontal and vertical planes, give two views. Of these, the view obtained on the horizontal plane is called the plan (Top Plan), and that on the vertical plane is called the elevation (Front elevation). Of these two principal planes (vertical and horizontal), generally the vertical plane is assumed to be fixed and the horizontal plane movable about the line XY in a clockwise direction through 90° so as to bring it in line with the vertical plane. [See Fig. 12 (*b*).]

For practical reasons, first and third angles only are used for projections. The second and fourth angles are not used in machine drawing, because the views overlap and cause confusion.

Although still in use, the third angle method has certain drawbacks as compared with the first angle method. In the third angle method the planes of projection come between the observer and the object; the planes themselves being assumed to be transparent. Such a conception is a bit difficult to follow. Again in this method, the plan (top plan) of an object always appears above the front elevation, (Fig. 11), whereas in the first angle projection the object will be between the observer and the planes and a shadow cast or profile of the object on the planes can be easily conceived, interpreted and drawn. The plan (top plan) of an object as understood in the ordinary way, should have a place below the front elevation and not above it. Where the bottom plan of an object is projected above the front elevation, the view is clearly marked off as 'Bottom Plan'. Besides the ease it offers for projecting and interpreting views, the British Engineering Standards Association have recommended the first angle method,[1] which gives uniformity in drawing office practice, and the authors prefer this method to anything else. The shaped block shown in perspective projection in Fig. 12 (*a*) is represented in three views in Fig. 11 using the third angle method. [Compare this with Fig. 14 (*a*).] Fig. 12 (*b*) gives the plan and elevation of the shaped block shown in Fig. 12 (*a*) according to the first angle projection.

In many cases, it will be necessary to have an additional view of an object. If an additional plane or auxiliary plane [Fig. 13 (*a*)] perpendicular to both the principal planes, is chosen, the projectors will give an additional view, known as the end view (end elevation, side elevation or side view). Fig. 13 (*b*) shows a shaped block in position and the projectors give the respective views on the three planes. Fig. 14 (*b*) shows the same block in three views when the planes are turned about PO and

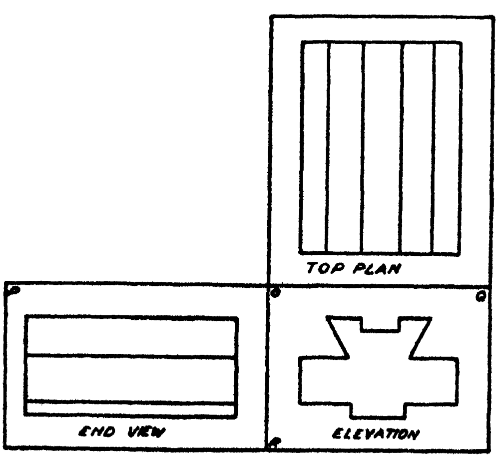


FIG. 11

[1] B.E.S.A. Report No. 308-1927. The British Standards Institution have also recommended the Third Angle method since 1949.

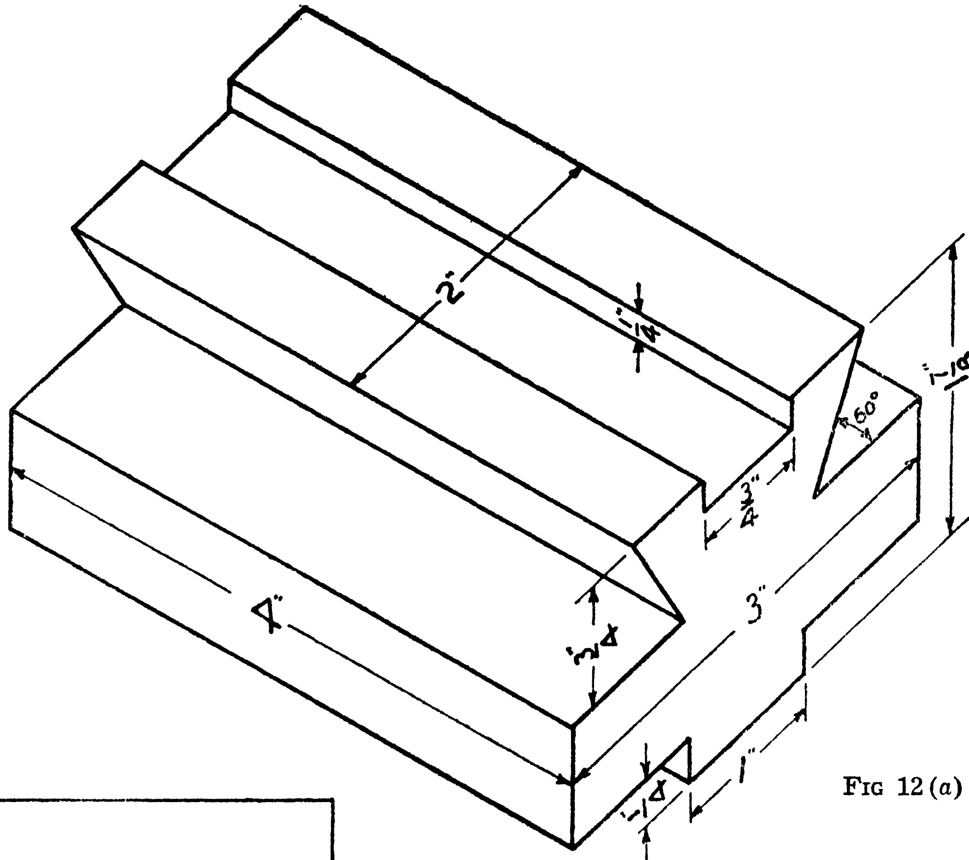


FIG 12 (a)

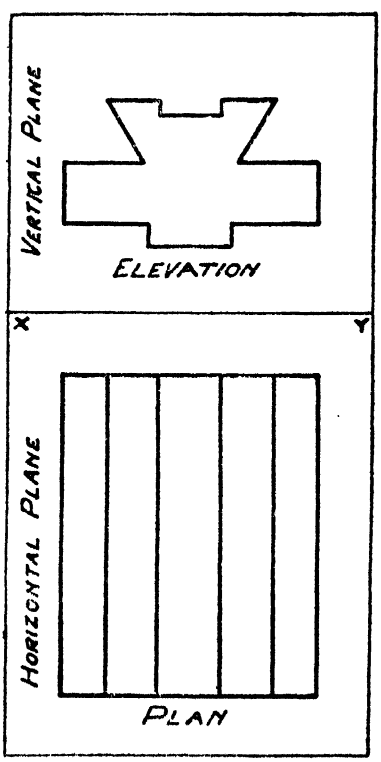


FIG. 12 (b)

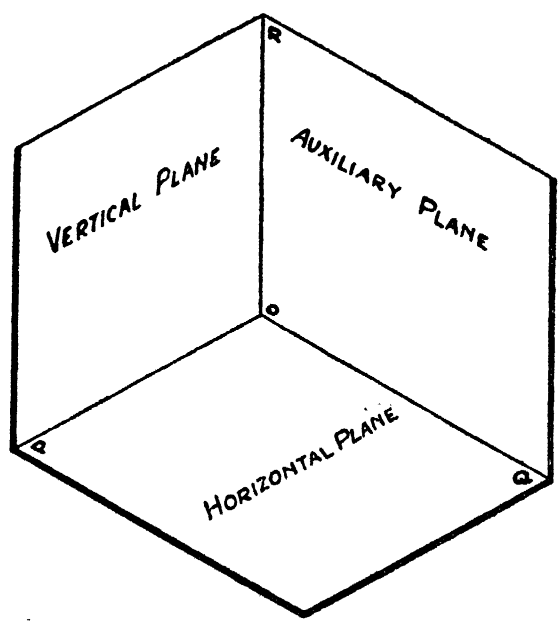


FIG. 13 (a)

OR. It should be remembered that the auxiliary plane has to be turned about OR and not along OQ. When we look at the object in Fig. 13 (*b*), on the face to our left, the auxiliary plane as shown, is away from us to our right hand side and behind the object. When the point O is transferred to P and P to O the auxiliary plane will be to our left hand side, in which case the end view will appear to the left of the front

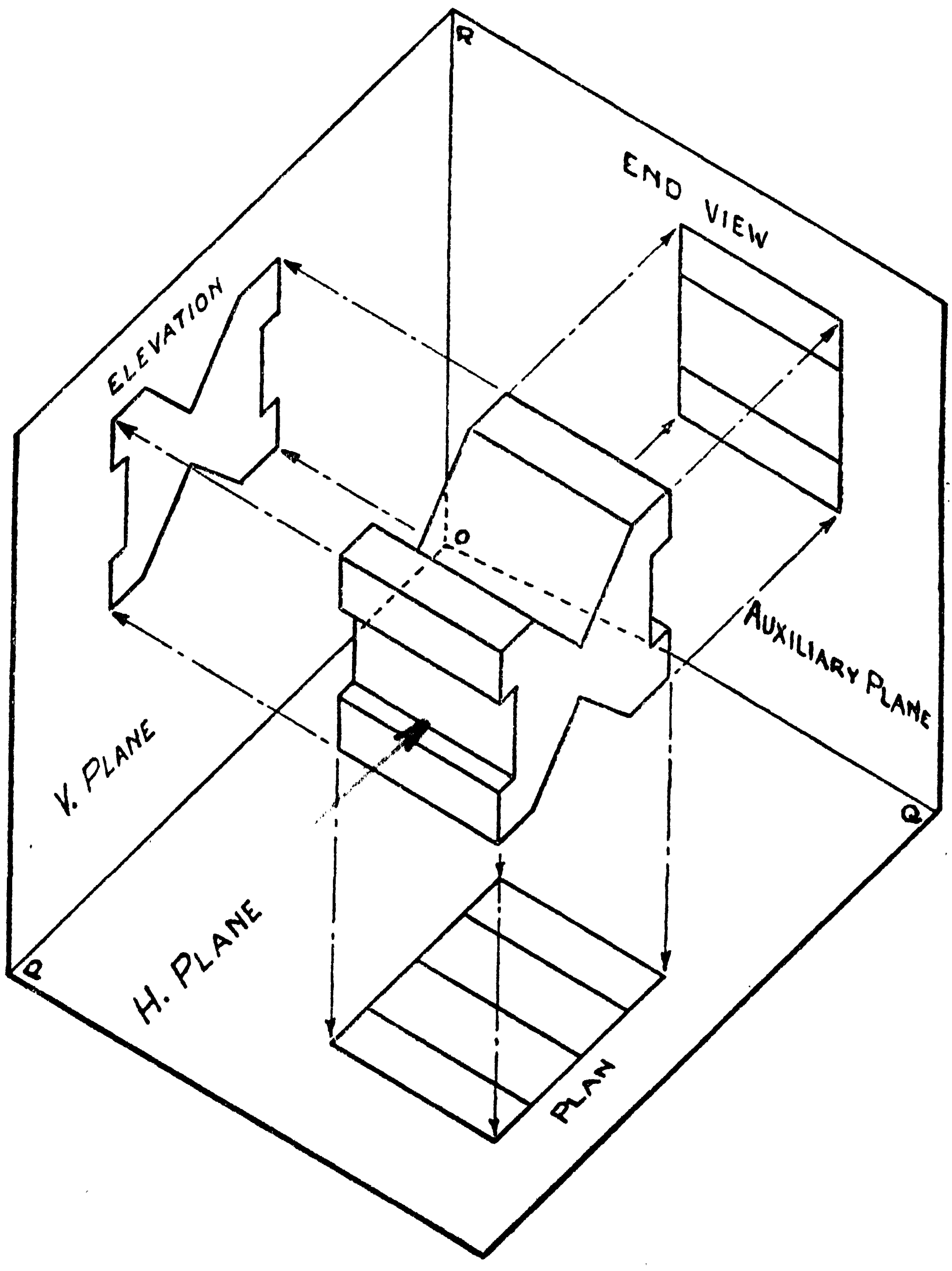


Fig. 13 (*b*)

elevation when the planes are opened out. As a standard practice in machine drawing, the end view drawn on the right hand side should be assumed to be that of the object when it is viewed from the left with the auxiliary plane on the right and *vice versa.* When end views from both sides of the object are required, they can be drawn to

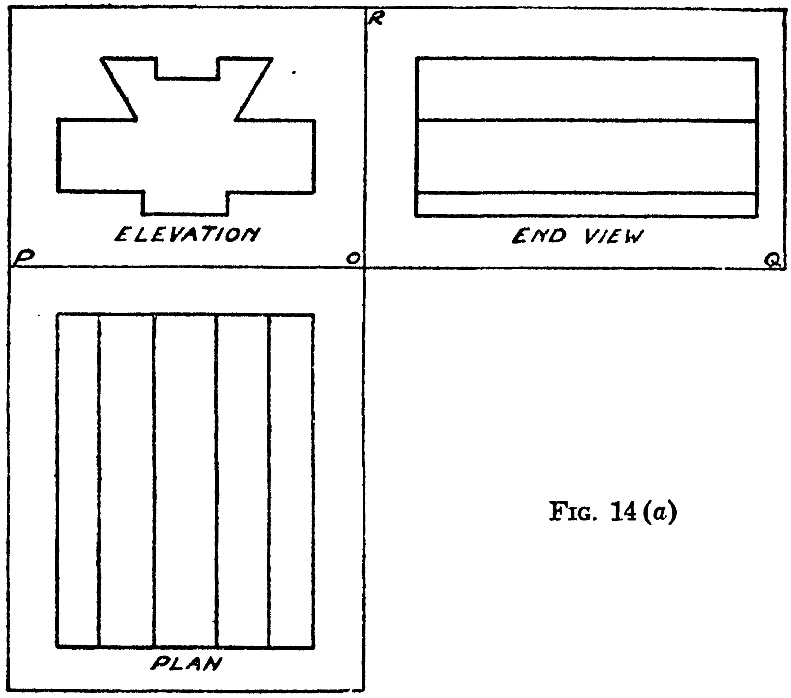


FIG. 14 (*a*)

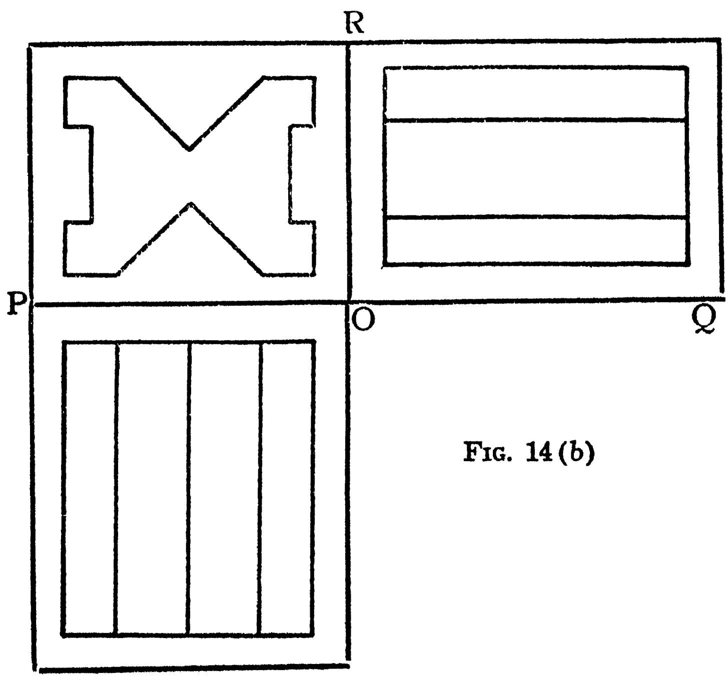


FIG. 14 (b)

the left and right of the front elevation. But where end views are taken in halves and combined into one view only, instead of having them separately, the combined end view may be placed to the right or to the left of the front elevation. Where such a method is adopted the end view should be marked off clearly by a short note as in Fig. 50. Although an experienced eye can interpret any drawing in its true form of projection, the beginner, by adopting the above principles, can express his ideas truly and systematically.

Preliminary Exercises

Before beginning to draw, the question should be read and the views to be drawn should be thoroughly understood and pictured in the mind. After this, the views should be roughly sketched on a piece of paper, inserting the dimensions. The sketch should be presented to the teacher who will guide the student and correct him wherever necessary.

A beginner will do well to learn how to allot space for three views (plan, front elevation and end view) of an object and choose a suitable scale to accommodate the three views within the drawing paper he uses. As an example let us take Fig. 41 (Wall Bracket) and have half Imperial size drawing paper. Proceed as follows :—

Half Imp. size drg. paper.

Length	= 22″	(1)
Width	= 15″	(2)
In Fig. 41		
Length for front elevn. ..	= 28″	
„ end „ ..	= 10″	
Space between views ..	= 3″	
Margin	= 2″	
Total	= 43″	(3)
Height (elevation) ..	= 30″	
Width (plan)	= 10″	
Space	= 3″	
Margin	= 2″	
Total	= 45″	(4)

Next divide (1) by (3) and (2) by (4). That is $\frac{22}{43} = \frac{1}{2}$ (approx.) $\frac{15}{45} = \frac{1}{3}$. The quotient gives the size of scale to be chosen. Though the first gives half size and the second, one third size, the lesser of them has to be chosen for drawing all the views. Hence a scale 4″ = Foot will suit and all the three views can be accommodated in the paper. (The scale given for this figure in text is slightly smaller, as is the case with many others. This is done so because students are apt to begin a view anywhere without apportioning space.) Centre lines are backbones to drawings. Therefore, after choosing a scale and after allotting spaces for the views, the student should first begin

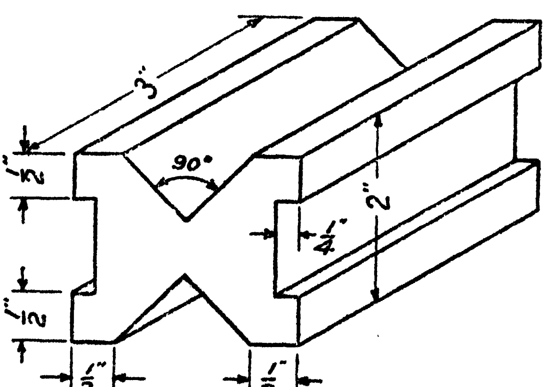


FIG. 15

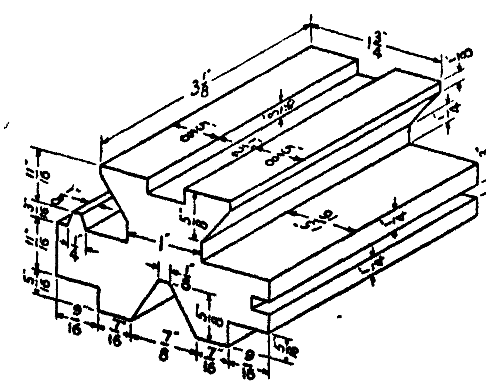


FIG. 16

a drawing by first drawing the centre line or such other outline of the drawing from which other dimensions can be scaled off. It should be borne in mind that the views are to be completed first by drawing the outlines only. Dimensions and other particulars are inserted next. Section lines are drawn last.

Ex. 1. Figs. 12 (*a*), 15 and 16 give three shaped blocks. Width of block (Fig. 15) = $2\frac{1}{2}''$. Draw to full size scale the following views of the shaped blocks. Each block should be represented in three views :

(i) Front elevation.
(ii) End elevation.
(iii) Plan.

In Fig. 17, a simple casting is shown in three views, i.e. complete plan, complete front elevation and half sectional front

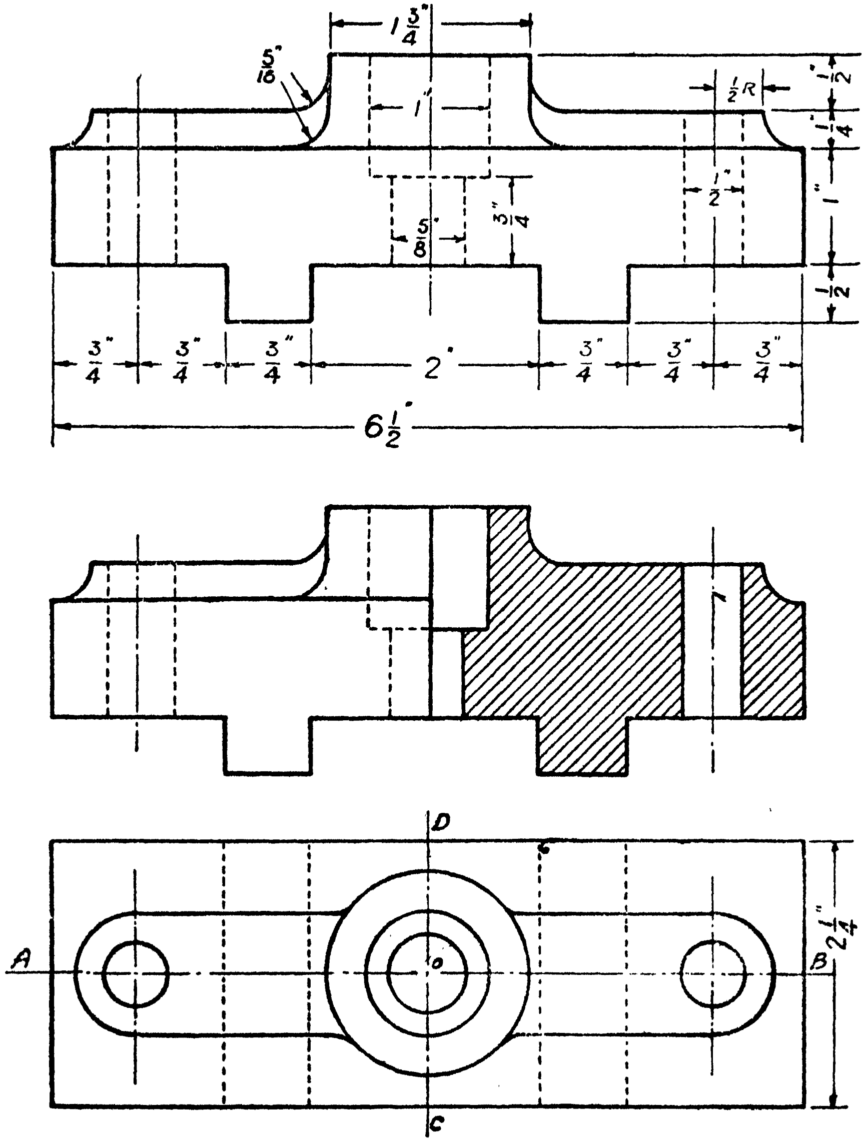


FIG. 17

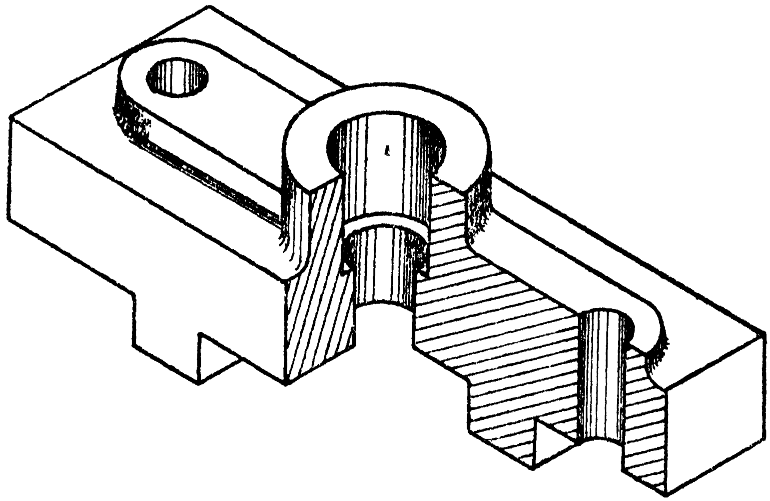


FIG. 17 (*a*)

elevation. When a part is to be shown in half section the plane of section is taken along COB, so that the object is supposed to be cut along COB and the corresponding sectional elevation is drawn by looking on a plane at right angles to AB and turning the object through 90 degrees. Similarly when half sectional (right half) end elevation is to be drawn, the object is supposed to be cut along AOC and the corresponding view projected. The portion so exposed by the cutting plane is shown by lines drawn at 45 degrees.

Ex. 2. Represent the casting shown in Figs. 17 and 17 (*a*) in the following three views to full size scale:

(i) Front elevation—left half in section.
(ii) End elevation—right half in section.
(iii) Plan.

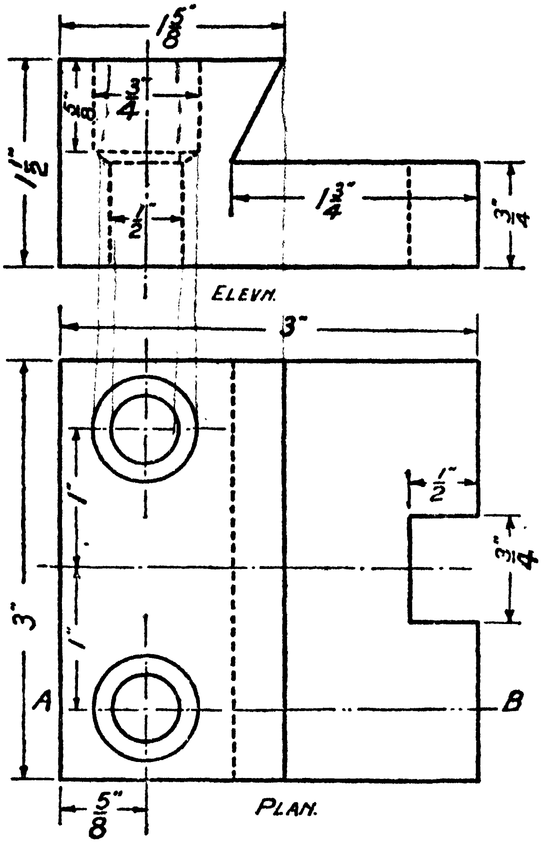


FIG. 18

Ex. 3. In Fig. 18 a shaped block is shown. Draw to full size scale:

(i) Front elevation, section on AB.
(ii) End elevation, looking from right.
(iii) Plan.

[*Note.*—In Fig. 18 (*a*) the same block is shown. The section plane AB divides the object into two parts P and Q. When the portion Q is removed the sectional elevation of the object as seen in the direction of the arrow can be projected.]

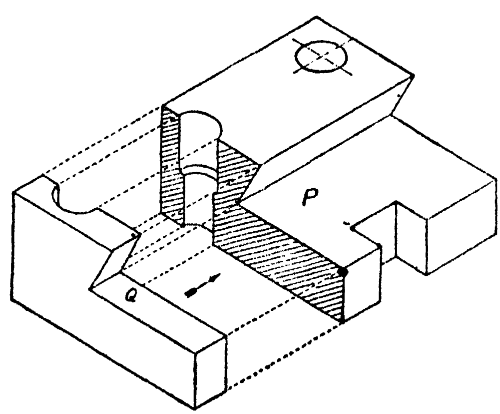


FIG. 18 (*a*)

Ex. 4. A simple bearing is shown in Figs. 19 and 19 (*a*). Draw to full size scale :

(i) A complete sectional elevation on EF.

(ii) End elevation, half section on AB.

(iii) Plan, half section on CD.

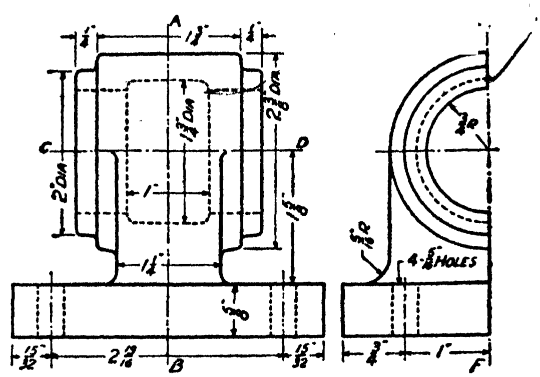


Fig. 19

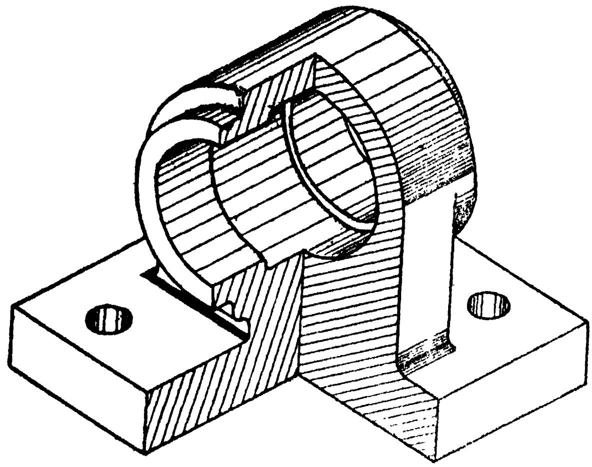


Fig. 19 (*a*)

Ex. 5. A simple valve body is shown in Figs. 20 and 20 (*a*). Draw to full size scale :

(i) The given front elevation.

(ii) End elevation, half section looking from right.

(iii) Plan, half section on CD.

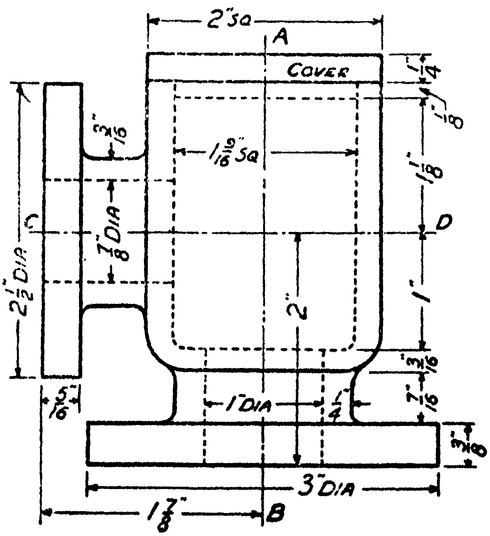


Fig. 20

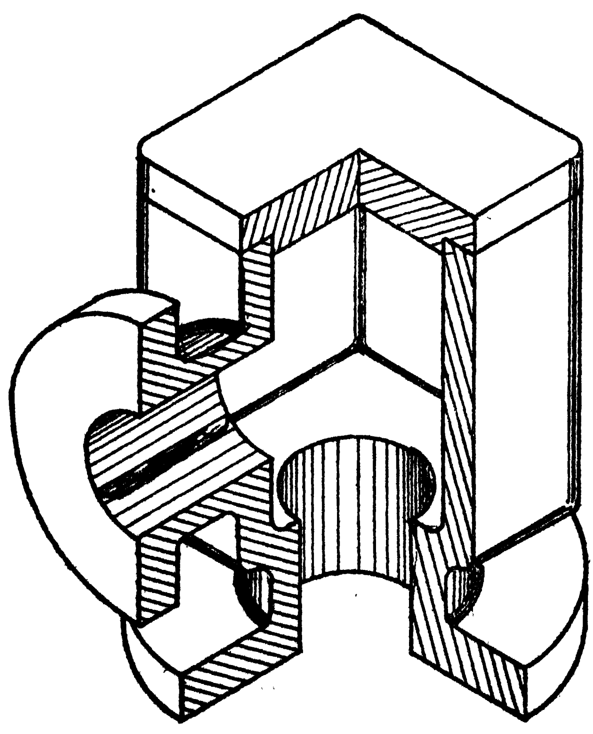


Fig. 20 (*a*)

SECTION III

FASTENINGS

In engineering practice, parts are joined together in various ways. Fastenings so used can be classified into two main groups :

(i) Temporary.

(ii) Permanent.

In temporary fastenings, the parts can be disconnected or dismantled at will. In permanent fastenings the parts are locked together permanently.

Examples of temporary fastenings are screws, bolts and nuts, studs, pins, cotters and keys.

Examples of permanent fastenings are brazing, welding and riveting.

Rivets and Riveted Joints

When two or more plates are to be connected permanently, rivets are used. The plates may be of mild steel or wrought iron. The holes in the plates to take the rivets are either punched or drilled. Punching distorts the plate in the neighbourhood of the hole and therefore drilling holes is a better operation. The burr at the edges of a drilled hole is removed by filing or grinding. The rivets are heated in special furnaces, and, after insertion in the holes made in the plates, they are closed by any one of the three common processes :

(i) Hand riveting.

(ii) Pneumatic riveting.

(iii) Hydraulic riveting.

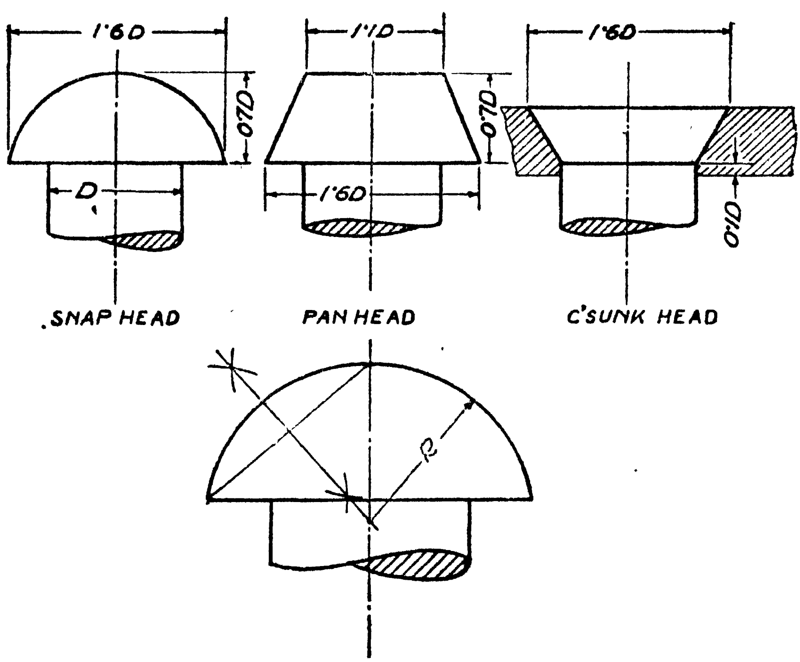


FIG. 21

In hand riveting the rivets may not fill the holes completely. Therefore, in a joint which has to be fluid tight, the other two methods are employed to close the rivets. When the rivets cool they draw the plates firmly.

Rivets and Rivet Heads

A rivet consists of two parts, the head, and the body or shank. A rivet head may be of any form. The common types of rivet heads are shown in Fig. 21. The proportions are based on the diameter of the rivet.

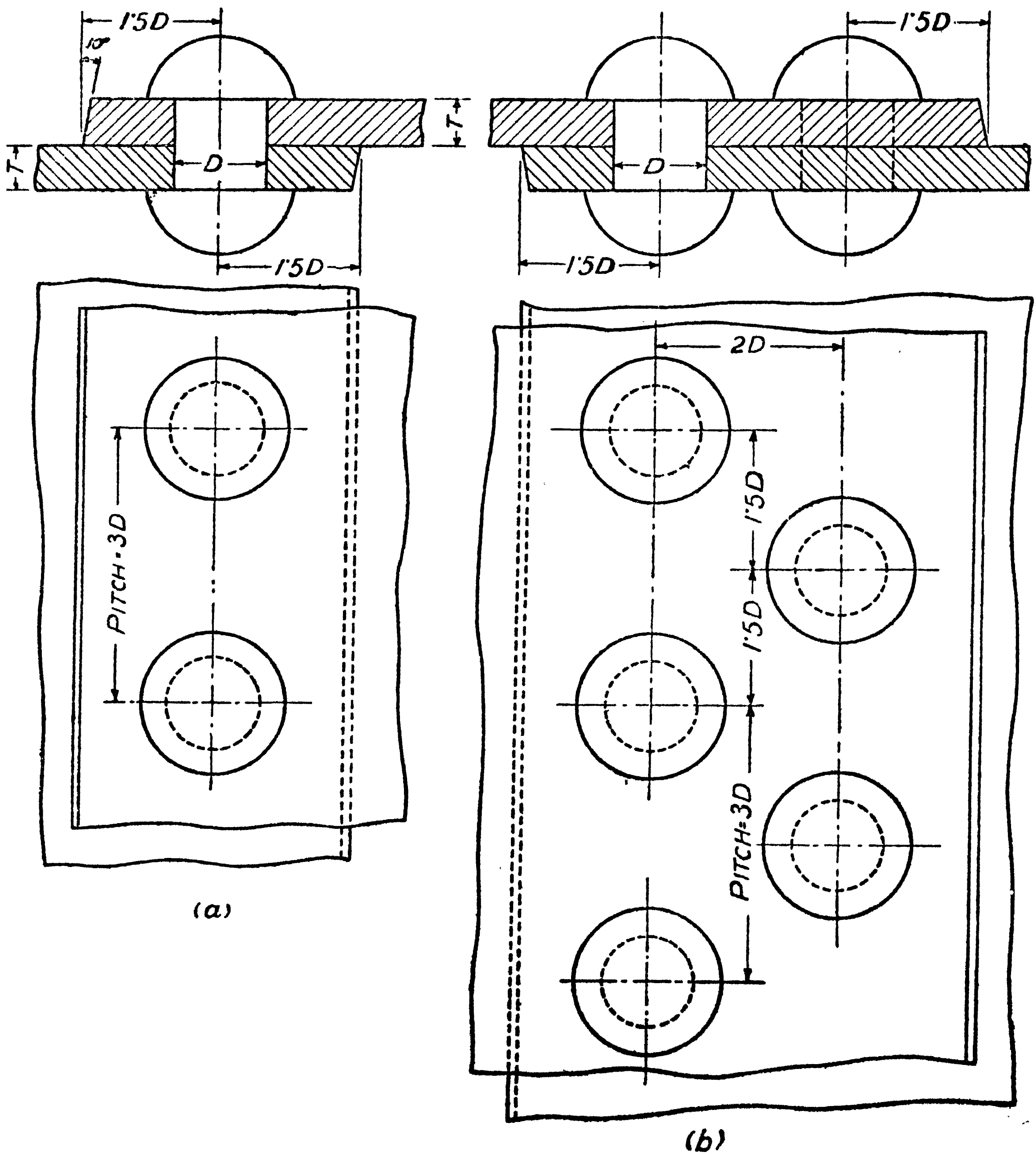


Fig. 22

Rivet Diameter and Plate Thickness

The formula connecting the thickness of plate and the diameter of rivet, as given by Professor Unwin, is $D = 1.2\sqrt{T}$ where D and T are the diameter of the rivet and thickness of the plate in inches.

Pitch of Rivets

The distance from the centre of one rivet to the centre of the next rivet is called the pitch, measured along the line of rivets.

Classification of Riveted Joints

Of the different kinds of riveted joints, the following are common:

(i) Lap joint—single or double riveted.

(ii) Butt joint—single, double or multiple riveted.

Lap Joint

In lap joints, the plates overlap each other. A single riveted lap joint and a double riveted lap joint (zig-zag riveted) are shown in Fig. 22 (*a*) and (*b*).

Butt Joint

In this the ends or edges of the main plates are kept butt against each other, and a single cover plate or two cover plates are put over the junction of the main plates and are riveted over. Fig. 23 shows a single riveted butt joint with two cover plates. When a single cover plate is used, it is made slightly thicker than the main plates and when two cover plates are used, they are slightly less in thickness than the main plates. If T is the thickness of the main plates in inches, the thickness of the cover plates (single) $T_1 = 1\frac{1}{8}\ T$, and when two cover plates are used $T_1 = \frac{3}{4}\ T$.

Ex. 6 (*a*). Fig. 22 (*a*) and (*b*). Draw the plan and elevation (in section) of single and double riveted lap joints to plate thickness $\frac{1}{2}''$, $\frac{5}{8}''$ and $\frac{3}{4}''$. Draw to full size scale, using snap head rivets.

Ex. 6 (*b*). Fig. 23. Draw the plan and elevation (in section) of a single riveted butt joint for plates, $\frac{3}{8}''$, $\frac{1}{2}''$ and $\frac{5}{8}''$, to full size scale.

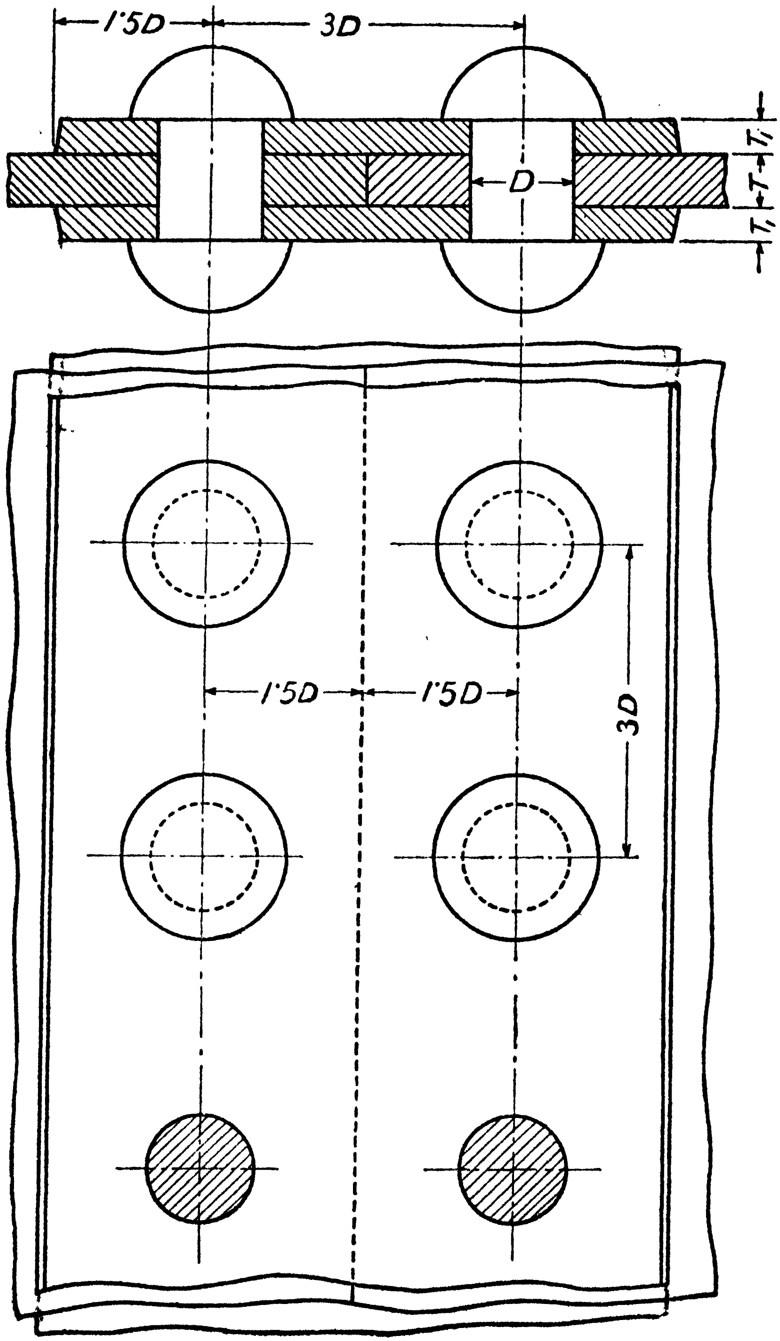


FIG. 23

Threads are projections, which form a smooth helix round a cylinder.

Forms of Threads

There are many forms of threads in use. Some are:

(i) Whitworth V thread.
(ii) Square thread.
(iii) British Association thread.
(iv) Sellers thread.
(v) Buttress thread.
(vi) Acme thread.
(vii) Knuckle thread.
(viii) Cycle engineers thread.
(ix) American screw thread.

Of these, the first three are common. Others are used according to the purpose which they suit best. Fig. 24 gives the profile of some forms of the above threads.

Pitch

Pitch of a screw is the distance measured from one point on a thread to the corresponding point in the next thread. This is true for single threaded screws, whereas in double and triple threaded pieces, the pitch is the distance measured from one point of a thread to the corresponding point of the same thread in the same straight line, parallel to the axis of the screw.

In single threaded screws the slope or inclination of the thread is half pitch. In double and treble threaded screws the slope will be half the corresponding pitch. The depth of cut or whole height of thread for a Whitworth screw is 0.64 pitch. The core diameter, or the diameter at the bottom of the threads, is the diameter of a screw over threads minus twice the whole depth of thread. The threads are usually stated as so many per inch, usually written as T.P.I. The pitch is the reciprocal of the number of threads per inch, i.e. $P = \frac{1}{\text{T.P.I.}}$

Fig. 25 (*d*) and (*f*) shows the conventional representation of Whitworth threads on drawings. In Fig. 25 (*d*) the depth of thread is shown as ½ P. This will help the student to show the threads on a drawing more quickly than an elaborate calculation and setting off the exact depth of thread. Similarly the pitch P need not be set off to exact pitch. What is required on a drawing is that a particular part is threaded. So it

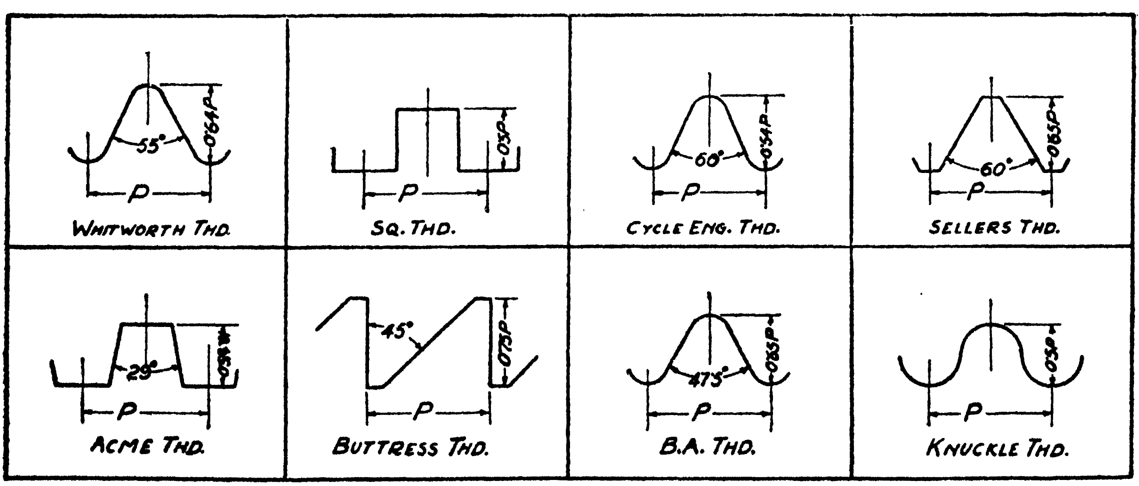
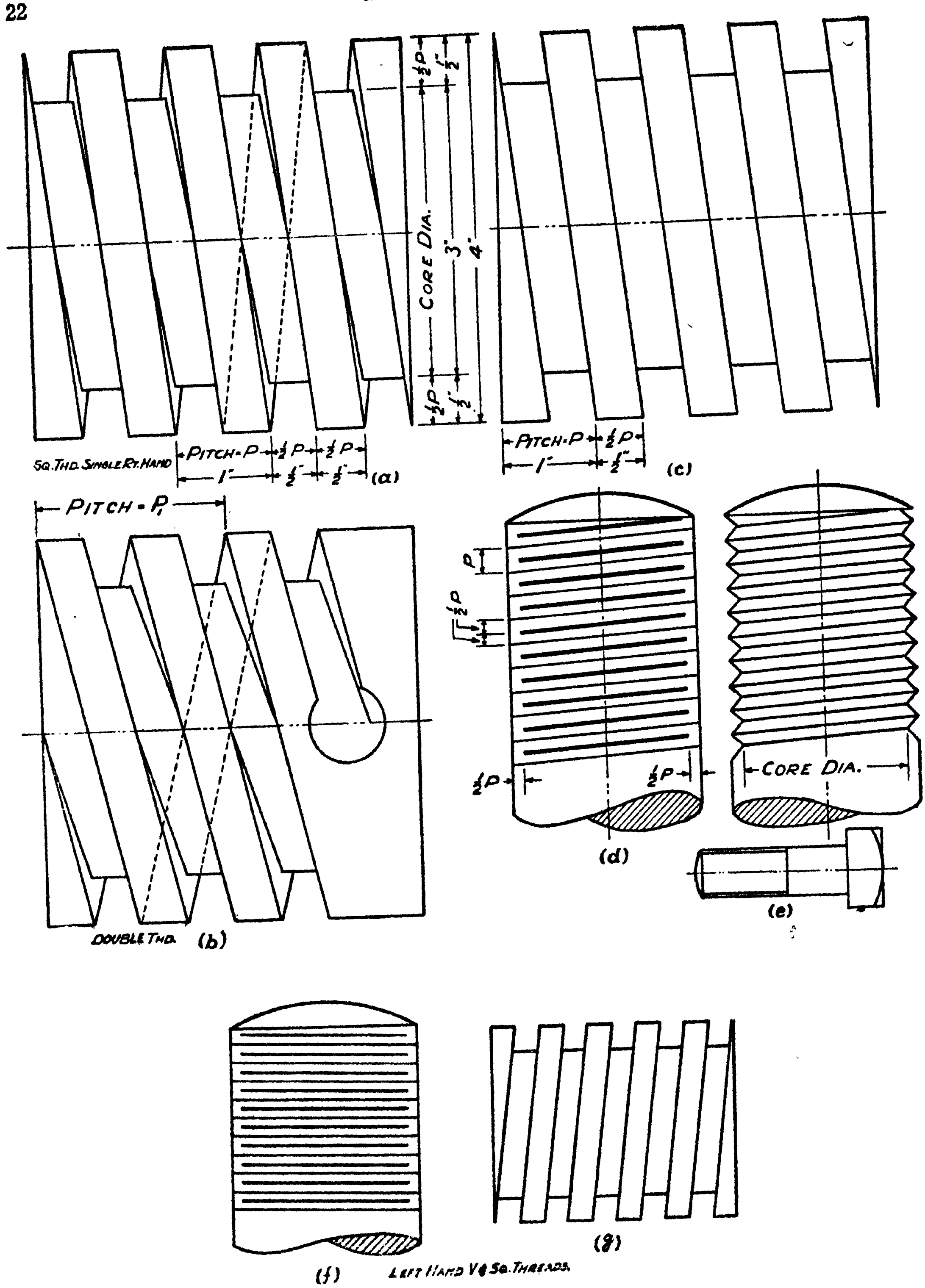


FIG. 24



½P
½"
CORE DIA.
3"
4"
½P
½"
SQ. THD. SINGLE RT. HAND
PITCH = P
½P
½P
1"
½"
½"
(a)
PITCH = P
½P
1"
½"
(c)
PITCH = P₁
DOUBLE THD.
(b)
P
½P
½P
½P
CORE DIA.
(d)
(e)
(f)
LEFT HAND V & SQ. THREADS.
(g)

FIG. 25

will be easier to draw alternate thick and thin lines, the latter to meet the extreme lines. Whitworth threads are standard and the idea can be conveyed better by a short note, instead of laboriously marking off the exact number of threads. The difficulty is more in the case of half threads and odd numbers of threads. The alternate thick and thin lines, with the whole diameter of screw and the number of threads per. inch (1 Dia., 8 T.P.I., Whit.) will convey a clearer idea, and the student should follow this system. This will really be a saving of time, which otherwise will be wasted in scaling the drawing to know the number of threads per inch, and so on. Threads are always shown right handed on screwed pieces. Where left hand threads are to be had, the conventional representation alone will not guide the workman. The fact has to be brought before him by a short note against the threaded piece, as for example, 1 Dia., 8 T.P.I., Whit. Left Hand.

Square Threads

In Fig. 25(*a*), (*b*), (*c*) and (*g*) square threads, single and double, are shown. The depth of thread in a square threaded screw is usually $\frac{1}{2}$ pitch for a single thread screw, and $\frac{1}{4}$ pitch for double threads and so on. In double threaded and multiple threaded screws, the pitch is usually denoted as the lead. Single and double threaded screws are also called single start and double start screws. Left hand V and square threads are represented in Fig. 25(*f*) and (*g*). In drawings, square and V threads must be represented always as shown in Fig. 25(*c*) and (*d*) except otherwise required. A threaded piece can be represented also as in Fig. 25(*e*).

Ex. 7. Draw to full size scale Whitworth V and square threads (conventionally) on a length of 3 inches with diameters of 1″, $1\frac{1}{2}$″, $1\frac{3}{4}$″ and 2″. Take the pitch for sq. thds. as $\frac{3}{16}$″, $\frac{1}{4}$″, $\frac{5}{16}$″ and $\frac{3}{8}$″ respectively.

Ex. 8. Two views of a coupler are given in Fig. 26. Draw to scale 9″ = foot the two given views. Dia. of screw = $1\frac{1}{2}$″.

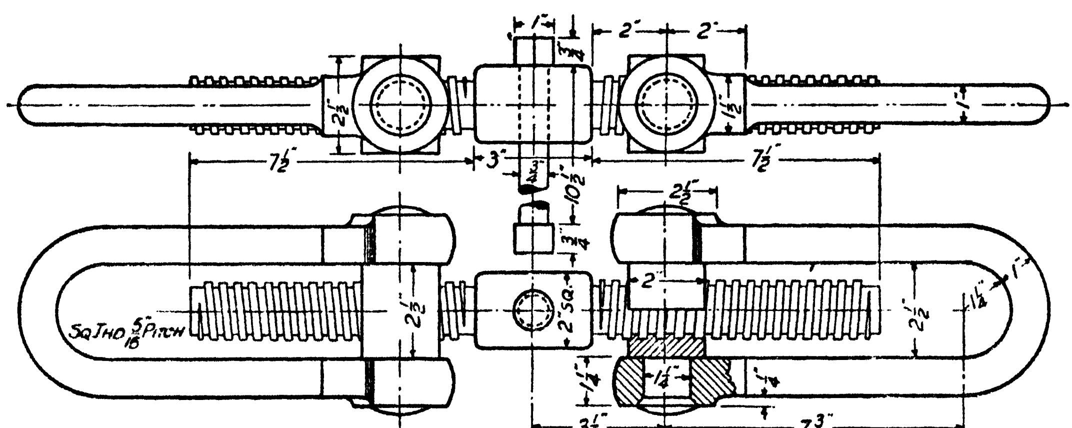


Fig. 26

KEYS, COTTERS AND PINS

They are used to fasten two parts. The parts can be separated when the key is withdrawn. Keys may be rectangular, square or round in section. Among the other types of keys, the woodruff key and the saddle key may be mentioned. Sunk keys are either rectangular or square in section and the metal in the parts to be fastened together is removed to enable the key to be inserted. The cut out portion is called the keyway. Keys may have a taper on one side. Sometimes it may have a double taper. Keys without a taper are called parallel keys or feathers.

Fig. 27 gives three types of keys and Table 2 at the end of the book gives the dimensions of the keys for various sizes of shaft. Fig. 27 (i) gives a sunk key. Fig. 27 (ii) shows a key on flat. Fig. 27 (iii) gives a saddle key. Where a particular size of key for a shaft is not available from the table the dimensions can be calculated as follows: Width of key $W = \frac{1}{4}D$, where D is the diameter of shaft in inches. Thickness of key $T = \frac{1}{6}$ D.

Taper

Taper of key (single taper) is 1 in 96 ($\frac{1}{8}$ inch per foot length), or 1 in 100.

The keyway in a shaft is cut parallel to the axis and the depth of cut is equal to half the thickness of key and is measured from the crown of the shaft. The method of obtaining a taper is explained on page 3, (Fig. 4).

Sunk keys are sometimes provided with a gib head, which helps the insertion or withdrawal of the keys.

Sunk keys are used where relative motion between two parts has to be prevented. Feathers or parallel keys can either secure a part firmly to a shaft or allow an axial sliding motion over the shaft, while the part rotates with the shaft.

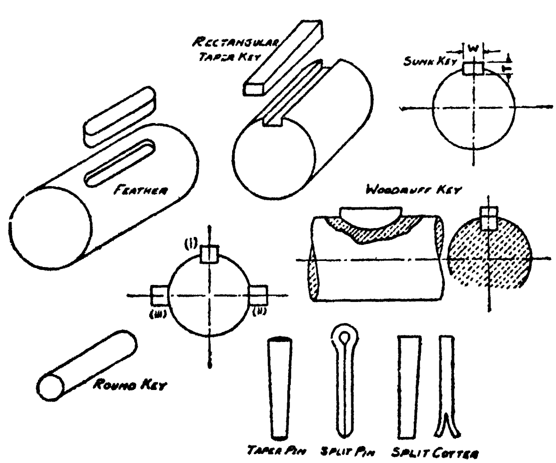


Fig. 27

Round keys or Pins, Taper Pins, Split Pins, and Cotters (Fig. 27)

They are used in one form or another to lock two parts temporarily. In joints where cotters are used, the joints can be separated or assembled easily. Cottered joints are used in places where the axial adjustment required is limited. The taper of the cotter (single) is usually 1 in 24. When the cotter is made with a double taper or when the taper is great, the cotter should be locked in position by set screws to prevent it from slackening back. Taper pins have a taper of 1 in 48, but they can be made to suit any taper.

NUTS

Nuts can be considered to be short regular prisms, square or hexagonal in section. The periphery or the edge along the corners at one end of a nut is cut off or chamfered at an angle of 30°. Generally one end of a nut only is chamfered, but in some cases, both ends. All nuts have a central hole which is threaded to take a screwed piece. The diameter of the threaded hole and the diameter of a screwed piece should be the same and the threads in the nut and on the screwed piece must also be of the same character. Fig. 28 shows three views of a hexagonal nut with the different dimensions

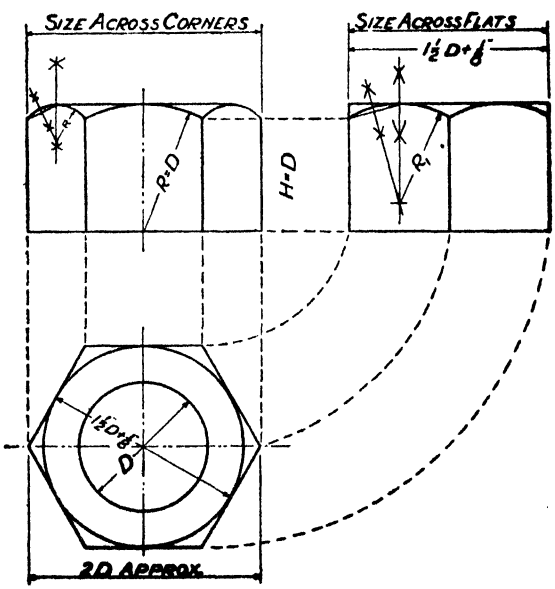


FIG. 28

based on the diameter of the central screwed hole. A nut may also be square. In a hexagonal nut, the sides of the hexagon are drawn tangential to a circle of diameter $1\frac{1}{2}D + \frac{1}{8}''$, where D is the diameter of the central hole in inches. This outside circle is drawn concentric with the inner one. In a square nut, while the proportions remain the same as for a hexagon nut, the square is described about the same circle whose diameter is $1\frac{1}{2}D + \frac{1}{8}''$. Although in Fig. 28 the three sided view of a nut is projected from the plan, it will be found easier to represent nuts on drawings, taking the size across corners to be approximately equal to 2D. Hexagon and square nuts are available ready made in standard sizes, which conform to standard dimensions. Therefore in a drawing a hexagonal nut across corners need not be accurate. The approximate width of 2D across corners is sufficiently accurate, when big machines or parts are drawn to scales less than full size. However, the size across flats of a nut has to be taken as $1\frac{1}{2}D + \frac{1}{8}''$. There is no approximation for the two sided view of a nut. So far as a drawing is concerned these proportions will hold but the standard dimensions of nuts for various sizes of bolts given in Table 1 have to be used where correct sizes are required. Nuts are usually made of mild steel or steel. When cast iron, brass, or gun-metal nuts are used the height or thickness of the nut, H while being equal to D, may be more than D, i.e. $1\frac{1}{2}D$ to 2D.

Ex. 9. Draw to full size scale three views of a hexagonal nut to the following values of D : 1", $1\frac{1}{2}''$, 2", $2\frac{5}{8}''$.

BOLTS AND NUTS

Bolts and nuts are used to bind together parts of machines. In Fig. 29 (i) (*a*) three views of a hexagonal headed bolt and nut are given. Bolts have four distinct parts :

(i) The head (which may be sq., hex., T, or round).

(ii) The shank or body (which is circular).

(iii) The neck (the portion of the body just below the head, which may be sq. or round).

(iv) The threaded part to take a nut. (The nut may be sq. or hexagonal.)

In Fig. 29 (i) (*a*) the bolt has a hexagon head, hexagon nut and round neck. Fig. 29 (i) (*b*) gives a bolt having a square head, round neck and square nut. The proportions of the parts are based on the diameter D of the bolt. The length of a bolt L is always measured from the bottom of the head upto the end of the threaded portion, excluding the curvature at the end. The thickness of the head of a bolt in some cases is made equal to D instead of $\frac{3}{4}$D. Fig. 29 (ii) (*a*) gives a bolt with a hex. head, sq. neck and hex. nut, and in Fig. 29 (ii) (*b*) the bolt has a T head, sq. neck and hex. nut. The proportions of the parts are again given in terms of the diameter of the bolt. The size of the T is equal to $1\frac{1}{2}D + \frac{1}{8}''$. The length L of a bolt, while being a minimum of $1\frac{1}{2}$D can be made to any desired length. The threads are always Whitworth Standard V threads, except where otherwise stated. Where the proportions given do not suit, the bolts could be designed to suit the purpose. Bolts and nuts are made of wrought iron, mild steel, steel, brass, or other alloy metals according to requirements. Again there are bright bolts and nuts, black bolts and special bolts. Bright bolts and nuts are machined bolts, made to size. Black bolts are rough bolts and they are made from rolled bars of metal. Being rough the parts will not be exact to dimensions, like bright bolts, and therefore they are used for rough work only. Special bolts are made to suit specific purposes and are machined and made to size.

Ex. 10. Draw to full size scale the following bolts to the given dimensions :

Three views of each bolt are to be drawn.

(i) Hex. head, round neck, hex. nut. Bolt dia. $= 1''$

(ii) Sq. head, round neck, hex. nut. Bolt dia. $= 1\frac{1}{4}''$

(iii) Hex. head, sq. neck, hex. nut. Bolt dia. $= 1\frac{3}{8}''$

(iv) T head, sq. neck, hex. nut. Bolt dia. $= 1\frac{1}{2}''$

(v) Sq. head, round neck, hex. nut. Bolt dia. $= 1\frac{5}{8}''$

Make neat drawings and dimension each drawing completely.

Take the length of the bolt to be 6″ for the first three and 8″ for the rest.

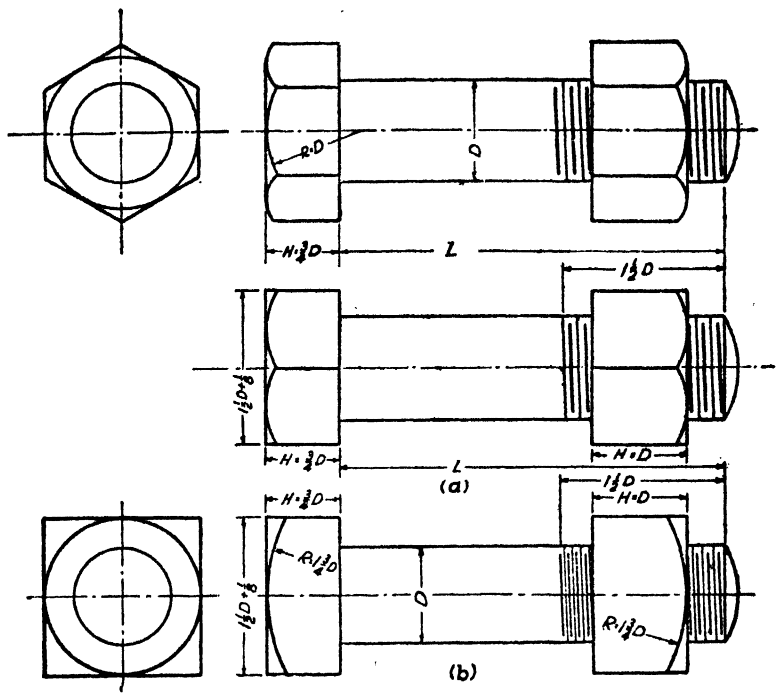


FIG. 29 (i)

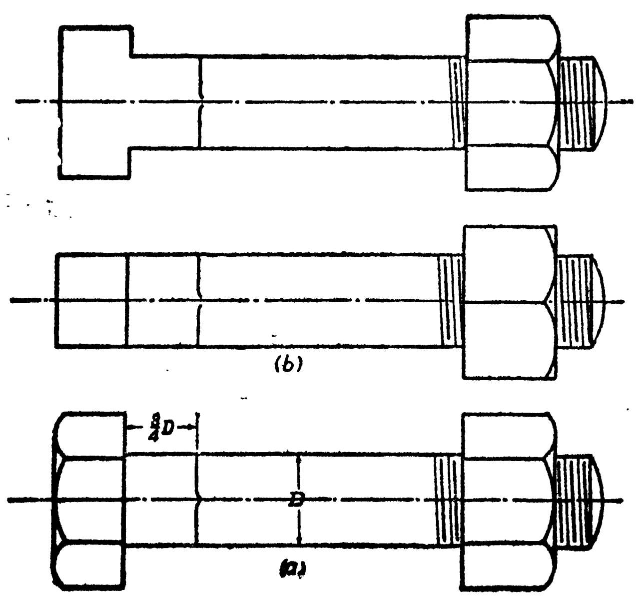


FIG. 29 (ii)

LOCK NUTS AND LOCKING ARRANGEMENTS

In the parts of machines where nuts tend to slacken or get loose, locking arrangements are provided to prevent nuts from slackening back. Some common arrangements are shown in Fig. 30 where the proportions are based on the diameter D of the bolt or stud. Fig. 30 (*a*) gives a lock nut or jamb nut. Although theoretically the smaller nut has to be inserted first and drawn against the other one (when the nuts will be locked in position) it is reasonable practically to have the bigger nut put on first and the smaller one over it as shown. An alternative method is to have two nuts

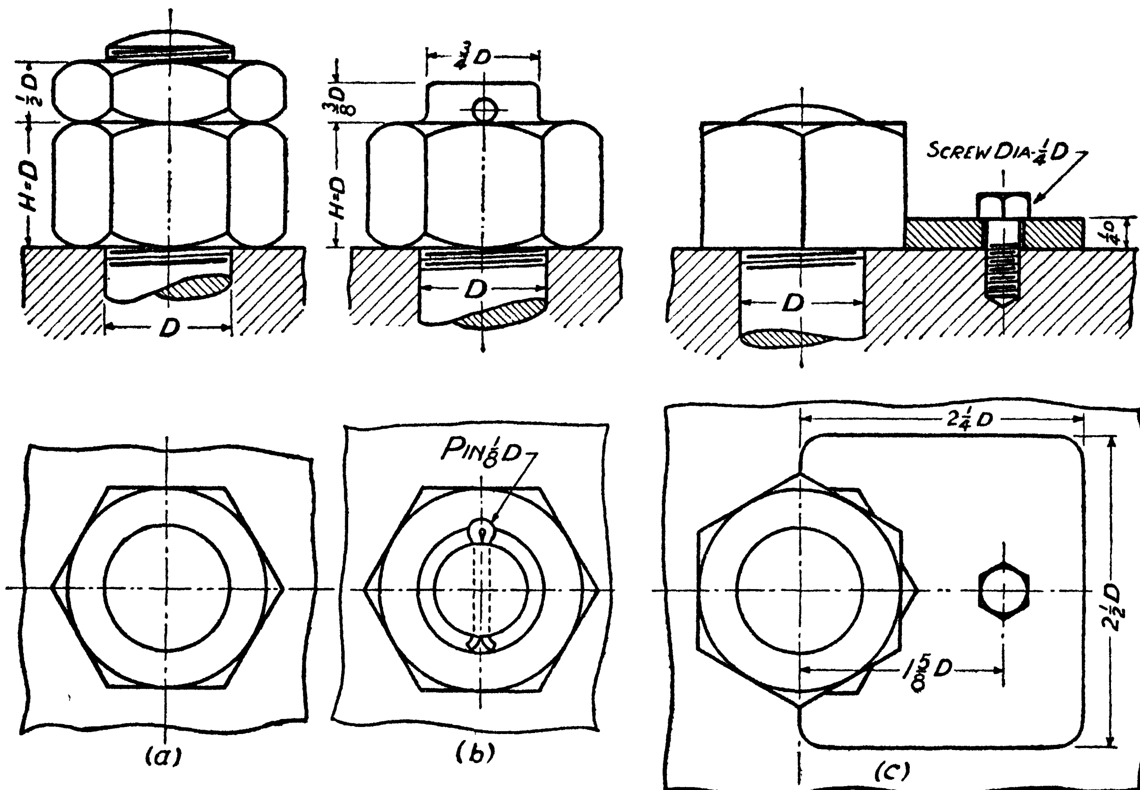


FIG. 30

each equal to $\frac{3}{4}$D instead of a full nut and half nut. In Fig. 30 (*b*) a single nut is locked in position by the split pin. Sometimes split cotters or taper pins are used. The bolt or stud projecting beyond the nut is turned down a little below the diameter at the bottom of the threads. If this is not done the threads in this part might get injured when the pin is inserted or withdrawn, and it may be difficult to take out the nut. Fig. 30 (*c*) shows a nut locked in position by a locking plate. The locking plate is held in position by a small set screw. The serrations in the locking plate suit the contour of the nut and are cut suitably to engage the nut when it is turned through 30°.

Washers

Washers are metal pieces used along with bolts or studs and nuts. The nuts rest on washers when it is necessary to prevent scoring of parts by nuts, or when the force has to be distributed over a larger area. There are bright washers, black washers, spring washers or lock washers. Black washers are stamped out of sheet metal and are intended for rough work. Bright washers are finished washers which are used for special work. Spring washers are made in various types to suit particular purposes. They prevent nuts from working loose. Plate washers on drawings may be shown to the following proportions. Dia. of Washer $= 2\frac{1}{4}$D. Thickness of Washer $= \frac{1}{8}$D where D = Dia. of bolt.

SET SCREWS OR CAP SCREWS OR TAP BOLTS

Among the screwed fastenings, set screws are used where bolts are useless. Some of the more common set screws are given in Figs. 31(*a*) to (*d*). The proportions are given in terms of the diameter.

Where the head of a set screw is not a hexagon or square, a saw cut on the heads of the screws facilitates the insertion of a screwdriver, and by turning the screwdriver, the screws can be inserted or taken out from machines or their parts. The length of a set screw, though given as $1\frac{1}{2}$D, can vary according to the demand. It should be noted that the threads cannot be put on the shank of a set screw right up to the head. At least a length of $\frac{1}{8}$ inch from the bottom of the head will be clear of threads.

Ex. 11. Draw all the screws to full size scale, using the following values for D = 1″, $1\frac{1}{4}$″.

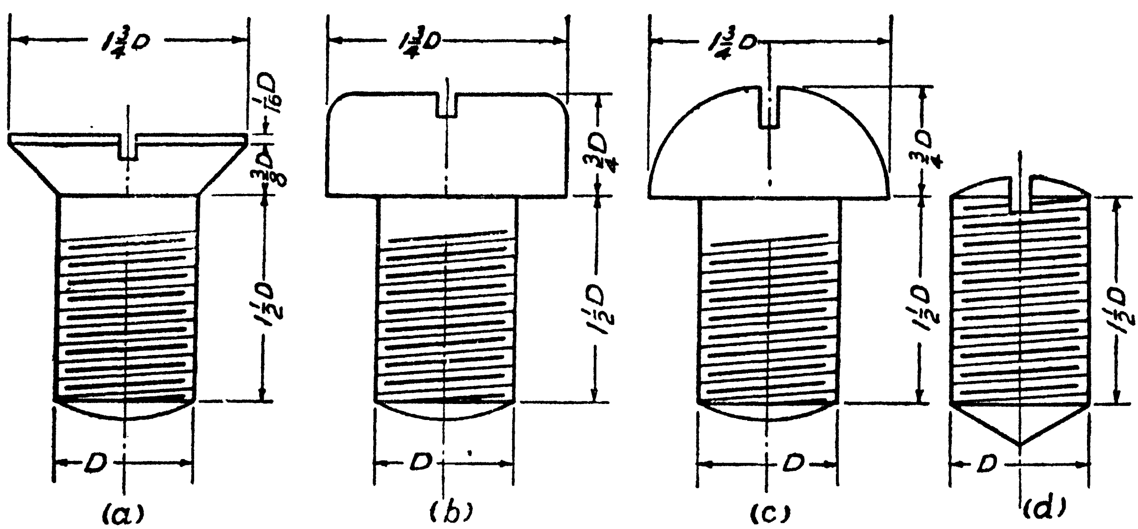
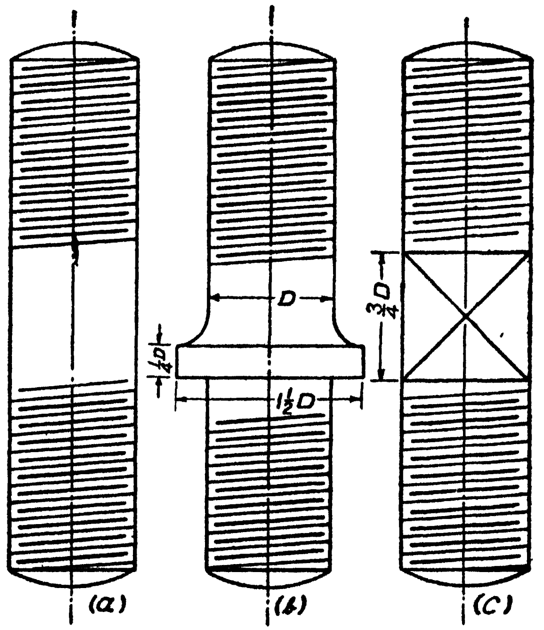


FIG. 31

Where bolts or set screws cannot be employed, studs are used to fasten parts of a machine. Studs are straight cylindrical pieces, having threads at both ends. An ordinary stud is cylindrical, having threads on either end. A collared stud, in addition to threads at both ends, has a collar somewhere on the body. A stud may also have a square neck. The three common types of studs are shown in Figs. 32 (*a*), (*b*) and (*c*). One end of a stud is screwed down in a tapped hole and the part or parts, inserted over the stud and a nut (sometimes two) put on the other threaded end. Fig. 33 (*d*) gives a stud in a tapped hole.

Ex. 12. Draw the three studs given in Fig. 32 to full size scale for diameters $\frac{3}{4}''$, and 1″ and 4″ and 5″ long.



PLAIN STUD COLLARED STUD SQ. NECKED STUD

FIG. 32

DRILLED HOLES AND TAPPED HOLES

In order to fit set screws or studs in parts of a machine, the holes which take them in have to be threaded. Where bolts are used, the holes are clear, through which they can be inserted and a nut draws the parts together when it is tightened up over the threaded portion. The holes for studs and set screws are to be made in two stages. The step by step operation in getting a threaded hole consists in making a hole first. In order to put a hole in any material, a drill is used. Fig. 33 (*a*) shows the end of a twist drill, which is ground to include an angle of 118° at the end. Although the end includes an angle of 118° it is convenient to show on a drawing the end of a drilled hole to include an angle of 120°. The diameter of the hole, that is, tapping hole, depends upon the diameter of the stud or set screw, and is reckoned on the diameter at the bottom of the threads. The depth of a drilled hole is also related to the diameter of a stud or screw. The diameter of the drilled hole D_1 is taken to be 0.84D where D is the diameter of the stud or set screw. Standard diameter of tapping holes are given in Table 1 for Whit. threads. The depth of the hole is 1¾D. In special cases the depth of a drilled hole is more or less than 1¾D. Fig. 33 (*b*) gives a drilled hole. The next step consists in threading the hole to a required depth. The threads are cut either by a hand tap or by a tapping machine. The taps are made according to the diameters of the studs or screws, and therefore a one inch tap will make 8 T.P.I. Whit. to take a one inch dia. stud or screw. The depth of the tapped portion must not be less than 1⅝D, except in special cases. Fig. 33 (*c*) gives a tapped hole in section. Note that a section through a tapped hole exposes the threads, and a right hand thread will appear left handed in the section of a tapped hole, and vice versa. The stud or screw is screwed down into a tapped hole and the length to which it should go in must be 1½D, except in special cases, when it can be less or more. Fig. 33 (*d*) shows a stud in a tapped hole.

Ex. 13. Draw a section of a drilled hole, a tapped hole, and a stud in proper position in a tapped hole having diameters of studs = ¾″ and 1″.

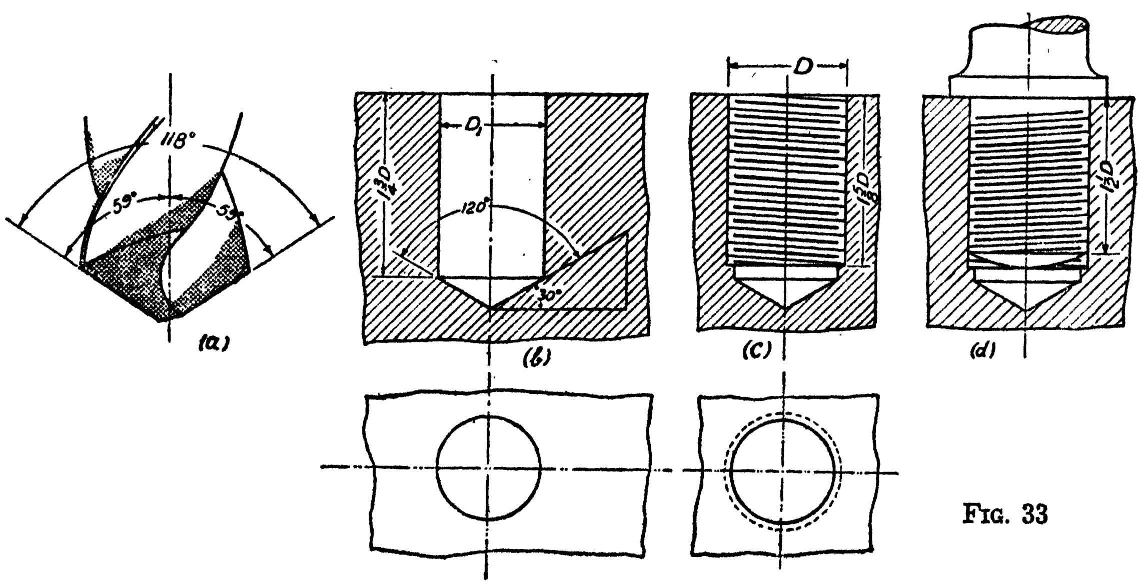


Fig. 33

SECTION IV

Spark Plug

In Fig. 34 the front elevation and sectional end view of a spark plug are given, with all the dimensions to the nearest 64th of an inch.

Ex. 14. Draw to scale double full size the following views of the spark plug. (Fig. 34)

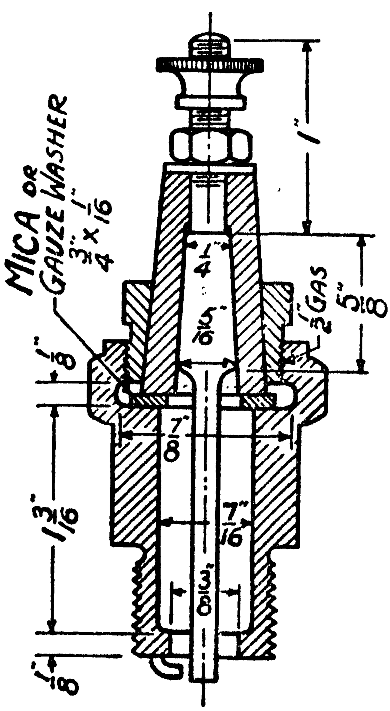
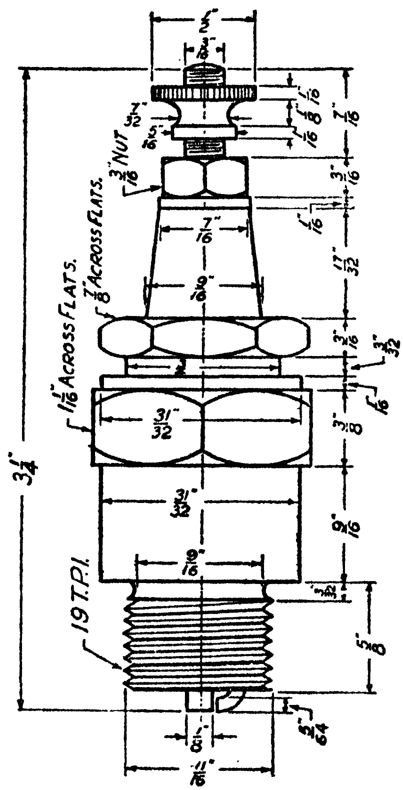


FIG. 34



(i) Front elevation, complete section.
(ii) End elevation instead of the section.
(iii) Plan.

Cranks and Crank Shafts

In engines the reciprocating motion of pistons is transformed into circular motion by a crank. The connecting rod transmits the force on the piston to the crank, which moves in the path of a circle. The crank pin is secured to crank arms. The out of balance weight of the arms and pin is counterpoised by balance weights, which are secured in some cases by bolts or studs. Generally the crank arm and pin are balanced by extending the arms to the other side of the crank pin. Crank shafts of engines have to be well balanced to ensure smooth running.

Ex. 15. In Fig. 35 an end elevation and a sectional front elevation of an over-hung crank are given. The crank pin is bolted to the crank arm and the crank shaft is keyed to the crank.

Draw to scale $4\frac{1}{2}'' =$ foot:
(i) Front elevation.
(ii) Sectional end elevation on AB.
(iii) Half plan and half sectional plan on MN.

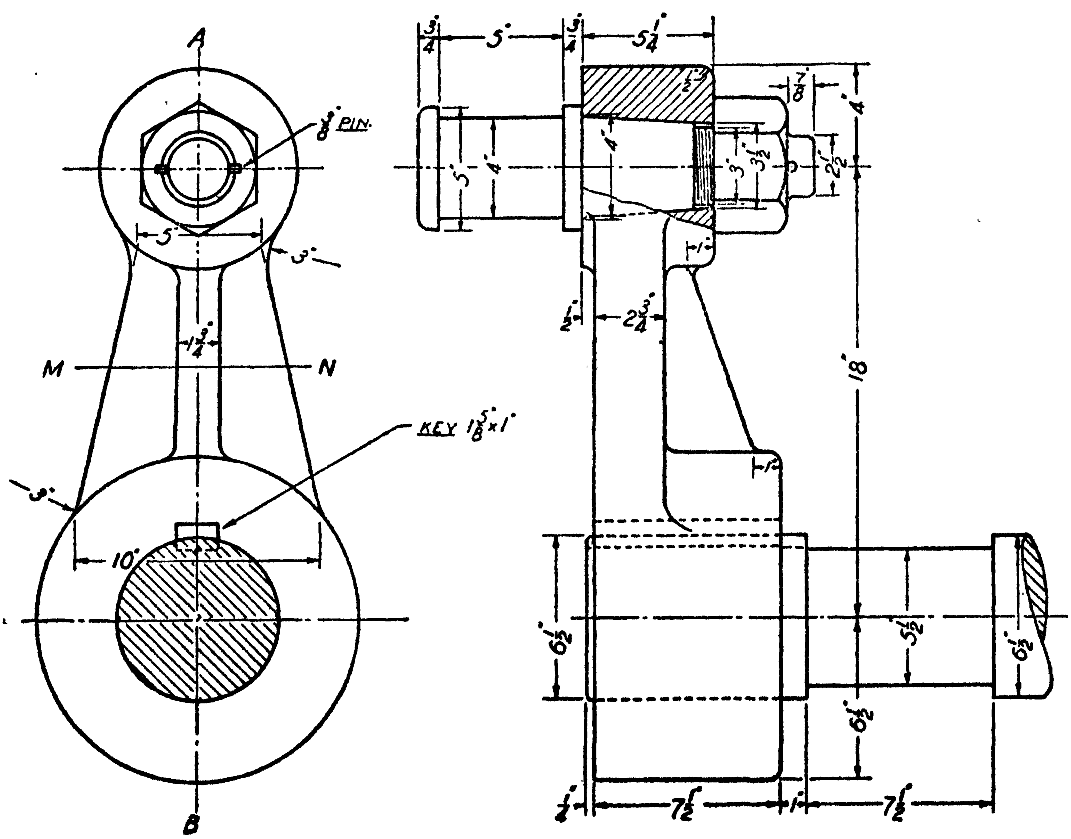


FIG. 35

BEARINGS

Bearings are supports for shafts. There are :

(1) Journal Bearings.

(2) Footstep or Pivot Bearings.

(3) Thrust Bearings.

Journal Bearings

In bearings of this type the shaft is supported horizontally. Figs. 36 and 36 (*a*) show a simple bush bearing. The brass bush effectively reduces the friction be-

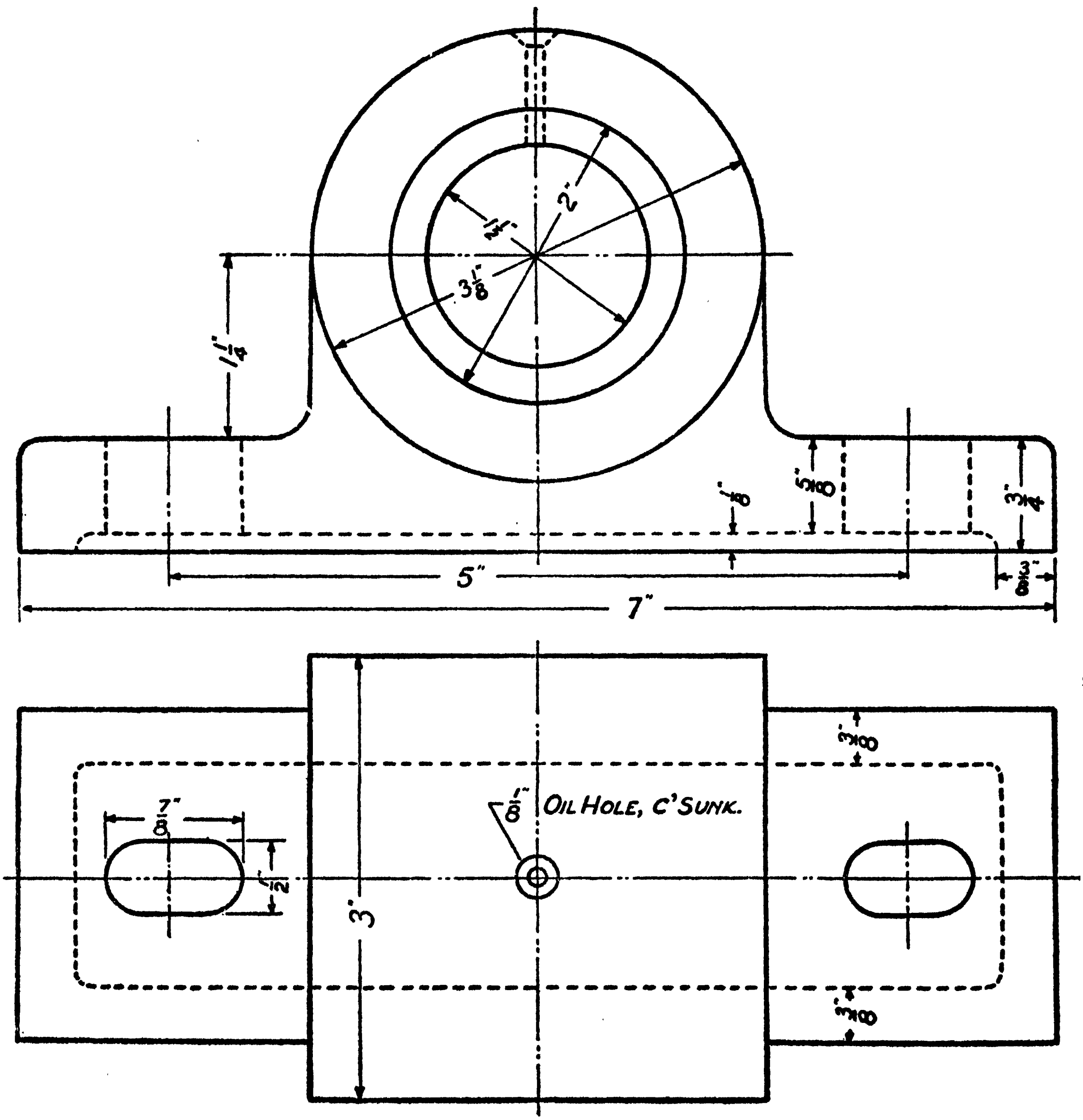


FIG. 36

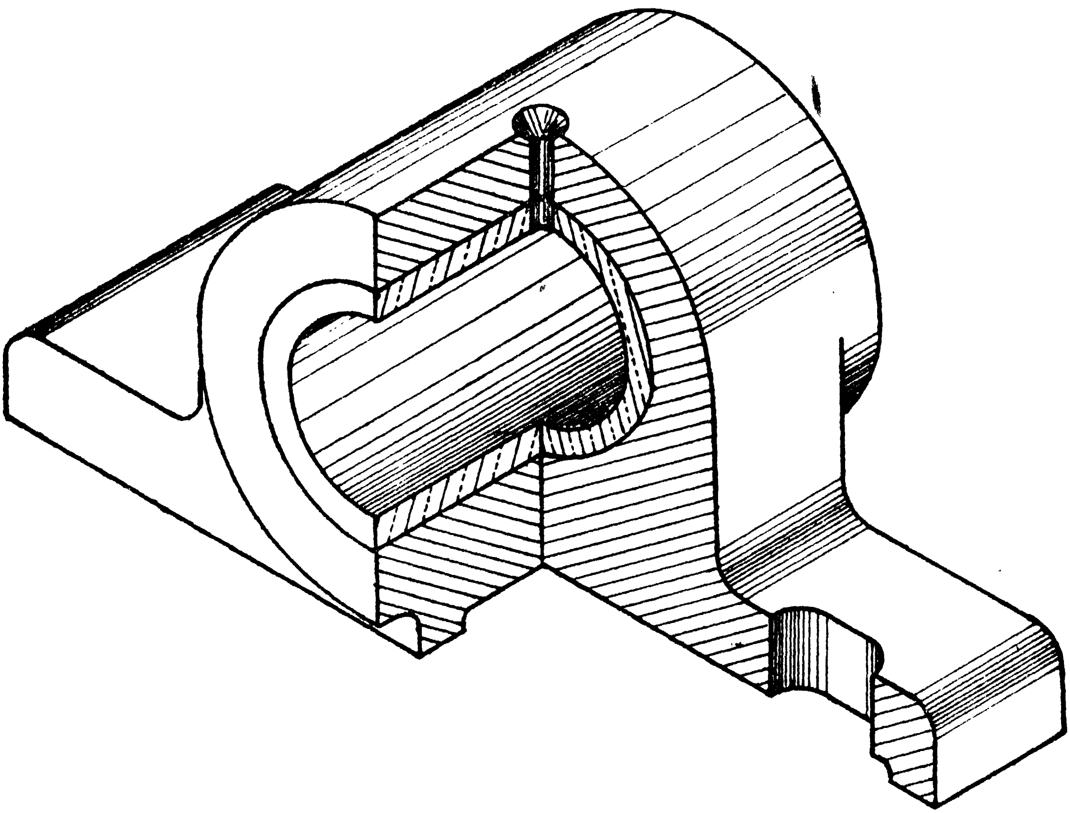


Fig. 36 (*a*)

tween the shaft and bearing. Bushes are also made of gun metal, bronze or other antifriction alloy metals. Bushes are driven tight in the castings to prevent them from rotating with the shafts.

Ex. 16. Draw to full size scale:

(i) Front elevation, right half in section.

(ii) End elevation, right half in section.

(iii) The given plan.

(Width of base 2¼".)

Footstep or Pivot Bearings

In a footstep bearing the shaft is pivoted or supported vertically. The end of the shaft usually rests on a steel disc.

Ex. 17. Fig. 37 gives two views of a footstep bearing.

Draw to full size scale:

(i) A front elevation instead of the section.

(ii) End elevation, right half in section.

(iii) Half plan, and half sectional plan on XX.

Sole Plate for Footstep Bearing

The footstep bearing given in Fig. 37 can be supported on a sole plate given in Fig. 38.

Ex. 18. Draw to scale, full size:

(i) Front elevation, complete section.

(ii) End elevation, right half in section.

(iii) Plan.

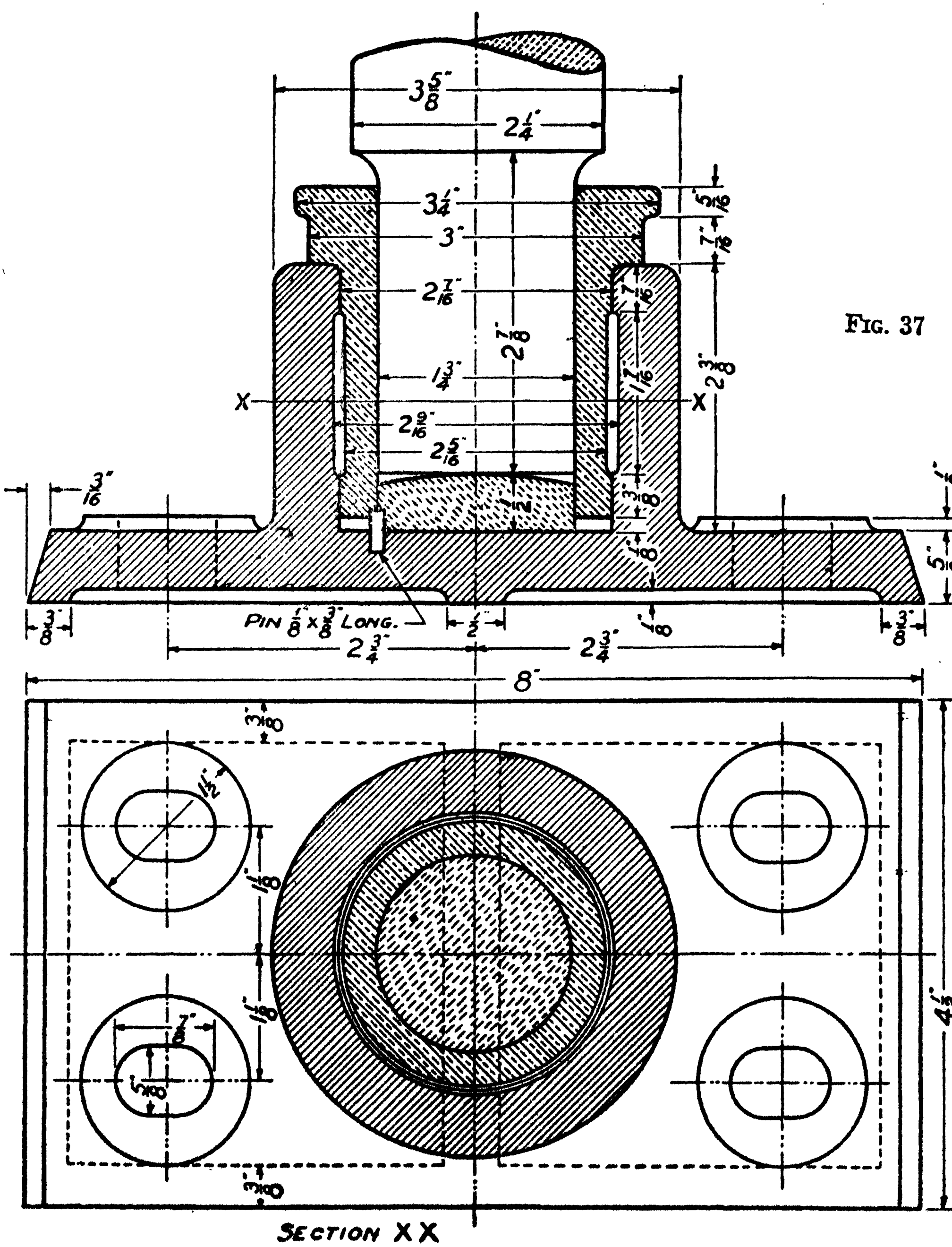


FIG. 37

Ex. 19. Draw to a scale of 9″ = foot the sole plate (Fig. 38) and footstep bearing (Fig. 37) together and use four ½″ square head bolts with hexagonal nuts and washers to hold down the bearing on the sole plate.

(i) Front elevation, right half in section.

(ii) End elevation.

(iii) Plan.

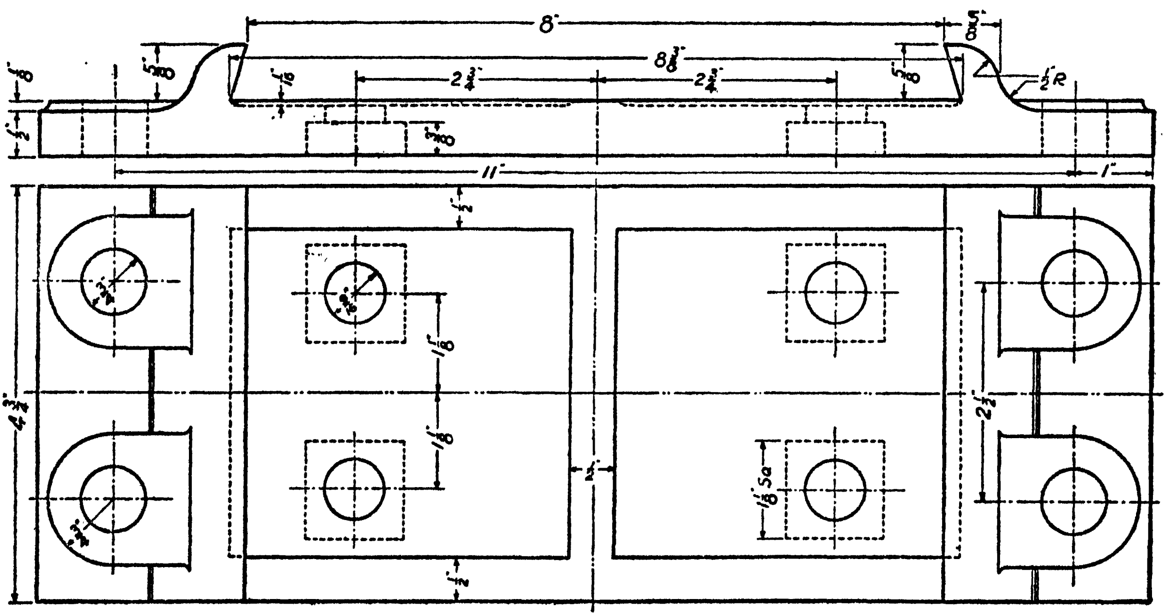


FIG. 38

Ex. 20. A half sectional front elevation, a half plan and a half end view of a Plummer Block are given in Fig. 39. Draw to full size scale :

(i) Front elevation instead of the section.

(ii) End elevation, half section.

(iii) Plan half with cap and upper half brass removed.

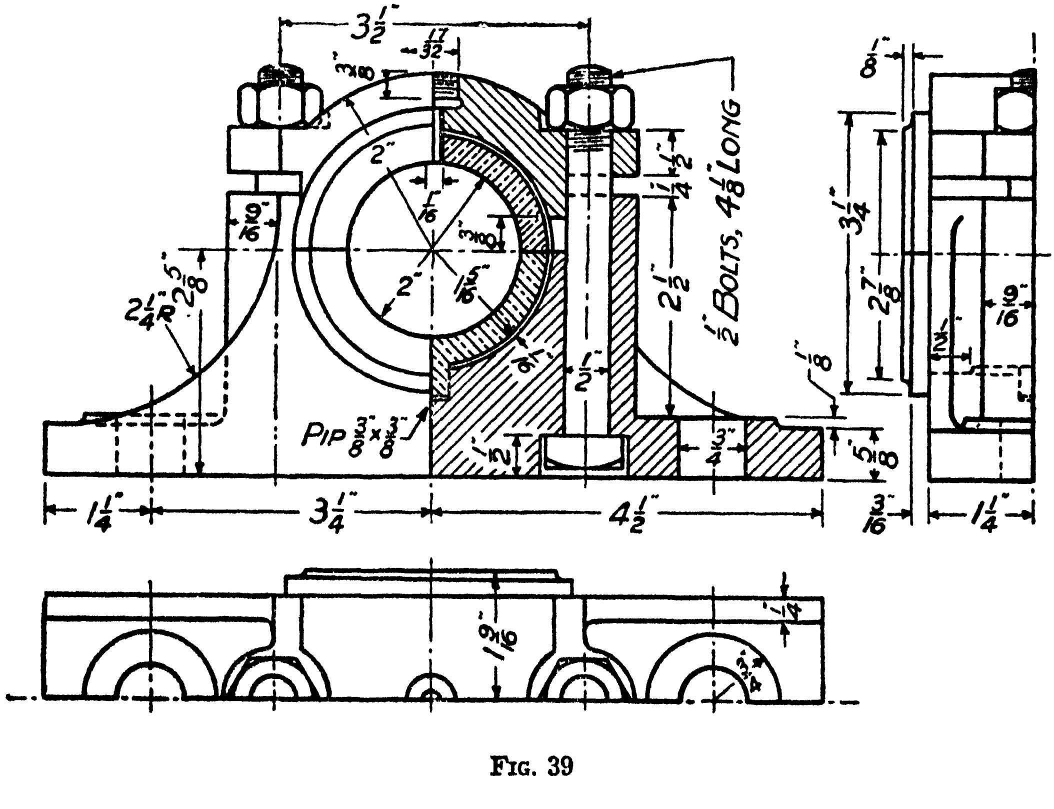


FIG. 39

Pedestals or Plummer Blocks

In bushed bearings the single brass bush cannot be easily removed or replaced when wear occurs. Bushed bearings, therefore, have given way to plummer blocks, where the brasses are made in two halves. One half rests in a casting and the other half is placed above the former. A cap or cover is placed above the upper half-brass and is bolted hard. The brasses have flanges on either side, preventing them from axial movement. Brasses can be given good alignment by providing a lug or a pin, or by making their sections hexagonal or octagonal or square.

Ex. 21. Two views of a plummer block are given in Fig. 40. Draw to full size scale:

(i) Front elevation, left half in section.
(ii) End elevation, right half in section.
(iii) Half plan, and half with cap and upper half of brass removed.

Ex. 22. Make a half size scale drawing, showing all the parts separately. At least two views of each part should be drawn. Dimension the details and on the same paper produce a general arrangement drawing without consulting the book.

Lubrication of Bearings

It is important that bearings should be properly lubricated with some good quality lubricant, to reduce friction. Otherwise the heat generated by friction will damage the bearing brasses and the shaft. There are a good many ways of lubricating parts. Some of the common methods are—

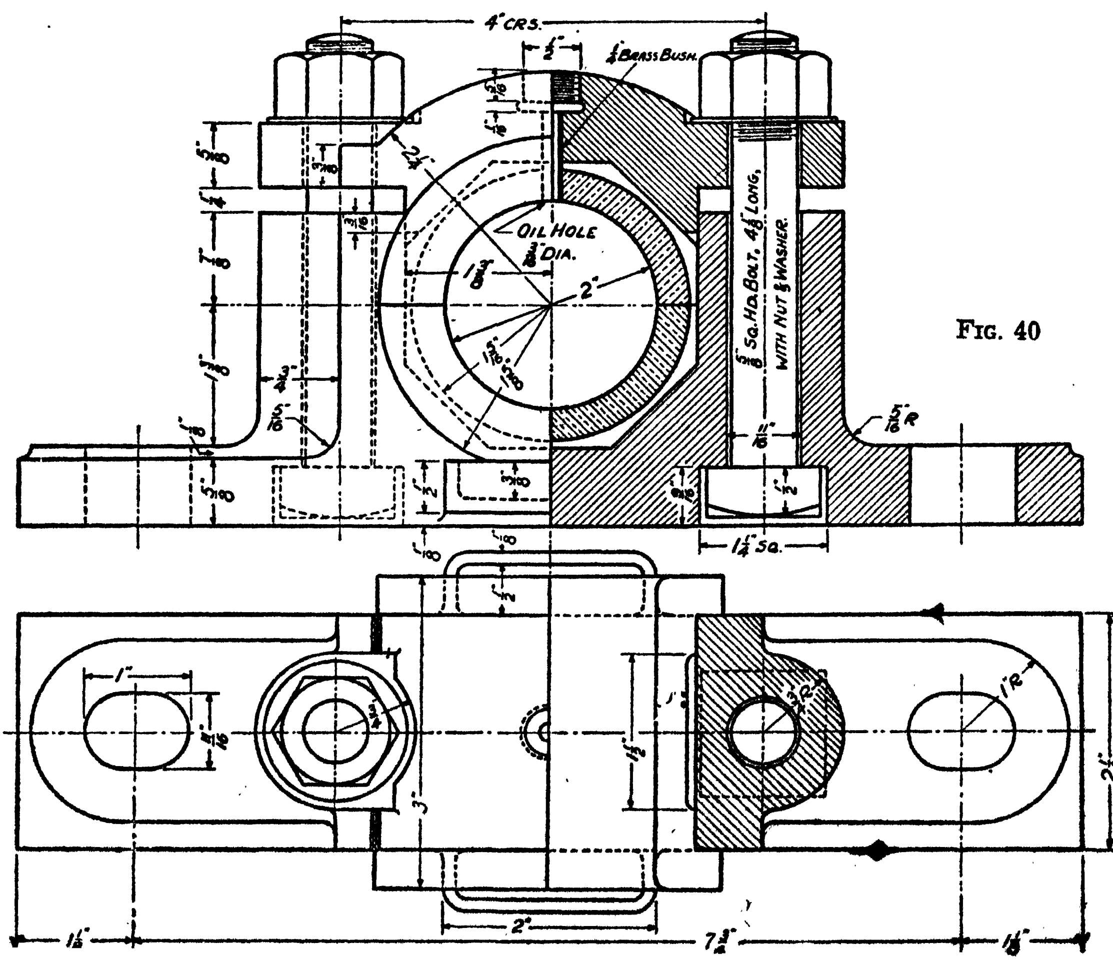


FIG. 40

(1) Ring oiling, as in generator bearings.

(2) Wick lubrication, where a constant supply of lubricant is required in small quantity.

(3) Grease lubrication, where ordinary lubricant is useless or will not suit, as in gears.

(4) Sight-feed lubrication, where a predetermined quantity of oil can be supplied.

(5) Forced lubrication, as in the valve chest of steam engines, etc., where the lubricant has to be supplied under pressure.

Wall Bracket

A cast iron wall bracket suitable for carrying a plummer block is given in Fig. 41.

Ex. 23. Draw to scale 3″ = foot:

(i) Front elevation.
(ii) End elevation.
(iii) Plan.

Ex. 24. A cast iron stool for a bearing is shown in two views in Fig. 42. Draw to full size scale:

(i) The given front elevation.
(ii) Sectional end elevation on AB.
(iii) Plan.

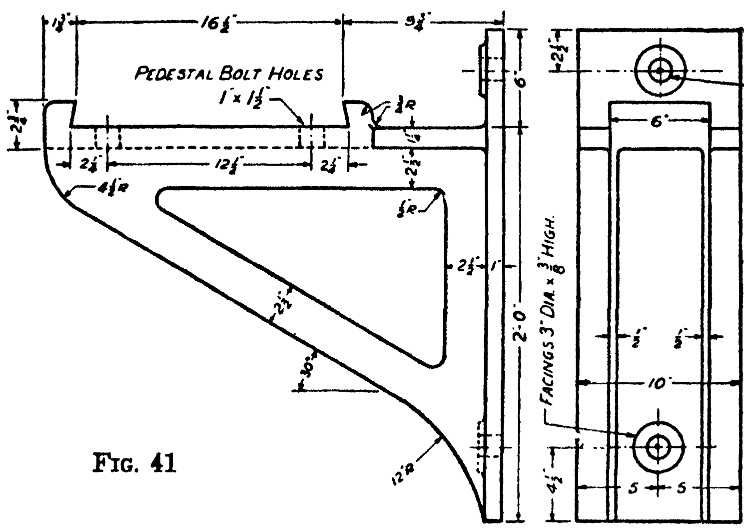


Fig. 41

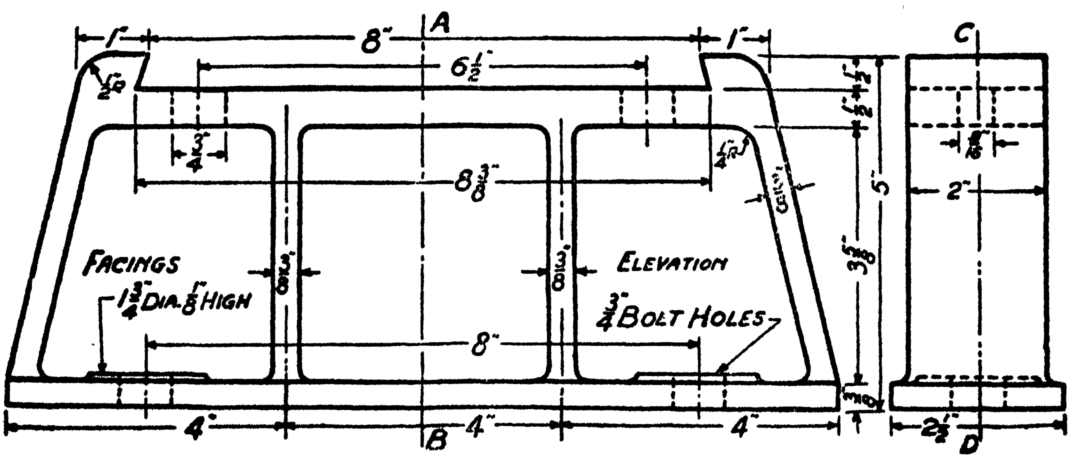


Fig. 42

Sling Hanger

A front elevation, half sectional plan and half end view are given in Fig. 43.

Ex. 25. Draw to half size scale:

(i) The given front elevation.
(ii) End elevation.
(iii) Half plan and half sectional plan on XX.

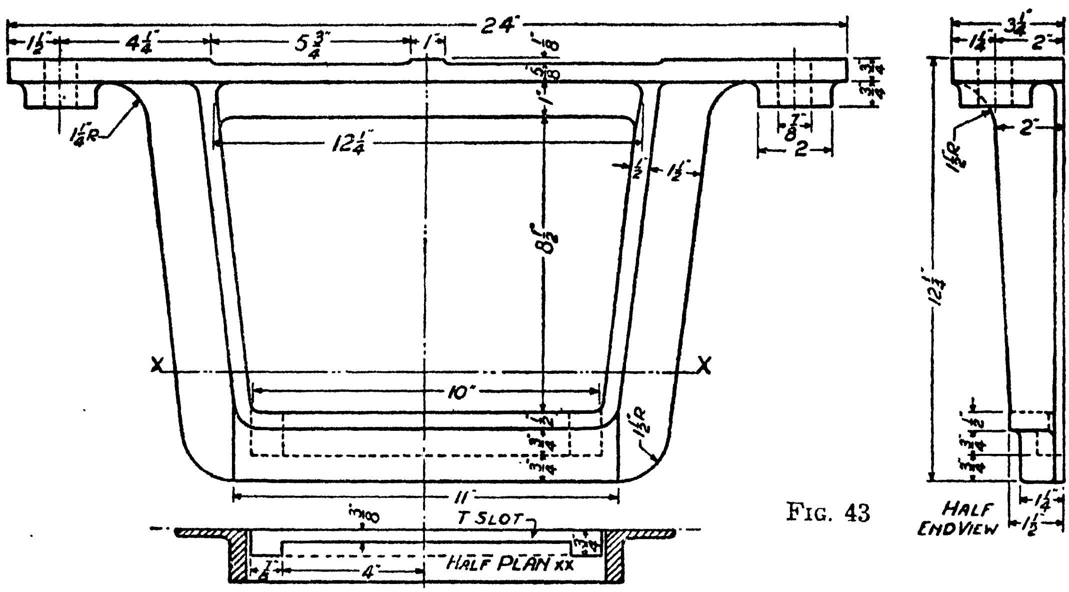


FIG. 43

(The bearing shown in Fig. 39 could be drawn in position along with this bracket, as an additional exercise.)

Wall Bracket for End Shaft Bearing

Ex. 26. Draw to half size scale the given views and add a plan of the bracket given in Fig. 44.

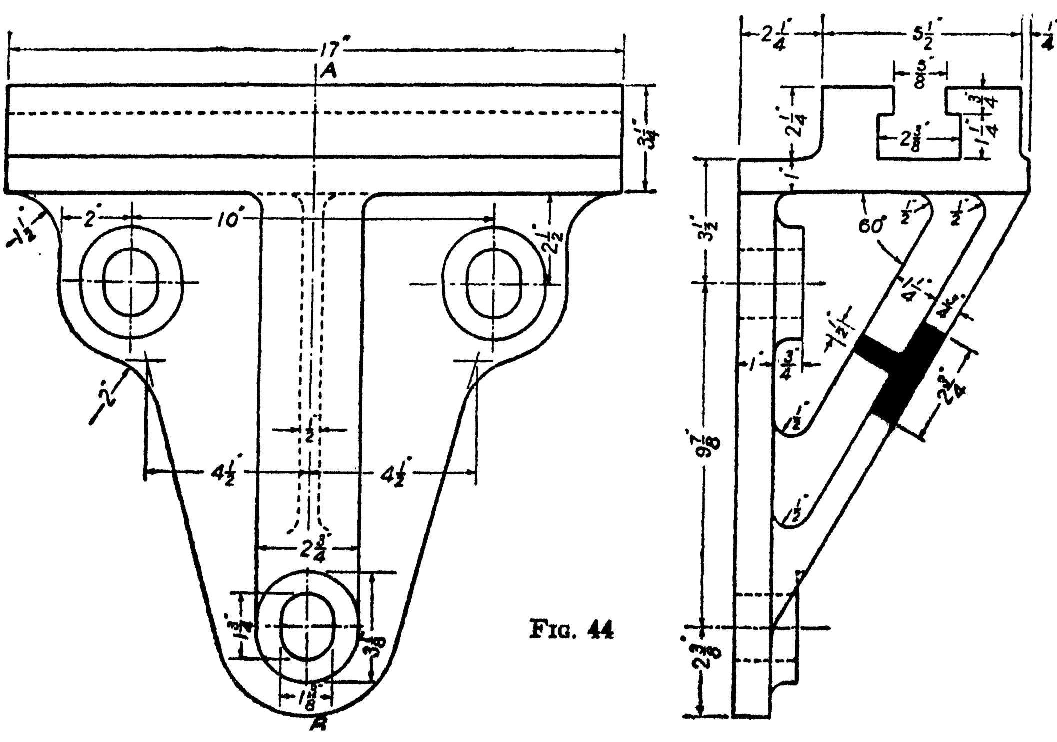


FIG. 44

Wall Bracket

Ex. 27 (Fig. 45). Two views of a wall bracket are shown. Draw to scale $4\frac{1}{2}''$ = foot, the following views:

(i) The given front elevation.
(ii) The end view.
(iii) Plan.

(Length of bearing surface 15")

(The bearing shown in Fig. 40 could be drawn in position over the brackets in Fig. 44 or Fig. 45 as additional exercises.)

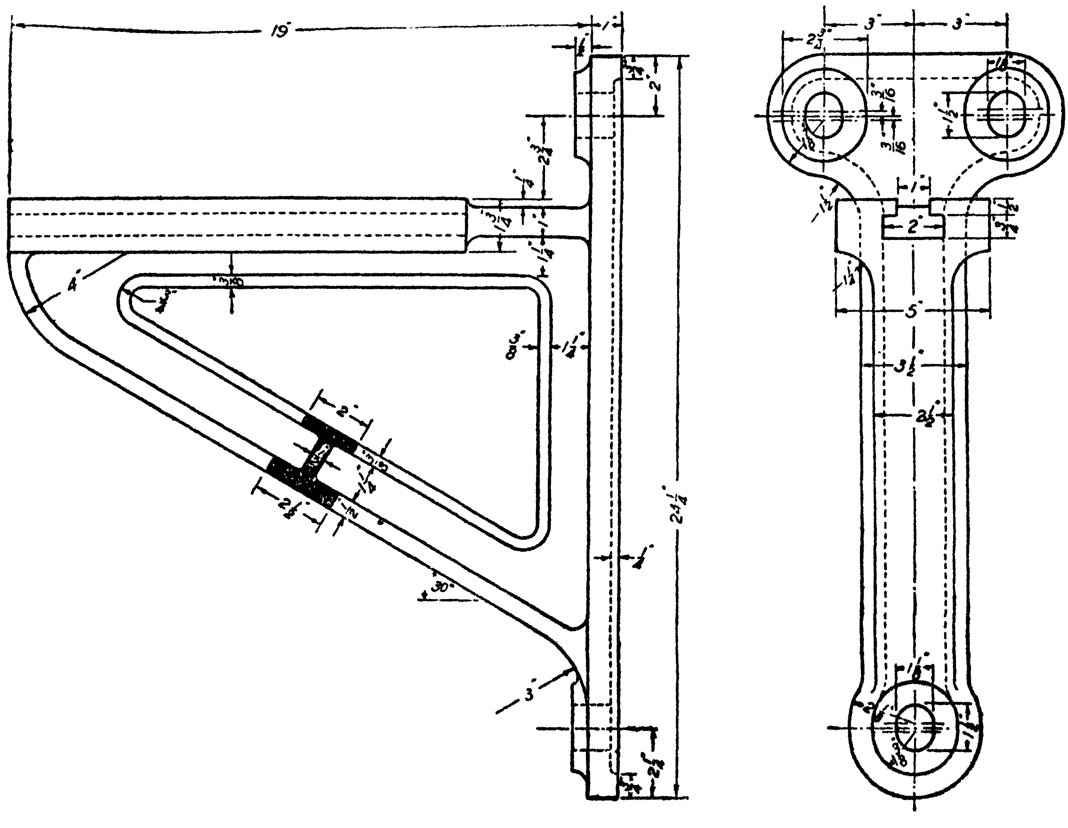


FIG. 45

Combined Wall Bracket and Bearing

Ex. 28 (Fig. 46). Draw to scale 6″ = foot :

(i) Front elevation.

(ii) End elevation, looking from right.

(iii) Plan, right half of bearing in section.

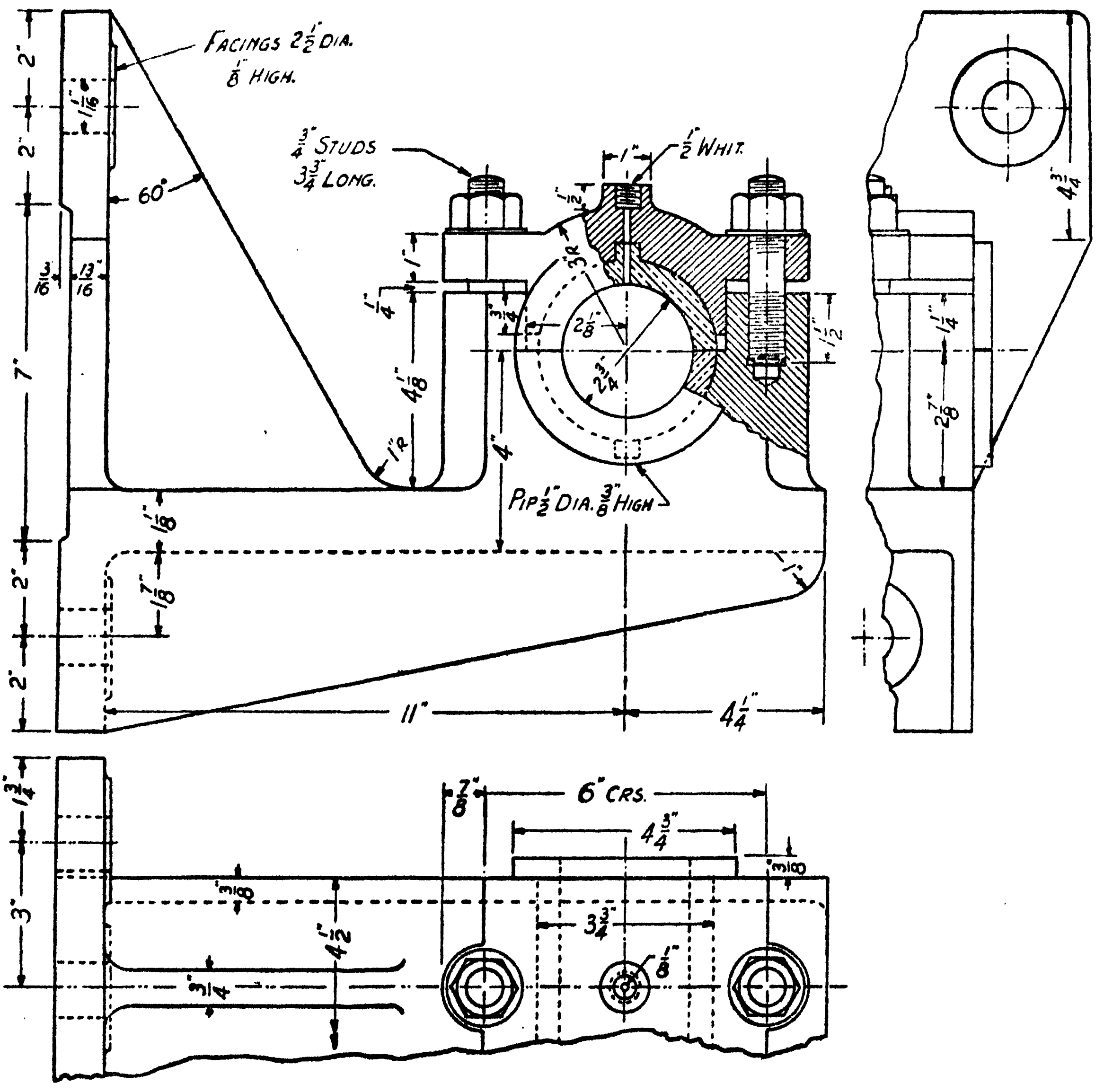


FIG. 46

J Hanger Bearing

Two different types of J hangers are given in Fig. 47 and in Fig. 48.

Ex. 29. Draw to scale 9″ = foot (Fig. 47) :

(i) A complete front elevation instead of the section.

(ii) End elevation section on AB in the direction of arrow.

(iii) Sectional plan on CD.

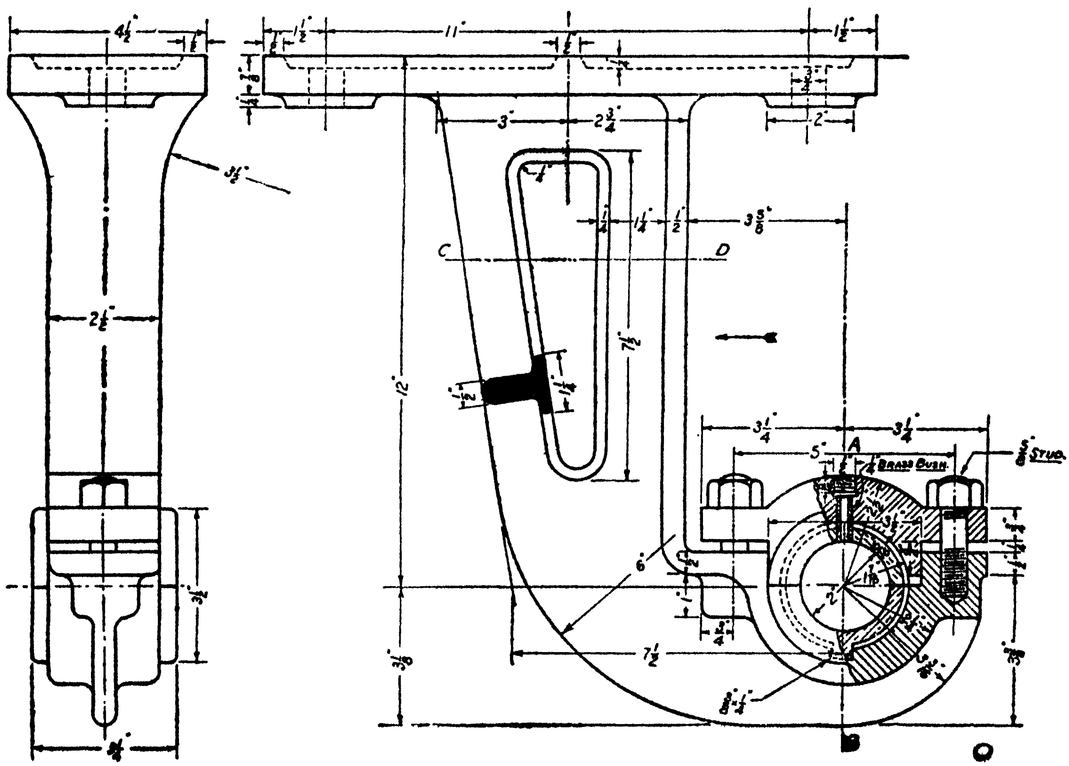


FIG. 47

Ex. 30 (Fig. 48). Draw to scale 9″ = foot:

(i) A complete elevation instead of the section.

(ii) End elevation, section along CD.

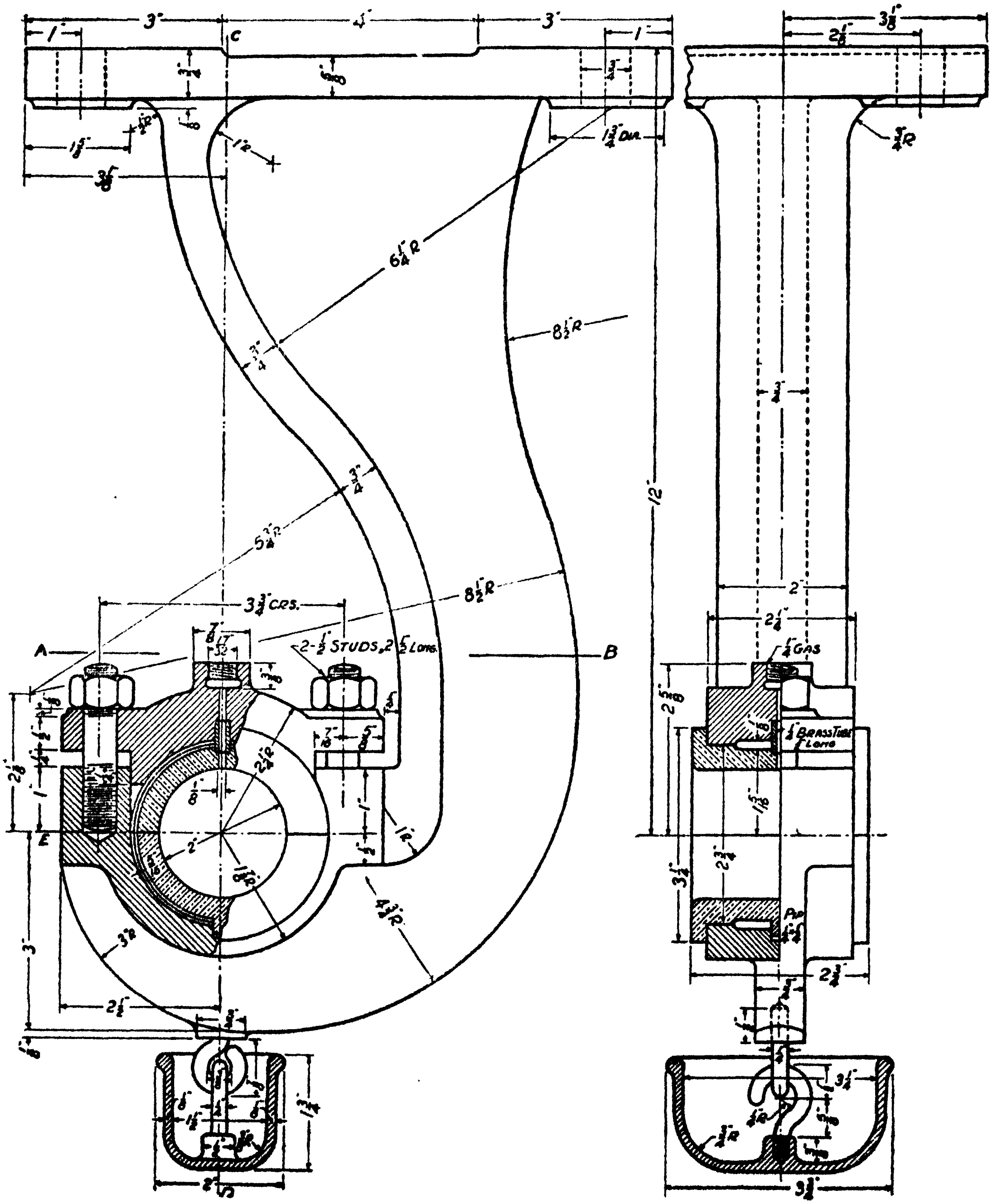
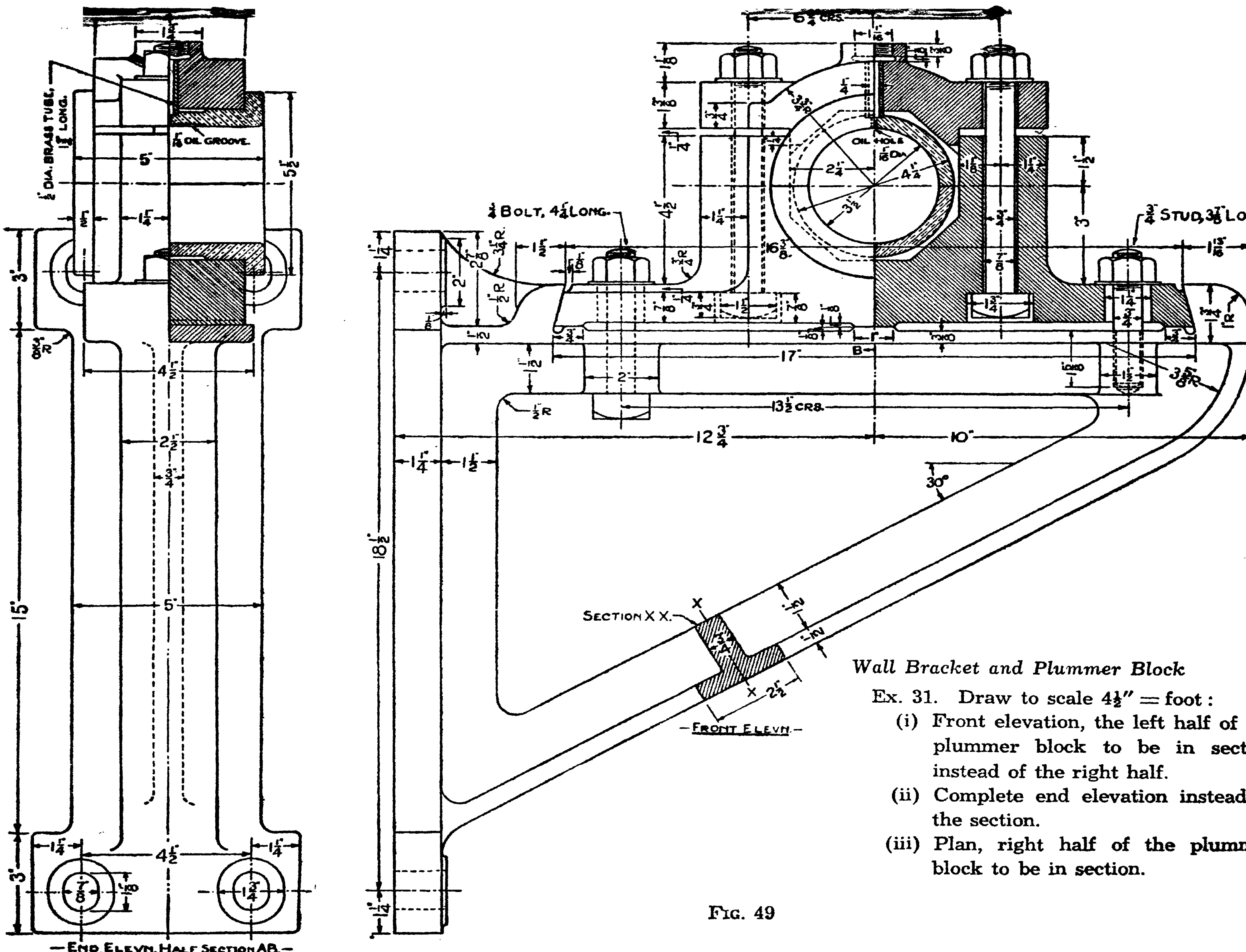


Fig. 48



Wall Bracket and Plummer Block

Ex. 31. Draw to scale $4\frac{1}{2}''$ = foot :

(i) Front elevation, the left half of the plummer block to be in section instead of the right half.

(ii) Complete end elevation instead of the section.

(iii) Plan, right half of the plummer block to be in section.

FIG. 49

SECTION V

Shaft Couplings

When two lengths of a shaft are to be connected together, a coupling of suitable form is used. Couplings can be classified into three groups:

(1) Hard bolted couplings (rigid).

(2) Flexible couplings.

(3) Universal couplings or universal joints.

(1) Hard bolted couplings connect shafts rigidly without any flexibility at the junction. Among the types are muff couplings, flange couplings (including shrouded couplings, and friction grip or cone couplings).

Ex. 32. Fig. 50 gives two views of a coupling of the rigid type. Draw to scale 9″ = foot:

(i) Front elevation, upper half in section.

(ii) End elevation, looking from right.

(2) Flexible couplings allow a certain amount of axial distortion when the axes of two shafts are not in perfect alignment.

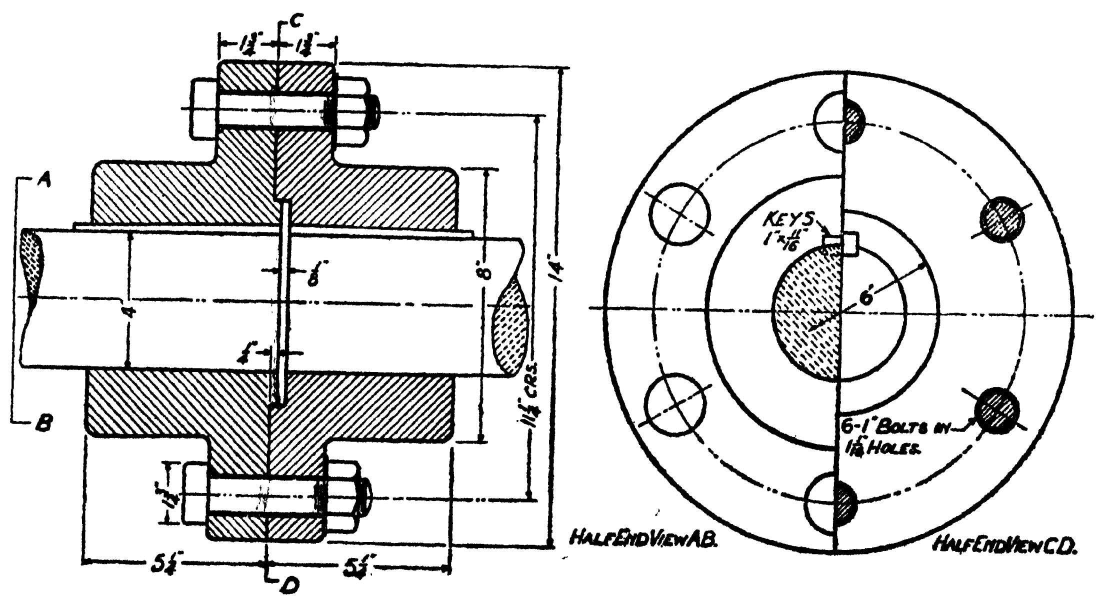


Fig. 50

Ex. 33. Fig. 51 gives details of a flexible coupling. Assemble the parts and draw to scale 9″ = foot :

(i) Front elevation, upper half in section.

(ii) End elevation, half from left and half from right.

(Portions of shafts are to be shown in each half of coupling in the assembled view. A gap of $\frac{1}{8}''$ to be left between the faces of the coupling.)

Friction Grip Coupling or Friction Clutch

Ex. 34. Fig. 52 gives a complete sectional elevation of a friction clutch. Draw to scale 6″ = foot :

(i) Front elevation, upper half in section.

(ii) End elevation, looking from right.

(3) Universal couplings are used to connect shafts which are at different levels and whose axes are not in the same straight line. Such couplings allow slight axial play.

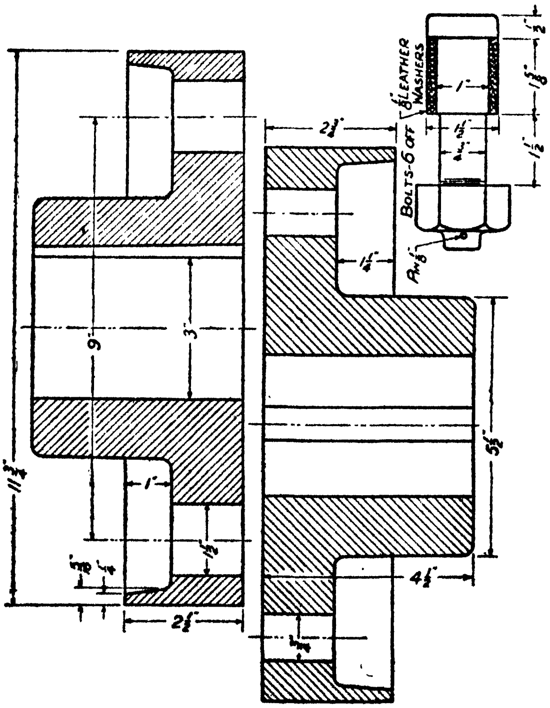


Fig. 51

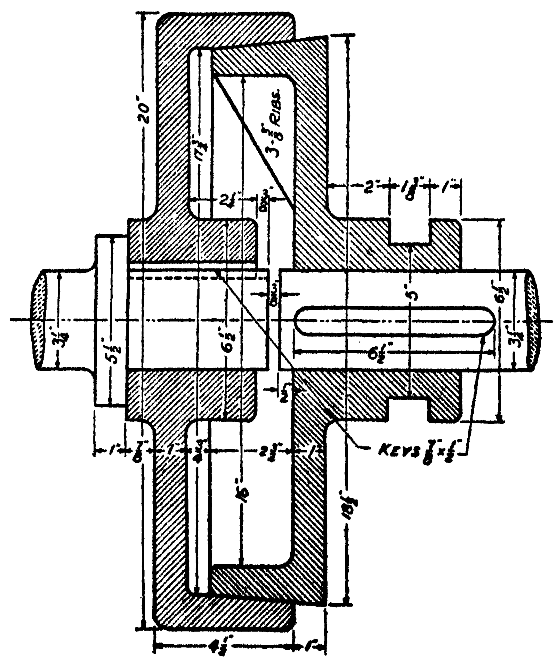


Fig. 52

Ex. 35. A complete sectional elevation of a flexible fabric coupling is given in Fig. 53. Draw to double full size scale :

(i) Front elevation, uppper half in section.

(ii) End elevation, looking from left.

Valve and Tappet Mechanism

Ex. 36. In Fig. 54 a valve and tappet mechanism of a petrol engine are given. Draw to full size scale :

(i) Front elevation.

(ii) Plan.

(Dia. of Cam Shaft = ¾″.)

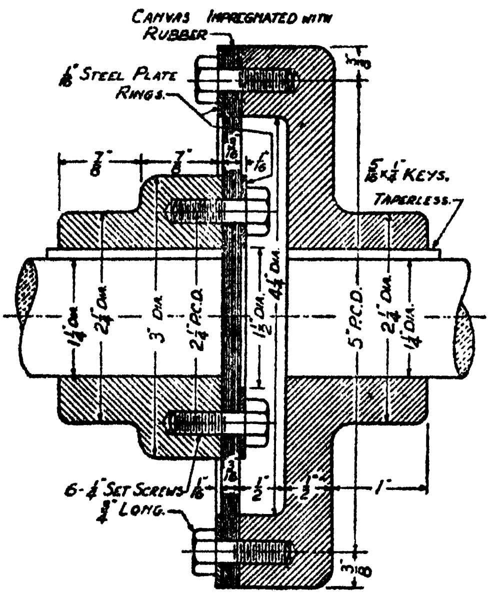


FIG. 53

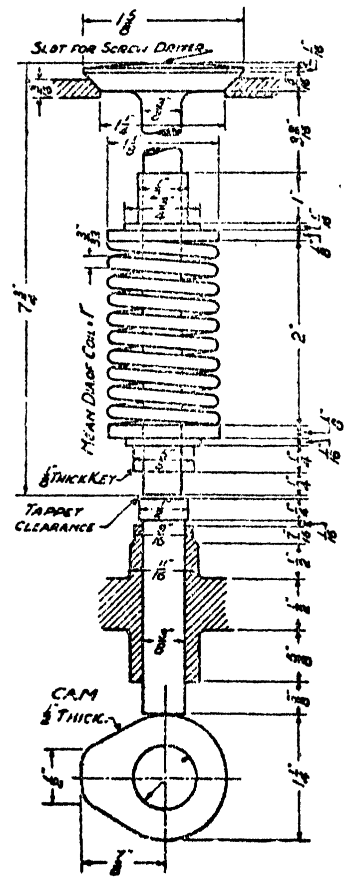


FIG. 54

Ram of Slotting Machine

Ex. 37. In Fig. 55, complete end view and other details of a ram of slotting machine are given. Draw to scale: 6″ = foot, showing tool holders in proper assembly:

(i) Elevation.
(ii) End elevation.
(iii) Plan.

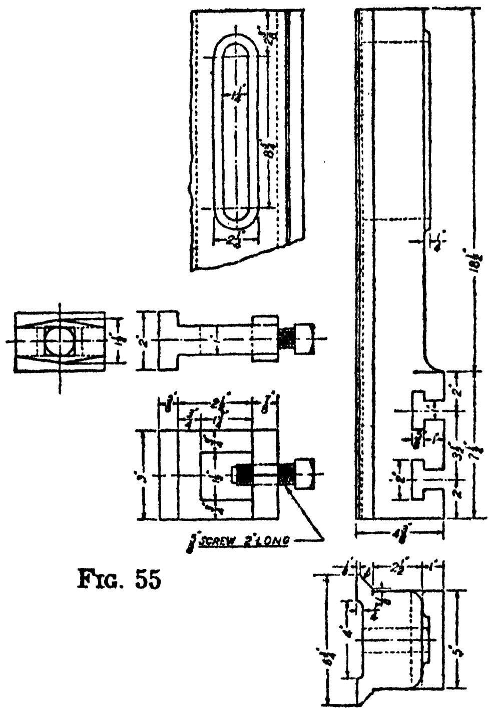


FIG. 55

Lathe Stay (Fig. 56)

Ex. 38. Two elevations and a part plan are given. Draw the following views to full size scale:

(i) Front elevation.
(ii) End elevation, looking from right.
(iii) Plan to be a section on AB.

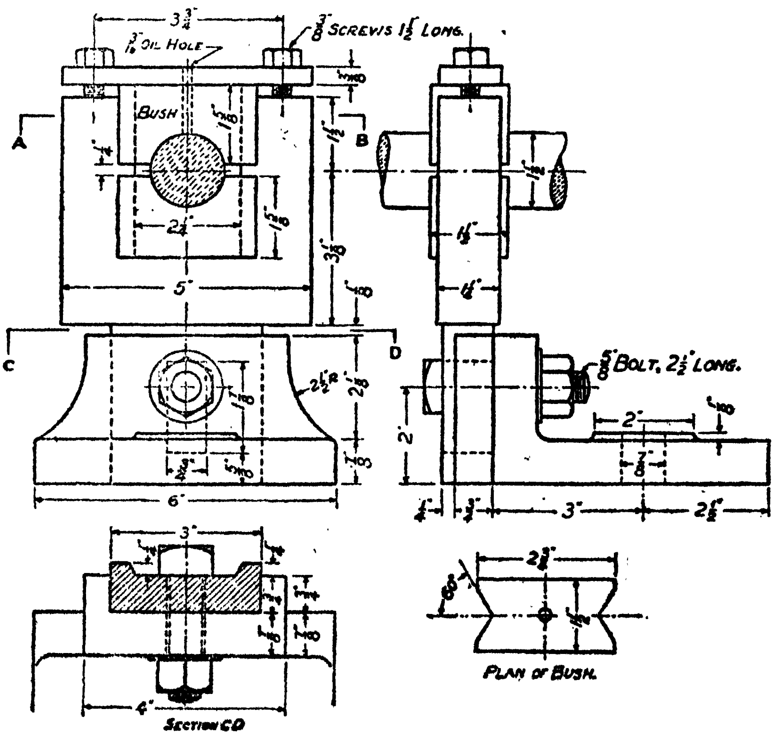


FIG. 56

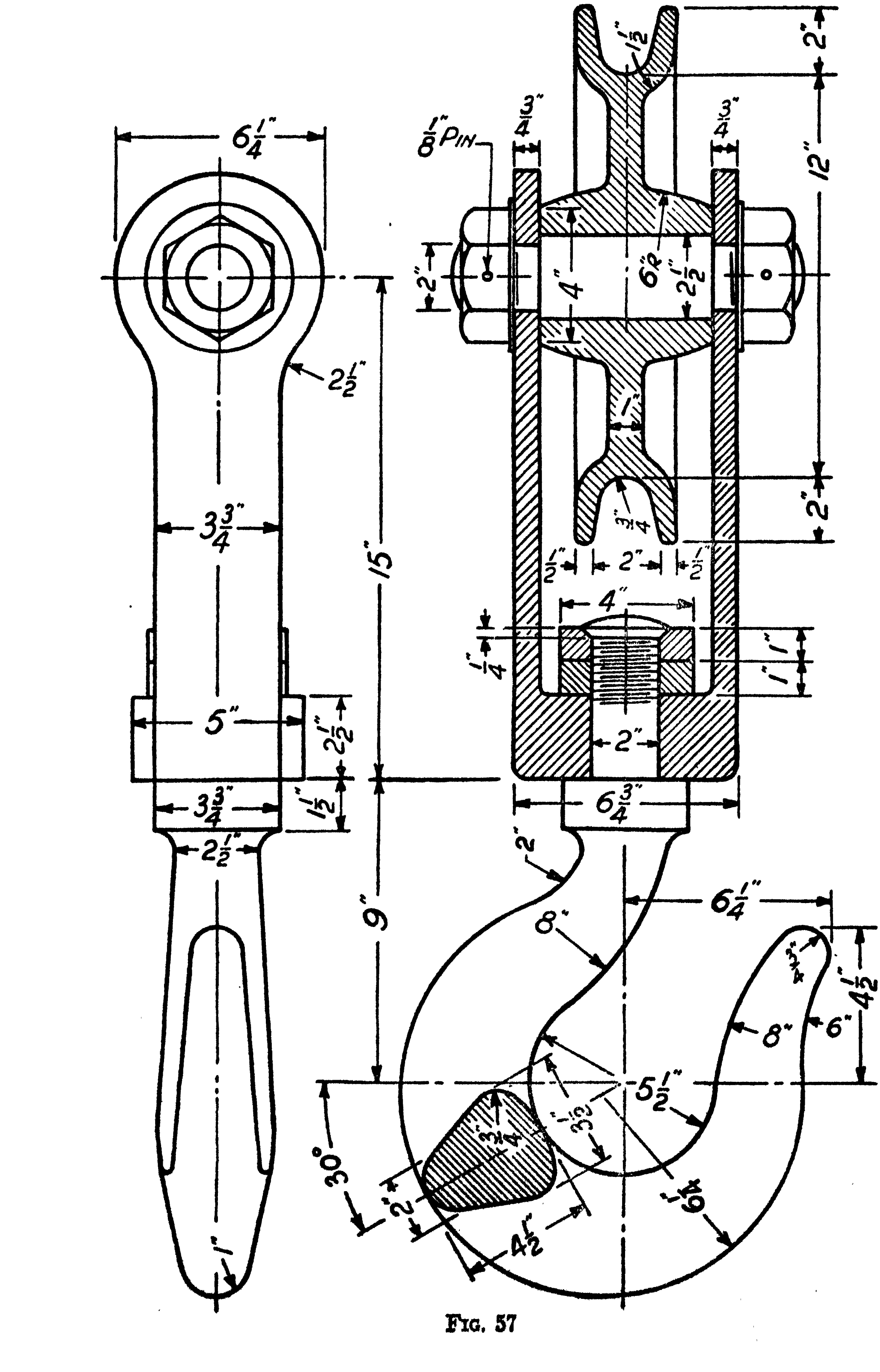
Snatch Block

Snatch blocks or pulley blocks are used in cranes and other hoisting machines where loads are carried or transferred from one place to another.

Ex. 39. Two views of a snatch block are given in Fig. 57. Draw to scale, half size:

(i) A front elevation, instead of the section.
(ii) A complete end elevation.

(Instead of the stud and nut, a pin with a collar can be used for mounting the pulley. The stud 2″ dia. works in a bush 2¼″ dia. driven tight into the pulley.)



$6\frac{1}{4}''$
$2\frac{1}{2}''$
$3\frac{3}{4}''$
$15''$
$5''$
$2\frac{1}{2}''$
$3\frac{3}{4}''$
$1\frac{1}{2}''$
$2\frac{1}{2}''$
$1''$
$9''$
$\frac{1}{8}''$ PIN
$\frac{3}{4}''$
$\frac{3}{4}''$
$1\frac{1}{2}''$
$2''$
$12''$
$2''$
$4''$
$6\frac{1}{2}''$
$2\frac{1}{2}''$
$1''$
$\frac{3}{4}''$
$2''$
$\frac{1}{2}''$
$2''$
$\frac{1}{2}''$
$4''$
$\frac{1}{4}''$
$1''$
$1''$
$2''$
$6\frac{3}{4}''$
$2''$
$6\frac{1}{4}''$
$8''$
$4\frac{1}{2}''$
$8''$
$6''$
$5\frac{1}{2}''$
$3\frac{1}{2}''$
$30°$
$2''$
$4\frac{1}{2}''$
$6\frac{1}{4}''$

FIG. 57

Connecting Rod Ends

There are various types of connecting rod ends. Connecting rods have two ends. The end of the rod connected to the piston or crosshead is termed small end, and that which goes to the crank pin, the big end.

Marine Engine Connecting Rod

Ex. 40. Two views of a connecting rod are given in Fig. 58. Draw to scale 6″ = foot :

(i) Front elevation, upper half in section.

(ii) End elevation, looking from right.

(iii) Plan, lower half in section.

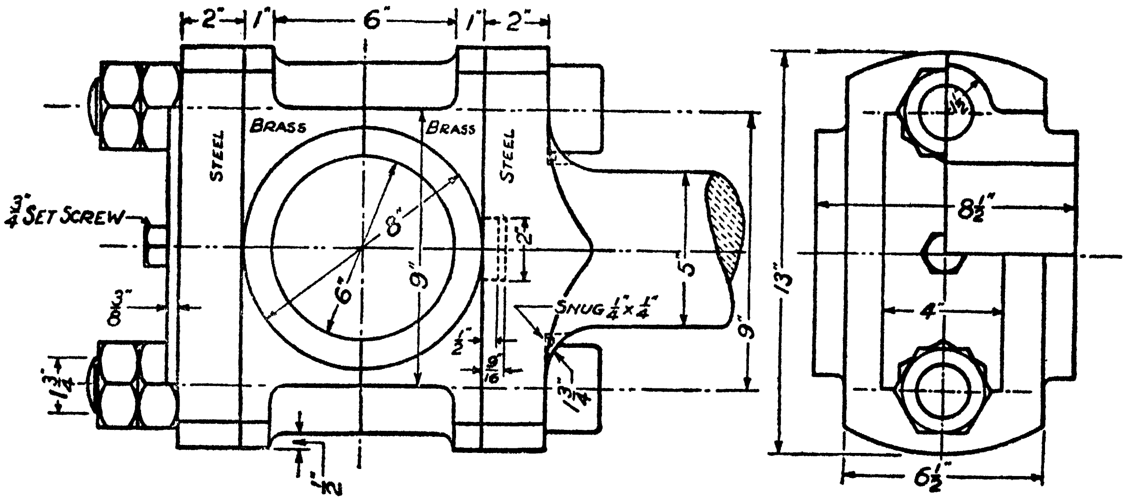


FIG. 58

Connecting Rod End for Gas Engine

Ex. 41 (Fig. 59). A front elevation and a half plan are given. Draw to full size scale :

(i) Front elevation, upper half in section.

(ii) End view, half from left and half from right.

(iii) Half plan and half sectional plan on AB.

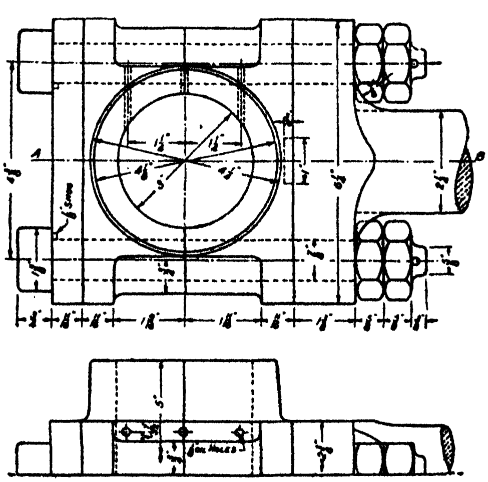


FIG. 59

Connecting Rod for Steam Engine

Ex. 42 (Fig. 60). Draw to scale 9″ = foot :

(i) A complete sectional front elevation.
(ii) The given end elevation.
(iii) Plan lower half in section.

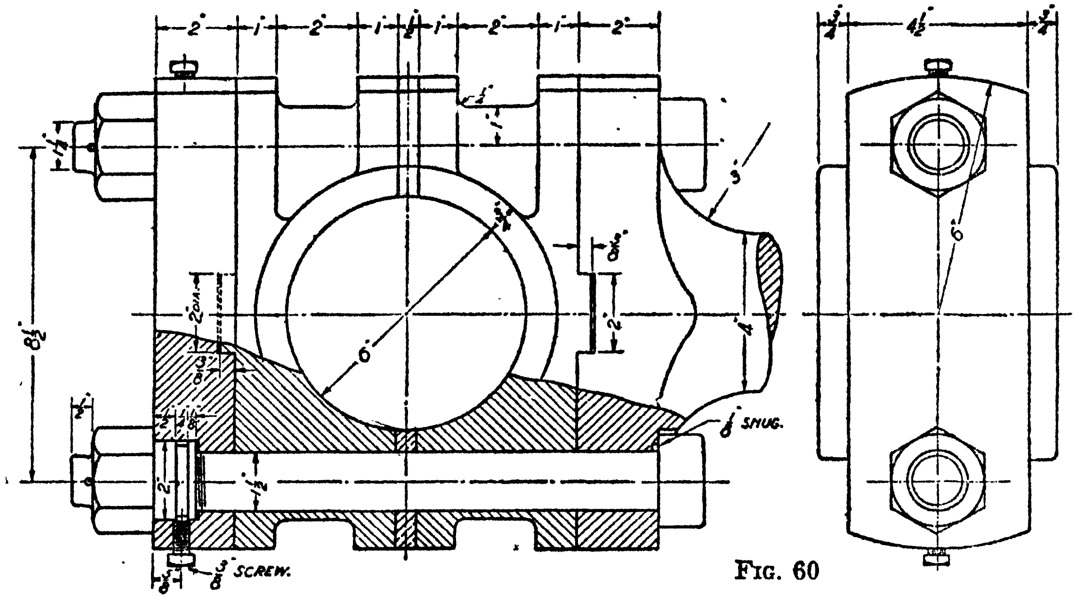


FIG. 60

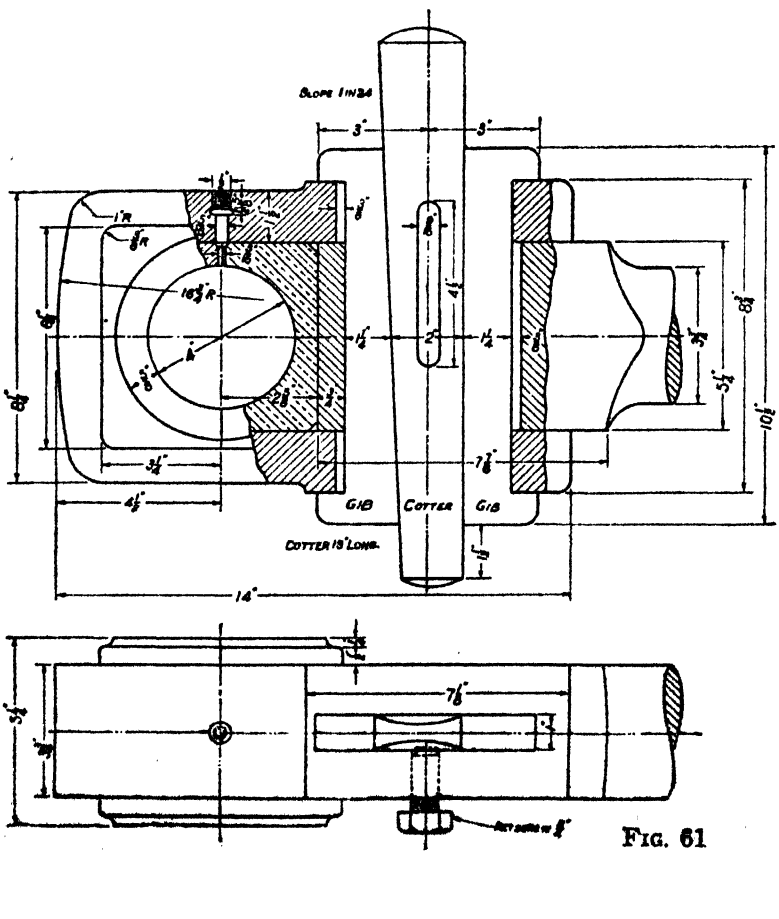


FIG. 61

Connecting Rod

A simple type of connecting rod end incorporating gib and cotter arrangement, by means of which the various parts are held together, is shown in two views in Fig. 61.

Ex. 43 (Fig. 61). Draw to half size scale :

(i) Front elevation upper half in section.
(ii) End elevation looking from right.
(iii) Plan, lower half in section.

Connecting Rod End for Locomotive

In Fig. 62, two views of a connecting rod end with a bolted strap are given. The brasses are driven tight by the cotter passing through the strap, and the rod end is bolted down with the strap.

Ex. 44 (Fig. 62). Front elevation half in section and plan half in section are given. Draw to full size scale :

(i) Front elevation instead of the section.

(ii) End elevation, looking from right.

(iii) Plan, lower half in section.

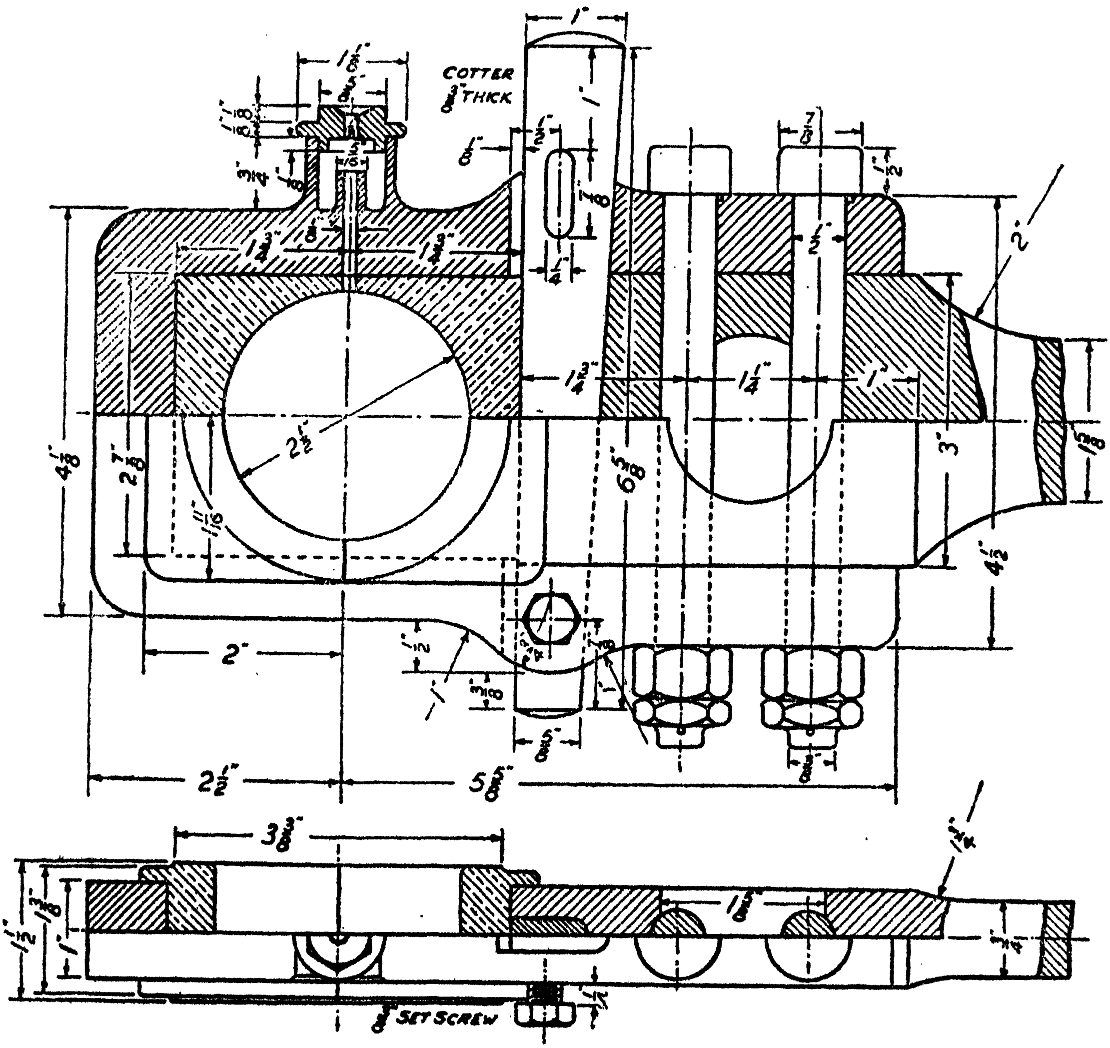


FIG. 62

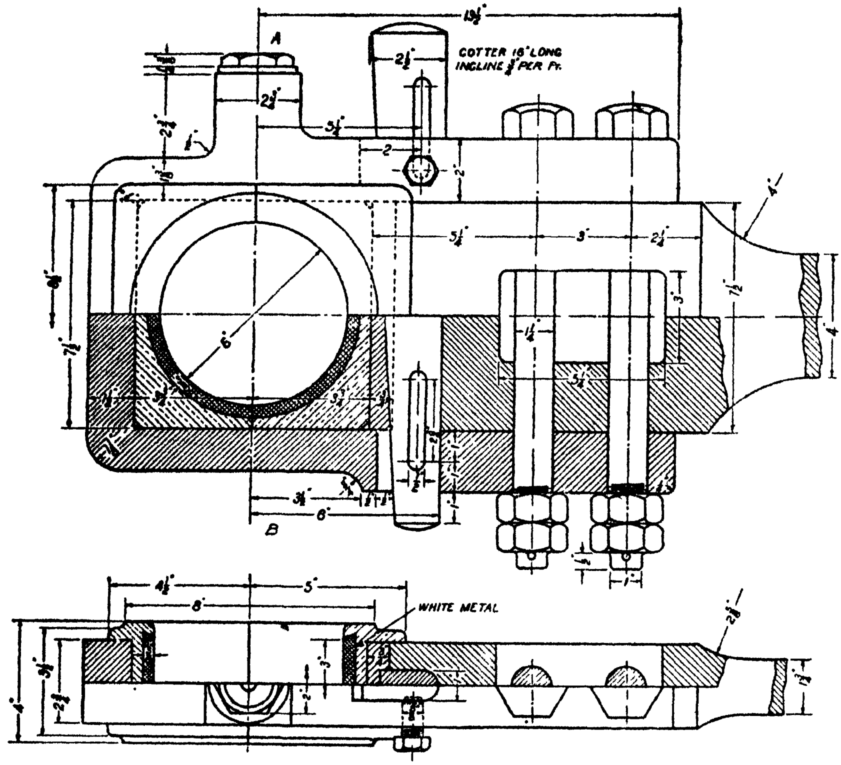


FIG. 63

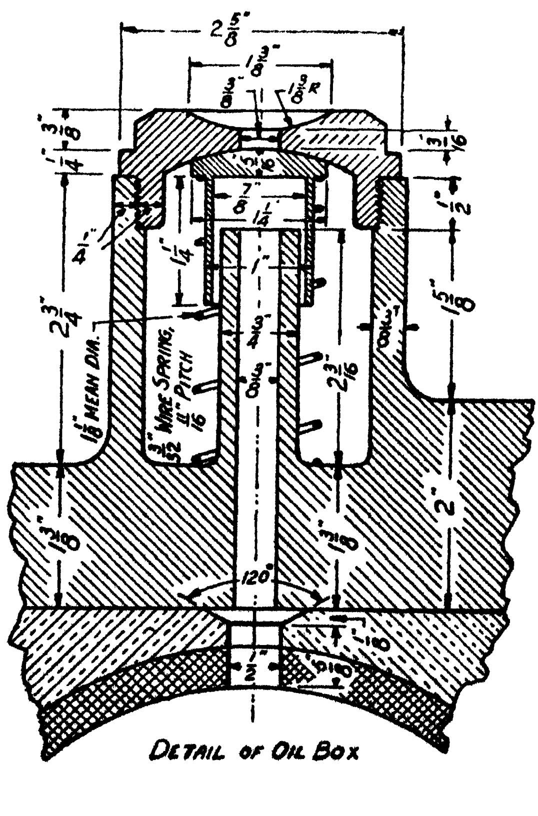


FIG. 63 (a)

Connecting Rod End

Ex. 45 [Figs. 63 and 63 (a)]. Draw to scale half size :

(i) Front elevation, upper half in section.

(ii) End elevation, half section on AB.

(iii) Plan, lower half in section.

Connecting Rods for Petrol Engines

Two types of connecting rods are given in Fig. 64 and Fig. 65.

Ex. 46 (Fig. 64). A front elevation and sectional end view are given. Draw to double full size scale:

(i) Front elevation, lower half below CD in section.

(ii) A complete end elevation instead of the section.

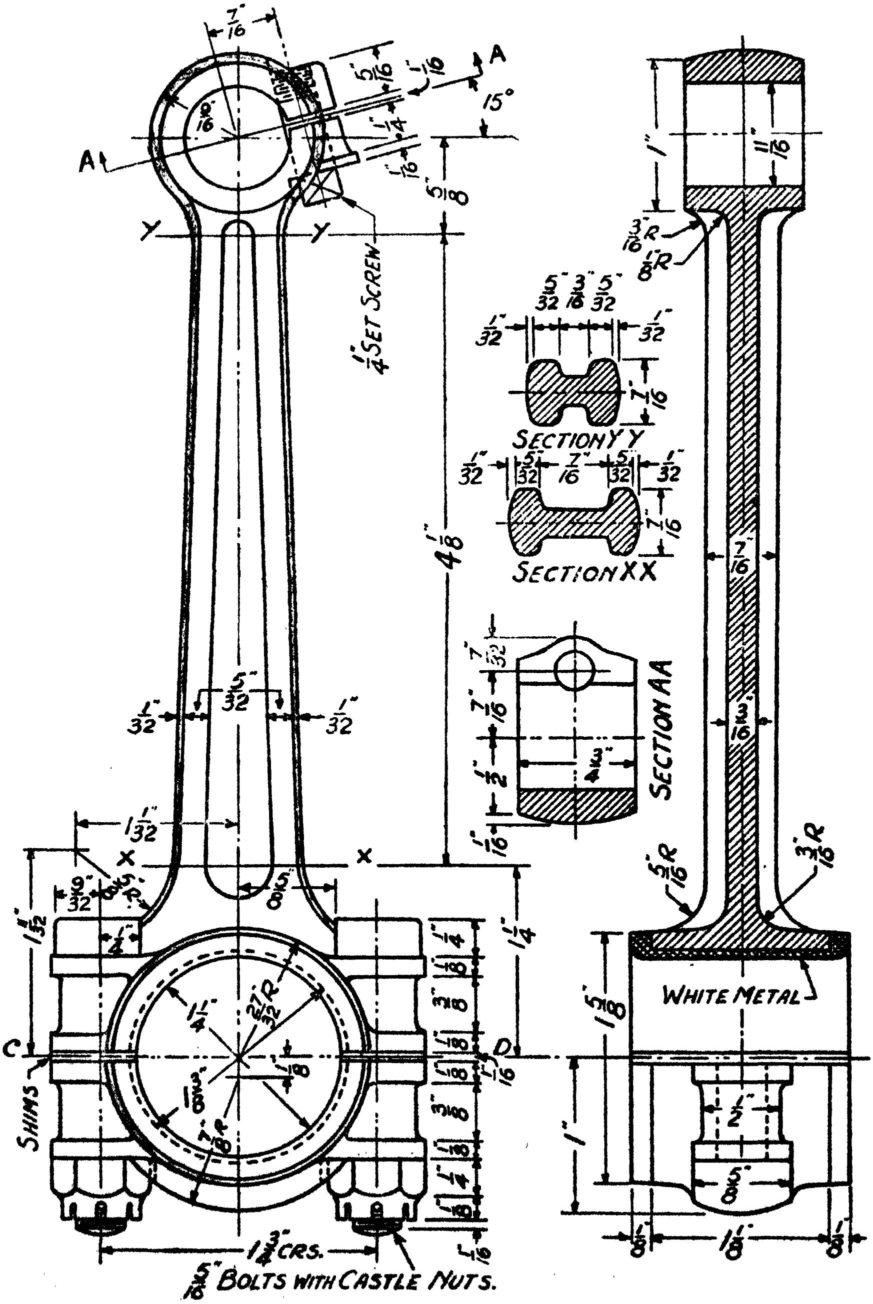


FIG. 64

Ex. 47 (Fig. 65). Draw to full size scale:

(i) Front elevation.

(ii) End elevation, right half in section.

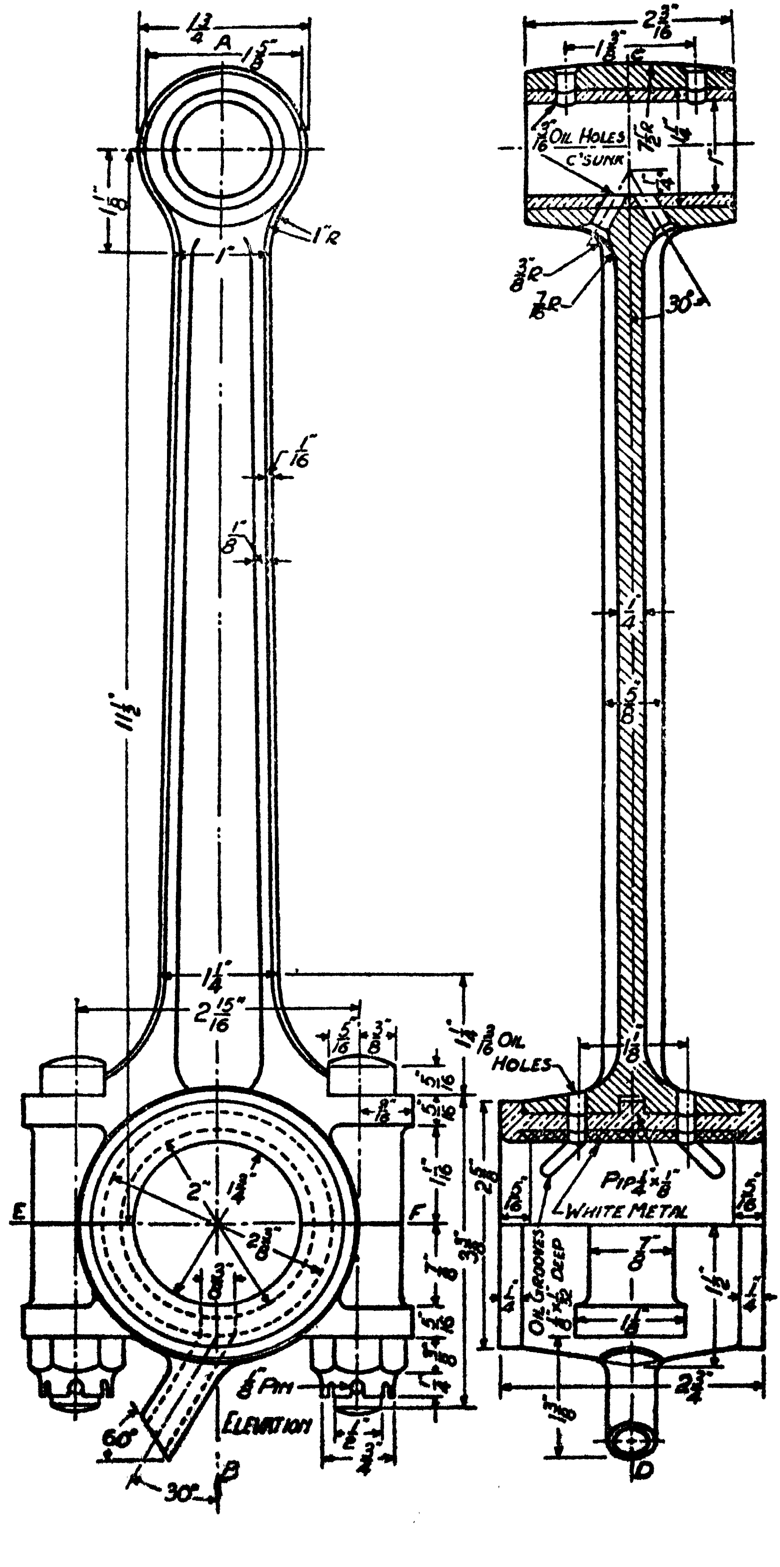


FIG. 65

Gland and Stuffing Box

In engineering practice, leakage of the working fluid around piston rods, valve spindles, pump rods, etc., is prevented by an arrangement called the gland and stuffing box. Generally the stuffing box is an annular space, provided in the casting of cylinder covers, valve and pump bodies or covers, in which some kind of packing material is stuffed around the rods or spindles, and is compressed against them when a gland is drawn tight by studs or bolts.

Ex. 48 (Fig 66). Draw to full size scale:

(i) The given front elevation.
(ii) End elevation.
(iii) Complete the given plan.

Ex. 49 (Fig. 67). Draw to full size scale, showing the parts assembled together:

(i) A complete sectional elevation.
(ii) End elevation.
(iii) Plan.

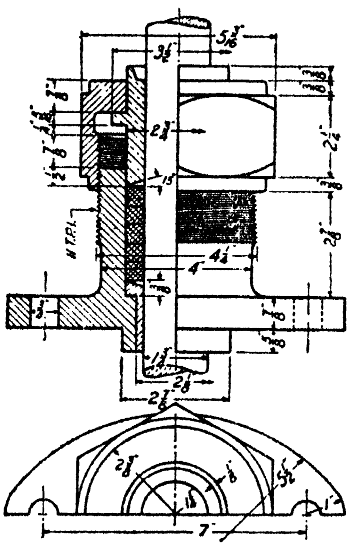


Fig. 66

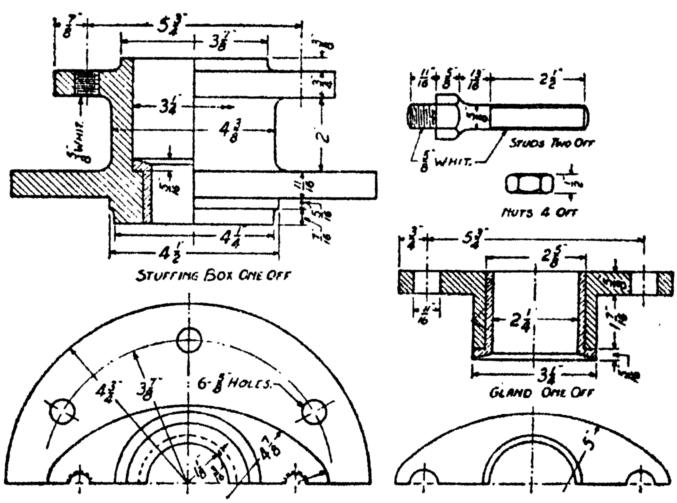


Fig. 67

Eccentric

In engines and machines eccentrics transform circular motion into linear or straight line motion. In engines the reciprocating motion obtained by an eccentric mounted on the crank shaft, is employed to move a side valve or piston valve of steam engines. In gas or oil engines the eccentrics operate the fuel valves, etc. An eccentric consists of a disc called the sheave. The rims of eccentric sheaves are made in various forms. Over the rim of a sheave, two straps are put on and bolted together. The eccentric rod is attached to one of the straps. The sheave is usually made of steel and the straps are of brass, gun metal or other alloys. In some cases the straps are made of steel or mild steel, and in such cases a brass liner is put in between the straps and sheave. Sheaves are also made in two pieces, and are bolted together. Lubricating arrangements are generally provided in one of the straps.

Ex. 50. Fig. 68 gives details of an eccentric. Assemble the parts and draw to scale 6″ = foot:

(i) Front elevation, upper half in section.
(ii) End elevation, looking on rod end.

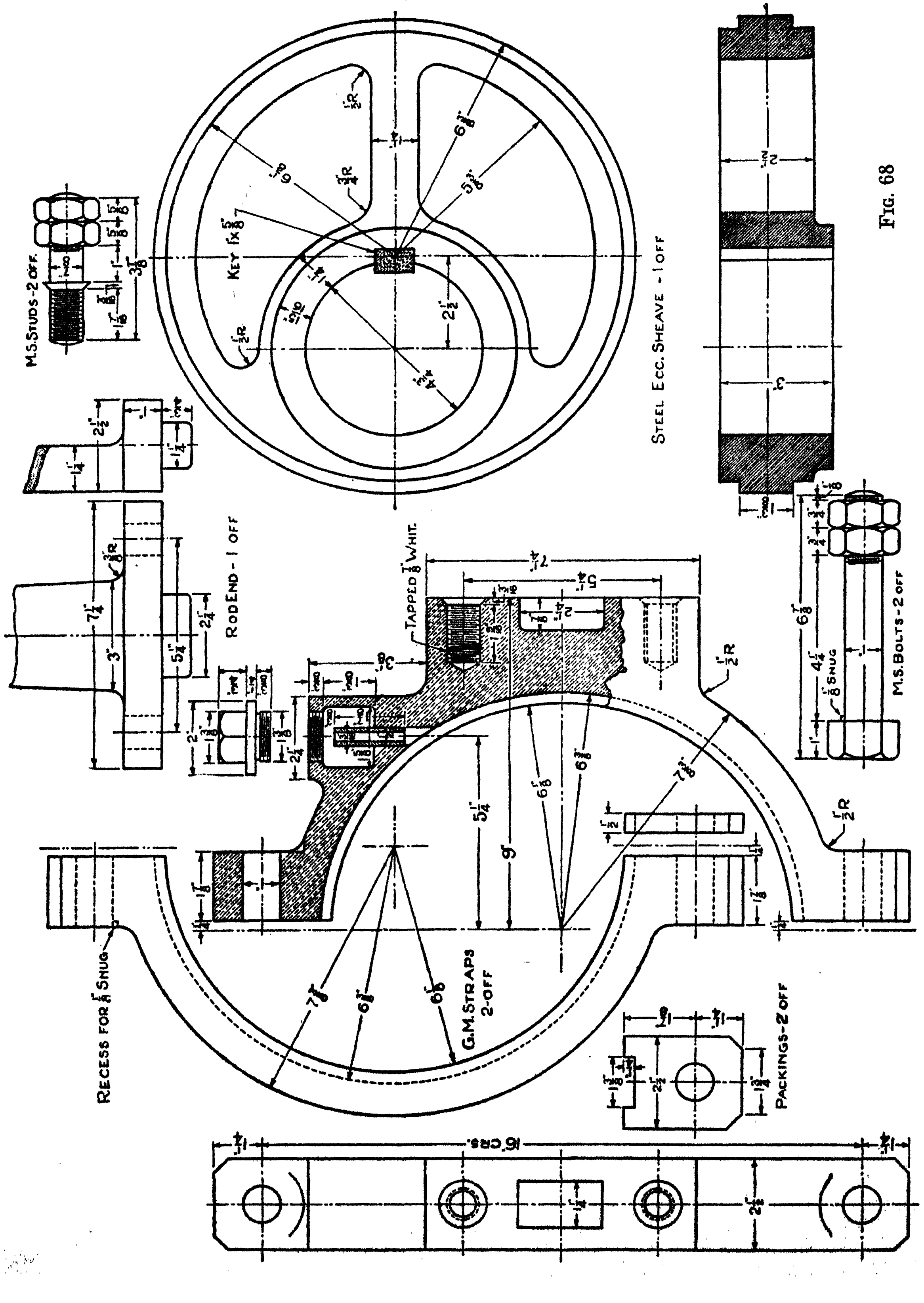

M.S. STUDS - 2 OFF.
STEEL ECC. SHEAVE - 1 OFF
KEY 1 × 5/8
ROD END - 1 OFF
TAPPED 7/8" WHIT.
M.S. BOLTS - 2 OFF
SNUG
G.M. STRAPS 2-OFF
RECESS FOR 1/8" SNUG
PACKINGS - 2 OFF
16" CRS.

FIG. 68

Ex. 51. Fig. 69 gives two views of an eccentric with split sheave. Draw to scale 9″ = foot :

(i) Front elevation instead of the section.

(ii) Half end elevation and half section.

(iii) Complete plan.

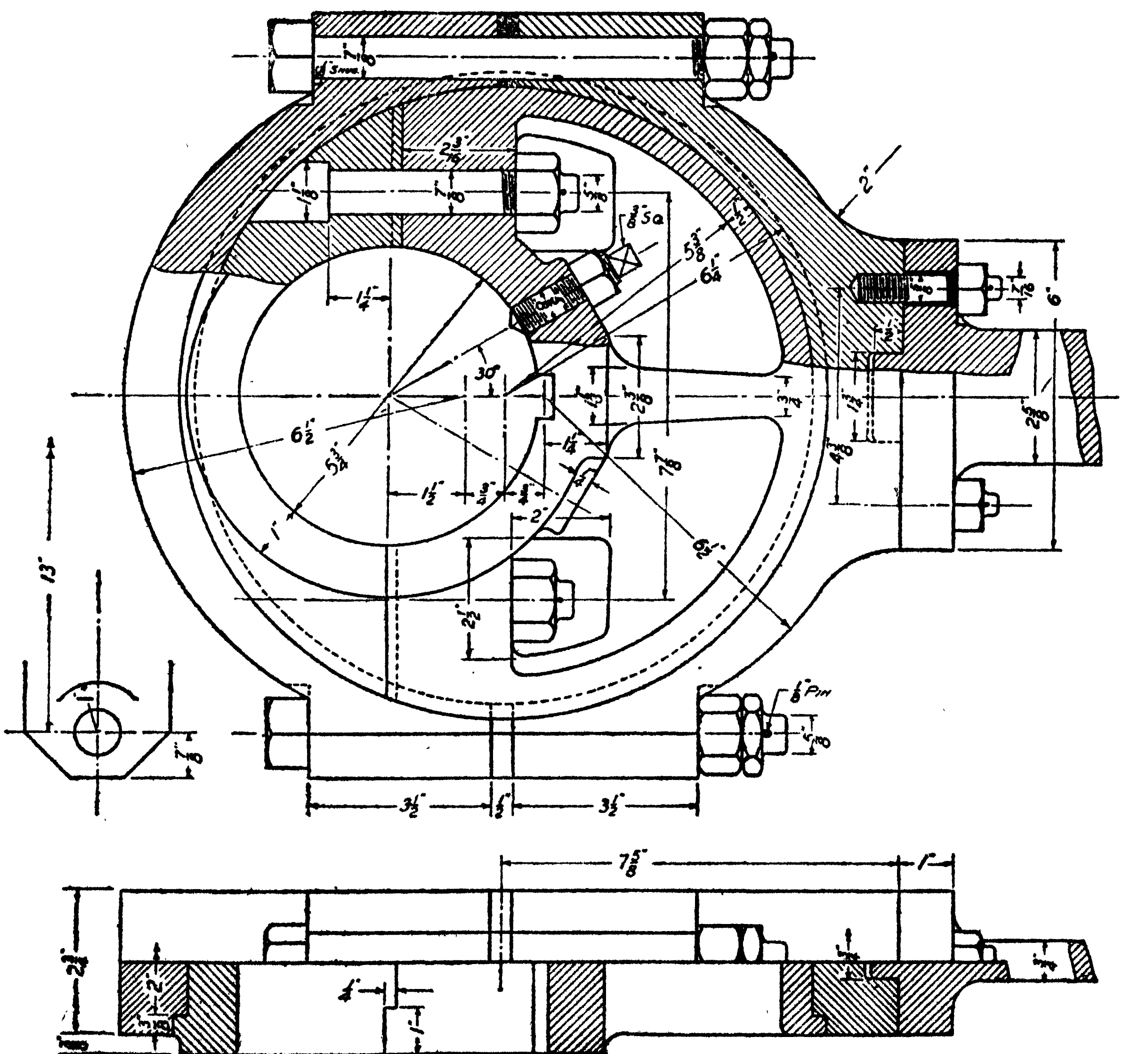


FIG. 69

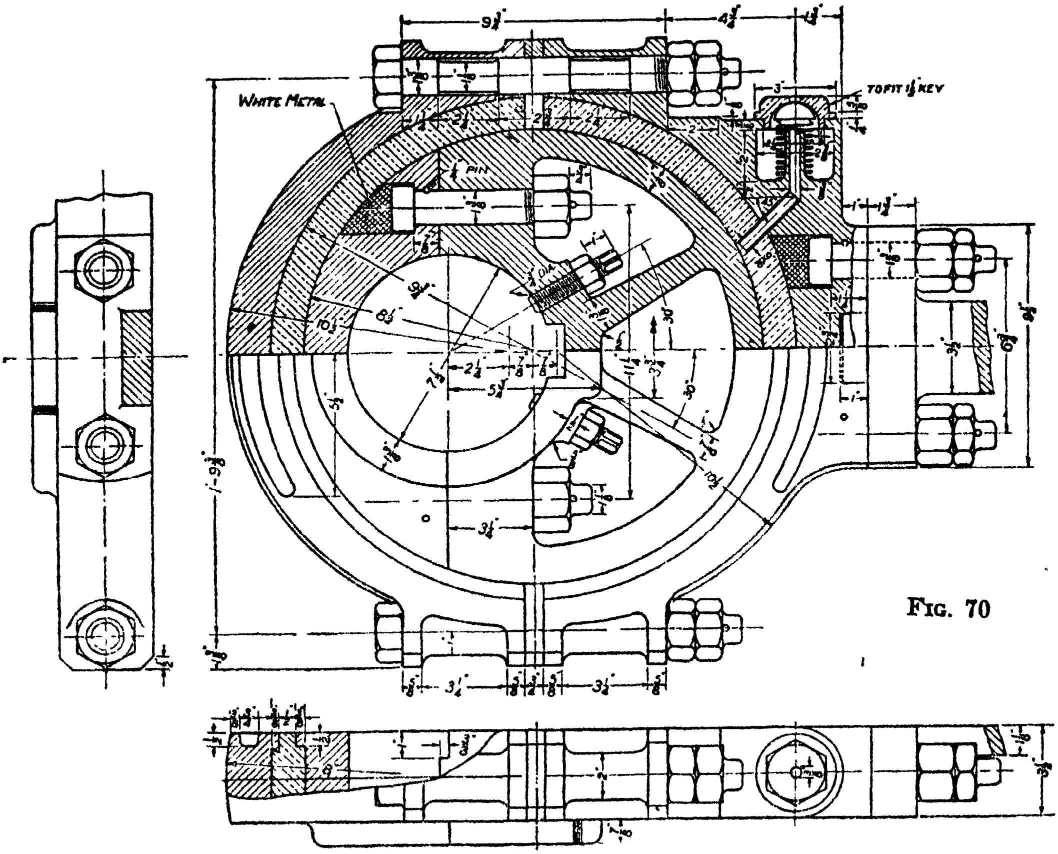
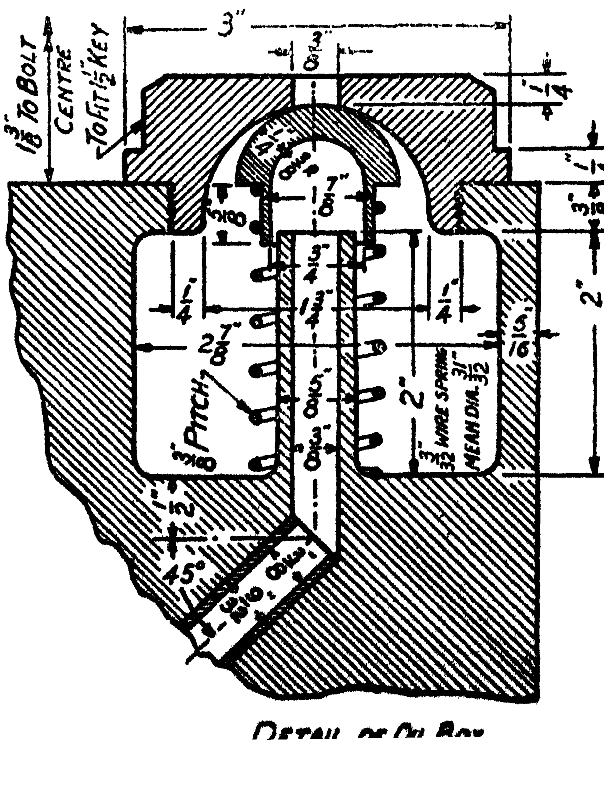


FIG. 70



Ex. 52 [Figs. 70 and 70(a)]. Draw to scale 4½" = foot:

(i) The given front elevation.

(ii) End elevation looking along rod end.

(iii) Plan, lower half in section.

FIG. 70(a)

Steam Engine Piston

In all engines, the piston has a to and fro motion inside the cylinder. The piston rod is in the centre of the piston and the piston is secured to one end of the rod.

Fig. 71 shows a piston and piston rod end of a locomotive. The disc type piston is of C.I. The piston rings, also of C.I., are sprung into grooves turned on the piston. The piston rod is tapered to take the piston which is drawn tight by the nut. The slackening of the nut is prevented by the pin.

Ex. 53 (Fig. 71). Draw to full size scale :

(i) The given front elevation.

(ii) End elevation, looking from the nut end.

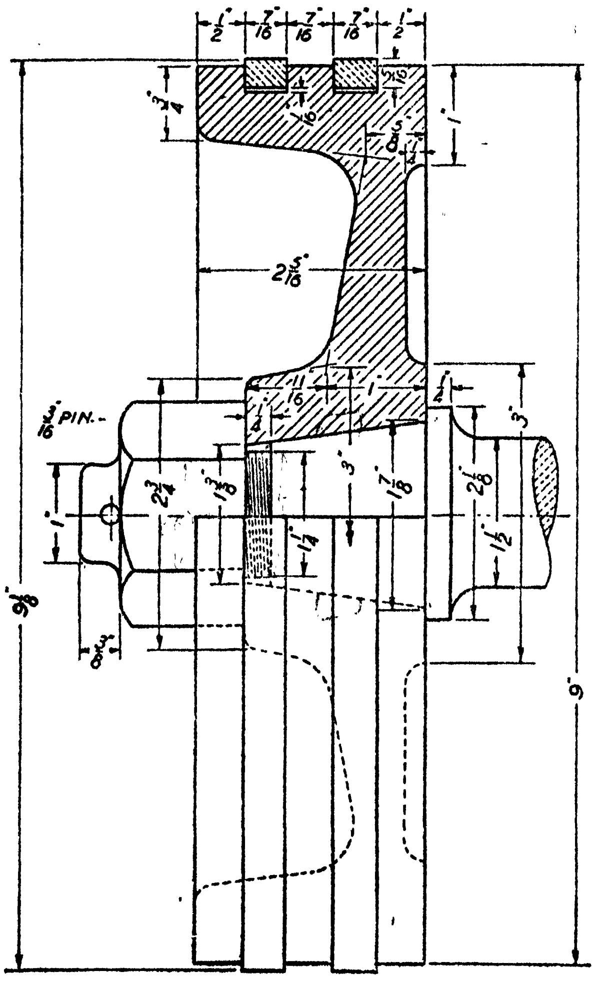


FIG. 71

Petrol Engine Piston

The pistons of petrol engines are made of aluminium alloys, which are comparatively lighter than other alloy metals, while retaining the other properties. Sometimes they are also made of cast iron. Petrol engines are mostly single acting, and therefore the pistons vary in design with different makers. The piston is secured to the connecting rod by a gudgeon pin. The crown of the piston may be convex, concave or flat. The piston rings may be of cast iron or alloy metals. They spring into grooves in the upper half of the piston. In certain cases, the inside of the piston is provided with a number of ribs, to give a greater amount of strength or rigidity to the crown of the piston. Two projections or lugs cast along with the piston take the gudgeon pin. The gudgeon pin may be secured either to the piston or connecting rod.

Ex. 54. Two views of a petrol engine piston are given in Fig. 72. Draw to full size scale :

(i) Front elevation, left half in section.
(ii) End elevation, right half in section.
(iii) Half plan and half sectional plan along CD.

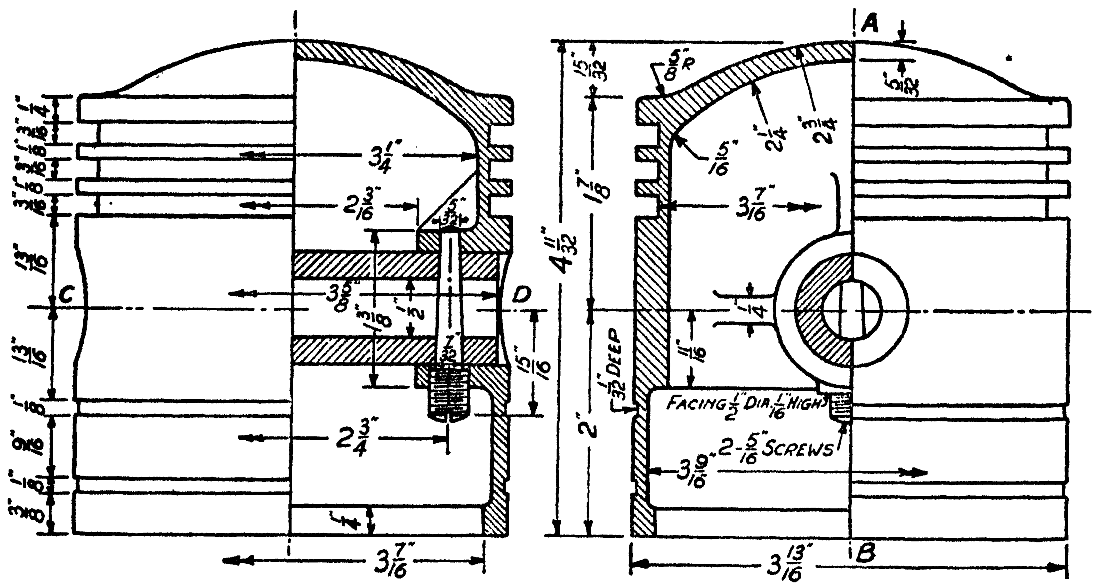


FIG. 72

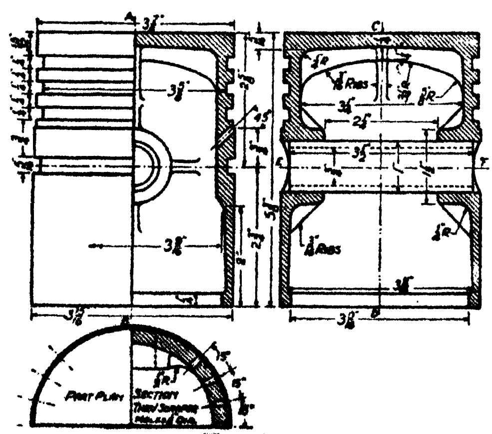


FIG. 73

Ex. 55 (Fig. 73). Draw to double full size scale :

(i) A complete elevation.
(ii) The given sectional end elevation.
(iii) Complete the given plan.

Hub and Brake Drum

Ex. 56 (Fig. 74). Draw to full size scale :

(i) Front elevation, upper half in section.

(ii) End elevation looking from left.

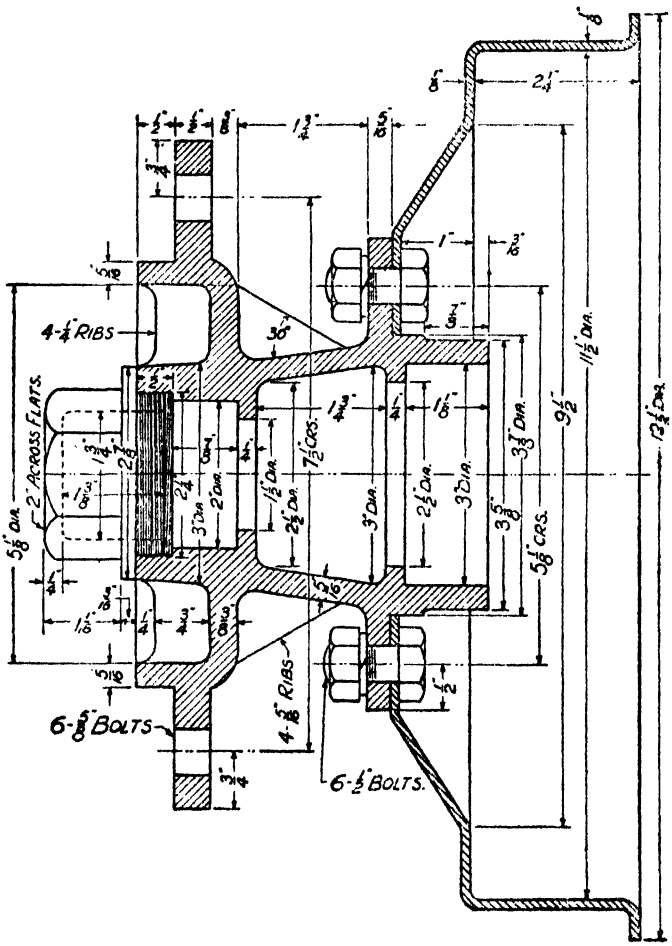


FIG. 74

Petrol Engine Cylinder

Ex. 57. In Fig. 75 a sectional front elevation and end view are given. Draw to scale 9″ = foot :

(i) Front elevation, right half in section.

(ii) End elevation, looking from right, the left half section on AB, and right half section on CD.

(iii) Plan, right half section on AG.

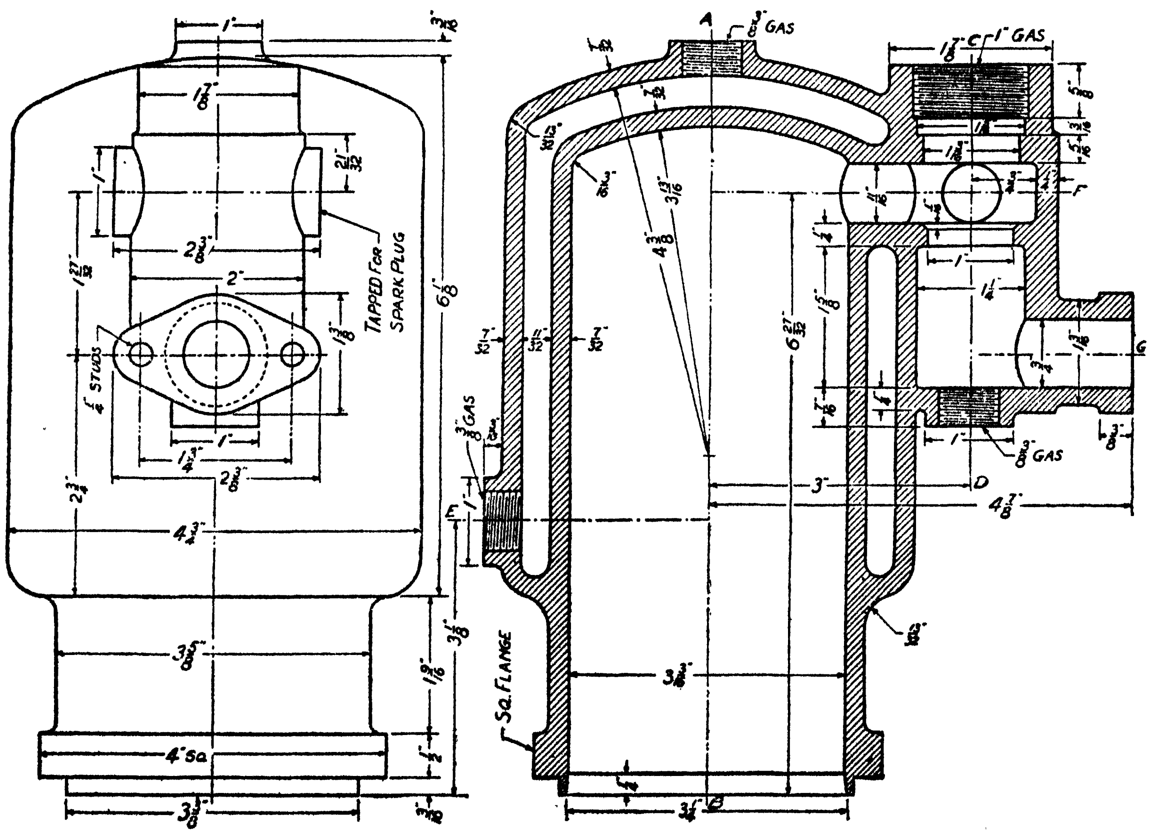


Fig. 75

Jet Carburettor

Ex. 58 (Fig. 76). Draw the following views to double full size scale:

(i) The given sectional elevation.

(ii) Plan, section on AE.

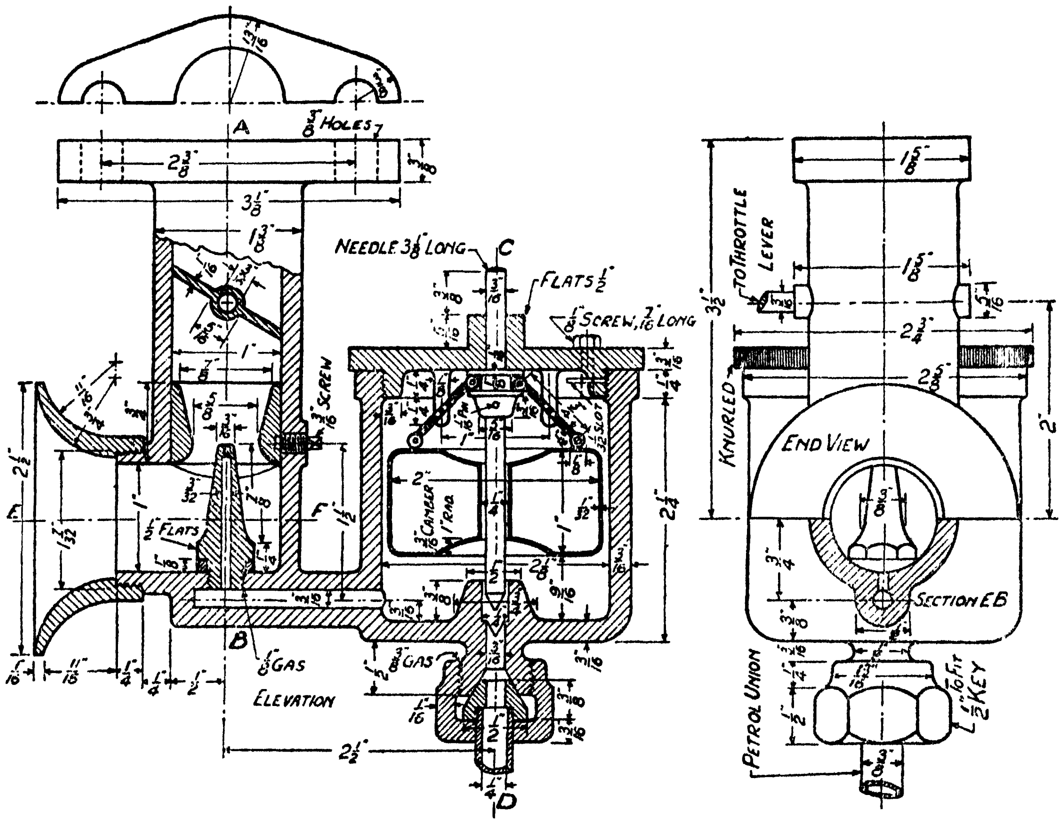


FIG. 76

Feed Check Valve

Ex. 59 (Fig. 77). Draw to scale 6" = foot:

(i) A complete front elevation instead of the section.

(ii) End elevation from left, right half in section.

(iii) Half plan and half with cover removed.

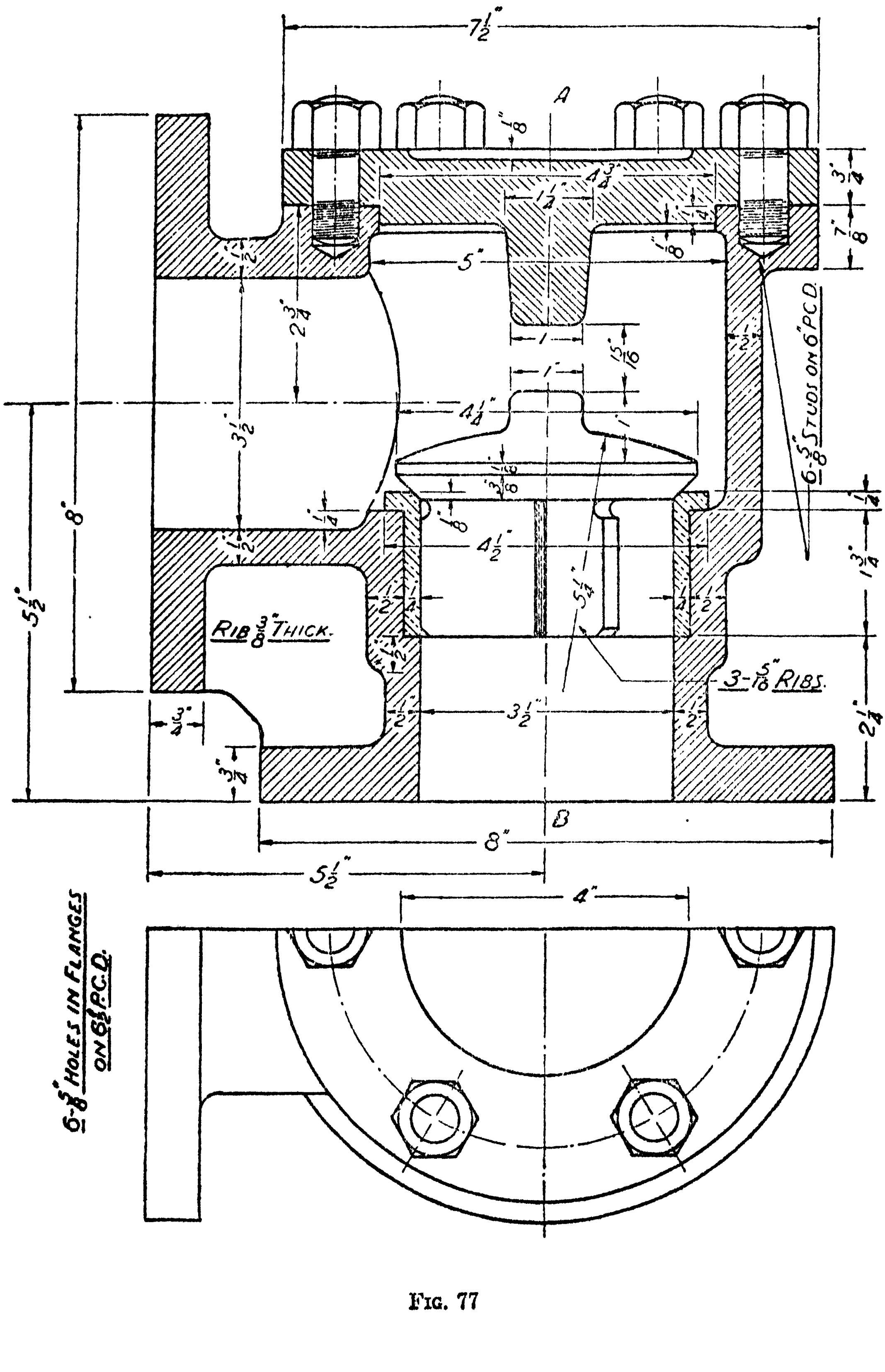

7½"
A
⅛"
4¾"
1½"
¼"
⅛"
¾"
⅞"
5"
½"
2¾"
1"
15/16"
1"
4¼"
1"
3½"
3/16"
⅛"
¼"
½"
4½"
5¼"
8"
5½"
RIB ⅜" THICK.
3-5/16" RIBS.
3½"
2¼"
1¾"
6-⅝" STUDS ON 6" P.C.D.
B
8"
5½"
4"
6-⅝" HOLES IN FLANGES ON 6½" P.C.D.

FIG. 77

SECTION VI

Feed Check Valve

Ex. 60 (Fig. 78). A sectional front elevation and part plan are given. Draw to scale 9″ = foot:

(i) Front elevation instead of the section.

(ii) A complete sectional end elevation looking from left.

(iii) Complete plan.

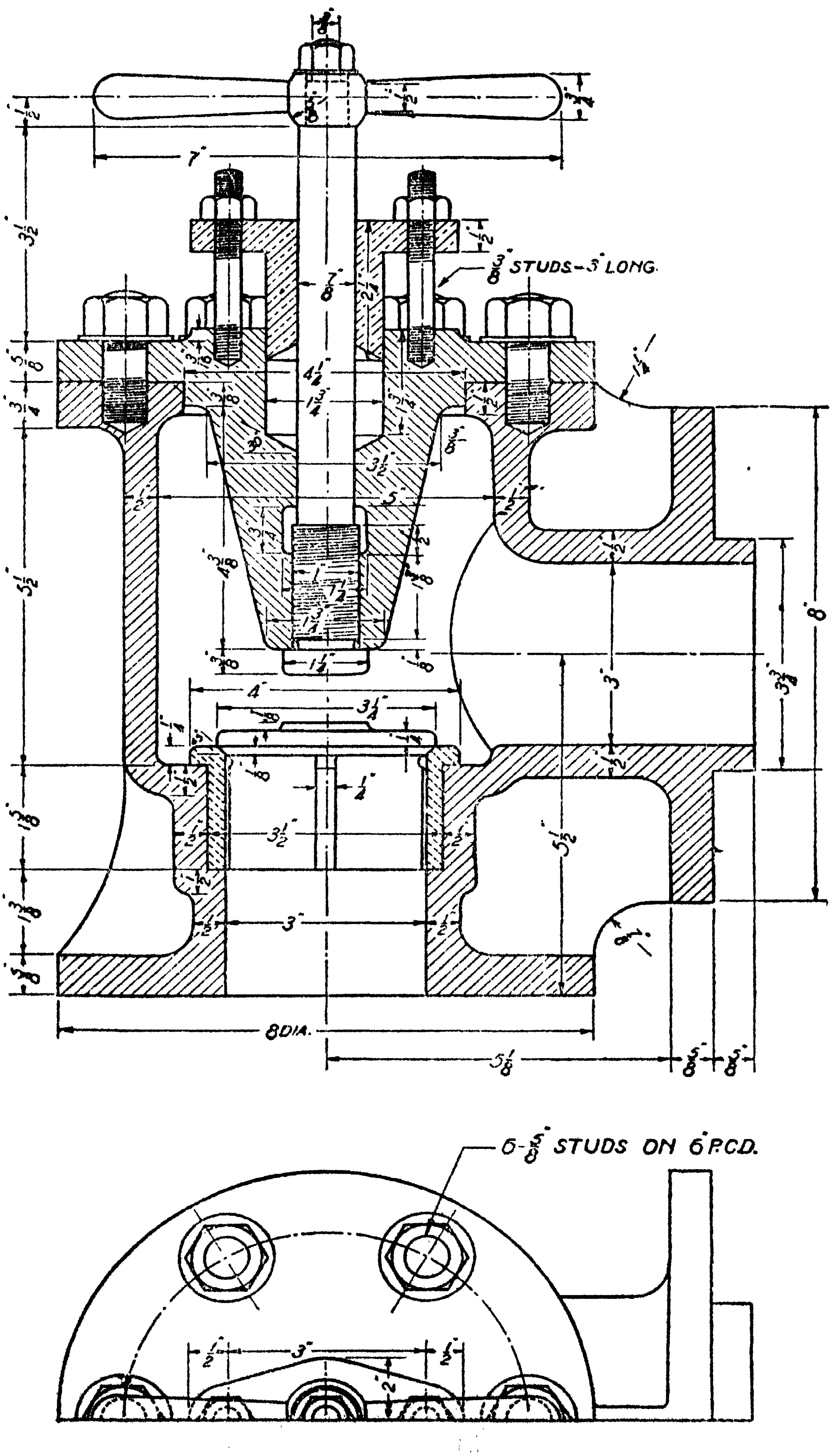
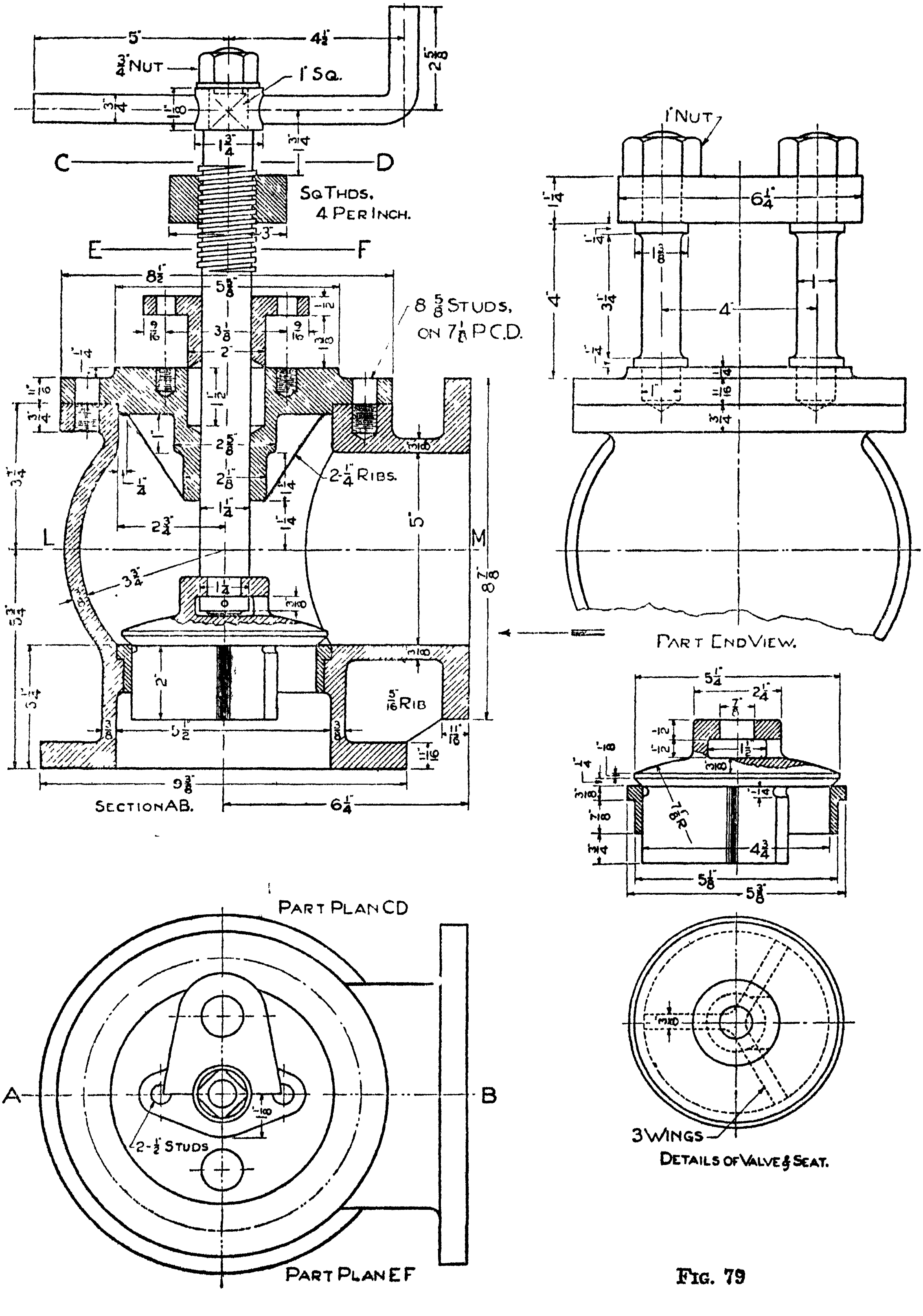


Fig. 78



¾" Nut
1" Sq.
C
D
Sq Thds.
4 Per Inch.
E
F
8 ⅝ Studs,
on 7⅛ P.C.D.
2-¼" Ribs.
L
M
5/16 Rib
Section AB.
1" Nut
Part End View.
Part Plan CD
A
B
2-½" Studs
Part Plan EF
3 Wings
Details of Valve & Seat.

Fig. 79

Stop Valve

Ex. 61 (Fig. 79). Draw the following views to scale 6″ = foot:

(i) A complete front elevation instead of the section.

(ii) Half plan and half sectional plan on LM.

(iii) End elevation, left half in the direction of arrow, and right half in section on vertical centre line.

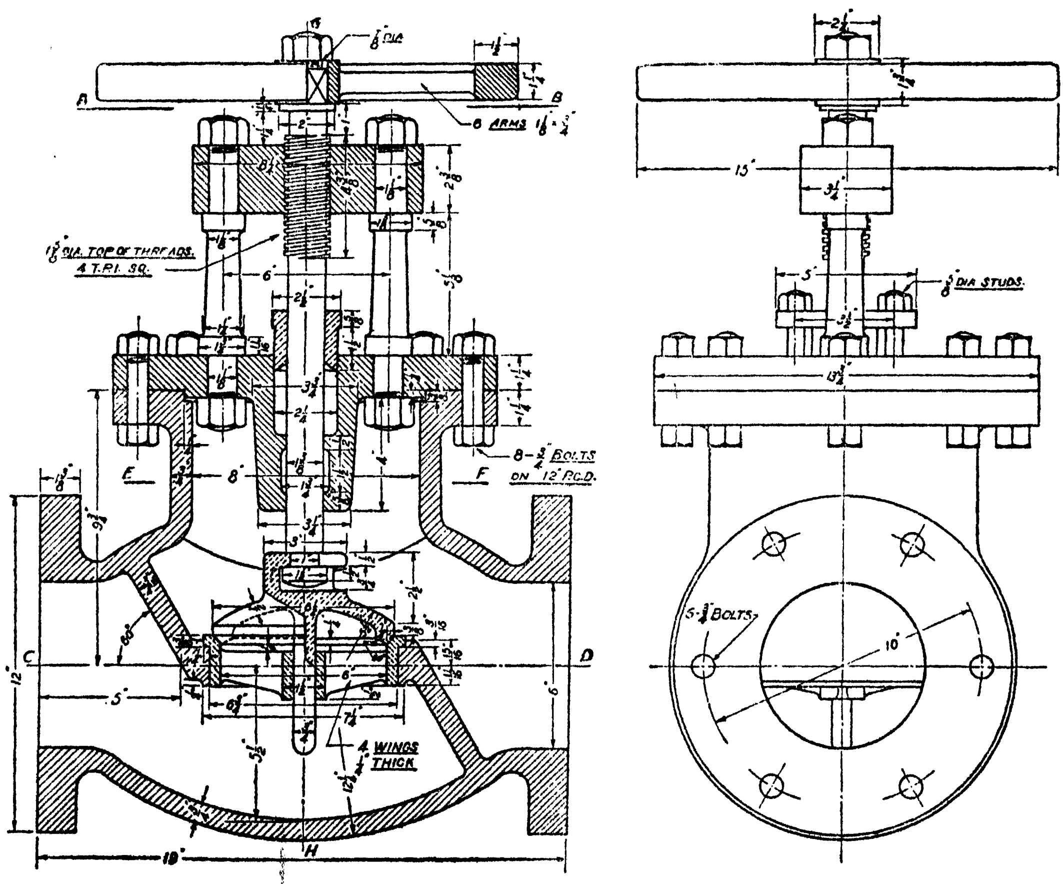
Steam Stop Valve

Ex. 62 (Fig. 80). Draw to scale 4½″ = foot:

(i) The given sectional elevation.

(ii) Half end elevation only.

(iii) Half plan and half sectional plan along EF.



Fɪɢ. 80

Travelling Carriage for Pulley Block

Ex. 63 (Fig. 81). Two views of a travelling carriage are given. The carriage is suitable for transporting loads or small machines or parts in a workshop or factory. Draw to scale $4\frac{1}{2}'' =$ foot :

(i) A complete front elevation.
(ii) End elevation.
(iii) Plan.

Ex. 64. Make another drawing showing the details of all the parts. At least two views of each part are to be drawn.

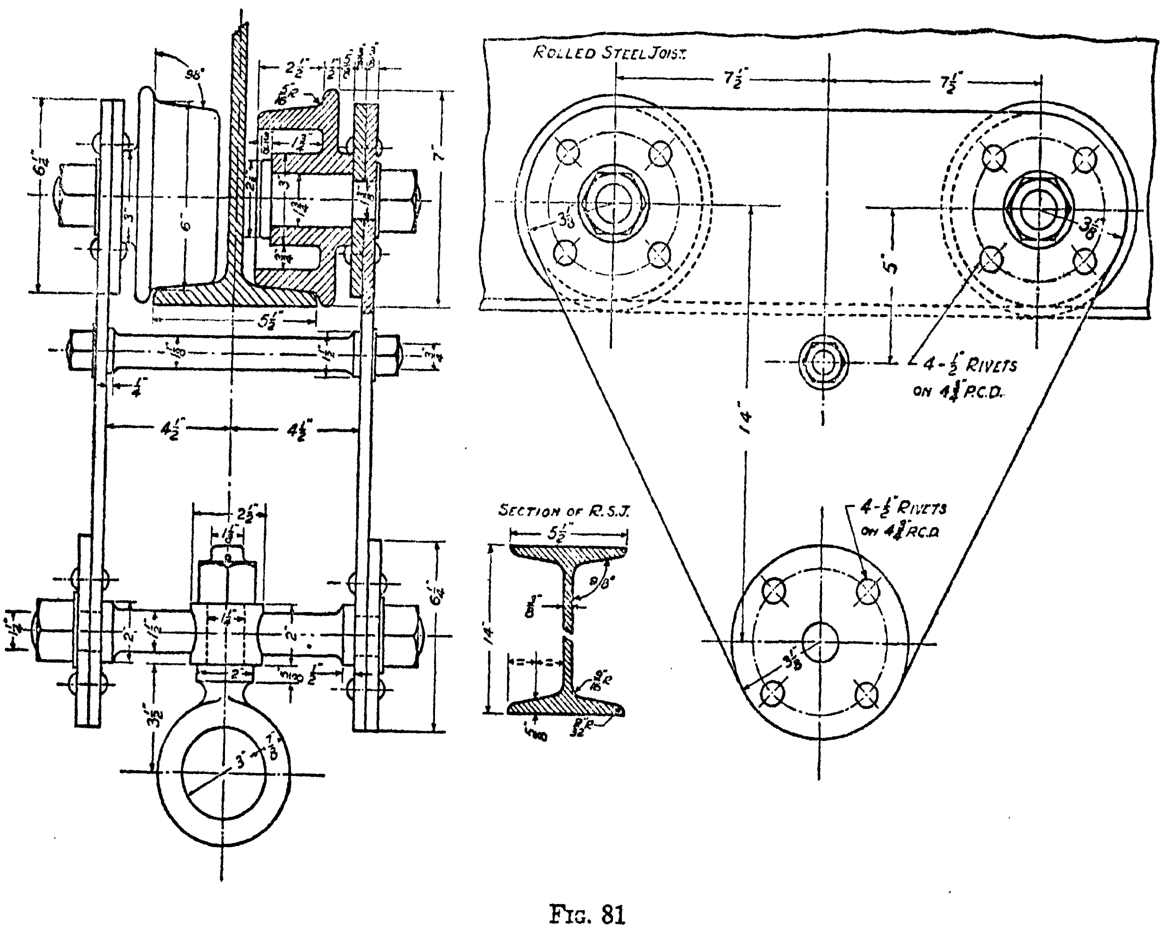


FIG. 81

Machine Vice

Ex. 65 (Fig. 82). Draw to a suitable scale, the details of all the parts and show the parts assembled together in three views. The general assembly drawing should be attempted without consulting the book.

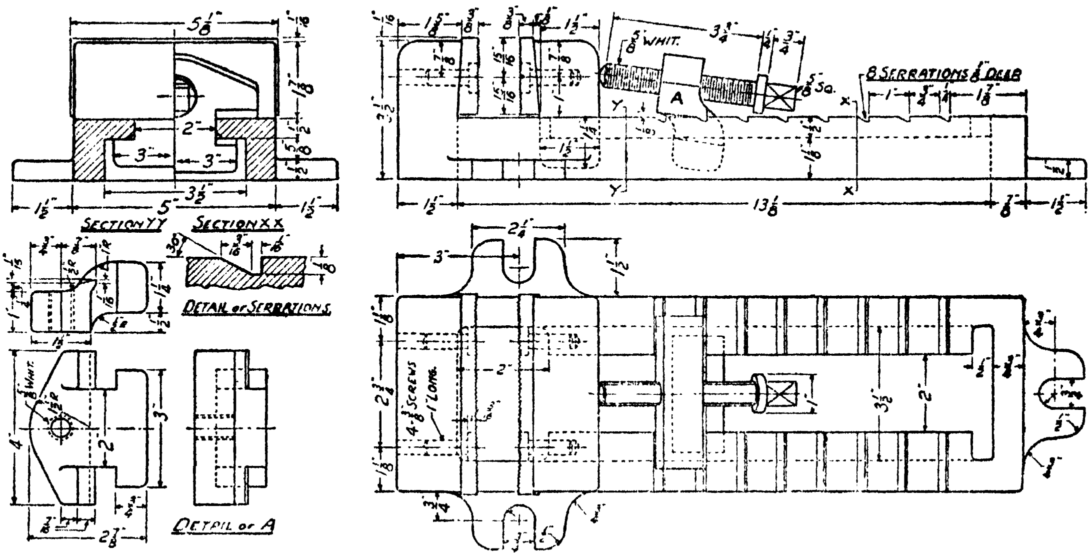


FIG. 82

Ex. 66. In Fig. 83 some particulars of valve box for an I.C. engine are given. Draw the details of all the parts in at least two views to full size scale, and from the details drawn, draw an assembled view corresponding to the one given and add an end view.

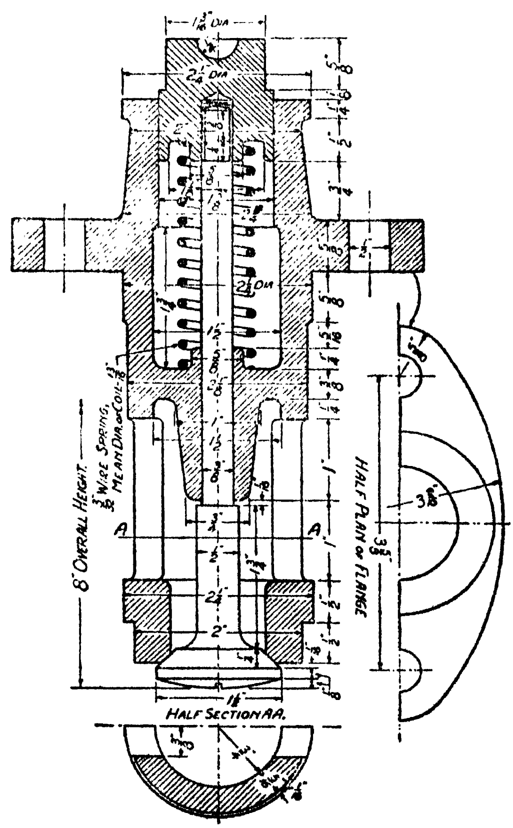


FIG. 83

Lathe Tail Stock

Ex. 67 (Fig. 84). Draw to full size scale:

(i) The given sectional front elevation.

(ii) Half end elevation and half sectional end view on AB, looking along arrow.

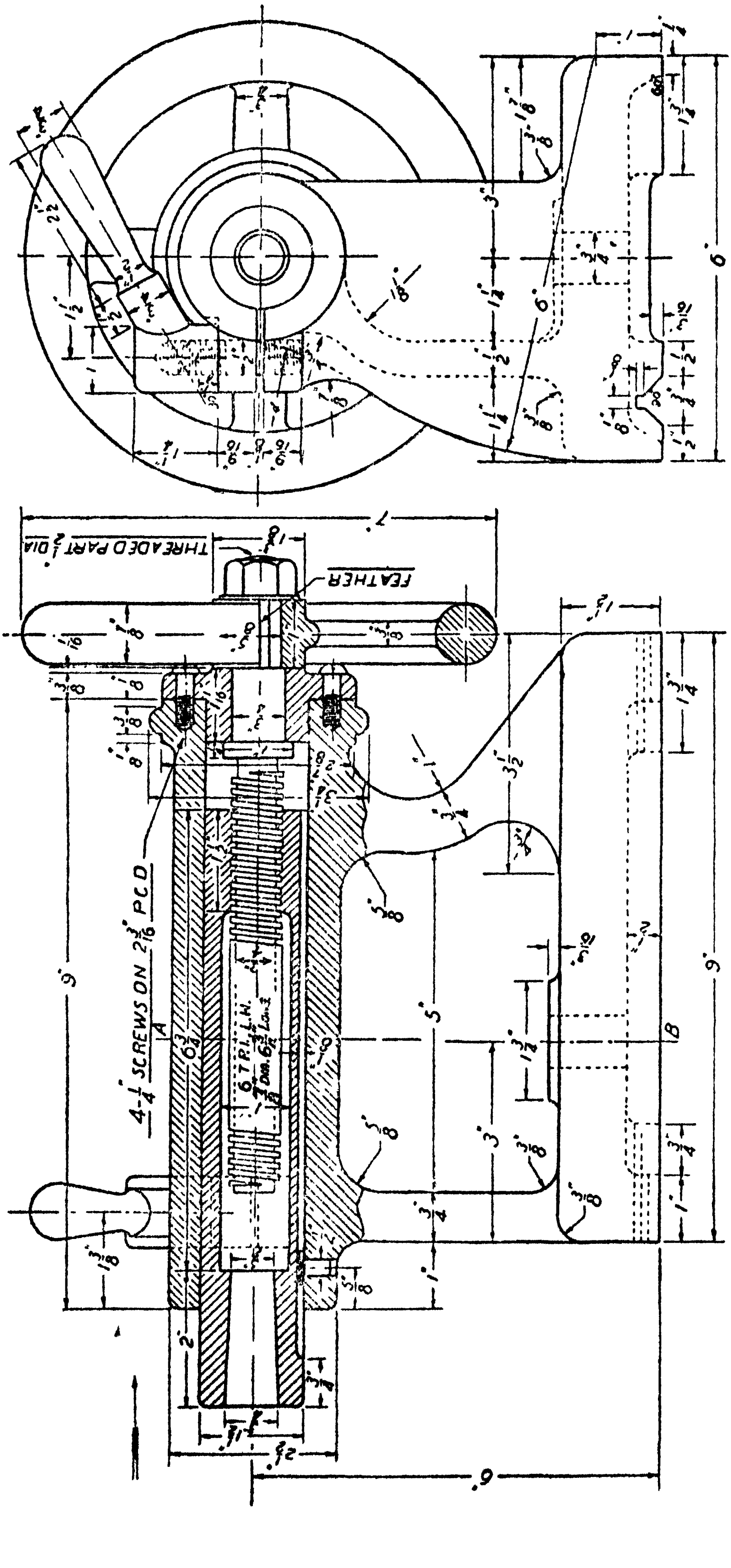


FIG. 84

BOLTS AND NUTS

STANDARD WHITWORTH

(DIMENSIONS ARE IN INCHES)

TABLE—1

Diameter of Bolt D	Bolt Head & Nuts		Number of Threads per Inch	Diameter at Bottom of Threads D_1	Diameter of Tapping Hole
	Width Across Flats	Height of Bolt Head H			
$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{32}$	24	0.134	$\frac{9}{64}$
$\frac{1}{4}$	$\frac{33}{64}$	$\frac{7}{32}$	20	0.186	$\frac{3}{16}$
$\frac{5}{16}$	$\frac{39}{64}$	$\frac{17}{64}$	18	0.241	$\frac{1}{4}$
$\frac{3}{8}$	$\frac{45}{64}$	$\frac{21}{64}$	16	0.295	$\frac{19}{64}$
$\frac{7}{16}$	$\frac{53}{64}$	$\frac{3}{8}$	14	0.346	$\frac{23}{64}$
$\frac{1}{2}$	$\frac{29}{32}$	$\frac{7}{16}$	12	0.393	$\frac{13}{32}$
$\frac{9}{16}$	$1\frac{1}{64}$	$\frac{31}{64}$	12	0.455	$\frac{15}{32}$
$\frac{5}{8}$	$1\frac{3}{32}$	$\frac{35}{64}$	11	0.508	$\frac{33}{64}$
$\frac{3}{4}$	$1\frac{19}{64}$	$\frac{21}{32}$	10	0.622	$\frac{5}{8}$
$\frac{7}{8}$	$1\frac{31}{64}$	$\frac{49}{64}$	9	0.733	$\frac{47}{64}$
1	$1\frac{43}{64}$	$\frac{7}{8}$	8	0.84	$\frac{27}{32}$
$1\frac{1}{8}$	$1\frac{55}{64}$	$\frac{63}{64}$	7	0.942	$\frac{61}{64}$
$1\frac{1}{4}$	$2\frac{3}{64}$	$1\frac{3}{32}$	7	1.067	$1\frac{1}{16}$
$1\frac{3}{8}$	$2\frac{7}{32}$	$1\frac{13}{64}$	6	1.162	$1\frac{11}{64}$
$1\frac{1}{2}$	$2\frac{13}{32}$	$1\frac{5}{16}$	6	1.287	$1\frac{19}{64}$
$1\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{17}{32}$	5	1.494	$1\frac{1}{2}$
2	$3\frac{5}{32}$	$1\frac{3}{4}$	$4\frac{1}{2}$	1.72	$1\frac{23}{32}$
$2\frac{1}{4}$	$3\frac{35}{64}$	$1\frac{31}{32}$	4	1.93	$1\frac{15}{16}$
$2\frac{1}{2}$	$3\frac{57}{64}$	$2\frac{3}{16}$	4	2.18	$2\frac{3}{16}$

(Reproduced from B.S.S. Report No. 190-1924)

TABLE—2

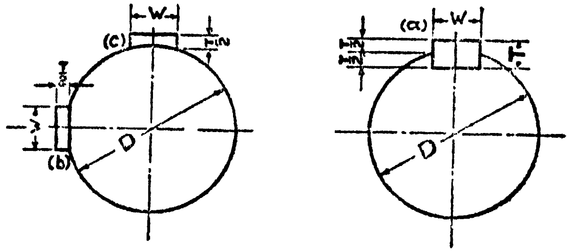


FIG. 86

Dia = D"	Width = W"	Thickness = T"	Dia. = D"	Width = W"	Thickness = T"
$\frac{1}{4}$	$\frac{3}{32}$	$\frac{3}{32}$	4	1	$\frac{11}{16}$
$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{4}$
$\frac{1}{2}$	$\frac{5}{32}$	$\frac{5}{32}$	5	$1\frac{1}{4}$	$\frac{13}{16}$
$\frac{3}{4}$	$\frac{3}{16}$	$\frac{5}{32}$	$5\frac{1}{2}$	$1\frac{3}{8}$	$\frac{15}{16}$
1	$\frac{1}{4}$	$\frac{3}{16}$	6	$1\frac{1}{2}$	1
$1\frac{1}{4}$	$\frac{5}{16}$	$\frac{7}{32}$	$6\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{1}{16}$
$1\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{4}$	7	$1\frac{3}{4}$	$1\frac{3}{16}$
$1\frac{3}{4}$	$\frac{7}{16}$	$\frac{9}{32}$	$7\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{1}{4}$
2	$\frac{1}{2}$	$\frac{11}{32}$	8	2	$1\frac{3}{8}$
$2\frac{1}{4}$	$\frac{9}{16}$	$\frac{3}{8}$	9	$2\frac{1}{4}$	$1\frac{1}{2}$
$2\frac{1}{2}$	$\frac{5}{8}$	$\frac{13}{32}$	10	$2\frac{1}{2}$	$1\frac{5}{8}$
$2\frac{3}{4}$	$\frac{11}{16}$	$\frac{15}{32}$	11	$2\frac{3}{4}$	$1\frac{7}{8}$
3	$\frac{3}{4}$	$\frac{1}{2}$	12	3	2
$3\frac{1}{2}$	$\frac{7}{8}$	$\frac{5}{8}$			

NOTE.—For intermediate diameters, the next larger size of key applies.

(Reproduced from B.S.S. Report No. 46-1929)

CONVERSION TABLE

(Fractions-Decimals)

TABLE—3

Fractions				Decimals	Fractions				Decimals
			1/64	0.015625				33/64	0.515625
		1/32		0.03125			17/32		0.53125
			3/64	0.046875				35/64	0.546875
	1/16			0.0625		9/16			0.5625
			5/64	0.078125				37/64	0.578125
		3/32		0.09375			19/32		0.59375
			7/64	0.109375				39/64	0.609375
1/8				0.125	5/8				0.625
			9/64	0.140625				41/64	0.640625
		5/32		0.15625			21/32		0.65625
			11/64	0.171875				43/64	0.671875
	3/16			0.1875		11/16			0.6875
			13/64	0.203125				45/64	0.703125
		7/32		0.21875			23/32		0.71875
			15/64	0.234375				47/64	0.734375
1/4				0.25	3/4				0.75
			17/64	0.265625				49/64	0.765625
		9/32		0.28125			25/32		0.78125
			19/64	0.296875				51/64	0.796875
	5/16			0.3125		13/16			0.8125
			21/64	0.328125				53/64	0.828125
		11/32		0.34375			27/32		0.84375
			23/64	0.359375				55/64	0.859375
3/8				0.375	7/8				0.875
			25/64	0.390625				57/64	0.890625
		13/32		0.40625			29/32		0.90625
			27/64	0.421875				59/64	0.921875
	7/16			0.4375		15/16			0.9375
			29/64	0.453125				61/64	0.953125
		15/32		0.46875			31/32		0.96875
			31/64	0.484375				63/64	0.984375
1/2				0.5	1				1.0

TABLE—4

SCREW THREADS FOR GAS, WATER & STEAM PIPES

Bore of Pipe in Inches	Outside Diameter in Inches	Number of Threads per inch
$\frac{1}{4}$	$\frac{17}{32}$	19
$\frac{3}{8}$	$\frac{11}{16}$	19
$\frac{1}{2}$	$\frac{27}{32}$	14
$\frac{3}{4}$	$1\frac{1}{16}$	14
1	$1\frac{11}{32}$	11
$1\frac{1}{4}$	$1\frac{11}{16}$	11
$1\frac{1}{2}$	$1\frac{29}{32}$	11
$1\frac{3}{4}$	$2\frac{5}{32}$	11
2	$2\frac{3}{8}$	11
$2\frac{1}{4}$	$2\frac{5}{8}$	11
$2\frac{1}{2}$	3	11

The approximate outside diameter of pipes beyond $2\frac{1}{2}$ ins. and up to 6 ins. is equal to bore plus $\frac{1}{2}$ ins. Number of threads is eleven per inch.

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