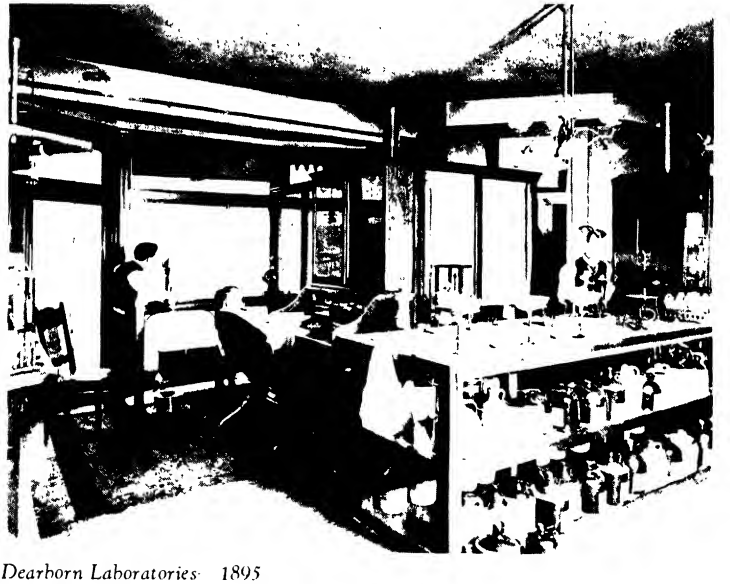
SCIENTIFIC WATER CORRECTION

SCIENTIFIC WATER CORRECTION

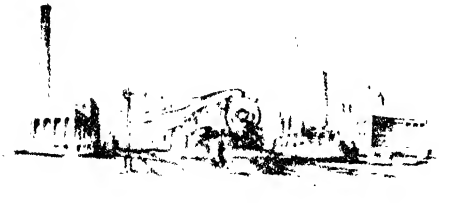
DEARBORN CHEMICAL COMPANY

Concentration of able men and money in factories showed the need and supplied the funds for improve-



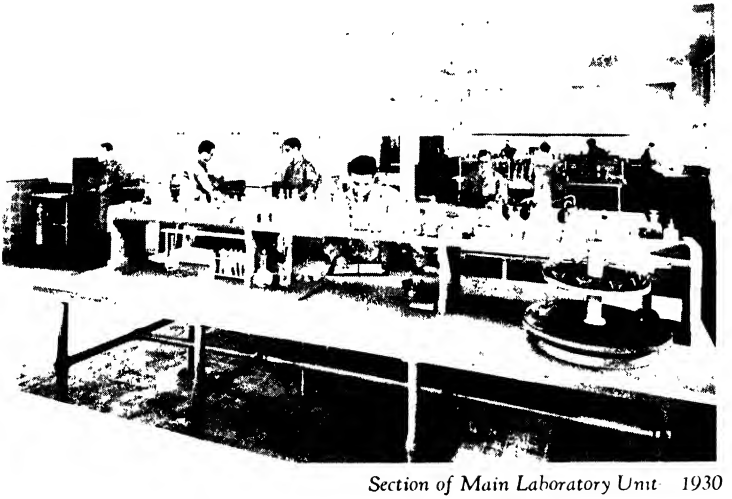
Dearborn Laboratories 1895

ment of method and "research." As a result alchemy, the mysterious art by which men had been trying to turn non-precious metals to gold for centuries, suddenly found a purpose in service to others and became chemistry. Chemistry, in capable and practical hands, disclosed facts so far-reaching, that today a "crowded" country like England supplies healthful living for more



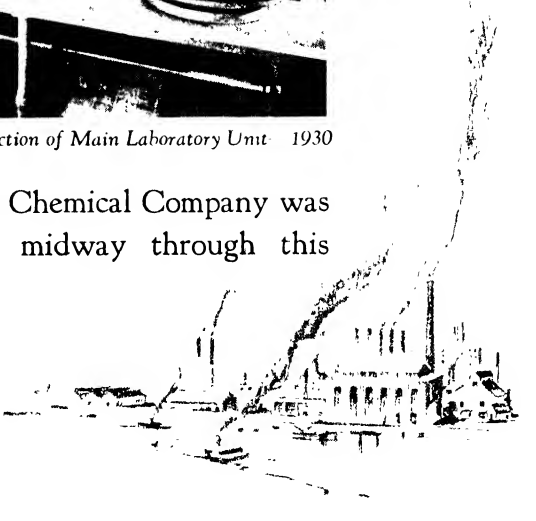
than three times as many inhabitants as she could a century ago.

There accumulated gradually a tremendous increase of knowledge in all lines of progress. A man could no longer know all there was about steam or chemistry. He specialized in his new departure and performed a detailed service for which general knowledge would not have fitted him.

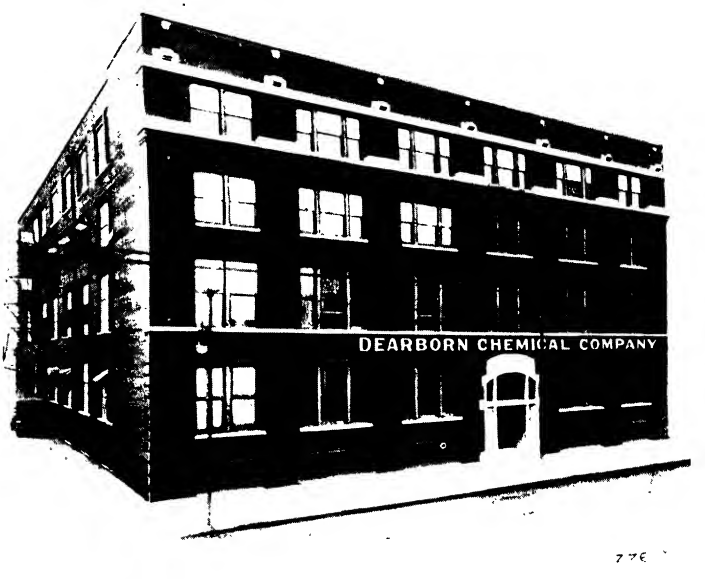


Section of Main Laboratory Unit 1930

Thus, when the Dearborn Chemical Company was founded, at a time about midway through this

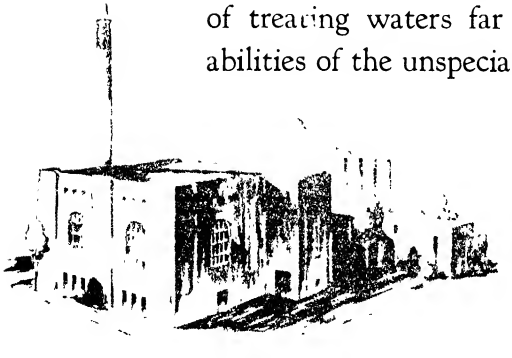


"Century of Progress," the era of specialization was already well under way, but no one had as yet specialized scientifically in the field of correcting harmful tendencies in the waters used for making steam. The Dearborn Chemical Company was the pioneer in its



Principal Building of Dearborn Manufacturing Plant at Chicago

chosen field, and specializing, has carried the science of treating waters far beyond the conceptions and abilities of the unspecialized.



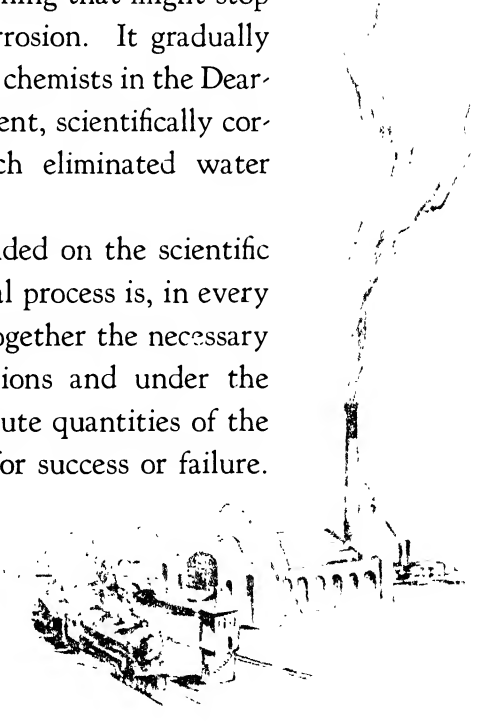
FOREWORD

The old time "boiler compound" flourished half a century ago, because it was the best remedy known,

Factory in Los Angeles

and the engineer grasped at anything that might stop foaming, scale formation and corrosion. It gradually dropped out of sight, however, as chemists in the Dearborn Laboratories produced efficient, scientifically correct treating preparations which eliminated water trouble.

The Dearborn method is founded on the scientific fact that the success of a chemical process is, in every case, dependent upon bringing together the necessary reagents in the correct proportions and under the proper physical conditions. Minute quantities of the essential materials may account for success or failure.



The choice of reagents and the use of the proper quantities is therefore all important.

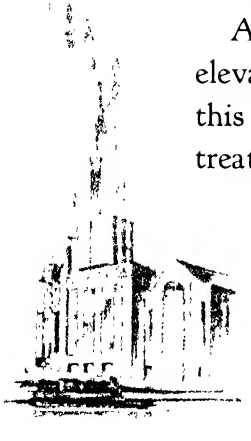
The treatment of boiler water by the application of small quantities of properly adjusted chemicals directly to the feed water, results in the complete control of

Factory in Toronto

water troubles with respect both to economical and efficient steam production.

Many years of practical experience supplemented by extensive experimental research, have developed suitable methods for controlling scale formation, corrosion and foaming by this means.

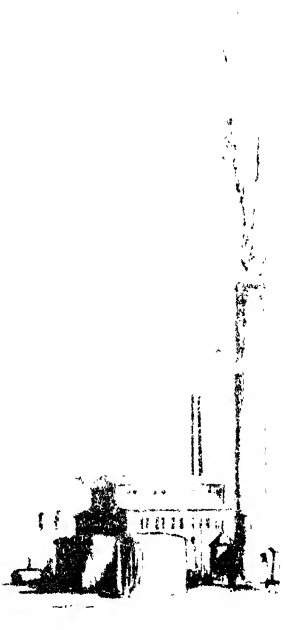
A more complete knowledge of chemical reactions at elevated temperatures and pressures has made possible this step forward in the science of internal feed water treatment.



FOREWORD

In the following pages the principal considerations in the subject of internal treatment are pointed out; a logical method of treating water is discussed and useful data relative to water chemistry is presented. The service and equipment of the Dearborn Chemical Company is discussed in its relation to scientific water correction. The accompanying laboratory pictures have all been taken in the new greater Dearborn Laboratories. The necessity for enlarging our facilities speaks for itself. This latest expansion is the third in the last twenty years.

A House of Chemical Engineers
in Service to Industry
Since 1887



Dearborn Chemical Company

General Offices

310 South Michigan Avenue — Chicago

General Laboratories

1029 West 35th Street — Chicago

General Eastern Office

205 East 42nd Street — New York City

Factories in the United States

Chicago — Los Angeles

Branch Offices in the United States

647 Martin Building
Birmingham, Ala.

38 Chauncy Street
Boston, Mass.

2001 Union Central Building
Cincinnati, Ohio

1205 Terminal Tower Building
Cleveland, Ohio

1012 U. S. National Bank Building
Denver, Colo.

2809 Book Tower
Detroit, Mich.

312 Traction Terminal Building
Indianapolis, Ind.

717 Commerce Building
Kansas City, Mo.

807 Mateo Street
Los Angeles, Cal.

4084 Plankinton Building
Milwaukee, Wis.

478 Bourse Building
Philadelphia, Pa.

618 Farmers Bank Building
Pittsburgh, Pa.

727 Frisco Building
St. Louis, Mo.

252 Spear Street
San Francisco, Cal.

518 City Bank Building
Syracuse, N. Y.

Factories in Other Countries

Toronto, Canada — Redfern, Australia

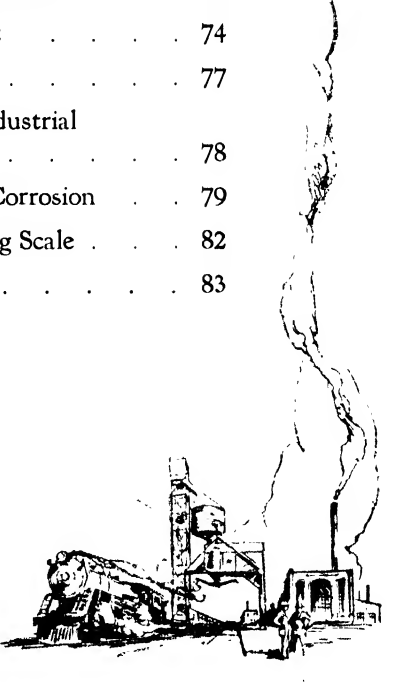
Havana, Cuba

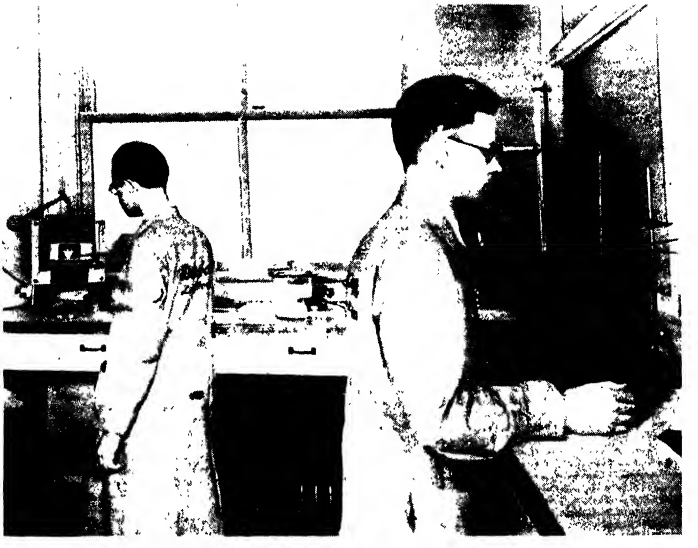
Branches and Selling Agencies in Other Countries

Toronto
Honolulu
Manila
Havana
Mexico City
Buenos Aires
Montevideo
Barcelona
Paris
London
Santiago
Lima
Oruro
Tientsin
Shanghai
Calcutta
Sydney
Johannesburg

Efficient feed water treatment
is necessary for
Economical Steam Production

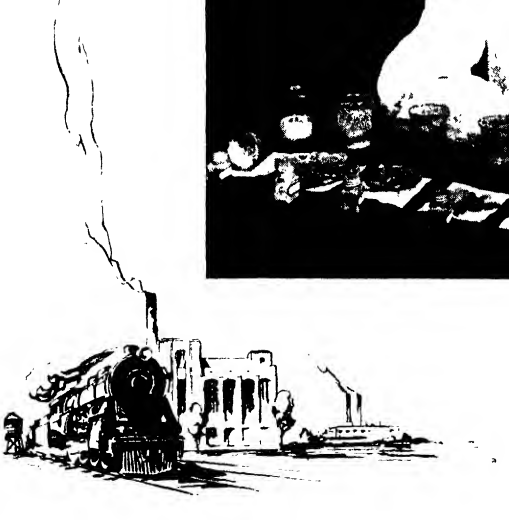
TABLE OF CONTENTS





Coal Analysis—Determinations of B. T. U. and Volatile Matter

Analyses of Boiler Scale



Chapter 1

BACK OF THE NAME "DEARBORN"

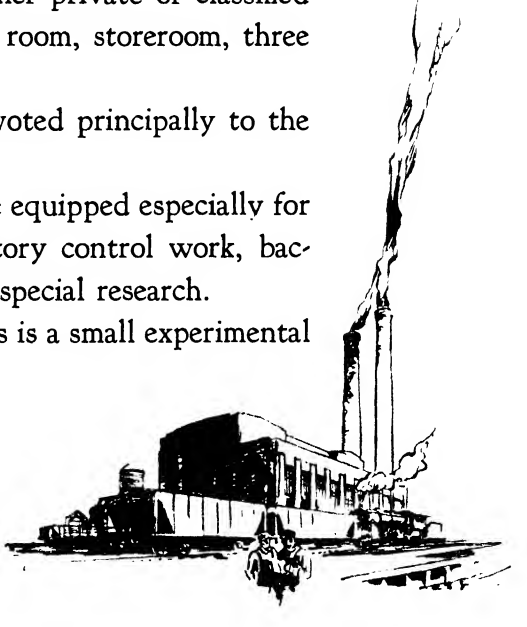
IT IS FITTING that an organization whose chosen work is founded on chemical analysis and research should build itself around its laboratories. These new laboratories pictured throughout this book are a proud necessity in this company's world-wide service. They are indeed a splendid tribute to the vision, enthusiasm and sincerity of the company's founders.

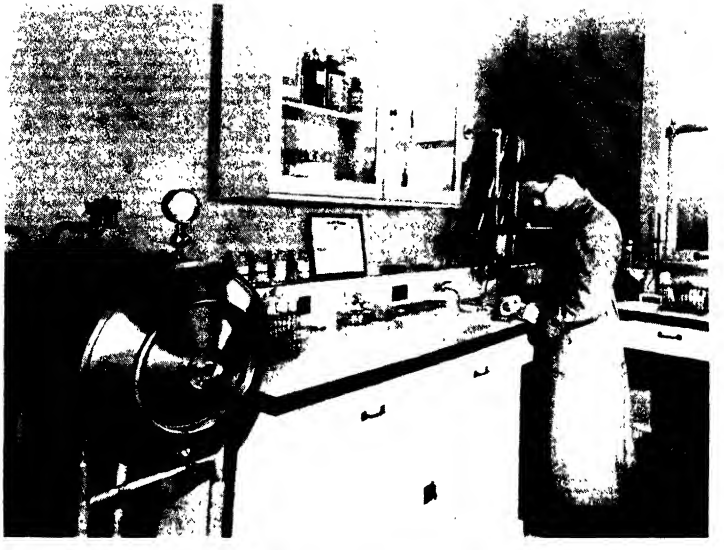
The new laboratories are complete in themselves—they occupy the second floor of a special building at the Chicago plant and comprise a main laboratory around which are grouped eight smaller private or classified laboratory rooms, a receiving room, storeroom, three offices and a library.

The main laboratory is devoted principally to the work of water analysis.

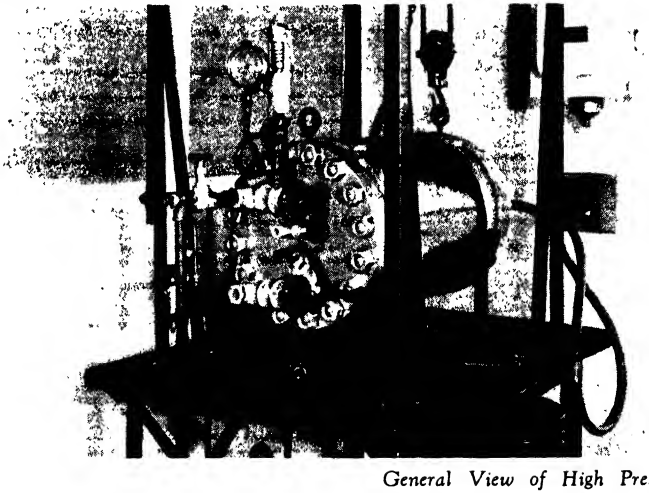
The eight smaller rooms are equipped especially for coal analysis, oil testing, factory control work, bacteriological examinations and special research.

In one of the research rooms is a small experimental

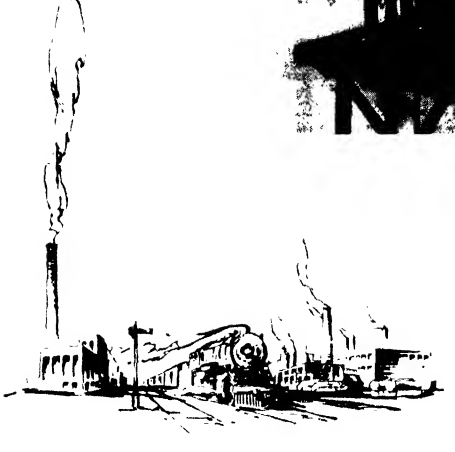




Bacteriological Analysis of Water—Preparation of Culture Media



General View of High Pressure Experimental Boiler (500 lbs.)



boiler capable of operation up to 500 lbs. pressure from which samples can be removed and into which water and chemicals can be forced at any time. It is heated by horizontal electrical elements similar in location to boiler tubes. Another boiler has glass insets to permit actual interior observation.

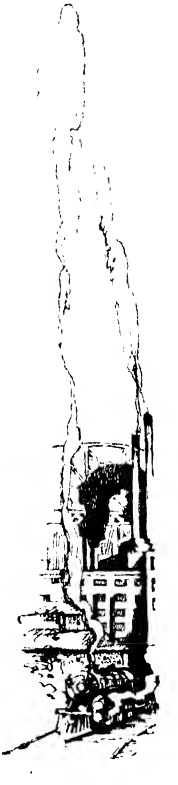
The library is a room about eighteen by twenty-four feet—bookcase lined—in constant use for reference and research. Articles, abstracts and references covering every subject in which the company has an interest which have been collected over a period of many years are catalogued, carded and indexed.

The senior executives and many of the men throughout the entire organization are graduate chemists and engineers.

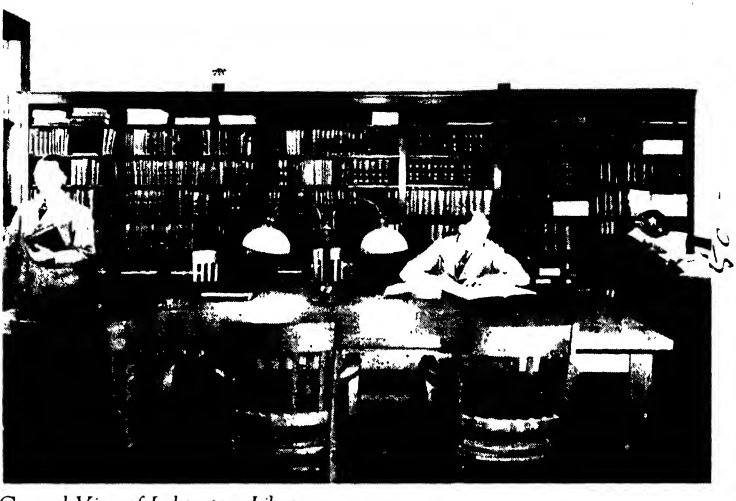
The laboratory staff is made up of college men. They devote their time principally to water analysis and research.

These men represent the freshest, keenest viewpoints in chemistry and engineering. They advise and consult with our older scientists who have been seasoned in practical service to the customers of this company for many years.

In the manufacture of Dearborn Treatment, the newest approved methods are followed, and much

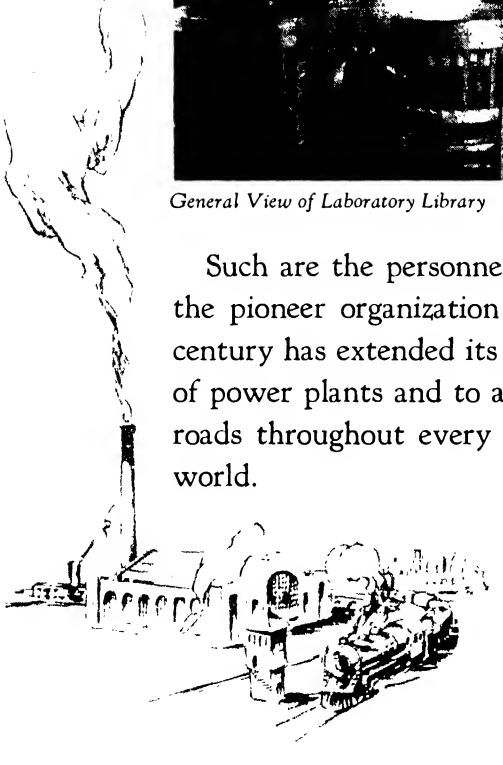


especially designed machinery is used. In conjunction, Dearborn Laboratories maintain exacting factory control work, both in the selection of raw materials and in watching the quality of finished Dearborn products.



General View of Laboratory Library

Such are the personnel and scientific equipment of the pioneer organization which during nearly a half century has extended its service into many thousands of power plants and to a large percentage of the railroads throughout every power-using country in the world.

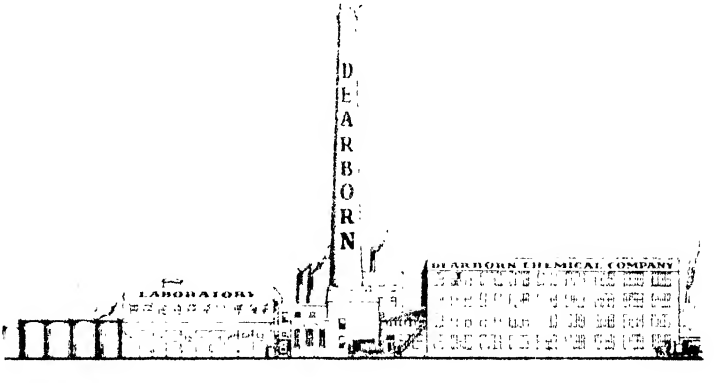


Chapter 2

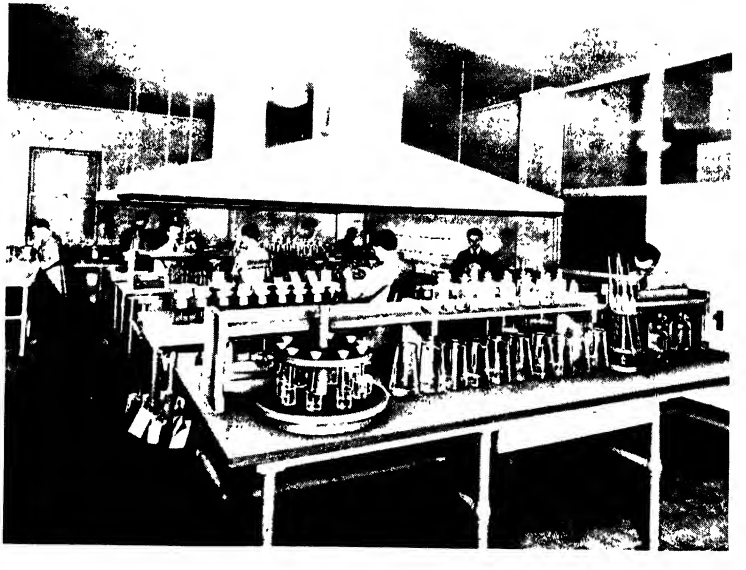
DEARBORN SERVICE

THE MORE difficult the solution of your problem, the more intensely will the Dearborn Chemical Company apply itself, and you have our entire organization to call in consultation. You and the men of your own company as well must be interested in the success of Dearborn Methods as applied to your problems and must lend your aid in carrying out the prescribed routine. If this is done, you may be assured that the broad understanding of the subject and the scientific methods employed by the Dearborn Chemical Company will bring an end to your boiler water troubles.

A message to one of our Branch Offices or to the General Offices at Chicago will put you in touch with a Dearborn representative.



Receiving Room Entering and Numbering Water Samples



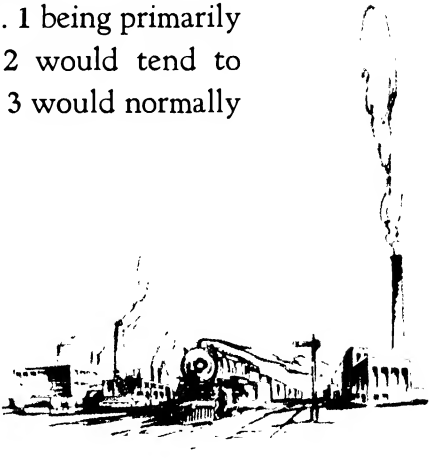
General View of Water Unit

Chapter 3

THE WATER ANALYSIS AND ITS INTERPRETATION

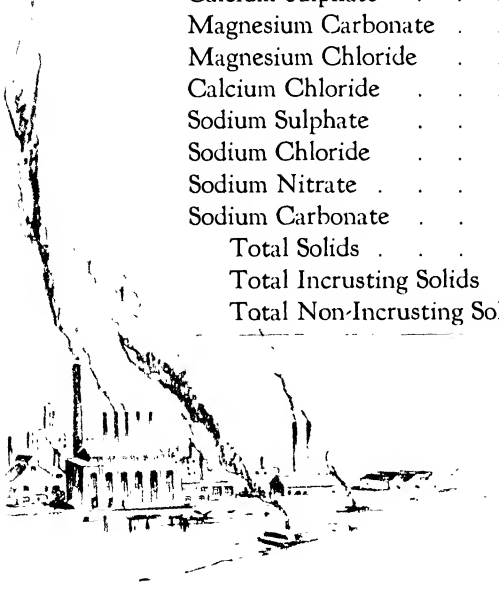
THE FIRST step in the preparation of a proper boiler water treatment is the obtaining of a complete and accurate mineral analysis of the water. Wide variations in the mineral content of natural waters make impossible any general treatment to meet all conditions. Together with the water analysis, and information as to its possible variation, boiler operating conditions and complete plant data are also necessary in making recommendations for the most suitable treatment and dosage required. The Dearborn Chemical Company makes water analyses and recommendations without charge.

The three analyses shown on page 26 represent waters of widely different types, No. 1 being primarily a scale-forming water, while No. 2 would tend to cause corrosion and pitting and No. 3 would normally result in foaming.



First Filtration of Water Samples for Determination of Suspended Matter

	1 Gr. per gal.	2 Gr. per gal.	3 Gr. per gal.
Silica	.231	.241	.220
Oxides of Iron and Aluminum	.050	.070	.070
Calcium Carbonate	5.120	2.311	3.250
Calcium Sulphate	2.102	....	.....
Magnesium Carbonate	3.025	1.017	2.657
Magnesium Chloride	.....	3.712	.....
Calcium Chloride	.....	1.532	.....
Sodium Sulphate	1.500	trace	5.312
Sodium Chloride	2.235	8.750	8.615
Sodium Nitrate	.....	.735	.....
Sodium Carbonate	.....	.....	5.637
Total Solids	14.263	18.368	25.761
Total Incrusting Solids	10.528	3.639	6.197
Total Non-Incrusting Solids	3.735	14.729	19.564



The mineral solids usually found in water supplies may be divided into the following primary groups with respect to their characteristics in a steam boiler, the items being listed in the order of their importance.

Scale Formation

1 Calcium Sulphate
2 Calcium Carbonate
3 Magnesium Carbonate
4 Magnesium Chloride
5 Calcium Nitrate
6 Silica
7 Oxides of Iron and Aluminum
8 Suspended Matter

Corrosion

1 Oxygen
2 Free Acid
3 Magnesium Chloride
4 Magnesium Sulphate
5 Calcium Sulphate
6 Calcium Chloride
7 Calcium Nitrate
8 Alkali Salts

Foaming

1 Sodium Carbonate
2 Sodium Sulphate
3 Sodium Chloride
4 Sodium Nitrate
5 Suspended Matter
6 Organic Matter

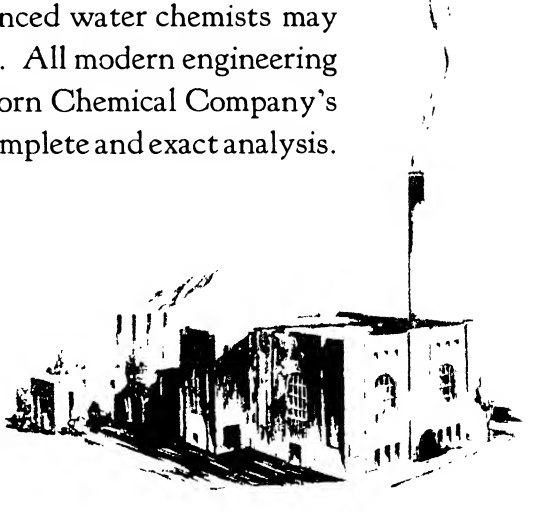
Evaporation of Samples of Water Preparatory to Mineral Analysis

Determinations of Nitrates and Total Solids

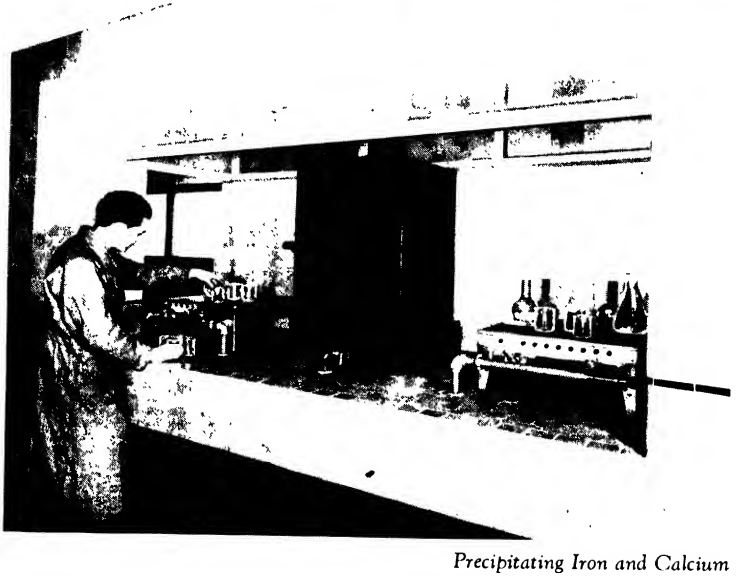
There can be no strict division drawn between waters tending to bring about these conditions for the reason that one water supply may bring about all three conditions, and also there is a close interrelation between these salts in a boiler water which permits only an approximate classification when referring to the water analysis.

A bad scale-forming supply will cause foaming under some conditions of boiler operation and concentrated sodium salts which may cause foaming may also give rise to serious corrosion. The classification will suffice, therefore, in a general way to identify the various impurities in water and will be useful in discussing the water analysis.

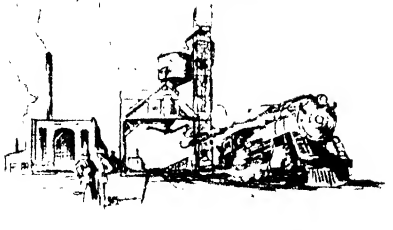
Technical journals frequently print articles on "short cut" methods for determining a water's impurities. These often have value, if carried out exactly, in indicating which direction to look for trouble. But these tests tell only a small part of the story, and in the hands of any but experienced water chemists may create a false sense of security. All modern engineering experience justifies the Dearborn Chemical Company's early conceived standard of complete and exact analysis.



Weighing the Various Substances Obtained from Waters



Precipitating Iron and Calcium



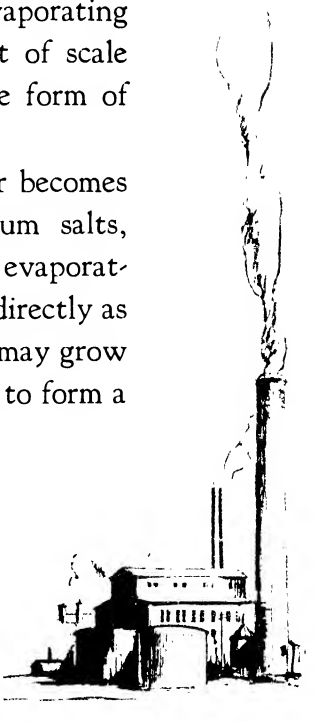
Chapter 4

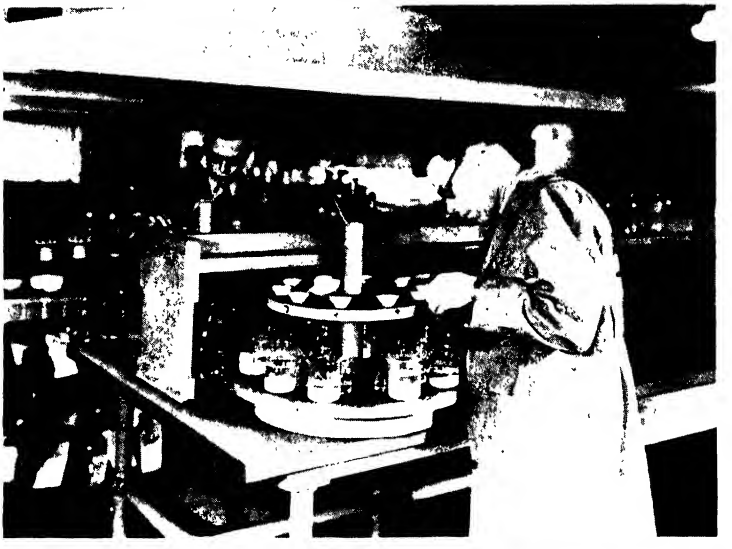
THE MECHANISM OF SCALE FORMATION

DATA relative to the mechanism of scale formation has been obtained by the examination of scale deposits and the use of experimental boilers. The development of high pressure laboratory equipment has made possible accurate figures on the solubility of calcium and magnesium salts and the chemical reactions of dissolved matter which may take place in connection with steam production.

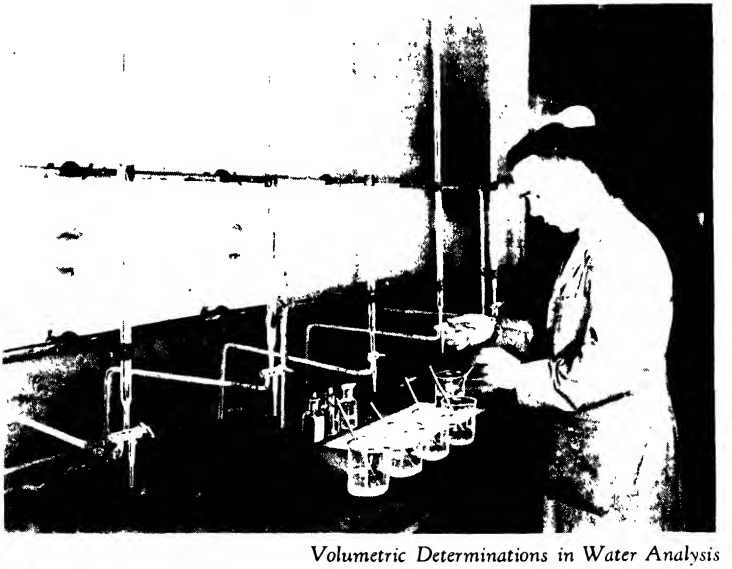
It is apparent that scale deposits may be formed by two methods, (1) by direct deposition on evaporating surfaces, and (2) by mechanical attachment of scale particles already out of solution and in the form of suspended matter.

In the case of the first method, the water becomes supersaturated with calcium and magnesium salts, especially in the film of water directly at the evaporating surface, which as a result are deposited directly as crystals at this point. Crystals once formed may grow in size or new layers may be deposited so as to form a compact and crystalline mass.

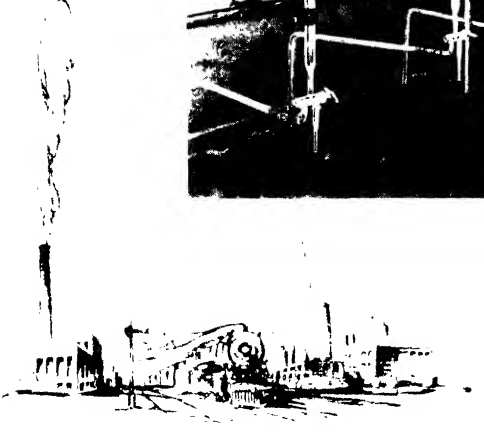




Filtering and Washing Calcium and Sulphate Precipitates



Volumetric Determinations in Water Analysis

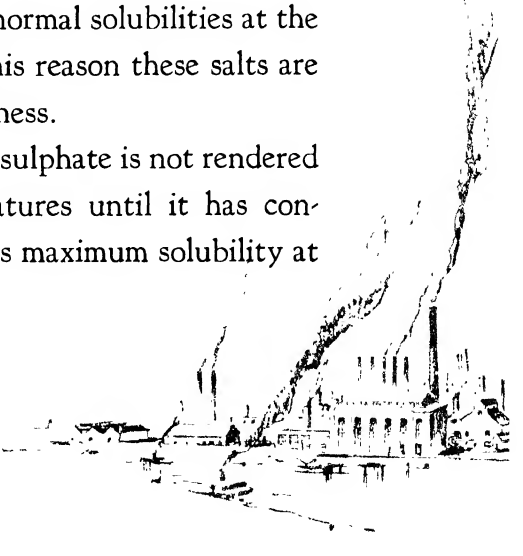


By the second method or mechanical attachment, particles of scale-forming salts which have been formed in the water as a result of temperature or supersaturation are mechanically attached to heating surfaces due to the impingement of these finely divided particles or by the settling out of this suspended material which in turn may bake to a solid mass.

Scale deposits formed by both methods may be found in the same boiler, depending upon the rate of evaporation and temperature of heating surfaces.

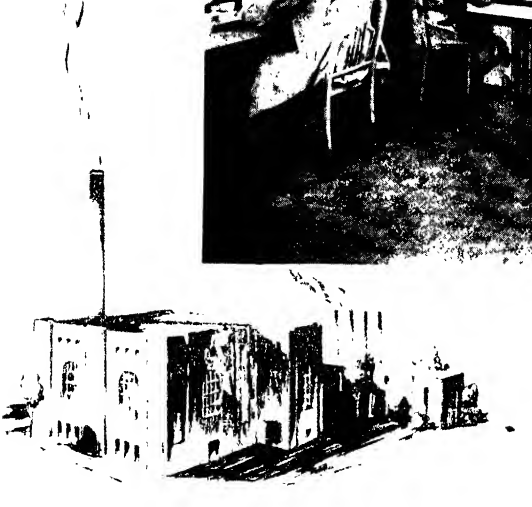
In considering further the details of this action it becomes necessary to differentiate between the solubilities of sulphates and carbonates in a boiler water. Calcium and magnesium carbonates are held in solution by carbon dioxide gas and are therefore present in a water supply as bicarbonates. When water is brought to the boiling point, the gas is driven off and the normal carbonates are rendered insoluble to a point equivalent to their normal solubilities at the temperature involved. For this reason these salts are referred to as temporary hardness.

On the other hand, calcium sulphate is not rendered insoluble at elevated temperatures until it has concentrated up to the point of its maximum solubility at



Igniting Silicas and Sulphates

General View of Balance Room



the given temperature. For this reason it is called permanent hardness. Figures 1 and 2 show the solubility values for calcium sulphate and carbonate at various pressures.

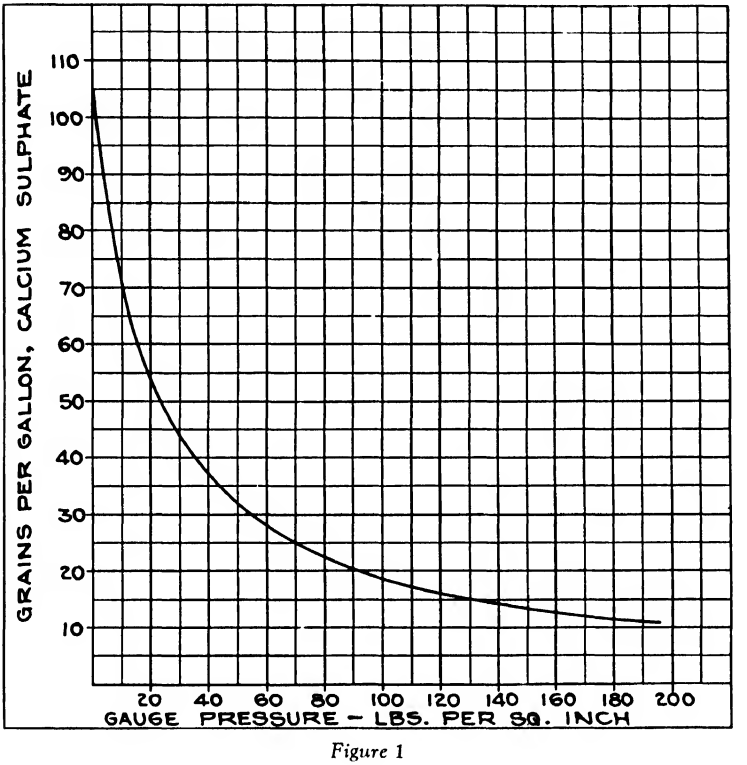
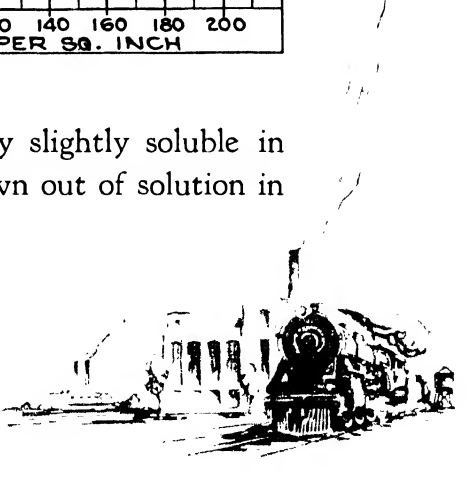


Figure 1

Calcium carbonate being only slightly soluble in water at 212° F. is partially thrown out of solution in



the heater or feed lines and tends to form deposits at these points and also in the boiler near where the feed water enters. These deposits are as a rule soft and granular, but will cause considerable trouble unless corrective measures are taken.

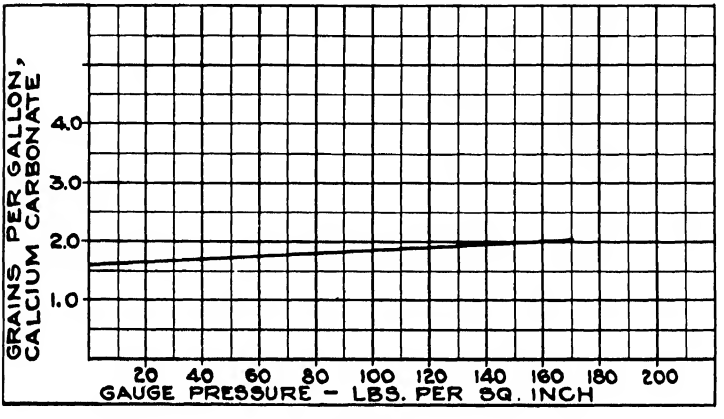
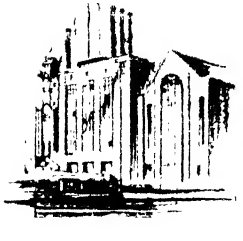


Figure 2

As the water temperature increases, its capacity for carrying most dissolved salts increases, but since the water is evaporating and concentrating, maximum solubility is soon reached. Thereafter, the carbonates will be going into the solid phase at all times, either building scale by direct deposition or forming suspended matter which may become mechanically attached to heating surfaces.

Even though calcium carbonate is slightly more



soluble at higher temperatures, the rate of formation of the solid phase is much more rapid than the tendency to redissolve. The slow rate of solution is due to the

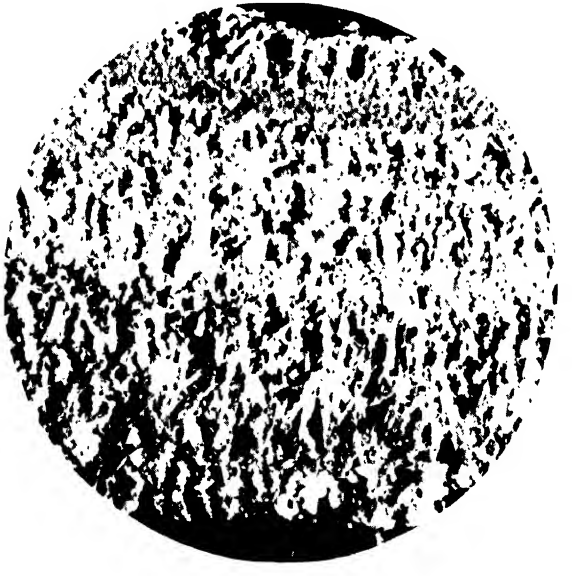
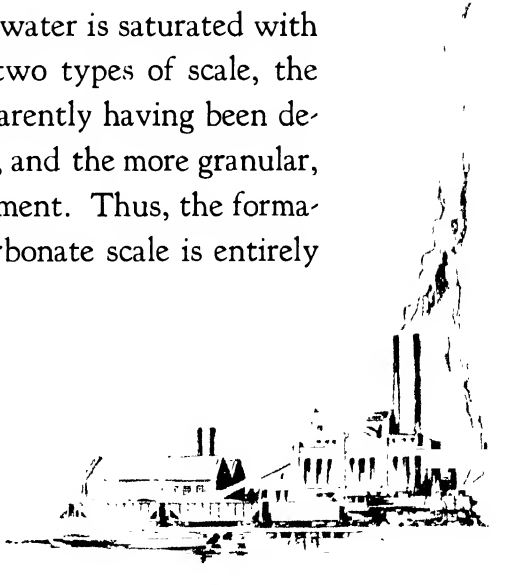


Figure 3

fact that in all cases the boiler water is saturated with this salt. Illustrations show two types of scale, the dense formation, Figure 3, apparently having been deposited by direct precipitation, and the more granular, Figure 4, by mechanical attachment. Thus, the formation of hard and insulating carbonate scale is entirely possible.



The solubility curve for calcium sulphate shows a different result in that this salt becomes more insoluble as the temperature increases. Theoretically a boiler

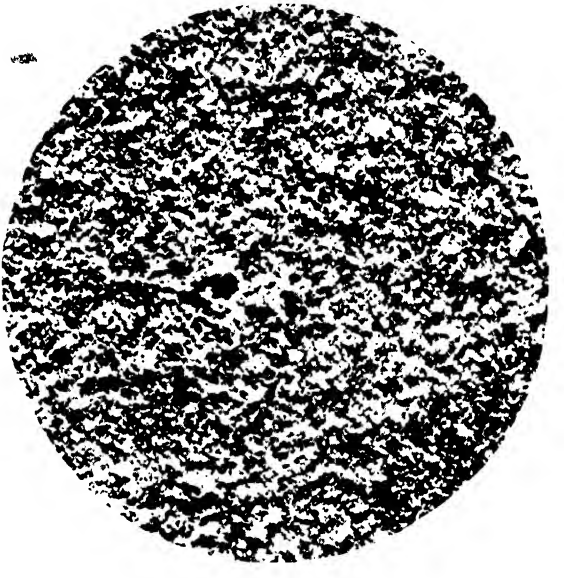
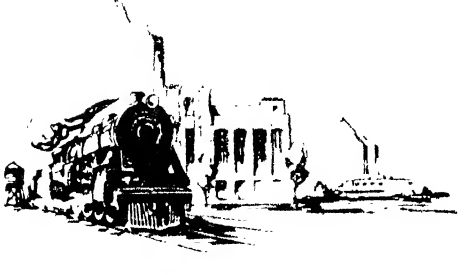


Figure 4

operating at 150 pounds pressure (366° F.) could contain water having a concentration of 13 grains per gallon calcium sulphate and still form no sulphate deposits, but such is not the case.

On the other hand, under this condition sulphate scale could be formed only by the first method described or that of direct deposition due to super-

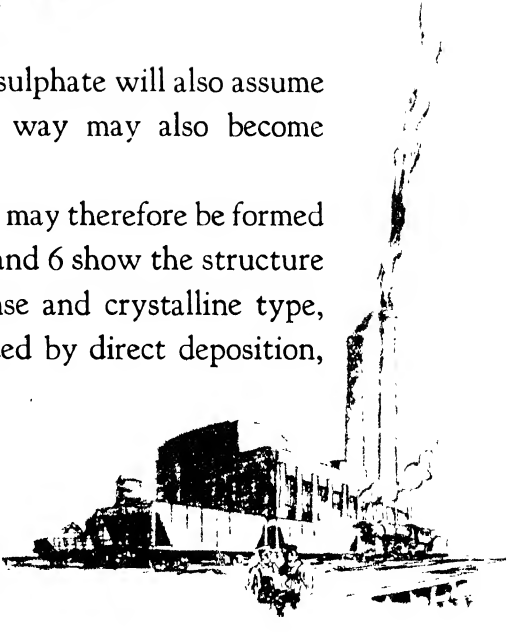


saturation at heating surfaces. However, as the boiler water concentrates, the calcium sulphate continues to increase and when the solubility figure for a given tem-

Figure 5

perature is exceeded, calcium sulphate will also assume the solid phase and in this way may also become mechanically attached.

Two types of sulphate scale may therefore be formed in the same boiler. Figures 5 and 6 show the structure of these forms, the more dense and crystalline type, Figure 5, having been produced by direct deposition,



while Figure 6 clearly shows the cementing effect of the sulphate crystals in a deposit made up of calcium carbonate and calcium sulphate.

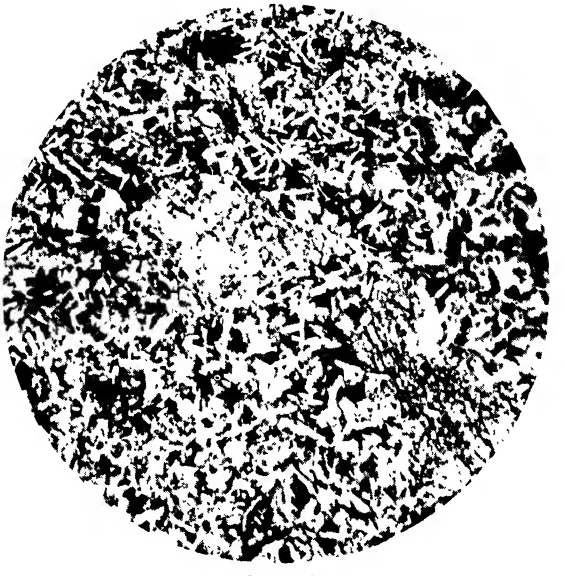
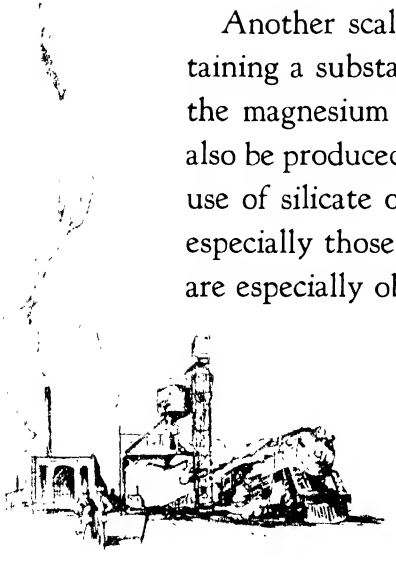


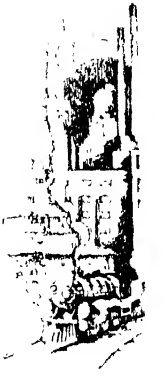
Figure 6

Another scale encountered with some waters containing a substantial amount of silica in solution is of the magnesium silicate type. These formations may also be produced in connection with the indiscriminate use of silicate of soda compounds with some waters, especially those of low mineral content. These types are especially objectionable due to the great difficulty

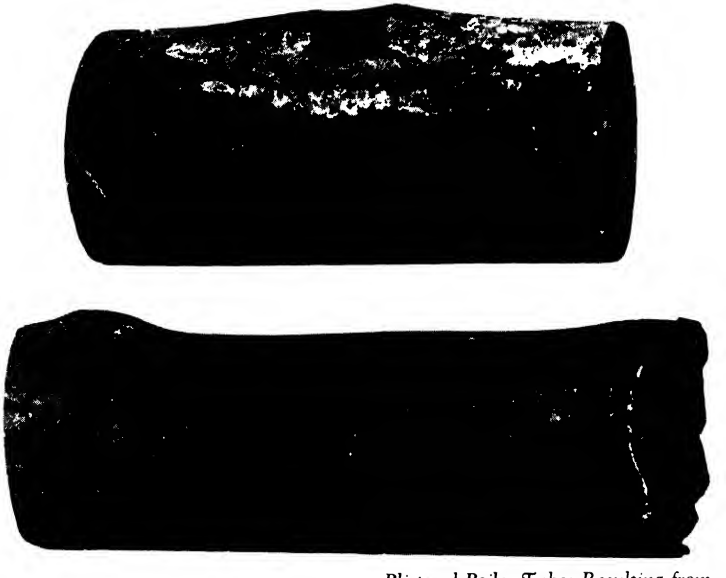


of removal. Various percentages of silica may also be found in scale deposits because of suspended matter in the boiler feed supply. Oxide of iron is an important constituent where corrosion is encountered. Under some conditions calcium hydroxide is found, and if present in sufficient quantity results in a compact and crystalline structure.

Conglomerate of Boiler Scale —Principally Calcium Carbonate



Samples of Boiler Scale



Blistered Boiler Tubes Resulting from Scale or Oil and Overheating

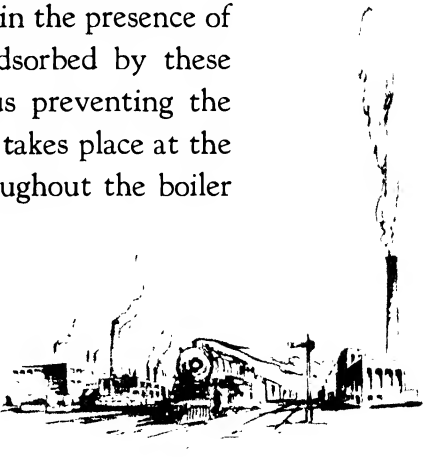
Chapter 5

TREATMENT FOR THE CONTROL OF SCALE FORMATION

TREATING boiler water to bring about a rapid and more complete precipitation of scale-forming salts and to cause the resulting suspended matter to be of such a form as to be readily removed as a sludge is the function of Dearborn Feed Water Treatment.

In furnishing a treatment to meet specific water conditions, the nature and amounts of scale-forming salts together with operating data must be considered. In bringing about the control of scale by this method the sodium salt content of the water is not materially increased and therefore foaming is not aggravated.

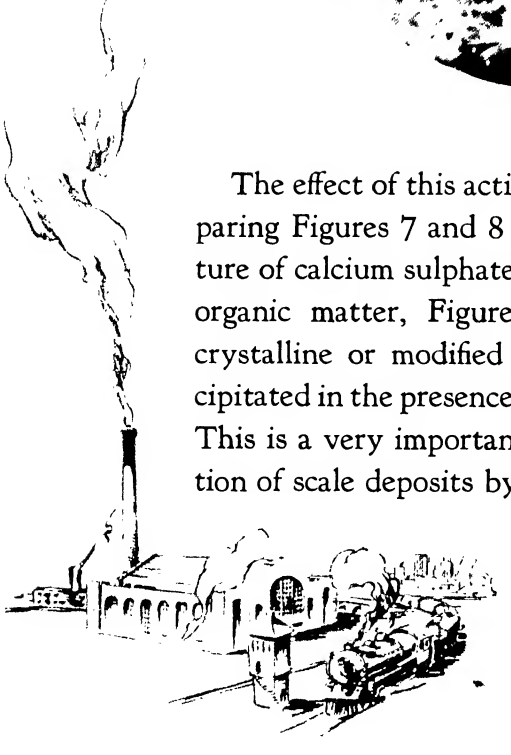
In preparing treatment, carefully selected organic reagents are made use of when the data at hand indicates this specific. The colloidal action of certain of these reagents is especially desirable in the presence of lime and magnesium salts, being adsorbed by these salts as they become insoluble, thus preventing the building up of crystals. This action takes place at the evaporating surfaces as well as throughout the boiler



water itself and functions continuously, provided the treatment is applied uniformly to the feed water.

Figure 7

The effect of this action is clearly illustrated in comparing Figures 7 and 8 showing the crystalline structure of calcium sulphate precipitated in the absence of organic matter, Figure 7, and the definitely semi-crystalline or modified form where it has been precipitated in the presence of organic treatment, Figure 8. This is a very important consideration in the prevention of scale deposits by this method.



Inorganic salts are also made use of to change scaling matter into forms most readily subject to control by this means of treatment.

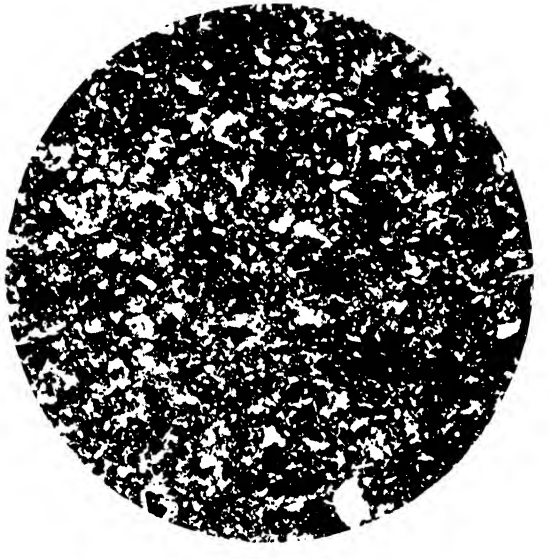
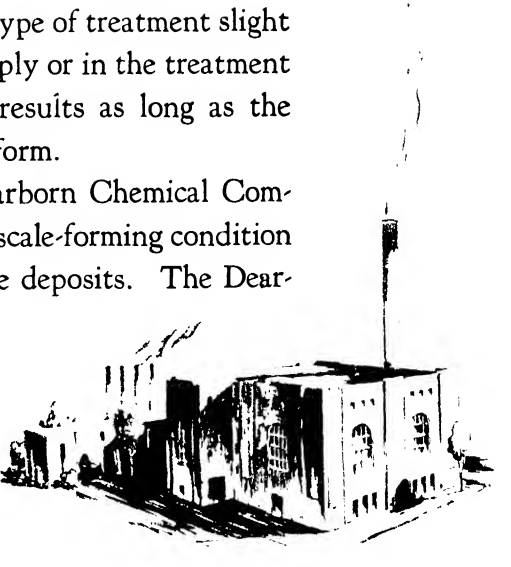


Figure 8

Due to the flexibility of this type of treatment slight variations in the boiler feed supply or in the treatment dosage do not interfere with results as long as the application of treatment is uniform.

In most cases when the Dearborn Chemical Company is called upon to correct a scale-forming condition the boilers already contain scale deposits. The Dear-



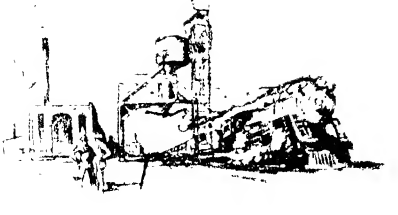
born Treatment supplied not only stops the formation of new scale but also disintegrates the scale already present, bringing it down gradually while the boilers remain in service. This disintegrated scale or sludge can be removed easily by frequent use of the blow-off.

The following report from one of our railroad service men illustrates the effectiveness of this procedure:

> "Inspected two engines. The boiler of engine —— is showing decided improvement, the crown and side sheets showing about 50% clean metal and stays are beginning to scale off. Some of the old scale still in evidence, but don't want it to come down too fast. Engine —— is cleaning up very nicely, showing about 75% clean metal on crown and firebox sheets and the stays are nearly clean. All concerned are very well pleased. Mr. F——— said that the scale had come down in the stationary boilers also."

Another typical case reported recently in the industrial division speaks for itself:

> "They turbined a great deal of the old scale out, but much of it was too hard to be touched by the turbine, and since starting with Dearborn Treatment this remaining scale is now coming down. Today they opened up a boiler and are delighted with conditions as they found them."



Chapter 6

THE REMOVAL OF SCALE DEPOSITS FROM EQUIPMENT OF ALL TYPES

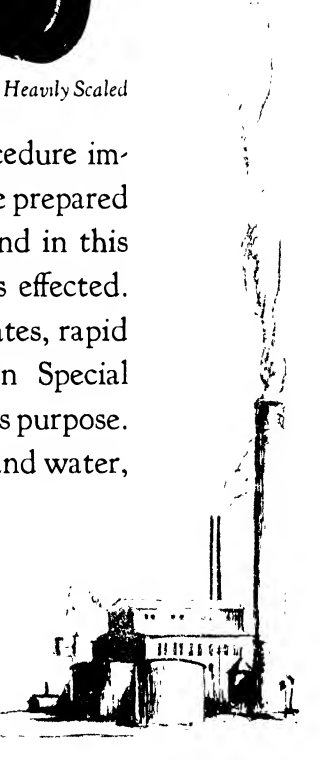
WHEN scale has been allowed to collect on evaporating surfaces, the treatment used for its removal depends upon the composition. Where silicates or calcium sulphate are the principal components, treatment for boiling out is specified. If the

Elbows in Feed Line Heavily Scaled

scale is of such a nature as to make this procedure impractical, regular feed water treatment may be prepared to be used in comparatively large dosages and in this way a gradual disintegration and solution is effected.

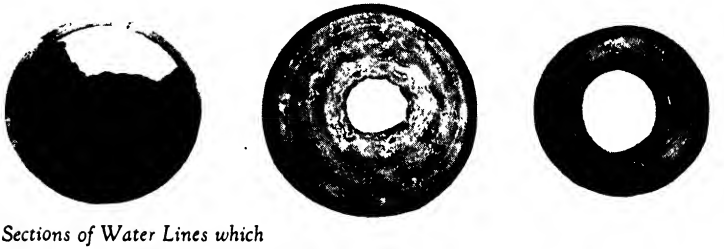
In deposits made up principally of carbonates, rapid cleaning methods are available. Dearborn Special Formula No. 134 has been standardized for this purpose.

By circulating a mixture of this treatment and water,

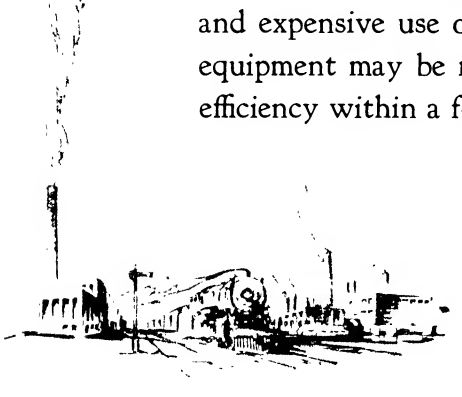


feed lines, heaters, cooling coils, Diesel engine heads and jackets, condensers, pumps, evaporators, water meters, pasteurizers and boilers may be freed from scale in very short periods of time. An average thickness of scale is cleaned off completely in one to three hours.

Extra heavy deposits require a longer time proportionately, but no deposit can be too heavy for complete removal as long as the treatment mixed with water can be forced into contact with the surface of the scale. The dissolved and disintegrated scale is drained off and the equipment thoroughly washed. Dearborn Special Formula No. 134 is reliable and completely effective, eliminating danger of acid or the laborious and expensive use of hand tools. By this means the equipment may be returned to service at its original efficiency within a few hours.

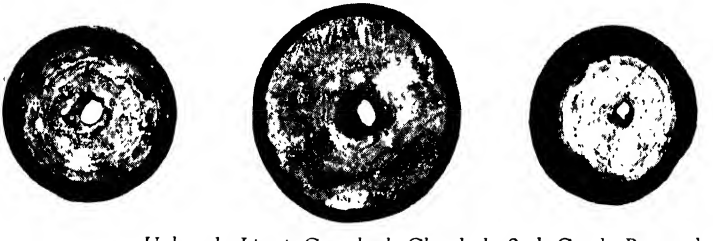


Sections of Water Lines which Dearborn Special 134 has Cleaned



Here as elsewhere the service of the Dearborn Chemical Company follows the product to the satisfactory accomplishment of the purpose for which it is sold. Where practicable, a representative of the company will be present to assist in your first use of Dearborn Special Formula No. 134. In any event detailed instructions will be supplied.

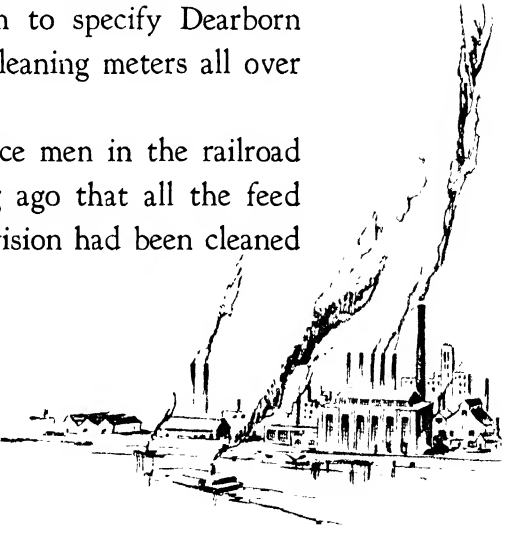
A well known manufacturer of Diesel engines recently sent out a circular letter advising their customers that if they are having scale in their water jackets, the



Unless the Line is Completely Closed, the Scale Can be Removed

best treatment for this trouble is Dearborn Special Formula No. 134. A meter manufacturer with seventy-five salesmen instructed them to specify Dearborn Special Formula No. 134 for cleaning meters all over the United States.

One of the Dearborn Service men in the railroad department reported not long ago that all the feed water heaters on a certain division had been cleaned

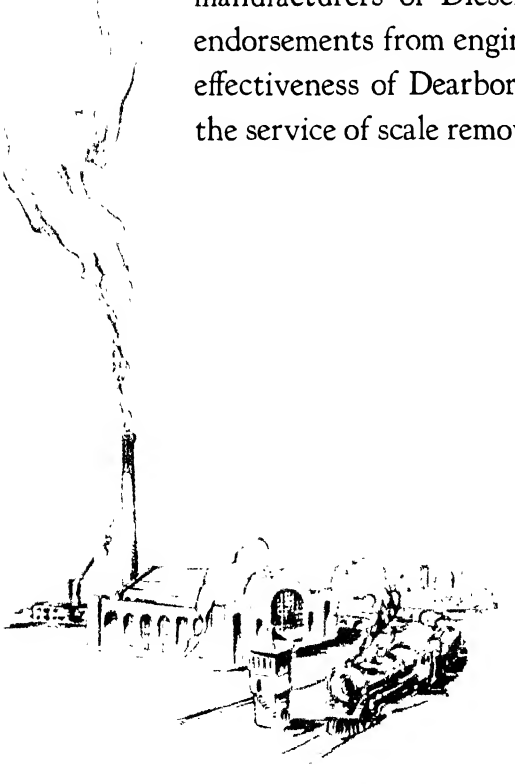


with Dearborn Special Formula No. 134. Everyone concerned was well pleased, as it had made a cleaner job than anything they had ever used and was declared

Removal of Scale Restores Original Capacity

far superior to acid. Another customer reports a saving of eighty dollars a month in cleaning condenser tubes with Dearborn Special Formula No. 134.

Results which bring recommendations for use from manufacturers of Diesel engines and of meters, and endorsements from engineers everywhere, indicate the effectiveness of Dearborn Special Formula No. 134 in the service of scale removal.



Chapter 7

CORROSION

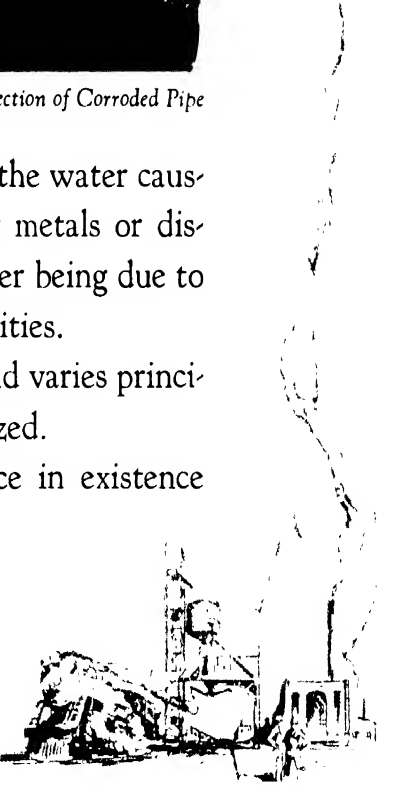
NO LESS important in the treatment of boiler water is the subject of corrosion. This is especially true when the action is localized and pitting results. The contributing causes of corrosion and pitting may be divided into three groups: (1) The presence of dissolved oxygen in the boiler water. (2) The concentration of hydrogen ions or the presence of acids or acid

Section of Corroded Pipe

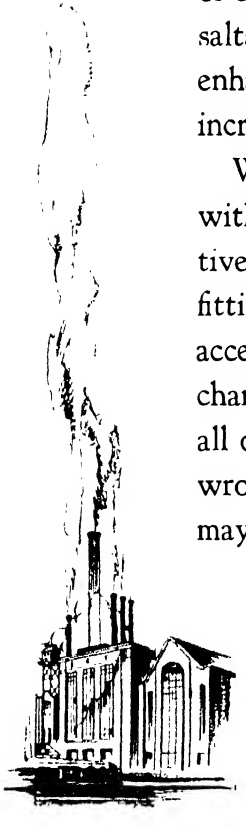
forming salts, and (3) dissolved salts in the water causing galvanic action between dissimilar metals or dissimilar parts of the same metal, the latter being due to strain, temperature variations or impurities.

All corrosion is basically the same and varies principally in the degree to which it is localized.

Science tells us that every substance in existence



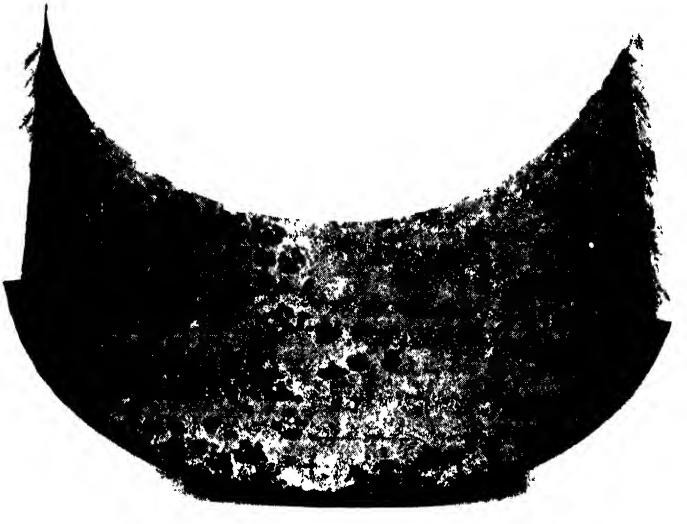
is either electro-negative or electro-positive to every other substance. We also know that it is not uncommon in boiler practice to have present a noticeable galvanic current, which directly results in corrosive action. There are three essentials to galvanic action, viz., an electro-positive area, an electro-negative area and an electrolyte or carrier. Due to the irregular composition, or non-continuity of iron and steel, we have, even in a small area of sheet or flue, the necessary different substances to act as the two poles, and the presence of a layer of water over the surface will act as the carrier. Therefore, we have the necessary elements of corrosion. If the water carries more or less soluble salts, the current-carrying capacity of the water is enhanced and the tendency to corrosion relatively increased.



We must not for a moment lose sight of the fact that with a normally equipped industrial plant or locomotive, the boilers are directly connected with brass fittings, copper ferrules and at times other metallic accessories, to say nothing of the difference in the character of many flues or the flues and shell, or both, all of which tend to corrosion. We may have either wrought iron or steel flues or tubes in a boiler, which may be absolutely as good as it is possible to produce,

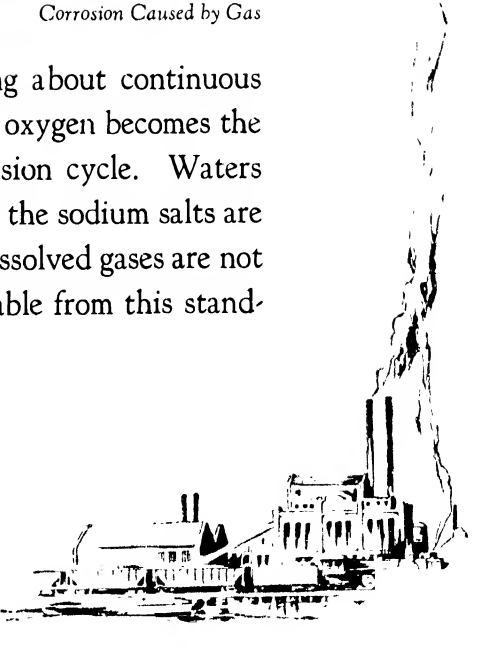
but sufficiently different in their composition to bring about a condition leading up to corrosion.

Science has further pointed out that the presence of dissolved oxygen in boiler water causes the above action



Corrosion Caused by Gas

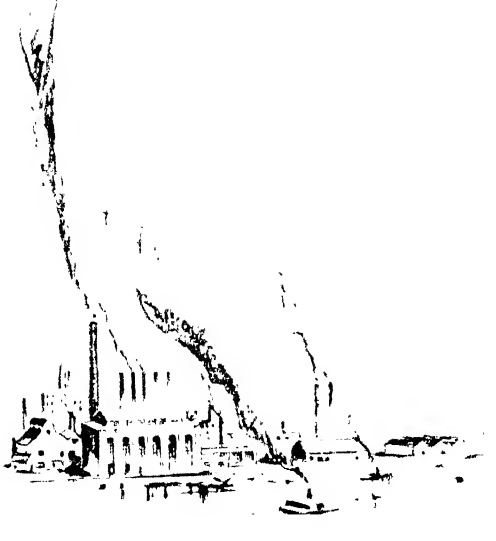
to progress more rapidly, bringing about continuous destruction of boiler metal. Thus oxygen becomes the principal accelerator in the corrosion cycle. Waters treated by softening plants where the sodium salts are materially increased, and where dissolved gases are not removed, are especially objectionable from this standpoint.



Corrosion in the presence of acids or acid-forming salts such as magnesium chloride, progresses rapidly, especially at elevated temperatures. Even such a weak

Severe Corrosion Apparently the Effect of Dissimilar Metals with Probably Some Electrolysis

acid as carbonic becomes active under these conditions, and causes iron to go into solution more rapidly. Calcium sulphate when deposited as scale may also decompose and give rise to acid corrosion.



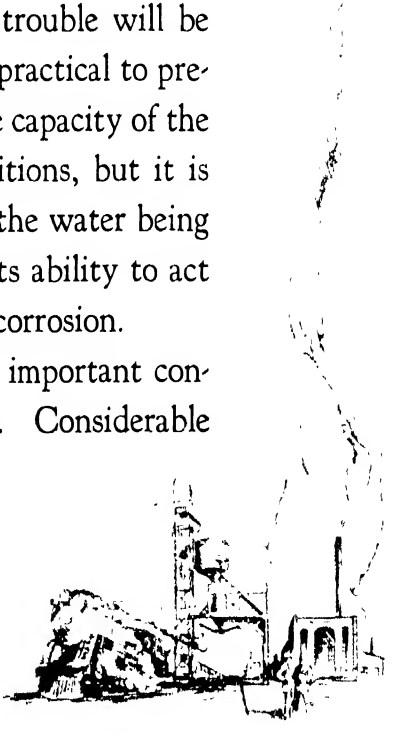
Chapter 8

TREATMENT FOR THE CONTROL OF CORROSION

OXYGEN being present in all natural waters and being the principal corrosion accelerator, the use of internal treatment for absorbing this gas is an important step in corrosion control. Certain organic reagents are of great value in this respect because of their oxygen-absorbing properties. Figure 9 shows the amount of oxygen taken up by one of the most efficient reagents in various concentrations of alkali.

Since there are three essentials to corrosive action. if we can eliminate one of these the trouble will be overcome. It is not, however, always practical to prevent two substances from acting in the capacity of the poles of a battery, under boiler conditions, but it is possible to so change the character of the water being used as a feed supply as to suppress its ability to act as an electrolyte, and thereby control corrosion.

Protective film formation is also an important consideration with some types of water. Considerable



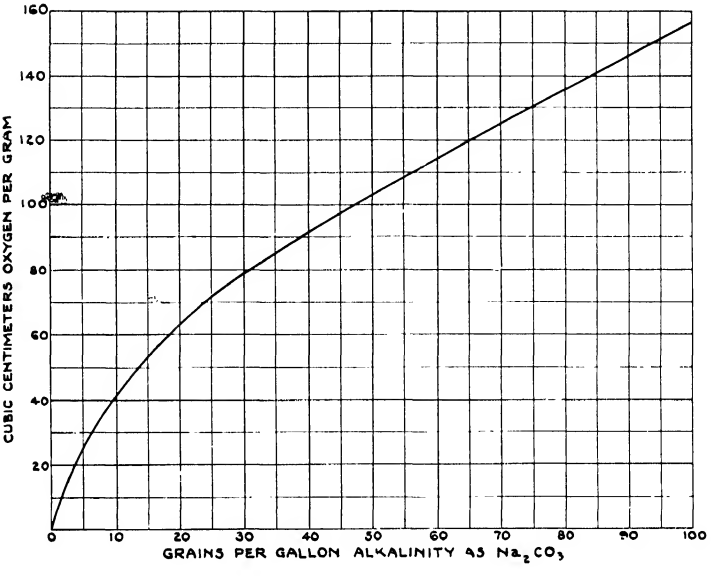
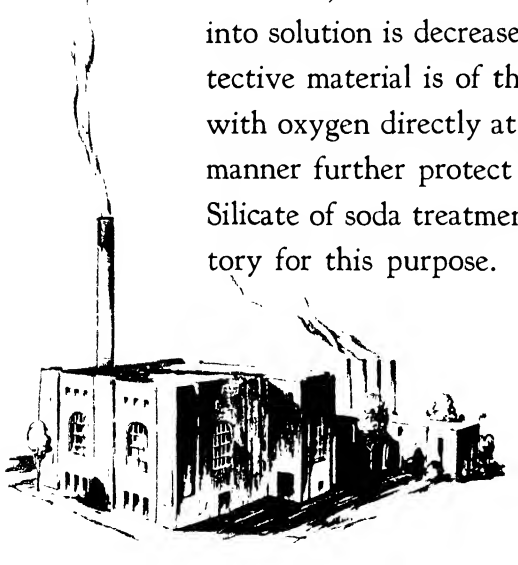


Figure 9

success has been obtained in using this method, which depends upon the formation of a protective coating on the metal, in which case the tendency of the iron to go into solution is decreased. In some instances the protective material is of the type that will also combine with oxygen directly at the metal surfaces and in this manner further protect against progressive corrosion. Silicate of soda treatment has not been found satisfactory for this purpose.

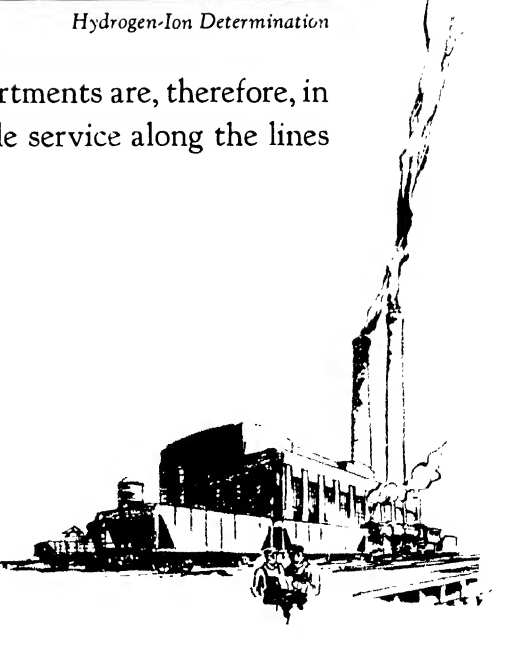


[TREATMENT FOR CORROSION]

The Dearborn Chemical Company has made an intimate study of corrosion in all its forms and has carried on extensive research in this subject for years. Our

Hydrogen-Ion Determination

chemical and engineering departments are, therefore, in a position to offer you valuable service along the lines of corrosion control.



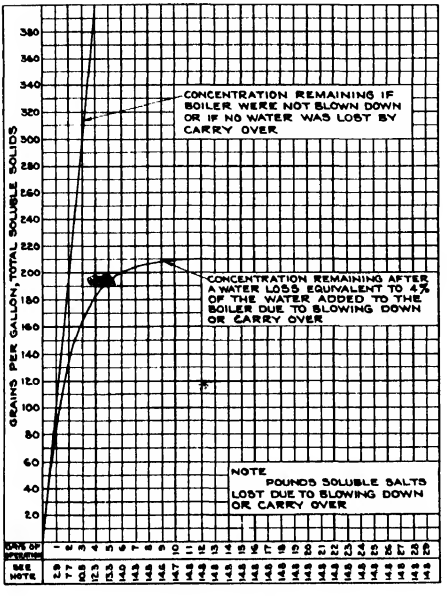


Figure 10

Concentration Curves for 100 H. P. Boiler Operated at Normal Rating when Feed Water Contains 5.0 Grains per Gallon of Sodium Salts

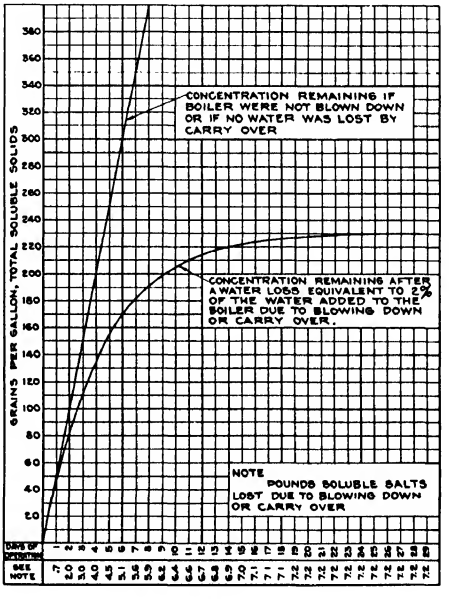


Figure 11

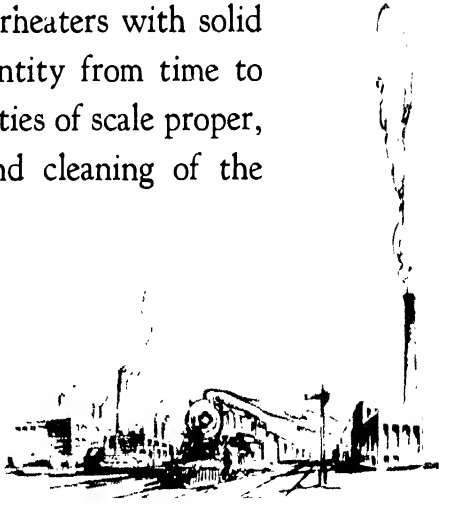
Concentration Curves for 100 H. P. Boiler Operated at Normal Rating when Feed Water Contains 10.0 Grains per Gallon of Sodium Salts

Chapter 9

FOAMING AND PRIMING

THE entrainment of small quantities of boiler water in steam, up to an excessive foaming or priming condition, constitutes an important problem in steam production.

Foaming is, no doubt, far more prevalent in locomotive boilers than in those in stationary service; however, it is not uncommon in the latter. The more serious final effects of foaming or priming in locomotive boilers are: first, inability to make "on time runs" or disruption of train schedules; second, serious impairment of lubrication due to carrying over into the cylinders of water and suspended matter (mud); third, interference with proper functioning of the superheater, due to accumulation of water which must be evaporated before increase in steam temperature can take place; fourth, fouling of superheaters with solid matter which accumulates in quantity from time to time, and assumes all of the properties of scale proper, making necessary the removal and cleaning of the superheaters.

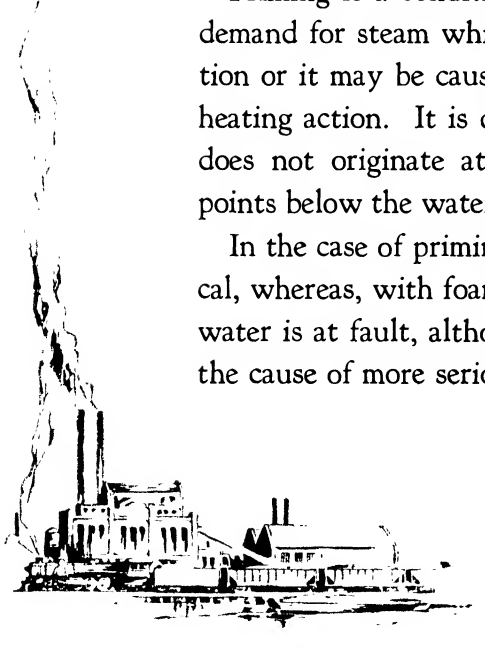


In industrial plants, where engines of the reciprocating type are used, the first effect of foaming is that of destroying lubrication, scoring of rubbing surfaces, deposition of suspended matter, and an accumulation of water, which ofttimes proves to be decidedly hazardous, frequently resulting in bending of connecting or piston rods, or forcing off or breaking of cylinder heads. In the case of steam turbines, one of the very serious aspects is erosion of the blades or an accumulation of deposits upon them, resulting in throwing the rotor out of balance.

A true foaming condition is usually considered as being the continuous or intermittent formation of a stabilized froth or foam in the steam space which carries boiler water into steam lines.

Priming is a condition brought about by a sudden demand for steam which may result in syphoning action or it may be caused by uneven boiling or superheating action. It is distinct from foaming in that it does not originate at the steaming surface, but at points below the water line.

In the case of priming, the cause is purely mechanical, whereas, with foaming the condition of the boiler water is at fault, although mechanical factors may be the cause of more serious steam contamination with a

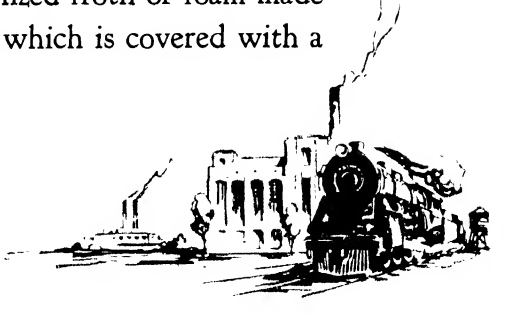


given foaming water condition than would otherwise be the case.

The amount of solids carried over by steam as compared with the amount eliminated from a boiler by blowing down is illustrated in Figures 10 and 11, page 58.

From a vast amount of practical observations and from the study of this subject by the use of experimental high pressure boilers equipped with sight glasses, it is apparent that a certain concentration of soluble salts in the boiler water together with finely divided suspended matter must both be present before a true foam is produced. The only observed exceptions to this are with a few waters containing certain types of vegetable material, oil, sewage and trade waste which may give rise to this action.

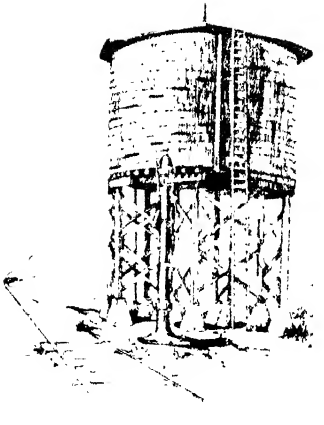
In boiling a concentrated salt solution, a definite film is produced at the steaming surface which tends to form bubbles above the liquid. This is due to the difference in concentration in the surface layer and that of the water below. If finely divided calcium or magnesium salts or other suspended matter are present in the water, it tends to adhere to or be adsorbed on these films, thereby causing a stabilized froth or foam made up of small bubbles, each of which is covered with a



tough or viscous layer of suspended matter. These foams, being stable, do not break up in the steam space, but work over into steam lines carrying along the suspended matter and also soluble salts.

Water, treated by outside softeners using the lime-soda or zeolite process, is, with few exceptions, especially subject to foaming. This is due to the increased sodium salt content brought about by the softening reactions, together with calcium and magnesium salts that are never completely removed by softening and as a result of concentration in the boiler soon become insoluble and give rise to suspended matter.

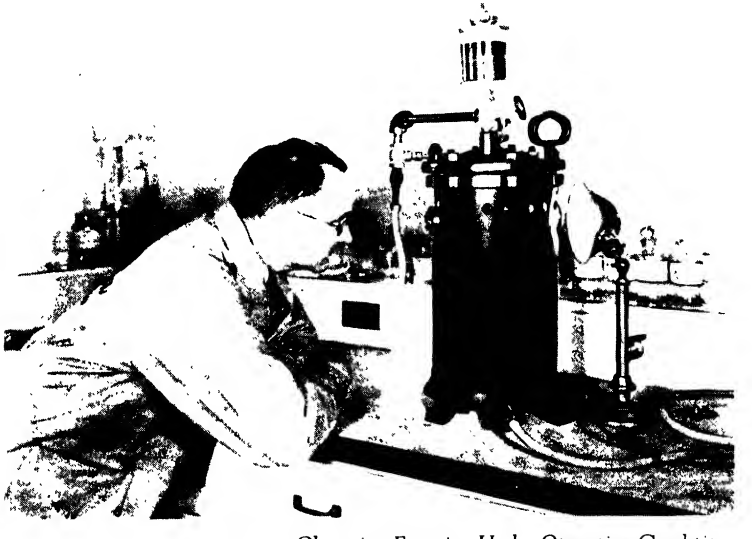
These are the principal facts constituting the basis on which it is possible to formulate treatment which is corrective for this condition.



Chapter 10

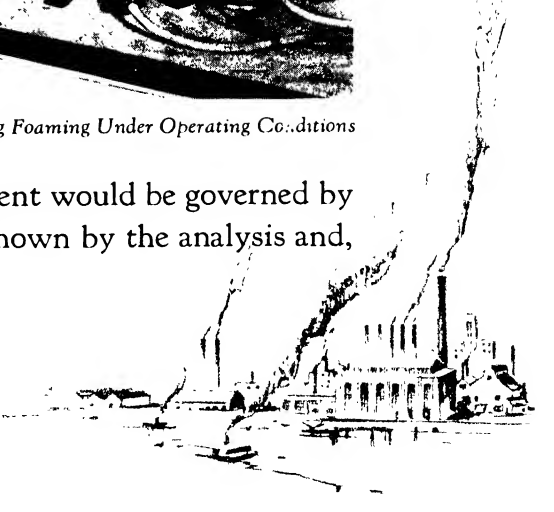
TREATMENT FOR FOAMING AND PRIMING

IN THE preparation of anti-foaming treatment, the water analysis and operating data must be con-



Observing Foaming Under Operating Conditions

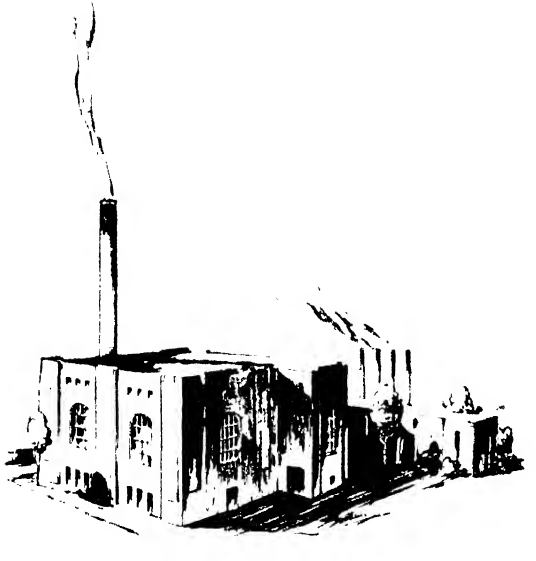
sidered. The type of treatment would be governed by the nature of the water as shown by the analysis and,



if the water has been softened, by the method of softening.

The principal consideration is to use reagents which will be adsorbed on or adhere to the surface films of the foam bubbles in preference to allowing the finely divided suspended matter to remain so attached, the object also being to coagulate the suspended matter and destroy its tendency to stabilize the foam.

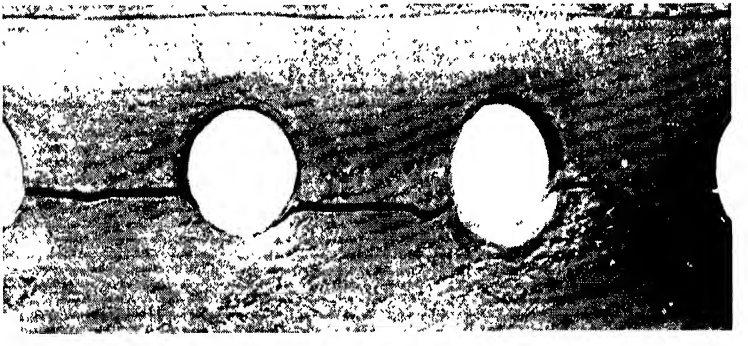
In using a properly adjusted Dearborn Anti-Foaming Treatment in conjunction with a scheduled blow-down of locomotive or stationary boilers, higher concentrations may be carried and at the same time a clean, dry steam produced.



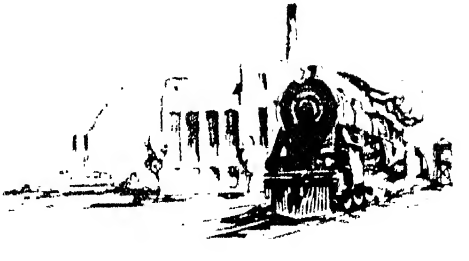
Chapter 11

EMBRITTLEMENT

THE prevention of embrittlement of boiler plate is an important factor in selecting treatment for some waters. Where excessive concentrations of soda ash or caustic soda are brought about by the use of softening equipment or improperly adjusted treatment



and when the total sulphate concentration is comparatively low, embrittlement of the boiler plate is a possibility unless corrective measures are taken. For pressures up to 150 pounds the recommended ratio of sodium carbonate alkalinity to sodium sulphate is not less than 1:1; for pressures between 150 and 250

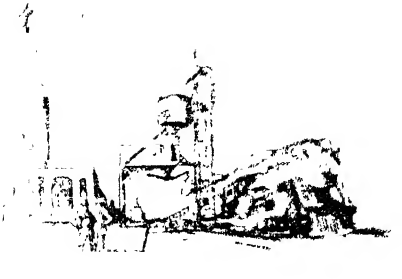


pounds the ratio recommended is 1:2, and over 250 pounds 1:3.

These ratios call for increasing concentrations of sodium sulphate and this is objectionable from the standpoint of calcium sulphate scale formation, corrosion and foaming.

Other means have therefore been developed for the control of embrittlement which do not require excessive concentrations of treating materials, their choice and amount depending upon the feed water and operating conditions.

In preparing treatment to meet specific water conditions, all factors are taken into consideration, and Dearborn Feed Water Treatment contains the most effective agents to bring about the desired reactions.

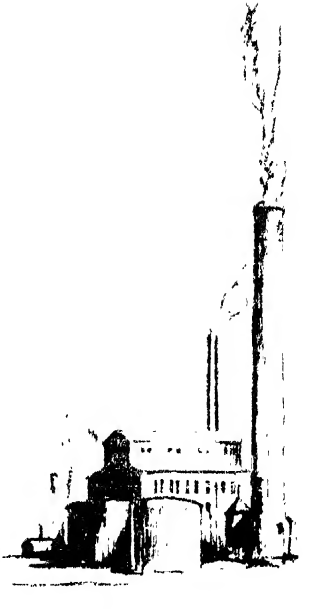


Chapter 12

OIL IN BOILER WATER

Oil in feed water is objectionable from several standpoints. Mineral oil contamination may cause blistering or bagging of boiler tubes and sheets because of its insulating properties, thus keeping water away from the heating surface. It also acts as a binder, causing sludge deposits to accumulate on heating surfaces. Low grade compounded lubricating oils, if allowed to contaminate boiler feed water, may produce foaming or wet steam.

Dearborn Treatment may be adjusted to take care of moderate quantities of oil present in the feed water, but excessive amounts should be guarded against and prevented by the proper handling of equipment and the use of efficient oil extracting devices.



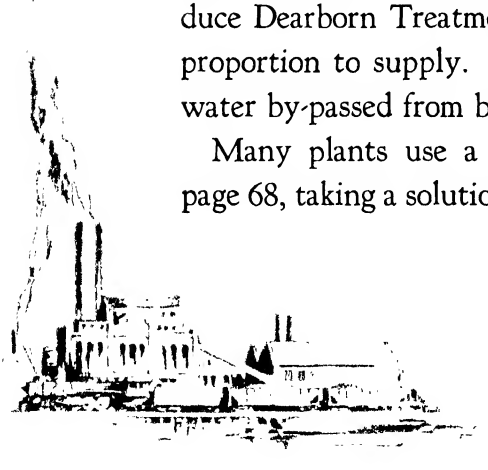
boiler feed pump will not permit a gravity feed, the Dearborn Water Treatment Pump operating by action of rocker arm of boiler feed pump will introduce a uniform feed of Dearborn Treatment into the suction in correct proportion to boiler feed supply.

Dearborn Pot Feeder

Dearborn Gravity Feeder

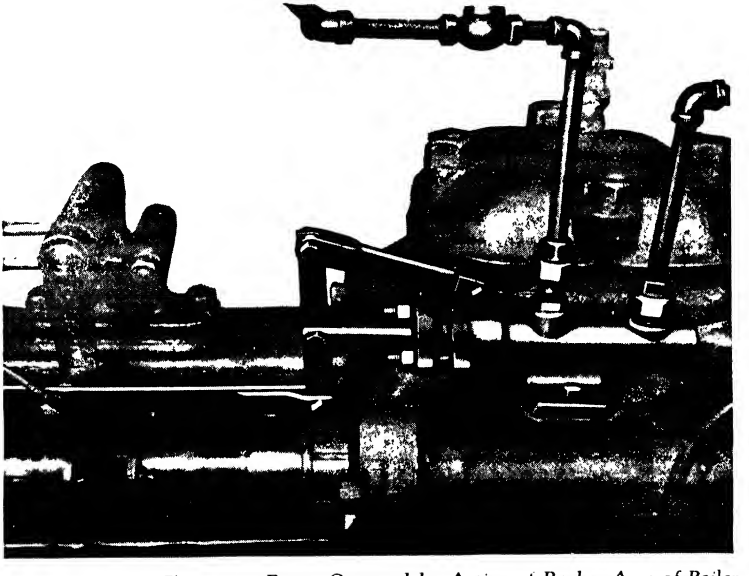
Boiler plants with centrifugal boiler feed pumps may use the Dearborn type C or D Treating Plant to introduce Dearborn Treatment into feed water in correct proportion to supply. These plants are operated by water by-passed from boiler feed line.

Many plants use a small steam pump, Type G, page 68, taking a solution of Dearborn Treatment from



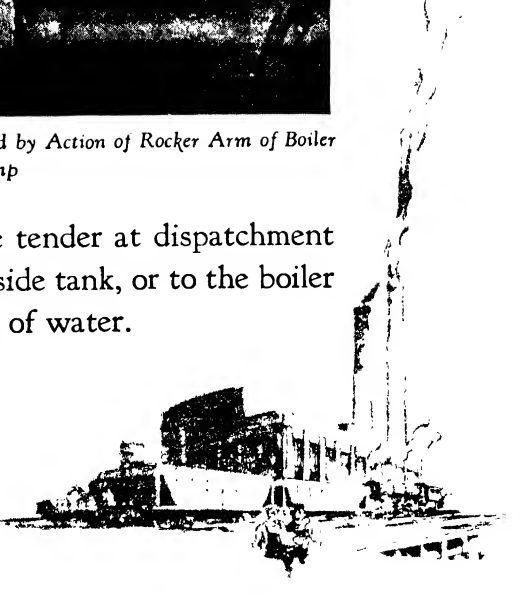
a tank, and discharging either into suction or discharge line of boiler feed pump. In small plants the Dearborn pot type of feeder may be used, connected after injector or on either suction or discharge line of boiler feed pump.

In railroad service there are several methods of applying Dearborn Treatment. The simplest are by direct

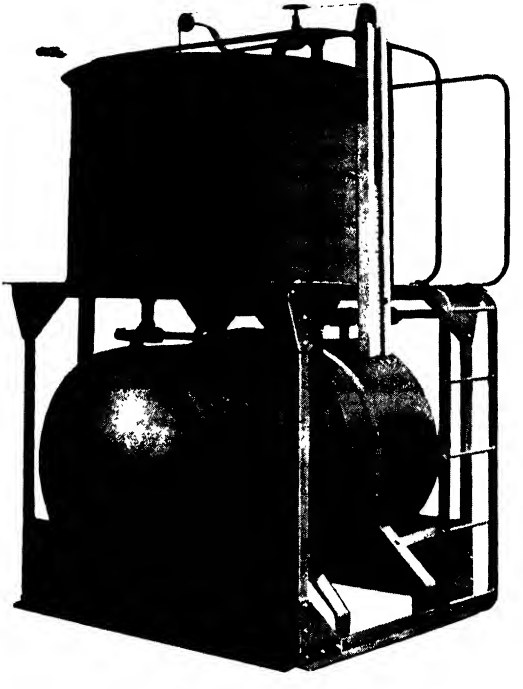


Dearborn Water Treatment Pump Operated by Action of Rocker Arm of Boiler Feed Pump

application to the locomotive tender at dispatchment or when taking water at wayside tank, or to the boiler at time of washout or change of water.

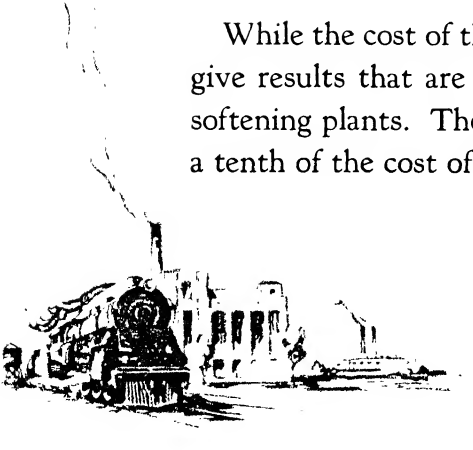


The ideal arrangement for treating locomotive water supplies is by feeding Dearborn Treatment into the feed water with Dearborn Treating Plants.



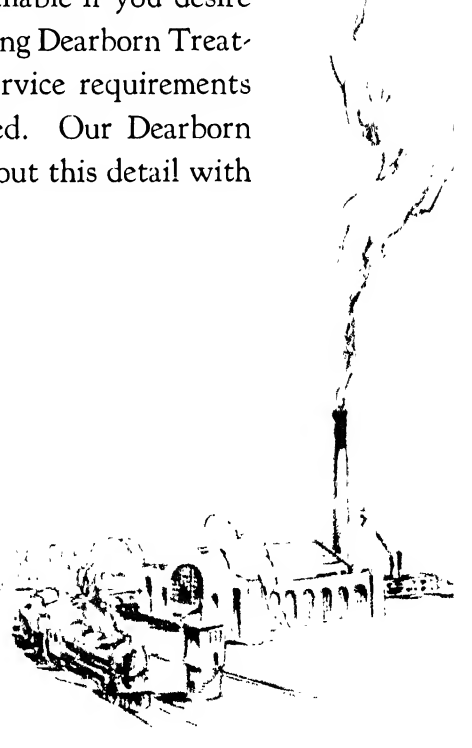
Dearborn Treating Plant—Type A

While the cost of these treating plants is small, they give results that are entirely reliable and superior to softening plants. The investment is actually less than a tenth of the cost of a lime-soda system. The cost of



treating water is about half as much as with a lime-soda plant. These simple compact plants operate automatically and require the service of an attendant for only a few minutes daily to charge the solution drum. The slight operating pressure is obtained from the water supply line without additional pumps. Dearborn Treating Plants, made in several sizes, require no auxiliary equipment and only a small amount of floor space. Many pump houses have a corner sufficiently large to house one of these plants. They treat up to a million gallons of water at one charging. Monthly inspections are ample.

More detailed descriptions and blue prints of the various methods of feeding are available if you desire them. However, the matter of feeding Dearborn Treatment is readily adjusted to the service requirements and volume of water to be treated. Our Dearborn service and engineering staff work out this detail with you.

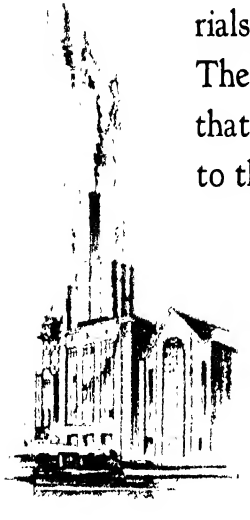


Chapter 14

COMPLETING THE TREATMENT OF SOFTENED WATER

SYSTEMS employing lime-soda or the zeolite process, may sometimes be desirable to treat water highly impregnated with scale-forming salts before it enters the boilers. However, the temperatures at which the systems operate, whether hot or cold, never approach the operating boiler temperatures and the reactions are not completed as they are when carried on at boiler temperatures. The accomplishment of the softening plant is the removal of a percentage of the scale-forming salts. Since their removal is not complete, the remaining scale-forming salts concentrate and slowly deposit in the boilers.

Softening is attended with increases in the salts that tend to produce foaming, for the softening materials are among the most active stimulators of foaming. The presence of scale in superheater tubes indicates that scale-forming salts have been carried in foam to the tubes.



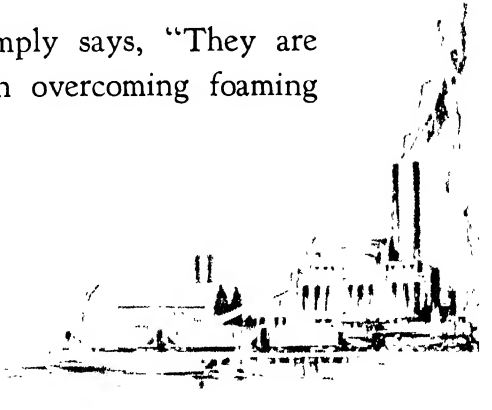
The principal accelerator of corrosion is oxygen. There is no type of softener which removes dissolved oxygen.

The limitations of softening plants have disappointed a great number of engineers and mechanical men who felt that any system which required such a sizable investment should provide complete correction of water troubles. Many of these men have submitted their problems to us and we have helped them—first, with an understanding of what they could and could not expect from their softening systems—and, second, by providing treatment for use in the softened water supplied to their boilers which would complete the treatment and eliminate all trouble.

A service report on a plant that had not obtained expected results from a softening plant, states briefly:

"This company is getting along fine with Dearborn Treatment. The treatment for the boilers for use with the zeolite water has entirely eliminated the pitting and corrosion. Also, the special treatment in the hot water lines has entirely cleared up the corrosion and red water."

Another service report simply says, "They are using Dearborn Treatment in overcoming foaming with very good results."

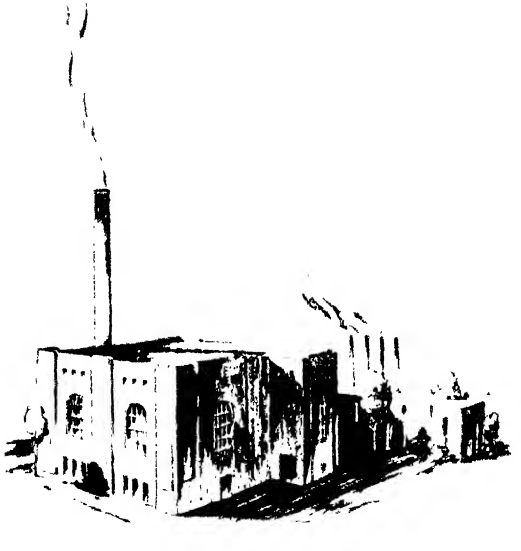


Dearborn Treatment will produce like results for you if your problem is to complete the work of a softening plant.

The cases that cannot be better handled entirely by the internal treatment method, however, are fewer than is generally supposed. Internal treatment gives far better results where the scale-forming salts are within the range of hardness of the average water.

Dearborn Treatment brings about reactions inside the boilers at operating temperatures and pressures and effects a complete correction of water troubles.

The cost, on the average, of Dearborn Treatment is uniformly low– about half as much per thousand gallons of water treated as with a softening system. **The softening system requires a large initial investment for equipment, a considerable outlay for installation, and a constant operating expense.**



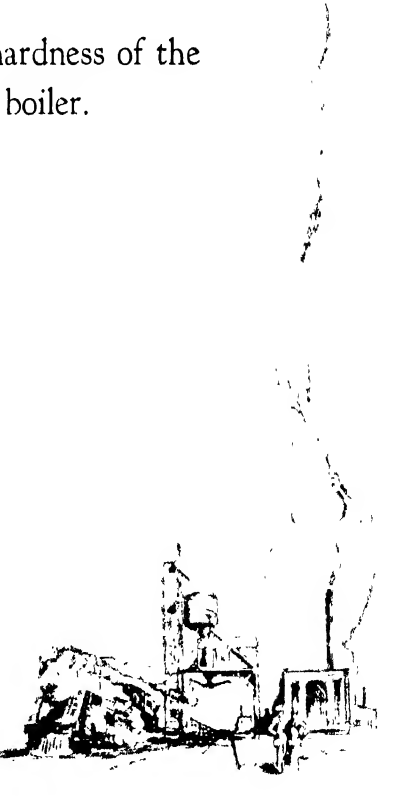
Chapter 15

PREPARING NEW BOILERS FOR SERVICE

BEFORE a new boiler is placed in service, all foreign matter such as grease and oil should be eliminated. An efficient boiling-out treatment should completely emulsify all such materials and thus provide perfectly clean evaporating surfaces.

Dearborn Special Boiling-Out Treatment, Formula No. 275, is made up especially for this purpose. Boiling out for approximately eight hours and following with a thorough flushing out of the equipment, will assure oil and grease-free surfaces.

The quantity used varies with the hardness of the water and the type and capacity of the boiler.

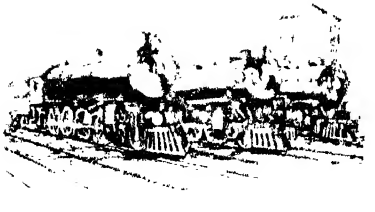


Chapter 16

THE PROTECTION OF BOILERS OUT OF SERVICE INDUSTRIAL AND LOCOMOTIVE

BOILERS out of service for several months at a time are subject to deterioration due to corrosion. This is caused by the film of moisture on tube and shell surfaces which is replenished continually by alternate heating and cooling causing condensation on the surfaces The excess of air present furnishes a large supply of oxygen to accelerate the corrosive action.

The efficient methods of protection provided by the Dearborn Chemical Company are adapted as required to the various conditions encountered.



Chapter 17

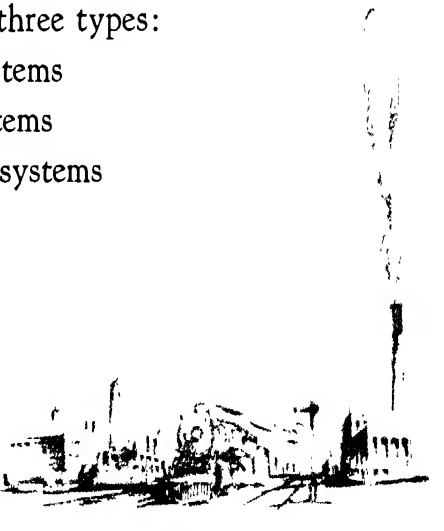
PROTECTION OF CIRCULATING SYSTEMS FROM CORROSION

THE SYMPTOMS of trouble in circulating systems are pits, disintegrated pipe, accumulation of heavy rust deposits in tank bottoms and valves, or the more common "red water." While scale sometimes occurs in connection with corrosion, the present chapter is devoted entirely to corrosion control and Chapters 6 and 18 relate to scale removal and control of scale formation. Where both corrosion and scale are found, treatment is provided to take care of the combined trouble.

This discussion does not apply to any system in which water is evaporated in any quantity and not returned to the system.

Circulating water systems are of three types:

Circulating cold water systems
Circulating hot water systems
Circulating cooling water systems



SCOPE OF TREATMENT

Considerable success has been obtained in controlling corrosion in systems of limited range. As a rule, this is a simple matter from both the chemical standpoint of a properly balanced remedy and the mechanical standpoint of introducing the remedy effectively throughout the system.

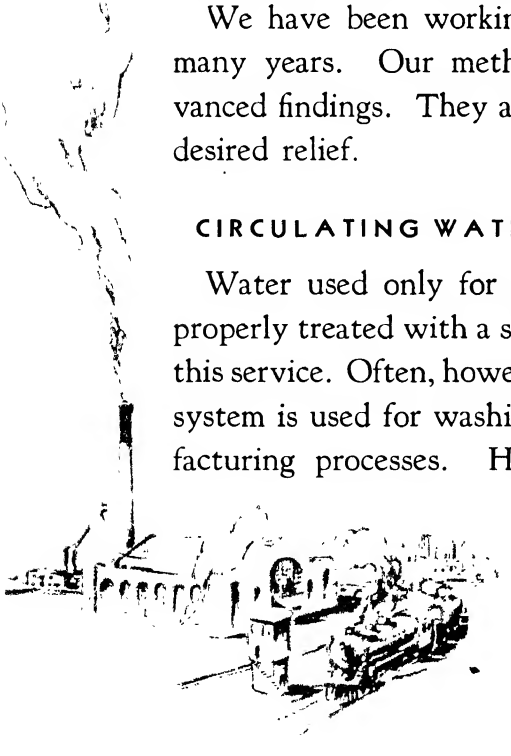
Large systems have presented a more difficult problem requiring a more comprehensive method of introducing the treating material, as well as exactness in quantity and kind of correcting agents used.

The illustration on page 70 shows a "gravity feeder" of a type frequently used to introduce Dearborn Treatment into circulating systems.

We have been working with these conditions for many years. Our methods represent the most advanced findings. They almost invariably produce the desired relief.

CIRCULATING WATER USED FOR DRINKING

Water used only for circulating purposes may be properly treated with a series of formulae designed for this service. Often, however, the water of a circulating system is used for washing and drinking, or in manufacturing processes. Here a considerably modified

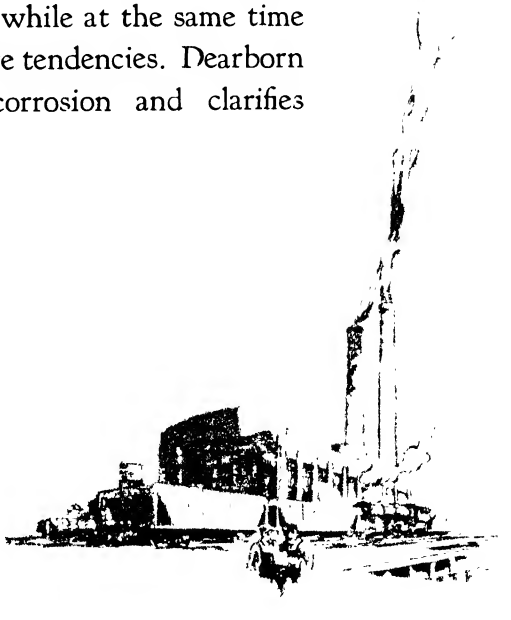


treatment is required, and while it is very difficult to stop corrosion entirely, it is held in satisfactory control.

In one large city several years ago, three buildings—a department store, a bank and a club—submitted the problems of corrosion in their circulating systems to us. The department store used the water for drinking in their tea room; the bank and the club had both cold and hot water systems. After a study of conditions, corrosion was eliminated through the use of suitable Dearborn Treatment and has not reappeared. Small quantities of Dearborn Treatment are fed into the lines continuously.

BRINE CIRCULATING SYSTEMS

Brine offers another series of problems. Sodium chloride and calcium chloride react quite differently and it is necessary to employ chemicals that will not reduce the value of the brine, while at the same time they must eliminate its corrosive tendencies. Dearborn Brine Treatment prevents corrosion and clarifies the brine.

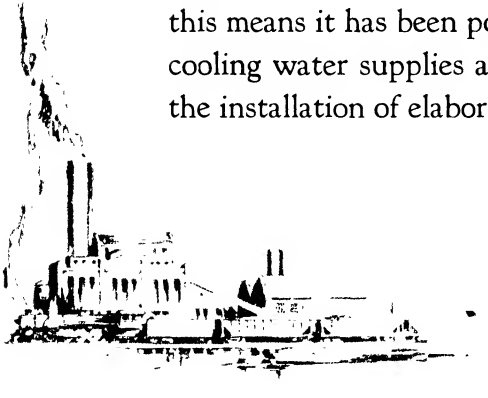


Chapter 18

DEARBORN COOLING WATER TREATMENT FOR CONTROLLING SCALE

In the treatment of cooling water for the control of scale deposits in condensing equipment, compressors and Diesel engines, the Dearborn Chemical Company is prepared to render complete service. This being a very specialized phase of water treatment, each case must be treated separately and the most efficient chemicals prescribed for the softening and coagulation of make-up water before it is added to the circulating system.

Suitable treating equipment, together with complete information as to the water supplies, their variation and the amount of water in the cooling system, are essential. The Dearborn Laboratories are especially equipped to render the analytical service in making frequent tests on the raw and treated waters and by this means it has been possible to produce satisfactory cooling water supplies at moderate cost, and without the installation of elaborate equipment.



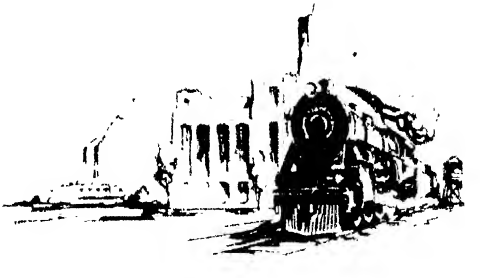
Chapter 19

ADDITIONAL DEARBORN SERVICES

It was natural for engineers and mechanical men who saw their water troubles so well taken care of by Dearborn scientific methods to ask for assistance on some of their other problems. The research facilities of the Dearborn Laboratories were employed in working out these problems with the result that products of high merit have been developed.

NO-OX-ID RUST PREVENTIVE

In a dozen years, this product has been adopted in practically every industry. More than a hundred and fifty railroads and marine interests use it in a range of services as broad as their use of iron and steel. Hundreds of miles of oil and gas pipe lines are coated with it. The industry of ice manufacture and cold storage, long suffering from rust which formerly limited the average life of a plant to about ten years, has turned to NO-OX-ID and forgotten the problem of equipment deterioration due to rust. Manufacturers of machinery

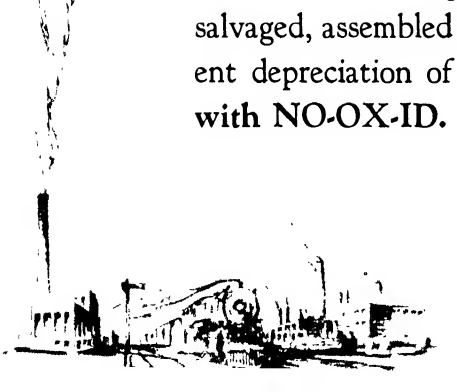


of all types: automobiles, trucks, tractors, airplanes, farm equipment, engines, lathes and all the way through

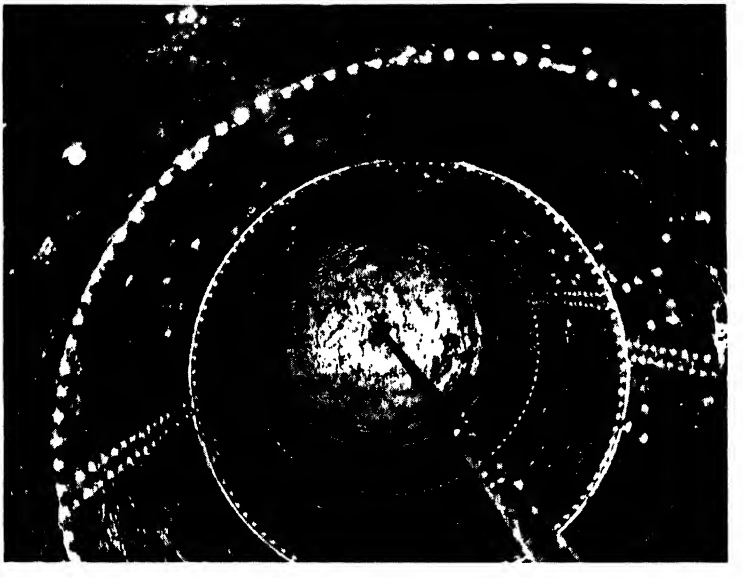
Preparing Polished Plates for Corrosion Tests

to adding machines and alarm clocks use NO-OX-ID in the protection of their products, all over the world.

A motor truck was dropped from a hoist into the ocean. After a long stay with Father Neptune it was salvaged, assembled and put in service without apparent depreciation of any sort. **It had been coated with NO-OX-ID.**

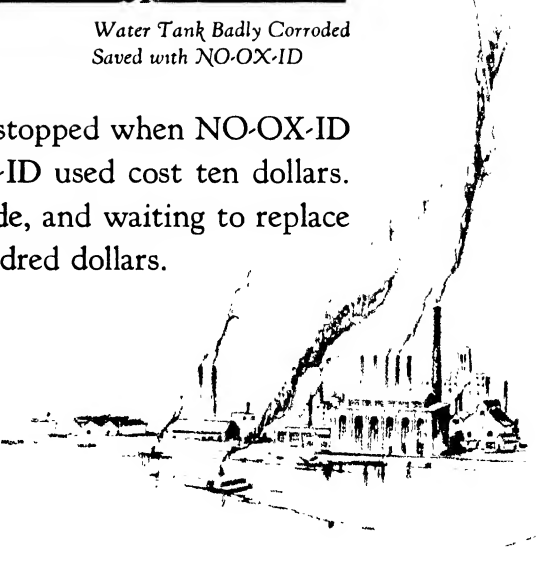


A large public building in Chicago had a water tank in service. It was condemned about ten years ago. As an experiment, the engineer, at the recommendation of the Dearborn Service man, had the tank coated with NO-OX-ID. The tank, here illustrated, is in service



Water Tank Badly Corroded Saved with NO-OX-ID

today. Pitting and rusting stopped when NO-OX-ID was applied. The NO-OX-ID used cost ten dollars. The new tank built alongside, and waiting to replace the old one, cost fifteen hundred dollars.



Use NO-OX-ID on piping, tanks and fittings of all types of water softening and treating equipment.

Preceding NO-OX-ID were indifferent purely mechanical coatings which often sold at high prices. The Dearborn Laboratories produced NO-OX-ID with the following characteristics:

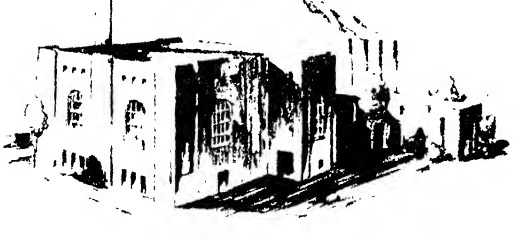
Mechanical fitness. The non-drying base of NO-OX-ID is flexible and non-hardening. It cannot crack, flake or leave the metal surface exposed.

Chemical ingredients which inhibit rusting on the surface of the metal.

NO-OX-ID has won title as the most efficient rust preventive ever devised, and in constantly increasing service is fighting against the national annual loss of seventeen million tons of iron and steel due to rust. Its cost is low and application simple. There is a range of consistencies adjusted to every service requirement.

NO-OX-ID-IZED WRAPPERS

Where conditions are severe and where there is a possibility of mechanical removal of the NO-OX-ID coating, it is found advisable to wrap the NO-OX-ID



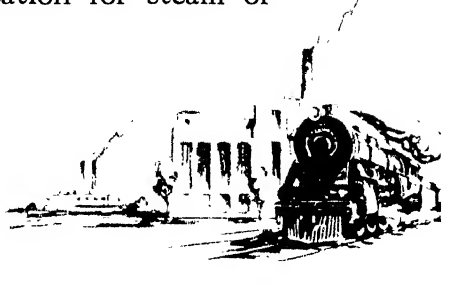
coated metal with NO-OX-ID-IZED Wrapper. This wrapper is made in several types to meet various service conditions on exposed water lines and metal parts and on buried oil, gas and water pipe lines.

Aside from the NO-OX-ID rust inhibiting coatings, special formulas are developed and manufactured by this company to meet individual conditions. When confronted with problems of any type in rust prevention, ask the Dearborn Chemical Company.

INDUSTRIAL LUBRICATION

A half century ago, the engine was still lubricated with tallow. The Dearborn Chemical Company entered early into the scientific study of lubrication and pioneered to such an extent that today the Dearborn Laboratories and the lubrication specialists of this organization are counselors of leading manufacturers of equipment on their lubrication requirements.

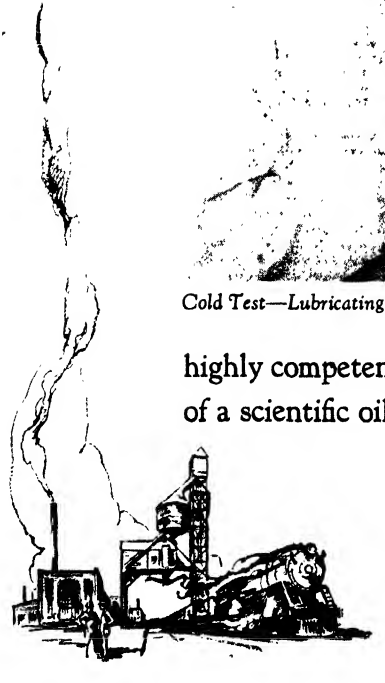
The problem of correct lubrication for steam or



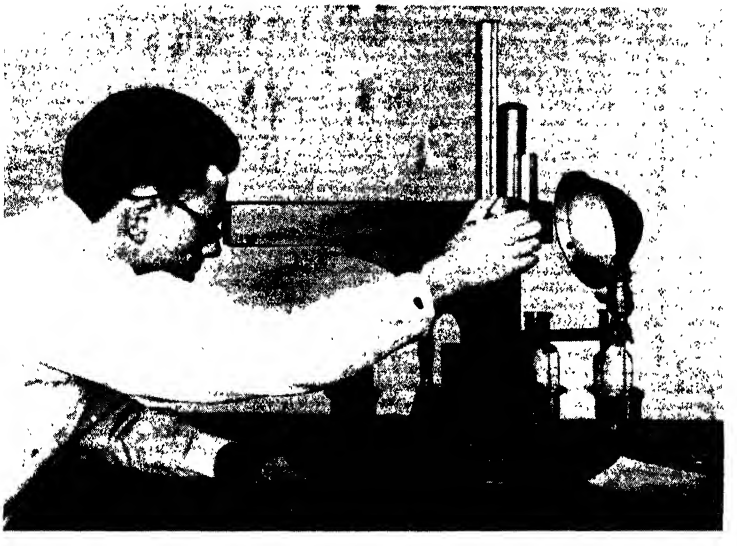
internal combustion engine power plants is of such importance that its successful solution is the work of a

Cold Test—Lubricating Oils

highly competent lubricating engineer, along with that of a scientific oil chemist.



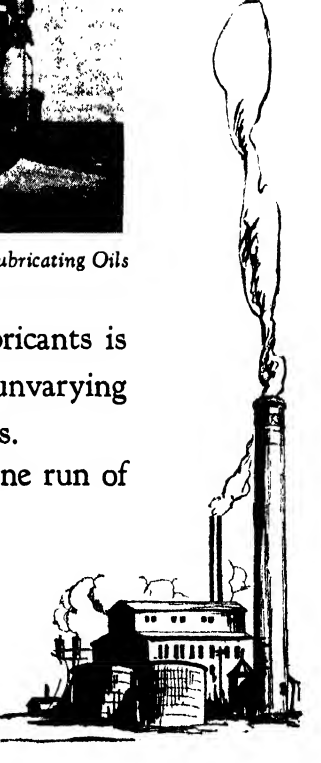
Our purpose has always been to provide lubrication which exactly suited the service requirement, regardless of the initial cost of our product. In general, because of the high quality and perfect suitability, Dearborn oils cost less per month or year than lubricants selling at a lower price, and the fact that thousands of



Color Test—Lubricating Oils

plants all over the world use Dearborn lubricants is the greatest tribute that can be paid to our unvarying standards of scientific fitness of the products.

The world's record "long distance" turbine run of

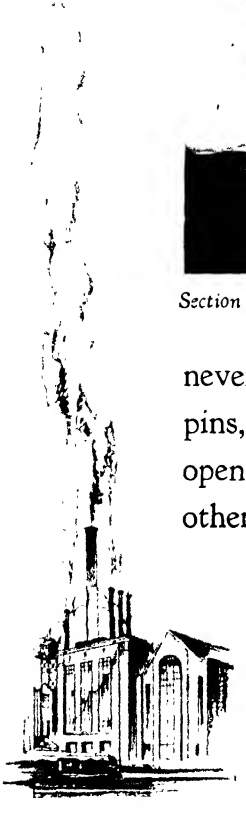


52,000 hours was accomplished with Dearborn oil, in the plant of the Hawaiian Electric Company.

There is a plant in the United States where the engine bearings of an Allis-Chalmers cross compound 1900 type engine erected in the spring of 1903 have

Section of Oil Testing Laboratory

never seen daylight in twenty-seven years. The crank pins, still running cool and quiet, have never been opened, even for inspection. In the same room are four other cross compound units that have been running for



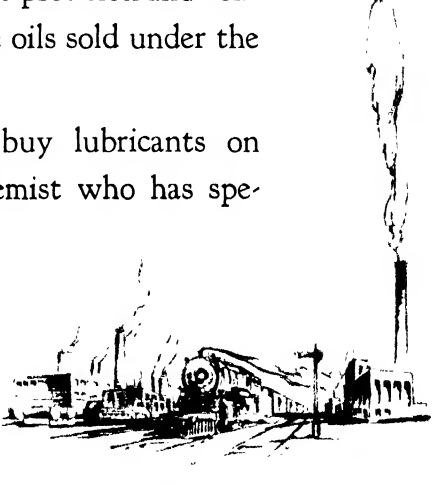
twenty-three years, of which the same is true. The only oils ever used on these bearings were Dearborn oils.

An engineer operating a 2,500 H.P. Allis-Chalmers unit purchased an oil at a lower cost than the Dearborn product he had been using. His oil consumption increased one-third. Trying to use up the product, he burned out the bearings on his unit. Needless to say, his next purchase was Dearborn oil. Many engineers have had similar, if not as harsh, experiences. Many more have wisely avoided them by using only Dearborn lubricants of known value.

A large refrigerating plant with three units of Fairbanks Morse Diesel Engines reports that since the adoption of Dearborn Ft. Trumbull X oil their oil consumption has decreased, along with a marked decrease of carbon deposit under the same load conditions.

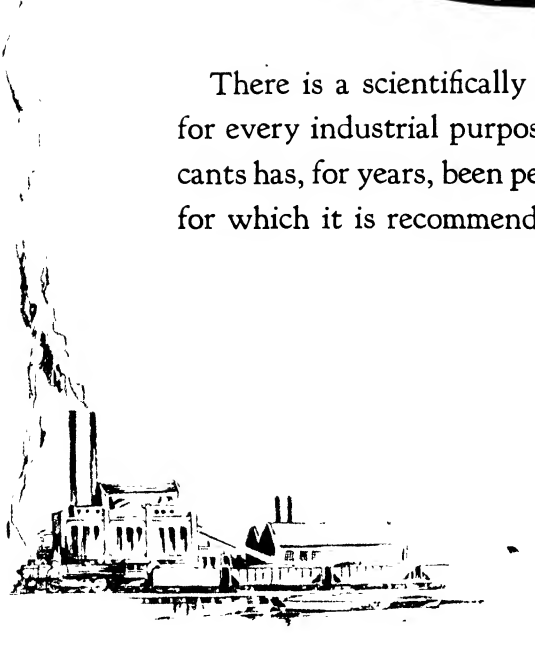
These and many similar instances which could be quoted, are tribute to the scientific precision and constant laboratory supervision of the oils sold under the name Dearborn.

The average purchaser must buy lubricants on reputation. When it takes a chemist who has spe-



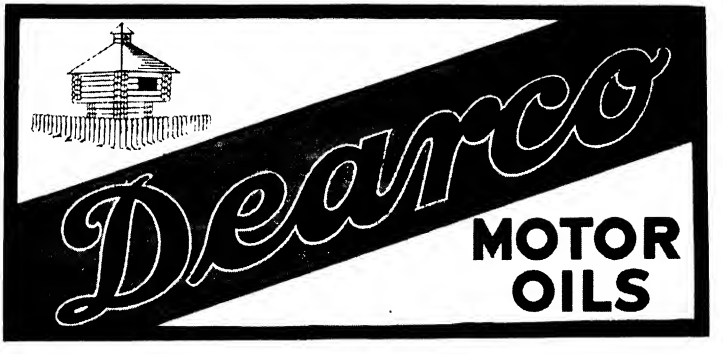
cialized in oils, several hours with delicate testing equipment before he can pass judgment on an oil, what chance does the average purchaser have in judging it by the "feel," the "color" and the price?

There is a scientifically correct Dearborn lubricant for every industrial purpose. Each one of these lubricants has, for years, been performing the type of service for which it is recommended.



DEARCO MOTOR OILS

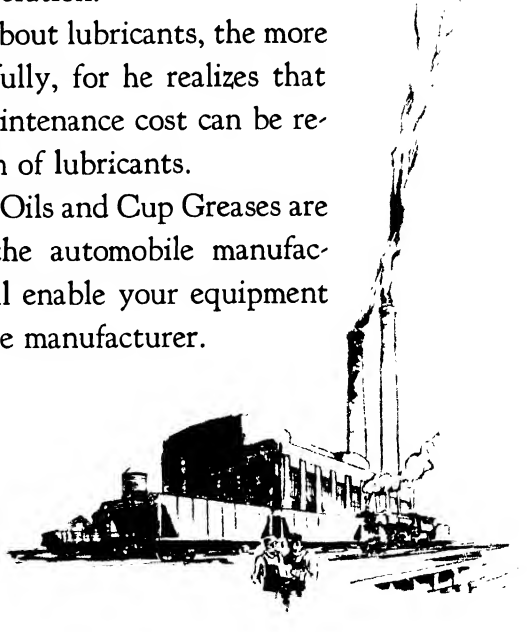
Our Dearco Motor Oils are made from a paraffin base crude and produced by the most modern refining methods. They are made up to the finest standards we have ever encountered in motor oils. Constant labora-



tory control guarantees this standard absolutely. Dearco Motor Oils represent unusually high stability under conditions of motor operation.

The more a driver knows about lubricants, the more certain he is to choose carefully, for he realizes that automobile operation and maintenance cost can be reduced by intelligent selection of lubricants.

Dearco Transmission Gear Oils and Cup Greases are made in accordance with the automobile manufacturers' requirements and will enable your equipment to function as planned by the manufacturer.



Use Dearco Products on your automobile equipment to obtain economical operation.

DEARBORN CLEANERS

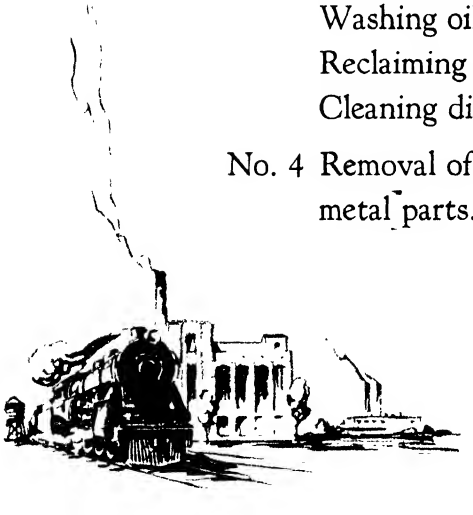
Dearborn powdered cleaners of graduated strengths and Dearboline, for metal surfaces, a liquid cleaner, are all products of the Dearborn Laboratories. They have been available for many years and are thorough and economical. Typical purposes which these powdered cleaners serve are:

No. 1 Washing woodwork and linoleum.
Softening water before adding soap.

No. 2 General cleaning in public institutions, hotels, schools, bakeries, packing houses, creameries, ice cream factories, bottling works.
Washing dishes and glassware, floors of wood, tile or composition.

No. 3 Cleaning metal parts (milder than No. 4)
Washing oily clothes.
Reclaiming rags.
Cleaning dirty concrete floors.

No. 4 Removal of grease, dirt and deposits from metal parts.



Cleaning locomotive air cylinders.
Cleaning freight car floors.

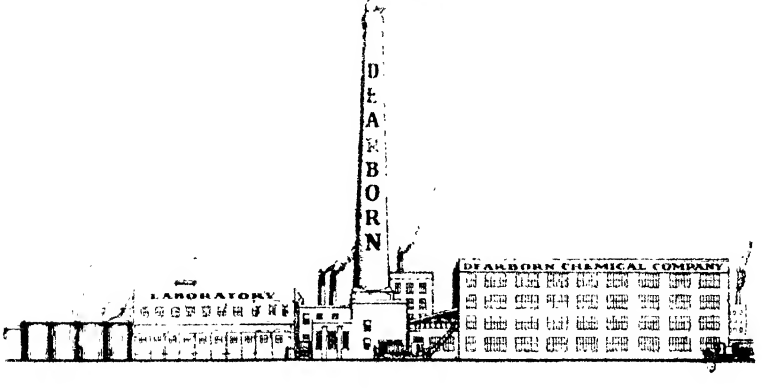
No. 5 Preparing metal for enameling and painting.
Cleaning oil and dirt from very dirty floors.
Cleaning oil field equipment.
Cleaning oil and organic deposits from power plant condensers and oil from ammonia condensers.

No. 6 Similar to No. 3, but not quite so powerful.

No. 7 Cleaning drain pipes, grease traps, sewer traps, *without producing objectionable odors.*
Removal of paint, lacquer or japan.
Cleaning caked and extra dirty concrete floors.

Special cleaners are supplied to use in connection with aluminum and aluminum alloys.

A House of Chemical Engineers
In Service to Industry Since 1887



EVERY DEARBORN PRODUCT IS RELIABLE