GALVANIZING AND TINNING.

W. T. FLANDERS.

GALVANIZING AND TINNING

A Practical Treatise on Coating with Tin and Zinc

with a

Special Chapter on Tinning Gray Iron Castings

BY

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In 1876 the firm I was employed by, finding it necessary to galvanize the goods they were manufacturing, placed the matter in my hands. Having little or no knowledge of the process, I spent considerable money in buying technical books that purported to treat on the subject, but found that what little they had to say was of no practical value whatever. I think the same conditions prevail now. Since 1889 I have made the installation of galvanizing and tinning plants a business and have built nearly sixty. The increased demand for galvanized and tinned goods within the last ten years has brought me many requests from people for information regarding the two processes, and some four years ago I gave a brief description of the process of galvanizing in THE IRON AGE and THE METAL WORKER. At the request of the publishers I have undertaken to describe the different methods of coating with zinc and tin by immersion. Having no previous work on the subject as a guide and being wholly unused to writing, I realize that my work lacks the finish of most technical books. I think, however, that my treatment of the several subjects, coupled with the illustrations given, will enable one to make a successful start in any of the processes.

W. T. FLANDERS.

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CONTENTS.

GALVANIZING.

The coating of articles of iron and steel with zinc, or, as the process is generally known, "galvanizing" them, as a means of retarding oxidation and for other reasons, has become a vast industry, in which a large number of men find employment.

It is not our purpose to attempt a description of the methods employed by the great manufacturers of galvanized sheets and wire, but to confine our efforts to the requirements of those who wish to engage in the business in a small way and to enable those whose location would otherwise compel them to ship goods long distances to erect and operate a plant of their own.

It may not be out of place to say that it has been the practice of some engaged in the business to make as much of a mystery of it as possible. One fallacy given out and generally credited is that a galvanizing kettle must not be allowed to cool off. This, perhaps, has deterred a greater number from attempting their own work than anything else. While it is true that it is not practicable to allow a kettle holding several tons of metal to cool off every few days, there is no reason why a kettle containing a few hundred pounds of metal cannot be allowed to cool when it is not required for use.

While it is our purpose to treat the subject in a way that will give a general idea of the whole business, our efforts will be mostly confined to explaining the methods to be employed in galvanizing castings of gray and malleable iron, small articles of wrought iron and steel and sheet metal goods.

LOCATING A PLANT AND SELECTING A KETTLE.

To those contemplating the installation of a galvanizing plant the first question that naturally comes up is, where can it best be located? In settling this question it should be kept in mind that the fumes of the chemicals used in the business are destructive to tools and machinery. For this reason the galvanizing plant should be in a building by itself.

The next question is, what size kettle should be used and what is the best material to make it of ? On account of the difficulty in controlling the heat of a small body of metal, we would not advise the use of a kettle, for any purpose, less than 3 feet in length, 20 inches in depth and 18 inches in width. The material for the kettle should be refined iron or best fire box steel, and should not be less than ½ inch thick.

THE GALVANIZING ROOM.

In providing a room or a building in which to locate the plant, provision should be made to obtain good ventilation. It should be high posted and have a good ventilator in the roof, and if the character of the work to be done will admit, a hood may be built over the kettle, coming low enough to catch all the smoke possible, while not interfering with the movements of the operator. When the work is castings or small articles, there is no objection to having the hood come to within 6 feet of the floor, and it should be at least 2 feet larger than the brick work surrounding the kettle.

Considerable water is used in the process, and provision should be made to secure proper drainage. A good

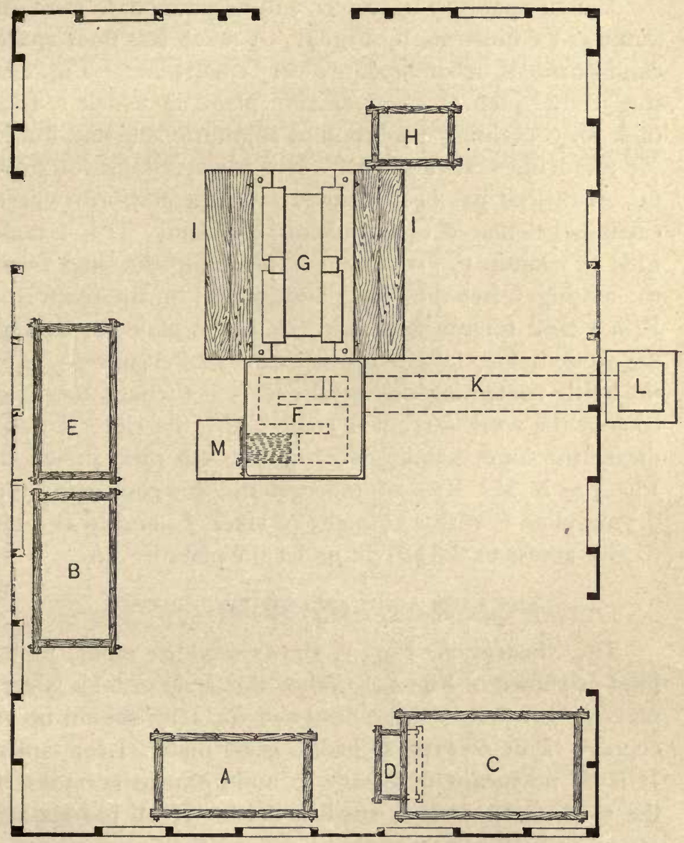

Fig. 1.—Floor Plan of Galvanizing Room.

plan is to put in a cement floor, which can be laid so as to provide gutters on each side of the room. If the work to be handled is castings it is not absolutely necessary to use steam, but if the work is of a nature that requires the removal of scale, steam should be brought into the room.

A floor space 25 x 50 feet will accommodate such an outfit as we illustrate by Fig. 1. A much less floor space can be made to accommodate a very small plant. Fig. 1 is the ground plan of a galvanizing plant, in which A is a tank for containing a solution of sulphuric acid and water for removing scale and rust. B is a water tank for storing work that has been cleaned. C is a platform where castings are placed to free them from sand. D is a tank used to contain the solution for removing the sand from the castings after they have been placed on the platform. E is a tank for muriatic acid. F is the plate for drying the work before immersing it in the molten metal. G is the kettle containing the metal and H is the tank used for cooling the work after it is coated with the zinc. I I indicate the loose planks covering the ash pits, shown in Fig. 3 as M M. K is an underground flue connecting the drying plate F with a chimney or stack, L, and M is a pit to give access to the ash pit under the plate F.

TANKS FOR ACIDS AND OTHER PURPOSES.

The illustration, Fig. 1, shows wooden tanks, to be built as shown in Fig. 12. When this style of tank is employed the bolts, in those designed for acid, should be of copper. Pine or cypress makes good material for tanks. It is by no means necessary to build expensive tanks if the work to be done is small articles. If oil barrels are sawed in half and thoroughly cleaned they answer every purpose, provided, of course, that the work is of a size that half barrels will accommodate.

It used to be considered necessary to line acid tanks with lead. The experience of the writer is that it is money thrown away. The practice has been almost entirely abandoned.

TOOLS FOR GALVANIZING.

The tools employed in galvanizing usually consist of tongs of various shapes and sizes, baskets of sheet iron or heavy wire cloth, and wires bent in various shapes. The necessary shape of the tongs will be suggested by the

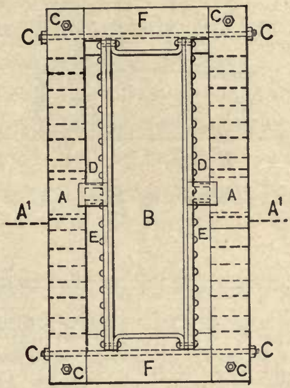

Fig. 2.—Top View of Large Galvanizing Kettle.

shape of the article to be handled. In Fig. 13 we illustrate the shape of baskets and wires most generally in use. B is a sheet iron basket having a handle about 3½ feet long. The basket should be about 8 inches in diameter at the top and 7 inches at the bottom, with a depth of 9 inches. Both the bottom and body should be well perforated to allow the metal to pass out. This style of basket is well adapted to galvanizing nails and other small articles, and the holes should be of a size that will not admit of the articles being handled falling through. A is a basket made of heavy wire cloth, the body being about 8 inches wide, 10 inches long and 6 inches deep. This basket is adapted to large work that cannot be strung on wires and is too small to be handled singly with tongs.

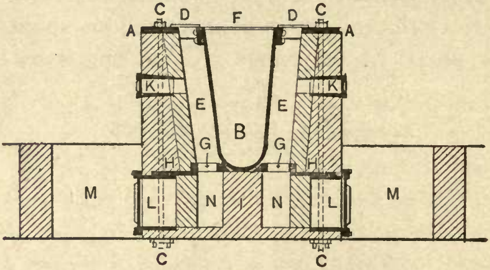

Fig. 3.—Section of Fig. 2 at A', A'.

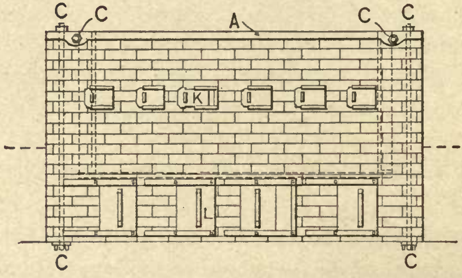

Fig. 4.—Side Elevation of Large Galvanizing Kettle

E and G are wires for handling small work in the molten metal. F is a scoop for removing the dross from the bottom of the kettle. D and H are skimmers, and E is a hook to suspend in the molten metal articles that are strung on wires. The use of all will be explained in their turn

Most of these tools are adapted to use in tinning as well as galvanizing.

FILLING AND FIRING A NEW KETTLE.

In filling a kettle for the first time with the pigs of zinc, or, as it is termed in the trade, "spelter," place the metal in a way that it will lie as closely as possible to the sides of the kettle, and also arrange it so that as the outside slabs of metal melt those next to them will be forced against the sides of the kettle. Unless this is done the kettle is apt to be injured by the heat. Do not allow the fires to burn too freely in melting a kettle of zinc or in firing up a kettle that is full of cold metal. In melting a kettle of metal for the first time keep the fires about even with the molten metal in the kettle, allowing them to rise in about the same proportion as the metal melts. Do not use the top drafts until the molten metal is about even with them.

THE USE OF A PYROMETER.

A good pyrometer placed in the kettle will be found of great value in keeping the bath at a uniform temperature. Unless, however, the stem of the pyrometer is protected from the action of the metal it will soon be destroyed. The writer has devised a means by which the stem of the pyrometer is kept from contact with the molten zinc and at the same time gives the same result as though the molten zinc was in direct contact with the pyrometer stem.

The arrangement consists of a piece of 2-inch pipe about 20 inches long, with one end closed tight. The top of the pipe is provided with a bushing, with a hole a little larger than the stem of the pyrometer. A second bushing should also be placed in the pipe about 3 inches from the bottom. These bushings serve to keep the pyrometer in an upright position. The casing surrounding the stem of the pyrometer is filled with lead, so that when the arrangement is placed in the kettle there is a direct metal connection with the stem of the pyrometer. Fig. 14 shows a pyrometer in position in the kettle, while Fig. 15 shows the "protector" in detail.

MATERIALS USED IN GALVANIZING.

The principal materials used in galvanizing are zinc,

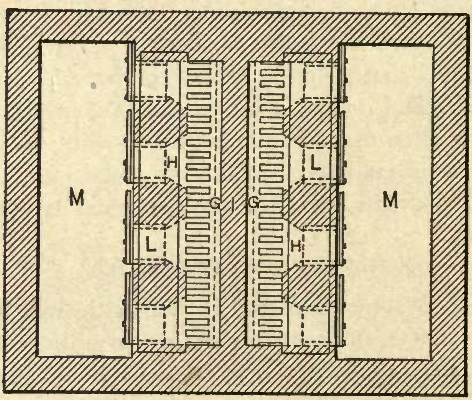

Fig. 5.—Section at Grate Line of Large Galvanizing Kettle.

sal ammoniac, muriatic, sulphuric and hydrofluoric acids and gas coke. We cannot with fairness express a preference for any brand of spelter, and will only say, use spelter smelted by a reliable firm, keeping in mind that much of the so-called spelter is recovered from zinc dross by parties who do not have the facilities for doing the work properly. The best sal ammoniac to use is the "gray granulated," although the "white granulated" answers every purpose.

BUILDING AND SETTING KETTLES.

In deciding what size kettle to put in you must be guided by the nature of the work to be done. If it is small articles that are to be handled, and the amount such

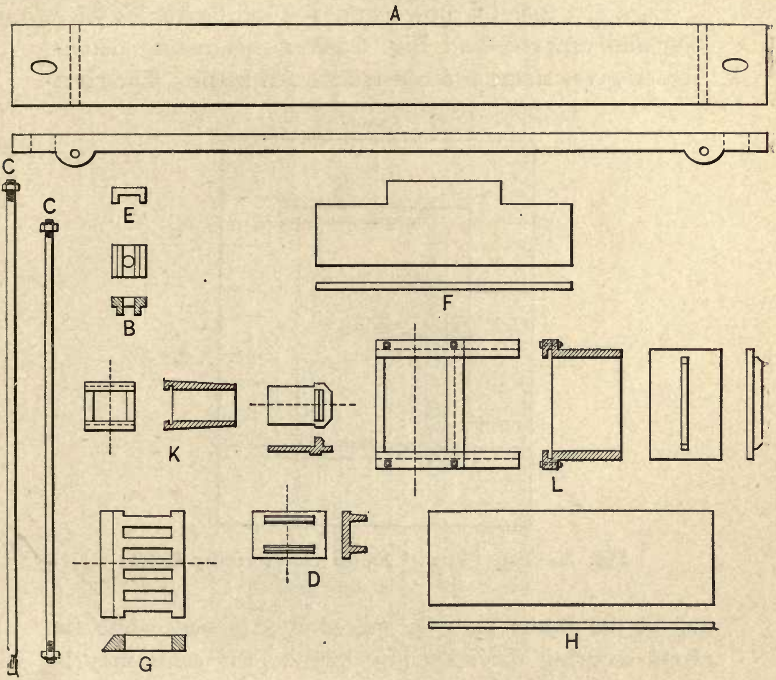

Fig. 6.—Casting Details of Large Galvanizing Kettle.

as will only require the plant to be operated at intervals, a kettle 3 feet long, 18 inches wide and 20 inches deep will answer the purpose. A kettle more than 20 inches deep makes it necessary to provide ash pits at the sides, as shown in Fig. 3 and designated M M.

In Figs. 7, 8 and 9 we show method of setting a small kettle that is not designed to be operated continually. The grates C C in Fig. 9 are bars of iron that may be withdrawn when it is desired to let the fire out and replaced when required for use.

Figs. 2, 3, 4 and 5 show manner of setting kettles 5 feet long and upward, and Fig. 6 gives the casting details. Fig. 10 gives shape and construction of kettle. The rivet-

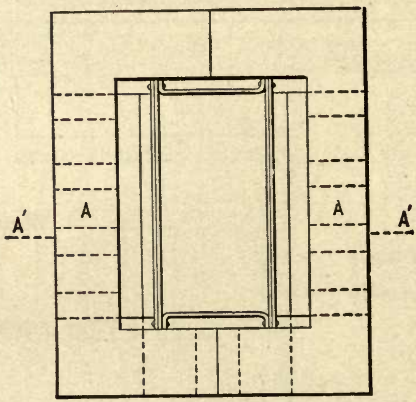

Fig. 7.—Top Plan of Small Galvanizing Kettle.

ing in the heads may be spaced 2½ inches, while the rivets securing the stiffening bars to the sides may be spaced 4 inches. For kettles from 4 to 6 feet in length material ⅞ inch thick will answer for the body and ½ inch for the heads. Above 6 feet material at least 1 inch thick should be used.

Fig. 10 shows a kettle in which the body is formed of one piece, and with the rivets where the fire will not affect them. A kettle for general use built after this illustration is our preference for many reasons, but it does not follow that the work could not be done in a kettle of any shape.

A, Fig. 6, are the coping plates, the position of which is shown in Figs. 2, 3 and 4. These plates, when held in

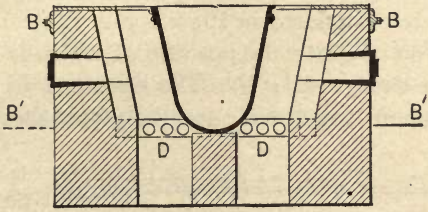

Fig. 8.—Section of Fig. 7 at A', A'.

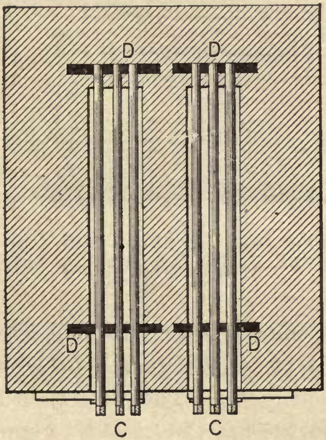

Fig. 9.—Section of Small Galvanizing Kettle, Showing Method of Setting Grates.

place by the bolts C, serve to prevent the sides of the kettle from springing outward when the iron blocks D D are in place, as shown in Figs. 2 and 3. Coping plates for kettles from 4 to 6 feet long should be 2½ inches thick and 10 inches wide. The fire spaces E E in Figs. 2 and 3 should not be more than 7 inches wide and the same length as the inside of the kettle.

D in Fig. 6 are the blocks designated in Figs. 2 and 3 as D. F in Fig. 6 are the iron plates 1 inch thick. Their positions are designated in Figs. 2 and 3 as F. G in Fig. 6 is a section of grate, the position of which is designated in Figs. 3 and 5 as G G. The openings of this grate should be about 1 inch wide and the grates should be wide

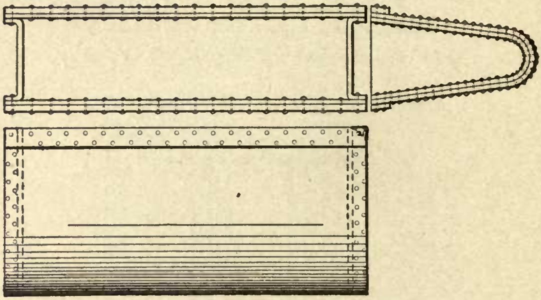

Fig. 10.—End and Side Elevations and Top View of Large Galvanizing Kettle.

enough to span the fire spaces E E in Figs. 2 and 3 and rest on plates H H and the pier I, on which the kettle B rests, as shown in Fig. 3. The plate H in Fig. 6 may also be used to cover the fire spaces E E, Figs. 2 and 3. The plates should be about ½ inch thick and 12 inches wide; their length is determined by the length of the kettle. K in Fig. 6 is the casing for the upper draft holes indicated as K K in Figs. 3 and 4. The casing should be about 10 inches long, with the opening about 4 x 4 inches. It should be arranged to close with a slide, as shown in Fig.

4. L in Fig. 6 shows the casings for the lower set of drafts, the openings in which should be 8 x 12 inches. Their position in the brick work is designated in Figs. 3, 4 and 5 as L. Fig. 2 is a top plan of the brick work. Fig. 3 is a vertical section at A′ A′ and Fig. 4 is a side elevation.

The ash pits M M, in Fig. 3, should be about 2 feet wide. The pits are covered with loose planks, so that access to the lower drafts may be had for the purpose of

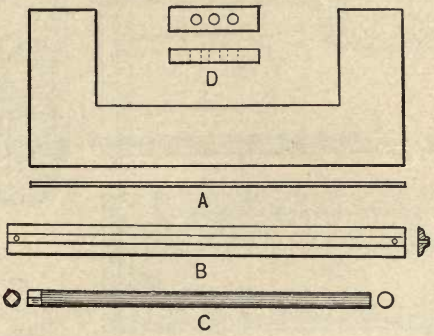

Fig. 11.—Casting Details of Small Galvanizing Kettle.

opening or closing them, and also for the purpose of removing the ashes from the spaces N N under the grates G G, Fig. 3.

Fig. 5 is a horizontal section of the brick work at the grate line and shows the grates G G in position, and also the manner of laying the bricks between the draft casings L L. I indicates the pier on which the kettle rests. It will be seen that the brick work between the lower draft casings L L is built in a way to allow all the access possible to the grates G G from the ash pits M M. The plates

H H are used to rest the outer edge of the grates G G on, and also to support the brick walls at each side of the kettle. The walls on each side of the kettle should have a lining of fire brick commencing at the grate and extending upward to the coping plates A A, Fig. 3.

Figs. 7, 8 and 9 show manner of setting a kettle that is not deep enough to require ash pits at the sides. For

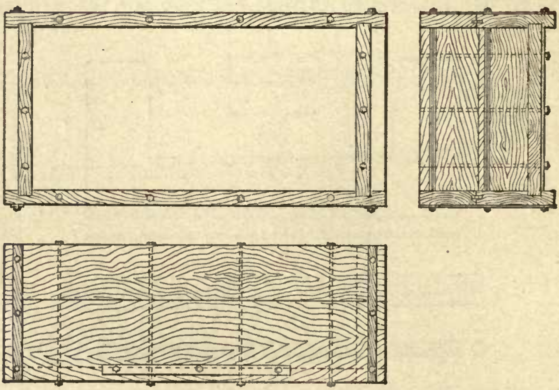

Fig. 12.—Details of Acid Tank.

casings for the upper and lower drafts make the patterns as shown in Fig. 6 and which are designated K and L. Fig. 7 is a top plan of the brick work surrounding the kettle. Fig. 8 is a vertical section of Fig. 7 at A′ A′, and Fig. 9 is a horizontal section at B′ B′.

Fig. 6 shows all the casting details necessary to set a kettle in the manner shown in Figs. 2, 3, 4 and 5. The bolt C that sets in the brick work vertically is provided at one end with a foundation washer, B, which is held in place by the key E. The positions of the other castings in this figure are all shown by corresponding letters in Figs. 2, 3, 4 and 5.

Fig. 11 gives the casting details necessary to set a kettle after the plan shown by Figs. 7, 8 and 9. A is a plate

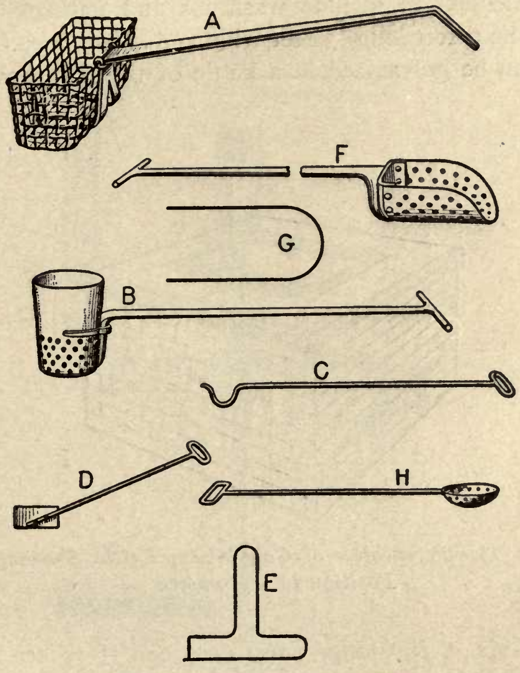

Fig. 13 —Galvanizing Tools.

to cover the top of the brick work surrounding the kettle, and its position is designated in Fig. 7 as A. B is a casting used in connection with bolts passing through the ends to bind the brick work together. Its position is designated in Fig. 8 as B. C is the grate, the position of which is shown in Fig. 9 at C, and D, Fig. 11, are the castings for supporting each end of the grates C, the position of which is designated in Figs. 8 and 9 by D.

A kettle for galvanizing pipe should be 23 feet long, 3 feet deep and 2 feet wide. One for sheet iron ware, if it is intended to include washtubs and garbage cans, should be 6 feet long, 3 feet wide and 4 feet deep. Coal hods can be galvanized in a kettle of the size shown in

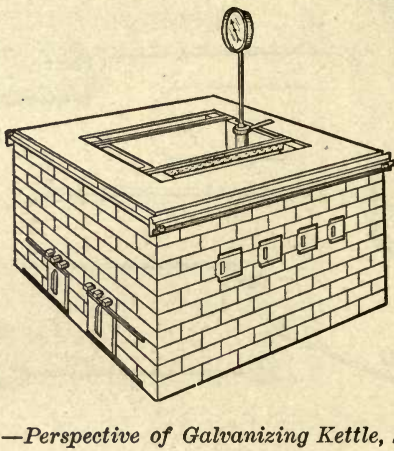

Fig. 14.—Perspective of Galvanizing Kettle, Showing Position of Pyrometer.

Fig. 2—viz., 6 feet long, 3 feet deep and 18 inches wide. A kettle designed especially for galvanizing wire should be 11 feet long, 2 feet deep and 2 feet wide. Wire cloth and poultry netting is best run in a kettle 6 feet long, 4 feet wide and 2 feet deep.

In bricking in a kettle use care to protect all the calked joints from the fire and do not make the fire spaces too wide. If too much space is left for fire the heat of the metal cannot be kept under control.

REMOVING SCALE WITH SULPHURIC ACID.

Nearly all articles made of wrought iron or steel or of sheet metal are covered with more or less heavy scale, which must be completely removed before the zinc will

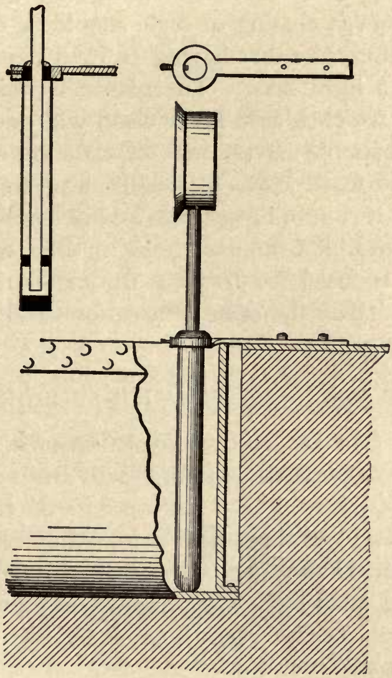

Fig. 15.—Pyrometer " Protector " in Detail.

adhere. To accomplish its removal make a pickle of sulphuric acid and water, 1 part acid to 20 of water, and bring the solution to a temperature of about 150 degrees F.

The length of time required to accomplish the work varies with the thickness of the scale. In many cases it is necessary to remove part of it with some sharp pointed tool. When the material has been burned in welding, and where the scale has been rolled deeply into the stock, it is necessary to use a tool to loosen the scale. Stock having an uneven coating of scale should be cleaned in a weaker solution than that having an even coating or than that having a light scale. The reason is that that part of the stock which is first made clean will be overpickled before the parts having the heavier scale are clean.

When the work seems perfectly clean and free from scale or rust it should be put into a tank containing water enough to cover it completely. A, in Fig. 1, designates the tank to be used for treating the material to remove the scale, and B in the same illustration denotes the storage tank.

CLEANING SANDY CASTINGS WITH SULPHURIC ACID.

Castings that are sandy may be cleaned by pouring over them a solution of sulphuric acid and water, 1 part acid to 6 of water. Place the castings on the platform C in Fig. 1 and wet them with the solution which is contained in tank D, Fig. 1. Continue this operation until the sand will wash off by the application of water. The castings should be wet every hour or so, and they should be cleaned in about 12 hours.

Cast iron that has been allowed to remain in the pickle too long will be covered with a gummy or greasy substance, and will not properly take the coating of zinc unless it is left in the metal a long time, and even then it will not be nicely coated, but will be rough and covered with thick patches of metal. It will not have the gloss that a properly prepared casting will have. We refer to this method of cleaning sandy castings in the chapter on tinning, and it will be well to read what is said there in this connection, as the rules there given apply to galvanizing, as well as what is said regarding dry tumbling as an aid in cleaning work for tinning.

PREPARING THE WORK FOR DIPPING IN THE ZINCING BATH.

To enable the zinc to take to the work quickly and firmly a solution of muriatic acid and water is used. This not only serves as a flux, but it removes any rust that has formed on the work in the operation of inspecting and removing the scale or sand that the sulphuric acid pickle failed to remove. If the work has been thoroughly cleaned by dry tumbling the use of sulphuric acid is not necessary. If no rust has formed on the work all that is necessary is to immerse it for two or three minutes in this muriatic solution. If rust is present it must be immersed long enough to remove it.

Some galvanizers use full strength acid for this preparatory dip, but we prefer to dilute the acid about one-half and to add 1 pound of sal ammoniac to a gallon of the mixture. Tank E, Fig. 1, is for containing this mixture.

DRYING THE WORK.

From tank C, Fig. 1, or, in other words, from the muriatic acid, the work is taken to the place provided for drying it. The position of this drying arrangement is designated F in Fig. 1. This drying arrangement may be the plates covering the fires that heat the kettle. If the work to be handled only amounts to a few hundred pounds per day it can be dried in this way. If, however, the amount of work necessitates keeping the kettle in constant operation, a drying arrangement such as shown in Figs. 16, 17 and 18 should be provided. Sheets and pipe should be dried in an oven.

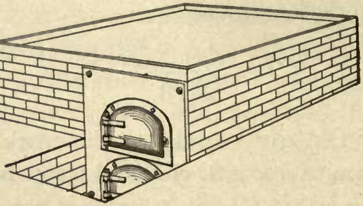

Fig. 16.—Perspective View of Drier.

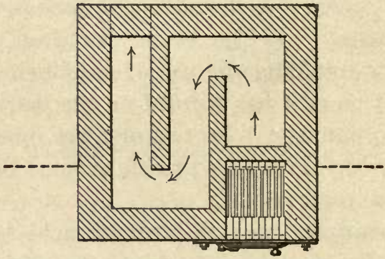

Fig. 17.—Horizontal Section of Fig. 16 at Grate Line.

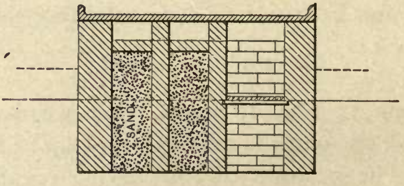

Fig. 18.—Vertical Section of Fig. 16.

The location of this drying arrangement is a mere matter of choice. In Fig. 1 we show it located at one end of the kettle. The work should be perfectly dry, but it should not be allowed to get hot enough to burn the acid. When properly dried the muriatic acid should show on the surface of the work in the form of a white powder. Work that has been prepared for dipping and dried should not be allowed to get cold, and if more has been prepared for dipping than can be finished it should not be allowed to remain on the drier over night, but returned to the water tank. It should, of course, be redipped in the muriatic solution and dried again before putting it into the zincing kettle.

Figs. 16, 17 and 18 show a good arrangement for drying the work. Fig. 16 is a perspective view of the completed work, Fig. 17 is a horizontal section of Fig. 16 at grate, and Fig. 18 is a vertical section.

THE HEAT OF THE ZINC.

This part of the business is not only the most difficult to describe, but it is the most difficult to learn, for the reason that different kinds of work require that different temperatures be maintained. A kettle of zinc at the proper heat for wire or wire cloth would be much too hot for galvanizing castings of either gray or malleable iron, while with the zinc at the proper heat for large work it would be impossible to coat small work properly, even if the material was the same. Large pieces require that a low heat be maintained on the zincing bath. Small work that is strung on wires for dipping requires a higher heat of the zincing bath than heavy pieces. Work that is galvanized in baskets requires a higher heat of the zincing bath than work that is strung on wires and drawn from the coating bath without the aid of a flux on the surface of the molten metal, as hereafter described.

We shall give the degrees of heat that a pyrometer should indicate when different kinds of work are being done, basing the rules given on the supposition that when the metal is barely melted—that is, at a temperature that would just keep it in a liquid state, the pyrometer indicates 750 degrees of heat. We shall also give the best rules possible for determining the proper temperature by the looks of the metal and by other signs.

Large gray iron castings require that the metal be at the lowest temperature possible and have it liquid. At about this temperature it will be silver white in color, will burn sal ammoniac slowly when thrown on its surface, and when a skimmer is passed over its surface the oxide will be slow in appearing. In this condition the pyrometer should indicate about 775 degrees of heat. This temperature is also suitable for galvanizing very thin castings that it is designed to " spangle " or to have a crystallized appearance—for example, sinks and like work.

For small castings that are to be drawn through the metal without using a flux the pyrometer should indicate about 840 degrees. At this temperature the metal should have a slightly bluish cast, burn sal ammoniac moderately quick and show the oxide in a few seconds after the skimmer has been passed over its surface. This temperature is about right for galvanizing wrought iron pipe; the cheaper grades of sheet iron or goods made from it, such as coal hods, ash cans and chamber pails. Heavy malleable iron castings will also coat nicely at this heat.

For small work, such as nails and, in fact, almost any work that is done in baskets or strung on wires and drawn through a flux, the pyrometer should indicate from 870 to 890 degrees of heat. The metal should burn sal ammoniac quickly and oxidize quickly. It will be quite blue in color. This temperature is about right for sheet steel and articles made from it, as well as steel pipe.

DIPPING THE WORK IN THE MOLTEN METAL.

We will describe the manner of handling several different articles as a general guide for handling all kinds of work. Considerable skill is required to bring a piece of work out of the metal and cool it so that the surface will be smooth, free from blisters and with no lumps of surplus metal attached.

Before dipping the work, cover the surface of a part of the molten zinc with a flux of sal ammoniac to keep the oxidized metal from adhering to it. To prepare this flux sprinkle a few handfuls of sal ammoniac on the surface of the molten metal, and as soon as it is melted add a few drops of glycerine. This will cause the flux to thicken up and will prevent it, in a measure, from covering the entire surface of the metal. The glycerine also causes the flux to remain stationary, so that when the operator is ready to draw the article from the bath the flux will not cover the space he has cleared with his skimmer for that purpose. The tool designated D in Fig. 13 is used for the purpose of skimming the surface of the metal before drawing the work from the bath.

This flux not only prevents the zinc from oxidizing, but it assists the metal to take quickly and evenly to the work. Keep the flux fresh by adding more sal ammoniac from time to time.

We will suppose the article to be dipped is a cast iron sink or some similar casting—that is, a thin casting. Have the metal at the temperature first described under the heading "The Heat of the Zinc." After satisfying himself that the casting is perfectly dry and hot enough to have expelled all moisture from it the operator catches the article with a pair of tongs and plunges it as quickly as possible, and not cause the metal to spatter, into the molten zinc. He must hold the article beneath the zinc until it is as hot as the zinc itself. After the article has been in the bath a few minutes it should be rinsed around in the metal in such a way that the flux floating on the surface of the molten zinc will come in contact with all parts of it. When the article is thoroughly coated clear a space on the surface of the molten zinc with the skimmer, and after dusting on a very little dry powdered sal ammoniac draw the article from the metal.

In performing this operation catch the article with the tongs in such a way that the part they grasp will be the last to leave the metal. Do not lift the article clear of the metal with the tongs you use in the metal, but provide a second pair to handle the article with until it is cooled. In drawing the article raise it slowly with the tongs held in the position described, and as soon as it is partly clear of the metal grasp it with the tongs provided for that purpose, and complete its removal. Hold the article in such a position as will admit of the metal flowing to one point, and just as the drop is about to harden remove it with a stiff brush or an old file. Expose the article to the air until crystals appear, and then brush it with a brush wet in clear water. Do not dip the article in water, especially if it is a sink or a very thin casting, as that would be quite likely to break it. In any event the coating would not be as bright as it would be if left to cool gradually after brushing with the wet brush. Thick heavy castings may be dipped in water at once on removing them from the molten metal.

Coal hods and similar goods of sheet steel or iron only require to be left in the bath a few seconds. The flux through which they pass should be confined at one end of the kettle by a piece of sheet iron long enough to go across the kettle from side to side. This is called a " flux guard," and it should enter the metal about 2 inches, with the upper edge as high or a little higher than the sides of the kettle. In galvanizing sheet metal ware the flux should be made to foam up nearly to the top of the kettle by using glycerine. The goods should be passed through this flux into the metal, and as soon as they are coated, which will be in a very few seconds, they must be passed under the flux guard to the end of the kettle that is kept free of flux. In passing the article under the flux guard keep the opening up so that none of the flux will be carried along with it. Remove the article from the metal in the way just described for sinks and similar articles, but do not sprinkle the surface of the zinc with sal ammoniac. Allow the work to cool in the air. If any particles of the sal ammoniac have adhered to the work in drawing it from the molten metal remove them with a wet brush.

Some articles can be galvanized very nicely by stringing them on stout wires about 1½ feet long. When this method is employed string on a number of the pieces, and then bring both ends of the wire together and clinch them securely. To suspend work in the metal strung this way use a hook, shaped after the form given in Fig. 13 and designated C. Provide several of these hooks, so that a batch may always be ready when the previous one is removed from the kettle. A piece of ⅜-inch round iron, bent in the shape of the letter S, will serve to remove the strings of castings from the hooks, and also for handling them after they are removed. The wires E and G, Fig. 13, are intended for stringing small articles on for the purpose of dipping them in the molten metal.

In handling small articles on these wires use a motion, after they are drawn from the metal, calculated to free them of surplus metal and also to prevent their adhering to each other when they are plunged in the water. To do this properly will require some practice.

It is a good plan to warm the cooling water slightly for cooling some articles, and to have a thin film of oil on the surface. Small articles strung on wires may be drawn through the metal after sprinkling on a small quantity of powdered sal ammoniac, or may be drawn through a clear thin flux of sal ammoniac, to which a few drops of glycerine have been added. If the latter plan is used, as it should be if the articles are such as are liable to rub and stick together, the oil should not be used on the cooling water.

Small work that cannot be strung on wires may be galvanized by using a basket of wire or sheet iron. We have already described these, and they are designated in Fig. 13 as A and B.

When these baskets are employed the flux should be of a consistency that will run freely among the work. A block of iron should be placed in a position beside the kettle that will permit the operator to rest the handle of his basket over the block with the basket hanging over the kettle. Using this block as a rest, the operator should shake the basket sharply, and for several seconds, to free the work of surplus metal, and when it is accomplished he will shake them into the water to cool them, after which dry them off by dipping them in boiling water and then throwing them into sawdust. Nails or tacks may be shaken out of the basket onto an iron plate, placed at an angle, over a tub of water. The plate should be inclined sufficient to allow the work to slide into the water readily.

Sheet iron, wire, wire cloth and poultry netting are mostly passed through the zincing bath mechanically, and as the means employed are too expensive and complicated to illustrate or describe we shall not attempt it. Sheet iron may be, and once was, galvanized by parting the kettle lengthwise with a flux guard. The side where the prepared sheet enters the bath is covered with a sal ammoniac flux, and the opposite side, where it leaves the bath, is covered with coke dust to the depth of about 1 inch. A light single block and fall is used to assist in drawing the sheet from the kettle, and every kettle in which work of large size is galvanized should be so provided.

Wire cloth, wire and poultry netting may be galvanized by running it through the kettle by means of a reel. In galvanizing wire cloth and poultry netting the kettle should be parted by a flux guard, as previously described, and the coke dust piled up to a depth of several inches and kept sprinkled with water by using an ordinary watering pot. The flux should be present where the work enters the metal.

Wire requires no flux at the point where the work enters or on any other part of the kettle. Sand or coke dust or dies of asbestos may be used to wipe off the surplus metal. If the kettle for wire is the usual length of 10 feet the wire may be drawn through the metal at a speed of about 75 feet per minute. If it is being done in a short kettle the speed must be slow enough to allow the work to be perfectly coated.

In Fig. 19 we give the position of the different pieces of apparatus required to do the work in a small way. Large plants equipped to do this work exclusively are fitted with reels driven by power, and several strands are run through simultaneously. In Fig. 19 A is the position of the reel holding the black wire, B is the tank holding the muriatic acid, C is the kettle, D a tank containing water and E the position of the reel for drawing the wire.

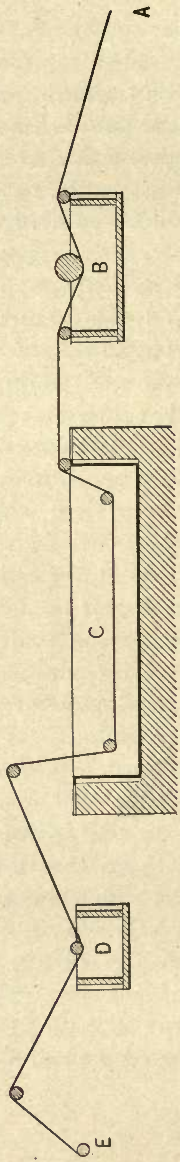

Fig. 19.—Position of Apparatus Required in Galvanizing Wire.

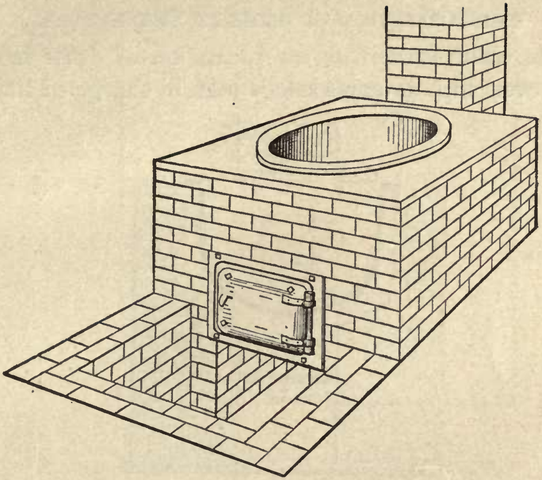

Fig. 20.—Perspective of Dross Kettle.

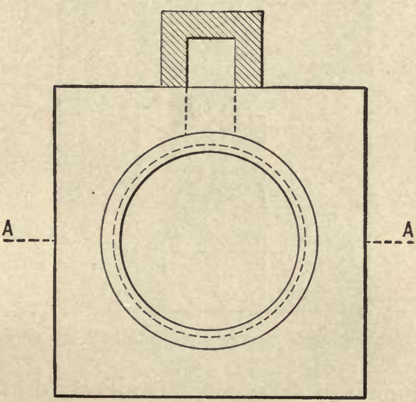

Fig. 21.—Top Plan of Dross Kettle.

THE FORMATION OF DROSS IN THE KETTLE.

The waste caused by the formation of dross is quite large, even with an experienced man in charge of the ket-

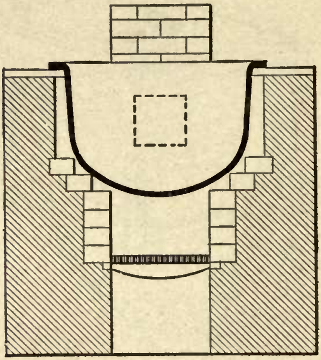

Fig. 22.—Vertical Section of Fig. 21 at A. A.

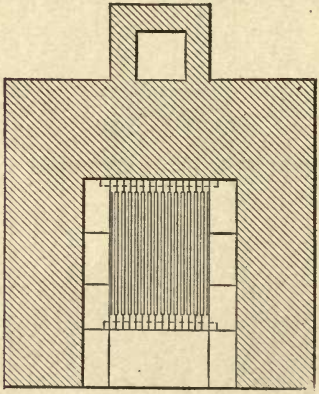

Fig. 23.—Horizontal Section of Fig. 22 at Grate Line.

tle. The amount of dross made is increased by failure in keeping the metal at a temperature that will not injure it, by allowing the work to be lost in the kettle and through

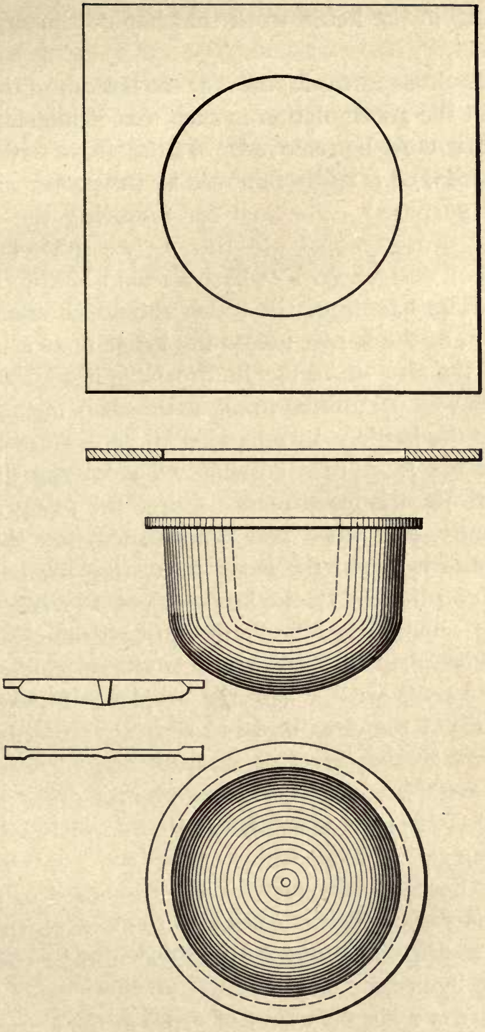

Fig. 24.—Details of Dross Kettle.

immersing in the kettle work that has not been properly prepared.

As the dross forms it settles at the bottom of the kettle, and when the accumulation is such that it interferes with the work it must be removed. As the dross settles it becomes hard, and is easily removed by the proper appliance for that purpose. The tool for removing the dross is called a "dross scoop." In Fig. 13 we show the shape of this tool, designated F, where a round bottom kettle is in use. The handle of the scoop should be about twice the length of the kettle, unless the kettle is of a size that requires the use of tackle in drossing it. The scoop should be well perforated to allow the clear metal to flow back into the kettle. In removing the dross use care not to stir or rile more than possible when forcing the dross scoop into the hardened mass. Force the scoop into the dross gently, and when you are satisfied that the scoop is full, raise it out of the metal by resting the handle of the scoop on the end of the kettle to get a leverage. Let the scoop remain over the kettle until all the clear metal that will has dripped back into it. If the handle of the scoop is rapped with a hammer or piece of iron it will cause more of the clear metal to separate from the dross than would be the case if it was not done. As soon as the clear metal has ceased to drip dump the dross into cast iron pans. These pans should be about 2 inches deep, 15 inches long and 9 inches wide.

Dross hardens very rapidly when exposed to the air, and no more time than is necessary to allow all the metal possible to drip back into the kettle should be consumed in getting it into the dross pans.

If there is a large amount of dross in the kettle and it is desired to allow the fires to go completely out it should be removed. If the kettle is allowed to cool with a large amount of dross lying in the bottom of it the result will most likely be a burst kettle. Before commencing to dross the kettle—that is, remove the dross—skim all the flux from the surface of the metal with a perforated skimmer. This tool is shown in Fig. 13, and is designated H.

RUNNING OVER OR "SWEATING" ZINC DROSS.

The writer is often asked if it pays the galvanizer to try and recover the good metal from the dross, and how best to accomplish it. Without entering into a discussion regarding the desirability of attempting its recovery, from a financial point of view, we will say that it is our practice to "sweat" our dross.

In Fig. 20 we give a perspective view of the kettle and brick work for running over dross. Fig. 21 is a top view, Fig. 22 is a vertical section at A A and Fig. 23 is a horizontal section at the grates. The kettle and casting details for bricking in are shown in Fig. 24. The arrangement is so simple that we do not think it necessary to describe it in detail.

The kettle should be made of cast iron, with the bottom about 1 inch thick. A kettle 30 inches in diameter and 20 inches deep answers the purpose very well.

To separate the good metal from the dross first melt up about 6 or 8 inches of lead in the bottom of the kettle and then put in the dross. Bring the dross to a temperature that will cause it to have rather a dark blue color or where the pyrometer will register about 1050 degrees. When this is accomplished stir the mass with a long handled ladle for about one-half hour, and then allow it to settle. When the mass has settled the lead will be at the bottom, the dross will lie on the lead and the clear metal will be at the top, where it can be bailed out into pans. The stirring may be repeated once or twice after each bailing operation. After all the clear metal has been extracted that can be remove the dross and put it into pans.

TINNING IRON AND STEEL

TINNING MALLEABLE IRON, WROUGHT IRON AND STEEL.

Simply to give articles of malleable and wrought iron a coating of tin is a comparatively easy process to master, but tinning on certain articles of hardware has reached a high state of perfection, and to tin saddlery hardware and the cheaper grades of table cutlery requires considerable skill. The methods employed to do the work vary greatly in different establishments, and the degree of perfection attained is equally at variance. Work that is tinned in an indifferent and slovenly manner is not necessarily done cheaply, as the material wasted on an article roughly and imperfectly coated is of more value than the slight saving in labor cost obtained by rushing the work through without proper attention to obtaining a light and even coating. The high price of the metal used to tin articles makes the cost of the material much more than the labor cost. A loss of 10 per cent. of the material by careless handling would represent a much larger proportion of the entire cost of the work than would an increase of the same per cent. added to the labor cost. Painstaking in bringing out the finished article free from surplus tin not only adds greatly to the commercial appearance of the goods, but materially decreases the cost of the work. This economical result is reached by careful attention to the heat of the tinning bath and to the skillful handling of the articles after their removal from the tinning pot and before they are cooled. If the tin is not hot enough the articles will be heavily coated, and it will cool on the work bunchy and wavy. A degree of heat above a certain limit also causes the work to have a rough and uneven appearance, injures the color and destroys the luster. The use of a good pyrometer in a tinning bath is a great help to the operator in maintaining a uniform heat of the tin.

PREPARING THE WORK.

Ordinarily the common grades of tinned articles are made ready for tinning by simply removing the sand, scale or rust by an application of either commercial sulphuric, muriatic or hydrofluoric acid. The finer grades of work are prepared for tinning by careful and lengthy rolling in gravel and water. This preparation not only effectually removes all impediments to a perfect coating, but gives the articles a smooth and perfect surface on which to deposit the tin, the degree of perfection obtained being determined by the time and care expended in the rolling operation.

A piece of wrought iron from which the scale has been removed by the application of acid will not have the smooth and perfect coating that the same would have if the removal of the scale was accomplished by irritation. The same is true of articles of malleable iron. The best and most perfect results are obtained by giving the castings a thorough tumbling in gravel and water, which operation brings the surface of the castings to a state of smoothness only equaled by buffing or grinding. Malleable castings on which it is desired to obtain a fine finish should invariably be given this treatment. It is, of course, necessary that the patterns from which castings are taken that are designed to be tinned be made with a view to obtaining the smoothest surface possible as an assistance to the tumbling operation.

Some tinners not only roll their castings in gravel and water, but for the purpose of obtaining a still finer surface than can be obtained by this method they roll them in dry, coarse sand, and also give them a third rolling with scraps of leather, the entire operation often requiring 30 or 40 hours in going through the several treatments. Water rolling is so common and so thoroughly understood that we consider it unnecessary to go into detailed instructions regarding the apparatus to be used or the methods to be employed. There are several concerns who make the manufacture of rolling barrels for this purpose a specialty, and the cheapest method to adopt in equipping a tinning plant with wet rolling barrels would be to buy the outfit from a manufacturer who has made the business a study.

The care of the tin, in regard to keeping it free from dross or slag, is an important point in obtaining perfect work, and will be referred to in its proper place.

TOOLS AND KETTLES.

The tools employed in handling the work are very simple in construction. They consist of wires formed into various shapes, perforated ladles or baskets made from sheet iron or wire cloth, and tongs with the jaws formed to adapt themselves to the various articles it is designed to handle with them. Those illustrated by Fig. 13 in chapter on galvanizing will be found useful and all that will be required in many cases. The ingenuity of the operator will readily suggest what is required for the work in hand.

The number of tinning kettles to be used depends altogether on the class of goods to be tinned. The most common kinds of hardware specialties can be tinned very satisfactorily by the use of a single kettle of tin, while the better class of tinning, such as saddlery hardware, iron spoons, etc., require, in order to get the best results, two kettles, and three may be employed to good advantage.

Where a plant is fitted up to do a fine grade of tinning the kettle used to give the castings their first coating of tin is designated as the "roughing kettle," and the other kettle or kettles as the finishing. When the roughing kettle is used no particular care is necessary to have the articles come out smoothly coated or free from surplus tin, as the unevenness of the coating will be removed by their later treatment in finishing. The object of the roughing kettle is to give the iron a thorough coating of tin as rapidly as it is prepared to receive it, which prevents rusting. After the iron receives a thorough coating of tin it may be stored away until it is desired to finish it.

For those having only a small amount of tinning to do it would not pay to invest in an expensive outfit of wet rolling barrels, and very good results can be obtained without them. We will say here that only a few of the large concerns engaged in tinning are so fitted and the work they turn out is of a nature that calls for the best results possible to obtain as regards smoothness and brightness of the finished work.

A TINNING PLANT.

In installing a tinning plant the convenient handling of the work should be given all the consideration possible, and the operator will find it a great help toward making his work easy, as well as to the advantage of his employer, if he will make a study of the best methods and tools to employ in handling the various articles that come to him to be tinned.

While it is our purpose to treat this subject in a manner that will enable a novice to make a successful beginning, the best results can, of course, only be reached by actual practice. With the principles and requisites necessary to perfection in results obtained well understood, there should be no trouble experienced by one of average mechanical ability in mastering the business.

To make the different operations of preparing and tinning articles of malleable iron, wrought iron and steel easily understood, we shall treat each operation separately.

While the illustrations we give will serve as a general guide in equipping a plant, it does not follow that they must not or cannot be changed to suit local conditions. It would be impossible to illustrate the exact course to be followed in individual cases, and those undertaking the installation of a plant must be governed to a great extent by their requirements as they see them.

It should be kept in mind in deciding what part of the factory can best be devoted to the tinning department that more or less gases and fumes prevail when the work is carried on. These gases and fumes are not only disagreeable to inhale, but are destructive to fine machinery and tools and to finished work. To the end that the work may not become a source of annoyance to those not immediately engaged in it and detrimental to machinery and goods, the plant should be located if possible in a building by itself, taking good care to provide good ventilation and drainage.

A room devoted to this work should not be less than 10 feet in hight, and the kettles and acid tanks provided with hoods connected with the ventilators to carry off the gases. The hoods should, of course, be high enough not to interfere with the perfectly free movements of the operator.

The illustrations given contemplate tanks of cypress or pine for containing the different solutions used in preparing and finishing the work, but oil barrels sawed in half may be employed for the purpose if they are properly cleaned either by burning out the interior or washing in a hot, strong solution of soda ash and water.

For heating the tin hard coal is best, as it gives the most even heat and is most easily controlled. Soft coal, coke, natural gas and even wood can, however, be employed for the purpose.

PLAN OF TINNING PLANT.

We show in Fig. 25 a ground plan for a tinning plant for general work, except the tinning of common cast iron. In this illustration A denotes the roughing kettle—that is, the kettle containing the tin used to give the work its first coating of tin; B is the finishing kettle; C is the tank containing muriate of zinc; D is what is termed in the trade the " whipping box," which is simply an arrangement to prevent the drops of molten tin being thrown promiscuously over the room when the operator is shaking or swinging his work to free it from the surplus metal; E is a tank made of sheet iron for containing the kerosene oil used in cooling the work, the intent being to have this tank surrounded by running water to keep the oil cool, the water being contained in the companion tank F; G is a tank provided with a steam coil, the intent being to have the tank filled with clean hot water, in which to rinse the finished work before drying it off in the saw-

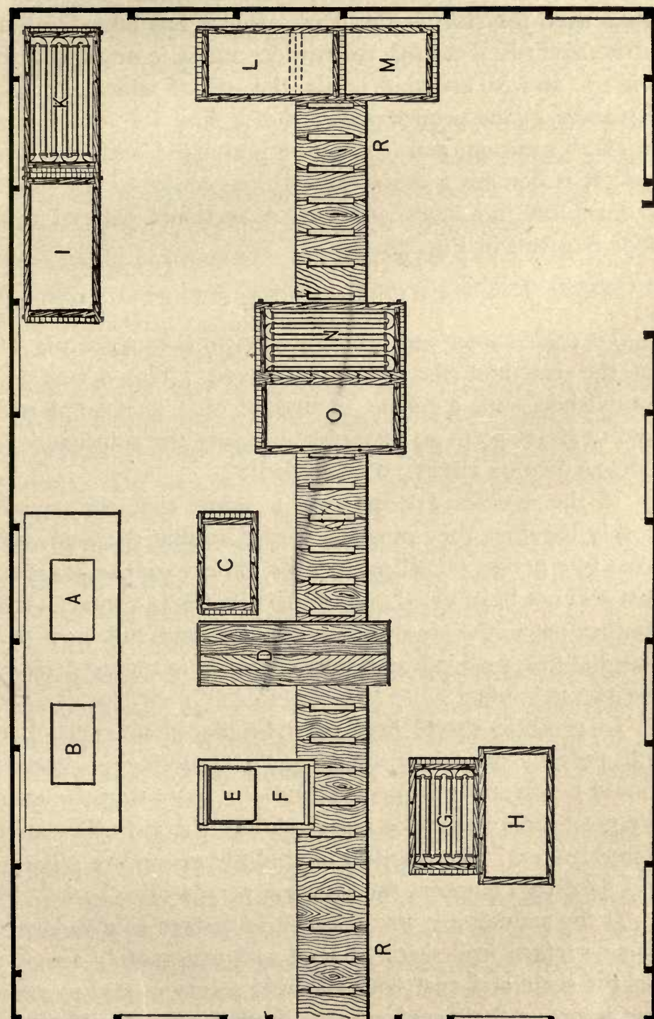

Fig. 25.—Ground Plan of Tinning Plant for General Work.

dust, which is contained in the box H; I and O are water tanks used for storing the work after it has been treated in the acid; K is a tank containing muriatic or sulphuric acid; L and M are acid tanks, the use of which will be explained in the proper place; N is a tank for containing an alkali solution, and it should be provided with a steam coil; R R denotes a drain through the center of the room to carry off the waste water. A sectional plan of this floor is given in Fig. 38.

REMOVING SCALE AND RUST WITH SULPHURIC ACID.

To enable steel and wrought iron to take a coating of tin, the scale and rust must be removed. This is best accomplished with a pickle composed of 1 part sulphuric acid to about 30 to 40 of water, bringing the solution to a temperature of about 150 degree F.

If the articles are of such a shape that they pack closely together they must be stirred so that the acid will have free action on all parts alike, otherwise the scale or rust will not be affected on that part that is in contact with another piece, the result being that the acid will burn the material first made clean before the scale is removed from the part in contact.

In pickling sheets they must be placed in racks that will prevent one sheet lying against another. Sheets should be carefully inspected, and any spots that the acid has not touched must be removed with the aid of a sharp pointed steel. The shank of an old file ground to a point and hardened answers the purpose very well.

If the articles are small, and it is desired to give them a fine surface, roll them in sand and water after removing the scale and rust with the acid solution, and to further improve their surface give them a second rolling in scraps of leather. The effect of rolling is to give the articles a smooth surface, and the smoother the surface obtained the smoother and brighter will be the goods after tinning.

We do not wish it to be understood that the rolling operation is absolutely necessary to obtain a complete coating of the goods, as they will take the tin perfectly if that operation is omitted, but the appearance of the goods is greatly improved by the rolling, and when it is desired to obtain the best finish possible the rolling barrel must be employed.

When the removal of scale and rust has been affected and the material is perfectly clean it should be stored in tanks containing clear water, there to remain until the operator is ready to put it through the subsequent operations. Do not allow the work to remain in running water, as it will soon rust or oxidize if it is.

The operator must not fail to examine the work frequently while it remains in the hot pickle to determine when the desired result has been obtained. If it is allowed to remain too long a time after the scale and rust have been removed the acid will attack the surface of the material and leave it rough and seamed. Imperfections caused by overpickling cannot be covered up by the coating of tin, and the commercial appearance of the goods is injured.

The removal of scale and rust can be accomplished by a pickle composed of 1 part muriatic acid to 15 to 20 parts of water, but the cost is greater and the result obtained no better. It is not advisable to use this acid for the purpose unless the amount of work to be treated is very limited.

In Fig. 25 K represents the tank to be used for the purpose just explained, and I indicates the storage tank for the prepared work.

CLEANING SANDY CASTINGS BY SULPHURIC ACID.

Castings that have sand on them must be subjected to a treatment that will effectually remove it, as a perfect coating cannot be obtained if a particle of sand remains. The removal of sand can be accomplished by placing the castings on an inclined platform and keeping them wet with a pickle composed of 1 part sulphuric acid to 6 of water, until the sand is loosened enough to wash off by the application of water. From 10 to 20 hours is required to accomplish its removal and then a casting brush often has to be employed to get out all the little particles that are burned in where there are sharp angles.

Rolling with plenty of sharp scratches or shot is the only sure way to obtain a perfectly clean casting, and we should never attempt to tin malleable castings in any considerable quantity without the aid of a rolling barrel. As in the case with articles of steel or wrought iron, the wet rolling barrel supplemented by the dry rolling in leather scraps fits the castings to take a beautiful coating of tin and a bright luster.

The platform on which the castings are placed for pickling should have a tank placed under one end at its lowest point to catch the acid as it flows from the castings after each bailing operation. This pickling arrangement is designated as L in Fig. 25, and the tank designated as M can be used to store the prepared work until it is desired to give it the finishing treatments.

CLEANING SANDY CASTINGS WITH HYDROFLUORIC ACID.

We have given the course to be followed for cleaning sandy castings with sulphuric acid, because it may not always be possible to obtain hydrofluoric acid, and because hydrofluoric acid is a comparatively new agent in the business. Where it is possible to substitute this powerful acid for sulphuric acid it should be employed, as its effects are much more rapid and certain, and are less destructive to the castings.

In employing hydrofluoric acid to remove sand make a solution for slow pickling in the proportion of 1 part acid to 30 of water. For quick pickling make the proportion 1 of acid to 20 of water. Immerse the castings until the sand is dissolved, which will be in from 15 minutes to 3 hours, depending on the strength of the solution and the tenaciousness of the sand.

A good arrangement for doing this work is to have two tanks, one elevated by means of a bench or stand, so that the bottom of the upper tank will be a few inches above the top of the lower tank. Provide a hole in the upper tank so that when the plug is removed the solution will escape into the lower tank and leave the castings uncovered by the solution. When all the solution has escaped into the lower tank cover the castings with water until it is desired to remove them for subsequent treatments. The solution in the lower tank is ready to use on a fresh batch of castings. We do not show this arrangement in Fig. 25, as it can take the place of the sulphuric acid, designated as M in that illustration.

REMOVING PAINT OR GREASE.

If the work is greasy or has paint on it, it must be cleaned with a hot solution of caustic soda or soda ash and water. Make the solution very hot and strong, and immerse the work in it until it is free from all such matter, after which rinse it thoroughly in clean water. This operation should precede pickling when it is necessary to perform it. The tanks for this purpose are designated in Fig. 25 as N and O.

TINNING WITH A SINGLE KETTLE OF TIN.

As already stated, very good results can be obtained by simply using one kettle of tin where the commercial appearance of the work is of secondary importance. Where only a single kettle is employed the tin should be maintained at a temperature of about 500 degrees F., and the work may be cooled in hot water and dried off in sawdust.

The operations preliminary to dipping the work in the tinning bath are precisely what they would be if more than one kettle of tin was used. As these operations will be explained in connection with those for using two kettles we will not give them here.

Where only a single kettle is employed more or less trouble will be experienced in keeping the dross or slag which rises to the surface of the tin from adhering to the work and in keeping the tin at a uniform temperature. The dross or slag must be removed from the tin frequently with a perforated skimmer, and when the black flux that forms on the surface of the tin from the muriate of zinc, in which the castings are dipped previous to immersing them in the molten tin, is present in sufficient quantities to interfere with drawing the work, it must also be removed in part. A small amount is beneficial to the work, but when it accumulates in a sufficient quantity to catch on the work as it is drawn out it is apt to stain the work and leave white streaks wherever it touches. The cooling water should also be kept clean and free from acid. If it is not the work is liable to rust. In Figs. 29, 30 and 31 we show manner of bricking in a single kettle, the casting details being shown in Fig. 32.

TINNING WITH TWO OR MORE KETTLES OF TIN.

When the work has been made perfectly clean from sand, scale, rust, grease or paint by some one of the treatments described, it is ready for the final operations. If the work is of a kind that will admit of its being strung on wires, use such wires as seem best adapted to the work in hand. For many kinds of work a piece of wire bent in the shape of a croquet wicket will be found just the thing. Good stiff wires should be used, and they should be long enough to allow plenty of room for the operator to grasp the ends without getting burned. That is to say, if you have 10 inches of tin in the kettle, make the wire 20 inches long, which will allow 10 inches of wire to be out of the tin where the operator can grasp it when he is ready to draw the work from the kettle. Provide plenty of these wires so that the handling of the work may be facilitated.

String on wires as much of the work as you think you can handle comfortably, and put them, several strings at a time, into the alkali solution. The work may be allowed to remain in this solution for several minutes, or while the operator is filling more wires. From the alkali solution the work is to be passed into the rinsing tank, and care should be taken that all traces of the alkali are removed.

When this is accomplished the work is to be given a few minutes' immersion in a solution of muriatic acid and water. This mixture should be in the proportion of 1 of acid to 4 or 5 of water in cold weather, while in warm weather 8 or 10 of water to 1 of acid will do the required work. The object of this dip is to remove any trace of rust that may have formed on the work. The tank for this purpose is designated as K in Fig. 25, and for many kinds of work, such as castings that have been cleaned by dry rolling and goods that have been made of material that has no scale on it, all that is necessary is to give it a few minutes' immersion in this solution.

From this last dip of muriatic acid and water, which by the way should never be omitted, the work is to be dipped in muriate of zinc, which is the last dip previous to immersing it in the molten tin. Tank C, Fig. 25, is used to contain the muriate of zinc, which solution is made by dissolving scraps of zinc in clear muriatic acid.

PASSING THE WORK THROUGH THE TINNING KETTLES.

If two kettles of tin are in use, as shown in Fig. 25 by A and B, take a wire full of the work to be dipped and immerse it while wet with the muriate of zinc in the kettle of tin designed to give the work its first coating. This is the roughing kettle, and is designated in Fig. 25 as A. Put several of the strings of work into the kettle and allow them to remain until the work is as hot as the tin. The tin in this kettle should be maintained at a heat of about 500 degrees F.

After the work has remained in the first kettle the requisite time take a wire full in the left hand, and with a skimmer held in the right hand clear a space on the surface of the tin large enough to admit of the wire full of work being removed without any of the slag or flux adhering to it. Remove the wire full of work and pass it directly to the second kettle. It is not necessary to shake off the surplus tin when removing from the first kettle, but it is necessary to use care that none of the flux or slag is carried over to the second kettle on the work.

Retaining hold of the wire containing the work the operator allows it to remain in the second kettle for the fraction of a minute until the heat of the work attained in the first kettle is reduced to about the temperature of the tin in the second kettle, which for most purposes should be about 400 degrees F. Very small articles may require that the tin in the second kettle attain a temperature of 450 degrees F. A much higher heat will cause the tallow, which is on the second kettle, to a depth of ½ to 1 inch, to ignite. When the work is in the condition named draw it quickly from the tin, and after a few rapid swinging motions to free it of surplus metal plunge it into a tank of kerosene oil, using a motion calculated to keep the articles from sticking together. A little practice will soon determine what motion is best adapted to keep the articles separated and also prevent any lumps of tin forming on the work.

D in Fig. 25 denotes the position of the box provided to catch the drops of tin that are thrown from the work as the operator swings it to and fro. E denotes the tank for containing the oil used for cooling, as already explained. The tank containing this oil should be surrounded by water to prevent the oil heating to a point where it would ignite.

The work should be allowed to remain in the oil long enough to set the tin, and it should then be thrown into fine sawdust to clean it of the oil. If the articles are very heavy it may be necessary to plunge them into cold water from the oil.

If the work cannot be strung on wires a "basket" may be used for dipping it. The basket may be of sheet iron, in which case it should be provided with plenty of holes to allow the tin to pass off, or it may be made of wire netting with a mesh sufficiently small to prevent the work falling through. Fig. 13 illustrates the shape of these baskets, which are designated as A and B. Nails, tacks, rivets and all similar articles are dipped in the tin by means of these baskets. Tongs are also used for handling heavy articles, but those used in the tin should not be used for cooling the work, as they would mark it. The tongs used for cooling should not be put into the molten tin. Their shape may be varied to suit the form of the article handled.

TINNING WIRE IN COILS.

In large manufacturing establishments machinery is employed whereby several strands of wire are passed through the tinning kettle simultaneously. To do the work on a small scale, provide reels that will accommodate a coil of wire. Place one of the reels in a position where the black wire will pass, as it is uncoiled, through a tank containing muriate of zinc, and then through the kettle of tin. The other reel is placed in a position where it will take up the wire as it passes through the tin. The reel used to draw the work through the kettle must, of course, be provided with an arrangement for turning it, and a device to hold the wire under the muriate of zinc and also under the tin as it passes from one reel to the other must be employed. As the necessary arrangement will readily suggest itself we do not think it necessary to illustrate it.

At the point where the wire leaves the molten tin a piece of tow is twisted around the strand, sufficiently tight to wipe off the surplus metal, which flows back into the kettle. If the wire is very heavy it must be made to pass through water after it leaves the tin, the water tank being placed where the wire will not enter it until it has passed through the bunch of tow used to wipe off the surplus metal.

If the wire is covered with a heavy scale or rust it must be cleaned in sulphuric acid the same as any other work. If it is bright wire all that is necessary is to immerse it in a solution of muriatic acid and water, 1 part acid to 6 of water. If wire is to be tinned in quantity a long shallow kettle is best adapted to the purpose.

TINNING STEEL SPOONS AND SIMILAR ARTICLES.

For this purpose provide a good sized kettle for "roughing" the work—that is, for giving it a preparatory coating. For finishing the work use small kettles. A kettle 15 inches long, 8 inches wide and 6 inches deep is ample for work of this kind. We refer to a plant fitted especially for this business. The work can be done in an outfit such as we illustrate by Fig. 25, but large finishing kettles are not as well adapted for this business as small ones, as the tin in a large kettle is apt to become dull in color by constant use, while in a small kettle the tin is turned over more rapidly, which allows it to hold its color much better.

The articles should be rolled in tumbling barrels with scraps of leather and then carefully cleaned in an alkali solution. After rinsing off the alkali they should be immersed in quite a strong solution of muriatic acid and water for five or ten minutes, and then dipped in the roughing kettle by means of a wire basket, first dipping the work in a solution of muriate of zinc. As soon as they are thoroughly coated shake them out of the basket in such a way as will insure the separation of as many as possible. It makes no difference whether they come smooth or not so long as they are thoroughly coated. The smoothness will come in the finishing operation.

To finish the goods take them, a piece at a time, in a pair of tongs adapted to hold them and immerse in the finishing kettle, the tin in which is covered with beef tallow to the depth of about ½ inch. As soon as the article reaches the same heat as the tin remove it and allow it to cool enough so that the tin will not run, after which wipe up the goods in flour.

RETINNING.

This branch of the business is comparatively simple, since no pickling is required. An outfit for doing the work usually consists of the three kettles—one for roughing the work and two for finishing. The roughing kettle is usually set up by itself, although it may be contained in the same brick work with the finishing kettles.

For retinning, kettles shaped like those used for sweating zinc dross are best adapted for the work, and the manner of setting is practically the same. They should be covered with a hood to catch the smoke and fumes which are constantly rising. The hood should be constructed to leave one side open so that the operator has free access to the kettles from one side. A view of a "tinning stack" resembles an open grate or the fire place of olden times, the brick setting to the kettles being about the hight of an ordinary work bench.

The finishing kettles are kept covered with beef tallow and palm oil, and care must be taken to prevent any dross or slag being carried over from one kettle to the other in the operation of passing the work from kettle to kettle. When large articles are being treated, like pressed dishpans, a swab of hemp is often used to free the article from dross before removing it to the last kettle.

In drawing the article from the finishing kettle the

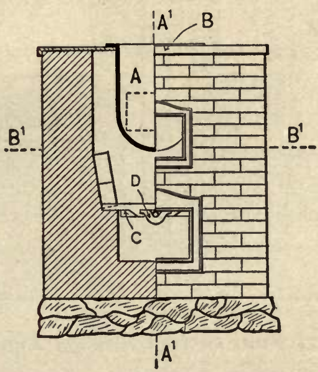

Fig. 26.—End Elevation of Brick Work for Setting Two Kettles.

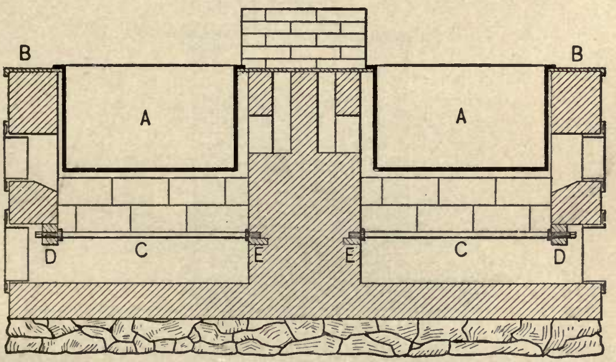

Fig. 27.—Vertical Section through Fig. 26 at A^1, A^1.

motion should not be too rapid. The piece should be held in one position and the drop of tin that forms at the lowest point removed by passing a piece of round iron along the edge. One end of this rod of iron is kept in the kettle of tin so that it is always ready for use.

When the tin has "set," the article is passed to the

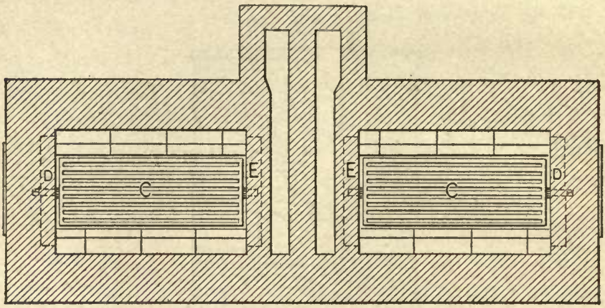

Fig. 28.—Horizontal Section through Fig. 26 at B¹, B¹.

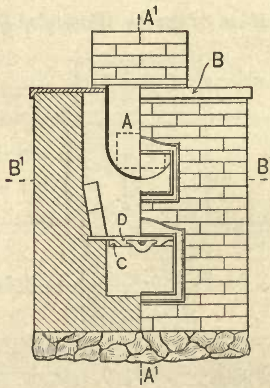

Fig. 29.—End Elevation of Brick Work for Setting Single Kettle.

"bench" to be rubbed in flour. In large establishments girls are mostly employed to clean the work with flour after it is tinned.

The heat of the tin must be gauged to a nicety. If too hot the tallow will ignite and the work come out yellow. If too cool the coating will be heavy and will not flow smoothly.

It is perhaps unnecessary to say that in case rust has

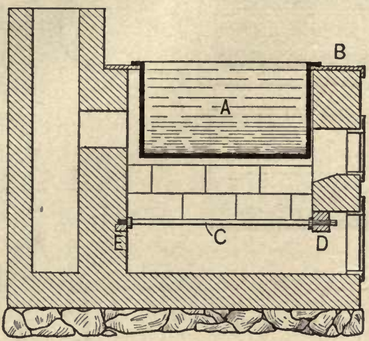

Fig. 30.—Section through Fig. 29 at A', A'.

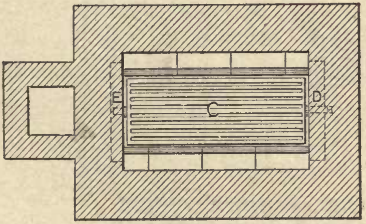

Fig. 31.—Section of Fig. 29 at B', B'.

formed on the work from any cause it must be removed with acid the same as from any other work. Preparatory to dipping in the roughing kettle the work must be dipped in muriate of zinc.

SETTING RETINNING KETTLES.

Kettles for retinning are set in a variety of ways, and hardly any two plants have the same arrangement of kettles or other apparatus. The principal point to consider in

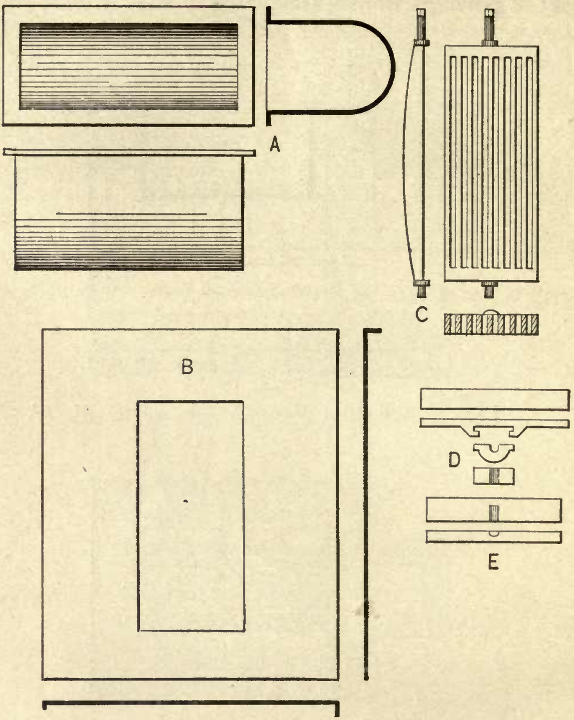

Fig. 32.—Details of Tinning Kettle.

bricking in kettles for retinning and, in fact, those for any purpose, is to place the fire and ash pit doors where they will not interfere with the working of the kettles while the fires are being attended to.

We give in Figs. 39 and 40 perspective views of the brick setting of a retinning stack. Fig. 39 shows the kettles in position, and Fig. 40 is a view of the back of the stack, showing the fire and ash pit openings.

In these illustrations the entire stack is represented as being of brick. This plan is undoubtedly the most economical in the end, although many stacks are inclosed with sheet iron about the brick work surrounding the kettles. We think the perspective views will enable one to construct a stack without our giving the entire arrangement in detail, as we do in Figs. 26 to 31, inclusive.

Fig. 32 shows the casting details for setting kettles as represented by Figs. 26 to 31, inclusive. A gives a top, side and end view of the kettle; B shows the coping plate; C is the grate in detail; D is the front bearing bar in detail, and E the back bearing bar. The position of each piece is designated by a corresponding letter in Figs. 26 to 31, inclusive.

Fig. 26 is an end elevation of the brick work, Fig. 27 is a vertical section of Fig. 26 at A′ A′ and Fig. 28 is a horizontal section of Fig. 26 at B′ B′. Figs. 29, 30 and 31 show the manner of bricking in a single kettle.

TINNING COMMON GRAY IRON.

The tinning of common gray iron castings has become quite an extensive industry in the last seven or eight years. Previous to this time there were only one or two parties in the country able to do the work with any degree of success. While manufacturers had long recognized the fact that tin was a much more desirable metal than zinc for coating certain articles of culinary use the want of a cheap and practical process for tinning on gray iron precluded their giving the matter serious attention.

The author perfected a method in 1891, a full description of which will be given in this article, that proved a practical success, and to-day it is almost impossible to sell zinc coated articles that are to be used in the preparation of food.

In addition to the uses to which tinned gray iron is put by the manufacturers of kitchen and other hardware specialties, it has been found of great advantage to give articles of cast iron that are to be copper or brass plated a coating of tin previous to plating them. The advantages come from the lessened quantity of material necessary to use in electroplating, the preventing of "leaking" or "sweating," so common where the plating is deposited directly on the bare casting, and also in giving the articles the appearance of spelter or brass castings.

By this process gray iron castings are prepared for tinning by rolling them in a solution of muriatic acid, sal ammoniac and water, the rolling barrel being constructed to retain at a high pressure the gas formed by the chemicals used. The use of this barrel makes it desirable to locate the tinning plant in a building by itself, as the gas generated is constantly escaping, carrying with it quantities of the solution. At the best the barrel room for gray iron tinning is a wet, dirty place, and the entire operation requires the use of considerable water.

DESCRIPTION OF TINNING PLANT.

In erecting a building for this purpose particular attention should be paid to ventilation and drainage. A plan for constructing a floor, with a view to perfect drainage, is shown by Fig. 38. The arrangement of the outfit is shown by Fig. 33, in which A is the rolling barrel for preparing the castings for tinning. B is a tank to receive the castings after they have been treated in the rolling barrel A. This tank should be provided with trucks, and a track should be laid so that the tank can be run under the rolling barrel to receive the prepared work. C is a tank for storing the prepared castings previous to further treatment, as hereafter described; D, E, F and G are divisions of one common tank; D is to contain an alkali solution, and is to be provided with a steam coil, as shown, to heat the solution; E is a compartment for containing water for rinsing; F is to contain an acid solution; G is for the muriate of zinc; H is the roughing kettle of tin; K is the finishing kettle; L is the oil for cooling the work. The arrangement of this tank was explained in the chapter on general tinning; M is a wooden tank large enough to accommodate the iron tank L and allow it to be surrounded with water; N is a tank for containing hot water, in which the tinned work is dipped to remove any traces of oil or acid; it is provided with a steam coil, as shown; O is a

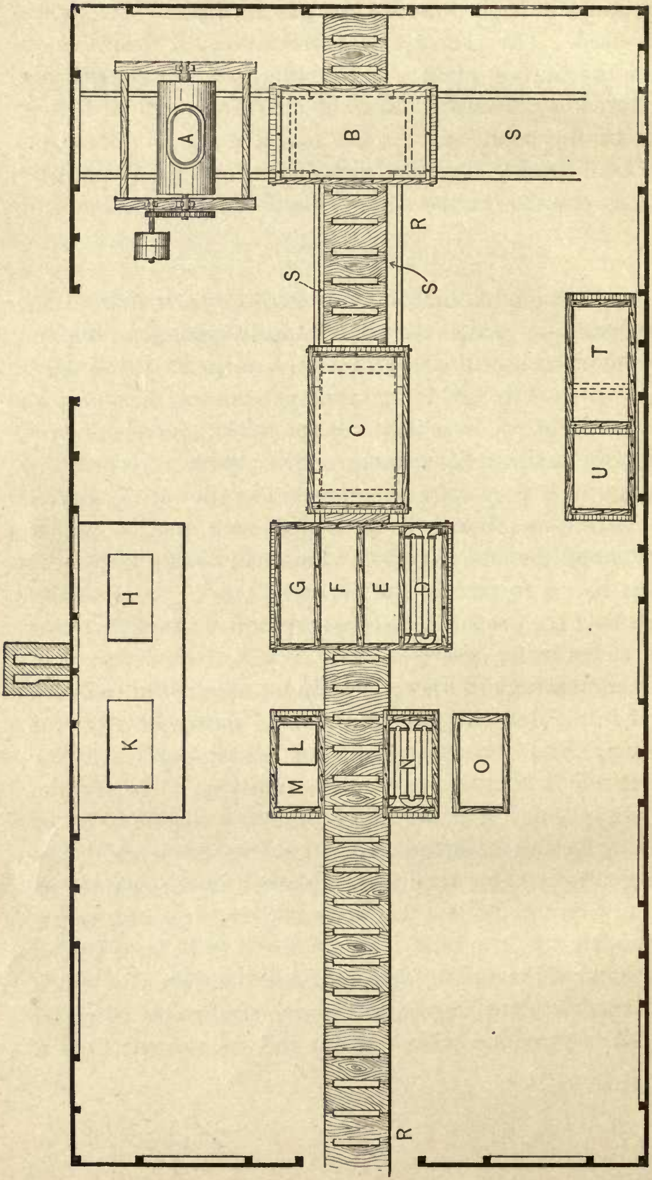

Fig. 33.—Ground Plan of Plant for Tinning Cast Iron.

box to contain sawdust for drying off the work when it comes from the hot water contained in the tank N; R R is a drain for carrying off the waste water and S S are the tracks for moving the tanks B and C; T is a tank for containing a solution of hydrofluoric acid, to be used as hereafter described, and U is a storage tank. It is perhaps needless to say that the ground plan may be changed to suit local conditions.

Only the most simple tools are required, which may be varied by the ingenuity of the operator to suit existing conditions of work. We give a sketch showing the most common in Fig. 13.

GENERAL CONSIDERATIONS.

In preparing gray iron castings to take a coating of tin there are several essential things to be taken into consideration: the quality of the iron, the form of the castings, their condition when they come to the tinner, and if cored, the nature of the cores used.

Hard iron needs a longer preparation than soft iron and a longer immersion in the molten tin. Castings that are made from patterns not designed with a view to avoiding sharp angles, in which the molding sand can find lodgment, are much more difficult to prepare than those made from patterns free from these obstacles. It is, of course, not always possible to do away with sharp angles in making patterns for castings that are designed to be tinned, but whenever possible they should be avoided in the interest of easy cleaning from sand and perfect coating of the work.

Castings that have been freed from sand by the use of sulphuric acid require a special preparation before they will take a perfect coating of tin, and the use of this acid should be avoided if possible. Cored castings made with cores in which rosin has been used must be treated differently from those made with an oil or glue core. For the intelligent understanding of the different conditions we give the specific course to be followed in each case.

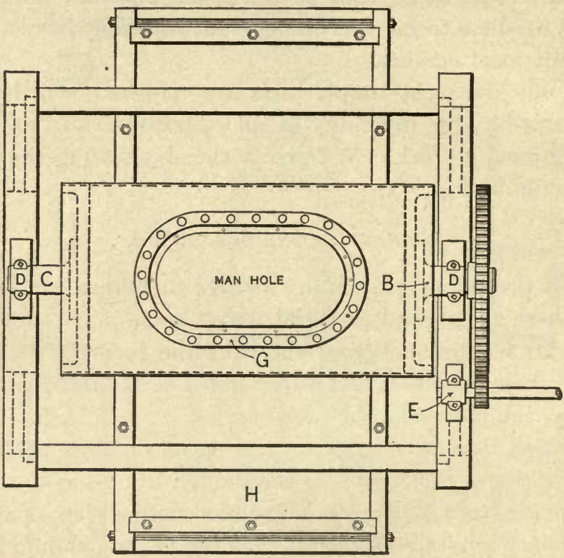

Fig. 34.—Top View of Rolling Barrel with Receiving Tank in Position.

The perfect coating of gray iron requires the use of two tinning kettles, and where castings are to be tinned previous to electroplating three kettles of tin should be used to insure the smoothest coating and the brightest luster.

TUMBLING BARREL.

An outfit for preparing and tinning cast iron consists of a tumbling barrel, constructed in accordance with the plan shown by Figs. 34, 35, 36 and 37. The points wherein this barrel differs from the ordinary wet rolling

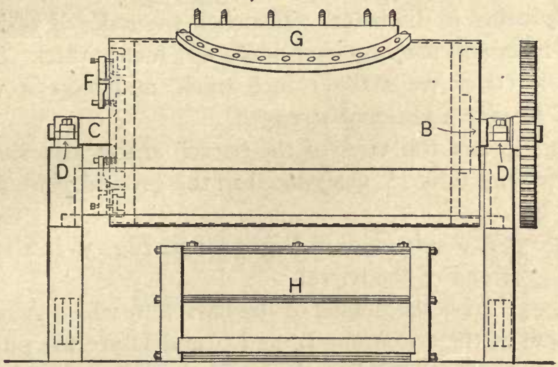

Fig. 35.—Side View of Fig. 34.

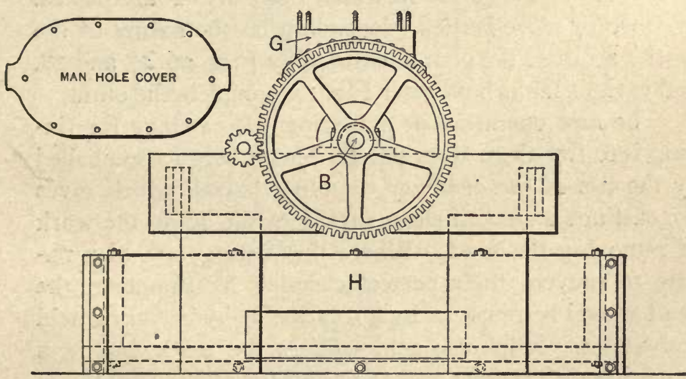

Fig. 36.—Gear End of Fig. 34.

barrel are that it is built very heavy and strong. It is provided with valves for the escape of the gases generated by the chemicals used, and the opening where the barrel is filled is arranged to close tightly.

For general work we prefer a barrel 48 inches long and 24 inches in diameter. The shell we make of ⅜-inch boiler iron, and use cast iron heads 1½ inches thick. The manhole cover we make 1 inch thick, and have it well ribbed to give additional strength.

Fig. 34 is a top view of the barrel, and it also shows the receiving tank H, designated in the ground plan, Fig. 33, as B.

Fig. 35 is a side view of Fig. 34, and Fig. 36 is a view of the gear end of the barrel.

Fig. 37 gives the details of the barrel, in which A is an end view of the trunnions B, and C and D are the pillow blocks supporting the barrel and E those for the pinion shaft; F is the valve for the relief of gas and G is a view of the end of the barrel on which the valves F are placed.

Two or more kettles (depending on the nature of the work) set after the plan illustrated by Figs. 26, 27 and 28, and various tanks built after Fig. 12, complete the outfit.

The first operation in preparing the castings for tinning is to free them from sand. This is best accomplished by the use of the ordinary tumbling barrel, which gives the castings a smooth clean surface while doing the work of removing the sand. Where the castings are of a nature to prevent their perfect cleaning by tumbling, the sand should be removed by a solution of hydrofluoric acid and water. Sulphuric acid will do the work, but in a much inferior manner and to the injury of the castings in relation to their ready and perfect coating. The reason for this is easily understood. Hydrofluoric acid acts directly on the sand, dissolving it rapidly without attacking the iron to any great extent. The action of sulphuric acid

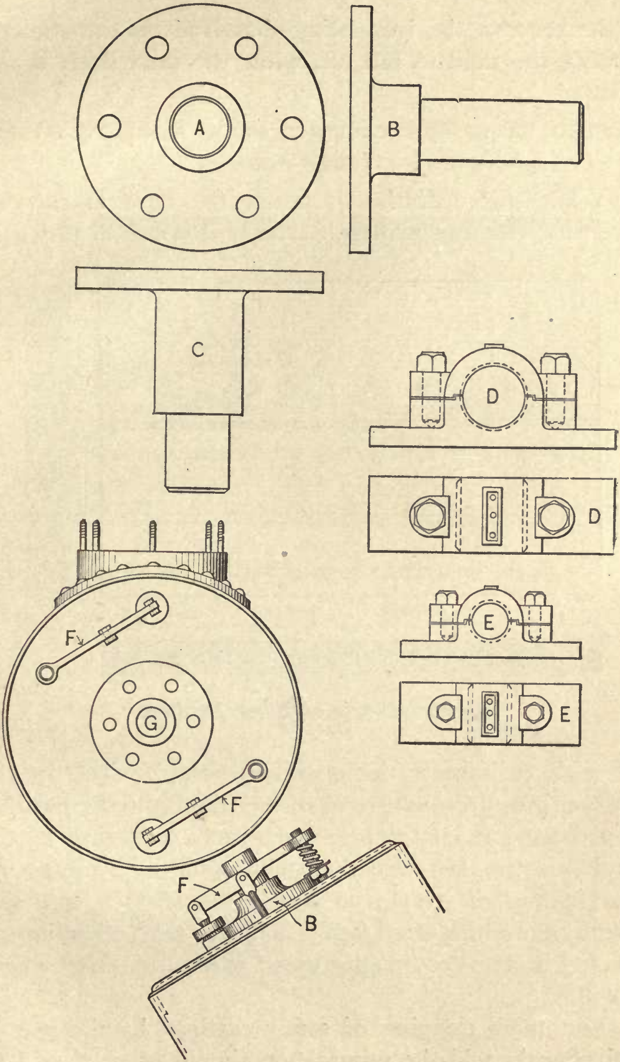

Fig. 37.—Details of Rolling Barrel.

is the reverse, the iron being dissolved on the surface, causing the sand to fall off, while the sand itself is not affected.

FREEING GRAY IRON CASTINGS FROM SAND BY HYDROFLUORIC ACID.

While this operation is nearly the same as the one given for cleaning malleable iron by the use of this acid

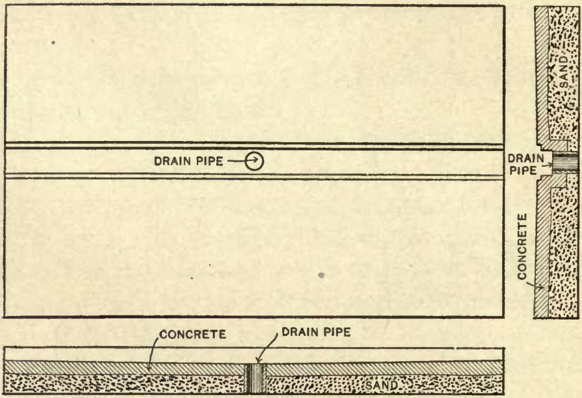

Fig. 38.—Detail of Floor Drainage.

we wish to impress the operator with the fact that in treating gray iron with acid of any kind, for the purpose of preparing it for tinning, much more care must be expended in the operation than with malleable iron, as the overpickling of gray iron leaves the surface soft and gummy, in which condition it will not take a coating of tin, and it is no easy matter to get it in a condition where it will.

For quick cleaning of sandy castings by the use of hydrofluoric acid the preparation should be 1 of acid to

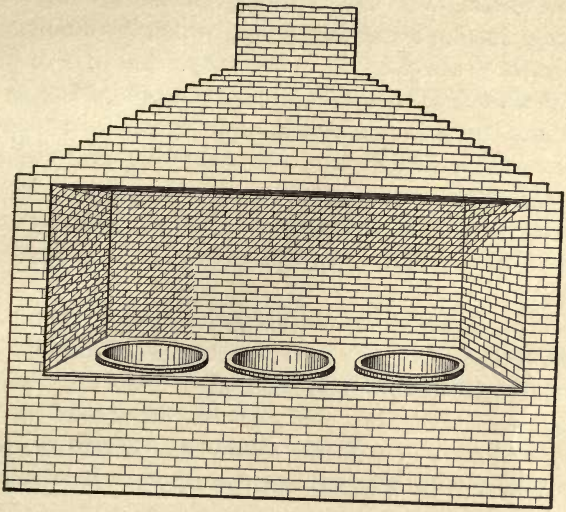

Fig. 39.—Front View of Retinning Stack.

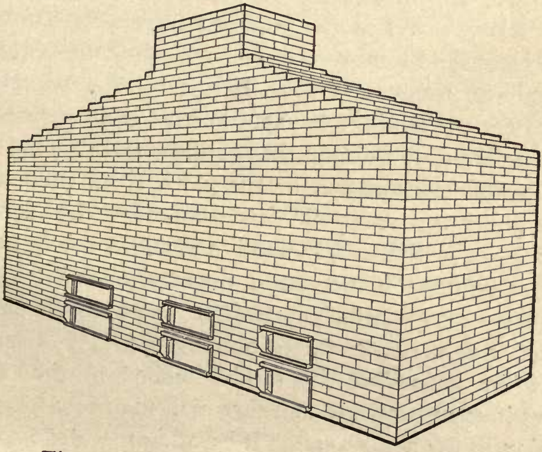

Fig. 40.—Back and End View of Fig. 39.

20 of water. For slow cleaning, which is necessary on castings having sharp angles into which the molding sand has burned, use the acid in the proportion of 1 of acid to 30 of water. The castings may remain in this solution until the sand is dissolved, after which, provided they have not been made with rosin cores, they are ready to be placed in the tumbling barrel used to prepare them for tinning. If rosin cores have been used they are to be treated in a special way, which will be explained in its turn.

A good arrangement to clean sandy castings with hydrofluoric acid is to have two tanks (oil barrels sawed in half will answer), one elevated above the other by means of a stand or bench, so that the top of the lower tank will be 3 or 4 inches below the bottom of the elevated tank. Bore a hole in the side of the upper tank close to the bottom and provide a plug. Place the castings in the upper tank and cover them with the solution, which has previously been mixed and is contained in the tank below. When the castings have been completely freed from sand remove the plug and allow the solution to escape into the tank below, where it remains until required for use again. No specific rule can be given as to the time required to clean the castings, and it is not necessary, as an examination of the work from time to time while under treatment will determine when they are clean. Castings on which a light sand is attached might be clean after 15 minutes' immersion in the solution, while castings having a heavy coating of sand, or on which the sand has burned, might require three or four hours.

If the nature of the sand attached to the castings makes it seem probable that they will require a longer immersion in the acid, weaken it by adding water to a point where there can be no possible danger of the castings being affected in the way mentioned in the beginning of this subject.

T and U in Fig. 33 are the tanks designed for treating the castings with hydrofluoric acid. If it is found impracticable to get this acid the work may be done with sulphuric acid, in which case the arrangement for its use will occupy the same position as designated for hydrofluoric acid.

CLEANING SANDY CASTINGS WITH SULPHURIC ACID.

If sulphuric acid is used to free the castings from sand place them on an inclined, raised platform, which platform should be of a size to accommodate the intended production and arranged to allow the solution to flow back into the tank placed at the lowest point to receive it. Make the solution in the proportion of 1 of acid to 6 of water, and keep the castings wet with this solution until the sand is readily removed by the application of water. Gray iron castings cleaned in this way will have a soft, gummy deposit on the surface, and will not take as perfect a coating of tin as castings cleaned by dry tumbling or by the use of hydrofluoric acid, and they must be given a special treatment before tinning, which will be described in connection with the treatment for castings made with rosin cores and hard and greasy castings.

After the castings have been freed from sand in some one of the ways described, provided they are not excessively hard castings or made with rosin cores, are not greasy or "pickled" with sulphuric acid, and have not been faced with black lead facing, then they are ready for tumbling in the solution of muriatic acid, sal ammoniac and water. If any of these conditions exist they must be given a treatment in a bath of hot caustic soda or soda ash.

THE USE OF A HOT ALKALI BATH IN CERTAIN CASES.

If castings have been overpickled—that is, left in the pickle until the surface has become covered with a soft, gummy substance—or if rosin cores have been used in making the castings or black lead facing used to give a smooth surface, or if grease or paint is present, they must be immersed for several minutes in a boiling solution of caustic soda or soda ash. Make the solution very strong, and see that the strength is maintained by adding fresh material as needed.

After this treatment the castings must be thoroughly washed with clean water before they are placed in the barrel used to prepare them for tinning. D in Fig. 33 designates the tank to be used for the hot alkali solution and F in the same illustration is the tank used for rinsing.

PREPARING THE CASTINGS IN THE GAS BARREL.

The details of cleaning having been carefully attended to, place the castings in the tumbling barrel, together with a quantity of ordinary " stars," such as are used in dry tumbling, being careful to load the barrel in such a way as to prevent breaking or wearing the corners of the castings. Tea kettles should be filled full of the stars or shot before placing them in the tumbling barrel and light, delicate castings should be packed tight enough to prevent breaking. Stars or shot sufficient to fill the barrel about one-fourth full will be found the most desirable quantity for ordinary work, although on hollow ware much more is needed, or enough to take up nearly all the vacant space. After the barrel has been loaded in the way described put in sufficient water to fill it about three-fourths full, then add to the barrel 15 pounds of commercial muriatic acid and 2 pounds of gray granulated sal ammoniac. The barrel is now ready to be closed and started, presuming that the operator has examined the valves to see that they are in perfect working order previous to loading the barrel.

After the barrel has been in motion from 5 to 15 minutes, depending on the temperature of the water used, there will be formed sufficient gas to cause the valves to open. The escape of gas will be accompanied by quantities of the solution, and the end of the barrel on which the valves are placed should be inclosed, unless the barrel is set up in a different room from the rest of the outfit.

The time that the castings should be rolled in this solution varies from two and one-half to five hours. Soft smooth castings will take a nice coating after a preparation of two and one-half hours, while to obtain the same results on hard iron, iron cleaned by the use of sulphuric acid, hollow ware and tea kettles and castings having a black lead facing, five hours in the barrel are necessary. It is safe to say that three and one-half hours will properly prepare ordinary castings, the barrel making 40 revolutions a minute. For hollow ware, tea kettles and very delicate castings the barrel should not attain a speed of over 30 revolutions per minute. After the castings have been rolled in the solution the required time open the barrel and cover its contents with water immediately. Do not let any time be wasted in getting the castings covered with water, as a slight exposure to the air will cause them to oxidize and prevent them from taking the tin. If the castings are properly prepared—that is, if they have been rolled in the solution long enough—they will be in such a condition after rinsing that they will not soil a white cloth to any extent.

As soon as the operator has determined whether the castings will tin properly (which is done by putting one or two of the pieces through the regular treatment) he will proceed to dump the contents of the barrel into the receiving tank, located directly under the barrel. This tank is designated in Fig. 33 as B, and should contain about one-third more cubic feet than the rolling barrel. From this receiving tank the castings should be removed to the storage tank designated C in Fig. 33. A good sized coke fork is best for handling the castings from tank to tank as it lets the shot or stars fall to the floor and separate from the castings.

In placing the castings in the storage tank care should be taken to have those with depressions or cavities go under the water with the depressions or cavities up. In other words castings of a shape that would admit of a particle of air being retained should be so placed that no air will be retained. If this occurs there will be a rusty place form on the casting to which the tin will not adhere. Should it be found that the castings are not properly prepared the barrel should be recharged by adding 6 pounds of muriatic acid and allowed to run about an hour longer.

The important point to be kept in mind in preparing cast iron for tinning is that the surface of the iron must be made perfectly clean. Not only clean from sand and rust, but from every foreign substance. It may seem to the reader that we are dwelling on this point unnecessarily, but only by the most careful attention to the proper preparation of the castings and in keeping them in the same clean condition until they receive the first coat of tin can perfectly satisfactory work be obtained.

If the iron is allowed to roll in the solution too long a time the surface becomes soft from the action of the acid, and the tin will not take. The same trouble will be experienced if the solution in the rolling barrel is too strong, or if the castings are allowed to remain in the solution too long after they are rolled. In rolling the castings calculation should be made to complete the work before the stopping of the power at noon and night. Three and one-half hours being required on an average to prepare most iron in the rolling barrel, it is easy to arrange to start the barrel in time to complete one batch in the morning and one in the afternoon. This would furnish work enough to keep two hands engaged, although one set of kettles would take care of all the iron that could be prepared in a barrel the size we show—viz., 2 feet in diameter by 4 feet in length.

If the castings are quite soft and clean three batches may be prepared in ten hours, in which case the second batch should be in the barrel in time to give it at least one hour's rolling before the power is stopped at noon. When a batch of iron is left in the barrel during the noon hour, leave the barrel closed, and in a position where one of the valves will be up or the opening above the solution in the barrel. Unless this is done the valves may open and allow the solution to escape, necessitating recharging the barrel. If the batch is not completed in season to remove it to the storage tank before the time for stopping the power at night, remove the cover, and allow enough fresh water to flow into the barrel to displace at least half of the solution, and leave it in that condition until morning, taking care that the valves do not leak, that the iron is completely covered, and that the water is not left running, as iron will rust in running water even if the water covers it.

In rolling a batch of iron it will often be found that a black foam will rise to the surface of the solution when the barrel is opened. This is from the iron dust left on castings that are cleaned by dry tumbling, and it will also be found in preparing castings that have been faced with foundry facing of any sort. When this foam or scum is present, let water flow into the barrel, with the opening in such a position as to allow the objectionable matter to pass off. The first one or two batches prepared in a new barrel are liable to give trouble in tinning unless the inside of the barrel, with the shot to be used, is cleaned with a strong alkali solution. The simplest way is to put the shot into the barrel, and after filling it about half full of strong, hot alkali solution, close the barrel, and allow it to run an hour or more, after which the interior of the barrel and the shot used should be rinsed with plenty of clean water.

Where castings are tinned for the purpose of electroplating them it is desirable, if an extra smooth surface is desired, to give them a rolling in gravel and water in the ordinary wet rolling barrel, although this treatment is not necessary in order to prepare them to take a coating of tin. In treating castings in this way use a coarse hard gravel, and some castings may be rolled 20 to 30 hours to good advantage if the barrel is properly loaded.

It sometimes happens that castings are encountered that have a ground work of delicate design into which the sand has burned. If such are placed in the rolling barrel with a good quantity of shot and given two or three hours' rolling in a solution of hydrofluoric acid and water, 1 part acid to 75 or 100 of water, they will be cleaned very nicely. Where this is done let the hydrofluoric solution run out of the barrel before charging it with the regular solution of muriatic acid, sal ammoniac and water.

The operator must bear in mind at all times, as a safeguard against accident, that he must see that the valves on the rolling barrel are in working order previous to loading the barrel. These valves should be adjusted to open at a pressure of 40 pounds. If by reason of a leak in any part in the barrel gas is not generated the work will not tin properly. Do not approach the barrel with a light at any time when the gas is escaping, or at any time when the gas is being generated in the barrel. If after stopping the barrel it is found that the valves leak, as they may from becoming clogged, stop the leak, as the solution will escape, allowing the work to oxidize. Badly oxidized castings will not tin. The solution contained in tank F, Fig. 33, is calculated to remove a light oxide, but castings that are heavily oxidized must be rerolled.

COATING THE CASTINGS WITH TIN.

The tin in the kettles being at the proper heat for the work in hand, as specified later on, the operator takes a small quantity of the castings from the storage tank C, Fig. 33, and places them in the wire basket designated A in Fig. 13, taking care to place those having concave sides, holes or depressions so that none of the various solutions through which they are now to pass will be retained. The castings contained in the wire basket must now be immersed in the solution of caustic soda or potash, referred to in connection with the treatment for greasy, hard or lead faced castings, which solution is contained in tank D, Fig. 33. This solution must be kept at the boiling point, and from one to two minutes is sufficient time to leave the castings in. The best plan for heating this solution is to have a steam coil in the bottom of the tank, as shown in the illustration, and to allow the exhaust steam to pass into the rinsing tank, which is placed directly beside it, as shown in the ground plan. The rinsing tank is designated E in Fig. 33. After the castings have stood in the alkali bath contained in tank D the desired time they are placed in the rinsing tank E until all traces of that solution are removed. This will take the fraction of a minute provided a stream of water is kept flowing into the tank, as it should be.

The next move is to immerse the castings in a very weak solution of muriatic acid and water, 1 part acid to 40 of water. The castings must not be allowed to stand in this solution more than two or three seconds. The tank to contain this solution is designated as F in Fig. 33.

Next place the castings in the tank G, Fig. 33, which contains muriate of zinc, to which has been added 5 pounds of gray granulated sal ammoniac for every gallon of the muriate. Muriate of zinc is made by dissolving zinc in muriatic acid, allowing the acid to dissolve all the zinc it will. For the purpose of making this cut acid an earthen crock can be employed, or an oil barrel sawed in half will answer the purpose.

The castings are now ready to be immersed in the molten tin contained in the first kettle and shown in Fig. 33 at H. The tin in this kettle should attain a heat of 500 degrees F., and this heat should be maintained during the time the kettle is in use.

Before immersing the castings in this kettle the surface of the tin should be covered by a flux made by boiling a quantity of the muriate of zinc on top of the molten tin, and adding quickly to the boiling mass a quantity of white granulated sal ammoniac. The sal ammoniac must be added by sprinkling it on before the acid is evaporated by the heat of the tin. It will take a little time and experience before the proper consistency of this flux can be attained. The proper combination of this flux is one of the most essential points in the successful coating of the cast iron in this first kettle of tin. If the flux is allowed to become hard and dry, as it soon will by continued use unless careful and constant attention is given to it, the flux will adhere to the castings as they pass through it into the tin below, and thereby prevent them from coating.

When it is found that the flux is becoming thick and lumpy add a sufficient quantity of the muriate of zinc and powdered sal ammoniac to cause the flux to boil up to a depth of ½ inch or more. When this result is obtained take a perforated iron skimmer and carefully remove any hard lumps and congealed matter remaining in the flux, allowing such as readily pass through the skimmer to remain in the kettle. The purpose of this flux is to prevent the surface of the tin from becoming oxidized by exposure to the air, and also to prevent the hot metal from spattering and burning the operator when the wet castings come in contact with the tin. Keep carefully in mind that this flux must at all times be kept in a thin liquid condition, otherwise the succeeding operations through which the castings are to pass before they are completed will be unsuccessful.

In placing the castings in this first kettle of tin care should be taken to get them immersed as soon as possible. If they are allowed to float on the surface of the tin the muriate of zinc with which they are wet (for the purpose of causing the tin to adhere) will dry off, and the tin will not adhere to that part of the casting left exposed. The work must be kept below the surface of the tin until it has become as hot as the tin itself, and until the tin has ceased to bubble or to be agitated by the castings that are immersed. This boiling or agitation will cease when the air is expelled from the iron and the flux that adhered to it as it passed through has risen to the surface of the tin again.

The proper way to immerse the work in this first kettle of tin is to rest the handle of the basket containing it on the edge of the tin kettle, elevating the basket at an angle that will prevent it touching the molten tin until the operator is ready to have it. Cant the basket so that one of the lower corners will enter the tin first; in other words, do not allow the bottom of the basket to come directly onto the surface of the tin, as the effect of having so much wet metal as the bottom of the basket presents come in contact with the molten tin will be an explosion, resulting most likely in the serious injury of the operator or any one standing near. When the basket is in the described position lower it carefully until 1 inch or 2 inches of the bottom and one side is immersed in the tin, then lower rapidly, but steadily, until the basket and its contents are completely immersed.

At this point turn the basket completely over, bottom up, and, using the edge of the tin kettle as a rest for the handle, lift the basket from the tin. When the basket is free turn it bottom down and use it in that position to keep the castings it contained below the surface of the tin. Fill the kettle as full of castings as it will hold and allow them to be completely immersed. Several of the wire baskets may be employed to insure having a batch ready to immerse when the previous one is disposed of.

It sometimes happens that the operator carelessly omits dipping the work in the cut acid contained in tank G, Fig. 33; that is, he may attempt to immerse the work in the molten tin directly from tank D, E or F. Such neglect is dangerous and likely to be attended with serious results to the operator, from the hot metal spattering.

There are many kinds of work that may be strung on wires and handled through the different stages without the use of the wire baskets. When wires are used the shape may be varied to suit conditions. While we show the most common in Fig. 13, the ingenuity of the operator must be employed in selecting those best adapted to his wants and in devising others for himself.

The kettle being full as described, the castings must remain where they are from 5 to 15 minutes, or until they have taken a perfect coating of tin. If in this time they are not properly coated, some error has been committed in the previous operations and the work must be rerolled.

What dross or slag forms in a tin kettle rises to the surface. A considerable part of this objectionable matter will be found in the first kettle, which must be removed before the work can be carried to the finishing kettle or kettles. To accomplish the removal of this dross or slag, floating on the surface of the tin, use a perforated, concave iron skimmer. The holes in the skimmer should be large enough to allow the clear tin to flow through freely, and care should be taken not to waste the flux in skimming out the dross. If the skimmer is canted edgewise as soon as the clear tin passes off the slag will adhere to the skimmer and the flux will flow back into the kettle.

When all the slag has been removed grasp one of the castings with a pair of tongs and remove it with a quick motion from the tin. If wires have been employed and the work is strung, take one or more wires and remove in the same way to the next kettle, taking care that no flux or dross is carried along with the work. The temperature of the tin in the first kettle is much too high for finishing the work, and when the castings that are taken from this first kettle are exposed to the air they will be more or less yellow, depending on the heat of the tin. A bright yellow or golden color indicates too high a heat of the tin and must be avoided. A slight yellowish tinge indicates the proper heat.

The tin in the second kettle, which is designated in Fig. 33 as K, and which is, in most cases, the finishing kettle, must be maintained at a temperature of about 400 degrees F., and the surface kept covered to the depth of from ½ to 1 inch with pure beef tallow. Palm oil may be introduced into the tallow with good results, using of the latter about 10 per cent. The operator retains the castings held by the tongs or wires immersed in this second kettle one or two seconds and then, with the tongs held in the left hand, he removes the piece from the tin. As soon as the piece is clear of the tin the operator grasps it with a pair of tongs held in the right hand, and with a few rapid swinging motions to free the article from surplus tin, he plunges it into a tank containing kerosene oil. If wires are being employed he swings the work to and fro rapidly to free it from the surplus tin, and when plunging it into the oil he must give the work a motion calculated to prevent the articles in contact from adhering to each other.

The tank, which is designated in Fig. 33 as L, in connection with a companion tank M, should be of sheet iron and placed in the companion tank M with a view to having a body of water surrounding it to keep the oil from becoming heated, as it soon would be from the hot castings constantly immersed in it. The work must be immersed in this oil long enough to set the tin and then immersed in the cold water contained in the companion tank M.

If the tin in this last or finishing kettle is at the right temperature the work will be white and have a nice luster after it is cooled. If the work is rough and lumpy it indicates that the tin in the finishing kettle was not hot enough or that the work was kept in the air too long a time before dipping it in the oil. The tin in the finishing kettle requires very little fire to be maintained as there will be nearly enough heat in the castings when they come from the first kettle to keep the tin in the second at a proper heat. If the work is yellow after cooling in the oil, it may indicate too high a heat in the finishing kettle, or it may indicate that the casting was not kept in the finishing kettle long enough to bring the heat that the casting attained in the first kettle down to a point where the tin would not be yellow.

The work will come out of the finishing kettle smoothly and brightly coated even when the temperature of that kettle is so low that if a piece of cold iron be put in the tin would adhere to it in a mass. The heat the castings attain in the first kettle makes it possible to run the finishing kettle at a very low temperature and it is desirable to do so on very heavy castings. Light castings require, of course, that a much higher heat be maintained in the finishing kettle than is necessary on heavy castings. The reason is apparent: Light castings must be exposed to the air a few seconds while the operator is switching off the surplus tin, and being light, they, of course, do not hold the heat long enough to allow the surplus tin to be shaken off without leaving rough, ragged edges.

A great deal of ingenuity can be displayed by the operator in handling castings of various shapes in such a way that no lumps or bunches of tin will remain on the work after it is cooled. For example, in grasping the article to be cooled care should be used to find what part of the casting is best adapted to be taken hold of by the cooling tongs without marks of the tongs being left after the article is cooled. The tongs used for cooling should never be put into the tin kettle, as the heat of the casting would cause it to adhere to the tongs if they were tinned. After shaking off the surplus tin change the position of the casting so that the drop of tin, which will naturally collect at the lowest point, will flow back onto the casting and dip in the oil at once when this is accomplished.

A "switching box" should be employed when "strung" work is being handled to catch the tin that is thrown from the work in the operation of "switching" it to throw off the surplus tin. This box is a very simple arrangement. Its position when in use is designated D, Fig. 25. Cover the interior of the box with heavy paper, as the hot tin will stick to the wood unless paper is used. The tin thus collected may be thrown into the kettle together with the paper when the tin is needed for use.

When the castings have been finally cooled as already described, they should be immersed in a tank of boiling water to free them from oil and also to remove any trace of acid that may be on them. This final rinsing tank is designated N in Fig. 33. The water must be kept clean and at the boiling point at all times when in use. An ordinary foundry riddle with upright handles long enough to allow the operator to set the riddle, with the work to be treated, into the tank without scalding his hands, may be employed to immerse the work in this tank.

The castings should be dried off in clean dry sawdust, and for this purpose use sawdust made from pine or some soft wood, as hardwood sawdust will scratch the tinned surface. The drying box is shown at O in Fig. 33.

When three kettles of tin are employed, as they may be to good advantage in tinning work that is designed to be plated, the second kettle must be run at a temperature of 450 degrees F. The surface of the tin in this kettle must be kept covered with an acid and sal ammoniac flux the same as the first kettle. The castings in the first kettle are to be passed in quantities to the second kettle, there to remain until the first kettle is refilled. The same care must be taken not to allow any of the slag or flux that accumulates on the first kettle passing with the work to the second kettle, and the tin in the second kettle must be kept free from slag.

The tin in the third or finishing kettle should be maintained at a temperature of 400 degrees F., and the depth of the tallow increased to 3 or 4 inches.

If three kettles are employed they should be square or round and arranged to fire from one side, instead of at the ends.

The water in storage tank C, Fig. 33, will in a short time become charged with the acid solution from the rolling barrel unless it is changed frequently. If much acid is present in the water it will impair the alkali solution into which the castings pass directly from the storage tank. If a few pounds of the alkali selected for use (caustic soda or soda ash) is added two or three times a week the alkali will do its work properly for some time, although it is best to clean out the tank and make the solution up fresh once in two weeks where it is in constant use.

In rinsing the castings in tank E, Fig. 33, do not let them remain in a great length of time if water is flowing in, as iron will soon rust in running water. The solution in tank F, Fig. 33, should be made up fresh after 2 or 3 tons of iron has passed through it, and, as already stated, the castings should not be allowed to stand in this solution more than two or three seconds.

The solution of muriate of zinc contained in tank G, Fig. 33, should be deep enough to cover the castings contained in the wire basket used to immerse them in the first kettle, and the solution should be kept in good condition—that is, care should be taken not to allow it to be weakened to any great extent by the solution in tank F passing into it with the work. The tank containing this muriate of zinc should be lead lined and an inner lining of wood used to protect the lead lining.

As it is almost impossible to make castings that have been imperfectly coated at the first attempt take a satisfactory coating of tin, the operator should give careful attention to details.

It is possible by practice to keep the tin at a proper heat, but the operator will find more difficulty in doing this than any other one thing in the entire operation. That the proper heat be maintained is very essential, for if it is not, all previous care in preparing the iron will have been in vain. If too hot the flux on the first kettle of tin will evaporate or burn off, and the tin will not take to the iron. If too high a heat is reached on the kettle containing the tallow, the tallow will be set on fire. As a help to a novice and, in fact, to an experienced man, we recommend the use of a pyrometer, one for each kettle. The expense of providing them is not to be considered in comparison with the advantages obtained.

The kettles for containing the tin may be, and usually are, of cast iron, although fire box steel is often employed to make oblong kettles.

A floor space of 20 x 40 feet will accommodate a tinning plant running two rolling barrels. If possible, the plant should be located handy to power and with a view to obtaining easy and perfect drainage. If necessity compels the setting up of the plant in the factory building above the ground floor, as is sometimes the case, the floor of the tinning room must be so constructed that leakage into the room or rooms below will be prevented.

The dross or slag formed in the kettles should be stored away until a sufficient amount is accumulated to make profitable the remelting of the slag for the purpose of reclaiming what pure tin is in it. For the purpose of remelting this dross the pure tin can be removed from the kettle H, Fig. 33, and the dross melted up in it. When the entire mass is in a molten state, and at a temperature of about 550 degree F., bail off the liquid tin into cast iron pans provided for that purpose, and what dross remains into separate pans. This tin dross has a market value of from 40 to 50 per cent. of the price of pure tin.

With the addition of tanks for containing acids a plant built to tin cast iron is adapted to all descriptions of tinning, except retinning of tinware and the tinning of sheets.