THE MANUFACTURE OF TIN PLATE.

The first step in the manufacture is to cleanse the surface of the sheet steel from oxide, dust and grease. This is effected by dipping the sheets in a pickle of dilute sulphuric acid, 1 part of acid to 16 to 20 parts of water. The pickle is prepared by pouring the acid into the water, keeping the latter constantly agitated.

In small shops the pickling is done in lead-lined tanks by hand, but larger establishments employ machinery for the purpose of more rapidly exposing the surface to the acid, and then washing the acid away when the pickling is complete. The acid leaves the plate with a clean, dullish-gray metallic surface. Sometimes the action of the acid is assisted by scouring with sand and water. When no mechanical apparatus is used the plates are immersed in the acid bath for from fifteen to twenty minutes.

The cleaned plates, free from scale, are now ready for the first annealing process. The effect of the repeated rolling is to make the plates very stiff and brittle, and this has to be remedied by subjecting them to a long-continued heat and allowing them to cool slowly, this process is called annealing. The plates are piled one upon another on a cast-iron base plate, and covered over with a hood or cover to protect them from oxidation. The edges of the base plate stand higher than the rest, so that, when the cover is placed over the pile of plates, the space between the cover and the edge of the bottom plate may be luted with

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sand. The boxes are conveyed to the furnace by means of a low truck.

The annealing furnace has its bed on a level with the floor, several boxes being placed in it at one time. The fire-bridge is tolerably high, and the flame travels slowly over the boxes, gradually raising them to a cherry-red heat, at which temperature they are maintained for from twelve to twenty-four hours, the heat never being allowed to become so great as to cause the plates to become stuck together, or it will be impossible to separate them when the piles are removed from the boxes after cooling.

The plates are then cold-rolled between chilled rolls which have a highly polished surface and are very accurately adjusted, so that the plates may be perfectly flat and the surface finely polished. A second annealing is now necessary to remove the stiffening effect of the cold-rolling, but the temperature of the furnace is kept lower and the time is shortened to about six hours.

After having been annealed and cold-rolled, the plates are again found to be thinly coated with oxide, which must be entirely removed by a second pickling in acid, though the strength of the acid solution is very much weaker, being only 1 pound of acid to the hundredweight of plates. Scouring with sand and water is then resorted to, after which the plates are placed in troughs of clean running water. They now have a perfectly clean surface of a grayish metallic color, and can be kept in cold water without injury for some time. In all the stages so far any defective plates are carefully sorted out, but in spite of this it is sometimes found that during the process of tinning

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some of the plates are covered with small blisters, due to some defect in the steel.

Coating the plates with tin is the next and last operation. Cast-iron pots, some containing tin and some grease, are arranged in a row and surrounded by a flue from a fireplace. The black plates are taken up singly from the water, and placed in the first pot containing molten palm-oil until all moisture has been removed. They are then transferred to a pot containing molten tin covered with palm-oil.

After remaining a short time the plates are lifted out, and, to make the alloy of tin on the surface more perfect, they are dipped into the second tin pot containing pure molten tin. The excess of tin is brushed off each side of the sheet by means of a hempen brush, and the marks of the brush are obliterated by again dipping the sheets into pure tin in the third tin pot. The operation of tinning is completed by quickly passing each sheet from the third tin pot into the second grease pot, which contains an arrangement of rollers between which the tin-plates pass, first downwards, then upwards and out. The temperature of the second grease pot is carefully regulated, for its object is to allow the excess of tin to run off the surface of the plates, the speed of the rolls and the pressure regulate the quantity of tin left on the finishing plate. Coke plates take up about 2½ pounds of tin to the hundred pounds, being passed slowly through the rollers in the grease pot under considerable pressure, while charcoal plates have a thicker coating of about 6 pounds of tin per hundred pounds, as they are passed twice quickly through the rolls, which are adjusted to give less pressure.

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To remove the grease left on the plates from the last stage of the tinning process, they are rubbed with coarse bran and then with finer bran, being finally polished with a duster made of the woolly side of a sheepskin.

Galvanizing. By galvanizing is meant merely the application of a coat of zinc which alloys with the surface of the metal to which it is applied. Thus the material known as galvanized iron is sheet steel, upon which has been deposited a film of zinc. Metal in sheet, galvanized before it is worked up, is treated generally by a method different from that adopted for vessels, utensils, etc., but there is no reason why the following process should not be suitable for galvanizing both metal in sheet and the articles into which it is formed. The success of the process, as in tinning metals, depends on the thoroughness with which the metal is cleansed previous to being passed through the molten zinc. The plates or vessels are first immersed in a warm bath of equal parts of sulphuric or muriatic acid and water, being afterwards scoured with emery or sand. They are now ready for the preparing bath, made by mixing together equal parts of saturated solutions of chloride of zinc and chloride of ammonium. The metallic bath through which they are next passed is a molten alloy of 640 parts by weight of zinc, 106 parts of mercury, and one-third part of sodium. Throw some sal-ammoniac on the top of the bath, previously skimming off any oxide that might have formed, and immerse the articles, bringing the temperature up to 680° Fahrenheit. Remove the articles directly this heat is attained, otherwise the zinc will dissolve a portion of the iron. Zinc has a great affinity for iron, and it is a

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good plan to partly satisfy this by allowing the molten zinc to previously act on a piece of scrap wrought-iron.

Small articles of solid iron or steel are galvanized preferably by the following method. The articles are cleansed in a revolving barrel or tumbling box containing sand, which chafes the iron and removes the scale. A solution is made by saturating with sheet zinc 10 parts of hydrochloric acid, and, when the evolution of gas has ceased, dissolving in it 1 part of muriate or sulphate of ammonia. The iron articles are heated and plunged in this solution for an instant, if of the right heat, they will dry at once on removal and be covered with crystals. Prepare a bath of molten zinc as before, removing all oxide and throwing in plenty of salammoniac to stop further oxidation. Heat the articles, dip them while quite dry into the zinc, shake off the superfluous metal, and cool in water. Small articles may be held in a wrought-iron basket when dipping into the zinc.

It may have been noticed that the process of galvanizing proper in both of these two methods is the same, the only difference being in the cleansing processes preceding the galvanizing. Two or three more methods of preparing the iron or steel for the galvanizing bath may now be noted. Immerse the iron articles for a few hours in muriatic acid diluted with twice its weight of water, and then wash thoroughly in hot water and scrub with brush and sand. The final preparation for the bath of molten zinc is immersion in a hot solution of 1 pound of salammoniac to 2 gallons of water. Dry before galvanizing. First remove all scale by passing through a bath of 1 part of muriatic acid and 4 parts of water. After brushing and scraping,

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pass through a fresh bath of 1 part of muriatic acid, 4 parts of water, and 1 ounce of salammoniac to every gallon of solution, and then dry in a hot oven. Scour with sand all scale and rust from the surface of the metal, and remove all grease and oil by boiling in a solution of caustic soda. Immerse in dilute muriatic acid, scrub with a metallic brush, and rinse in hot water, afterwards drying thoroughly. The molten metal is liable to spit if the article is passed into it wet. It is even possible for slight explosions to occur if moisture is left among the laps and rivets.

Perhaps the most general method of galvanizing sheet-steel or iron is the one by which the metal first receives a preparatory coat of tin. The sheet metal is passed through baths of dilute muriatic acid, scoured with sand and otherwise made perfectly clean. A bath is prepared in a wooden vat by adding 1 part of a saturated solution of metallic tin in concentrated muriatic acid to 600 or 800 parts of water. The preparation of the tin solution occupies from two to three days. At the bottom of the vat is a thin layer of finely-granulated zinc, on top of this being a clean iron or steel plate, which in its turn is covered with granulated zinc, and so on until the bath is full. The zinc, iron, and solution form a weak galvanic battery, tin being deposited from the solution on the iron plates, a coat sufficiently thick for the purpose being obtained in about two hours. The plates are removed, and immediately carried by rollers through a bath of molten zinc covered with a thick layer of salammoniac mixed with earthy matter to lessen its volatilization. The speed with which the rollers revolve practically determines the thickness of the zinc coat on the plates.

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Owing to the under coating of tin, galvanized plates prepared by this process have a crystalline appearance.

Not only steel and iron, but brass and copper utensils are often galvanized, there are two or three processes by which this can be done, though they are chemical rather than metallurgical. A simple method is to boil the brass or copper in a solution of chloride of zinc, adding at the same time a small quantity of zinc turnings to the solution. Another process is to cover granulated or powdered zinc, contained in a wooden vessel, with a concentrated solution of salammoniac. Heat to about the boiling point, and immerse the copper or brass articles, which should be chemically clean. A firm coating of zinc will be deposited in a few minutes.

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