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S. OTIS ET AL

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COATING METAL PIPE WITH METAL

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Fig. 1

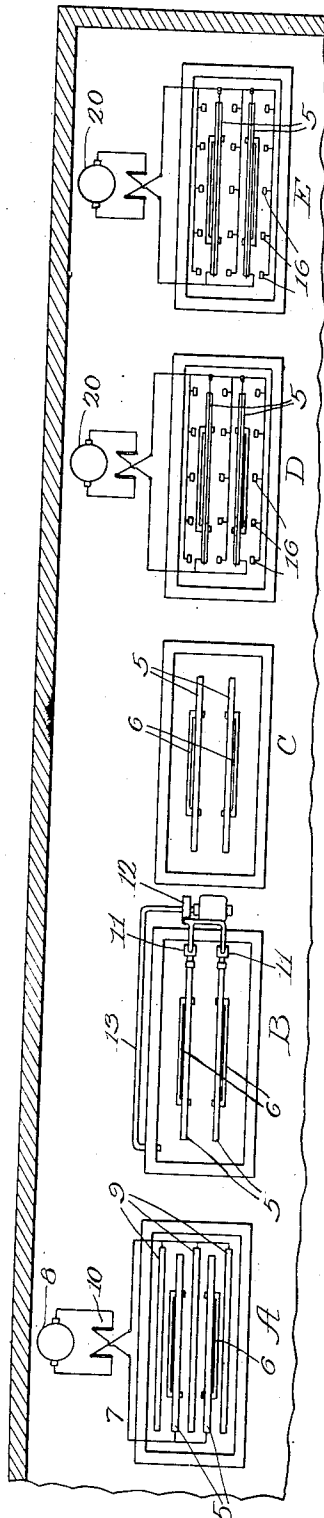


Fig. 2

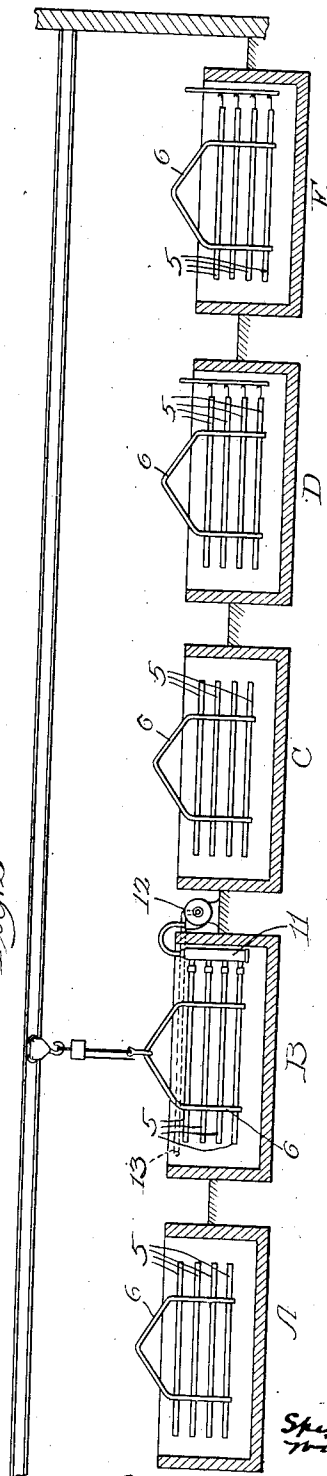


Fig. 3

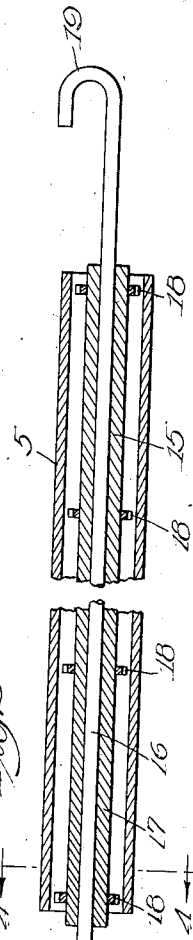


Fig. 4



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COATING METAL PIPE WITH METAL.

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Our invention has been developed in connection with the coating of steel pipe for protecting it against corrosion and is particularly applicable to coating such pipe with lead. It will be apparent, however, from the more detailed description below, that in certain of its features it is applicable to the coating of other articles than pipe and in connection with other coatings than lead. Thus it is equally applicable to coating pipe with tin.

By our improved process we are able to secure firm, dense, adherent coatings substantially free from the imperfections, such as pin holes and areas of poor adhesion, which have heretofore been largely responsible for the limited use which has been made of coated steel pipe.

One of the features of our improved process relates to the preparation of the pipe to receive the coating, and the other to the coating process proper and more particularly to the coating of the inside of the pipe.

The first step in the preparation of the pipe for coating is the ordinary one of tumbling, by which much of the loosely attached scale and other adherent matter is removed. The pipe is next immersed in a hot solution of caustic soda and alternately made the anode and cathode of an electric circuit traversed by a strong current. Any ordinary source of current which will give a fairly high current density may be used and connected to the pipe and to iron electrodes also immersed in the bath, provision being made for the reversal of current referred to above. Preferably the current is reversed a number of times before it is cut off and the pipe removed from the bath. The reversal of current in this manner and the use of the hot caustic soda solution greatly assist in loosening the scale and removing any grease adhering to the pipe. The pipe are next connected to a common header by rubber piping or the like and then immersed in a sulphuric acid solution which may be of 17 per cent acid strength and is preferably kept at about 200 degrees F. temperature. The header is connected to a pump, the inlet of which connects to the bath so that the pickling solution may be pumped through the inside of each pipe during the entire time that it is in the pickle. Fresh

solution is thus constantly brought into contact with the interior of the pipe, thus hastening the action thereof on the pipe and quickly removing from the interior of the pipe by the flow of the liquid any scale or the like which becomes detached. At the same time the exterior surface of the pipe is subjected to the pickling action of the bath.

After the pickling is completed the pipe is removed from the pickling bath and preferably is mechanically cleaned to remove the loosened scale. It is next dipped for a minute or two in a bath of sulphate of copper from which it receives a very light coating or "flash" of copper. Other salts of copper in which the metal is readily replaced by iron may be used in place of the sulphate and the strength of the solution in any event is made such as to give a light coat of metal in the course of a short treatment. Almost any ordinary strength of solution of the copper sulphate will answer, though the greater the dilution the longer must the pipe remain therein to secure a coating. A solution of $\frac{1}{2}$ per cent is satisfactory. If preferred the copper may be deposited electrolytically by a known or approved method. It aids in securing a satisfactory coating to pass a current through the pipe or other article to be plated and the bath with the article as the anode for a few minutes to free it of gas and this is so whether the chemical or the electrolytic method of coating is employed.

After the pipe has been thus treated to remove scale, etc., and apply a light copper coating thereto it may, if desired, be given its lead coating by dipping in the latter metal after being heated in a hot flux, and then drained and quenched in oil. Preferably, however, it is treated by the following method forming a part of the present invention. Each length of pipe to be coated receives in its interior a lead anode of substantially the same length which is suitably spaced or held away from contact with the pipe by rubber disks or spreaders applied thereto at suitable points. The anodes each consist of a small copper core surrounded by a layer or coating of the metal to be deposited. Thus if the pipe is to be lined with lead the anode in each case

consists of a copper core surrounded by a layer or body of lead. We have found that for the smaller size pipe such as those 1 to 2 inches in diameter we may use an anode the core of which is a $\frac{3}{8}$ inch copper rod and which is surrounded by a lead pipe the outside diameter of which is about $\frac{1}{2}$ inch. It is desirable to prevent the penetration of liquid between the pipe and core and this may be accomplished by soldering or swaging the pipe at its ends to or against the copper core.

The pipe provided with the interior anodes as described is next immersed in an electrolytic bath for plating. We have found the wellknown fluoboric lead bath consist of 24 ounces hydrofluoric acid, 12 ounces boric acid and 16 ounces lead carbonate to the gallon of water satisfactory for this purpose. Lead anodes are distributed at suitable intervals along the outside of the pipe, but at a suitable distance therefrom, or if, as we prefer, a rack of pipes is treated at once, along the latter, and the pipe are connected as cathodes to a suitable source of current, the anodes, both exterior and interior, also being properly connected to the source of current. As the interior anodes are so much nearer the pipe constituting the cathodes than the exterior anodes can well be placed, provision must be made for proper distribution of the current between the respective sets of anodes and this is preferably done by introducing suitable resistance in that branch of the circuit which includes the interior anodes. Obviously, if desired, different sources of current could be used for the interior and exterior anodes in order to secure the proper distribution. If too dense a current is used the lead deposited is loose and spongy in character. We have found a suitable current density to be from $\frac{3}{4}$ to 1 ampere per square foot. Manifestly the distance between the interior anode and the pipe surrounding it determines the voltage which is permissible between the anodes and the pipes and this distance, with anodes of the same size, depends upon the interior diameter of the pipe. Preferably the exterior anodes are also made with cores of copper or other metal of high conductivity.

In using the interior anodes the source of current is connected to the copper cores the metal of which has a high specific conductivity because of which conductivity there is no substantial drop in current distribution along the length of the anodes, and a very even coating may be produced throughout. The copper cores also give greater rigidity to the anodes. We have described the electrical connections as being such as to make the pipe to be coated the cathode and in any event this is true during the plating operation proper. Preferably, however, we pro-

vide means for reversing the current, and at the outset the current is passed through from the pipe as anodes for a few minutes, which puts the pipe in much better condition to receive the coating, doubtless because it drives off gases occluded or mechanically trapped in or on the surface of the pipe and also tends to free it of other adherent matter.

In some cases it is preferable to coat the outside of the pipe with lead and the interior with tin. This may be done in separate steps, using substantially the process described above for the outer coating and a similar process with copper cored tin anodes and a suitable electrolyte for the inner coating. Preferably, however, the two steps are done in the same operation in a bath of the described fluoboric lead solution with the exterior lead anodes but with tin interior anodes, preferably copper cored. In this case there is a small but unobjectionable amount of lead in the inner coating, mainly in the layer next the metal of the pipe.

In the drawing accompanying and forming a part of this application is shown diagrammatically an apparatus suitable for practicing our improved process. In said drawing Figure 1 is a plan view of the apparatus; Fig. 2 a vertical longitudinal section thereof; Fig. 3 a longitudinal axial section of a pipe with our improved anode in place therein and in condition for treatment in the electrolytic plating apparatus, and Fig. 4 is a cross-section thereof. In Figs. 1 and 2 the vat in which the pipe are submitted to the action of the caustic alkali and electric current is shown at A, the pipe being cleaned at 5, the racks on which they are supported at 6. The pipes are shown as connected by wire 7 to an electric generator 8 to which are also connected electrodes 9 immersed in the bath. A reversing switch 10 is interposed in the connections to the generator for the purpose of reversing the current as above described.

The acid vat is shown at B and the pipes 5 which are transferred thereto in the lifting racks 6 are connected to headers 11. The latter are connected to the discharge side of a centrifugal pump 12, the inlet side of which is connected by a line 13 to the vat, preferably at the far end of the pipes so that the liquid of the bath may be continuously circulated through the pipes and back to the vat.

At C is shown the vat for applying a flash coat of copper to the pipes.

We preferably employ two lead coating vats D, E, as more time is consumed in depositing the coat than in either of the preceding operations, and therefore these vats are used for treating alternate racks of pipe, respectively, coming from the copper vat. In these vats the pipes 5 in their racks are immersed in the electrolyte previously de-

scribed after the anodes 15 have been inserted therein. The external anodes 16 are arranged at suitable intervals alongside the racks of pipe and both sets of anodes are connected to a generator or generators 20 of electric current to the other terminals of which the pipes being coated are connected. Referring to Figs. 3 and 4, the pipe to be coated is shown at 5 and the electrode 15 located therein is composed of a core 16 of copper and a surrounding layer 17 of the lead or other metal to be plated. The end 18 of the copper core extends beyond the pipe and beyond the coating metal and is adapted for connection to the electric generator. The core is spaced from the interior of the pipe by the spacers or spreaders 18 which preferably are cut from fibre board or the like. It is to be noted that these spacers touch the pipe only over small areas and in order to avoid too thin a coating at the areas of contact the spacers may be moved slightly in the course of the treatment of the pipe.

We claim:

- 25 1. A process for cleaning ferrous articles for the deposition of metal thereon which consists in immersing the articles in a bath containing a caustic alkali and passing an electric current through the article and bath.
- 30 2. A process of preparing an article of ferrous metal for coating which consists in immersing it in a solution of caustic alkali

and passing an electric current through the article as an anode and the solution.

3. A process of preparing an article of ferrous metal for coating with metal which consists in immersing it in a solution of a caustic alkali and passing an electric current through said article and bath alternately in opposite directions.

4. A process of preparing a metal article for coating with metal which consists in immersing it in an electrolyte and passing an electric current through the article and electrolyte alternately in opposite directions.

5. A process of preparing an article of ferrous metal for coating with another metal which consists in immersing the article in a solution of a caustic alkali, passing an electric current through the article and solution with the article as the anode and then treating the surface of the article with an acid solution.

6. A process of preparing a ferrous metal article for coating with another metal which consists in immersing the article in a solution of a caustic alkali, passing a current in alternately opposite directions through the article and solution, removing the article from the solution and then treating it with an acid bath.

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