Dec. 3, 1946. I. WHITEHOUSE ET AL 2,412,186

METHOD OF BRIGHT POLISHING STAINLESS STEEL TUBES

Filed Oct. 24, 1942

Fig. 2

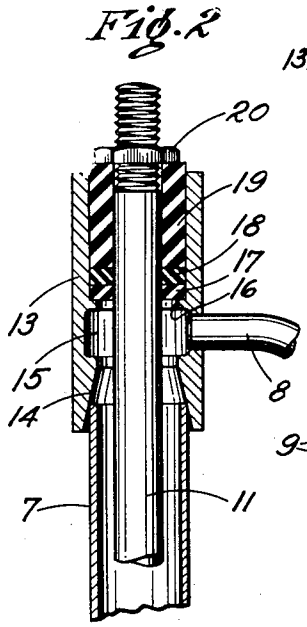
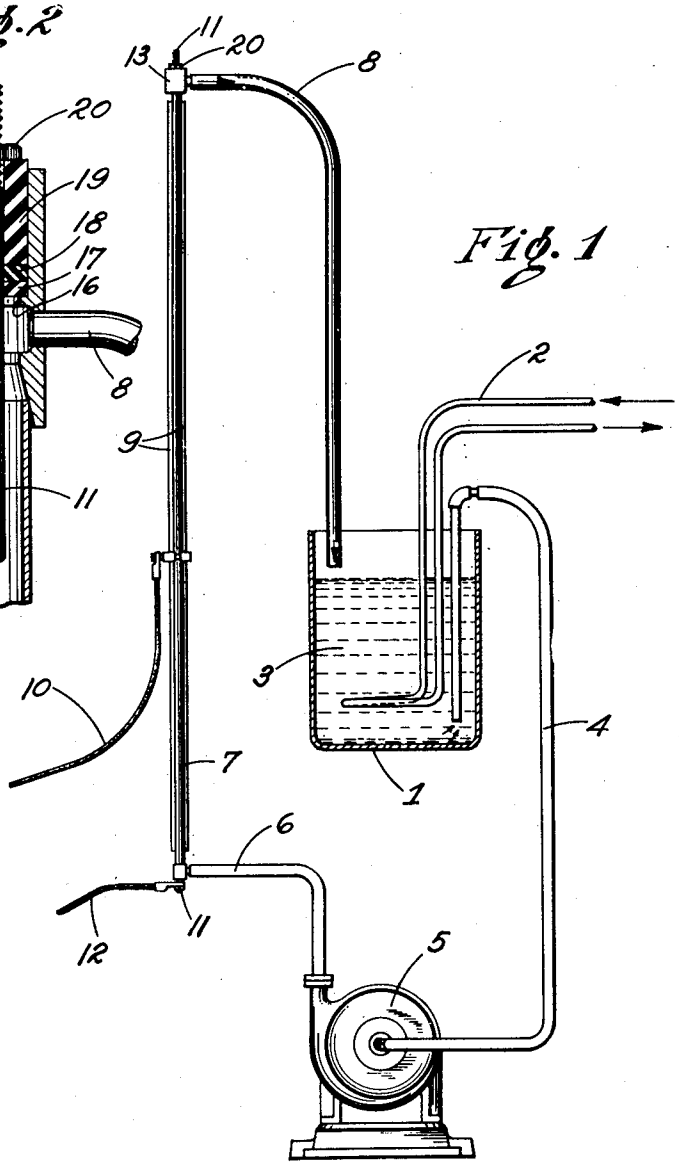



Fig. 1




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Patented Dec. 3, 1946 2,412,186

# UNITED STATES PATENT OFFICE

2,412,186

## METHOD OF BRIGHT POLISHING STAINLESS STEEL TUBES

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Application October 24, 1942, Serial No. 463,216

8 Claims. (Cl. 204—140)

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This invention relates generally to the art of polishing stainless steel articles and particularly to the bright polishing of the inner surfaces of stainless steel tubes.

A demand has existed for a considerable time for stainless steel pipes and tubes for uses where the maintenance of sanitary conditions is essential, for example, in the milk industry. Altho efforts have been made by others to meet this demand none of those efforts have been entirely satisfactory so far as we are advised. To be satisfactory for uses requiring a high degree of sanitation, it is important that the inner surfaces of the pipes and tubes should be bright polished, that is, they should be free from scratches, pits and, in general, any surface roughness in which foreign material may lodge and from which it cannot be removed readily.

Heretofore efforts have been made to bright polish the inner surfaces of stainless steel pipes and tubes by the use of endless abrasive belts. In addition to being quite expensive this method is not entirely satisfactory for, no matter how fine the abrasive material on the belts was, the belts made a multitude of minute scratches on the inner surface of the tube from which foreign material could not readily be removed. Altho the exterior surfaces of stainless steel tubes and pipes have been bright polished satisfactorily by the process of electrolytic polishing in which the tubes were immersed in or drawn through the electrolyte, that process, when applied to the inner surfaces of such pipes and tubes, resulted in pitting and otherwise roughening those surfaces so that they were unsatisfactory for uses where a high degree of sanitation was required.

We have discovered the causes of unsatisfactory performance of electrolytic polishing as experienced heretofore on the inner surfaces of stainless steel pipes and tubes and have devised an improved method and apparatus which avoids those causes and bright polishes such inner surfaces and makes such articles suitable for use where the sanitary requirements are very high.

We have found that the unsatisfactory results obtained when the procedures which are satisfactory for polishing exterior surfaces are applied to inner surfaces are traceable to certain factors and conditions which are peculiar to the polishing of inner surfaces of pipes and tubes. Apparently one of such factors is that the ratio of amount of electrolyte to the area of the surface to be pickled is much smaller when that surface is the inner surface of a tube than when it is an exterior surface, for example, that of

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a sheet or strip. The use of a smaller amount of electrolyte seems to result in more rapid depletion of the active ingredients in the electrolyte, rapid rise in electrolyte temperature and liberation of more gases per unit of electrolyte. Seemingly gases formed in a tube adhere to the tube and create the problem of detaching and removing them whereas gases formed on exterior surfaces, either dislodge themselves or are readily dislodged and, once separated from the metal surface escape thru the electrolyte. Gases which are mechanically trapped in the electrolyte as distinguished from those which may adhere to the tube must also be removed quickly to avoid unequal pickling and resulting roughness of the tube.

The present invention is predicated on the discovery of the foregoing factors and on the provision of means and steps by which those factors and their disadvantages may be avoided. Briefly stated, the present invention consists of the steps of flowing a suitable polishing electrolyte, preferably under pressure, thru a pipe whose inner surfaces are to be bright polished, and passing polishing current in substantially uniform amount between each unit of the inner surface of the tube and a cathode disposed on the longitudinal axis of the tube, and preferably extending beyond each end of the tube. The temperature and concentration of the electrolyte are controlled within predetermined ranges and gases are allowed to escape from electrolyte leaving the tube. Preferably the tube is polished while in a vertical position and while the electrolyte is being forced upward therethru under pressure somewhat greater than atmospheric pressure.

In the drawing accompanying and forming a part of this specification,

Figure 1 is a somewhat diagrammatic view of one form of apparatus in which the present invention may be practiced; and,

Figure 2 is an enlarged fragmentary view, partly in section, of one end of the tube being treated and associated parts of the apparatus of Fig. 1.

In Fig. 1, 1 designates a receptacle for electrolyte which has a capacity several times that of the tube whose inner surface is to be polished. A heat exchange coil 2 serves to control the temperature of the electrolyte 3 in receptacle 1. A pipe line 4 serves to conduct electrolyte from the lower part of receptacle 1 to a pump 5 which forces the electrolyte under pressure thru pipe 6 and into and thru the tube 7 whose inner surface is to be polished. The electrolyte discharged

from tube 7 passes thru pipe 8 and is discharged into receptacle 1, the gases escaping into the air above the surface of the electrolyte in receptacle 1 whence they may be withdrawn by a fan or other suitable means (not shown) if desired. Along opposite sides of tube 7 electrically conductive metallic strips 9 are held in close contact with the tube 7 and serve to distribute throughout the length of the tube 7 current supplied to strips 9 thru a cable 10 from a source of current (not shown). A cathode 11 in the form of a rod is connected by cable 12 to the source of current. This cathode 11 is disposed centrally in tube 7, i. e., preferably on the longitudinal center line of the tube and, as shown, is long enough to project from each end of tube 7.

In Fig. 2 is shown the construction and combination of parts at either end of the tube 7 of Fig. 1. There the tubular metal fitting 13 has a beveled surface 14 at one end to engage the end of tube 7. Between its ends fitting 13 has an enlarged chamber 15 which communicates with the opening defined by tapered surface 14 and with either pipe 8 or pipe 6 depending on whether the fitting is at the upper or lower end of tube 7. An annular inwardly projecting flange 16 adjacent to the chamber 15 serves as a stop for a gasket 17. A nonconductive ring 18 engages the gasket 17 opposite to the surface engaged by flange 16 and a tube 19 projects from ring 18 to slightly beyond the end of fitting 13. The gasket 17 and tube 19 are preferably composed of rubber material but any other material may be used which has the property of deforming under endwise pressure with coincident reduction in internal diameter.

The fittings 13 with gaskets 17, rings 18 and tubes 19 serve to locate the cathode 11 on the axis of or concentrically with tube 7 and to prevent loss of electrolyte at the ends of the tube and cathode. When nuts 20 are screwed onto cathodes 11 and exert endwise pressure on tubes 19 the surfaces 14 of fittings 13 are pressed against the ends of tube 7 and the gasket 17 and rings 18 are deformed into sealing engagement with the fittings 13 and cathode 11. Thus screwing nuts toward one another, or turning one while the other is fixed, results in not only positioning cathode 11 centrally in tube 7 but also in sealing the ends of the tube against loss of electrolyte. It will, therefore, be seen that by the above described parts and arrangement of parts the cathode 11 is disposed and maintained concentrically in tube 7 and that liquid may circulate freely thru tube 7 from the fitting 13 at one end of the tube to a similar fitting at the other end. It will further be seen that the fittings 13 do not afford any pickets in which gases may be trapped in contact with the inner surface of the tube 7 and do have, in chamber 15, a space which is well above the upper end of tube 7 and in which gases may collect and from which they may be removed without coming into contact with the tube.

When the apparatus is assembled as shown by the figure, it may be operated substantially as follows: Actuation of pump 5 withdraws electrolyte from receptacle 1 and forces it under pressure, preferably greater than atmospheric pressure, thru tube 7 and back to receptacle 1. When a source of current is connected to cables 10 and 12, current flows between strips 9, substantially the full length of tube 7 in substantially equal amounts between each unit area of the inner surface of tube 7 and the centrally disposed cathode 11.



Such flow of current thru the electrolyte polishes the inner surface of tube 7, liberating gases which are dislodged from the inner surface of the tube 7 by the moving electrolyte and are carried out of the tube 7. The major amount of these gases escapes from the electrolyte when the latter is discharged into the air above the surface of the electrolyte in receptacle 1. Most of the remaining gases escape from the upper portions of the electrolyte in the receptacle. As the polishing action progresses, the temperature of the electrolyte increases. Cooling fluid is passed thru the cooling coil 2 to maintain the temperature of the electrolyte within the predetermined temperature range.

The following examples of various operating conditions which have been found to be satisfactory will make it possible for those skilled in the art to apply the present invention to tubes of different sizes and compositions without the necessity of experimentation.

A tube of 16 gage, 18–8 type, stainless steel 1½" in diameter and about 12 feet long was satisfactorily polished on its inner surface by being assembled in the apparatus shown in the drawing and treated as follows: While the tube was maintained in an approximately vertical position about 5 gallons of electrolyte per minute were circulated upwardly therethru for about ten minutes and the temperature of the electrolyte was maintained between about 120° F. and 140° F. and a current of about 3 amps. per sq. in. at about 5 volts was passed between the walls of the tube and the cathode thru the electrolyte.

For the 18–8 type steels, the temperature range of the electrolyte may extend from about 100° F. to about 150° F. and the amperage may range from about ¾ amp. to about 6 amps., while the voltage ranges from about 5 to about 5.5 volts. Satisfactory polishing has been obtained under these conditions in about ten minutes. The 18–8 type stainless steels have, as a typical analysis, carbon .08% to .20%, manganese 1.25% maximum, silicon .75% maximum phosphorous and sulfur .03% maximum each, chromium 17.5% to 20%, nickel 8% to 10%, the remainder being iron with minor amounts of ordinary impurities.

When tubes of the type AA stainless steel are to be polished somewhat higher electrolyte temperatures may be employed, preferably ranging between about 170° F. and about 200° F. A typical analysis of the AA type stainless steels is carbon .12% maximum, manganese .50% maximum, silicon .50% maximum, phosphorous and sulfur .03% maximum each, and chromium 14% to 18%, the remainder being iron with minor amounts of ordinary impurities. A somewhat shorter polishing time is required with the AA type stainless steel tubes than with the 18–8 types. The current may be about the same as with the 18–8 types of steel.

The currents specified hereinabove are, for the sake of brevity, referred to in the appended claims as "polishing" currents, that is, currents which when employed with a suitable electrolyte and for the times stated will polish the inner surfaces of stainless steel tubes of the 18–8 and AA types to a bright finish.

There are various electrolytes which are suitable for use with the present process. One such electrolyte is composed of about 40% by weight of 96% sulfuric acid, about 5% by weight of tartaric acid, the remainder being water. Another suitable electrolyte consists of about 50% by weight of 96% sulfuric acid, about 10% tartaric

acid, the remainder being water. Electrolytes of this general composition may contain from about 40% to about 70% of 96% sulfuric acid by weight and from about 5% to about 20% tartaric acid by weight, the remainder being ordinary tap water. These tartaric and sulfuric acid-containing electrolytes may be used at temperatures between about 100° F. and about 200° F. Another electrolyte which has given fairly satisfactory results consists of about 60% of glycerine and 40% of an 85% solution of phosphoric acid. This electrolyte seems to operate more satisfactorily at temperatures at approximately 200° F. Other electrolytes which are capable of polishing stainless steel surfaces to a bright finish when used in conjunction with "polishing" currents may also be employed in carrying out the present process. All such electrolytes are collectively referred to in the appended claims as "polishing" electrolytes, for the sake of brevity.

It is important, as noted above, that there should be a substantially uniform flow of current between each unit area of the tube and the cathode. A satisfactory flow of current may be obtained when the strips 9 and cathode 11 are composed of good electrically conductive material, such as copper, and when the cathode is disposed centrally in the tube and the strips are clamped against opposite sides of the tube 7 at a plurality of places so that the strips will press against the tube thruout substantially their full lengths. In this manner the metallic part of the circuit is highly conductive, with the exception of the part composed of the stainless steel tube. However, that part of the circuit can not disturb the substantially uniform flow of current at each area of the inner surface of the tube for the current does not pass lengthwise thru the tube, as would be the case if the strips 9 were not employed.

Having thus described our invention so that others skilled in the art may be able to understand and practice the same, we state that what we desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. The method of polishing which includes the steps of passing thru the annular space between an elongated stainless steel tube and a cathode disposed axially therewithin a polishing electrolyte which fills said space and flows at a rate sufficient to dislodge gases from the inner surface of the tube, and passing thru the flowing electrolyte and between the tube and cathode a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube.

2. The method of polishing which includes the steps of passing a polishing electrolyte up thru a stainless steel tube, and passing thru the flowing electrolyte and between the tube and a cathode disposed axially therewithin a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube.

3. The method of polishing which includes the steps of passing thru a stainless tube several feet long a polishing electrolyte which flows at the rate of several gallons per minute and fills the tube, and passing thru the flowing electrolyte and between the tube and a cathode disposed axially therewithin a polishing current which of



substantially uniform density on every unit area of the inner surface of the tube.

4. The method of polishing which includes the steps of passing thru a stainless steel tube several feet long a polishing electrolyte which flows at the rate of several gallons per minute and fills the tube, and passing thru the flowing electrolyte and between the tube and a cathode disposed axially therewithin for approximately ten minutes a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube and which ranges between about .75 and about 6 amps. per sq. in.

5. The method of polishing which includes the steps of passing thru a stainless steel tube a polishing electrolyte which fills the tube, passing thru the flowing electrolyte and between the tube and a cathode disposed axially therewithin a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube, liberating gases from the electrolyte after it has passed out of the tube, cooling such electrolyte to between about 100° F. and 200° F. and returning the cooled electrolyte to the tube.

6. The method of polishing which includes the steps of passing a polishing electrolyte at the rate of several gallons per minute up thru a stainless steel tube several feet long, passing thru the electrolyte between the tube and a cathode disposed axially therewithin for approximately ten minutes a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube and which ranges between about .75 amp. and about 6 amps. per sq. in., liberating gases from the electrolyte after it has passed out of the tube, cooling such electrolyte to between about 120° F. and 200° F. and returning the cooled electrolyte to the tube.

7. The method of polishing which includes the steps of passing thru a stainless 18–8 type steel tube several feet long a polishing electrolyte which flows at the rate of several gallons per minute and fills the tube, passing thru the flowing electrolyte and between the tube and a cathode disposed axially therewithin for approximately ten minutes a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube and which ranges between about .75 and about 6 amps. per sq. in., liberating gases from the electrolyte after it has passed out of the tube, cooling such electrolyte to between about 120° F. and about 140° F. and returning the cooled electrolyte to the tube.

8. The method of polishing which includes the steps of passing thru a stainless AA type steel tube several feet long a polishing electrolyte which flows at the rate of several gallons per minute and fills the tube, passing thru the electrolyte and between the tube and a cathode disposed axially therewithin for not over ten minutes a polishing current which is of substantially uniform density on every unit area of the inner surface of the tube and which ranges between about .75 and about 6 amps. per sq. in., liberating gases from the electrolyte after it has passed out of the tube, cooling such electrolyte to between about 170° F. and about 200° F. and returning the cooled electrolyte to the tube.

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