252-148 CROSS REFERENCE EXAMINE

Aug. 26, 1952 2,608,392

R. O. BOWMAN
APPARATUS FOR CONTINUOUSLY ADDING AN INHIBITOR TO A MIXING TANK

Filed March 10, 1949

Fig. 1.

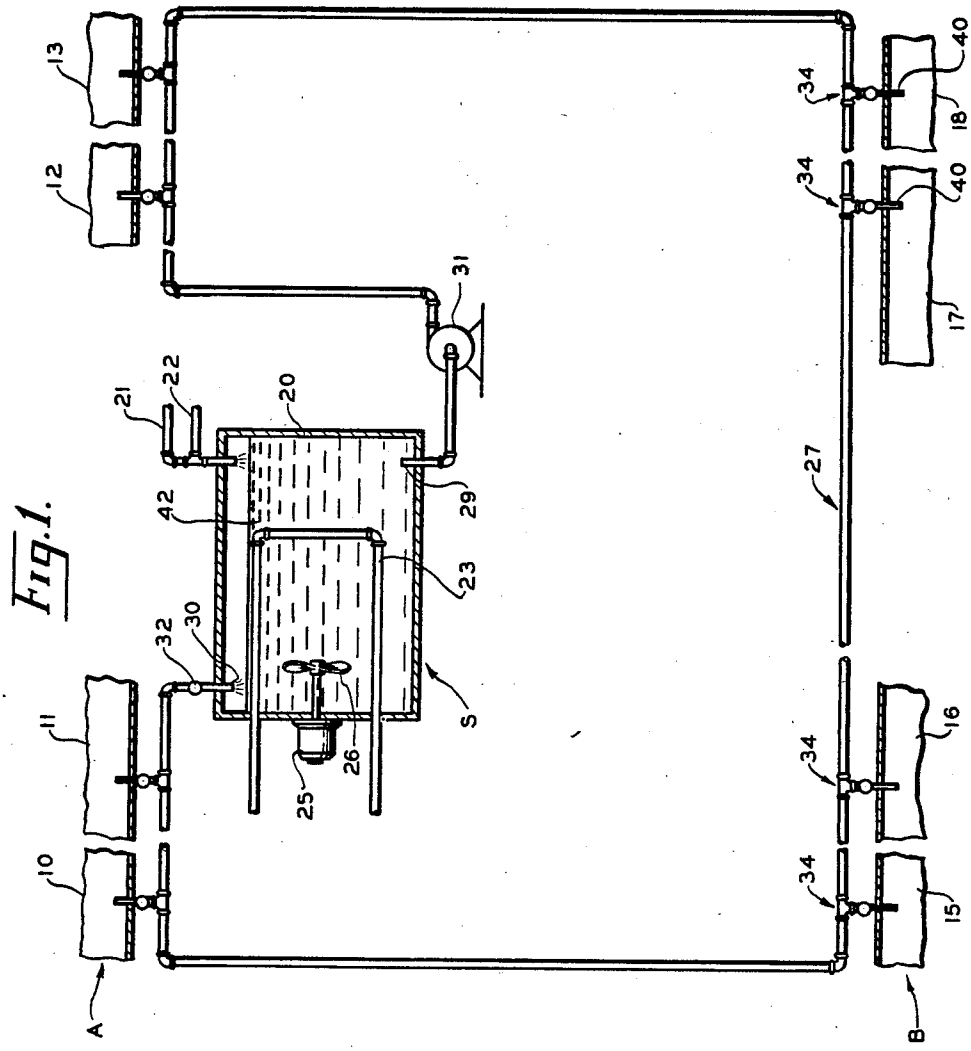
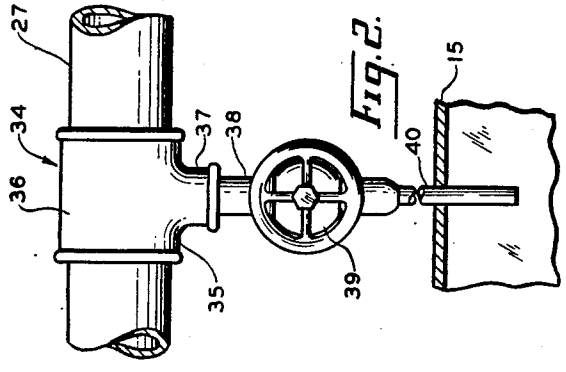


Fig. 2.



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Patented Aug. 26, 1952 2,608,392

UNITED STATES PATENT OFFICE

2,608,392

APPARATUS FOR CONTINUOUSLY ADDING AN INHIBITOR TO A MIXING TANK

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Application March 10, 1949, Serial No. 80,665

3 Claims. (Cl. 259—95)

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This invention relates to an apparatus for pickling ferrous metal in an acid bath and more particularly relates to an apparatus for continuously adding solid particles of inhibitor to a ferrous metal, acid pickling bath so as to maintain the inhibitor content of the bath substantially constant.

Ferrous metal articles are pickled in strong acid baths to remove oxides from the surfaces of the articles. Sulphuric acid is widely used for such purposes, and the present invention will be described in connection with this acid, but other acids such as hydrochloric acid or mixtures of acids are often used. Sulphuric acid attacks both the oxide coating and the base metal. The purpose of pickling is to remove the oxide coating so a good inhibitor reduces or inhibits reaction between the acid and the base metal while not reducing, or only slightly reducing, the rate of oxide removal. As the pickling baths are used, the inhibitor in the bath is gradually depleted through chemical reactions and by being removed from the bath in the solution dragged out on the surface of the articles. In order to maintain the pickling bath in the best condition, the percentage inhibitor content should be substantially constant. Some of the more desirable types of inhibitors are relatively insoluble solids. It has been impossible to add such inhibitors to the pickling bath, except by the batch process. In this batch method of adding such inhibitors, the operator prepares the inhibitor by stirring it in a liquid to form a slurry of solid particles of inhibitor suspended in the liquid. The liquid may be water or any other liquid compatible with the pickle liquor. The particles of inhibitor tend to settle out and the entire batch of slurry is added at once to the bath. With this procedure, the bath at times contains an excess amount of inhibitor and at other times contains a deficient amount of inhibitor. The usual practice is to add a greater quantity of inhibitor than is theoretically necessary at the time the inhibitor is added so that the pickling bath will at all times contain sufficient inhibitor. Attempts have been made to do this continuously by means of machinery, but these attempts have not met with success. The rate of inhibitor addition is quite low, and the particles of inhibitor clog the small passages.

An object of the present invention is to provide an improved apparatus for continuously adding solid particles of inhibitor to a ferrous metal pickling bath.

Another object of the present invention is to provide in combination with ferrous metal

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pickling apparatus including tanks adapted to contain pickle liquor, apparatus for continuously adding solid particles of inhibitor to the tanks.

Another object of the present invention is to add solid particles of inhibitor to a ferrous metal pickling bath without the difficulties or troubles encountered heretofore as a result of the particles clogging the passages or apertures.

In accordance with the present invention, a slurry of solid particles of inhibitor suspended in a liquid is continuously circulated from a large body of such slurry through a relatively large passage back to said body. The rate of flow is maintained sufficiently high to prevent the particles of inhibitor from dropping out and collecting so as to clog the passage. If the rate of flow—that is quantity of slurry per unit of time—is sufficiently high, then the flowing slurry will have sufficient velocity to prevent the solid particles from dropping out and clogging the passage. A relatively small quantity of the circulating slurry is withdrawn and discharged through a relatively small elongated passage into the tank of pickle liquor. The relatively small elongated passage which may be provided by means of a tube is of such a length and size as to provide sufficient resistance to maintain the desired rate of flow into the tank. The small passage is always full of relatively rapidly flowing slurry so that the particles can not drop out of suspension and clog the passage. By using a small elongated tube, the size of the passage through the tube may be larger than if a valve such as a needle valve were used to obtain the same small rate of flow. When valves are used to obtain the small rate of flow, the pressure and velocity rapidly drop to zero and the valves become clogged and will not function properly over a period long enough to be practical. By using a long tube to control the rate of flow, there is a gradual pressure gradient along the entire length of the tube and the velocity is maintained relatively high so that the particles do not drop out and clog the tube.

These and other objects and advantages of the present invention will become more readily apparent when considering the following detailed description, taken with the accompanying drawings, in which:

Figure 1 is a diagrammatic showing of apparatus embodying and operated in accordance with the principles of the present invention; and,

Figure 2 is an enlarged fragmentary view of a portion of the apparatus shown in Figure 1.

Referring to the drawings, the system S is combined with two pickling lines at A and B, each being adapted for pickling ferrous metal articles.

CROSS REFERENCE EXAMINER

The pickling line A includes four tubs or tanks 10, 11, 12 and 13, each shown in part. The line B also includes four tubs or tanks 15, 16, 17 and 18, also shown in part. The pickling lines A and B may be of any customary type and each may include any number of tubs. Each tub contains an aqueous, acid pickling bath, and the ferrous metal articles, such as sheets, plates, strip or the like, may be completely pickled in one tub or may be partially pickled in one tub and then pickled in the next tub and so on down the line until the article has been treated in all of the tubs and completely pickled.

The particular acid concentration in the pickling baths may vary depending upon a number of factors. Usually, aqueous sulphuric acid pickling baths contain about from 5% to 20% of sulphuric acid. As the pickling acid is used up, it is replenished so as to maintain the acid content as near constant as is practically possible.

The system S is a closed system and includes a tank 20 having pipe connections 21 and 22 for supplying water and, if desirable, steam. A heating coil 23 is mounted in tank 20 and connected to a source of steam or other hot fluid, not shown. The coil 23 can be omitted where it is not desirable to heat the tank contents, as can steam connection 22. A motor 25 is mounted on the tank for driving the mixer propeller 26. A closed pipe line 27 has its inlet end 29 and its outlet end 30 in communication with the tank 20. A pump 31 is interposed in pipe line 27 for pumping slurry from tank 20 through line 27 and back to the tank 20 at 30. A valve 32 is installed in line 20 near outlet 30 for maintaining back pressure in the line and for controlling the rate of flow and the velocity of flow through the line 27, the rate of flow being the quantity per unit of time.

For each one of the tubs there is provided a means 34 for drawing off part of the slurry flowing through line 27 and as the different means 34 are identical, only the means 34 for tub 15 will be described in detail. Referring more particularly to Figure 2, the pipe line 27 contains for each means 34 a T-connection reducer 35 having a portion 36 connecting the adjacent lengths of pipe line 27 and a portion 37. Portion 35 contains a passage that is the same size as the passage in pipe line 27. The portion 37 is a reducer receiving one end of a relatively smaller, short length of pipe or tubing 38 containing a valve 39. The length of pipe or tube 38 is connected to a small diameter, relatively long length of outlet tube 40 which is arranged to discharge into tub 15.

The passage through line 27 is relatively large and in one installation, for example, is ¾ inch in diameter. The passage through section 38 and valve 39 is ¼ inch, and the passage through tube 40 is ⅛ inch. The cross-sectional area of pipe line 27 is greater than the total cross-sectional area of all eight sections 38 or all eight tubes 40. Thus, the capacity of line 27 is greater than the capacity of all of the outlet means 34. With this arrangement, the pipe line 27 can supply all of the outlets and the outlet means 34 will not divert all of the slurry flowing through pipe line 27. The valve 39 in this same installation is a ¼ inch gate valve.

At the start of a cycle of operations, sufficient slurry is prepared in tank 20 to operate the system continuously for a long period of time. Water and steam are admitted through connections 21 and 22 into tank 20 until the tank contains the desired, relatively large quantity of water. Steam flows through coil 23 to maintain the liquid hot. The solid particles of inhibitor are added to the liquid in tank 20 and motor 25 is started to rotate the blade 26 and mix the solid particles of inhibitor and water and form a suspension or slurry 42 of solid inhibitor in water. The motor 25 may be operated throughout the cycle of operations or may be stopped after the slurry has been mixed. Quite often the agitation provided by the recycled slurry will agitate the body of slurry 42 sufficiently to prevent settling out of the particles.

After the slurry in the tank 20 has been prepared, in a quantity sufficient to last over a relatively long period of time, the pump 31 is started and the slurry is pumped through the pipe line 27 at a relatively high volume per unit of time and at a sufficiently high velocity to prevent the particles of inhibitor dropping out of suspension and clogging the line. The valve 32 which is wide open may be partially closed to regulate the rate of flow of slurry and the pressure in pipe line 27. The valve 32 is never closed and is never partially closed sufficiently to reduce the velocity of the slurry to the point where the particles of inhibitor can drop out and collect in line 27.

The tubes 40 are relatively small and long and restrict the volume of slurry flowing into the tubs per unit of time to that which is desired. With the valves 39 wide open, the rate of flow through tubes 40 is substantially the rate of flow required to maintain the desired concentration of inhibitor in the pickling tanks. With such an arrangement, the tube 40 of each means 34 is the primary means for controlling the flow of slurry to the corresponding tub. By using the tube 40 to limit and control the discharge flow of slurry, the pressure in line 27 is impressed on the slurry in tube 40 and as the capacity of line 27 is greater than the total capacity of all eight tubes 40, the slurry is forced through the tube 40 at sufficient velocity and under sufficient pressure to prevent dropping out of the inhibitor particles. By having the capacity of line 27 greater than the total capacity of all tubes 40, the passage in each tube is always filled with slurry and any particles tending to drop out are swept along by the flowing slurry so that particles can not collect and form a mass blocking the tube.

Thus, the tubes 40 each have a length and diameter such as to limit the flow of slurry substantially to the rate of flow desired when the pump produces a known pressure in line 27. The valve 39 may be adjusted to vary the flow to the corresponding tub by a limited amount but is not used to vary the flow from zero to the maximum. The valve 39 is always open sufficiently so that the pressure does not drop to zero between the valve and the outlet end of the tube and so that the passage from the valve to the outlet end of the tube is always filled with slurry. The valve 39 should be a gate valve or similar valve which has a full size passage. Needle valves and the like can not be used.

The present system is applicable for adding any type of solid particles of inhibitor to ferrous metal pickling baths. The particles of inhibitor should be relatively fine and must be smaller than the smallest passage in the system. While the present invention is not limited to any particular type of inhibitor, it has been successfully used for adding powdered inhibitors of the urea type to sulphuric acid pickling baths containing for example about 25% sulphuric acid.

With the present arrangement in which the tubes **40** are the primary means of flow control, the pressure in each tube **40** is gradually reduced along its entire length and the slurry as it approaches the end of the tube is under pressure. This prevents the particles collecting and clogging the passage. Valve **39** may be adjusted to vary the flow through the corresponding tube **40** to a limited extent. The valve **39** may be partially closed to reduce the pressure of the slurry in tube **40** and the rate of flow through the tube. The valve **39** is not closed sufficiently to reduce the pressure at any point along the length of the tube **40** to zero. The passage through the valve is always maintained at least as large as the passage through the tube. If the valve **39** is partially closed so that the passage through the valve is smaller than the passage through the tube **40**, then the pressure would tend to drop to zero on the outlet side of the valve and the passage would become clogged.

I claim:

1. In combination with means including a series of pickling tanks for acid pickling ferrous metal, apparatus for continuously adding solid particles of inhibitor to the tanks, said apparatus comprising, a supply tank for holding a bath of slurry of inhibitor particles suspended in a liquid, means for agitating the slurry in the supply tank, a conduit defining a relatively larger passage having an inlet and an outlet communicating with the supply tank, pump means for circulating slurry from the supply tank through the conduit passage back to the supply tank under pressure, and a series of passage means, each defining a relatively smaller passage separately connected to the conduit passage and a corresponding one of the pickling tanks, for withdrawing slurry from the conduit and adding the slurry to the pickling tanks, each passage means terminating in an elongated tube of uniform size leading to the corresponding pickling tank and controlling the rate of flow to the pickling tank, the total cross-sectional passage area of all of the relatively smaller passages being less than the cross-sectional area of the conduit passage whereby only part of the slurry circulating through the conduit is withdrawn.

2. In combination with means including a series of pickling tanks for acid pickling ferrous metal, apparatus for continuously adding solid particles of inhibitor to the tanks, said apparatus

comprising, a supply tank for holding a bath of slurry of inhibitor particles suspended in a liquid, a conduit having an inlet and an outlet communicating with the supply tank, pump means for circulating slurry from the supply tank through the conduit back to the supply tank under pressure, and a series of passage means, each separately connected to the conduit and a corresponding one of the pickling tanks, each passage means including an elongated relatively smaller outlet passage controlling the rate of flow of slurry to the corresponding pickling tank and including a relatively larger passage communicating with the conduit and the outlet passage, the total cross-sectional area of the relatively larger passages being less than the maximum cross-sectional area of the passage through the conduit.

3. In combination with means including a series of pickling tanks for acid pickling ferrous metal, apparatus for continuously adding solid particles of inhibitor to the tanks, said apparatus comprising, a supply tank for holding a bath of slurry of inhibitor particles suspended in a liquid, a conduit having an inlet and an outlet communicating with the supply tank, pump means for circulating slurry from the supply tank through the conduit back to the supply tank under pressure, a series of passage means, each separately connected to the conduit and a corresponding one of the pickling tanks, each passage means including an elongated relatively smaller outlet passage controlling the rate of flow of slurry to the corresponding pickling tank and including a relatively larger passage communicating with the conduit and the outlet tube, the total cross-sectional area of the relatively larger passages being less than the maximum cross-sectional area of the passage through the conduit, and a gate valve interposed in each of said relatively larger passages.

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