Nov. 25, 1958 J. F. JUMER 2,861,937

APPARATUS FOR ELECTROPOLISHING INTERIOR SURFACES OF VESSELS

Filed Sept. 15, 1954

2 Sheets-Sheet 1

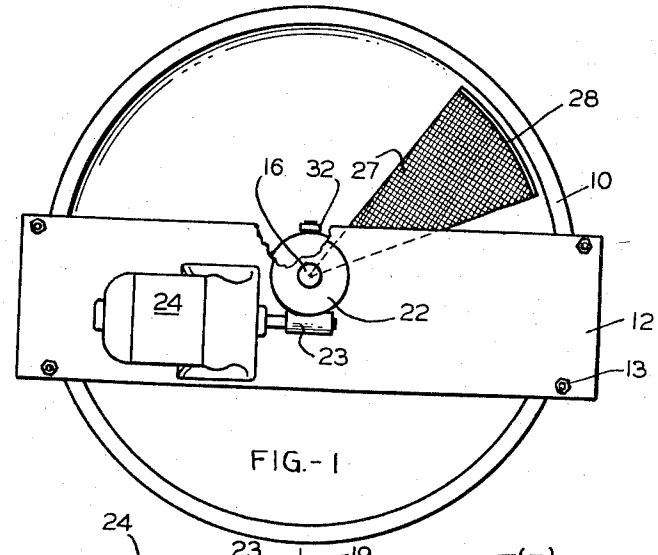

FIG.-1

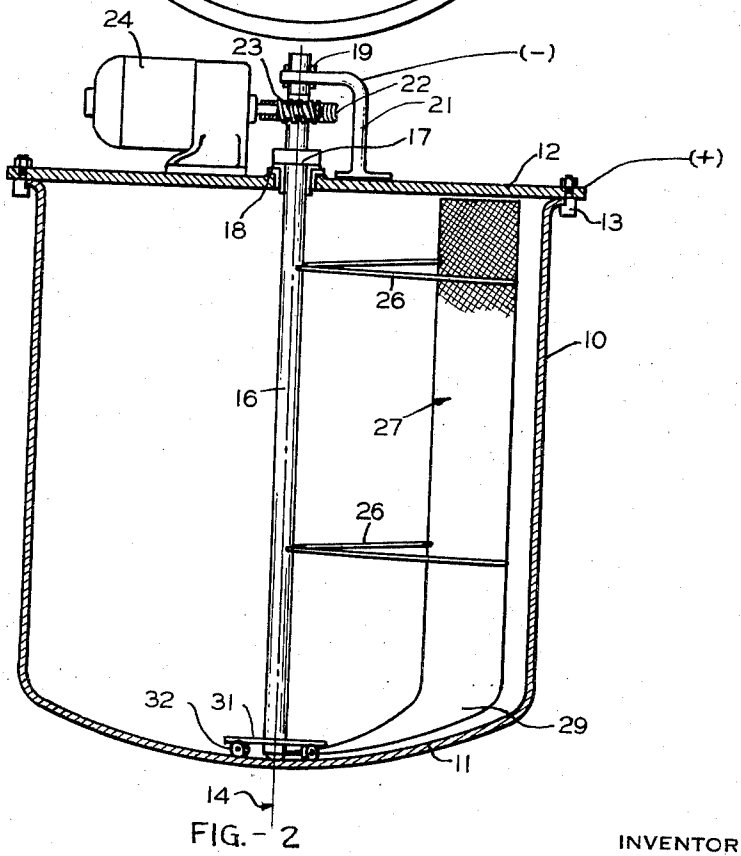

FIG.-2

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2 Sheets-Sheet 2

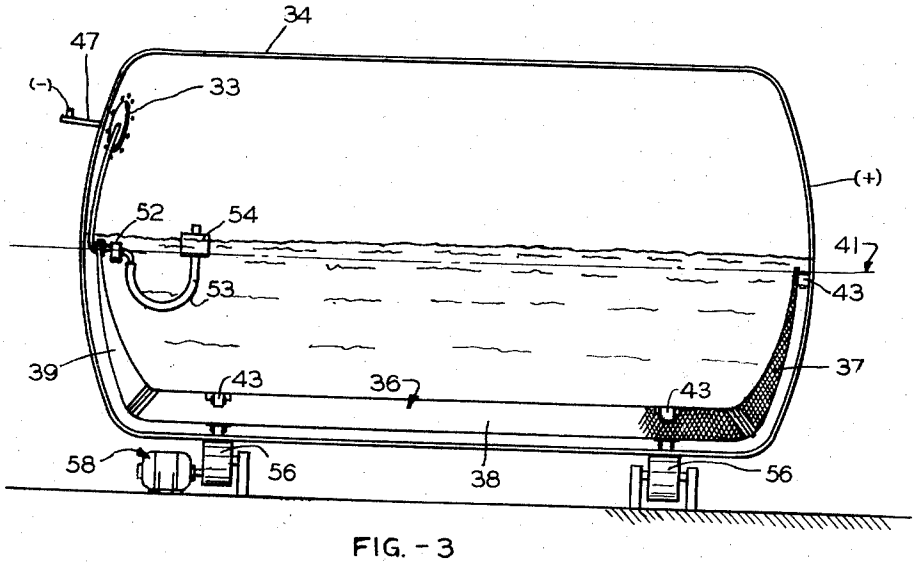

FIG. - 3

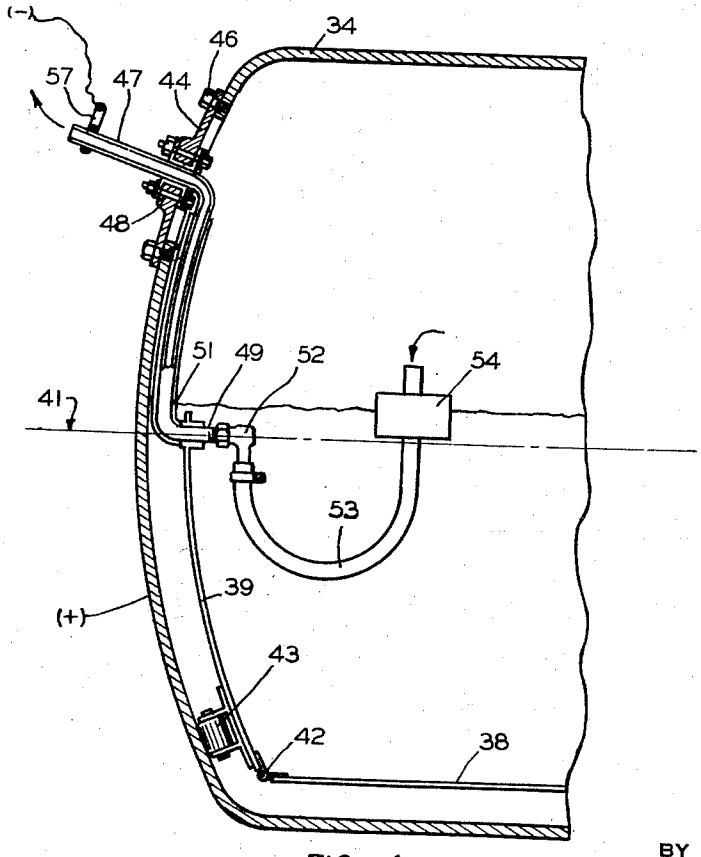

FIG. - 4

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APPARATUS FOR ELECTROPOLISHING INTERIOR SURFACES OF VESSELS

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Application September 15, 1954, Serial No. 456,292

10 Claims. (Cl. 204—212)

My invention refers to apparatus for electrolytically polishing the interior surfaces of metal vessels formed symmetrically about a central axis.

Certain industries, such as the chemical process industry, utilize large symmetrical vessels or tanks which must be provided with a polished interior surface to permiit through cleaning and sterilization, or to promote resistance to corrosion, or for other reasons. The polishing must be accomplished after the vessel has been fabricated, since otherwise the welding or joining of components would create rough and unpolished areas and thereby largely destroy the utility of the device. Usually the exposed interior surface area of these vessels is quite extensive, thereby making the uniform mechanical polishing of the surface very difficult and expensive. The problem is aggravated when access to the interior of the vessel may be obtained only through a manhole or port of limited dimension.

A primary object of my invention is the provision of apparatus for electrolytically polishing the interior surfaces of vessels and the like which are symmetrical about an axis of revolution.

Further important objects of my invention are the provision of apparatus of the type described which may be introduced into a large vessel through a manhole, port, or other limited opening and which will economically produce on the interior of a vessel the uniformly polished surface in a relatively short period of time.

Other objects as well as many of the advantages of my invention will be disclosed in the following description and in the appended drawings, in which:

Fig. 1 is a plan view of apparatus embodying my invention and adapted for use with tanks having an open end;

Fig. 2 is a vertical section through the device illustrated in Fig. 1;

Fig. 3 is a vertical section through a modified form of apparatus adapted for use in electrolytically polishing interior surfaces of tanks having closed ends and an access port of limited dimension;

Fig. 4 is a vertical section illustrating in detail certain portions of the device shown in Fig. 3.

The polishing action of my invention is dependent upon the passage of electric current through a bath between the interior surface of the tank or vessel and a cathode uniformly spaced from such surface. The composition of the bath employed as well as the current density, temperature, and other similar matters will vary with the type of metal employed in fabricating the tank and with the type of finish desired, but since these matters are well known in the art and form no part of this invention, they will not be herein described

A majority of the metals usually encountered in commercial operations can be most effectively electropolished by making the metal object or work the positive electrode of a direct current circuit, the cathode constituting the negative electrode. Consequently the following description makes reference to such a system but it should be

understood that my apparatus is equally applicable to electropolishing systems in which alternating current is caused to flow between the work to be polished and an electrode.

In Fig. 1, I have illustrated a tank **10** of cylindrical configuration having a bottom **11** and an open top. A support **12** extends across the open top of the tank **10** and may be secured thereto by bolts **13** or the like. If desired, the support **12** may be of wood or other insulating material but ordinarily metal will be employed to obtain sufficient rigidity. The tank **10** is symmetrical about an axis of revolution indicated at **14**. A metal shaft **16** extends along this axis into the tank and is supported by a bearing **17**, which may in turn be supported by an insulating washer **18** in the member **12**. Spaced upwardly from the bearing **17** is a single bearing **19** carried by a support **21**, which is mounted on the member **12**. Worm gear **22** is secured to the shaft **16** and engages a worm **23** driven by a suitable motor **24**.

Metal arms or supports **26** extend radially outwardly from the shaft **16** and support a metal cathode **27**. The cathode **27** may be formed of perforated metal screen or the like adapted for preventing entrapment of gas generated during the polishing operation. The outer surface of the cathode **27** is curved, as indicated at **28**, in such manner that it may be spaced uniformly inwardly a short distance from the inner surface of the tank **10**. The lower portion of the cathode **27** is curved, as indicated at **29**, to conform with the configuration of the bottom **11**, and is generally triangular in configuration, the apex of the triangle joining the shaft **16** near its lower extremity. If desired, a disk or arms **31** may be secured to the shaft **16** near the bottom and serve as a support for insulating rollers **32** adapted to wholly or partially support the shaft **16** and cathode **27**.

After welds and other gross interior surface imperfections have been ground and the apparatus mounted as described, the tank **10** is filled with electropolishing bath solution of suitable composition. The negative terminal of a direct current source is connected to the shaft **16**, as for example, through the metal support **21** and metal bearing **19**, or through conventional sliding contacts engaging the shaft **16** directly. The positive lead from the direct current source is connected to the tank **10** in such manner that current will flow between the cathode **27** and tank **10** through the electropolishing bath. The motor **24** is then started and drives the cathode **27** about the axis **14** at a slow uniform rate. The rate selected will vary somewhat with conditions but will normally be from ¼ to 5 revolutions per minute. The speed should be selected to avoid disruption of the gaseous film which forms on the electrode surfaces during operation, since in the absence of such film a satisfactory uniform polish cannot be obtained. Care must be observed to maintain the uniform distance between the cathode **27** and the tank since otherwise a uniform polish cannot be attained. It is also necessary to subject each unit area of the tank to the polishing action for the same period of time. The portion of the cathode adjacent to the bottom is therefore of generally triangular configuration, the apex of the triangle being near the shaft **16**, which accomplishes the desired effect.

The apparatus illustrated in Figs. 1 and 2 is satisfactory for vessels having an open end, but cannot be employed in the more conventional tanks of the type illustrated in Figs. 3 and 4 wherein access to the interior is obtainable only through a port or manhole **33** formed in tank **34**. To polish the interior of such vessels, I provide a cathode, generally designated **36**, comprising in this instance an outer end member **37**, an intermediate member **38**, and an inner end member **39**. Since the tank

34 is symmetrical about an axis 41, the intermediate cathode member 38 will be shaped as a segment of a cylinder, the width of the segment being less than the maximum dimension of the port 33. The end members 37 and 39 are connected to the intermediate member 38 by hinges 42 and are generally triangular in shape, the apex of the triangle being disposed at or near the axis 41. Insulating rollers 43 are secured to the outer surface of the cathode 36 to insure uniform spacing between the cathode and the tank 34.

The port 33 is sealed during operation by a cover 44 attached to the tank 34 by bolts 46 and defining a single aperture through which a tube 47 of copper or the like extends. A gasket 48 of deformable insulating material, such as rubber, insulates the tube 47 from the cover 44 and secures the tube firmly in position.

The portion of the tube 47 within the tank is covered with insulating material and extends parallel to the tank walls toward the axis 41. The inner extremity 49 of the tube 47 is bent in such manner that its centerline coincides with the axis 41. A bearing 51 is mounted on the portion 49 of the tube 47 and supports the free end of the inner end cathode member 39. A swivel connection 52 is secured to the end of the tube 49 and to a flexible hose 53, the other end of which is supported above liquid level by a float 54.

In operation the tank 34 is supported on a plurality of rollers 56 with the axis 41 horizontal. The cathode 36 is introduced through the port 33 with the ends 37 and 39 folded inwardly generally parallel to the intermediate portion 38. After insertion the end members 37 and 39 are swung outwardly to the position indicated in Fig. 3 with the rollers 43 contacting the walls and ends of the vessel. The tube 47 is carefully positioned in such manner that the end 49 is on the axis 41, after which the cover 44 is secured and the gasket 48 tightly seated. The force applied to the gasket must be sufficient to maintain the position of the tube within the tank so that the cathode 36 may turn freely about the axis 41. The electropolishing solution may be introduced into the tank before securing the cover 44 or through the tube 47. As the tank fills with solution the float 54 will maintain the end of the hose 53 above the level of the solution so that gas generated during operation of the device can be vented through the hose 53 and the tube 47 to the atmosphere. A sliding contact 57 connects the tube 47 with the negative lead of a direct current source, the positive lead being connected to the tank 34 by any suitable means such as a swivel or slip ring. When the level of liquid within the tank 34 is above the axis 41, the tank is sealed and current is applied to the tube 47 and tank 34. A motor 58 is employed for driving at least one of the rollers 56 supporting the tank, thereby causing the tank 34 to turn at a slow steady rate, preferably between ¼ and 5 R. P. M. about the axis 41. Preferably the rollers 56 are covered with rubber, although if desired one or more of the rollers may be of metal and serve as a contact between the tank 34 and the direct current source.

In this, as in the operation previously described, the cathode 36 is maintained by the rollers 43 a uniform distance inwardly from the inner of the tank 34. The solution within the tank as well as the cathode cover every portion of the interior surface during one complete rotation of the tank for a uniform period and will therefore polish the interior uniformly within a relatively short period. Since the rollers 43 are not on the axis 41, there is no area masked from the polishing action of the current. At the completion of the operation the solution may be drained and the cathode removed by reversal of the installation process described.

From the foregoing it may be seen that my device is adapted to vessels of configurations other than those illustrated, it being necessary only that the surfaces to be polished be symmetrical about an axis extending through the vessel. The configuration of the cathode 36 may be

altered as necessary to conform with these surfaces and to permit insertion through the port 33. Vessels treated in the manner described will have a highly uniform smooth polished interior surface which may be easily cleaned or sterilized and which is resistant to corrosion, provided the composition of the bath, its temperature and the current density are suitable for the particular metal being treated.

Even though the inner surface to be polished is large, it is not necessary to provide a large and expensive source of high amperage current, as would be required with a fixed cathode. Instead, the surface area of my rotating cathode may be reduced until the source of current available is adequate to supply the desired current density or current per unit of surface area. This expedient increases the time required for treatment, but eliminates the necessity of large initial capital investment. It should also be noted that when the vessel is rotated about a horizontal axis, only slightly more than half the tank need be filled with electrolyte, rather than the entire tank, which still further reduces the cost of utilizing my invention.

I claim:

1. Apparatus adapted for electropolishing the inner surface of a vessel having closed ends and a side wall concentric about an axis of revolution and an access port displaced from said axis of revolution comprising a metal cathode having a maximum width less than the largest dimension of said access port, said cathode having a first section for treatment of the vessel side wall, second sections for treatment of the ends of the vessel, hinges connecting said sections, insulated rollers on the cathode spacing said cathode uniformly from said side wall and ends, bearing means on said axis engaging the cathode, a cover for the access port, and an electrically conductive member sealed through the cover and supporting said bearing.

2. The structure defined in claim 1 which includes means for rotating the vessel about said axis.

3. The structure defined in claim 1 wherein only an end of one of the said second sections of the cathode is supoprted on the axis by said bearing means.

4. Apparatus adapted for electropolishing the inner surface of a vessel having closed ends and walls concentric about an axis of revolution and an access port displaced from said axis of revolution comprising a metal cathode having a maximum width less than the largest dimension of said access port, said cathode having a first section for treatment of the vessel walls, second sections for treatment of the ends of the vessel and hinges connecting said sections, insulated rollers on the cathode spacing said cathode uniformly from said walls and ends, bearing means on said axis engaging the cathode, a cover for the access port, an electrically conductive member sealed through the cover and supporting said bearing, said electrically conductive member comprising a tube, a swivel on the end of said tube within the vessel, a float and a flexible tubular member connected at one end to the swivel and supported at its opposite end by said float whereby gas may be discharged through said tube and flexible tubular member within the tank.

5. Apparatus adapted for electropolishing the inner surface of a vessel having closed ends and a side wall concentric about an axis of revolution and an access port displaced from said axis of revolution comprising a metal cathode having a maximum width less than the largest dimension of said access port, said cathode having a first section for treatment of the vessel side wall, a pair of second sections for treatment of the ends of the vessel each of generally triangular shape having its apex adapted to be positioned adjacent to said axis and its opposite side hinged to an end of said first section, insulated rollers on the cathode adapted to space said cathode uniformly from said wall and ends, bearing means adapted to be positioned in alignment with said axis adapted to engage the cathode, a cover for the access port, and an electrical-

ly conductive member sealed through the cover and supporting said bearing means.

6. Apparatus for electropolishing the internal end and side wall surfaces of a vessel which is symmetrical about an axis of revolution and adapted to contain an electropolishing solution, said aparatus comprising a bearing adapted to be positioned in alignment with said axis, insulating means adapted to engage the vessel and supporting said bearing, a metal cathode rotatably supported by said bearing and comprising a generally triangular shaped end section having its apex adapted to be positioned adjacent to said axis and a second section connected to the end of the first section opposite said apex, the width of said second section being substantially equal to the width of the adjacent end of the first section, insulating means adapted to space the respective sections substantially uniformly from the internal end and side wall surfaces of the vessel, said end and second sections of the cathode including reticulated areas extending across the path of gas bubbles arising from said internal surfaces of the vessel, motor means for producing relative rotation of the vessel and cathode, and means for passing electric current through the solution between the vessel and the cathode.

7. Apparatus as claimed in claim 6 in which the second section of the cathode is arcuately curved in conformity with the curvature of the side wall surface of the vessel.

8. Apparatus as claimed in claim 6 for electropolishing the internal end and side wall surfaces of an upright cylindrical vessel having an open upper end, said apparatus including a support for mounting on said upper end and containing said bearing, a shaft journaled in said bearing, and support means connecting said second section of the cathode to said shaft.

9. Apparatus as claimed in claim 6 for electropolishing the internal end and side wall surfaces of an upright cylindrical vessel having an open upper end, said apparatus including a support for mounting on said upper end, said bearing and said motor means being mounted on said support, a shaft journaled in said bearing, support means connecting said second section of the cathode to said shaft, and a drive connection between said motor means and said shaft.

10. Apparatus as claimed in claim 6 for electropolishing the internal end and side wall surfaces of an upright cylindrical vessel having an open upper end, said apparatus including a support for mounting on said upper end, said bearing and said motor means being mounted on said suport, a shaft journaled in said bearing, said second section of the cathode being arcuately curved in conformity to the curvature of the side wall of the vessel and having its convex surface facing said side wall with all portions of said convex surface spaced substantially equidistantly from said side wall surface, support means connecting said section of the cathode to said shaft, and a drive connection between said motor means and said shaft.

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