

Nov. 27, 1934.

P. E. McKINNEY ET AL

1,982,009

MEANS FOR ELECTROPLATING THE INTERIOR SURFACES OF HOLLOW ARTICLES

Filed Nov. 30, 1931

4 Sheets-Sheet 1

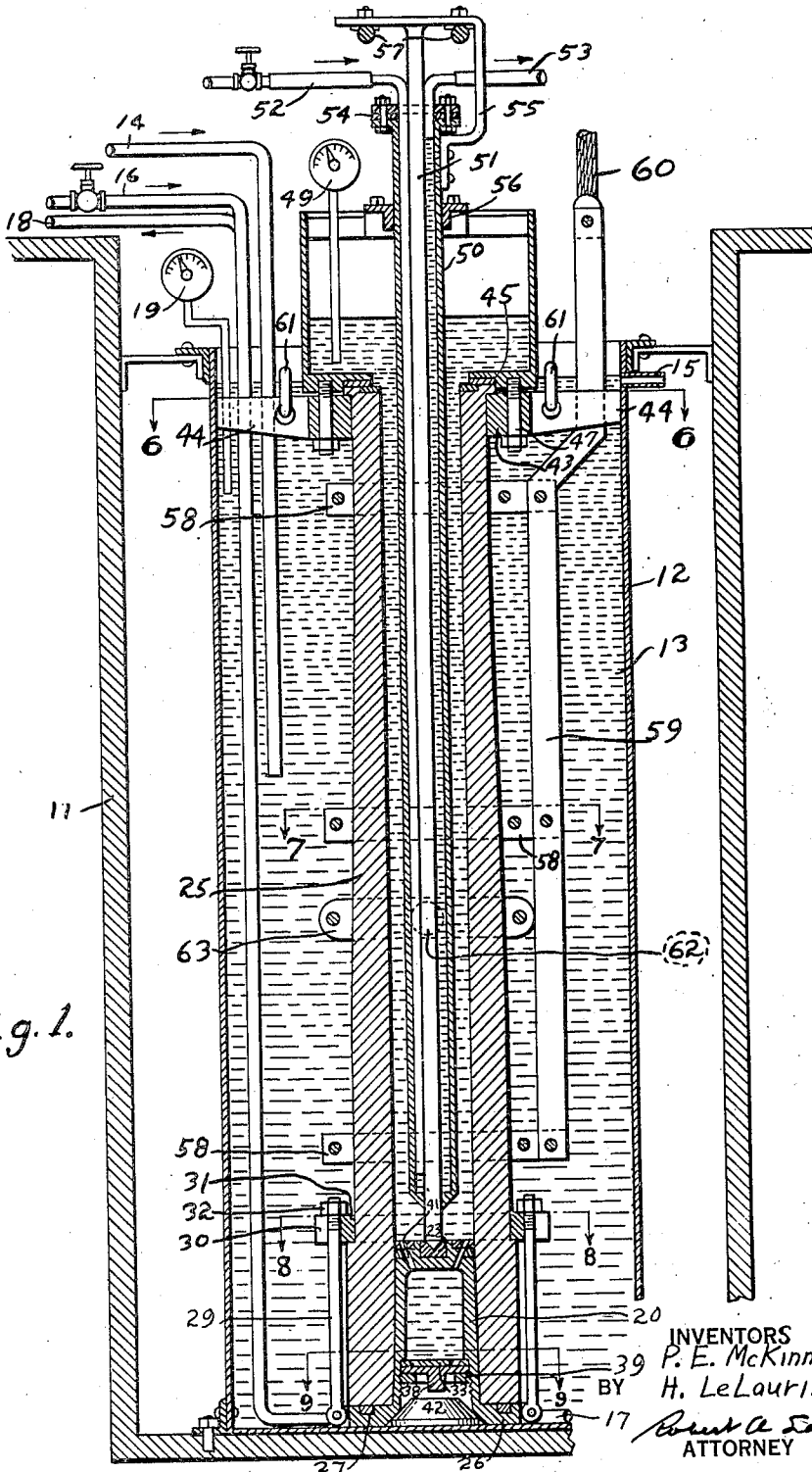


Fig. 1.

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4 Sheets-Sheet 2

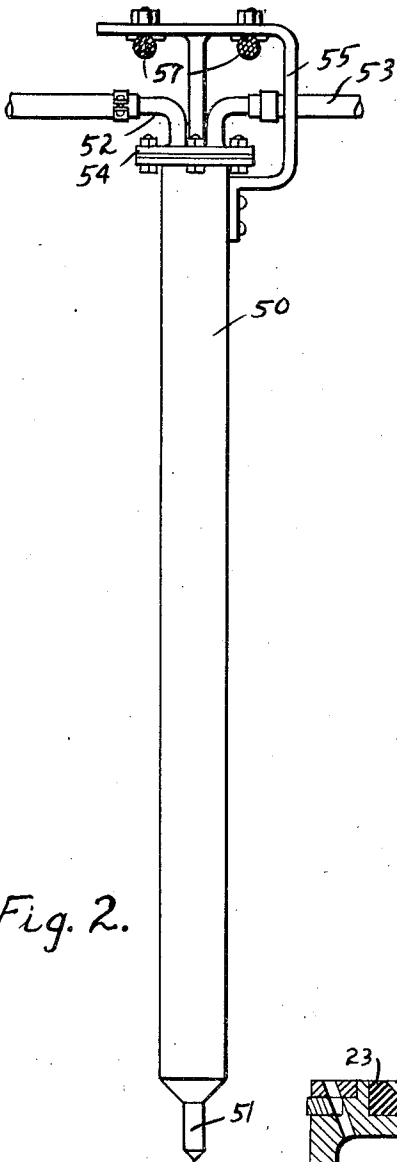


Fig. 2.

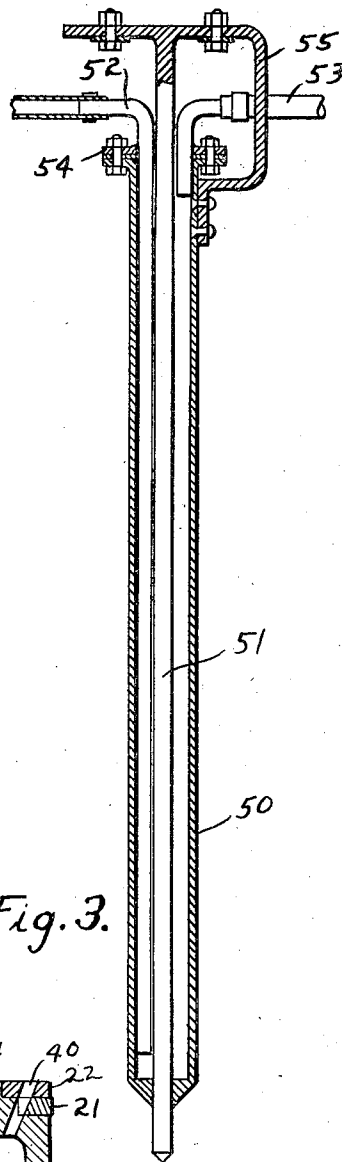


Fig. 3.

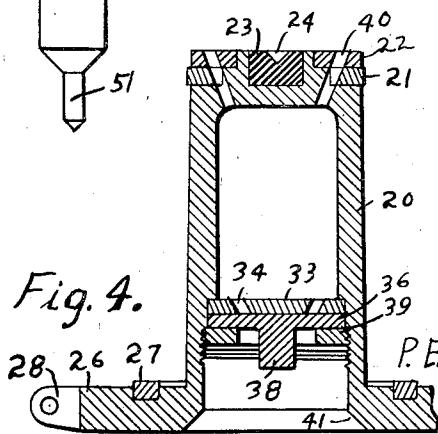


Fig. 4.

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4 Sheets-Sheet 3

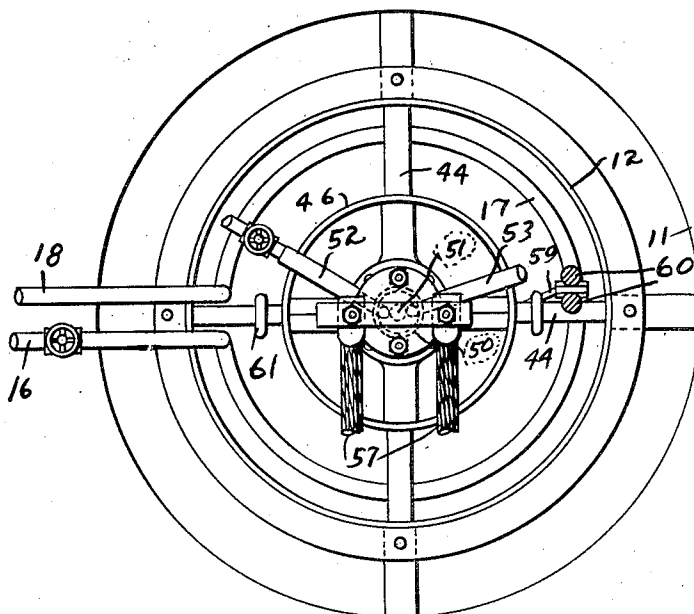


Fig. 5.

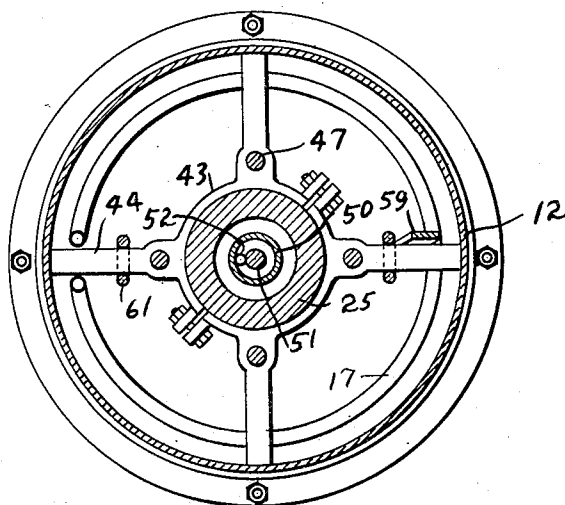


Fig. 6.

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4 Sheets-Sheet 4

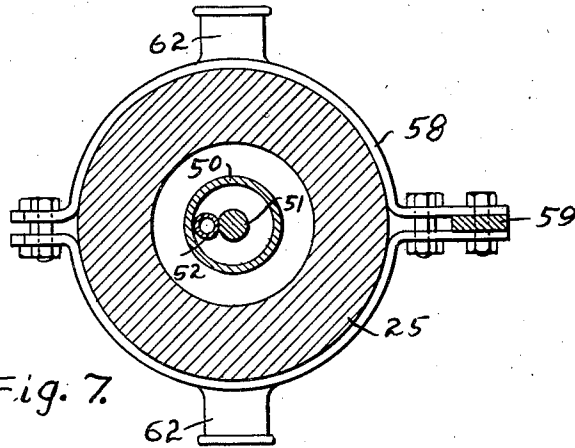


Fig. 7.

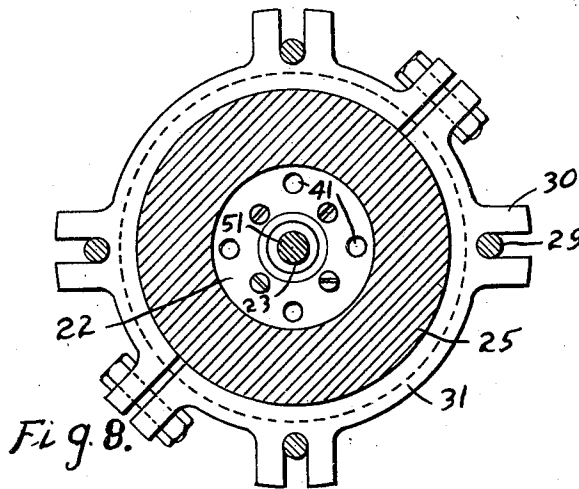


Fig. 8.

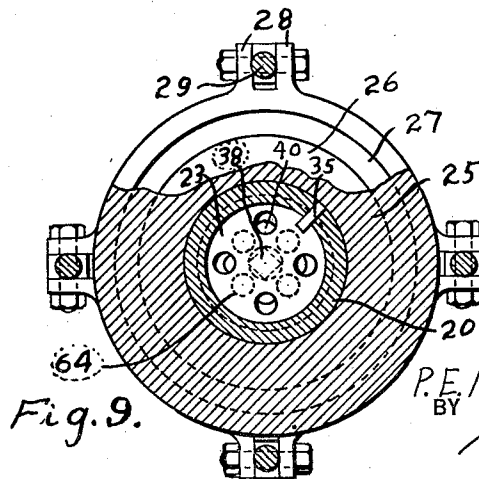


Fig. 9.

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UNITED STATES PATENT OFFICE

1,982,009

MEANS FOR ELECTROPLATING THE INTERIOR SURFACES OF HOLLOW ARTICLES

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Application November 30, 1931, Serial No. 578,172

8 Claims. (Cl. 204—5)

Our invention relates to apparatus for electroplating the interior surfaces of hollow articles.

The objects of this invention include the provision of means for making possible the use of high current densities, means for controlling closely the temperatures under which the operation is carried out, and a novel electrode capable of carrying a heavy current.

In the drawings:

Fig. 1 is a longitudinal sectional view of a plating installation according to our invention;

Fig. 2 is a side elevation of the electrode;

Fig. 3 is a longitudinal section of the electrode;

Fig. 4 is a longitudinal section of a plug used in the breech chamber of a gun barrel when it is desired to plate the bore thereof;

Fig. 5 is a plan view of the device shown in Fig. 1;

Fig. 6 is a cross section on the line 6—6 of Fig. 1;

Fig. 7 is a cross section on line 7—7 of Fig. 1;

Fig. 8 is a cross section on line 8—8 of Fig. 1; and

Fig. 9 is a cross section on line 9—9 of Fig. 1.

In ordinary electroplating work it is customary to provide a ratio of anode surface to cathode surface of three to one, but it is obviously impossible to adhere to these proportions when the surface to be plated is the interior of a hollow object, such as the inner surface of a hollow cylinder, as it is necessary to provide adequate space between the anode and the surface to be plated to contain the electrolyte.

Chromium plating requires very high current densities and control of the temperature within 7° of the optimum for securing best results. For example, where the current density is 150 amperes per square foot of surface to be plated the temperature should not vary much from a range of 113° F. to 120° F.; at 225 amperes per square foot, the temperature should be from 135° F. to 140° F.; and at 325 amperes per square foot the temperature should be from 140° F. to 145° F. The present invention provides an anode capable of carrying the heavy current requisite for successful plating with chromium without overheating, and means for controlling the temperature of the work within the specified narrow limits.

In Fig. 1 the numeral 11 indicates the wall of a pit of sufficient depth to accommodate apparatus suitable to articles of the length it is desired to plate. A tank 12 is disposed in the pit to contain a temperature control bath 13. When the temperature becomes too high, water is admitted to bath 13 through pipe 14 to cool the bath, the ex-

cess water passing out through overflow 15. When the temperature drops too low, steam is admitted through pipe 16, through coil 17 at the bottom of tank 12 and out of pipe 18 until bath 13 is again at the proper heat. Water or steam may be admitted by manually operated valves, depending upon the indication of thermometer 19 (which may be of the recording type), but preferably the temperature control is made automatic by any of the well known thermostatic means for that purpose.

The article to be interiorly plated, here shown for purpose of illustration, as a gun barrel 25, is positioned in bath 13. The tapered breech chamber, which is not to be plated, is closed by a tapered plug 20 that has a gasket 21 secured thereon near its upper end by means of clamping ring 22, the gasket being somewhat larger than the plug at that place to make a fluid tight seal. An insulating block 23 is set into the top of plug 20; a depression 24 is formed in the block to receive a correspondingly shaped portion of the electrode, whereby the electrode is in part supported upon plug 20. Base 26 of plug 20 has a gasket 27 set into it to form a seal against the end of barrel 25, and is provided with pairs of ears 28 between which eye-bolts 29 are pivoted, these bolts being disposed between ears 30 on split ring 31 that is clamped around barrel 25 and having nuts 32 thereon screwed against ears 30 to secure the plug 20 tightly in place.

A drain valve in plug 20 comprises a disk 33 having apertures 34 therethrough, held against rotation by a key 35, and a rotatable disk 36 having apertures 37 that may be brought into registry with apertures 34 and a polygonal shank 38 to be engaged by a tool to rotate the disk 36, the two disks being held tightly together by a clamping ring 39 screwed into plug 20 against disk 36. Apertures 40 place the space within plug 20 in communication with the interior of barrel 25, so that by turning disk 36 to align the openings 64 therein with the apertures 34 in disk 33, the electrolyte may be drained from the barrel after the barrel has been removed from bath 13. The lower portion of the bore in plug 20 has a frusto-conical face 41 to engage a like shaped lug 42 fixed in the bottom of tank 12 to position the barrel 25 properly in the tank.

Around barrel 25 at the muzzle end is clamped a split ring 43 from which arms 44 extend radially outwardly, these arms being of such length as to fit snugly within tank 12 to position the upper end of the barrel. A gasket 45 is clamped between the end of barrel 25 and the base of

a receptacle 46 for electrolyte, there being a sufficient quantity of the plating solution therein in excess of that required to fill the bore of the barrel 25 to replace any evaporation or other losses and keep the bore full throughout the plating operation. Stud bolts 47 screwed into the base of receptacle 46 and passed through arms 44 have nuts 48 that bear against arms 44 to hold receptacle 46 firmly in place. The temperature of the electrolyte is shown by thermometer 49.

As the electrolyte used in chromium plating attacks copper quite vigorously, it is the usual practice to make the anodes of lead when chromium is to be electro-deposited upon an article. The resistance of lead is too high to be used successfully in plating the bores of guns, as the high current density necessary would develop in it at temperatures too great for satisfactory electrolysis.

The difficulty mentioned in the previous paragraph has been obviated by our novel anode which comprises a tube 50 made of copper because of the high conductivity of that metal, electroplated on its exterior surface with lead or some other metal resistant to the action of the electrolyte to be used. In the present instance, lead to the thickness of approximately 0.01 inch was applied, then cleaned and treated by the so-called "scratch-brush" method, to prevent the formation of large crystals which are not highly resistant to the action of the electrolyte, then another coating of lead that in turn was cleaned, and so on until a thickness of about 0.05 inch or more of lead had been deposited on the tube. With the last-mentioned thickness of lead on the tube there is no hazard of serious contamination of the electrolyte with the copper, and yet the conductivity of the tube is not markedly impaired.

Extending through tube 50 is a bar 51 of copper that is sealed into the tube at the lower end thereof and has a conical point to rest in the recess 24 in member 23 in the top of plug 20. An inlet water pipe 52 is provided to carry cooling water into tube 50 and discharge it near the bottom of the tube, and an outlet pipe 53 near the top of the tube as a discharge. Pipes 52 and 53 and bar 51 pass through a cap 54 that forms a water-tight closure for the top of the tube. A heavy bar 55 of high conductivity connects the top of bar 51 to tube 50. The current is thus supplied to the tube from both ends and a uniform distribution of the current over the tube is secured. The anode assembly is laterally supported by an insulating member 56 carried by member 46. Cables 57 conduct the current to the anode.

The current is carried away from the cathode (barrel 25) by heavy copper bands 58 clamped thereon that are connected to bus-bar 59 and thereby to cables 60.

Lifting links 61 secured to arms 44, and lugs 62 on band 63 that is clamped around barrel 25, provide means for hooking a crane to the barrel 25 to lower it into or lift it from the bath 13.

It has been found that when the bore of a gun is plated with chromium the life thereof is very much prolonged. For instance, the life of a large caliber gun barrel is about one-hundred twenty rounds, when unplated. When plated with chromium, the plating lasts sixty rounds when it should be re-plated. As this process may be practiced repeatedly, the life of the barrel may be prolonged indefinitely. The chromium plating not only prevents pitting by the corrosive action

of the gases from the propellant charge, but also seems to delay very much the crystallization of the metal of the barrel, the reason for which is not yet known.

It will be understood that the above description and accompanying drawings comprehend only the general and preferred embodiment of our invention, and that various changes in construction, proportion and arrangement of parts may be made within the scope of the appended claims without sacrificing any of the advantages of our invention.

We claim:

1. An apparatus for electroplating the inner surfaces of hollow cylinders, comprising a tank to contain a temperature control bath in which the article to be plated may be immersed, means to vary the temperature of said bath, a hollow plug fitted into the lower end of such cylinders to form a closure therefor, an insulating block set into the closed upper end of said plug, apertures through said closed end, a disk non-rotatably positioned in said plug spaced from said end, a rotatable disk in contact with the first mentioned disk and having apertures therethrough that may be made to register with the apertures in the said first mentioned disk and means engageable by a tool to rotate said rotatable disk, means to retain said disks in contact, a frusto-conical face formed at the lower end of said plug, a frusto-conical boss on the bottom of said tank to interfit with said face; an anode disposable in said cylinders comprising a copper tube exteriorly coated with lead and a solid copper bar extending through said tube and sealed thereto at the lower end, the lower end of said bar being disposed on the insulating block in said plug, means to circulate cooling liquids in said tube, and a heavy copper bar connecting the upper ends of said bar and said tube; and means connectible to said cylinders to conduct the current away therefrom.

2. In an apparatus for electroplating the interior surfaces of hollow cylinders, a temperature-control bath in which such cylinders may be immersed, a closure for the lower ends of said cylinders, said closure being adapted to cooperate with a member in said bath to position said lower end and to support an electrode and having drain valve mechanism incorporated therein, an anode in said article comprising a tube of copper exteriorly plated with lead, a solid bar of copper extending therethrough and connected thereto at both ends, said bar being adapted to rest upon said closure, and means to circulate a cooling liquid in said tube, means to carry current away from said cylinders, and means connectible to said cylinders engageable by a lifting mechanism.

3. In a means for electroplating the interiors of hollow cylindrical articles, a closure for an end of such articles, said closure being hollow with one end closed, an insulating block set into said closed end, apertures through said end, a sealing annulus set into the periphery of said closure, a perforated disk non-rotatably disposed in said closure, a rotatable disk having perforations alignable with the perforations in said non-rotatable disk and means engageable by a tool to rotate said rotatable disk, and an annular nut screwed into said closure to retain said two disks in contact with each other; an anode disposable in said cylinder to rest upon said insulating block in said closure, comprising a hollow tube of copper exteriorly plated with lead, a solid bar of copper extending through said tube

and connected thereto at both ends, and means to circulate coolant in said tube.

4. An anode for chromium plating the interior surfaces of hollow cylinders, comprising a tube of copper exteriorly plated with lead, a solid bar of copper extending through said tube and sealed to said tube at one end, means connecting said bar to said tube at the other end thereof, and means to circulate a fluid in said tube.

5. An anode for electroplating the interior of hollow cylindrical articles, comprising a tube of metal having a surface resistant to the action of the electrolyte, a conducting member extending through said tube and connected thereto at both ends, and means to circulate a fluid in said tube.

6. An anode for electroplating the interior of hollow cylindrical articles, comprising a tube of metal that constitutes the anodic surface and a

conducting member extending through said tube and connected thereto at both ends.

7. An anode for electroplating the interior of hollow articles, comprising a hollow member of substantially the same shape as the surface to be plated but of smaller size, conducting means within said member connected to opposite extremities of said member, and means to circulate a fluid in said member.

8. An anode for electroplating the interior of hollow articles, comprising a member of substantially the same shape as the surface to be plated but of smaller size, and means to supply current to said member at a point exteriorly of the article to be plated and at a point adjacent the other end of said member within said article.

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