April 11, 1950 S. G. BART 2,503,863

APPARATUS FOR ELECTROPLATING THE INSIDE OF PIPES

Filed Nov. 18, 1943 2 Sheets-Sheet 1

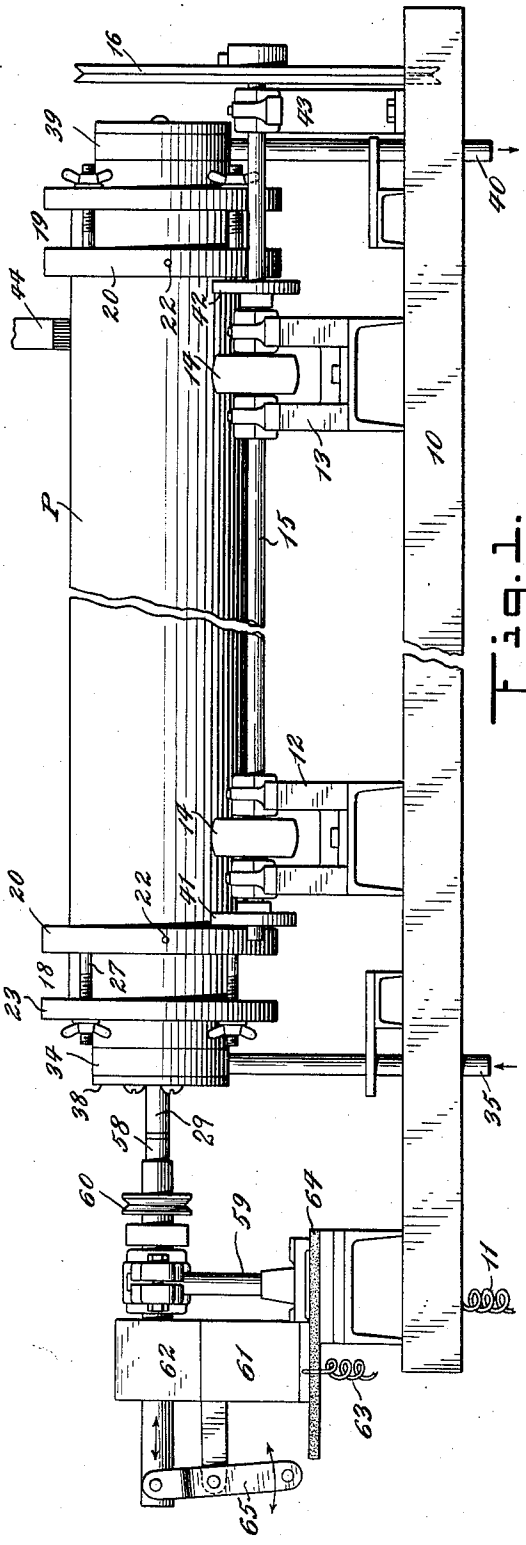

Fig. 1.

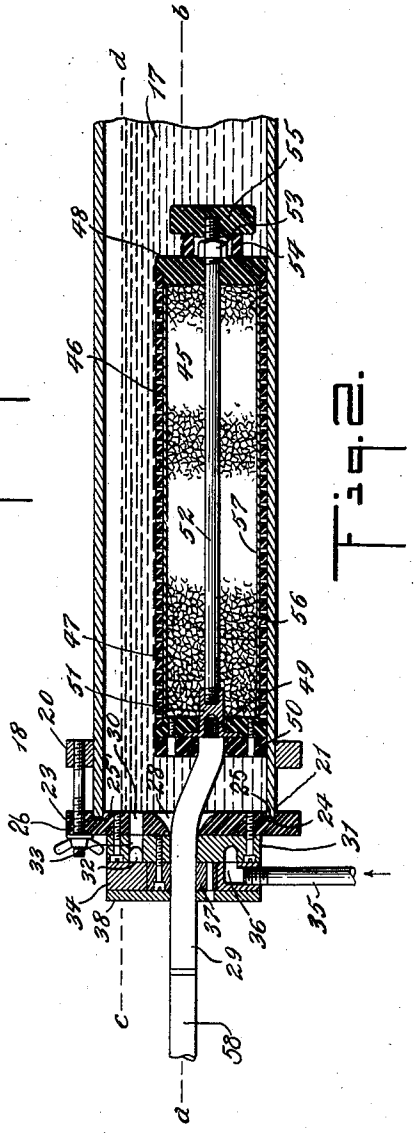

Fig. 2.

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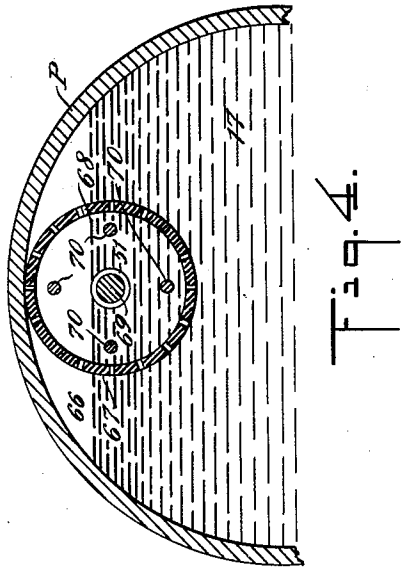

Fig. 4.

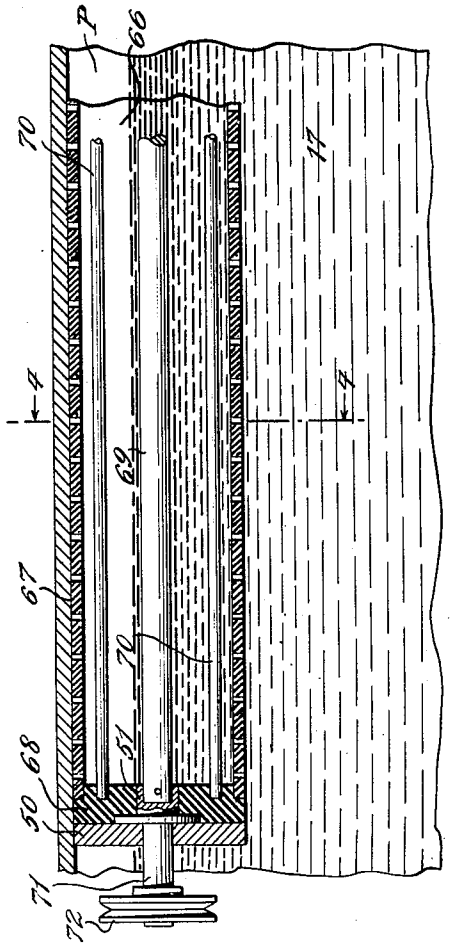

Fig. 3.

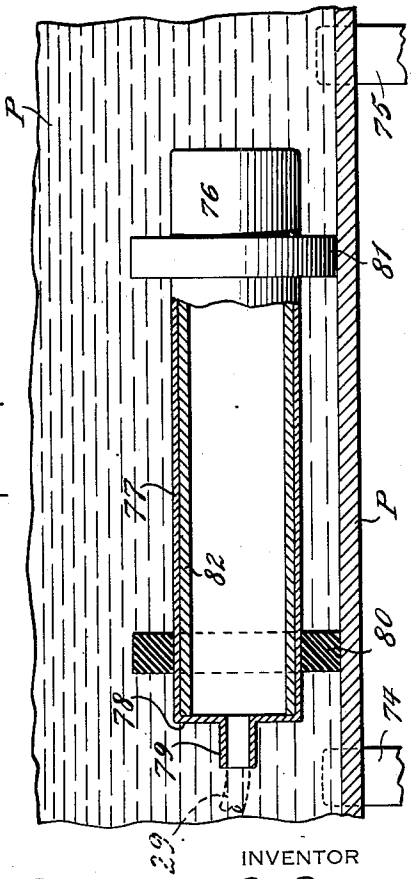

Fig. 5.

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APPARATUS FOR ELECTROPLATING THE INSIDE OF PIPES

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Application November 18, 1943, Serial No. 510,768

8 Claims. (Cl. 204—224)

1

The invention relates in general to apparatus for electroplating the insides of pipes, and similar hollow vessels.

The primary object of the invention is to provide an improved technique by the practicing of which a better character of metallic liner for pipes may be obtained than has been possible heretofore with incidental economy in manufacturing costs, both in the anode material used as well as in the amount of electric current consumed in effecting the necessary density of lining.

Primarily, the invention features the locating of the anode in closer relation to the surface being plated than has been possible heretofore in known methods heretofore used in the lining of pipes by electrolytic deposition and in keeping both the anode forming material as well as the electrolyte in a constant state of agitation.

Broadly defined the invention features the confining of the electrolyte within the pipe being lined, thus economizing in the amount of electrolyte necessary, and the locating of the anode structure close to and, preferably, in rolling contact with the surface under treatment and at the same time to remove the freshly deposited material from the electrolyte periodically during the plating process.

Another object of the invention is to provide a simple form of electrolytic cell to which can be fitted different sizes of pipes to be lined without necessity of dismantling very much of the equipment and by means of which apparatus the method herein disclosed may be practiced economically.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosure and from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one method of practicing the invention, and the invention also consists in certain new and novel modifications of the preferred method and other features of construction and combination of parts hereinafter set forth and claimed.

In the accompanying drawings:

Fig. 1 is a view in side elevation of a preferred form of apparatus for forming a lining for a pipe shown in operative position thereon with the mid-portion of the pipe and apparatus broken away to save space;

Fig. 2 is a vertical sectional view taken axially through the left hand portion of the pipe shown in Fig. 1 and showing positioned therein a preferred form of anode structure rolling on the bottom of the pipe under treatment;

2

Fig. 3 is a longitudinal vertical sectional view taken axially through a modified form of anode construction, featuring the use of rod anodes and otherwise distinguishing from the Figs. 1 and 2 form in that the anode structure supports and rotates the pipe under treatment;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 3 looking in the direction indicated by the arrows, and

Fig. 5 is a vertical longitudinal sectional view of still another modified form of the anode structure featuring a solid shell form of anode and like the preferred form rolling on the bottom of the pipe under treatment.

Referring first to the disclosure in Figs. 1 and 2, there is disclosed a metallic support or long frame 10 connected conventionally to the negative side of a source of electric energy through a cable 11. Mounted on the support 10 are four roller supporting brackets, two marked 12 and 13 in Fig. 1, on each side of the apparatus. Each of the brackets carries a pipe supporting roller 14, the four rollers coacting to form a cradle support for the pipe P. The rollers on one side as shown in Fig. 1 are mounted on and rotated by a drive shaft 15 extending lengthwise of and located to one side of the pipe under treatment.

The shaft 15 is provided at its right end with a drive pulley 16 which rotates the shaft and the two rollers carried thereby. In actual practice, it has not been found necessary to drive the pair of idler rollers on the opposite side of the machine from that shown in Fig. 1. The pipe P which is to have its inner bore lined is located on the four supporting rollers and the parts are arranged so that when pulley 16 rotates it operates through the drive shaft and active rollers to rotate the pipe about its own longitudinal axis indicated by the line *a—b* in Fig. 2.

The opposite open ends of the pipe are temporarily closed so as to maintain a pool 17 of electrolyte therein with the pool maintained at all times at about the level *c—d* well above the anodes herein described. The left closure 18 and the right closure 19 for temporarily closing the opposite ends of the pipe P are of substantially the same construction so that the detailed description of one will be sufficient for the other.

Referring specifically to the left closure 18 as illustrated in Fig. 2, there is disclosed an annular strap 20 which is slipped on the adjacent end of the pipe located by the stops hereinafter described and secured in spaced relation from its

adjacent end 21 by set screws 22. The flat-disc-like plate 23 of insulating material, insoluble in the electrolyte present, is provided on its inner face with an annular recess 24 in which is received the adjacent end 21 of the pipe with a gasket 25 seated in the recess to prevent leakage of the electrolyte out of the pipe. Externally of the pipe, the end plate is provided with four bolt holes 26 extending therethrough and clamping bolts 27 are passed through strap 20 and through these bolt holes to securely anchor the closure considered as a whole in place on the pipe. The end plate is provided centrally thereof with a funnel shaped opening 28 for receiving a flexible anode cable 29 and is provided outwardly therefrom with an inlet port 30 for passing the electrolyte into the pipe.

Secured to the outer face of the end plate 23 is a channel plate 31 provided on its outer face with an annular groove 32 open through passageway 33 therein to the inlet port 30. Abutting the channel plate is a fixed plate 34 so designated as it forms a fixed part of the apparatus and is provided with an intake pipe 35 for supplying a stream of electrolyte to the left end of the pipe. An L passageway 36 leads from the pipe 35 to groove 32 in all rotative positions of the end closure.

Secured to the outer face of the channel plate at its center is a cylindrical hub 37 which is journalled for rotary movement in a bearing therefore provided in the center of the fixed plate and held against axial movement by a face plate 38. It is understood that the anode cable 29 extends snugly through an opening provided therefor in the axial centers of the channel plate, the hub and the face plate to avoid leakage of the electrolyte out of the pipe past the cable.

The right closure 19 is of similar construction to the closure thus described except that the several plates and the hub are solid at their centers as there is no anode cable at the right end of the apparatus. The fixed plate 39 at the right end of the showing corresponding to the fixed plate 34 at the left is provided with a discharge pipe 40, opening from the interior of the pipe by passageways similar to those shown at the left of Fig. 2. It is understood that the electrolyte is pumped by means not herein disclosed through the inlet pipe 35 and flows from left to right through the pipe P, and through the discharge pipe 40 back to the source of supply.

In order to provide a gauge for locating the straps 20 as they are inserted on pipe P and, incidentally, to prevent subsequent inward creeping of the same, a pair of stops in the form of discs 41 and 42 is mounted on, rotates with the drive shaft 15, and engages the inner faces of the straps. A supporting journal 43 for the shaft 15 is shown in close relation to the drive pulley 16. It has been found that as the rollers 14 and associated parts are connected electrically through frame 10 and the cable 11 to the source of electric energy this has been a sufficient electric contact and the entire pipe P becomes the cathode of the system. As a matter of precaution, there is disclosed a brush 44 in bearing engagement with the rotating pipe P engaging the same adjacent its right end or electrolyte discharging end. It is understood that brush 44 is conventionally supplied from cable 11 and supplements the application of current through the four supporting rollers 14.

Located within the pipe P and in rolling contact with the bottom thereof is an anode construction 45 composed primarily of a hollow thin walled cylindrical shell 46 formed of any insulating material, insoluble in the electrolyte present. The shell is provided with a large number of apertures 47 extending therethrough to permit passage of the electrolyte into contact with the anode material. The right end of the cylinder is closed by an end plate 48 of insulating material and the opposite end by a similar end plate 49 to the outer face of which is secured a cable guiding plate 50.

Fitted in the end plate 49 is a metallic cable connector or thimble 51 in the outer end of which is intruded one end of the conductor elements of the insulated anode cable 29. A combined tie rod and anode rod 52 is threaded into the inner end of the connector 51 and is passed through the end plate 48. The end plates 48 and 49 are firmly secured in place by nut 53 engaging the right end of the tie rod and bearing on plate 48. The protruding end of the tie rod is protected from the deposition of metal thereon by a sleeve 54 and cap 55 both of insulating and insoluble material.

Positioned within the anode construction is a mass of loose particles forming anode material and in the illustrated case shown to be fine nickel particles 56. Preferably, the nickel particles are contained in a fabric bag 57 which acts to prevent the loss of the particles in the electrolyte stream.

It is understood that the anode cable is sufficiently flexible to assume the different positions imposed thereon by variations in the internal diameter of the plate for the time being located in the apparatus and to permit some shifting of the construction incidental to the rotation of the pipe. The outer end of the cable is connected mechanically and electrically with an anode shaft 58 journalled in a shaft bracket 59 and rotated by connection with some suitable form of motor through anode pulley 60. Current from the positive side of the source of electric energy is conveyed to the shaft 58 through wide brush 61 and bearing on long cylinder 62 secured to the shaft and supplied through cable 63. A sheet of insulation 64 insulates the shaft bracket 59 and parts carried thereby from the electrically charged support 10.

It is herein suggested that the anode structure within the pipe may be reciprocated axially of itself and of the pipe and for this purpose there is shown at the left of Fig. 1 a rocker or lever 65 having one end pivoted to the shaft and its other end connected to reciprocating mechanism forming no part of this disclosure. In the illustrated instance the pipes P are of four to eighteen inches diameter and in twenty foot lengths.

In operation, and assuming that the parts are assembled as shown in Figs. 1 and 2, and that through the drive pulley 16 the pipe P is caused to rotate bodily about its own axis and that a flow of liquid electrolyte, such as a nickel solution, is being pumped through the pipe, an electrolytic action will be set up in the apparatus. In the instant case an extremely thin layer of nickel will be deposited on whatever may be the bottom of the pipe for the time being. The frictional engagement between the pipe and the cylindrical anode construction rolling on the same will tend to rotate the construction even in the absence of any outside power acting thereon through the armature pulley 60. The peripheral speeds of the pipe and anode structure will be about the same.

As the inner surface of the pipe P receives its lining deposit, it is raised up with the rotation of the pipe out of the pool of electrolyte and for a period of time during the rotary movement of the

pipe while the deposit is uppermost the freshly deposited layer is raised free of the electrolyte. At this time, there is permitted the escape of hydrogen and other gases adhering to the precipitated layer of metal. This discharged gas accumulates in the space above the level *c—d* of the pool and is carried off more or less by the stream of electrolyte as it is discharged from the apparatus.

After passing through this period of gas discharge, the previously deposited portion of the lining reenters the electrolyte and the depositing action is repeated with an additional film of nickel on the previously deposited nickel film. The deposition is thus continuously applied until the desired thickness of lining is attained. The amount of anode material **56** initially contained in the structure as it is assembled is apportioned so that with a particular electrolyte used there will be available sufficient solid material to provide for the requisite thickness of lining desired. After the pipe has thus been lined, it is demounted from the apparatus and a new section of pipe inserted in place thereof and the operation continued with a replenished charge of nickel particles in the anode structure should this be necessary under the current conditions.

In those cases where it is desired to roll the anode construction independently of whatever rolling effect may be imposed thereon by the rotating pipe, the anode pulley **60** may be connected to a source of power as hereinbefore suggested and the anode structure rotated by power independent of the pipe. Also in those cases where a more uniform plating effect is obtained by shifting the anode structure, and this becomes desirable particularly where the pipe is materially longer than the length of the anode construction, the anode may be given a longitudinal as well as a rotating movement by the simultaneous actuation of the rocker **65** with the rotation of the pipe.

Referring to the modified form of the invention shown in Figs. 3 and 4, it is therein suggested that the pipe P be supported interiorly on a cylindrical form of anode structure **66** somewhat resembling the corresponding structure shown in Fig. 2 in its inclusion of perforated shell **67** and closures **68** of insulating material and metallic tie rod **69**. In place of the loose nickel particles **56** there is positioned within the shell **67** and between its end closures a plurality, in this case shown to be four nickel anode bars **70**. The anode structure as a whole is supported by anode shafts at opposite ends thereof and one of which is shown at **71**. The anode construction is rotated about its own axis by means of a driving pulley **72** mounted on at least one of the shafts. The level of the electrolyte **17** is maintained sufficiently high in the pipe P to maintain at least two of the anode bars **70** submerged in all rotative positions of the anode construction.

In operation, it will be understood that the device in the Figs. 3–4 modified forms acts substantially as has been described for the preferred form, except that the pipe P is rotated by virtue of its frictional engagement with the rotating cylindrical anode construction on which the pipe rests. However, it is to be understood that this arrangement does not prohibit the use of the pipe supported cradle provided by the four rollers disclosed in the Fig. 1 form. In this case current is supplied to the shaft **71** as has been described in connection with shaft **58**.

Referring to the modified structure shown in Fig. 5, pipe P is supported on rollers **74** and **75** as in the Fig. 1 form, and anode structure **76** likewise rolls on the bottom of the pipe under treatment. In this case the structure is formed of an outer nickel anode shell **77** provided at one end with a closure head **78** in the center of which projects a nipple **79** designated to receive an end of the exposed conductors of the anode cable **29** as disclosed in Fig. 2. In place of the insulating shell shown in Fig. 2, the anode structure **76** is encircled adjacent opposite ends by a pair of solid spacing rings **80** and of insulating material which likewise roll on the inner surface of the pipe. It is the intent here as in the Fig. 2 disclosure to bring the anode structure close to the surface being coated and thus permit the use of a current density greater than would be possible where the anode is spaced a greater distance from the surface being plated than in the case here illustrated. Fitted within the nickel shell **77** is a rugged copper liner **82** designed to give structural strength to the thinner nickel shell anode.

In operation the structure shown in the Fig. 5 form operates substantially as has been described for the Figs. 1 and 2 showings in that the rotating pipe rotates the anode structure while this anode structure is held gravitationally in the lower portion of the pipe under treatment and in close relation to the part for the time being receiving the deposit. It is particularly suggested in connection with this showing that it is advisable to shift the anode structure longitudinally during the plating operation to avoid the formation of tracks or areas of less deposition which may be imposed by the rollers **80—81** if they were confined to fixed transverse planes of engagement with the pipe.

It is understood, of course, that the anode bars **70** and the shell-like anodes **77** eventually become dissolved in the electrolyte and it will be necessary to replenish these parts from time to time.

By means of the apparatus herein disclosed pipes are lined with a dense and compact layer of electrolytically deposited metal in the form of a one-piece seamless shell, uniform in thickness at all portions of the pipe and otherwise there are retained the advantages in this art where anodes are maintained at a fixed distance and at the same time a very close relation to the surface on which the depositions are being laid is effected.

It is understood, of course, that any of the features of one figure of the drawings is interchangeable with the corresponding features of every other figure with whatever mechanical changes may be necessary, for instance, the anode construction of Fig. 5 may be substituted for the anode constructions of Figs. 3 and 4 or the anode bars **70** with their end closures **68** of Figs. 3 and 4 may be substituted for the anode shell **77—82** with its end closures **78** in the Fig. 5 disclosure.

While the use of nickel has been noted herein as a specific example of a suitable anode material for use in lining pipes, the disclosure is not so limited and any other suitable insoluble metal such as the platinum metals or platinum alloys may be substituted for the nickel. Obviously, the metal of the solid anode in any case may be the same metal as is dissolved in the electrolyte, for example, both the anode and the electrolyte may contain copper. It is also appreciated that with,

say, a platinum metal anode, the pipe may be plated with copper, cadmium, silver, palladium, zinc, or other suitable metal, and that the electrolyte solution may be replenished at its source following known practices in this respect.

I claim:

1. Apparatus for lining the bore of a pipe by electrolytic deposition, including a set of rollers coacting to form a cradle on which the pipe is mounted for rotary movement about a horizontal axis, power means operatively connected to at least one of the rollers to turn the same and therethrough to rotate the pipe, an anode structure of cylindrical form, having a diameter materially less than the internal diameter of the pipe, located entirely within the pipe and free to rotate about an axis parallel to the axis of rotation of the pipe, said anode structure including means forming an anode and at least one roller of insulating material secured to the anode to turn therewith in rolling engagement with the pipe and insulating the anode therefrom, said anode structure and pipe supporting one from the other and otherwise independent of each other and thus capable of relative movement both rotatively and axially, closure means for closing opposite ends of the pipe to contain within the pipe all of the plating electrolyte, said closure means provided with conduits for introducing the electrolyte into and for discharging the electrolyte from the interior of the otherwise closed pipe, means for temporarily securing said closure means to opposite ends of the pipe, a cable intruded through one of the closure means at the axis of rotation of the pipe for supplying electric current to the anode of the anode structure, the portion of the cable within the pipe being sufficiently flexible to permit its inner end to follow the adjacent end of the anode structure in all positions of the same relative to the pipe as the anode structure rolls on the pipe and means for connecting the exterior of the pipe and the cable to a source of electric energy.

2. In a device for electroplating the bores of pipes or the like, the combination of means for temporarily closing the ends of the pipes to be plated to confine the active electrolyte therein, means for mounting the pipe for rotary movement about its axis and with its axis horizontally disposed, means for passing a stream of electrolyte through the closed pipe while being rotated to maintain a pool therein of less volumetric capacity than that of the closed pipe thereby to maintain in the upper portion of the pipe a gas receiving space, an anode structure including an anode and spacing means therefor of cylindrical form located to roll on and thus be supported by and intergeared with whatever for the time being may be the portion of the bore of the pipe engaging the same and rotated thereby about its own axis, said spacing means being of insulating material, secured to the anode to turn therewith and acting to space the anode from the pipe in all rotative positions of the pipe and anode, and means introduced into the pipe at one end thereof for supplying electric current to said anode in all of its rotative positions.

3. In a device for electroplating the bores of pipes or the like, the combination of a pipe constituting the cathode element of an electrolytic cell and mounted for rotary movement about its own axis when horizontally disposed, temporary closures of insulating material at opposite ends of the pipe and coacting therewith to form a container for all of the electrolyte present, said container having its outer cylindrical surface exposed to the air and adapted to have a current supplying brush contact the same, an anode construction of hollow form contained in the pipe, of less diameter than the internal diameter of the pipe, in interdriving relation therewith, emersed in the electrolyte with its axis of rotation offset from the axis of rotation of the pipe to locate one side of the anode construction nearer one side than the opposite side of the pipe, a flexible anode cable passed through one of the closures to supply the anode construction with electric energy, a perforated cylindrical shell of insulating material defining the cylindrical surface of the anode construction and means operatively connecting the anode construction to the pipe to constantly change the surface of the anode construction which is nearest the pipe.

4. Apparatus for lining the bore of a pipe by electrolytic deposition, including cradle-forming mounting means adapted to receive thereon electrolytic cells of different sizes without necessity for adjusting the mounting means to accommodate the different sizes of cells, of a preformed electrolytic cell mounted on the cradle for rotary movement about a horizontal axis, said cell including the pipe to be plated functioning as its cathode element, closure means temporarily secured to the open ends of the pipe to close the same and to form a container for the plating electrolyte, an anode construction within the cathode element and including an anode element and at least one roller of insulating material secured to the anode element to turn therewith, said roller having a diameter materially less than the internal diameter of the pipe, bearing on and in frictional rolling engagement with whatever for the time being is the lower portion of the pipe and at all times insulating the anode element therefrom, means for supplying electric energy to the anode and cathode elements, and power means engaging the exposed outer surface of the cathode element to rotate the same, and in its rolling engagement with the roller to cause it to drive the anode construction in epicyclic relation with the pipe.

5. The apparatus described in claim 4 in which the anode structure is also free to move axially in the pipe while rotating, and power driven means having both rotary and axial movements passing through one of the closure means and engaging the anode construction to both rotate and axially shift the same relative to the pipe.

6. In a device for electroplating the interior of pipes, the combination of a fixed support including a cradle, a prefabricated electrolytic cell mounted on the cradle for rotary movement about a horizontal axis, said cell including a pipe to be plated and forming the cathode element of the cell, said pipe being open at opposite ends, heads demountably fitted to the open ends of the pipe to close the same and coacting therewith to form a closed cell containing the electrolyte, at least one of the heads including two parts in sidewise abutting relation, one of the parts being fixed relative to the support and thus not rotatable, and the other part being journaled in the fixed part for rotary movement about the axis of the pipe, means for temporarily securing said rotating part to the pipe to be supported thereby and to turn therewith, said head provided with a conduit offset from the axis of the pipe contained partly in the rotating part fixed to the pipe and partly in the fixed part and at all times in fluid communication with the interior of the

pipe, an anode construction including the anode element of the cell located within the pipe and rotatable about its own axis with the axes of pipe and said anode construction eccentrically related, and power driven means for rotating both the pipe and the anode construction.

7. In an electrolytic cell for electroplating the bores of pipes when rotating about their own axes and horizontally disposed, the combination of a pipe to be plated forming the cathode element of the cell, a hollow anode construction of squirrel-cage type located in the bore of the pipe, of materially less external diameter than the internal diameter of the pipe and rotatable about an axis offset from the axis of rotation of the pipe, means for mounting the pipe with its axis of rotation fixed in space said anode construction including end members of insulating material for insulating the anode construction from the pipe, a plurality of anode rods having their ends carried by the end members and the balance of the rods being exposed to the pipe and to the electrolyte of the cell, and means for rotating the cathode element and the anode element, said means including a drive shaft directly engaging one of the end members in axial prolongation of the same to turn the squirrel cage anode construction about its own axis.

8. In an electrolytic cell for electroplating the bores of pipes when rotating about their own axes and horizontally disposed, the combination of a pipe to be plated forming the cathode element of the cell, a hollow anode construction of squirrel-cage type located in the bore of the pipe, of materially less external diameter than the internal diameter of the pipe and rotatable about an axis offset from the axis of rotation of the pipe, means for mounting the pipe with its axis of rotation fixed in space, said anode construction including end members of insulating material for insulating the anode construction from the pipe, a plurality of anode rods having their ends carried by the end members and the balance of the rods being exposed to the pipe and to the electrolyte of the cell, and means for rotating the cathode element and the anode element.

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