United States Patent

Buckley

[15] **3,664,944**

[45] **May 23, 1972**

[54] ELECTROPLATING APPARATUS

[72] Inventor: **Edward Z. Buckley,** Birmingham, Mich.

[73] Assignee: **Udylite Corporation,** Warren, Mich.

[22] Filed: **Oct. 29, 1969**

[21] Appl. No.: **872,045**

[52] **U.S. Cl.** .....**204/212,** 204/286, 204/297 R

[51] **Int. Cl.** **C23b 5/68**

[58] **Field of Search**.....204/212, 215, 216, 217, 218, 204/222, 6, 17, 286, 297 R

[56] **References Cited**

UNITED STATES PATENTS

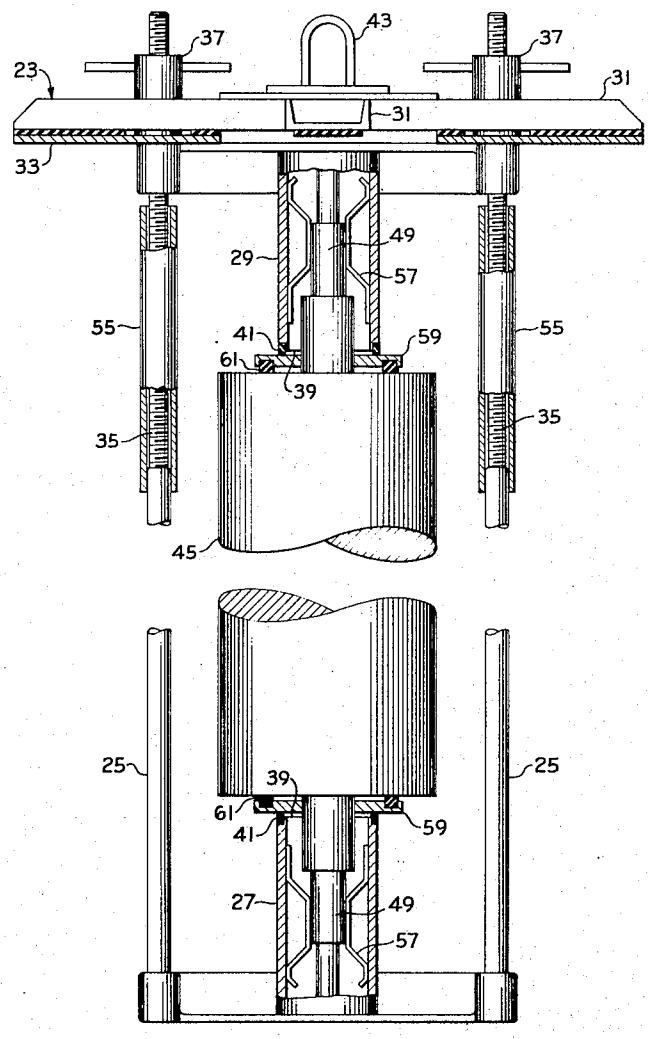
193,204	7/1877	Wilde	204/212
637,581	11/1899	Hett	204/212
1,233,906	7/1917	Perreur-Lloyd	204/212
2,137,806	11/1938	Paige	204/212

Primary Examiner—Howard S. Williams
Assistant Examiner—W. I. Solomon
Attorney—Stanley H. Lieberstein and William J. Schramm

[57] **ABSTRACT**

An apparatus for use in electroplating cylindrically shaped objects which comprises a reservoir for an electroplating solution, said reservoir having a bottom, side walls and a substantially open upper end opposite the bottom. A support member is provided which is adapted to hold a cylindrically shaped object to be electroplated within the reservoir in a substantially vertical position below the level of the electroplating solution in the reservoir. The support member has means by which it is removably supported by the reservoir at the upper end thereof and is electrically insulated therefrom. Means are provided for effecting rotation of the support member and the object to be electroplated within the reservoir around the vertical axis of the reservoir, the rotation effecting means being electrically insulated from the support member. The support member has oppositely disposed, adjustable engaging members which are adapted to engage the cylindrically shaped object to be electroplated and hold it in a substantially vertical position within the reservoir. The engaging members are in electrical contact with the object to be plated and are electrically connected to that portion of the support member which is supported by the reservoir. There are means for providing electrical insulation between the electrical plating solution in the reservoir and the outer surfaces of the support member in contact therewith and means for preventing plating of that portion of the object to be plated at and contiguous to the point of electrical contact with the engaging members. Anode means are disposed within the reservoir, at least partially below the level of the electroplating solution and positioned between the reservoir side walls and the cylindrically shaped object to be electroplated which is held in the support member.

10 Claims, 4 Drawing Figures



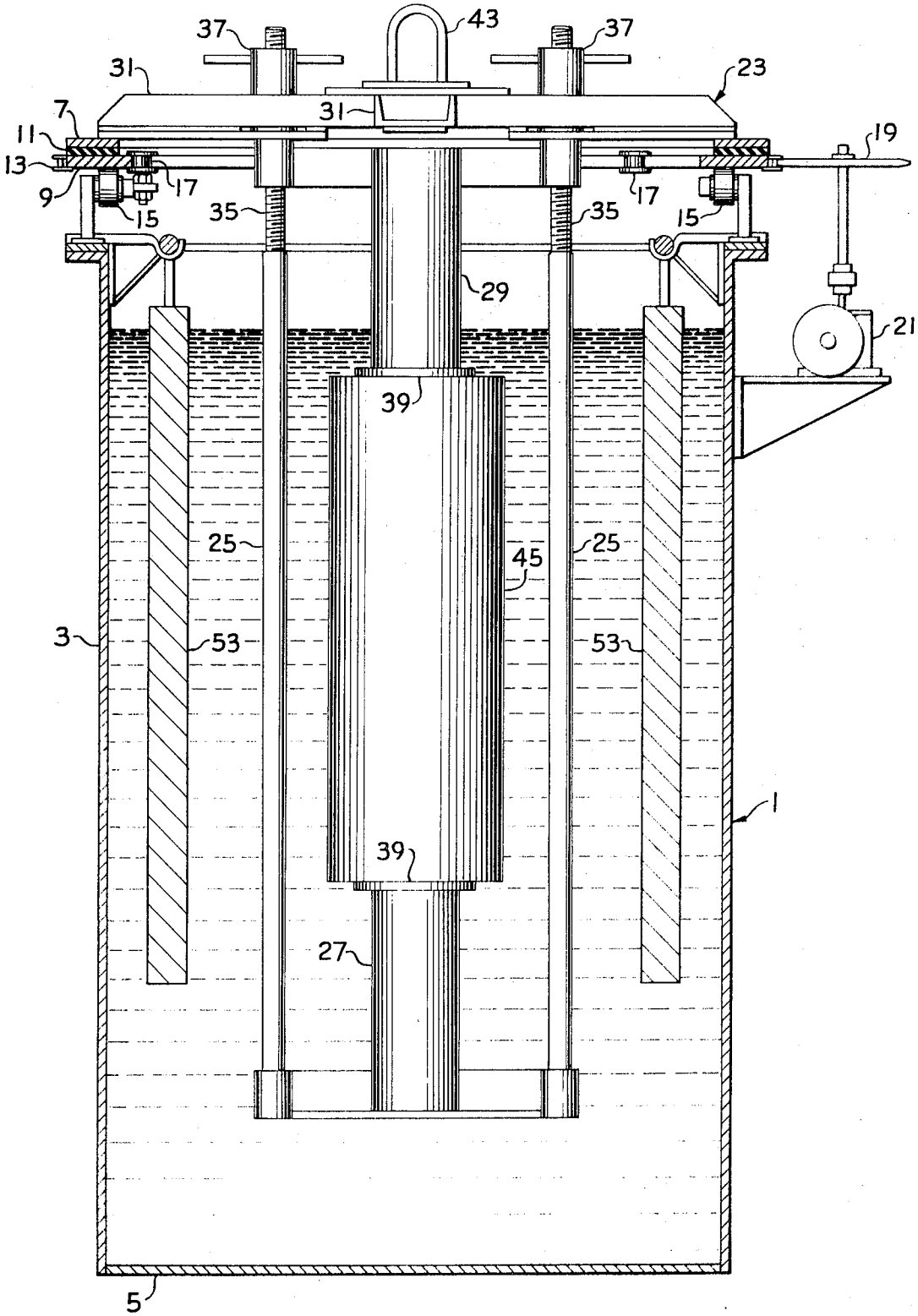

37
43
37
31
23
31
7
11
13
9
17
15
35
35
17
15
19
29
21
39
25
45
25
3
53
53
1
39
27
5

Fig. 1

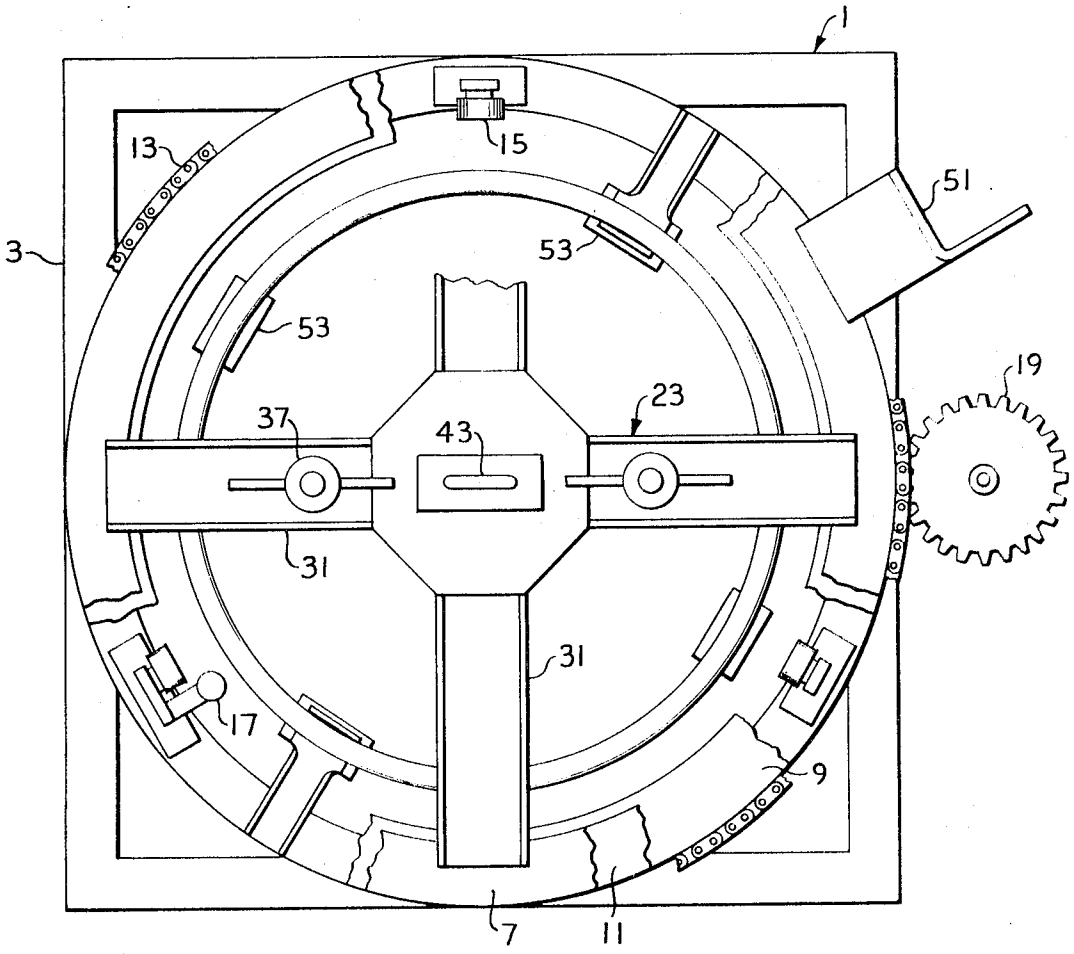


Fig. 2

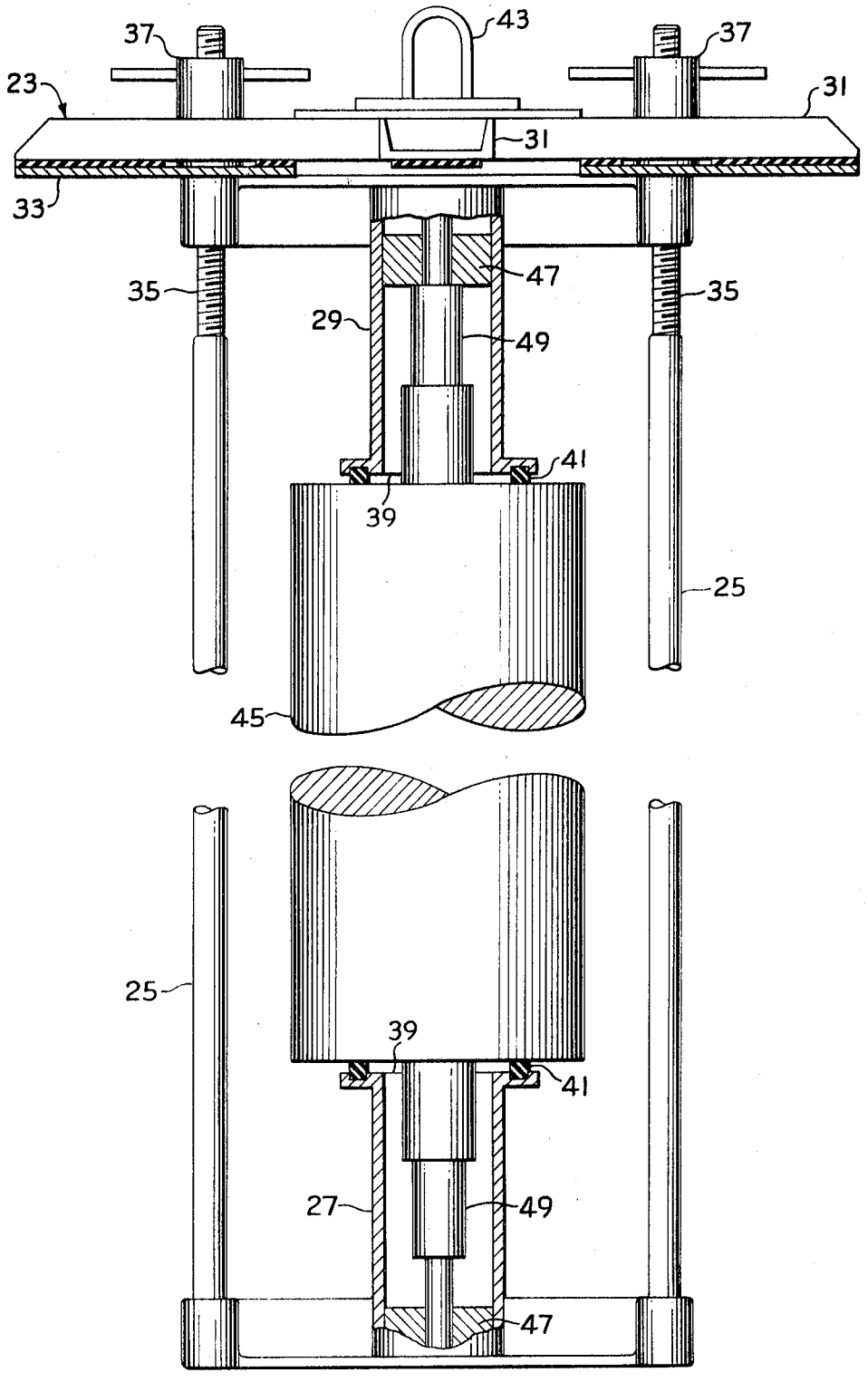


Fig. 3

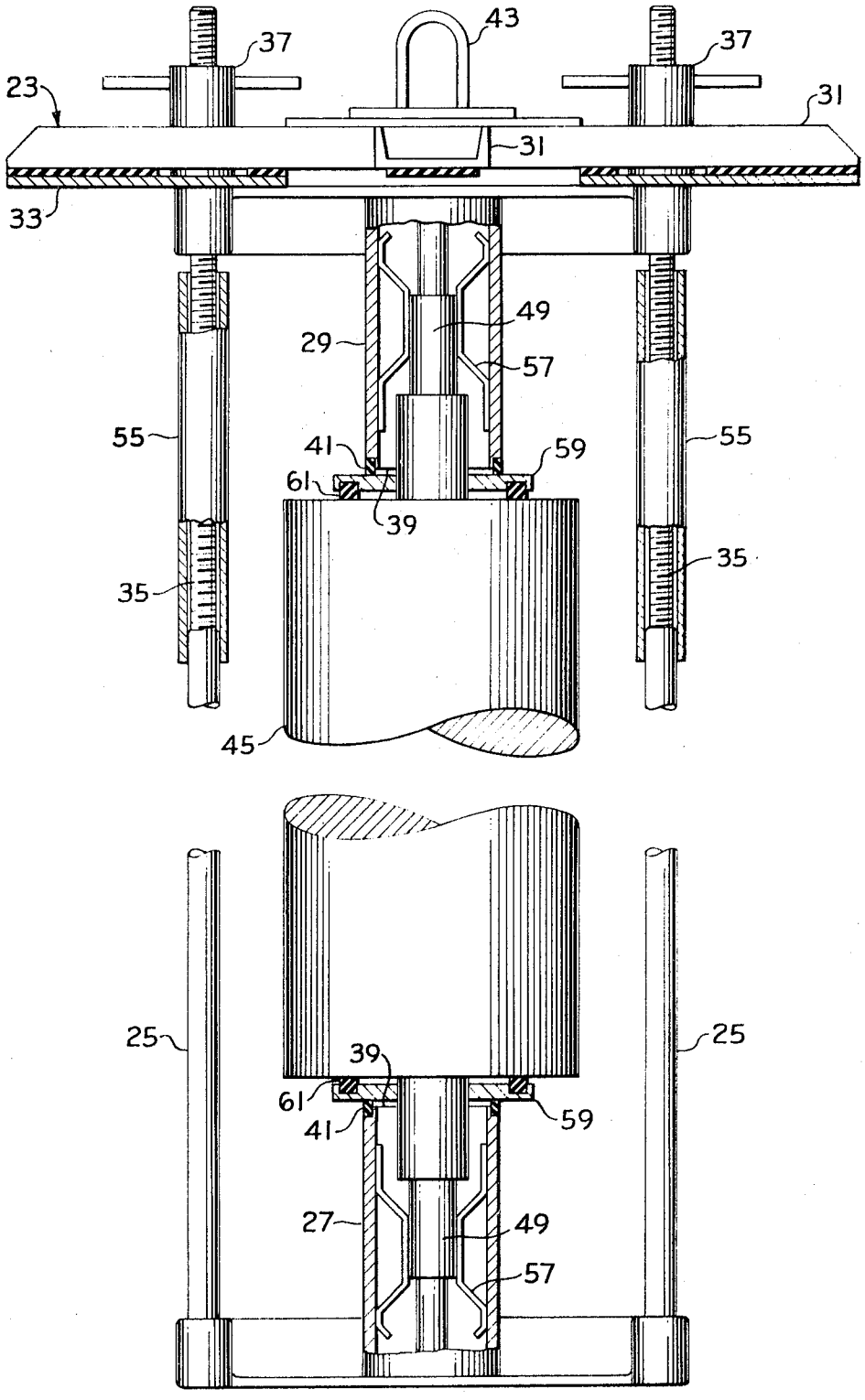

43
37
37
23
31
31
33
49
29
57
55
55
41
59
61
39
35
35
45
25
25
39
61
59
41
27
49
57

Fig. 4

ELECTROPLATING APPARATUS

The present invention is directed to an improved apparatus for use in electroplating processes and more particularly relates to an improved apparatus for use in electroplating cylindrically shaped objects.

Heretofore, the electroplating of elongated, cylindrically shaped objects, and particularly the copper electroplating of Gravure cylinders, has been carried out with the cylinder in a substantially horizontal position during the plating process. This involves some difficulties, particularly those which result from the equipment and processing complexities which are required to carry out the plating in this manner. Thus, for example, since it is desirable to rotate the cylinder during plating in order to obtain a smooth even plate and the mechanism for effecting the rotation should not be in contact with the plating solution, when the cylinder is plated in a horizontal position, either the cylinder cannot be completely immersed in the plating solution or seals must be provided in the walls of the plating tank where the rotating means pass through, into the tank. Additionally, even where the cylinder to be plated is completely immersed in the plating solution, because of the necessity for permitting access to the tank for the placing of the cylinder in the horizontal position for plating, anodes cannot be placed in this access opening at the top of the tank. This results in a decrease in the anode area around the cylinders to be plated, thus reducing the plating efficiency. Moreover, because of the difficulties of loading the cylinders to be plated in the horizontal tank, coupled with the necessity for having a large number of holders and adapters for the cylinders so as to accomodate varying cylinder sizes, these processes are not readily adapted to automatic plating operations.

It is, therefore, an object of the present invention to provide an improved apparatus for use in the plating of cylindrically shaped objects.

A further object of the present invention is to provide an improved apparatus for use in plating cylindrically shaped objects, which apparatus overcomes the difficulties encountered in the prior apparatus and is readily adapted for use in automatic plating systems.

These and other objects will become apparent to those skilled in the art from the description of the invention which follows.

In the drawings which are attached hereto and form a part hereof,

FIG. 1 is a vertical sectional view of the improved apparatus of the present invention,

FIG. 2 is a top view of the apparatus shown in FIG. 1;

FIG. 3 is a vertical sectional view of the improved support member for holding the objects to be plated which is a part of the apparatus of this invention; and

FIG. 4 is a sectional view of a modified support member.

Pursuant to the above objects, the present invention includes an apparatus for use in electroplating cylindrically shaped objects which comprises a reservoir for an electroplating solution, said reservoir having a bottom, sidewalls and a substantially open upper end opposite the bottom, a support member adapted to hold a cylindrically shaped object to be electroplated within the reservoir in a substantially vertical position below the level of the electroplating solution in the reservoir, said support member having means by which it is removably supported by the reservoir at the upper end thereof and electrically insulated therefrom, means for effecting rotation of the support member and the object to be electroplated within the reservoir around the vertical axis thereof, said rotation effecting means being electrically insulated from said support member, said support member further having oppositely disposed, adjustable engaging members adapted to engage the cylindrically shaped object to be electroplated and hold it in a substantially vertical position, said engaging members being in electrical contact with the object to be plated and electrically connected to that portion of the support member which is supported on the reservoir, means for providing electrical insulation between the electroplating solution in the reservoir and the outer surfaces of the support member in contact therewith, means for preventing plating of that portion of the object to be plated at and contiguous to the point of electrical contact with the engaging means, and anode means disposed within the reservoir, at least partially below the level of the electroplating solution therein and positioned between the reservoir sidewalls and the cylindrical shaped object to be electroplated which is held in the support member.

More specifically, the apparatus of the present invention, for use in electroplating cylindrically shaped objects, comprises a reservoir for an electroplating solution, said reservoir having a bottom, side walls and a substantially open upper end opposite the bottom, an electrically conductive member disposed at the open upper end of the reservoir, above the level of the electroplating solution therein and being adapted for rotational movement around the vertical axis of the reservoir, means for effecting the rotational movement of said member, the rotation effecting means being electrically insulated from the electrically conductive member, a support member adapted to hold a cylindrically shaped object to be electroplated within the reservoir in a substantially vertical position below the level of the electroplating solution in the reservoir, said support member having means by which it is removably supported by and in electrical contact with the electrically conductive member on the reservoir so as to be rotated with said electrically conductive member, said support member further having oppositely disposed, adjustable engaging members adapted to engage the cylindrically shaped object to be electroplated and hold it in a substantially vertical position, said engaging members being in electrical contact with said object and electrically connected to the means by which the support member is supported by the electrically conducted member on the reservoir, means for providing electrical insulation between the electroplating solution in the reservoir and the outer surfaces of the support member in contact therewith, means for preventing plating of the object to be plated at and contiguous to the point of electrical contact with the engaging members, and anode means disposed within the reservoir, at least partially below the level of the electroplating solution therein and positioned between the reservoir side walls and the cylindrically shaped object to be electroplated which is held in the support member.

Referring now to the drawings, as is shown in FIG. 1 and FIG. 2, the apparatus of the present invention includes a reservoir indicated generally as 1, which reservoir has side walls 3 and a bottom 5, the upper end of the reservoir opposite the bottom 5, being substantially open. An electrically conductive ring 7 is disposed at the upper end of the reservoir, above the level of the electroplating solution in the reservoir. The conductive ring 7 is supported on a ring gear 9, having gear teeth 13 around its outer circumference. The ring gear 9 is rotatably supported at the upper open end of said reservoir by means of a plurality of roller elements 15 and 17. The conducting ring 7 is electrically insulated from the ring gear 9 by means of the insulating material 11, disposed between the conducting ring and the ring gear. Rotation of the ring gear 9 around the top of the reservoir 1, and hence rotation of the conducting ring 7 supported by the ring gear, is effected by means of a suitable gear member 19, driven by a suitable motor 21. Desirably, as is shown in FIG. 1, the motor 21 is mounted on the side wall 3 of the reservoir although it may be in any other suitable location.

As is shown in FIG. 3, the present apparatus also includes a support member or frame 23, adapted to hold a cylindrically shaped object which is to be electroplated. The support member or frame includes a pair of vertical support members 25 mounted on a lower engaging member 27 and extending upwardly therefrom. At the upper end of the vertical support members 25 there is mounted an upper engaging member 29, which includes a pair of cross-members 31 which are formed with an electrically conductive material 33, such as copper, on the lower surfaces thereof. The upper portion of the vertical support members 25 are provided with screw threads 35

which, with the fastener members **37** make it possible to change the distance between the upper and lower engaging members **27** and **29**, thus accommodating cylinders of different lengths.

The lower and upper engaging members **27** and **29** are each provided with oppositely disposed cylinder engaging surfaces **39**, which surfaces are of an electrically conductive material. Additionally, the electrically conductive material **33** on the lower surfaces of the cross arm members **31** is in electrical contact with the screw thread portion **35** of the vertical members **25**. There is, thus, formed an electrically conductive circuit from the electrically conductive material **33** through vertical support members **25** to the electrically conductive cylinder engaging surfaces **29** on the lower and upper engaging members **27** and **29**. Additionally, the cylinder engaging surfaces **39** are each provided with a deformable sealing ring **41**, which sealing ring acts to prevent any of the electroplating solution from coming into contact with the surfaces **39** and the ends of the cylinder to be plated when the cylinder is secured between the lower and upper engaging members, thus preventing plating of the cylinder ends at the point of electrical contact with the cylinder engaging surfaces.

Additionally, the surfaces of the support member **23** which come in contact with the electroplating solution in the reservoir, i.e., all of the surfaces of this member in the electroplating solution except the surfaces **29** which are within the sealing ring, are coated with an electrically insulating material. Various suitable insulation paints or similar coatings, e.g., plastisols and the like, as are known for this purpose, may be used.

The support member or frame **23** is also provided with a suitable lifting member **43**, secured to one of the cross arm members **31**, so as to permit lifting and transporting of the support member. This lifting member may be of any suitable type, depending upon the type of the lifting and conveying mechanism with which it is to be used.

With reference now again to FIGS. **1** and **2**, the support member or frame **23** rests on the conductive ring **7** which is supported at the upper open end of the reservoir **1**. The support member **23** is positioned on the conducting ring **7** so that the electrically conductive surface **33** of the cross arm members **31** is in electrical contact with the conducting ring **7**. Generally, it has been found that the weight of the support frame **23**, with the cylinder to be plated, is sufficient to effect the desired electrical contact between the electrically conductive surfaces **33** of the cross arm members **31** and the conducting ring **7**, without the need for clamps or similar positive securing means. If desired, such securing means may be used, although their use could make it difficult to utilize the present apparatus in a fully automated system, unless such securing means were automatically, rather than manually, actuated.

A cylindrically shaped article to be plated, **45**, such as a Gravure cylinder, is mounted in the support frame **23** in electrical contact with the cylinder engaging surfaces **39** of the lower and upper engaging members **27** and **29**. When thus secured, the cylinder **45** is supported in a substantially vertical position within the reservoir **1**, below the level of the electroplating solution contained therein. The support frame **23** is provided with centering collar members **47** which are disposed within the lower and upper engaging members **25** and **27**, which centering collars have an internal diameter which will permit the supporting shafts **49**,at each end of the cylinder **45**, to be inserted into them.

Thus, in mounting the cylinder to be plated in the support frame **23**, the upper engaging member **29** is removed from the vertical support members **25** and a centering collar **47**, having the proper internal diameter, is inserted in the lower engaging member **27**. A cylinder **45** to be plated is then inserted into the lower engaging member **27** with the shaft **49** at one end of the cylinder inside the centering collar **47** in the lower engaging member and the end of the cylinder resting on the sealing ring **41** on the cylinder engaging surface **39**. A second centering collar **47** is placed over the cylinder shaft **49** at the upper end of the cylinder and the upper engaging member **29** is then placed over the shaft and collar so that the sealing ring **41** on the cylinder engaging surface **39** of the engaging member **29** rests on the upper end of the cylinder **45** which is to be plated. When the upper engaging member is then tightened by means of the fastener members **37**, the sealing rings **41** are both deformed to the extent that the electrically conductive portions of the cylinder engaging surfaces **39** on both of the members **27** and **29** are brought into electrical contact with the ends of the cylinder **45**. The cylinder is thus supported in a substantially vertical position in the support frame **23**, which frame is then inserted into the reservoir **1** and supported on the electrically conducting ring **7** so as to provide electrical contact between this ring and the electrically conducting surface **33** on the cross arm members **31** of the support frame.

The reservoir **1** is also provided with a suitable bus or electrical brush member **51** which is in electrical contact with the conducting ring **7**. This bus member is connected to a suitable source of electrical power (not shown). Additionally, anode members **53** are disposed within the reservoir, between the side walls **3** and the cylinder **45** which is to be plated. These anode members are provided with an electrical connection which is external of the reservoir, so that they may be connected into the electrical circuit. Desirably, there are a plurality of anodes which are spaced apart equidistant around the cylinder to be plated. It is generally preferred that these anodes are disposed so as to be partially above the level of the electroplating solution, so that the fastening member or hanger is not in the plating solution. In this manner corrosion at the point of contact between the anode and the hanger is minimized. It is to be appreciated that various types of anodes may be used, including solid anodes, anode bags or baskets and the like and that these will be copper where the cylinder is to be copper plated.

Additionally, as has been previously noted, the surfaces of the support member or frame **23** which are in contact with the electrolyte solution in the reservoir are coated with an electrically insulating material, so that there is no electroplating of these surfaces.

Thus, with the cylinder to be plated secured in the support frame **23** and the entire frame assembly inserted into the reservoir in the manner which has been described, the electroplating of the cylinder in the reservoir is effected by the passage of current from the bus member **51** to the conducting ring **7**, from the conducting ring to the electrically conductive surface **33** of the cross arm members **31**, from the surface **33** through the vertical support members **25** to the electrically conductive cylinder engaging surfaces **39** on both the lower and upper engaging members **27** and **29**. From here, the current flows through the cylinder **45** to be plated, which is the cathode, through the electroplating solution to the anodes **53**, which anodes are of the metal which it is desired to plate on the cylinder **45**, such as copper. As the electroplating of the cylinder is being effected, the entire support member or frame **23** is being rotated, thereby obtaining improved quality in the electroplate produced while reducing the plating time.

Referring now to FIG. **4**, this shows an alternative configuration for the support member or frame **23**, which configuration has in many instances been found to be preferred. In this configuration, the support member **23** is made up of the vertical support members **25** and the upper and lower engaging members **29** and **27**, mounted thereon. The screw threads **35** on the vertical support members **25** extend downwardly from the cross members **31** a greater distance than in the configuration shown in FIG. **3**, so that when the entire assembly is placed within the reservoir **1**, the level of the electrolyte is above part of the screw threads. This then makes it possible to obtain more adjustment of the frame to accomodate a greater variety of cyliner lengths. Since the screw threads are electrically conductive and would thus be plated during operation, they are provided with a moveable sleeve **55** of an electrically non-conductive material. This sleeve may be moved up or down the members **25** to cover that portion of the screw

threads 35 which is in the electroplating solution, thus providing electrical insulation.

The upper and lower engaging members 29 and 27 are each provided with spring members 57, disposed within the engaging members. These spring members provide the electrical contact with the cylindrical object to be plated and further serve to center and hold the object within the engaging members. Thus, these spring members take the place of the centering collars 47 used in the embodiment shown in FIG. 3. Various types of spring members may be used which will permit the insertion of different sizes shafts 49 of the cylinder 45 so as to hold the shaft and provide electrical contact with it. With this arrangement, the need for a plurality of centering collars to accomodate a variety of shaft sizes is eliminated, thus simplifying the apparatus and making it more versatile.

As in the embodiment shown in FIG. 3, the engaging surfaces 39 are provided with a sealing ring 41. In the present embodiment, however, the surfaces 39 need not be electrically conductive, as they do not provide the point of electrical contact with the cylindrical object to be plated. Additionally, there are provided adjusting rings 59, which rings each have a sealing ring 61. These adjusting rings 59 are positioned between the ends of the cylinder 45 and the engaging surfaces 39 of the upper and lower engaging members 29 and 27. The adjusting rings may be formed of an electrically non-conductive material or they may be metal coated with a plastisol or similar electrically non-conductive coating or paint. The size of these adjusting rings should be such that the shaft 49 of the cylinder 45 can pass through them and so the sealing rings 41 will contact them on one side and the sealing rings 61 will contact the ends of the cylinder 45.

In this manner, when the cylinder is mounted in the frame 23 and the fastener members 37 are tightened, both sets of sealing rings are deformed and an excellent liquid tight seal is formed which prevents any of the electroplating solution from coming into contact with the end of the cylinder within the ring 61 or with the cylinder shafts 49. Plating of the cylinder shafts and ends at and contiguous to the point of electrical contact is, thus, prevented. Moreover, variations in cylinder sizes may be compensated for merely by changing the adjusting rings 61. In this manner even cylinders having very small diameters may be plated in this apparatus without the need for using a frame member having smaller diameter upper and lower engaging members.

By means of the apparatus of the present invention, it is possible to form an electroplate, such as a copper electroplate, on a cylinder while it is completely submerged in a vertical position. By means of this assembly, the electrical current is conducted to both ends of the cylinder being plated, thereby providing a more even plate on the cylinder. Moreover, there is a great flexibility of operation possible with this assembly in that a wide range of different lengths of cylinders can be handled in the same apparatus with the only change necessary being the selection of suitably sized centering collars for the cylinder shaft as with the embodiment of FIG. 3 or of suitably sized adjusting rings, as with the embodiment of FIG. 4. Additionally, since the cylinder shafts are completely enclosed and do not come in contact with the electroplating solution, the electroplating is carried out only on the areas where it is desired and this is achieved without the need for using stop-off lacquers. It is further seen that with this assembly, anodes may be placed within the reservoir so as to completely surround the cylinder to be plated thereby giving increased anode area with the resulting increase in efficiency. The assembly further makes it possible to completely automate the entire processing system once the cylinder to be plated has been placed in the support frame, which is then transported or conveyed to the various treating stations without the need for manual handling.

It is to be appreciated that in the particularly preferred embodiments of the apparatus of the present invention which have been described, alterations and modifications are possible and equivalent structures which function in the same or equivalent manner may be substituted for those which have been specifically described. In this regard, for example, if desired, the electrical bus connection may be made directly to the support member or frame 23 rather than through the conducting ring 7 as is shown in the drawing. Moreover, a friction drive, rather than a direct gear drive may be provided to rotate the support frame, and the reservoir may be of various cross sections, including square, rectangular, circular, hexagonal or even triangular, and the like. Additionally, both fewer and more cross arm supporting members 31 may be provided for the frame member, although for reasons of stability, it is often preferred to have at least four arms, as shown. It is believed that similar modifications and substitution of equivalent elements may be made by those in the art to accomplish the same results as those achieved by the preferred embodiments of the present apparatus without departing from the spirit and scope of the present invention.

What is claimed is:

1. An apparatus for use in electroplating cylindrically shaped objects which comprises a reservoir for an electroplating solution, said reservoir having a bottom, side walls and a substantially open upper end opposite said bottom, a transportable support member adapted to hold a cylindrically shaped object to be electroplated within the reservoir in a substantially vertical electroplating position below the level of the electroplating solution in the reservoir, a supporting frame rotatably and permanently mounted in encircling relationship around said open upper end of said reservoir for rotation about a substantially vertical axis and formed with an opening through which said support member is adapted to extend into said reservoir, electrified supporting means secured on said frame for supporting and electrifying said support member, coacting drive means for effecting rotation of said frame about a substantially vertical axis, said support member further having oppositely disposed adjustable engaging members adapted to engage the cylindrically shaped object to be electroplated and hold it in a substantially vertical position, said engaging members being in electrical contact with said object and electrically connected to that portion of the support member which is supported by said electrified supporting means, means for providing electrical insulation between the electroplating solution in the reservoir and the other surfaces of the support member in contact therewith, means on said support member for preventing plating of that portion of the object to be plated and contiguous to the point of electrical contact with the engaging members and anode means disposed within the reservoir, at least partially below the level of the electroplating solution therein and positioned between the reservoir side walls and the cylindrically shaped object to be electroplated which is held in supporting member.

2. An apparatus for use in electroplating cylindrically shaped objects which comprises a reservoir for an electroplating solution, said reservoir having a bottom, side walls and a substantially open upper end opposite said bottom, an electrically conductive member permanently mounted at the open upper end of said reservoir above the electroplating solution therein, said member being adapted for rotational movement around the vertical axis of the reservoir, means for effecting the rotational movement of said member, said rotation effecting means being electrically insulated from said electrically conductive member, a transportable support member adapted to hold a cylindrically shaped object to be electroplated within the reservoir in a substantially vertical electroplating position below the level of the electroplating solution in the reservoir, said support member having means by which it is removably supported by and in electrical contact with the electrically conductive member on the reservoir so as to be rotated with said electrically conductive member, said support member further having oppositely disposed, adjustable engaging members adapted to engage the end portions of a cylindrically shaped object to be electroplated and hold it in a substantially vertical position, said engaging members being in contact with the said object to be plated and electrically connected to the

means by which the support member is supported by the electrically conductive member on the reservoir, means for providing electrical insulation between the electroplating solution in the reservoir and the outer surfaces of the support member in contact therewith, means for preventing plating on that portion of the cylindrically shaped object at and contiguous to the point of electrical contact with the engaging means and anode means disposed within the reservoir at least partially below the level of the electroplating solution therein, and positioned between the reservoir sidewalls and the cylindrically shaped object to be electroplated which is held in the support member.

3. The apparatus as claimed in claim 2 wherein the means for effecting the rotational movement includes a ring gear, movably and permanently supported at the upper end of the reservoir, motor means for driving the ring gear, and wherein said electrically conductive member comprises an electrified ring secured to said ring gear and electrically insulated therefrom, and wherein the support member which holds the cylindrically shaped object to be plated is supported by said electrified ring and in electrical contact therewith.

4. The apparatus as claimed in claim 3 wherein the oppositely disposed engaging members on the support member each have a deformable sealing ring mounted thereon on the surface which engages the cylindrical member to be electroplated, which sealing ring prevents plating of the cylinder at and contiguous to the point of electrical contact with the engaging members.

5. The apparatus as claimed in claim 4 wherein the surfaces of the support member which are in contact with the electroplating solution in the reservoir are coated with an electrically insulating coating.

6. The apparatus as claimed in claim 5 wherein there are a plurality of anode members disposed within the reservoir.

7. The apparatus as claimed in claim 3 wherein the oppositely disposed engaging members are provided with spring members which engage the end portions of a cylinder to be plated and make electrical contact therewith.

8. The apparatus as claimed in claim 7 wherein an adjusting ring is disposed between each of the engaging members and the ends of the cylinder to be plated, each said adjusting ring having a deformable sealing ring in contact with one end of the cylinder to be plated and each of said engaging members having a deformable sealing ring in contact with said adjusting ring.

9. The apparatus as claimed in claim 8 wherein the surfaces of the support member which are in contact with the electroplating solution in the reservoir are coated with an electrically insulating coating.

10. The apparatus as claimed in claim 9 wherein there are a plurality of anode members disposed within the reservoir.

* * * * *