Oct. 4, 1932. R. A. GARLING ET AL 1,880,382

METHOD AND APPARATUS FOR ELECTROPLATING

Filed April 20, 1931 2 Sheets-Sheet 1

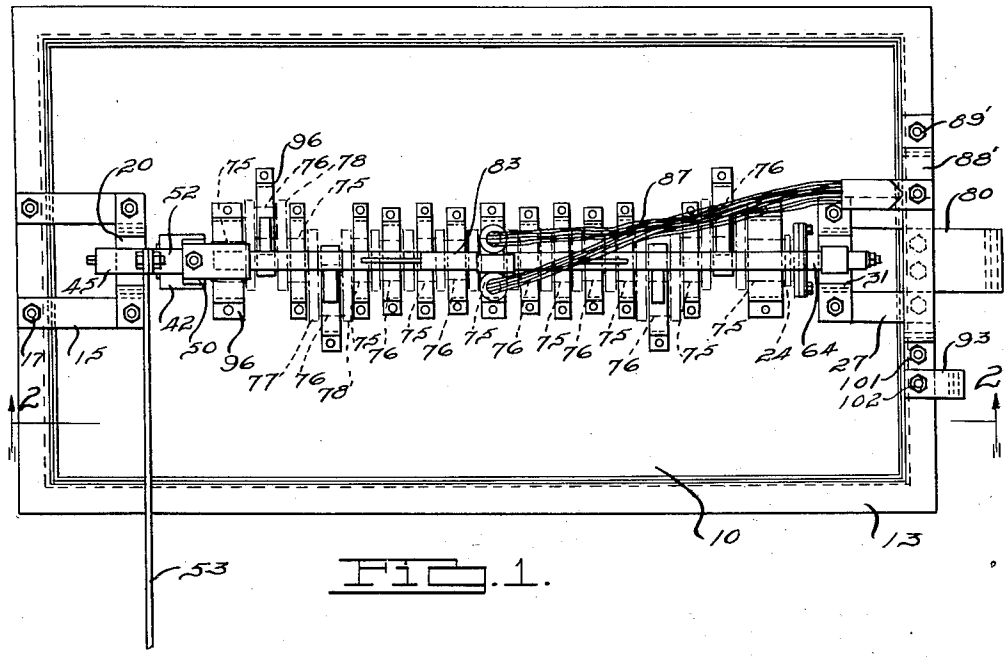


Fig. 1.

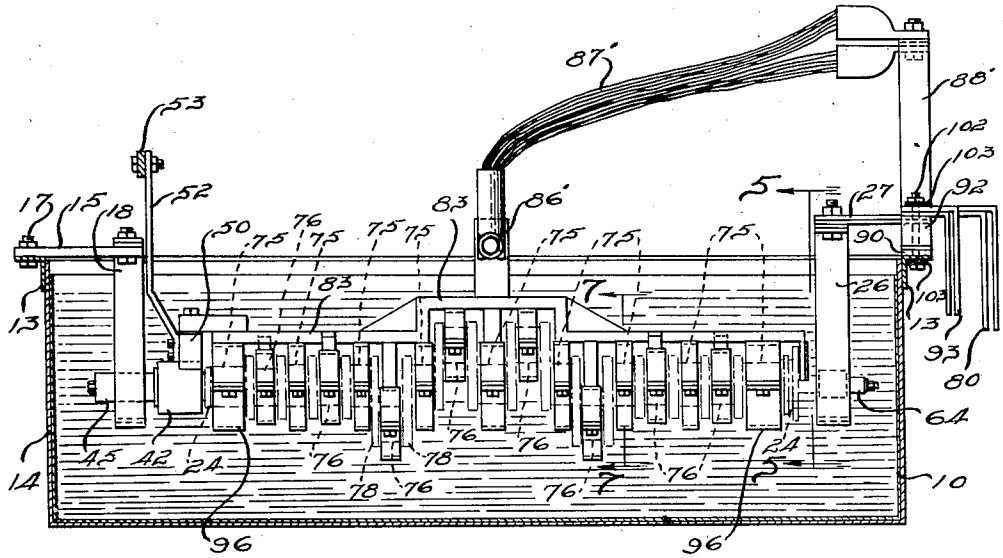


Fig. 2.

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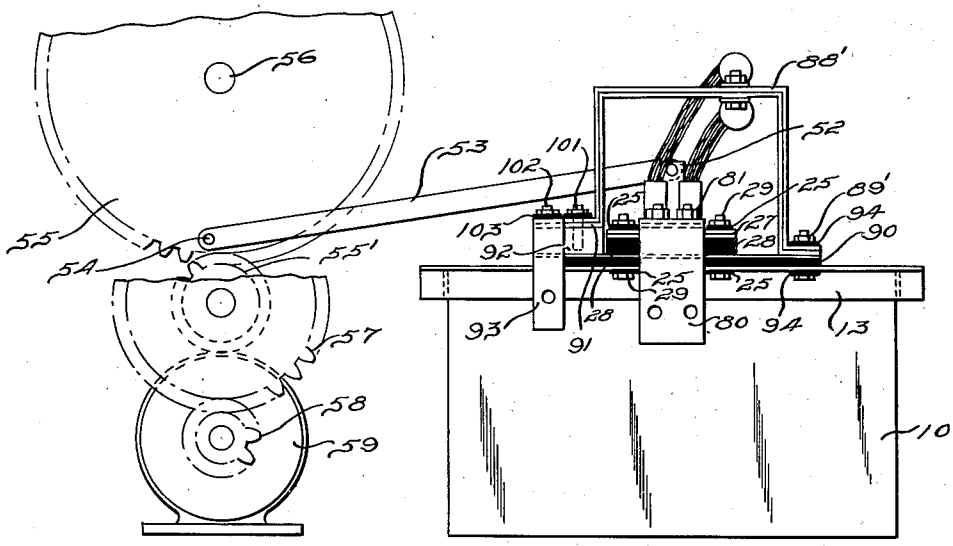


Fig. 3.

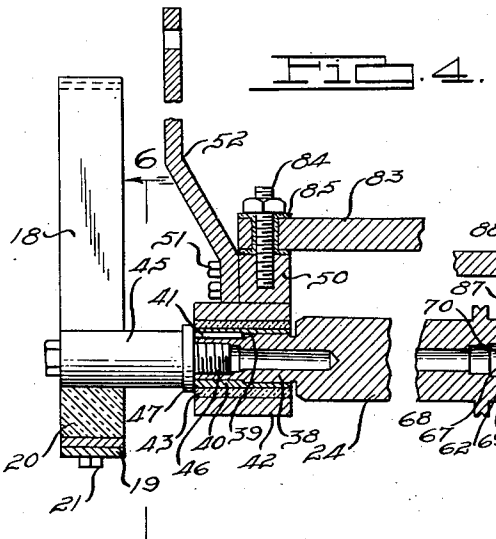
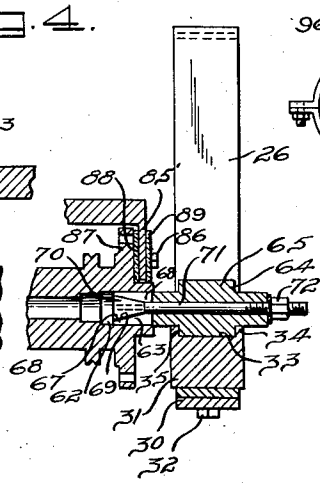


Fig. 4.



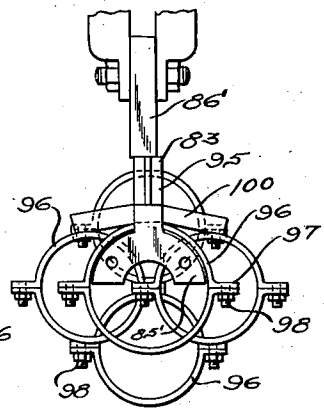


Fig. 5.

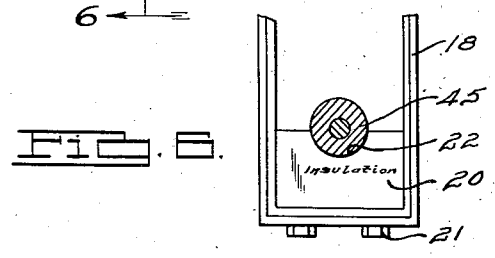


Fig. 6.

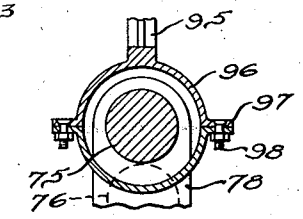


Fig. 7.

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR ELECTROPLATING

Application filed April 20, 1931. Serial No. 531,311.

The invention relates to electroplating in general, but is particularly adaptable to electroplating the bearing surfaces of crank shafts for motor vehicles.

The principal objects of the invention are to provide a method of electroplating the surface of an object which will insure an even and uniform deposit of metal thereon; to provide a method of electroplating a metal object by means of which stagnant pockets of electrolyte between the anode and the object, and gas bubbles on the surface of the object, are definitely eliminated; to provide a method of electroplating a metal object which will always insure the presence of a proper electrolytic solution in proximity to the surface of the object to be electroplated; to provide an apparatus for electroplating a metal object by means of which the object is maintained in uniformly spaced relation with respect to the anode while at the same time the object and anode are moved through in electrolyte; to provide an apparatus for electroplating a crank shaft by means of which the shaft can be oscillated or moved about its axis while at the same time an anode is maintained in a definite relation with respect to portions of the shaft to be electroplated; to provide an apparatus for electroplating a metal object which causes a constant circulation of the electrolyte between the anode and the object; and to provide an apparatus of this character which enables electroplating the bearing surfaces of a crank shaft in such manner that the metal deposited on such surfaces is of uniform thickness, of even texture, and adheres strongly to the surface upon which it is deposited.

At the present time crank shafts for motor vehicles are manufactured from steel and are initially provided with smooth bearing surfaces adapted to support the shaft in bearings in the crank case of the engine of the motor vehicle and to connect the shaft to the connecting rods of the engine. For manifest reasons such surfaces must be very hard and it has been found desirable to coat them with a very hard material such as chromium. The latter metal should be deposited on the bearing surfaces evenly and uniformly in order to preserve the accuracy of the cylindrical contour of the surfaces and at the same time provide a hard bearing material which will not be of greater thickness at one point than at another. Prior to the invention, various methods and apparatus have been employed for depositing a bearing material of this character on the bearing surfaces of crank shafts but none of them has been completely satisfactory because it did not insure an equal application of the material on the bearing surfaces. Particularly this has been true in the use of chromium because bubbles of gas created during the electroplating process, collect on the bearing surfaces, and particularly on the lower portions thereof, and insulate portions of such surfaces against the deposit of the plating metal thereon. Hence the flow of current to the surfaces from the anode is not uniform and the deposit of metal on the shaft is irregular. Furthermore, difficulty is sometimes experienced in maintaining a uniform concentration of the electrolyte between the cathode and anode, and the present invention insures a constant change of the electrolyte in proximity to the object being plated, so as to overcome such difficulty.

According to this invention, the ends of the crank shaft are rotatably supported within a tank containing the electrolyte and accordingly the shaft may be rotated or oscillated about its own axis, although, as will hereinafter be apparent, the apparatus may be modified to move the crank shaft bodily about another axis if desired, to obtain an equivalent result. For the purpose of moving the crank shaft in this manner, mechanically operated means are provided which insure uniform movement thereof. The crank shaft constitutes the cathode in an electrical circuit including the electrolyte, while the anode comprises cylindrical bands encircling the bearing surfaces of the crank shaft in definitely and uniformly spaced relation to such surfaces. These bands are supported by a bar extending longitudinally of the crank shaft in spaced relation thereto but which is supported by the ends of the crank shaft in an insulated manner. Consequently, when the shaft is moved in the manner previously de-

scribed the anode including the metal bands are moved likewise without changing the relation of the bands to the surfaces on the shaft. Flexible conductors connect the anode to a stationary terminal in the electrical circuit and accordingly permit its movement in the tank. The support at one end of the crank shaft constitutes its connection in the electrical circuit while the opposite end of the crank shaft is insulated from any other metal contact, although of course it should be understood that any arrangement may be used as long as movement of the shaft and anode is permitted in the manner described and the electrolyte constitutes the electrical conductor between them.

For a better understanding of the invention reference may be had to the accompanying drawings, in which:

Fig. 1 is a plan view of an electroplating apparatus constructed according to one form of the invention;

Fig. 2 is a cross sectional view taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is an end view of the construction shown by Fig. 1 illustrating in conjunction therewith, a means for oscillating the crank shaft in the tank;

Fig. 4 is a fragmentary cross sectional view of the construction shown by Figs. 1 and 2 illustrating the manner in which the anode is connected to the cathode and insulated therefrom;

Fig. 5 is a cross sectional view taken substantially along the line 5—5 of Fig. 2 with certain parts removed for the purpose of illustrating more clearly other parts of the construction;

Fig. 6 is a cross sectional view taken substantially along the line 6—6 of Fig. 4;

Fig. 7 is a cross sectional view on a larger scale taken substantially along the line 7—7 of Fig. 2.

Referring to Figures 1 and 2, a metal tank 10 of conventional construction is provided. An angle iron 13 extends around the upper edge of the tank 10 for the purpose of reinforcing the edge and providing a support for certain parts of the apparatus. At one end of the tank indicated at 14, a bracket 15 is secured to the angle iron 13 as indicated at 17 and is provided with a U-shaped metal strap 18 that extends a considerable distance downwardly into the tank 10. As best shown by Figure 4 the base portion of this strap, indicated at 19, is provided with an elongate block of insulating material 20 on its upper surface and which is secured thereto by machine bolts 21 that extend through the base 19 of the strap and partially into the insulating material. As best shown by Fig. 6, a semi-cylindrical groove 22 is formed in the upper surface of the block of insulating material 20 which is adapted to receive an extension 45 on and thereby rotatably support one end of a crank shaft 24.

A similar U-shaped metal strap 26 is suspended in the opposite end of the tank 10 by means of a bracket 27 secured by bolts to the angle iron 13 at the upper edge of the tank. This bracket is insulated from the tank (Fig. 3) by means of blocks 28 of any suitable insulating material secured to the angle iron 13 by bolts 29 and insulating washers 25. The base of the U-shaped strap 26 indicated at 30, instead of being provided with a block of insulating material as provided at 20 on the strap 18, is provided with a metal block 31 (Fig. 4) which is secured to the base 30 by bolts 32. The upper surface of the block 31 is provided with a semi-cylindrical groove 33 similar to the groove 22 provided in the insulating block 20, and which has shoulders 34 and 35 at opposite ends thereof.

The shaft 24, in this instance, is a crank shaft for an engine, and its end adjacent the strap 18, as indicated at 38, is of reduced diameter and is provided with a longitudinally extending keyway 39 in its outer surface. A metal sleeve 40 is keyed to the reduced portion 38 of the shaft by means of a key 41 disposed in the keyway 39 on the shaft and a similar keyway in the inner surface of the sleeve. A second sleeve 42 encloses the sleeve 40 but is separated therefrom by a sleeve of insulating material 43, although the two sleeves and the insulating material are so associated that they constitute in effect a single sleeve which is adapted to rotate as a unit. A cylindrical bearing 45 has a reduced threaded portion 46 which is threaded into the end of the reduced portion 38 of the shaft 24 and also is provided with an annular shoulder 47 which engages the end of the shaft and the ends of the sleeve 40 and 43 for the purpose of retaining the sleeves on the shaft. The bearing 45 is rotatably supported in the groove 22 provided in the upper surface of the insulating block 20 mounted on the base of the strap 18.

At its upper side the sleeve 42 is rigidly associated with a block 50 that in turn is secured by bolts 51 to an arm 52 projecting above the upper edge of the tank 10. As best shown by Fig. 3, the upper end of the arm 52 is pivotally connected to a link 53 which in turn is eccentrically pivoted as indicated at 54 on a gear 55 rotatably mounted on a shaft 56. The gear 55 meshes with a pinion 55′ secured to a second gear 57 that in turn meshes with a gear 58 which is keyed to the shaft of a motor 59. It will be apparent from this description that when the motor 59 is energized the pivotal connection 54 will rotate about the shaft 56 which causes a reciprocatory movement of the link 53 and consequently an oscillatory movement of the arm 52 connected in driving relation to the shaft 24 by means of the sleeves on the latter. Accordingly, the shaft 24 will be oscillated about its axis.

The opposite end of the shaft 24 is provided with an axially aligned opening 62 which receives a radially expansible portion 63 of a metal bearing 64 having an enlarged cylindrical portion 65 which is rotatably supported in the groove 33 of the metal block 31 between the annular shoulders 34 and 35 on the block. These shoulders prevent endwise movement of the shaft while it is being oscillated. The radially expansible portion 63 of the bearing 65 comprises segments 67 formed by slots 68 extending axially of the bearing in circumferentially spaced relation. A conical aperture 69 formed in the expansible portion 63 of the bearing 65 is adapted to receive a conically shaped wedge 70 which is integral with one end of a bolt 71 extending axially through an opening in the bearing 65. This bolt extends beyond the outer end of the bearing and is provided with a nut 72. When the nut is tightened on the bolt, movement of the wedge 70 into the opening 69 occurs which causes a radially outward movement of the segments 67 and in turn a rigid engagement of the outer surfaces of the segments with the cylindrical surface of the shaft 24 defined by the aperture 62.

As particularly shown by Figs. 1 and 2 the shaft 24 is provided with main bearing surfaces 75 and connecting rod bearing surfaces 76 which are arranged in an alternating manner. It should be understood that the main bearing surfaces are concentric to the axis of the shaft 24 while the connecting rod bearing surfaces are disposed in offset or eccentric relation with regard to the axis of the shaft by means of radially disposed arms 78 that are integral with the shaft.

In the apparatus so far described the crank shaft constitutes the cathode and is connected in the electrical circuit in the following manner. Heavy copper bars 80 in the electrical circuit are secured by bolts 81 (Fig. 3) to the bracket 27 which in turn is connected to the metal strap 26 that supports the metal block 31. In turn the block 31 has a metal bearing contact with the bearing 65 which is rigidly associated with the shaft 24 by means of the expansible portion 63 of the bearing. It will be apparent from the previous description that the bracket 27 is insulated from the tank by means of the insulating material 28, while the opposite end of the shaft 24 is rotatably supported in the strap 18 by the insulating block 20.

The anode in the apparatus comprises an elongated metallic bar 83 which is secured by means of a bolt 84 to the block 50 rigidly associated with the sleeve 42 on that end of the shaft adjacent the metal strap 18. A sleeve 85 composed of a suitable insulating material separates the bolt 84 from the bar 83 and also the latter from the block 50. The opposite end of the bar 83 has a depending flange 85' which is secured by means of bolts 86 to an annular flange 87 at the end of the shaft adjacent the metal strap 26. Plates 88 and 89 composed of suitable insulating material separate the flange 85 from the annular portion 87 of the shaft and also the bolts 86.

As best shown by Figures 1 and 2 the bar 83 intermediate its end is provided with an upwardly projecting portion 86' which is connected to flexible copper elements 87' that in turn are connected to a bracket 88' secured to the angle iron 13 at the upper edge of the tank by means of a bolt 89' projecting through insulating washers 94 and a strip of insulating material 90 extending also between the bracket 27 and the angle iron. At one side, the bracket 88' is provided with a flange 91 which is secured by a bolt 101 to a metal block 92 disposed between the insulating material 90 and the flange. This block in turn is connected by a bolt 102 and insulating washers 103 to heavy copper bars 93 constituting a part of the electrical circuit including the previously mentioned copper bars 80 and to the angle iron 13.

Also as best shown by Figures 1, 2 and 5 the bar 83 is provided with depending arms 95 which support annular bands 96 that encircle respectively, the main bearing surfaces 75 of the crank shaft 24. Preferably the bands 96 comprise cylindrical segments having complementary flanged ends which are connected by means of bolts 98. Other arms 100 projecting from the bar 83 extend into positions of proximity to the connecting rod bearing surfaces 76 and similarly are provided with bands 96 that encircle these surfaces. It should be understood that the bands 96 do not engage the crank shaft at any point and that they are uniformly spaced in a radial direction from the bearing surfaces on the shaft.

In operation of the apparatus described the tank 10 is substantially filled with an electrolyte preferably comprising a suitable chromium solution because it has been found best to plate the bearing surfaces of the crank shaft with chromium. Then the motor 59 is energized which causes the crank shaft 24 to oscillate about its axis in the manner previously described, and since the bar 83 is rigidly connected to the ends of the crank shaft 24, it likewise will be oscillated with the latter. During this oscillation of the shaft and the bar it is apparent that the bands 95 encircling the various bearing surfaces on the shaft, are positively maintained in uniformly spaced relation with respect to the bearing surfaces. This is of particular importance if an even plating of chromium is to be deposited on the bearing surface. The chromium solution or electrolyte in the tank completes the circuit between the cathode or crank shaft 24 and the anode or the bands 96 and accordingly when the circuit is energized with a low voltage, high amperage current,

chromium will be deposited on the various bearing surfaces. During the process of electroplating the surfaces in this manner the cathode and anode are being oscillated together without disturbing their initial relation and a fresh part of the solution will be constantly flowing between the bearing surfaces on the crank shaft and the metal bands 96 on the bar 83. This process also obviates weakening of the solution between the bearing surfaces and the straps 96 which would otherwise occur if the solution were not continually flowing between them. Any of the conventional methods of circulating the electrolyte in the tank, in addition to the above, may of course be employed if desired.

This process not only insures any bubbles which form on the bearing surfaces, being washed away, but the shaft in oscillating causes any bubbles that are formed on the lower surface to be oscillated out of such lower position to a position on the side thereof whereby, their natural buoyancy aids the circulation of the electrolyte in detaching them from the bearing surface.

Electroplating crank shafts in the manner described insures an even and uniform depositing of chromium on the bearing surfaces of the shaft and accordingly such surfaces will be more durable during the operation of the motor with which the shaft is associated. Moreover, the surfaces will be smoother and cylindrical, which will facilitate associating the crank shaft with the main bearings and connecting rod bearing, of the engine. The invention is particularly important where the electrolyte comprises a chromium solution because the character of this solution is such that it becomes weak in the region of the surface being electroplated, more rapidly than most electrolytic solutions.

Although only one form of the invention has been described and illustrated in detail, and that in connection with an object of a particular type, it will be apparent to those skilled in the art that various modifications may be made and plating solutions of various types may be used without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

We claim:

1. The method of electroplating a metal crank shaft constituting the cathode, which comprises extending the anode around the bearing portions of the shaft, and moving the anode through the electrolyte while maintaining it in spaced relation to the shaft in the electrolyte.

2. The method of electroplating a metal crank shaft constituting the cathode, which comprises extending the anode around bearing portions of the shaft, and moving the shaft and anode through an electrolyte while maintaining them in substantially uniformly spaced relation.

3. An apparatus for electroplating a metal crank shaft constituting the cathode, which comprises a tank containing an electrolyte, a pivotal support for the shaft so positioned that the latter may be moved in the electrolyte, an anode comprising a member extending about a portion of the shaft, means for maintaining the anode and shaft in predetermined relation and means for moving them through the electrolyte.

4. An apparatus for electroplating a metal shaft constituting the cathode, which comprises a tank containing an electrolyte, means for movably supporting the shaft in the electrolyte for movement about an axis, an anode, means for maintaining the anode in definite relation to the shaft, and means for moving the shaft and anode in a curvilinear path in the electrolyte about such axis while maintaining them in such relation.

5. An apparatus for electroplating a metal crank shaft constituting the cathode, which comprises a tank containing an electrolyte, a pivotal support for the shaft so positioned that the latter may be moved in the electrolyte, an anode comprising a member extending about a portion of the shaft, means for maintaining the anode and shaft in predetermined relation and means for moving them through the electrolyte about the axis of the shaft.

6. An apparatus for electroplating a metal object constituting the cathode, which comprises a tank containing an electrolyte, means for movably supporting the object in the electrolyte for movement about an axis, an anode comprising a member extending about the object, means for maintaining the object and anode in this relation, and means for moving the object and anode about the axis.

7. An apparatus for electroplating a crank shaft having bearing portions constituting the cathode, which comprises a tank containing an electrolyte, metal bands encircling the bearing portions and comprising the anode, means for maintaining the bands in uniformly spaced relation to the bearing portions, and means for moving the anode and cathode through the electrolyte.

8. An apparatus for electroplating a crank shaft having bearing portions constituting the cathode, which comprises a tank containing an electrolyte, metal bands encircling the bearing portions and comprising the anode, means for maintaining the bands in uniformly spaced relation to the bearing portions, and means for moving the anode and cathode about the axis of the shaft.

9. An apparatus for electroplating a crank shaft having bearing portions constituting the cathode, which comprises a tank containing an electrolyte, means for supporting the ends of the shaft in such manner that the lat-

ter may be oscillated through the electrolyte, metal bands extending around the bearing portions on the shaft in spaced relation thereto and constituting the anode, means for maintaining the bands and shaft in such relation, and means for rotating the shaft on its support first in one direction and then in the other direction.

10. An apparatus for electroplating a crank shaft having bearing portions constituting the cathode, which comprises a tank containing an electrolyte, means for supporting the ends of the shaft in such manner that the latter may be oscillated through the electrolyte, metal bands extending around the bearing portions on the shaft in spaced relation thereto and constituting the anode, means for maintaining the bands and shaft in such relation, and means for rotating the shaft on its support first in one direction and then in the other direction said bands being mounted on a bar extending longitudinally of the shaft and being connected thereto by insulating means.

11. The method of electroplating a metal shaft constituting the cathode, which comprises extending an anode around portions of the shaft, maintaining the anode in definite, spaced relation to the shaft, and moving the anode and the shaft through the electrolyte about a predetermined axis.

12. The method of electroplating a shaft constituting the cathode, which comprises extending an anode around portions of the shaft, maintaining the anode in definite, spaced relation to the shaft, and moving the anode and shaft through the electrolyte about the axis of the shaft.

13. An apparatus for electroplating a shaft constituting the cathode, which comprises a tank containing an electrolyte, means for movably supporting the shaft in the electrolyte for movement about the shaft axis, an anode, means for maintaining the anode in definite relation to the shaft, and means for moving the shaft and anode in a curvilinear path in the electrolyte about such shaft axis while maintaining them in such relation.

In testimony whereof we affix our signatures.

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