APPARATUS FOR ELECTROPLATING CRANK-SHAFT JOURNALS

Ralph E. Ludwig, Brokenstraw Township, Warren County, and Donald D. Dalrymple, North Warren, Pa., assignors to National Forge Company, Irvine, Pa., a corporation of Delaware

Filed Aug. 23, 1954, Ser. No. 451,576

4 Claims. (Cl. 204—212)

This invention relates to apparatus for electroplating a metal such as chromium onto the pin and main journals of crankshafts and particularly those employed in diesel engines for locomotive use.

The apparatus can of course be utilized for plating journals of newly manufactured crankshafts but it is designed particularly for use in conjunction with reconditioning of crankshafts that have long been in service and have worn journals. The method preferred for reconditioning is to grind the worn journals where necessary to remove any badly worn spots in order to reestablish an essentially true cylindrical surface, then electroplate with chromium to rebuild the diameter of the journal to a size slightly greater than its original, and then finish grind to the exact original size. This results in a reconditioned shaft that is substantially a duplicate of a new one except that the surfaces of the journals are now chromium instead of the original steel. Moreover the reconditioned shaft will wear well since the chromium layer is very hard and standard sized bearings can be used as distinguished from the alternative and less desirable method of grinding the worn journals to the next undersize and then reassembling the crankshaft in the engine with correspondingly undersized bearings.

In general the improved apparatus according to the present invention comprises a jig for supporting the crankshaft preferably in a horizontal attitude and rotating the same about its axis, an anode associated with each journal, the latter functioning as a cathode, an electroplating bath consisting of a solution of chromic acid in water in which the anode and cathode are immersed, and means for sending a direct current through the bath from anode to cathode thus to deposit the chromium onto the surface of the journal. However as distinguished from the general class of such apparatus heretofore developed wherein the entire crankshaft is immersed in the electrolytic bath, the apparatus according to the present invention features independent baths or chambers for each journal on the crankshaft and through which the plating solution is continuously recirculated from a source of supply. Constant forced recirculation of the plating solution through each chamber is helpful in maintaining a solution more uniform than can be obtained by general agitation in a much larger bath in which the entire crankshaft is submerged. Moreover the improved apparatus, employing individual baths for the journals, requires correspondingly less of the plating solution, the system is closed thus avoiding loss of solution by evaporation to the surrounding atmosphere, continued forced ventilation of the room in which the apparatus is located becomes unnecessary which thus reflects a saving in heating costs for the room during winter, and the cost of collecting and exhausting the gases given off during the plating process is also reduced.

Independent electroplating baths for the various pin and main journals as distinguished from a common bath for all journals also have other advantages. Independent baths enable independent control of the plating process going on at each journal thus making it possible to control the thickness of chromium deposit at each journal. Also by using transparent material such as a plastic for the walls of each bath chamber one is able to better supervise the process at each journal at all times.

Another disadvantage inherent in the prior system wherein the entire crankshaft is immersed in a tank containing the plating solution and which the present invention avoids is that by immersion the entire supporting structure for the crankshaft, including bearing supports, mercury contact and other parts, and even the carbonaceous deposits on those surface areas of the crankshaft itself not masked off tend to contaminate the plating solution and the solution in turn tends to gradually deteriorate those parts. Also, those portions of the crankshaft surface not masked off and not being plated are exposed to the hydrogen content of the plating solution which tends to make the surface brittle. Any absorption of hydrogen into the fillet areas of the journals is particularly to be avoided for here the shaft stresses are the greatest and absorption of hydrogen can reduce the fatigue strength of the metal by as much as 50%. Of course, the entire surface of the crank-shaft except for those areas to be plated could be masked off by application of a temporary coating compound but this adds materially to the overall cost of the reconditioning process and also does not give assurance of positive and complete masking due in part to the physical shape of the work.

A further objective of the invention is to provide an improved anode structure which completely surrounds the journal (cathode), the anode being constituted by a helix of round bar stock which thereby assures a uniform distance and hence uniform potential between anode and all points on the surface of the journal as the latter revolves about its axis inside of the anode. Moreover the total area of the anode is made greater than that of the journal (cathode) so as to prevent conversion of any of the chromium in the solution from its normal hexavalent state to a trivalent state which not only is of no value in the plating process but also tends to retard the same.

The foregoing as well as other objects and advantages inherent in the invention will become more apparent from the following specification and drawings which describe and illustrate one practical embodiment of the invention.

Fig. 1 of the drawings is a view in side elevation of the apparatus as designed for chromium plating a crankshaft having five main journals and four crank pin journals.

Fig. 2 is a vertical transverse section taken on line 2—2 of Fig. 1.

Fig. 3 is a central vertical section of one of the housings shown in Fig. 1 which surrounds a journal on the crankshaft to establish an electroplating chamber, the view being taken on line 3—3 of Fig. 4 and drawn to a larger scale in order to better show details of the structure.

Fig. 4 is also a central vertical section similar to Fig. 3 and is taken on line 4—4 of Fig. 3, and

Fig. 5 is a horizontal section through one of the journal housings taken on line 5—5 of Fig. 4.

With reference now to the drawings in which like parts in the various views are designated by like reference numerals and to Figs. 1 and 2 in particular, the apparatus for supporting the crankshaft is seen to be comprised of two longitudinally spaced pedestals 1, 2 containing sleeve bearings in which stub shafts 3, 4 are rotationally mounted, the stub shafts being secured by suitable means to opposite ends of the crankshaft 5 to be plated. The particular crankshaft illustrated has five main journals 5a—5e and four crank pin journals 5f—5i, and the stub
shfts 3, 4 being coaxial with the main journals, it will be seen that the crankshaft is thus arranged for rotation about the axis through the main journals. For rotating the crankshaft there is provided a slow speed motor 6, the shaft of which is coupled to one of the stub shafts such as the shaft 3 by a sprocket and chain drive 7.

As indicated at the outset, the present invention is characterized principally by use of housings individual to the journals being plated and through which the plating solution is circulated as distinguished from immersion of the entire crankshaft in a tank containing the electrolyte. These housings, designated by numeral 8 are made in two parts so as to enable them to be fitted around and enclose the journals and will be described later in further detail. Below the crankshaft and extending parallel therewith is a trough-like tank 9 which serves to catch any spillage of the electrolyte from the journal housings and return the same to the circulating system for the electrolyte. The housings 8 are made fluid tight but there is bound to some spillage as the housings are removed and replaced. Tank 9 also serves as a support for manifolds 10-13 extending along the outside thereof which serve to collect the electrolyte after it has passed through the housings 8 and to collect the discharge gases that are given off during the plating process. The electrolyte return manifolds 10-11, preferable made up of plastic material not affected by the electrolyte, which lead to the electrolyte outlets 17, 18, at opposite sides of the upper end of housings 8. This is best seen in Fig. 4. In a similar manner, other flexible plastic conduits 19, 20 connect the gas discharge outlets 21, 22 to the manifolds 12, 13 on tank 9 by which the gases are conveyed away through exhaust conduit 23.

Extending upwardly from each of the electrolyte housings 8 is an electrically conductive rigid pipe 24 which serves to both support and carry current to the anode 25 in each housing, and also as a conduit to bring the electrolyte into the housing. As shown in Fig. 2, a flexible conduit 26, also of flexible plastic material, extends from the top of each pipe 24 into a supply or inlet manifold 27 made of rigid plastic material and secured to the support 28 made of insulated material extending parallel with the tank 9. The supply manifold is connected to a bottom outlet 29 of a storage tank 29 for the electrolyte and the tank 29 is located above the manifold to establish gravity flow of the electrolyte to the several housings 8. The outlet from the electrolyte pump 14 connects with a pipe 30 leading to an inlet 29b located at the top of storage tank 29.

It will thus be seen that the electrolyte 31 is caused to circulate in a closed system from storage tank 29 through manifold 27, conduits 26 and pipes 24 into the several housings 8, out of the latter via conduits 15, 16, into the return manifolds 10, 11, back to pump 14 and from the latter via conduit 30 back into the tank 29 for recirculation.

In order to assure a good circulation of the electrolyte through the housings 8 it will be seen from Fig. 4 that baffle plates 32, 33 are arranged at each side of the anode 25 between the latter and the electrolyte outlets 17, 18. Thus the electrolyte entering the housing 8 through pipe 24 is caused to travel downward through the anode 25 and around the crankshaft journal to the bottom of the housing, then up through the bottom edge of baffles 32, 33 which are spaced from the bottom wall of the housing and then upward through the space between baffles 32, 33 and the side walls of the housing and out through the outlets 17 and 18. The course of fluid flow is indicated by the arrows. Each of the baffles 32, 33 is preferably provided with a small vent hole 34 through the same at approximately the level of the outlets 17, 18 to prevent syphoning of the electrolyte through these outlets.

The anode 25 is preferably constituted by a helix of round bar stock which is cut along a diameter after it has been wound to thus form an upper section 25a and a lower section 25b, the turns of each section being held in rigid spaced relationship by bars 35, 36 that are placed in place and held in place respectively of the helix before cutting. Pipe 24 is secured to top bar 35 in such manner as will not block free flow of electrolyte out of the bottom end thereof and thus supports the upper half 25c of the anode. In a similar manner, a solid rod 37 of electrically conductive material is secured to bottom bar 36 to thus support the lower half 25d of the anode. Pipe 24 is in turn secured to the top wall of housing 8 at its pass through point and rod 37 is secured to the lower wall of housing 8 at its pass through point. As stated previously, the area of the helical anode 25 is made greater than that of the crankshaft journal so as to prevent any of the chromium in the plating solution from being converted from its normal hexavalent state to a trivalent state. The latter is of no value in the plating process and also tends to retard the same. Moreover, due to the helical configuration of the anode, a uniform potential between all points on the anode and the crankshaft journal as the latter rotates is assured.

The housings 8, preferably of transparent material such as a plastic, are each divided horizontally into upper and lower half sections 8a, 8b to form a fluid tight fit around the crankshaft journals and are held together by means of clamps 38, 39 at each half of the housing. To avoid undue complexity in the drawings, these clamps have been omitted from Figs. 1 and 2. A plastic is preferred for the housings 8 since it is not adversely affected by chromic acid and, being transparent, one is able to observe the plating action at each journal and also sec. 32, 33 are likewise divided horizontally into upper and lower sections 32a, 32b and 33a, 33b, the upper baffle sections 32a, 32b and 33a, 33b being secured to the side walls of the upper housing section 8a, and the lower baffle sections 32b, 33b being secured to the side walls of the lower housing section 8b.

The upper housing section 8a also preferably includes a wiper blade 50 of a plastic material that is comparatively stiff and which extends between the side walls of the housing section 8a in the longitudinal direction of the crankshaft journals inside of the upper section 25a in such manner that the lower edge thereof which is toothed at 50a engages the surface of the journal to establish a wiping action as the journal rotates thus brushing off any gas bubbles or foreign particles which otherwise would tend to adhere to the surface of the journal and interfere with a uniform deposit of chromium on the journal. Consequently the upper housing sections 8a are each structurally united with pipe 24, the upper anode section 25a, the upper baffle sections 32a, and 33a and wiper blade 50, and the lower housing sections 8b are each structurally united with rod 37, the lower anode section 25b and lower baffle sections 32b, 33b. When the upper and lower halves of the housing are assembled, as shown in Fig. 4 the two halves of the anode 25 will meet at a uniform distance from the journal being plated and will be concentric with the latter.

In order to better feed current to the lower anode section 25b, a strap 49 of conductive material is connected by clamps 41 to the pipe 24 and rod 37. Current is supplied to the anodes 25 through the pipes 24 and each of the latter is connected by a flexible conductive strap 42 to a bus bar 42 extending longitudinally of the support 28 and secured to the ends of the latter by means of insulating members 44.

With reference to Fig. 2 it will be seen that the support member 28 is provided with a horizontal portion containing a plurality of slots 28a in vertical alignment with the pipes 24 and through which the pipes 24 extend,
When the crankshaft 5 is rotated on its axis, the pipes 24 and housings 8 associated with the main journals remain stationary. However those pipes 24 and housings 8 associated with the crankpin journals describe a planetary motion. The function served by the slots 25a is to guide the pipes 24 and prevent the housings from rotating with the crankshaft.

As previously explained, the electroplating is done with direct current and the circuit is shown in a schematic manner in Fig. 1, the source of direct current being indicated by terminals 45 and the conducting path and symbols. A lead 46 extends from the + terminal to the bus bar 43, and hence to anodes 25, and another lead 47 extends from the -- terminal to a mercury type contact device 48 associated with the stud shaft 4, the latter being rotated in a pool of mercury to assure good electrical contact to the crankshaft and thereby to the journals Sa-Si which function as cathodes in the plating process.

In operation, the crankshaft to be plated is arranged as shown in Fig. 1 for rotation about a longitudinal axis through the center of the main journals. The housings 8 together with the anodes 25 supported therein and pipes 24 are then mounted on the pin and main journals, and the flexible tubes 15, 16, 19, 20 and 26 are connected to the manifolds 10-13 and 27. Straps 42 are then attached to the bus bar 43 thus electrically connecting the pipes 24 and anodes 25 to the bus bar and positive terminal of the direct current source. The electrolyte 31 has now admitted into the manifold 27 from storage tank 29 and flows outwardly from manifold 27 through valves 53 at each lateral outlet to conduits 26, downwardly through the pipes 24 into the anode housings 8 and filling the overflow outlets of the outlet valves 17, 18.

As will be seen best from Fig. 3, the sides of the housings 8 fit tightly about the end portions of the journals and hence prevent any of the electrolyte from getting to the fillet areas 8a at the junction of the check plates 5m and the journals. As explained at the outset this is most important since any absorption of hydrogen from the electrolyte into these areas where the crankshaft stresses are greatest tends to make the surface more brittle which is reflected by a reduction in fatigue strength and hence the safety factor at the very places where it can least be tolerated.

Motor 6 is now started, as is also the pump 14, and the chromium plating process now begins as the crankshaft slowly rotates. The electrolyte circulates continuously in and out of the anode housings and the electrolyte will remain at substantially the level indicated in Fig. 4, i.e., slightly above the vents 34 in baffles 32, 33. The helical configuration of the anode 25 assures a uniform electrical potential between the anodes and all points on the surface of the journal as the latter rotates. Being transparent, one is enabled to supervise the plating process at each journal at all times and it becomes quite a simple matter to inspect any journal whenever desired by shutting off valve 53 thus to stop the flow of electrolyte into the anode housing and then removing the latter. Moreover independent treatment of the journals makes it possible to stop the plating process at any journal at any time without interfering with the plating process going on at the other journals. This feature thus provides independent control over the thickness of chromium deposit at each journal and cannot very well be duplicated with apparatus of the type wherein the entire crankshaft is submerged in a tank containing the electrolyte.

In conclusion, it is to be understood that the particular embodiment of the invention as described and illustrated in the drawings is to be considered typical rather than limiting of the scope of the invention as defined in the appended claims, a basic concept of which resides in the use of a combined anode and electrolyte housing for each journal, and a closed system for continuous circulation of the electrolyte through the several housings. Consequently various modifications of structural details such as for example the arrangement of inlets and outlets on the housings for the electrolyte, the anode structure and the electrolyte manifolding may be resorted to without however departing from the spirit and scope of the invention.

We claim:

1. Apparatus for electroplating a crankshaft journal comprising a housing surrounding only the journal portion of said crankshaft, said housing including aligned openings in the sidewalls thereof for receiving the journal, and said housing being sectionalized at said openings to permit installation and removal with respect to the journal, an arcuate anode within said housing maintained in concentric spaced relation to said journal, said anode being sectionalized to permit installation and removal with respect to the journal, an electrically conductive pipe passing through a wall of said housing, said pipe being connected to said anode and also constituting an inlet for electrolyte into said housing, an outlet on said housing for removing electrolyte therefrom, means for circulating electrolyte through said housing between said inlet and outlet, and means for rotating said journal.

2. Apparatus for electroplating a horizontally disposed crankshaft journal comprising a housing surrounding only the journal portion of said crankshaft, said housing including aligned openings in the sidewalls thereof for receiving the journal, and said housing being sectionalized at said openings to permit installation and removal with respect to the journal, an arcuate anode within said housing maintained in concentric spaced relation to said journal, said anode being sectionalized to permit installation and removal with respect to the journal, an electrically conductive pipe secured to said anode and also constituting an inlet for electrolyte at the top of said housing intermediate the side walls thereof, an outlet for electrolyte through the upper portion of a side wall of said housing, a vertical baffle in said housing between said inlet and side wall whereby to establish a path for electrolyte flow downward from said inlet to the bottom portion of said housing and thence under said baffle and upward between said baffle and side wall to said outlet, means for circulating electrolyte through said housing, means for rotating said journal, and means restraining said housing and anode against rotation.

3. Apparatus for electroplating the journals of a crankshaft comprising means for supporting said crankshaft for rotation in a horizontal attitude, means for rotating said crankshaft, a trough extending longitudinally of and below said crankshaft, housings individual to and surrounding each journal portion only of said crankshaft, each said housing including aligned openings in the sidewalls thereof for receiving its corresponding journal, and each said housing being sectionalized at said openings to permit installation and removal with respect to its corresponding journal, an arcuate anode within each housing maintained in concentric spaced relation to said journal, each said anode being sectionalized to permit installation and removal with respect to its corresponding journal, means restraining said housings and anodes against rotation, an inlet and outlet for electrolyte to and from each housing, an outlet manifold extending along said trough and to which the outlets on said housings are connected, an inlet manifold located at a level above said housings and to which the inlets on said housings are connected, a storage tank for electrolyte located at a level above said inlet manifold and to which said inlet manifold is connected, a pump having its intake side connected to said outlet manifold and its discharge side connected to said tank, an outlet on said tank for electrolyte, and a gas collecting manifold extending along said trough and to which said gas outlets are connected.

4. Apparatus for electroplating the journals of a crankshaft comprising means for supporting said crankshaft for rotation in a horizontal attitude, means for rotating
said crankshaft, a trough extending longitudinally of and below said crankshaft, housings individual to and surrounding each journal portion only of said crankshaft, each said housing including aligned openings in the sidewalls thereof for receiving its corresponding journal, and each said housing being sectionalized at said openings to permit installation and removal with respect to its corresponding journal, an arcuate anode within each housing maintained in concentric spaced relation to said journal, each said anode being sectionalized to permit installation and removal with respect to its corresponding journal, means restraining said housings and anodes against rotation, an electrically conductive pipe secured to said anode and also constituting an inlet for electrolyte into each housing through the top wall thereof, outlets for electrolyte extending through the upper portion of opposite side walls of each housing, vertical baffles in each housing between the said opposite side walls thereof and said inlet whereby to establish paths for flow of electrolyte downward from said inlet to and under the lower edges of said baffles and thence up between said baffles and opposite side walls to said outlets, an outlet manifold extending along each side of said trough and to which the outlets on said housings are connected, an inlet manifold located at a level above said housings and to which the inlets on said housings are connected, a storage tank for electrolyte located at a level above said inlet manifold and to which said inlet manifold is connected, and a pump having its intake side connected to said outlet manifolds and its discharge side connected to said tank.

References Cited in the file of this patent

UNITED STATES PATENTS

1,757,235 Clark et al. 1898 May 6, 1930
1,872,290 Hitter 1898 Aug. 16, 1932
1,880,382 Garling 1900 Oct. 4, 1932
1,955,046 Baumann 1904 Apr. 17, 1934
2,431,949 Martz 1947 Dec. 2, 1947
2,491,925 Lazaro 1948 Dec. 20, 1949
2,710,384 Vrilakas 1955 June 14, 1955

FOREIGN PATENTS

925,912 France 1947 Apr. 14, 1947
117,302 Australia 1943 July 22, 1943