

Nov. 22, 1955

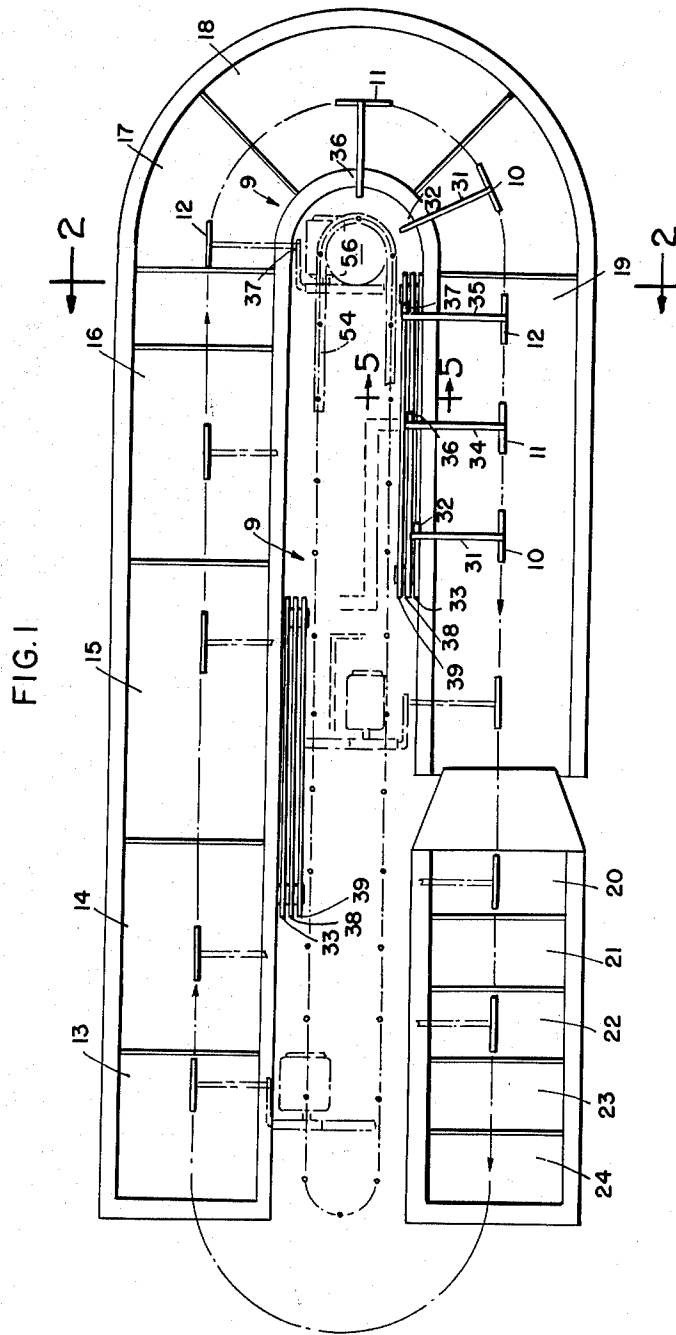
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2,724,691

APPARATUS FOR ELECTROPLATING ARTICLES

Filed June 13, 1951

5 Sheets-Sheet 1



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FIG. 2

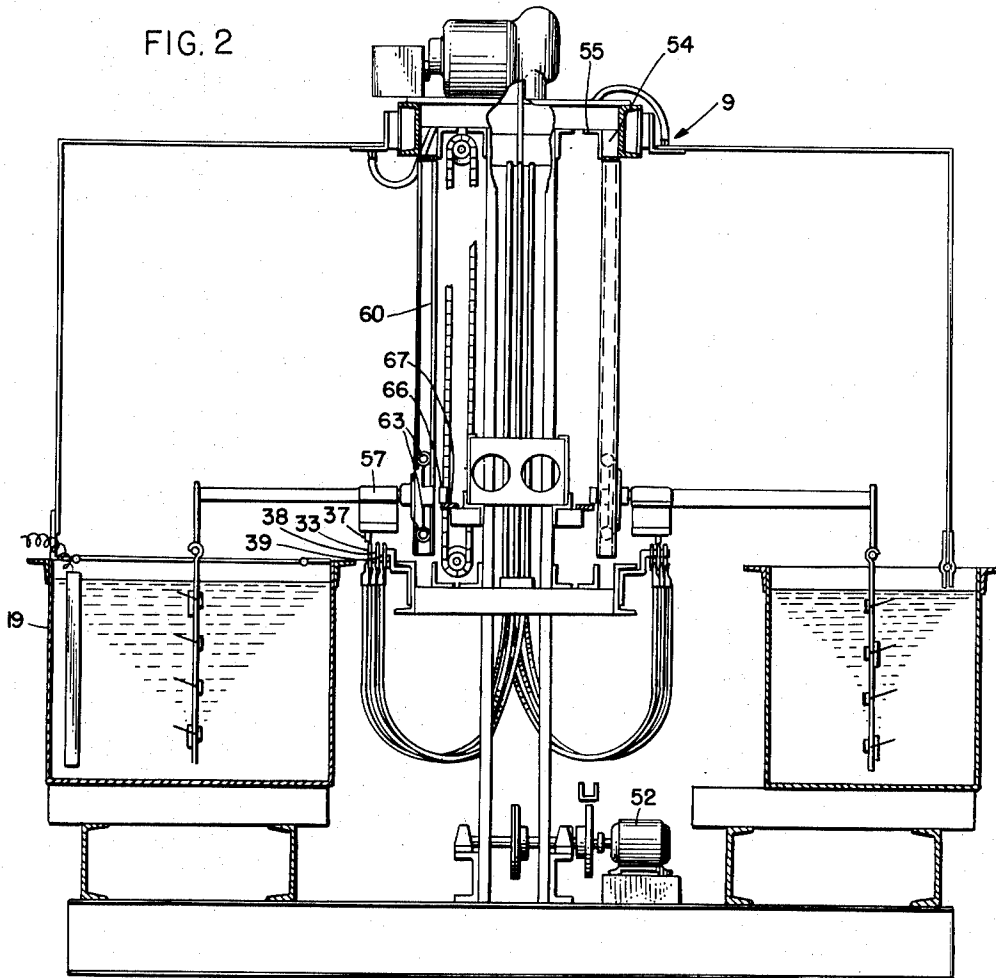
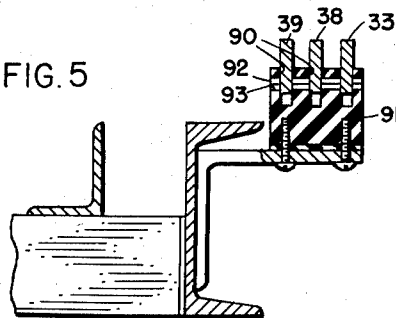


FIG. 5



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FIG. 3

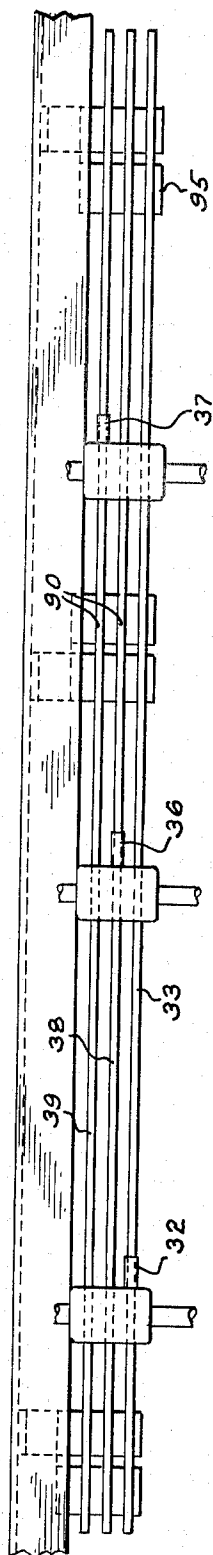
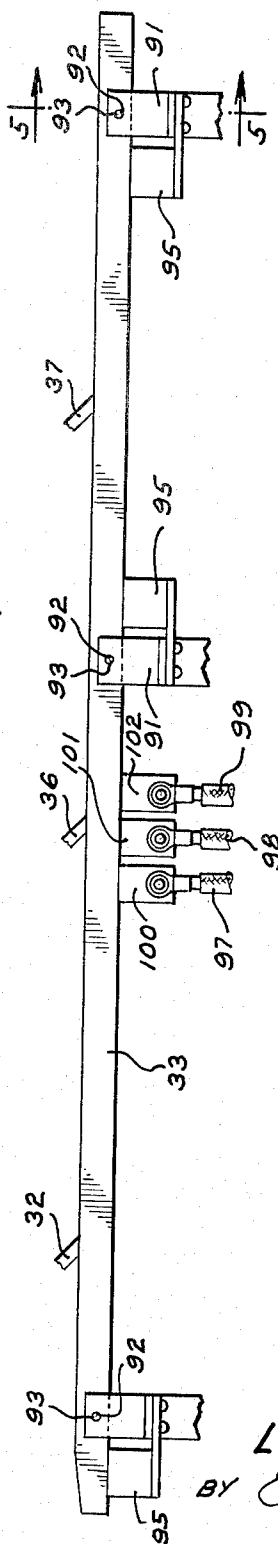


FIG. 4



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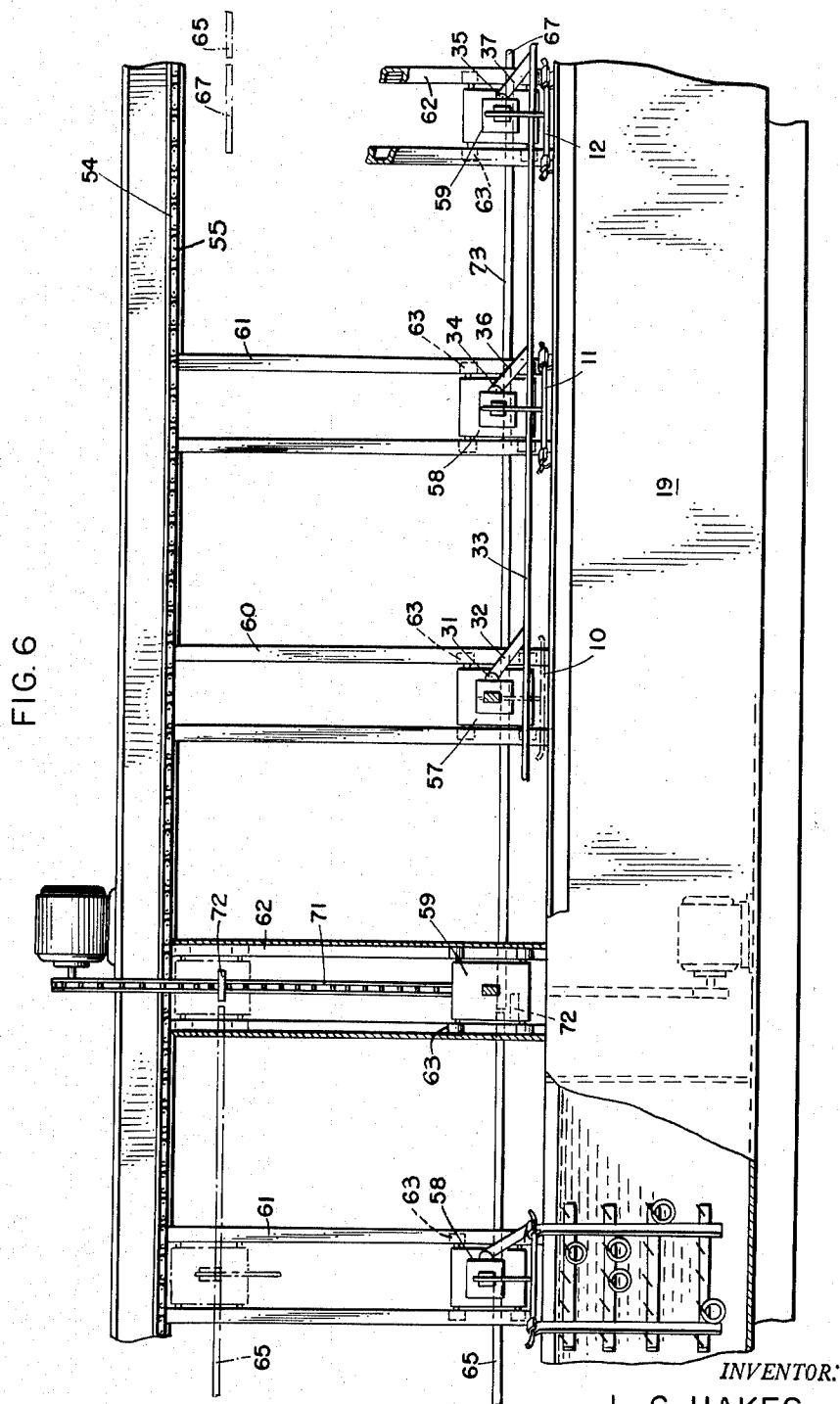
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Filed June 13, 1951

5 Sheets-Sheet 4



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2,724,691

APPARATUS FOR ELECTROPLATING ARTICLES

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Application June 13, 1951, Serial No. 231,353

7 Claims. (Cl. 204—204)

This invention relates to methods of and apparatus for electroplating articles, and more particularly to methods of and apparatus for gold-plating articles.

In the electroplating of articles with precious metals, such as gold, platinum and the like, it is highly desirable to closely regulate the amount of the precious metal applied to each article to be plated. While such control is possible manually on a small scale production, there has been no automatic apparatus for large scale commercial electroplating of precious metals wherein the quantity of electricity is closely measured and controlled in the plating of each article or groups of articles.

An object of the invention is to provide new and improved methods of and apparatus for electroplating articles.

A further object of the invention is to provide new and improved methods of and apparatus for gold-plating articles.

Another object of the invention is to provide methods of and apparatus for closely controlling the electroplating of precious metals on articles.

A method illustrating certain features of the invention may include immersing articles one after another in an electroplating bath, forcing a predetermined quantity of electricity through each of the articles in the bath, stopping the flow of electricity through the articles in the bath when said predetermined quantity has been obtained, and removing the articles from the bath.

An apparatus illustrating certain features of the invention may include an electroplating bath, means for advancing articles through the bath, means for forcing a predetermined quantity of electricity through each of the articles in the bath to plate a predetermined amount of metal on the articles, and means for removing the articles from the bath.

A complete understanding of the invention may be obtained from the following detailed description of a method and an apparatus forming specific embodiments thereof, when read in conjunction with the appended drawings, in which

Fig. 1 is a top plan view of an apparatus for practicing a method forming a specific embodiment of the invention;

Fig. 2 is a vertical section of the apparatus taken along line 2—2 of Fig. 1;

Fig. 3 is an enlarged, fragmentary, top plan view of the apparatus shown in Fig. 1;

Fig. 4 is an enlarged, fragmentary, front elevation of the apparatus shown in Fig. 1;

Fig. 5 is a vertical section taken along line 5—5 of Fig. 4;

Fig. 6 is an enlarged, fragmentary, front elevation of the apparatus shown in Fig. 1, and

Fig. 7 is a schematic view of a portion of and a control circuit of the apparatus shown in Fig. 1.

Referring now in detail to the drawings, there is shown therein a conveyor 9 for advancing racks 10, 11 and 12 successively through an acid dipping tank 13 filled with nitric acid, a rinsing tank 14 filled with rapidly

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circulating water to rinse the acid from articles carried by the racks, a flash plating nickel tank 15, in which a flash coating of nickel is plated on the articles, a cold rinse bath 16, which rinses the electrolyte from the articles therefrom, an acid dipping bath 17 containing hydrochloric acid, a water rinsing bath 18, a gold-plating bath 19, a recovery rinse tank 20, a second recovery rinse tank 21, a third recovery rinse tank 22, a dilute acid tank 23, and a cold rinse tank. The conveyor 9 raises and lowers the racks and advances them one after another through the several tanks. Each of racks 10 is suspended from an arm 31, and when it is advanced through the gold-plating bath, a contactor 32 carried rigidly by the arm 31 and connected electrically to the rack 10 engages a cathode rail 33. Similarly, arms 34 and 35 carrying the racks 11 and 12 are connected by contactors 36 and 37, respectively, to cathode rails 38 and 39, respectively, so that each of the racks 10, 11 and 12 receives current from an individual one of the cathode rails 33, 38 and 39.

A control circuit shown in Fig. 7 controls the quantities of electricity forced through the groups of articles on each of the racks 10, 11 and 12 from a powerline 50, a control circuit 51 controlling the quantity of electricity flowing through the articles on each of the racks 10, a control circuit 52 controlling the quantity of electricity forced through the articles on each of the racks 11, and a control circuit 53 identical with the control circuits 51 and 52 controlling the quantity of electricity forced through the articles on each of the racks 12.

The conveyor 9 includes a chain 54 (Figs. 1 and 6) automatically advanced intermittently along an endless track 55 by an intermittently driven sprocket 56. The arms 31, 34 and 35 are mounted by rollers 63 on carriers 57, 58 and 59 freely slidable along vertical guides 60, 61 and 62 carried with the chain 54. As each of the racks is advanced to the gold-plating tank 19, it is supported in a raised position by an elevator 65 (Fig. 6) on which rollers 66 (Fig. 2) fastened to the carriers ride, which keeps the racks above the tank 19 as they are brought to the tank. As each of the guideways reaches the position of the righthand guide 62 shown in Fig. 6, the conveyor chain 54 is stopped and an escapement lowering plate 67 of the elevator 65 lowers the carrier to immerse the articles on the rack carried thereby in the gold-plating tank in a first plating position, and move the contactor of the carrier into engagement with the one of the cathode rails 33, 38 and 39 for which the contactor is set, all the contactors on the carriers 57 being set for the cathode rail 33, those on the carriers 58 being set for the cathode rail 39.

Prior to the next movement of the conveyor chain 54, the conveyor drives an advance pickup chain 71 (Fig. 6) to move a lug 72 under the carrier in a fourth or drip position, in which the lefthand carrier 59 is shown, to raise the rack carried thereby above the level of the broken-line position of the elevator 65, in which position the rack is out of the gold-plating solution, to permit the gold-laden plating solution to drip from the rack and articles thereon back into the tank 19. The elevator 65 then is raised to its broken-line position, and, on the next movement of the conveyor chain, the carrier raised by the chain 71 is moved to the left, as viewed in Fig. 6, and is supported by the elevator. Simultaneously, the carrier just behind the carrier in the first plating position of the gold-plating tank is moved onto the lowering plate 67, and the carriers in the first and second plating positions are moved to second and third plating positions, respectively, without being raised. The chain 54 then is stopped, the lowering plate 67 lowers the carrier thereon into the first plating position immersing the rack carried thereby, and the elevator 65 is moved from its broken-line position to

its full-line position to immerse the plating racks supported thereby in the tanks 20, 21, 22, 23 and 24. The carriers at the tank 19 are supported partially by a guide track 73 under the rollers 66 and partially by the cathode rails 33, 38 and 39 so that there is firm contact between the contactors and the cathode rails.

The cathode rails 33, 38 and 39 are mounted slidably in slots 90 (Figs. 3, 4 and 5) formed in blocks 91 composed of electrical insulating material, such as phenol fiber or the like, and are secured slidably in the slots by pins 92 composed of phenol fiber or other electrical insulating material extending through slots 93 (Fig. 5) formed in the cathode rails. The slots 93 are sufficiently large to permit the cathode rails to move up and down in the slots 93. The cathode rails are supported on resilient blocks 95 (Fig. 4) composed of electrical insulating material, such as neoprene (polymerized chlorophrene), or the like. The contactors 32, 36 and 37 are pressed hard against the cathode rails from the weight of the carriers, and the resilient blocks 95 keep the force of the contactors uniform through the travel of the contactors thereon. The rollers 66 of the carriers, when in the first, second, third and fourth positions rest on the guide track 73 to support the bulk of the weight of the carriers and the racks carried thereby. Conductors 97, 98 and 99 (Figs. 4 and 7) are connected electrically to conductive lugs 100, 101 and 102, respectively, brazed to the cathode rails 33, 38 and 39, respectively.

When one of the contactors 32 first engages the cathode rail 33 in the first plating position, it closes a circuit from a rectifier 105 supplied with power by a secondary winding 106 of a transformer 107, which has a primary winding 108 which is continuously energized by the powerline 50. The circuit from the rectifier 105 includes an ampere-minute meter 110, an anode 111, a normally closed relay contact 112 of a relay 113 having a winding 114, a rheostat 115 and a rheostat 116 and a normally closed relay contact 117 mounted in parallel with the rheostat 115. The relay contact 117 is controlled by a winding 118 of a relay 119. Current flows through the parallel rheostats 115 and 116, and the rheostat 116 is set to have a substantially lower resistance than the rheostat 115 so that it applies a higher strike voltage across the plating rack 10 and the anode 111, and whenever the contact 117 is closed, a high strike current flows to form a flash deposit of gold on the articles carried by the rack 10.

An armature 120 of the meter 110 is driven by a winding 121 through which the plating current passes, and after a predetermined quantity of electricity has flowed through the articles on the rack 10 to the anode 111 in the strike, the armature 120 momentarily closes a sensitive switch 122 to energize the relay winding 118 to open the contact 117. The relay 119 also closes a holding contact 123 in parallel with the switch 122, after which the switch 122 opens. The rheostat 115 then causes a lower voltage to be impressed across the anode 111 and the articles on the plating rack 10, and the articles are plated by a plating current which is substantially lower than the strike current. After a predetermined quantity of electricity has flowed through the articles on the rack 10, the ampere-minute meter 110 closes a sensitive switch 130 to energize the relay winding 114 to open the contact 112 and close a holding contact 131 in parallel with the switch 130. Opening of the contact 112 stops the flow of current to the articles.

When the rack 10 is lifted by the advance pickup chain 71 (Fig. 6), the contactor 32 is lifted out of engagement with the cathode rail 33, and a resetting limit switch 135 having contacts 136 and 137 in series with the holding contacts 123 and 131 and the relay windings 118 and 114, respectively, is opened by the contactor 32 as it is raised by the advance pickup to drop out the relays 113 and 119 to reclose the contacts 112 and 117 for plating the rack on the next carrier 57 to be brought into engagement with

the cathode rail 33. The circuits 52 and 53 connected to the anode 111 and the cathode rails 38 and 39, respectively, similarly control the plating on the articles carried by the carriers 58 and 59. The mechanical connections between the armature 120 and the switches 122 and 130 are individually adjustable to actuate the switches 122 and 130 by different revolutions of the armature. Variable gearings 150 and 151 for controlling the actuators of the switches 122 and 130 are shown.

Operation

The conveyor 9 advances the carriers 57, 58 and 59 intermittently along the endless path thereof, and at the start of each movement raises the carrier in the fourth playing position in the tank 19, lets the rack carried by this carrier drip so that most of the gold-plating solution is returned to the tank 19, and then moves each of the carriers carried thereby the distance between the plating positions. The conveyor then lowers another carrier into the first plating position and the contactor of that carrier engages the cathode rail for which it is designed. Whenever one of the carriers 57 is raised out of the plating tank and moved from the fourth position, the next carrier to be moved to the first plating position is the second carrier 58. Likewise, when one of the carriers 58 is removed from the gold-plating tank, the carrier which is moved into the first plating position is the second carrier 59, and when one of the carriers 59 is removed from the gold-plating tank from the third plating position, the second succeeding carrier 57 is moved into the first plating position.

When one of the carriers 57 is moved into the first plating position, the contactor 32 thereof engages the cathode rail 33. This closes the circuit to the meter 110 and a strike voltage is applied across the anode 111 and the articles on the rack 10, the meter 110 being driven at a rate of speed proportionate to the strike current flowing through the winding 121. After a predetermined amount of electricity has flowed through the winding 121 in the strike, the armature 120 closes the switch 122 momentarily to energize the relay winding 118 and lock it in. The winding 118 then closes the holding contact 123 in parallel with the switch 122 and opens the contact 117 to cut out the low resistance path to the cathode rail 33. Then a lower selected plating voltage is applied across the articles on the rack 10 and the anode 111 to cause current of a plating value to flow. After a predetermined quantity of electricity in the plating has flowed, the armature closes the switch 130 momentarily. This energizes the relay 114 in series with the switch 130 and opens the contact 112 to stop the flow of current through the meter 110 and to the cathode rail 33. The armature coasts sufficiently to open the switch 130. Shortly after this occurs, the advance pickup chain 71 is actuated automatically by the conveyor drive to raise the carrier 57, the carrier 57 having been moved to the fourth position during the plating of the articles on the rack 10 carried thereby. As the carrier 57 is lifted by the advance pickup chain 71, it trips the limit switch 135 to open the contacts 136 and 137 thereby resetting the relays 113 and 119, so that the locking contacts 123 and 131 are opened and the contacts 112 and 117 are closed. Raising of the carrier permits the gold-plating solution to drip from the rack 10 and the articles carried thereby. Then the conveyor drive shifts the carriers the distance between two adjacent plating positions, moves another carrier 57 to the first plating position, and lowers it into this position. The new carrier 57 starts a new cycle.

When the carrier 57 is moved from the first plating position to the second plating position, the carrier 58 directly therebehind is moved in the first plating position and the contact 36 thereof is moved into engagement with the cathode rail 38, and the control circuit 52 serves to supply metered strike and plating currents to the articles on the rack 11 carried by the carrier 58, and, simi-

larly, when the carrier 57 is moved to the third plating position, the carrier 58 is moved from the first plating position to the second plating position, and the carrier 59 directly behind the carrier 58 is moved to and lowered into the first plating position and metered quantities of strike and plating electricity are forced through the articles carried by the carrier 59. The control circuits 52 and 53 are identical with the control circuit 51 except that the circuits 52 and 53 are provided with limit switches corresponding to the limit switch 135 but operable only by the contactors 36 and 37, respectively, while the limit switch 135 is operable only by the contactors 32. From the time each of the contactors is lowered into engagement with one of the cathode rails 33, 38 and 39, until this contactor is raised out of contact therewith, the cathode rail is urged into engagement with the contactor by the resilient pads 95—95 so that contact is maintained between the contactor and the cathode rail.

The above-described apparatus may be used to apply gold-plating of the same or different thicknesses to three different types of articles at the same time if desired. That is, the control circuit 51 for the carriers 57 may be set for predetermined strike and plating quantities, the control circuit 52 for the carriers 58 may be set for different selected quantities of electricity for the strike and plating run and the control circuit 53 may be set still differently to force quantities of electricity for the strike and plating on articles carried by the carriers 59. Furthermore, the rheostats, such as the rheostats 115 and 116, may be adjusted to attain strike and plating voltages over wide ranges of these voltages. Thus, this apparatus gives a high flexibility of operation and is simple and inexpensive in construction and operation.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A plating apparatus, which comprises a container for an electrolytic plating bath, anode means extending along the bath, conveyor means for advancing a series of articles through the bath one after another along a path in such a manner that each article is in the bath for substantially the same period of time, a plurality of cathode rails extending along the bath in positions adjacent to said path through the bath, means for sequentially connecting said articles to different cathode rails, means for applying such potentials across each cathode rail and the anode of the bath individually that a predetermined quantity of electricity flows through each article in a period of time slightly less than said predetermined period of time, means for measuring the quantity of electricity flowing through each cathode rail, and means responsive to the measuring means for cutting off the potential-applying means from each cathode rail individually when said predetermined quantity of electricity has passed through the article.

2. A plating apparatus, which comprises a container for an electrolytic plating bath, anode material in the bath, a plurality of conductive carriers for advancing a series of articles through the bath one after another along a predetermined path in such a manner that each article is in the bath for substantially the same period of time, a plurality of cathode rails insulated one from another extending along the bath in positions adjacent to said path through the bath, contact means for connecting different ones of the carriers to different ones of the cathode rails in a given sequence as the carriers are advanced along the bath, means for applying predetermined potentials across the cathode rails and the anode material of the bath individually such that predetermined quantities of electricity flow through the carriers in said

period of time, means for measuring the quantity of electricity flowing through each carrier each time it is advanced along the bath, and means responsive to the measuring means for cutting off the potential-applying means from each cathode rail individually when a quantity of electricity predetermined for that carrier has passed through.

3. A plating apparatus, which comprises a container for an electrolytic plating bath, anode material extending along the bath, a plurality of conductive carriers for suspending articles therefrom, conveyor means for advancing the carriers seriatim through the bath in a predetermined path in such a manner that each article is in the bath for substantially the same period of time, a plurality of cathode rails insulated one from another extending along the bath in positions adjacent to said path through the bath, contact means for contacting the cathode rails, said contact means being mounted on the carriers in such positions that only one of the carriers at the bath at any instant is connected to each cathode rail, and a plurality of recycling control circuits connected to the cathode rails and the anode material for causing a predetermined quantity of electricity to flow through each carrier in said period of time.

4. An apparatus for electroplating articles, which comprises an elongated plating tank for a plating solution, anode material extending along the tank, a plurality of carriers for supporting articles and connected electrically thereto, recycling conveyor means for lowering the carriers one at a time to the tank, advancing them along a predetermined path through the tank, lifting them from the tank and moving the lifted carriers beyond the tank, said conveyor means serving to keep each article in the plating solution for substantially the same period of time, a plurality of cathode rails extending in parallel laterally spaced positions adjacent to said path through the tank, contactors mounted on some of said carriers for engaging one of the cathode rails as each of the last-mentioned carriers is lowered by the conveyor means to place the rack carried by the carrier in the tank, contactors carried by others of the carriers for engaging a second one of the cathode rails, a plurality of control circuits, one for each cathode rail, for applying sequentially a strike potential and a plating potential individually to said cathode rails and the anode material, each of said control circuits including current and time responsive means for cutting off the potential within said period of time, and means for resetting each control circuit after each carrier controlled thereby is moved out of the tank.

5. An apparatus for electroplating articles, which comprises an elongated plating tank for a plating solution therein, anode material extending along the tank, a plurality of carriers for supporting racks and connected electrically thereto, a plurality of racks for carrying articles to be plated, recycling conveyor means for lowering the racks one at a time into the tank, advancing them along a predetermined path through the tank, lifting them from the tank, and moving the lifted racks beyond the tank, said conveyor means being so designed and constructed that each article is in the tank for substantially the same period of time, a plurality of cathode rails extending in parallel laterally spaced positions adjacent to said path through the tank, a plurality of contactors mounted on some of said carriers for engaging a first one of the cathode rails as each of the last-mentioned carriers is lowered by the conveyor means to place the rack carried by the carrier in the tank, a plurality of contactors carried by others of the carriers for engaging a second one of the cathode rails, said contactors and said carriers being so spaced that only one contactor of each of said first-mentioned contactors engages said first one of the cathode rails and only one of each of said second-mentioned contactors engages said second one of the cathode rails at any instant, means for applying potentials individually to said cathode rails and the anode material such that a

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predetermined quantity of electricity flows through each carrier in a period of time less than said period of time, individual means for metering the quantity of electricity forced through each of the cathode rails, a plurality of means each responsive to one of the metering means for stopping the flow of electricity to the cathode rails associated therewith when said predetermined quantity of electricity has flowed through the carrier connected electrically with that guide rail by the contactor associated therewith, and means individual to each flow-stopping means for resetting the flow-stopping means after the carrier associated therewith is lifted out of the tank.

6. An electroplating apparatus, which comprises an elongated electroplating tank for a plating solution, an anode in said tank, a plurality of article carriers, recycling conveyor means for advancing the carriers along a predetermined path through the tank in such a manner that each article is in the tank for substantially the same period of time, a plurality of cathode rails, a plurality of supports composed of insulating material having slots therein for receiving the cathode rails and spacing them from one another in parallel positions extending adjacent to said path through the tank, resilient means for supporting the cathode rails in positions projecting into the slots, contactors carried by spaced ones of the carriers for engaging given ones of the cathode rails, contactors carried by others of the carriers interspaced between the last-mentioned carriers for engaging another cathode rail, means for applying a predetermined voltage across the cathode rails individually and the anode such that a predetermined quantity of electricity flows through each carrier in a period of time less than said period of time, resettable means individual to each cathode rail for measuring the quantity of electricity forced through each carrier in engagement with each cathode rail, means responsive

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to the measuring means for stopping flow of current to each cathode rail when said quantity of electricity has flowed through each carrier, and means for resetting the measuring means associated with each carrier after that carrier has been lifted from the tank.

7. An electroplating apparatus, which comprises an elongated electroplating tank for a plating solution, an anode in said tank, a plurality of article carriers, conveyor means for advancing the carriers along a predetermined path through the tank in such a manner that each article is in the tank for substantially the same period of time, a plurality of cathode rails, a plurality of supports composed of insulating material having closely spaced parallel slots therein for receiving the cathode rails and spacing them from one another in positions extending along the tank and adjacent to said path through the tank, pads of resilient insulating material for supporting the cathode rails in positions projecting into the slots, contactors carried by spaced ones of the carriers for engaging given ones of the cathode rails, contactors carried by others of the carriers interspaced between the last-mentioned carriers for engaging another cathode rail, and means supporting the carriers only partially so that the contactors are pressed firmly against the cathode rails.

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