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ELECTROPLATING METHOD AND SYSTEM

Filed Sept. 22, 1965

FIG. 1

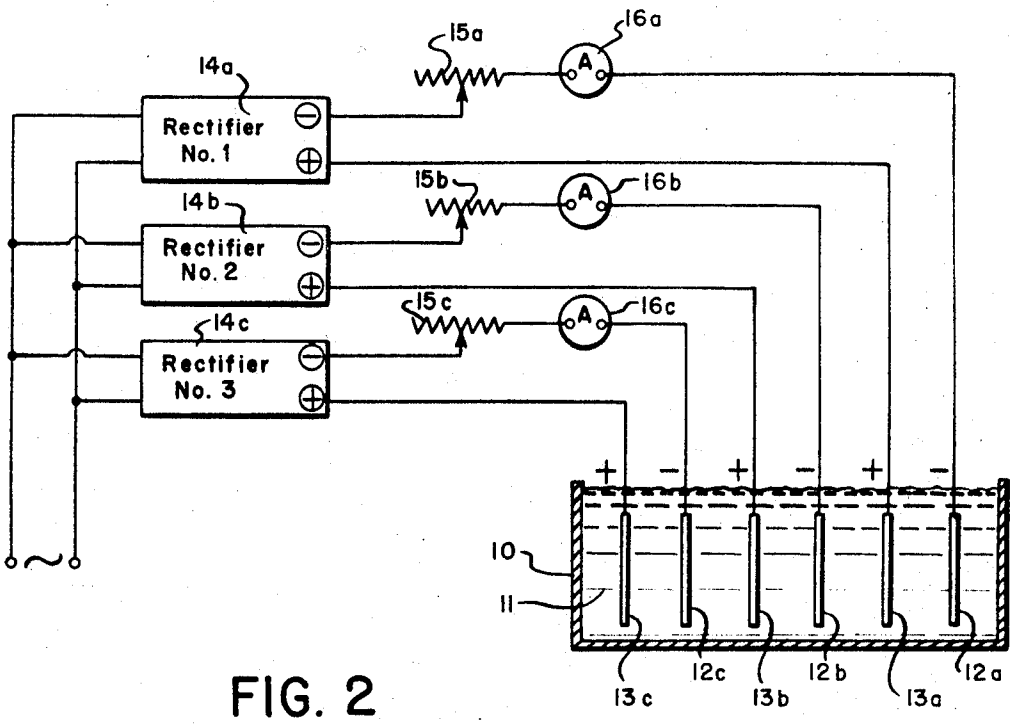


FIG. 2

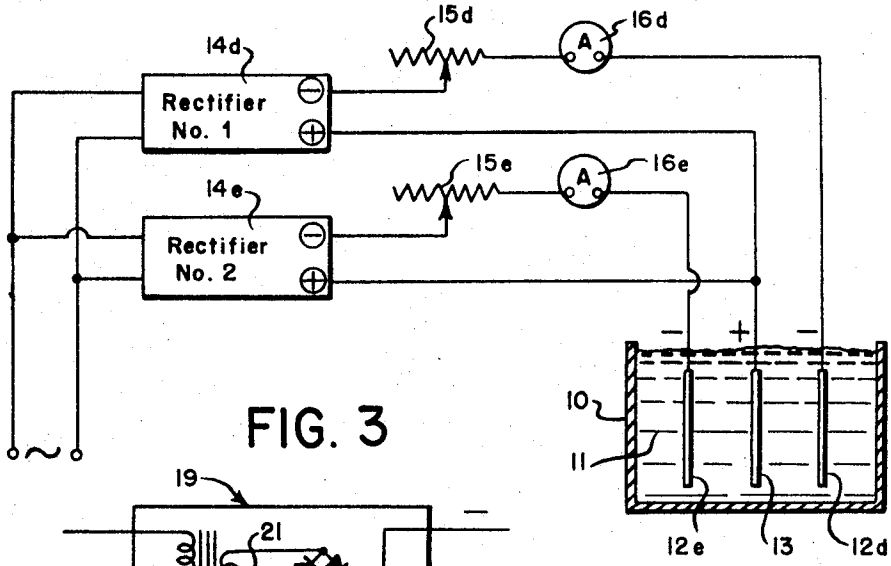
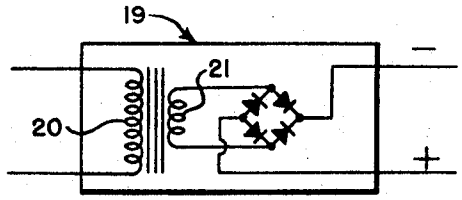


FIG. 3



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ELECTROPLATING METHOD AND SYSTEM

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ABSTRACT OF THE DISCLOSURE

A plurality of individual parts are electroplated in a common electroplating electrolyte by providing a separate and mutually independent source of electrolyzing current for each part being electroplated (for example, a separate rectifier for each part). The negative pole of each of the separate sources of electrolyzing current is connected to a separate one of the parts being electroplated and the positive pole of each source is connected either to separate anodes or to a common anode immersed in the electrolyte. Separate means are provided for controlling the amount of electrolyzing current flowing from each source of electrolyzing current through the electrolyte and the cathode associated with that source of electrolyzing current.

This invention relates to the electroplating of metals and other materials, and in particular to the electroplating of a plurality of different objects immersed in a common electroplating electrolyte.

In the electroplating of a metal object or part (or a part made of any other electrically conductive material), the part to be electroplated is immersed in an electrolyte containing cations of the metal being electroplated thereon, and an electrolyzing current from an external source (for example, a battery or a rectifier) is passed between the part being electroplated (that is, the cathode) and an anode (which may be soluble or insoluble) also immersed in the electroplating electrolyte. In the simplest case wherein a single object or part is being electroplated in the electroplating electrolyte, the quantity of metal electrodeposited onto the cathodic part can be precisely predicted and controlled in accordance with Faraday's Law. Moreover, by appropriate control of the composition of the electrolyte, solution temperature, cathode current density and other factors governing the electrochemical reaction at the cathode, an electrodeposited metal coating of uniform density and thickness can be obtained over the entire surface of the single part being electroplated. However, in the usual case wherein a large number of parts are of necessity being electroplated at the same time, it is not economically feasible to provide a separate electrolyzing tank and electroplating electrolyte for each individual part being electroplated. As a consequence, in the usual case a number of parts are ordinarily electroplated at the same time in a common electroplating electrolyte, each part being electroplated being connected in parallel to the cathodic pole of the source of electrolyzing current and the consumable anodes being connected in like fashion to the anodic pole of this source. However, when more than one object or part is being electroplated in a common electrolyte, it has heretofore been the experience of workers skilled in this art that the precise control over the quantity and quality of the metal coating being electrodeposited on each part is no longer attainable due to the presence of stray electrical currents in the electrolyte and to the resulting uneven and unpredictable distribution of electrolyzing current at each of the cathodic parts being electroplated.

The existence of stray currents and the resulting uneven distribution of the electrolyzing currents in an electrolyte containing a large number of parts being simultaneously electroplated has been a longstanding and difficult problem in the electroplating art, and a great deal of time and effort have been devoted to the solution of this problem. One well-known expedient for attempting to control the distribution of electrolyzing currents at each cathodic part being electroplated involves the installation of an ammeter and variable resistor or potentiometer in series in each parallel branch connecting each cathode part to the source of electrolyzing current. Each resistor or potentiometer is adjusted so that the total resistance of each parallel cathode branch is equal, in which event the quantity of current flowing through each branch (and hence through each cathodic part being electroplated) should also be equal. However, despite the fact that the same quantity of current apparently flows through each parallel branch of the cathodic side of the circuit, the existence of stray currents within the electrolyte which pass indiscriminately between all of the cathodic parts and all of the anodes immersed in the electrolyte prevents the attainment of the desired degree of predictability, precision and uniformity in the electroplating operation. A similar, somewhat more elaborate, attempt to solve this vexing problem involves the installation of a variable resistor and ammeter in all of the parallel branches, both cathodic and anodic, of the electrolyzing circuit. However, this expedient, and all others heretofore known to use, have met with equally unsatisfactory results due primarily to the fact that the various parallel branches of the electrolyzing circuit are not electrically isolated from each other either in the electrolytic bath or at the source of the electrolyzing current.

We have now developed a new method or system for carrying out simultaneously but nonetheless completely independently of each other the electroplating of a plurality of parts that are immersed in a common electrolyte, our new electroplating system substantially completely eliminating stray electrical currents in the common electrolyte and, as a result, insuring the attainment of a predictably uniform and evenly distributed layer of electrodeposited metal on each of the parts being electroplated. Our method for eliminating stray currents in an electroplating electrolyte containing a plurality of cathodic parts being electroplated and an anode associated with each of said parts comprises, in brief, providing a plurality of separate, mutually independent and electrically isolated sources of electrolyzing current, and electrically connecting each cathodic part and its associated anode (which may or may not be common to more than one of said parts) to the cathodic and anodic poles, respectively, of one of the aforesaid independent sources of electrolyzing current. The apparatus employed in the practical of our invention comprises an electrolyzing tank containing the electrolyte, at least one anode and at least two cathodic parts immersed in the electrolyte, and a plurality of mutually independent sources of electrolyzing current equal in number to the number of cathodic parts being electroplated. The cathodic pole of each source of electrolyzing current is electrically connected to a separate one of the cathodic parts being electroplated and the anodic pole of this source of current is electrically connected to the anode associated with said cathodic part. Potentiometer means are associated with each of said independent sources of electrolyzing current for controlling the amount of the electrolyzing current flowing from each source through the electrolyte between the electrodes (that is, the cathodic part and the anode associated therewith) of opposite polarity electrically connected thereto.

Our new system for eliminating stray currents ordi-

narily present when a plurality of cathodic parts are electroplated in a common electrolyte is a significant improvement over the aforementioned prior art practice, particularly in plating operations involving precise control over the thickness of the electroplate, as is the case in certain chrome plating operations.

Our invention will be more fully understood from the following description thereof in conjunction with the accompanying drawing of which

FIG. 1 is a schematic view showing a plurality of cathodic parts being electroplated in a common electroplating electrolyte in accordance with our invention,

FIG. 2 is a modification of the arrangement shown in FIG. 1 wherein a common anode is employed in conjunction with a plurality of otherwise independent and electrically isolated parts being electroplated in accordance with our invention, and

FIG. 3 is a schematic view of a rectifier suitable for use as one of the separate and mutually independent sources of electrolyzing current employed in the practice of our invention.

When a number of parts are to be electroplated at the same time, it is common practice to suspend the parts being electroplated in a common electroplating electrolyte containing cations of the metal being electrodeposited onto the cathodic parts, the electrolyte also having suspended therein a number of anodes which may be insoluble or soluble in the electrolyte, depending on the kind of electroplating operation being carried out. The cathodic parts (or cathodes) and anodes are commonly arranged so that anodes and cathodes are disposed alternately in the electrolyte as indicated in FIG. 1 of the drawing. The cathodic parts are normally electrically connected in parallel to the cathodic pole of a source of electrolyzing current (for example, a battery, or D.C. generator, or rectifier, or the like), and the anodes are electrically connected in like manner to the anodic pole of this source of electrolyzing current. Provision is usually made for controlling the amount of current flowing through each of the parallel branches of the electrolyzing circuit, but as previously explained the presence of stray currents throughout the electrolyte due to the lack of electrical isolation of the several branches of the electrolyzing circuit prevents the attainment of the degree of predictability and control over the layer of metal being electroplated on each cathodic part that is to be desired.

In accordance with our invention, the presence of stray currents in the electrolyte is substantially completely eliminated by providing separate, electrically isolated and mutually independent sources of electrolyzing current for each cathodic part being electroplated in the common electrolyte, as clearly shown in FIG. 1 of the drawing. The apparatus shown in FIG. 1 for carrying out our invention comprises an electrolyzing tank **10** containing an electrolyte **11** having dissolved therein cations of the metal being electroplated into the various cathodic parts immersed in the electrolyte. The cathodic parts **12***a*, **12***b* and **12***c* and the anodes **13***a*, **13***b* and **13***c* associated therewith are suspended in the electrolyte in the usual manner with the anodes and cathodes disposed alternately throughout the electrolyte. Each of the cathodic parts **12***a*, **12***b* and **12***c* is electrically connected to the cathodic pole of one of a plurality of separate and mutually independent sources of electrolyzing current (for example, separate rectifiers) **14***a*, **14***b* and **14***c*, respectively, the anodic pole of each of said sources of electrolyzing current being electrically connected to the anodes **13***a*, **13***b* and **13***c* associated with the cathodic part adjacent thereto. A variable resistor **15***a*, **15***b* and **15***c* (or an equivalent means for controlling the current flowing through each electrolyzing circuit) and an ammeter **16***a*, **16***b* and **16***c* are installed in each of the mutually independent electrolyzing circuits, as clearly shown in FIG. 1, in order to provide precise control over the quantity of current flowing through each of the mutually independent electrolyzing circuits and particularly between the cathodic part and the anode associated therewith in each circuit.

It is an essential feature of our invention that each of the separate and mutually independent sources of electrolyzing current be electrically isolated from all of the other sources of electrolyzing current so that the possibility of leakage of electrical current between the cathodic poles of the several sources of electrolyzing current is completely eliminated. The requirement for electrically isolated sources of electrolyzing current may be met by the use of separate storage batteries or separate D.C. generators for each electrolyzing circuit. However, when the source of electrolyzing current is a device for converting alternating current into direct current (i.e., a rectifier), as is usually the case, it is important that each rectifier be supplied with alternating current by means of its own individual transformer the secondary winding of which is electrically isolated from the secondary winding of all other such rectifier supply transformers. Thus, as indicated in the schematic drawing of a suitable transformer-rectifier arrangement **19** shown in FIG. 3, although the primary winding **20** of the rectifier supply transformer may be connected to a source of alternating current common to all such transformers, the secondary winding **21** of the transformer is electrically isolated from all other such secondary windings by the transformer air gap.

In view of the foregoing, it is apparent that the cathodic leg of each electrolyzing circuit in the common electroplating tank is electrically isolated from the cathodic leg of all of the other circuits in the tank by reason of the fact that separate and mutually independent sources of electrolyzing current are employed in each circuit. That is to say, the electrons travelling in each circuit in the common electrolyte are unique to that circuit and cannot stray into other circuits to upset the precise control over the electrolyzing conditions prevailing at each cathodic part. Because each of the electrolyzing circuits is electrically isolated from all of the other circuits, the current in each circuit can be independently adjusted to compensate for the different resistances of the cathodic parts being electroplated. Morever, the electroplating operation taking place at the cathodic part of each electrolyzing circuit can be started, adjusted, reversed or terminated without having any discernable effect on the other cathodic parts being electroplated in the common electrolyte.

At times it is desirable to plate a number of cathodic parts by the use of a common anode. Accordingly, in the modification of our electroplating system shown in FIG. 2, a plurality of cathodic parts **12***d* and **12***e* and a single anode **13** are immersed in a common electrolyte **11** contained in the electroplating tank **10**. Each cathodic part **12***d* and **12***e* is connected to a separate and mutually independent source of electrolyzing current **14***d* and **14***e* in the manner previously described. However, the anodic poles of both of the independent sources of electrolyzing current are connected to the single anode **13** that is common to both of the cathodic parts **12***d* and **12***e*. As in the embodiment of our invention previously described, the cathodic leg of each electrolyzing circuit is provided with a variable resistor **15***d* and **15***e* and an ammeter **16***d* and **16***e* by means of which the quantity of current flowing through each of the electrolyzing circuits may be individually controlled.

Although the anode leg in each electrolyzing circuit is connected to a common anode, the cathode leg of each circuit is connected to a separate cathodic part and to the cathode output of separate and mutually independent rectifiers each supplied with alternating current by its own independent rectifier supply transformer. The use of mutually independent rectifiers for each cathodic part being electroplated isolates the electron flow in each electrolyzing circuit. That is to say, the number of electrons leaving a rectifier at the cathode pole thereof equal the num-

ber returning at the anode pole, and no stray currents can be present in the electrolyte to interfere with the uniform deposition of metal on each of the cathodic parts being electroplated therein.

From the foregoing description of our new system for electroplating a number of cathodic parts in a common electrolyte, it will be seen that we have made an important contribution to the art to which our invention relates.

We claim:

1. In the method of simultaneously electroplating a plurality of cathodic parts in a common electroplating electrolyte in which a plurality of mutually independent and electrically isolated sources of electrolyzing current are provided, the number of said sources of electrolyzing current being equal to the number of cathodic parts being electroplated in the common electroplating electrolyte, the improvement which comprises:

electrically connecting the cathodic pole of each source of electrolyzing current exclusively to a separate one of the cathodic parts being electroplated and electrically connecting the anodic pole of each source of electrolyzing current to an anode, the electrical connection between each cathodic part and the associated cathodic pole of the source of electrolyzing current being maintained for the entire time that said cathodic part is being electroplated in said common electroplating electrolyte, and

controlling the amount of electrolyzing current flowing from each source of said current between the electrodes of opposite polarity electrically connected thereto.

2. The method according to claim 1 in which the anodic pole of each source of electrolyzing current is electrically connected to a separate anode.

3. The method according to claim 1 in which the anodic pole of each source of electrolyzing current is electrically connected to all of the anodes immersed in the common electrolyte.

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U.S. Cl. X.R.

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