350-363 SR FRENCH SEARCH ROOM
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CROSS REFERENCE

FIG. 1

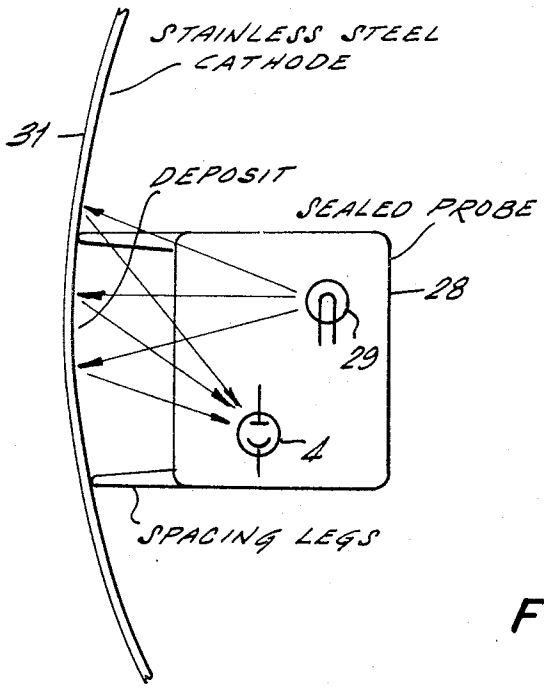


FIG. 1A

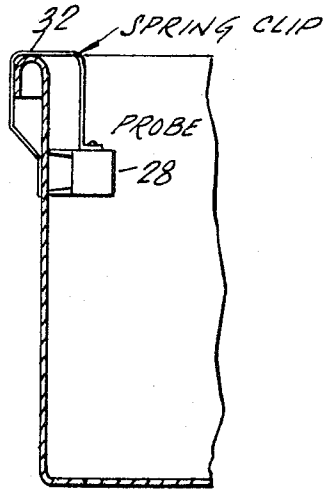


FIG. 2A

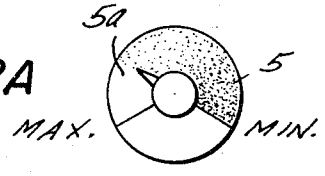
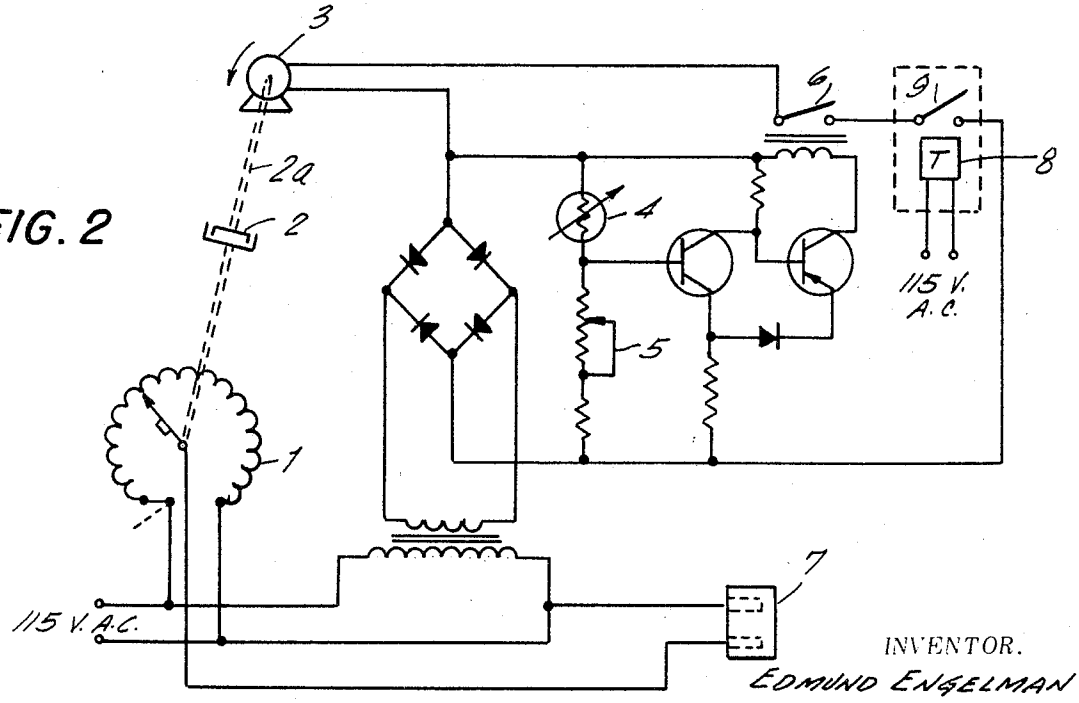


FIG. 2



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Aug. 18, 1970 E. ENGELMAN 3,524,805

SILVER RECOVERY SYSTEM

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FIG. 3

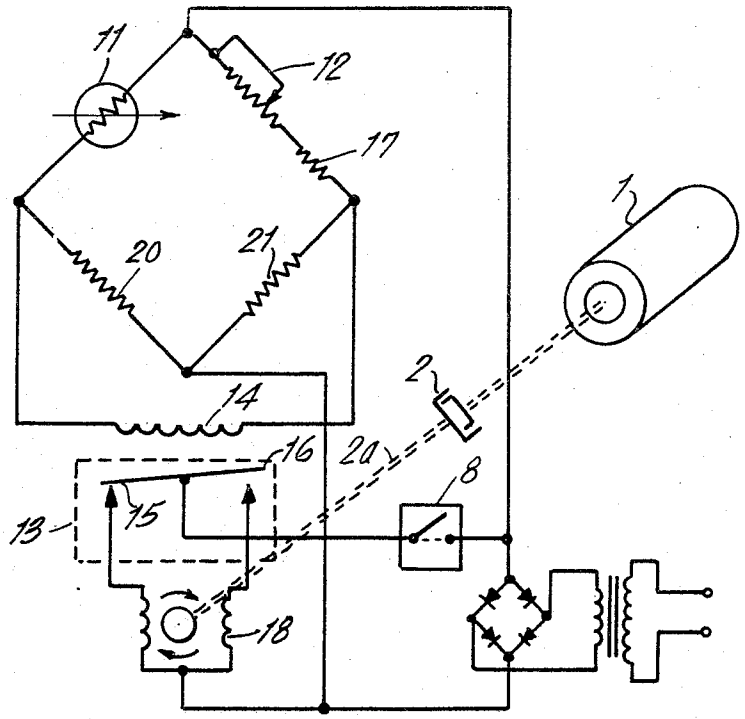
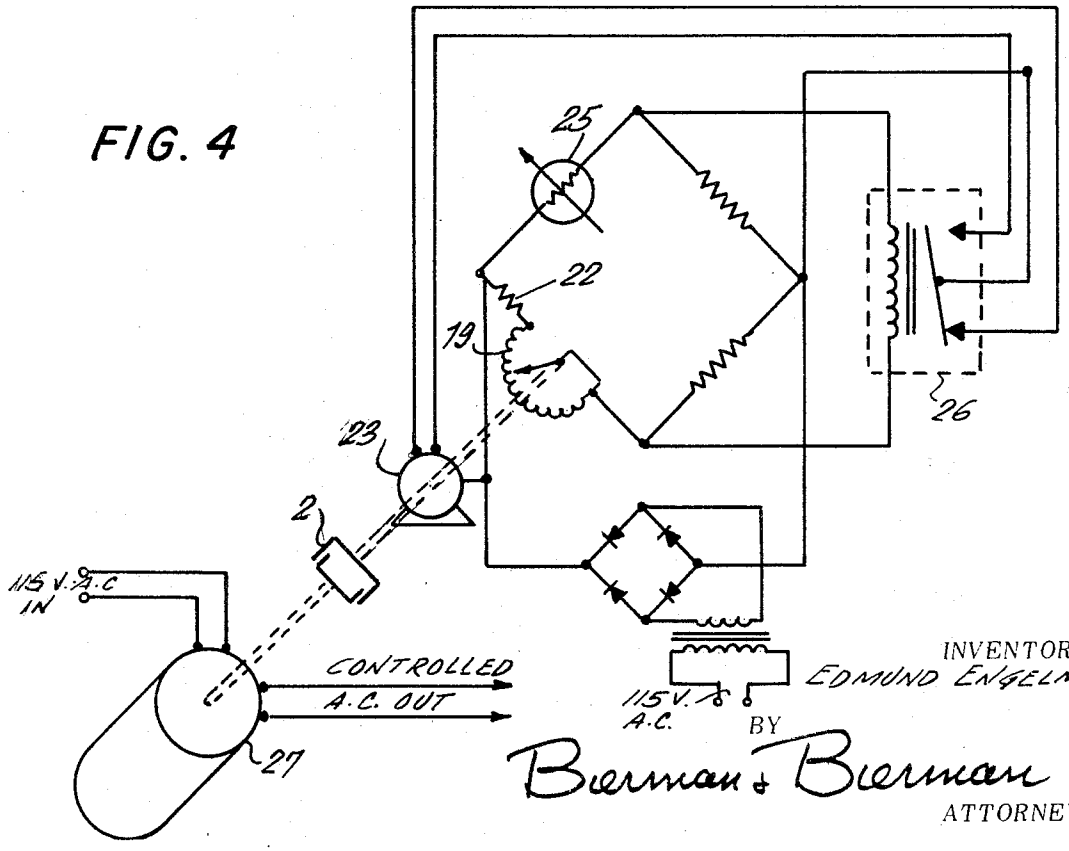


FIG. 4



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3,524,805

SILVER RECOVERY SYSTEM

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Int. Cl. B01k 3/00; C22d 1/12
U.S. Cl. 204—228 9 Claims

ABSTRACT OF THE DISCLOSURE

In a silver recovery system which includes the usual electrolytic cell, a silver-containing electrolyte and appropriate electrodes, the improvement comprising a sealed probe including a photoelectric cell which reads the reflections from the coat of silver deposited on the cathode through a series of balanced resistances, a variable transformer coupled to a motor operating the transformer to step down the voltage when the silver deposit starts to darken, thus preventing overload and too rapid deposition.

Deposition and/or recovery of silver from electrolyte solutions containing it have been known for many years. One of the problems inherent in such a system is the limitation of the rate of deposition so that the deposit is suitably bright and is not sulfidated. Sulfiding results from the use of excessive currents for the amount of silver in solution.

It can readily be seen that as silver is plated out from a given bath, the concentration of silver will decrease. This requires a corresponding decrease in the current flowing through the cell in order to avoid sulfiding. The present invention is intended to provide an automatic control system for this purpose.

It is therefore among the objects of this invention to provide an automatic control for a silver deposition and/or recovery system.

It is also among the objects of this invention to provide a control means which requires no supervision throughout the entire cycle of deposition.

It is further among the objects of this invention to provide a silver deposition control means which is unaffected by the cloudiness of the electrolytic bath.

It is still further among the objects of this invention to provide a control mechanism for a silver deposition and/or recovery system which will permit reduction of the silver content in the bath to less than 0.5 gram per liter.

In the accompanying drawings, constituting a part hereof and in which like characters represent like parts:

FIG. 1 is a schematic view of a suitable scanning device for use in the present invention;

FIG. 1A is a schematic view of a means for supporting the probe in the bath;

FIG. 2 is one form of control circuit for operating the bath in accordance with the present invention;

FIG. 2A is the rheostat equipped with suitable scale for determining the point at which no further deposition is to take place;

FIG. 3 is a schematic diagram of a modification of the invention in which the photo cell constitutes one arm of a Wheatstone bridge; and

FIG. 4 is a variation of the system shown in FIG. 3 in which the voltage is continuously and evenly varied in relation to the nature of the deposit.

Referring to FIG. 1 there is provided probe **28** containing lamp **29** and photoelectric cell **4**. The light from lamp **29** is directed at cathode **31** and reflects off onto photoelectric cell **4**. The entire unit is held by spring clip **32** on the edge of the cell in such position as will permit the photoelectric cell to read the amount of light being reflected off of cathode **31**.

In view of the fact that darkening of the silver deposit precedes sulfiding, good control can be obtained by developing a system such as the present invention which would react to a predetermined or pre-set amount of darkening and reduce voltage accordingly. In FIG. 2 a circuit for achieving this result is shown. Variable transformer **1** is coupled by means of clutch **2** and shaft **2***a* to a unidirectional stepping motor **3**. A direct current impulse turns motor **3** and with it shaft **2** and variable transformer **1** in the direction which decreases the output voltage of the transformer. The photoelectric cell **4** is placed in a standard triggering circuit which is adapted to close relay **6** at a predetermined setting of rheostat **5**.

Another view of rheostat **5** is shown in FIG. 2A. Scale **5***a* on rheostat **5** is shaded from dark to light grey corresponding to the darkest color of the deposit which will be obtained before relay **6** is tripped.

The system is started up by plugging the conventional silver recovery control unit into plug **7** of the control device. Clutch **3** is then released and the variable transformer **1** set to 115 volts. The recovery current is set to the amount indicated in the instructions of the commercial unit. Clutch **2** is then engaged after probe **28** has been placed in position.

When the silver content of the solution is reduced to the point that the deposit darkens to the shade of grey at which rheostat **5** is set, relay **6** will close. A direct current pulse will then be sent to the stepping motor **3** which through shaft **2***a* actuates variable transformer **1** to reduce the voltage by a predetermined unit.

This voltage reduction results in a reduction in current flowing through the cell and hence will make the silver deposit brighter. However, this change does not take place instantly but rather over a period of time up to as much as ten minutes.

Therefore it is necessary to actuate the probe every so often as for example every ten minutes. In order to achieve this, timer **8** with timing switch **9** is set to remain open for the desired period of time and to close after that interval for a few seconds. The timer is of standard and well-known construction and need not be further described here.

During the few seconds in which switch **9** is closed, the current can be transmitted to the motor **3**. While switch **9** is open no current can flow.

If during the period of time in which switch **9** is closed a deposit darker than the permissible is noted, relay **6** will close and the stepping motor **3** will be energized. This in turn will reduce the output voltage of transformer **1** and with it the current flowing in the cell. If on the other hand, during the closed portion of the cycle of switch **9** the deposit becomes lighter than the tripping point, relay **6** will remain open and the transformer will not be moved. Should the reduction in current previously made be insufficient to cause the desired lighter deposit, the motor **3** would receive a pulse due to the closing of relay **6** and timer switch **9** which would make it reduce the current still further. Obviously, in attempting to maintain the predetermined greyness of the deposit transformer **1** will ultimately reach zero voltage at which point switch **10** of the variable transformer would shut off the system completely and terminate the cycle.

In starting up, clutch **2** must be disengaged and the variable transformer set to 115 volts. After a while a lighter deposit from the new silver-rich solution will cover the darker deposit of the previous recovery cycle. At this point clutch **2** is engaged and the automatic control of the system commenced.

A modification of the basic invention is shown in FIG. 3. Photocell **11** on the probe **28** consitiutes one arm of a Wheatstone bridge. Rheostat **5** is provided with the

usual greyness scale 5*a* and is connected in the circuit in the same manner as the device of FIG. 2.

A bi-directional sensitive relay 13 is located as shown in FIG. 3 so that when the Wheatstone bridge is balanced, relay 13 will float. In this position no current passes through coil 14.

The contacts 15 and 16 of relay 13 are each connected to a stepping mechanism working in opposite directions from one another. When the deposit darkens beyond the point pre-set by rheostat 5, direct current flows through coil 14 causing the closing of contact 15 and energizing the stepper which turns the variable transformer in the direction of reduced voltage output and hence lower current through the cell. On the other hand, should the deposit become lighter than is necessary or desirable, current would flow through coil 14 in the opposite direction closing contact 16. This energizes the stepper which turns the transformer in the direction of higher output voltage and hence greater current through the cell.

As in the previously-described modification, timer 8 may be included in the circuit to provide sample testing either at predetermined time intervals or starting at a given time interval after the last movement of the variable transformer. Needless to say, this system can be used with a single stepper which turns the transformer in the direction of lower voltage only.

A further modification of the device can be achieved by replacing resistor 21 of the Wheatstone bridge with a photoelectric cell of the same kind as cell 11. This will provide automatic compensation for any effect which clouding or color change of the liquid in the deposition cell may have on the correct reading of cell 11. The photocell replacing resistor 21 would read the reflection from a non-metallic surface which has no silver deposit on it, but nonetheless is immersed in the electrolyte liquid.

Another modification of the invention is shown in FIG. 4. In this system one arm 22 of the Wheatstone bridge comprises a rheostat follower on a common shaft with a two-directional gear motor and the variable transformer 24. Rheostate 19 has the same range of resistance as does photoelectric cell 25 comparable to a shiny silvery deposit to the darkest grey which is satisfactory for reasonably good quality. As the deposit darkens, the resistance of cell 25 increases. The bridge becomes unbalanced and the sensitive relay is tripped setting the motor in motion. This in turn turns the variable transformer 27 as well as rheostat follower 22 until the resistance in rheostat 19 and the rest of arm 22 of the Wheatstone bridge is equal to that of cell 25. The bridge is then balanced and the motor stops.

In view of the value of the silver being deposited in systems such as the ones described herein, desirability of preventing theft or other loss of metal is clear. In the present systems an ampere hour meter may be sealed with the rectifier in a single unit. It will be made tamper-proof. Clearly, the number of ampere hours of electricity expended is a direct measure of the amount of silver (or any other metal) deposited. A fairly simple calibration of this meter can be made so that it reads directly in terms of amount of deposition.

While only a limited number of embodiments of this invention have been specifically described, these are intended to be illustrative only and this invention is to be broadly construed and not to be limited except by the character of the claims appended hereto.

What is claimed is:

1. In a silver recovery system comprising an electrolytic cell, adapted to hold a silver containing electrolyte, an anode and a cathode in said cell, said anode connected to a source of direct current, said cathode connected to said source of direct current, the improvement which comprises a sealed probe in said cell, said probe consisting of a light sensitive photoelectric cell positioned to receive reflections from silver deposited on said cathode, whereby variations in brightness of said silver cause variations in the resistance of said photoelectric cell, a relay in circuit with said photoelectric cell and a motor, whereby variation in said resistance causes said relay to close, a variable transformer coupled to said motor, the output voltage of said transformer controlling the input voltage of said electrolytic cell, said motor operating said transformer, whereby darkening of said silver to a predetermined point causes said photoelectric cell to trip a relay actuating said motor which in turn adjusts said transformer to vary the output voltage thereof.

2. In a system according to claim 1 wherein there is provided a timer switch in series with said motor, said switch permitting flow of current only when in the closed position, said switch remaining open for a predetermined period of time after each actuation of said motor.

3. A system according to claim 2 wherein said timer switch is open for predetermined periods of time.

4. A system according to claim 3 wherein said motor is uni-directional and reduces said voltage with each actuation.

5. A system according to claim 3 wherein a source of light is provided in said probe, said light be directed onto said silver whereby it reflects into said photoelectric cell.

6. A system according to claim 2 wherein said photoelectric cell is one arm of a balanced Wheatstone bridge, a bidirectional relay adapted to float when said bridge is balanced, whereby changes in color of said silver actuate said relay in either direction, whereby said input voltage is varied with the color of said silver.

7. A system according to claim 6 wherein a second arm of said bridge is a compensating photoelectric cell, said compensating cell adapted to read reflection from a non-metallic surface having no silver deposit in said electrolyte, whereby any change in color of said electrolyte is automatically compensated.

8. A system according to claim 6 wherein there is provided a rheostat in said probe whereby said predetermined point can be varied.

9. A system according to claim 1 wherein there is provided a sealed meter adapted to record the total ampere hours expended in the system during any given cycle.

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U.S. Cl. X.R.

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