

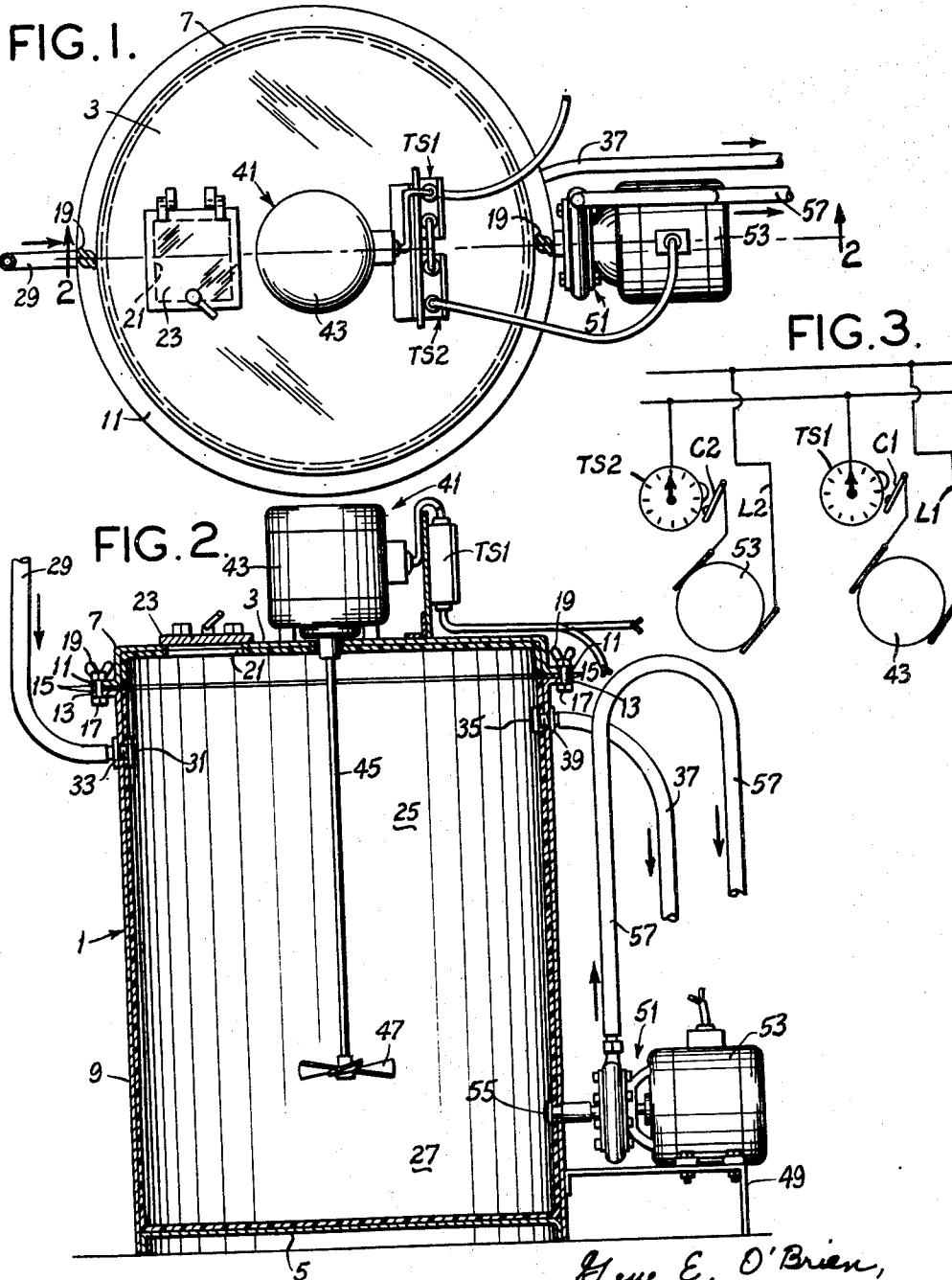
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SILVER RECLAIMING APPARATUS

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This invention relates to reclaiming apparatus and more particularly to novel apparatus for chemically reclaiming silver from silver-containing solutions.

As is known, the spent solutions from automatic X-ray film processing machines and photographic film and paper processing machines (which have their solutions automatically replenished) contain recoverable amounts of silver. It has been the practice to reclaim or recover the silver from such silver-laden solutions by collecting the solutions in bulk and transporting them to a central processing plant or station. After somewhat large quantities of the silver-containing solutions have been thus collected, the silver is reclaimed through the use of a precipitating agent such as powdered zinc or zinc dust or by means of conventional electroplating apparatus known to those in the art. The methods and apparatus heretofore utilized for reclaiming silver from such solutions have certain shortcomings which limit their utility and efficiency. Thus, the storage space, trucking facilities and labor involved in collecting silver-containing solutions and transporting them in bulk to a processing plant are expensive and somewhat impractical. Moreover, in view of the fact that most X-ray film and photographic film processing laboratories find space at a premium, it is impractical to use large storage tanks for the spent silver-containing solutions thereby necessitating frequent collections on the part of the reclaimer. Further, since the value of reclaimed silver is marginal, it is important to effect substantially complete recovery of the silver from such solutions to justify the cost of collecting and processing them. Also, existing electroplating apparatus and methods do not effect substantially complete recovery of silver from certain types of silver-containing solutions (e.g., those resulting from the processing of color film) without extensive supervision and adjustment thereof. Finally, while electroplating apparatus may be installed in film processing laboratories, the operation of such apparatus requires frequent adjustments thereof and close supervision on the part of technicians.

Accordingly, among the several objects of the present invention may be noted the provision of apparatus which effects substantially complete recovery of silver from silver-containing solutions of all types processed therein; the provision of such apparatus which is adapted to automatically process silver-containing solutions supplied thereto and which requires a minimum of maintenance, supervision and adjustment by a technician or attendant; the provision of apparatus of this type which is adapted to process silver-containing solutions which cannot effectively or conveniently be processed in other conventional apparatus; the provision of such apparatus which effectively processes silver-containing solutions irrespective of variations in their silver content; the provisions of such apparatus which occupies a minimum amount of space and which may be made portable; and the provision of apparatus of the character described which is of simple and economical construction. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

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FIG. 1 is a top plan view of the apparatus of the invention;

FIG. 2 is a cross section taken on line 2-2 of FIG. 1; and

FIG. 3 is a schematic circuit diagram of certain motors and time switches of the apparatus of the invention.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIGS. 1 and 2, the reclaiming apparatus of the invention is shown to comprise a stainless steel receptacle of circular cross section generally designated 1 constituting a chamber. It will be understood that receptacle 1 may be of any corrosion-proof or corrosion-resistant material or any material having an inside surface or lining resistant to corrosion. Thus, instead of stainless steel, receptacle 1 may be constructed of other metals or, if desired, of wood lined, for example, with a polyester resin, asphalt or other corrosion-resistant material. It will also be understood that receptacle 1 may be of rectangular cross section in which case the corners may be reinforced with fiberglass cloth, if desired.

As shown, receptacle or chamber 1 is closed at its top 3 and bottom 5 and is fabricated in two sections, namely, an upper section generally designated 7 and a lower section generally designated 9. Extending around the circumference of the upper section 7 adjacent the top 3 of the receptacle 1 is a flange 11 and extending around the circumference of the upper end of the lower section 9 is a like flange 13, flange 11 having a pair of holes 15 therearound in registry with a similar pair of holes 15 in flange 13. Upper section 7 of the receptacle is secured to lower section 9 by bolts 17 extending through holes 15 in flanges 11 and 13 and threaded into wing nuts 19. In the top 3 of the receptacle 1 is an access opening 21 provided with a hinged cover 23. Access to the inside of receptacle 1 may thus be gained through access opening 21 by lifting hinged cover 23 or by removing the upper section 7 from lower section 9 through removal of bolts 17 and wing nuts 19.

It will be understood that the receptacle 1 may be fabricated in various other ways known to the art which permit access to the inside of receptacle 1.

As will appear more fully hereinafter, receptacle or chamber 1 has an upper portion designated 25 for receiving silver-containing solution and a lower portion generally designated 27 for receiving silver precipitated from the silver-containing solution in the upper chamber 25.

At 29 is indicated a line leading from a source of silver-containing solution such as an automatic film processing machine (not shown), for example, to an inlet 31 in the wall of the receptacle 1 adjacent the upper end of lower section 9. As shown, line 29 is fitted into an adapter 33 threaded into the wall of the receptacle 1. Opposite inlet 31 is an overflow outlet 35 provided with a line 37 leading from the receptacle 1 to the drain pan (not shown) of the automatic film processing machine. As shown, line 37 is fitted into an adapter 39 threaded into the wall of the receptacle 1. Lines 29 and 37 may be of any suitable material such as flexible or rigid plastic tubing or metal pipe.

Mounted on the top 3 of receptacle or chamber 1 is mixing apparatus generally designated 41 which includes a motor 43, a mixer shaft 45 driven by the motor 43 and extending down into the upper portion 25 of the chamber 1, and a mixer blade 47 at the end of the shaft. Motor 43 is connected in an electrical circuit including line L1, time switch TS1 and contacts C1.

Mounted on a supporting bracket 49 adjacent the lower end of the chamber 1 is a centrifugal pump generally designated 51 which includes a motor 53. Pump 51 communicates with the inside of chamber 1 through inlet 55 and discharges solution pumped from upper portion 25

out through line 57. As shown, inlet 55 is located adjacent the lower end of chamber 1 above the bottom of chamber 1 and above the level in the lower portion 27 of the chamber to which precipitated silver will accumulate. Pump motor 53 is connected in an electrical circuit including line L2, time switch TS2 and contacts C2. Time switches TS1 and TS2 are conventional time switches, for example, of the 24-hour synchronous clock timer type with an "on" cycle of one hour. Lines L1 and L2 are connected to a source of electrical power (110 v.).

Operation is as follows:

Assume the apparatus of the invention is employed to reclaim silver from silver-containing solution supplied from an automatic film processing machine operating for a period of eight hours a day (9:00 a.m.-5:00 p.m.). A supply of powdered zinc or zinc dust is first placed in chamber 1. The amount of zinc used is determined by the volume of silver-containing solution to be processed each day and the silver content of the solution, and can be readily calculated by those skilled in the art on the basis of these two factors. Preferably, the amount of zinc placed in the chamber should be in excess over that required to process the volume of silver-containing solution to be supplied to the apparatus over a period of two to four weeks.

Silver-containing solution is supplied to chamber 1 through line 29 from the automatic film processing machine intermittently throughout the eight-hour period of operation of the machine. The capacity of chamber 1 measured from pump outlet 55 to overflow outlet 35 (i.e., in upper portion 25) should be greater than the total volume of the silver-laden solution supplied to the receptacle in any given period of operation of the automatic film processing machine. However, if the volume of silver-containing solution supplied during a given period, in this case eight hours, exceeds the capacity of the chamber 1, the excess flows out of the chamber 1 through outlet 35 and line 37 to the drain pan of the automatic film processing machine.

Time switch TS1 is set so as to close contacts C1 and energize mixing apparatus motor 43 at a predetermined time, in this case 6:00 p.m. (an hour after the automatic film processing machine has discontinued operation and is no longer supplying silver-containing solution to the receptacle 1). Energization of motor 43 continues for one hour (i.e., until 7:00 p.m.) after which contacts C1 are opened and remain open for 23 hours until 6:00 p.m. of the following day. During this one-hour period, the silver-containing solution in the upper portion 25 and the zinc dust in the chamber 1 are continuously stirred by mixer blade 47 whereby the zinc reacts with the solution to precipitate silver therefrom. After motor 43 has been deenergized, the precipitated silver is allowed to settle from upper portion 25 down to lower portion 27 of chamber 1. For best results, a period of at least three hours, and preferably six hours, is allowed for complete settling of the precipitated silver.

Time switch TS2 is set so as to close contacts C2 and energize pump motor 53 at a predetermined time, in this case 1:00 a.m. (after the precipitated silver has been allowed to settle into lower portion 27 for a period of six hours). Energization of pump motor 53 continues for one hour (i.e., until 2:00 a.m.) during which time the supernatant liquid remaining in upper portion 25 and from which silver has been precipitated and allowed to settle to lower portion 27, is pumped out through outlet 55 and line 57. The precipitated silver in lower chamber 27 is, of course, unaffected by this pumping operation. After pump motor 53 has been deenergized, contacts C2 remain open for 23 hours until the following day at 1:00 a.m. when time switch TS2 again operates to close these contacts and reenergize pump motor 53 for one hour.

After the above described operations have been completed, chamber 1 is then ready to receive and process

additional quantities of silver-containing solution at 9:00 a.m. the second day. The above described operations are automatically repeated each day with the reclaimed silver from each batch of solution thus processed being collected in lower portion 27 of chamber 1 as described. After an operating period of two to four weeks, for example, the residual zinc (if any), reclaimed silver and any solution in lower portion 27 are removed therefrom in any desired manner, as by means of a semi-solid pump. The reclaimed silver is thereafter dried and smelted in the conventional manner to complete the reclaiming operation.

It will be understood that time switches TS1 and TS2 may be set to operate at any predetermined time desired and also may be adapted to have an "on" cycle of more than one hour if desired. It will also be understood that a single time switch may be employed in place of two time switches to intermittently energize motor 43 and motor 53 as described with any desired time lapse between the deenergization of motor 43 and the energization of motor 53.

The above described apparatus of the invention is particularly useful for reclaiming silver from silver-containing solutions supplied from automatic film processing machines on a continuous basis. The apparatus may be readily modified so as to be adapted for use in reclaiming silver on a batch process basis from silver-containing solutions used in the manual photographic and X-ray film developing process. For this purpose, casters are added to the base of receptacle or chamber 1 to make it mobile and time switches TS1 and TS2 are replaced with two time switches of the type which may be set manually. Also, a self-priming pump is provided on the top 3 of the receptacle 1.

With these modifications, the apparatus may be rolled to a stationary hypo tank containing spent silver-containing solution. The solution is pumped from the tank into chamber 1 through access opening 21 by the self-priming pump. The apparatus is then rolled back to the storage area and line 57 is placed in a sink or drain. Lines L1 and L2 leading from the manually set time switches are connected to a source of electrical power (110 v.). A measured amount of zinc dust or powdered zinc is then placed in chamber 1 and the first time switch (connected to motor 43) is manually set so as to energize motor 43 for a period of one hour. The second time switch (connected to motor 53) is set so as to energize motor 53 six hours after motor 43 is deenergized. Thus, motor 43 will be energized for one hour to cause continuous stirring of the silver-containing solution and zinc by mixer blade 47 to react the zinc with the solution to precipitate silver. After motor 43 has been deenergized, the precipitated silver is allowed to settle for six hours into lower portion 27 after which motor 53 is energized and pump 51 pumps out the solution remaining in upper portion 25 through outlet 55 and line 57. The precipitated silver is then removed from lower portion 27 of chamber 1 as previously described.

The above described modified apparatus of the invention effectively removes silver from silver-containing solutions, requires only a minimum amount of a technician's time to operate and is substantially less expensive than other forms of reclaiming apparatus such as electroplating apparatus.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Apparatus for reclaiming silver from silver-containing solutions comprising a receptacle constituting a

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chamber and having an upper portion for receiving silver-containing solution and a lower portion for receiving silver precipitated from said solution in said upper portion, an inlet for admitting silver-containing solution to the upper portion of said chamber, means for introducing a precipitating agent into said chamber, a stirrer for stirring the solution in said upper portion of the chamber to react the silver in said solution with a precipitating agent, a pump having an inlet in the lower portion of said chamber, said inlet being connected to the lower portion of said chamber above the bottom of the chamber and above the level in the lower portion of said chamber to which precipitated silver will accumulate, a first motor for driving said stirrer, a second motor for driving said pump, and control means for periodically energizing the stirrer motor to operate for a predetermined time cycle followed by a dwell interval of said stirrer motor until the time for the next cycle of operation thereof and for periodically energizing the pump motor to operate for a predetermined time cycle followed by a dwell interval of said pump motor until the time for the next cycle of operation thereof, with a time interval between the stirrer motor cycle and the pump motor cycle sufficient to permit settlement of silver precipitated from said solution to the lower portion of said chamber, said control means comprising a pair of switches, one of which is interconnected with the stirrer motor and the other of which is interconnected with the pump motor, and clock means for actuating and deactuating each of said switches once during each said time cycle.

2. Apparatus for reclaiming silver from silver-containing solutions comprising a receptacle constituting a chamber and having an upper portion for receiving silver-containing solution and a lower portion for receiving silver precipitated from said solution in said upper portion, an inlet for admitting silver-containing solution to the upper portion of said chamber, an overflow adjacent the upper

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end of said chamber, an opening for introducing a precipitating agent into said chamber, a stirrer for stirring the solution in said upper portion of the chamber to react the silver in said solution with a precipitating agent, a pump having an inlet in the lower portion of said chamber, said inlet being connected to the lower portion of said chamber above the bottom of the chamber and above the level in the lower portion of said chamber to which precipitated silver will accumulate, a first motor for driving said stirrer, a second motor for driving said pump, and control means for periodically energizing the stirrer motor to operate for a predetermined time cycle sufficient to react the silver in said solution with said precipitating agent, followed by a dwell interval of said stirrer motor until the time for the next cycle of operation thereof and for periodically energizing the pump motor to operate for a predetermined time cycle to pump the solution remaining in said upper portion of the chamber from said upper portion after silver precipitated therefrom has settled to the lower portion of the chamber, followed by a dwell interval of said pump motor until the time for the next cycle of operation thereof, with a time interval between the stirrer motor cycle and the pump motor cycle sufficient to permit settlement of silver precipitated from said solution to the lower portion of the chamber, said control means comprising a pair of switches, one of which is interconnected with the stirrer motor and the other of which is interconnected with the pump motor, and clock means for actuating and deactuating each of said switches once during each said time cycle.

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