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APPARATUS FOR PHOTOGRAPHIC PROCESSING

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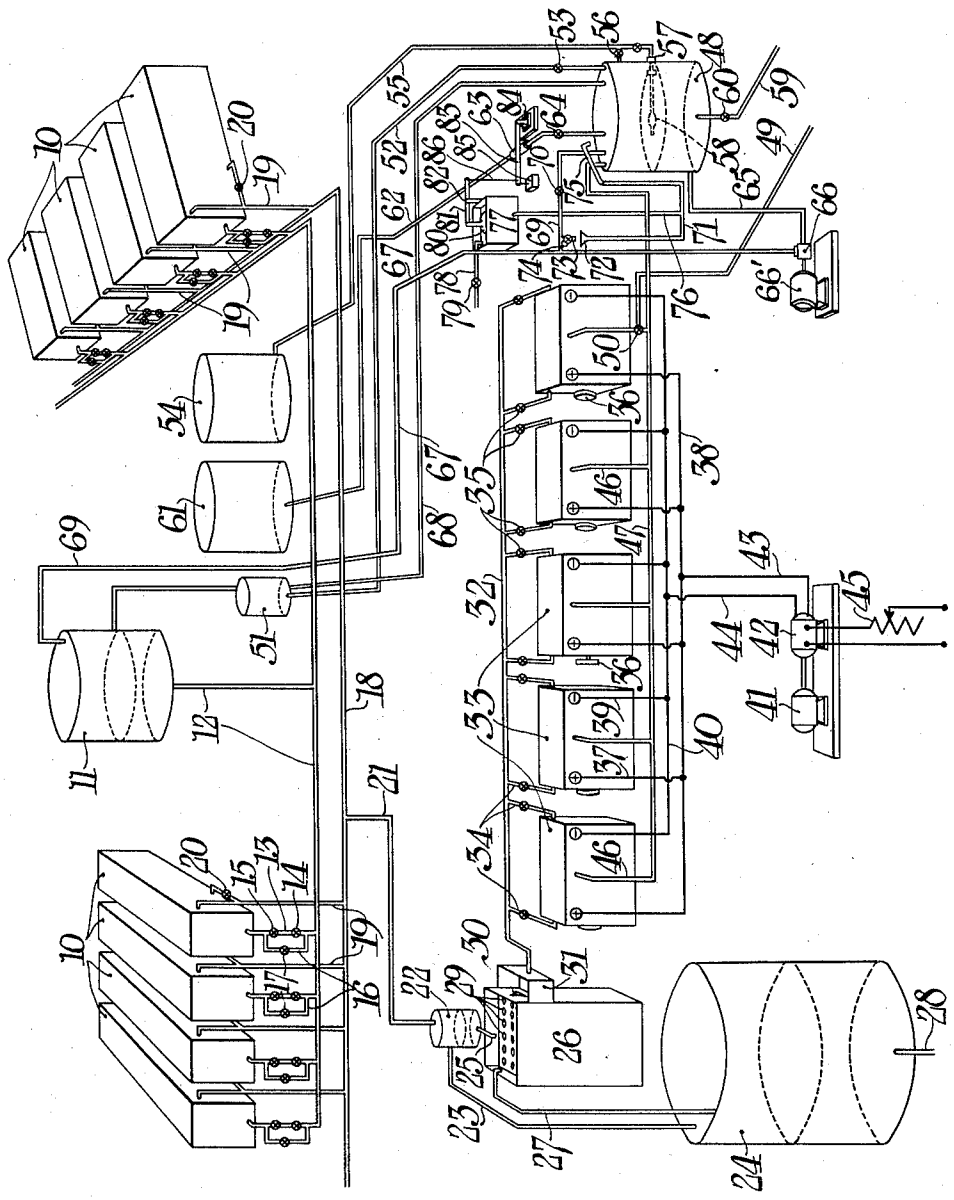

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APPARATUS FOR PHOTOGRAPHIC PROCESSING

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7 Claims. (Cl. 204—5)

The present invention relates to an apparatus for photographic processing and more particularly to an apparatus for circulating and recirculating a used photographic fixing solution through a plurality of electrolytic units, being a division of my copending application Serial No. 542,053, filed June 4, 1931, for a Method for photographic processing.

The primary object of the invention is the provision of an apparatus for photographic processing which continuously circulates and recirculates the silver laden fixing solution through one set of electrolytic units for incomplete but high efficiency plating and which bleeds a portion of said solution through another set of electrolytic units for substantially complete but low efficiency plating of the silver from the solution.

Another object of the invention is the combination with a silver recovery apparatus of a means for automatically replenishing the fixing solution so that the quantity and concentration of the solution remain substantially constant.

A further object of the invention is the grouping of the electrolytic units into working units and tailing units, the continuous circulation and recirculation of the electrolyte through the working units, and the circulation and exhaustion to waste of the electrolyte through the tailing units.

Other objects of the invention will be suggested to those skilled in the processing art as the description of my invention is developed hereinafter.

With these objects in view, the present invention consists in certain features of novelty in the construction, combination and arrangement of parts by which the said objects and certain other objects are effected, all as fully described with reference to the accompanying drawing, and more particularly pointed out in the appended claims.

In the drawing like reference numerals designate similar units and the figure is a diagrammatic illustration of a processing laboratory which may be operated according to my invention and which contains the apparatus suitable for the operation of my invention.

The obvious way to utilize the electrolytic units is to fill them with silver laden fixing solution, apply a maximum plating current and gradually diminish the plating current according to the depletion of silver content. If half of the silver is removed in a unit of time, only half of the remaining silver will be plated out in the next unit of time, etc. so that it will require considerable time before all of the silver is removed from the solution. As a practical means, the last traces of silver are plated from the solution more rapidly than is indicated by the exponential scale. Even so this method of operation requires periodic analyses of the solution of electrolyte so that the plating current may be properly controlled. Consequently, the intermittent method of operation is not recommended.

On the other hand, with a continuous flow of silver laden fixing solution through the electrolytic units, the silver plating is effected quite efficiently when only a portion of the silver is removed from the solution. It is apparent that if N electrolytic units are required to reduce the silver content to one-half of the original, 2N electrolytic units will be necessary to reduce the silver content to one-quarter of the original, 3N electrolytic units to reduce the silver content to one-eighth of the original, etc. For the removal of 99% of the silver, N units will remove approximately 50%, whereas it will require 5N electrolytic units to plate out the remaining 49% of the silver.

The electrolytic silver recovery is effected with much higher efficiency if the electrolytic units are grouped into working units and tailing units. The units comprising each of these groups may be individual plating cells or may be individual compartments within a single cell for small installations. The group of working units receives the main bulk of the fixing solution in a rapid, continuous flow. Heretofore, the fixing solution has been used in the processing or fixing apparatus until its silver concentration was 5–8 grams of silver per liter of fixing solution. Since the present apparatus greatly facilitates the removal of silver from the fixing solution and since greater efficiency of operation may be obtained with smaller silver concentration in the fixing solution, the fixing solution is used in processing only until the silver content of the solution becomes 2–3 grams of silver per liter of fixing solution and is then passed through the electrolytic units where the silver content is reduced to ¾ of a gram per liter of fixing solution.

The tailing electrolytic units receive a small portion of the total fixing solution to remove substantially all the silver therefrom before allowing the solution to be discharged to waste. The flow of solution as an electrolyte through the tailing units is somewhat smaller than through the working units so that substantially complete recovery of the silver may be effected more readily.

The economy achieved by the grouping of the

electrolytic cells is well illustrated by an examination of the situation where a certain quantity of fixing solution is circulated through the units. For instance, for the purpose of the present illustration it is assumed that the fixing solution passes through the working cells three times before a portion is bled off through the tailing units to waste. The quantity of silver recovered by the working units will be

$$3N(2\frac{3}{4})=3\frac{3}{4} \text{ grams Ag}$$

while that removed by the tailing units will be

$$1N=\frac{3}{4} \text{ grams Ag}$$

Thus, five times as much silver will be removed at high efficiency plating as will be left at lower efficiency tailing.

In the illustrated embodiment of my invention the fixing solution is used in a processing apparatus until the silver content thereof increases to the limit previously indicated. The processing means may comprise a plurality of fixing tanks 10, for positive or negative photographic material, or both. The fixing tanks 10 may be located in different parts of the laboratory and if necessary at different levels therein.

The fixing solution contemplated through the disclosure of my apparatus may be any standard solution which is suitable for the requirements at hand. As an example, only, the constituents of a thiosulfate photographic fixing bath are given below:

	Parts
Sodium thiosulfate	300
Sodium sulfite	10
Acetic acid (or the equivalent)	10
Chrom alum	10
Water	1000

The fixing solution of desired composition is supplied to a service tank 11, which is located preferably at sufficient height above the fixing tanks 10 so that solution will be supplied thereto by gravity through the supply main 12. The individual fixing tanks 10 are connected to supply main 12 by pipes 13, each of which contains a regulating valve 14 and a shut-off valve 15. A by-pass 16 for the valves 14 and 15 contains a quick-filling valve 17 to permit rapid flow of solution to fixing tank 10 without alterating the adjustment of regulating valve 14.

The fixing solution is discharged from the fixing tanks to a discharge main 18 connected by individual branch pipes 19 to the fixing tanks 10. One branch of pipe 19 is connected to a fixing tank 10 so as to maintain the desired level of solution within tank 10. The other branch of pipe 19 is connected to dump valve 20 to the bottom of tank 10 so that the solution therein may be rapidly discharged if necessary or desired.

The discharged fixing solution is conducted by a pipe 21 to a spill tank 22. An overflow pipe 23 is connected at an intermediate level to spill tank 22 and extends into an overflow tank 24. Spill tank 22 has a spout 25 connected to the bottom thereof and conducts the solution into a filter box 26. An airlift 27 returns overflow solution from overflow tank 24 to filter box 26. If required, fixing solution may be discharged to waste from overflow tank 25 by a discharge pipe 28. The filter box 26 may be of any well known construction or may consist of a plurality of felt socks (not shown) suspended beneath the hold 29 in the filter box.

After filtration, the fixing solution flows through a weir into a weir box 31 from whence it is conducted through an electrolytic unit supply main 32. A plurality of electrolytic units 33 are each connected to the supply main 32 by a pair of branch pipes 34. Each of the branch pipes 34 are connected at opposite ends of the electrolytic units 33 and contain valves 35 for regulating the supply of fixing solution or electrolyte to the individual electrolytic units 33. The electrolytic units are preferably constructed in accordance with the co-pending application of Hickman & Weyerts, Serial No. 540,621, filed May 28, 1931, for improvement in Apparatus for electroplating silver from used photographic fixing solutions. The electrolytic units 33 are provided with mechanical agitating means rotated by belt drives to pulleys 36.

The plates within the electrolytic units 33 are alternately connected in a known manner by leaders 37 to an anode bus bar 38 and by leaders 39 to a cathode bus bar 40. A source of low voltage uni-directional electrical energy is provided by a low voltage direct current generator 42 driven by a motor 41, the positive side of generator 42 being connected by a wire 43 to the anode bus bar 38, while the negative side of generator 42 is connected by a wire 44 to the cathode bus bar 40. The plating current supplied by generator 42 is controlled by regulation of a variable resistance or field rheostat 45 which is inserted in the excitation circuit for the generator. The field rheostat 45 may be manually operated to give the desired plating current or may be automatically operated to vary the plating current corresponding to the silver concentration of the fixing solution and rate of flow thereof, according to my co-pending application, Serial No. 540,620, filed May 28, 1931, for improvements in Automatic silver recovery control.

The desilvered fixing solution may be conducted from the center of units 33 by outlets 46 through a discharge main 47 to a tank 48. The discharged fixing solution from one or more of units 33 may be conducted to waste by pipe 49 connected to a two-way valve 50 in outlet 46. The units 33, which have solutions continuously circulating therethrough, are classed or grouped as working units, while the units 33 which are adapted to have the solution therefrom discharged to waste are grouped as tailing units. The rate of flow of solution through the working units 33 is preferably more rapid than the rate of flow of solution through the tailing units 33, because as previously mentioned, the rate of silver plating in the working units is more rapid than in the tailing units and is not continued until the silver is substantially exhausted from the solution, as in the tailing units.

The desilvered fixing solution in tank 48 may be deficient in hardener which may be supplied from a hardener tank 51 through a pipe 52 leading into tank 48. The supply of hardener to tank 48 may be manually controlled by regulation of valve 53 in pipe 52. Since a portion of the fixing solution is preferably discharged to waste from the tailing units 33, it will be necessary to replenish the solution in tank 48 in order to maintain a constant quantity of solution in circulation through the entire apparatus. Consequently, the tank 54 is filled with replenishing solution which is merely a photographic fixing solution of proper composition. The tank 54 is connected by a pipe 55 through a manually controlled valve 56 to the tank 48 or alternatively through a float operated valve 57, which is auto-

matically controlled by the position of float 58 within tank 48 to maintain a solution level, such as indicated by the dotted line in the drawing. If desired, solution from tank 48 may be discharged to waste through pipe 59 and valve 60.

In practice the sodium thiosulfate concentration of the solution will be diminished upon passage through the processing apparatus and desilvering in the electrolytic units 33. Therefore, a tank 61 is supplied with a solution of sodium thiosulfate which has a higher concentration than the proper or desired fixing solution. This solution of higher concentration may be conducted from tank 61 through a pipe 62 having a rubber hose 63 intermediately inserted therein and having a manually controlled valve 64.

The fixing solution is conducted from tank 48 by a pipe 65 to a pump 66 actuated by a motor 66'. The solution is discharged from pump 66 through a pipe 67 into the service tank 11. If the level of solution in service tank 11 reaches that indicated in dotted line, the solution will overflow through pipe 68 back into tank 48.

A by-pass 69 leads from pipe 67 into tank 48. This by-pass 69 may be regulated manually by a valve 70 to control the amount of solution being returned through pipe 67 to the service tank 11. Therefore, the rate of flow of solution between tank 48 and service tank 11 will depend upon several factors, among them the capacity of pump 66, the quantity of solution being discharged from service tank 11 to fixing tanks 10 and the opening of valve 70 in the by-pass 69.

The continual use of solution for processing and subsequent desilvering thereof will result in a decrease of sodium thiosulfate concentration. This deficiency is automatically compensated for by automatically controlling the supply of strong sodium thiosulfate from tank 61 to tank 48. The automatic control for the supply of strong sodium thiosulfate comprises a balancing means which operates a valve means to control the supply of solution. The balancing means comprises in part a U-tube, 71, which has a funnel shaped end 72 under a tap 73 which leads from by-pass 69 and which may be manually controlled by a valve 74. The other end of U-tube, 71, has an adjustable spout 75, which may be moved into any desired position above the tank 48.

Thus, it will be seen that the level of solution in the U-tube, 71, will depend directly upon the position of spout 75, while the rate of flow of solution through U-tube 71 will depend upon the adjustment of valve 74. The balancing means also includes a vertical pipe 76 connected at its lower end to the center of U-tube 71 and its upper end to a float box 77. The float box 77 receives through a pipe 78 a supply of water which may be regulated by valve 79. The float box 77 contains a float 80. A lever 81 fulcrumed at 82 is moved by float 80 into positions corresponding to the level of water within float box 77. A lever 83 is fulcrumed to a bracket 84 at one end and has a weight 85 attached to its free end. The free end of lever 83 is connected by a rod or wire 86 to one end of lever 81. The lever 83 is located adjacent the rubber hose 63 in pipe 62, and weight 85 is heavy enough so that lever 83 will kink hose 63 to prevent the flow of strong sodium thiosulfate from tank 61 to tank 48 but still light enough to be raised by the weight of float 80 when the liquid level in float box 77 decreases.

If solution of proper concentration is passing through U-tube 71, the head of water in pipe 76 and float box 77, which is balanced by the column of solution in one leg of U-tube 71, will be of such a level that lever 83 closes off the supply of more concentrated sodium thiosulfate from tank 61. The quantity of solution flowing through the other leg of U-tube 71 will depend upon the adjustment of valve 74 and valve 79 for the water supply, that is, both water and solution will be discharged from spout 75. A decrease in the sodium thiosulfate concentration of the solution being circulated between tanks 48 and 11 will decrease the weight of solution in one leg of U-tube 71. The head or column of water in float box 77 and pipe 76 will now predominate, and more water will flow through spout 75 to decrease the water level in float box 77. The float 80 will lower with the decrease in water level to raise lever 83 and allow a quantity of more concentrated solution of sodium thiosulfate to flow into tank 48 from tank 61. It should be noted that the spout 75 may be adjusted to alter the concentration of solution, which will be maintained by this automatic control. If spout 75 is raised, a greater column of solution will be maintained in U-tube 71 and it will require a greater head of water or higher level in float box 77 to balance the same. A larger decrease in solution concentration will be necessary before the float 80 will drop to such a level that lever 83 will be raised. Conversely, if spout 75 is lowered, the decrease in water level necessary to raise lever 83 will be less. Therefore, lowering of spout 75 will increase and raising of spout 75 will decrease the concentration of solution which is automatically maintained in tank 48.

The operation of the entire laboratory layout according to my invention will now be described:

The fixing solution may originally be supplied to service tank 11 to maintain a regulated flow through fixing tanks 10, this apparatus may properly be included in the generic current "processing means". The discharge from fixing tanks 10 is conducted through the electrolytic units 33 in a manner already particularly described. Some of the solution is circulated through the electrolytic units 33 into tank 48 from where it is returned to the service tank 11. A portion of the solution is bled off through the tailing electrolytic units from whence it is preferably discharged to waste. The tank 48, pump 66 and circulating pipes of the apparatus comprise a circulating means which is adapted to recirculate solution through the processing tanks and electrolytic units as well as between the tank 48 and service tank 11. The operation of a balancing means for automatically maintaining a definite fixing solution concentration has already been explained with respect to the particular description of that apparatus.

Since many modifications of my invention are possible, the present disclosure is to be construed in an illustrative and not in a limiting sense, the scope of my invention being particularly defined in the appended claims.

Having now particularly described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus for recovering silver from a photographic solution, the combination with a processing means for treating photographic material with a photographic fixing solution and increasing the silver ion concentration of said fixing solution, of a working electrolytic unit for incomplete removal at high efficiency of the silver ions from said fixing solution, a tailing electrolytic unit for substantially complete removal at

lower efficiency of said silver ions from said fixing solution, and a means for transferring part of the silver laden fixing solution from said processing means to said working electrolytic unit and for transferring part of the silver laden fixing solution from said processing means to said tailing electrolytic unit.

2. In an electrolytic recovery apparatus, the combination with a processing means for increasing the silver concentration of a thiosulfate photographic fixing solution, of a plurality of working and tailing electrolytic units for electroplating the silver from said solution, a circulatory means for recirculating the fixing solution between said processing means and said working units, and a concentration control means for automatically maintaining the thiosulfate concentration of the recirculated fixing solution at a predetermined value.

3. In an electrolytic recovery apparatus, the combination with a processing means for increasing the silver concentration of a thiosulfate photographic fixing solution, of a plurality of working and tailing electrolytic units for electroplating the silver from said solution, a circulatory means for recirculating the fixing solution between said processing means and said working units, and for bleeding some of the solution off to said tailing units, a replenishing means for maintaining the quantity of recirculated solution constant and to compensate for the solution bled off to said tailing units, and a thiosulfate concentration control means for automatically maintaining the recirculated fixing solution at a predetermined thiosulfate concentration.

4. In an electrolytic silver recovery apparatus, the combination with a photographic processing means adapted to increase the silver concentration of a photographic fixing solution therein, and a plurality of electrolytic units for plating silver from said solution, of a circulatory means adapted to circulate solution between the electrolytic units and the processing means, and a concentration control means for said solution including a valve means adapted to be automatically opened upon decrease of solution concentration and adapted to control the supply of a more concentrated solution to the solution.

5. In an electrolytic silver recovery apparatus, the combination with a photographic processing means adapted to increase the silver concentration of a photographic fixing solution therein and a plurality of electrolytic units for plating silver from said solution, of a circulatory means adapted to circulate solution between the electrolytic units and the processing means, and a concentration control means for said solution including a U-tube adapted to contain a column of solution, a pipe connected to said U-tube and adapted to contain a column of water balanced by the solution in said U-tube, and a valve adapted to control the supply of a more concentrated solution to the solution and opened by a decrease in the level of water in said pipe.

6. In an apparatus for recovering silver from a photographic solution, the combination with a processing means for treating photographic material with a photographic fixing solution and increasing the silver ion concentration of said fixing solution, of a plurality of working electrolytic units for incomplete removal at high efficiency of the silver ions from said fixing solution, a tailing electrolytic unit for substantially complete removal at lower efficiency of said silver ions from said fixing solution, and a circulatory means for recirculating the fixing solution between said processing means and said working units, and for conducting into said tailing unit a portion of the fixing solution from said processing apparatus.

7. In an apparatus for recovering silver from a photographic solution, the combination with a processing means for treating photographic material with a photographic fixing solution and increasing the silver ion concentration of said fixing solution, of a plurality of working electrolytic units for incomplete removal at high efficiency of the silver ions from said fixing solution, a tailing electrolytic unit for substantially complete removal at lower efficiency of said silver ions from said fixing solution, and a circulatory means for recirculating the fixing solution between said processing means and said working units, and for bleeding off a portion of the fixing solution from said processing means into said tailing unit from which said portion of the fixing solution is discharged to waste.

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