Feb. 20, 1968 H. G. HARTMAN 3,369,801

SILVER RECOVERY UNIT

Filed Nov. 10, 1965

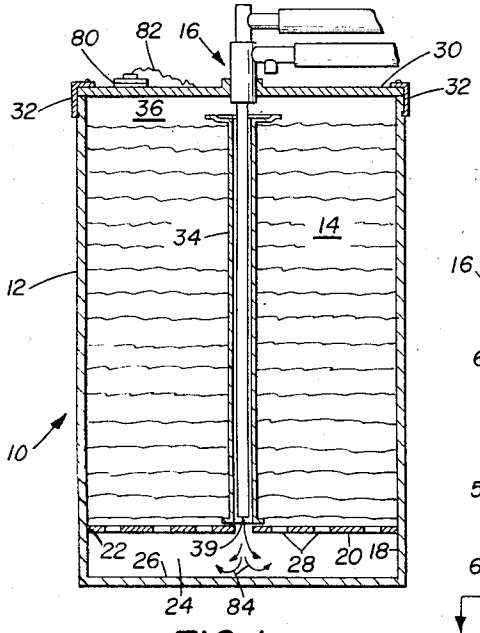
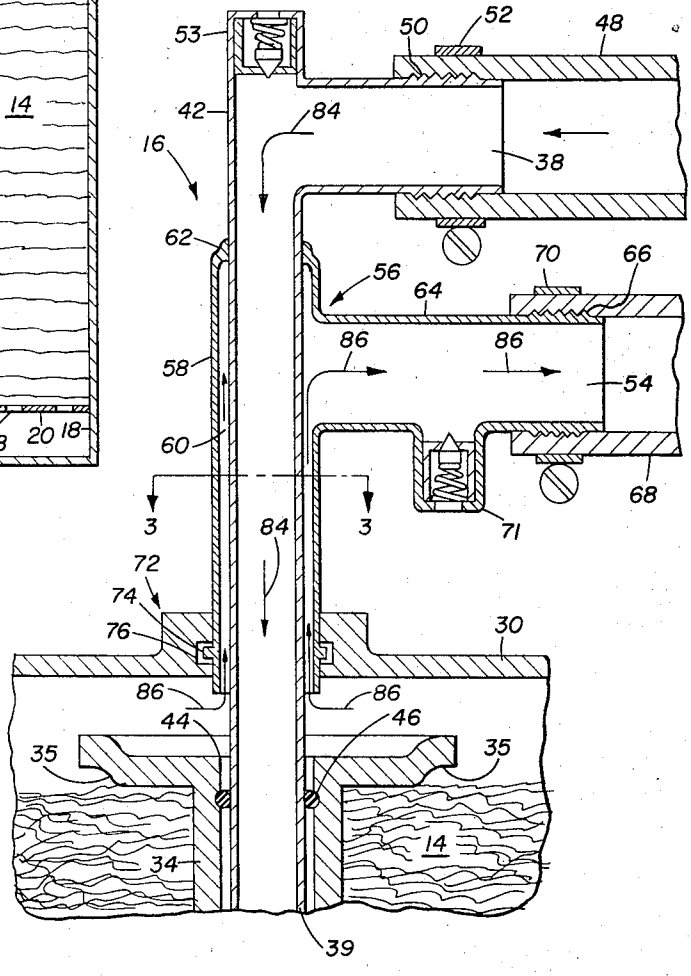


FIG. 1

FIG. 2



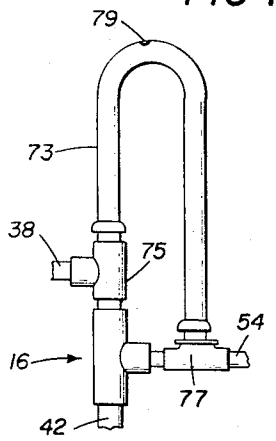


FIG. 4

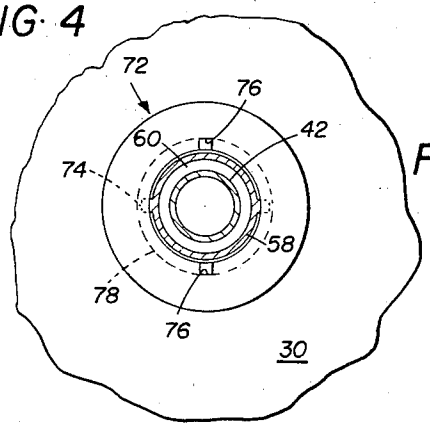


FIG. 3

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SILVER RECOVERY UNIT

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ABSTRACT OF THE DISCLOSURE

Apparatus for recovering silver from a silver-containing solution, such as a photographic fixing bath, comprising a container enclosing a fluid permeable metallic filler element composed of a metal above silver in the electromotive force series, for example, a continuous sheet of steel wool wound about an open core, and fluid fitting means removably attached to the container, for example, a pair of concentrically arranged pipes equipped with quick attach and release means, adapted to direct the solution through the filler element, whereby the solution reacts with the metal of the filler element so that the silver is deposited therein.

This invention relates to a novel silver recovery unit and manner of making the same. More particularly this invention relates to an improved silver recovery unit which is easily handled, installed and replaced thus making it particularly adapted for use in photographic processing systems.

Numerous instances are encountered where it is desirable that certain concentrations of materials suspended or dissolved in a fluid medium be removed therefrom. One such instance where this is true is to be found in the developing process normally followed in processing exposed photographic plates or films. For example, the various silver salts employed in the manufacture of photographic paper and film when fixed by the various fixatives or stop agents produces a complex silver salt which is dissolved or suspended in the solution. As the fixatives or stop agents become depleted it is necessary that they be replaced to keep the fixing solution at a given strength or concentration if uniform and acceptable results are to be obtained. Often this replenishing is done on a continuous basis by the addition of a given volume of concentrated solution of the fixatives or stop agents to the fixing vats while at the same time an equivalent volume of the spent solution is withdrawn. If no apparatus is provided for removing the silver salts from this spent solution that is being withdrawn from the vats then the silver dissolved or suspended therein will be lost. This loss of silver can reach sizable proportions where a large commerical developing operation is involved.

Therefore, considerable time and expense has been expended in an effort to develop a simple, inexpensive yet highly efficient silver recovery unit that can be used in existing photographic processing systems. Recently this development effort has centered around passing the solution containing the silver salts through various metallic elements or "fillers." The metallic filler is selected from the group of metals that is anodic to silver so that a chemical replacement action will occur which causes precipitation and depsition of the silver as the metallic element is dissolved. Silver recovery units of this type have been found to be highly efficient as far as recovery is concerned. However, they generally are rather expensive to produce and, more importantly, hard to install and service on existing photographic processing systems. Furthermore, there is no convenient way of handling the silver sludge during shipment, following the depletion of the metallic filler element.

According to this invention it has been found that an effective silver recovery unit can be produced which is compatible with existing photographic processing systems and can be included therein at a nominal cost. The construction of the recovery unit is such that the metallic filler elements need never be removed from the housing, and no special time consuming and laborious connecting steps are involved in coupling the unit into or removing it from a processing system.

Basically, the recovery unit of this invention consists of a unique container having a novel metallic filler located therein. A special connector is employed for rapidly connecting the recovery unit to a photographic processing system with a minimum of effort. This connector permits the silver containing solution to flow completely through the filler prior to its being sewered or returned to a fixing tank thus leaving the silver deposited as a sludge in the container.

Therefore, an object of this invention is to provide a simple, inexpensive, yet highly reliable silver recovery unit.

Another object of this invention is to provide a cartridge type silver recovery unit that can be installed and removed from existing photographic processing systems in a rapid, simple and inexpensive manner.

Yet another object of this invention is to provide a cartridge type silver recovery unit that can be handled shipped and stored without any special precautionary or preparatory steps being required.

Yet still another object of this invention is to provide a silver recovery unit having a quick detachable fluid coupling system for expediting the changing of such units.

A further object of this invention is to provide a silver recovery unit having a container and metallic filler element that are stored, shipped, used and returned as a single unitary body.

These and further objects and advantages of this invention will become more apparent upon reference to the following description, appended claims and drawings wherein:

FIGURE 1 is a front elevation, partly in section, showing a silver recovery unit constructed in accordance with the present invention;

FIGURE 2 is an enlarged fragmentary view of the top of the metallic filler element, container lid, and quick attach and release fitting fluid conductor of this invention;

FIGURE 3 is a cross-sectional view taken along line 3—3 of FIGURE 2 showing details of the quick attach and release coupling unit; and

FIGURE 4 is a side view of a second type pressure bypass unit that can be used for preventing dangerous buildups in pressure from occurring within the silver recovery unit.

With continued reference to the accompanying figures wherein like reference numerals designate similar parts throughout the various views, and with particular attention directed to FIGURE 1, reference numeral **10** is used to designate generally a silver recovery unit constructed in accordance with this invention. The silver recovery unit **10** consists of three major units, namely: (1) an outer container **12**; (2) a cartridge-like metallic filler element **14**; and (3) a quick disconnect fluid conduit and fitting **16**. The outer container or housing **12** can be constructed of any suitable material such as metals or plastics and can be of any size or shape that is practical for the particular use to be encountered. Normally, the only element attached to the inner wall **18** of the container **12** is a perforated baffle or diffusion plate **20**. The outer peripheral edge **22** of the plate **20** is shown engaged against the wall **18** in a fluid tight manner to assure that any flow of liquid from the area **24** between the lower face of the plate and the bottom **26** of the container will

occur through the apertures 28 in the plate. However, the plate can be loosely mounted within the container and supported on legs rather than attached directly to the container wall if such is desirable. The lid or top 30 of the container can be of the removable type that is held securely in place by quick releasable clamps 32 if such is desirable. However, the use of such a removable lid is not necessary nor even particularly desirable since the container can be made in such an inexpensive manner that it can be smelted with the filler element thus eliminating the need to ever remove or handle the filler element per se.

The metallic filler element 14 is fluid permeable and must be made from a free metal which is above silver in the electromotive series. Although several such metals are known that will perform satisfactorily, it has been found that iron in the form of "steel wool" is best suited to this use. Preferably the steel wool is in the form of a continuous strand which is wound about a spool or open core 34 in a tight and continuous manner. The use of such a continuous sheet of steel wool is advantageous since it not only is easily applied, but its use assures that no cavities or open areas are left in the finished filler element as often occurs if a loose wool is packed into a cartridge unit. Conversely, the use of the continuous steel wool assures that no overly packed areas are formed which would unduly inhibit the flow of a solution therethrough. If desirable, the filler element may be made by assembling a number of preformed steel wool discs around the core as long as no voids or overpacked areas are produced.

The spool 34 around which the steel wool is wound is important since it not only serves as a convenient holder for the filler element, but the passageway within the spool helps properly position the fluid fitting 16 in a manner that will be more fully explained hereinafter. Lifting ears or handles 35 may be formed on the upper end of the spool for handling or positioning the filler element within the container 12 if such is desirable.

The diameter of the complete filler element 14 is such that it fits snuggly into the container 12 so that no channel or passage between the inner container wall and element exists through which the silver solution can flow. Thus all fluids which leave the recovery unit will have to flow through the fluid permeable filler element 14. The length of the filler element may vary depending on the quantity and silver concentration of the fluid to be handled per unit of time, but preferably the filler element extends from the diffusion plate 20 to a point close to the lid 30 of the container. However, a small open area 36 must be left between the lid 30 and the top of the filler element 14 for permitting the silver depleted solution to enter the exit port of the fluid fitting 16.

The quick disconnect fluid fitting 16 used with the container 12 consists of concentrically located hollow fluid conducting conduits, the first of which is indicated at 42. The conduit 42 has an inlet port 38 at one end and is of sufficient length so that the free end 39 thereof will extend through most of the passageway 44 of the spool 34 whenever the fitting 16 is locked in place, but not through the diffusion plate 20 into the open area 24 within the container 12. If the free end 39 of the fluid fitting 16 is permitted to project into the open area 24, or otherwise be exposed on its outer surface to the silver containing solution, silver may deposit on the free end and prevent the easy withdrawal of the fitting. Thus the outer diameter of the hollow fluid conduit 42 is such that a snug fit is obtained between the outer wall of the conduit 42 and the wall of the passageway 44. Such a tight fit is also necessary to minimize the amount of solution that flows up the passageway and thereby avoids passing through the filler element 14. If necessary, an O-ring seal 46 can be used to assure that no solution will flow between the outer wall of the conduit 42 and the wall of the passageway 44. An inlet hose 48 is force fitted over the upper end 50 of the conduit 42, which may be smooth, threaded or serrated, and is held thereon in a fluid tight manner by a suitable C-ring type clamp 52. A pressure relief valve 53 is provided in the conduit 42 for releasing any excess pressure that may develop within the container 12. This relief valve 53 is shown as being of the type employing a spring loaded poppet, but may be of any other suitable type that will open when the internal pressure within the conduit exceeds a predetermined value.

An outlet port 54 is provided for the silver removal unit 10 which consists primarily of a hollow L-shaped fluid conduit 56. As will be seen in FIGURE 2, one leg 58 of the L-shaped fluid conduit 56 is positioned around and encases the inlet conduit 42 but is spaced radially therefrom by a sufficient amount so as to form a passageway 60 for the upward flow of the silver depleted solution. A suitable fluid tight seal 62 is provided at the top of the leg 58 to prevent the escape of any solution between the two conduits 42 and 56. The second leg 64 of the L-shaped conduit 56 is provided on its outer surface with a threaded or toothed surface 66 for receiving in a fluid tight manner a flexible outlet hose 68. A C-ring 70 or other like clamping device is used to secure the hose to the conduit leg 64. A pressure relief valve 71 is also provided on the conduit 56 for releasing any pressure within the conduit that exceeds a predetermined value.

Various other suitable types of pressure release valves and systems besides those shown at 53 and 71 may be used to prevent a dangerous build-up in operating pressure from occurring within the cartridge unit. One such pressure release system is shown in FIGURE 4 and consists of an inverted U-shaped bypass conduit 73 attached at either end to the inlet port 38 and outlet port 54 by two T units 75–77, respectively. An aperture or pressure opening 79 is provided at the top of the conduit 73 so that any pressure build-up in the container 12 which is high enough to force the solution up the conduit 73 against the force of gravity will be vented through the pressure opening.

A quick attach and release catch 72 is provided on the conduit 56 (see FIGURE 2) for securing the fluid fitting 16 to the lid 30 of the container 12. This catch 72 is shown for purposes of illustration in FIGURES 2 and 3 as being of the keyed type consisting of keys or locking ears 74 carried on the conduit leg 58 which are adapted to slide down mating grooves 76 into a lock channel 78 (as indicated by the broken line in FIGURE 3) formed in the lid 30. With the keys 74 positioned within the lock channel 78, the fitting 16 is locked in place by rotating either the lid or fitting 16 one-quarter turn. Any other suitable catch could be used which permits the fitting 16 to be readily attached and removed from the container 12 without the use of special tools or the disconnecting of the flexible hoses 48 and 68.

The operation of the silver recovery unit may be described in the following manner. A container unit 12 having a filler element 14 installed therein is taken from storage and positioned in the place it is to be used. The cap 80, which is used to seal the opening or aperture in the lock unit 78, is removed by a simple one-quarter turn and placed on the lid 30 where it may be held by an attached safety line 82. The lower end of the inlet conduit 42 of the quick disconnect fluid fitting 16 is now inserted through the aperture in the lock unit 78 and into the passageway 44 of the filter element spool 34. At this point the keys 74 of the quick attach and release catch 72 are aligned with the grooves 76 in the lock unit 78. The fluid fitting 16 is now pressed down until the keys 74 are seated at the bottom of the grooves after which the fitting is rotated one-quarter turn thereby locking it onto the container 12 in a fluid tight manner.

With the fluid fitting 16 now locked in place the silver containing solution is fed into the recovery unit through the inlet port 38 and conduit 42 in the direction indicated by the arrowheads 84. The silver containing solution flow-

ing from the lower end of the conduit **42** into the open area **24** at the bottom of the container **12** where it is diffused and permitted to flow upward through the apertures **28** into the filler element **14**. While passing through the filler element **14** in an upward direction the solution will react with the metallic element causing the silver salts contained in the solution to be deposited as a sludge in the filler element thus leaving a substantially silver free fixing solution. This fixing solution will be forced on through the filler element and will be collected in the open area **36** at the top of the container **12** where it is withdrawn through the outlet conduit **56** and port **54** in the direction indicated by arrowheads **86**.

As will be apparent, should any sudden pressure build-up develop in the inlet conduit **42** or outlet conduit **56**, either or both of the pressure relief valves **53** and **71** will open. This opening of the valve or valves will prevent any damage to the silver recovery unit **10** or the processing equipment feeding the unit.

Whenever the metallic filler element **14** need to be replaced, as will occur when it becomes depleted with silver sludge, it is only necessary that the quick release fitting **16** be pressed down and rotated one-quarter turn until the keys **74** are aligned with the grooves **76** after which the entire fitting is withdrawn from the container **12**. The cap **80** is then replaced on the lid **30** and the container **12** with the filler element **14** inside is ready to be shipped to a silver processing plant. At the processing plant the remaining part of the filler element and the silver sludge is removed and smelted or, if the container **12** has no removable lid, the container and remaining filler element with the silver sludge can be placed in the smelting vat thus alleviating the need for ever removing the filler element **14**.

From the foregoing it will be apparent that the silver recovery unit of this invention has numerous advantages over any heretofore known or used by the silver industry. For example, the novel fluid fitting and container permits a spent or saturated filler element to be replaced with a new cartridge unit in a matter of moments without the services of a trained technician or any special tools being required. This quick interchange alleviates the need to either stop the photographic developing process during the time required to change the silver recovery unit or accept the loss of large quantities of silver containing solution as has heretofore occurred. The safety factor afforded by the pressure relief valves or bypass system is also accomplished without the use of additional units on the fluid lines as has often been required in the past. Furthermore, the fact that the container serves as both the shipping and storage unit for the filler element, as well as the container during the silver recovery operation, is very important since it eliminates a laborious and expensive handling operation that was heretofore necessary when other prior known silver recovery methods were used. The continuous wound or disc shaped, spool carried metallic filler element of this invention is also important since it is easily produced and gives superior results.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. Apparatus for recovering silver from a silver-containing solution, comprising:

(1) means defining a container having an opening therein;

(2) core means positioned within said container, said core means having a longitudinal passageway extending therethrough;

(3) continuous fluid permeable metallic filler means peripherally disposed about said core means to space said core means from the interior wall of said container, said metallic filler means being formed from a metal above silver in the electromotive force series; and

(4) fluid fitting means removably attached to and closing said container for receiving silver-containing solution from a source thereof, circulating said solution through said container so that the silver in said solution is deposited in said metallic filler means and discharging the solution which the silver has been removed, said fluid fitting means comprising:

(a) a first fluid conduit open at one end extending into said container through the opening therein and passing through the passageway in said core means in substantially fluid tight relationship with the wall of said passageway and with the open end thereof in juxtaposition with one end of said metallic filler means, and

(b) a second fluid conduit open on one end extending into said container through the opening therein in spaced surrounding relationship with said first fluid conduit to provide a passage for fluid flow therebetween and with the open end thereof in juxtaposition with the other end of said metallic filler means.

2. Apparatus as described in claim **1** including a perforated diffusion plate positioned within said container perpendicularly to the axis of said first fluid conduit and in proximity to the open end thereof to uniformly direct the flow of solution within said metallic filler element.

3. Apparatus as described in claim **1** wherein said container is a cylindrical container having an opening in one end thereof, said core means is positioned so that said longitudinal passageway is in alignment with said opening, and said first and second fluid conduits are circular pipes extending into said container through the opening therein in concentric relationship to provide an annular passage for fluid flow therebetween.

4. Apparatus as described in claim **1** wherein a pressure release means is included in said first and second fluid conduits to prevent the build-up of excessive pressure within the apparatus.

5. Apparatus as described in claim **4** wherein said pressure release means consists of a pressure relief valve included in each of said first and second fluid conduits.

6. Apparatus as described in claim **4** wherein said pressure release means is an inverted U-shaped conduit connected between said first and second fluid conduits and having an aperture in the top thereof for releasing any excessive pressure existing within the apparatus.

7. Apparatus as described in claim **1** wherein said metallic filler means is steel wool.

8. Apparatus as described in claim **7** wherein said steel wool is wrapped in a number of spirals adjacent said core means.

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Dedication

3,369,801.—*Harlan G. Hartman*, Rochester, N.Y. SILVER RECOVERY UNIT. Patent dated Feb. 20, 1968. Dedication filed Jan. 9, 1975, by the assignee, *Eastman Kodak Company.*

Hereby dedicates to the Public the entire remaining term of said patent. [*Official Gazette March 25, 1975.*]