Aug. 22, 1961 C. E. JAMES ET AL 2,997,438

DEVICE FOR RECLAIMING SILVER FROM PHOTOGRAPHIC HYPO BATHS

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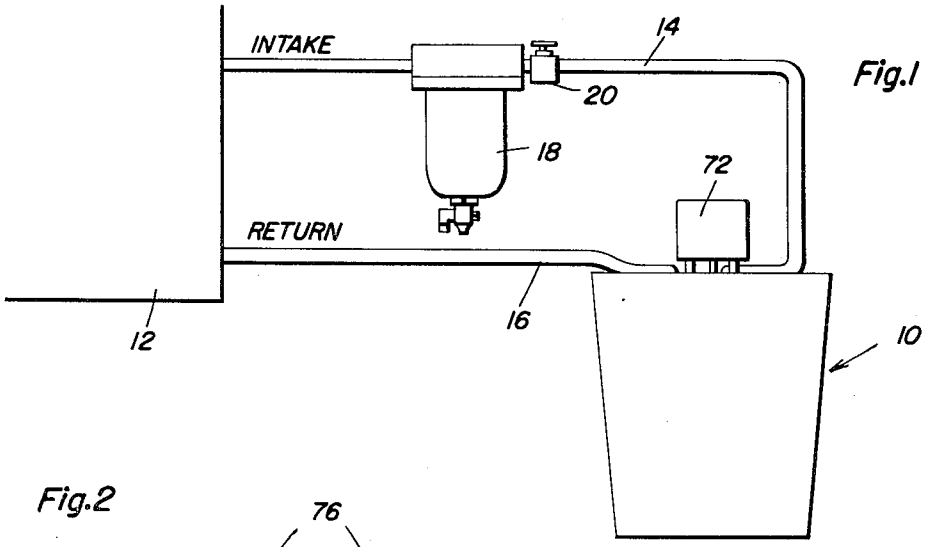


Fig.1

Fig.2

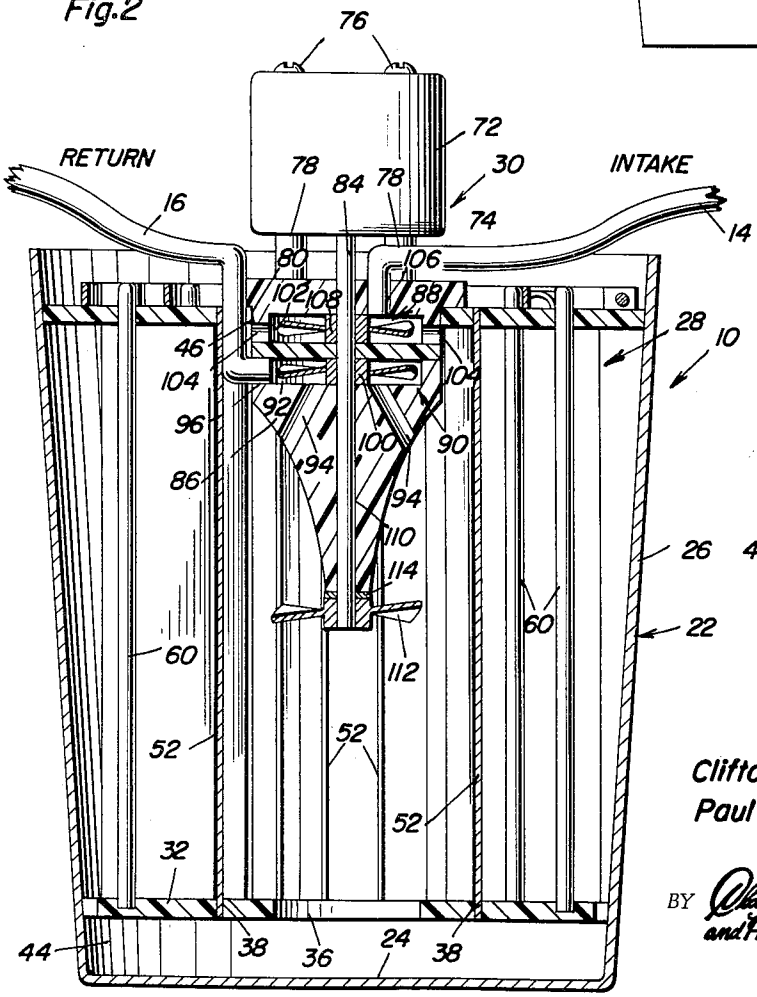
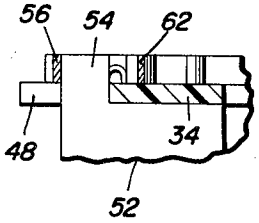


Fig.8



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Fig.3

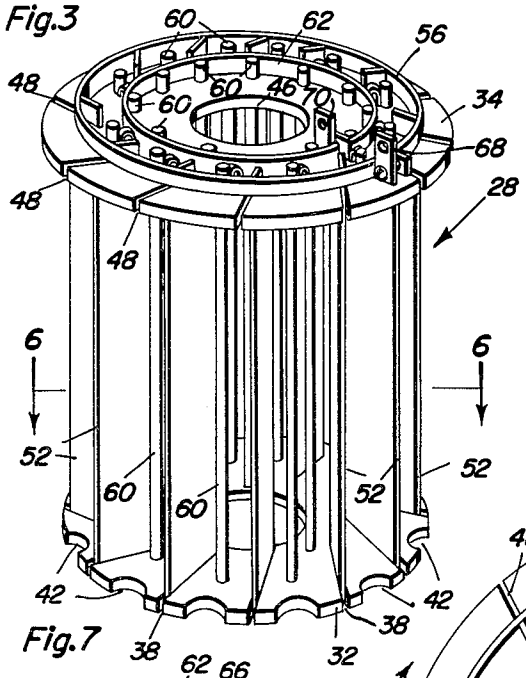


Fig.4

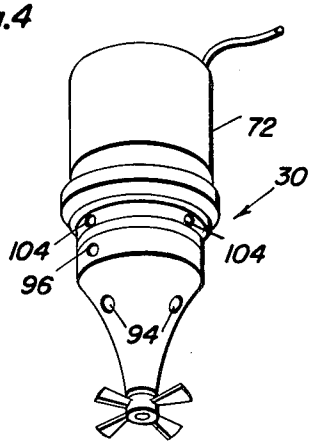


Fig.5

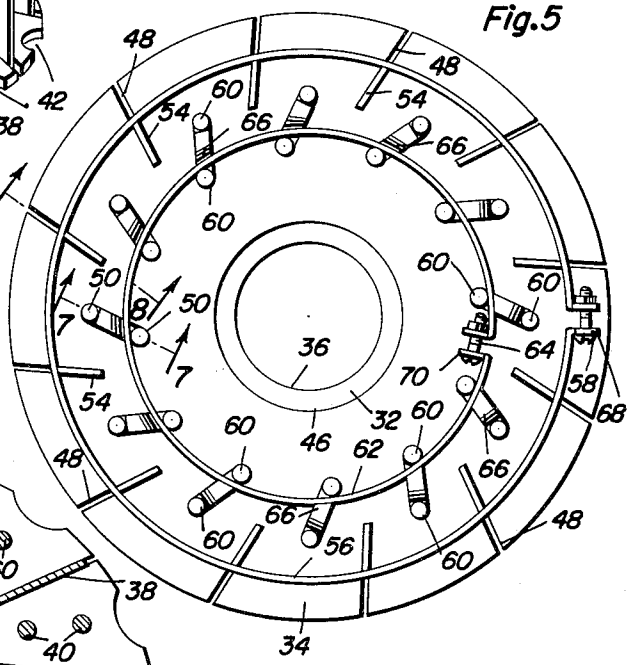


Fig.7

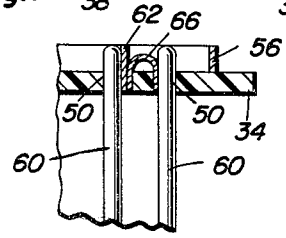
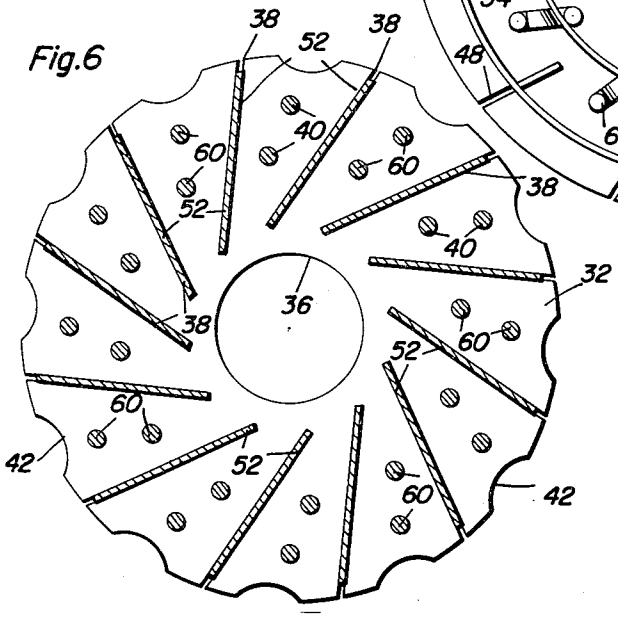


Fig.6



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DEVICE FOR RECLAIMING SILVER FROM PHOTOGRAPHIC HYPO BATHS

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4 Claims. (Cl. 204—273)

This invention relates in general to a new and useful device for the regeneration of photographic fixing baths and reclaiming the silver therefrom by an electrolytic process.

There are many installations in daily use processing photographic sensitized materials where the exhausted fixing baths are discarded down the drain. These solutions can be regenerated by the removal of the photosensitive silver which has been dissolved from the photographic emulsions. Heretofore there has been devised devices for the purpose of removing such silver. However, since the amount of silver is a relatively small one and since the cost of hypo also relatively low, the installations heretofore provided have been too expensive as to be economically feasible. Either these devices have either required the services of a valuable employee, or they themselves have been too expensive to purchase, install and operate.

It is therefore the primary object of this invention to provide a device for regenerating exhausted fixing baths by removing photographic silver, the device being so constructed whereby it will constantly transfer hypo from a hypo bath to the device and remove the silver from the hypo in a continuous operation without requiring the attendance of the operator of the laboratory.

Another object of this invention is to provide a device for removing silver from hypo baths, the device being constructed on an extremely small scale and being feasible for operation within relatively small laboratories, such as the laboratories used in developing X-ray film in hospitals and the like.

Another object of this invention is to provide an electrodepositing device wherein the sum of the distance between an anode and a cathode and the rate of flow across such distance is substantially constant throughout the length of the cathode.

Another object of this invention is to provide an improved electrodepositing device for use in removing silver from photographic hypo baths, the electrodepositing device being so constructed whereby access to the anode and cathode thereof is readily obtainable so that in the event of a short, the deposited silver across the short may be readily removed to eliminate the short.

A further object of this invention is to provide an improved device for removing silver from photographic hypo baths by electrodepositing such silver on cathodes, the cathodes being so mounted whereby they may be readily removed to facilitate the stripping of the deposited silver therefrom.

Still a further object of this invention is to provide an improved electrodepositing device for removing silver from photographic hypo baths, the electrodepositing device including a single unit which functions as an inlet pump, an outlet pump and an agitator, the unit including a small electric motor requiring a minimum of current whereby the cost of operation of the electrodepositing device is reduced to a minimum.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a schematic view showing the connection between the device for reclaiming silver and a photographic hypo bath;

FIGURE 2 is an enlarged vertical sectional view taken through the device which is the subject of this invention and shows the specific details of construction thereof;

FIGURE 3 is an enlarged perspective view of the electro unit of the device removed from the container thereof;

FIGURE 4 is an enlarged perspective view of the pump and circulating unit of the device and shows the specific details thereof;

FIGURE 5 is an enlarged plan view of the electro unit and shows the manner in which the anodes and cathodes are retained in place and electrically connected;

FIGURE 6 is an enlarged horizontal sectional view taken substantially upon the plane indicated by the section line 6—6 of FIGURE 3 and shows the relationship of the anodes with respect to the cathodes;

FIGURE 7 is an enlarged fragmentary sectional view taken substantially upon the plane indicated by the section line 7—7 of FIGURE 5 and shows the particular mounting in connections between the upper ends of the anodes; and

FIGURE 8 is an enlarged fragmentary sectional view taken substantially upon the plane indicated by section line 8—8 of FIGURE 5 and shows the specific mounting of the upper ends of the cathodes.

Referring now to the drawings in detail, it will be seen that there is illustrated a typical installation utilizing the device which is the subject of this invention, the device being referred to in general by the reference numeral **10**. The device **10** is connected to a hypo bath **12** by means of an intake line **14** and a return line **16** whereby the hypo solution of the hypo bath **12** may be circulated through the device **10** for the purpose of continuously removing the silver therefrom. The intake line **14** is provided with a commercially available filter **18** whereby foreign matter is removed from the hypo solution prior to the entry thereof into the device **10**. Also, there is provided a metering valve **20** which may be adjusted to control the flow of the hypo into the device **10** to that which is the capacity of the device **10**.

Referring now to FIGURE 1 in particular, it will be seen that the device **10** includes a container **22** which is preferably formed of plastic, but may be formed of any suitable non-metallic material. The container **22** includes a bottom wall **24** and a body **26**, the body **26** being in the form of an inverted frusto-conical member tapering from the top to the bottom and decreasing in size so as to have a minimum cross-section at the bottom. Removably carried by the container **22** is an electrode unit **28**. Removably carried by the electrode unit **28** is a pump and agitating unit which is referred to in general by the reference numeral **30**.

As is best illustrated in FIGURES 2 and 3, the electrode unit **28** includes a bottom plate **32** and a top plate **34**. The plates **32** and **34** are preferably formed of suitable plastic material with the plate **32** being of a smaller diameter than the plate **34**. The plates **32** and **34** have diameters corresponding to the taper of the body **26** so that the plates **32** and **34** wedgedly engage within the body **26**, as is best shown in FIGURE 2. This facilitates the positioning of the electrode unit **28** within the container **22**, as well as the removal therefrom.

Referring now to FIGURE 6 in particular, it will be seen that the bottom plate **32** has a central opening **36** therethrough. Extending generally tangential to the opening **36** is a plurality of circumferentially spaced slots **38**. Disposed intermediate the slots **38** are recesses

40 which do not extend through the entire depth of the plate 32. Further, removed from the periphery of the plate 32 at circumferentially spaced intervals are materials to provide recesses 42. The purpose of the opening 36 and recesses 42 is to facilitate the free flow of the hypo solution past the plate 32 and down into the portion of the container 26 below the plate 32 which forms a sump 44.

The plate 34 is constructed similarly to the plate 32 and has a central opening 46 which is disposed concentric to the opening 36. Also, formed in the plate 34 and opening through the outer edge thereof are slots 48 which are disposed tangential to the opening 46. The slots 48, however, are of lesser length than the slots 38. The plate 34 is also provided with bores 50 therethrough which align with the openings 40.

Extending between the plates 32 and 34 are plate-like cathodes 52. The cathodes 52 are preferably formed of stainless steel. The cathodes 52 terminate at the upper ends in upwardly projecting ears 54 which extend above the plate 34. Extending about the ears 54 and clampingly engaging the ears 54 is a hoop 56 which is provided with a suitable clamp 58, such as shown in FIGURE 5. The hoop 56 overlies the plate 34 and serves not only to form an electrical connection between the cathodes 52, but also to retain the cathodes 52 in place relative to the plates 32 and 34. The ends of the cathodes 52 are coated with wax or similar material to prevent a build up of silver in the slots 38 and 48.

Extending between the plates 32 and 34 are also anodes 60. The anodes 60 are preferably formed of carbon and while they extend through the plate 34, they terminate in the plate 32 so as to prevent an electrolysis within the sump 44.

The innermost ones of the anodes 60 are engaged by a hoop 62 which overlies the plate 34 and which is provided with a clamp fitting 64 so as to tightly engage the anodes 60 and form an electrical connection therewith. The outermost anodes 60 are electrically connected to the innermost anodes 60 and to the hoop 62 by means of inverted U-shaped connectors 66, as is best shown in FIGURE 7.

From the foregoing description of the electrode unit 28, it will be readily apparent that by releasing the hoops 56 and 62, the electrode unit 28 may be readily disassembled. Electrical connections with the hoops 56 and 62 are made by means of terminals 68 and 70, as is best shown in FIGURE 3.

Referring now to FIGURES 2 and 4 in particular, it will be seen that the pump and agitator unit 30 includes a small powered electric motor 72 which is connected to a supporting plate 74 by means of bolts 76. The electric motor 72 is spaced above the supporting plate 74 by means of spacers 78. The supporting plate 74 has a reduced lower portion 80 which is received in the opening 46 in the plate 34 so as to center the pump and agitator unit 30.

The electric motor 72 includes an elongated armature shaft 84 which extends down through a housing 86 carried by the plate 74 and depending therefrom. The housing 86 has formed in the extreme upper part thereof a first pump 88. Disposed immediately below the first pump 88 is a second pump 90. The pump 88 is an intake pump whereas the pump 90 is a return pump.

Pump 90 includes a pump chamber 92 which has an inlet opening 94 opening through the exterior of the housing 86 into the container 22. It also includes an outlet 96 to which there is connected the return line 16. The pump 88 has mounted in the pump chamber 92 thereof the rotor 100 of the pump, the rotor 100 being carried by the armature shaft 84.

The pump 88 includes a pump chamber 102 which is communicated with the interior of the container 22 by means of an outlet passage 104. The chamber 102 is communicated with the intake line 14 by means of a passage 106. Mounted within the chamber 102 is a rotor 108 carried by the armature shaft 84. It is to be understood that the pumps 88 and 90 are both centrifugal pumps although other types of pumps may be used.

The lower part of the armature shaft 84 is journalled in the housing 86 by being positioned in a longitudinal bore 110 formed therein. The armature shaft 84 projects below the housing 86 and is provided with an impeller 112 for the purpose of circulating the hypo solution within the container 22. A suitable thrust washer 114 is provided between the impeller 112 and the lower end of the housing 86.

Referring once again to FIGURE 6 in particular, it will be seen that as the impeller 112 rotates, the hypo solution within the container 22 will be circulated and thrown outwardly tangentially between the cathodes 52. As the hypo solution is circulated between the cathodes 52 and the anodes 60, silver carried by the hypo solution will be deposited on the cathodes 52. It will be readily apparent from the arrangement of the cathodes 52 and the anodes 60 in FIGURE 6 that as the hypo solution moves outwardly, the velocity of flow will decrease due to the divergence of the cathodes 52 outwardly thereby increasing the spacing between the cathodes 52 and the anodes 60.

It is pointed out that plating occurs only during the very initial starting time of the device and after that the present device will deposit metallic silver along with impurities such as bits of wood, thread, dirt, gelatin and the like on the cathode. This buildup along the leading edge of the cathode represents impurities in the solution which have received a positive electro charge and adhere to the first cathode surface they come in contact with.

It is known that in the electrolytic separation of the metal from the aqueous solution of a simple salt, the metal ions travel towards the cathode where it is discharged and becomes an atom of the metal. The acid ion travels to the anode to which it attaches or it liberates oxygen by reacting with water. In the electrolysis of the complex salt sodium argentothiosulphate, sodium ions migrate to the cathode and argentothiosulphate ions move towards the anode. The sodium atoms formed at the cathode react with neighbouring ions in solution, including the argentothiosulphate ions. When there are sufficient argentothiosulphate ions, the sodium atoms react with these thus liberating silver.

Thus, it will be seen that metallic silver is produced by a secondary reaction on ions which are tending to move away from the electrode on which the metal is deposited. In order to ensure a sufficient concentration of argentothiosulphate ions at the cathode, it is necessary to either stir or agitate the solution quite vigorously so that a high current density may be used or to limit the current density to a few milliamperes per square decimeter of electrode surface. The second mentioned procedure would cause the use of a very large electrode surface in order to achieve an industrially practical rate of recovery. Therefore, the present invention incorporates the vigorous agitation of the solution in order to ensure a sufficient concentration of argentothiosulphate ions at the cathode.

In view of the foregoing, it will be understood that the current density is internally controlled within the unit and the solution is agitated to a relatively high degree in order to permit a high current density without polarization. Further, the electrolytic deposition of silver without the formation of sulphide which discolors the bath and renders it useless is practical only in an acid bath. The maximum current density that can be used, increases within certain limits, with the degree of agitation, the temperature, the silver content, the acidity and the sulphite concentration.

The advantages of the agitation become more apparent when considering the small amount of energy required

plus higher current density tolerated within the system which provides the higher silver recovery rate. The physical structure of the cathode and anode assembly coupled with the velocity agitation system provides many advantages not available in currently available industrial recovery units. The arrangement of the cathode permits both sides of this electrode to receive silver thus increasing the cathode area which permits higher solution velocity and of course permits greater current density within increased tolerance in current density. This in turn allows the construction of a smaller unit for the amount of silver recovered per gallon of hypo solution and for the electrical energy required for operation.

It is the intent of this invention that when a photographic laboratory is being operated, the device **10** will continuously function. The quantity of the hypo being circulated through the device **10** will be a minimum so as to not vary the temperature of the hypo solution and at the same time will be sufficient to remove the silver as it is deposited into the hypo solution. By so doing, not only will the life of the hypo solution be extended, thus resulting in the saving of the cost of hypo, but also valuable silver will be removed from the hypo solution, which silver may be reclaimed. The arrangement suggested in FIGURE 1 is of such a nature whereby the device **10** requires no attention whatsoever. Therefore, not only does the device **10** function without requiring special attention, except for the stripping of the silver from the cathodes **52** at extended intervals, but also it serves to save both the hypo and the silver which is normally permitted to run down the drain.

Because of the particular construction of the device **10**, the pump and agitator unit **30** may be readily removed so as to permit access to the electrode unit **28**. Thus in the event there should be any minor shorting between the anodes and cathodes, the deposited material causing the short may be readily scraped away and the device **10** returned to operation. Further, because of the particular manner in which the anodes and cathodes are related, there is a constant rate of depositing of the silver on the cathodes so as to produce a maximum efficiency. Therefore, the operation of the device **10** requires a minimum of current and thus makes the invention economically feasible for small operations such as X-ray developing laboratories in hospitals and the like.

From the foregoing, the construction and operation of the device will be readily understood and further explanation is believed to be unnecessary. However, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A unit for reclaiming silver from photographic hypo baths comprising a container, an electrode unit removably disposed in said container, and a hypo circulating pump means removably mounted on said electrode unit, said electrode unit comprising an upper plate, a lower plate, said plates being disposed in vertically spaced relation, a plurality of circumferentially spaced anodes extending between said plates, a plurality of circumferentially spaced cathodes extending between said plates, said cathodes and anodes being circumferentially spaced from each other and circumferentially alternately arranged, means electrically interconnecting the upper ends of the anodes and adapted to be connected to a source of electrical energy, means electrically interconnecting the upper ends of the cathodes and adapted to be connected to a source of electrical energy, said container including a tapered peripheral wall removably and wedgedly supporting said plates, each of said plates including an enlarged central opening, said circulating pump means including a support plate removably supported in the opening in the upper plate, a motor carried by said support plate, a depending housing carried by said support plate, said motor including an output shaft extending downwardly through said support plate, said housing having a bore extending therethrough rotatably receiving the output shaft, said output shaft terminating intermediate the upper and lower plates, an impeller mounted on the terminal end of said output shaft, said anodes and cathodes being disposed radially outwardly of the impeller whereby the impeller will circulate hypo within the container and move hypo past the anodes and cathodes when the motor is energized, said circulating pump means also including intake pump means mounted in the housing and driven from said shaft, said intake pump means having an intake communicated with a supply of hypo and a discharge communicated with the interior of the container, and a discharge pump means mounted in the housing and driven from said shaft, said discharge pump means including an intake communicated with the interior of the container and a discharge communicated with a supply of hypo for circulating hypo through said unit.

2. The combination of claim 1 wherein said intake pump means includes a hollow chamber in said housing, said intake extending from the center of the chamber, said housing having a radial discharge passage communicating the housing with the interior of the container, and an impeller mounted within said chamber and connected to said output shaft.

3. The combination of claim 1 wherein said discharge pump means includes a hollow chamber in said housing, said housing including intake passageways communicating the center of the chamber with the interior of the container, said discharge including a radially extending passageway.

4. The combination of claim 1 wherein said cathodes are in the form of thin metallic strips disposed in outwardly diverging relation to each other, said strips being disposed in a plane tangential to the central opening.

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