Sept. 26, 1972 W. R. LUCK, JR 3,694,341

METAL RECOVERY DEVICE

Filed Jan. 27, 1971 3 Sheets-Sheet 1

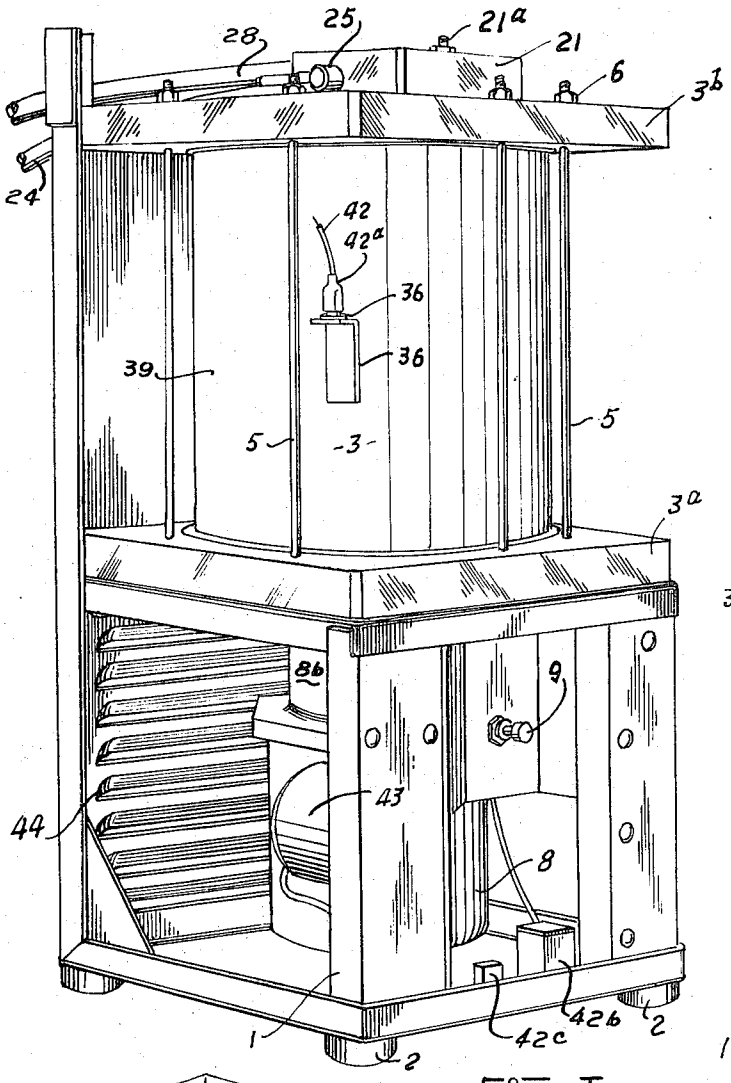

Fig. I

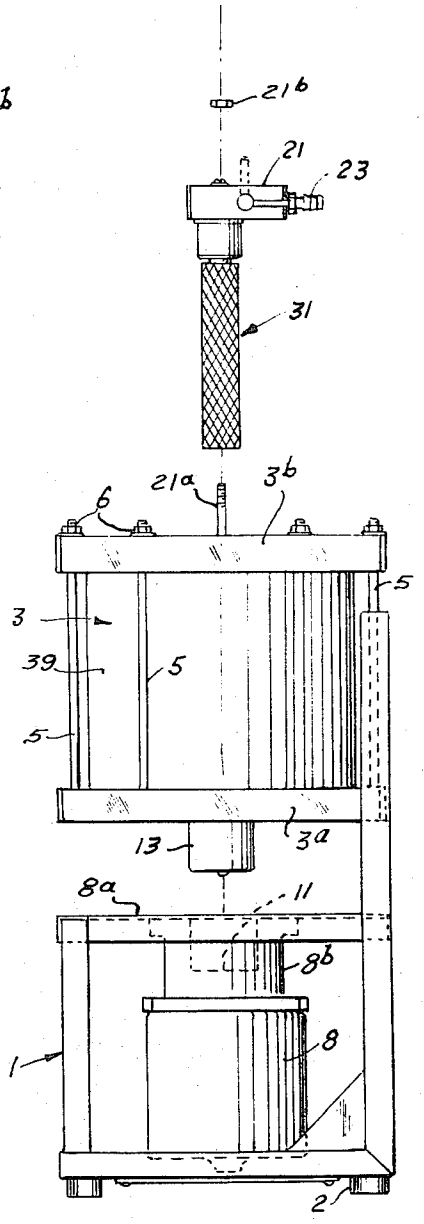

Fig. II

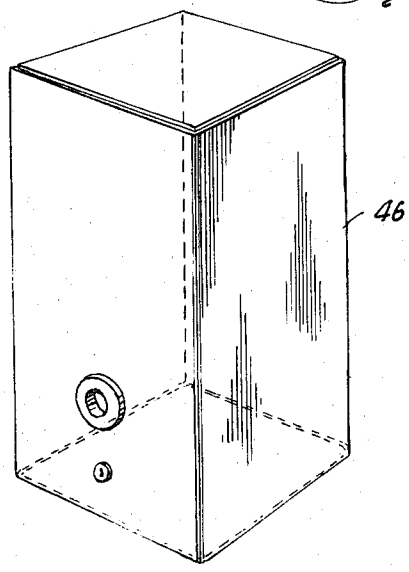

Fig. III

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METAL RECOVERY DEVICE

Filed Jan. 27, 1971 3 Sheets-Sheet 2

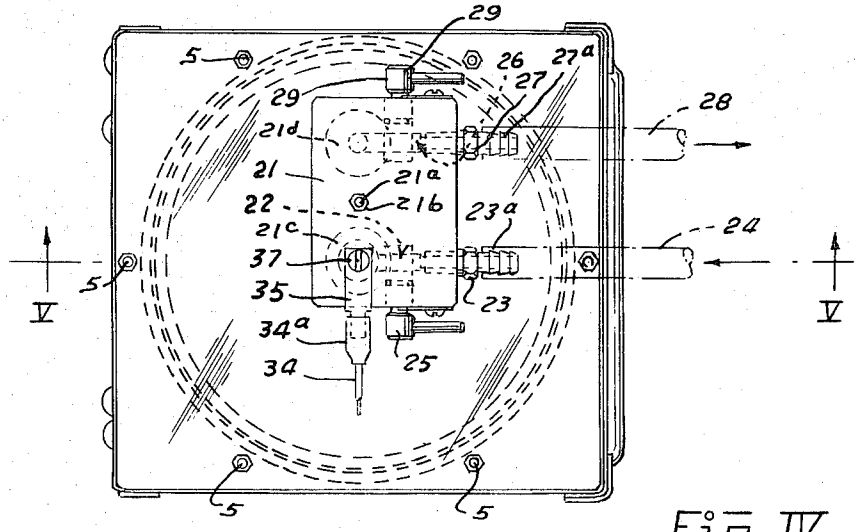

Fig. IV

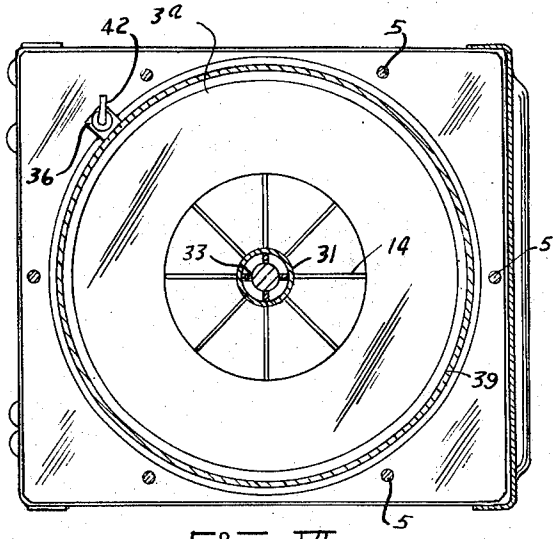

Fig. VI

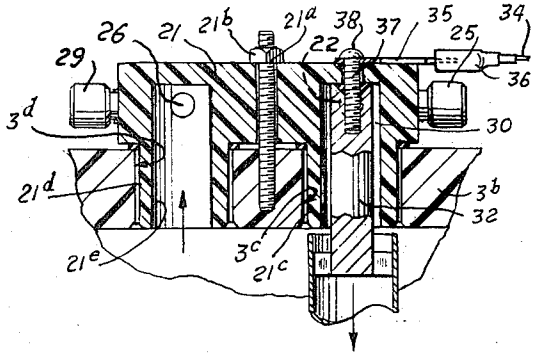

Fig. VIII

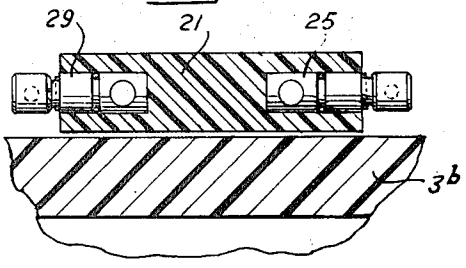

Fig. IX

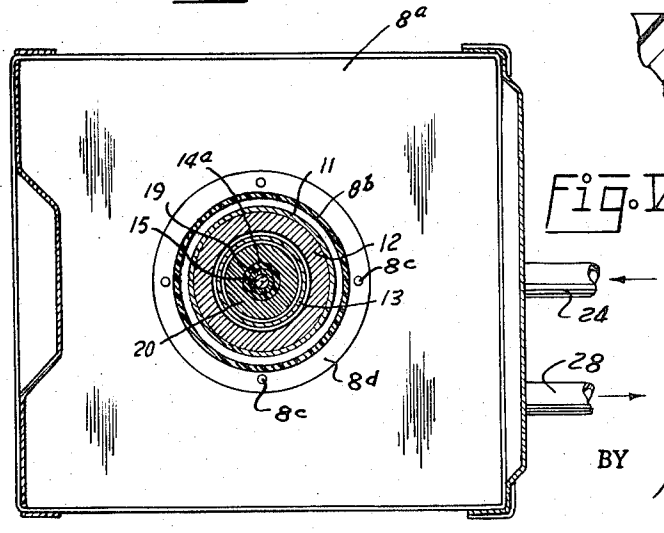

Fig. VII

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METAL RECOVERY DEVICE

Filed Jan. 27, 1971 3 Sheets-Sheet 3

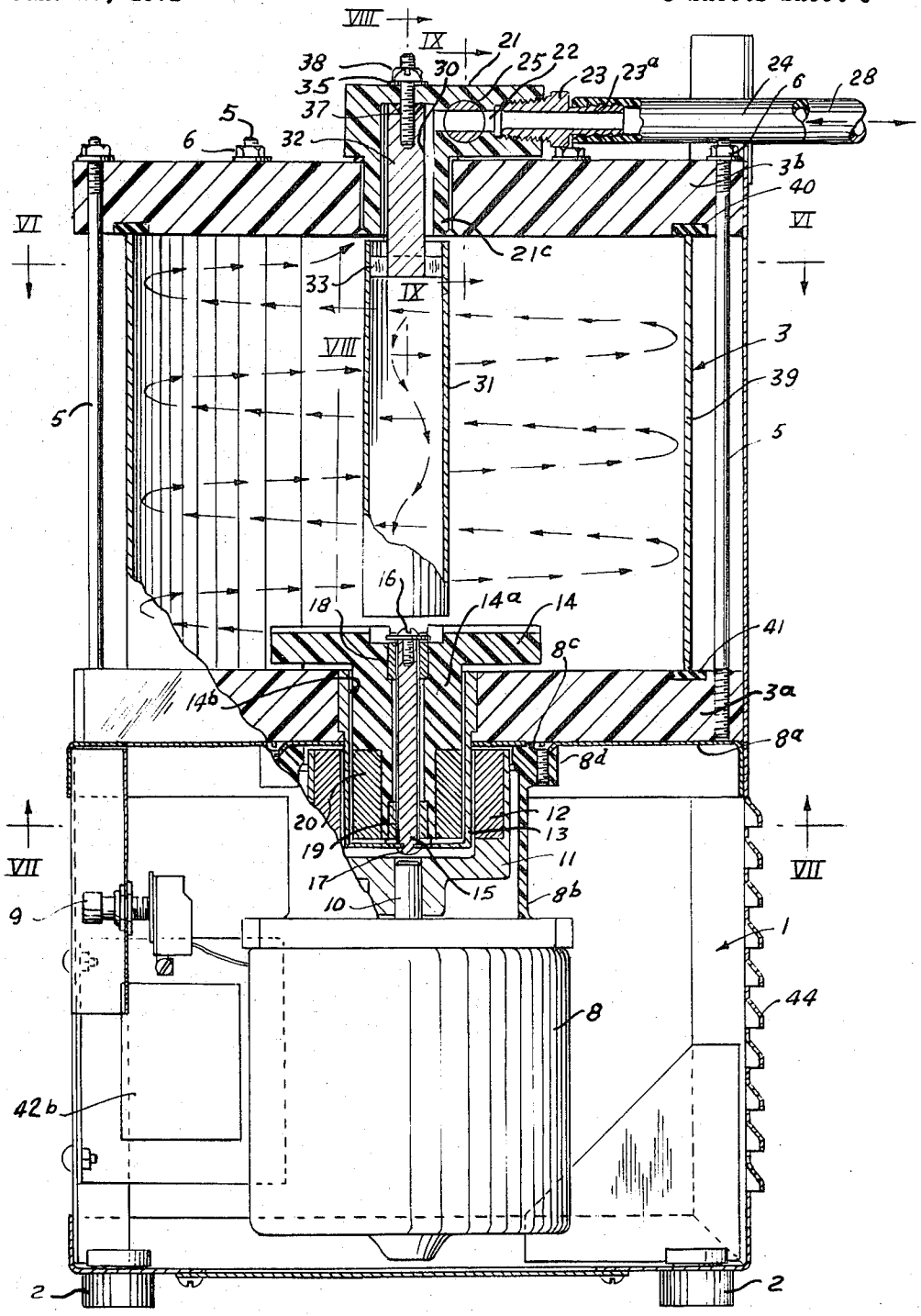

Fig. V

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3,694,341

METAL RECOVERY DEVICE

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Int. Cl. C22d 1/02
U.S. Cl. 204—273 12 Claims

ABSTRACT OF THE DISCLOSURE

A device for recovering metallic elements from plating solution baths, photographic and radiographic fixing solutions and other related processes to recover such metals from the solution for sale or use, to permit the reuse of fixing solution and to prevent undesirable metallic elements passing into sanitary sewers, contaminating water supplies and streams beyond acceptable levels of human consumption. It consists generally of a container whose outer wall is a cylindrical cathode and having an anode suspended centrally thereof. Electrical current is passed between the anode and the cathode through the liquid causing silver or other metallic material in solution in the fluid passed through the container to be deposited on the cathode by electrolysis. An impeller is disposed centrally and interiorly of the bottom of the container which is driven by an external motor through a magnetic drive. Fluid is admitted centrally of the upper wall of the container and discharged through the upper wall of the container outwardly of the center thereof. The impeller draws fluid through the central passage which is at lower pressure and the fluid is discharged through the outer passage which is at higher pressure, thereby eliminating the necessity of a pump to circulate the fluid therethrough. Although the device is primarily designed for recovery of silver from photographic fixer liquid, it may be employed to remove metal from other liquid.

BACKGROUND OF THE INVENTION

In the photographic process film having a coating of silver halide is bathed in the solution of fixer or hypo in which the silver compound is dissolved and goes into solution.

Several methods have been employed in the past for removing the silver from the fixer so as to recover the silver for resale and to allow the reuse of the fixer. These methods include metallic replacement, chemical precipitation and electrolytic action.

The metallic replacement process consists of slowly circulating used fixer solution through a container having steel wool or other like metallic material therein. Through an ion exchange, the silver is removed from the hypo and refined.

The chemical precipitation method consists of the addition to the fixing solution of chemicals to precipitate the silver in the form of a sludge of silver sulphide and other compound which is refined to remove the silver.

The electrolysis method consists of employing two electrodes, a cathode and an anode, which are placed in the silver bearing fixing solution and passing electric current between them to cause silver to be deposited on the cathode.

The present invention is addressed to an improvement on the electrolysis method.

Previous devices used in the practice of this method had to be operated at a carefully controlled current density relationship, either manually or by a timer in order to accurately control the current to exactly relate same to the amount of silver in solution, because if too much current is supplied, the solution deteriorates and cannot be reused. If too little current is supplied, the silver concentration left in the solution is too high and is lost down the drain or the solution loses its effectiveness as a chelating agent, causing the developing process to break down.

The device which is the subject matter of this application provides a portable device which may be placed in the hospital or other place where film is processed. The chamber in which the silver is deposited on the cathode is removable from the base portion of the device so that it can be collected and replaced and taken to a central point where the silver is removed from the cathode. It is efficient in that it provides a larger area of cathode on which to deposit the silver or other metal, the fixing solution is circulated at a high rate of speed over the surface of the cathode, without the use of a pump, the container is positively sealed, eliminating the leakage problem and by reason of the more rapid circulation of fluid, the greater cathode area, and the better circulation of fluid over the surface of the cathode, more rapid and efficient removal of silver from the fluid is accomplished so that a constant high current level can be applied without danger of damaging the effectiveness of the solution for reuse.

SUMMARY OF THE INVENTION

As hereinafter more fully disclosed the device consists of a recovery unit which is removable from the base. The recovery unit includes a cylindrical cathode and an anode suspended centrally thereof. An impeller is located centrally of the lower wall of the recovery unit which is driven through a magnetic drive consisting of an outer circular magnet rotated by a motor and an inner magnet carried about the shaft of the impeller which is mounted in a sealed sleeve so that no auxiliary seals are necessary as would be required if the impeller were driven by an external drive member by a shaft extending through the end wall of the container.

Metal carrying fixer or other solution is admitted to the cathode chamber through an inlet located centrally of the end wall of the recovery unit which is in line with the axis of the impeller and the solution is discharged through an outlet passage located outwardly of the central passage so that by reason of the vortex in the solution created by the rotation of the impeller the pressure is lowered centrally of the container adjacent the inlet passage, therefore, fluid is circulated through the container without the use of external pump and is circulated at a uniform and rapid rate in a spiral pattern so that the fluid impinges against the cathode comprising the outer wall of the container in a uniform manner, thereby more efficiently and rapidly removing the silver or other metal in the solution by depositing same on the cathode. A source of DC current is supplied with the positive side thereof connected to the anode and the negative side to the cathode so that current is passed through the solution from the anode to the cathode, which precipitates the silver out of the solution onto the cathode by electrolytic action.

DESCRIPTION OF THE DRAWING

A suitable embodiment of the invention is disclosed in the attached drawings wherein;

FIG. I is a front perspective view of the machine;

FIG. II is an exploded view showing the recovery chamber separated from the base and the anode and valve assembly separated from the recovery chamber;

FIG. III is a perspective view of a cover for the silver recovery unit;

FIG. IV is a top plan view of the machine;

FIG. V is a vertical elevational view partially sectionalized taken along the section line V—V of FIG. IV;

FIG. VI is a transverse sectional view taken along the line VI—VI of FIG. V;

FIG. VII is a transverse sectional view taken along the line VII—VII of FIG. V;

FIG. VIII is a sectional view taken along the line VIII—VIII of FIG. V; and

FIG. IX is a sectional view taken along the line IX—IX of FIG. V.

Numeral references are employed to indicate the various parts shown in the drawings and like numerals indicate like parts throughout the various figures of the drawings.

DESCRIPTION OF A PREFERRED EMBODIMENT

The numeral **1** indicates a base which is supported by resilient feet **2**. A recovery chamber **3** is formed by a lower end plate **3***a* and an upper end plate **3***b* which are joined together by tie rods **5** threadedly engaged at **7** to the lower end plate **3***a* and extends through passages in the upper end plate **3***b* and are secured in place by nuts **6** threaded on the outer ends thereof. The end plates **3***a* and **3***b* are preferably made of acrylic plastic material which is inert to the fixer solution passed through the recovery chamber **3**.

The motor **8** is suspended to the upper wall **8***a* of the base portion **1** by means of a mounting bracket **8***b* and screws **8***c* which pass through suitable recessed passages in the wall **8***a* and are threaded into the flange **8***d* extending about the upper portion of the bracket **8***b*. The motor **8** may be a conventional AC motor to which suitable electric current is supplied through a push-button switch **9**. The motor **8** rotates a shaft **10** which is secured to a cup shaped magnet holder **11**.

A circular magnet **12** is recessed in the inner wall of the holder **11** and is rotatable therewith.

A circular casing **13** made of non-magnetic material is secured in a passage extending centrally through the lower end plate **3***a* of recovery chamber **3**.

A multi-bladed impeller **14** is mounted on the upper end of a stem **15** which passes centrally through the impeller body **14***a* and is secured at its lower end at **17** centrally of the casing **13** in sealed relationship therewith.

The impeller body **14***a* is rotatable about the shaft **15** on the bushings **18** and **19** which are recessed in the passage **14***b* through the impeller body **14***a*.

A circular magnet **20** is secured to and recessed in the wall of the impeller body **14***a* at the lower end thereof, and the magnets **12** and **20** are matched in polarity so that upon rotation of the outer magnet **12** the inner magnet **20** will track same to thereby rotate the impeller **14** at the same speed as the rotation of the outer magnet **12**.

A valve block **21** which is made of acrylic plastic material inert to the fixer solution is secured to the upper surface of the end wall **3***b* by means of a threaded screw **21***a* which extends through a passage provided through the valve block **21**, is threaded into the upper end wall **3***b*, and is secured in place by means of a nut **21***b* on the outer end thereof.

The valve block **21** has a hollow extension **21***c* thereon which extends into a central passage **3***c* extending through the end plate **3***b*. The valve block **21** has another hollow

extension **21***d* thereon which extends through a passage **3***d* provided through the end wall **3***b* outwardly of the center of the said wall. An inlet passage **22** is provided through the wall of the block **21** which communicates with the hollow portion **30** in the extension **21***c* which provides a passage leading into the interior of the recovery chamber **3**. A threaded hollow fitting **23** is threaded into the wall of the block **21**, and has a corrugated connection surface **23***a* on the outer end thereof onto which the end of a flexible liquid supply hose **24** may be sealingly stretched.

A plug valve **25** is rotatably disposed in the passage **22** to control the flow of fluid therethrough.

An outlet passage **26** extends through the wall of the valve block **21** and communicates with the hollow area **21***e* in the extension **21***d* to thereby cause communication of said outlet passage **26** with the interior of the recovery chamber **3**.

A fitting **27**, having a passage therethrough communicating with the outlet passage **26** is threadedly engaged in the wall of the valve block **21** and has a corrugated surface **27***a* on the outer end thereof to which the end of the flexible outlet hose **28** may be connected by stretching the end thereover. The inlet hose **24** is connected in communication with a reservoir containing silver laden fixer solution from which same is drawn in the manner hereinafter described, and the outlet hose **28** is connected to the original or another reservoir in which the fixer fluid is deposited for reuse after removal of silver therefrom.

A plug valve **29** extends through the wall of the valve body **21** and into the passage **26** to control the flow of fluid therethrough.

A hollow anode made of platinumized titanium is suspended in the passage **30** by means of the metallic suspension member **32** which is secured thereto by means of spacers **33** which are secured to the inner wall of the anode **31**. The suspension member **32** is attached in the upper end of the bore **30** to the valve body **21** by means of a suspension screw **37** which passes through the wall of the valve body and is threadedly engaged with the suspension member **32**. The screw **37** and suspension member **32** also provide conductors for current supplied through the positive lead **34** connected to a source of DC current. The positive lead **34** has a press-on connector **34***a* on the end thereof which is engaged with a connector **35** which in turn is in electrical contact with the screw **37** which passes therethrough and is held in place by means of a nut **38**.

A cylindrical cathode made of stainless steel is disposed about the anode **31** located centrally thereof, and is clamped between the end plates **3***a* and **3***b*. The ends of the cathode **39** are pressed against the resilient seals **40** and **41** at the upper and lower ends thereof so as to provide a sealed connection between the ends thereof and the end plates **3***a* and **3***b*. Thus, the end plates and the cathode provide a container through which the fixer fluid is circulated.

A negative electrode **36** is secured to the outer wall of the cathode **39** and has an outwardly extending connector portion **36** over which the press-on socket **42***a* on the negative lead **42** is pressed to make electrical connection between the cathode **39** and the negative lead **42**. The negative lead **42** is attached to the negative side of the source of DC current to complete the circuit between the anode **31** and the cathode **39** through the fluid in the recovery chamber **3**.

A transformer **42***b* may be provided in the base portion **1** for supplying voltage at the proper level and amperage to a rectifier **42***c* which is connected to leads **34** and **42**. Preferably, the voltage should be six volts and ten amps for maximum recovery rate.

A fan motor **43** may be also mounted in the base portion **1** which drives a fan to draw air through the louvers **44** to cool the motor **8** and transformer **42**.

The operation and function of the device hereinbefore described is as follows: The motor **8** is energized by pressing the switch **9**. The rotation of the motor **8** rotates the magnet carrier **11**. The rotation of the magnet **12** causes the magnet **20** to track same at the same speed of rotation, thereby rotating the impeller **14** at a rapid rate of speed. The valves **25** and **29** are open. The rotation of the impeller **14** lowers the pressure centrally of the recovery chamber **3**, thereby drawing liquid through the hose **24** from the silver laden fixer reservoir. Such liquid is circulated by the impeller **14** by being first drawn downwardly through the hollow anode **31** and in a spiral pattern about the recovery chamber **3** as it impinges against the inner wall of the cathode **39**, and such liquid is discharged through the passages **21***e* and **26** and through outlet hose **28** to the reconditioned fixer reservoir from which silver or other metal has been removed. As such liquid is circulated through the recovery chamber **3** current passes through same from the anode **31** to the cathode **39**, and the silver therein is electrolytically deposited on the cathode **39**.

When it is desired to take the recovery chamber **3** to a place where the cathode may be removed for removal of silver deposited thereon, the recovery chamber **3** may be removed from the base **1** by simply lifting it therefrom, causing the casing **13** to be removed from the cup shaped magnet carrier **11** in the manner shown in FIG. II. The anode assembly **31** may be easily removed by simply removing the nut **21***b*, allowing the valve body **21** and anode suspended thereto to be removed from the top plate **3***b*. Thus, the entire assembly including the recovery chamber **3** may be removed and transported intact in a suitable carrying case. Another recovery chamber **3** may be substituted for the one removed without moving or disturbing the base member **1** in any manner.

The cathode **39** may be easily removed from the recovery chamber by simply removing the nuts **6** from the tie rods **5**, and lifting the top plate **3***b* therefrom, thereby exposing the cathode for removal.

It will be seen that I have provided a silver or other metal recovery device by electrolysis process which includes means to circulate fluid therethrough without the use of external pumps at a rapid rate in a manner which gives maximum exposure of the fluid to the cathode and more efficiently removes and deposits silver and other metal from the liquid circulated therethrough, in which the impeller which both circulates the fluid therethrough and agitates same in a desired pattern is driven magnetically by an external motor without the necessity of a shaft extending through the wall of the container, thereby eliminating seal problems, and permitting the recovery chamber to be quickly disconnected from the base portion for transportation to a desired place for removal of the cathode and the subsequent removal of the silver therefrom.

It will be understood that this device can be employed to remove various metals from liquid which is subject to cathodic action, thereby permitting removal of undesirable metallic contents from liquid before being disposed of or permits the reuse of such liquid after removal of the metallic particles therefrom, thereby resulting in economy and contributing to the solution of pollution problems.

Having described my invention I claim:

1. A metal recovery device comprising, a cylindrical cathode; upper and lower end walls secured across opposite ends of the cathode, said upper end wall having an inlet passage extending substantially centrally therethrough and having an outlet passage extending therethrough adjacent the periphery thereof; an anode suspended substantially centrally of the upper end wall; an impeller rotatably secured to said lower end wall, said impeller being adapted to draw fluid through said inlet passage and to discharge fluid along an unobstructed spiral path adjacent said cathode toward said outlet passage; and means to rotate the impeller.

2. The combination called for in claim **1** wherein the means to rotate the impeller is a motor suspended beneath the cathode and drive means between the motor and the impeller.

3. The combination called for in claim **1** wherein the end walls are disengagably joined by tie members extending therethrough and about the cylindrical cathode.

4. The combination called for in claim **1** wherein the anode comprises a member concentrically disposed in the inlet passage forming an annular flow passage through the upper end wall and through the cylindrical cathode.

5. The combination called for in claim **1** with the addition of means to maintain the anode and the cathode in stationary positions such that the electrical current flow therebetween is substantially constant.

6. The combination called for in claim **1** wherein the impeller is constructed of electrical insulator material.

7. The combination called for in claim **1** wherein the drive means is comprised of an outer annular magnet attached to the motor drive shaft and an inner annular magnet attached to the impeller within the outer magnet, whereby upon rotation of the outer magnet the inner magnet is caused to rotate, thereby rotating the impeller.

8. The combination called for in claim **7** with the addition of a cup shaped member carried by the motor shaft with said outer annular magnet secured therein, and a cap of non-magnetic material suspended to the lower wall and extending below same within the outer magnet and the cup shaped member.

9. A metal recovery device comprising, a recovery chamber having upper and lower end walls, said lower end wall having a passage extending through a central portion thereof; a cup-like member of non-magnetic material having sides secured to the lower end wall about the passage extending therethrough; an impeller in the recovery chamber rotatably secured adjacent said lower end wall; magnetic means on the impeller positioned to extend into said cup-like member; support means arranged to receive the recovery chamber; annular magnetic means rotatably secured to said support means, said annular magnetic means having a central opening extending therethrough into which the cup-like member is telescopically disposed; means to rotate the annular magnetic means; means to admit liquid into the chamber; means to discharge liquid from the chamber; an anode positioned in the chamber; and a cathode in the chamber; said impeller being arranged to circulate liquid over surfaces of the anode and cathode.

10. The combination called for in claim **9** wherein the recovery chamber includes a cylindrical cathode forming the outer wall thereof disposed between the end walls in sealed relationship therewith, said anode being suspended centrally of the upper end wall of the chamber and extending downwardly to a point above the impeller; means to admit fluid into the chamber substantially centrally of the upper end thereof; and means to discharge fluid from the chamber outwardly of the central portion of the upper end wall.

11. Metal recovery apparatus comprising, a base; a recovery chamber detachably secured to the base; a motor carried by the base; an impeller located substantially centrally of the bottom of the recovery chamber; drive means driven by the motor and extending through the bottom of the recovery chamber to drive the impeller; means to admit liquid substantially centrally of the upper end of the recovery chamber; means to discharge liquid from the recovery chamber in spaced relationship to the central portion of the upper end of the chamber; a cylindrical cathode forming the outer wall of the chamber; and an anode extending from the upper end of the chamber substantially centrally thereof above the impeller, said im-

peller being adapted to create a vacuum to draw liquid longitudinally of said anode and to propel liquid along an unobstructed spiral path over the surface of the cylindrical cathode to the means to discharge liquid.

12. The combination called for in claim **11** wherein the drive means is a magnetic drive comprising a sealed cap extending from the bottom of container; a body on the impeller rotatably extending into the cap; an annular magnet extending about the body; a cup like member attached to the motor shaft and extending about the cap; an annular magnet extending about the inner side of the cup like member, said magnets being matched in polarity whereby upon rotation of the cup like member the impeller will be rotated.

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U.S. Cl. X.R.
204—109, 261, 272; 259—102