

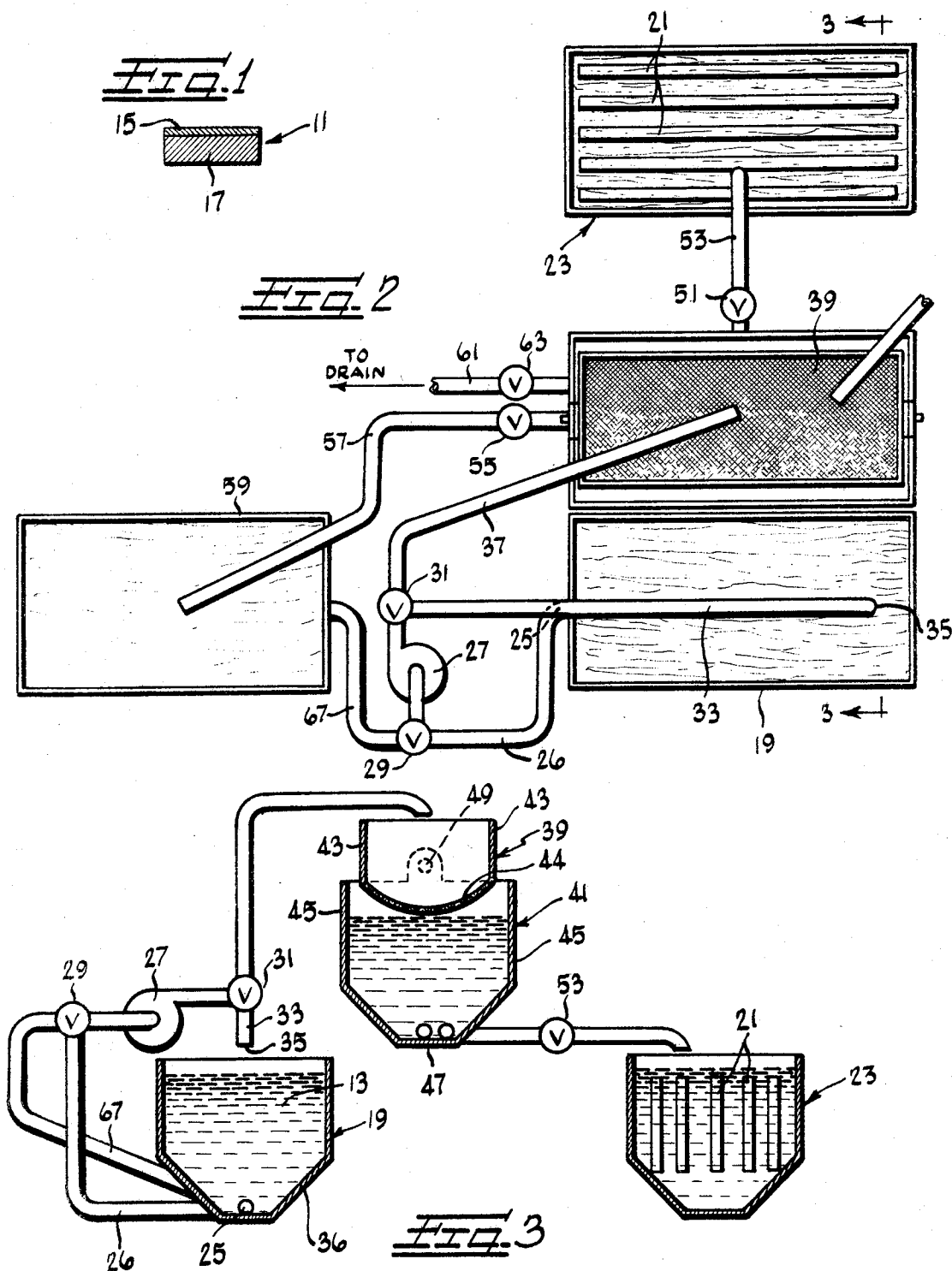
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PROCESS FOR RECOVERY OF SILVER FROM FILM

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PROCESS FOR RECOVERY OF SILVER FROM FILM

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9 Claims

ABSTRACT OF THE DISCLOSURE

A system in which silver and the base material from photographic or X-ray films is reclaimed and in which large quantities of film are handled in an economical manner. The film is cut into small chips and the chips are disposed in a tank with a warm bath and they are agitated to remove the emulsion from the chip base material. The chips and bath may be pumped to and from various tanks, and the chips are agitated by pumping some of the chips and bath to a position above the tank and discharging them back into the tank. After removal of the emulsion, the chips may be strained from the bath and the silver in the bath removed by plating the silver out on an electrode in a plating tank.

The above abstract is provided in accordance with Rule 72(b) and only for the purposes set forth therein.

This invention relates to a system for reclaiming silver from emulsions on photographic or X-ray films and also for reclaiming the emulsion support or film base which is usually cellulose acetate or some other plastic material.

Movie films, X-ray films and the like are known to contain relatively large quantities of silver and processes have been employed in the past such as burning and then condensing silver vapors to recover the silver. Burning film is not only objectionable from the standpoint of polluting the atmosphere but also because burning destroys the base material and a certain amount of the vaporized silver is lost during the process.

Various processes have been proposed to reclaim the base and silver, principally silver nitrate from movie film, but not have been successful in providing a quick and economical method for removing the emulsion and recovering the silver and base material. Of particular difficulty has been the problem of easy manipulation of long movie films or very large rectangular sheets of X-ray film during the various steps of the process. Also, prior art processes have not economically reclaimed the silver from the emulsion once it is removed from the base.

Accordingly, an object of the invention is to provide an economical and efficient method for reclaiming silver and the base material of films.

Other objects and advantages of the invention will become apparent from the detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is an enlarged, diagrammatic cross-section of a film chip.

FIG. 2 is a plan view of an apparatus for practicing the process of the invention.

FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 2.

As shown in the drawings for purposes of illustration, the method very generally includes the steps of providing a batch of film chips 11, which are small discrete particles severed from a film, disposing the chips in a liquid bath 13 which will remove the emulsion layer 15 (FIG. 1) from the film base 17, mixing and agitating the bath and chips to facilitate the scrubbing and removal of the emulsion from the chips and into the bath, separating the chips from the bath such as by straining the

chips from the emulsion bearing bath, and removing the silver from this bath by plating the silver on an electrode in a plating tank.

Obsolete photographic movie films and obsolete X-ray films are difficult to handle and manipulate if the films are allowed to remain rolled into reels or if the X-ray films are still in the form of large rectangular sheets. In accordance with the preferred embodiment of the invention, the films are comminuted into chips not only to obtain a good surface contact with the removing bath, but are comminuted to a size to facilitate their being movable with the bath as by pumping. Stated differently, the chips are small enough to be suspended in the bath 13 during agitation thereof and capable of being pumped with the bath whereby the film is easily transported to and from various steps of the process.

In the preferred embodiment of the invention, long continuous webs of film (not shown) are chopped into small discrete particles usually about a 1/8 inch in width and less than one and one-half inches in length. As will be explained in greater detail hereinafter, the chips become extremely slippery when wet and can be readily pumped with the bath to transport the same to and between the different tanks used in the recovery process.

The present process is particularly fast in operation because of the unusually good physical scrubbing action of the bath on the chips and because chips rub against each other to mechanically strip the emulsion bearing layer 15 from the film base 17. The mixing and scrubbing is preferably caused by pumping a portion of the bath and chips to a position above a removal tank 19 (FIG. 2) and then discharging the chips and bath to drop into the tank 19 whereupon the bath in the tank agitates and mixes the chips.

Another important aspect of the invention is reclaiming of the cleaned film chips 11 which are a relatively pure grade of cellulose acetate, or another plastic. Such base materials have a rather high resale value because of the high quality and transparent nature of the base material 17. The chips make an easy and convenient form for packaging and for incorporation into their various other products.

As will be explained in detail, it is preferred that the silver be separated from the bath by plating out the silver from the bath on electrodes 21 disposed within a plating tank 23. By adding a suitable chemical such as glacial acetic acid to the bath, the silver readily plates on the electrode in the plating tank. The plated silver is found to be relatively pure and, if necessary, requires only a simple refining action to make it usable for most commercial products.

Proceeding now with a more detailed description of the invention, rolls of film are suitably chopped or severed into discrete particles which are usually 1/2 inch or less in width and one and a half inches or less in length. In usual practice, the film chips from movie films do not exceed 35 mm. in length and are severed to approximately 1/8 inch in width. A suitable machine for severing rolls of film is shown in U.S. Pat. No. 3,324,753. To economically process wide aerial photographic films and large rectangular sheets of X-ray film, they are preferably slit and severed into individual discrete pieces by an apparatus such as that disclosed in copending application S.N. 659,691 entitled "Cutting Apparatus" filed Aug. 10, 1967.

The chips 11 are disposed in the removal tank 19 in which is placed the warm water bath 13 for removing the emulsion carrying layer or layers 15 from the film base 17. The temperature of the water is usually between 90° to 120° F., and to speed up the process a chemical or an enzyme, such as pancreatin or pepsin, is added to the warm water. The ratio of water is approximately one gallon of water for two pounds of chips. Pancreatin is

added to the bath at a rate of about $\frac{1}{2}$ oz. for each gallon of water.

In order to provide a quick and efficient process for removing the emulsion 15 from the film base 17, it is preferred to mix and agitate the film chips 11 and bath 13 to obtain a scrubbing of the emulsion layer from the film base. The preferred manner of providing such a mixing and agitating is by removing chips and bath from an outlet 25 at the bottom of the removal tank 19 and passing them through a pipe 26 and a valve 29 to the inlet side of a pump 27 which pumps a portion of the bath and the chips upwardly through a valve 31 to an overhead pipe 33 which terminates at an open end 35 from which the film chips and bath are discharged to drop back to the removal tank whereupon the chips and bath are continually mixed and agitated. The chips thus are rubbed against one another and are moved relative to the bath resulting in a mechanical action which facilitates the loosening of the emulsion 15 from the film base 17. To facilitate removal of the chips from the tank 19, the latter is formed with downwardly converging side walls 36 connected to vertical side walls 38 for the tank.

To separate the chips 11 from the emulsion carrying bath 13, it is preferred to pump the chips and emulsion carrying bath from the removal tank 19 through a pipe 37 and discharge the same into a strainer 39 which strains the chips from the bath. The bath passes through the filter into a collecting tank 41 disposed beneath the filter. In the present instance, the valve 31 is a two-way valve which can be set to a position whereby the chips and bath being pumped through a pipe 30 are diverted to the pipe 37 which extends over the strainer 39. Thus, the chips and bath may all be removed from the first tank 19 and deposited in the strainer 39 with a minimum of effort.

In this instance, the strainer 39 is generally rectangular in cross section with four side walls 43 supporting a generally curved, bottom screen 44. The top of the strainer is open to admit the chips which collect on the upper side of the screen within the strainer while the emulsion carrying bath moves through the screen into the collecting tank 41 which also is generally rectangular with four side walls 45 and a bottom wall 47. It is preferred that the strainer be removably mounted by pivot shafts 49 on open trunnions so that the strainer may be turned to extend over its side walls 45 and above the tank 19 so that chips may be dumped back into the tank 19 for the washing operation.

In the preferred embodiment of the invention, the strained chips 11 are still wet with some of the emulsion carrying bath 13. To enable recovery of this bath and its silver content and to provide a cleaner chip 11, it is preferred that the chips be dumped from the strainer 39 back into the removal tank 19 and that warm water be run over the chips to wash the same. The chips may be circulated by pumping them and the warm water for a brief period. After suitable washing of the chips, the valve 31 is turned and the pump 27 is operated to pump the chips into the strainer 39 whereupon the warm water is collected in the collection tank 41 and the chips 11 are collected on the strainer screen 44. At this time, a valve 51 in the line 53 leading to the plating tank 23 is closed and the warm water is diverted through a now open valve 55 in a line 57 to a storage tank 59 where the warm water is stored. A chemical, such as pancreatin, is added to make the bath water for the next batch of chips.

If desired, the chips 11 can be given another wash while in the strainer 39 by a suitable hose (not shown). This wash water exits the collector tank 41 through a discharge line 61 through a now opened valve 63 to a suitable drain.

For a new batch of chips 11, the three-way valve 29 is positioned to connect a pipe 67 to the inlet of the pump 27 so that the new bath is removed from the storage tank 59 and pumped through pipe 33 into the removal tank 19 for removing the emulsion layer from this subsequent batch of chips.

The capacity of the plating tank 23 is relatively large so that a number of baths may be retained for a simultaneous plating action because it is a relatively slower operation than the emulsion removing operation. To facilitate the plating action, glacial acetic acid is added to the emulsion carrying baths in the plating tank at the rate of 6.4 ozs. per gallon of bath liquid. With the electrodes of the bath connected to a suitable electrical source, the silver begins to deposit out on the metal electrodes 21. The silver on the electrodes can be readily scraped from the electrodes. The plated silver is approximately 90% pure and by simple refining operations can be made more pure.

For purposes of illustration, the following example is given. About 600 pounds of 35 mm. movie chips film each measuring $\frac{1}{8}$ inch by 35 mm. are deposited into the removal tank 19 in which there is about 300 gallons of H_2O at a temperature of about $100^\circ F$. The bath contains about 150 ozs. of pancreatin. The pump 27 is turned on for about 10 minutes, during which time a portion of the bath and chips are continually removed from the bottom of the tank and circulated upwardly to discharge through open end 35 of the pipe and dropped back into the tank 19. By this method, the chips are mixed and agitated so that the emulsion layer 15 bearing the silver halide crystals is quickly removed from the film base 17.

The valve 31 is then operated to a position to divert the bath and film chips through the pipe 37 which discharges them into the strainer 39 which removes the chips 11 from the bath which flows into the collection tank 41. The bath flows from this tank by gravity through line 53 and the valve 51 to the plating tank 23.

After the tank 19 has been emptied and the chips have been strained from the bath, the strainer 39 is rotated to dump the chips back into the tank 19. Warm water of about $100^\circ F$., either with or without chemicals, is pumped into the tank to wash the chips which are still wet with the silver bearing bath. The film chips 11 may be agitated by pumping them above the tank and dropping them back into the removal tank 19. When the chips are rinsed, the bath and chips are pumped through the line 37 and again collected in the strainer 39. This wash water is collected in the collection tank 41 and flows by gravity through now open valve 55 and line 57 to the storage tank 59 where the water is stored for the next batch of chips. To assure that the chips are very clean, the chips in the strainer may be rinsed to clean the same of the previous wash water. This latter rinse water is allowed to drain out through the pipe 61 and discharged. The clean chips may now be removed from the strainer 39 and collected in suitable containers for resale.

The bath within the plating tank 23 is treated with about 6.4 ozs. of glacial acetic acid and the electrodes 21 are able to remove silver. After about four hours, the baths in the tank 23 are discharged. To start a new operation, a new batch of chips may be dumped in the removal tank 19 and the pump 27 operated to pump the bath from the bath storage tank 59 into the tank 19. Caustic soda may be used in lieu of the pancreatin. When caustic soda is used, the glacial acetic acid is added to make the bath have a pH value of about 5 in the plating tank.

From the foregoing it will be seen that the present invention provides a unique process whereby not only the silver but also the base material may be economically recovered. The process is most economical in that it requires relatively little manual effort and in that the chips and bath are so interrelated that they both can be moved as a fluid stream and can be separated from one another by a simple straining operation.

While a preferred embodiment has been shown and described, it will be understood that there is no intent to limit the invention by such disclosure, but rather, it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as defined in the appended claims.

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What is claimed is:

1. In a process for reclaiming silver from a photographic emulsion and the film base from photographic and X-ray films, the steps of: cutting said film into chips, placing said chips in a bath for removing the emulsion from said film base, mixing said chips in said bath to rub said chips against each other and continuously expose the surfaces of the chips to the bath, separating said chips from said bath whereby said film base is recovered in chip form, placing said emulsion-carrying bath in a plating tank, and plating said silver from said bath on an electrode.

2. The process of claim 1 in which said film is severed into chips of about less than $\frac{1}{2}$ inch in width and less than about two inches in length so that said chips move readily in and with movement of said bath.

3. The process of claim 2 in which the step of mixing is performed by pumping a portion of said chips and said bath to a position above a tank holding the chips and bath and then dropping said chips and bath back into said tank.

4. The process of claim 1 including the step of washing said chips after separation from said bath with a liquid to clean said chips, and including the step of using said liquid in a subsequent bath for a subsequent batch of film chips.

5. The process of claim 1 in which said chips and said bath are pumped from a first tank to a strainer at a second tank and in which the bath is collected in said second tank and said chips are collected in said second tank and said chips are collected in said strainer.

6. The process of claim 5 in which said strained chips are dumped back into said first tank and washed with a liquid to remove any residue of said bath on said chips

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whereby the chips are relatively clean of said bath and said emulsion.

7. A process for reclaiming silver from a silver bearing emulsion and reclaiming an emulsion support layer from chips of film, said process comprising the steps of: disposing the film chips within a first tank and in a warm bath for removing said emulsion from said support layer, pumping some of said chips and bath to a position above said tank and discharging the same into said first tank to agitate and tumble said chips to scrub said emulsion from the support layer while dissolving said emulsion in said bath, pumping said bath and chips to a strainer and a second tank, and straining the chips from said bath whereby said chips are reclaimed, and then removing said silver from said bath.

8. The process of claim 7 in which said bath contains pancreatin and said bath is at a temperature in the range of about 90° to 100° F.

9. The process of claim 8 in which said silver is removed from said bath by a plating process and in which glacial acetic acid is added to said bath to assist in the plating of the silver.

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