

Oct. 9, 1962

B. E. LUBOSHEZ

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Filed April 6, 1959

5 Sheets-Sheet 1

Fig. 1

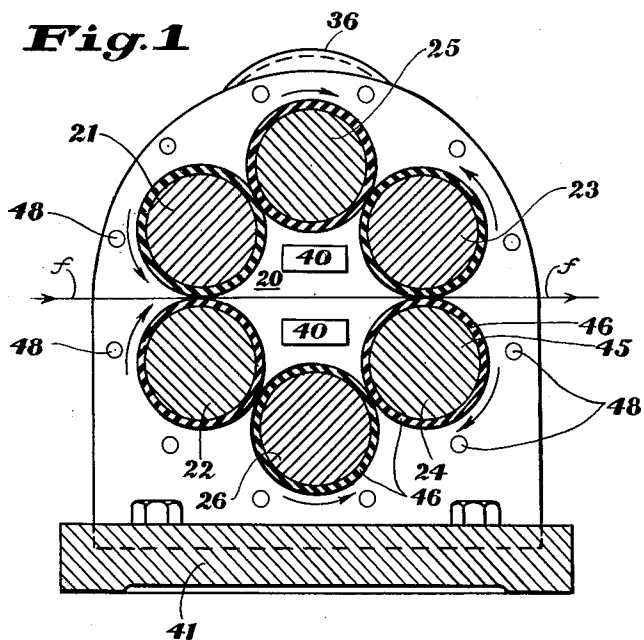
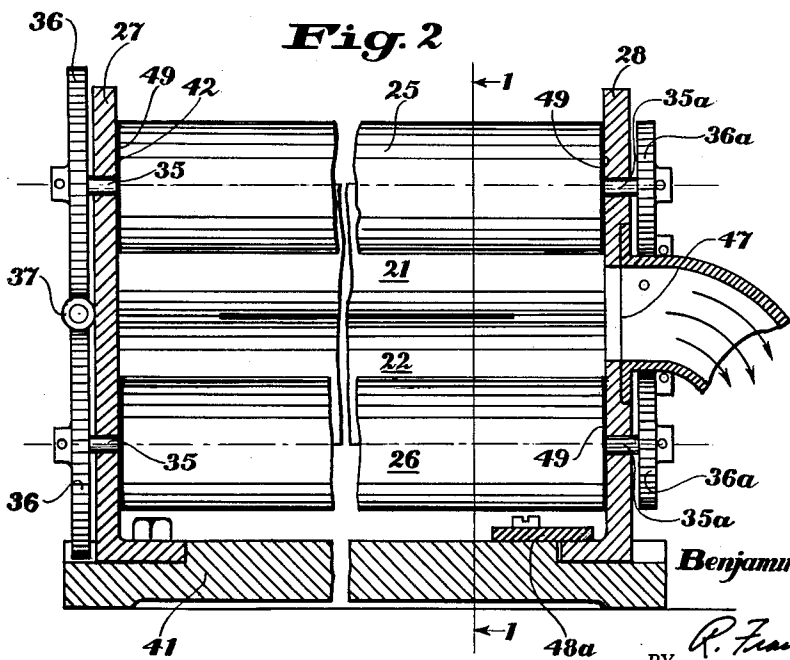


Fig. 2



Benjamin E. Luboshez

INVENTOR.

BY *R. Frank Smith*
J. Hoff
ATTORNEYS

Oct. 9, 1962

B. E. LUBOSHEZ

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Filed April 6, 1959

5 Sheets-Sheet 2

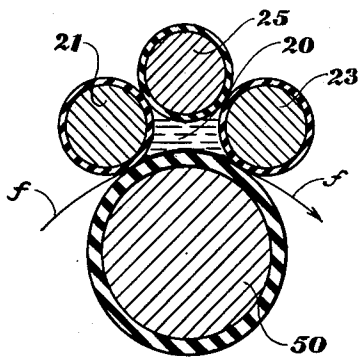


Fig. 3

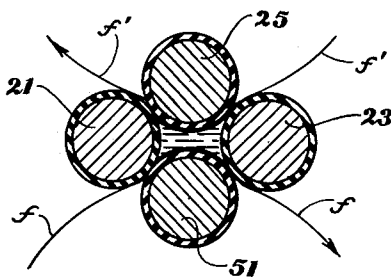


Fig. 4

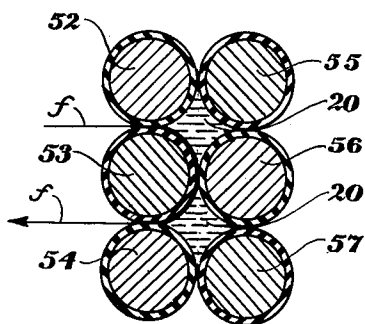


Fig. 5

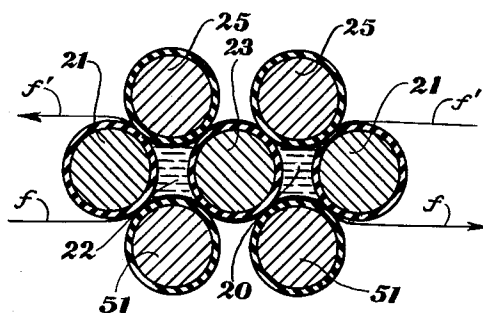


Fig. 6

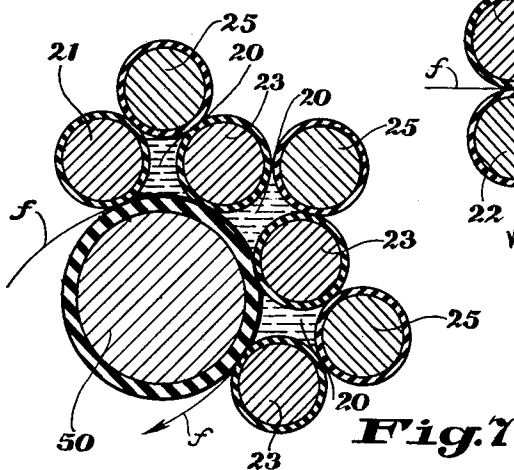


Fig. 7

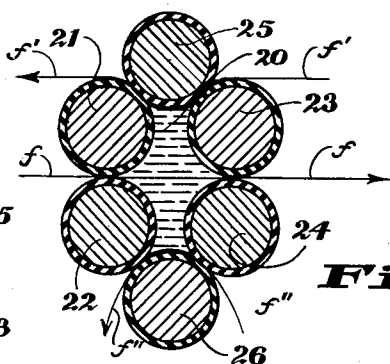


Fig. 8

Benjamin E. Luboshez
INVENTOR

INVENTOR.
R. Frank Smith
BY
J. Griffin Little
ATTORNEYS

Oct. 9, 1962

B. E. LUBOSHEZ

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Filed April 6, 1959

5 Sheets-Sheet 3

Fig. 9

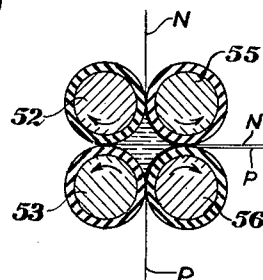
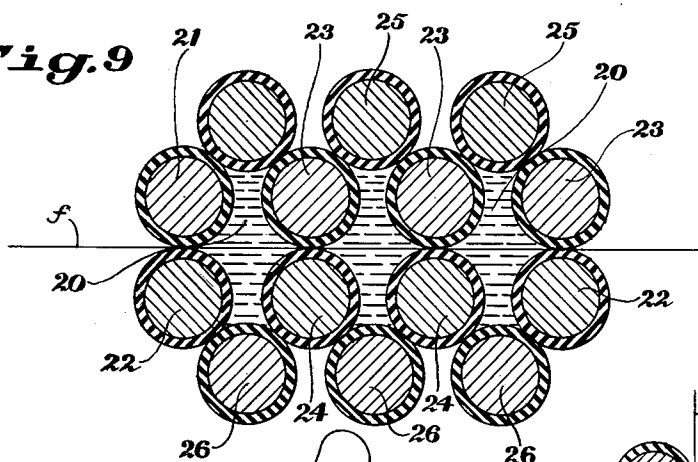


Fig. 11

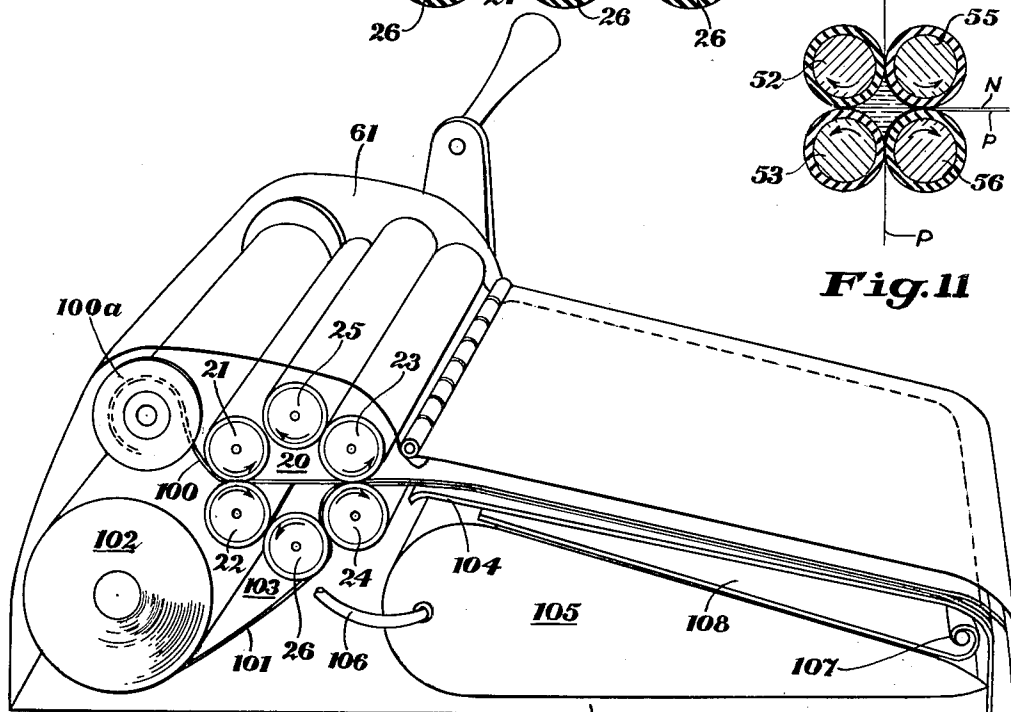


Fig. 10

Benjamin E. Luboshez

INVENTOR.

BY *R. Frank Smith*
J. Eugene Lira

ATTORNEYS

Oct. 9, 1962

B. E. LUBOSHEZ

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Filed April 6, 1959

5 Sheets-Sheet 4

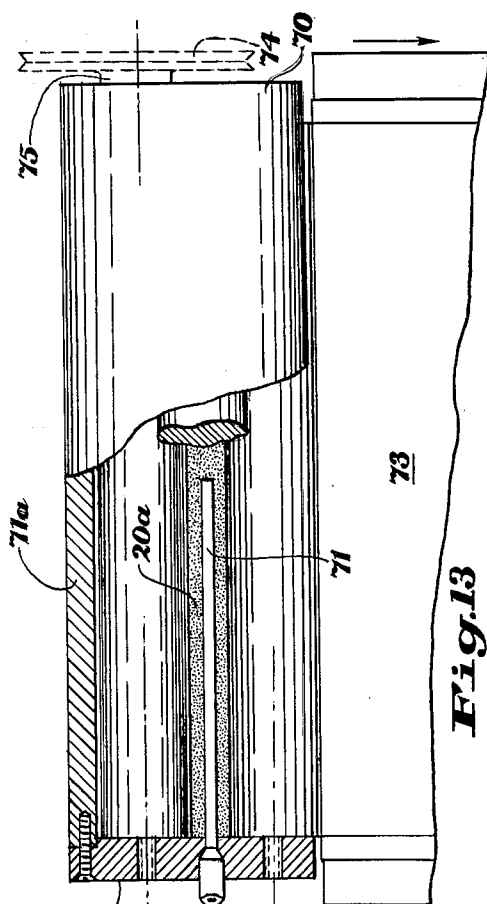


Fig. 13

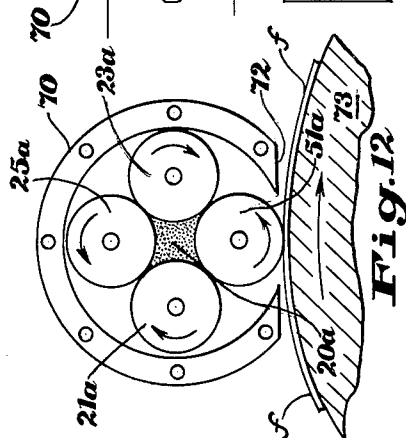


Fig. 12

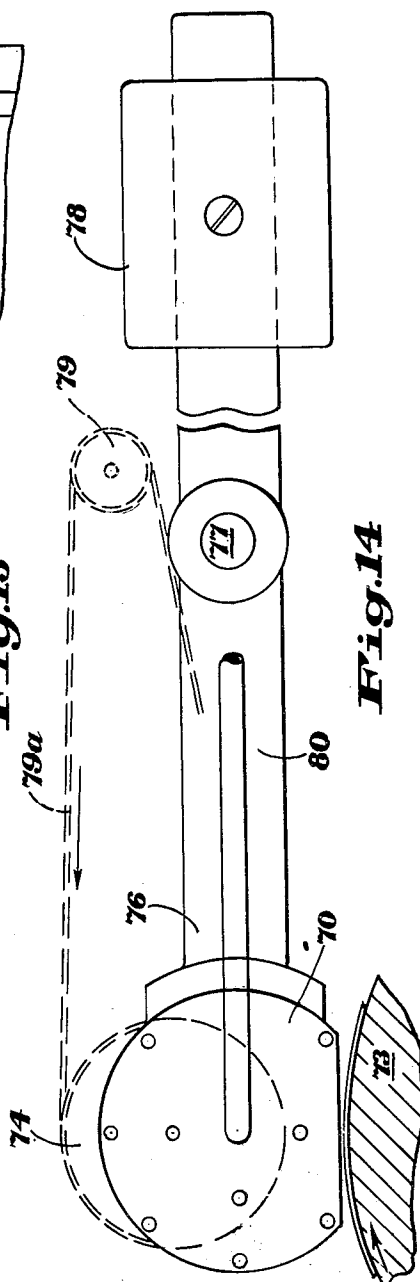


Fig. 14

Benjamin E. Luboshez
INVENTOR.

BY *R. Frank Smith*
J. Griffin Little
ATTORNEYS

Oct. 9, 1962

B. E. LUBOSHEZ

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Filed April 6, 1959

5 Sheets-Sheet 5

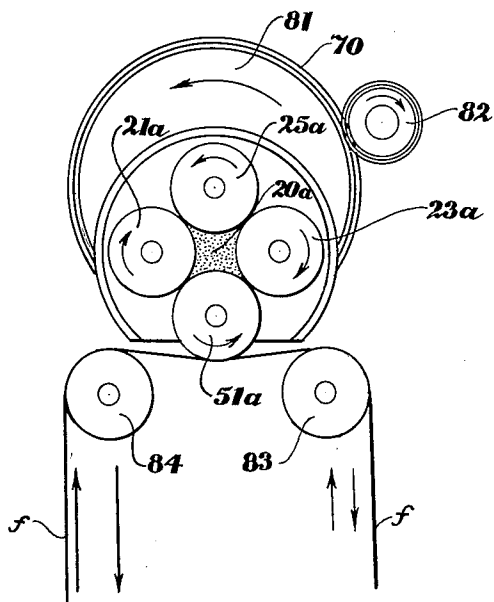


Fig. 15

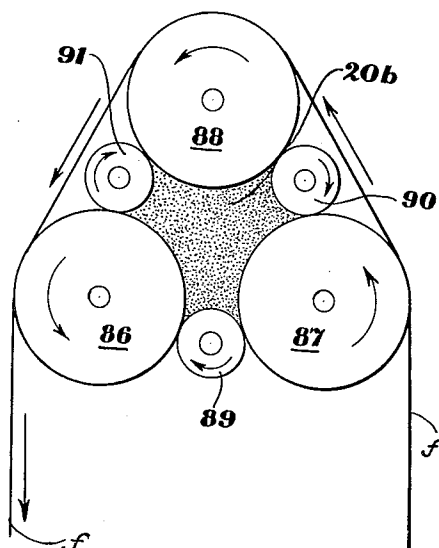


Fig. 16

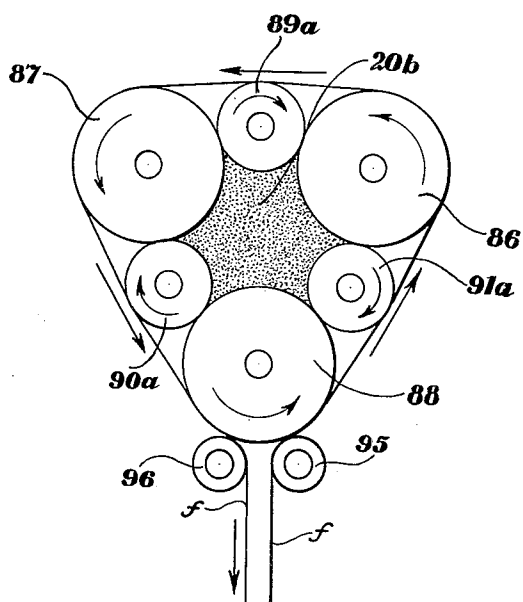


Fig. 17

Benjamin E. Luboshez
INVENTOR.

BY *R. Frank Smith*
J. Griffin Little
ATTORNEYS

1

3,057,282

FLUID TREATING DEVICE FOR SHEET OR STRIP MATERIALS

Benjamin Ellan Luboshez, Rochester, N.Y., assignor to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

Filed Apr. 6, 1959, Ser. No. 804,305

3 Claims. (Cl. 95—89)

The present invention relates to a device for treating one or both surfaces of sheet material, and more particularly to a device for treating or processing photographic material.

The principal object of the invention is to provide a novel film treating chamber through which a web may be continuously fed for different kinds of treatment.

Another object is to provide a fluid tight film treating device comprising a chamber bounded on two sides by parallel end plates and circumferentially by four, or greater even numbers of rollers, each in rolling line contact with its two neighbors and all rotatable about parallel axes so that strip or sheet materials may be passed between pairs of rollers into and out of said chamber without substantial leakage of fluid therefrom for the treatment of one or both surfaces of the web. The strip to be treated can be moved in surface contact with one or more of said rollers which will apply a regulated amount of fluid from the interior of the chamber to the surface of the strip.

Another object of the invention is to provide a method or means for applying a fluid to a surface in a regular, controlled manner so that the desired parts of the material will receive uniform treatment longitudinally and across the width of the material.

Another object is to provide a processing device that is able to utilize treating fluids of high or low viscosities.

Still another object is to provide a device that shall be capable of operating with very small quantities of fluid.

And still another object is to provide a device for continuous unattended operation.

Another object is to provide a fluid applicator that will be operable and leakproof under all possible variations in the direction, and reasonable variations in the magnitude of, accelerational forces such as gravity so that the device may be operated on moving platforms such as ships, planes or satellites.

A final object is to provide an apparatus that shall be exceedingly small in weight and bulk.

To these and other ends, the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

FIG. 1 is a vertical sectional view of one embodiment of the device of the present invention, taken substantially on line 1—1 of FIG. 2, showing the arrangement of the rollers to form a fluid tight periphery of a fluid treating or processing chamber;

FIG. 2 is a side elevation view of the structure shown in FIG. 1, with the end walls and base in section, showing the relation of the rollers to the end walls to form seals between the rollers and the end walls;

FIGS. 3-9 are vertical sectional views, similar to FIG. 1, showing the differently arranged rollers to form one or more fluid type chamber peripheries. For the purpose of clarity the end walls have been eliminated in these figures;

FIG. 10 is a side elevation view of a roll film processor showing the application thereto of the treating chamber of

2

the present invention, only one of the end walls being shown in this view;

FIG. 11 is a view similar to one section of FIG. 5 showing the arrangement for treating and laminating two sheets;

FIGS. 12-17 show additional embodiments for applying a fluid to a film without necessitating the passage of film through a fluid chamber, fluid being applied to the web from the outside of the rollers.

It will be noted that multiple chambers or devices may be formed by combining one or more of the chambers illustrated in the drawings.

Similar reference numerals throughout the various views represent the same parts.

Referring to FIGS. 1 and 2, this embodiment of the invention relates to a new method and means for drying sheet materials in either the continuous strip form or in the form of sheets of various size and shape. More particularly, the embodiment of FIGS. 1 and 2 of the invention is concerned with the rapid drying of photographic materials by automatic machinery where the difficulties involved in the handling of various sizes of sheet material, in mixed sequence, gives rise to awkward problems. The automatic drying of X-ray films is a specific example which illustrates the principal difficulties involved, for since such films are double coated (i.e. emulsion coated on both sides), the amount of water carried over to the drier is considerable, while at the same time both sides of the film become sticky and easily damaged at certain stages of the drying procedure. The difficulties of satisfactory transport and handling through the drier are further augmented by the fact that the film sizes may vary between 4 x 5 inches to 14 x 17 inches which must pass through the drier in mixed sequence.

The application of the invention to X-ray films, being the most difficult, will be considered first, but it must be remembered that the invention is also applicable to the drying or treating of other types of photographic, as well as non-photographic, materials in both the continuous strip and cut-sheet forms.

As far as the applicant is aware, the universal method of drying X-ray films has hitherto been to dry them in air, with or without a preliminary removal of excess water by an alcohol bath followed by wipers, squeegees, or the like. In order to speed up the drying, more and more air is blown through the drier at higher and higher temperatures, until a stage is reached where a number of serious difficulties arise. In the first place, it becomes increasingly difficult to transport the various sizes of film through the drier; secondly, the film may become overheated and buckle; or be otherwise damaged; thirdly, the large volume of hot humid air must be disposed of; fourthly, the noise from the blower becomes excessive; and, finally, a disproportionately large space must be devoted to the drier.

According to the present invention, the drying problem is approached from a totally different standpoint with the object of eliminating most, if not all, of the difficulties associated with hot air drying and this is accomplished by simply eliminating the air entirely, or as far as possible.

Briefly, this embodiment of the invention, illustrated in FIGS. 1 and 2, consists in passing the films or sheets, after the usual removal of excess surface water, through a short vacuum chamber, thereby allowing the molecules of water to leave the film unimpeded by any bombardment by surrounding air molecules.

A certain amount of heat must be supplied to the film during the drying process to compensate for the amount lost by evaporation, in the form of latent heat of vaporization, and at the same time to warm up the film in order to agitate the water molecules to allow them to escape from the film more easily. The amount of heat required for these purposes is incomparably less

than that required to heat up the vast quantities of air usually used in air drying. The heat may be supplied to the film either as radiant heat from infrared lamps inside the vacuum chamber, or it may be generated in the film itself by electrical means (as in medical diathermy). In any case, the smallest amount of heat required to dry the film in the desired time interval is employed, so as to avoid film stickiness.

As far as is known, it has not previously been proposed to dry photographic sensitized materials in vacuo. Of course, in some air drying devices, the air blower has occasionally, for mechanical convenience, been located so as to draw, instead of force, the air through the drier, although it is more usual to blow the air through. In such cases, there is a slight difference in air pressure between the drying member chamber and the outside air but this small decrease in air pressure can hardly be considered a vacuum; furthermore, one of the objects of the present invention is to draw in as much air as possible.

The invention is not restricted to any specific methods for carrying it out. However, by way of example, a preferred form for putting this invention into practical effective as an automatic drier for either continuous strip or cut sheet materials will be described, and then other possibilities applicable to special problems will be considered.

It will be evident that the main problem that arises in the practical application of the invention as a continuous drying device, consists in devising means for introducing and removing the strip, or individual sheets, of photographic material into and out of the vacuum chamber without at the same time permitting too much air to leak in. The efficiency of these arrangements will be determined by the size and capacity of the vacuum pump required to maintain the requisite very low pressure in the chamber, for, apart from leaks, all that the pump has to do is to remove the water vapor that originates in the material passing through the chamber. This water vapor can then be condensed and collected in a receptacle, or drained off continuously, so that the problems of heat and humidity disposal, so objectionable in air driers, do not arise. It is estimated that a vacuum pump of quite reasonable capacity would suffice to dry even X-ray films as far as they could be delivered by an automatic processing unit.

According to one form of the invention, FIGS. 1 and 2, the film, or other photographic material, enters the vacuum chamber between a pair of wringer rollers 21 and 22, which, incidentally, act as squeegee rollers, and leave the vacuum chamber by a similar pair of rollers 23 and 24 located in horizontal aligned relation to the first pair so that the distance between the two sets of rollers can be comfortably bridged by the smallest length of film to be dried. The vacuum or treating chamber 20 is completed by close fitting end plates 27 and 28, and by means of two other rollers, roller 25 pressing against the top rollers 21 and 23 of both the entering and exit pairs, and another roller 26 touching the bottom rollers 22 and 24 of both the entering and exit pairs of rollers, as clearly illustrated in FIG. 1. The six rollers 21—26 are pressed together in peripheral contacting relation by the external air pressure or otherwise to form a fluid tight periphery of the treating chamber 20, which is traversed by the material to be dried. The left ends of rollers 25 and 26, FIG. 2, are provided with stub shafts 35 extending through end plates 27, and having mounted thereon gears 36 which mesh with a worm 37. Thus, rollers 25 and 26 are driven positively. On the other hand, the right end of each roller is provided with stub shaft 35a which extends through the right wall 28 and has mounted thereon a smaller gear 36a which meshes with similar gears on adjacent shaft 35a. Thus, the rollers 25 and 26 are driven positively and directly, while the other rollers are driven by gears 36a.

FIGS. 1 and 2 show one of the simplest forms of this kind of drier or fluid-treating device. The film enters the vacuum chamber 20, which may contain heaters 40, between two wringer rollers 21 and 22, which are closely pressed together, and emerges between the rollers 23 and 24. The vacuum or treating chamber 20 is completed by the two sealing rollers 25 and 26, together with the end plates 27 and 28 which bear against the flat ends 42 of the rollers. These end plates are suitably attached to a base plate 41. Each roller 21—26 is preferably made of steel 45 covered with a sufficient layer of rubber 46 or other resilient material, but may take the form of hollow inflated resilient envelopes under high internal pressure. The vacuum chamber 20 is connected with a vacuum pump, not shown, through a large hole 47 in the end plate 28.

One of the end plates, the right one 28 of FIG. 2, is mounted on the base 41 with a slight degree of flexibility by means of pad 48a, and the other end plate 27 is fixed rigidly to the base 41. The two end plates 27 and 28 are held together in contact with the roller ends by means of twelve stout rods, not shown, of adjustable length. These rods pass through holes 48 in the end plates, see FIG. 1. By means of the rods the pressure may be adjusted between the accurately machined end plates 27 and 28, and the roller ends 42, so that a fluid-tight chamber can be obtained without too much end friction. Of course, all the rollers 21—26 must be of the same length and accurately made. Since the rollers 21—26 turn quite slowly, a thick grease, graphite or similar material, 49 may be positioned between the ends of the rollers 21—26 and the end plates 27 and 28, and serve to reduce friction and aid in the fluid-tight end-seals. In many cases it is not necessary to use all of the gear wheels 36a shown in FIG. 2, and some of the six gears 36a may be eliminated, leaving only one or more wheels 36a to drive all six rollers by frictional contact.

In FIG. 1, the vacuum chamber 20, has been shown as symmetrical and all of the rollers are shown of the same diameter. However, the invention is not limited to this, as will be later pointed out, but where the rollers are of different diameters proper care must be taken to see that all of the circumferential speeds are alike, as will be evident to one skilled in the art. Furthermore, the device is not limited to the use of a total of only six rollers, for the required number of rollers may be added to form the treating chamber or chambers, which may be of almost any desired shape and size, see FIGS. 3-9.

It will be seen that the simple roller device described in connection with FIGS. 1 and 2, provides a treating chamber which is very effectively sealed against air leakage during the passage of films, or other sheet material, through it and thus provides a rapid drier, or fluid-treating chamber, of great versatility and quite small external dimensions. This device should have many practical applications in industry where rapid drying or treating of sheet or strip materials is required. It should also find many military applications especially in connection with radiography and all forms of photography upon ships and airplanes.

It might be pointed out that although the device shown in FIGS. 1 and 2, is primarily designed for use as a dryer, it is contemplated that it may be used in an entirely different way without materially altering the basic structure. For example, the chamber opening 47 in plate 28 may be sealed and the chamber 20 filled with a fluid or liquid, and thus serve as an efficient sealed processing or treating tank. In fact, a whole processing unit might be built up with a sequence of such sealed chambers, as will be later pointed out, so as to permit developing, rinsing, fixing, washing and finally vacuum drying. It could even be used in conjunction with a hot air drying system, with an opening similar to 47, FIG. 2, in both end plates, so that dry hot air can be blown through the chamber in a closed circuit, the water being extracted

from the air later by cooling, the air then being reheated for repassage through the chamber. The form shown in FIGS. 1 and 2 well illustrates the general idea of this invention; it is self-threading and will take strip materials or cut sheets of various sizes in mixed sequence; it can likewise deal with materials that are to be treated on one or both sides simultaneously.

Again referring to FIGS. 1 and 2, it is seen that the chamber 20 is formed by arranging a plurality of rotatable rollers 21—26 in annular contacting relation to form a fluid tight periphery for the chamber 20. The ends of the chamber 20 are sealed by end plates 27 and 28.

FIGS. 3—11 show different arrangements of rollers to form sealed liquid-tight chambers through which a sheet or web may be passed to treat the latter, as will be presently described.

FIG. 3 shows an arrangement in which the three lower rollers 22, 24 and 26, FIGS. 1 and 2, are replaced by a single large roller 50, while FIG. 4 shows the bottom rollers 22, 24, 26 FIG. 1, replaced by a single small roller 51. Thus, FIG. 4 differs from FIG. 3 only in the size of the lower roller and shows how two film strips *f* and *f'* may be simultaneously fed through the one chamber.

FIG. 5 shows a group of chambers 20 arranged in vertical aligned relation. To secure this result, the rollers 52—57 are arranged in two parallel vertical rows to form a series arrangement of two chambers 20, as is deemed apparent from this figure. With this arrangement one or more sheets on one or both sides may be processed simultaneously, as is deemed apparent.

FIG. 6 is a horizontally arranged multiple chamber arrangement in which two units of FIG. 4 are arranged in end to end relation with the roller 23, common to both groups. Here again the simultaneous treatment of two film strips *f* and *f'* are illustrated.

FIG. 7 is similar to FIG. 3 with additional smaller rollers to provide two extra chambers 20.

FIG. 8 is similar to FIG. 1, but shows an arrangement by which separate sheets *f* and *f'* may be fed through a chamber.

The structure of FIG. 9 is formed by arranging three units of FIG. 1 in side by side relation, certain rollers of each section being common to two adjacent sections.

FIG. 10 shows how the chamber arrangement of FIG. 1 may be positioned inside a roll film processor-printer 60 for making prints without a darkroom from exposed, but not processed, negatives by the solvent-transfer-reversal process. In this arrangement, the ends of the chamber are sealed by the walls 61 of the processor-printer 60, only one of the walls being shown.

In the embodiment of FIG. 10 a strip of exposed, but not processed negatives 100, is unwound from a spool 100a and is passed straight through chamber 20 from left to right, to process the negative strip 100. In addition, a web of positive print paper 101 is unwound from a supply roll 102 and is passed under a roll 26, between the latter and roll 24, and into the chamber 20, to expose only one surface 103 of paper 101 to the fluid in chamber 20. The wet paper 101 is then passed between rolls 23 and 24 at which point the paper web 101 is pressed against the negative strip 100 and the two are discharged from the chamber 20 in an overlying or laminated relation. The laminated web is then passed to the right over a backing plate 104 to the right end of the unit where the strips 100 and 101 may be separated and/or separately wound up. The paper now has a positive image of the negative transferred thereto, and if it is desired to fix the print and/or negative for further future use then each of the paper and negative strips can be passed through additional treating chambers for this purpose. A flexible bag 105 is positioned in the unit 60 below the plate 104. The bag 105 contains the processing fluid which is supplied to chamber 20 through a hose 106 which is connected through one of the end plates or walls 61 of

chamber 20. A spring 107 has an arm 108 which presses on the top of bag 105 to force the liquid from the bag 106 to the chamber 20 to maintain the desired amount of liquid therein.

It is apparent from the above description that the sealed chambers 20 of FIGS. 1—11 are formed by a plurality of rubber covered rollers arranged in peripheral contacting relation to form fluid tight peripheries, while the rollers cooperate with end plates 27 and 28 to seal the ends of the chambers 20. The rollers may be driven positively to feed the sheets through a chamber or chambers. In any event the film actually passes into and out of the chambers, and is treated during the passage there-through. The film may take a variety of paths depending upon the type of treatment desired. If the film strip is passed through a chamber in a direction otherwise than straight, suitable leader strips may be placed in the device, and the film to be processed attached to the leader strip so the latter will feed or draw the film strip in the desired direction, as is deemed apparent from the arrows in some of the figures.

The roller-chamber devices above described may be used to treat the same piece of material several times, or several separate pieces simultaneously. For example, referring to the six roller devices of FIG. 1, it is clear that while a sheet or strip material is passing centrally through the chamber 20 to process both sides of the sheet, two other sheets or strips, may be simultaneously passed between other rollers to process one side only. However, only the central passage is self-threading without special guides. This may be an important consideration where frequent loading, as with cut sheet materials, is concerned. It might be noted that in all forms of this device there are as many potential entries as exits.

Referring to FIG. 11, it is deemed apparent that the structure of this figure is the same as FIG. 5 with the two lower chambers being removed to provide a single chamber. The remaining rollers of FIG. 11 are designated by the same numerals as FIG. 5. Also, in FIG. 11, sheets N are fed between rollers 52 and 55 while sheets P are fed between rollers 53 and 56 and the two sheets are treated on one side only with the fluid in chamber 20. The sheets are then deflected to the right and fed out of the device in laminated or overlying relation between rollers 55 and 56.

The embodiments illustrated in FIGS. 12—17 are principally concerned with methods and means for applying liquids, or the like, in an even layer to strip materials. These devices can be used for many purposes, such as, for example, wetting, coating, painting, and the processing of photographic materials. Although the basic device can be used for treating almost any surface, such as cut sheets or even walls, and murals, only the application to thin flexible strip materials will be considered here.

The basic form of the new device comprises a closed chamber formed by contacting rollers and end plates, and this device is similar in structure with a chamber arrangement described in connection with FIG. 4, in which the device is used, but the way in which the fluid is applied is entirely different. The strip material no longer passes between the rollers and through the fluid in the treating chamber, but always remains outside the chamber. This is a complete inversion of the previous system, for it is only the fluid which has leaked out between the rollers or rather has been drawn out by the rotating rollers from the closed chamber, that is now applied to the surface of the strip material. FIGS. 16 and 17 show different forms of an important variation of this embodiment wherein the strip material is wrapped around the outsides of the rollers which enclose and form the periphery of the fluid chamber 20.

In all the illustrations the actual dimensions and the proportions of the parts are dependent upon the specific applications contemplated so that the drawings are merely diagrammatic representations for explanatory purposes.

For example, when used for photographic processing of 70 mm. or 35 mm. motion picture film, the dimensions might be less than half those actually shown, and for 16 mm. and smaller film, the device might be quite minute depending upon the process involved and the desired speed of operation. Several of the devices shown may, of course, be used in tandem to perform various processing, or coating, operations in sequence.

FIGS. 12-14 show a fluid chamber 20a which is bounded circumferentially by the four rotatable rollers 21a, 25a, 23a and 51a similar to FIG. 4, the ends of the chamber 20a being closed by two flat end plates 70 which bear against the end of the rollers in the manner above-described. A closed chamber 20a is thus formed for holding the fluid which is fed in through a tube 71. The rollers 21a, 25a, 23a and 51a are formed of steel and do not have a rubber coating, as in FIGS. 1-11. The result is that each of the rollers will pick up the fluid from the chamber 20a and carry the fluid to a point outside the chamber. The amount of any carry out or leak from chamber 20a is dependent upon many factors such as the nature and viscosity of the fluid, the internal pressure and the detailed mechanical design including the choice of materials used for the rollers and end plates. Only the simplest form is shown in FIGS. 12-17 since that form seems to be adequate for most applications. The rollers 21a, 25a, 23a and 51a are machined, ground, and mounted with considerable precision and similar care is taken with the contact sides of the end plates 70. The materials for all the parts are also carefully chosen. For example, when used for photographic purposes the rollers 23a and 21a might be of stainless steel. In FIG. 13 the end bearing plates 70 are shown supported by an outer tube 71a which holds all of the parts together in proper alignment. The strip material *f* is shown passing over a drum 73 which has a suitably soft resilient surface. This drum rotates and carries the strip material *f* with it, or, in a slight variation, the strip is pulled by other means and, in turn, rotates the drum. The parts are mounted and aligned so as to obtain the desired contact and pressure between the strip material *f* and the applicator roller 51a.

The device operates in the following manner: As the strip material is pulled through against the roller 51a at a uniform rate, it causes that roller 51a and the other contacting rollers 21a, 23a and 25a to rotate at the same peripheral speed. As the roller 51a rotates, a thin film of fluid adhering to its surface is drawn out of the chamber 20a and is deposited on the surface of the strip material *f* by roller 51a. The thickness and amount of the deposited, or coated fluid is dependent in part, upon the pressure between the roller 51a and the strip material *f*, the nature of that material and the time of contact. All these are factors that can be controlled. It might be mentioned, that not only does the kind of material from which the rollers 21a, 23a, 25a and 51a are formed have an important effect upon the amount of fluid carried around, but also the nature of the surface *f*; i.e. degree and kind of "roughness" is significant. This is especially true of the applicator roller 51a. This gives further means for controlling the flow.

A driving wheel 74 is shown in dotted lines on the right hand side of FIG. 13, and this wheel is mounted upon an extension 75 of the roller 25a. In many cases it is neither practicable nor desirable to depend upon friction alone between the strip surface and the roller 51a to drive all the rollers; in such cases it is sufficient to drive roller 25a at the required speed or to overdrive the other rollers through slip clutches, not shown. In some cases all of the rollers may be power driven, and if desired the roller 51a can be used to drive the drum 73.

When one or more of the rollers 21a, 23a, 25a or 51a is power driven, as well as the drum 73 carrying the strip material, it is possible to have a very slight amount of contact pressure between the applicator roller 51a and the

strip surface *f*; in that case there are advantages in running the applicator roller 51a at a much higher surface speed than that of the strip material, thus obtaining an even wiping action. The value of this will depend in each case upon the use to which the device is being put.

FIG. 14 shows how the device of FIGS. 12-13 may be mounted upon an arm 76 pivoted at 77 and having an adjustable counterweight 78 permitting regulation of the pressure between the applicator roller 51a and the strip material *f*, or enabling the arm 76 to be completely balanced so that the pressure necessary can be left to a spring, not shown. Again, as in FIG. 12, the strip material may be pulled through on the rotating drum 73 while the applicator roller 51a makes contact with its surface. The applicator may be driven by a motor at 79, FIG. 14, which is also mounted and balanced on the arm 76. Motor 79 is connected to wheel 74 by a belt 79a. It might be pointed out that this design, even if perfectly balanced and with the contact pressure derived from a spring pulling in the direction of the arrow 70, FIG. 14, would not be dynamically balanced against rotational accelerations. Of course, it would not be too difficult to make it so, but since the devices shown in the FIGS. 15-17 are most suitable for use on moving platforms, that will next be considered.

The device diagrammatically illustrated in FIG. 15 is basically the same as that described in connection with FIGS. 12-14. Structurally, the chamber 20a has the same parts as before and the top roller 25a is shown driven by gear wheels 81 and 82, FIG. 15. This roller 25a drives the other three rollers, but if desired, all the rollers can be power driven through four intermeshing gear wheels mounted on extensions of their shafts at the opposite end from 81. In FIG. 15 all the parts are in fixed relative position and pressure between the roller 51a and the strip material *f* is obtained by passing the strip material over the two guide rollers 83 and 84 so placed that the roller 51a pushes the strip *f* a little way down from the straight-across position, see FIG. 15, so that the contact pressure can be regulated by altering the tension in the strip material *f*. In this example, FIG. 15, the contact pressure can be made as small as may be desired and that is one object of this arrangement for it enables the roller applicator 51a to be run at a very much greater peripheral speed than the strip material and if this difference in speed is considerable, it does not matter much in which direction the strip material moves in relation to the roller 51a. This higher speed of roller 51a is conducive to even application and in connection with many practical problems that is a very important consideration. Furthermore, this particular device is not at all sensitive to accelerational disturbances, for small differences in the roller to strip pressure are probably not very important in this kind of application and such differences as might occur would be quite minute since the only part that can be influenced by accelerational forces is the short length of strip material stretched between the rollers 83 and 84. The mass of this material is so small that the weight under normal gravity is quite negligible and several times that force in any direction is not likely to cause trouble.

The devices shown diagrammatically in FIGS. 16 and 17, although within the scope of this invention, have certain new features which are important in specific applications. The inner fluid chamber 20b, FIG. 16, is enclosed circumferentially by three large rollers 86, 87 and 88 which contact the moving web, and three small rollers 89, 90 and 91 shown in the end view, each roller being in line contact with two of the others, as shown in FIG. 16. Through holes, or tubes, not shown, in the end plates, not shown, fluids can be admitted to, or removed from, the fluid chamber 20b. The rollers 86-91 rotate in the direction of the curved arrows, and the strip material *f*, which is wrapped around the outsides of the large rollers, 86, 87 and 88, in the manner shown, moves in

the direction of the straight arrows. The device is not limited to the use of six rollers; any greater even number of rollers suitably disposed may be used to form the closed chamber. The end plates follow the contour of the track of the strip material, but do not extend so far that the side plates touch the strip.

It will be seen that in the device of FIG. 16, the strip material *f* is partially wrapped around all three of the larger rollers thereby rotating all six of the rollers. At the same time, fluid is drawn from the inner chamber 20*b* by the rollers 86, 87 and 88, and is applied thereby to the inner surface of the moving strip *f*. All of the six rollers, or only one of them, could be motor driven, but in the most likely applications of this device, the pull on the three rollers 86, 87 and 88 from the moving strip material gives ample driving power without slip. It is noted that in FIG. 16 the three smaller rollers 89, 90 and 91 cooperate with the larger rollers 86, 87 and 88 to form the periphery of chamber 20*a*, but the smaller rollers do not touch the web. This device has most of the advantages of the previous devices for many applications since it deposits the fluid three times in succession. This may be valuable in cases where multiple thin films are desirable and stickiness between applications is not a problem.

FIG. 17 shows a device that is similar to that shown in FIG. 16, but the roller sizes and disposition have been slightly changed. Also, two guide rollers 95 and 96 have been added. A new, and in some cases, very valuable effect is thereby achieved; every single roller 86—88 and 89*a*—91*a* in the system now comes into contact with the surface of the strip material or web; the three large rollers 86, 87 and 88 rotate in the direction of motion of the strip, or are turned by it, while the three smaller rollers 89*a*, 90*a* and 91*a* which rotate in the opposite direction, very gently wipe over the surface of web *f* while applying fresh fluid. There are also other useful features presented by this design, for not only are inequalities in the application of the fluid to the strip evened out by the six applicators, but the device itself is kept in better operating condition by virtue of the fact that every roller is always in use picking up fluid and depositing some of it on the strip. There is, therefore, no likelihood of an accumulation of fluid on the rollers as each surface moves around outside the chamber, so that continuous unattended operation for extended periods is practicable. An important feature of this device, is its almost complete indifference to any variations in either the direction or magnitude of accelerational forces provided, of course, that proper care is taken in the design of the fluid feed system. In this connection, it might be advisable for extreme cases to feed the fluid into the chamber through holes or pipes such as 71, FIG. 13, passing through both end plates so as to neutralize transverse accelerational forces. These delivery pipes might be used in collaboration with twin supply reservoirs, not shown, to balance pressure changes in the delivery system. Thus, this design is especially suitable for operation on moving platforms such as occur in connection with land vehicles, ships, airplanes, missiles or satellites. For example, the processing of radar screen records in situ might be a useful application.

In most useful applications of the devices, FIGS. 16 and 17, considered in the above paragraphs, a single applicator device would be used, with or without multiple rollers, and this single device would apply the fluid on one side only of the strip material. For the application of several different fluids in sequence, all that is necessary is to locate different applicator devices at suitable positions along the path of the web, the closeness depending upon the drying and other characteristics involved. When desired, the reverse side of the strip material can be treated either simultaneously with the other, or preferably at a slightly displaced position. When both sides receive treatment, guide rollers, etc., might need to be undercut to

avoid contact with a stick surface. The whole width of the strip material may be treated at one time by having the applicator roller or rollers, extend right across the width of the strip, but in most applications this is neither necessary nor desirable. In order to avoid creeping of the fluid onto the back of the strip, or onto the carrying drum or any guide rollers, it is usually best to have the applicator rollers of lesser length than the width of the strip material. This idea is capable of further extension; for if it be desired to treat only a narrow band along the length of the strip material, and in a specific position in relation to the strip width, the length of the applicator rollers can be made to correspond with the desired band width and the location across the width of the strip can be pre-set. Of course, there is no reason why several such treated bands may not be laid down side by side along the strip material as desired, the different bands being, for constructional reasons, preferably treated in sequence. In these cases the rollers might look more like "discs" than rollers. This arrangement might prove useful in connection with sound tracks.

In connection with the possibilities of selective strip treatment mentioned in the above paragraph, it should be noted that the fluid may likewise be applied selectively in a longitudinal sense instead of, or concurrently with, any transverse selective application. This can be achieved by separating the applicator from the strip material and skipping the treatment wherever it is not wanted. The forms of the devices shown in FIGS. 12—14 are particularly adaptable to this kind of usage when both the applicator and the strip material are kept in continuous motion, for then contact between the two may be made and broken whenever desired.

There is a further way in which these devices may be modified for unusual specific purposes. It is occasionally desirable to deliberately apply the fluid at an uneven rate across the width of the strip material and this effect can be very easily obtained in several simple ways. For example, if it should be desired to apply more fluid to the central regions of the strip than to the sides, the roller 51*a*, FIGS. 12—14 might be made slightly smaller in the central regions than towards the ends, the difference, of course, being very small and measurable in thousand or ten thousand of an inch. On the other hand, should the outer regions require more fluid than the center, the ends would be slightly smaller than the middle. Also, for progressively supplying more fluid towards one edge than the other, the roller might have a very slight taper from end to end. The same effect could also be attained by setting the axis of the roller slightly out of parallelism. Another way of varying the amount of flow across the width is to arrange a suitable change in the texture of the roller surface, such as in the degree of smoothness or roughness. These same methods may be more usefully employed for corrective purposes when difficulty is experienced in obtaining normal uniform treatment across the width of the strip material.

It is believed apparent that the present invention provides a new and improved arrangement to form a fluid type processing chamber. To secure this result, the rollers are arranged in annular contacting relation to provide a fluid-tight periphery for the chamber, while end walls cooperate with the ends of the rollers to form fluid-tight seals for the chambers. Furthermore, in certain embodiments a strip is passed in and out of a chamber so as to be treated by the fluid therein, and the rollers act as squeegees to prevent or reduce leakage from the chambers. In other embodiments the web to be treated is passed on the outside of the rollers rather than through the treating chamber. To secure this last result, the rollers pick up some of the fluid in the chamber and carry it to a point outside the chamber where it is applied to the web passing over the rollers. The device formed according to the present invention may provide a single or plurality of

11

connected feeding chambers through which a web may be passed.

While certain embodiments of the invention have been described, it is to be understood that the inventive idea may be carried out in a number of ways. Therefore, this application is not to be limited to the precise details described, but is intended to cover all variations and modifications thereof which fall within the scope of the appended claims.

I claim:

1. In a photographic processing-printing device, the combination comprising: a plurality of annularly arranged parallel rollers positioned in peripheral contacting relation to form the periphery of a chamber adapted to contain a processing solution; means co-operating with the ends of said rollers to seal the ends of said chamber; means for rotatably driving said rollers; means including a first pair of said driven rollers for feeding an exposed photographic material into the solution in said chamber for

12

processing; means including a second pair of said driven rollers not including any roller from said first pair for feeding an image-receiving paper into said chamber; and means including a third pair of said driven rollers for receiving the ends of said material and said paper in said chamber and pressing same into intimate face-to-face contact for transferring an image from said material to said paper as they are discharged from said chamber.

2. The invention according to claim 1 wherein means including a collapsible bag connected to said chamber are provided for maintaining said chamber full of solution.

3. The invention according to claim 2 wherein a spring co-operates with the bag for forcing said solution into said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,946,627 Karrer Feb. 13, 1934