

Jan. 12, 1960

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2,920,960

METHOD AND APPARATUS FOR TREATING WEBS

Filed Aug. 16, 1952

6 Sheets-Sheet 1

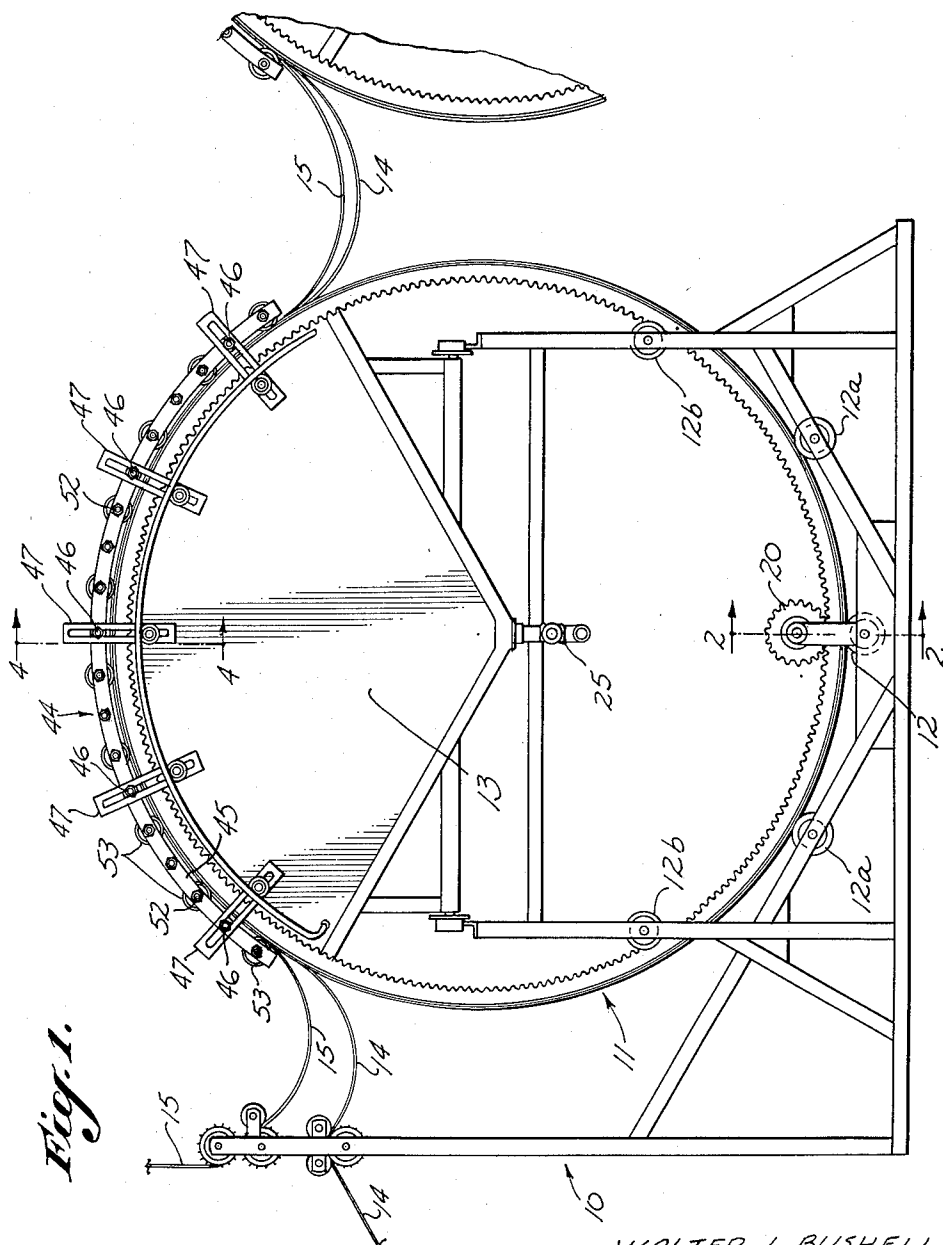


Fig. 1.

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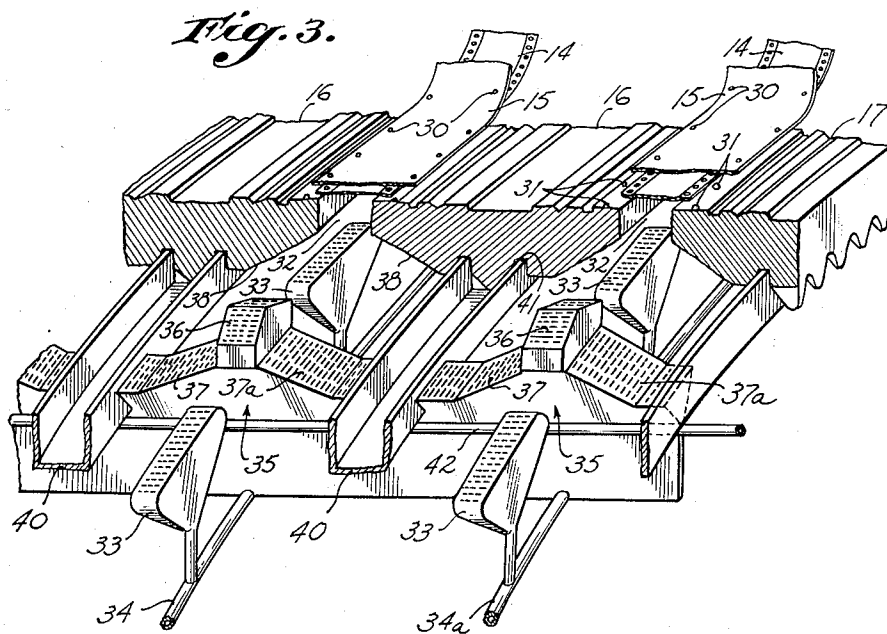
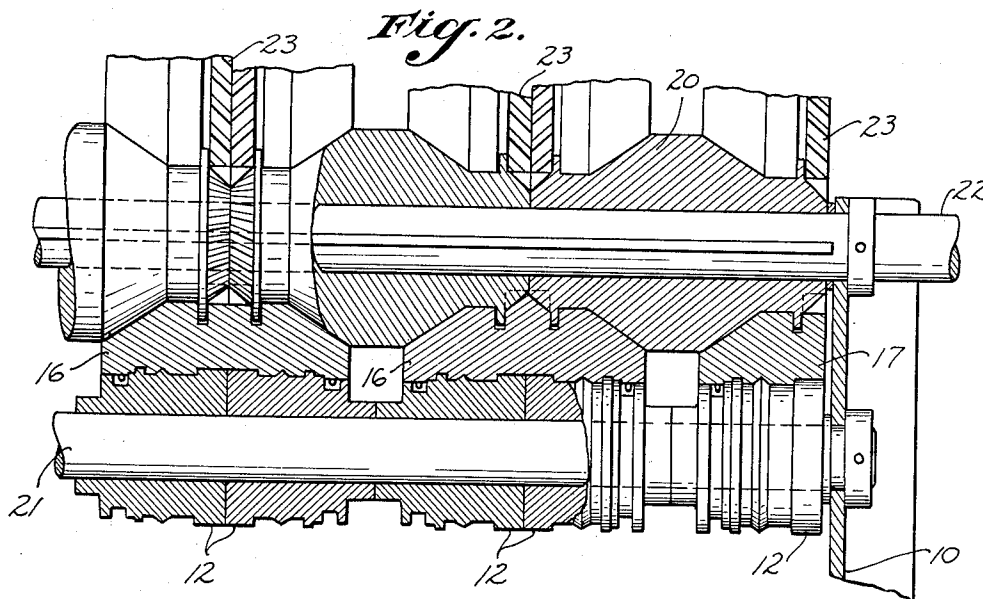
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Fig. 4.

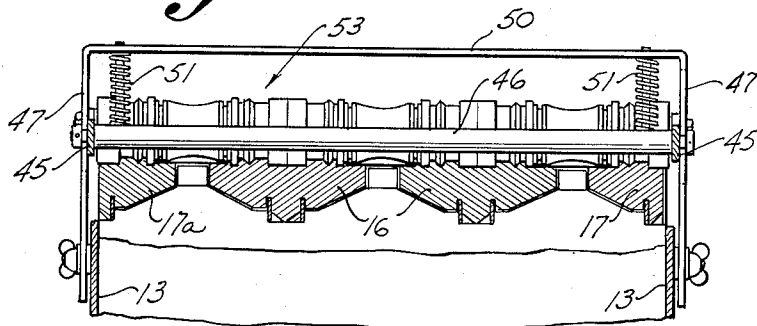


Fig. 5.

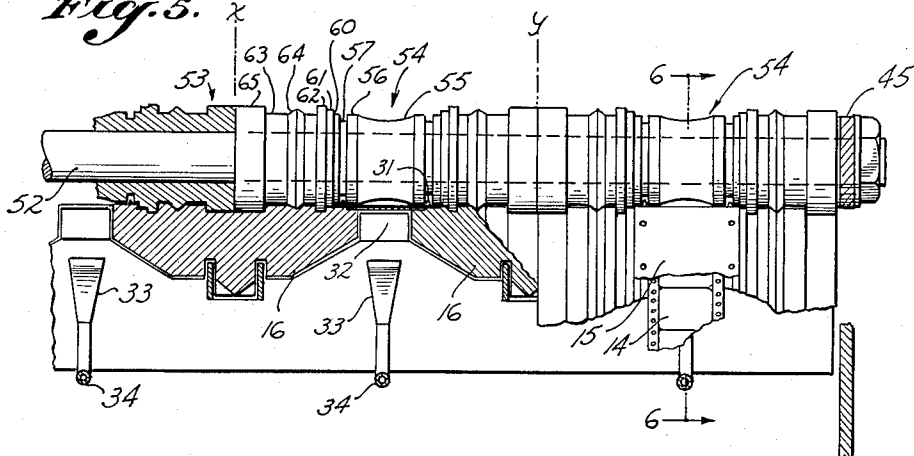
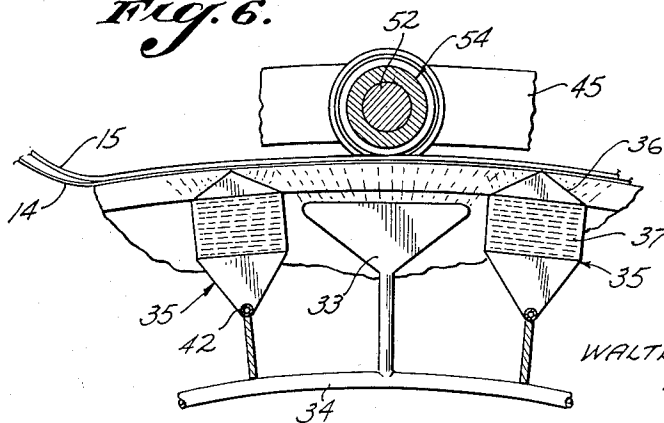


Fig. 6.



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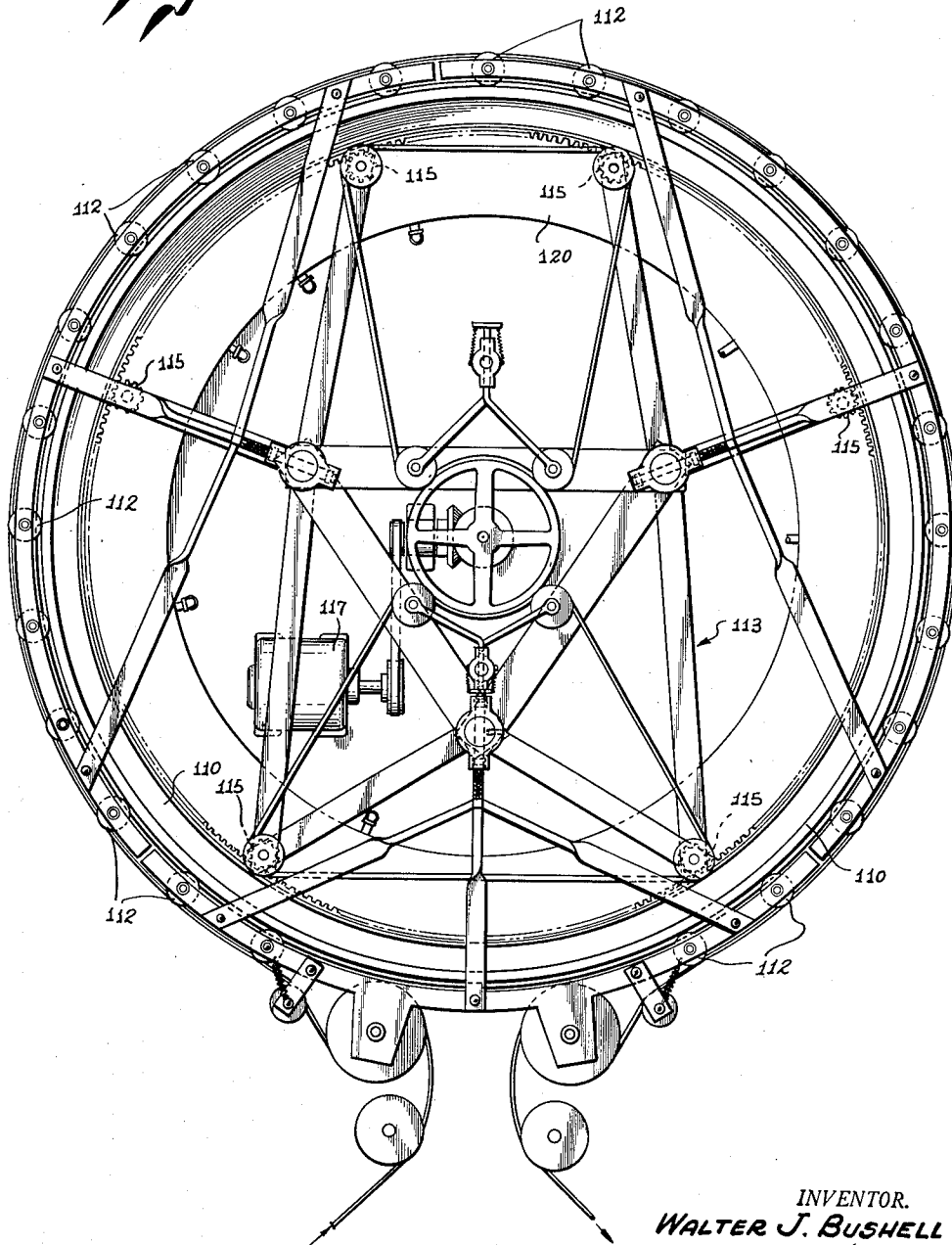
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Fig. 7



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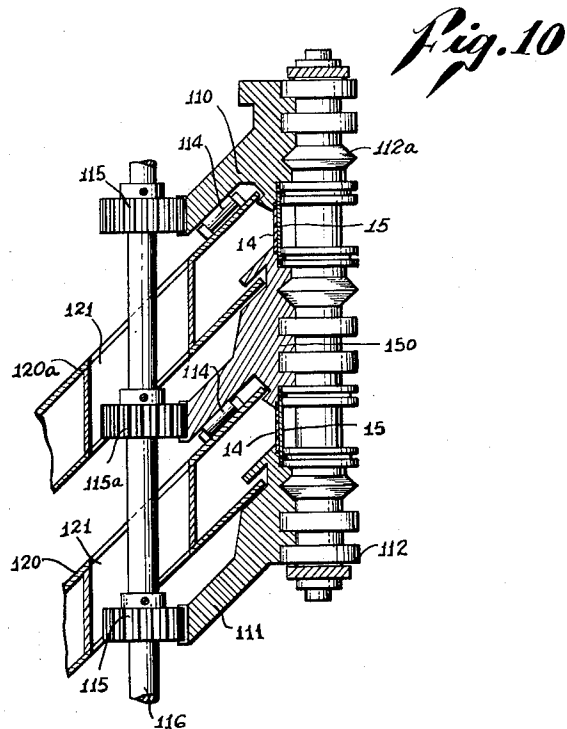
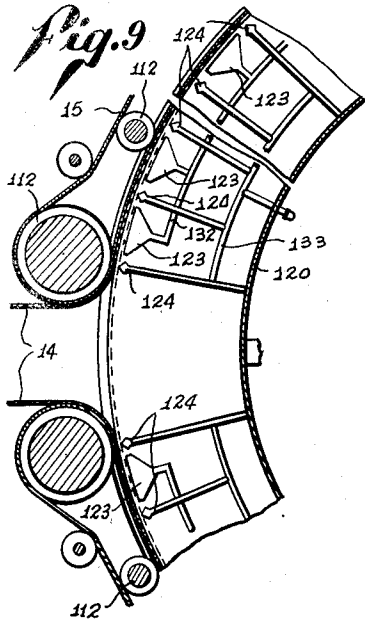
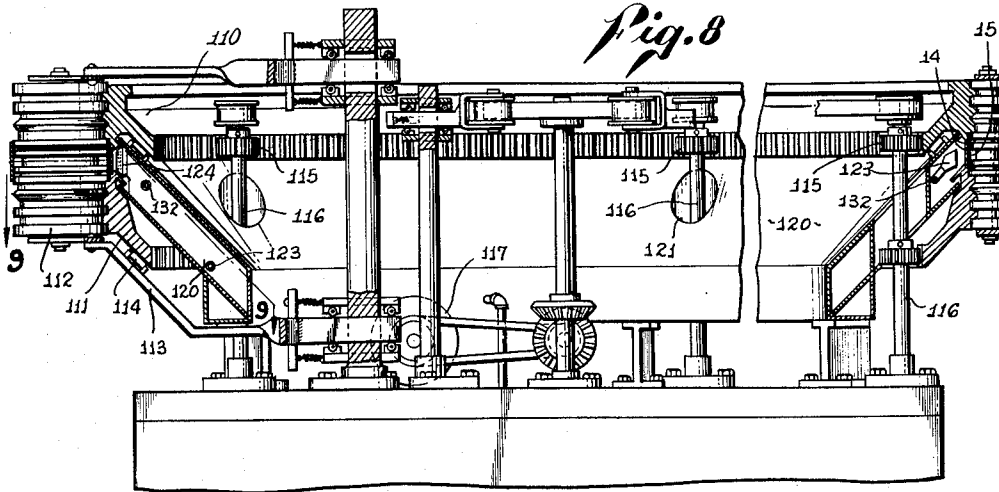
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METHOD AND APPARATUS FOR TREATING WEBS

Filed Aug. 16, 1952

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2,920,960

**METHOD AND APPARATUS FOR
TREATING WEBS**

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Application August 16, 1952, Serial No. 304,677

5 Claims. (Cl. 96—48)

My invention relates generally to web treating and processing methods and apparatus and more particularly to a device intended to treat one side of a web such as a length of motion picture film in a new and more efficient manner.

The present application is a continuation-in-part of my previous application Serial No. 105,360, filed July 18, 1949, and entitled "Web Treating Device," now abandoned.

In the processing of narrow webs of considerable length, such as motion picture film, considerable difficulty has always been experienced in treating only one side of the web with a liquid, such as a developing solution, without having some of this solution find its way to the opposite side of the web. The problem has become particularly acute in the processing of color film where separate emulsions are provided on the opposite sides of the film, and one of these emulsions is stained or dyed one color, while the other emulsion is treated to form a different color.

Heretofore, the problem has generally been solved by floating the web or film upon the desired bath of liquid, but warping of the film often causes the latter to plunge into the solution, thereby wetting both surfaces. Various methods of spraying the solution upon the web have been attempted, but these have generally been unsatisfactory because of a tendency of the treating solution to "creep" or otherwise flow to the opposite side of the web, thereby spoiling the process. Additionally, such systems have been generally unsatisfactory where a large quantity of film or other form of web is to be treated, because of the inherent low rate of speed that such systems require.

Furthermore, previous film treating processes and devices have placed the film or web under tension in carrying it through the equipment, thereby tending to stretch the film and the emulsion carried thereby. Because of the delicate physical nature of the gelatine emulsion and the chemical reactions taking place, this stretching has, in my opinion, caused a certain degradation of the resulting image, and has definitely created problems in registering the images of one film with those of another.

Another problem that has faced workers in this field is that of providing sufficient agitation of the treating solution to secure uniform, satisfactory processing of the film. It will be appreciated that when a web is moved through a liquid, a certain amount of the liquid tends to cling to the web, forming a layer that prevents the remainder of the liquid from contacting the web and acting upon it. Mechanical agitation of the liquid tends to destroy this layer, but mechanical agitation is subject to vibration or pulsation effects, and as a result the web is not uniformly treated.

Closely related to these problems is that of maintaining the treating solution at a proper and substantially constant strength. As the film or web is processed, the original chemical compounds in the solution are depleted, and reaction products are formed. The addition of a con-

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centrated replenisher solution will replace the original compounds, but the reaction products must be removed, and this is usually done by discarding a portion of the treating solution. Since the latter contains a high proportion of usable chemicals, this represents a definite waste.

It is therefore a major object of my invention to provide an improved process for treating webs or films, and a device making use of this process.

Another object of my invention is to provide such a device and process especially designed to promote the various chemical reactions so that, in the case of film development for example, gases liberated during the development process are carried away as they are freed.

It is a further object of my invention to provide a device of this type that may be used for many different forms of processing such as, in the case of films, developing, fixing, bleaching, coloring, etc., without stretching or shrinking of the web, and with no abrasion thereof.

Still another object of my invention is to provide a web treating apparatus particularly well adapted to continuous and automatic operation so that the entire treating process may be carried out with a minimum of human supervision.

It is a still further object of my invention to provide a device of this character of relatively inexpensive construction and requiring a minimum of space so that the most efficient operation will be obtained.

These and other objects and advantages of my invention will become apparent from the following description of two forms of my device, and from the drawings illustrating those forms, in which:

Fig. 1 is a side elevational view of one embodiment of my web treating device;

Fig. 2 is a cross sectional view taken on the line 2—2 of Fig. 1, showing the method of driving the device;

Fig. 3 is a section of the upper portion of the first form of the device, shown in perspective, and illustrating the relative position of the various elements thereof;

Fig. 4 is a cross sectional view of the upper portion of my device, taken on the line 4—4 of Fig. 1;

Fig. 5 is a sectional view similar to Fig. 4, but to a slightly enlarged scale showing other details of construction;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 5 to show the operation of the various jets;

Fig. 7 is a top plan view of another form of my web treating device in which the hoops are in a generally horizontal plane;

Fig. 8 is a sectional view of the second form of my device, taken along the line 8—8 of Fig. 7;

Fig. 9 is a horizontal section, to a slightly larger scale, taken on the line 9—9 of Fig. 8;

Fig. 10 is a vertical section taken through the hoops and showing one form of construction that may be used when two or more webs are to be simultaneously processed;

Fig. 11 is a perspective view of another form of construction used to hold the backing member or mat against the film and the hoops;

Fig. 12 is a perspective view of still another hoop and mat connection; and

Fig. 13 is a schematic diagram illustrating the various processing steps that may be carried out with my invention.

Stated briefly, my invention contemplates the use of a traveling belt or mat that carries the film or web through the processing device so that the film is neither stretched nor shrunk. The belt, with the film upon its inner surface, is passed around a drum or pair of hoops having a series of sprays therein that spray the treating solution onto the film or web, while jets of gas or air insure the removal of the products of the chemical reaction, while

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preventing the "creeping" of the solution to the opposite side of the web. The sprays of processing liquid thus treat the entire surface of the web uniformly and do not remain on the web in the form of drops that would be likely to cause uneven treatment or require extra drying.

Description of device shown in Figs. 1-6

Referring now to the drawings and particularly to Figs. 1 and 2 thereof, the numeral 10 indicates generally a frame of suitable structural members such as angles, channels, and other suitable sections adapted to receive and rotatably support a plurality of hoops 11. A number of rollers 12, 12a, and 12b guide and rotatably support the hoops 11, and a tank 13 in the general form of a sector of a circle is located within the hoops 11 in the upper portion thereof. A film or web 14 that is to be treated upon its front or forward surface has a belt or mat 15 superimposed upon it and the two then are placed upon the hoops 11 and pass above the tank 13.

Preferably, the processing machine is designed to receive and treat a number of webs 14 simultaneously, these webs each being provided with its own belt or mat 15 and the webs being laterally displaced so that each is treated separately from, though simultaneously with, the remaining webs. Consequently, in the embodiment of my web treating machine illustrated in Figs. 1-6, I have shown it in the form intended to treat a plurality of webs simultaneously.

The hoops 11 are preferably formed of a rigid material such as steel and preferably take the forms indicated in Figs. 2 and 3 where it is seen that I have provided double hoops 16 and a single or end hoop 17. Essentially, the end hoop 17 is half of one of the double hoops 16, while a generally similar hoop 17a is provided at the opposite end of the series of hoops, corresponding to a reversed form of the end hoop 17.

As previously mentioned, the hoops 16, 17 and 17a are supported by rollers 12 that are complementary to the exterior of the hoops, and a set of driving rollers and gears 20 are mounted in the frame 10 at the lower portion thereof to rotate all of the hoops in unison. This construction is best illustrated in Fig. 2 where it is seen that a shaft 21 is mounted in the frame 10 beneath the hoops 16 and 17 to carry the supporting rollers 12. Immediately above the shafts 21 is a second shaft 22 that carries the rollers 20 so that the latter bear against the inner surface of the hoops 16 and 17. These hoops are thus firmly held between the rollers 12 and 20. On the interior of each of the hoops 16 and 17, I provide a toothed section 23, and the aligned portion of each of the rollers 20 is correspondingly toothed so that in effect the hoops are driven as a ring gear is driven by an internal pinion. The hoops 16 and 17 are all of the same size, as are the internal geared rollers 20, and consequently all of the hoops rotate in synchronism. A driving gear, pulley, or other suitable means (not shown) is connected to the shaft 22 to drive the latter, and this constitutes the only driving connection necessary for the operation of my machine. Other rollers 12a are circumferentially spaced each side of the rollers 12 to assist in carrying the weight of the hoops 11, these rollers bearing against the exterior of the hoops and being shaped similarly to the rollers 12. Still other rollers 12b are spaced circumferentially from the rollers 12a and bear against the interior of the hoops 11, these rollers being shaped generally similar to the rollers 20 but not acting as driving rollers.

In the upper portion of the hoops 11 is the previously mentioned tank 13 that is mounted upon the frame 10 and carries the liquid treating sprays and the jet members previously mentioned. The liquid sprays, it will be appreciated, direct the treating solution to the web 14 from whence it is thereafter allowed to fall into the tank 13 where it collects and is drawn off through suitable piping connections 25 to be recirculated.

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The construction and cooperation of the various elements including the treating sprays, the air jets, the hoops, and the film or web are best shown in Fig. 3, where the tank 13 has been omitted for the sake of clarity. As shown in that figure, the hoops 16 are spaced apart a distance slightly less than the width of the web 14 to be treated, while the mat or belt 15 that is slightly wider than the web overlies the latter and is provided with perforations 30 along its outer edges that are engaged by correspondingly spaced pins 31 formed on the outer surface of the hoops 16. While the pins 31 could be so located as to engage the perforations normally found along the edges of motion picture film, I have found it preferable to space these pins so that the entire width of the web or film 14 lies between them. In this way, no stress is placed upon the web that tends to stretch or shrink it during the treating process.

It will be noted that each of the hoops 16 is symmetrical about a centerline or plane midway between the opposite edges of the hoops, and between this plane or axis of symmetry and the edges of the hoops are a series of grooves that are engaged by corresponding ridges of the various rollers around the exterior of the hoops. The space between the hoops 16 provides an opening 32 leading into the interior of the tank 13, and the web or film 14 may thus be treated by the equipment within the tank.

For the purposes of illustration, let it be assumed that the web 14 is a motion picture film, carrying image-bearing emulsions on both sides thereof, and let it further be assumed that only one of these emulsions is to be developed. In this process, the film will be subjected to sprays of a developer, and will thereafter be washed and further treated in other suitable devices. To spray the developer onto the film 14, I have provided a series of spray members 33 within the tank 13, each of these spray members being aligned with the opening 32 between adjacent hoops 16. Each of these openings is provided with a plurality of individual spray members spaced along the circumference of the upper portion of the tank 13, and all of the spray members within a single opening 32 are connected to a single supply pipe 34, 34a, etc., for purposes that will hereinafter become apparent. In between each of the spray members 33, I mount a jet member 35 that includes a central portion 36 projecting upwardly into the space or opening 32, with side portions 37 and 37a that are formed generally complementally to the interior of the hoops 16 and 17. The jet members 35, like the spray members 33, are each provided with a plurality of small openings so that a number of fine streams of fluid are directed in the desired manner to cover completely the intended objects. Thus, the spray members 33 direct a number of fine streams of developing fluid against the forward surface of the film or web 14, covering this surface completely so that all parts thereof are completely and uniformly developed.

In a similar manner, the jet members 35 direct a plurality of streams of air or other gas against both the film 14 and the hoops 16 and 17, the central portions 36 directing the air against the film itself to insure that any gases liberated by the chemical process of development will be completely and immediately removed so that the developing action will proceed properly and uniformly. This action of the jet member 36 also has the effect of forcing surplus developer from the film 14 to the opposed sides of the adjacent hoops 16, thereby preventing an excessive amount of developing fluid from remaining on the film in the form of drops, etc. The liquid that thus collects at the sides of the openings 32 runs down the opposed faces of the hoops 16, toward the center of the tank 13, to angularly position interior surfaces 38 of the hoops 16.

The angularly positioned or sloping surfaces 38 are intended to carry the used developer or treating fluid

away from the film or web 14, and the side portions 37 and 37a of the jet members 35 direct a stream of air or other gas onto the sloping surfaces so that the developer is assisted in its downward travel, toward the center of the tank 13.

While it is important that the entire surface of the film or web 14 be subjected to the action of the sprays 33, it will be apparent that the toothed portion 23 of the hoops 16 and 17 will frequently be greasy or oily, and it is important that the developer not be contaminated by the lubricant. Consequently, I have provided shields that protect this portion of the hoops 16 and 17, these shields preferably taking the form of arcuate channel sections 40 associated with each of the hoops 16, as indicated in Fig. 3. The flanges or legs of each of the channel sections 40 extend generally upwardly into grooves 41 formed in the hoops 16 at each side of the toothed section 23. The base or web of the channel section 40 connects the lower edges of the flanges to form a protective enclosure that keeps the developer from the toothed portion 23 and the lubricant contained thereon. In this way, the developer remains uncontaminated, and the grease or oil does not lose its lubricating value by having developer or other solutions mixed with it.

It would be possible, of course, for the developer solution to be forced upwardly into the grooves 41 and then into the channel 40 if the pressure within the tank 13 were considerably above atmospheric pressure. However, almost all treating operations can be carried out at atmospheric pressure, and consequently this problem does not arise under normal usage. The jet members 35 are fluid connected by a pipe or tubing 42 that is connected to a suitable source of air or gas, and where there is likely to be oxidation of the treating solution, as in the case of a film developer, an inert gas may be used that prevents oxidation. Under such conditions, the tank 13 will normally be provided with an exhaust connection (not shown) so that the gas may be recirculated for the most efficient and economical operation.

Turning next to the details of construction of the rollers and elements at the top of the hoops 16 and 17, it will be noted that I have provided a roller assembly 44 including a number of spacer bars 45 that extended around the exterior of the hoops in the region of the tank 13. Preferably, the spacer bars 45 are pivotally connected together at their ends, and in the middle each carries a shaft 46 extending across the hoops and connected to the corresponding spacer bar 45 on the opposite side. A plurality of slotted ears 47 are connected to the tank 13, each engaging one of the shafts 46 to guide and support the latter.

At its outer or upper end, each of the ears 47 is bent or otherwise formed to extend across the hoops 11, parallel to the shafts 46, to form a connecting member 50 that carries a similar ear 47 on its opposite end. In this manner, the ears 47 and connecting member 50 cooperate to form a yoke, and springs 51 bear against the shaft 46 and the connecting member 50 to urge the shaft toward the hoops 11.

Intermediate the shaft 46 and the ends of the supporting members 45 are roller shafts 52 journaled or otherwise supported by the members 45. Rollers 53 are mounted on the shafts 52, and the action of the roller assembly is to force the rollers 53 against the exterior of the hoops 11 so that the web or film 14 and the belt or backing member 15 are firmly pressed against the hoops as the film and belt pass over the sprays 33 and jets 35 previously described.

As best seen in Figs. 5 to 6 of the drawings, the rollers 53 are shaped generally complementally to the exterior of the hoops 11 and are provided with grooves and ridges adapted to provide the most efficient operation. While the rollers 53 may be formed integrally with the supporting shafts 52, it will be seen that each such roller is

formed as a series of repeating sections, there being one such section for each film or web 14. Such a section includes that portion of the roller 53 as included between the lines X and Y of Fig. 5, and a number of these sections may be assembled on a single shaft 52 instead of forming the entire roller 53 of one piece, whether or not it is integral with the shaft 52. Each section, designated by the numeral 54, is symmetrical about a central plane perpendicular to its longitudinal axis, the plane passing perpendicularly through the center of the film or web 14 being treated, and it will be noted that the central section of the roller is relieved or formed generally concave so that it bears against only the edges of the belt or backing member 15.

The concave portion 55 terminates at a point somewhat short of the edge of the film 14, and a flat portion 56 bears against the belt 15 to force the latter firmly against the edge of the film so that there is no possibility of the sprayed liquid entering the space between the film and the belt. The reason for the concave portion 55 will be understood when it is remembered that narrow webs often have a tendency to buckle longitudinally, and if the belt 15 and the film 14 were pressed together over their entire width, there might be a tendency for a "pumping" action to take place when the pressure was released that would suck the treating solution into the space between the film and belt, thereby subjecting the back or reverse side of the film to the action of the treating solution.

Adjacent the flat pressure portion 56 of the roller section 54 is a groove 57 adapted to receive the pins 31 of the hoops 16, and next to the groove is an outer pressure section 60, the same diameter as the first pressure section 56, adapted to bear against the extreme edge of the belt 15. To retain the belt 15 in its correct position, I provide an enlarged portion 61 that fits into a corresponding groove of the hoops 16 and bears against the side of the belt so that the latter is held against any lateral movement. In this way the belt 15 is guided into proper engagement with the pins 31 and held in that position, thereby materially reducing the wear on the pins and on the perforations 30 in the belt.

Next to the side-engaging enlargement 61 is a further enlargement 62 that fits into a comparable groove in the hoops 16 to carry a portion of the radially directed load and prevent lateral shifting between the roller section 54 and the corresponding hoop 16. Adjacent the enlarged portion 62 is a smaller portion 63 having a generally triangularly-shaped ridge 64 thereon that acts to move and locate the hoop 16 with respect to the roller section 54 so that proper alignment is secured at all times. An enlarged portion 65 adjacent the portion 63 completes the roller section 54, it being understood that the opposite end of the section, from the plane of symmetry, is similar to the portion just described, and each of the sections 54 is identical to the others.

From the foregoing description, it will be clear that the rollers 53 press the film 14 and the belt 15 firmly against the hoops 16, simultaneously insure the proper alignment of the belt with respect to the hoops, and hold and guide the hoops themselves. As previously mentioned, the rollers 12 and 12a near the bottom of the hoops are formed to engage the corresponding grooves and ridges of those hoops, and consequently they have the same general shape as the rollers 53 just described. The rollers 12b that fit within the hoops and engage the inner surfaces thereof are shaped to conform to the corresponding surfaces of those hoops, and consequently rigid but rotatable support is provided for the hoops 11. In this connection, it will be noted that the rollers 53 are supported by the tank 13, which in turn is held by the frame 10, and consequently both the upper and lower portions of the hoops 11 are held against misalignment.

Preferably, the spray members 33 are substantially circumferentially aligned with the rollers 53 so that the

best possible contact is made between the belt 15, the film 14, and the hoops 16 in the area where the treating solution is directed to the film. This construction is clearly shown in Fig. 6, where it will likewise be seen that the jet members 35 are positioned so that the central sections 36 thereof tend to blow the developer or other treating solution from the surface of the film so that an effect similar to a detergent action is obtained. In this manner, any dust or other particles that might otherwise tend to remain on the film are removed, and the sweeping of the developer over the surface of the film insures uniform treatment.

While it is possible to use a treating device of this type which is adapted to receive only one web at a time, it is generally preferable to make provision for the treatment of a number of such webs simultaneously. In this manner, the maximum efficiency of operation may be secured, and a large amount of material may be processed within a relatively short length of time. Where the machine is of the multiple web type, as illustrated, it is always possible that something less than the maximum number of webs will be processed at the same time. Consequently, I have found it desirable to connect the spray members 33 so that all of them associated with one web 14 are connected to a single manifold 34, and the passage of treating fluid through this manifold may be controlled by a suitable valve (not shown) at the end of the manifold. In this way, when one set of spray members is not to be used, it is a simple matter to close that valve, thereby lessening any possible contamination of the treating solution, and reducing the work that the pump must do to recirculate the treating solution. The jet members 35 may be similarly manifolded if desired, but generally this is of less importance and they may all be controlled by a single valve.

It will be appreciated that the spray members 33, the jet members 35, the shields 40, and the similarly disposed and associated elements of my device are mounted within and supported by the tank 13. When it becomes necessary to clean the tank or any of the associated equipment, the slotted ears 47 supporting the roller assembly 44 may be loosened and the entire roller assembly removed from the outside of the hoops 11. Thereafter, the tank 13 may be lowered with respect to the frame 10 and moved axially, out of the hoops 11. The tank 13 and the hoops 11 may then be cleaned, repaired, or otherwise serviced in any desired manner.

The speed with which the film or web 14 passes over the hoops 11 will normally be determined by the length of time required for the treatment of the web. Should the process be one which requires a considerable length of time, the rotation of the hoops 11 will normally be reduced to provide this time. However, it is possible, of course, to pass the web from one treating device to another, where the process is continued in the second device. Normally, though, this can be avoided by the selection of a proper rotational speed, etc. In the treatment of motion picture film, for example, the development of a film may be completely carried out by one passage of the film over the hoops 11, and the film 14 and belt 15 then passed to a second set of hoops where the film is subjected to a so-called "short stop," washing, fixing, or other bath. Thereafter, the film may be further treated in accordance with the requirements of the particular situation so that a complete and continuous system of developing and fixing motion picture film may be set up in a comparatively small area. The belt 15 is normally a continuous loop that passes with the film 14 through all of the treating processes to which the latter is subjected, and is then returned to its starting point, so that a comparatively short length of belt may be used to treat a very long length of film.

Description of device shown in Figs. 7-13

While the previously described form of my device, as illustrated in Figs. 1 through 6, requires compara-

tively little floor space for the capacity of the machine, it does require a room or enclosure of some height. Additionally, because of the particular type of construction used, it is preferable to have one machine perform only one step in the processing of a film or web, such as performing the developing or the fixing operation. In Figs. 7 through 13 I have illustrated another form of my invention that is adapted to be used where rooms with high ceilings are not desired or available, and where more than one step of the processing is to be done on a single machine.

As in my previously described form, this second form makes use of a plurality of sprays and jets so that uniform chemical reaction during the processing is insured. However, where the first form made use of generally vertically extending hoops, my presently described form makes use of generally horizontally extending hoops. As a result, it is possible to construct larger diameter hoops than would be practical with vertical hoops, and by using a different form of tank, it is possible to conduct a series of processing operations within a single machine.

In the form of device illustrated in Figs. 7 through 13, it will be seen that I have provided an upper hoop 110 that is separated a small distance from a lower hoop 111. Both hoops are substantially horizontal, and a series of circumferentially spaced rollers 112 carried by a framework 113 accurately maintain the separation of the hoops and partially support them. The rollers 112 are grooved to mate with corresponding grooves and ridges on the exterior of the hoops 110 and 111, and these rollers thus support a portion of the weight of the hoops, as well as hold them in proper alignment. In addition, other rollers 114 may be mounted upon the framework 113 to assist in carrying the weight of the hoops.

Spaced around the interior of the hoops 110 and 111 are pinions 115 mounted on generally vertically extending shafts 116 that in turn are driven by a motor or other suitable means 117. The pinions 115 mesh with teeth formed on the inner periphery of the hoops 110 and 111 so that the latter act as internal ring gears driven by the pinions 115. As illustrated in Fig. 8, separate pinions 115 drive the upper and lower hoops 110 and 111, but in each case the hoops are driven in synchronism so that they may be considered as rotating as a unit.

As in my previously described form, the space between adjacent hoops is bridged or covered by a web or film 14 that is to be processed, and exteriorly of the web is a belt or mat 15 that, in effect, carries the web 14 and firmly presses it against the hoops. The web 14 and the belt 15 may engage each other and the hoops in the same manner as in my previously described form, it being remembered that the belt 15 firmly presses the film or web 14 against the upper and lower hoops 110 and 111 so that a seal is formed between the web and the hoops that prevents any liquid from passing to the rear or outer surface of the web. Additionally, the belt 15 is provided with perforations that are engaged by pins projecting outwardly from the exterior periphery of the hoops 110 and 111 so that the belt is positively driven by the hoops and in synchronism with them. The web 14 is held between the hoops 110 and 111 and the belt 15, and is carried by them without any tension being applied to the web, thereby minimizing, if not completely eliminating, any stretching or deformation of the web.

Projecting downwardly and inwardly from the inner periphery of the hoops 110 and 111 is an annular trough or tank 120 that is supported by the framework 113 and is held stationary while the hoops 110 and 111 revolve. As illustrated in Figs. 8 and 10, the tank 120 extends generally downwardly from the hoops 110 and 111 and the upper and lower edges fit into corresponding grooves in the upper and lower hoops 110 and 111 so that liquid from the sprays will drop from the hoops, into the tank and fall to the bottom thereof. Also, as indicated in those figures, apertures 121 are formed in

the tank 120 to receive the pinions 115 and their driving shafts 116.

Within the tank 120 I provide a plurality of sprays and jets that direct streams of liquid and air or other gaseous material, respectively, against the web 14 that is being treated. For example, in Fig. 9 there are shown a series of spray members 123, each of which directs treating fluid against the face of the film or web 14. The inner surface of the film is completely covered by these fine streams, and the liquid moves against the direction of the film or web, as well as with it. The entire width of the exposed surface of the web 14 is covered by the streams, and while the force is not great, because of the possibility of injuring the delicate emulsion in the case of film, the action of the spray members is thorough so that there is a detergent or scrubbing action that prevents a film or layer of liquid from being carried along on the surface of the web that would prevent the fresh treating solution from coming into contact with the web.

To aid in the removal of any possible boundary layer or surface coating of liquid, I provide a series of jet members 124 that direct streams of air or other gas against the web, thus blowing any remaining moisture from the surface of the web and, to a certain extent, drying the web so that it does not become soaked. It will be noted that the arrangement I have shown in Fig. 9 indicates that a jet 124 is placed between sprays 123. While this particular sequence is not essential, the use of spray members followed by jet members and then in turn followed by more spray members produces a completely different result from that obtained by the usual tank type of treatment. It will be appreciated that by removing all surface liquid, the spray from succeeding spray members 123 will come into intimate contact with the surface of the web, unhampered by any boundary layer or film, and with the reaction products from the preceding sprays removed.

After the liquid from the spray member 123 strikes the film, it runs down the film, assisted by the jet of air from the jet member 124, passes downwardly and inwardly along the upper inner surface of the lower hoop 111, and then drops into the tank 120. The treating fluid thus collects in the lower portion of the tank 120, and, by means of any suitable pump or pressure system (not shown) may be recirculated through the same spray members 123. In this way, the quantity of solution required may be kept quite small.

However, my improved processing machine makes possible another important advantage. By compartmenting the tank 120, and by supplying relatively small groups of spray members 123 from a single pressure source, it is possible to start with a fresh processing solution in one group of spray members 123, collect that solution in one compartment of the tank 120 and then pump it to the next group of spray members, where the process is again repeated. By coordinating the amount of solution used with the amount of web that is processed, it is possible to exhaust or deplete the treating solution so that by the time it reaches the last compartment in the tank 120, it is no longer useful for processing, and may be discarded. An example of such a procedure is indicated in Fig. 13 where it is seen that fresh developer solution is contained in a tank 126 and flows from there, by gravity or through a pump 127, to a first group of spray members 123 (not shown). The solution that collects in that compartment of the tank 120 passes through a pump 128 and into a second group of spray members, and the developer solution is then pumped into a third group of spray members by a pump 130. The solution collecting in the final compartment of the tank is then discarded, since its useful life has been exhausted.

It will be realized that the foregoing is by way of example only, and many variations are possible. For example, while the film or web 14 has been indicated in Fig. 13 as first encountering the fresh developer and then progressively weaker or spent developer, the order may

be reversed, and a counter-flow principle used. In each case, however, the jet members 124 act to remove developer or treating solution from the surface of the web, thereby allowing the next spray to have access to the surface of the web and speeding the treating process.

Where the treatment of the web is accomplished primarily by the treating liquid, the spray members 123 are normally connected, in relatively small groups, to a supply pipe or header 132. The next group of spray members will, of course, be connected to their own header, this construction being continued around the device, or as far as wished. On the other hand, the jet members 124 are, in the present embodiment, intended primarily to remove the moisture from the surface of the web and to provide a certain detergent or scouring action. Consequently, under these conditions, the jet members 124 may be connected to a single header pipe 133, thereby simplifying the construction of the device somewhat.

Since the jets 124 remove the liquid from the surface of the web 14, the processing time of any individual step may be very accurately controlled. For example, in the processing of film, development usually proceeds for a certain fixed time, and is thereupon stopped by a so-called "short stop." Since the developer has previously been removed by the jet members 124, the shortstop solution applied by other spray members 123 acts immediately upon the film, without first having to overcome the effects of any residual solution upon the surface of the film. In this connection, I have found it very convenient to mount a jet member 124 upon each of the partitions or dividing plates within the tank 120 that subdivide the latter in accordance with the particular treatment being given the web 14 therein. For example, a jet member 124 may be mounted upon the partition separating that portion of the tank 120 wherein development of a film is carried out, from the portion wherein the short stop solution is applied. Similarly, another jet member 124 may be applied to the partition separating the "stop" from the "fixing" portion of the tank. Where a process such as development is carried out by recirculating the developer solution through different spray members 123, as previously described, jet members 124 prevent the treating solution from one set of spray members being carried by the film or web 14 into the next division or compartment of the tank 120.

It should be realized that the principal action of the jet members 124, at least during the treatment of the web 14 by suitable liquid from the spray members 123, is that of removing the surface moisture or drops of liquid, and not primarily that of drying the web. In removing the surface moisture, however, there is a certain cleaning or scrubbing action which insures that a clean surface of the web is presented to the next spray member. As previously mentioned, the fact that the web is not immersed in a liquid, but instead is sprayed with a liquid and then subjected to a jet of air or other gas which removes the surface moisture, means that the film or web 14 does not become so saturated with moisture, and consequently can be dried more easily and quickly.

As a result, it is possible to construct a treating machine in which the steps of developing, fixing, washing, and drying are progressively carried on in the one device with a single passage of the web or film around the exterior of the hoops. By way of example, the various steps may be performed in the general manner indicated in Fig. 13 where it is seen that a portion of the circumference of the hoop is devoted to the process of developing, followed by a short portion devoted to stopping the action of the developer, known as the "short stop." As previously discussed, the developing is carried on by a recirculatory method, with the spent or used developer being discarded. The same recirculatory principle may be applied to the "fixing" of the film, or some other suitable method may be used. For example, the

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fixer may be applied simultaneously through a number of spray members 123, and this solution recirculated through the same spray members, or, in certain cases, it may be desirable to discard the solution after it has been sprayed onto the film but once. The fixing process, of course, occupies a portion of the periphery of the hoops, and is followed by a portion devoted to washing of the web or film. In this section, the spray members 123 are provided with water to direct streams of cleaning or washing solution to remove the unwanted products of previous treatment. Finally, a portion of the periphery of the hoops is devoted to drying of the film or web 14, and in this section there is no need for spray members 123. Jet members 124 are, of course, provided in all of the sections mentioned, but where their use in the previous sections has generally been directed to the removing of surface moisture, in the drying section they are intended primarily to remove moisture from the web or from the emulsion of the film. After it leaves the drying section, the web or film 14 may then be wound on reels or other suitable members in accordance with conventional practice.

Where oxidation of any of the treating solutions is likely to occur and cause undesirable results, the jet members 124 may be supplied with some inert gas instead of air. For example, nitrogen may be used, and under some conditions, carbon dioxide may prove very satisfactory. By enclosing the entire device, the gas may be recirculated so that while the process eliminates oxidation, very little of the inert gas will be lost.

The rollers 112 spaced around the periphery of the hoops 110 and 111 not only guide and support those hoops, but also hold the belt or backing member 15 firmly against the cooperating portions of the two hoops. As in the previously described form, the hoops may be provided with pins that are spaced to lie beyond the edges of the film or web 14, and to project into the belt 15 to guide and transport the latter. In Fig. 11 I have illustrated a generally similar type of construction, but instead of using pins, I have used small projections 140 that engage generally longitudinally extending slots 141 in the belt 15. With this arrangement, as in the previously described construction, the edges of the web or film 14 are supported by the hoops 110 and 111 so that these edges are not treated or processed.

Where it is desired to process the film or web 14 to the edges thereof, an arrangement similar to that shown in Fig. 12 may be used. In this construction, the film or web 14, instead of being supported directly on the hoops 110 and 111, is supported by small pads or blocks 142 attached to the hoops, and preferably made of rubber or some other suitable material. The pads 42 preferably have sides that converge to form a line or very narrow area extending transversely of the web or film 14, and against which the web rests. The pads 142 do not extend completely across the web, but instead extend only a short way, so that once again only the edges of the film are supported. In this way, the maximum area of the web is subjected to the action of the spray members 123 and the jet members 124.

In Fig. 12 I have also illustrated an optional method of forming the hoops 110 and 111 and the belts 15. In this form, the hoops 110 and 111 are provided with notches 145 around their periphery, and the belt 15 is provided with cooperating protuberances 146. This is clearly another variation that may be applied to the form of construction shown in Fig. 11, where the edges of the film or web 14 are supported by the hoops 110 and 111. Under most conditions, however, the form of construction shown in Fig. 11 is preferable to that shown in Fig. 12.

It is possible, of course, to design a processing machine making use of generally horizontally extending hoops, and intended to receive a plurality of webs in-

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stead of a single web. A partial vertical section through such a device is shown in Fig. 10, where I have indicated the construction of a processing machine intended to take two webs and process them simultaneously and independently. The construction there illustrated is substantially identical to that shown in Figs. 7, 8 and 9, with the exception that an intermediate hoop 150 is placed between the upper hoop 110 and the lower hoop 111. The intermediate hoop 150 is shaped to act both as a cooperating lower hoop with the upper hoop 110, and a cooperating upper hoop with the lower hoop 111.

An additional pinion 115a is added on the shaft 116 to drive the intermediate hoop 150, and an upper tank or trough 120a is positioned to receive the treating solution from the upper hoop 110 and the intermediate hoop 150. Clearly, if desired, this same principle of construction could be carried further, and more intermediate hoops could be used to provide for the processing of more webs or films 14.

It will be realized that my improved web treating device is particularly adapted to the treatment of the so-called "duplitized" film having emulsions on both sides thereof. Particularly in the case of colored pictures, it is important that the different sides of the film be entirely separately and independently treated. By the use of my improved treating device, it is a simple matter to treat one side of the film, knowing that the other side will remain completely unaffected during all this treatment. Thereafter, the film is twisted or looped so that the opposite side is presented to the various treating solutions, and the film further processed.

One of the important aspects of my invention is the provision of the jet members that blow air or other gas across the surface of the film. In addition to the detergent action previously mentioned, it will be realized that this will remove any gaseous products of the chemical reaction involved in the treating of the film, thereby producing better and more uniform results. In addition, the jets remove any drops of water or solution that may remain on the film, thereby preventing the formation of so-called "water spots," and reducing the drying time of the film to a minimum. By treating the film in as dry a condition as possible, expansion and shrinkage of the film is kept to a minimum so that mechanical problems of handling the film and optical problems of registration are kept to a minimum.

From the foregoing it will be seen that I have provided an improved web treating device that is fully capable of achieving the objects and securing the advantages heretofore set forth. While I have shown and described two embodiments of my device, it will be apparent that changes and modifications may be made in the broad features described herein without departing from the important points of novelty. Consequently, I do not wish to be restricted to the particular forms or arrangement of parts herein described and shown, except as limited by my claims.

I claim:

1. The method of treating a web of photographic film which includes: subjecting one surface of said web while disposed in a gaseous medium to the action of a spray of treating solution, the major portion of which is immediately removed from said surface, said spray completely covering that portion of said web which is to be treated and effecting partial treatment thereof; thereafter subjecting said surface of said web to the action of a jet of gaseous material that is chemically inert with respect to said treating solution, said jet forcing from said surface the remainder of said treating solution left by said spray; collecting said treating solution projected from said first-mentioned spray and projecting it onto said web in the same manner from a second spray; subjecting said surface of said web to the action of a second jet of gaseous material; and subjecting said surface of said web to alternate

spray and jet action until the treatment of said web is completed.

2. The method of treating a web of photographic film which includes: moving said web while disposed in a gaseous medium with respect to a spray of treating solution, the major portion of said solution being immediately removed from the surface of said web, said spray completely covering that portion of said web which is to be treated and effecting partial treatment thereof, and consisting of a plurality of streams of liquid some of which are projected against the direction of movement of said web and some of which are projected with said direction of movement; thereafter subjecting said surface of said web to the action of a jet of gaseous material that is chemically inert with respect to said treating solution, said jet forcing from said web the remainder of said treating solution left on said surface by said spray; collecting said treating solution projected from said first-mentioned spray and projecting it onto said web in the same manner from a second spray; subjecting said surface of said web to the action of a second jet of gaseous material; and subjecting said surface of said web to alternate spray and jet action until the treatment of said web is completed.

3. The method of treating a web of photographic film which includes: subjecting one surface of said web while disposed in a gaseous medium to the action of a spray of treating solution, the major portion of said solution being immediately removed from said surface, said spray completely covering that portion of said web which is to be treated and effecting partial treatment thereof; thereafter moving said web with respect to a jet of gaseous material that is chemically inert with respect to said treating solution and consisting of a plurality of streams of said material, some of which are projected against the direction of movement of said web and some of which are projected with said direction of movement, said jet forcing from said surface the remainder of said treating solution left by said spray; collecting said treating solution projected from said first-mentioned spray and projecting it onto said web in the same manner from a second spray; subjecting said surface of said web to the action of a second jet of gaseous material; and subjecting said surface of said web to alternate spray and jet action until the treatment of said web is completed.

4. The method of treating a web of photographic film which includes: moving said web while disposed in a gaseous medium with respect to a spray of treating solution, the major portion of said solution being immediately removed from the surface of said web, said spray completely covering that portion of said web which is to be treated and effecting partial treatment thereof, and consisting of a plurality of streams of liquid, some of which are projected against the direction of movement of said web and some of which are projected with said direction of movement; thereafter moving said web with respect to a jet of gaseous material that is chemically inert with respect to said treating solution, consisting of a plurality of streams of said material, some of which are projected

against the direction of movement of said web and some of which are projected with said direction of movement, said jet forcing from said surface the remainder of said treating solution left by said spray; collecting said treating solution projected from said first-mentioned spray and projecting it onto said web in the same manner from a second spray; subjecting said surface of said web to the action of a second jet of gaseous material; and continuing the above described alternate spray and jet action until the treatment of said web is completed.

5. The method of processing photographic film which includes: moving said film while disposed in a gaseous medium with respect to a spray of treating fluid, the major portion of said fluid being immediately removed from the surface of said film, said spray completely covering that portion of said film which is to be treated and effecting partial treatment thereof, and consisting of a plurality of streams of fluid, some of which are projected against the direction of movement of said film and some of which are projected with said direction of movement, said streams providing a turbulent action on the surface of said film that tends to remove all surface material therefrom without damaging the emulsion of said film; thereafter moving said film with respect to a jet of gaseous material that does not react with said treating fluid, said jet consisting of a plurality of streams of said gaseous material, some of which are projected against the direction of movement of said film and some of which are projected with the direction of movement, said jet forcing from said surface the remainder of said treating fluid left by said spray; collecting said treating fluid projected from said first-mentioned spray and projecting it onto said film in the same manner from a second spray; subjecting said film to the action of a second jet of gaseous material; and continuing the above described alternate spray and jet action until the treatment of said film is completed.

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