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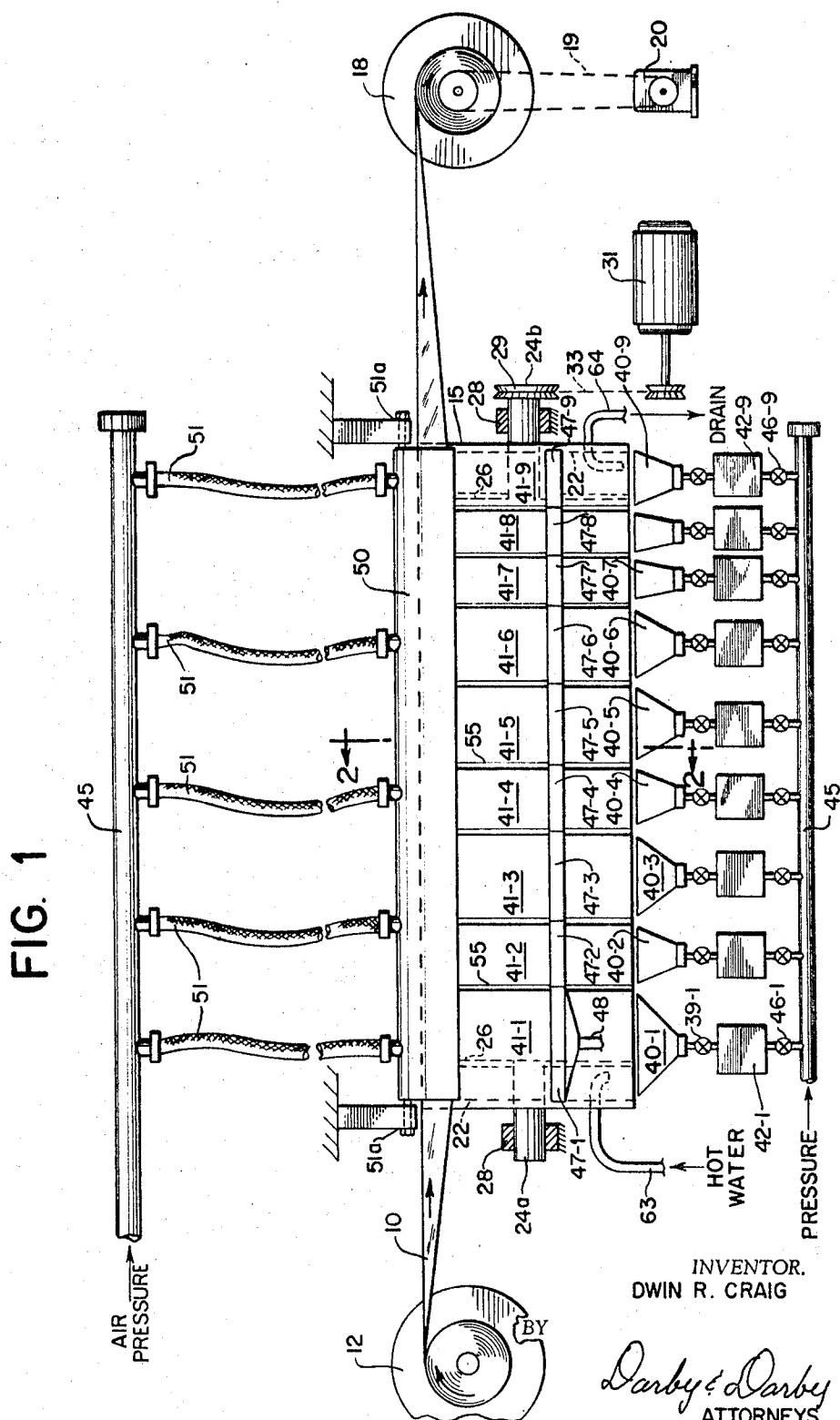
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3,453,944

TRANSAXIAL PROCESSOR

Filed Nov. 18, 1965

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FIG. 2

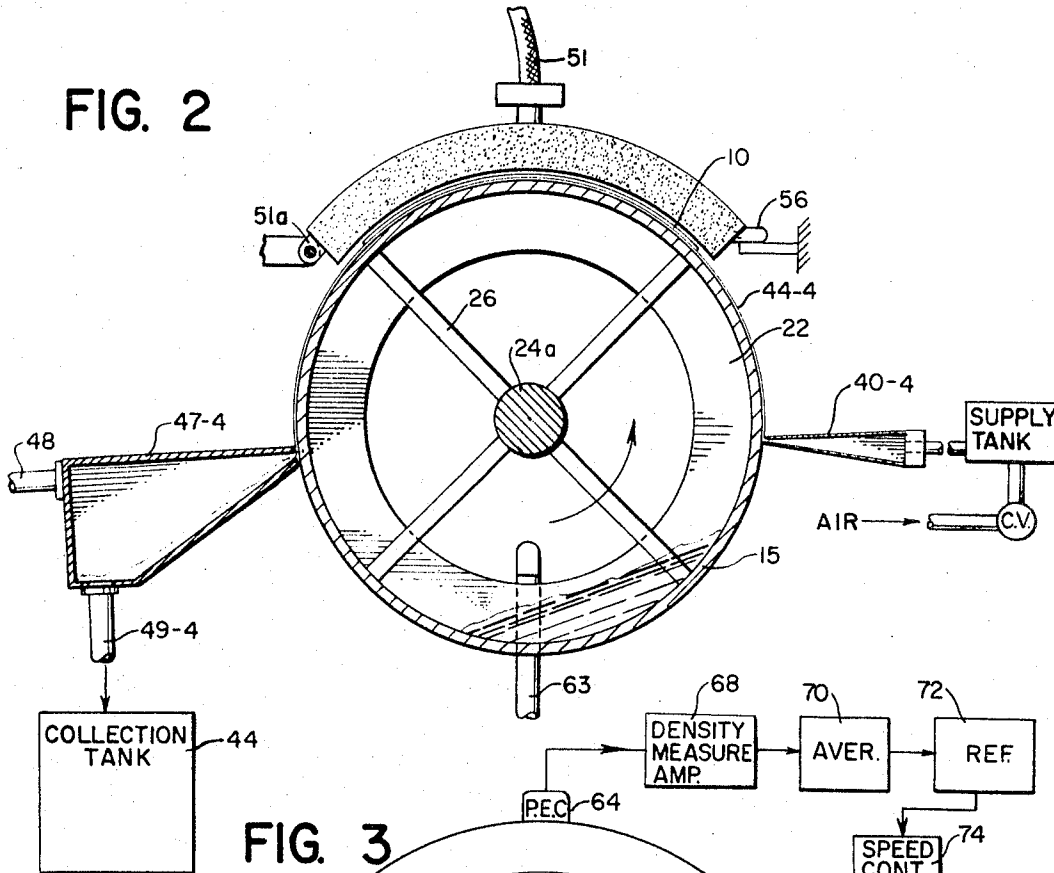
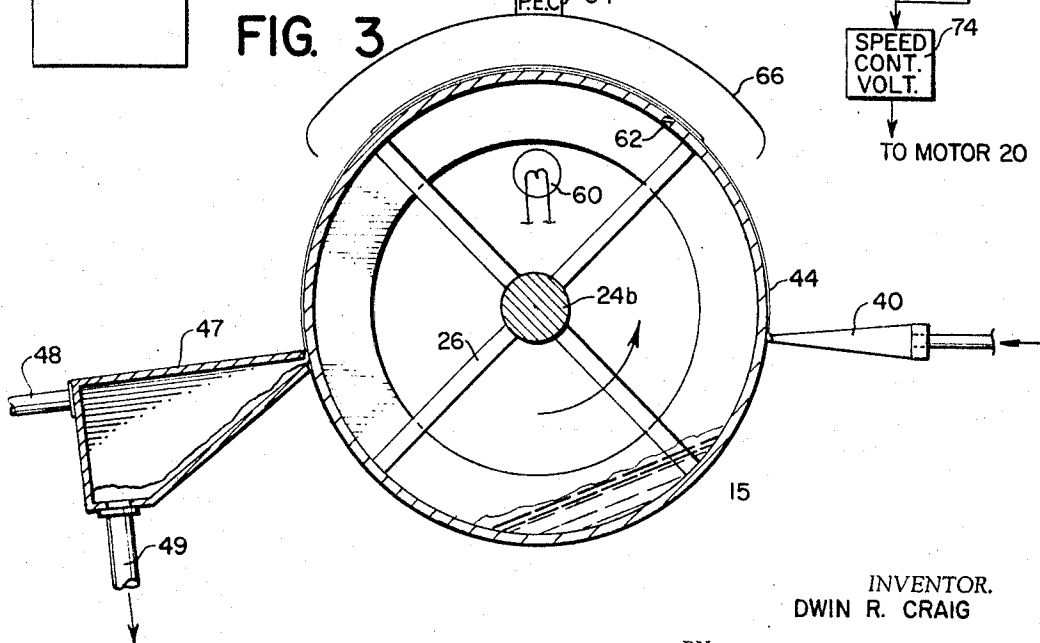


FIG. 3



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TRANSAXIAL PROCESSOR

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10 Claims

ABSTRACT OF THE DISCLOSURE

A film processing system and method in which the treating solutions are applied to the surface of a rotating drum and cling thereto in a plurality of separate bands as the drum is rotated. The film to be processed is moved across the drum through the separate bands of processing solutions in a direction transverse to the direction of rotation of the drum. The processing device also has a member for holding the film being processed in a curved configuration conforming to the shape of the drum and for bringing the film into contact with the fluids on the drum. A plurality of exhaust nozzles remove the excess treating solution from the drum and a sensing device controls the speed at which the film is moved across the surface of the drum.

This invention relates to a method and apparatus for processing film and more particularly to a method and apparatus for processing film in which the film is transported substantially parallel to the longitudinal axis of a processing drum.

Many types of high speed film processors are currently available for processing web type film, either of the black and white or color type. These usually include a plurality of drums which are placed in an in-line or staggered configuration and over which the film is passed. Each drum is associated with a particular fluid utilized in the processing step, such as a developer, fixer or wash, and the film is transported over each drum by being wrapped around all or a portion of its surface.

Processing systems of the foregoing type using a number of drums with the film wrapped around the drum surface have several disadvantages. First of all, the bending of the web film as it is wrapped around the drums subjects the emulsion to flexing in several directions during the time that it is softened. Also, the drum itself is normally used to transfer a processing liquid to the film from a supply pan making it difficult to control the amount of liquid applied to the film. Further, the time that the film spends in each step of the cycle on a particular drum has to be adjusted either by changing the drum size or changing its speed.

The present invention is directed to a film processing apparatus and method which is considerably simpler to construct and operate than those of the prior art. In accordance with the present invention a single rotating drum is provided and the film is bent about its longitudinal axis and passed over the drum surface substantially parallel to the drum's longitudinal axis. A plurality of fluid supply sources are located adjacent the drum and the fluid from each source is applied to the drum which carries it to the under surface of the film. In a preferred embodiment of the invention the film is held in position by an air bearing adjacent the upper surface of the film and the film's only contact is with a fluid layer adjacent its under surface.

Among the major advantages of the method and apparatus of the present invention are increased speed of film processing, ease of film threading, and ease of selection of a predetermined processing time for any step of the processing cycle.

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It is therefore an object of the present invention to provide a method and apparatus for rapidly processing film.

A further object is to provide a method and apparatus for processing film in which the film moves across the surface of a rotating drum substantially parallel to the drum's longitudinal axis.

Another object is to provide a transaxial film processor in which a web film is bent on its longitudinal axis and laid over the surface of a rotating drum which is supplied with a plurality of different processing liquids.

Other objects and advantages of the present invention will become more apparent upon reference to the following specification and annexed drawings, in which:

FIGURE 1 is a side elevational view of the film processing system of the present invention;

FIGURE 2 is an end view of a portion of the system of FIGURE 1, taken along lines 2—2 of FIGURE 1; and

FIGURE 3 is an end view of a modified embodiment of the present invention.

Referring to FIGS. 1 and 2, an undeveloped film negative 10 fed from a supply reel spool 12 is bent around its longitudinal axis and laid across the surface of the processing drum 15 generally parallel to the longitudinal axis of the drum. Film 10 is drawn across the drum surface by a take up reel 18 driven through a belt or chain 19 by a motor 20. The drum 15 is made of a heat conducting material, such as stainless steel, and is hollow with a lip 22 at each end thereof so that a quantity of heating liquid can be held therein.

The drum is supported on its longitudinal axis by a central shaft 24 which can either run the length of the drum or be split into two parts. As shown, shaft 24 is split into two parts 24a and 24b and each part is mounted at a respective end of the drum by a yoke 26 and supported in a bearing 28. Shaft part 24b has a pulley 29 attached thereto so that the drum 15 can be rotated by a motor 31 in the direction shown by the arrow in FIG. 2, through a suitable belt or chain 33.

Located adjacent the drum and below the film 10 are a number of fluid supply nozzles 40—1 through 40—9. While nine nozzles 40 are shown, it should be understood that any number can be used. Each of the nozzles 40 is connected to a respective fluid supply source 42—1 through 42—9 through a respective control valve 39—1 through 39—9. Each supply source 42 is pressurized by a common source of air pressure in conduit 45 through a respective check valve 46.

Each of the fluid supply tanks 42 contains a predetermined type of fluid, for example a developing chemical mixture or compound, a wash, water, fixer, stop, etc. The nozzles 40 connected to the sources 42 are arranged in a predetermined manner along the drum and adjacent its periphery from its input end to its output end. The type of fluid supplied to each nozzle 40 depends upon the type of film being developed, and the width of each nozzle is selected to provide a liquid coating 44 on a zone 41 of the same width on the drum with its fluid. The drum carries the fluid up to the undersurface of the film.

The air pressure from conduit 45 supplies the respective fluid under pressure through its respectively connected spray nozzle onto the surface of the drum. The nozzles 40 are preferably located on a horizontal plane through the drum's longitudinal axis, as shown in FIG. 2. As the drum rotates the fluid sprayed thereon by each nozzle 40 is carried in its zone 41 around the surface of the drum and forms the fluid film or coating 44 on top of which the undersurface of the film to be developed rides. If desired, the tanks 42 and nozzles 40 can be arranged to provide a gravity feed of the fluid to the nozzles.

The film 10 is held in position on the top of the drum

by a curved shoe 50 of complementary shape to the drum. Shoe 50 is preferably an air bearing of stainless steel or sintered bronze material and it is supplied with air pressure from the source 45 through a number of conduits 51 spaced along its length. The air leaking out of the bearing on its under surface forms a fluid film bearing which holds the film 10 away from the shoe's undersurface. Therefore, the outer surface of film 10 is held out of contact with the inner surface of the shoe and its under surface is held out of contact with the drum by the film of fluid. This subjects the film to very little friction during processing. Shoe bearing 50 has hinges 51 at each end and a latch stop 56 on the side of the shoe opposite the hinges to hold the shoe away from the drum.

A plurality of exhaust nozzles 47-1 through 47-9 are located adjacent the respective drum fluid zones 41-1 through 41-9. As shown in FIGURE 2, the supply nozzles 40 and corresponding exhaust nozzles 47 are spaced substantially 180° apart around the surface of the drum and are located in a horizontal plane through the drum's axis. Of course, any desired arcuate spacing may be utilized and the exhaust nozzles can be located below the horizontal plane. Each of the exhaust nozzles 47 receives reduced pressure from a line 48, such as a vacuum source (not shown) and has a respective output line 49, which gravity feeds to a respective collection tank 44. If desired, the respective fluid collected by each of the nozzles 47 can be returned directly to the corresponding supply tank 42. However, it usually is desired to purify each of the returned fluids and/or, such as, in the case of the wash solutions, to provide fresh fluids.

The inside of the hollow drum is supplied with water, or some other suitable fluid, at a predetermined temperature through a nozzle 63 located at the drum input end. A drain 64 is provided at the other end of the drum. This maintains a predetermined temperature along the entire drum length. Of course, if desired, only selected portions of the drum can be heated by a water carrying means. Also, additional heat sources may be provided adjacent selected portions of the drum, for example, infrared lights to heat it to a predetermined temperature.

As should be clear from FIGS. 1 and 2, each nozzle 40 evenly applies a fluid to the drum in a band 41. The width of each nozzle 40 and its corresponding fluid band 41 is proportional to the required processing time for each fluid. The film 10 is transported substantially parallel to the longitudinal of the axis of the drum, that is 90° to the direction of drum rotation, and successively passes over each fluid band 41 where a processing step is carried out. The width of each band 41 and the transport speed of the film 10 determines the time for each processing step. Preferably, the drum 15 has a textured surface, for example it is made of stainless steel, so that there is a high degree of agitation between the emulsion on the undersurface of the film and the solution of each band. The film rides on the liquid bearing on the emulsion side and on an air bearing on the upper side so that no part of the film is in contact with rollers or friction surfaces.

Separation between bands of fluid 41 used for developing and fixing can be accomplished in a number of ways. For example, every other band 41 on the drum can be a wash fluid, such as water, so that no two "active" fluids are adjacent each other. Also, drum 15 can be machined with narrow raised ridges 55, of a height somewhat less than the thickness of the fluid film, to aid in the separation of the fluids of adjacent bands.

As pointed out above, the duration of each processing step can be controlled by selecting the width of the fluid band, and/or the film transport speed. This is advantageous in a system where automatic density control is to be provided for development. Such an arrangement is shown in FIG. 3 where the output end of the drum has a continuously or intermittently operated light source 60 in side of the drum. The light from source 60 passes through a transparent plug 62 in the drum surface and

impinges onto a photocell 64. The photocell 64 can be located on top of a hole cut through air bearing shoe 50 or else, as shown in FIG. 3, mounted on top of a light collecting reflector 66 located on a portion of the output end of the drum not covered by the shoe.

The output of cell 64 is amplified in an amplifier 68 and averaged in a circuit 70. The latter is used since the cell output is varying depending upon the information on the film. The averaged voltage from circuit 70 is compared with a reference voltage corresponding to a predetermined desired average film density in a circuit 72, which may be a difference amplifier, for example with one fixed input, and the difference output amplified by amplifier 74 to produce a speed control voltage. This voltage is applied to film transport motor 20 which either increases or decreases the film speed, depending upon whether the developed film was too dark or too light. All of the circuits 64, 68, 70, 72 and 74 are conventional in the art and no further description thereof is needed.

While the drum 50 is shown mounted in a horizontal position, it should be understood that it also can be mounted vertically. Also, several of the processors of FIGS. 1 and 2 can be mounted in-line.

The apparatus and the film processing method of the present invention have several advantages over prior art systems. As pointed out above, there is no frictional contact between the film and drum or the film and shoe 50. Additionally, the film is flexed only along its longitudinal axis during the time that its emulsion is softened by the developing fluid. This prevents the emulsion from cracking. Flexing of the film in this manner also imparts longitudinal rigidity to the film permitting straight line transport without tension. Further, it simplifies threading since all that is necessary is to swing back the shoe 50 on its hinges and to replace it.

As an additional advantage of the present invention, vigorous mechanical agitation is introduced between the fluids and the film and fresh chemicals are continually supplied to the processing surface bands 41. Also, the times in the bands 41 of processing solutions do not have to be integral multiples of each other but can be the minimum time needed for each chemical reaction involved.

The present invention is also extremely versatile since it permits infinite variability in the number and relative duration of processing steps. It also permits dynamic control of the processing cycle in accordance with the embodiment of FIGURE 3. Further, the film transport speed, the drum speed and the temperature of the drum can be independently controlled to manipulate the process.

The invention is also extremely simple, since it contains only two moving parts, the drum and the film feed. Further, the temperature of all solutions is controlled at one point by the water from source 63. The feed of the fluids from supply tanks 42 together with the drum speed also control the rate of solution application and the use of fresh solutions continually from each supply tank 42 eliminates the need for replenishment equipment.

The invention also provides a high degree of reliability since it can be used with no air gaps between the bands of solutions. This insures freedom from oxidation, thermal transients and dirt collection. Also, all solutions are at identical temperatures and the film rides on fluid and air bearings. Further, there is a large temperature controlled water core within the thin film 44 of the solution which insures even heating of the solution.

The invention is also economical, since minimum solution is used due to thin film application. Further, minimum maintenance is needed due to the small number of parts. The invention also enhances quality of the developed film, since fluid flow transverse to the film transport direction eliminates streaking. Further, there is no change in film direction during the entire web cycle, so that the emulsion is maintained stable. Also the con-

tinual contact of the emulsion with the fluid eliminates thermal shocks and the film is operated with near zero tension during transport. Additionally, a large number of in-lines stages permits prewetting, stabilizing, etc., cycles without undue complexity.

The invention is also rapid in its operation, since elevated temperatures can be easily controlled through the water core and a high drum speed used to produce vigorous agitation. Also, each process stage can be operated at minimum time and not restricted to an integral multiple of some other processing stage. Additionally, there is no time loss between solutions.

The invention is also convenient since it is a straight-line self-threading transport; there is only a single processing surface to clean either to make ready or to clean up; and a simple interchange of the manifold length of any of the nozzles 40 changes the process gamma without altering any other part of the cycle.

What is claimed is:

1. A processor for a web type film comprising:
 - a drum,
 - means for supplying a fluid to a zone of the outer surface of said drum comprising a predetermined length along its longitudinal axis,
 - means for rotating said drum to cause said supplied fluid to cling to the drum outer surface and rotate therewith to form a band of fluid on the drum outer surface,
 - means for moving a web film in a direction along the length of the drum with a surface of the film in contact with the fluid of the band clinging to the drum outer surface,
 - and means for holding web film in a curved configuration conforming generally to the shape of the drum outer surface and in proximity thereto for contact with the fluid band on the surface of the drum.
2. A processor as set forth in claim 1, wherein said holding means includes an arcuate shaped air bearing.
3. A processor for a web type film comprising:
 - a drum,
 - means for supplying a respective fluid to each of a plurality of zones on the outer surface of said drum along its longitudinal axis,
 - means for rotating said drum to cause said supplied fluid of each zone to cling to the drum outer surface and rotate therewith to form respective bands of fluid on the drum outer surface,
 - and means for moving a web film in a direction along the length of the drum with a surface of the film in contact with the fluid so that any given portion of the film is moved sequentially through the plurality of bands clinging to the drum outer surface.
4. A processor as set forth in claim 3, further comprising:
 - means for holding said web film in a configuration con-

forming generally to the circumference of the drum and in proximity to the drum outer surface.

5. A processor as set forth in claim 3, further comprising:

a plurality of means located adjacent the drum outer surface and spaced along its longitudinal axis for collecting the fluid from a respective band after it has come into contact with the film.

6. The film processor of claim 3 further comprising: means for measuring the density of the film at a predetermined point in the processing cycle, and means responsive to the measured density for controlling the rate at which the film is moved along the length of the drum.

7. A processor as set forth in claim 3 further comprising means for separating the fluids in the bands formed on the outer surface of the drum.

8. A processor as set forth in claim 3 wherein said moving means moves said web film in a substantially straight line generally parallel to the longitudinal axis of the drum.

9. A method for developing film comprising the steps of:

supplying each of a number of zones located along the length of the outer surface of a drum with a respective fluid,

rotating said drum to cause each of the applied fluids to cling to the outer surface of the drum in a respective band,

and moving said film over the length of the outer surface of the rotating drum with the film under surface held in proximity to said drum outer surface and in contact with the fluids thereon whereby any given portion of the film passes sequentially through the respective bands of fluid on the drum.

10. The method of claim 9 further comprising the steps of arcuately flexing the film about its longitudinal axis and holding the film in the arcuate shape as it is moved over the length of the drum.

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