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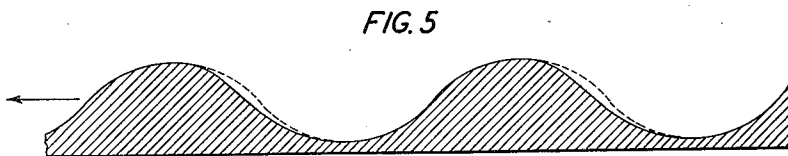
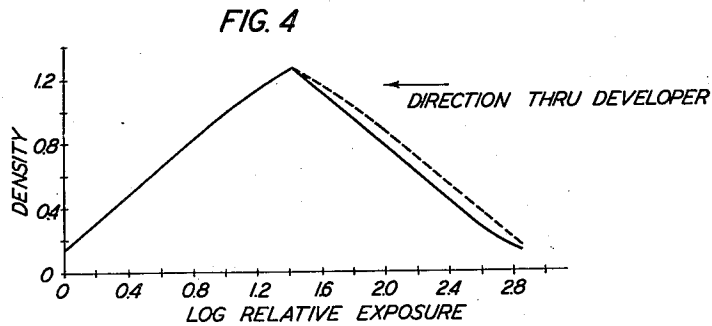
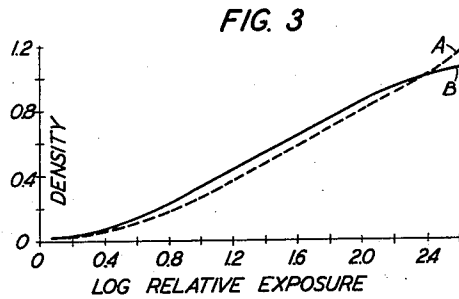
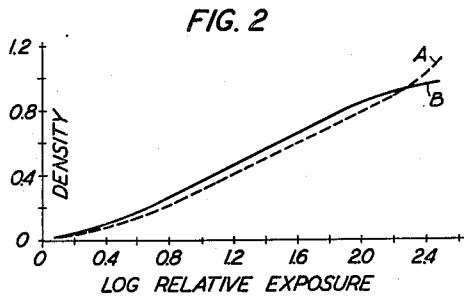
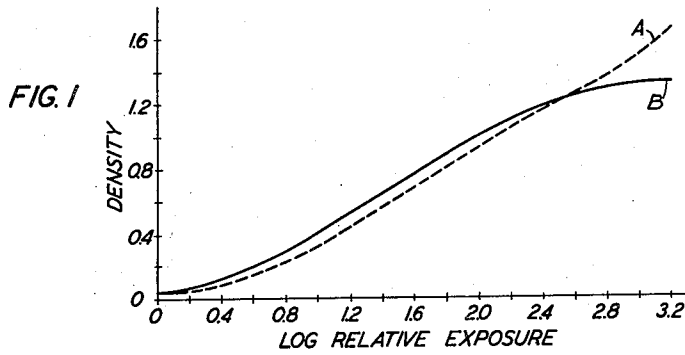
J. CRABTREE

1,921,404

CONTINUOUS FILM PROCESSING MACHINE

Filed May 21, 1931

3 Sheets-Sheet 1



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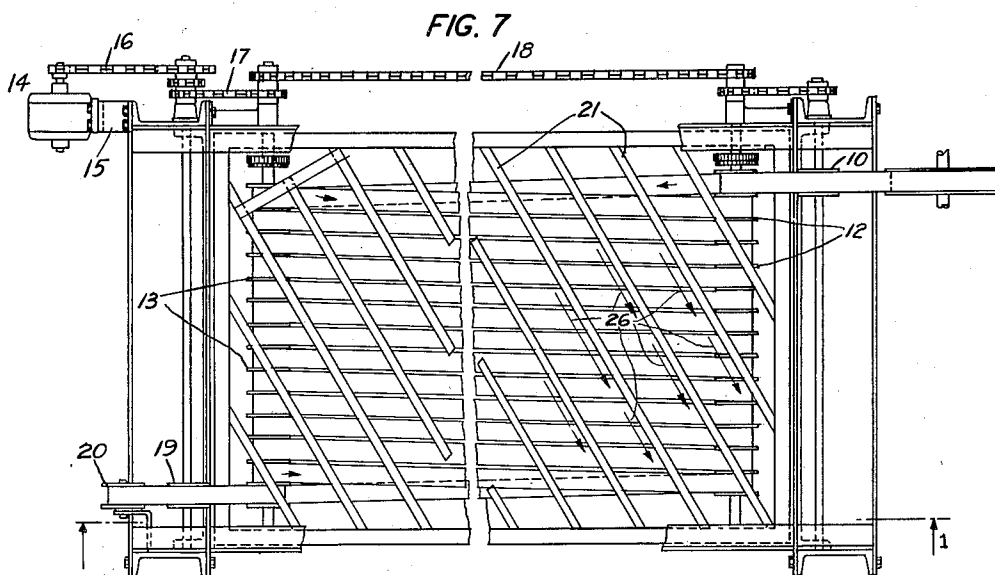
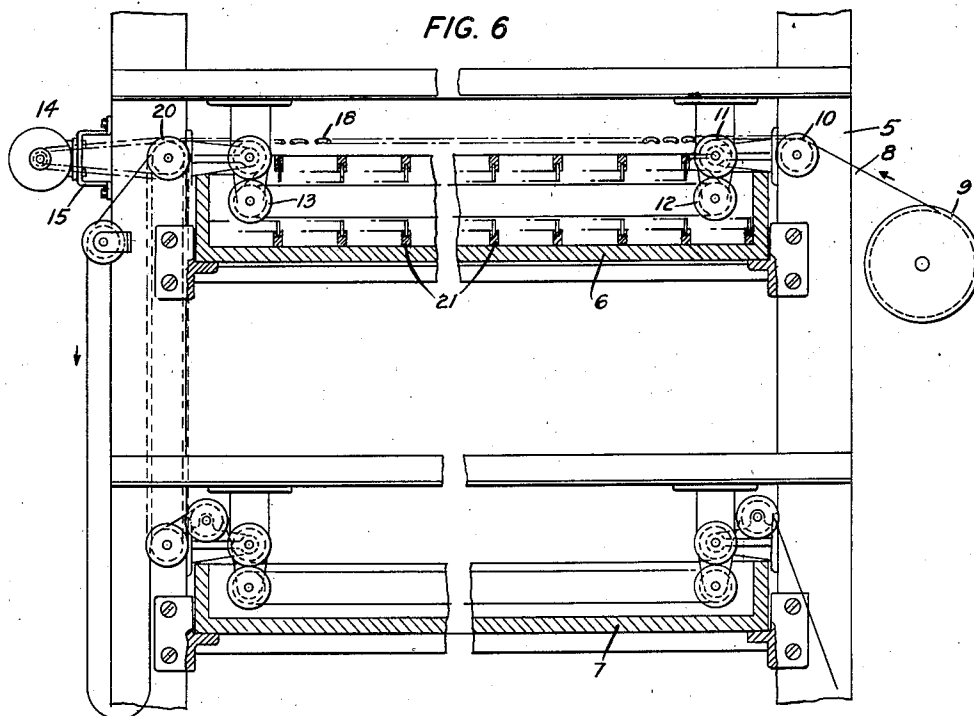
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CONTINUOUS FILM PROCESSING MACHINE

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3 Sheets-Sheet 2



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CONTINUOUS FILM PROCESSING MACHINE

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3 Sheets-Sheet 3

FIG. 8

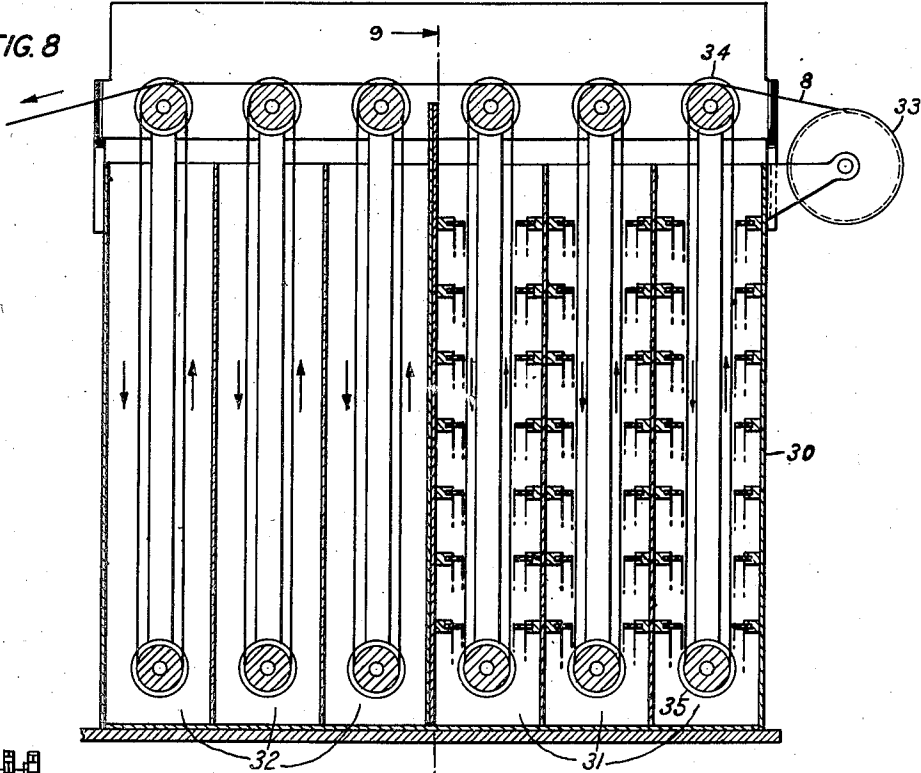


FIG. 9

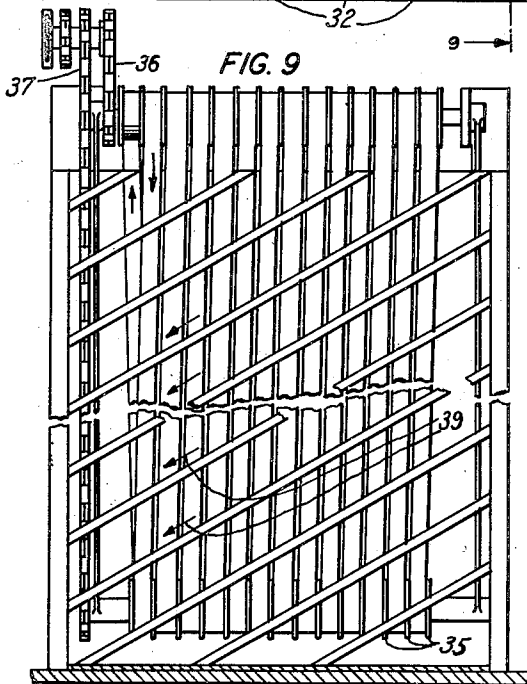
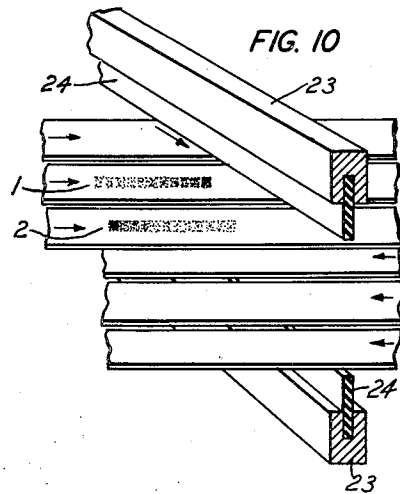


FIG. 10



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UNITED STATES PATENT OFFICE

1,921,404

CONTINUOUS FILM PROCESSING
MACHINE

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Application May 21, 1931. Serial No. 539,047

4 Claims. (Cl. 95—94)

This invention relates to photographic film processing and more particularly to a method and means for producing a uniform developing action in a machine processing of photographic film.

5 It is the usual practice in the motion picture art to employ continuous film processing machines for the developing, fixing, washing and drying of exposed photographic film which has been used to record either picture or sound, or
10 both picture and sound. The processing machines referred to are well known in the art and the two types in general use are the vertical tank type and the horizontal tank or tray type machines. In both of these machines the length of
15 exposed film is continuously drawn through the successive baths constituting the complete process.

It has been found, particularly in the development of sound film, that the development of the photographic sound record is not uniform for all
20 equally exposed adjacent portions of the record. Adjacent portions of the sound record which should be of equal density have been found, after development, to be of unequal density. This non-uniform developing action produces an undesired
25 distortion in the wave shape of the recorded sound.

It is the object of this invention to produce a uniform developing action in film processing machines.

Another object of the invention is to provide means suitable for use in standard film processing machines to eliminate the effects producing non-uniform developing action.

35 A feature of the invention lies in the provision of a plurality of brushes or squeegee units equally spaced along the path of travel of the film in the developing tank and adjacent the emulsion side thereof.

40 Applicant has discovered that the non-uniform developing action in processing machines arises from the following facts. The film in its travel through the developing solution in one direction produces, relative to the motion of the film, a movement or countercurrent of the developing solution in the opposite direction. The developing
45 solution in developing a small area of the film is exhausted locally in proportion to the density produced. The products of reaction at the developed surface are of such a character that they tend to lower the density produced on the next
50 adjacent area if they are free to make contact with it. Due to that travel of the solution in a direction relatively opposite to that of the film, these products of reaction do make contact with

the next adjacent area and exercise a restraining influence upon it which results in the production of an abnormally low density in this area. This action may be cumulative and therefore may cause a greater defect in the development of the next succeeding area.

In accordance with the method produced by this invention for insuring uniform developing action, the developer employed in developing a small area of the film together with the resulting products of reaction are immediately removed from the region of the film and displaced by a fresh developing solution to affect the next succeeding area of the film. The means provided by this invention for effecting displacement of the exhausted developer comprises a plurality of wiping units, which may take the form of rubber squeegees, spaced at intervals in the developing tank along the path of travel of the film adjacent the emulsion side thereof. These wiping units are preferably set at an angle to the direction of travel of the film.

Fig. 1 is a showing of two characteristic Hurter and Driffield curves plotted from readings obtained from two identical sensitometer exposures which were subjected to identical development on a continuous film processing machine.

Fig. 2 is a similar set of curves obtained from a pair of sensitometer exposures which were run through a non-circulating developer solution.

Fig. 3 shows a set of "H and D" curves obtained from a pair of identical sensitometer exposures which were run through a circulating developer solution.

In Fig. 4 is shown a curve disclosing the results of "directional effect" on the development of a photographic sound record in a continuous processing machine.

Fig. 5 is a diagrammatic showing of the results of "directional effect" on a recorded sound wave.

Fig. 6 is a view in elevation, partly in section, of a developing tank of a horizontal tray type continuous processing machine with the addition of the squeegee means for preventing "directional effects" in development.

Fig. 7 is a plan view of the developing tank disclosed in Fig. 6.

Fig. 8 is an elevation, partly in section, of the developing tank of a vertical tank type continuous processing machine showing the position of the squeegee units therein.

Fig. 9 is a section taken along line 9—9 of Fig. 8.

Fig. 10 is a detail showing of the relative posi-

tions of the squeegee units and the film in either of the type machines disclosed.

To provide for precise control of development operation, it is customary in the development of continuous film to attach to each length of film that passes through the processing machine a short length of film upon which a sensitometer exposure has been impressed. As is well known in the art, this sensitometer exposure consists of a series of exposures in which small areas of the film are exposed to different and known quantities of illumination. After exposure and development of the film, the measurement of the different densities produced on these areas enables one to determine the characteristics of the film material employed and also to measure the degree of development that has been given to the film.

Difficulties have been experienced in obtaining close sensitometric control of the development of a continuous film in machines as described above. It has been found that characteristic curves obtained from separate sensitometric strips having identical exposures on the same or similar film and which were given identical development were found to vary widely. Applicant has discovered that these characteristic curves could be divided into two distinct classes, according to the direction in which test strips are passed through the developer.

In Fig. 1 are shown two characteristic "H and D" curves A and B. These curves were obtained from two identical sensitometric exposures which were given identical degrees of development. The differences in the shape of these two curves may be explained more fully by reference to Fig. 10 in which numeral 1 denotes a sensitometer strip in which the areas of higher exposure precede the areas of lesser exposure with respect to the direction of film propulsion, while 2 denotes a sensitometer exposure strip in which the areas of lesser exposure precede the areas of higher exposure with respect to the direction of film propulsion. The curve A in Fig. 1 is representative of a characteristic curve obtained from a reading of the developed sensitometer exposure strip 1, while curve B is representative of a characteristic curve obtained from a reading of the developed sensitometer exposure strip 2. It will be seen that in curve A, in which the areas of higher density precede the areas of lower density, the areas of higher density have received full development while the areas of lesser density have received a lowered development. This is caused by the fact that the developer solution in developing the area of higher density has released products of reaction at the developed surface which make contact with the next succeeding area to cause imperfect development of this area. In curve B, in which the lighter areas preceded the darker areas, the lower densities received substantially full development while the higher densities were lowered due to the action of the accumulated products of reaction from the lower density areas. It can therefore be seen that the extent of development of a sensitometer exposure strip depends upon the direction in which it is sent through the developer solution. This effect is what applicant terms "directional effect" in the development of photographic film in continuous film processing machines. The general effect is to straighten out the shoulder in curve A and to suppress it somewhat in curve B. As can be seen, the effect on the resultant gamma or slope

of the curve is slight but there is an appreciable difference in the estimate of latitude (straight line portion) and inertia (intercept on log E axis) in the two cases.

It has further been found that the general circulation of a developer solution by the pumps had but little effect in breaking up this "directional effect". In Fig. 2 the curves A and B were obtained from readings of a sensitometer exposure strip run through the developer in opposite directions, the developer being non-circulating or stagnant. The curves obtained in Fig. 3 were plotted from readings taken from sensitometer exposure strips as in Fig. 2 with the exception that the developer solution was caused to circulate by pumps provided for this purpose. It can be seen by reference to the two figures that a directional effect is present regardless of the circulation of the developer solution in the developing tank of the continuous processing machine.

Fig. 5 is a diagrammatic showing of a cross-section of the emulsion of a photographic film on which a single frequency record had been recorded. In this figure is shown the effect of "directional effect" in the development of a sound record in a continuous film sound processing machine. The film bearing the sound record is being propelled through the developer in a direction indicated by the arrow, and the second half of the wave is subjected to the restraining influence of the product of reaction set free in the development of the first half of the wave. It is seen therefore that the first half of the wave will receive full development and the second half will receive a lowered development as indicated by the difference between the full and dotted lines shown in the figure. As a frequency cycle of a variable density sound record consists of a series of gradations of density arranged much like a pair of minute sensitometers with their high densities abutting, the readings for the curves shown in Fig. 4 were taken from exposures from a very small step sensitometer strip having steps arranged so as to give a series of densities simulating a sound wave of 45 cycles. These curves show a definite difference of slope for the two sides of A—B and B—C of the wave as shown. It can be seen that the side of the wave leading through the developer was given full development while the half of the wave following received lowered development. From the results obtained in plotting the curves as shown in Fig. 4, it was concluded that "directional effect" in a processing machine will distort the recorded sound waves as shown diagrammatically in Fig. 5.

To eliminate "directional effect" in developing film in a continuous film processing machine, applicant has produced a method and means of effecting uniform developing action and therefore prevent distortion in the recorded sound wave.

In Fig. 6 is shown a continuous film processing machine 5 of the horizontal tray type having a developing tank 6 and a fixing tank 7 employed for the continuous processing of photographic film. A photographic film 8 is fed from a film reel 9 to rollers 10 and 11. Two sets of rollers 12 and 13 are arranged on opposite sides of tank 6. A driving motor 14 secured to the machine by means of bracket 15, drives the sets of rollers 12 and 13 through endless chains 16, 17 and 18. The film 8 is directed back and forth over the rollers 12 and 13 as shown in Fig. 7. The film 8 after development is led over rollers 19 and 20

down to the fixing tank 7. From this tank it is led to a washing and drying tank to complete the processing operation.

In accordance with the method produced by applicant for eliminating "directional effects" in such machines, the products of reaction at the developed surface are removed simultaneously at a plurality of points. This is accomplished by the provision of a number of squeegee units 21 secured to the tank 6. A set of these units is disposed diagonally across the top and another set disposed diagonally across the bottom of the tank 6. As shown more clearly in Fig. 10, each unit consists of a member 23 having a groove therein into which is secured a strip member 24 of rubber or some other suitable material. These units may be spaced from 3" to 6" apart and at an angle to the direction of travel of the film as shown. It is desirable, but not essential that the member 24 be in actual contact with the surface of the film. However, as shown, a small space may exist between the two surfaces. By means of these units eddy currents are generated at each of these points which brings about a displacement of the solution in contact with the film surface in that region. The effect obtained by the use of these units is a resulting circulation of the products of reaction in the direction indicated by arrow 26 in Fig. 7. As these products of reaction are removed from the film surfaces immediately and displaced by fresh developer they do not have an opportunity to affect the next succeeding area on the film.

Readings taken from identical sensitometer exposure strips directed to the developer in opposite direction with respect to the film emulsion in a machine equipped with such squeegee units have resulted in identical characteristic "H and D" curves. Therefore, if no differences in the curves result, there can be no confusion as to the characteristics of the film and the degree of development given.

In Figs. 8 and 9 a continuous processing machine 30 of the vertical tank type is shown. This machine consists of a developing tank 31 and a fixing tank 32. In this case the film 8 is fed from a reel 33 to two sets of rollers 34 and 35 arranged at the top and bottom of the tank 31 respectively. The film 8 is fed up and down over the rollers 34 and 35 as shown in Fig. 9. The rollers 34 and 35 are rotated by means of chains 36 and 37, respectively, which are actuated by some suitable driving means (not shown). After development the film is fed into the fixing tank and from there to the drying tank to complete the film processing operation.

The sets of squeegee units 21 are secured in a diagonal position in the tank 30 and between the two sets of driving rollers 34 and 35. These units may be spaced from 3" to 6" apart in the direction of travel of the film. The spacing between the squeegee units and the film may be identical to that previously described in connection with the horizontal tray type machine. Each squeegee unit produces a circulation of the developer in a direction indicated by arrow 39 in Fig. 9. It will therefore be seen that by this local circulation simultaneously at a plurality of points, the

products of reaction are immediately removed to be displaced by new developer before they have an opportunity to come in contact with the succeeding areas of the film.

The "directional effect" is normally somewhat less in this type machine than in the tray type machine due to the fact that in the vertical tank type machine gravity will assist in removal of the reaction products since they are of higher specific gravity than the fresh developer. However, the effect has been found to be sufficiently pronounced to cause non-uniformity in development and therefore confusion as to the correctness of the results obtained.

The characteristic curves obtained from identical sensitometric exposure strips developed in a machine of the vertical tank type provided with squeegee units as described, have been found to be uniform regardless of the direction in which the sensitometer strip was sent through the developer.

It can therefore be seen that the provision of means as described for the elimination of "directional effect" in film development in a continuous film processing machine will produce uniformity in the development of exposure strips of sensitometric latent images and also eliminate distortion in the recorded sound waves resulting from non-uniform development.

What is claimed is:

1. The combination with the developing chamber of a continuous film processing machine having means for guiding and moving a photographic film, of means for eliminating directional effect in the developing of said film, said means comprising a plurality of wiping units secured to said chamber along the path of travel of said film at an angle to the longitudinal axis thereof.

2. In a continuous film processing machine, a developing chamber, film guide rollers in said chamber, a set of wiping units secured in a diagonal position across the top of said chamber, a second set of wiping units secured in a diagonal position across the bottom of said chamber, and means for moving said film over said guide rollers between said sets of wiping units.

3. In a continuous film processing machine, a treating chamber for containing a fluid, film guide rollers in said chamber, means for moving said film over said guide rollers, and means for eliminating directional effects in the treatment of said film, said means comprising a plurality of fixed wiping units spaced from said film and secured to said chamber along the path of travel of said film at an angle to the longitudinal axis thereof.

4. A continuous film processing machine, in combination, a treating chamber for containing a fluid, a plurality of sets of guide rollers in said chamber, means for moving said film back and forth over said sets of guide rollers, a plurality of fixed rubber strips spaced from the emulsion side of said film at an angle to the longitudinal axis thereof, said strips secured to said chamber along the path of travel of said film between said sets of guide rollers.

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