

Oct. 11, 1949.

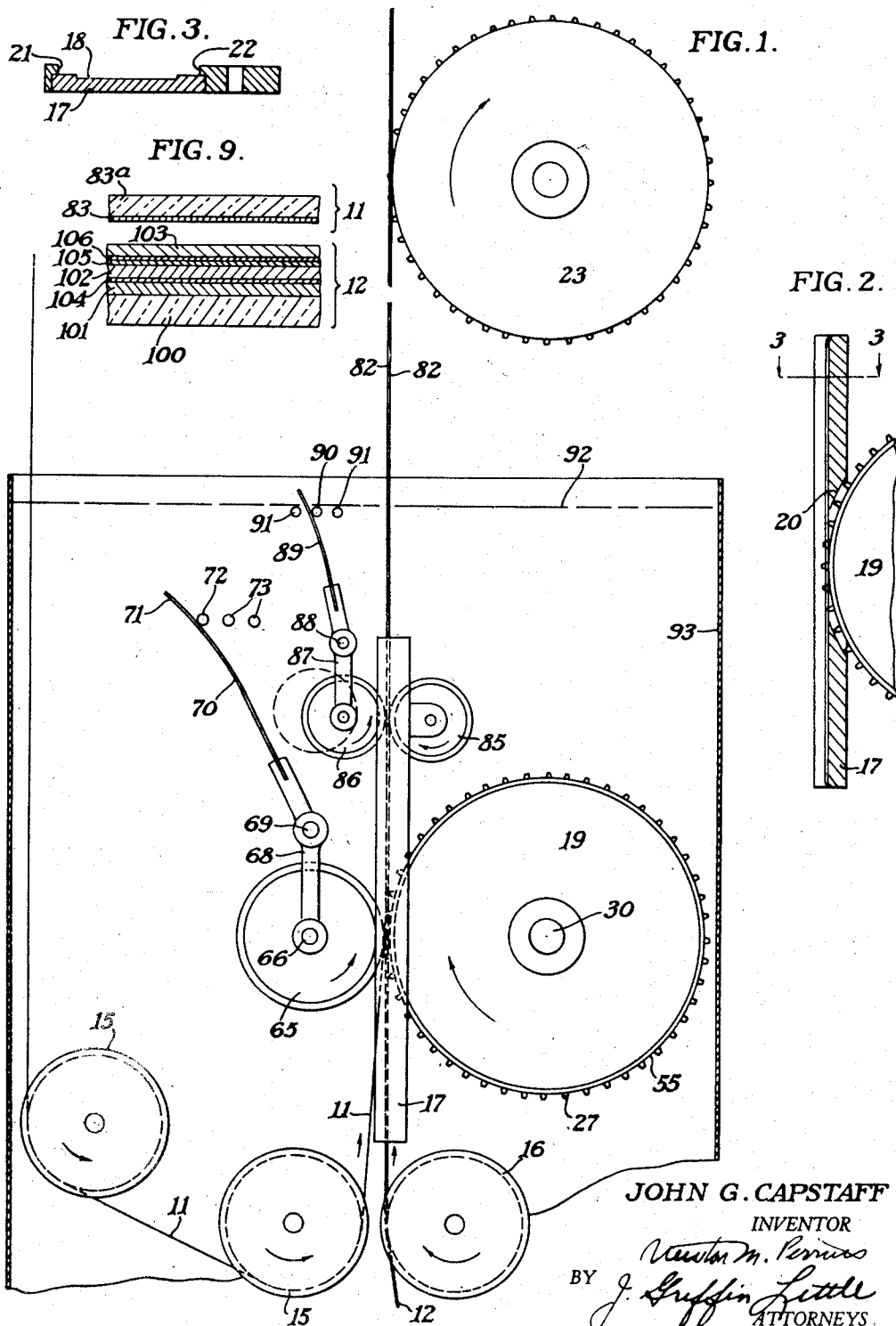
J. G. CAPSTAFF

2,484,446

EXPANSIBLE TOOTH SPROCKET

Filed April 20, 1945

3 Sheets-Sheet 1



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2,484,446

EXPANSIBLE TOOTH SPROCKET

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FIG. 4.

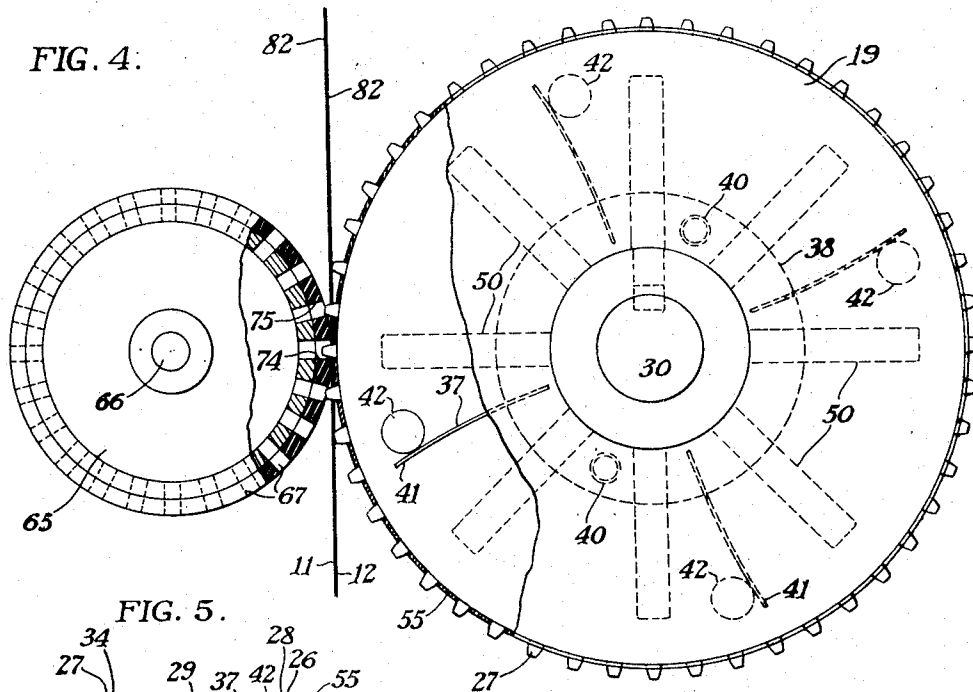


FIG. 5.

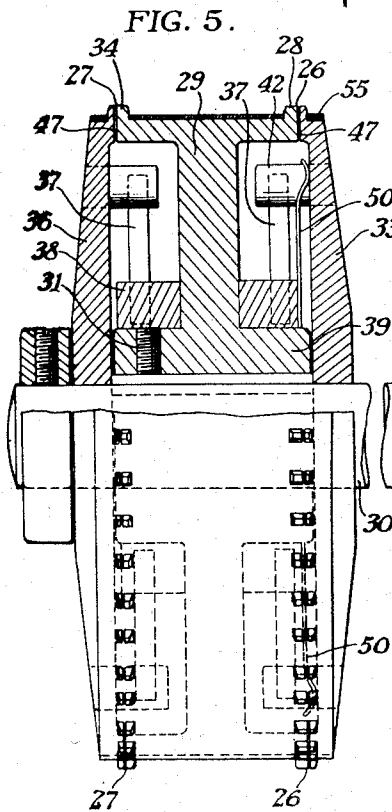


FIG. 6.

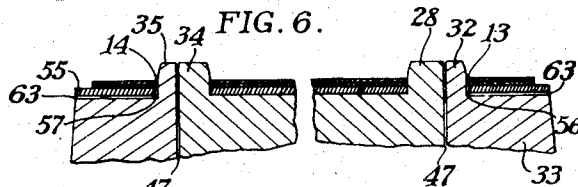


FIG. 7.

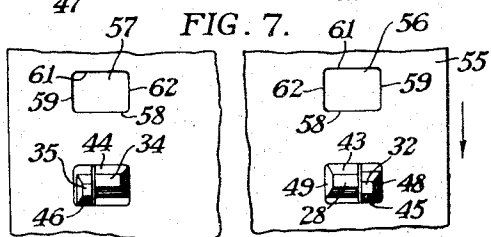
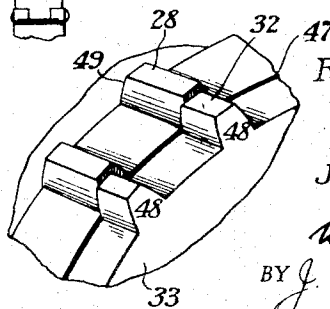


FIG. 8.



JOHN G. CAPSTAFF

INVENTOR

BY *Newton M. Perigo*
Griffin Little
ATTORNEYS

Oct. 11, 1949.

J. G. CAPSTAFF

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FIG. 10.

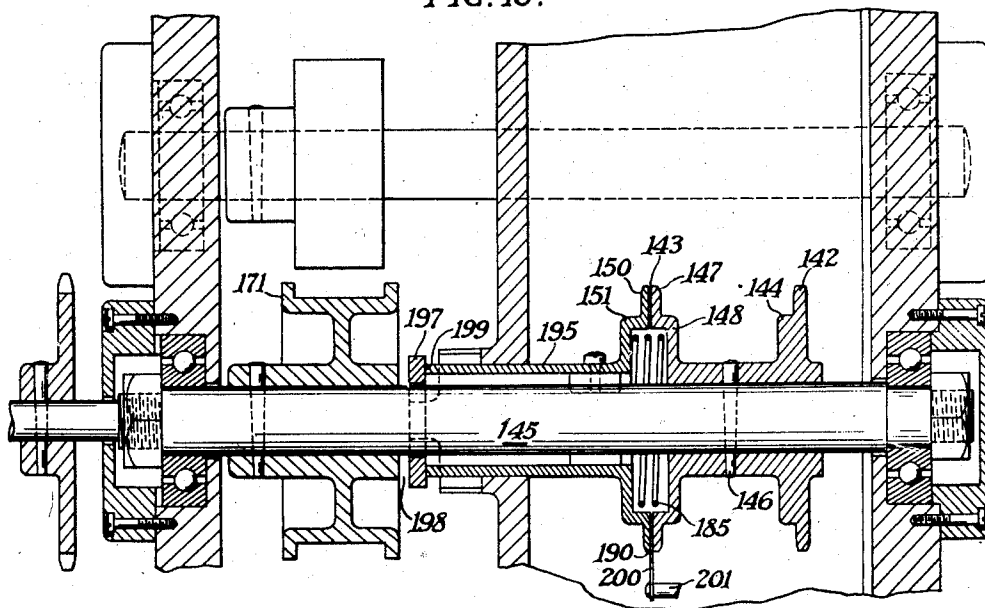
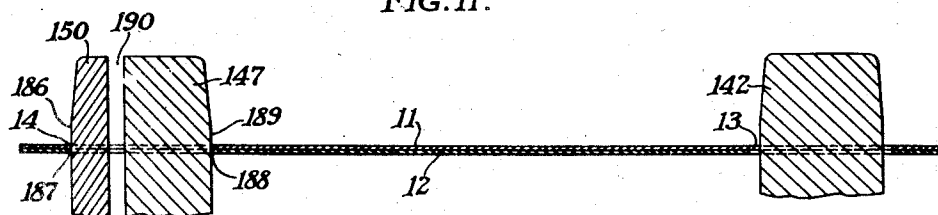


FIG. 11.



JOHN G. CAPSTAFF
INVENTOR

BY *Walter M. Perrins*
J. Griffin Little
ATTORNEYS

UNITED STATES PATENT OFFICE

2,484,446

EXPANSIBLE TOOTH SPROCKET

John G. Capstaff, Rochester, N. Y., assignor to
Eastman Kodak Company, Rochester, N. Y., a
corporation of New Jersey

Application April 20, 1945, Serial No. 589,327

26 Claims. (Cl. 271-2.6)

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The present inventions relate to a process and apparatus for transferring emulsion layers from one support to another and also to an improved sprocket for use therein for registering a photographic film by means of the film perforations. These are particularly intended for the purposes and in structures of the types shown and described in my copending applications, No. 453,949, (now abandoned) and 488,672 now Patent No. 2,417,060, filed August 7, 1942, and May 27, 1943, respectively, over both of which they are improvements, the film being shown in Patent No. 2,367,655, granted January 23, 1945, to G. F. Nadeau, C. B. Starck and myself.

In said applications, apparatus and methods are shown and described by which several of the various emulsion layers of a multi-layer color film are successively transferred to separate supports. This transfer is made before development, and produces three separate supports each of which carries one of the emulsion layers of the original multi-layer film. When such transfers are made, it is essential that the support to which a transfer is to be made and the layer which is to be transferred be properly positioned or registered.

In the applications referred to registration was secured by providing a sprocket, band or drum with solid teeth which would exactly and completely fill the film perforations along one edge. It is obvious, however, that such teeth, even if accurately and precisely made, wear in service and do not always give the desired exact registration. Also, such solid teeth would, of necessity, have to be made of such size as to fill either the largest or smallest perforations, preferably the smallest, and would be less suited for perforations differing, even within permitted tolerances from such tooth sizes. Hitherto, as in said applications and in other apparatus such as contact printers, such registration has been obtained by dimensioning one row of teeth to a standard size to fill a standard sprocket hole transversely, and registering the film laterally by these teeth, with the teeth in the other row narrower than the perforation to allow for some departure from standard because of film shrinkage, longitudinal registry being secured by slight film tension.

The object of the present invention is to overcome these objections and to secure precise and

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accurate registrations of the two films by means of their perforations only. I attain this by making one set of teeth expansible, that is, in two parts, so as to fill the perforations snugly.

Another advantage of such split teeth is that there is less tendency for the film to catch at the edge of the perforations. That is, when solid tightly-fitting teeth are used, it sometimes happens that the friction between the solid teeth and the walls of the perforations tends to cause the different emulsion layers to separate at their edges. The split teeth arrangement of the present invention overcome this difficulty and enable the films to be stripped from the sprocket teeth without disturbing the contact of the various emulsion layers.

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

Reference will be made to the accompanying drawings in the several figures of which the same reference characters denote the same parts:

Fig. 1 is a side view, large diagrammatical, of one form of the registering and roll down mechanism constructed in accordance with the present invention;

Fig. 2 is a longitudinal sectional view through the film guide and stripping member, showing the relation thereto of the registering sprocket;

Fig. 3 is a section of the guide and stripping member illustrated in Fig. 2; taken on the line 3-3;

Fig. 4 is a side view of the registering sprocket and the roll-down or socket roller, with parts of the members broken away, showing the mechanism for securing the expansion of the sprocket teeth and the rolling down of a two-film strip;

Fig. 5 is a front view of one type of registering sprocket with parts in section, showing the relation of the various sprocket members and the sprocket brake;

Fig. 6 is a section through the rim of the registering sprocket on a larger scale than Fig. 5, showing the relation of the expansible sprocket teeth and the retaining band relative to the two film strips to be registered;

Fig. 7 is a top view of a fragment of the endless

band showing the relation of the expanding teeth thereto;

Fig. 8 is a fragmentary view of the sprocket with the retaining band removed, showing the relation of the stationary and movable teeth portions which form the expansible teeth utilized in accurately registering the perforations of the films to be joined; and

Fig. 9 is an enlarged fragmentary section of the transfer film or support, and the film strips to be joined therewith.

Fig. 10 is a sectional view through another form of registering sprocket, showing the relation of the sprocket parts and the control means therefor.

Fig. 11 is a sectional view taken through the sprocket teeth showing the relation of the two film strips and the teeth of the sprocket, shown in Fig. 10 during the registering operation.

While the structure here shown is primarily designed for use in connection with the film stripping method of the type shown and described in my copending application 488,672, it has a wide range of other applications. It is to be understood that this invention is applicable wherever accurate positioning of a motion picture film by its perforations is desirable, as in contact or projection printers, film laminating or cementing apparatus, color cameras or other apparatus as well as in apparatus of the type herein described. When in the claims I use the expression "photographic apparatus," I intend thereby to include all such apparatus. This invention is not, therefore, intended to be limited except insofar as necessitated by the prior art and the scope of the appended claims. As the present invention relates more specifically to the registration of two film strips, only so much of the mechanism as is necessary for a complete understanding of the present invention is shown and will be described. Reference may be had to my above-mentioned copending applications for a full disclosure of the complete method and the additional apparatus used in connection herewith.

The transfer-film or support 11 and the multi-layer film 12, a layer of which is to be transferred to the support 11, in the manner described in my copending applications, are each provided with rows of perforations 13 and 14 arranged adjacent the marginal edges thereof, in a manner well known in the motion picture film art. As shown in Patent 2,367,665, the transfer film 11 comprises a subbing layer 83 carried by a base or support 83a, while the film 12 is formed with a transparent backing or support 100 on which are positioned three color sensitive layers 101, 102 and 103 separated by stripping layers 104 and 105 and a filter layer 106.

The films 11 and 12 are delivered from a suitable conditioning chamber, as shown in application 488,672, and are passed over suitable guide rolls, 15 and 16 respectively, from which they pass to a film guide and stripping member, broadly designated by the numeral 17. The latter is formed with a flat plate 18 which is arranged substantially tangent to a registering sprocket 19 so as to move the film in a straight line past the sprocket. The plate 18 is provided with a cut-out portion 20, see Fig. 2, to permit the passage of the sprocket teeth therethrough to engage the films 11 and 12 to bring the perforations thereof successively into exact registration. In order to limit lateral movement of the films 11 and 12 and to facilitate threading of the machine, the guide

plate 18 is provided with side walls 21 and 22, as best shown in Fig. 3.

By means of this arrangement, the two films are guided in a straight line, with the perforations 13 and 14 in approximate registration, to the sprocket 19 where the film perforations are brought into exact registry, after which the registered films are moved in a straight line by the drive sprocket 23, positioned considerably above the registering sprocket 19, and above the tank 93 in which sprocket 19 and rollers 85 and 86 are immersed. The drive sprocket 23 serves to pull the two films 11 and 12 through the preceding apparatus. From the drive sprocket 23, the films 11 and 12 then pass along for a bonding period and thence to a suitable stripping and drying mechanism as shown in application Serial No. 488,672:

In order to secure the desired registration of the two films 11 and 12, these films must be registered both longitudinally as well as laterally. The smallest tolerances in connection with motion picture film are those related to the film perforations. These tolerances permit a variation of the perforation size of only $\pm .0004$ inch. It is thus obvious, therefore, that if the perforations 13 and 14 of the two strips 11 and 12 can be brought into exact registration, both longitudinally and laterally of the film strip, the best possible registration of the films will be obtained. The present invention, therefore, provides arrangements by which such exact registration of the film perforations is secured as the film strips pass over the registering sprocket or sprockets.

To secure this result, the sprocket 19 is provided with two double rows of expansible teeth which engage in the approximately aligned perforations of the two strips to bring the perforations into perfect and exact registration. During this registering operation, the two films are rolled down and adhered together so that they will leave the sprocket 19 substantially as a single film. Provision is made to maintain the longitudinal and lateral registration of the perforations until the layer of the film 12 which is to be stripped has been firmly bonded to the support or transfer film 11. Then when the stripping occurs, the perforations of the transfer film 11 and the layers secured thereto are in perfect and exact registration. By means of this arrangement, the two layers 103 and 102 may be stripped successively off the film 12 and transferred to supports, such as the film 11, with the perforations of each layer in exact registration with the perforations of its support along at least one edge. Now if the various supports, with their transferred layers, are brought together and the perforations brought into registry, the various layers on the supports will then be in exactly the same relation they occupied prior to the stripping thereof from the film 12.

To secure the necessary registration of the perforations of the film strips 11 and 12, the registering sprocket 19 is provided with two rows of properly pitched expanding teeth 26 and 27 each of which is made in two parts which are relatively movable to fill the perforations 13 and 14 in such a manner as to bring the perforations into exact registry. Each of the teeth 26, comprises a portion 28 carried by a web member 29 fixed on a shaft 30 by means of a set screw 31, or other suitable means, and a portion 32 carried by a disk or frame 33 loosely mounted on the shaft 30. Each tooth 27 also comprises a portion 34 also carried by the web 29, and a portion 35 carried by

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a disk or frame 36, also loosely mounted on the shaft 19. It is thus seen that the sprocket 19 is made up of three parts, namely, the web 29 carrying the tooth portions 28 and 34 which are stationary relative to the sprocket shaft and the two disk members or frames 33 and 36 carrying the tooth portions 32 and 35 which may be movable relative to the fixed portions 28 and 34 to provide a two-part expanding tooth arrangement, as best illustrated in Fig. 8. The portions 28 and 34 may, therefore, be designated as stationary or fixed tooth portions, while the portions 32 and 35 may be designated as the movable or expanding tooth portions. As the portions 32 are movable, both longitudinally and laterally of the film strip and cooperate with the stationary portion 28 to fill the perforations 13 in two directions, longitudinally and laterally, the teeth 26 may be designated as big teeth. On the other hand, the portions 35 of the teeth 27 are movable only longitudinally and cooperate with the fixed portion 34 to fill the perforations 14 only in the longitudinal direction, because allowance must be made for some difference in width between the two films. For this reason, the teeth 27 are designated as small teeth.

In order to secure the longitudinal movement or adjustment of the movable or expanding tooth portions 32 and 35, the disks 33 and 36 are spring pressed forward in the direction of film movement, as shown by the arrow, Fig. 7, by means of springs 37 having the ends thereof fastened in collars 38 positioned on the hub 39 of the web 29 by means of locating pins 40 in such a manner that the free ends 41 of the springs 37 engage studs 42, carried by the disks 33 and 36 and tend to move the disks, and hence the tooth portions 32 and 35, in the forward or film moving direction. By means of this arrangement, each of the teeth 26 and 27 is expanded longitudinally of the film strips 11 and 12, or in the direction of the film movement, so that the rear faces 43 and 44 of the fixed tooth portions 28 and 34 engage the rear edges of the perforations 13 and 14, while the front faces 45 and 46 of the movable portions 32 and 35, respectively, engage the front edges of the perforations 13 and 14.

Thus, as the two film strips 11 and 12 are fed onto the sprocket 19, the expanding teeth 26 and 27 engage in the rows of perforations 13 and 14 of the two film strips, and the forward movement of the movable tooth portions against the forward or front edges of the perforations serves to bring the back edges of the perforations to a definite stop against the rear faces 43 and 44 of the fixed tooth portions 28 and 34. Thus the fixed or stationary portion and the movable portion of each tooth will fill the respective perforations longitudinally to bring the perforations 13 and 14, which are already approximately aligned, into exact and accurate longitudinal registration.

As films tend to have a greater variation laterally than longitudinally between the center lines of the perforations, it is preferred to secure the desired lateral registration by the use of only one of the rows of expanding teeth. In the preferred embodiment, the big teeth 26 are, therefore, utilized for the lateral registration, and the small teeth 27 are made narrower than the big teeth, as shown in Figs. 6 and 7, to permit the slight lateral adjustment necessary to bring the film perforations into exact lateral registration. To secure this result, the disk 33 is moved laterally, or to the right as viewed in Figs. 5, 6 and 7, by springs 50, until the outer or right edges 48 of

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the movable tooth portions 32 engage the outer edges of the film perforations 13, as shown in Figs. 6 and 7. Such movement serves to bring the inner edge of the film perforations to a definite stop against the inner face 49 of the fixed tooth portions 28. Thus, the stationary portions 28 and the movable portions 32 also fill the right row of film perforations, see Figs. 5, 6 and 7, laterally, with the exception of the slight clearance 47 between the tooth portions, thus laterally registering the perforations along one side of the film strip.

This lateral registration of one row of perforations is sufficient to bring the balance of the two film strips into proper lateral registration. This lateral movement of the tooth portion 32 and disk 33 is secured by means of springs 50 having the inner ends thereof fixed to the collars 38 and the outer free ends pressing against the inner face of the disk 33 to move the latter outwardly or to the right, as is apparent from Fig. 5. Thus the springs 37 serve to move the movable or expanding tooth portions 32 and 35 longitudinally to cooperate with the fixed portions 28 and 34 to fill the perforations 13 and 14 in the direction of the film movement to secure the desired longitudinal registration of the perforations, while the springs 50 tend to move the disk 33 laterally to shift the movable tooth portion 32 to cooperate with the stationary portion 28 to provide the necessary lateral registration of the films.

However, in order to limit the movement of the movable tooth portions 32 and 35 so as to maintain the teeth 26 and 27 of such size as to engage readily and easily in the film perforations, the present invention further provides an endless band 55, preferably of stainless steel, overlying the surface of the sprocket 19 and provided with rows of perforations 56 and 57 which have a pitch substantially equal to that of the film strips 11 and 12 and through which the expanding teeth 26 and 27 project, as shown in Figs. 5, 6 and 7. The size of the perforations 56 and 57 are preferably equal to the largest film perforations which will be encountered, and thus provide free movement of the movable or expanding teeth portions therein, but limit the expansion of the teeth to a definite maximum. The front edges 58, however, serve to engage the front faces 45 and 46 of the movable teeth members 32 and 35 to limit the longitudinal movement thereof, while the outer edges 59 of the perforations 56 serve to engage the right or outer faces 48 of the movable portions 32 of the big teeth 26 to limit the lateral movement thereof. The band 55 is positioned on the sprocket 19 so that the rear edges 61 of the perforations 56 and 57 are drawn into close contact with the rear faces 43 and 44 of the fixed tooth members 28 and 34, as best shown in Fig. 7. This band constitutes a fixed part of the rim of the wheel, and the perforations constitute means limiting the expansion or defining the maximum dimensions of the expansible teeth 26 and 27.

Thus when the sprocket 19 is empty, the faces 43 and 49 of the fixed tooth portion 28 will engage the rear and inner edges 61 and 62 respectively of the perforations 56, while the faces 45 and 48 of the expanding tooth portions 32 will contact the front and right edges 58 and 59 respectively of the perforations 56 to fill said perforations both longitudinally and laterally, as is apparent from Fig. 7. Each of the teeth 26, on the other hand, have the rear

face 44 of the portion 34 in contact with the rear edge 61 of the perforations 57, while the front edge 46 of the expanding portion 35 engages the front edge 58 of the perforations 57 to fill the latter longitudinally. The side edges of the portions 34 and 35 are, however, preferably spaced from the side edges of the perforations 57, as shown in Fig. 7, to permit the necessary lateral movement of the films 11 and 12 during the lateral registration.

However, when the films are pressed into position on the teeth 26 and 27, the movable or expanding portions 32 and 35 may move longitudinally, and the portion 32 may also move laterally or inwardly to permit the teeth to engage in the film perforations 13 and 14. After such movement, however, the teeth 26 expand to fill the perforations 13 in two directions, longitudinally and laterally, while the teeth 27 expand to fill the perforations 14 only in one direction, namely longitudinally. The perforations 56 and 57 thus serve to limit the spread or expansion of the teeth 26 and 27 to suit the maximum size film perforations, and position the teeth so they can be readily and easily engaged in the film perforations as the films are fed over the sprocket 19. In order to permit the free movement of the expanding portions 28 and 35 in the band perforations 56 and 57, the disks 33 and 36 are made slightly smaller in diameter than the web 29 to provide a slight clearance between the disks and the band, as shown at 63, Fig. 6. The band 55 also provides a smooth, accurate, cylindrical surface on which the two films 11 and 12 may be rolled down or pressed together during the registering operation.

After, or preferably simultaneously with, the registering operation, the two film strips 11 and 12 are rolled down or pressed together so that the film 12, or the layer to be stripped therefrom, will be adhered to the transfer film 11. This roll down is accomplished by means of a rubber-covered socket roller 65 rotatably mounted on a shaft 66 and provided with two rows of open end radial slots 67 of such size as to receive the teeth 26 and 27. This socket roller cooperates with the endless band 55 to press the films 11 and 12 firmly together over their entire width to secure the necessary adhesion between the substratum of the film 11 and the emulsion to be stripped from film 12. The shaft 66 is carried on one end of an arm 68 pivoted at 69 to the apparatus frame, not shown. The other end of the arm 68 has secured thereto one end of a spring 70 the free end 71 of which engages a pin 72 positioned in one of the holes 73 for varying the tension of the spring 70, and hence the force applied by the socket roller 65 against the films 11 and 12 on the sprocket 19. Thus the socket roller 65 cooperates with the sprocket 19 to roll down or join the films substantially simultaneously with the registering operation. The above described registration and roll down operation are performed below the level of a liquid 92 in the treating tank, a portion of the wall of which is indicated at 93.

The sprocket 19 and the roll-down roller 65 are rotated solely by the movement of the two film strips 11 and 12 thereover. However, in order to avoid any interference with the proper functioning of the movable teeth portions 32 and 35 of the teeth 26 and 27 the relative sizes of the sprocket 19 and roller 65 must be within certain limits. If, for example, the roller is larger relative to the sprocket, it would tend

to have a relative angular speed slightly less than its desired speed so that the roller would gradually lag behind the sprocket. The inevitable result would be that the front edges 75 of the slots 67 would finally engage the front faces 45 and 46 of the movable teeth portions 32 and 35, and would tend to hold these portions away from the front edges of the film perforations, thus preventing the teeth 26 and 27 from filling the perforations longitudinally to secure the desired longitudinal registration. If, however, the roller 65 has a slightly smaller relative size, it would tend to rotate slightly faster, angularly, relative to the sprocket 19 until the rear edges 74 of the slots 67 engaged the rear faces 43 and 44 of the fixed tooth portions 28 and 34, and would thus leave the movable portions 28 and 35 free to perform their registering operations. This latter arrangement is preferred for obvious reasons. While any suitable relative sizes may be used, it has been found that the desired results are obtained if the roller 65 is slightly less than one-half the size of the sprocket 19. It is to be understood, however, that I do not in any way limit myself to such a size relation.

After the longitudinal and lateral registration has been secured on the sprocket 19, it is essential that such registration be maintained until the films have been sufficiently adhered so they can then hold the proper registration. In order to maintain the longitudinal registration of the film perforations, the films are maintained under tension. To secure this result, the shaft 30 is provided with a pulley 80 to which is secured a brake-band 81 which serves to apply a braking action on the shaft 30, and hence the sprocket 19. This braking action serves to hold back the sprocket 19 which, like the socket roller 65, is driven solely by the movement of the film strip thereover. The pull of the drive sprocket 23 then imparts sufficient longitudinal tension or pull to the portions 82 of the film strips 11 and 12 between the two sprockets 19 and 23 to maintain the two films in longitudinal registration between these points. The bonding or subbing layer 83 of the transfer strip 11 joins or adheres films 11 and 12 at the rolled down stages, and also serves to maintain the lateral registration of the film perforations until the films reach the drive sprocket 23. At this point, the two films adhere sufficiently to maintain the film perforations in proper registration. Thus the tension of the film strips between the two sprockets 19 and 23 maintains the film perforations in longitudinal registration while the bonding materials or layer 83 serve to maintain the perforations in lateral registration. As the films are pulled by the sprocket 23, the rear edge of the film perforations 13 and 14 are pulled into engagement with the rear edges 43 and 44 of the fixed teeth portions 28 and 34 which provide suitable bearing surfaces for the films.

Immediately after the registered films 11 and 12 leave the registering sprocket 19, they are pressed between a pair of auxiliary rolldown rollers 85 and 86, which again firmly press the film together in case they might have been slightly separated due to the disengagement of the teeth 26 and 27 from the film perforations 13 and 14. Such separation, which may be caused by a slightly worn or rough spot on the teeth 26 and 27 does not, however, in any way change the registration secured on the sprocket 19. The roller 85 is rotatably mounted on the film guide 17, as shown in Fig. 1, and engages one face of

the adhered films. The other auxiliary roller 86 is, on the other hand, carried on the end of an arm 87 pivoted at 88 on the apparatus frame, not shown. The arm 87 has secured thereto one end of a spring 89 the other end of which engages a pin 90 positioned in one of the holes 91 to vary the tension on the roller 86. The spring 89 is adjusted to give a suitable pressure on the roller 86 against the films to insure proper contact of the films in case they might have become slightly separated upon disengagement of the teeth 26 and 27. During threading of the film, the rollers 86 and 85 may be moved to the left to an inoperative position against the action of the springs 70 and 89, or the pins 72 and 90 may be removed, in which case the rollers 85 and 86 will automatically swing to a vertical position and out of contact with the sprocket 19 and roller 85 to facilitate threading of the films, Figure 1 showing, in dotted lines, the inoperative or threading position of the roller 86.

Figs. 10 and 11 show a simpler form of sprocket having a row of properly pitched teeth 142, and a similarly pitched row of expansible teeth 143. The teeth 142 are solid and are slightly smaller longitudinally than the film perforations 13, and are carried by a disk 144 pinned at 146 to the sprocket shaft 145, each of the teeth 143, on the other hand, is made in two parts which are relatively movable laterally to expand and fill perforations 14 laterally to bring these perforations of the two strips 11 and 12 into exact lateral registration as shown in Fig. 11. Each tooth 143 comprises a fixed portion 147 carried by a web or frame 148 preferably formed integral with the disk 144, see Fig. 10 and a laterally movable portion 150 carried by a web or frame 151 splined to shaft 145 for movement axially there along. It is thus seen that this sprocket is made up of two parts, namely, the integral webs 144 and 148 pinned at 146 to shaft 145 and carrying the solid teeth 142 and the fixed portions 147 of the expanding teeth 143 respectively, and a disk 151 splined to the shaft 145 and carrying the movable teeth portions 150 which are movable laterally relative to the fixed or stationary portions 147 to bring the perforations 14 along one edge of the films 11 and 12 into registration laterally along one edge.

In this simpler sprocket structure, therefore, only the single row of expansible teeth 143 are utilized for the lateral registration, the solid teeth 142 being made slightly narrower laterally than the film perforations 13, as shown in Fig. 11, to permit the slight lateral adjustment necessary to bring the film perforations 14 of the two strips 11 and 12 into exact lateral registration. To secure this result, the disk 151 is movable laterally or to the left as viewed in Figs. 10 and 11, by a coil spring 185 interposed between the disks 148 and 151. The spring 185 serves to move the disk 151 and the movable toothed portions 150 to the left until the outer edges 186 of the portions 150 engage the outer edges 187 of the perforations 14. Such engagement serves to bring the inner edges 188 of the perforations to a definite stop against the inner faces 189 of the portions 147, as shown in Fig. 11. Thus the fixed or stationary portions 147 of the teeth cooperate with the laterally movable portions 150 to fill the perforations 14 laterally except for a slight clearance 190 between the two portions, thus bringing the perforations 14 into exact registration laterally. As there is no transverse stretch applied to

the films, it has been found that the satisfactory lateral registration can be secured by lateral registration of only one row of perforations.

During such lateral registration however, it is imperative that the disk 151 and tooth portions 150 be prevented from tipping so as to insure that the part of the edge 186 of the tooth portion 150 which engages the perforation edge 187 is maintained normal to the shaft 145 and the film perforation edge 187. For this reason, the shaft 145 extends for a substantial distance to the left beyond the disk 151, as shown in Fig. 10, and has splined thereto a sleeve 195 connected to or formed integral with the disk 151. This sleeve acts as an elongated bearing which prevents tipping of the disk 151 and, hence, the movable tooth portions 150. This spline connection allows sleeve 195, disk 151 and tooth portions 150 to move laterally relative to the tooth portions 147, under the action of spring 185, but prevents relative rotation of the toothed portions 147 and 150. A stop 197 secured to the shaft 145 or the machine frame extends into the space 198 between the end 199 of sleeve 195 and the pulley 171 to limit the endwise or lateral movement of sleeve 195 and hence the laterally movable tooth portions 150.

In order to insure the proper functioning of the laterally movable teeth portions 150, it is imperative that the clearance space 190 be kept free from any particles, such as pieces of emulsion, dirt, or film, etc. which may find their way thereinto. I, therefore, provide a thin blade 200 the free end of which projects into the space 190 to effectively remove any particles therefrom. The blade 200 is of a thickness less than the minimum clearance 190 between the tooth portions 147 and 150 so as to in no way interfere with the functioning of the parts. The blade 200 is fixed to a part 201 mounted on the mechanism frame, in any suitable manner.

The expansible tooth portions 147 and 150 are thus spring pressed apart to fill the perforations 14 laterally to bring the two films 11 and 12 into exact lateral registration. The shaft 145 may have applied thereto a pulley 171 to which is secured a brake band, similar to 81, to apply a braking action of the last described sprocket shown in Fig. 10. This sprocket may then cooperate with the driven sprocket 23 to bring both rows of perforations 13 and 14 into exact longitudinal registration, the solid teeth 142 and the portions 147 of the expansible teeth cooperate with the teeth of the driven sprocket 23 to secure the necessary stretch of the films to bring the latter into longitudinal registration.

Further details of this last described sprocket and the mechanisms associated therewith are fully shown and described in application No. 589,326 filed concurrently with the present application, which claims a specific apparatus utilizing such sprocket now Patent No. 2,469,915, dated May 10, 1949.

The above described apparatus is primarily designed for use in connection with the multi-layer film 12, the layers 103 and 102 of which are transferred successively to separate supports, such as the film 11. It is apparent however, that such registration of films by means of these perforations is also admirably adapted for use in cementing two films which are to be permanently joined with their perforations in exact registry. In such case, a layer of cement could be applied to one or both of the films prior to the passage thereof to the film guide 17. Also,

if desired, a suitable gate could be positioned between the sprockets 19 and 23 and the registered films could be either simultaneously projected or printed, if one is a negative and other a sensitive film.

It will now be apparent from the above descriptions that the present invention provides arrangements for obtaining the proper registration of the two films by means of the exact longitudinal and lateral registration of the film perforations irrespective of variations of the size thereof, within the tolerance limit set up. Furthermore such registration is secured automatically while the film strips are being moved through the apparatus. Simultaneously with the registering operation the film strips are suitably adhered or joined. After the roll down operation the films are maintained in registration until the emulsion to be transferred has bonded on the sub of the transfer film as described in application No. 488,672.

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

In the above mentioned application filed concurrently herewith, an apparatus including the form of sprocket is shown and claimed. This embodies certain of the advantages of the apparatus herein shown and is an embodiment of the invention herein broadly claimed.

I claim:

1. A sprocket comprising a body portion, a series of two-part expansible teeth carried by said portion, an endless band carried by said portion and provided with perforations through which said teeth project, the perforations limiting the expansion of the teeth, and means for relatively moving said parts in said perforation to vary the size of said teeth.

2. A sprocket comprising a cylindrical body portion with a rigid rim having perforations therein, and a series of expansible teeth mounted within said portion and extending through said perforations, the edges of the perforations limiting the expansion of the teeth.

3. A sprocket comprising a body portion, a series of two-part teeth carried by said portion, an endless band carried by said portion and provided with perforations through which said teeth project to maintain said parts in cooperative relation, means for relatively moving said parts in said perforations to vary the sizes of said teeth, and means on said band for limiting said relative movement to control the sizes of said teeth.

4. A sprocket for use with a film having accurately dimensioned perforations along its borders, having two rows of sprocket teeth, the teeth of one row being dimensioned to engage the perforations along one border of the film and each of the teeth of the other row being formed in two parts, and means for expanding the parts of the two-part teeth longitudinally to fill the perforations longitudinally along the other border of the film.

5. A sprocket for use with a film having accurately dimensioned perforations along its borders, having two rows of sprocket teeth, the teeth of one row being dimensioned to engage the perforations along one border of the film and each of the teeth of the other row being formed in

two parts, and means to move said parts relatively laterally to fill the perforations laterally along the other border of the film.

6. A sprocket for use with a film having accurately dimensioned perforations along its borders, having two rows of sprocket teeth, the teeth of one row being dimensioned to engage the perforations along one border of the film and each of the teeth of the other row being formed in two parts, and means for moving said parts relative to each other both longitudinally and laterally to fill the perforations along the other border of the film.

7. A sprocket, two rows of teeth formed thereon, each of said teeth comprising a movable portion and a stationary portion, and means for separately moving the movable portions of each row relative to the stationary portions to vary independently the size of the teeth of each row.

8. A sprocket, two rows of teeth formed thereon, each of said teeth comprising a movable portion and a stationary portion, means for moving the movable portions in both rows in one direction to vary the size of the teeth in both rows in said one direction, and means for moving the movable portions in one of said rows only in another direction to also vary the size of said teeth in said one row in said other direction.

9. A sprocket comprising a cylindrical body portion, two rows of teeth formed thereon, each of said teeth comprising a movable portion and a stationary portion, a member carried by said body portion and formed with perforations each of which is adapted to receive the stationary and movable portions of one of said teeth, said perforations being of a size to permit limited relative movement of said portions therein, means for moving the movable portions in said perforations to vary the size of the teeth therein, the rear edge of each perforation being positioned in engagement with the rear face of the stationary portion therein, and another edge of said perforation being positioned to engage an edge of the movable portion to limit the movement thereof in said perforation to control the tooth size.

10. A sprocket comprising a body portion, two rows of teeth formed on said sprocket, each of said teeth comprising a movable portion and a stationary portion, a member carried by said body portion and formed with rows of perforations which register with and receive said rows of teeth, each of said perforations being of a size to permit relative movement of the tooth portions therein, means for moving the movable portions of each row in a longitudinal direction in said perforations to vary the size of said teeth longitudinally, means for also moving the movable portions of one of said rows laterally so as also to vary the size of the teeth of said last row laterally, at least one edge of each perforation being arranged to engage a face of the stationary portion positioned therein, the edges of said perforations being positioned in the path of the movable portions to limit the movement thereof to control the size of said teeth.

11. A sprocket for engaging and accurately registering a film strip having accurately formed perforations along its edges and comprising, a cylindrical body having an apertured rim overhanging one edge, rigid teeth extending through the apertures, and a frame coaxially mounted with said body and having teeth also extending through said apertures, and spring means engaging said frame and tending to turn it about the axis of the sprocket.

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12. A sprocket for engaging and accurately registering a film strip having accurately formed perforations along its borders and comprising, a cylindrical body having apertured rims overhanging its edges, teeth rigid with said body and extending through said apertures, frames on each side to the body and coaxial therewith and having teeth also extending through said apertures, and spring means engaging said frames and tending to turn them about the axis of the body.

13. A sprocket for engaging and accurately registering a film strip having accurately formed perforations along its borders and comprising, a cylindrical body having apertured rims overhanging its edges, teeth rigid with said body and extending through said apertures, frames on each side of the body and coaxial therewith and having teeth also extending through said apertures, spring means engaging said frames and tending to turn them about the axis of the body, and separate spring means pressing one of said frames outwardly.

14. A sprocket for engaging and accurately registering a film strip having accurately formed perforations along its borders and comprising, a cylindrical body having two equal rows of accurately spaced rigid teeth, frames coaxial with said body mounted one on each side of said body and having teeth equal in number to the teeth in said rows, spring means carried by said body and engaging one of said frames to spring-press said one frame laterally away from said body and also longitudinally of the rows, spring means on said body and engaging the other frame to spring-press the latter longitudinally, and means limiting the movement of the spring pressed frames whereby the teeth are assembled in pairs, each pair consisting of a rigidly mounted tooth and a tooth spring pressed away from the rigidly mounted tooth but limited in its movement.

15. A sprocket mounted on a shaft and comprising a sleeve fixed to said shaft, rows of spaced stationary teeth members carried by said sleeve, a second sleeve splined on said shaft for axial movement thereon, a row of teeth members carried by said second sleeve and cooperating with said stationary teeth members to form a row of laterally expansible teeth, and means for laterally moving said second sleeve to vary the size of the expansible teeth.

16. A sprocket mounted on a shaft and comprising a sleeve fixed to said shaft, rows of spaced stationary teeth members carried by said sleeve, a second sleeve splined on said shaft for axial movement thereon, a row of teeth members carried by said second sleeve and cooperating with said stationary teeth members to form a row of laterally expansible teeth, means for laterally moving said second sleeve to vary the size of the expansible teeth, and means positioned in the path of said second sleeve to limit the axial movement thereof to control the maximum size of said expansible teeth.

17. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, and a row of expansible teeth carried by said sprocket and adapted successively to engage in and fill said perforations in at least one direction to accurately adjust and position said film strip relative to said apparatus.

18. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations arranged adjacent each edge

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thereof through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, a row of expansible teeth carried by said sprocket and adapted to successively register with and engage in said perforations, means for adjusting said expansible teeth so as to fill the perforations of one row in two directions, a second row of expansible teeth carried by said sprocket and adapted to register successively with and engage in the perforation of the opposite row, and means for adjusting said opposite row of teeth so as to fill the perforations in said opposite row in only one of said directions, said second teeth cooperating with said first teeth to accurately adjust and position said strip relative to said apparatus.

19. In a photographic apparatus, means for moving continuously through said apparatus a film strip formed with a row of perforations, a film positioning sprocket rotatably mounted on said apparatus, a row of expansible teeth carried by said sprocket, each of said teeth comprising a portion fixed relative to said sprocket and an adjustable portion movable relative to said fixed portion and cooperating therewith to fill one of said perforations in at least one direction to adjust and position said strip accurately relative to said apparatus, and means for moving said adjustable portion.

20. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, rows of expanding teeth carried by said sprocket, each of the teeth of one of said rows comprising a stationary portion and a movable portion adapted to engage in one of the perforations along one edge of said strip, means for moving said movable portion longitudinally and laterally to cooperate with said stationary portions to fill said one perforation in two directions, each of the teeth of the other row comprising a stationary part and an adjustable section adapted to engage in one of the perforations along the other edge of said strip, and means for moving said section relative to said part so as to cooperate with the latter to fill said second one perforation in a longitudinal direction.

21. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket movably mounted on said apparatus, rows of expansible teeth carried by said sprocket, each of the teeth of one of said rows comprising a stationary portion and a movable portion adapted to engage in one of the perforations along one edge of said strip, means for moving said movable portion longitudinally and laterally to cooperate with said stationary portion to fill said one perforation in two directions, each of the teeth of the other row comprising a stationary part and an adjustable section adapted to engage in one of the perforations along the other edge of said strip, and means for moving said section relative to said part so as to cooperate with the latter to fill said second one perforation in a longitudinal direction.

22. In a photographic apparatus, the combination with a means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, a row of expansible teeth carried by said sprocket and adapted to successively engage in and fill

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said perforations in at least one direction to accurately adjust and position said film strip, means for expanding said teeth, and means for positively limiting the amount of said expansion of said teeth.

23. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, a row of expansible teeth carried by said sprocket and adapted to successively engage in and fill said perforations in at least one direction to accurately adjust and position said film strip, means for expanding said teeth, and a band carried by said sprocket and formed with perforations through which said expanding teeth extend, the edges on said last mentioned perforations limiting the expansion of said teeth.

24. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, a row of expansible teeth carried by said sprocket and adapted to successively engage in and fill said perforations in at least one direction to accurately adjust and position said film strip, means for expanding said teeth, a member carried by said sprocket and formed with a row of perforations having a pitch corresponding to that of the film strip and adapted to receive said expansible teeth, the edges of said member perforations being positioned in the paths of the expansible teeth to limit the movement thereof.

25. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, film adjusting teeth carried by said sprocket, each of said teeth comprising a fixed portion and a movable portion adapted to register with and engage in one of said perforations, means for adjusting said movable portion in at least one direction so that said movable portion will cooperate with said fixed portion to fill said perforation in said one direction and to accurately adjust and position said film strip relative to said apparatus, a band carried by said sprocket and formed with a row of perforations having a pitch corresponding to that of the film strip and of a size to allow movement of said movable portion therein, and an edge of said last mentioned perforation being engageable by

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said movable portion to limit the movement thereof to control the size of said teeth.

26. In a photographic apparatus, means for moving continuously a film strip formed with a row of perforations arranged adjacent each edge thereof through said apparatus, a film positioning sprocket rotatably mounted on said apparatus, rows of expansible teeth arranged along the opposite sides of said sprocket, the teeth of one row comprising a stationary portion and a movable portion adapted to engage in one perforation at one side of said strip, means for moving said movable portion to cooperate with said stationary portion to fill said one perforation both longitudinally and laterally, the teeth of the opposite row comprising a stationary part and a movable section both arranged to engage in one perforation at the other side of the film strip, means for moving said section so that the latter will cooperate with said part to fill said last mentioned one perforation longitudinally only, a band carried by said sprocket, said band having rows of perforations adapted to receive the rows of expansible teeth and of a pitch corresponding to that of the film perforations and of a size equal to the largest film perforation to permit movement of the movable portion or section therein, the rear edge of each band perforation being arranged in contact with the rear face of the stationary portion of the tooth positioned in said band perforation, and the front edge of each band perforation being positioned to be engaged by the front edge of the movable portion of the tooth positioned therein to limit the movement of said portion and to control the tooth size.

JOHN G. CAPSTAFF.

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