March 11, 1947. J. G. CAPSTAFF 2,417,060

APPARATUS AND PROCESS FOR MOTION-PICTURE COLOR PHOTOGRAPHY

Filed May 27, 1943 3 Sheets-Sheet 1

Fig. 2

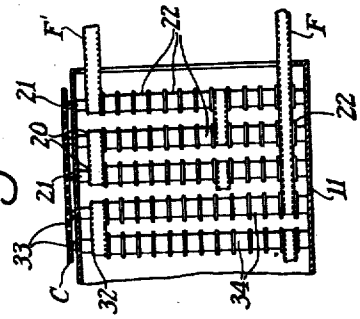


Fig. 3

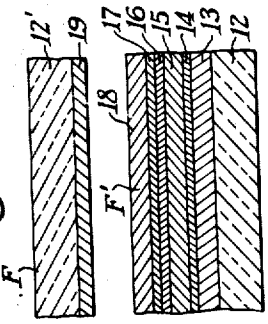
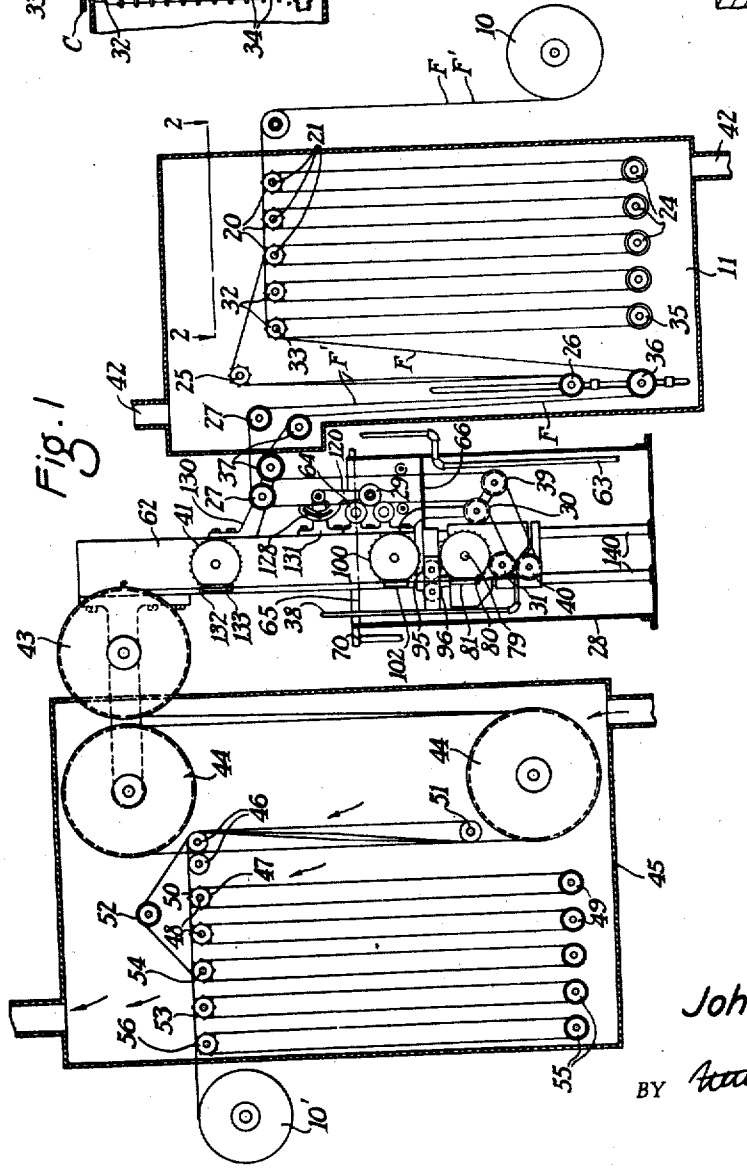


Fig. 1



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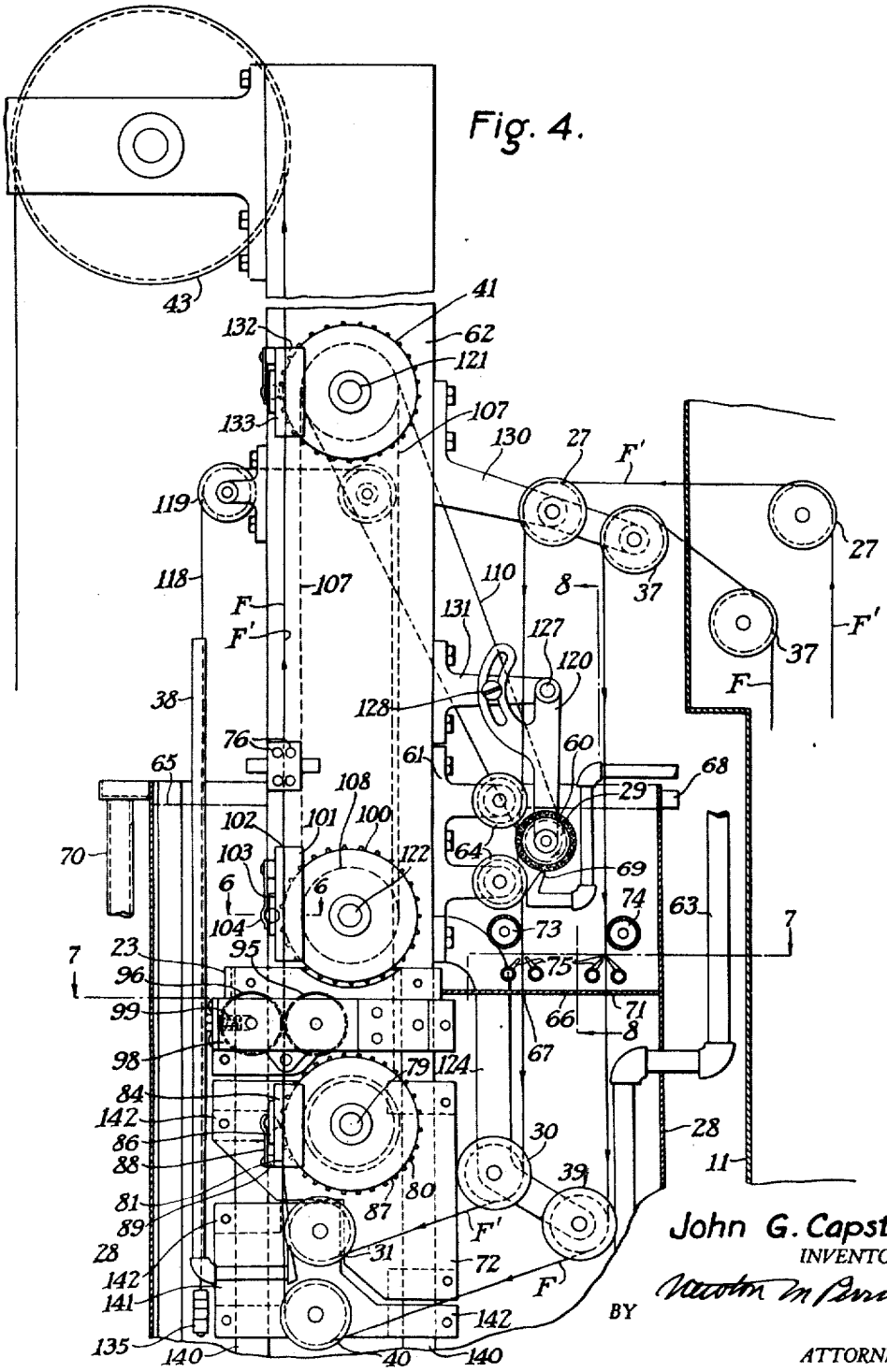
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APPARATUS AND PROCESS FOR MOTION-PICTURE COLOR PHOTOGRAPHY

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Fig. 4.



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APPARATUS AND PROCESS FOR MOTION-PICTURE COLOR PHOTOGRAPHY

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Fig. 5.

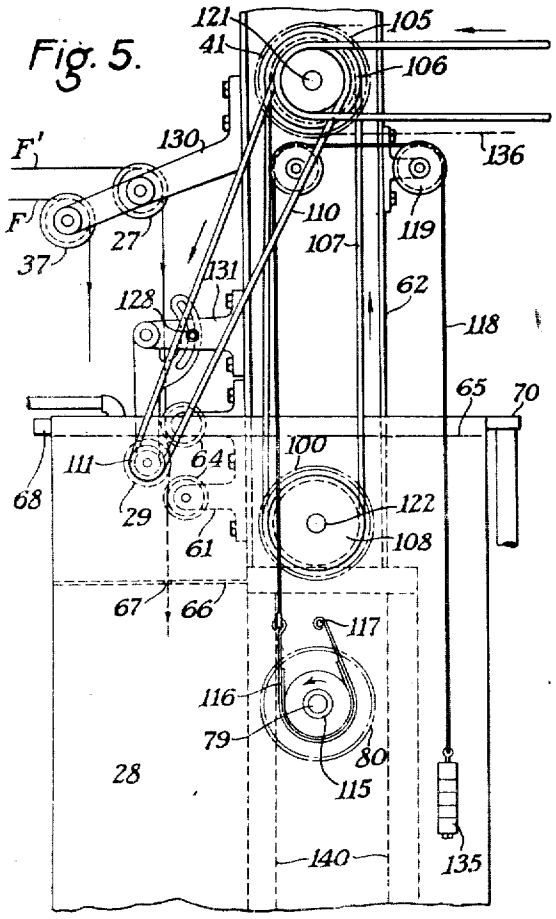


Fig. 7.

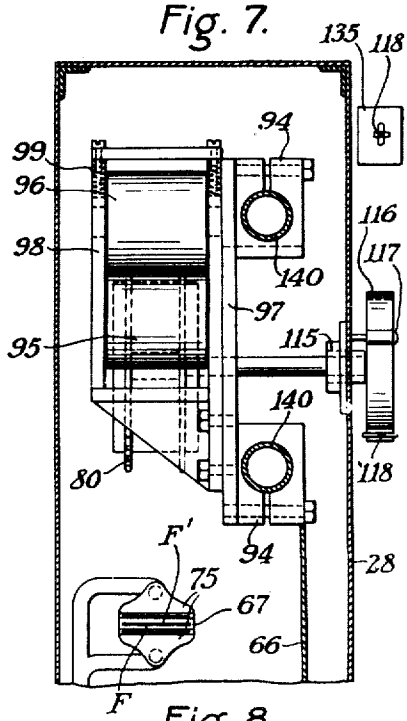


Fig. 8.

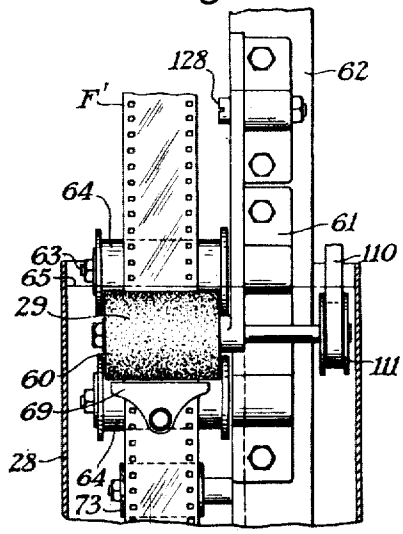
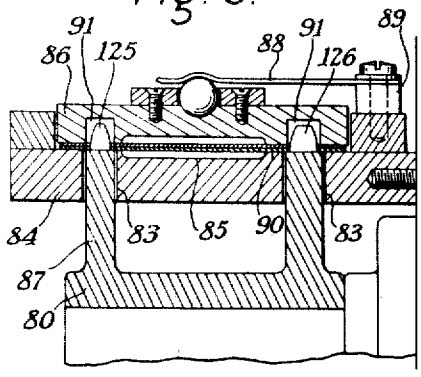


Fig. 6.



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Patented Mar. 11, 1947 2,417,060

UNITED STATES PATENT OFFICE

2,417,060

APPARATUS AND PROCESS FOR MOTION-PICTURE COLOR PHOTOGRAPHY

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Application May 27, 1943, Serial No. 488,672

17 Claims. (Cl. 41—1)

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This invention relates to photographic apparatus and more particularly to improved apparatus for carrying out the process described in my copending application Serial No. 453,959, filed August 7, 1942, and to improvements in that process.

The primary object of the present invention is to provide an apparatus that will very accurately register and align the perforations on a support with the perforations of an exposed multi-layer color film so that two of the three color layers may be transferred successively to separate supports, usually before developing, thus producing three separate lengths of picture film on which, when the perforations of one film are brought into exact registry with those on either of the other films, all points in the picture area will also be in exact registry. While the apparatus shown in said application Serial No. 453,959 in which the films are rolled down on a drum or band performs the operations of registering satisfactorily, the very numerous teeth on the wheel or band and the registering sockets of the roll-down rollers must be very accurately and uniformly made. The roll-down as there shown occurs between the smooth, hard surfaces of the sprocket wheel and the socket rollers. I have found that rolling under these conditions tends to produce pressure marks on the stripped emulsion if small, hard particles happen to be on either of the rolling surfaces or on the support side of the films under treatment. Imperfections such as tool markings on the sprocket wheel or socket roller also leave their imprints on the tender emulsion layer.

I have overcome these and other objections in the apparatus hereinafter described and have also improved the rolldown operation in the areas around the perforations. The two films can be rolled down very satisfactorily between smooth, rubber rollers of a suitable degree of firmness with practically total absence of the pressure mark defect. Furthermore, the roll-down can be performed uniformly and with certainty over both the picture and perforation areas. According to the present invention, the advantages of the smooth, rubber rollers can be combined with relatively small sprocket wheels having but few teeth for registering the perforations, giving a final product fulfilling all requirements for color motion-picture processes in which two or three separate negatives are needed.

Among the important features are the submission of both the multi-layer film and the transfer film to identical moisture conditioning

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before and after being registered and bonded together, their paths through the conditioning chambers being of equal length, the provision of an apparatus in which the length of the multi-layer film and the transfer film paths are maintained exactly the same during conditioning to insure exact registry; and in which both the multi-layer film and the transfer film are maintained at a constant uniform tension at all times while being registered and bonded together, and the provision of means for accurately registering and maintaining in registry the several separate emulsion and support layers.

The above and other features are embodied in an apparatus comprising a humidifying cabinet for the multi-layer film and the transfer film, means for maintaining the multi-layer film and the transfer film under constant tension, a tank containing a liquid in which the apparatus is immersed, means for removing dirt and loosening the stripping layer from the multi-layer film before registering and bonding, means for accurately registering and bonding the color-sensitive layer and the transfer film, means for stripping the transfer support and one color-sensitive layer from the multi-layer film, and means for drying said transfer support with the color-sensitive layer and said multi-layer film before returning said multi-layer film for removal of another color-sensitive layer.

For a fuller understanding of the invention, reference will be made to the accompanying drawings wherein like reference characters designate similar parts and wherein:

Fig. 1 is a diagrammatic assembly view of the apparatus showing the path of the multi-layer film and the transfer film through the complete apparatus;

Fig. 2 is a section, taken substantially on the line 2—2 of Fig. 1, showing the arrangement of the pulleys and the film path in the humidifying and drying cabinets;

Fig. 3 is an enlarged fragmentary section of the transfer film and the multi-layer color film;

Fig. 4 is a partial front elevation of the registering and bonding stations and the arrangement of the parts associated therewith;

Fig. 5 is a rear elevation of the tank showing the drive for the apparatus and the means for maintaining the film under tension;

Fig. 6 is a partial section, taken substantially on the line 6—6 of Fig. 4, showing the arrangement of the gate at the registering station;

Fig. 7 is a partial section, taken substantially on the line 7—7 of Fig. 4, showing the arrange-

ment of the roll-down rollers for bonding the color layer of the multi-layer film to the transfer film; and

Fig. 8 is a partial section, taken substantially on the line 8—8 of Fig. 4, showing the arrangement of the rollers for removing dirt and the interlayer from the multi-layer film.

A brief description of the entire apparatus will first be given with a discussion of the requirements of the process, followed by detailed descriptions of the structure and operation of the several parts.

In brief, an unsensitized transfer support F and an exposed multi-layer film F' are passed through a humidifying and conditioning chamber 11 to bring them to the same condition and are then passed into a wetting tank 28 to a registering station 81 where they are accurately registered and then pressed into contact between presser rolls 95, 96.

In the present embodiment of my invention, rolls of unsensitized transfer support F and exposed multi-layer film F' are mounted coaxially side by side, as indicated at 10 in Fig. 1, outside of the humidifying cabinet 11. The transfer film F and the multi-layer film F' are spliced to leaders which are threaded through the entire apparatus.

The film F' is a stripping film such as is described in the U. S. patent application Serial No. 453,960, filed August 7, 1942, by Gale F. Nadeau, Alfred B. Starck, and the present applicant, which matured January 23, 1945, into Patent No. 2,367,-665. Referring to Fig. 3, layer 12 is a support of cellulose ester or other suitable material carrying a red-sensitive silver halide emulsion layer 13, a cellulose ester stripping layer 14 permeable to water or soluble in aqueous organic solvent or in alkali, a green-sensitive silver halide emulsion layer 15, a water permeable cellulose ester stripping layer 16, a yellow filter layer 17, and a blue-sensitive layer 18. The transfer film F comprises a support layer 12' and a subbing layer 19.

The multi-layer stripping film and the subbed, perforated support are drawn through the wetting tank over suitable pulleys by sprocket wheel 41 and first come together on sprocket wheel 80 and its straight-in-line precision track and pressure plate. Sprocket 80 is suitably braked by a smooth acting friction brake, preferably of the band and drum type. The sprockets 41 and 80, because of tension exerted on the two films, bring these into exact registry at least longitudinally while passing over sprocket 80. The films are not rolled down at this stage but pass on between the rubber rollers 95 and 96 where they are smoothly rolled under pressure (about six pounds) into intimate contact. As this roll-down operation usually disturbs registry slightly, the films pass over another sprocket 100 and its precision track which brings the perforations into exact and final registry along at least one edge of the films. The distance and time interval between pressure rollers 95 and 96 and registering sprocket 100 is important. The timing must be such that the emulsion destined to be stripped has adhered only slightly to its subbed final support so that the two films can be made to slip over each other if necessary during the registering operation without disturbing the temporary bond between the top emulsion layer and the next strippable emulsion layer. After passing sprocket 100, the two films adhere securely enough to prevent slippage occurring between them on their way to the driving sprocket 41. The time interval between sprockets 100 and 41 must be great enough to permit good adhesion to develop so that the films, when relieved of the longitudinal tension, can continue on their path without slipping during the balance of the bonding time essential for perfect stripping performance.

Referring again to the three registering sprocket wheels 41, 100 and 80 and their assembly, the pitch of the sprocket teeth should be such as to mesh perfectly in film perforation of standard pitch and along one side of the wheel should precisely fill the perforations transversely. The companion sprocket teeth engaging the other set of perforations should fail slightly to transversely fit the perforations so as to allow for a slight shrinkage tolerance in film width. Following the practice common in motion picture printing when two or more negatives have to be printed onto one length of print stock in registry, care must be taken when stripping that the wide sprocket teeth are always on the same side of the multilayer film, say the sound track side.

If the film perforations are of the negative (rounded sides) type, it will be advisable to maintain a weak forward frictional drive on the registering sprocket wheel 100. With straight sided perforations, the registering sprocket wheel could be idly driven by the film itself or it could be advanced at the same speed as the film without traction by either film or sprocket on the other.

It is to be understood that the two film supports are made of material as nearly identical as manufacturing conditions permit, preferably from the same batch of plastic composition including cellulose acetate, cellulose acetate-butyrate, or the like, as the principal ingredient, and that they are slit and perforated with extreme accuracy when in equilibrium with an atmosphere of definite relative humidity. It is nevertheless unavoidable, because of different humidity conditions to which they are subjected in the field and laboratory, that the perforation pitch of the two films will differ slightly. I, therefore, prior to transferring, submit them to a conditioning cabinet where they are maintanied in an atmosphere of substantially the same relative humidity as when perforating was done, for a period long enough to again bring them to equilibrium with the standard atmosphere, thus restoring them as nearly as possible to the same condition and dimensions.

The multi-layer film F', after being exposed, and the transfer support F to which it is to be bonded are passed through the humidifying cabinet 11 to bring both the film and the support relatively near the same moisture content. This is important to insure proper registering, and it has been found that subjecting both films to a relative humidity of 58% for 15 minutes while moving at 30 feet per minute, produces satisfactory results.

The air in cabinet 11 is circulated by means of conduits 42 which is connected to a suitable air conditioning system. The length of both paths of travel should be the same. In practice two lead strips of equal length are threaded through the machine and the ends of the films F and F' are attached to these, with the assurance that, when brought into contact, their ends will be in registry. That is, the lengths of the paths of the films through cabinet 11 is the same; and the lengths of the paths from the exits from cabinet 11 to the point where the films contact each other at the sprocket 41 are the same. The paths of the film through the bath is slightly different, but this is a short distance. It is important that the path

of film F' having the stripping layers be precisely correct for perfect stripping and bonding, but the time during which strip F is in the bath is not at all critical.

However, if the film F' has been used under severe conditions, and has, for instance, been on location for some time on a desert scene, it may have become so shunken that it would not be completely restored in the conditioning cabinet. Any discrepancy for this reason would ordinarily be taken care of by the tension from sprockets 41, as is later pointed out.

However, the two strips may be conditioned in separate cabinets under different conditions, if this seems necessary to overcome considerable differences in their dimensions.

Moreover the cabinet 45 is also a conditioning cabinet. The comparatively short time that the films are in the tank 28 does not materially affect them. The film F' will thus be submitted twice to the conditioning cabinet 11 and once to cabinet 45 before the second stripping operation takes place. This is important because accurate registrations of the images in the layers 13 and 15 is more important than the one in blue sensitive layer 18.

In the apparatus as shown, there are five parallel shafts in the upper part of cabinet 11, three being designated 21 and carrying driving sprockets 20 and idle rollers 22, on which the film F' passes, and two being designated 33 and carrying sprockets 32 driving transfer support F.

The film F' is passed into the cabinet 11 to the sprockets 20 on the driven shafts 21 and is spirally wound around the idle rollers 22 on the shafts 21 and the floating rollers 24, as indicated in Figs. 1 and 2. After leaving the last sprocket 20, the film F' passes over a driven sprocket 25 and is given a half turn to bring the emulsion side into its correct position, and then passes around the floating roll 26 to form a feed loop. It then passes over the guide rollers 27, out of cabinet 11 and into the tank 28 filled with water from supply pipe 63 to the level indicated by a dotted line 65.

The support F is threaded over the rollers 22 at one end of shafts 21 and driven through the cabinet 11 by the sprockets 32 on the shafts 33 and spirally wound around the idle rollers 34 on the shafts 33 and the floating rollers 35, as indicated in Figs. 1 and 2. The transfer support F then passes around the floating roller 36 to provide a feed loop and then over the guide rollers 37 after which it also enters the tank 28.

The sprockets 20 and 32 may be driven as a unit by the chain C which may engage sprockets on the shaft 21 and 33 located outside of the cabinet 11 and may be connected to any suitable source of power.

In the tank 28 is a vertical frame member 62 which carries brackets 130 supporting rolls 27 and 37, already mentioned, and also brackets 131 to which an arm 120 is pivoted at 127. This arm carries the scrubber roll 29 having a layer 60 of chamois or viscose sponge. The arm 120 is adjustable and may be fixed in position by the slot and bolt connection 128 with the brackets 131. Also carried by frame member 62 are brackets 61 carrying rolls 64. These rolls 29 and 64 are in a compartment or trough 66 in the upper part of tank 28 and having slots 67 and 71 in its bottom for the passage of film. The functions and structure of the scrubber roll and associated parts will be mentioned later.

The support member 62 is shown as a structural steel channel, the upper portion of which may

be suitably anchored to a wall or ceiling, not shown, its lower end being seated in a collar 23 that is welded to the upper ends of tubular posts 140 fixed to the bottom of the tank 28. These posts constitute guide members on which plate brackets 72 and 141 may be adjusted vertically to various positions, clamp lugs 142 being provided whereby these brackets may be secured in any selected position.

The frame member 62 also carries bracket 124 by which are supported guide rolls 30 and 39. Adjustably mounted on a frame member 62 is the bracket plate 72 previously mentioned upon which are carried the sprocket 80, the gate assembly 81, and the accompanying gate members 84 and 86. The member 84 is rigidly carried by bracket 72. The floating member 86 is resiliently pressed toward member 84 by spring 88 secured to block 89 on the fixed member 84, as shown in Fig. 6.

Sprocket 80 is an idler sprocket and has flanges 87 carrying sprocket teeth which extend through slots 83 in the member 84. These sprocket teeth are narrower than the thickness of the flanges so that the latter form abutments upon which the films rest when fully seated on the sprocket teeth. The teeth 125 on one flange are narrower than those 126 on the other flange, the teeth 126 fitting the perforations snugly in a transverse direction and acting as registry pins to seat and register the films, which are also under a longitudinal pull. The edge of the plate 84 (Fig. 6) is precisely tangent to the periphery of the flanges, that is, the bases of the sprocket teeth, and acts as a stripper plate to disengage the film from the teeth. The plate 84 is undercut slightly at 85 under the picture area of the film to prevent scratching, but a shoulder 90 may be left under the sound track area where slight abrasions are less injurious in their effect. Slots 91 are provided in plate 86 for the passage of the sprocket teeth.

The film F passes, as already stated, over roll 37 and thence around rolls 39 and 40 to the gate 81 with which the latter roller is precisely in line.

Also adjustably carried on support 62 is a bracket 98 carrying the presser roll 95 which is fixed in position and the roll 96 which is pressed by spring 99 against roll 95 with a pressure of the order of six pounds. The bracket 98 is shown in plan view in Fig. 7 and is preferably welded to a secondary or backing member 97 that has clamp lugs 94 similar to the lugs 142 whereby the rolls 95 and 96 may be adjustably supported by the posts 140.

Above the presser rolls 95 and 96 is a second gate assembly 102 comprising a sprocket 100, a fixed gate member 101, and a floating gate member 103 which is pressed lightly by spring 104 toward the fixed gate member and contacts the film only at its edges.

The vertical support 62 extends a considerable distance above the top of the tank 28 and carries at an elevated position a third gate assembly comprising a sprocket 41, a fixed gate member 132, and a floating gate member 133 similar in structure to the gate members 84 and 86 respectively.

Any means can be used to drive the respective film advancing rolls and sprockets, a preferred method being a friction clutch on the shaft 121 of the upper sprocket 41. As shown in Fig. 5, one end of the shaft 121 on which the sprocket 41 is mounted has fixed thereto a sprocket 105 and a pulley 106. The sprocket 105 is driven by a chain 136 which may be connected to a suit-

able source of power or to the same source as the drive for shafts in the humidifying chamber 11 and the drying chamber 45. The pulley 106 is connected by the belt 107 to a pulley 108 on the shaft 122 of the sprocket 100, a tendency drive being provided between the shaft 122 and sprocket 100 so as to maintain the teeth of the sprocket 100 continually in engagement with the leading edge of the film perforations during the lateral registering, but without exerting a driving force.

The shaft 79 of sprocket 80 extends through one side wall of the tank 28 and has fixed thereto a sleeve 115. A metal band 116 has one end fixed to a pin 117 and the other end attached to a cord 118 which passes around the pulley 119 and has fixed thereto a weight 135. A leather or felt braking strip may be secured to the band 116 and engages the periphery of the sleeve to act as a brake therefor. By adjusting the size of the weight 135 any desirable tension on the films between the teeth of the sprockets 41 and 80 may be obtained. It was found that a tension of the order of one pound produces satisfactory results.

It is important that the films pass in a straight line with constant tension through the gate 81, between the presser rolls 95 and 96, through gate 102 and past sprocket 41. The function of the first sprocket and gate is to register the two films accurately. At this station they are not pressed tightly together, and the pressure is not sufficient to squeeze out the thin film of water that will be carried between them. As shown in Figs. 1 and 4, film F enters directly in line with the gate 81 from roll 40, while film F' is directed at a slight angle by roll 31. In order to insure that the film surfaces are clean, a stream of clear water is directed by inlet pipe 38 between the two films as they approach gate 81. The water from pipe 38, after passing over the film, progresses to the overflow 68 which it can reach only after passing through slot 67. Any particles removed from the film by the scrubber roll 29, therefore, are washed upwardly and are not deposited in the tank 28. At the gate 81 the films are accurately registered by the sprocket teeth and together pass directly to the presser rolls 95 and 96, between which they are pressed tightly together, any surplus water being pressed out from between them. Thence they pass directly to gate 102. If there has been any slippage between them, they are not at this point so bonded together but that the sprocket teeth of sprocket 100 can re-register the films. The gate structures at each sprocket are the same.

As pointed out hereinbefore, the films are maintained under a slight tension between the registering sprocket 80 and the driving sprocket 41. This is necessary in the event that the humidifying chamber fails to equalize the moisture content of the transfer support F and the multilayer film F'. It is conceivable that the multilayer film may have been exposed under very "dry" conditions. When this film is subjected to a moisture conditioning for the 15 minutes period of time it may not be quite restored to its original dimensions. As a result, there is a slight difference in the relative lengths of the two films which must be compensated for. This is accomplished by stretching one or the other of the two films so that they are finally of the same length when bonded together. By the time the films reach sprocket 41 they have become so set or bonded together that no further lateral or axial displacement can take place. It is therefore important that the tension during this period be uniform and direct. Variations in the "conditioning" time may be accomplished by placing the roll support bracket 141 higher or lower on the posts 140, and so relocating the rolls 31 and 40 relatively to the rolls 30 and 39.

It is to be noted that the films are under water from the time they pass roll 29 until after they have passed gate 102. It is important that the wetting and bonding times are right and that the temperatures are not too high. The times and temperatures found suitable for a particular multi-layer film of the type shown in Patent No. 2,367,665, moving at the rate of approximately 30 feet per minute were for wetting, 4–5 seconds, and for bonding, 60–90 seconds at approximately 72° F. After bonding, the two films readily strip apart, the emulsion 18 adhering to the new support when the films are passed over the rollers 46 and drawn apart at approximately right angles.

As the joined films leave bath 28, they pass between flow-off squeegees 76 which remove loose drops of water partially from the perforations.

If, for convenience in handling, it is desirable to have greater tolerance in wetting time, the bath instead of being plain water may be made up to 25 per cent ethyl alcohol. This extends the required wetting time for the particular multi-layer film to approximately 12–16 seconds, but in general is not preferred.

The correct wetting time is that which is sufficient to destroy the adherence between the top blue-sensitive emulsion layer 18 and the stripping layer 16, or at least sufficient to render this bond less than the bond that is established between the top blue-sensitive emulsion layer 18 and the newly applied transfer support F so that when the films are separated, the emulsion layer 18 will adhere to the transfer support F and the stripping layer 16 will remain with the second or green-sensitive emulsion layer 15. Excessive wetting results in failure to bond and the premature partial stripping of the second strippable emulsion layer.

The wetting time with either bath must be just long enough for the water to penetrate the emulsion layer to be stripped and penetrate the cellulose ester interlayer. All excess water must instantly be removed by the roll-down operation. A bonding period is essential so that the imbibed water can distribute itself between the top blue-sensitive emulsion layers 18, thus insuring close adhesion between the now tacky top emulsion 18 and the "sub" 19 on its final support 12'. A slight trace of moisture penetrating to the second permeable cellulose ester interlayer 14 whilst the first, or blue-sensitive emulsion, layer 18 is under treatment does not necessarily loosen the temporary bond between the green- and red-sensitive emulsions 13 and 15. In fact, it has been found that these two emulsions may adhere even more firmly under these conditions than when entirely free from moisture. This fact explains why two stripping operations can be performed on multilayer film even when using identical permeable cellulose ester materials for both interlayers.

The bonded transfer film and multi-layer film are passed over the large roller 43 and spirally wound around similar rollers 44 in the drying cabinet 45. The first color component layer 18 is stripped from the multi-layer film by the stripping rollers 46, and the support F with the color layer 18 adherent thereto is spirally wound around the rollers 47 on the shafts 48 and the

floating rollers 49 and moved by the sprockets 50 to the take-up roll 10' in a manner similar to that shown for the humidifying cabinet 11. The multi-layer film with the remaining color layers after passing over the stripping roller 46 is given a half turn to bring the emulsion side on the outside of the rollers and then passed around the rollers 51 and 52 and onto the rollers 53 on the shafts 54 and spirally wound around the roller 53 and the floating rollers 55, being driven by the sprockets 56 to a take-up roll 10' in a manner similar to that shown for the humidifying cabinet 11, it being understood that there are two coaxial take-up rollers 10'. One film now comprises a support F which bears the top-blue sensitive emulsion layer 18 and the dye filter layer 17 from the original multi-layer film and is ready for developing during which the dye layer 17 is destroyed, or at least the dye is decolorized or removed, while the second film still bears two layers of emulsion separated by hydrolyzed cellulose ester layer 14.

The stripping of the second or green-sensitive emulsion layer 15 onto its final support F is performed in a manner similar to that described except for the essential additional step of removing all traces of interlayer 16 from the multilayer surface. For this purpose the roll 29 is adjusted to bear with greater force against the rolls 64, or it may be driven at higher speed, or both, the purpose being to cause it to rub with much greater force against the film F' as this passes through the second time. At this stage film F' carries, wholly or in part, the separating layer 16, and all traces of this must be removed from the emulsion layer 15 before the latter is bonded to a second transfer film support.

Returning now to the scrubber roll 29 in compartment 66, it is to be noted that this has little use when the films first pass through the apparatus. The scrubber roll then presses only lightly against the film F' and merely serves to wipe off any air bubbles or particles of dirt or it may even be moved entirely out of contact with it. When, however, the film F' passes through the machine the second time, it will consist of layers 12, 13, 14, and 15, and will have adherent to it particles or sections of the stripping layer 16. It is essential that these be entirely removed before the film F' is brought into contact with the fresh second film F to which layer 15 is to be transferred. Accordingly the scrubber roll 29 is moved to press the film firmly against rolls 64, and engages the film for about 90° of the circumference of the scrubber roll. The tension on the film above the scrubber is of the order of two ounces. It is important that the scrubber be at or very near the water lead 65, and that it rub off the particles of layer 16 before the emulsion layer 15 becomes softened or the layer 14 be too much affected by moisture.

The scrubber roll may be about two and one-half inches in diameter and driven about 60 R. P. M. by a belt 110, driving pulley 111, and is turned against the direction of movement of the film. The speed may be varied by replacement of pulley 111.

In order further to keep both films clean and to remove trapped air from the perforations additional wiper rolls 73 and 74 with mohair surfaces may be provided which will contact the cellulosic or support sides of films F and F' and additional water jets 75 may be provided on each side of both films, forcing filtered water against their surfaces, and a jet 69 is directed against the roller 29 and the emulsion side of film F' to remove the particles. The upward direction of the water from the jets removes all particles through overflow pipe 68. The compartment prevents dirt and particles from circulating in the tank proper, particularly as the water from the supply pipe 63 in the tank will flow up through slots 67 and 71. An emergency overflow 70 may also be provided.

It is obvious from the above description that the accurate registration of the two films is based on the current positioning and registration of the perforations along one edge and that the methods and apparatus here described, insofar as they relate to the bonding together of two films, are of use wherever it is desired to unite two films each having a series of accurately and similarly dimensioned perforations.

Having thus described my invention, what I claim is:

1. A process of transferring an emulsion layer from one perforated film strip to another similarly perforated film strip comprising bringing the two film strips into accurate registry based on the perforations, pressing the two films into adhesive contact after being registered, repositioning said films in accurate registry after said pressing operation and maintaining said films under tension and in registry until they are firmly adherent together, and separating the film strips with transfer of the emulsion layer from one strip to the other.

2. A process of transferring an emulsion layer from one perforated film strip to a second similarly perforated film strip that comprises passing the two film strips through an aqueous bath, bringing them while in the bath into registry based on the perforations, holding the films under longitudinal tension and pressing them into contact while still in the bath and after being registered, repositioning said films in accurate registry while still under tension and in the bath, maintaining said films under tension and in registry until they are well adherent, drawing said films while in contact over an extended path until the emulsion layer on the first strip is firmly bonded to the second strip, and then stripping the films apart with the emulsion layer adherent to the second strip.

3. In an apparatus for transferring an emulsion layer from one perforated film strip to a second similarly perforated strip of film, a conditioning cabinet, means for controlling the atmospheric conditions in said cabinet, means for driving and guiding said strips through the cabinet at the same speed, over paths of the same length and under identical atmospheric conditions, means for accurately positioning said films in registry, means for guiding said films from the conditioning cabinet to the positioning means, and means for drawing said films in contact over an extended path and for separating them.

4. In an apparatus for transferring an emulsion layer from one perforated strip of film to a second similarly perforated strip of film, a conditioning cabinet, means for guiding said strips through the cabinet at the same speed over paths of the same length under identical atmospheric conditions, a bath, means in the bath for superposing said strips and accurately registering their perforations, means for drawing said strips to and through said baths and to said superposing and registering means, driven rolls acting to draw said superposed films in contact over a path long

enough for the emulsion layer to become bonded to the second strip, and means for separating the two films with the emulsion layer adherent to the second strip.

5. In an apparatus for the purpose described, a sprocket roll having accurately formed sprocket teeth of identical dimensions, a brake retarding the movement of said sprocket, a gate at said sprocket, a member constituting a part of said gate and spring-pressed toward the sprocket, the spring pressure being sufficient only to seat the film fully on the sprocket, a second sprocket and means for driving said second sprocket, means for guiding two films to said sprockets, whereby they may be accurately superposed and registered at said first sprocket and held under tension between said driven and braked sprockets, presser rolls between which films pass between said sprockets, and a third sprocket between said presser rolls and the second sprocket and in the path of the films and having accurately formed teeth of identical dimensions and acting to correct any variation in registration of said films caused by said presser rolls.

6. In an apparatus for transferring an emulsion layer from one perforated film strip having accurately dimensioned perforations along its borders to another similarly perforated strip, a sprocket having two series of teeth, one dimensioned to fit one set of perforations transversely and the other series adapted to engage the other set loosely, means for guiding both films to said sprocket, means for positioning said films in contact on said teeth whereby they are registered accurately by said transversely fitting teeth, means for drawing said films from said sprocket under tension, means for pressing said films firmly together after they have been drawn from said sprocket, a second sprocket similar to the first for reregistering said films accurately after they leave said pressing means and while still under tension, and means for maintaining the films in contact over an extended path and for stripping them apart.

7. In an apparatus for transferring an emulsion layer from one perforated film strip having accurately dimensioned perforations along its borders to another similarly perforated strip, a bath, a sprocket in said bath having two series of teeth, one dimensioned to fit one set of perforations transversely and the other series adapted to engage the other set loosely, means for guiding both films through the bath to the sprocket, means for positioning said films in contact on said teeth whereby they are registered accurately by said transversely fitting teeth, means for drawing said films from said sprocket under tension, rolls in said bath for pressing said films firmly together after they have been drawn from said sprocket, a second sprocket in the bath similar to the first sprocket for reregistering said films accurately after they leave said rolls and while still under tension, and means for maintaining the films in contact over an extended path and for stripping them apart.

8. In an apparatus for the purpose described, three sprocket wheels having accurately formed sprocket teeth of identical dimensions, contacting presser rolls between the first and second sprockets and adapted to press a film between them, gate members at each of said sprockets having straight line film paths tangent to the respective sprockets and in a straight line with each other and with the line of contact between the presser rolls.

9. In an apparatus for the purpose described, three sprocket wheels having accurately formed sprocket teeth, contacting presser rolls between the first and second sprockets, gate members at each of said sprockets having straight line film paths tangent to the respective sprockets and in a straight line with each other and with the line of contact between the presser rolls, the first sprocket having a retarding brake, and the third sprocket being driven, whereby films may be maintained under tension in a straight line through all of said gates and between said presser rolls.

10. In an apparatus for the purpose described, a sprocket roll having accurately formed sprocket teeth of identical dimensions, a brake retarding the movement of said sprocket, a gate at said sprocket, a member constituting a part of said gate and spring-pressed toward the sprocket, the spring pressure being sufficient only to seat the film fully on the sprocket, a second sprocket and means for driving said second sprocket, means for guiding two films to said sprockets, whereby they may be accurately superposed and registered at said first sprocket and held under tension between said driven and braked sprockets, presser rolls between which films pass between said sprockets, and a third sprocket between said presser rolls and the second sprocket and in the path of the films and having accurately formed teeth of identical dimensions and acting to correct any variation in registration of said films caused by said presser rolls, the gate at the first sprocket, the pressure line between the rolls, and the path of the film past the second and third sprockets being in a straight line.

11. In an apparatus for transferring an emulsion layer from one perforated film strip having accurately dimensioned perforations along its borders to another similarly perforated strip, a sprocket having two series of teeth, one dimensioned to fit one set of perforations transversely and the other series adapted to engage the other set loosely, means for guiding both films to said sprocket, means for positioning said films in contact on said teeth whereby they are registered accurately by said transversely fitting teeth, a brake operating on said sprocket, a second driven sprocket similar to the first for engaging the films and driving them through the apparatus whereby the films are under longitudinal tension caused by the driving action of the second sprocket and the braking of the first sprocket.

12. In an apparatus for the purpose described, a sprocket roll having accurately and identically dimensioned sprocket teeth, a brake retarding the movement of said sprocket, means for guiding two similarly perforated films into contact upon the teeth of said sprocket, whereby the perforations are registered, a second driven sprocket also having accurately and identically dimensioned sprocket teeth for engaging the perforated films and drawing them in contact through the apparatus against the braking action of the first named sprocket, whereby the films are placed under longitudinal tension and are accurately registered by the sprocket teeth.

13. In an apparatus for accurately registering two film strips each having a series of accurately dimensioned similar perforations, a first sprocket having a series of teeth dimensioned to fill said perforations transversely, a brake tending to retard said sprocket, means for guiding both films to said sprocket, means for positioning said films in contact on said teeth whereby they are reg-

istered accurately in a transverse direction, a second sprocket having teeth adapted to fill the perforations transversely for registering said films accurately after leaving said first sprocket and while still under tension, a third sprocket in line with the first two sprockets and adapted to engage and drive film from said first two sprockets, and means to drive said last mentioned sprocket and thereby exert a continuous driving tension on the films against the action of the brake, whereby the films are accurately registered longitudinally at the first and second sprockets by the engagement of the teeth with the perforations.

14. In an apparatus for accurately registering two film strips each having a series of accurately dimensioned similar perforations, a first sprocket having a series of teeth dimensioned to fill said perforations transversely, a brake tending to retard the movement of said sprocket, a member spring pressed toward said sprocket to seat the film fully upon the sprocket teeth, a second sprocket having accurately formed teeth dimensioned to fill said perforations transversely, means for holding film upon said second sprocket, a third sprocket, and means for driving said third sprocket, whereby accurately perforated films threaded over all three sprockets will be drawn under tension against the action of the brake and the perforations of the films will be accurately registered and reregistered at the first and second sprockets, respectively.

15. In an apparatus for accurately registering two similarly perforated films, means for positioning two such films in contact with their perforations in approximate registration and including means having a braking action on the movement of the films, a sprocket having two series of accurately dimensioned sprocket teeth, one series dimensioned to fit one set of perforations transversely and the other series dimensioned to engage the other set of perforations loosely, and a driven sprocket adapted to engage the films by their perforations and to draw them from the positioning means under tension caused by the action of the braking means and, while under tension, over the first mentioned sprocket, and means for pressing the films firmly against said sprocket while being drawn thereover, whereby the teeth of said sprocket correct any errors in registration of the perforations of the film.

16. In the process of transferring a stripping emulsion layer in accurate registration from one accurately perforated film strip to a second similarly perforated film strip of like composition and dimensions, the step that comprises passing both strips in a dry condition through a humidifying chamber over paths of equal length and at the same speed and under identical conditions of humidity and temperature prior to the transfer, whereby both strips tend to overcome any differences in dimensions caused by differences in use and storage conditions.

17. In a process comprising the transfer of an emulsion layer in accurate registration from a first accurately perforated film strip to a second similarly perforated film strip of the same composition and dimensions followed by the transfer of a second emulsion layer from the first strip to a third similarly perforated strip of the same composition and dimensions, the steps of passing the first and second strips in a dry condition through a humidifying chamber over extended paths of equal length at the same rate of speed and under the same conditions of temperature and humidity prior to the first transfer, passing the first strip after the first transfer through a drying chamber, and then passing the first and third strips in a dry condition through a humidifying chamber over extended paths of equal length at the same rate of speed and under the same conditions of temperature and humidity prior to the second transfer, the said operations diminishing any differences in dimensions caused by differences in prior use and storage conditions.

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Certificate of Correction

Patent No. 2,417,060. March 11, 1947.

JOHN G. CAPSTAFF

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 10, line 13, for "current" read *correct*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of June, A. D. 1947.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.