Aug. 11, 1953 A. MAYER 2,648,089

AIR SQUEEGEE

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Fig. 1.

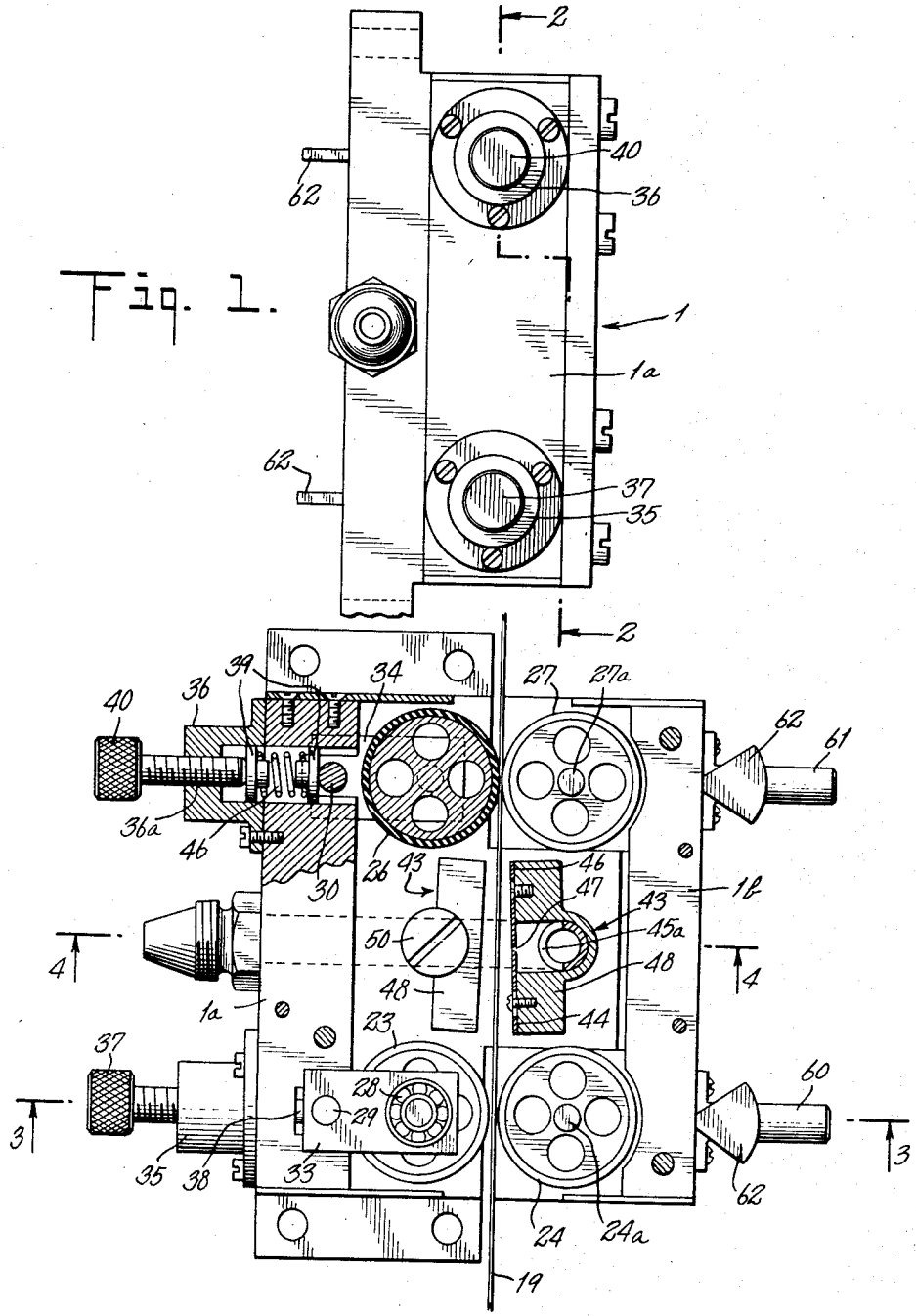


Fig. 2.

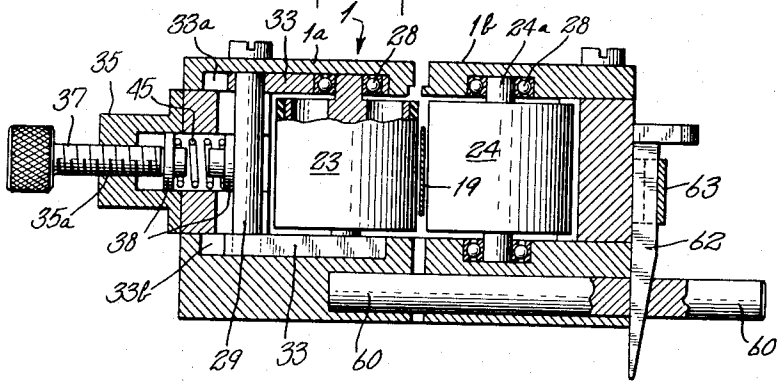
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Fig. 3.



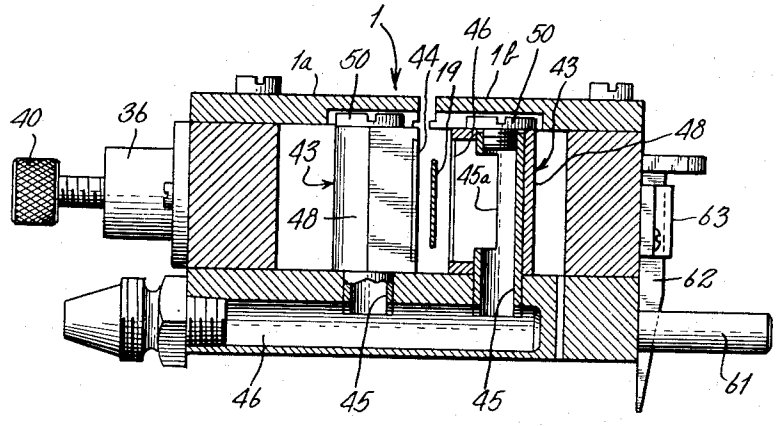


Fig. 4.

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2 Claims. (Cl. 15—306)

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This invention relates to air squeegees, and particularly to an air squeegee through which a web or film strip may be passed for the removal of moisture from the surfaces thereof.

The present invention is particularly adapted for use in conjunction with motion picture film treating apparatus to remove the excess treating liquid from the surfaces of the film before it is submitted to the drying operation. However, the invention is not limited to use with motion picture film, but can be used to remove excess moisture from the surfaces of a continuous web of any material after the web has been passed through a liquid or any region where it has accumulated an excess of liquid which must be removed from its surfaces.

Air squeegees of one type or another are commonly used for the purpose of removing excess liquid from the surfaces of a flexible strip which has been treated with a liquid. Most known types of air squeegees, however, use exposed air nozzles for causing the impingement of air upon the strip, and depend upon the direction of the nozzles being at an angle other than normal to the plane of the strip to enhance the effective stripping of excess droplets of liquid. It has been found that air squeegees of this type are very noisy and wasteful of air, and that when the strip moves at relatively high speed several nozzles are required for treating each of the two surfaces of the strip for effective removal of moisture. In prior squeegees in which the air nozzles are enclosed in a plenum chamber, air and entrapped liquid has been permitted to escape both at the film entrance and exit thereby causing the deposition of some moisture on the portion of the film from which all moisture should be removed. Also in such prior devices, in order not to damage the surfaces of the film, soft rubber rollers have been relied upon to provide the fluid seal, thus requiring excessively high air pressure and volume of air flow.

Therefore, one purpose of the present invention is to provide an improved air squeegee for the purpose of removing excess liquid from the surfaces of a strip, which is quieter and more efficient, and which is more economical of air than squeegees of known types.

Another purpose is to provide an improved air squeegee in which the air nozzles are enclosed in a plenum chamber and are directed at substantially right angles to the plane of the strip or web, the air being permitted to escape from the plenum chamber at the point of entrance of the web.

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A still further purpose is to provide an improved squeegee comprising a plenum chamber having a substantially air-tight exit for a strip or web under treatment and having an entrance therefor which constitutes an air vent, and in which the chamber is supplied with air which has characteristics especially adapted to its function of moisture removal.

Still another purpose is to provide an improved air squeegee that is designed to facilitate threading a strip therethrough.

The invention is best understood from the following detailed description when read in connection with the accompanying drawings in which:

Figure 1 is an end elevation view of the air squeegee of the invention.

Figure 2 is a sectional view on line 2—2 of Fig. 1.

Figure 3 is a sectional view on line 3—3 of Fig. 2.

Figure 4 is a sectional view on line 4—4 of Fig. 2.

Briefly, the present invention comprises a casing which constitutes a plenum chamber through which is moved a film or web which is to be dried, a partially fluid-tight seal being provided at the film exit and a partial fluid seal being provided at the film entrance. The plenum chamber, per se, is provided within the region between the film entrance and exit which in the example illustrated is in the form of pairs of rollers. A drying medium such as air is applied to the plenum chamber zone by means of nozzles which direct jets of air against the sides of the film at substantially right angels thereto and escapes from the plenum zone at the film entrance adjacent the sides of the film or strip.

The embodiment of the invention chosen for the purposes of illustration comprises a rectangular casing 1 which contains the plenum chamber, the casing being made in two sections 1a, 1b as shown most clearly in Figs. 3 and 4. The two sections 1a and 1b are adapted to fit together on the plane in which a film or web 19 which is being dried passes through the casing 1. The two sections of the casing are preferably parted on this line to facilitate the threading of the film in the drying mechanism.

In order to permit the movement of the film or web 19 without unnecessary deterioration thereof the fluid seals at the entrance and exit of the plenum chamber are in the form of a pair of rubber faced rollers 23 and 24 at the entrance and a second pair of similar rollers 26 and 27 at the exit. Although reference has been made to a

fluid seal at the entrance and exit it is to be understood of course, that the seals cannot be completely fluid tight and still permit the movement of the film through the casing. Nevertheless the leakage around the axit and the entrance is so small that it is not difficult to maintain a plenum zone within the region between the pairs of rollers and inside of the casing 1. The length of the entrance and exit openings are substantially the same as the width of the film strip or web being dried. One of the features of the present invention is the arrangement of the pairs of rollers in such a manner that there is substantially no flow of drying medium out the film exit, the entrance being so proportioned as to constitute a flat nozzle permitting the escape of the drying medium in thin layers immediately adjacent both sides of the film or web 19 in a direction opposite to the movement of the film thereby removing moisture from the film both by reason of the force of the flowing drying medium and also by evaporation. In this way substantially all of the moisture is removed from the film or web 19 before it passes between the exit rollers 26 and 27.

To this end, the entrance rollers 23 and 24 are spaced a distance which is slightly greater than the normal thickness of the film to be dried. As a specific example, a conventional motion picture film is approximately .006 of an inch thick and the surfaces of the entrance rollers 23 and 24 are spaced apart approximately .008 of an inch thus leaving approximately .001 of an inch between each roller and the adjacent surface of the film 19. It will be readily understood that when the air escapes from the plenum zone between the surfaces of the rollers and the film, the latter will be substantially centered between the rollers without touching either one because of the layers of the high velocity air. Preferably one of the rollers at the entrance, for example roller 23, is spring loaded so that it can accommodate variations in thickness of the film, such as lap splices.

The exit rollers 26 and 27 are preferably spaced apart a distance which is equal to the average width of the motion picture film, as an example in this instance .006 of an inch. One of the rollers, for example, roller 26 is spring loaded to accommodate variations in the thickness of the width of the film and to permit the passage of the lap splice.

It is clear from the drawings, particularly from Figs. 2 and 3 that the journals for one of each of the pairs of rollers, for example rollers 24 and 27, are rotatably fixed in one of the sections, for example 1b. The rollers are preferably provided with integral journals 24a and 27a, respectively, which are rotatably supported in suitable anti-friction bearings, such as roller bearings 28. The construction of all of the rollers is identical and the anti-friction bearings for all of the rollers are also identical. The bearing races for the fixed rollers 24 and 27 are received in suitable recesses in the sides of the section 1b. The other rollers 23 and 26 of the respective pairs are movably mounted with respect to the casing 1a and are each spring loaded. For example, pairs of slidable bearings blocks 33 and 34 which, respectively, support rollers 23 and 26 are adapted to slide within suitable guideways exemplified by the guideways 33a and 33b for the sliding blocks 33 and 34. In the case of the sliding blocks 33, their guideways are of such a depth that when the sliding blocks 33 engage the bottoms of their guideways the spacing between the surfaces of the rollers 23 and 24 will be substantially .008 of an inch, assuming of course that the two sections of the casing are fitted tightly together. In the case of the roller 26 the length of the guideways is such that when the sliding bearing blocks 34 engage the bottom of the guideways the surface of the roller 26 will be approximately .006 of an inch from the surface of the roller 27, again assuming of course that the two sections 1a and 1b of the casing are fitted tightly together.

The respective pairs of bearing blocks for each roller are adapted to move in unison in their guideways. Accordingly, a crossbar 29 engages holes in the upper ends of the sliding blocks 33 with a press fit. Similarly, a crossbar 30 engages holes in the upper ends of the sliding blocks 34. Suitable means are provided for resiliently urging the bars 29 and 30 downwardly to thereby provide the necessary spring loading on the movable rollers 23 and 26. To this end, caps 35, 36 are suitably secured to section 1a of the casing and each is provided with a screw threaded aperture such as 35a and 35a, which is each respectively engaged by cap screws 37 and 40. Interposed between the lower end of each of the respective cap screws 37 and 40, and the crossbars 29 and 30 are pairs of headed studs 38 and 39 between which is interposed respective compression springs 45 and 46. The heads of the upper one of each of the pairs of studs 38 and 39 are adapted to slide within recesses in the respective caps 35, 36 while the heads of the lower ones of the studs 38 and 39 are adapted to slide within respective cylindrical recesses in the wall of the section 1a. It will be readily apparent that by adjusting the position of the cap screws 37 and 40 the preloading on the rollers 23 and 26 can be varied. The compression of the spring 45 will hold the sliding bearing blocks 33 in engagement with the lower ends of the guideways 33a and 33b which thus determines the spacing between the movable roller 23 and the fixed roller 24. Similarly, the compression of spring 46 holds the sliding bearing blocks 34 against the lower ends of their guideways to determine the normal spacing between rollers 26 and 27.

All of the rollers are provided with a facing of soft rubber of a relative thickness indicated in the section in Fig. 2. A drying medium is supplied to the plenum zone between the pair of entrance and exit rollers through a pair of nozzles 43, one of which is shown in section in Fig. 2. Each nozzle has a main body 48 provided with a pair of nozzle blades 44 and 46 each of which are provided with bevelled edges which, when spaced as indicated in the section in Fig. 2, constitute a long narrow slot 47. Preferably one of the blades, for example 44, is adjustable in order to vary the width of the slot 47. The blade 46 is held immovable by suitable screws. The optimum width of the slot 47 depends on the air pressure used. For example, with air pressure at approximately 20 pounds per square inch a slot width of .008 to .010 inch is satisfactory. Preferably the two nozzles are positioned about ⅛ of an inch from the respective opposite sides of the film strip 19. Each of the nozzles is supported on suitable similar conduits exemplified by the conduit 45 which is connected to a suitable manifold 46 which is adapted to be connected to a source of drying medium such as air under pressure and heated to the desired temperature. Each of the conduits, exemplified by the conduit 45, are provided with

an opening 45*a* in one side thereof which communicates with the hollow portion of the nozzle body 48. Each of the nozzles 43 is angularly adjustable about its respective conduit and this construction is illustrated in Fig. 4 wherein a suitable short screw 50 threadedly engages the outer end of the conduit 45 and when it is screwed home the head of the screw 50 engages the cylindrical portion of the nozzle 43 providing sufficient friction to hold the nozzle in a desired adjusted position. The construction for both of the nozzles is identical. As shown in Fig. 2, preferably the nozzles are so adjusted so that the faces adjacent the film or web 19 diverge in a direction opposite to the movement of the film. This causes the jets of air from the respective nozzles 43 to strike the surface of the film or strip at an angle slightly less than 90° and thus facilitates the stripping of the droplets of water from the surface of the film and tends to direct the water toward the space between the entrance rollers 23 and 24 and the film strip 19.

Preferably the pressure of the air or other drying medium supplied through the nozzles 43 should not be so high as to set up turbulence or cause the film strip 19 to vibrate. The air should preferably be dry and must be clean and free from oil. It should also be at such a temperature as to overcome the cooling effect of evaporation and at the same time raise the temperature of the water that is being removed from the strip in order to facilitate evaporation. By the increased temperature the viscosity of the water is decreased and thus the droplets of water are more readily separated from the strip of film by the air blast from the nozzles. If desired, the temperature of the air blast may be as high as the material of the film or strip can withstand in order to facilitate the drying action.

Any suitable means may be provided for holding the two sections 1*a* and 1*b* together as one integral unit. In the embodiment shown the frame of the section 1*b* is provided with holes which are adapted to be engaged by a pair of pins 60 and 61 which are press-fit or otherwise secured in holes in the section 1*a*. Suitable means may then be provided for preventing the section 1*b* from separating from section 1*a*. To this end, suitable rectangular pins 62 are adapted to engage complementary transverse holes in pins 60 and 61, the shanks of rectangular pins 62 being received in recesses in brackets 63 which are suitably secured to the side of the section 1*b*. From the construction just described it will be apparent that it is a simple matter to insert the film or strip 19 to be dried in the squeegee of this invention by merely removing the pins 62, separating the two sections 1*a* and 1*b* and inserting the film or strip after which the sections are positioned together and the pins 62 are reinserted to engage the transverse holes in the pins 60 and 61.

Air or other drying medium introduced into the plenum zone by means of the nozzles 43, Fig. 1, escapes from the casing 1 adjacent the incoming film strip 19 between the cylindrical surfaces of the rollers 23 and 24, and also escapes through the several clearance spaces necessary for easy mechanical operation as, for instance, around the ends of the rollers, between the rollers and the sides of the sections of the casing and through a suitable drain hole 62. It is not intended that any air shall escape along

the outgoing film strip 19 between the cylindrical surfaces of the exit rollers 26 and 27, and in the construction described no air does escape at this point. This prevention of escape of air at this point is one of the essential features of the invention, and is vital to the improved operation thereof. If air should escape at this point, entrained moisture would rewet the film as it leaves the squeegee, in great part destroying the effectiveness of the device. Certain drying action occurs in this squeegee at the points of impingement of the streams of air from the nozzles 43 upon the surfaces of the strip 19 moving between them. The drying action is of two kinds, evaporation and physical removal of the water in discrete droplets. Any drops large enough to fall and any droplets that condense on objects within the chamber, collect on the floor thereof and may be drained out of the drain opening 62. Any droplets small enough to remain suspended will be exhausted with escaping air. Additional drying action takes place with the escape of the air beside the incoming film strip 19 between the rollers 23 and 24, through the .001-inch gaps on each side of the film strip. The volume of air employed is such as to maintain some pressure within the plenum zone between the entrance and exit rollers in spite of the several points of escape, so that the velocity of the air escaping past the incoming film is high. This high velocity air scours considerable moisture from the film strip 19 as it moves into the casing 1 preventing some of the moisture from entering the chamber with the strip.

The entrance rollers 23 and 24 touch the incoming film 19 only lightly, if at all, so that there is little or no frictional contact of the moving film strip with the rollers tending to rotate them. Therefore it is obvious that in place of these rollers there may be substituted fixed shoes forming the lips of an entrance film slot. Such shoes need have a separation only sufficient to pass a lap splice, which may have a thickness of perhaps as much as ten thousandths of an inch. Such shoes may be therefore placed this distance apart with only a slight reduction in the effectiveness of the air blast passing between them in drying the film. In such construction a very small amount of resilience should be provided, as for instance by flexible mounting of the shoe supports, so that the shoes may be easily forced apart momentarily by a lap splice to permit its passage.

From the foregoing description it will be apparent that the present invention provides an improved squeegee or drying apparatus for drying a film strip or web through the provision of jets of air or other drying medium applied to a plenum zone in such a manner that the air or drying medium escapes from the plenum zone in a thin layer on the opposite sides of the film in a direction opposite to the movement of the movement of the latter. In this manner the larger droplets of moisture are stripped from the film before it enters the plenum zone and the final drying action primarily by way of evaporation takes place inside of the plenum zone. In this way a minimum of moisture-laden air engages the film after it has passed through the plenum zone resulting in greatly increased drying action.

What is claimed is:

1. An air squeegee comprising a casing through which a strip or web of material is adapted to

pass for removing the water or moisture therefrom, an entrance and an exit for said strip in the form of respective pairs of rollers journalled on respective parallel axes in bearings slidably supported for movement toward and away from each other, stop means for determining the minimum spacing between the surfaces of the respective pairs of rollers, the stop means at the exit being placed so that the minimum spacing is substantially equal to the normal thickness of said strip to thereby provide a substantially fluid-tight seal, the stop means at the entrance being placed so that the minimum spacing between the surfaces of the entrance rollers is slightly wider than the normal thickness of said strip, means for directing a gaseous drying medium under pressure into the zone in said casing between said entrance and exit, the wider minimum spacing of said entrance rollers being adapted to permit said drying medium to pass out of said casing at said entrance at high velocity in thin sheets in a direction opposite to that of the movement of said strip, and means for independently resiliently urging each of said movable rollers against their respective stops.

2. A combination as set forth in claim 1 in which said means for directing a gaseous dry medium under pressure into said casing comprises a pair of nozzles, one of which is arranged on each side of said strip for directing fluid pressure against said strip, each nozzle having an elongated orifice opening transversely of a plane face, each face including pairs of respective spaced plates arranged in respective common planes with the adjacent edges of a respective pair of plates of a face forming an elongated orifice, said faces being arranged symmetrically on opposite sides of said film and divergent toward said entrance to constitute an expanding throat with said elongated orifices discharging toward said film and said entrance.

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