

Oct. 19, 1937.

H. N. ENSIGN ET AL

2,096,232

FILM DRYING MACHINE

Original Filed March 13, 1935 2 Sheets-Sheet 1

Fig. 1.

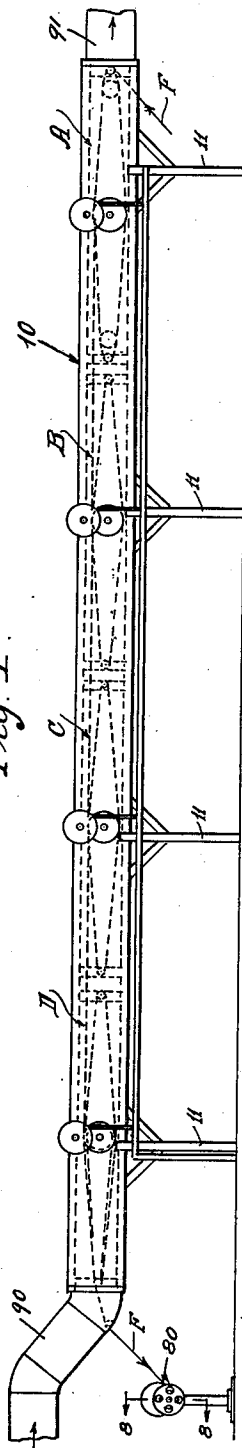
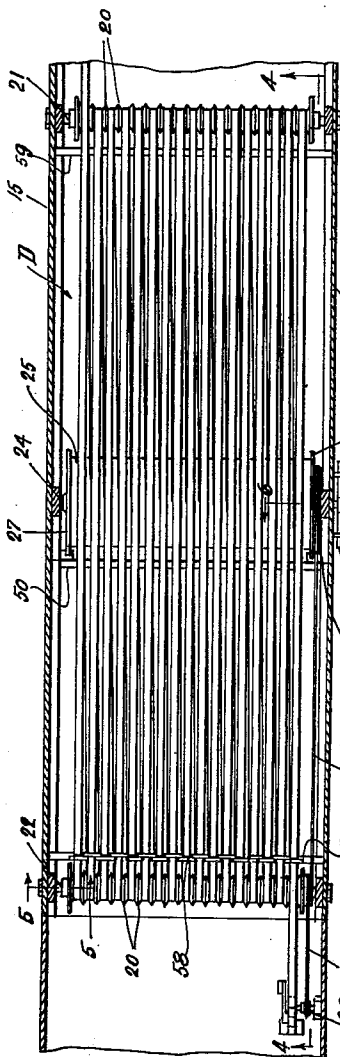


Fig. 3.

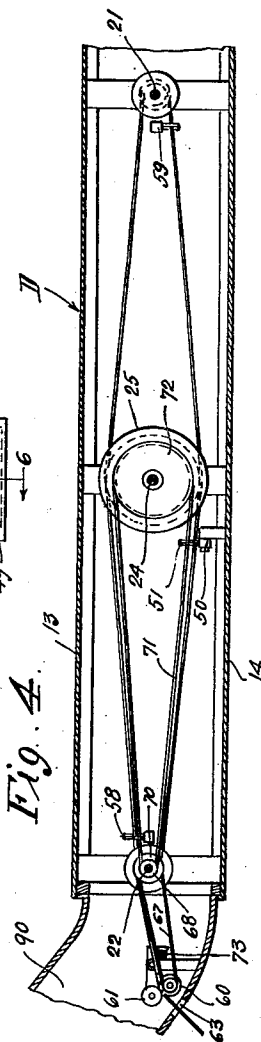


Fig. 4.

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Fig. 2.

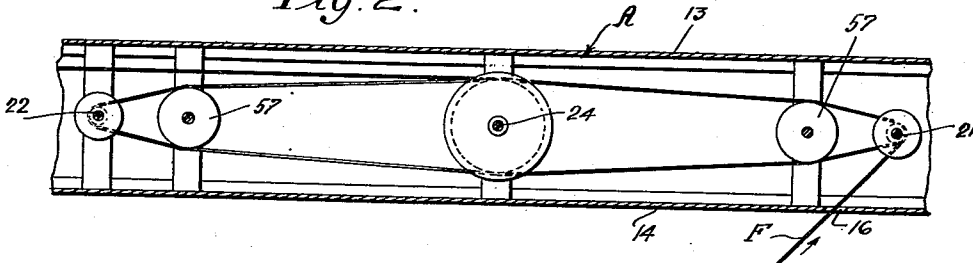


Fig. 5.

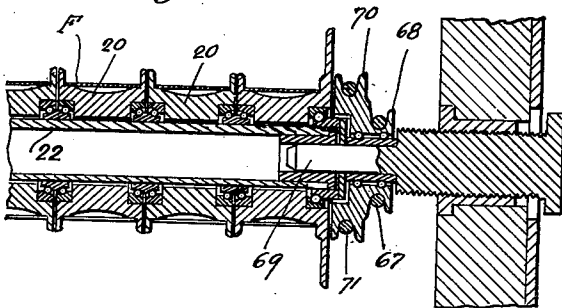


Fig. 7.

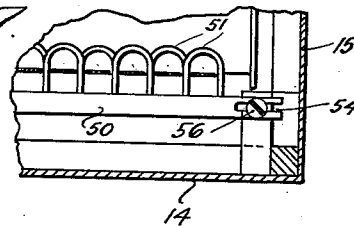


Fig. 8.

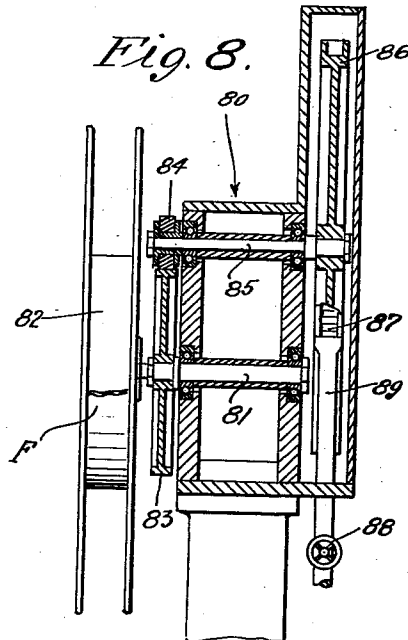
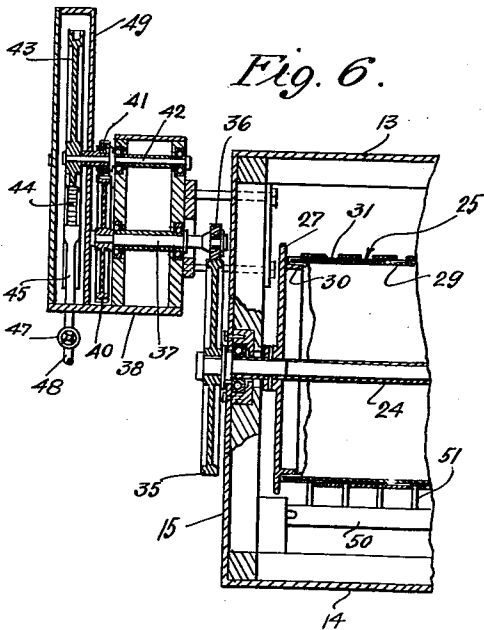


Fig. 6.



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2,096,232

FILM DRYING MACHINE

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Application March 13, 1935, Serial No. 10,841

Renewed May 3, 1937

2 Claims. (Cl. 34-48)

This invention relates generally to drying machines for motion picture film, and more particularly to machines for drying a continuously moving film strip supplied continuously from a wet bath.

The drying machine disclosed and claimed in the present application is also disclosed, and in some aspects claimed, in our copending application entitled Horizontal type film developing and drying machine, filed March 13, 1935, Ser. No. 10,840.

It may be stated as an object of the present invention to provide a film drying machine which is highly efficient and exceptionally rapid in drying the film.

It is a further object of the invention to provide a film drier with improved film driving and carrying means, designed with the view of equalizing film tension throughout the machine.

It is believed the invention itself, as well as additional objects not specifically named, will be most easily understood by proceeding at once to a detailed description of a present preferred embodiment of the invention, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a side elevation of the film drying machine of the invention;

Fig. 2 is a longitudinal vertical medial section of the first section of the drier;

Fig. 3 is a plan view of the last section of the drier, the upper wall being broken away;

Fig. 4 is a vertical section taken on line 4-4 of Fig. 3;

Fig. 5 is a section taken on line 5-5 of Fig. 3;

Fig. 6 is a section taken on line 6-6 of Fig. 3;

Fig. 7 is a detail section taken on line 7-7 of Fig. 4;

Fig. 8 is a section taken as indicated by line 8-8 of Fig. 1.

The drier is shown to embody a long, closed conduit 10, preferably rectangular in cross section, and is here illustrated as mounted on supports 11. Said conduit is made up of top and bottom walls 13 and 14, respectively, and side walls 15. The side walls may have suitable doors not shown, for the purpose of gaining access to the interior of the drier.

The drier is divided into a number of successive film-carrying sections, such as A, B, C and D, section A being shown in vertical longitudinal section in Fig. 2, and section D being shown in Figs. 3 and 4.

Each of such drier sections comprises a pair of longitudinally spaced film roller shafts 21 and

22, and midway between said shafts, and preferably on the same level, a third shaft 24. Freely and rotatably mounted on the end shafts 21 and 22 are individual film rollers 20 (see Fig. 5) and nonrotatably mounted on center shaft 24 is a film-driving drum 25, which in the present illustrative embodiment is of a diameter substantially six times that of the film rollers on end shafts 21 and 22. The diameter of this drum is of course susceptible to considerable variation, the diameter indicated not being limitative on the invention in its broader aspects.

As is shown in Figs. 3 and 6, drum 25 is made up of end plates 27 rigidly mounted on shaft 24, and a drum cylinder 29 mounted at its two ends on annular flanges 30 extending inwardly from plates 27. Preferably, a fabric covering 31 is stretched over the exterior of the cylinder 29, and is fastened tightly in place between the ends of the cylinder and the previously mentioned flanges 30, as clearly shown in Fig. 6. The fabric covering is of a nature suitable to give a frictional driving engagement with the drying film strip.

Drum shaft 24 has on its outer end, outside side wall 15, a wheel 35 which is drivingly engaged on its top side by friction wheel 36 mounted on the end of a spindle 37 journaled in a turbine wheel mounting box 38, the latter being secured to the side of the drier as indicated in Fig. 6. Friction wheel 36 is preferably formed of cork, which is found to have great durability, as well as to permit slippage should the turbine be too strongly driven. On the other end of shaft 37 is a gear 40 engaged by a gear 41 mounted on turbine wheel shaft 42. Shaft 42 has on its outer end an air turbine wheel 43 provided with blades 44. The turbine wheel is driven from air discharged by nozzle 45 which is positioned to direct air current against blades 44, the air being controlled by a hand valve 47 in supply pipe 48. The turbine wheel is enclosed by a casing 49, as indicated.

The film strip F, which may be understood as supplied continuously from the wet bath, not shown, is here illustrated as entering the drier conduit through an aperture 16 in its lower wall 14, said aperture being located near the right hand end of the conduit as viewed in Figs. 1 and 2. The film upon entering the drier conduit passes upwardly and around end film roller 20 on transverse shaft 21 of drier section A, thence traverses sections A, B, C and D in succession. As clearly indicated in the drawings, the film entering one of the sections passes over the top side of the film driving drum 25, thence passes downwardly at a small angle and loops around

the end roller on the other shaft 22, from there passes under the lower side of drum 25 and so on back to a roller 20 on shaft 21, looking upwardly around said roller and passing forwardly again over the top side of drum 25, and so on in successive convolutions to the other side of the conduit. After thus traversing a given drier section, the film from the top side of the center driving drum goes forwardly to the center driving drum of the next section, as indicated.

It is here to be noted that the film strip must be threaded on the sets of rollers on the several drier sections with its emulsion side out. This is of great importance, first, in that the emulsion is mutilated if the emulsion side of the film is allowed to come into contact with the surface of the rollers, and second, in that it is highly desirable that the emulsion side of the film be on the outer side of the film convolutions where the drying effect of the heated air stream is much the greater.

In the particular design here shown the individual film rollers 20 on the two end shafts 21 and 22 of each drier section are mounted directly opposite one another, rather than being staggered, and the film strip is carried straight forwardly from the top sides of the rollers on shaft 21 to the top sides of the rollers on shaft 22, and is angled in running from the lower sides of the rollers on shaft 22 to the lower sides of the rollers on shaft 21 (see Fig. 3). It is found that the angular stretches of the film strip tend to work laterally a fraction of an inch on the film driving drum during operation, so that the edge of the film strip rubs against any usual film guide means that might be provided adjacent the driving drum, such for instance as flanges on the wheel itself, or guide rollers, or wire loops mounted adjacent said drum. Accordingly, we provide a film guide means directly before the driving drum which is freely shiftable in a lateral direction to accommodate this tendency of the film to work over slightly on the drum. As shown in Figs. 4 and 7, there is provided just before the driving drum a bar 50 having individual film guides in the form of wire loops 51 which are adapted to take and space the successive stretches of the film strip passing under the drum. This bar extends transversely of the conduit and its two ends are notched at 54 and are slidably mounted on guide pins 56, as clearly indicated in the figure. It will be evident that the guide bar therefore floats laterally, and accommodates its position to that naturally taken by the film on the driving wheel.

Preferably, sets of fixed film guide loops 58 and 59 are mounted just before the rollers on shafts 20 and 21, respectively, as clearly indicated in Figs. 3 and 4.

Polishing rollers 57, covered with chamois or other suitable surface material, are preferably mounted between the film rollers and center driving drum in drier section A, as clearly indicated in Fig. 2, and serve to polish the celluloid surface of the film passing between the film rollers and the center driving drum.

From end drier section D, the film passes between a pair of ejector rollers 60 and 61 (Fig. 4), and passes outside the drier conduit by way of a comparatively narrow slot 63 to be reeled up on take-up reel 82. Roller 60 is constantly driven through the medium of a pulley 66 and belt 67 driven by a pulley 68 which is rotatably mounted on a spindle 69 that supports film roller shaft 22 (Fig. 5). Integral with pulley 68 is pulley 70

driven by a belt 71 which is driven in turn by a pulley 72 fastened to the end of film driving drum 25. The other film ejector roller 61 is pressed into engagement with the film by a spring, as at 73 (Fig. 4). Ejector roller 60 is driven at a speed such as to take the film just as it is supplied from drier section D.

The final film take-out device is designated at 80 (Figs. 1 and 8), and comprises a reel shaft 81, carrying take-up reel 82, and having rigidly mounted thereon a wheel 83 driven by a friction wheel 84 which is on the turbine shaft 85. Wheel 84 is preferably of cork, to give a frictional drive which is durable and also which will allow slip-page if the turbine is too strongly driven, or the film is held back. A turbine wheel 86 having blades 87 is mounted on shaft 85, and is driven by air from a nozzle 89. The air from this nozzle is adjusted by hand valve 88 to give the turbine just sufficient drive that the reel 82 on shaft 81 will be slightly overdriven, that is, will exert a slight tension on the film coming from the ejector of the drier.

It will be understood that the drier receives the film immediately from a wet bath machine of some description which in operation will supply the film strip at some given rate. The drier turbines are adjusted so that the rotating film driving drums 24, which are in frictional engagement with the sets of film convolutions in the drier, have a slight tendency to over-drive the film through the drier, and therefore to exert a slight tensing on the film coming from the wet bath machine. This over-drive, of course, is not sufficient to strain the film, but is only sufficient to maintain a suitable tension in the film and to take the film at whatever rate it may arrive from the wet bath machine. Accordingly, when the machine is in full operation, the air turbine wheels are held back slightly by the film strip.

Inasmuch as each film driving drum is in driving engagement with a number of film-convolutions, the tension exerted in each run of the film due to this over-drive tendency is very small, and the final result is to give a very gentle driving effect at each point of contact between the driving drum and the film strip.

The film ejector at 60, 61 and the final take-out device 80 then remove the film from the drier and reel it up, the take-out device also being adjusted with a slight over-drive tendency so as to draw the film from the drier and prevent slack therein.

It will now be evident that with the machine adjusted as thus described, the film will be taken up by the drier as fast as supplied thereto, but it is of course necessary that there be some restraint upon the rate at which the film is supplied to the drier since otherwise the film would slacken and driving engagement between the driving drums and the film would be lost. Such restraint is in practice imposed by the "wet" machine that supplies the film to the drier at some given rate. It will be sufficient for the present purpose merely to consider that the film is to be fed to the drier at substantially a constant rate of speed, thereby permitting the air turbines to be adjusted to give just the slight necessary over-drive tendency required to maintain proper tension in the film strip for that rate of film feed. Any slack which then comes into the film due to wetting and elongation occurring in the wet bath will be taken up by the over-drive tendency of the drier and its over-drive take-out, and the slack accordingly moved forwardly through the drier to be taken up finally

by the over-driven take-up reel. Of course, the greater part of such slack is taken up by natural film shrinkage as moisture is removed from the film within the drier, but any excess slack is constantly moved forwardly through the machine and is taken up by the final take-out device. As a result, the film strip in the drier is maintained with a proper tension to give required driving engagement between the driving drum and the film, regardless of changes in film length due to elongation in the preceding wet bath, or shrinkage in the drier.

The film roller and driving drum arrangement of the drier is designed with the particular view of equalizing tension between the various film convolutions. It is for this purpose that the film rollers 20 on the end shafts 21 and 22 of each drier section are mounted for free individual rotation. It will be evident that this individual freedom of rotation of each of said rollers allows the film strip to work in such a way as to equalize the tension throughout all its convolutions. The film strip of course must slip somewhat on the surface of the central driving drum as it is tensed up, or during movement of slack through the machine, but the individual rotatability of each of the film rollers allows the film strip to "work" through each of the several sections of the drier with such freedom, even with any such slip on the central drum, that tension in the film always is equalized in the convolutions of each drier section. The film convolutions therefore maintain a very accurate balance of tension between themselves, and the driving tendency of the central driving drum is held exactly the same on all film convolutions.

It has been described how the film is polished by the polishing rollers 57. The film is also polished in slipping slightly on the central driving drums 25. It will be evident that such slippage will depend upon the tension placed on the film, which may be controlled by regulating the hold-back on the film at the beginning end of drier, or by regulating the force exerted by the final take-out device.

A current of heated air is delivered to the film outlet end of the conduit through an air inlet conduit 90. This current of heated air passes over the successive sections of the drier comprised of several sets of longitudinally arranged film convolutions, and is finally discharged through outlet air conduit 91. It will be noted that the air blast is thus in a direction contrary to the direction of film progression through the conduit. Accordingly, the heated air upon introduction to the conduit comes first into contact with that portion of the film which has longest been in the drier conduit and is consequently already substantially dry, and then passes on through the successive sections of the drier wherein the film is in progressively wetter condition. The air of course becomes more and more laden with moisture as it passes from section to section, with the result that its drying effect is lessened as it passes through the conduit. The film in the last film section D, however, is always subjected to the influence of the dry incoming air. This arrangement is conducive to most effective and rapid drying of the film.

It is to be noted that the sets of parallel, elongated film convolutions of the drier are arranged longitudinally of the heated-air conduit, or in other words, parallel to the direction of heated air flow. It will also be remembered that the film strip passes over the successive sets of film

convolutions emulsion side out. These features of design and arrangement are productive of greatly increased efficiency of drying, as may be appreciated from the considerations following. It is of course well known that it is the emulsion face of the celluloid film strip that requires time for drying, the emulsion being in a very sticky and plastic state when wet, and requiring a much longer time to dry than does the celluloid. In our drier design, the film strip is arranged throughout the sets of elongated convolutions in each of the successive drier sections with its emulsion side out, that is, presented to the heated air stream that is continuously passed through the drier-conduit. Within the film convolutions, the air is relatively quiet, and drying would be relatively slow and ineffective; however, as has been said, the celluloid dries rapidly, and the inner side of the film strip nevertheless is completely dry before the film leaves the drier. Outside and along the outer sticky surfaces of the longitudinal runs of the film convolutions, the heated air stream flows rapidly along in a continuous stream, "licking" the emulsion surfaces of the film strands and rapidly removing the moisture therefrom as it passes. This air stream is not broken up and caused to flow in various cross and counter directions, but is always substantially parallel to the longitudinal runs of the film in the conduit; moreover, very nearly one hundred percent of the film within the convolutions of the drier runs in a longitudinal direction, parallel with the air stream and with its emulsion surface presented thereto in the most effective manner for rapid drying. As a result of the features here spoken of, the drying time is reduced very materially below what is usual in prior driers of standard types, and consequently the total film footage required within the drier, and therefore the size of the drier itself, are correspondingly reduced. As an example, we may state that a present drier constructed as here described has a total capacity of but 12,000 feet of film, and the film is completely dried when running at a speed of 130 feet per minute with air blown through the conduit at a temperature of but 85° F. In comparison with this performance, a film drier of a standard commercial type now in continuous use under our supervision carries a length of 26,000 feet of film, and operates at a speed of 100 feet per minute using air heated to 100° F. The reduction in necessary size of apparatus, in footage of film at any one time in the drier, and the increase in speed through the drier, together with the necessity of heating the drying air to but 85° F., all of which constitute features of greatest advantage, will be readily apparent from these comparative figures.

It will be understood the drawings and description are to be considered as illustrative of and not restrictive on the broader claims appended hereto, for various changes in design, structure and arrangement may be made without departing from the spirit and scope of said claims.

We claim:

1. In a film drier, the combination of an air conduit adapted to have a blast of air forced therethrough, and a plurality of film carrying units within said air conduit and spaced longitudinally thereof, said units being adapted to take the film successively and pass it from unit to unit in a direction contrary to the direction of the air blast, each of said units comprising two sets of film rollers mounted on parallel horizon-

tal axes spaced longitudinally of the conduit and arranged so that the film strip may be looped therearound in adjacent convolutions which extend longitudinally of the conduit, and a rotatable film driving wheel of a diameter greater than that of the film rollers extending through said film convolutions, with its axis of rotation parallel to and between the axes of said sets of film rollers, said driving wheel being arranged for frictional driving engagement with the film moving in both directions between said sets of rollers.

2. In a film drier, the combination of an air conduit adapted to have a blast of air forced therethrough, and film carrying means comprising two sets of film rollers mounted on parallel

horizontal axes spaced longitudinally of the conduit and arranged so that the film strip may be looped therearound in adjacent convolutions which extend longitudinally of the conduit, and a rotatable film driving wheel of a diameter greater than that of the film rollers extending through said film convolutions, with its axis of rotation parallel to and between the axes of said sets of film rollers, said driving wheel being arranged for frictional driving engagement with the film moving in both directions between said sets of rollers.

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