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W. GEYER
FILM TREATING MACHINES
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2 Sheets-Sheet 1

Fig.1

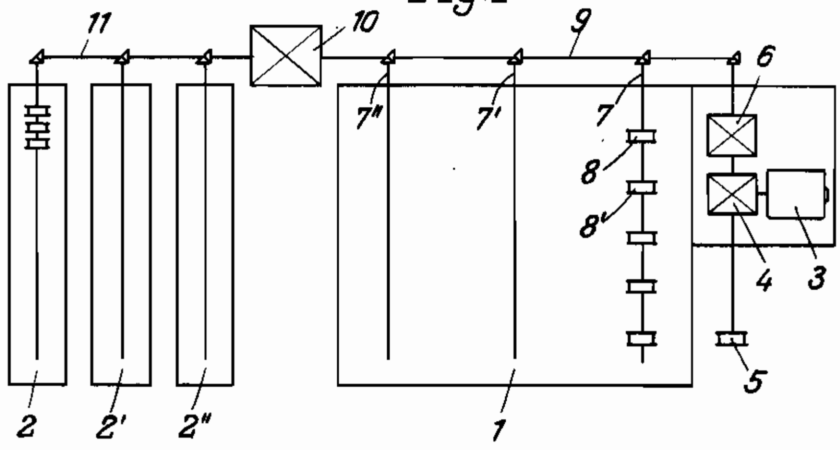


Fig.2

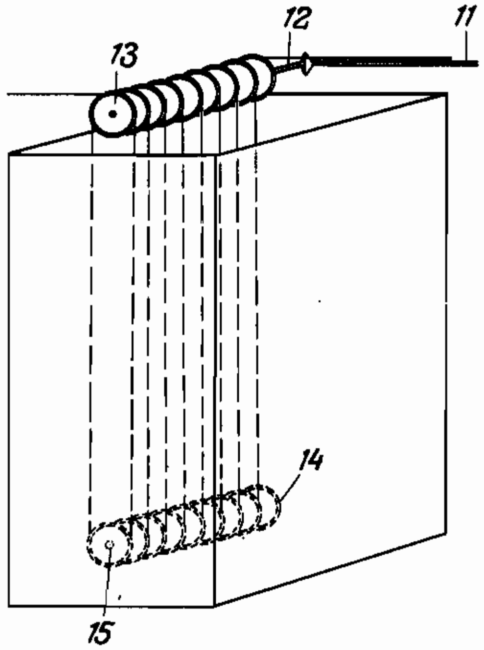
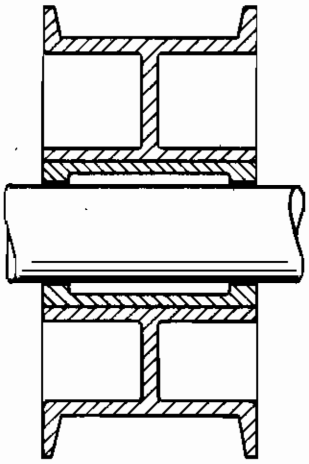


Fig.3



Inventor:
WALTER GEYER
BY Hammond & Littell
ATTORNEYS

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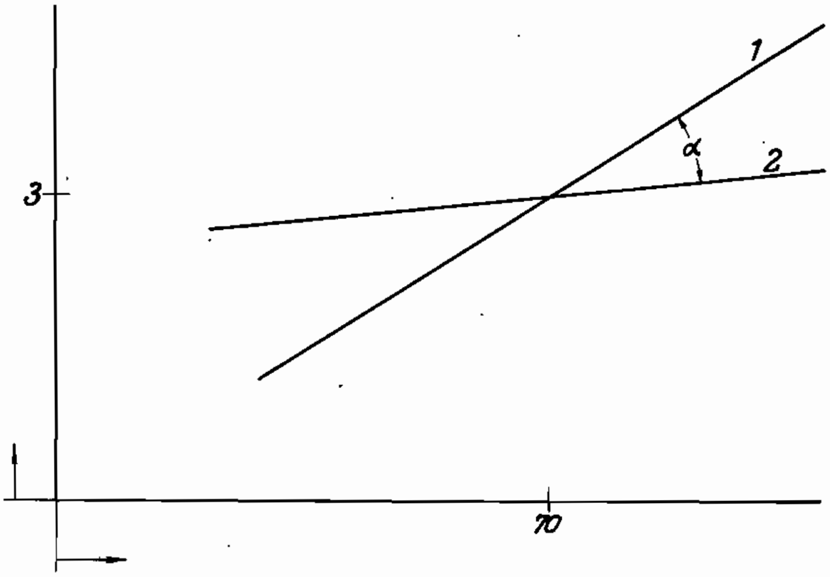

Fig. 4

Inventor:
WALTER GEYER
BY Hammond & Littell
ATTORNEYS

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ALIEN PROPERTY CUSTODIAN

FILM TREATING MACHINES

Walter Geyer, Berlin-Sudende, Germany; vested in the Alien Property Custodian

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This invention relates to film treating apparatus, particularly developing machines, in which the film is exclusively or chiefly transported by means of toothless rollers.

In the known machines of this class the looped film passes over several rollers arranged one after the other at different levels, and the difficulty connected with the operation of such machines is to provide for slight uniform tension without subjecting the film to mechanical stressing or damaging it. In some of the known devices in which all rollers are driven through friction clutches the upper rollers have some lead over the last roller. In the rear of every shaft driven in this manner and supporting several rollers the film forms a loop the length of which serves for checking the amount thereof delivered and controlling the braking of the shaft through friction. Machines of this type are expensive, complex in structure, not absolutely reliable in operation, and stress the film due to the development of a relatively strong pull.

To overcome this drawback it has been proposed to employ a fixed drive without the complex mechanism of friction and brake for the lower rollers which then take care of the film transport whilst the upper rollers are loosely arranged on their shafts. The principle underlying the construction of such machines also provides for imparting to the last roller fixing the film speed and disposed at the outlet of the drying chamber a lower circumferential speed than to the film transport drum within the machine. When the film is in contact with the lower driven rollers, more film is transported within the machine than is drawn out of it by the last rollers with the result that the film loops increase in length and remain free of the lower rollers until the last drawing roller at the drying chamber has shortened them again and they are in more or less firm contact with the lower transport rollers. This kind of film transport involves constant sliding of the film and rollers, their relative motion being greatest when the loop is loosely suspended and smallest when the loop is drawn tightly against the roller. The pull of the film is of course subject to considerable fluctuations entailing corresponding differences in the tension of the loops, and as the slip between roller and film easily causes scratches, even the slightest relative motion of film and roller, particularly in case of large machines equipped with hundreds of such rollers, will finally produce visible mechanical injuries.

In order to keep these relative motions as small as possible and simultaneously to obtain the slightest possible film pull it has further been proposed to employ transport rollers of different diameters which are greatest at the beginning of the machine and gradually decrease toward the film outlet. Such an arrangement constitutes, however, only a small improvement as to film pull and film preservation. According to another proposal to reduce relative motion to a minimum, only some of the rollers are to have a fixed drive and decreasing diameters.

Although the devices mentioned have brought about certain improvements, they do not completely avoid mechanical injuries to the film and particularly fail to eliminate fluctuations of the pull or to reduce them to a minimum, which would be required to prevent mechanical damaging and, above all, stretching of the film. Stretching occurs particularly in case of incombustible film materials and increases the spacing of the perforations, at least partly, during development so that the projected pictures will not be steady and the film is damaged, since all projectors are designed for a spacing of perforations that is smaller than that of the raw film.

According to the invention, relative motion of the film and rollers is completely eliminated and a much more uniform film pull adjustable as to intensity is provided by causing the driving rollers to be carried along by the driving shaft through bearing friction, whereby relative motion is restricted to a roller and its driving shaft and slip between the film and its driving roller is avoided.

The bearing friction of the film driving rollers and that of the rollers driven by the film are adjusted so that the desired film tension results, the driving rollers being taken along by their shafts at a frictional resistance somewhat greater than the one that has to be overcome in case of the rollers drawn by the film. In further accordance with the invention the friction at which each roller is driven is such that substantially only those forces are transmitted to the film that are required for the film transport in the neighborhood of the roller, so that any number of toothless rollers may be arranged in succession.

Tensile stressing of the film, i. e., the film load, may further be kept constant by the arrangement that the driving power transmitted by friction to the driving rollers is smaller at a film load below the desired value than the bearing friction that has to be overcome at the driven rollers, whereas at a film load above the desired value the transmitted driving power is greater than the friction to be surmounted at the driven rollers.

This is attained by utilizing the dependence of the intensity of friction upon bearing pressure which for the upper rollers is combined of the double film pull plus roller weight and for the lower rollers of double film pull minus roller weight, so that at equal film load the bearing pressure of the upper rollers is greater than that of the lower rollers. Friction at the upper rollers cannot fall below a minimum represented by the roller weight plus the minimum double film pull, whilst at the lower rollers, by suitable adjustment of the roller weight and film pull, the lowest possible friction may be brought down to zero. The lowest possible friction at the upper rollers, however, will be higher than at the lower ones, and for the same reasons. Depending on the desired film tension, the upper or lower rollers may therefore serve as driving rollers, the friction and thus the driving power transmitted to the roller by friction being in either case influenced by the film pull, so that at a decrease in film pull the friction and the driving power will be diminished in consequence whereof less film will be conveyed and the loops correspondingly increased in size. The tension to which the film is subjected can be readily adjusted by fixing the size of the inner and outer diameters of the rollers and the weight of the latter and by a corresponding construction of the bearings.

In a form of construction which has been found highly useful the lower rollers in the drying cabinet are made of synthetic material and disposed on brilliantly polished shafts of approximately 20 mm. diameter, and the upper rollers run in ball bearings. In the wet section, the lower rollers consist of synthetic material and are arranged on brilliantly polished shafts of approximately 20 mm. diameter, whereas the upper rollers are mounted on shafts of smaller diameter and their friction is, moreover, reduced by smaller seatings.

In further accordance with the invention the number of revolutions of the shafts driving the film transport drums by friction is regulatable so as to make possible any desired film tension.

It has been found particularly advantageous to make use of a continuous variable speed gear. The corresponding shafts may be driven also by a motor or motors, this arrangement being advisable when one or more dynamometers controlling the film pull, or similar devices, are provided for automatically, according to their strokes, insuring the desired speed of the shafts. The film transport according to the invention gives satisfaction in the developing section of the wet treatment as well as in the dry treating part, though it should be taken into consideration that the baths in the wet section partly vary the bearing friction, so that if the bearing construction in the dry section is retained in the wet section frictional conditions will be different and require a different speed of the shafts, which may also be regulated by a continuous gear to adjust the desired tension. When the differences are too great, the variations developing during wet treatment compared with dry treatment should be made allowance for in the construction and arrangement of the bearings.

The invention is illustrated by way of example in the accompanying drawing, in which

Figure 1 is a plan of a developing machine according to the invention;

Fig. 2, a perspective detail view of the developing machine;

Fig. 3, a section through a driving roller; and

Fig. 4 shows the dependence of friction on the film load.

In the drawings, 1 designates a drying cabinet and the numbers 2, 2', 2'' refer, respectively, to the developing, fixing and washing tanks. The machine is driven by a motor 3, and the speed of the machine whereby the developing time is regulated is controlled by a change speed gear 4 by means of which a film drawing drum 5 is driven which determines the film speed. On the same shaft is mounted another gear 6 with the aid of which the shafts 7, 7', 7'' and, by friction, the transport drums 8, 8', 8'' are driven.

Between the main driving shaft 9 of the drying cabinet and the main driving shaft 11 of the wet section a change gear 10 is provided by means of which and of the gear 6 the speed of rotation of the shafts 9 and 11 is so regulated that the desired film tension, controllable by dynamometers, not shown, is attained.

Fig. 2 shows the film guide arranged in a tank 2. The main driving shaft 11 drives a shaft 12 on which the film transport rollers 13 are driven by friction the intensity of which is determined by the film pull, the weight of the roller and the construction of the bearing.

The shaft 12 is made of brilliantly polished V2A-steel on which the rollers 13 are disposed for instance in the manner shown in Fig. 3. The rollers 15 driven by the film and mounted on a shaft 14 run in ball bearings. As ball bearings require per se a very slight power for transport, it is necessary to provide for correspondingly low friction of the rollers 13 on the shaft 12. This is attained by means of the brilliantly polished shaft 12 and a corresponding construction of the bearing faces as well as a corresponding fitting of the bore of the rollers 13 relative to the diameter of the shaft.

To compensate for the contraction of the film when the machine stops and to insure uniform film tension, one of the shafts, preferably the non-driven shaft 14, may be springy by consisting of an elastically flexible steel bar of corresponding thinness. In this way, the film tension is taken up by the elastic shaft and not by the film which is only slightly elastic.

It is possible, however, to drive the lower shaft 14 instead of the upper shaft 12. How in this case the film load is kept constant, illustrates Fig. 4 in which, as abscissa, the film load is entered in grams and, as ordinate, the tractive force, measured at the circumference of the roller, in grams. Curve 1 shows the tractive force developed at the driving rollers in dependence upon film load, and curve 2 shows the tractive force prevailing at the driven rollers in dependence upon film load. As indicated in the figure, the tractive force developing at the driving rollers increases with the film load to a higher degree than the tractive force at the driven rollers. The point of intersection of the two curves is assumed to coincide with the desired film load value, say, 70 grams. The arrangement according to the invention functions then as follows:

Assumed that at a given moment the film load is below the desired value, for instance at 50 grams. It will be seen that in this case the frictional force transmitted to the driving rollers is smaller than the friction appearing at the driven rollers and acting as braking force. The forces retaining the film are therefore greater than the forces pulling the film, that is, less film is conveyed than corresponds to the desired value and the film load must increase toward the end of the machine. The film load increases therefore until the desired value of 70 grams has been reached. When the drawing and braking forces are equal at every point of the machine, the film is not loaded anywhere more than 70 grams. If the film load increases beyond the desired value of 70 g., it is evident that the friction of the driving rollers pulling the film is greater than that of the driven rollers, so that the driving rollers tend to convey more film than is drawn out by the last firmly driven roller at the end of the machine, in consequence whereof the film loops will be lengthened again and thereby decrease the film load until a state of equilibrium and thus the desired load value have been reached.

The frictional conditions prevailing between the driving and the driven rollers according to the invention permit therefore automatic regulation of the entire machine to a certain film load. The fluctuations in film load depend upon the angle α formed by the two curves. If this angle is small, the load will fluctuate within larger limits than at greater values of the angle α. When the film is moved by a means which brakes it through friction, a constant additional force arresting the film transport appears, which means that the curve 2 would extend parallel to itself and upwardly displaced. But even in this case the frictional conditions may be chosen so that the point of intersection of the two curves coincides with the desired film load value.

WALTER GEYER.