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C. A. MIKETTA ET AL

2,244,170

DEVELOPING MACHINE

Filed June 15, 1938

2 Sheets-Sheet 1

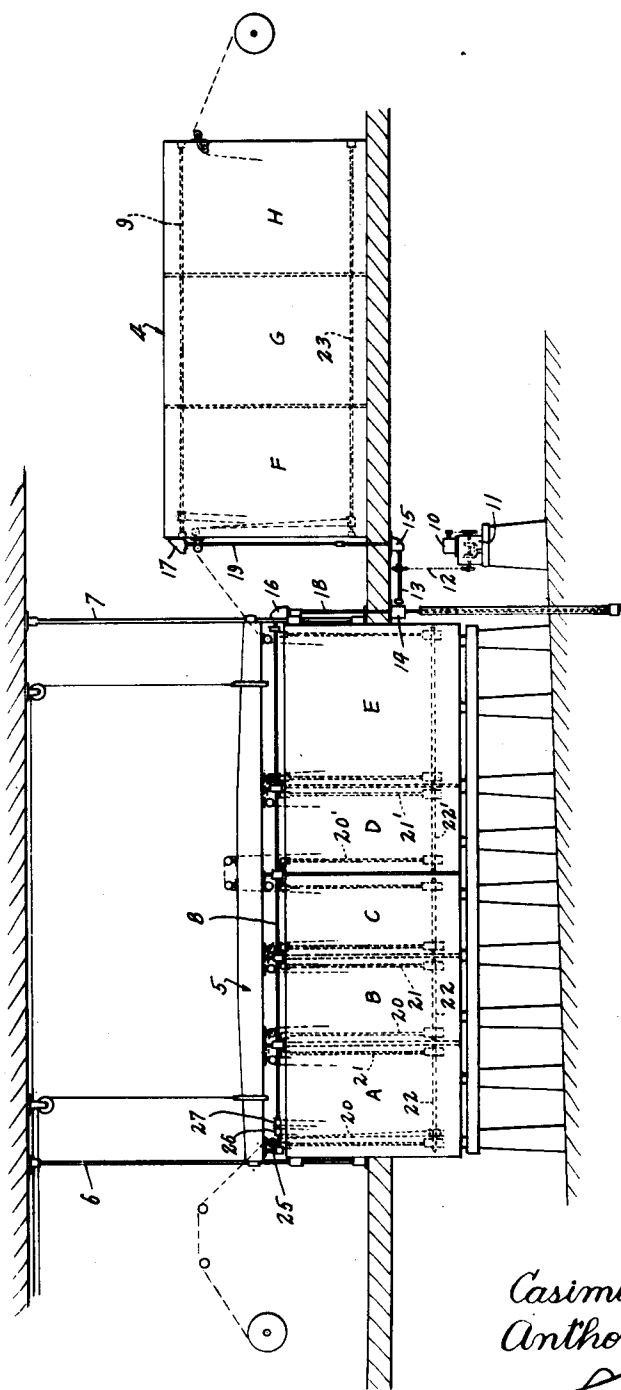


Fig. 1.

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2 Sheets-Sheet 2

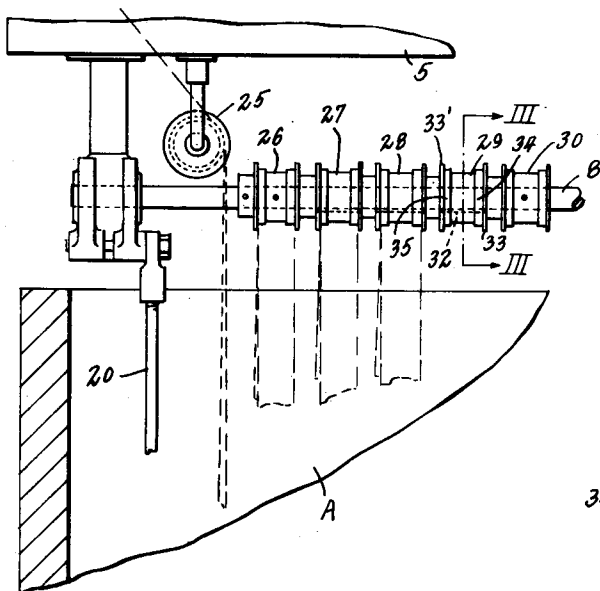


Fig. 2.

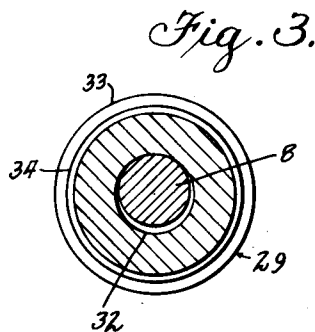
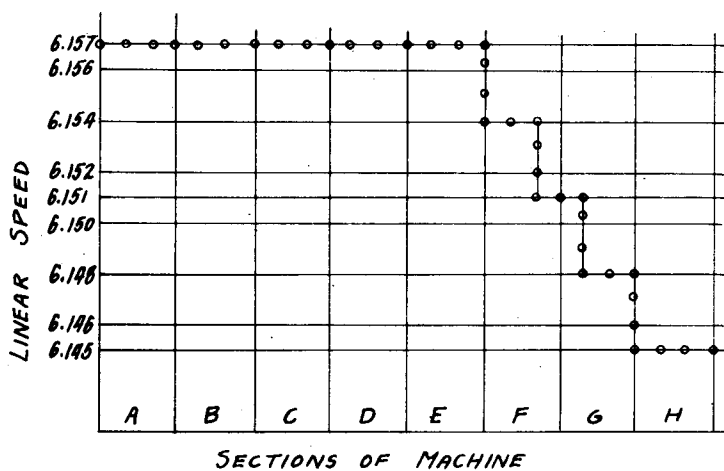


Fig. 3.

Fig. 4.



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DEVELOPING MACHINE

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3 Claims. (Cl. 271—2.3)

This invention pertains to improvements in the art of treating continuous strip film such as motion picture film. Such strip film after exposure needs be developed and for this purpose numerous devices are employed in which the continuous strips of film are passed through tanks containing desired liquid media such as developers, rinsing water, fixing solution, wash water, etc. Thereafter the continuous strip of film is ordinarily passed through a drier. In the motion picture industry large amounts of film need be treated and the machines are expected to handle the film continuously. The words "treatment of continuous film" as used herein will refer to developing, washing and drying operations of the character stated and also to related processes such as dye-toning, the subjection of the film to bleaching solutions, dye baths, hardening solutions, etc.

The operation of continuous machines which advance the film through tanks containing liquid media presents a number of difficulties. Ordinary strip film comprises a cellulosic base which carries and supports the photographic emulsion. When the film strip is wetted by the treating media, expansion takes place so that the length of film is increased; during drying, however, shrinkage takes place. Not all film strips expand or shrink to the same extent even when subjected to the same treating solutions and drying conditions. Minor variations in the thickness of the cellulosic base or minor variations in the characteristics of such base cause changes in the degree of expansion or contraction which is exhibited by the film during processing. Moreover, certain solutions or media employed appear to cause a greater expansion in the film than other solutions. Again, the time of contact between the film and the media is occasionally varied and these different variables make it extremely difficult to continuously operate a developing machine on continuous strip film without causing the film to break while in progress through the machine or without causing the film to become so loose on the various sprockets and spools as to "pile up" and either cease its forward travel through the apparatus or become badly over developed or spoiled by the action of the various media, etc. It is to be understood that in actual operation lengths of film are spliced together and sent through the machine in a continuous manner, each length being generally about 800 to 1000 feet long.

It is further to be remembered that the film as it enters the developing machine is substan-

tially dry and after passing through the developing tanks and then the drier the film is discharged in substantially dry condition. It would appear, therefore, that the linear speed of the film, during continuous operation of the machine, would be the same at the inlet end as it would be at the discharge from the driers. It has been discovered, however, that if the machine is built and operated in accordance with this assumption, it will be impossible to operate the machine continuously due to breakage.

The present invention is based in part upon the discovery that the driving force applied to the film to cause its progress through the machine should be varied somewhat in accordance with variations in the specific gravity and/or the viscosity of the liquid media to which the film is subjected. Moreover, in accordance with the present invention the driving means applied to the film throughout the wet end of the machine (where such driving means act upon film wetted by treating solutions) need rotate at a linear speed which is higher than the mean linear speed of the driving means in contact with the film in the drier.

In certain types of prior machines attempts have been made to drive the film through the machines by means of spools or rollers which were positively driven. Such machines have not been successful even though complicated means such as elevators have been used for the purpose of absorbing, in part at least, variations in length of the film due to expansion and contraction. The present invention is directed toward a driving means composed primarily of spools which are frictionally driven by their shafts, the spools or rollers being loosely mounted on the driven shafts. In conjunction therewith it has been found desirable to use a relatively minor proportion of spools or rollers which are positively driven.

It is an object of this invention, therefore, to provide a method of progressing continuous strip film through liquid media and through a drying room in a continuous manner without the necessity of employing complicated counterbalances, elevators, etc.

Another object is to provide a method of progressing continuous strip film through liquid media and a drier in a manner capable of automatically compensating for variations in shrinkage or expansion of the film.

A further object is to provide an apparatus for progressing film through various processing steps in a continuous and satisfactory manner.

These and other objects, advantages and adaptations of the invention will become apparent to those skilled in the art from the following detailed description. In order to facilitate understanding, reference will be had to the appended drawings, in which:

Fig. 1 is a diagrammatic representation in side elevation of one form of apparatus in which the invention may be embodied.

Fig. 2 is an enlarged view of a portion of the machine shown in Fig. 1.

Fig. 3 is a vertical transverse section taken along the plane III—III of Fig. 2.

Fig. 4 is a graph exemplifying linear speeds of spools throughout a machine constructed and operated in accordance with this invention.

The drawings are particularly directed to a form of motion picture developing machine. As there shown, film from suitable reels passes into the developing machine which may well comprise a series of tanks, such as the tanks A, B, C, D, E, etc. The various tanks may contain suitable liquid media. For example, tank A may contain developing solution, tank B may contain wash water, tank C may contain a fixing solution and tanks D and E may constitute wash tanks. The size, depth and arrangement of tanks may vary, depending upon the treatment to which the film is to be subjected and it is to be understood that the invention is not limited to the specific number or location of tanks nor to the liquid media which may be contained therein.

A drier is generally indicated at 4 and may be subdivided into a plurality of chambers, such as, for example, the chambers F, G and H. A beam 5 mounted on vertical guide posts 6 and 7 is movably positioned above the tanks A—E, suitable means being provided whereby the beam may be raised and lowered. Carried by the beam is a substantially horizontal shaft 8 journaled in a plurality of suitable bearings. A similar shaft 9 extends throughout the upper end of the drier 4. The shafts 8 and 9 are preferably simultaneously driven at the same rotational speed by means of a motor 10, gear box 11, chain 12, jack shaft 13 and bevel gearings in housings 14, 15, 16 and 17.

The gear boxes 14 and 16 are connected by means of a cross shaft 18, one of the gears in gear box 14 being feathered onto the shaft 10 so that when the beam 5 is lifted, a driving connection is maintained between the jack shaft 13 and the shaft 8. An upstanding cross shaft 19 also connects the gear boxes 15 and 17.

It is to be remembered that in view of the fact that the shaft 8 may be from 15 to 25 feet long, it may be impossible to obtain a single piece of shafting and therefore the shaft 8 may well be made of sections suitably connected one to the other. The shaft 8, however, is of substantially uniform external diameter. Similarly, the shaft 9 is of substantially uniform external diameter and this diameter is substantially identical to that of shaft 8 so that to all intents and purposes the shafts 8 and 9 are simply continuations of but a single shaft.

Depending from the beam 5 are supporting members 20 and 21, 20' and 21', etc., two of these supporting members preferably extending into each of the separate tanks A—E. The lower sections of these supporting members 20 and 21 are interconnected by means of the shaft or stud 22, this shaft or stud being positioned near the bottom of the tank into which the supporting arms 20 and 21 extend.

As a counterpart of the stud shaft 22, the stud 23 is positioned in the lower portion of the drier 4. None of the stud shafts 22, 22' or 23 is driven.

Journalled upon the shafts 8 and 9 is a multiplicity of spools. These spools are provided with bores of uniform diameter, said bores being slightly larger than the diameter of the shafts on which they are mounted. The difference between the diameter of the bore and the diameter of the shaft may be on the order of 0.004 to 0.01 inch (in the event the shaft is about 1.125 inches in outside diameter) but it is to be understood that these figures are simply illustrative of the degree of looseness which may exist between the spools and the shaft on which they are journaled. A greater degree of looseness, that is, a greater difference between the diameter of the bore and the diameter of the shaft, may be employed but the specific range given has been found to give very good results. The shafts 8 and 9 may carry as many as 200 spools, depending upon the length thereof. At spaced points along said shaft certain spools may be firmly mounted on the shaft. In actual practice it has been found that by firmly mounting from between 10% and 30% of the spools, improved and better results are obtained. These firmly mounted, positively driven spools are preferably positioned at the outlet ends of each tank, additional positively driven spools being distributed along the shaft so as to be spaced by the frictionally driven spools of larger bore than the diameter of the shaft. Freely journaled spools are also carried by each of the stud shafts 22, 22', etc., which normally are positioned near the bottoms of the various tanks and in the bottom of the drier.

When continuous motion picture film is being handled the spools employed are provided with flanges. The film-contacting outer surfaces of the spools vary in diameter. The film-contacting surfaces of the positively driven spools also vary in diameter. It has been found that continuous strip film can be continuously passed through an apparatus of the character described or through liquid media and then through a drier, without breakage, piling up or other operating difficulties, provided the continuous film is subjected to frictionally applied, forwardly directed impulses simultaneously at a large number of points along its length, the forwardly directed impulses to which the film is subjected, throughout the length thereof passing through the aqueous solutions, having a higher forwardly directed speed component than the mean speed component of the impulses to which the film is subjected in the drier. In other words, the film is brought into frictional contact with forwardly driven elements at a large number of points along its length throughout the machine, these elements being driven in the drying zone at progressively slower linear speeds whereas the elements in the wet end of the machine are driven at a linear speed which is higher than the mean linear speed of the elements in the drying zone. This variation in linear speeds of the driving elements or spools is attained by varying the diameter of the film-contacting surfaces of the spools.

The linear or peripheral speed of the spools carried by the shaft 8 is therefore adjusted to be higher than the linear or peripheral speed of the spools near the discharge end of the drier 4 and preferably higher than the mean linear speed of the various spools throughout the length of the drier 4. These speeds are adjusted, as stated hereinbefore, by varying the external diam-

ters of the spools, i. e., those portions of the external surfaces of the spools which are actually in contact with the film.

By referring to the enlarged views Figs. 2 and 3, it will be seen that the film 1 may travel over a guiding spool or roller 25 journaled upon a transversely extending shaft supported from the beam 5. The film moves downwardly, passes over one of the spools freely journaled on the lower jack shaft 22, and then upwardly over the first spool 26 carried by the longitudinally extending driven shaft 8. The film again passes downwardly over another spool on the jack shaft 22 and upwardly over the second spool 27 carried by the driven shaft 8.

The film repeats this travel a number of times and then passes over into the tank B or some other tank of the series. It will be understood that the tanks are relatively narrow and although a single line of these tanks is shown, it is to be understood that the beam 5 may carry two longitudinally extending drive shafts 8 instead of one, thereby permitting the operation of two separate lines of travel of film at the same time, these separate lines of travel either discharging into the same tanks or into closely adjacent tanks.

Although all of the spools 26 to 30 shown in Fig. 2 may be freely journaled upon the driven shaft 8, it has been found that it is desirable to introduce positively driven spools at spaced points throughout the machine. The initial spool 26 is represented in the drawings as being a positively driven spool. It may also be assumed that spool 30 is a positively driven spool whereas the intermediate spools 27, 28 and 29 are freely journaled upon the driven shaft and are simply driven by frictional contact with such shaft. It is to be understood that although in this description rollers 26 and 30 are deemed to be positively driven, these two spools being then separated by three frictionally driven spools, this arrangement is only referred to for purposes of illustration. In some instances the last spool in contact with film entering and discharged from a given tank may be the only spool which is positively driven, all of the other spools above such tank being frictionally driven. In other instances it may be desirable to have but one positively driven spool in contact with film passing through a given tank and such positively driven spool may be located at any desired point along the travel of the film through such tank.

By referring to Figs. 2 and 3 it will be seen that the spool 29, for example, is provided with an internal bore 32 of larger diameter than the diameter of the shaft 8. The spool may also be provided with upstanding flanges 33 and 33', the internal surfaces of these flanges being spaced apart a distance but slightly in excess of the width of the film carried through the machine. The cylindrical body portion of the spool may be provided with a depressed midportion and end portions, such as the portions 34 and 35, of slightly larger diameter. The cylindrical surfaces of the portions 34 and 35 are the surfaces which contact with the edge portions of the film being treated. The diameter of the surfaces 34 and 35 which are in actual contact with the film determines the linear speed of the forwardly directed impulses which act upon and are applied to the film to the end that the film progresses through the machine. In the wet end of the machine, the diameter of the surfaces 34, 35, etc., is larger than the diameter of similar surfaces in the dry end of the machine, it being assumed, of course,

that the driven shafts 8 and 9 are of substantially equal diameter.

If, however, the diameter of the shaft 9 differs from the diameter of the shaft 8, then the difference in the diameter of the driving shaft 9 may be compensated for by changing the external diameter of the spools so as to make certain that the spools near the discharge end of the drier, for example, have a linear or peripheral speed applied thereto which is lower than the linear speed of the film-contacting surfaces of the spools in the wet end of the machine.

The positively driven spools (if any) such as the spool 26, are suitably keyed or attached to the driven shaft and are provided with external film-contacting surfaces having a diameter sufficient to have a linear peripheral speed substantially the same as the linear speed of the film-contacting surfaces of the frictionally driven spools, such as the spools 27, 28, and 29 adjacent thereto.

The general order of linear speeds at which the various film-contacting spools may be driven throughout the machine is diagrammatically illustrated in Fig. 4.

It is to be noted that the linear speed of all of the positively driven spools throughout the wet end of the machine from tanks A to E inclusive is maintained substantially constant, such linear speed amounting to about 6.157 inches per revolution of the driven shaft 8. As the film passes through the drier, however, it is subjected to the action of positively driven rollers which impart forwardly directed impulses at progressively slower linear speeds. As the film passes from compartment F to compartment G of the drier, the positively driven roller has a linear speed of only 6.151 inches per revolution of the shaft. When the film is ready to be discharged and is passing through the last compartment H of the drier, the rollers have a linear speed of about 6.145 inches per revolution of the shaft.

The linear speed of the freely journaled rollers is substantially that of the positively driven rollers. It is to be noted that throughout the wet end of the machine the film is subjected to the action of elements in contact with the film, these elements having forwardly directed linear speed components which are higher than the linear speed components of the elements in the drier.

It has been found that it is necessary to drive the spools or rollers in the wet end of the machine at a higher linear speed than the linear speed of the rollers in the dry end of the machine in order to overcome the drag which the solutions or liquid media in the tanks exert upon the film. It is to be remembered that most of the spools or rollers in the machine are freely journaled upon the drive shaft so that slippage may occur between the driven shaft and the internal bore, such as the bore 32 of a spool. The linear speeds mentioned herein are linear speeds which a spool would have if there was no slippage of the spools with respect to the shaft 8. Actually, some slippage occurs and it is for this reason that the film does not pile up nor break when the machine is continuously operated since minor variations in length of the film are either overcome by the excessive speed at which the rollers are driven or compensated for by slippage between the spools and the driven shafts or between the film and the external surface of the spool. It is to be noted that the spools are not provided with sprockets or teeth capable of engaging perforations of the film.

It has been further discovered that some of the aqueous media employed in the treatment of motion picture film exert an appreciably higher drag upon the film being pulled through the media than others. In a general way, the increased drag of one medium over another is comparable with the difference in specific gravity of one medium over another. A part of the present invention, therefore, contemplates overcoming the drag exerted upon a film which it is intended to progress through a liquid medium by subjecting the film to forwardly directed impulses at a sufficiently high linear speed so that the frictionally applied impulses will overcome the retarding effect or drag of the medium.

Attention is also called to the fact that in accordance with the preferred mode of operation, the driving means operate at varying linear speeds but at substantially uniform angular velocities, any variation in angular velocity which may exist in a complete machine being incidental and immaterial provided, however, the linear speeds of the devices correspond to the rules enunciated herein.

Attention is called to the fact that even though heretofore attempts have been made to use frictionally driven rollers, such rollers did not vary in external diameter but instead the internal bores of such rollers varied for the purpose of imparting different angular velocities to such rollers. When rollers differing in internal bore are carried by a shaft of uniform diameter, the frictional component between the shaft and such rollers varies with variation in the diameter of the bore of the rollers. This variable frictional component introduces a source of error and becomes troublesome. In accordance with the present invention, however, the diameter of the bores is constant and the shaft diameter is constant so that the frictional component is uniform throughout the machine.

We claim:

1. A method of passing continuous strip film through a plurality of aqueous solutions and a drier in a continuous manner comprising: subjecting a continuous strip of film to frictional-

ly applied, forwardly directed impulses simultaneously at a large number of points along its length by contacting the film with frictionally driven rollers rotating at the same rotational speed but at differing linear surface speeds, the forwardly directed impulses to which the film is subjected throughout the length passing through the aqueous media having a higher forwardly directed linear speed component than the linear speed component of the impulses to which the film is subjected in the drier.

2. A method of driving a long continuous strip of film through a wet zone in which said film is subjected to the action of liquid media and then through an adjacent drying zone in a continuous manner, comprising: subjecting the film at a large number of points along its length simultaneously to frictional contact with forwardly driven elements, driving said elements in the drying zone at progressively slower linear surface speeds as the film is discharged, driving said elements throughout the wet zone at a linear surface speed higher than the mean linear speed of the elements in the drying zone, and increasing the linear surface speed of the elements in said wet zone with increase in the specific gravity and viscosity of liquid media to which the film is subjected in said wet zone.

3. In an apparatus for continuously advancing continuous strip film through a series of tanks and then through an adjacent drier, the combination of: a driven shaft extending above a series of tanks and through the upper portion of a drier, said shaft being of substantially uniform diameter, and a plurality of rollers loosely carried on said shaft, all of said rollers having substantially uniform internal bores, the outer film contacting diameters of rollers carried by the shaft above such tanks being larger than the outer film contacting diameters of rollers carried by the shaft in the upper portion of the drier whereby rotation of said shaft will impart a higher linear surface speed to rollers above said tanks than the linear surface speed of rollers in said drier.

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