United States Patent

[11] 3,545,584

[72] Inventor **Victor Takata**
Cambridge, Massachusetts

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[73] Assignee **Artisan Industries Inc.**
Waltham, Massachusetts
a corporation of Massachusetts

Original application Sept. 12, 1966, Ser. No. 578,768, now Patent No. 3,475,945.

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[54] **SLIP CLUTCH**
2 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **192/88,** 192/103
[51] **Int. Cl.** **F16d 19/00**
[50] **Field of Search** ..... 192/85(A3), 88(A), 103(F); 188/152.86(A)

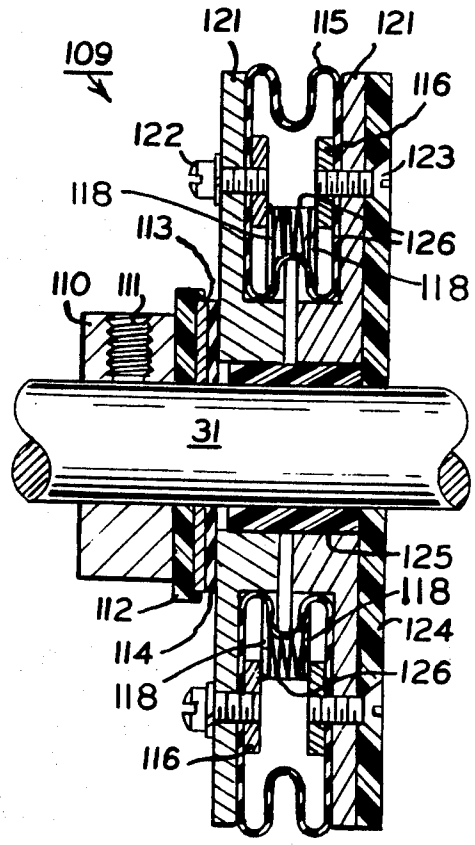
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Primary Examiner—Allan D. Herrmann
Attorney—Richard L. Cannaday

ABSTRACT: A bellows-type slip clutch for use in association with and as part of the drive system of a rotatable shaft, for example, a shaft carrying film spools in an apparatus for processing striplike photographic film, this clutch being adapted to receive rotational driving impulse from a prime mover and to have its bellows element expand under pressure and contract through resiliency with changes in fluid pressure signals to increase and decrease correspondingly its frictional driving engagement with said shaft through a pressure plate freely rotatably mounted on the shaft and turned by the prime mover and a friction disk axially movably but nonrotatably mounted on the shaft.



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SHEET 1 OF 2

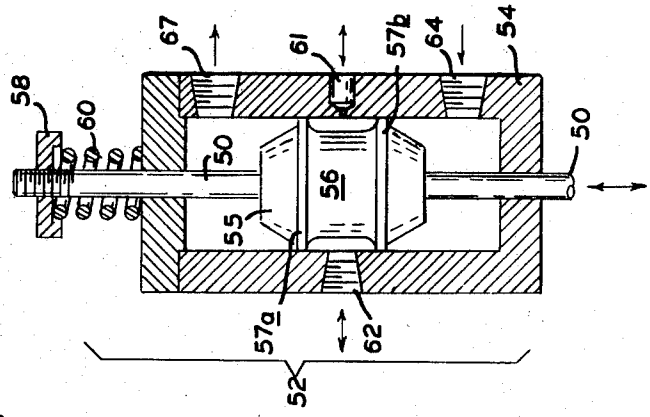


Fig.3

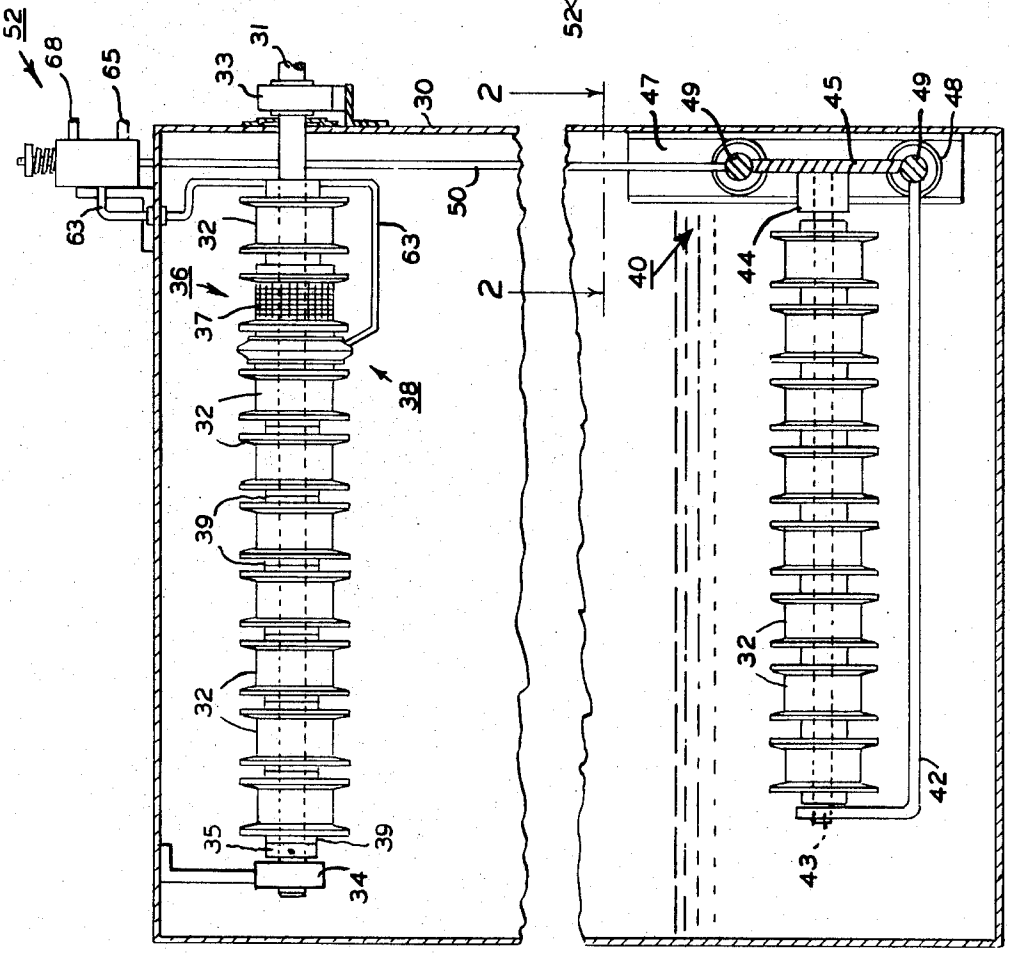


Fig.1

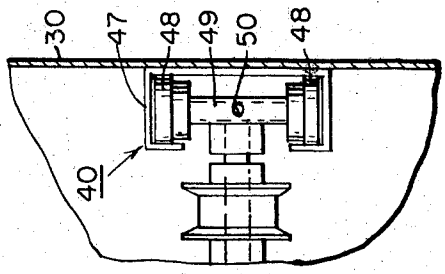


Fig.2

INVENTOR.
VICTOR TAKATA
BY
Richard L. Cannaday
ATTORNEY

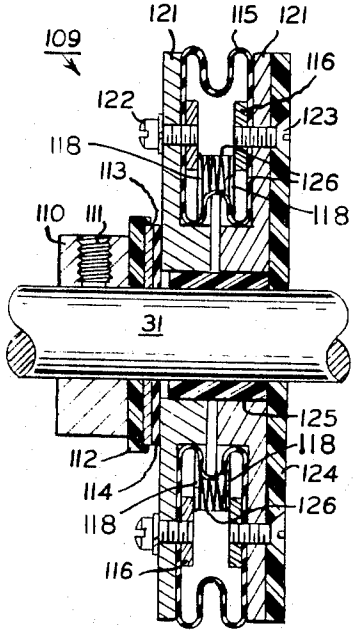


Fig.4

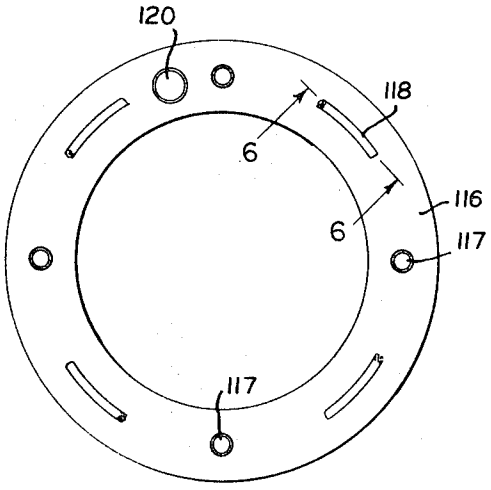


Fig.5

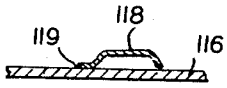


Fig.6

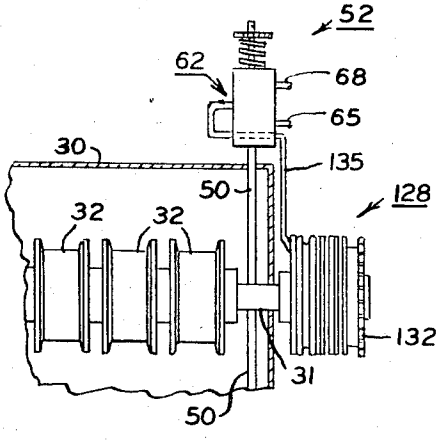


Fig.7

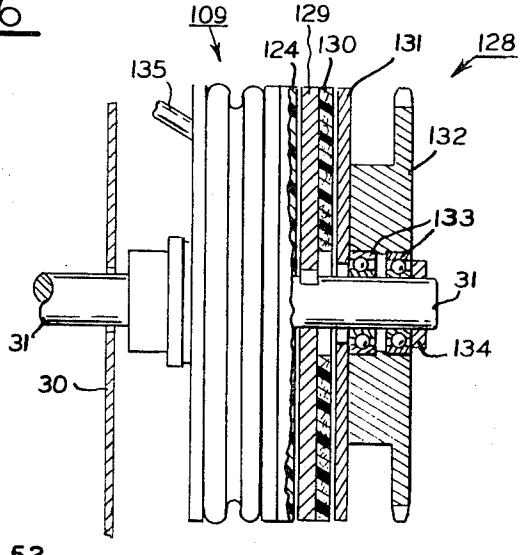


Fig.8

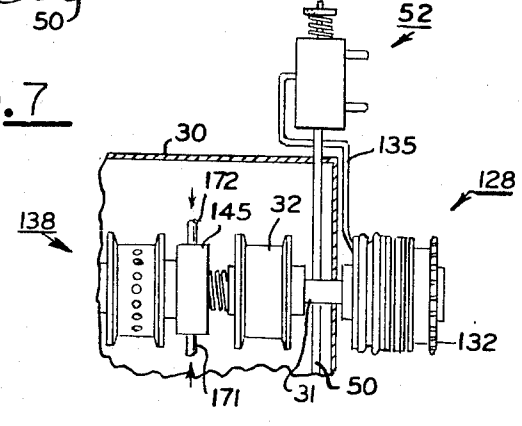


Fig.9

INVENTOR.
VICTOR TAKATA

BY
Richard L. Caumaday
ATTORNEY

SLIP CLUTCH

This application is a divisional of my Pat. application Ser. No. 578,768, filed Sept. 12, 1966, and now U.S. Pat. No. 3,475,945.

BACKGROUND OF THE INVENTION

In the processing of a strip interval exposed motion picture film it is most important that a very accurate timewise exposure or contact of the film material with the various processing materials and solutions be maintained. Currently used high-speed and color films require in their processing or developing steps certain treatments which are particularly noted as being of very short duration, for example, only a few seconds. Certain other steps of greater duration likewise require that the treatment time interval be closely regulated. As the reels of exposed film are usually several hundred feet in length, the most practical manner of processing is to feed the film in a continuous manner through a multiplicity of tanks in which each of the processing reactions may be precisely controlled. During processing it is highly desirable that the emulsion side of the film be free of contact with anything but the materials or chemicals used in the steps of developing. It is also to be borne in mind that the damp or wet film may be subject to unwanted stretching if undue or excessive tension is imposed upon it as it is transported through the various processing steps.

Automatic processing of film has been practiced for a number of years. Known apparatus for this practice includes banks of spools carried on upper and lower shafts. The spools are arranged to transport the film in a helical manner. Included in one of the known processing systems is apparatus in which the upper and lower spool-carrying shafts are in fixed relationship to each other with at least some of the spools on the lower shaft being driven so as to provide surface speeds in excess of the desired film speed. This method anticipates that film traveling a little too fast will bulge slightly from the determined path causing a slight reduction of the overall contact force of the film upon the driving spool or spools and slowing the film. If the film travels a little too slowly it does not bulge but engages the spool with a relatively greater overall contact force so as to increase its, the film's, speed. In other known systems vertically movable lower shafts are used and the speed of the film is regulated by employing an intermittent drive or by passing the film over drive spools of successively varying sizes. Still another known system utilizes a fixed sprocket on each shaft of the bank. As long as the size, type and sprocket engaging apertures of the film are the same this method of automatic processing is satisfactory, but necessarily has only very limited flexibility.

The present invention relates to an apparatus and method for film processing and the like in which film is fed to at least one bank of spools having an upper shaft and a lower shaft. The lower shaft is carried by an elevator having a means for actuating a flow control valve in response to the reciprocation of the elevator. The flow control valve modulates a flow of pressurized air, gas, or liquid, or the application of a vacuum to the interior of a clutch, spool or chamber to increase of decrease the speed of film. The flow control valve may be connected to apparatus in the same or different banks of spools. According to the inventive concepts hereinafter more fully described, variations in the tension in the strip of film being transported through the bank are used to raise and lower the elevator. Thus since the film being transported is accelerated or decelerated in response to the movement of the elevator as stated above, it is also and ultimately accelerated or decelerated according to its own tension varying either side of a normal value.

It is therefore an object of this invention to provide an apparatus for and a method of modulating the speed of traveling material of striplike form, the modulation being responsive to the tension in the material.

It is a further object of this invention to provide an apparatus for and a method of modulating the speed and tension of a traveling film strip disposed in a helix around spools carried on upper and lower shafts, the lower shaft being mounted on an elevator movable responsively to the tension of the traveling film, the elevator movement actuating a flow control valve adapted to accelerate or decelerate the film drive means or, most desirably, hold it in an essentially steady running condition.

It is a further object of this invention to provide apparatus for and a method of modulating the speed of a traveling film strip which is disposed in a helix around spools carried on upper and lower shafts, the lower shaft being mounted on an elevator movable responsively to the tension of the film strip and the elevator movement actuating a flow control valve adapted to transmit a fluid pressure signal or effect including a vacuum effect or signal, to actuate a clutch to accelerate or decelerate the spools carrying the traveling film.

These and other objects and advantages of the present invention as well as its nature and substance will be more clearly perceived and fully understood by referring to the following description and claims taken in connection with the accompanying drawings in which:

FIG. 1 represents a sectional side view of a typical film processing tank equipped with a modulating drive assembly representative of the present invention;

FIG. 2 represents a fragmentary sectional plan view showing a portion of an elevator mechanism taken along line 2–2 in FIG. 1 looking in the direction of arrows:

FIG. 3 represents a sectional side view of a modulating drive flow control valve;

FIG. 4 represents a sectional side view of a bellows-type slip clutch adapted for use with and responsiveness to a flow control valve;

FIG. 5 represents a plan view of a retaining ring used in the bellows-type clutch of FIG. 4;

FIG. 6 represents a fragmentary sectional view showing the spring hook of the retaining ring of FIG. 5 taken along line 5–5 therein looking in the direction of the arrows;

FIG. 7 represents a fragmentary sectional side view of a modulating drive including a sprocket drive and bellows-type slip clutch assembly using the bellows of FIG. 4, the drive being adapted to rotate the spool-carrying shaft at a tension-responsive variable speed;

FIG. 8 represents an enlarged view, partly in section, of a detail of the drive of FIG. 7;

FIG. 9 represents a fragmentary sectional view showing a modulating drive with a bellows-type slip clutch assembly in the manner of FIG. 7.

Referring now to the drawings in detail in which like numbers designate like members throughout the several FIGS. it is to be noted that in FIGS. 1 and 2 there is shown a processing tank 30 which although shown as being closed may be either open or closed at the top and which in the illustrated embodiment carries an upper shaft 31 on which there are mounted a series of film spools adapted to transport or convey film for processing into and out of the tank in a helical array and in a continuous manner. A series of film transporting spools 32 of conventional construction are freely rotatably and axially slidably mounted upon shaft 31, except for spool 32 farthest to the right which is freely rotatable only. This shaft itself is rotatably supported and retained by a bearing 33 mounted on a side wall or panel of processing tank 30, and is further supported within the tank by a depending bracket and bearing 34 near which there is a banking collar 35 pinned to the shaft. While the first or film in-leading spool 32 is of conventional construction, the next adjacent spool to the left generally designated 36 which is fixed to the shaft may have a special surface in its central portion 37 upon which film is carried, at least an outermost layer of this portion being of resilient material into which a series of both circumferential and longitudinal cuts are effected to provide a tread in the exterior surface of this central or film transporting portion 37. These

cuts are of sufficient spacing and depth that as spool **36** is rotated the tread surface presented to the film causes the film to be more positively gripped and advanced.

Between spool **36** and the next leftward regular spool **32** there is a bellows slip clutch generally designated **38** which is described in detail in my Pat. application Ser. No. 578,768, filed Sept. 12, 1966, and now U.S. Pat. No. 3,475,945. Between successive regular spools **32** there are pairs of collars **39**. Individually these collars may be formed as bosses on the spools, but preferably are independent elements and must in any case be free to move axially along shaft **31**. The collars are so sized as to permit each spool **32** to rotate on shaft **31** essentially independently of the adjacent spools in the absence of an axial compacting force on the spool array. A longitudinal or axial force may be applied to cause an increase in the frictional engagement of adjacent collars **39** with each other and with the adjacent spools including spool **36** and baking collar **35**. Helical springs may be used in place of collars **39**. Such springs would have a determined compressive bias, and as interspaced between the spools would provide a slightly resilient drive for the spools sequentially along the shaft.

In the lower portion of tank **30** there is disposed an elevator generally designated **40** which includes a horizontal member **42** having an upturned end which supports one end of a shaft **43**. The other end of this shaft is carried by a boss **44** extending laterally from a header **45**. A series of spools **32** are likewise carried on shaft **43**. This shaft may be thought of as a lower shaft in contrast to shaft **31** taken as an upper shaft, and in the embodiment of the present invention shown in FIGS. **1** and **2** may be considered a dead or nonrotating shaft with spools **32** which it carries turning freely with respect to it. However, if particular circumstances such as film strength make it desirable shaft **43** could be mounted in bearings in support **42** and header **45**, and spools **32** could be attached to the shaft or could be left free turning with the shaft itself either having or lacking a power drive. All of these arrangements are known to the prior art and no novelty is ascribed thereto except as the modulating drive of the present invention is associated with them and adapted to accommodate the variable operating factors found with these various film transport mechanisms.

Referring in particular to FIG. **2** it is to be noted that the right-hand side of elevator assembly **40** includes a channel element **47** mounted on the inner surface of tank **30**. This element is shaped and sized to engage and retain within U-formed leg end portions a set of our rollers **48** arranged in upper and lower pairs. These rollers are freely rotatable upon transverse shaft projections **49** carried on each end of header **45**, and are sized to be freely movable up and down in the leg end portions of the channel element. Correspondingly, boss **44** is sized and located on header **45** to be freely movable in the opening between the leg ends of channel **47**. Elevator assembly **40** is weighed appropriately either integrally or by external attachment for any given processing circumstance of the film, full liquid immersion, exposure to liquid spray, exposure to a drying atmosphere, etc., to provide a proper basic tension in the film wound helically between and around the spools on upper and lower shafts **31** and **43**, as the film extends and is transported through the whole processing apparatus.

Referring to both FIGS. **1** and **2** it is to be noted that a control rod **50** extends upwardly from elevator assembly **40**. This rod passes freely through the top panel of tank **30**, and at its upper end is operatively engaged with a modulating drive flow control valve generally designated **52**. This valve is more fully described in connection with FIG. **3**. It is to be noted particularly, however, in connection with FIGS. **1** and **2** that as the tension in film being transported over the various spools increases the elevator assembly **40** and control rod **50** are moved upwardly by action of the film, and as tension in the film is reduced the elevator assembly and the control rod are moved downwardly by gravity.

Referring next to FIG. **3** it is to be noted that modulating drive flow control valve **52** shown therein includes a housing **54** which encloses a contoured cylindrical spool **55** having tapered ends and a central portion **56** reduced in diameter. Lands or full diameter portions **57***a* and **57***b* respectively above and below reduced portion **56** are sized to a close sliding fit in the bore of housing **54** and act as gas or fluid seals therein. As shown, spool **55** is mounted on control rod **50** close to the upper end thereof so that as this rod is moved the spool attached to it is also moved in correspondence to the movement of the elevator, and thus in correspondence to the tension in the film as above described. In the modulating flow control valve of FIG. **3** the upper end of rod **50** is threaded to accept a nut **58** which retains a compression spring **60** between itself and the top surface of housing **54**, thus giving the elevator assembly a resilient suspension. Adjustment of nut **58** sets the elevator **40** at a final desired position considered to correspond to normal tension in the film and a given length of film in the tank at any one time.

In practice, the mount for valve **52** is preferably a bracket permitting gross vertical adjustment of the position of the valve and hence to a considerable extent of the elevator assembly, with fine adjustment of elevator position being effected by manipulation of nut **58**.

A vent **61** of determined size is provided in the sidewall of housing **54**. As shown, this vent is enlarged for the purpose of illustration. Opposite this vent there is a flow connection opening **62** for passage of pressurized fluid or pull of vacuum. A pipe or tube **63** as seen in FIG. **1** leads from opening **62** to diaphragm slip clutch **38**. In the lower portion of housing **54** there is an inlet opening **64** to which is connected a pipe **65** as shown in FIG. **1** which is further connected at its distant end to a source of fluid under pressure. In the upper portion of housing **54** there is an outlet opening **67** to which is connected a pipe **68** which is further connected at its distant end to a vacuum source or system. As valve spool **55** is carried upwardly by elevator rod **50** on account of increased film tension its lower land **57***b* is moved past opening **62**. Fluid under pressure entering port or opening **64** then flows through opening **62** and pipe or conduit **63** to slip clutch **38** so as to speed up the rotation of the spools on upper shaft **31** in a manner described in my Pat. application Ser. No. 578,768, filed Sept. 12, 1966 and now U.S. Pat. No. 3,475,945. This speedup causes more film to be present in the tank at a given time thereby reducing the tension in the film. As the tension is decreased the elevator is allowed to descend carrying spool **55** downwardly until upper land **57***a* passes opening **62** placing clutch **38** in communication with a source of vacuum through opening **67**. This causes a slowing down of the upper shaft spools and an increase in film tension. The foregoing operation cycle is more fully described in conjunction with the detailed description of the slip clutch in my patent application just mentioned.

Referring next to FIGS. **4**, **5** and **6** there is shown a bellows-type slip clutch **109**. As is brought out in greater detail in connection with the description of FIGS. **7**, **8** and **9**, this clutch functions in the first instance to modulate the speed of upper shaft **31** itself rather than the speed or speeds of the several spools upon this shaft. In the assembly of clutch **109** a collar **110** is attached to shaft **31** by means of setscrew **111**. A flat plastic thrust bearing **112** which is free on shaft **31** and adjacent collar **110** partially encloses a metal washer **113** which is also free on the shaft. This washer lies adjacent a second free flat plastic thrust bearing **114**. The plastic bearings **112** and **114** are preferably of Teflon or another material having a low coefficient of friction, while metal washer **113** is preferably of nonmagnetic stainless steel. A double bellows member **115** preferably made of rubber or other fluid-retaining resilient material may be molded or otherwise made of one piece or may be molded of two pieces. When of two pieces the bellows includes inner and outer generally U-shaped portions, the center part of each of which is partially folded upon itself. The bellows is provided with at least one fluid flow opening

through one of the sidewalls to the interior cavity of the bellows, this opening, not shown, being located to mate with a similar opening in a bellows retaining means described below. The side walls of the molded bellows are clamped in place by means of two retaining rings **116** shown in detail in FIG. **5**. Each ring **116** is characterized by tapped holes **117** which may be four in number. Between the holes **117** there are spring-retaining hooks **118** which are small metal tabs bent into a flattened or thin channel shape as shown in section in FIG. **6**. One end of each tab **118** is affixed to its base ring at point **119**, with the tab's other end being bent down close but not attached to the face of the ring. Also to be noted in ring **116** in FIG. **5** is a fluid flow opening **120** which is provided in at least one of the rings **116** of a given clutch assembly **109** for alignment with the aforementioned opening in bellows **115** so that a tube or conduit constituting a fluid flow conductor from the interior of the bellows element of the slip clutch may be attached to the flow connection opening of one of the valves **52**, **69**, described above. A pair of circular metal end members **121** provide rigid side supports for bellows **115**, these end members having clear holes through the n for the passage of fillister-head cap screws **122** seen on the left-hand side of FIG. **4** and flat head screws **123** seen on the right-hand side in FIG. **4** which are threaded into holes **117** in rings **116** whereby these rings, the bellows, and the end members are clamped together. Also attached by means of flat head screws **123** is a pressure plate **124** which is preferably made of Teflon and is both free turning and free sliding with respect to shaft **31**. A bearing **125** which also is preferably made of Teflon is provided to carry the bellows assembly including end members **121** and pressure plate **124** on shaft **31**. This bearing preferably has a press fit within one of the end members and a free turning fit on shaft **31**.

Collar **110** provides a stop reference so that all expansive movement generated by pressure applied to the interior of double bellows **115** causes pressure plate **124** to move outwardly or to the right. Likewise, when vacuum is applied to the interior of the bellows the pressure plate is drawn back leftwardly. As the action or movement to be generated by the bellows, that is, its expansion and contraction needed to move pressure plate **124** into and out of operating position, need be and preferably is only very slight, urging or moving of the pressure plate to the left or retracted or nonoperating position by the application of vacuum to the bellows **115** is made positive and particularly made even by an assist provided in the form of springs **126**. The ends of these springs are attached by means of hooks **118** to one of the bellows retaining rings **116** and extend and are attached to corresponding hooks on the opposite retaining ring. The bellows assembly of slip clutch **109** is maintained in a nonrotating condition by means of the tube or conduit connection to the fluid flow opening **120** or by a support or brace, not shown, similar to means used to keep bellows slip clutch **38** nonrotative.

Referring next to FIGS. **7** and **8** there is shown a clutch and sprocket drive assembly **128** associated with shaft **31** with one or more of the spools **32** being fixedly attached to the shaft and the rotational speed of the shaft itself being made responsive to the action of modulating drive flow control valve **52**. The bellows-type slip clutch assembly **109** shown in FIG. **4** is used to receive signals from flow connection opening **62** of the control valve. As seen in FIG. **8** the face of pressure plate **124** is adjacent a metal carrier disc **129** which is axially but not rotationally movable with respect to shaft **31**. A composition friction disc **130** is fixedly attached to and carried by disc **129**. The right-hand side of the friction disc is adjacent a metal pressure plate **131** which is fixedly attached to a sprocket or gear wheel **132** mounted on bearings **133** to be freely rotatable with respect to shaft **31**. The sprocket or gear wheel which is retained on the shaft by collar or snap ring **134** is driven at an essentially constant speed by a prime mover not shown. A tube or conduit **135** extends from the flow connection opening of control valve **52** to the opening in end member **121** of clutch assembly **109** in alignment with retaining ring flow opening **120**.

A pressure signal transmitted to clutch assembly **109** from control valve **52** will move pressure plate **124** to the right pushing carrier disc **129** and friction disc **130** ahead of it with the friction disc coming to bear against pressure plate **131**. This will generate at least some clutching action between sprocket wheel or gear **132** and shaft **31** with rotational slippage possibly taking place between disc **130** and plate **131**, and such slippage definitely occurring between pressure plate **124** and carrier plate **129** because of the bellows portion of assembly **109** being restrained against rotation and carrier plate **129** being required to turn with shaft **31**. The greater the fluid pressure applied to the bellows portion of clutch assembly **109** from the control valve through conduit **135** the greater will be the clutching action generated at the opposing faces of friction disc **130** and pressure plate **131** until, in the limit, there is no rotational slippage between this plate and this disc and shaft **31** is being driven at an angular speed equal to that of sprocket wheel **132**. Conversely, clutching action may be diminished or in the end entirely and rapidly destroyed by relieving the fluid pressure applied to clutch assembly **109** or changing the pressure signal from control valve **52** to a vacuum signal, all as determined by the vertical movement of elevator control rod **50** in response to varying conditions of tension in the film being processed.

The drive modulation system of the apparatus arrangement of FIG. **7** may be compared with that of the arrangement of FIG. **1** so far as intermediate effects are concerned, although it is to be understood that an ultimate result of modulation of the speed of spools around which the film is passing is achieved in each case. In the case of FIG. **7** as described just applied the rotational speed of shaft **31** is modulated up to a peak value of the speed of sprocket wheel gear rotational assumed to be turning at a constant speed, and the speeds of those spools **32** fixed to the shaft rise and fall with that of the shaft. In the case of FIG. **1**, on the other hand, upper shaft **31** is assumed to be driven at a constant speed with spools **32** being freewheeling on it and with respect to each other in the absence of fluid pressure in bellows-type slip clutch assembly **38**. As pressure is applied to this assembly from control valve **52** through conduit **63**, however, the otherwise freewheeling spools **32** are compacted axially between the clutch assembly and banking collar **35**, and this collar which is pinned to and turns with shaft **31** begins to impart some angular speed to these spools. With only light pressure transmitted to clutch assembly and only light packing of the spool array, there will still be discernable slip or difference in speed between spools **32** and the shaft, and indeed between various ones of the spools themselves. As clutch assembly **38** receives a stronger pressure signal, however, and the spool array is more tightly packed, both spool-to-shaft and spool-to-spool slip will decrease, and the rotational speeds of all of the spools will tend to approach that of the shaft. Contrarily, as a weaker pressure signal is transmitted from control valve **52** there will be more slip and a decrease in spool speeds.

Referring next to FIG. **9** there is shown a combination-type modulating drive actuated on a single upper shaft **31** which includes a bellows-type slip clutch and sprocket drive assembly **128** in the manner of FIG. **7**, and a film transporting spool assembly **138** having a fluid-actuated film gripping and releasing means operating through holes in the spool surface in a manner disclosed in my Pat. application Ser. No. 578,768, filed Sept. 12, 1966, and now U.S. Pat. No. 3,475,945. High- and low-pressure or vacuum signals are transmitted to drive assembly **128** from a modulating drive flow control valve **52** just as shown in FIG. **7**, while pipes or conduits **171** and **172** are joined to connections in block **145** of spool assembly **138** for the supplying and withdrawing of fluid for film grip modulation purposes. These pipes may be considered to be part of a film processing liquid pumping circuit shown and described in my patent application just mentioned. Flow through such a circuit may be regulated by a second valve **52**, not shown, which may be actuated by an elevator control rod **50** separate from the rod which is illustrated or which may indeed be placed in tandem with the illustrated valve on the same con-

trol rod. The particular combination-type modulating drive shown in FIG. **9** is provided for purposes of example only, that is, for showing that the several particular drive modulation systems or means illustrated and described herein and also in my said Pat. application Ser. No. 578,768, filed Sept. 12, 1966, are amenable to use in combination. Combinations other than the one illustrated will suggest themselves to those skilled in the art with the particular combination used in any given case depending on the circumstances of that case such as preferred film speed and tension, coefficients of friction between the film and the spool surfaces over which it is running, fineness of control required etc.

In all of the preceding description it has been indicated that power drive to a film spool bank is applied at the bank's upper shaft **31**. While the upper shaft is often the powered shaft, it is to be understood that lower shaft **43** may also be power driven. In this arrangement a power transmission shaft may be disposed vertically in tank **30**, extending from above the top to close to the bottom thereof. At its upper end this transmission shaft may be connected to a prime mover through a spline coupling to allow the shaft to have vertical motion while at its lower end it is connected to lower film spool shaft **43** through bevel tears. A clutch responsive to signals from a control valve actuated according to the up and down movement of the elevator may be carried on the lower shaft so as to provide a modulated f drive to the lower shaft's spools with reference to an assumed established angular speed of lower shaft **43** itself. Further, it may sometimes be desirable to apply a power drive to both the upper and the lower shafts of a given film spool bank with each of these shafts and/or the spool arrays on them having clutch mechanisms associated with them which are energized responsively to the vertical movement of the elevator of this bank and/or another bank or banks.

Protection by Letters Patent of this invention in all its aspects as the same are set forth in the appended claims is sought to the broadest extent that the prior art allows.

I claim:

1. In association with a rotatable shaft a slip clutch assembly wherethrough said shaft may be driven, said assembly comprising (1) a pressure plate freely rotatably mounted on said shaft, said pressure plate being adapted for operative engagement with a prime mover, (2) a friction disc and carrier means therefor axially movably but nonrotatably mounted upon said shaft so that said friction disc may be moved into contact with said pressure plate, and (3) an annular bellows surrounding said shaft and within which said shaft is freely rotatable, said bellows being disposed to be expanded to exert thrust against said axially movable friction disc and its carrier means to urge them against and into frictional, clutching engagement with said pressure plate while itself having negligible frictional engagement with said friction disc and carrier means.

2. A slip clutch assembly according to claim **1** which further comprises at least one tension spring within said bellows and attached to opposite ends thereof, this spring tending to maintain the bellows in contracted condition.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,545,584 Dated December 8, 1970

Inventor Victor Takata

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, column 1, line 10: for "3,475,945" read --3,474,945--. Regular text, column 1, line 5: for "3,475,945" read --3,474,945. Column 1, line 8: for "interval" read --of--. Column 1, line 61: for "of" (last word in line) read --or--. Column 3, line 7: for "3,475,945 read --3,474,945--. Column 3, line 17: for "baking" read --banking--. Column 3, line 48: for "our" read --four--. Column 3, line 55: for "weighed" read --weighted--. Column line 43: for "3,475,945" read --3,474,945--. Column 5, line 18: for "one of the valves" read --valve--. Column 5, line 18: cancel comma after "52". Column 5, line 19: cancel "69,". Column 6, line 30: for "applied" read --above--. Column 6, line 32: between "wheel" and "gear" read --or--. Column 6, line 32: for "rotational" read --132--. Column 6, line 62: for "3,475,945" read --3,474,945--. Column 7, line 23: for "tears" read --gears- Column 7, line 26: cancel "f".

Signed and sealed this 8th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents