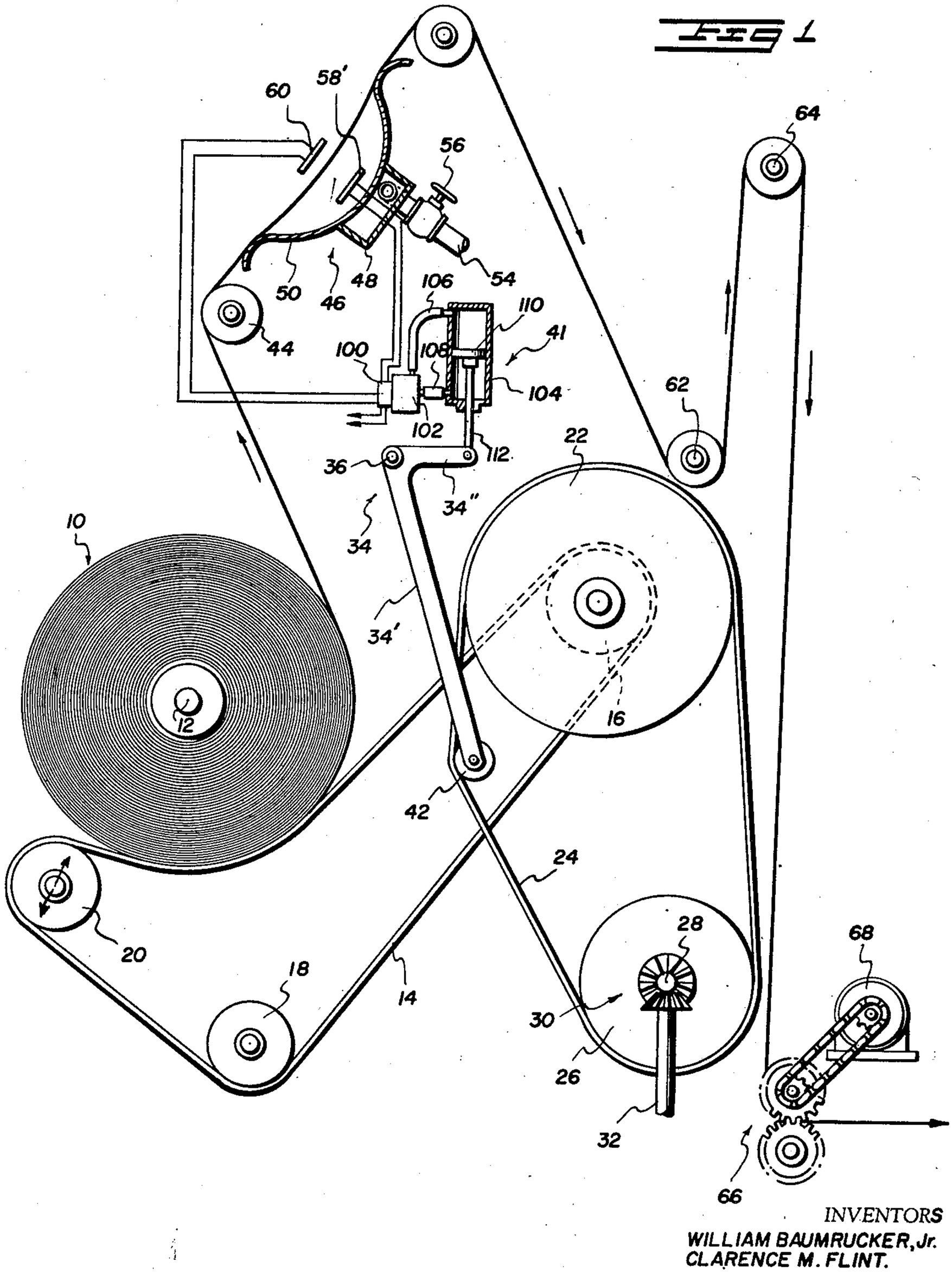
June 7, 1955 W. BAUMRUCKER, JR., ET AL 2,710,154

WEB TENSION CONTROL SYSTEM

Filed June 24, 1954 4 Sheets-Sheet 1

FIG 1



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WEB TENSION CONTROL SYSTEM

Filed June 24, 1954 4 Sheets-Sheet 2

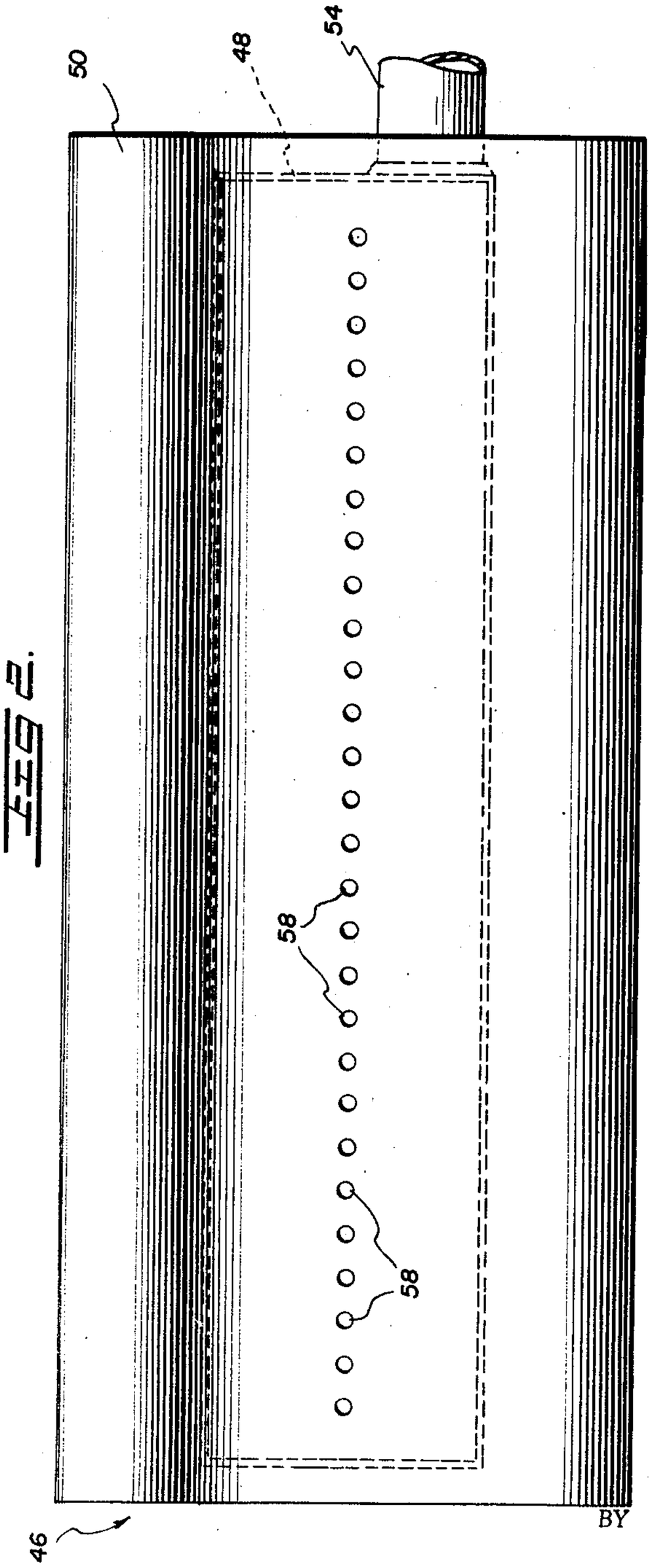

FIG 2.

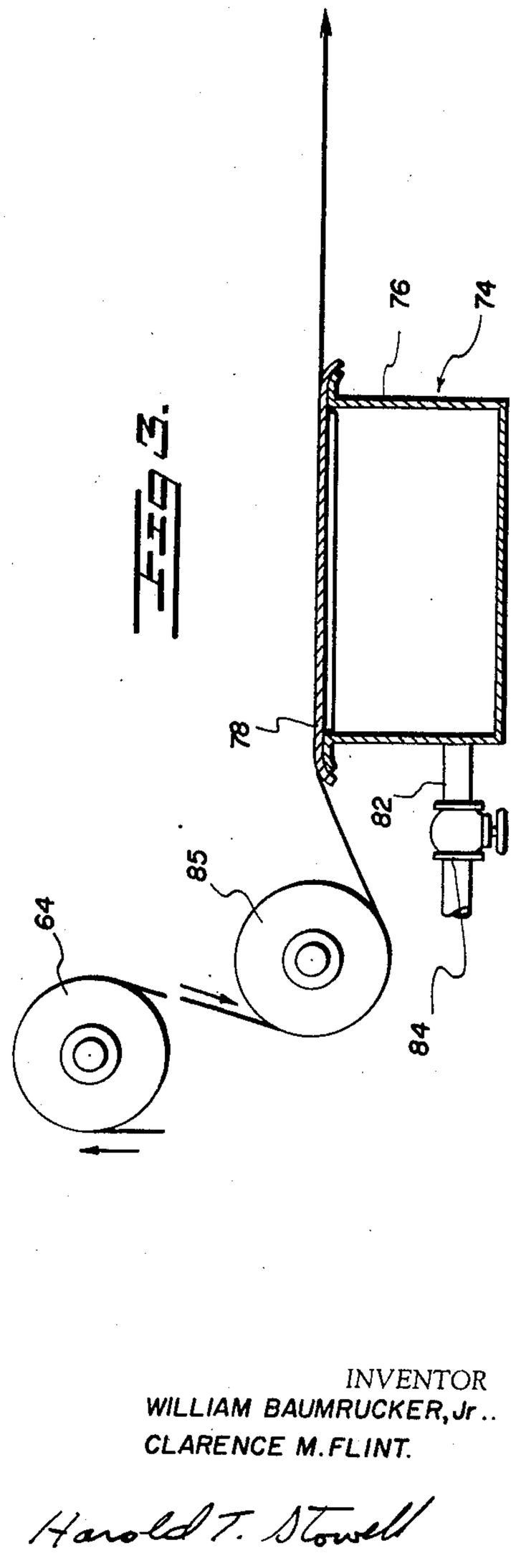

FIG 3.

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WEB TENSION CONTROL SYSTEM

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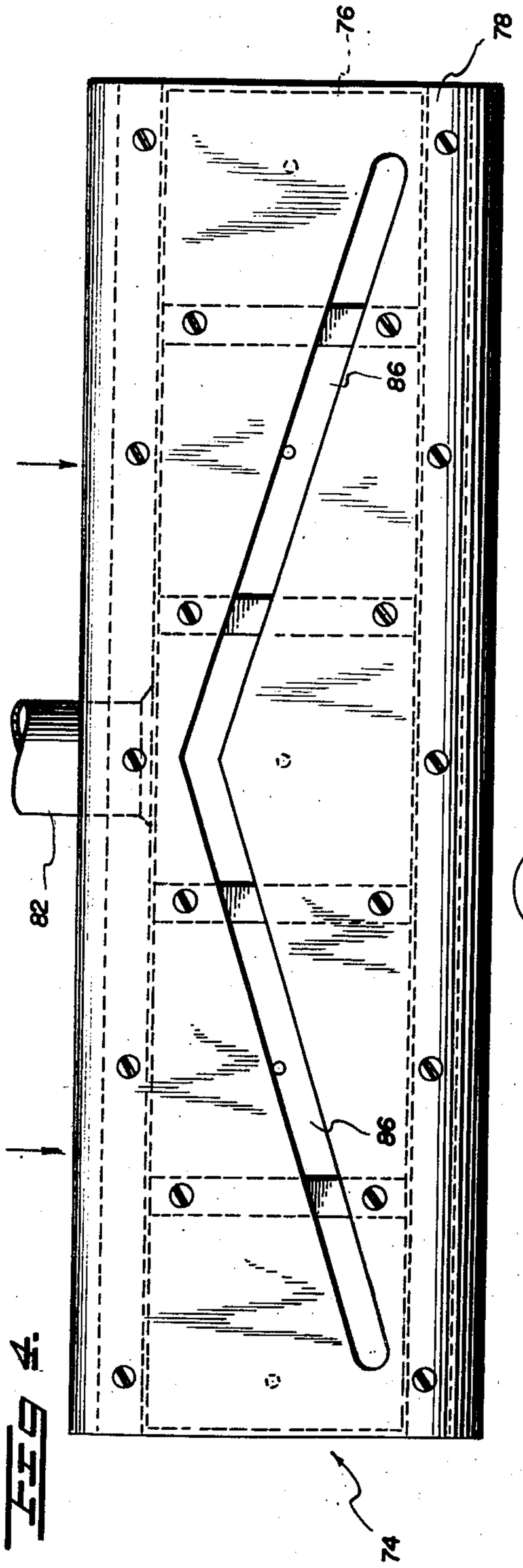

FIG 4.

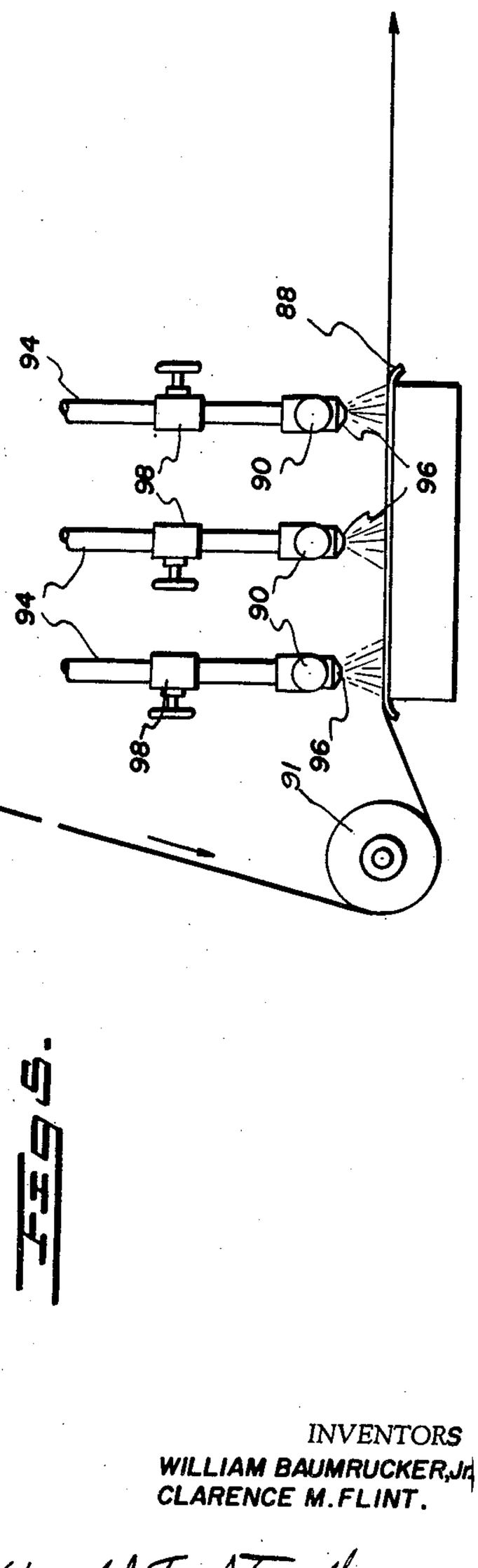

FIG 5.

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WEB TENSION CONTROL SYSTEM

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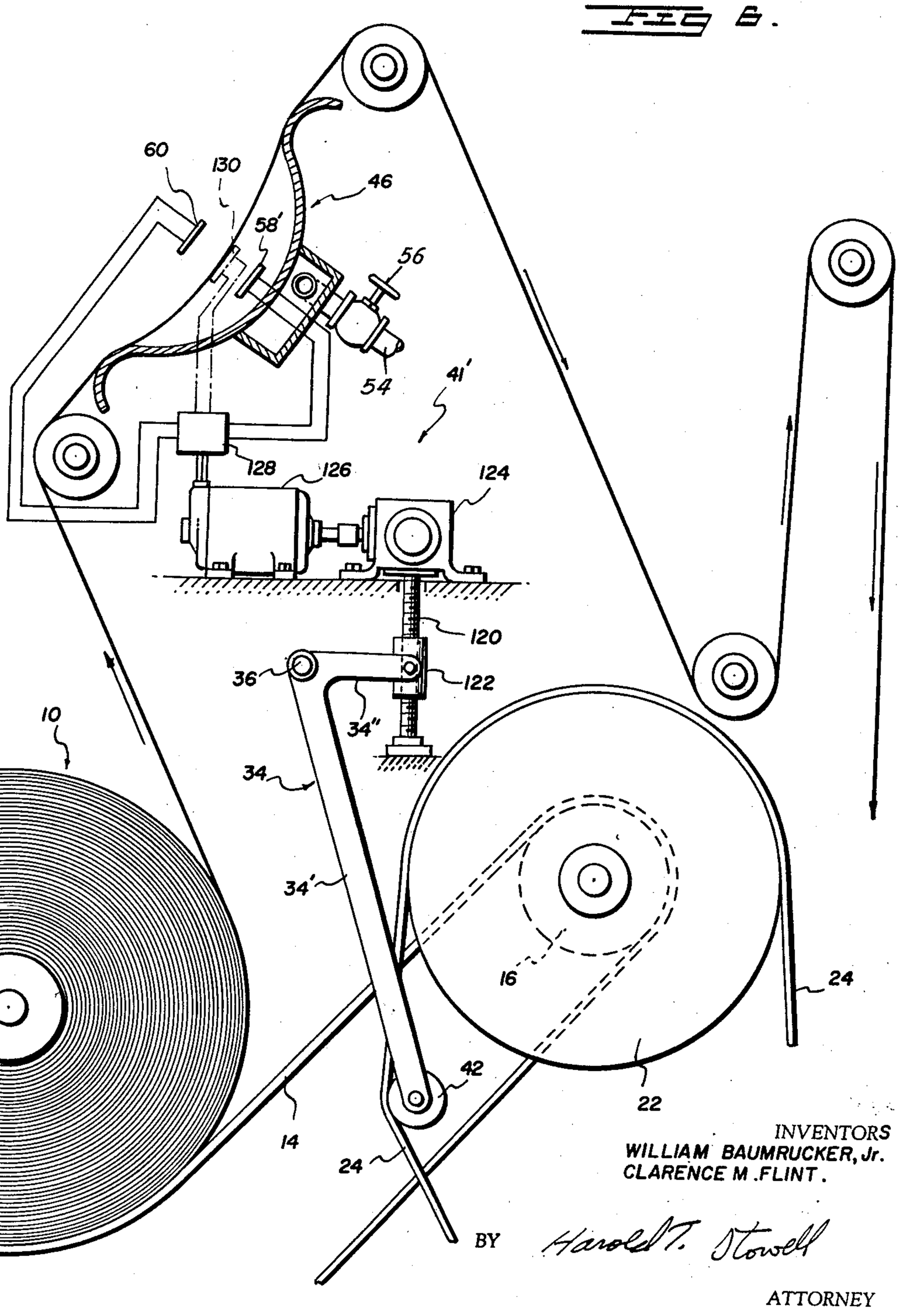
FIG 8.



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WEB TENSION CONTROL SYSTEM

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Application June 24, 1954, Serial No. 439,071

6 Claims. (Cl. 242—75)

This invention relates to a web tension control system wherein the tension in a web as it is unwound from a roll is independent of the web tension thereafter, and wherein the tension in the web as it is wound upon a roll is independent of the tension in the web prior to the winding step.

It is a principal object of the invention to provide web tension control means for web processing apparatus wherein the tension in the web as it is wound or unwound from a roll or the like is independent of the web tension before or after entering or leaving the web tension control system whereby variations comprised of both low and high frequency values of tension changes, and having a wide degree of amplitude, will not be transmitted to or from the web roll.

A further object is to provide such a control system wherein it is possible to maintain tension in the web within precisely controlled limits.

A further object is to provide a web tension control system that will substantially obviate web breaks when running or winding out of round rolls.

Another object is to provide a web tension control arrangement that is comparatively simple as to its parts, inexpensive to manufacture, less complex to install and maintain, and readily adaptable to various operating conditions.

The system of the invention may be advantageously employed in a wide variety of industries and with many types of products, for example, textile and plastic weaving, finishing and dyeing, and paper printing, finishing and drying.

The invention will be more particularly described by way of example with reference to a web printing machine.

Generally, on web-fed printing presses, provision is made for the application of tension on the web roll so that the web or paper leaves the unwinding roll in a taut condition, thus preventing the web of paper from fluttering or weaving and to provide for the control of the web as it enters the printing couple. This tension is often as high as 1 to 2 pounds per inch of width of the web and means must be provided whereby the press operator may change the tension on the web entering the printing press so that various webs being joined at the folder following printing will be in page register.

In the past web tension has customarily been applied by breaking the unwinding roll, for example, by providing brake drums on the web roll shaft; or through the use of friction straps which bear against the outside of the roll; or through the use of a "running belt" in contact with the periphery of the roll, the belt being driven at a slower speed than the corresponding surface speed of the press web as it is printed.

In all of the aforementioned web tension systems, the web leaves the roll at substantially full operating tension and means for maintaining uniformity of tension and for absorbing slight abrupt tension variations generally comprise a floating roller, over which the web passes prior to its entry into the printing couple. The floating roller must be sturdy and of heavy construction as the

web passing over it may be at a tension of from about 32 pounds to about 250 pounds, with a normal operating average of about 100 pounds, thus the roller's natural period is long and it is generally provided with hydraulic or the like damping mechanism. The combination of the heavy weight and long period, plus the damping, effectively prevents presently available floating rollers from following rapid fluctuations in the web tension such as those caused by out of round rolls. Thus when eccentric rolls are run at high speed, the web is jerked severely every time a change from the short to the long radius occurs. Even when the roll is only moderately out of round, a jerk as above described occurring simultaneously with the presence of a defect in the web leaving the roll, for example, a slime hole, mill calendar cut, or the like, will cause the web to break.

The web tension control system for a web processing device of the invention may be generally described as including a web roll, a web roll drive, drag means between the web roll and the processing device maintaining a controlled tension between said drag means and the processing device, slack gathering means between the web roll and said drag means to smooth out short term variations in the tension of the web and maintaining a predetermined drag on the web at said slack gathering means, means actuated by variations in slack in said web in the slack gathering means to vary the speed of the web roll drive to maintain said slack within a predetermined range and independent of the web tension between the drag means and the processing device.

In the specification and claims of the application, the term "slack" is used to denote variations in the length or tension of the web.

The web tension control system shown in the illustrative embodiments of the invention are shown for the purposes of illustration as applied to various web roll unwinding mechanisms including the roll unwinding mechanism set forth in applications Serial No. 770,440, filed August 25, 1947, now Patent No. 2,670,907, and Serial No. 242,199, filed August 17, 1951, by W. F. Huck.

In the drawings:

Fig. 1 is a diagrammatic view in elevation of one form of the web tension control apparatus of the invention;

Fig. 2 is an enlarged plan view of the web takeup mechanism shown in Fig. 1.

Fig. 3 is an enlarged fragmentary view in elevation of another web tension applying mechanism;

Fig. 4 is an enlarged plan view of the device shown in Fig. 3;

Fig. 5 is an enlarged diagrammatic view in elevation of still another form of the web tension applying apparatus; and

Fig. 6 is an enlarged fragmentary diagrammatic view in elevation of another form of the control apparatus of the invention.

With reference to the drawings and in particular to Fig. 1, a web of printing material indicated by the continuous heavy line having directional arrows, originates from a supply roll **10**. The roll is supported for rotation on a shaft **12** suitably carried by the side frames of the mechanism but not shown in the drawings for clarity of the principal components of the invention. The roll **10** is driven by at least one driving belt **14**. The driving belt passes over a driven pulley **16** and over two idler pulleys **18** and **20** so that a portion of the outer face of the driving belt **14** is in contact with a portion of the periphery of the roll **10**. In order to compensate for the normal change in diameter of roll **10** as it unwinds, idler pulley **20** is supported movably in the direction of the arrows and biased toward the roll whereby the drive belt **14** is always in contact with a portion of the periphery of the roll and at constant pressure.

Pulley 16 is drivably secured to a V-belt pulley 22, and the latter is driven by a V-belt 24 which in turn is driven by a variable diameter speed changing drive pulley 26. Pulley 26 is secured to a shaft 28 of which one end is driven by a pair of bevel gears 30, one of said gears being secured to a vertical drive shaft 32. The drive shaft 32 is driven by a motor, not shown in the drawings. It has been found to be advantageous when employing the device with prining machines to drive the shaft 32 by the same motor that drives the printing couples of the printing machine, whereby, if the printing machine is stopped, started, accelerated or decelerated, the shaft 32 and pulley 26 are likewise actuated.

A bellcrank 34 pivotally mounted on shaft 36 has an idler pulley 42 adapted to engage the inner surface of V-belt 24, rotatably supported on arm 34' while the other arm 34'' is connected to a drive mechanism generally designated 41, to be more fully described hereinafter.

The drive mechanism 41 is actuated by changes in the position of the web or the amount of slack at the loop and cause the bellcrank 34 to rock about its pivot shaft 36. The movements of the bellcrank 34 rock the idler pulley 42 changing the tension of V-belt 24 with the result that the V-belt 24 will run on either a larger or smaller diameter of the variable diameter V-belt pulley 26. This effectively increases or decreases the peripheral speed of the driving belt 14 and in turn the peripheral speed of the web of paper, thus providing the initial control of the speed of the web. This arrangement, however, does not effectively compensate for the fluctuations and jerks in the web occasioned by out-of-round or distorted rolls with the aforementioned roll drive mechanism.

As the web is unwound by the running belt, it passes over a standard pipe roller 44 thence into a loop. The loop may be maintained by any of the well known methods, for example, a light spring roller or bar, or a roller or bar held against the web by a constant air blast system, or a soft blast of air alone may be used. In the preferred form of the invention, however, the loop is formed and maintained by a vacuum box 46.

The vacuum box 46, as more clearly shown in Figs. 1 and 2 of the drawings, generally comprises an elongated trough-like lower portion 48 and an elongated U-shaped cover plate 50 with smoothly down-curved lateral edges. The length of the trough and cover plate is slightly longer than the maximum width of the web to be used on the particular printing machine. In one of the side or end walls of trough 48 an orifice is provided into which the vacuum conduit 54 is secured. The conduit is preferably provided with a control valve, such as the hand valve 56 shown in the drawings, for regulating the "pull" on the web.

Centrally disposed in the longitudinal axis of the cover plate are a plurality of orifices 58, which function to hold the web in a loop when a light vacuum is applied to the conduit 54. Fluctuations in the web feed, such as might be caused by out-of-round rolls cause the loop formed and maintained by the vacuum box, to raise and lower thus substantially eliminating web jerks beyond this point. Thus the web is kept from fluttering or weaving automatically with substantially little tension in the web whereby breakage in the printing material is substantially eliminated at this point.

These fluctuations do not generally effect any change in the speed of the variable speed drive device; however, secured to the vacuum box 46 are a pair of sensitive electrical control limit switches 58' and 60, which switches when actuated affect the roll speed. Switch 58' is positioned at a point corresponding to the lowest desirable limit of the loop to be maintained and switch 60 is positioned at the upper limit thereof. If the unrolling of the web by the variable speed drive is increased or decreased with respect to the feed of the web through the printing machine, switch 58' or 60 will be actuated and remain in the "on" position as long as the loop is in contact therewith. Closing of either switch 58' or 60 sends an electrical signal of a particular sense and direction to the electric solenoid 100, which actuates pressure fluid control valve 102 connected to a source of pressure fluid not shown in the drawings, and to the upper and lower ends of pressure fluid cylinder 104 through conduits 106 and 108, respectively.

Pressure fluid directed to and from the cylinder 104 through conduits 106 and 108 repositions the piston 110 and in turn the bellcrank 34 which is connected thereto by piston rod 112. The change in position of the bellcrank and its connected idler 42 brings about a change in the tension of the V-belt 24 and in turn a change in speed at which the roll 10 is unwound. The new position of the bellcrank is maintained until either of the limit switches 58' or 60 is again actuated to again reestablish the necessary relationship between the unwinding speed and the press speed.

From the foregoing description it will be seen that when the web is unwound at substantially the same speed as the web is fed into the printing machine, the rapid fluctuations in the web caused by distorted rolls of printing material will not affect the speed of the web of paper, but merely cause slight variations in the length of the loop formed by the vacuum box 46.

It will also be evident that other loop forming means may be employed in the system, such as a continuous blast of air, and the switches 58' and 60 may be replaced with photoelectric cells for sensing the position of the loop so formed.

The web after leaving the loop forming device passes under and over standard pipe rollers 62 and 64 thence to a pair of in-feed rollers 66 which grasp the web of newsprint. The in-feed rollers 66 are driven by a variable speed motor 68 under the control of the press operator, whereby the infeed rollers may be regulated to run at a slightly slower speed than the web in the printing couples, thereby increasing the drag on the web to provide correct printing register.

In the form of the invention shown in Figs. 3 and 4 of the illustrative embodiments of the invention the drag means whereby the web is placed under any desired tension within wide limits, for example, to the correct tension to insure accurate printing register, and correct page register at the folder following the printing couple, when the web tension control system is employed on a web printing machine is in the form of a suction box 74. Suction box 74 generally comprises an elongated trough-like lower portion 76 and an elongated cover plate 78 with smoothly down-curved lateral edges. The length of the trough and cover plate is slightly longer than the maximum width of the web to be used on the printing machine. In one of the side or end walls of the trough 76 an orifice is provided into which the vacuum conduit 82 is secured. The vacuum conduit is provided with a control valve such as shown at 84 whereby the press operator may change the suction in the vacuum box to control the drag on the web between the suction box and the printing couple.

The cover plate is provided with a polished upper surface to reduce frictional drag between the web and the box. In the cover plate one or more narrow slots 86 in the shape of V's are provided, the apex of the slot being directed opposite to the direction of web travel as shown by the arrows on Fig. 4 with the legs of the slot extending substantially the entire width of the suction box.

As the web is drawn over roller 64, under roller 85 and across this suction box by the printing couple of the printing press, the atmospheric pressure tends to hold the web to the upper surface of the cover plate 78 and creates a tension in the web proportional to the suction applied to the box 74. The V-shaped opening in the cover plate, in addition to tensioning the web, tends to hold or stretch the web sideways smoothing it prior to

its entry into the printing couple. It will be evident that other shaped openings may be used in the cover plate, either alone or in conjunction with the V-slot **86** without substantially altering the primary function of the suction box **74**.

In Fig. 5 of the drawings another form of drag means is shown, comprising a flat plate **88** of metal or the like having a length slightly greater than the width of the web, suitably supported adjacent a standard pipe roller **91**. Positioned above the plate **88** are one or more conduits **90** positioned across the width of the plate **88**. Each of the conduits **90** is supplied with compressed air or the like through conduits **94**, which in turn are connected to a suitable source of compressed air or other pressure fluid.

A plurality of pressure fluid outlets **96** are provided in the conduits **90** adjacent the upper surface of plate **88** through which jets or streams of air issue. The force of the air streams causes a friction drag between the travelling web and the upper surface of the plate **88**.

The amount of tension to be applied to the web is dependent on the magnitude of the pressure applied by the air stream and the surface texture of the plate **88**. A manual or automatic valve **98** may be provided in each conduit **94** whereby control of the drag means may be readily had.

In Fig. 6, a modified form of the invention is shown wherein the means for rocking the bellcrank **34** comprises a motor driven lead screw. The web roll **10** is driven by at least one driving belt **14** which passes over driven pulley **16**. The pulley **16** is drivably secured to a V-belt pulley **22**, which in turn is driven by V-belt **24** connected to a variable diameter speed changing drive pulley as described and shown in reference to Fig. 1. The bellcrank **34**, which is pivotally mounted on shaft **36** rotatably carries an idler pulley **42** at one end of arm **34'** adapted to engage the inner surface of V-belt **24**. The other arm **34''** of the bell crank is pivotally connected to a drive mechanism **41'**.

The drive mechanism **41'** generally comprises a lead screw **120**, screw follower **122** pivotally connected to arm **34''**, reduction gear unit **124** drivably connected to the lead screw, reversible motor **126**, and an electrically operated motor selector switch **128**.

Within the vacuum box **46** are sensitive limit switches **60** and **58'**. Switch **58'** is positioned at a point corresponding to the lowest desirable limit of the loop to be maintained and switch **60** is positioned at the upper limit thereof. If the unrolling of the web by the variable spaced drive is increased or decreased with respect to the feed of the web through the printing machine, switch **58'** or **60** will be actuated and remain in the "on" position as long as the loop is in contact therewith. Closing of either switch **58'** or **60** sends an electrical signal to the selector switch **128** which energizes the reversible motor **126** and the pulley **42** is rocked through bellcrank **34**, lead screw **120** and reduction gear unit **124** to bring about a change in the tension of the V-belt **24** and in turn a change in speed at which the roll **10** is unwound. The new position of the bellcrank is maintained until either of the limit switches **58'** or **60** is again actuated to again re-establish the necessary relationship between the unwinding speed and the press speed.

While switches **58'** and **60** have been described as being contact switches which are actuated to the "on" position only as long as the loop of the web is in contact therewith, it is apparent that the switches may be of the type which when actuated remain in the "on" position until the loop has reached a new predetermined position. For example, when switches of the latter type are employed in the control system, a third switch positioned approximately midway between the upper and lower switches could be employed to de-energize the reversible motor **126** when the loop reaches the approximate mid-point between the two limit switches at which time the driving lead screw would be stopped until such time as the web again moved to either of the extreme positions whence it would be once again adjusted to the middle position. Such a switch is shown in Fig. 6 at **130** in phantom lines.

It will be evident that while the present invention has been described in reference to web roll unwinding apparatus, it will be apparent the objects and advantages of the system may be fully realized on web roll winding machines.

This application is a continuation-in-part of our application Serial No. 290,668, filed May 29, 1952, now abandoned, and related subject matter is disclosed and claimed in our application Serial No. 415,508, filed March 11, 1954.

We claim:

1. A web tension control system for a web processing device including a web roll, and web roll drive, comprising drag means between the web roll and the processing device maintaining a controlled tension between said drag means and the processing device, slack gathering means between the web roll and said drag means to smooth out short term variations in the tension of the web and maintaining a predetermined drag on the web at said slack gathering means, means actuated by variations in slack in said web in the slack gathering means to vary the speed of the web roll drive to maintain said slack within a predetermined range and independent of the web tension between the drag means and the processing device.

2. A web tension control system for a web processing device including a web roll, and web roll drive, comprising drag means between the web roll and the processing device maintaining a controlled tension between said drag means and the processing device, slack gathering means between the web roll and said drag means to smooth out short term variations in the tension of the web and maintaining a predetermined drag on the web at said slack gathering means, said slack gathering means comprising a suction box, means for applying a negative pressure to said box, a concave cover plate secured to said box having openings therein communicating with the interior of the box, said concave cover plate being positioned adjacent one face of the web with the longitudinal axis parallel to the lateral axis of the web, means actuated by variations in slack in said web in the slack gathering means to vary the speed of the web roll drive to maintain said slack within a predetermined range and independent of the web tension between the drag means and the processing device.

3. The invention defined in claim 2 wherein the drag means comprises a second suction box positioned adjacent one face of the web, means for applying a negative pressure to said second suction box, and a substantially flat cover plate secured to the top of said second suction box having openings therein communicating with its interior.

4. The invention as defined in claim 3 wherein the openings in the cover of the second suction box are V-shaped with the apex of the V-shaped openings being directed opposite to the direction of web travel.

5. The invention defined in claim 2 wherein the drag means comprises opposed in-feed rollers.

6. The invention defined in claim 2 wherein the drag means comprises a plate positioned adjacent one face of the web, conduit means connected to a source of pressure fluid positioned above said plate and web, and a plurality of downwardly directed pressure fluid outlets connected to said conduit means.

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