June 7, 1955 W. BAUMRUCKER, JR., ET AL 2,710,153

WEB TENSION CONTROL SYSTEM

Filed March 11, 1954 4 Sheets-Sheet 1

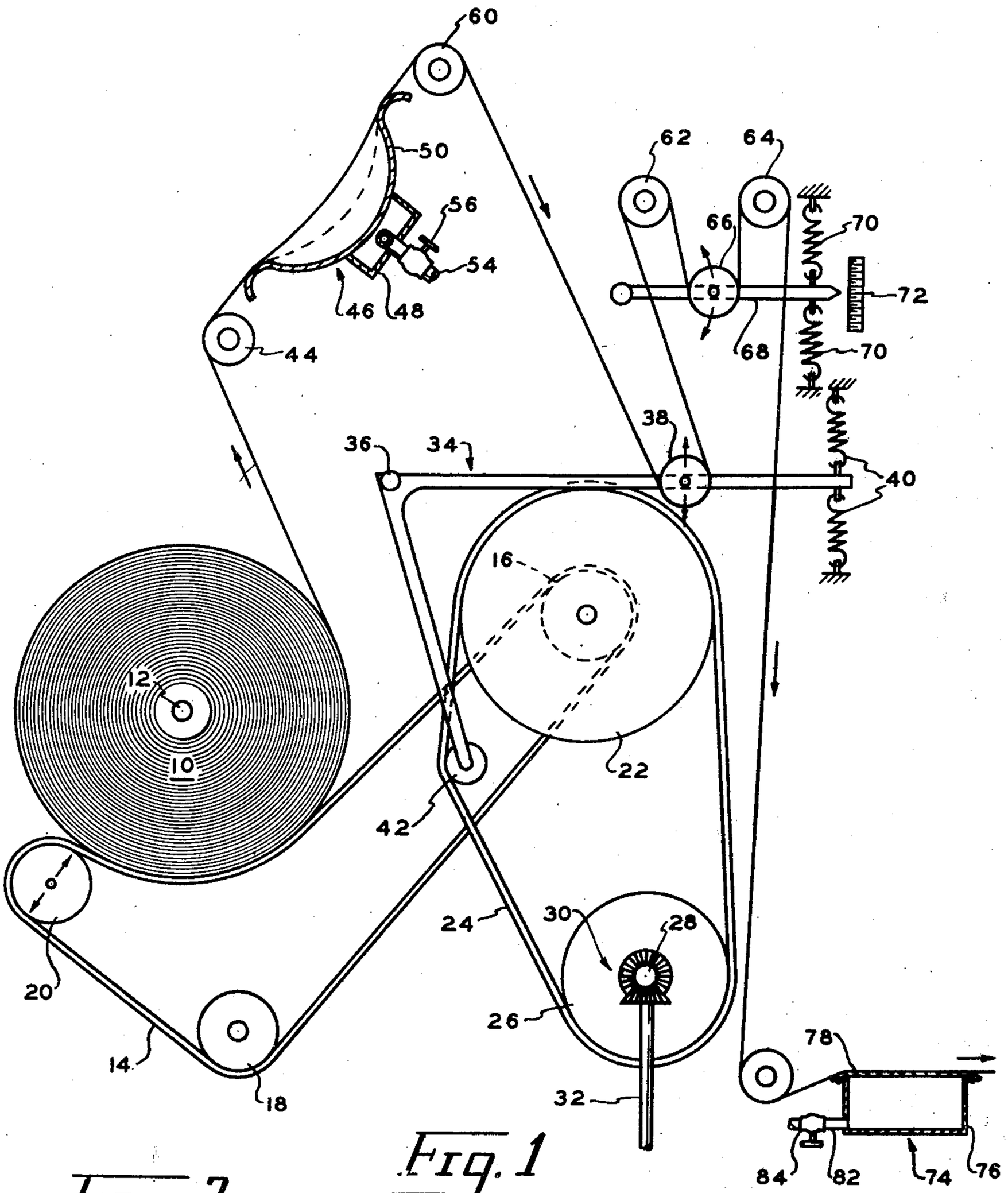
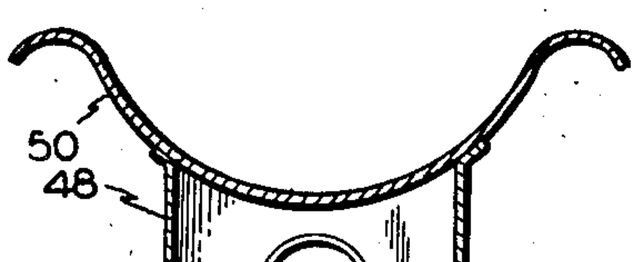


Fig. 1

Fig 2.



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WEB TENSION CONTROL SYSTEM

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Fig. 3

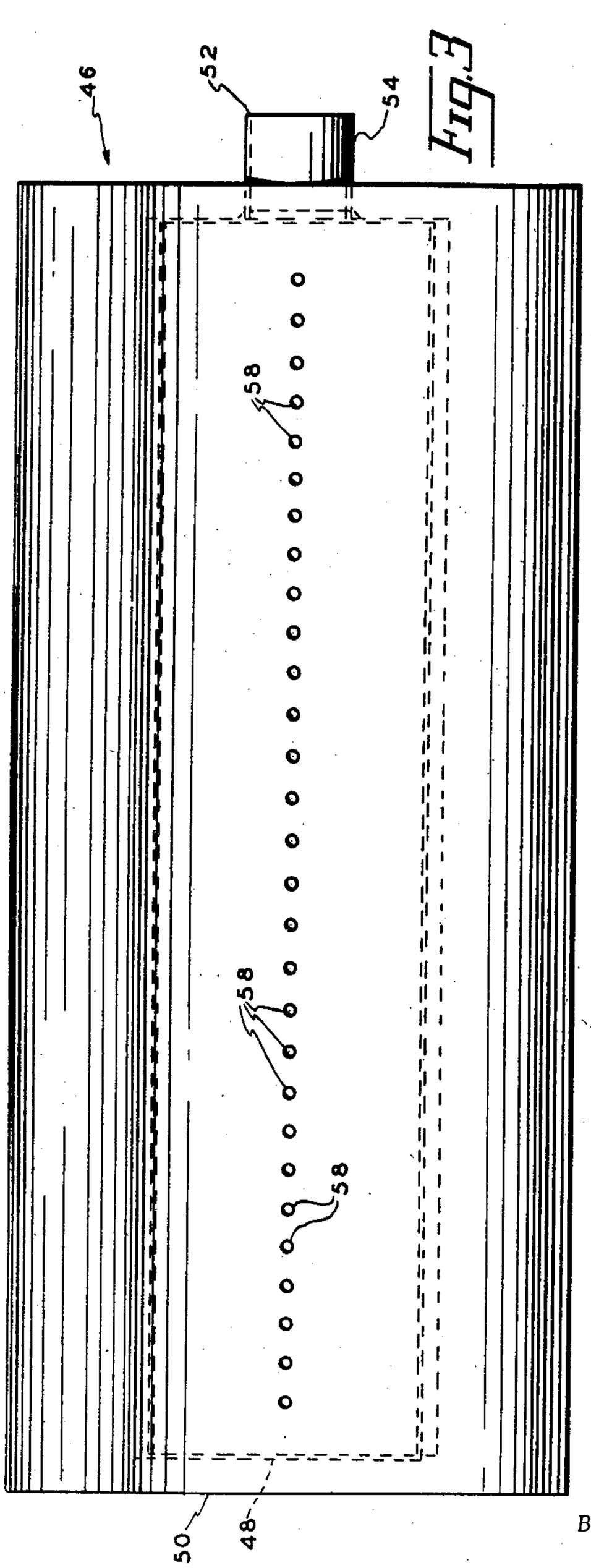
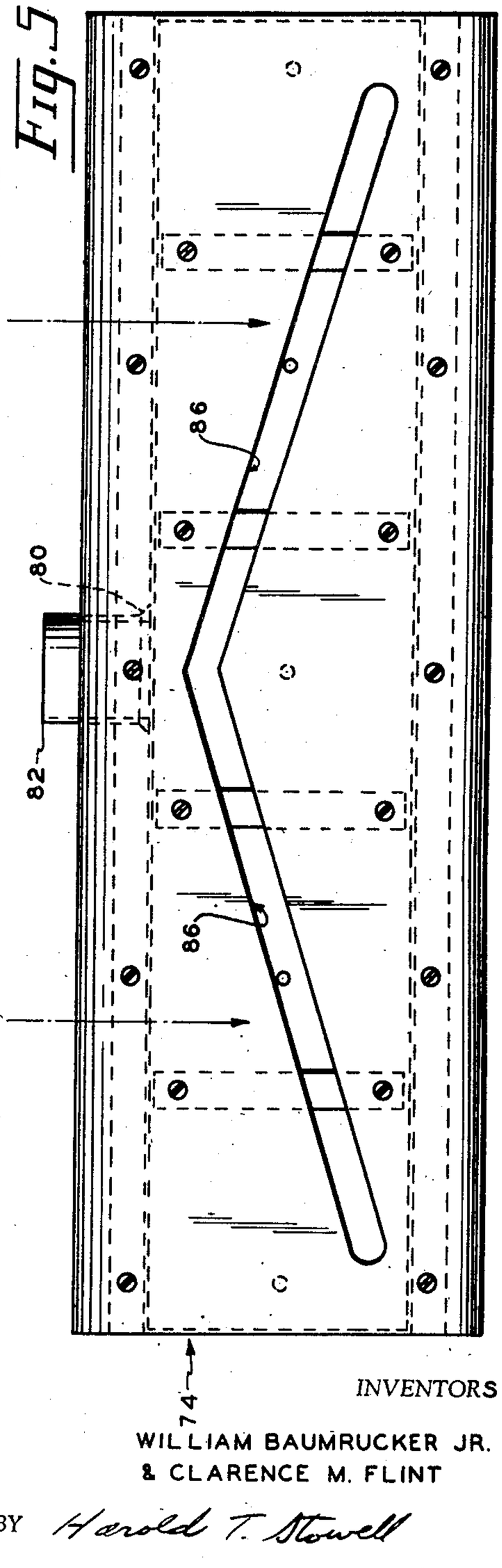


Fig. 5



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WEB TENSION CONTROL SYSTEM

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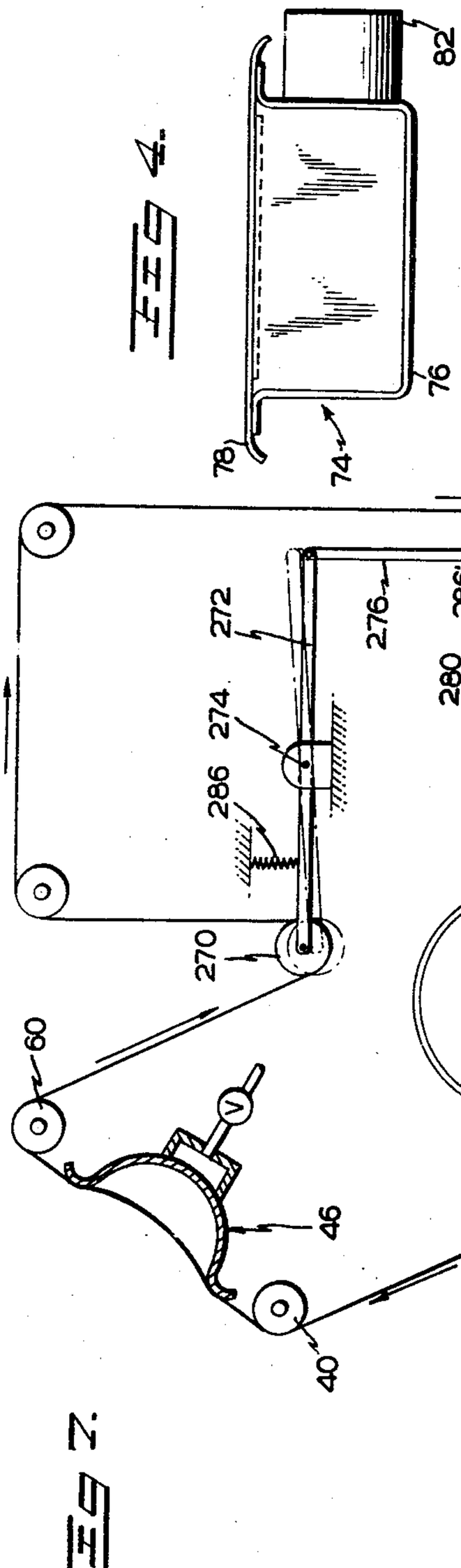

FIG. 4.

FIG. 7.

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WEB TENSION CONTROL SYSTEM

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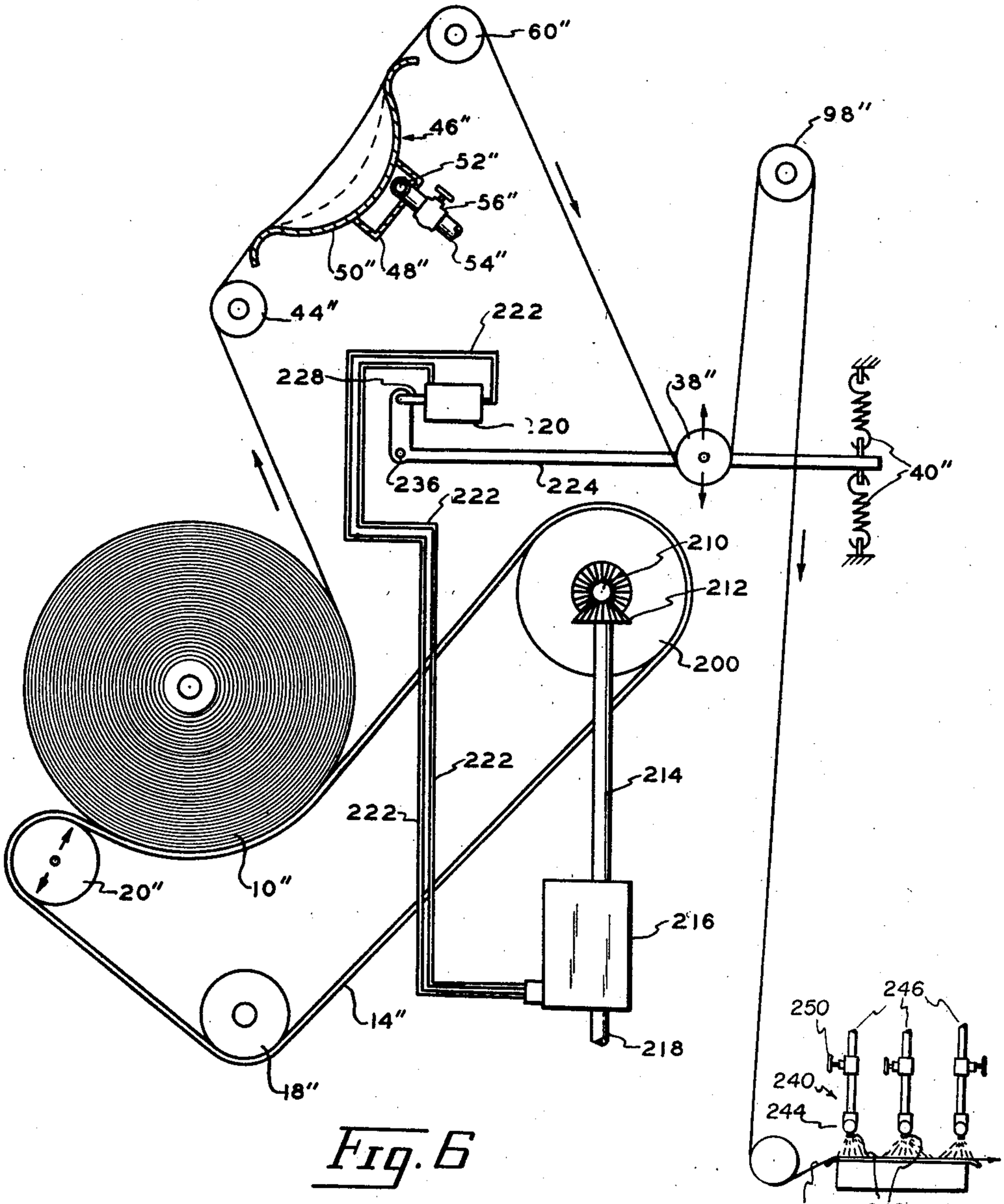

FIG. 6

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WEB TENSION CONTROL SYSTEM

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Application March 11, 1954, Serial No. 415,508

5 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 of 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 braking the unwinding roll, for example, by providing brake drums on the web roll shafts; 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 calender cut, or the like, will cause the web to break.

Our web tension control system for a web processing device generally includes 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 tension in said web between slack gathering means and the drag means to vary the speed of the web roll drive to maintain said tension 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 Number 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 sectional end view of the web takeup mechanism shown in Fig. 1;

Fig. 3 is an enlarged plan view of the device shown in Fig. 2;

Fig. 4 is an enlarged end view of the web tension applying mechanism shown in Fig. 1;

Fig. 5 is an enlarged plan view of the device shown in Fig. 4;

Fig. 6 is a diagrammatic view in elevation of another form of the web tension control apparatus of the invention; and

Fig. 7 is a diagrammatic view in elevation of a further form of the web tension control apparatus of the invention.

With reference to the drawings and in particular to Figs. 1 through 5, 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** contacts 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, the latter 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 printing 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 a floating roller 38 and biasing springs 40 on one arm and an idler pulley 42 which engages the inner surface of V-belt 24 rotatably supported on the other arm. Variations in the tensions of the web as it passes under floating roller 38 cause slight movements of the bellcrank 34. The movements of the bellcrank cause the idler pulley 42 to change the tension of the 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. 2 and 3 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 52 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.

The web upon leaving the loop passes over a pipe roller 60 and then under the floating roller 38, as hereinbefore described. The web after leaving the floating roller and before entering the tension device may advantageously pass to a tension indicator. In the drawings this indicator comprises fixed pipe rollers 62 and 64 and a pipe roller 66 rotatably carried by a lever arm 68 pivotally secured at one end to the main frame of the printing machine. The other end of lever arm 68 is provided with biasing springs 70 and an indicator pointer. Adjacent this pointed end there is a calibrated scale 72 whereby the press operator may at any time ascertain the tension in the web prior to its entry into the primary tensioning device.

Following the tension indicator the web enters a 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.

In the form of the invention shown in Fig. 1 of the illustrative embodiments of the invention the drag means is in the form of a suction box 74. Suction box 74, as is more clearly shown in Figs. 4 and 5 of the drawings, 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 80 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. 5 with the legs of the slot extending substantially the entire width of the suction box.

As the web is drawn 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.

Other drag means may be used in place of suction box 74 in the web tensioning system of the invention, for example a conventional in-feed roller couple geared to the press drive through a variable speed connector may be used.

Another form of drag means will be described with reference to Fig. 6 of the drawings. In view of the similarity of the apparatus like parts shown in Figs. 1 through 5 are given double primed numeral designations in Fig. 6.

In Fig. 6 the web originates from a web supply roll 10'', driven by at least one driving belt 14''. The driving belt passes over a driven pulley 200 and over two idler pulleys 18'' and 20'' so that a portion of the outer face of the driving belt 14'' registers 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 10'', for example, by air cylinders not shown in the drawings, whereby the drive belt 14'' is always in contact with a portion of the periphery of the roll at a constant pressure.

Drive pulley 200 is secured to a shaft 210 of which one end is driven by a pair of bevel gears 212, one of said gears being secured to a vertical drive shaft 214. The drive shaft 214 is the output shaft from the variable speed transmission shown diagrammatically in the drawings at 216. A power input shaft 218 for the variable speed transmission 216 may be connected to its own

prime mover or connected to the motor, not shown in the drawings, that drives the printing couples of the printing machine, whereby, if the printing machine is stopped, started, accelerated or decelerated, the input shaft **218** of the transmission **216** is likewise actuated.

The transmission **216** may be any of the well known electrical, mechanical or hydraulic variable speed transmission whereby the torque-speed ratio of the output shaft **214** may be varied relative to the torque-speed ratio of the input shaft **218**.

The variable speed transmission **216** is provided with a hydraulic control unit **220** which as shown in the drawings is connected to the transmission by pressure fluid conduits **222**. It is evident, however, that the control unit **220** may be of the servoelectric type, for example, and the conduits **222** may be replaced by mechanical linkages or electrical conductors.

A bellcrank **224** pivotally mounted on shaft **236** has a floating roller **38''** and biasing springs **40''** on one arm and control rod **228** which actuates the control unit **220** pivotally secured to the other arm. Variations in the tension of the web as it passes under the floating roller **38''** actuates the control unit **220** through control rod **228**. The variations thus produced in the control unit setting are transmitted by means of conduits **222** to the transmission **216** which increases or decreases the speed of output shaft **214**. This effectively increases or decreases the speed of drive pulley **200**, the peripheral speed of the driving belt **14''** and in turn the peripheral speed of the web. This arrangement, however, does not 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''** is substantially as shown and described with reference to Figs. 2 and 3 of the drawings and 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 **52''** 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, 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 with substantially no jerks in the web. 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.

The web after leaving the loop forming device passes over a pipe roller **60''**, then under floating roller **38''** and over and under standard pipe rollers **98''** thence to a drag means generally designated **240**. The drag means **240** comprises a flat plate **242** of metal or the like having a width slightly greater than the width of the web. Positioned above the plate **242** are one or more conduits **244**, the longitudinal axis of which preferably lies across the width of the plate **242**. Each of the conduits **244** is supplied with compressed air or the like through conduits

246 which in turn are connected to a suitable source of the pressure fluid. A plurality of pressure fluid outlets **248** are provided in the conduits **244** adjacent the upper surface of plate **242** through which jets or streams of air issue. The force of the air stream causes a friction drag between the travelling web and the upper surface of the plate **242**. 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 **242**. A manual or automatic valve **250** may be provided in each conduit **246** whereby control of the drag means may be readily had.

In Fig. 7 of the drawings a further form of the invention is shown. In this form of the apparatus only the means for sensing the tension in the web between the web roll and the drag means and the control means responsive to the sensing means for varying the speed of the web roll drive will be described as the other elements thereof are identical in structure and function to those shown and described in reference to Fig. 1. Identical reference numerals are, therefore, provided on the web roll **10**, pipe rollers **40** and **60**, slack gathering means **46**, and drag means **74**. After the web leaves the slack gathering means **46** where a predetermined light drag is applied to the web, it passes under a balanced floating roller **270** rotatably mounted at one end of lever **272**. The lever **272** is mounted for up and down pivotal movement at **274** and connected at its other end to link rod **276** which is pivotally connected to a second lever **278** also mounted for up and down pivotal movement at **280**. Lever **278** is connected to the piston of an air cylinder generally designated **282** provided with valves **284** for initially adjusting the system for the slack or tension in the web. The springs **286** and **286'** are balancing springs to compensate for the weight of the levers **272** and **280** and their connected elements.

Pivotal movement in lever **278** brought about by variations in the slack or tension in the web as it passes under roller **270** is transmitted to rods **288** and **290** which are connected to valves **292** and **294** respectively. These valves control the flow of pressure fluid to a pressure fluid actuated control motor generally designated **296**. The control motor **296** is connected through mechanical linkages **298** and **300** to a conventional speed changer **302**. The speed changer **302** mechanically moves the movable sheave of the adjustable pulley **304** of the web drive generally designated **306** through shaft **308**. As the movable sheave of the adjustable pulley **304** moves in or out as the case may be, its effective diameter and the resultant speed of the web roll driving belts are varied.

The drag means **240** in Fig. 6 may be advantageously replaced by the suction box **74** shown in Figs. 1 and 7 of the drawings or by in-feed rolls.

From the foregoing description it will be seen that the present invention provides an improved web tensioning system whereby the aims, objects and advantages of the invention are fully accomplished. It will be evident that while the present invention has been described in reference to web roll unwinding apparatus, it will be apparent that 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.

We claim:

1. A web tension control system for a web processing device including a web roll, and a 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 tension in said web between the slack gathering

means and the drag means to vary the speed of the web roll drive to maintain said tension 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 as defined in claim 1 wherein said slack gathering means comprises 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 and one face of the web.

3. A web tension control system as defined in claim 2 wherein said drag means comprises a second suction box, means for applying a negative pressure to said second box, a substantially flat cover plate secured to the top of said second box and having openings therein communicating with the interior of the box and one face of the web.

4. A web tension control system for a web processing device including a web roll, and a 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 for sensing the tension of said web between the slack gathering device and the drag means, means responsive to said sensing means for varying the speed of the web roll drive to maintain the tension of the web between the web roll and said drag means within a predetermined range and independent of the web tension between the drag means and the processing device.

5. The invention defined in claim 4 wherein the means for sensing the tension of the web comprises a balanced floating roller.

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