Nov. 19, 1940. C. R. KADDELAND 2,222,462

WEB TENSION CONTROL

Filed Jan. 5, 1938 5 Sheets-Sheet 1

FIG. 1.

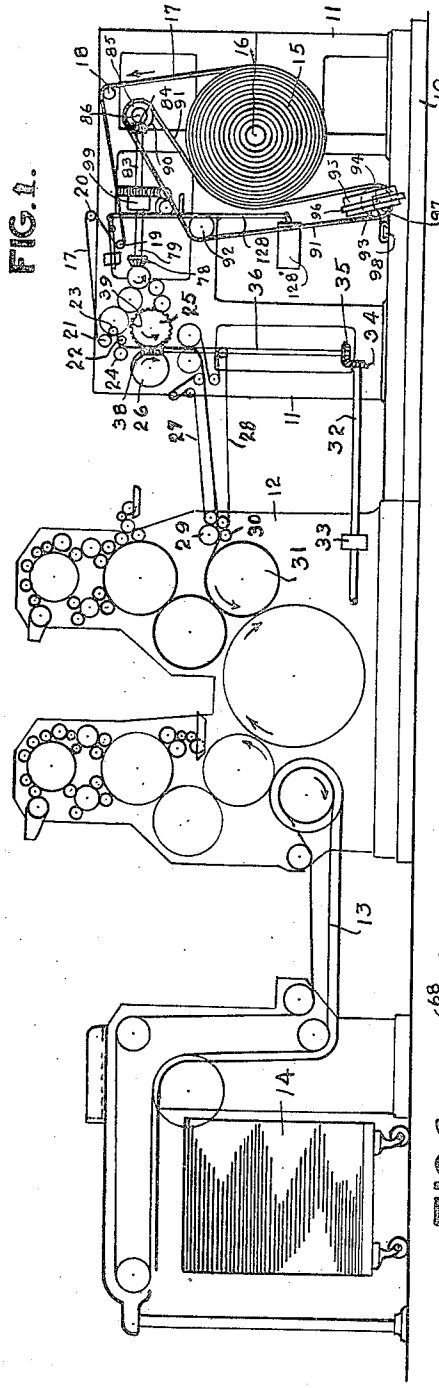


FIG. 7.

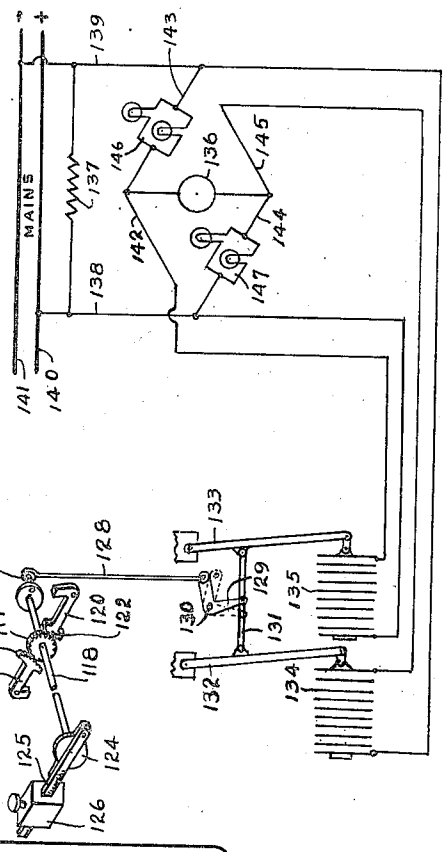
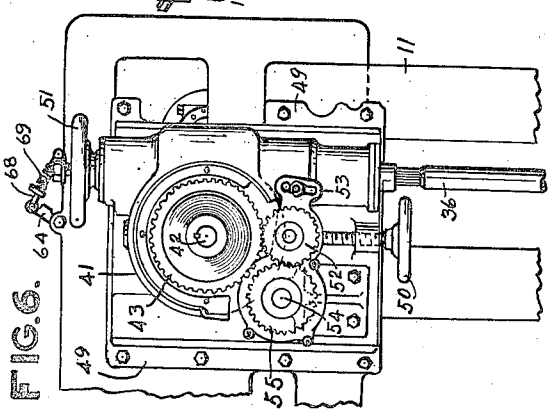


FIG. 6.



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WEB TENSION CONTROL

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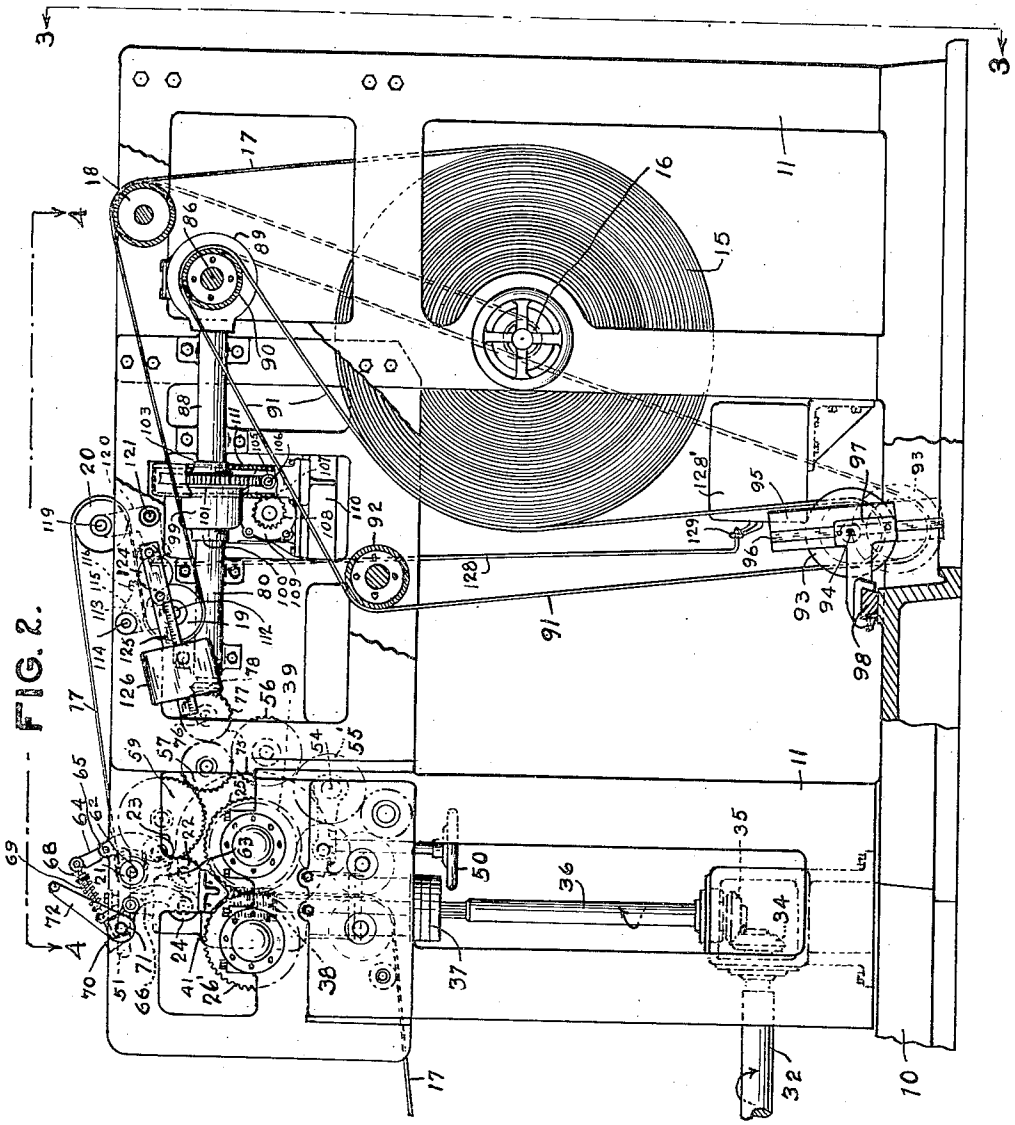


FIG. 2.

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WEB TENSION CONTROL

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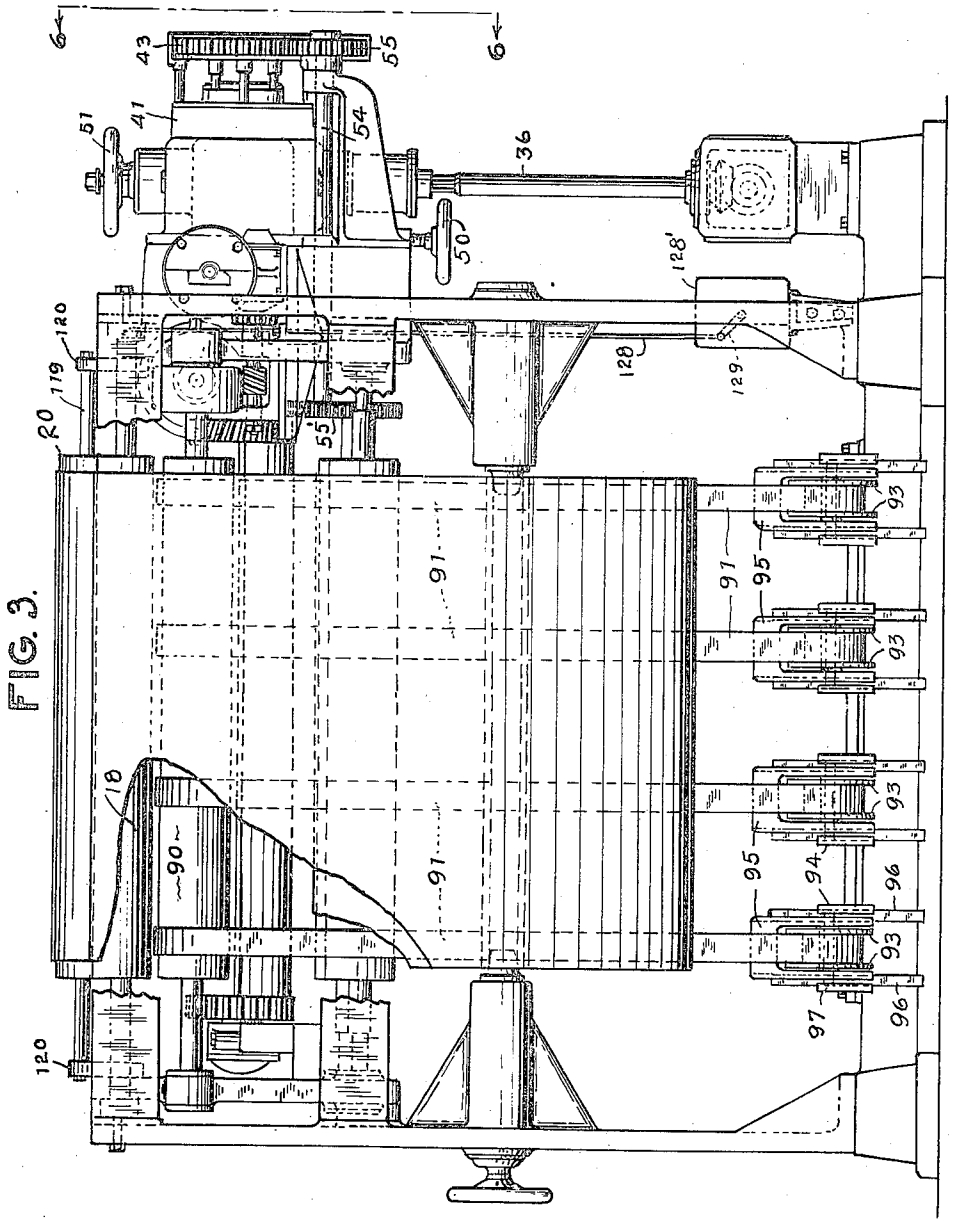


FIG. 3.

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WEB TENSION CONTROL

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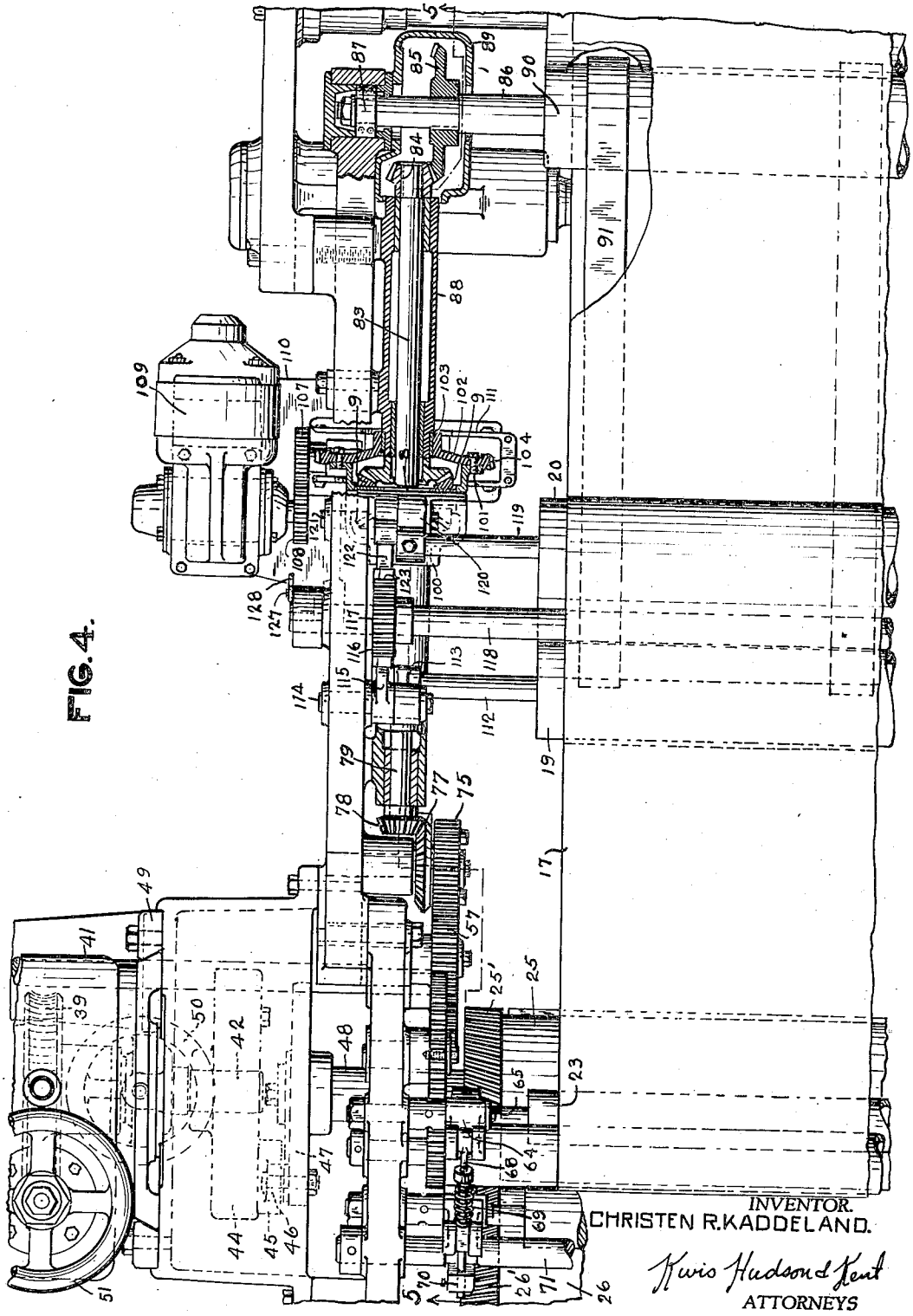


FIG. 4.

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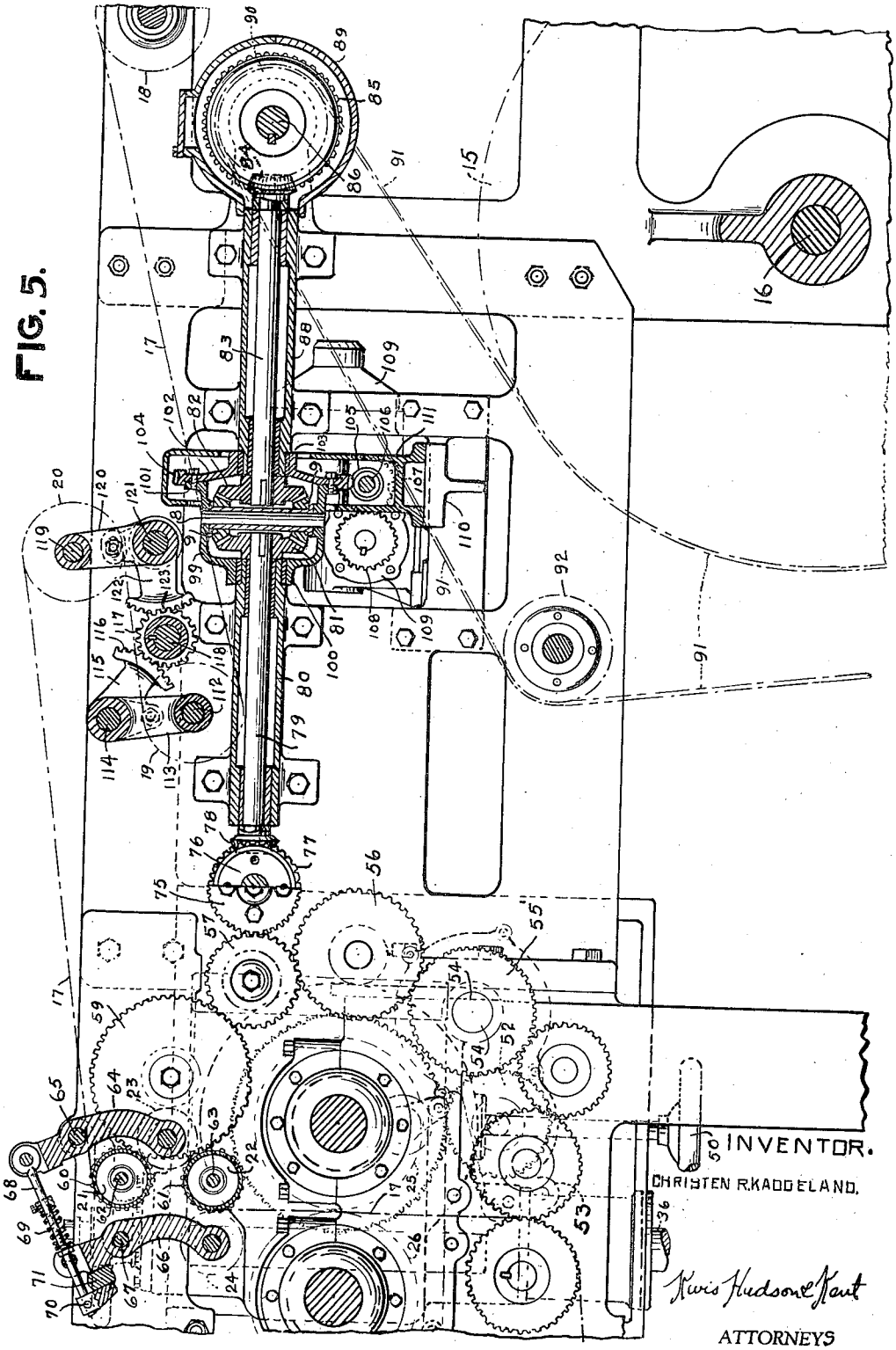
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WEB TENSION CONTROL

Filed Jan. 5, 1938 5 Sheets-Sheet 5

FIG. 5.



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Patented Nov. 19, 1940 2,222,462

UNITED STATES PATENT OFFICE

2,222,462

WEB TENSION CONTROL

Christen R. Kaddeland, Shelton, Conn., assignor to Harris-Seybold-Potter Company, Cleveland, Ohio, a corporation of Delaware

Application January 5, 1938, Serial No. 183,463

3 Claims. (Cl. 242—75)

This invention relates to improvements in web tension controls, that is to say means for maintaining substantially constant the tension of a web being fed from a roll or other supply to a printing press or the like. The invention, although of rather general application, is illustrated herein as applied to a printing press which acts upon sheets, provision being made in the machine for cutting the sheets from the web. Under such circumstances it is highly desirable to maintain accurate control of the tension in order that the delivery of web material to the cutting knives may be at a constant rate. If the tension is permitted to change the amount of slippage through the feeding rolls is correspondingly changed and the length of web fed past the cutting knives for each operation of the latter is thereby changed, so that the length of the sheets removed from the web is not constant. The difficulty of holding the web tension constant is increased by the fact that the diameter and mass of the web roll, which constitutes the web supply, decreases constantly as the web supply is used up. The present invention is directed to means for automatically controlling the tension of the web and maintaining it constant.

One of the objects of the invention therefore is the provision of means for establishing and maintaining a given tension of the web in a web feeding machine.

Another object is the provision of means for automatically varying the speed of rotation of the web roll as the tension of the web tends to change to deliver an amount of web equal to that taken by the feeding rollers.

Another object is the provision of a web tension controlling device which shall have means in contact with the supply roll traveling at the same speed as the surface of the supply roll and having substantially no slippage thereon.

A further object is the provision of an improved change speed drive for the web roll in order to regulate the rate of removal of the web from the web supply.

Still another object of the invention is the provision of novel control means for the change speed drive, said control means being responsive to small variations in the rate of release of the web from the supply and to the resulting small variations in the tension of the web.

Other objects and features of novelty will appear as I proceed with the description of that embodiment of the invention which, for the purposes of the present application, I have illustrated in the accompanying drawings, in which

Fig. 1 is a diagrammatic elevational view of the invention applied to a multi-color printing press for printing on sheets which have been cut from a web.

Fig. 2 is a side elevation on a larger scale showing an embodiment of the invention arranged to regulate the tension in a web being fed to mechanism for cutting the web into sheets.

Fig. 3 is an end elevation looking in the direction of the arrows 3—3 of Fig. 2.

Fig. 4 is a partial plan view on a still larger scale, the extent of the view being indicated by line 4—4 of Fig. 2.

Fig. 5 is a side elevation partly in section along the line 5—5 of Fig. 4.

Fig. 6 is a side elevation of a part of the driving mechanism, viewed from the line 6—6 of Fig. 3.

Fig. 7 is a diagrammatic view showing the mechanism which operates the electrical control device and the wiring diagram of that device.

In the drawings 10 is a base arranged to support a framework 11 of a web feeding and sheet cut-off mechanism which is illustrated as supplying sheets to a printing press 12 that operates upon the cut-off sheets and delivers them by means of a conveyor 13 to a pile 14 of finished sheets. In the frame 11 of the web feeder there is a web roll 15 constituting the web supply, this roll being mounted upon a pair of spindles 16 carried in the frame. The roll 15 is shown in a fixed position relative to the frame, but a mounting similar to that illustrated and described in my copending application Serial No. 183,462, filed January 5, 1938, or any other suitable roll mounting may be employed if desired.

The web 17 of paper or the like is led over a guide roller 18, around a pair of tensioning rollers 19 and 20, around the web pulling rollers 21 and 22 with which pressure rollers 23 and 24 cooperate, and between cut-off cylinders 25 and 26. These cut-off cylinders cut the web into sheets of desired length, and the sheets are carried between tapes 27 and 28 to the feed rollers 29 and 30 of the press, and thence to the impression cylinder 31 thereof.

A shaft 32 upon which is mounted a drive pulley 33 is driven by a suitable source of power such as an electric motor (not shown) for driving the press. By means of the bevel gears 34 and 35, shaft 32 also drives a vertical shaft 36 which supplies the power for actuating the web feeding and sheet cut-off mechanism. This shaft is joined by sliding connection 37 with a worm 38 which meshes with a worm wheel 39 (Fig. 4)

that is mounted inside a large casing 41, see particularly Figs. 3 and 4. The worm wheel 39 is mounted upon a shaft 42 to which is keyed a spur gear 43. The gear 43 therefore turns with constant speed in synchronism with the operation of the printing press, its speed being dependent upon the speed of the motor which drives shaft 32.

As shown in Fig. 4, the shaft 42 upon which the worm wheel 39 and the spur gear 43 are mounted, also carries at its end a driving disk 44 which is formed with an off-set slotted guide 45 which engages a block 46 carried by a driven disk 47 that is keyed to the shaft 48 of the cutting cylinder 25. Cutting cylinders 25 and 26 are interconnected by means of spiral gears 25' and 26' respectively. It should also be noted that the casing 41 may be raised and lowered between gibs 49 by means of a hand wheel 50, and that the angular position of the worm wheel 39 in relation to the driving worm 38 may be altered by raising or lowering the worm 38 by means of a hand wheel 51. The construction of this mechanism and its purposes are all more fully disclosed in connection with my copending application, Serial No. 183,464, filed January 5, 1938, and do not have direct bearing on the present invention.

The constant speed gear 43 may be of any suitable size, dependent upon the length of sheet to be cut by the cut-off mechanism. It meshes with an idler gear 52, Fig. 6, which is mounted upon a swinging bracket 53 pivotally connected to the shaft 54, so that the idler gear 52 may be meshed with gears of different sizes in place of the gear 43. Idler gear 52 meshes with a gear 55 keyed on the outer end of shaft 54, which shaft extends through the adjacent side frame member and has keyed on its inner end another gear 55' of the same diameter as gear 55. Gear 55' operates through idler gears 56 and 57 mounted upon studs in the frame of the machine, to drive the gear 59, also mounted on a stud in the frame. The gear 59 meshes with a gear 60 keyed to the upper web pulling roll 21, and also with a gear 61 keyed to the lower web pulling roll 22. These web pulling rollers 21 and 22 are rotatably mounted on stationary shafts 62 and 63 supported in the frame of the machine.

At each side of the machine close to the frame a pair of arms 64 are mounted on studs 65 for carrying the pressure roller 23 which is arranged to bear with some pressure against the web pulling rollers 21 and 22. Another similar pair of arms 66 mounted on studs 67 carry the other pressure roller 24 which bears against the roller 22.

The upper ends of the arms 64 and 66 on one or both sides of the machine are bifurcated to receive a spring rod 68 carrying a spring 69 which is adjustable as to length. This spring tends to separate the upper ends of the arms 64 and 66, and consequently tends to press the pressure rollers 23 and 24 against their associated web pulling rollers. The spring rod 68 is provided at one end with a head 70. A shaft 71 rotatably mounted in the frame of the machine carries at one outer end a handle 72, Fig. 2, by means of which the shaft may be turned through a portion of a revolution. This shaft is provided with a flat portion in the proper location to engage the head 70, and a similarly formed surface on the upper end of the arm 66. It will be seen that rotation of the shaft 71 in either direction from the position shown in Fig. 5 will cause separation of the head 70 and the upper end of lever 66 and that this separation, acting through the spring rod 68 and spring 69, will cause the pressure rollers 23 and 24 to be moved out of contact with the rollers 21 and 22. This manipulation of the levers 64 and 66 and the pressure rollers carried thereby is ordinarily used only during set-up periods.

In operation the web of paper 17 is led around the top of roller 21, between rollers 21 and 22, partially around roller 23, between rollers 23 and 22, and thence downwardly between rollers 22 and 24. From this point it is directed between the cutting cylinders 25 and 26. It will be seen that the pressure of rollers 23 and 24 maintains the web of paper in firm contact with the surfaces of rollers 21 and 22 and that the latter, being driven by the constant speed gear 59 therefore exert a pull upon the web of paper 17 which tends to move it forward at substantially constant speed.

It is a known fact however that the tension resulting from holding back the web of paper leaving the web supply varies to a certain extent the amount of paper measured off by a given number of rotations of the web pulling rollers 21 and 22. In other words there is apparently a slight slippage between the web and the pulling rollers, the extent of which is dependent upon the tension of the web. Consequently it is desirable that means be provided for maintaining this tension at an approximately constant value so that the amount of paper measured off by the pulling rollers may remain constant in the operation of the machine. This mechanism, in which the present invention principally resides, will now be described.

Referring principally to Figs. 2, 4 and 5, it will be seen that a spur gear 75, mounted on a stub shaft 76, meshes with idler 57, which is driven at constant speed. Shaft 76 also carries a bevel gear 77 which meshes with a bevel gear 78 on the outer end of an input shaft 79 that is mounted in bearings carried by a tubular bracket 80 provided with feet which are bolted to the machine frame. On the opposite end of shaft 79 there is keyed a bevel gear 81 which constitutes one element of a differential gearing. A similar bevel gear 82 is keyed to an output shaft 83 on the opposite end of which is a bevel gear 84 that drives a large gear 85 keyed to a transverse shaft 86 which is mounted in anti-friction bearings 87 carried by the side members of the machine frame. The shaft 83 is mounted in bearings at the ends of a tubular bracket 88 having feet bolted to the frame of the machine. A casing 89 encloses gears 84 and 85 and is suitably supported by the machine frame. The shaft 86 carries a cylindrical pulley 90 over which run a series of spaced belts 91. One run of each of these belts also passes over an elongated pulley 92 journaled in bearings in the frame, as indicated in Fig. 2, while the other runs of the several belts extend over one side of the web roll 15, bearing upon the same over a considerable perimetric distance when the roll is full and a greatly decreasing distance as the diameter of the roll decreases owing to the paying out of the web. The belts may be made of leather, rubberized fabric, or other material, preferably one having a fairly high coefficient of friction. The lower bight of each belt passes over one of a series of pulleys 93, each of which is carried by a short shaft 94 mounted in a weight 95 of inverted U-shape that is provided

with grooves on its sides fitting guide bars 96 that are carried in brackets 97 clamped to a transverse dove-tail supporting bar 98. The weights 95 move downwardly as the diameter of the roll 15 decreases, a lower position being indicated in dotted lines in Fig. 2, and they therefore tend to maintain a constant tension on the belts.

Returning now to the differential gear, by means of which the speed of rotation of the shaft 86 and the consequent speed of the belts 91 is controlled, I provide a differential housing member 99 which has a rotative bearing 100 on one extremity of tubular bracket 80. This housing is provided with an annular flange 101 to which is bolted a further housing member 102 provided with a hub which is revoluble on a bearing 103 carried by one end of tubular bracket 88. A shaft 8 is mounted in the differential housing intermediate the bevel gears 81 and 82, and this shaft with the housing itself constitutes a carrier for a pair of bevel pinions 9 which mesh with the two gears 81 and 82.

The periphery of housing member 102 beyond flange 101 of the other housing member is enlarged and is provided with worm wheel teeth 104 that mesh with the teeth of a worm 105 keyed to a shaft 106. At the outer end of shaft 106 there is a gear 107 which meshes with a gear 108 that is keyed to the output shaft of a geared head electric motor 109. The motor is supported upon a bracket 110 bolted to the frame, which bracket also supports a casing 111 that encloses and protects the worm and worm wheel.

Web tensioning roller 19 is carried by a shaft 112 which is mounted at its ends in arms 113 that swing about aligned stub shafts 114 mounted in the side frame members. Rigid with the arms 113 are cranks 115 formed at their outer ends with gear sectors 116 which mesh with gears 117 keyed to a shaft 118 which is oscillatably mounted in the side members of the frame. The tensioning roller 20 is carried by shaft 119 that is mounted in the upper outer ends of a pair of arms 120 which are mounted to swing upon stub shafts 121 mounted in the side frame members. Crank arms 122 rigid with arms 120 have gear sectors 123 on their free ends which mesh with gears 117 on the side thereof opposite the teeth which mesh with gear sectors 116.

The shaft 118 at one end carries a collar 124 to which is secured a bar 125 upon which is adjustably mounted a weight 126. Weight 126 provides a load upon shaft 118 which tends to turn that shaft anti-clockwise, as viewed in Figs. 2 and 5, and this motion when communicated through the gear 117 and gear sectors 116 and 123 tends to swing the arms 113 and 120 away from each other so as to separate the tensioning rollers 19 and 20. This force is opposed by the pull of the tensioned web which tends to draw the rollers 19 and 20 toward each other and thus to rotate the shaft 118 in the clockwise direction through the intermediacy of the sectors 116 and 123 and the gear 117.

In the present invention the small angular movements of the shaft 118 are utilized to bring about the variations in speed of the belt driving means necessary to maintain the web tension substantially constant. To this end, one extremity of shaft 118 carries a crank pin 127 to which is pivoted a rod 128, see particularly Fig. 7, that extends downwardly to a control box 128', Fig. 2, supported on a bracket carried by the machine frame. A bell crank lever 129 is pivotally mounted at 130 in the control box, and to one arm of this lever the rod 128 is connected. The other arm is pivotally connected with a link 131 which is connected to two lever arms 132 and 133, both pivoted at their upper ends to fixed supports. The lower ends of these levers are connected with carbon piles or the like constituting variable resistances 134 and 135. When the levers 132 and 133 move toward the left in Fig. 7 the variable resistances are both decreased, and when the levers move toward the right the resistances are increased. 136 represents the armature of motor 109, and 137 the field of that motor. Field 137 is bridged across lead wires 138 and 139 which are connected with line wires 140 and 141. The lead wires 138 and 139 each extend to one end of the adjustable resistances 135 and 134, respectively. Between the lead wires 138 and 139 are conductors which for convenience I have illustrated as a parallelogram of four arms 142, 143, 144 and 145, the motor armature 136 being connected at its ends with the junction points of arms 142 and 143 on the one hand and 144 and 145 on the other. In the arms 143 and 144 of the parallelogram I insert lamps or other resistances 146 and 147, these two resistances being preferably equal. The arms 142 and 145 of the parallelogram include the variable resistances 135 and 134 respectively.

Operation.—The weight 126 is positioned on its supporting bar 125 at such a position, determined by experience, as will result in the desired tension for the web stock to be handled. The web is threaded through the machine as previously described and the press and feeder set in motion. Drive is thus transmitted through the differential gearing to the belts 91, the latter moving at a speed to drive the web roll at a peripheral speed such as to release the web from the roll at the desired rate of travel of the web through the machine. The direction of rotation of the output shaft 83 will be opposite to the direction of rotation of the input shaft 79, and when the pinion carrier of the differential is standing still the speed of the shaft 83 will be the same as that of shaft 79. If the pinion carrier turns slowly in the same direction as shafts 79 rotates, the speed of shaft 83 will be slightly reduced. Contrariwise, if the pinion carrier is moved slowly in the opposite direction the speed of the shaft 83 will be slightly increased. The pulling rollers 21 and 22 are driven at a speed which tends to move the web through them at a rate slightly faster than it is released by the supply roll 15. The tensioning rollers 19 and 20 place a drag on the web, and this in combination with the slightly lower peripheral speed of the web roll results in a tension on the web between the pull-out rollers and the web roll. It is highly desirable to have this tension remain constant, because otherwise the slippage accompanying the action of rollers 21 and 22 would vary and the length of web delivered to the cutting cylinders for each revolution of the pulling cylinders would not be uniform. As the web roll becomes smaller the length of its surface contacted by the belts 91 becomes correspondingly smaller, and hence the driving force which the belts are able to deliver to the web roll changes. This and other factors tend to vary the rate of release of the web from the web supply, which in turn tends to vary the web tension. However, I keep the rate of release uniform by varying slightly the speed of the driving belts either up or down as conditions require.

When the rate of release of the web from the supply becomes excessive thereby tending to decrease the tension in the web, the weight 126 moves the tensioning rollers 19 and 20 farther away from each other than their predetermined normal operating position, thus compensating for the increased length of web between the supply and the pulling rollers 21 and 22 and maintaining the tension in the web substantially constant. This same movement by the weight 126 causes the shaft 118 to rotate in the counterclockwise direction in Figs. 2, 5 and 7. The link 128 then ascends, link 131 moves to the right in Fig. 7, and the levers 132 and 133 operate the variable resistances 134 and 135 to increase them. When this occurs, the voltage across armature 136 by way of conductors 138, 142, 145, and 139 is changed, causing the motor to turn in a direction and at a rate which will retard belts 91. This retards the rate of release of the web from the roll and causes a tendency to shorten the web, thus restoring the rollers 19 and 20 to their normal position.

On the other hand, if the rate of release is too slow, the tensioning rollers are drawn toward each other with the result that the shaft 118 is turned in the clockwise direction in Fig. 2 which serves to lower rod 128 and shift link 131 toward the left in Fig. 7. The latter movement works through levers 132 and 133 to compress the adjustable piles 134 and 135 to reduce their resistance. The voltage through armature 136 by way of conductors 142 and 145 is thereby altered in the opposite direction, with the effect that the speed of the motor 109 is correspondingly altered, or its direction changed, as the case may be, to release the web of paper from the supply more rapidly. The increase in the amount of web released will in turn permit the rollers 19 and 20 to again assume their normal or equilibrium position.

The electric system is so designed that when the speed of shaft 83 required for the proper rate of release of the web is the same as the speed of shaft 79 the resistance 135 will equal the resistance 147 and the resistance 134 will equal the resistance 146, when there will be no current passing through the armature 136, and the motor 109 will be idle. In every case where the motor is running, its operation may be such that the rotation of worm wheel 104 and the pinion carrier to which that worm wheel is attached is comparatively slow, as the gearing may be so proportioned that it is never necessary to operate shaft 83 at a speed greatly different from that of shaft 79 to obtain the desired speed of belts 91. The motor is preferably of the type whose speed is variable depending upon the voltage across the armature whereby the extent of change of speed of the belts 91 may be approximately proportional to the difference between the amount of web released from the supply and the amount taken by the web driving rollers 21 and 22. The control is automatic and accurate and operates within close limits.

While I have shown electrical means for controlling the rate of web release, mechanical and hydraulic means, such as the well known reversible ratchet mechanism and variable speed reversible hydraulic motors with suitable valve mechanism, could be used for the same purpose and in similar manner as the electric motor herein described. Thus the movement of shaft 118 may be utilized to control a ratchet pawl mask or a hydraulic valve gear or other suitable mechanism which would maintain the web tension by varying the speed of the web releasing means and include means whereby the tension may be varied at the will of the operator and to suit various widths and kinds of web material.

Having thus described my invention I claim:

1. In mechanism for regulating web tension, means for rotatably supporting a web roll, means for advancing the web delivered from said roll, belt means adapted to engage the roll and control the delivery of web therefrom, means for driving said belt at the desired peripheral speed of the web roll, said driving means comprising a differential gearing having a revoluble pinion carrier, and normally stationary positive driving means responsive to variations in web tension for revolving said pinion carrier, whereby the speed of said belt is changed to suit conditions, said last mentioned means comprising an electric motor and an electric circuit therefor containing variable resistance.

2. In mechanism for regulating web tension, means for rotatably supporting a web roll, means for advancing the web delivered from said roll, a shaft, means intermediate said roll and advancing means for turning said shaft in one direction or the other responsive to variations in web tension, belt means adapted to engage the roll and control the delivery of web therefrom, means for driving said belt at a rate corresponding to the peripheral speed of the web roll, said driving means comprising differential gearing having a pinion carrier, and normally stationary positive driving means responsive to the turning movement of said shaft for revolving said pinion carrier, whereby the speed of said belt is changed to suit conditions.

3. In mechanism for regulating web tension, means for rotatably supporting a web roll, means for advancing the web delivered from said roll, a shaft, means intermediate said roll and advancing means for turning said shaft in one direction or the other responsive to variations in web tension, belt means adapted to engage the roll and control the delivery of web therefrom, means for driving said belt at a rate corresponding to the peripheral speed of the web roll, said driving means comprising differential gearing having a pinion carrier, and normally stationary positive driving means responsive to the turning movement of said shaft for revolving said pinion carrier, whereby the speed of said belt is changed to suit conditions, said last named means comprising an electric motor and an electric circuit therefor containing variable resistance.

4. In mechanism for regulating web tension, means for rotatably supporting a web roll, means for advancing the web delivered from said roll, belt means adapted to frictionally engage the roll and control the delivery of web therefrom, tensioning rollers intermediate said advancing means and belt, means tending to maintain a predetermined relative adjustment of said rollers, means for driving said belt at a rate corresponding to the desired peripheral speed of the web roll, said driving means comprising differential gearing having a pinion carrier, and normally stationary positive driving means responsive to variations in the relative adjustment of said tensioning rollers for imparting rotation to said pinion carrier, whereby a substantially constant web tension is maintained regardless of the diameter or condition of the web roll.

5. In mechanism for regulating web tension, a web roll, web advancing means spaced from said

roll, web tensioning rollers located intermediate said advancing means and said roll over which said web passes, an endless belt contacting said roll and adapted to have advancing or retarding effects thereon so as to control the speed of rotation of the roll, driving means for said belt comprising differential gearing including a rotatable pinion carrier, normally stationary positive driving means for rotating said carrier in order to vary the speed of said belt driving means, said carrier rotating means being independent of said driving means and being variable in speed, and automatic means responsive to variations in web tension for setting said carrier rotating means in operation and for varying the speed thereof.

6. In mechanism for regulating web tension, a web roll, web advancing means spaced from said roll, web tensioning rollers located intermediate said advancing means and said roll over which said web passes, an endless belt contacting said roll and adapted to have advancing or retarding effect thereon so as to control the speed of rotation of the roll, driving means for said belt comprising differential gearing including a rotatable pinion carrier, a normally stationary electric motor for rotating said carrier in order to vary the speed of said belt driving means, an electric circuit for said motor, and automatic means responsive to variations in web tension and acting on said electric circuit for setting said motor in operation and varying its speed.

7. In mechanism for regulating web tension, a web roll, web advancing means spaced from said roll, web tensioning rollers located intermediate said advancing means and said roll over which said web passes, an endless belt contacting said roll and adapted to have advancing or retarding effect thereon so as to control the speed of rotation of the roll, driving means for said belt comprising differential gearing including a rotatable pinion carrier, a normally stationary electric motor for rotating said carrier in either direction in order to vary the speed of said driving means, an electric circuit for said motor, means in said circuit for reversing the motor and varying its speed in either direction, and automatic means responsive to variations in web tension for operating said motor reversing and speed changing means.

8. In mechanism for regulating web tension, means for rotatably supporting a web roll, means for advancing the web delivered from said roll, belt means adapted to frictionally engage the roll and control the delivery of web therefrom, means for driving said belt at the desired peripheral speed of the web roll, said driving means comprising a differential gearing having a normally stationary revoluble pinion carrier, and means responsive to a given variation in web tension upwardly or downwardly for revolving said pinion carrier to an equal extent in one direction or the other during normal operation of said machine, whereby the speed of said belt is changed to suit conditions.

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