Aug. 9, 1966 R. R. SMITH, JR 3,264,984

WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31. 1964 6 Sheets-Sheet 1

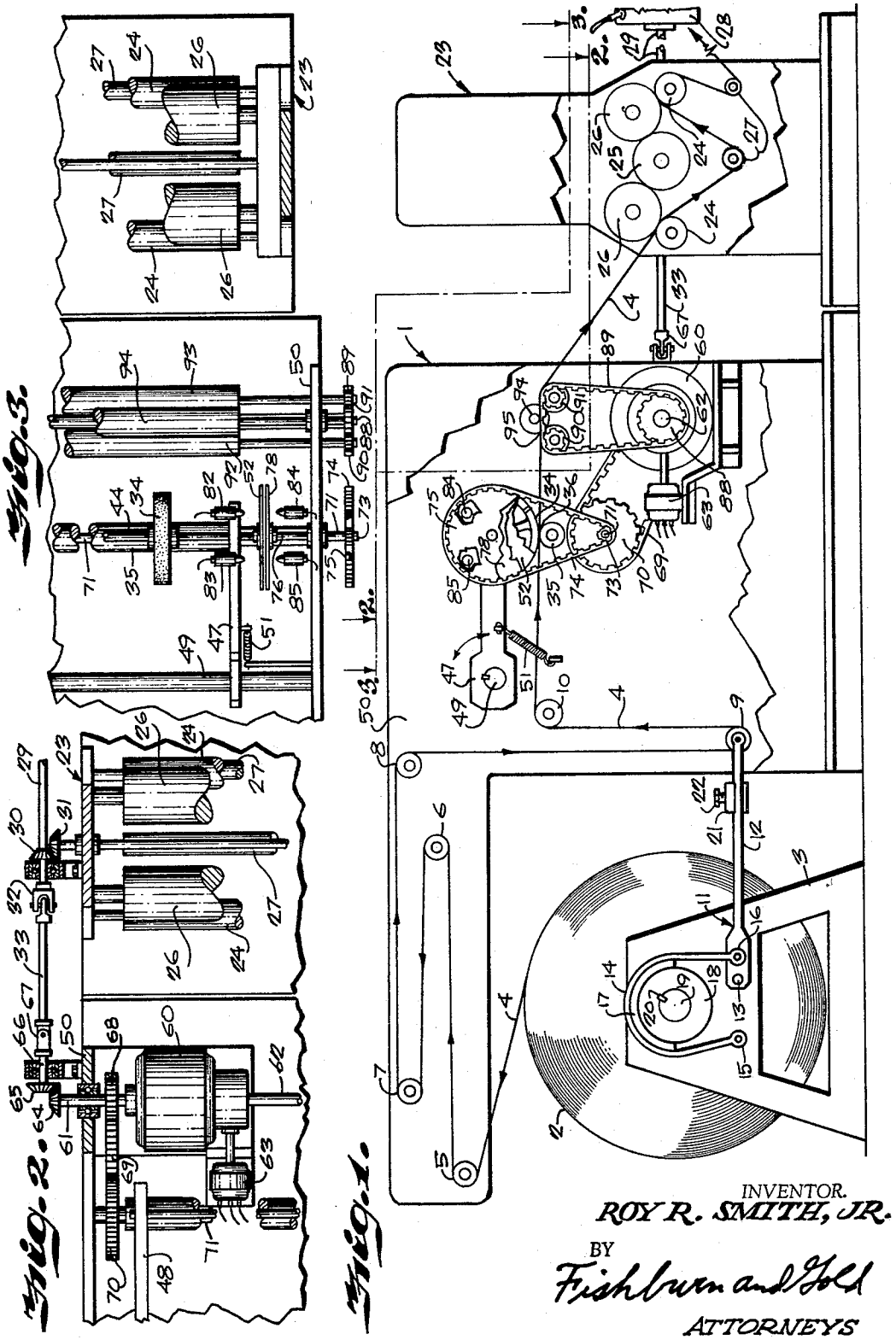


Fig. 3.

Fig. 2.

Fig. 1.

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WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31, 1964 6 Sheets-Sheet 2

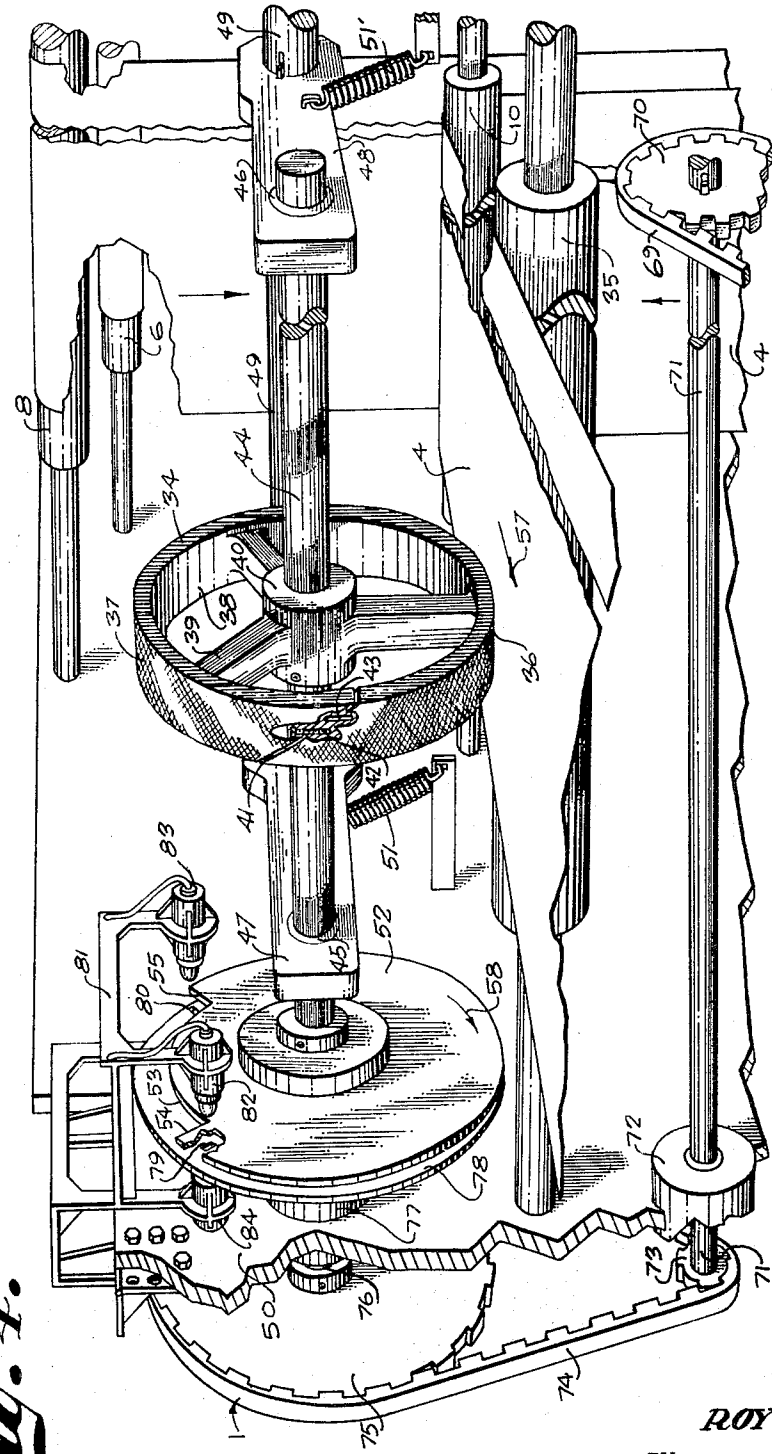


Fig. 4.

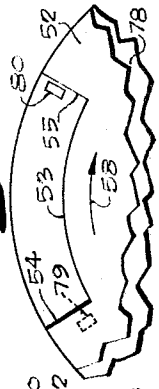


Fig. 7.

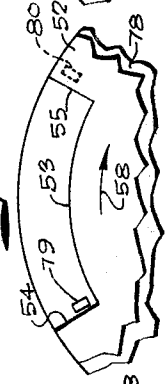


Fig. 6.

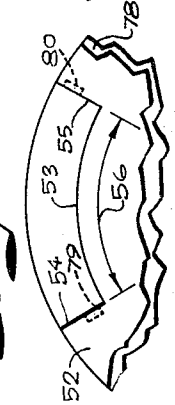


Fig. 5.

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Aug. 9, 1966 R. R. SMITH, JR 3,264,984

WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31, 1964 6 Sheets-Sheet 3

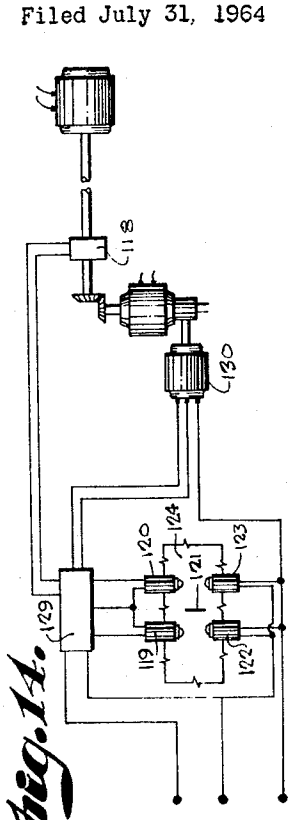


Fig. 11.

Fig. 8.

Fig. 10.

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Aug. 9, 1966 R. R. SMITH, JR 3,264,984

WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31, 1964 6 Sheets-Sheet 4

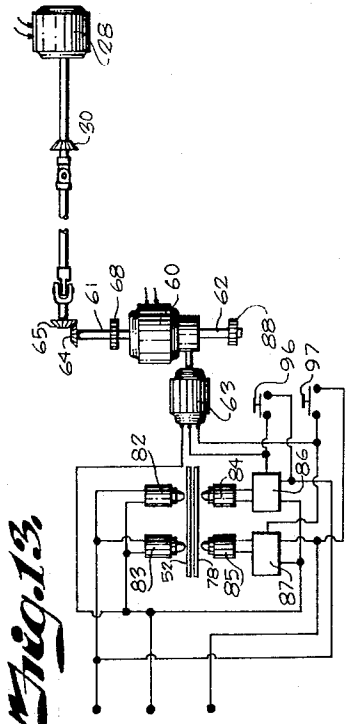


Fig. 13.

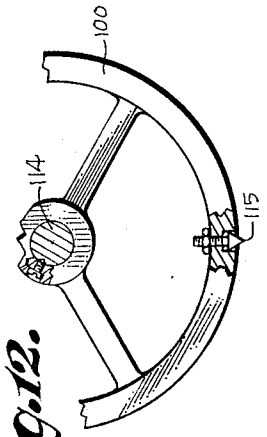


Fig. 12.

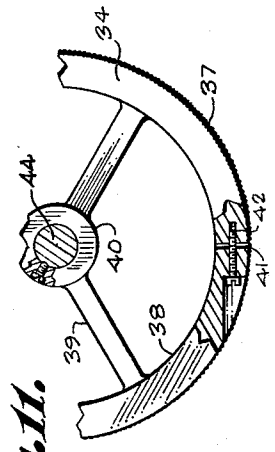


Fig. 11.

Fig. 9.

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Aug. 9, 1966 R. R. SMITH, JR 3,264,984

WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31, 1964 6 Sheets-Sheet 5

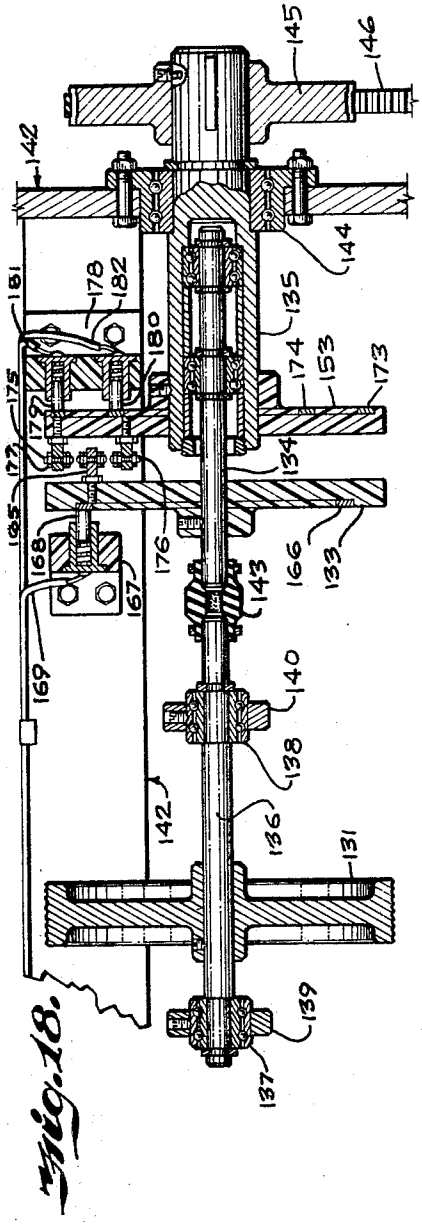


Fig. 18.

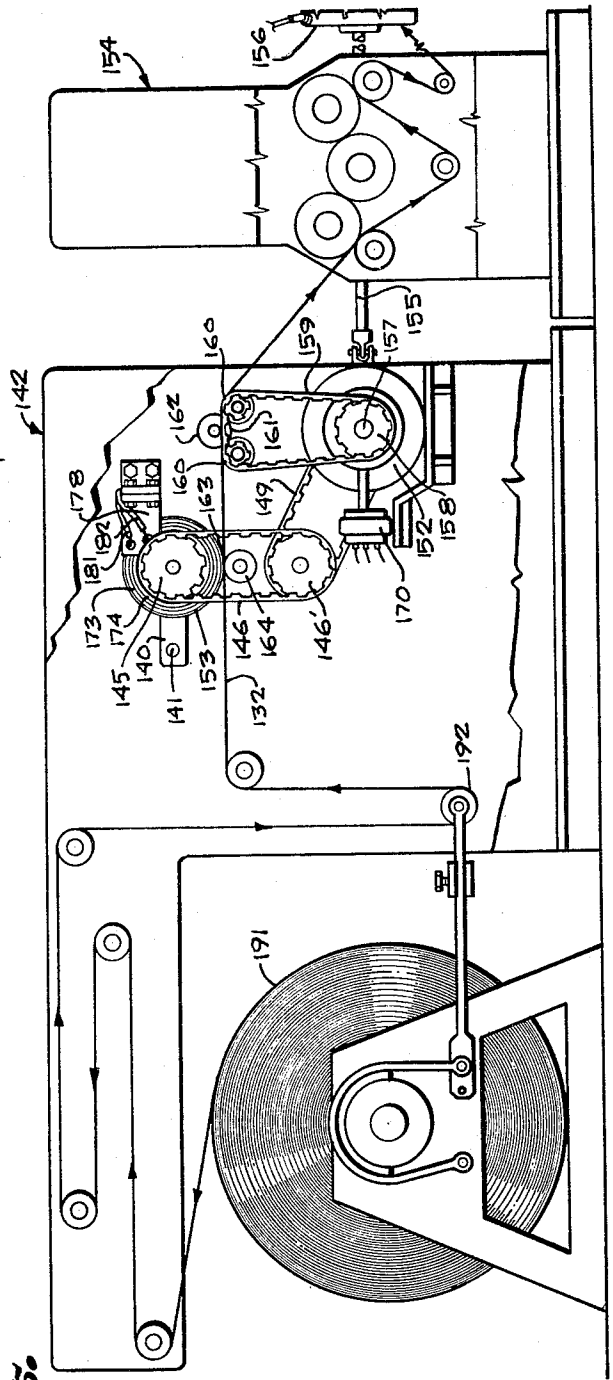


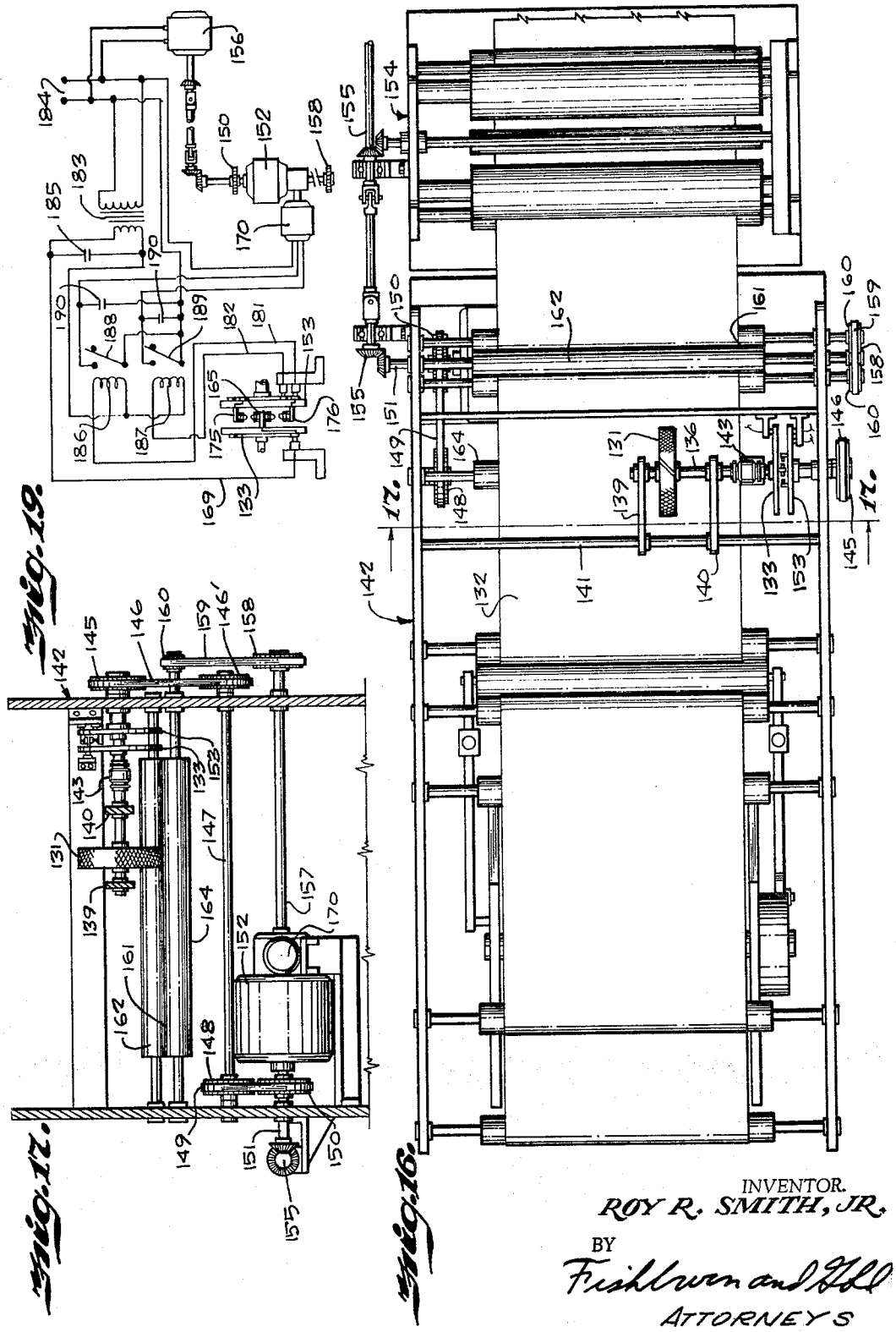
Fig. 15.

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WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

Filed July 31, 1964 6 Sheets-Sheet 6



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United States Patent Office 3,264,984 Patented August 9, 1966

3,264,984

WEB LENGTH CONTROL DEVICE FOR ROTARY PRINTING PRESS

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Filed July 31, 1964, Ser. No. 386,490
14 Claims. (Cl. 101—227)

This invention relates to paper web handling apparatus, and more particularly to web in-feeding devices for rotary printing presses and the like. This application is a continuation-in-part of application Serial Number 308,116, filed September 11, 1963, now abanodned.

Web-fed rotary printing presses are designed to transmit a particular length of web therethrough for each printing cycle or revolution of the printing cylinder. This web length, however, in absence of special compensating devices actually varies slightly from time to time due to changes in press-operating conditions. For example, the effective radius of a press driving roller about which the web is wrapped is altered when a web of different thickness is delivered into the press. Further, variations in paper type, press speed, humidity, temperature, etc., all have often unpredictable effect on the gripping action of the various driving rollers in the press which result in slight variations in web demand for each revolution of the printing cylinder.

In some types of printing operations, for example when cut-off occurs after each printing cylinder rotation, this slight variation in web length per printing cylinder revolution is not important and may be ignored. In high speed business form production, however, uniformity of the web length cylinder revolution ratio becomes extremely important because the finished form is usually produced from many printed and rerolled webs all of which must be in exact register over their entire length. If only one or a very few types and weights of paper web are used with long runs and ambient conditions are relatively constant, the length of web per cylinder revolution can be predicted and controlled, although with difficulty, by an experienced press operator through the use of manually adjustable in-feed tensioning devices such as dancer roll brakes on the in-feed paper roll shaft. The more common situation in business form production, however, is the requirement of a great variety of papers in various web thicknesses converted under uncontrolled ambient conditions in the plant. This necessitates frequent adjustment checks during printing runs, extended set-up periods and often excessive waste with resultant high production costs.

In controlling in-feed tension to produce the desired printing cycle web length, the thinnest web, for example .0015 inch, requires (and can withstand) the least amount of tension to obtain sufficient tautness for proper handling in the press. Thus, the thinnest web used determines the length of web per printing cylinder revolution at which all the other thicknesses of paper must be delivered for subsequent collating in register from printed rolls.

The principal objects of the present invention are: to provide an in-feed device which controls web delivery length into web converting apparatus by an automatic metered release or hold-back of the in-feeding web; to provide such a device which releases a predetermined length of web into a rotary printing press per printing cylinder revolution regardless of the press demand; to provide such a device which automatically controls the amount of in-feeding tension to obtain a predetermined web delivery length per printing cylinder revolution regardless of the weight or thickness of the web; to provide such a device which automatically compensates web in-feed for variations in ambient conditions such as humidity and temperature and is relatively unaffected by great changes in press speed; and to provide such a device particularly adapted for high speed business form production which is simple and relatively inexpensive in construction and highly reliable in use.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of this invention.

FIG. 1 is a partially schematic view in side elevation with portions broken away illustrating a web in-feeding device embodying this invention located in operative relation between an in-feed paper roll and a typical printing press tower or head.

FIG. 2 is a partially schematic, fragmentary, cross-sectional view through the in-feeding device taken on the line 2—2, FIG. 1, particularly showing the common drive relationship between said device and the printing head.

FIG. 3 is a partially schematic, fragmentary, cross-sectional view through the in-feeding device taken on the line 3—3, FIG. 1, showing the opposite side of the apparatus from that shown in FIG. 2.

FIG. 4 is a fragmentary perspective view on an enlarged scale showing details of the web in-feeding device of FIG. 1.

FIG. 5 is a fragmentary end elevation illustrating the relative angular positions of a pair of rotating opposed control discs when no correction in web tension is indicated.

FIG. 6 is a fragmentary end elevation illustrating the discs of FIG. 5 in a relative angular position indicating the need for lesser web tension.

FIG. 7 is a fragmentary end elevation illustrating the discs of FIG. 5 in a relative angular position indicating the need for greater web tension.

FIG. 8 is a partially schematic fragmentary cross-sectional view in side elevation taken on the line 8—8, FIG. 9, illustrating a modified form of web in-feeding device embodying this invention.

FIG. 9 is a fragmentary end elevation on an enlarged scale particularly illustrating the control wheel and related structure of the embodiment of FIG. 8.

FIG. 10 is a fragmentary cross-sectional view taken on the line 10—10, FIG. 9, on a reduced scale showing details of the control wheel mounting construction.

FIG. 11 is a fragmentary end elevation of a control wheel and particularly illustrating an adjustable circumference feature thereon.

FIG. 12 is a fragmentary end elevation of a web marking wheel used with the embodiment of FIG. 8.

FIG. 13 is a schematic wiring diagram of the control circuit used with the embodiment of FIG. 1.

FIG. 14 is a schematic wiring diagram of the control circuit used with the embodiment of FIG. 8.

FIG. 15 is a partially schematic view in side elevation with portions broken away illustrating a further modified form of web in-feeding device embodying this invention.

FIG. 16 is a partially schematic plan view of the embodiment of FIG. 15 particularly showing the relationship between the web length measuring apparatus and the web passing through the in-feeding device.

FIG. 17 is a cross-sectional view through the in-feeding device taken on the line 17—17, FIG. 16.

FIG. 18 is a fragmentary cross-sectional view on an enlarged scale particularly showing the relationship between the web contacting control wheel and the electrical contact supporting control discs.

FIG. 19 is a schematic wiring diagram showing a control circuit suitable for use with the embodiment of FIG. 15.

Referring to the drawings in more detail:

The reference numeral 1 generally indicates a web in-feeding device embodying this invention. The device 1 is illustrated in FIG. 1 in operative relation with an in-feed paper web roll 2 supported on a conventional roll stand 3 and adapted to deliver a paper web 4 to and through the in-feeding device 1. The web 4 is directed generally horizontally in a conventional manner over direction-reversing rollers 5, 6, 7 and 8, and then vertically downwardly around a dancer roller 9 where it reverses direction, proceeding upwardly over a stationary roller 10 from which it proceeds generally horizontally into the web in-feeding device 1. The dancer roller 9 forms part of a known relatively constant tension brake mechanism 11 which includes a generally horizontally directed arm 12 rotatably mounting the dancer roller 9 at one end thereof and pivotally mounted at the other end 13 thereof to the stand 3. A band 14 is anchored at one end 15 thereof to the stand 3 and at the other end 16 thereof to the arm 12 intermediate the arm end 13 and dancer roller 9 for downward movement with said arm. The band 14 has a brake lining 17 secured thereto and contacting a brake drum 18 rotatably fixed to the web roll shaft 19 by a suitable key 20 for rotation with the roll 2. A weight 21 is adjustably longitudinally slidable along the arm 12 and may be fixed in position therealong with a suitable screw lock 22. In operation, as the tension on the web 4 increases, the dancer roll 9 moves upwardly about the end 13 lowering pressure between the brake lining 17 and the brake drum 18 until the tension has been reduced to the desired amount as determined by the longitudinal position of the weight 21. A decrease in web tension results in a lowering of the dancer roll 9 to produce the opposite effect, resulting in a generally constant pull-out tension on the web 4.

Upon leaving the in-feeding device 1 described below, the web 4 is directed into a rotary printing tower or head generally indicated 23 comprising any one of several known designs which may include impression cylinders 24, a common drive gear 25 for equal diameter printing cylinders 26 and compensating rollers 27. The web may be directed from the head 23 to additional printing heads (not shown) or to a take-up roll station (not shown) as desired.

The apparatus includes a drive motor 28 which may be part of the head 23 or remote therefrom and having a drive shaft 29 through which the printing head 23 is powered by bevel gears 30 and 31. The drive shaft 29 extends past the head 23 for coupling by means of a universal joint 32 to a drive shaft 33 for the simultaneous synchronous driving of the web in-feeding device input with the printing head 23 as noted further below.

The web in-feeding device 1 includes a control wheel 34 and an idler roller 35 respectively positioned in paired running relation forming a control couple 36 adapted to receive and pass the web 4 therethrough in a straight run from the roller 10 while gripping the web therebetween. The control wheel 34 has a fine knurled or other hard friction-producing exterior cylindrical surface 37 which produces a non-slipping contact with the surface of the web 4 in urging same against the idler roller 35. The control wheel 34, in the illustrated example, is formed of an outer shell or hoop 38 supported by radially directed spokes 39 extending from a central hub 40. The circumference of the control wheel 34 at the surface 37, in the illustrated example, is equal to the circumference of the printing cylinder 26, but may be otherwise proportional thereto as long as a known relationship exists with respect to the rotation of the printing head 23 without departing from the scope of this invention. In order to insure that this control wheel-printing cylinder relationship exists within close tolerances, the shell or hoop 38 has a diagonal break or separation 41 extending thereacross with opposite sides urged toward each other by means of an adjusting screw 42 and suitable alignment pins 43 whereby the outer circumference may be adjusted in the order of a few thousandths of an inch if needed.

A shaft 44 extends through the central hub 40 for mounting the control wheel 34, the shaft 44 being freely rotatably supported in bearings 45 and 46 contained in arms 47 and 48 respectively fixed to a common shaft 49 pivotally mounted to the frame 50 of the web in-feeding device 1. The arms 47 and 48 normally extend generally horizontally from the shaft 49 and, in the illustrated example, suitable frame anchored tension springs 51 and 51' exert downward pressure on the arms 47 and 48 which is transmitted through the shaft 44 to the control wheel 34 for applying friction producing pressure at the control couple 36. The arms 47 and 48 may be pivoted upwardly on the shaft 49 against the tension of the springs 51 and 51' for convenience in web threading, maintenance and the like.

The shaft 44 extends through the supporting arm 47 and secures at the outer end thereof a control disc 52 having a peripheral cut-out portion 53. The portion 53 includes radially extending edges 54 and 55 which are spaced apart a predetermined angle 56 (FIG. 5) about the shaft 44. It is to be understood that the movement of the web 4 in the direction indicated by the arrow 57 (FIG. 4) freely rotates the control wheel 34 and control disc 52 in the direction indicated by the arrow 58 when the control couple 36 is closed by the springs 51 and 51'.

The web in-feeding device 1 also includes a positive infinitely variable speed transmission 60 having an input shaft 61 and an output shaft 62 and a remotely operable reversible control motor 63 for varying the rotation ratio between the input shaft 61 and output shaft 62. The input shaft 61 has a bevel gear 64 fixed thereto and meshing with a bevel gear 65 fixed to a stub shaft 66 rotatably mounted on the frame 50 and coupled to the drive shaft 33 through a universal joint 67 whereby the drive motor 28 rotates the transmission input shaft 61 simultaneously with the driving of the printing head 23. A non-slip or timing belt sprocket or pulley 68 is fixed to the input shaft 61 and meshes with a timing belt 69 for driving an idler sprocket or pulley 70 fixed to a shaft 71 rotatably mounted in support bearings 72 to the frame 50 for rotation with the drive shaft 33. The shaft 71 also has fixed thereto a timing belt sprocket or pulley 73, in the illustrated example of smaller pitch diameter than the pulley 70 and engaged with a timing belt 74 which operatively meshes with a sprocket or pulley 75 fixed to a shaft 76. The shaft 76 is rotatably mounted in and extends through a bearing 77 fixed to the frame 50 and supports a control disc 78 on the inner end thereof in opposed adjacent coaxial relationship to the control disc 52. Timing belts and pulleys are used herein to obtain positive motion transfer while avoiding backlash which may be present in gears. The input shaft 61 rotates at a known proportionally greater speed than the disc 78 for reasons set forth below.

The control disc 78 has a pair of openings or windows 79 and 80 respectively extending therethrough at a radius intersecting the edges 54 and 55 of the disc 52 and spaced apart an angle about the shaft 76 slightly greater than the angle 56 (FIG. 5) whereby during perfect instantaneous alignment the outer periphery of the disc 52 just covers both windows 79 and 80 with the cut-out portion 53 located therebetween.

A suitable supporting structure 81 is mounted to the frame 50 and carries a pair of light sources 82 and 83 spaced apart in positions whereupon light radiating respectively therefrom may simultaneously pass through the windows 79 and 80. Aligned with the respective light sources 82 and 83 are photoelectric scanners or cells 84 and 85 located on the opposite side of the disc 78 from the sources 82 and 83, the disc 52 also being therebetween. As best illustrated in FIG. 4, the light from the respective light sources 82 and 83 must radiate past both the disc

52 and disc 78 before it can strike the respective photoelectric cell. The cells 84 and 85 are adapted to transmit signals respectively to relay assemblies 86 and 87 (FIG. 13) which are electrically connected to the control motor 63, the relay assembly 86 when actuated causing the control motor 63 to rotate over a short increment of time in one direction while the relay assembly 87, when actuated, causing the control motor 63 to rotate for a small increment of time in the opposite direction. As noted above, the rotation of the control motor 63 changes the rotation ratio between the transmission input shaft 61 and output shaft 62.

The transmission output shaft 62 has a timing belt sprocket or pulley 88 fixed thereto and meshed with a timing belt 89 which, in turn, engages a pair of horizontally spaced-apart pulleys 90 and 91. The pulleys 90 and 91 rotate driving rollers 92 and 93 which are urged against an idler roller 94, the rollers 92, 93 and 94 forming a feed roll couple 95 adapted to receive and grip the web 4 from the control couple 36 and continually release same for entry into the printing head 23.

In operation, the drive motor 28 drives the rotary printing head 23 in synchronization with the input shaft 61 of the transmission 60. This produces a continuous release of the web 4 through the feed roll couple 95 at a speed which varies from the web demand speed of the printing head 23 by an amount proportional to the ratio between the input and output shafts of the transmission 60. As the web passes through the feed roll couple 95, the control wheel 34 is rotated by the web which, in turn, rotates the control disc 52 at a speed which is directly related to the speed of the web.

The rotation of the transmission input shaft 61 also produces a rotation of the control disc 78 at a speed proportional to but, in the illustrated example, less than the speed of the shaft 61. Assuming a ratio of ten turns of the shaft 61 to one turn of the disc 78, and ideal conditions wherein the control wheel 34 is rotating in the exact desired proportional speed to the rotation of the printing cylinder 26 (in the illustrated example a ratio of 1:1), upon each tenth turn of the control disc 52 the windows 79 and 80 will respectively align themselves with the light sources 82 and 83 at the exact instant that the cut-out portion 53 on the disc 52 is located therebetween (FIG. 5) in the manner of the minute and hour hands of a clock striking noon. Under these conditions, no light is permitted to pass through the windows and no change signal is received by the control motor 63. If, however, the printing head 23 demands more paper per revolution of the printing cylinder 26, for example as caused by a web of greater thickness, the control wheel 34 will begin to rotate at a slightly greater proportional speed than the printing cylinder 26. After the tenth turn of the control disc 52, the window 80 will be exposed (FIG. 7) for transmitting light from the source 83 to the photoelectric cell 85 which results in a timed control pulse rotating the control motor 63 through a small angle in a direction which causes the transmission 60 to turn the output shaft 62 thereof at a slightly more reduced speed with respect to the input shaft 61. This causes the feed roll couple 95 to hold back to a slightly greater extent increasing web tension and reducing the amount of web entering the printing head 23 per rotation of the printing cylinder 26.

In the same manner, a decrease in printing head web demand per rotation of the printing cylinder, for example caused by a reduction in web thickness, will cause the control disc 52 to rotate at a relatively slower speed which, upon the tenth turn thereof, will permit the window 79 (FIG. 6) to be exposed to the light source 82 resulting in a slight increase in feeding speed of the feed roll couple 95. This slightly reduces the tension in the web 4 being fed into the printing head 23 permitting a correcting increase in web length delivered per printing cylinder rotation.

If desired, the rotation ratio between the input shaft 61 and disc 78 may be varied, for example, by changing the relative diameters of the pulleys 73 and 75, for producing a signalling position of the discs 58 and 72 more or less often. It is noted that the positions of the edges 54 and 55 and windows 79 and 80 may be suitably modified by one skilled in the art so as to permit light pulses of desired length to pass while preventing stray pulses during non-checking positions of the discs. Suitable pushbutton controls 96 and 97 are provided for overriding the photoelectric cells 84 and 85 for ease in initially threading and roughly adjusting the apparatus with a minimum of web waste.

An alternative embodiment of this invention is illustrated in FIGS. 8, 9, 10, 12 and 14 and is similar to the embodiment of FIG. 1 except that instead of relatively rotating opposed discs for comparing the desired web speed with actual web speed, a web marking and scanning assembly generally designated 98 is used. In this latter embodiment, the control wheel 99, rotating in response to web movement, drives a marking wheel 100 rotatably supported in a yoke 101 which is vertically reciprocated a small distance above an idler roller 102 through the cooperation between a suitable splined universal joint 103 and a slidable vertically extending mounting shaft 104. A compression spring 105 surrounds the shaft 104 and urges at opposite ends thereof against a rigid frame 106 and a collar 107 fixed to the shaft 104 for continuously urging the yoke 101 upwardly. The upper end 108 of the shaft 104 engages a cam 109 mounted on a shaft 110 rotatably supported on the frame 106. The shaft 110 carries a timing belt sprocket or pulley 111 which meshes with a timing belt 112 engaging a pulley 113 on the control wheel mounting shaft 114. As the mounting shaft 114 is rotated by the control wheel 99, the cam 109 is rotated at a proportional lower rate, for example once for every ten revolutions of the control wheel 99, urging the marking wheel 100 downwardly for not over one revolution thereof. The marking wheel 100 always has the same peripheral speed as the control wheel 99 and includes a suitable marking member 115 extending outwardly from the periphery thereof. The marking member 115 periodically contacts suitable inking rollers 116 and 117 for receiving ink thereon to be deposited on the web during the downward displacement of the wheel 100.

A counter mechanism 118 is adapted to periodically produce a signal which momentarily activates a pair of photoelectric scanners 119 and 120 for determining the instantaneous position of the mark 121 made by the member 115 on the web. The scanning apparatus of both embodiments noted herein are of known types, for example those available from the Electric Eye Equipment Company of Danville, Illinois. A pair of light sources 122 and 123 are provided in positions angularly opposed to the respective scanners 119 and 120 for reflecting light off the web 124 in a known manner. The counter mechanism 118 is actuated by the main drive shaft 125 which simultaneously and synchronously drives the printing head 126.

By way of operation, the control wheel 99 is rotated by the web 124 which is permitted to feed into the printing head 126 by metered release of the feed roll couple 127. A mark 121 is impressed on the web, in this example, upon each tenth revolution of the marking wheel 100. If the web is being fed at the desired length for each rotation of the printing cylinder 128, the actuation of the scanners 119 and 120 will occur when the mark 121 is located therebetween which will produce no signal for varying the web tension. If, however, the press demand is greater than desired, the mark 121 will interfere with the reflection into the scanner 120 which produces a signal in a suitable relay assembly 129. The assembly 129 will then transmit a pulse into the control motor 130 slowing the relative speed of release of the feed roll couple 127 for slightly increasing the tension on the web 124 being delivered into the printing head 126. If the web

is entering the printing head at less than the desired length per revolution of the printing cylinder **128**, the scanner **119** will act in a manner similar to the scanner **120** to produce the needed opposite correction.

A further alternative embodiment of this invention is illustrated in FIGS. 15 to 19 and is similar to the embodiment of FIG. 1 except that instead of normally relatively rotating disc-light signal responsive apparatus for comparing the desired web speed with actual web speed, opposed discs are provided which rotate together except when a correction is needed which causes a slight angular displacement of one disc with respect to the other. This displacement closes one or another set of contacts, depending on the direction of relative displacement, for completing a circuit to the control motor to produce a correction in the desired direction.

In this embodiment, the control wheel **131**, rotating in response to the movement of the web **132** drives a control disc **133** rotatably supported on a shaft **134** which is freely journaled within a hollow shaft **135**. The control wheel **131** is mounted on a shaft **136** supported by respective bearings **137** and **138** mounted in arms **139** and **140**. The arms **139** and **140** are suitably supported on a shaft **141** secured to the frame of the web in-feeding device **142**. In the illustrated example a flexible coupling **143** is secured at opposite ends thereof to the shaft **136** and the shaft **134** whereby the rotation of the control wheel **131** produces the same rotation in the control disc **133** but some resilient rotational play is permitted between the control wheel **131** and the control disc **133**. The flexible coupling **143** is preferably of the type which urges the respective shafts **136** and **134** to return to a predetermined rotational position with respect to each other when any stress producing a change in relative positions is removed. Under some circumstances a rotationally rigid or a slip clutch type of coupling may be used.

The hollow shaft **135** is journaled by suitable bearings **144** in the frame of the web in-feeding device **142** and has a timing belt sprocket or pulley **145** fixed thereto. A timing belt **146** is engaged with the pulley **145** and is in turn engaged with a pulley **146'** fixed to a shaft **147**. The shaft **147** is rotatably mounted on the frame of the in-feeding device **142** and carries a pulley **148** having a timing belt **149** engaged therewith, which is in turn engaged with a pulley **150** fixed to the input shaft **151** of the positive infinitely variable speed transmission **152**. The hollow shaft **135** carries a control disc **153** which is rotated with the input shaft **151** through the above noted drive structure. The rotation of the control disc **153** thus becomes an exact measure of the input rotation to the positive infinitely variable speed transmission **152** and the rotational speed of the printing head **154** which are driven together by the drive shaft **155** from a suitable power source such as a drive motor **156**.

The output shaft **157** of the transmission **152** carries a pulley **158** engaged with a timing belt **159** which is in turn engaged with pulleys **160** driving rolls forming a feed roll couple **161** with an idler roller **162**.

The control wheel **131** forms a control couple **163** with an idler roller **164** which grips the web **132** therein causing the control wheel **131** to rotate at a surface speed equal to the speed of the web **132** through the control couple.

The control disc **133** carries a contact assembly **165** on one face near the periphery thereof and which is electrically connected to a slip ring **166** on the face opposite. A brush assembly **167** is secured to the frame of the web in-feeding device **142** and maintains a brush **168** in electrical contact with the slip ring **166**, the brush **168** electrically communicating with an electrical lead **169** discussed hereinafter for use in controlling the reversible transmission control motor **170**. The control disc **153** carries a pair of electrically isolated concentric slip rings **173** and **174** similar to the slip ring **166**. The slip rings **173** and **174** respectively electrically communicate with spaced apart contact points **175** and **176** mounted on a face and near the periphery of the control disc **153**. The contact points **175** and **176** are spaced apart on opposite sides or ends of the contact assembly **165** with a small open space therebetween which is adjustable by releasing suitable lock nuts **177**. A brush assembly **178** is suitably secured to the frame and carries brushes **179** and **180** respectively in electrical contact with the slip rings **173** and **174**. The brushes **179** and **180** communicate with electrical leads **181** and **182** for carrying signals to control the control motor **170** as noted below.

Referring particularly to FIG. 19, a suitable wiring diagram for use with this embodiment is depicted and includes a transformer **183** having the primary coil thereof energized by house power **184**. The lead wire **169** is connected to one side of the secondary which is thus supplied with low voltage control current. A suitable capacitor **185** or the like may be suitably connected into the circuit to minimize sparking at the contacts **175** and **176**. The leads **181** and **182** are connected to the respective coils **186** and **187** of relays having respective contact points **188** and **189** which are both normally open. The contact points **188** and **189** are connected into the circuit of the reversible motor **170** and upon closing one or the other the motor **170** is caused to rotate in opposite directions for changing the ratio of input to output rotational speed of the positive variable speed transmission **152**. Suitable capacitors **190** or the like may be provided like the capacitor **185** for spark suppression to maintain long relay contact life. Electronic or solid state relays may be used instead of contact relays if desired.

In operation, the control wheel **131** is rotated by the web **132** which is permitted to feed into the printing head **154** by metered release of the feed roll couple **161**, the web being supplied from a roll **191** preferably passing over a dancer roll brake **192** as in the first described embodiment. The rotational relationship between the input shaft **151** and the control disc **153** is such that if the web is being fed at the desired length for each rotation of the printing cylinders in the printing head **154**, the control discs **133** and **153** rotate together at exactly the same rate. Under these circumstances the contact assembly **165** maintains a position between the respective contact points **175** and **176** whereby neither relay coil **186** or **187** is energized. If however, the press demand is greater than desired, the control wheel **131** will cause the control disc **133** to rotate at a slightly greater rate than the control disc **153** which in turn will quickly produce electrical contact between the contact assembly **165** and the contact point **175**. This energizes the relay coil **187**, closing the contacts **189** and actuating the control motor **170** which will modify the input-output ratio of the transmission **152** to decrease the relative speed or release rate of the feed roll couple **161** for slightly increasing the tension on the web **132**. If, on the other hand, the web is entering the printing head at less than the desired length per rotation of the printing cylinders in the printing head **154**, an opposite relative motion will take place between the discs **133** and **153** to produce contact between assembly **165** and point **176**, initiating the needed opposite correction.

During normal operation the contact assembly **165** will monitor web feeding conditions by floating between the contact points **175** and **176**, producing a correction periodically, that is, from time to time as a sufficient relative rotation between the control discs **133** and **153** is produced. The space or clearance between the contact assembly **165** and the contact points **175** and **176** may be set to a very small distance if desired, the accuracy of control and frequency of correcting signals being generally increased as the clearance becomes less.

Thus, regardless of the demand of the press, the web in-feeding device of this invention will permit only the exact predetermined length of paper to enter the press per printing cylinder revolution. This length is inherent-

ly slightly less than the printing cylinder circumference so as to insure at least the necessary minimum of web tension for proper printing and rerolling. Once the control wheel has been adjusted to the proper circumferential relationship with the printing cylinder, it constitutes a reference always available to produce the desired printing length within satisfactory tolerances for subsequent multi-layer registration regardless of the particular web thickness and ambient conditions. The contact surface width of the control wheel may be varied if desired, a larger width being preferable for lower quality webs wherein the tension is likely to vary along the width of the web.

Although the in-feeding device has been described in connection with a printing press, it may also prove of value in other types of web handling equipment wherein a particular length of web per operating cycle must be maintained. It is to be further understood that while certain forms of this invention have been illustrated and described, it is not to be limited to the specific form or arrangement of parts herein described and shown except insofar as such limitations are included in the claims.

What I claim and desire to secure by Letters Patent is:

1. In combination with a web receiving apparatus having drive means, a web in-feeding device adapted to release a predetermined length of web per apparatus operation regardless of changing web demand of the apparatus, said device comprising; means forming a control couple adapted to grip the web and move therewith, a measuring member operably associated with said control couple and responsive to the web passing therethrough, means forming a feed roll couple adapted to grip and continuously release the web for entry into the apparatus, a variable speed transmission having an input member and an output member and a control member for varying the rotation ratio between said transmission input and transmission output members, said drive means and transmission input member being operably connected for driving said transmission and apparatus synchronously, motion transmitting means connecting said transmission output member to said feed roll couple for controlling the web releasing speed thereof, and means for comparing the measuring member response and the operation of said drive means, said comparing means being operably connected to said control member and adapted to order a change in said control member in response to predetermined variations in the comparison.

2. In combination with web receiving apparatus having a power input shaft and web pull-in members, a web in-feeding device adapted to release a predetermined length of web into the apparatus per operating cycle thereof regardless of the changing web demand of the apparatus, said device comprising; a control wheel and an idler roller positioned in paired running relation forming a control couple adapted to receive and grip the web therebetween, said control couple being driven by the web, said control wheel having an exterior non-slip web-contacting surface with an effective circumference proportional to the demand length of web for an apparatus operating cycle under one set of conditions, means forming a feed roll couple adapted to grip the web and continuously release the web for entry into the apparatus pull-in members, a positive variable speed transmission having an input shaft and an output shaft and a control member for varying the rotation ratio between said transmission input and transmission output shafts, positive drive means operably connected to said transmission input shaft and power input shaft for driving said transmission and apparatus synchronously at all speeds, motion transmitting means connecting said transmission output shaft to said feed roll couple forming means for controlling the web releasing speed thereof, means operably connected to said control wheel and responsive to the rotation thereof, means operably connected to said power input shaft and responsive to the rotation thereof, and means for comparing the responses of said control wheel means and power input shaft means, said comparing means being operably connected to said control member and selectively responsive to said responses for varying said rotation ratio when the length of web contacting said control wheel during a predetermined rotation of said power input shaft varies beyond predetermined limits from the length of web demanded during said one set of conditions.

3. The combination as set forth in claim 2 wherein said control wheel means includes a first rotating disc driven by said control wheel and said power input shaft means includes a second disc driven by said power input shaft and located in coaxial adjacent relation to said first disc, said first and second discs having light transmitting portions, said comparing means including light responsive members positioned to receive light through said transmitting portions during predetermined relative rotational positions of said discs.

4. The combination as set forth in claim 2 wherein said control wheel means includes a marking mechanism adapted to place a mark on the web after a predetermined rotation of said control wheel and said power input shaft means includes a rotation counting member operably driven by said power input shaft, said comparing means including light responsive members adapted to detect the position of said mark at an instant periodically determined by the position of said rotation counting member.

5. The combination as set forth in claim 2 wherein said control couple is positioned to pass the web therethrough in a straight run.

6. The combination as set forth in claim 3 including positive motion speed reducer members operably connected between said power input shaft and said second disc whereby said disc is rotated in synchronization with but at a lower speed than said power input shaft.

7. In combination with a rotary printing press having a power input shaft and web pull-in members and a printing cylinder, a web in-feeding device adapted to release a predetermined length of web into the press per printing cylinder revolution regardless of changing web demand of the press, said device comprising; a control wheel and an idler roller positioned in paired running relation foming a control couple adapted to receive and grip the web therebetween, said control couple being driven by the web, said control wheel having an outside non-slip web-contacting cylindrical surface with an effective circumference proportional to the circumference of said printing cylinder, means forming a feed roll couple adapted to grip the web and continuously release the web to said pull-in members, a positive infinitely variable speed transmission having an input shaft and an output shaft and a remotely operable control member for varying the rotation ratio between said transmission input and transmission output shafts, positive drive means operably connected to said transmission input shaft and power input shaft for driving said transmission and press synchronously at all speeds, motion transmitting means connecting said transmission output shaft to said feed roll couple forming means for controlling the web releasing speed thereof, means operably connected to said control wheel and responsive to the rotation thereof, means operably connected to said power input shaft and responsive to the rotation thereof, and means for comparing the responses of said control wheel means and power shaft input means, said comparing means being operably connected to said control member and selectively responsive to said responses for varying said rotation ratio when the length for web contacting said control wheel during a predetermined rotation of said power input shaft varies beyond predetermined limits.

8. The combination as set forth in claim 7 wherein said control wheel circumference is equal to the circumference of said printing cylinder.

9. The combination as set forth in claim 7 including substantially constant web tensioning means for feeding web to said web in-feeding device.

10. The combination as set forth in claim 7 wherein said control couple is positioned to pass the web therethrough in a straight run.

11. The combination as set forth in claim 1 wherein said comparing means is adapted to periodically compare the measuring member response and the operation of said drive means.

12. The combination as set forth in claim 2 wherein said control wheel means includes a first rotating member driven by said control wheel and said power input shaft means includes a second rotating member driven by said power input shaft and said comparing means comprises cooperating signal producing means on said first and second rotating members and adapted to produce a signal upon relative rotation between said first and second rotating members through a predetermined angle.

13. The combination as set forth in claim 12 wherein said signal producing means are electrical contacts and at least one of said rotating members includes electrical slip rings.

14. The combination as set forth in claim 1 wherein said measuring member includes first signal means rotatably driven by said control couple and said comparing means includes second signal means rotatably driven by said drive means and adapted to cooperate with said first signal means to produce a signal to order said change upon predetermined relative rotation between said first and second signal means.

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