Oct. 19, 1954 J. B. KOHLER 2,692,091

TENSION CONTROL DEVICE

Filed April 29, 1950

3 Sheets-Sheet 1

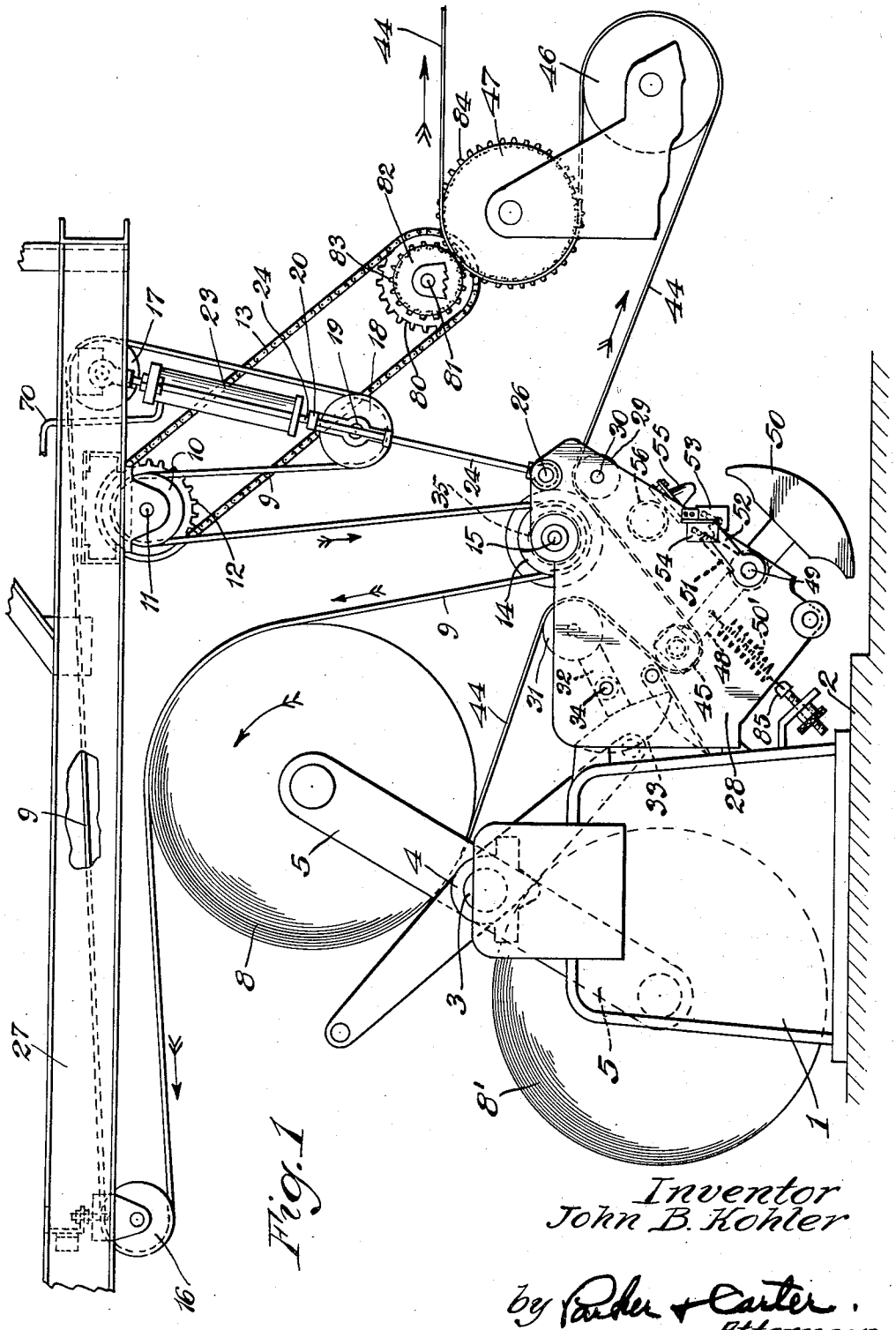

Fig. 1

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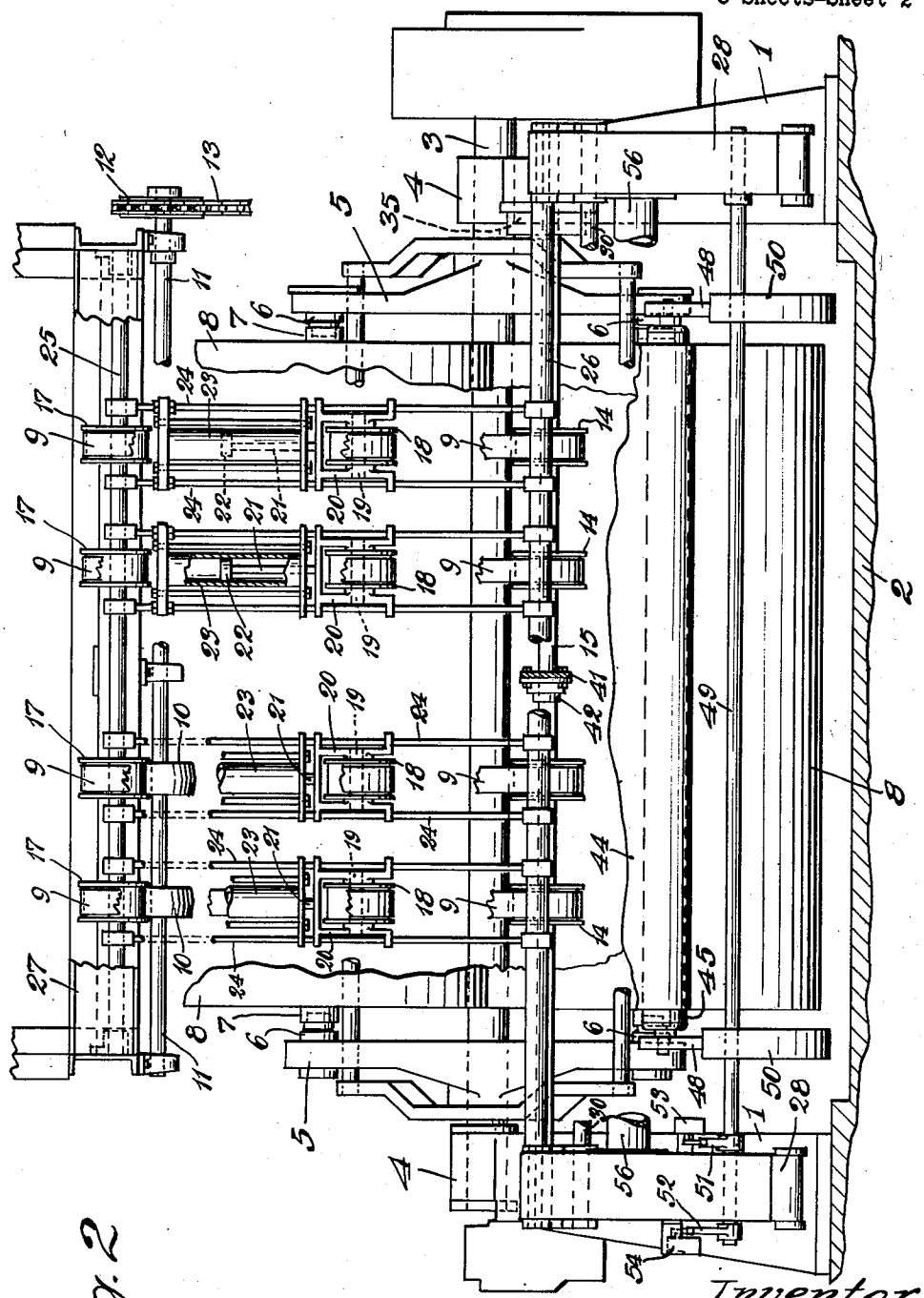

Fig. 2

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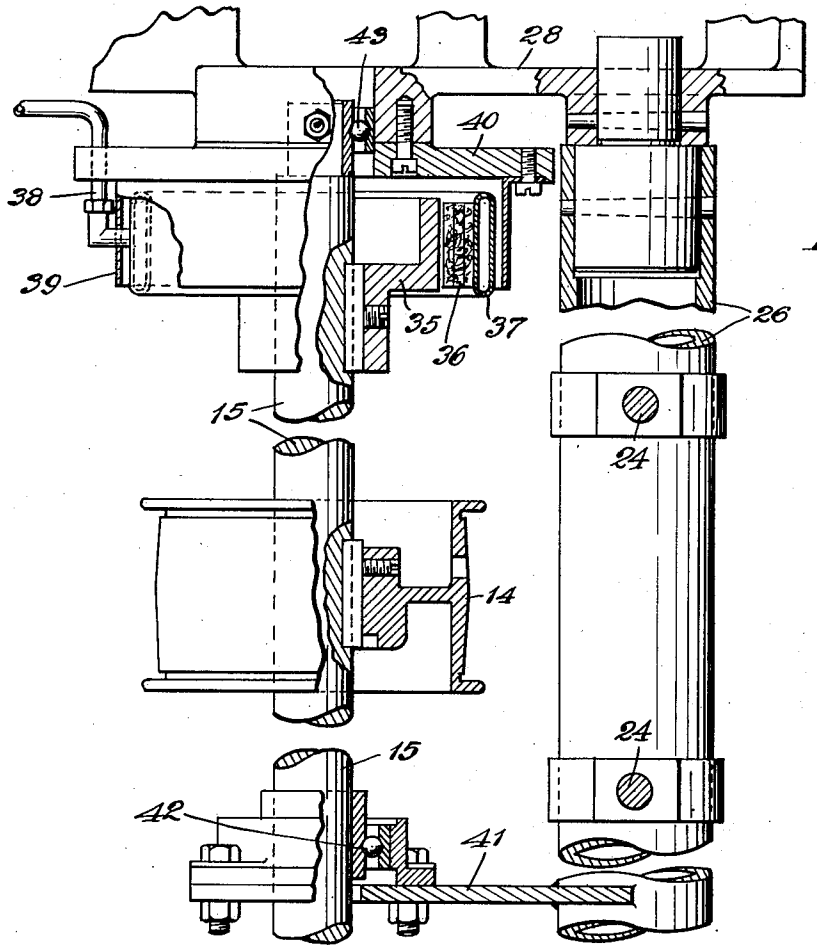

Fig. 3

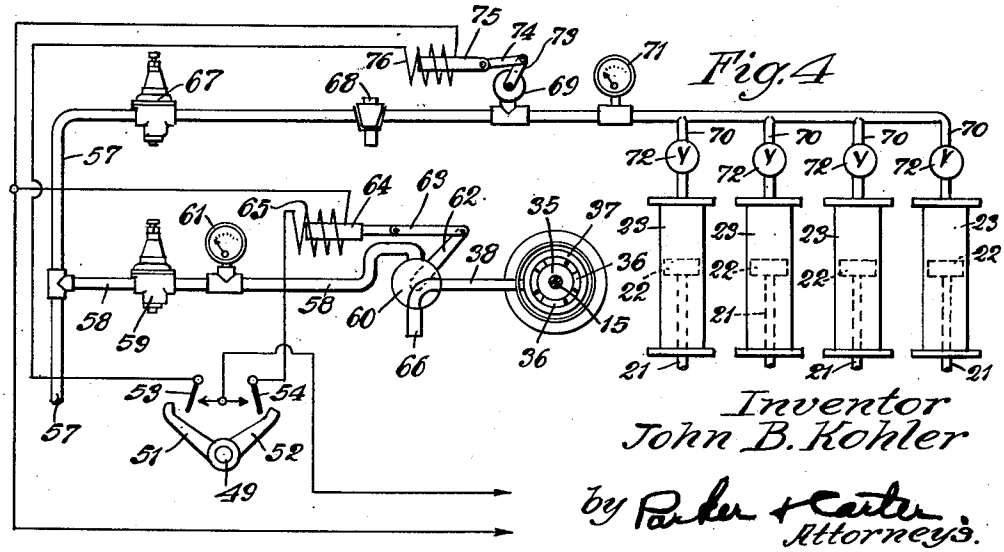

Fig. 4

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Patented Oct. 19, 1954

2,692,091

UNITED STATES PATENT OFFICE

2,692,091

TENSION CONTROL DEVICE

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Application April 29, 1950, Serial No. 159,027

13 Claims. (Cl. 242—75)

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This invention relates to a method and an apparatus for controlling the tension winding and unwinding devices or assemblies. It has for one object to provide automatic means for maintaining constant the tension on a web, for example, of paper, which is being unwound.

Another object is to provide automatic compensation for misadjustment of a tension controlling device; and also to provide automatic compensation as a result of operating conditions which tend to disturb the uniformity of tension maintained by a constant tension device, particularly the bodily displacement of a roll of web material.

Other objects will appear from time to time in the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:

Figure 1 is an end elevation of one form of the device;

Figure 2 is an end elevation of the device of Figure 1, with parts broken away and parts omitted;

Figure 3 is a partial top view of a portion of the mechanism of Figure 1, taken from above on an enlarged scale with parts omitted and parts in section; and

Figure 4 is a schematic diagram illustrating the electrical and the fluid pressure circuits embodied in the mechanism.

Like parts are indicated by like characters throughout the specification and the drawings.

As shown, the invention is applied to an unwinding mechanism. The particular form shown is suitable for use with machines to which paper or other web material is fed for treatment or for printing. Such a mechanism may conveniently be used in connection with a web-fed printing press. It may also be used with almost any unwinding device where the paper is to be treated. As shown, the mechanism comprises standards 1 that may conveniently be fixed on a foundation 2. A shaft 3 is supported in bearings 4 which are themselves carried by the standards 1.

Fixed on the shaft 3 are two arm members 5, one preferably adjacent each end of the shaft 3. The arms 5 carry bearings 6 adapted removably to receive mandrels 7 upon which rolls of paper or other web 8 and 8' may conveniently be wound.

Means not here shown in detail are provided for moving the shaft 3 and the arms and the rolls which are rotatably mounted on the arm so that the rolls are successively brought into

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the position of use. Such an assembly is known as a "magazine reel", and is generally available commercially.

Such a magazine reel may be equipped with devices for controlling the tension of the unwinding rolls, which will be hereinafter described, and also with devices permitting changing from an expiring roll to a fresh roll at speed, known generally as "Flying Paster" devices which are also generally known and available commercially and, therefore, not described herein.

The particular form of tension device disclosed herein, includes a system of belts 9 with attendant pulleys, shafts and other devices, later described, including a driven shaft 11 with keyed pulleys 10 engaging said belts 9, a means of drawing or pulling on the web, normally a part of the printing press or other machine to which the web is supplied, and a mechanical or other positive drive connecting the two.

The belts 9 pass from the pulleys 10 to pulleys 14 keyed on a shaft 15. Thence, the belts pass partially about the upper roll 8 from which unwinding is taking place, and about idler pulleys 16 and to idler pulleys 17 and about compensating pulleys 18. The compensating pulleys 18 are mounted on short shafts 19, each of which is carried in a cage 20. Each cage 20 is connected to a piston rod 21, and each piston rod is connected to a piston 22, then mounted for reciprocation in a cylinder 23. The cylinders 23 and the cages 20 are mounted on guide rods 24 which are carried at their upper ends on a rod or support 25 upon which the idler pulleys 17 are mounted.

At their lower ends the guide rods are secured on a rod or support 26. The cylinders are fixed on the guide rods, and the cages are mounted for reciprocation thereon. The pulleys 10, 16 and 17 and the shafts which carry them may be supported from the frame 27 which may form part of a building or be otherwise provided, so long as it is sufficiently strong and rigid to support the parts mentioned.

Frame or supporting members 28 are carried from the standards 1 as shown in Figures 1 and 2. The rod 26 and the shaft 15 are supported in these frame members.

Mounted also in the frame or support members 28 is an idler roller 29 carried on a shaft 30. Another idler roller 31 is carried on an arm 32 which is counterweighted as at 33 and supported on suitable bearings, as at 34.

The pulleys 14 and the shaft 15 upon which they are keyed have been mentioned above. As

shown in detail in Figure 3, a brake structure is mounted on the shaft 15. This includes a drum 35 keyed or otherwise fixed to the shaft 15. About the drum 35 are positioned a plurality of brake shoes 36. These are secured to a hollow annular member 37 to which pressure fluid is applied through a conduit 38.

When pressure is applied to the member 37, sufficiently, it expands and causes the brake shoes to contact the drum to accomplish a braking operation which will be described more fully below in connection with the description of the operation of the entire device.

A housing or protecting member 39, fixed on a support 40, may be positioned about the brake assembly. The member 40 is secured to the adjacent frame member 28. If desired, a central or intermediate support 41 may be provided for the shaft 15. If such a support is present, an antifriction bearing 42 will be carried by the support and will furnish a support for the shaft intermediate its ends. End bearings 43 are also provided for the shaft 15, and these end bearings are carried in the frame or support members 28.

As the web 44 of paper or other material is unwound from the uppermost or active roll 8, it passes about the roller 31 and thence about a roller 45, about the roller 29 and about the rollers 46 and 47 in the printing press or other machine to which the web is being supplied.

The roller 45 is carried in arms 48 which are fixed on a shaft 49 in the frames or supports 28. Counterweights 50 are carried on opposite ends of the arms 48. One or more springs 50' are secured to one or both of the arms 48 as shown in Figure 1. They tend to pull downwardly on the arms 48 so as to pull or move the roller 45 downwardly. An adjusting means 85 is provided for adjusting the tension of the springs 50'.

Fixed on the shaft 49 are two switch-operating arms. They comprise the arms 51 and 52. Associated with the arm 51 is a switch 53, and associated with the arm 52 is a switch 54. The operation and function of the switches will be described below.

Bumper or limit members 55 are provided for the counterweights 50 and are mounted on a tube or rod 56 which is itself connected to the frames 28.

In Figure 4 the pressure fluid circuit which operates the brake, and the piston and cylinder assemblies are shown. The pressure fluid may conveniently be air and is supplied through a main conduit 57 from any suitable source of air or other fluid under pressure. The fluid for operating the brake passes through a conduit 58, through a reducing and relief valve 59, and thence to a three-way control valve 60. A gauge 61 may be positioned in the line 58, if desired. The movable member of the three-way valve 60 is operated by an arm 62 which, through a link 63, is connected to the armature 64 of a solenoid 65. As shown in Figure 4, the valve 60 is in the normal or inactive position, and pressure fluid may bleed out through the conduit 38 and the discharge 66.

When pressure fluid is to be applied to the brake, the solenoid is actuated by the switch 54, and the movable element of the valve 60 is turned to cause the passage of fluid under pressure from the conduit 58 to the conduit 38, and finally to the brake operating means.

The main conduit 57 passes through a reducing and relief valve 67 and thence through a manually operable valve 68, thence to a bleeder valve 69, and finally to conduits 70. This valve 69 is arranged when the solenoid is energized to open the conduit to the atmosphere through a restricted opening for the purpose of reducing the pressure within the conduit while the valve is open. One such conduit 70 is provided for each of the cylinders 23. A gauge 71 may be provided if desired. In each of the conduits 70 a manually operable shut-off and adjusting valve 72 is provided.

The valve 69 is operated by means of a lever 73, which through a link 74 is connected to the armature 75 of a solenoid 76. The operation of this solenoid is controlled by the switch 53 through the movement of the arm 51. Suitable electrical connectors are provided for each solenoid circuit, and the two circuits are independent of each other.

80 is a sprocket positioned on a shaft 81 and meshing with the chain 13. 82 is a roller or printing cylinder also fixed on the shaft 81 and 83 is a gear fixed on that shaft. 84 is a gear fixed on the shaft which carries the roller 47. This gear meshes with the gear 83 on the shaft 81. 85 is an adjusting means for the spring 50'.

Although I have shown an operative form of my invention, it will be recognized that many changes in the form, shape and arrangement of parts can be made without departing from the spirit of the invention, and my showing is, therefore, to be taken as, in a sense, diagrammatic.

The use and operation of this invention are as follows:

The device as shown is arranged for supplying a continuous web of material to a printing press or processing machine at constant and adjustable tension. In the preferable form of the device, the speed relationship of the pulley 10 to the elements controlling the passage of the web through the machine to which the web is supplied is permanently set at a fixed relationship whereby the surface of the pulley 10 is driven by the chain 13 through the sprocket 12 and shaft 11 at a speed slightly less than the speed at which the web is drawn from the roll by the machine to which it is being supplied. Under these conditions, the roll being turned by the pull of the web as it is drawn from the roll, drives the belts 9 which tend to drive the pulley 10, thereby transmitting power back to the machine to which paper is supplied, which power is supplied to the roll by the pull of machine on the paper.

In general, under stable operating conditions, the tension in the web will be closely proportional to the pressure in the cylinders 23. This pressure is maintained constant by the reducing and relief valve 67, but may be varied by changing the adjustment of the valve 67. The uniformity of the tension, being dependent upon a fixed linear speed relationship, is disturbed by any factor in the operation of the web feeding machine or in the machine to which the web is supplied which disturbs this linear speed relationship. The primary cause of such disturbances is bodily displacement of the roll 8 caused by rotation of the shaft 3 and the arms 5 which carry the roll 8. Such movement is necessary during the operations of loading in a successive roll 8' and in changing from the roll 8 to the roll 8' during the web feeding operation as the roll 8 nears expiration.

The length of the web 44 between the roll 8 and the roll 46 will be changed by the bodily movement of the roll 8. Thus movement of the

roll 8 away from the pulley 14 requires the momentary supply of additional paper from the roll 8 or else the web 44 will be tightened up and will pull with increased tension. Conversely, movement of the roll 8 toward the pulley 14 will tend to cause a momentary slackening of the web. These changes are compounded by the fact that movement of the arms 5 tends to roll the roll 8 upon the belt 9 much like a differential pulley. Such disturbances, while of small quantitative amount, are serious in many operations, particularly when the device is required to maintain constant tension for register control in fine color printing, because any change in tension will affect the register of the printed web, and thereby cause waste.

Means which will be described below are provided for varying the pressure in the cylinders upon the appearance of certain conditions. In order to accomplish the desired control, the roller 45 is inserted in the system and the web 44 passes over it. Tension on the web will affect the position of the roller 45. Increase in the tension will tend to raise the roller, and decrease in the tension will tend to lower it. A slight variation in the tension will move the roller 45 up or down a distance not great enough to cause any action by the controls which are actuated by this movement.

If an up or down movement of the roller 45 beyond predetermined limits occurs, the controls will become effective. Thus, if tension on the web 44 is for some reason reduced, the roller 45 will tend to move downwardly. Since the roller is fixed in relation to the shaft 49, its movement up or down will rotate that shaft, carrying the switch operating arms 51 and 52. When tension on the web 44 is reduced and the roller 45 moves downwardly, the shaft 49 is moved in a counterclockwise direction as viewed in Figures 1 and 4, and this causes the arm 52 to operate the switch 54, thus actuating the solenoid 65 and moving the valve 60 to apply pressure on the brake drum 35, and thus to slow down the shaft 15, thereby slowing the movement of the belt 9, thereby delaying the discharge of the web 44 from the roller and increasing the tension on the web.

The slowing effect of braking force on the brake drum 35 is limited to an amount sufficient to cause the belt 9 to drag behind the surface speed of the pulley 10 rather than to tend to lead it. This may be a change of several per cent in the speed of the belt 9, but the ability of the pulley 14 to hold back the belt 9 is limited by the fact that excessive braking on the pulley 14 permits the pulley 10 to feed excess belt to the pulley 14, thereby loosening the belt 9 on the pulley 14 and permitting it to slip.

When the tension on the web 44 is increased, the roller 45 is raised, the shaft 49 is moved in a clockwise direction, and the arm 51 operates the switch 53 to energize the solenoid 76. This moves the valve 69 to bleed pressure from the cylinders 23, and thus to reduce the tension on the belt 9, and hence to permit a freer discharge of the web 44.

Each of the operations described may be of no more than momentary duration, and as soon as the condition which caused the movement of the shaft 49 has been remedied, the roller 45 returns to the normal position and brings the shaft again to that position and restores the switches to their normal condition. This operation will repeat itself whenever unsatisfactory tension conditions develop in the web. Means are thus provided

to operate in response to disturbances in tension to compensate for the disturbances automatically, and hold the tension within very close limits of control.

It will be seen that the position of the roller 45 is determined by the balance between the pull of the web 44 against the spring 50'. Since, with a given setting of the spring 50', the compensating effects and the neutral zone will always occur with the same tension in the web, and since it is necessary to vary the web tension to meet operating requirements, it is necessary to adjust the pressure applied to the roller 45 by the spring 50'. Adjusting means 85, consisting of a hand wheel and screw, are, therefore, provided at the fixed end of the spring 50' to permit an adjustment of the pressure exerted by the spring.

In the present disclosure the members 47 and 82 represent a pressure nip, or a printing couple, included in such a machine, and they may be disposed to draw the web from its source in the roll 8 at a rate of speed fixed in relationship to their speed of rotation. As here shown, a gear 84 on the extended shaft of the roller or cylinder 47 meshes with a gear 83 on the extended shaft 81 of the roller or cylinder 82, which also carries the sprocket 80 meshing with the chain 13 which engages the teeth of the sprocket 12 on the shaft 11.

Thus, it will be seen that there is a fixed speed relationship between the surface of the rollers 47 and 82, and the web 44 which passes and is nipped between them, and the surface of the pulleys 10. In the preferred form of the device, the gear ratios and diameters of the elements are so selected that the surface of the pulleys 10 moves at slightly lower speed than the surface of the rollers 47 and 82 and the web 44.

It should be noted that the rollers 47 and 82 are a part of a machine outside the machine of this invention, which machine is separately driven. The actual form of this outside device is immaterial to the present invention, and, in fact, may take the form of a driven suction apron, S rolls, or any type of device capable of exerting pull on the web. In all cases, however, the pulleys 10 should have a fixed speed relationship to the said pulling device for the best results.

I claim:

1. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for contact with said web after it leaves the roll, and supporting means for said roller, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the tension varying device.

2. In combination in a web unwinding mechanism, means for automatically and intermittently adjusting the tension of said web as it is un-

wound, said means including a movable member in contact with said web and parts operated in response to the movement of said member to vary the tension of said web, said mechanism including means for holding a roll of web, and a belt for rotating said web, and a pressure operated take-up device in contact with said belt for varying its movement to control the tension of the web, the said parts being connected to said pressure operated take-up device and actuating them in response to movement of said member to reduce the pressure in said pressure operated take-up device, said varying devices including a pressure cylinder and a valve for bleeding pressure from it, and means for actuating said bleeding valve in response to the movement of said first mentioned tension adjusting means.

3. In combination in a web unwinding mechanism, means for controlling the tension of the web as it is unwound, said means including an apparatus for supporting a roll of web, and a rotating means for said roll, said rotating means including a belt, a brake member in contact with said belt, and a fluid pressure tensioning device in contact with said belt, a valve for bleeding pressure from said tensioning device and a movably mounted roller in contact with said web after it leaves the roll, and parts adapted to be moved by said roller, one of them effective upon said brake and another upon said fluid pressure tensioning device to reduce the pressure in said device, and means for actuating said bleeding valve in response to the movement of said first mentioned tension adjusting means.

4. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the tension varying device.

5. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for extended contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the tension varying device.

6. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of pivoted arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the tension varying device.

7. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of pivoted, counterweighted arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the tension varying device.

8. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, fluid pressure means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to oper-

ate said brake, and movement of said roller in the opposite direction is effective to vary the pressure in said fluid pressure of said tension varying device.

9. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, fluid pressure means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for extended contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of pivoted arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the pressure in said fluid pressure of said tension varying device.

10. In combination in a web unwinding mechanism, means for supporting a roll of web to be unwound, and means for rotating said web, said rotating means including a belt, a member in contact with said belt, a brake adapted to affect said member, a tension varying device in contact with said belt, fluid pressure means for operating said device to vary the tension of said belt, and tension control means, said control means comprising a roller mounted for extended contact with said web after it leaves the roll, and supporting means for said roller comprising a pair of pivoted, counterweighted arms, spring means effective on said roller to move it against said web, and a pair of switches, a pair of switch operating members positioned to operate said switches, said switch operating members positioned to be moved by the movement of said roller, one of said switches connected to said brake, the other of said switches connected to said tension varying device, whereby movement of the roller in one direction is effective to operate said brake, and movement of said roller in the opposite direction is effective to vary the pressure in said fluid pressure of said tension varying device.

11. In combination in a web roll unwinding and web tensioning system, means for supporting a roll of web rotatively, means for drawing out the web from said roll, means defining a belt in contact with said roll for controllably restraining the rotation of said roll, rotative means defining a pulley in contact with said belt and having a fixed speed relationship to said web drawing means, pressure means for controlling the tension in said belt, tension determining means comprising a movable member in contact with said web between said roll and said web drawing means, means for positioning said tension determining means against the pull of said web, means for momentarily reducing the speed of said belt, means for reducing the restraining effect of said belt, and means for actuating either of said last two means according to the position of said tension determining means.

12. In combination in a web roll unwinding and web tensioning system, means for supporting a roll of web rotatively, means for drawing out the web from said roll, means defining a belt in contact with said roll for controllably restraining the rotation of said roll, rotative means defining a pulley in contact with said belt and having a fixed speed relationship to said web drawing means, pressure means for controlling the tension in said belt, tension determining means comprising a movable member in contact with said web between said roll and said web drawing means, means for positioning said tension determining means against the pull of said web, means for momentarily reducing the speed of said belt comprising a brake and a pulley in contact with said belt, means for reducing the restraining effect of said belt comprising means for reducing pressure in the pressure means, and means for actuating either of said last two means according to the position of said tension determining means.

13. In combination in a web roll unwinding and web tensioning system, means for supporting a roll of web rotatively, means for drawing out the web from said roll, means defining a belt in contact with said roll for controllably restraining the rotation of said roll, rotative means defining a pulley in contact with said belt and having a fixed speed relationship to said web drawing means, pressure means for controlling the tension in said belt, tension determining means comprising a movable member in contact with said web between said roll and said web drawing means, means for positioning said tension determining means against the pull of said web, means for momentarily reducing the speed of said belt comprising a brake and a pulley in contact with said belt, means for reducing the restraining effect of said belt comprising means for reducing pressure in the pressure means, and means for actuating either of said last two means according to the position of said tension determining means comprising a switch and control means and a rotary member in contact with said web, mounted to actuate said switch and said control means.

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