May 1, 1956 D. H. KNOWLES 2,743,882

WEB TENSION CONTROL

Original Filed Feb. 9, 1953

Fig. 1

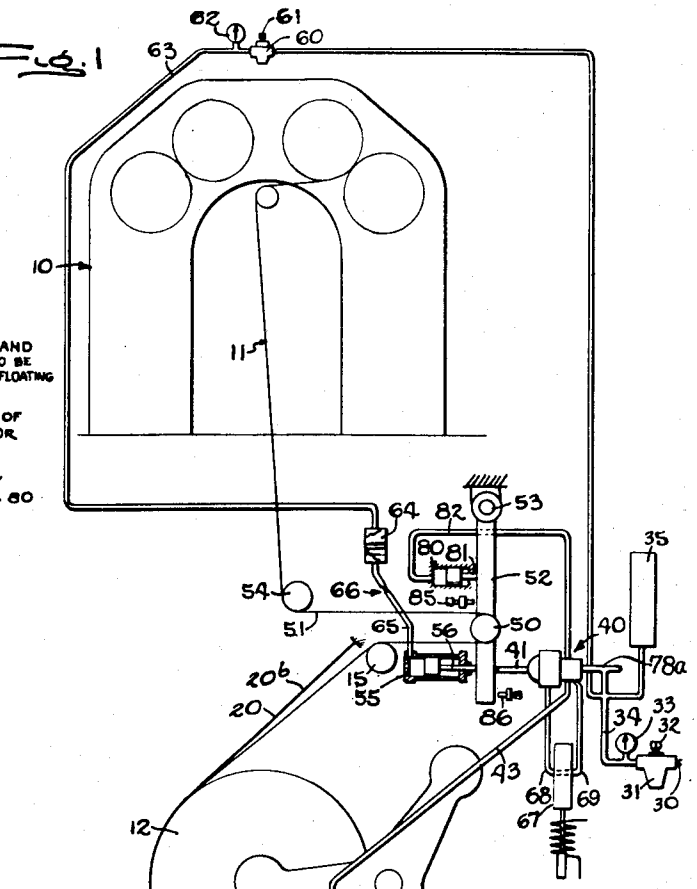


Fig. 3

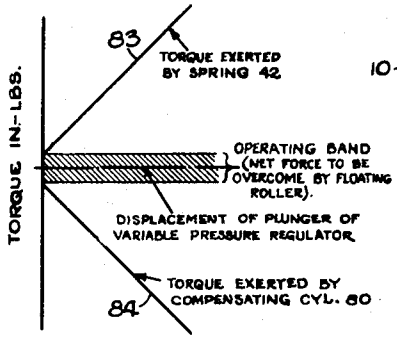
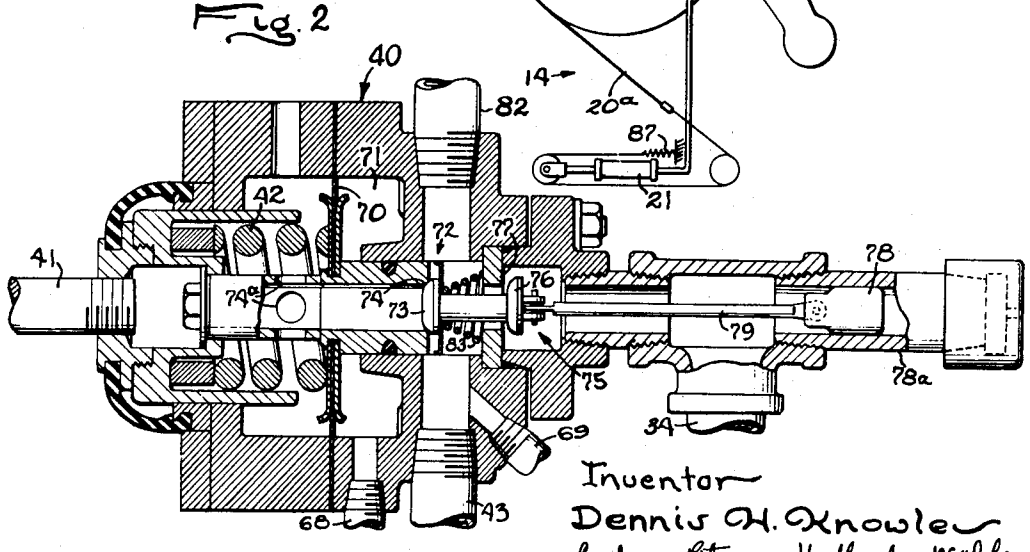


Fig. 2



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WEB TENSION CONTROL

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3 Claims. (Cl. 242—75)

The present invention relates to web tension control systems of the type finding particular utility in web-fed printing presses.

In a copending application of Henry L. McWhorter, Ser. No. 335,762, filed February 9, 1953, of which this application is a division, there is disclosed a web tension control arrangement. It is an object of the present invention to provide an improvement which enables an even more precise and sensitive controlling action in this general type of system.

Other objects and advantages will be apparent upon reading the attached detailed description and upon reference to the drawing, in which

Figure 1 is a schematic diagram of the present control system as applied to a conventional printing press.

Fig. 2 shows a cross section of the variable pressure regulator employed in practicing the present invention.

Fig. 3 shows the net force characteristic of the variable pressure regulator.

While the invention will be described herein in connection with a preferred embodiment, it will be understood that I do not intend to limit the invention thereto, but intend to cover all alternative constructions and uses falling within the spirit and scope of the appended claims.

Turning now to Fig. 1, a control system constructed in accordance with the present invention is shown installed on a conventional printing press. The printing press is indicated at 10, and has the usual arrangement of printing and impression cylinders. A web 11 is fed from a roll 12, which is mounted on a spider 13 in a web supply mechanism 14 located below the press floor. For the sake of simplicity, conventional mechanisms for bringing the roll up to speed and for effecting a splice or paster have been omitted from the drawing. The web, after leaving the roll 12, passes over a conventional cocking roller 15 having an adjustment (not shown) of the usual type.

In order to produce tension in the web 11, a brake is provided having a belt 20 and brake cylinder or actuator 21. Only one belt and one brake cylinder have been shown. It will be understood that in a normal installation a plurality of belts are used, each connected to a brake cylinder, the cylinders being connected in parallel to the source of pressure fluid.

In practicing the present invention, improved means are provided for detecting a departure in the desired value of web tension and for causing pressure fluid to be supplied to the brake cylinder in accordance with such departure to effect a corrective change in braking force. As shown, air is supplied from a compressed air source through a line 30. The pressure is adjusted by means of a constant pressure regulator 31 having an adjustment 32 and an indicator dial 33. Such regulator is of conventional design, holding the set pressure in spite of variations in the supply line. From the regulator the air is fed into a line 34 and is stored in a reservoir 35.

In order to control the pressure of the air flowing to

the brake cylinder 21 under normal operating conditions, a variable pressure regulator 40 is used having a control rod 41. The regulator is of the type having an internal control spring 42 and is so constructed that the pressure appearing at an output line 43 is determined by the position of the control rod 41 and the degree of compression of the spring 42 associated therewith.

Arranged in the path of movement of the regulator control rod is a floating roller 50 which engages a loop of web indicated at 51. The floating roller 50 is mounted for movement in a direction to lengthen and shorten the loop of web, being suspended in suitable bearings on a pair of pendulum-like arms 52 having upper pivots 53. An arm is located at each end of the roller but only one of them is shown in the drawing. The web subsequently passes over an output roller 54 and into the press.

For the purpose of setting the amount of pressure to be exerted by the brake cylinder 21 and therefore the average web tension, the floating roller 50 is equipped with a loading cylinder 55 having a plunger 56 arranged generally opposite the control rod 41 of the regulator. The pressure in the loading cylinder is adjusted so that a predetermined amount of web tension will keep the floating roller centered in a position of equilibrium. In the present instance the control pressure for the loading cylinder is obtained from an adjustable pressure regulator 60 fed from the supply line 34 and having an output line 63. The pressure regulator may be of the same type as that (31) previously referred to, having a manual control 61 and indicator 62. The regulator is preferably placed at a convenient position on the press and the indicator 62 is calibrated directly in terms of web tension. As set forth in Fig. 1, an air-oil interface is established in a reservoir 64 which is connected to the loading cylinder by an oil line 65. Included in the oil line is an orifice 66. This orifice is so constructed that the movement of the floating roller 50 takes place at a controlled rate.

To understand the operation of the variable pressure regulator 40, reference is made to Fig. 2. Here it will be noted that the control rod 41 is mounted for telescoping movement within the regulator body and presses against the control spring 42. This control spring in turn bears upon a diaphragm 70 which defines a pressure chamber 71. When the pressure in the chamber 71 counterbalances the force exerted by the spring 42, equilibrium is achieved. The pressure chamber 71 is normally connected to the output line 43, such connection being accomplished by an "emergency" valve 67 which is connected to the regulator by lines 68, 69.

For the purpose of bleeding air from the chamber 71 and the output line 43 when the pressure is above the set value, a valve 72 is provided having a poppet 73 and a seat member 74 which is movable with the diaphragm. The seat member 74 is hollow, being vented to the atmosphere through vents 74*a*. It will be apparent that movement of the diaphragm to the left when the pressure is above the set value will cause the valve 72 to open, thereby permitting passage of air between the seat and the poppet which is exhausted through the vents 74*a*. This passage takes place until the pressure in the output line 43 and chamber 71 drops to its equilibrium value, at which time the diaphragm is restored to its equilibrium position, cutting off further flow.

Moreover, for the purpose of admitting additional air to the line 43 when the pressure therein is below the set value, a second valve 75 is provided having a poppet 76 and a seat 77, the poppet 75 being mechanically connected to the poppet 73. In operation a drop of pressure in the chamber 71 below the set value causes movement of the diaphragm to the right against the force of the

poppet spring 83, opening the poppet 76. This causes replenishment of air in the output line 43 until the equilibrium pressure is reached, at which time the poppet 76 closes, cutting off further flow. The two poppets 73, 76 are spaced so as to operate in sequence, the sequential spacing being exaggerated in the drawing for ease in understanding. This insures that the exhaust poppet 73 is completely closed when the supply poppet 75 is open. Stated in other words, the two poppets open alternatively depending upon whether the pressure is slightly below or slightly above the equilibrium value. As a result, the pressure in the output line 43 tends to remain at the set value which is determined by the degree of compression of the control spring 42 and, consequently, by the position of the control rod 41.

To complete the description of the valve, a piston 78 is provided connected to the poppet 76 by a rod 79 and slidable in the vented cylinder 78*a*.

As described in the above copending application, means are provided for neutralizing the force of the control spring 42 to reduce almost to zero the amount of energy required to operate the regulator 40. This neutralization is accomplished by providing a compensating cylinder 80 which is arranged at the opposite side of the arm 52. The compensating cylinder has a plunger 81 and is supplied with air through a line 82 which is connected to the regulated output line 43. The area of the piston in this cylinder and the moment arm of the plunger 81 are adjusted so that the torque exerted by the cylinder 80 exactly neutralizes the torque of the control spring 42. For convenience in adjusting the moment arm of the cylinder 80, it will be apparent that the cylinder may be mounted for bodily adjustment along the length of the arm 52.

It may be shown that the forces of the control spring 42 and the compensating cylinder 80, once they have been balanced at a particular pressure in the output line (43), remain in balance for all other pressures in the operating range. Suppose, for example, that starting from a condition of balance or equilibrium there is a decrease of web tension below the set value. The resulting unbalance causes the floating roller 50 to tend to move to the right. This produces corresponding movement of the control rod 41. Such movement causes the pressure at the output of the regulator 40 to be increased. The increased pressure is applied to the compensating cylinder 80 via line 82 and the compensating cylinder therefore assists the control rod 41 in its further movement against the force of the control spring 42 until the resulting increase in the output pressure causes a corresponding increase in web tension, thereby arresting and reversing the movement of the floating roller. During the reverse movement the converse takes place. In either event, the forces which must be overcome by the floating roller are reduced almost to zero.

In accordance with the present invention, means are provided for eliminating error caused by the area of the poppet 76. This is accomplished by providing an auxiliary pressure-responsive element connected to the poppet valve for exerting a force which is substantially equal to and opposite the force exerted upon the poppet by the air pressure when the poppet is in closed position. In the present instance this is accomplished by the piston 78 which is connected to the poppet 76. To equalize the pressures, the "projected areas" of the piston and poppet are equalized, the projected area being defined as the net area in the axial direction upon which the input air pressure is applied and which tends to move the part acted upon. As a result, there is no "break-away" pressure at the poppet which must be overcome by the control rod 41, and the "valve area" error is eliminated.

In order to visualize the way in which the force of the compensating cylinder offsets the force of the control spring, reference is made to Fig. 3. Here the torque 83 exerted by the compensating cylinder is shown equal and opposite to the torque 84 exerted by the control spring. In the device shown in the drawing the force required to operate the regulator 40 is approximately 300 pounds at a representative point in its range when the compensating cylinder 80 is not used. With the compensating cylinder, the force is reduced to about 4 pounds, which is the amount of force required simply to overcome friction and may be indicated by an operating band over the range of plunger movement. This force corresponds to a web tension of two pounds since the web is doubled back upon itself. A change of two pounds in web tension is accordingly required to initiate a corrective change in tension. This is desirable since it insures that the device will not operate with only negligible changes in tension, and, in any event, the two-pound force distributed over the entire width of the web is sufficiently small so that the sensitivity of the system is not adversely affected.

Preferably, stops are provided to limit the roller movement to about ¼ inch or less. The stops in the present instance are located on opposite sides of the depending arm 52 and have been designated 85, 86.

Résumé of operation

While the operation of the device will be apparent from the foregoing, it may be helpful to summarize it briefly:

Prior to starting up the press, the pressure regulator 60 may be set to the point of desired web tension. This tension is maintained by the control arrangement during acceleration and after the press comes up to speed. In the event that tension in the web momentarily drops below the desired value, the balance of forces at the floating roller is upset and the roller tends to swing bodily to the right under the urging of the loading cylinder 55. This results in inward movement of the control rod 41, which, assisted by the auxiliary piston 78, cracks open the poppet 76 in the variable pressure regulator 40. The latter produces a slightly higher output pressure, which is applied both to the brake cylinder 21 and to the compensating cylinder 80. The increase in the force exerted by the compensating cylinder exactly overcomes the opposing force of the spring 42 so that the floating roller is perfectly free to move. The increased pressure at the brake cylinder causes a correspondingly increased braking force on the roll 12. The resulting increase in web tension causes the floating roller to move leftward to its initial equilibrium position. The converse sequence of events occurs when the tension in the web increases above the set value for any reason.

I claim as my invention:

1. In a tension control system for maintaining a desired tension in a running web fed from a paper roll, the combination comprising a brake belt peripherally engaging the roll to apply a braking force thereto, a pneumatic actuator connected to said belt for tensioning the same, a variable pneumatic pressure regulator having a control rod and a poppet valve operated thereby and in which the output pressure is a direct function of the position of the control rod, said regulator having a source of air pressure connected to its input, means for connecting the pneumatic actuator to the output of said regulator, a floating roller for engaging a loop in the running web, means for mounting said roller for bodily movement and having means for biasing the roller in a direction to increase the size of the loop, means for coupling the control rod of the regulator to said roller so that a change in tension in the loop causes a corrective change in braking force, and means including an auxiliary piston in said regulator connected to said poppet valve and acted upon by the input air pressure for assisting in opening said poppet valve.

2. In a tension control system for maintaining a desired tension in a running web fed from a paper roll, the combination comprising a brake belt peripherally engaging the roll to apply a braking force thereto, a pneumatic

actuator connected to said belt for tensioning the same, a variable pneumatic pressure regulator having a control rod and a poppet valve operated thereby and in which the output pressure is a direct function of the position of the control rod, said regulator having a source of air pressure connected to its input and acting upon the poppet in said poppet valve, means for connecting the pneumatic actuator to the output of said regulator, a floating roller for engaging a loop in the running web, means for mounting said roller for bodily movement and having means for biasing the roller in a direction to increase the size of the loop, means for coupling the control rod of the regulator to said roller so that a change in tension in the loop causes a corrective change in braking force, and an auxiliary pressure-responsive element connected to the poppet of said poppet valve and arranged to be acted upon by the input air pressure, said auxiliary element having substantially the same projected area as the poppet to counteract the effect of pressure on said poppet valve.

3. In a tension control system for maintaining a desired tension in a running web fed from a paper roll, the combination comprising means for applying a braking

force to the roll, pneumatic actuating means therefor, a variable pneumatic pressure regulator having a control rod and a poppet valve operated thereby and in which the output pressure is a direct function of the position of the control rod, said regulator having a source of air pressure connected to its input and acting upon the poppet in said poppet valve, means for connecting the pneumatic actuating means to the output of said regulator, web tension sensing means engaging the running web, means for coupling the control rod of the regulator to said web tension sensing means so that a change in tension in the web causes a corrective change in braking force, and an auxiliary pressure responsive element connected to the poppet of said poppet valve and arranged to be acted upon by the input air pressure, said auxiliary element having substantially the same projected area as the poppet to counteract the effect of pressure on said poppet valve.

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