APPARATUS FOR CONTROLLING TENSION IN A RUNNING WEB

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This invention relates to improved apparatus by means of which it is possible to control very accurately the tension in a web during running of the latter from one roll to another in processing of the web.

In the running of the web, the tension thereof is commonly imparted by imposing a braking effect upon a pay-out roll of the web material and the web tension is controlled by either increasing or reducing the braking effect. According to this invention, the pressure of compressed air which operates a brake, effective upon such a pay-out roll, is continuously subjected to very fine control in response to variations in force applied upon a guide roller by the tension in a web passing over said roller.

A preferred embodiment of the invention and a second of numerous possible variations of the invention are illustrated in the accompanying drawing without, however, limiting the invention to the particular arrangements disclosed in said drawing.

In the drawing:

Fig. 1 is a diagrammatic illustration of a preferred embodiment of this invention, and

Fig. 2 is a view showing a modification of a portion of the apparatus shown in Fig. 1.

Referring to Fig. 1, a running web 10, which may be paper, sheet plastic, cloth or other web material being processed, is caused to pass upwardly, onto, over and downwardly with respect to a guide roller 12. The latter, ordinarily, is located between a pay-out roll and a receiving roll, neither of which is shown although in the lower right part of Fig. 1, there is shown a neck or shaft 14 of a pay-out roll having associated therewith two oppositely working brake arms 16, 18, the operation of which controls the paying out of web material from such a related pay-out roll.

The guide roller 12 is rotatably supported at its ends in spherical bearings 20 and 22, the latter being rigidly supported upon a suitable bracket 24, riveted, bolted or otherwise rigidly fixed to a frame member 26 of or adjacent to the machine by which the web is being processed; and the bearing 20 is yieldably supported by means which will permit minute vertical movement of the bearing 20 in response to variations in tension of the running web 10. The support for the bearing 20 comprises a pressure cylinder 28 (sometimes referred to herein as a tension sensing cylinder), having a mounting stud 30 by means of which the cylinder 28 is supported for vertical adjustment upon a bracket 32 which is suitably fixed to a machine-frame member 34. A pair of adjustment nuts 36, threaded on the stud 30 and co-acting with bracket 32, permit the mentioned vertical adjustment of the position of the cylinder 28.

Within the cylinder 28 is a diaphragm 38 from the center of which a stem 40 extends upwardly through and to the exterior of a guide portion 42 of the top wall of said cylinder. Upon the upper end of said stem is threaded a spring-seat element 44, and between the latter and an adjustable nut 46, threaded on said guide portion, is disposed a compression coil spring 48.

The bearing 20 rests upon the spring-seat element 44; and the adjusted positions of nut 46 and of cylinder 28 are such that the spring 48 is in the cylinder 30 and in a tension-sensing valve (hereinafter described) will yieldably support the roller 12 in an approximately horizontal attitude and the diaphragm 38 will be located approximately in the plane of its peripheral attachment to said cylinder.

The interior of the cylinder 28, above the diaphragm 38, is suitably vented as, for example, by a port 50. The area within cylinder 28, below the diaphragm, serves as a hydraulic chamber 52 and is connected, in a manner now to be described, with fluid-pressure instrumentalities by means of which the brake arms 16 and 18 are so operated as to vary their braking effect upon shaft 14 and thereby control continuously the tension in a web being drawn from a roll carried by said shaft and constrained to rotate only as permitted by said shaft's rotation.

The principal mentioned fluid-pressure instrumentalities are substantially similar fluid-pressure responsive pressure-regulating valves 54 and 56 (valve 54 being sometimes referred to herein as a tension-sensing valve and valve 56 being sometimes referred to herein as a brake supply valve), a manually adjustable pressure-regulating valve 58 (sometimes referred to herein as a tension-adjusting valve), a cam-actuated pressure-regulating valve 60, oppositely acting cam-actuating pressure cylinders 62 and 64, and a brake-actuating pressure cylinder 66.

The mentioned fluid-pressure instrumentalities are interconnected by suitable piping, as shown in Fig. 1, between the tension-sensing cylinder 28 and the brake arms 16, 18. Also connected in the piping, where shown, are a check valve 68 permitting free flow of liquid from valve 54 toward cylinder 28, an adjustable throttle valve 70 controlling flow of liquid from cylinder 28 toward valve 54, and a pressure gauge 72.

Connected between piston rods 74, 76 of diaphragms 78, 80 of the cylinders 62, 64 is a mounting piece 82 upon which is pivoted a cam member 84 the angularity of which is adjustable by means of an adjusting screw 86 to permit the establishment of a desired relationship of the cam member's cam surface 88 with reference to a plunger 90 which is operated by said cam member to control the valve 60. A spring 92, compressed between the extremities of brake arms 16 and 18, tends to urge said arms apart to reduce the braking effect on pay-out roll shaft 14 while the pressure cylinder 66 tends to draw said arms toward each other to increase the braking effect.

In the described apparatus, a substantially closed or confined body of oil or other suitable liquid completely occupies chamber 52 of the tension-sensing cylinder 28, an upper or hydraulic chamber 94 of valve 54 and the piping and valves connected between said two chambers. All other illustrated piping and pressure chambers are occupied and/or operated by air which, in a compressed state, enters the piping from a suitable source of supply where indicated by a legend to that effect in the drawing.

The several illustrated pressure-regulating valves, per se, are not the present invention; hence, they have been shown only diagrammatically. They should have characteristics now to be given. Each should have, respectively, one line pressure chambers 54LP, 56LP, 58LP and 60LP, connected to the supply of compressed air to receive that air at supply pressure, regulated-pressure chambers 54RP, 56RP, 58RP and 60RP, from which regulated pressure may pass to function as hereinafter described, and suitable internal valve elements, diaphragms and exhaust
ports permitting pressure regulation in a well understood manner.

In valves 54 and 56, control of pressure regulation is effected by changes in fluid pressure in chambers 94 and 96, respectively, of said valves. In valve 58, control of pressure regulation is effected by manipulation of pressure-control screw 98 and in valve 60, control of pressure regulation is effected by longitudinal movement of plunger 99.

As broadly considered, maintenance of a desired tension in the running web 10 depends upon counter-acting pressures introduced into cylinders 62 and 64 through valves 54 and 58. Variations in such counter-acting pressures govern the movement of the plunger 90 and thereby cause valves 56 and 60 to control the brake arms 16 and 18 and thereby control the web tension. Thus, it is important to consider the means by which such counter-acting pressures are continuously controlled and, if necessary, varied to achieve correction of variations in the web tension.

Such counter-acting pressures are controlled, on the one hand, by movement of liquid or shifting of liquid pressure into and from chamber 94 of valve 54 as diaphragm 38 of cylinder 28 rises and falls minutely with variations in the downward force imposed upon roller 12 by variations in the tension of the running web 10. The increase of the liquid volume or pressure in chamber 94 increases the air pressure against diaphragm 78 and urges cam 84 rightwardly while liquid volume or pressure reduction in chamber 94 permits cam 54 to move leftwardly. On the other hand, screw 98 of valve 58 constitutes manual means for similarly controlling air pressure in cylinder 64 to control movement of the cam 84 leftwardly.

From experience, it may be ascertained that, by manual adjustment of screw 98 to establish a given air pressure against diaphragm 80 (indicated on gauge 72), the difference between that pressure and the pressure applied oppositely against diaphragm 78 under the control of diaphragm 38 will, if unvaried, hold the cam 84 in such position as to cause valves 56 and 60 to keep steady the braking effect of brake arms 16 and 18 and thereby maintain the desired web tension. It is important, however, to provide for practically instantaneous compensation for web tension changes that occur from conditions arising apart from the disclosed apparatus. The disclosed apparatus accomplishes such compensation.

Thus, let it be supposed that the web 10 is running and that screw 98 has been set to yield the desired web tension, and that an undesired increase of decrease or alternate increases and decreases occur in the web tension. If the variation is a tension increase, the resultant increased downward force upon roller 12 causes diaphragm 38 to move minutely downwardly, thereby forcing additional liquid to move into chamber 94. This causes valve 54 to establish an increased pressure in chamber 54RP and against diaphragm 78, thereby shifting cam 84 rightwardly to permit plunger 90 to rise to decrease the air pressure in chamber 60RP of valve 60 and chamber 96 of valve 56. The decreased pressure in chamber 96 causes a decrease of the air pressure in chamber 56RP of valve 56 and in brake cylinder 66, thereby enabling spring 92 to provide compensatory reduction in the tension of the running web.

In the event of an undesired decrease in the web tension, the diaphragm 38 will rise, thereby causing operations opposite to those just described with reference to undesired tension increases. The described apparatus is very effective for giving quick compensation by minute rising and/or falling of the diaphragm 38 with consequent tension-controlling operations as just described.

The modification of Fig. 2 is an arrangement in which the tension-adjusting valve 58 may be located at a considerable distance from the other disclosed apparatus if desired. When that is desired, the regulated pressure, in chamber 56RP, instead of being applied directly to diaphragm 80, as in Fig. 1, is communicated to a pressure-control chamber 100 of a pressure-regulating valve 102 which may be similar to valves 54 and 56. The valve 102 has a line pressure chamber 102LP receiving air at the pressure of the compressed air supply, and a regulated-pressure chamber 102RP. Pressure in the latter chamber and in cylinder 64 is regulated in response to pressure in chamber 100 in a mode of valve operation similar to valves 54 and 56.

Under not too rigid requirements as to rapidity of web tension compensation, the valve 58 in the arrangement of Fig. 1 could be somewhat remotely located, but for remote control the arrangement of Fig. 2 is preferred for most effective web tension compensation. Somewhat similarly, valve 56 could be omitted and valve 60 arranged to control directly the operation of brake cylinder 66, but the inclusion of valve 56 usually yields more satisfactory results.

It will readily be perceived that the inventive concept may be utilized in various other ways without, however, departing from the invention as set forth in the following claims.

1. In running-web, tension-controlling apparatus having an elongate guide member against which a running web presses when the web is under tension and which guide member is movable in response to variations in the pressure of the web thereagainst, a fluid-pressure-operated brake mechanism adapted to vary the tension in a running web, and a fluid-pressure circuit adapted to supply fluid under pressure to said brake mechanism to control the operation of the latter; means for controlling the fluid pressure in said circuit, comprising mounting means, pivotally supporting one end of said guide member, a fluid-pressure cylinder having a diaphragm therein, a stem connected between the other end of said guide member and said diaphragm to actuate the latter in response to movement of the guide member's said other end, a fluid-pressure-responsive control valve connected in controlling relation to said circuit, and a substantially closed body of liquid under pressure applied directly against both said diaphragm and said control valve to control operation of the latter in response to minute movements of said guide member resulting from variations in the web tension and thereby control the operation of the brake mechanism to compensate substantially for said tension variations.

2. Control means according to claim 1, further including spring means in supporting relation to said other end of the guide member.

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