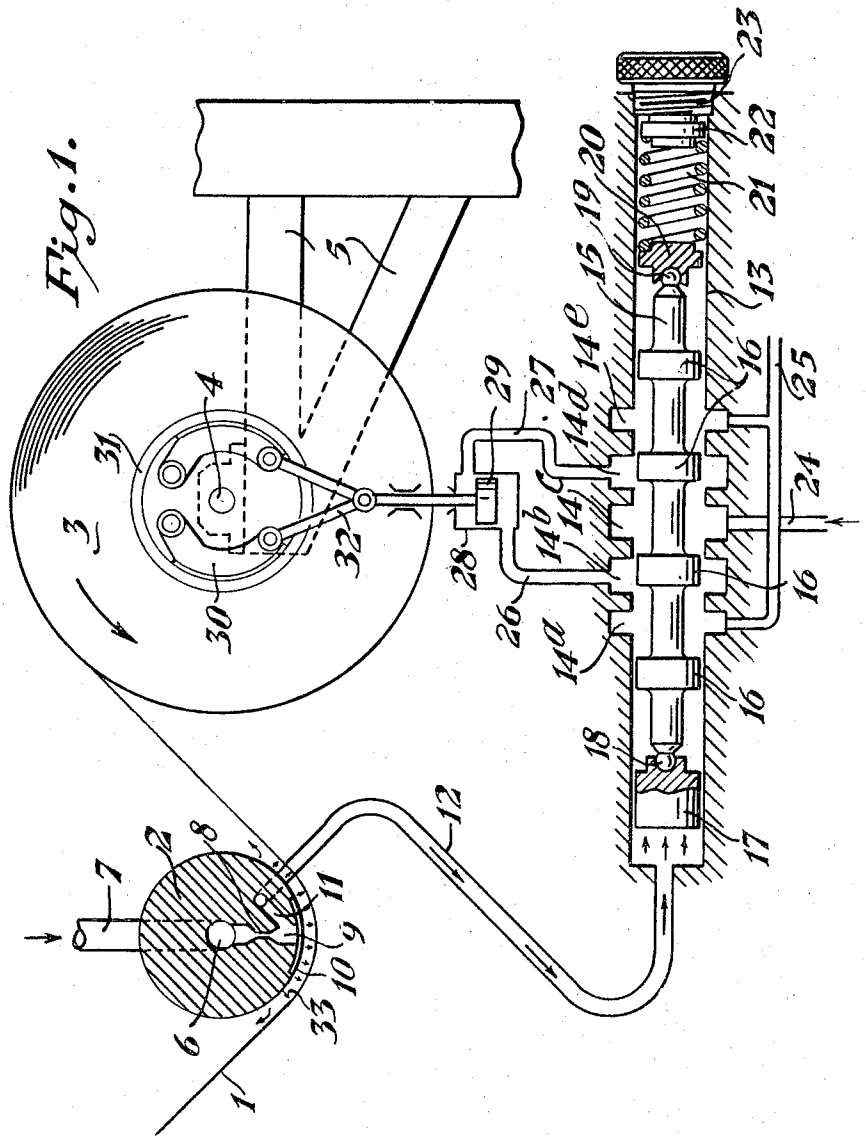
April 4, 1967 M. A. JEANS 3,312,415

MEANS FOR CONTROLLING THE TENSION OF A WEB

Filed March 3, 1965 2 Sheets-Sheet 1

Fig. 1.



Inventor:
Michael Anthony Jeans
BY Baldwin & Wight
Attorneys

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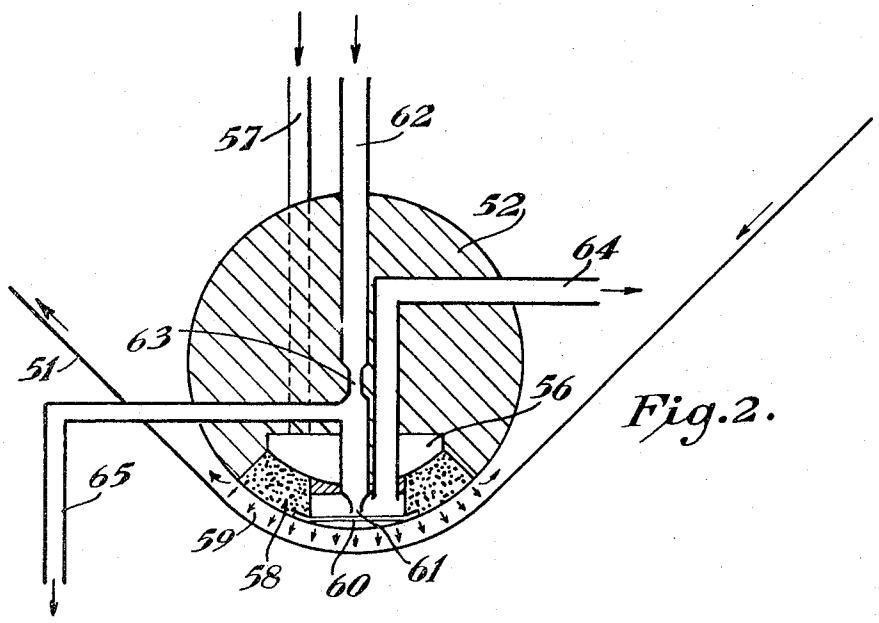


Fig.2.

Inventor:
Michael Anthony Jeans
BY Baldwin & Wight
Attorneys

United States Patent Office

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MEANS FOR CONTROLLING THE TENSION OF A WEB

Michael Anthony Jeans, Dorking, Surrey, England, assignor to The Printing, Packaging and Allied Trades Research Association, Leatherhead, Surrey, England, a corporation of the United Kingdom

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10 Claims. (Cl. 242—75.43)

This invention relates to a tension sensing device whereby variations in the tension of a travelling web may be detected, and to a method of controlling the tension of a travelling web using such a tension sensing device.

Known methods of web tension controlling include the use of a "dancing roller," which is resiliently mounted on sprung bearings and around which passes the tensioned web. Variations in the web tension cause variations in the force acting on the springs fixed to the bearings and consequent variations in the position of the "dancing roller." Such a tension regulating device is operated by means controlled by the variations in the position of the "dancing roller." Such apparatus provides an appreciable frictional resistance to the passage of the web, and has the further disadvantage that the speed of response to rapid variations in the web tension is limited by the inertia of the roller.

It is an object of the present invention to provide a tension sensing device in which friction is minimized, and which operates tension regulating means with a faster response to sudden variations in the tension of the web than previously known arrangements.

According to the present invention, a tension sensing device comprises a fixed shaft or bar, round which a travelling web is guided, formed with an opening in its surface, said opening communicating with a source of fluid under pressure through one or more restricted passages situated within said shaft or bar closely adjacent to said opening and adapted to provide a fluid cushion between the web and the shaft or bar, thereby holding the web away from the surface, and pressure detecting means in communication with means being a part of the fluid cushion.

Two or more openings may be provided in the surface of the shaft or bar, each of said openings being connected to the source of pressure fluid by restricted passages.

The or each opening may be connected directly to the pressure detecting means; alternatively one or more separate apertures may be connected to the pressure detecting means, and be situated in the shaft or bar surface so as to communicate with the fluid cushion.

Preferably means is provided for regulating the tension in the web.

Also according to the present invention a method for controlling the tension of a travelling web includes subjecting the travelling web to the action of pressure fluid, so that variations in tension in said web cause variations in the pressure of said fluid, which pressure variations cause in turn variations in the speed of travel of, and hence tension in, said web.

The pressure detecting means may comprise a slide valve operated by the pressure of the fluid cushion acting against the thrust of an adjustable reference spring. The tension regulating means may comprise a shoe brake

adapted to inhibit movement of a roll from which the web material is unwound. Alternatively the tension regulating means may comprise a motor controlled by the pressure detecting means and adapted to drive the travelling web itself or the roller on which the web material is wound.

The invention is now described by way of example with reference to the accompanying schematic drawings, in which:

FIGURE 1 shows a tension sensing means for use in the feed of a web of material, e.g., paper, and

FIGURE 2 shows a modified form of the shaft or bar.

Referring to FIG. 1, a web **1** of paper, sheet metal, textile or similar material is led around a fixed shaft or bar **2** from a reel **3**, supported by a spindle **4** on a bracket **5**. The fixed shaft or bar **2** is formed with a central duct **6** which is connected via an external pipe **7** to a source of fluid under pressure (not shown).

The duct **6** communicates through one or more restricted passageways **8**, with a chamber **9** running along the shaft or bar. The chamber **9** communicates with an opening in the form of a shallow recess **10** formed in the surface of the shaft or bar **2**, and extending over a part of that portion thereof over which the web **1** is trained. The chamber **9** also communicates directly with a further duct **11** formed in the bar **2**.

A pipe **12** connected to the duct **11** couples the tension sensing means described above to a pressure detecting device, which has the form of a slide valve. This valve comprises a cylindrical tube **13** formed with five equally spaced annular grooves **14***a*, **14***b*, **14***c*, **14***d* and **14***e* in its inner surface, inside which tube a rod **15** formed with four equally spaced lands **16** is a tight sliding fit. The lands **16** are so arranged that at any time two pairs of adjacent grooves are in communication with each other. The pipe **12** is connected to one end of the tube **13**, and a plunger **17** is slidable in the valve tube **13**, and is connected, through a ball joint **18**, to the end of the rod **15** adjacent the tube end connected to the pipe **12**. Consequently the fluid pressure in the tube **12** acts against the plunger **17** and through this on the rod **15**. At its other end, the rod **15** is connected, through a ball joint **19**, to an end member **20**, slidable in the tube **13**. A spring **21** lies in compression between the end member **20** and an abutment member **22** which is longitudinally adjustable in the tube **13** by means of a screw head **23**.

The central annular groove **14***c* is connected by a flow line **24** to a second source of fluid under pressure (not shown), and the two outermost grooves **14***a* and **14***e* are connected by a line **25** to exhaust. The two remaining grooves **14***b* and **14***d* are connected by lines **26** and **27** respectively to opposite ends of a cylinder **28**, in which slides a piston **29**. The piston **29** controls means for regulating tension in the web **1**. The piston **29** operates a shoe brake **30**, which is arranged to act against an annulus **31** rotating with the reel **3**, by means of levers **32**.

When the apparatus is in operation, the web **1** is drawn from the reel **3**, round the stationary shaft or bar **2**. The pipe **7** is connected to a source of fluid under pressure, and this fluid flows at an approximately constant rate through the restrictions **8**. The fluid then flows out between the web **1** and the shaft or bar **2**, so that a fluid cushion is formed therebetween as indicated by the arrows **33**. The frictional drag on the web is thus

minimised. The thickness of the fluid cushion between the web and the bar is very narrow, being normally of the order of 1/1000 inch, so that there is an appreciable pressure drop in the fluid as it flows from the chamber 9 out through the fluid cushion. It is this pressure in the fluid cushion that holds the web away from the bar against the tension in the web. Variations in the web tension cause corresponding variations in the thickness of the fluid cushion, and consequent variations in the pressure in the chamber 9, which maintains the flow in the cushion, and in the pressure communicated through the pipe 12 to the pressure detecting means. The tension sensing device thus converts variations in the web tension into pressure variations in the fluid, while offering the minimum frictional resistance to the passage of the web.

These pressure variations act through the pipe 12 against the plunger 17, which is caused to move to the right as shown against the bias of the spring 21. A rise in the fluid pressure causes the valve to slide to the right so that the grooves 14*a* and 14*b* are put in communication with each other, as are the grooves 14*c* and 14*d*. This movement of the valve increases fluid pressure in the line 27 which is placed in communication with the inlet 24, the line 26 being connected to exhaust 25. Hence the piston 29 moves downwardly (as shown in the drawing), releasing the shoe brake and allowing the web to run freely. Conversely, a drop in the web tension leads to a drop in the fluid pressure in the pipe 12, causing the valve to slide to the left, as shown in the drawing, so that the grooves 14*b* and 14*c* communicate with each other, as do the grooves 14*d* and 14*e*. This movement of the valve increases the pressure in the line 26 which is placed in communication with the inlet 24 while the line 27 is connected to exhaust 25. Hence the piston 29 moves upwardly as shown in the drawing, causing the shoe brake 30 to be applied, thus retarding the web, and tending to increase its tension. The spring 21 may be adjusted by the screw head 23, and thus the tension in the web may be controlled.

When the apparatus is in operation, this method of tension control has a much faster response to sudden changes of the tension than previously used methods thus minimising the risk of breaks in the web. Also there is only a very small frictional resistance to the passage of the web round the bar, this resistance being much less than would result from the use of any form of roller.

The choice of fluid for use in the tension sensing device depends upon the nature of the web. For a web of paper or textile material, air is the most suitable fluid. If, however, a metal film is passing the sensing device, it may be more appropriate to use a liquid, which will increase the speed of response to tension variations. In such a case some recirculation device would be used to prevent wastage of the liquid. In the slide valve, any suitable fluid may be used, in particular, such a fluid as a light low viscosity oil.

The apparatus may be modified in many respects, though the principle of the method of tension control remains unchanged. The shoe brake may be replaced by, for example, an electric or hydraulic motor driving the reel 3, or directly driving the web 1, and with its speed regulated by means connected to and operated by the valve 13. Instead of using a slide valve to detect the pressure variations in the pipe 12, this could be done by any other known means, such as by using a diaphragm with a sensing system attached thereto. The tension sensing device itself may be modified from the form shown in FIG. 1 and described above. In one modified form, two chambers 9 each connected by a restriction 8 to the central duct 6, can be used symmetrically disposed, so that the web travels past the opening of each. The pipe 12 then is connected to an opening along the length of the bar 2, between the openings of the chambers 9.

The fluid cushion provided between the travelling web and the surface of the shaft or bar in accordance with the present invention may if desired be generated by means of an insertion of a porous material fitted in the shaft or bar and affording the restricted passages and openings in its surface referred to earlier. The porous material may be sintered bronze or another sintered metal, for example. This measure gives more even air distribution and more uniform pressure over the main portion of the web, and is particularly advantageous when the web being supported is easily flexible, as a paper web would be.

The use of a porous material insertion, which may be a sintered metal, is illustrated in FIG. 2. Here a web 51 is led around a fixed shaft or bar 52 from a reel not shown in this figure. The shaft or bar 52 has a duct 56 which is connected by a pipe 57 to a source of fluid under pressure (not shown) and which in turn leads the fluid under pressure to the porous-material insertion 58. The latter affords restricted passages and openings through which the fluid under pressure passes to generate a fluid cushion as indicated by the arrows 59.

FIG. 2 also illustrates the use of a diaphragm to afford the pressure detecting means. The diaphragm is shown in FIG. 2 at 60 and is mounted at the constricted end 61 of a constant-pressure fluid supply pipe 62, which is also constricted at 63, bridging a gap in the porous-material insertion 58. The diaphragm 60 is thus exposed to the pressure of the fluid cushion 59 on its outer side. When the latter is relatively low, therefore, fluid from pipe 62 flows out through the constrictions 63 and 61 and through an exhaust pipe 64, but when it is relatively high the diaphragm 60 closes the constriction 61 and the pressure downstream of constriction 63 rises towards the full value of the pressure upstream of 63. The increased pressure is transmitted by way of pipe 65 to regulating means, not shown in FIG. 2, which are actuated to reduce the tension in the web 51. The regulating means are similarly actuated to increase the tension in the web 51 when the pressure of the fluid cushion 59 and the pressure in the pipe 65 become excessively low, the diaphragm 60 being in the nature of a "flapper valve."

I claim:

1. A tension sensing device which comprises a fixed elongated body, round which a travelling web is guided, formed with an opening in its surface, said opening communicating with a source of fluid under pressure through at least one restricted passage situated within said elongated body closely adjacent to said opening and being adapted to provide a fluid cushion between the web and the surface of the elongated body, thereby holding the web away from the surface, and pressure detecting means in communication with means being a part of the fluid cushion.

2. A device according to claim 1, in which at least two openings are provided in the elongated body, each of said openings being connected to the source of pressure fluid by a restricted passage.

3. A device according to claim 2, in which the elongated body has within it an insertion of a porous material and this insertion affords the said restricted passages and openings.

4. A device according to claim 3, in which the porous material is a sintered metal.

5. A device according to claim 1, in which the opening is connected to the pressure detecting means.

6. A device according to claim 2, having at least one aperture separate from the said openings, connected to the pressure detecting means and situated in the elongated body surface so as to communicate with the fluid cushion.

7. A device according to claim 1, in which the pressure detecting means controls means for regulating the tension in the travelling web.

8. A device according to claim 7, in combination with a rotatable web roll from which said web is unwound and

travels to said elongated body, and in which said regulating means comprise a shoe brake adapted to inhibit rotation of said roll.

9. A device according to claim 1 in which the pressure detecting means comprise a diaphragm with a sensing system attached thereto, the pressure prevailing at one of the faces of the diaphragm being the pressure of the fluid cushion.

10. A device according to claim 1 in which said opening is in the form of a shallow recess formed in the surface of said elongated body and extends over a part of

that portion of said elongated body over which said web is trained.

References Cited by the Examiner

UNITED STATES PATENTS

2,079,268	5/1937	Wiedmann	242—75.53
2,755,032	7/1956	Justus	242—75.43
2,908,290	10/1959	Hamilton-Peters	251—118 X

FRANK J. COHEN, *Primary Examiner.*

N. L. MINTZ, *Assistant Examiner.*