Dec. 15, 1959 C. B. BUSHNELL ET AL 2,917,252

TENSION CONTROL APPARATUS

Filed April 25, 1958 2 Sheets-Sheet 1

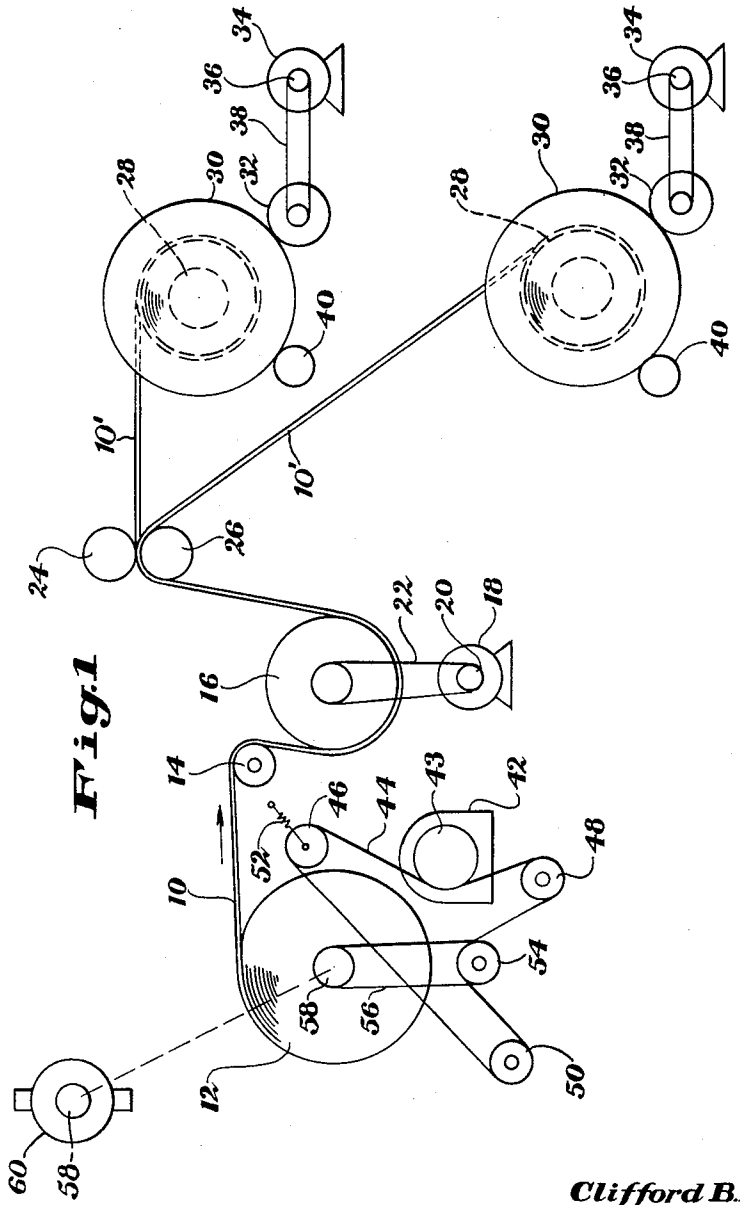


Fig. 1

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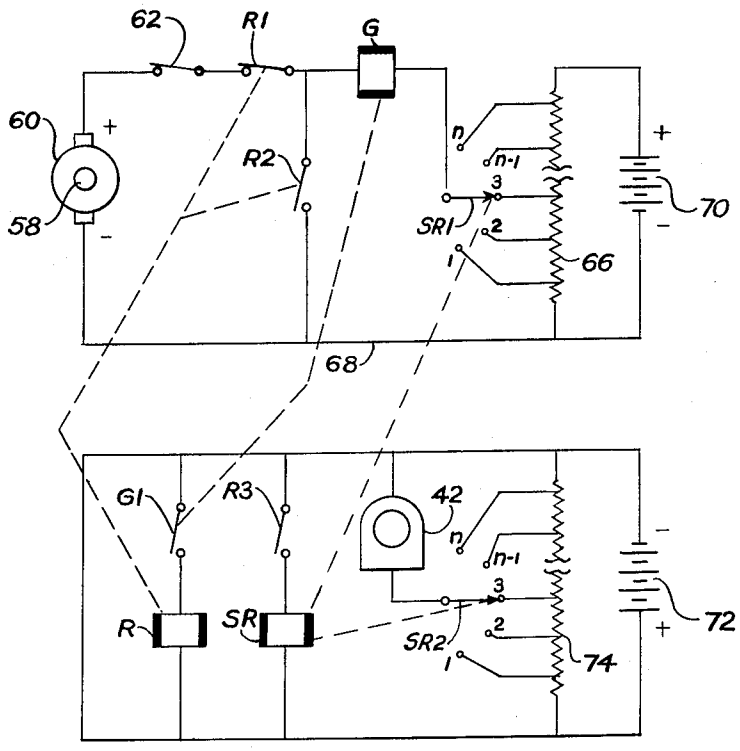


Fig. 2

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TENSION CONTROL APPARATUS

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Application April 25, 1958, Serial No. 730,958

3 Claims. (Cl. 242—75.47)

The present invention concerns the control of tension in a moving web and more particularly concerns apparatus for controlling the tension in a web that is being unwound from a stock roll.

When a web of flexible material is unwound from a stock roll, operated upon in some manner and rewound, it is frequently desirable to control the tension of the web between the stock roll and the operating point to avoid tearing or crimping of the material. When the web is pulled from the stock roll at a constant linear speed, for example by a metering roller interposed between the stock roll and the operating point, the decreasing diameter of the stock roll diminishes the length of the lever arm between the web and the center of the stock roll. In order to stabilize the value of the tension of the web between the stock roll and the metering roller, it is necessary to decrease the unwinding torque along with the length of the lever arm. A continuous decrease in the unwinding torque has been accomplished in several ways in the prior art, such as under the control of a device which senses the decreasing diameter or the increasing angular speed of the stock roll. However, such continuous control systems have been found either to be complex and expensive or to lack the necessary accuracy of tension regulation. It is therefore a principal object of the present invention to provide a relatively inexpensive apparatus for changing the unwinding torque of a web which is being unwound from a stock roll.

It has been found that the necessary accuracy of tension regulation can be achieved by changing the unwinding torque in small steps rather than continuously, the size of each step being determined by the acceptable limits of web tension. It is therefore another object of the invention to incrementally change the unwinding torque of a web being unwound from a stock roll. A more specific object is to generate a signal that is a function of the angular speed of an unwinding stock roll of web material and to compare that signal with a reference signal for initiating changes in the unwinding torque and in the value of the reference signal when the two signals differ by more than a predetermined amount. Other objects of the invention will appear from the following detailed description of the invention, reference being made to the accompanying drawings, wherein:

Fig. 1 is a schematic side view of a slitting mechanism embodying the present invention; and

Fig. 2 is a schematic wiring diagram of the tension control circuit.

Referring to Fig. 1, a continuous web **10** of flexible material from a stock roll **12** is passed in contact with an idling roller **14** and a metering roller **16** and through a pair of rotary slitting knives **24** and **26**, where it is cut longitudinally into at least two portions. Each cut portion 10^1 of the web is then wound onto a respective spool **28**. The metering roller **16** is driven at a constant angular speed by means shown schematically as a motor **18**, a pulley **20** and a belt **22**, and pulls the web from the stock roll **12**. Each winding spool **28** is supported by

its rims **30** on a drive roller **32** and an idling roller **40**. A respective A.C. torque motor **34** drives each roller **32** by means shown schematically as a pulley **36** and a belt **38**. Motors **34** have the ordinary characteristic of A.C. torque motors by virtue of which speed and output torque are related inversely. Since the linear speed of the web is maintained constant by the metering roller **16**, the angular speed of the winding spools **28** gradually decreases as the diameter of the wound web increases, and drive motors **34**, which are inherently self-regulating over a chosen range of operation, maintain the convolutions of web taut on spools while the web diameter increases.

In order to compensate for the decreasing diameter of the stock roll **12** and the decreasing lever arm of the web leaving the stock roll, and thereby stabilize the web tension between the stock roll **12** and the metering roller **16**, the unwinding torque at the stock roll is decreased as the slitting operation progresses. The mechanism employed by varying the unwinding torque includes a magnetic particle brake **42** of any conventional type, for example the type disclosed in U.S. Patent No. 2,603,103, granted July 15, 1952, to H. Sohon et al. The degree of energization of brake **42** controls the drag of a roller **43** on the brake in the conventional manner. Roller **43** contacts a control belt **44**, which also passes in contact with three support rollers **46**, **48** and **50**. At least one of the support rollers may be urged by a spring **52** in a direction for tightening belt **44**. The latter belt also contacts a roller **54** which is maintained in driving engagement with the gudgeon **58** of the stock roll by means of a belt **56**. The drag applied to roller **43** by brake **42** is therefore transmitted to the stock roll through belt **44**, roller **54** and belt **56**.

The circuit for controlling the energization of brake **42** is shown in Fig. 2 and includes a tachometer generator **60** driven by the gudgeon **58** of the stock roll and generating an output voltage that is proportional to the angular speed of the stock roll. The high-potential, or output side of generator **60** is connected through a start switch **62**, a pair of normally closed contacts R1 and the winding of a galvanometer-type relay G to a stepping switch SR1 that sweeps a series of *n* contacts of a potentiometer **66**. This potentiometer, which constitutes a source of variable reference potential for relay G, is connected through a return lead **68** to the low-potential side of generator **60** and is energized by a source of D.C. power, shown as a battery **70**. The low-potential side of generator **60** also is connected through a pair of normally open contacts R2 to the generator side of relay G.

Brake **42** is connected from the negative terminal of a second source of D.C. power, shown as a battery **72**, to a second stepping switch SR2 that sweeps a series of *n* contacts of a second potentiometer **74**. The latter potentiometer is connected across battery **72** in parallel with two relay circuits, the first of which comprises a pair of normally open contacts G1 in series with a relay R, and the second of which comprises a pair of normally open contacts R3 in series with a stepping switch relay SR. Contacts G1 and R3 are controlled by relays G and R, respectively; stepping switches SR1 and SR2 are both controlled by relay SR and their contacts are swept in cyclic fashion in the direction indicated by the increasing values of the contact numbers.

As the angular speed of the stock roll increases during a slitting operation, the output voltage from generator **60**, which constitutes an information signal representing the instantaneous value of such angular speed, increases and is applied to relay G. When the voltage across relay G reaches a predetermined value, that relay is energized and closes contacts G1, thereby energizing relay R to open contacts R1 and close contacts R2 and R3. The closure of contacts R3 energizes relay SR and advances each of

the stepping switches SR1 and SR2 one step along its respective bank of contacts.

The advancing of switch SR1 applies a new and higher reference voltage from potentiometer 66 to relay G and thereby establishes a new value for the input voltage from generator 60 required to energize that relay. The advancing of switch SR2 applies a new and lower voltage across brake 42 from potentiometer 74, thereby decreasing the energization of the brake to decrease the drag on the stock roll. The opening of contacts R1 disconnects the high-voltage side of generator 60 from relay G, while the closing of contacts R2 connects the low-voltage side of the generator to the same relay, thereby de-energizing relay G and restoring it to its initial condition. This reopens contacts G1 to de-energize relay R, which thereupon recloses contacts R1 and reopens contacts R2 and R3 to restore the entire relay circuit to its initial condition, with the stepping switches advanced by one contact each. The operation just described is then repeated when the output voltage from generator 60 reaches a new value that is sufficiently high to energize relay G against the new reference voltage from potentiometer 66.

The invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. In a device for winding a web of flexible material from a stock roll, means for regulating the tension of said web, said regulating means comprising, in combination, a tachometer generator coupled to said stock roll for generating a voltage proportional to the angular speed of the stock roll; a potentiometer; a stepping switch in sensing relation to said potentiometer; a normally unactuated relay interconnecting said generator and said

stepping switch and actuated in response to the occurrence of a predetermined minimum difference in the voltages applied to said relay from said generator and from said potentiometer; electrically energized braking means coupled to said stock roll for applying to the stock roll a braking effect in proportion to the degree of energization of said braking means; and means controlled by said relay, in response to actuation thereof, for advancing said stepping switch and for changing the degree of energization of said braking means.

2. In a device for unwinding a web of flexible material from a stock roll, means for regulating the tension of said web, said regulating means comprising, in combination, means coupled to said stock roll for generating an information signal representing the instantaneous angular speed of the stock roll; a source of variable reference signal; comparison means interconnecting said generating means and said source for sensing and comparing said information and reference signals and for generating a control signal in response to the sensing of a predetermined relationship between said information and reference signals; electrically energized braking means coupled to said stock roll for applying to the stock roll a braking effect in proportion to the degree of energization of said braking means; and means interrelating said source, said comparison means and said braking means and operable, in response to generation of said control signal, for varying said reference signal and for varying the degree of energization of said braking means.

3. The tension regulating means defined in claim 2, wherein said interrelating means includes a potentiometer and a stepping switch in sensing relation to said potentiometer.

References Cited in the file of this patent

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,917,252 December 15, 1959

Clifford B. Bushnell et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 30, for "winding" read -- unwinding --.

Signed and sealed this 14th day of June 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents