

W. B. HEINZ

AUTOMATIC TENSION CONTROL

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Inventor
W. B. Heinz,

By Edmund A Parry

Attorney

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W. B. HEINZ

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Fig. 3

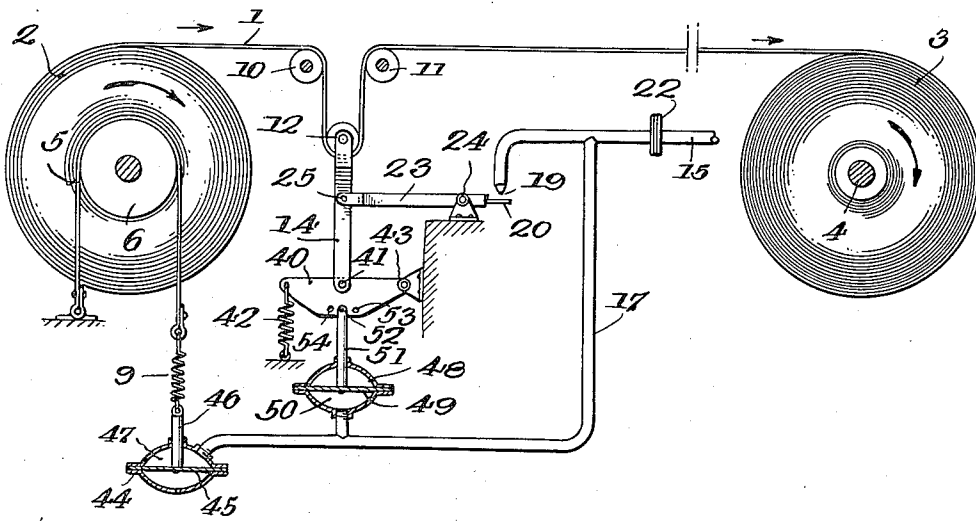
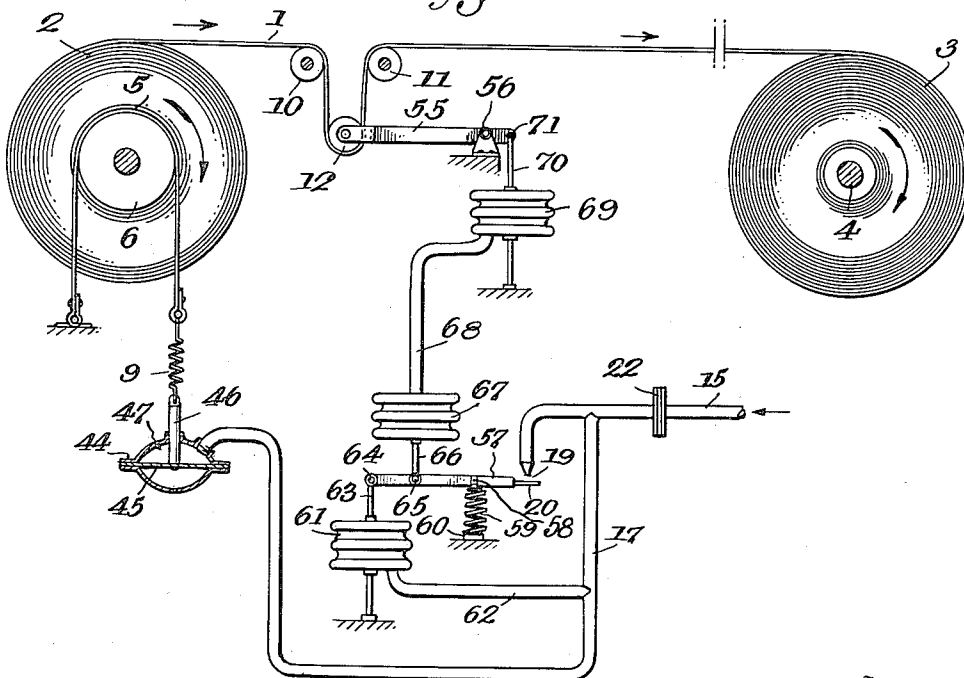


Fig. 4



Inventor
W. B. Heinz,

By *Edmund H. Parry*

Attorney

UNITED STATES PATENT OFFICE

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AUTOMATIC TENSION CONTROL

Winfield B. Heinz, Bound Brook, N. J.

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This invention relates to the automatic control of tension in traveling strand or strip materials such as textile fabrics, paper, sheet metal, or wire. Maintenance of constant tension in traveling materials is important in connection with machines which operate in some phases on the material. It is usual in these machines to unreel and reel up the material before and after the operation and during the process the tension must be maintained constant regardless of the diameter of the unwinding and winding reels and the varying friction which may be applied to the material by the operation of the machine.

An object of this invention is to provide a control device maintaining constant tension in traveling material regardless of various strains to which the material is subjected.

Another object of the invention is to provide a tension detector engaged by the traveling material and movable in response to changes in tension therein to operate means for controlling the tension in the material.

A further object of the invention is to couple the tension detector to the tensioning means to prevent overcorrection of tension variations and to render the detector more responsive to tension changes produced by the tensioning means.

A secondary object of the invention is to make possible the use of higher speeds in handling traveling materials.

In carrying this invention into effect tensioning means are provided for controlling the tension in the traveling material. This tension control device may consist of a brake engageable with an unwinding reel or variable clutch means to control the torque to a winding reel. A power operated actuator is provided for the tensioning means, and may be resiliently coupled thereto. Means is provided to control the motor by varying the power supplied to it.

A tension measuring device is provided in the form of a member engaged in a loop of the traveling material. This member is movable by the tension in the material and is resiliently constrained so that its movement is proportional to the force exerted on it by the tension. The detector is operatively connected to the means for varying the power to the tensioning motor and the detector thereby maintains a constant tension in the material through its control of the tensioning means. The tensioning motor is coupled to the detector so that a movement of the motor to alter the tension in the material accelerates movement of the detector so that it will be ad-

justed more quickly than if the detector were movable only in response to corrective change in tension of the traveling material. Consequently, overcorrection of tension variations is prevented and at the same time transient effects from the inertia of the tension detector on the traveling material are avoided.

Several embodiments of my invention are illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of my invention applied to an unwinding reel;

Fig. 2 is a diagrammatic representation of a further embodiment of my invention applied to a winding reel;

Fig. 3 is a diagrammatic view of another embodiment of my invention applied to an unwinding reel; and

Fig. 4 is another embodiment of my invention applied to an unwinding reel.

In Fig. 1 strand or strip material 1 is shown traveling from unwinding reel 2 to winding reel 3. Power may be applied to shaft 4 of the winding reel. A brake 5 is provided for acting on the brake drum 6 mounted on unwinding reel 2 to control the tension in the traveling material.

Brake 5 is operated by the piston 7 of the fluid pressure operated motor 8. As shown, the piston may be resiliently connected to the brake by spring 9.

The traveling material is passed over the fixed supporting rollers 10 and 11 to provide a loop engaging movable roller 12. The movable roller constitutes the tension detector. The tension in the traveling material exerts a force upwardly on roller 12, which is resiliently opposed by spring 13 acting through member 14 in which roller 12 is journaled. The resilient action of spring 13 permits roller 12 to change its position proportionately to changes in tension in the material. The movable roller therefore constitutes an accurate device for measuring the tension present in the material.

Fluid pressure for operating the motor 8 is supplied by conduit 15. Connecting the conduit 15 are pressure supply lines 16 and 17 for conducting fluid pressure to each side of piston 7. The action of the piston is controlled by the pressure differential between supply lines 16 and 17. The pressures in lines 16 and 17 are controlled by vane 20 in cooperation with the opposed vents 18 and 19 in lines 16 and 17, respectively. In its intermediate position, vane 20 permits equal flow from lines 16 and 17, and equalizes the pressure in these lines. As vane

20 is moved closer to one of the vents the flow therefrom is decreased to raise the pressure in the corresponding supply line and the flow from the other vent is increased to lower the pressure in the other supply line. In this way, vane 20 proportions the pressures in lines 16 and 17 and thereby controls the actuation of piston 7.

The supply of pressure to lines 16 and 17 is preferably restricted, and for this purpose orifices 21 and 22 are provided. As shown, vents 18 and 19 are larger than the orifices so that complete control of the pressures in lines 16 and 17 is obtained over a wide range by movement of vane 20.

Vane 20 is carried by member 23 which is journaled on a fixed pivot 24. Member 23 is attached to member 14 by the pivot 25. In this way, tension detector roller 12 controls the operation of motor 8 and, through the action of brake 5, the tension in the traveling material.

For coupling motor 8 to the tension detector 12, there is provided lever 26 attached to connecting rod 30 by pin 29 and engaging spring 13 at 28. Lever 26 is intermediately journaled on pivot 27. Through lever 26, movement of piston 7 to increase the tension on the material by taking up brake 5 raises roller 12 to accelerate the response in the roller to the increase in tension resulting from the application of brake 5. At the same time the movement upwardly of the roller decreases the length of the loop of material engaging the same and thereby affects the tension reversely of the action of brake 5. Corresponding effects are produced on the roller 12 by a movement of piston 7 to reduce the tension in the material.

The operation of the device shown in Fig. 1 in response to an undesired variation of tension in the material may be described as follows: Assuming that the tension is momentarily diminished, spring 13 causes roller 12 to move downwardly until the tension of the spring is decreased to a point where it is counterbalanced by the force exerted on roller 12 by the reduced tension. This movement of roller 12 immediately alters the position of vane 20 through the action of lever 23, decreasing the flow through vent 19 and increasing the flow through vent 18. In accordance with the alteration of the position of vane 20, pressure is increased in line 17 and decreased in line 16 so that a greater force is exerted on piston 7 to increase the action of brake 5 on brake drum 6. As piston 7 is moving to increase the action of brake 5 at the same time, through lever 26, tension on spring 13 is reduced to accelerate the upward movement of roller 12 with the increase in tension and to prevent overcorrection of the tension by shortening the loop engaging the tension detector. As roller 12 moves up under the action of the increased tension in the material and the movement of lever 26, member 23 restores vane 20 toward its original position, roller 12 coming to rest when the desired tension is reached.

In Fig. 2 is shown an embodiment of my tension control device applied to a winding reel. In this construction winding reel 3 is carried on shaft 4 and adapted to be driven by pulley 30. A loose belt 31 connects pulley 30 to a driving pulley 32. The tension in belt 31 is adjusted by movable idler 33. By adjustment of the position of idler 33 the engagement of belt 31 with pulley 30 can be varied to control the torque applied to the winding reel 3.

As in the construction shown in Fig. 1, I pro-

vide in Fig. 2 a movable roller 12 engaged by a loop of the traveling material 1 which is supported on fixed rollers 10 and 11. The movable roller is journaled in member 14 and is resiliently held against movement by the tension in the material by spring 13. This construction permits the position of the roller to vary in dependency on variations of the tension in the traveling material.

Member 14, through member 23, journaled on the fixed pivot 24, controls the position of movable vane 20. The movable vane in coaction with the vents 18 and 19 proportions the pressures in the pressure supply lines 16 and 17, thereby controlling the actuation of piston 7 of the fluid pressure operated motor 8. Member 34, which carries the movable idler 33, is connected to piston rod 30 so that the movable roller 12 maintains a constant tension in the traveling material by controlling the tension of belt 31 and the torque thereby applied to winding reel 3.

In order to prevent overcorrection of tension variations and to accelerate the response of the movable tension detector roller 12 to changes in tension resulting from variations in the position of movable idler 33, member 34 is coupled to spring 13 through arm 35, link 36, and lever 37. The operation of this construction is similar to the embodiment shown in Fig. 1 with the exception that the tension is controlled by varying the torque received by winding drum 3 instead of varying the braking action on the unwinding reel. If desired, the construction shown in Figures 1 and 2 may be used in conjunction where the traveling material is subjected to intermediate operations between its unreeling and reeling.

In Fig. 3 is shown another embodiment of my invention applied to traveling material drawn off from unwinding reel 2 by winding reel 3. The tension in the traveling material is controlled by the action of brake 5 on brake drum 6 which is carried by the unwinding reel 2. The tension in the material is measured by movable roller 12 engaged in a loop of the traveling material supported by fixed rollers 10 and 11. Movable roller 12 is journaled in member 14. By the action of spring 42 engaging link 40 journaled on the fixed pivot 43 and connected to member 14 by pivot 41, the movable roller 12 is resiliently held against movement by the tension in the traveling material. This construction permits the tension detector roller to vary its position in accordance with variation of the tension in the material, and, through member 23 journaled on fixed pivot 24 and connected to member 14 at 25, the position of the vane 20 is controlled. Vane 20 in cooperation with vent 19 controls the pressure in pressure supply line 17.

I provide the pressure operated motor 44 resiliently connected by spring 9 to brake 5 for controlling the tension in the traveling material. Pressure supplied to chamber 47 by pressure supply line 17 acts on diaphragm 45 which is connected by connecting rod 46 to spring 9. In this way the tension detector roller controls the tension on the material by varying the braking action on the unwinding reel.

In order to stabilize the tension in the material and to prevent overcorrection of pressure variations, I provide pressure operated motor 48 for accelerating movement of the tension detector roller 12 in dependency on the action of brake 5. As shown, motor 48 is provided with a diaphragm 49 which is actuable by pressure sup-

plied to chamber 50 from pressure supply line 17. Diaphragm 49 is connected to link 40 by connecting rod 51 attached to the link at 52. If it is desired to vary the effective coupling to the movable tension detector roller pivots 53 and 54 on link 40 may be provided for adjusting the point at which the force exerted by motor 48 is applied to link 40.

It will be understood that through the common pressure supply line 17 the action of motors 44 and 48 are both controlled by movable vane 20 in cooperation with vent 19. As a result, stabilization of tension in the material and the prevention of overcorrection of tension variations and hunting is produced by the action of motor 48 in moving the tension detector roller to accelerate its response to changes in tension resulting from variation in the action of brake 5 and to affect the tension reversely of the action of brake 5 by altering the length of the loop of traveling material engaging roller 12.

In Fig. 4 is shown a tension control device maintaining a constant tension on traveling material 1 through the action of brake 5 on brake drum 6 carried by reel 2 as it is unwound from reel 2 to winding reel 3. The tension in traveling material 1 is measured by movable roller 12 engaged by a loop of material supported by fixed rollers 10 and 11. Roller 12 is journaled in member 55 which is carried on fixed pivot 56. The tension in the traveling material is controlled by the action of pressure operated motor 44 on brake 5. Motor 44 is provided with a diaphragm 45 actuated by pressure in chamber 47 supplied by pressure supply line 17. Diaphragm 45 is connected to brake 5 through connecting rod 46 and the resilient member 9. The pressure in pressure supply line 17 is controlled by movable vane 20 in cooperation with vent 19. Vane 20 is carried by movable arm 57 attached by member 58 to compressed spring 59 supported by member 60. Pressure operated motor 61 consists of an expandible bellows to which pressure is applied by conduit 62 from pressure supply line 17. Through connecting rod 63 pivoted to arm 57 at 64 the pressure present in line 17 exerts a force on arm 57. Coupled to arm 57 at 65 through connecting rod 66 is bellows 67. Bellows 67 is connected by conduit 68 to bellows 69 and the system consisting of the two bellows and conduit 68 is filled with a substantially incompressible fluid.

Bellows 69 carries connecting rod 70 coupled to member 55 by pivot 71. As bellows 69 is compressed by movement of the connecting rod 70, the pressure effects in the fluid contained in the system expand bellows 67 and through connecting rod 66 operate arm 57 to vary the position of vane 20 in relation to vent 19 and thereby control the pressure in line 17. Through pressure operated motor 44 the pressure in line 17 controls the braking action on unwinding reel 2 and thereby determines the tension in the traveling material.

For the purpose of accelerating the response of roller 12 to variations of tension in the material resulting from changes in the force applied to brake drum 6, bellows 61 and pressure operated motor 44 both operate in dependency on the pressure in pressure supply line 17. The coupling between bellows 61 through movable arm 57 supported by spring 59 to bellows 67 causes bellows 69 to change its position in dependency on variation of pressure in line 17. Through connecting rod 70 and member 55 the movement of

bellows 69 is communicated to movable roller 12 so that the latter's response to variation in tension in the material produced by brake 5 is accelerated. Assuming an increase in web tension, upward movement of roller 12 causes fluid pressure to urge rod 66 downwardly. Arm 57, pivoting on its left end pivot 64 is swung downwardly against the opposition of spring 59 to move vane 20 away from vent 19 with the result that pressure in line 17 decreases. The motor diaphragm 45 accordingly moves upwardly and braking action is decreased to diminish the tension on the web. The lowering of pressure in line 62 connecting with line 17 permits rod 63 to move downwardly so that arm 57, swinging on its intermediate pivot 65, is urged upwardly by spring 59 to diminish the opening of vent 19. The upward thrust exerted by rod 63 and spring 59 act on rod 66 to increase the fluid pressure in line 68 and to prevent excessive upward movement of the detector roll 12. As previously described, this operation of the tension detector roller avoids hunting and overcorrection of variations in tension in the material.

It will be understood that the invention is capable of some range of modification and equivalency without departing from the essential features thereof which distinguish the same from prior tension control arrangements. The embodiments shown are therefore to be taken as merely illustrative and the scope of the invention determined from the appended claims.

It will be observed that all of the illustrative embodiments of the invention are so designed that the detector roller can function efficiently and rapidly to adjust the means controlling the tension in the material under changes of tension occurring in the material. I have found that a fluid system utilizing the several forms of pressure relief vents controlled by the detector roller is admirably suited to my purpose of maintaining the tension in the traveling material constant. The use of spring means applying a counterbalancing tension to the detector roller in opposition to the tension of the traveling material insures stability in the operation of the device, since the roller is moved in response to variations in the material tension from the normal only in proportion to the extent of the tension variation. Whether or not employed with such counterbalancing means the arrangement for adjusting the detector roller, and hence the control means for the tension varying means, in response to actuation of the brake or other tension varying means, serves to prevent excessive operation of the tension varying means so that variations in the tension of the traveling material are corrected rapidly and without overcorrection.

I claim:

1. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element controlling operation of the tension varying means adapted to engage the traveling material and movable in response to changes of tension therein, and control means controlling movement of the tension responsive element operated by the tension varying means independently of the material.

2. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element controlling operation of the tension varying means adapted to engage the traveling material and movable in response to

changes of tension therein, and means independent of the material for adjusting the position of the tension responsive element operated by the tension varying means.

3. A tension control device for traveling strand and strip material comprising a tension responsive element adapted to engage the traveling material and movable in response to changes of tension therein, means actuatable in response to movement of the tension responsive element for varying the tension in the traveling material, and means independent of the material operating in response to actuation of the tension varying means acting to cause the tension responsive element to adjust the tension varying means.

4. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element controlling operation of the tension varying means adapted to engage the traveling material and movable in response to changes of tension therein, and means independent of the material responsive to operation of the tension varying means to effect adjustment of the tension responsive element and prevent overcorrection by the tension varying means of the tension in the traveling material.

5. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element controlling operation of the tension varying means adapted to engage the traveling material and movable in response to changes of tension therein, and means independent of the material coupling the tension responsive element to the tension varying means causing movement of the tension responsive element in dependency on operation of the tension varying means to vary the tension in the material.

6. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element controlling operation of the tension varying means adapted to engage the traveling material and movable in response to changes of tension therein, and means independent of the material responsive to operation of the tension varying means to accelerate movement of the tension responsive element as the tension in the material is changed.

7. A tension control device for traveling strand and strip material comprising motor operated means for varying the tension in the traveling material, a tension responsive element adapted to engage the traveling material and movable in response to changes of tension therein, control means for said motor means responsive to movement of said element, and means independent of the material responsive to operation of the motor means as it acts to vary tension in the material for adjusting the tension responsive element.

8. A tension control device for traveling strand and strip material comprising fluid pressure operated means for varying the tension in the material, conduit means for supplying fluid pressure to said tension varying means, fluid pressure control means for controlling pressure in said conduit means, a tension responsive element for actuating the pressure control means engageable with the traveling material and movable in response to changes of tension therein, and means independent of the material coupling the tension responsive element to the tensioning means for adjusting the position of said element in de-

pendency on operation of the tensioning means in varying the tension in the material.

9. A tension control device for traveling strand and strip material comprising fluid pressure operated means for varying the tension in the material, conduit means for supplying fluid pressure to said tension varying means, fluid pressure control means for controlling pressure in said conduit means, a tension responsive element for actuating the pressure control means engageable with the traveling material and movable in response to changes of tension therein, and mechanical linkage independent of the material coupling the tension responsive element to the tensioning means for adjusting the position of said element in dependency on operation of the tensioning means in varying the tension in the material.

10. A tension control device for traveling strand and strip material comprising means for varying the tension in the material, a tension responsive element engageable with the traveling material and movable in response to changes of tension therein, fluid pressure operated means for actuating the tension varying means to change the tension in the material and means operative in dependency on actuation of the fluid pressure operated means for causing movement of the tension responsive element independently of the change of tension in the material, conduit means for supplying fluid pressure to said fluid pressure operated means, and means responsive to movement of the tension responsive element controlling the pressure in said conduit means.

11. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, a tension responsive element adapted to engage the traveling material and movable in response to changes of tension therein, control means for the tension varying means actuatable by the tension responsive element, and means independent of the material operated in dependency on actuation of the tension varying means to simultaneously adjust the tension responsive element and actuate said control means of the tension varying means.

12. A tension control device for traveling strand and strip material comprising means for varying the tension on the material, power-operated actuating means therefor, power control means controlling transmission of power to said actuating means, a movable tension responsive element engageable with the traveling material and movable by changes of tension in the material, said power control means being operated by the tension responsive member, and means for operatively connecting the tension responsive member to the power-operated means to resiliently oppose movement of the tension responsive member by the tension of the material and to cause movement of the tension responsive member in response to movement of the power-operated means.

13. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, fluid pressure operating means for the tension varying means, a tension responsive element adapted to engage the traveling material and movable in response to changes of tension therein, valve means controlling the supply of fluid pressure to said fluid pressure means operated by the tension responsive element, and means independent of the material operated by the power

operated means for adjusting the position of the tension responsive element.

14. In a tension control device for traveling strand and strip material, tensioning means for controlling the tension in the material, fluid pressure operated double acting motor actuating means for the tensioning means, a first conduit means for supplying fluid pressure for actuating said motor means in one direction to increase the tension in the material, a second conduit means for supplying fluid pressure for actuating said motor means in the opposite direction to decrease the tension in the material, opposed nozzles in the first and second conduit means for discharging fluid pressures therefrom, a movable vane member interposed between the nozzles and coacting with the nozzles to control flow there-through and thereby proportion the pressures supplied through the first and second conduit means to the double acting motor means, and means responsive to the tension in the material controlling the operation of the movable vane member.

15. A tension control device for traveling strand and strip material as in claim 14, further including means operated by the double acting motor actuating means independently of the material for adjusting the means controlling operation of the movable vane member.

16. A tension control device for traveling strand and strip material comprising means for varying the tension in the traveling material, fluid pressure operating means therefor, valve means controlling the supply of fluid pressure to said pressure operated means, an element for actuating said valve means adapted to engage the traveling material and being movable in response to changes of tension in the material, variable tension means applying to said element an opposing tension counterbalancing the tension in the material, and means operating independently of the material in response to operation of the fluid pressure operated means for adjusting said valve actuating element.

17. A tension control device for traveling strand and strip material comprising power-operated means for varying the tension in the traveling material, a tension-responsive element adapted to be engaged by the traveling material and capable of movement to different positions with changes in the tension in the material, and variable tension means applying to the element an opposing tension counterbalancing the tension in the material and being automatically operative to change the counterbalancing tension in response to changes of the tension in the material

so that the position of the element is moved to an extent proportional to the extent of change of tension in the material, control means for the power-operated material tensioning means operated by movement of the tension-responsive element, and means operated by the tension varying means independently of the material for adjusting the position of the tension responsive element.

18. A tension control device for traveling strand and strip material comprising power-operated means for varying the tension in the traveling material, a tension-responsive element adapted to be engaged by the traveling material and capable of movement to different positions with changes in the tension in the material, and variable tension means applying to the element an opposing tension counterbalancing the tension in the material and being automatically operative to change the counterbalancing tension in response to changes of the tension in the material so that the position of the element is moved to an extent proportional to the extent of change of tension in the material, control means for the power-operated material tensioning means operated by movement of the tension-responsive element, and means operated by the tension varying means independently of the material for adjusting the position of the tension-responsive means, said last mentioned means being operatively connected to the tension-responsive element through said variable tension means.

19. In a tension control device for traveling strand and strip material, tensioning means for controlling the tension in the material, fluid pressure operated double acting motor actuating means for the tensioning means, a first conduit means for supplying fluid pressure for actuating said motor means in one direction to increase the tension in the material, a second conduit means for supplying fluid pressure for actuating said motor means in the opposite direction to decrease the tension in the material, valve means operable to simultaneously increase the pressure supplied through one of the first and second conduit means to the double acting motor means and proportionately decrease the pressure supplied through the other of said conduit means, means responsive to the tension in the material controlling the operation of the valve means, and means for adjusting the tension responsive element independently of the material and operated in response to actuation of the pressure operated means.

WINFIELD B. HEINZ,