Dec. 25, 1956 D. B. RUSH ET AL 2,775,414

CONSTANT TENSION CONTROL MECHANISM

Filed July 9, 1953

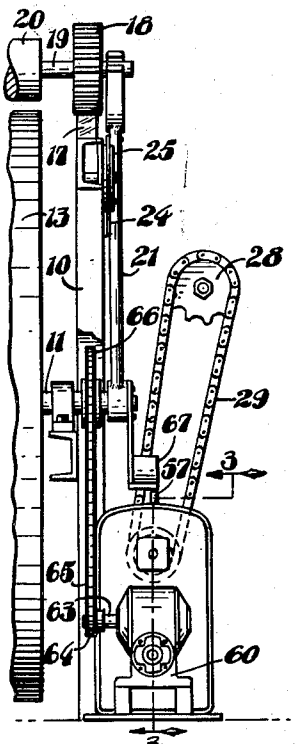

Fig. 1.

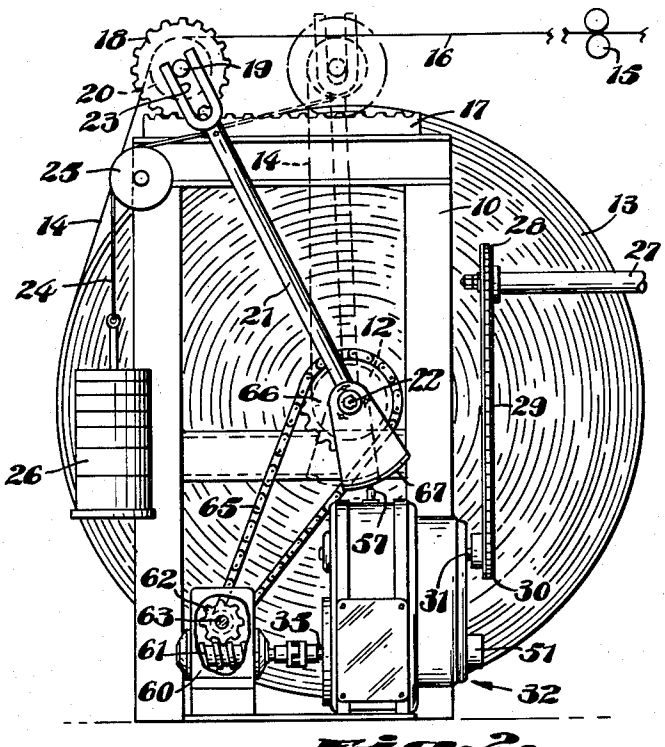

Fig. 2.

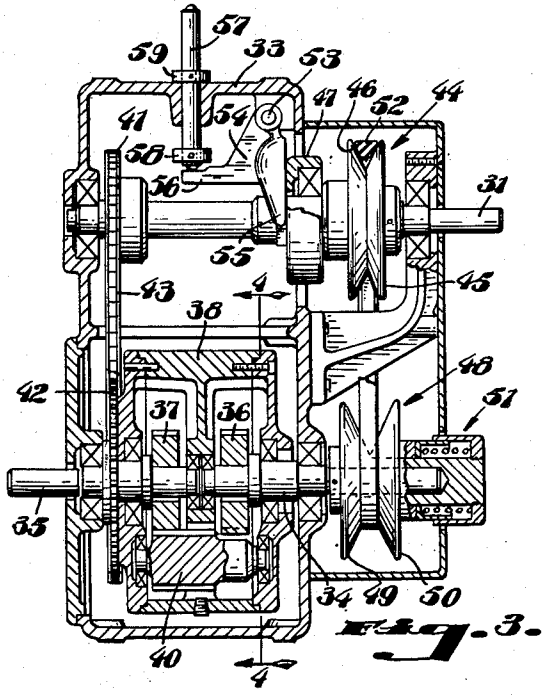

Fig. 3.

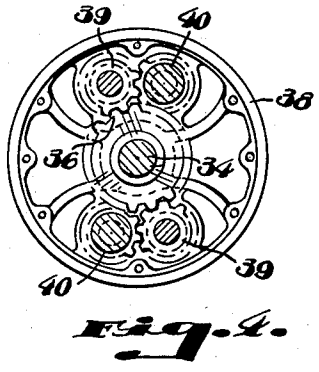

Fig. 4.

INVENTORS.
DALE RUSH,
WILLIAM SPRINGER,
JOHN B. THOMAS and
DONALD E. WOODY,
By: Harold B. Hook.
ATTORNEY.

United States Patent Office 2,775,414 Patented Dec. 25, 1956

2,775,414

CONSTANT TENSION CONTROL MECHANISM

Dale B. Rush and William E. Springer, Columbus, Ind., and John B. Thomas, Belmont, and Donald E. Woody, Medford, Mass., assignors, by mesne assignments, to The Reliance Electric and Engineering Company, Cleveland, Ohio, a corporation of Ohio

Application July 9, 1953, Serial No. 367,042

5 Claims. (Cl. 242—75)

The present invention relates to a drive for a storage roll for flexible material, and the primary object of the invention is to provide a mechanism which, in response to tendencies toward variation in a condition existing in a length of such material moving relative to the axis of said roll, such as, for instance, tension, will automatically vary the speed at which such a storage roll is driven, either for winding or for unwinding of the material, in order to maintain such condition against substantial effective variation.

A further object of the invention is to provide novel means, involving a differential gear, for driving a rotary element at varying speeds in response to variations in the positon of a member affected by the moving material.

The invention has been particularly designed for use, and has been illustrated and will be described in connection, with a beam let-off drive; but it will be clear that the invention is capable of use in many other environments.

To the accomplishment of the above and related objects, our invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific construction illustrated and described, so long as the scope of the appended claims is not violated.

Fig. 1 is an end elevation of one form of the control of the present invention, assembled with a beam let-off mechanism, fragmentarily and somewhat diagrammatically illustrated;

Fig. 2 is a side elevation thereof;

Fig. 3 is an enlarged vertical section through a preferred form of combined variable speed and differential mechanism which may be used in the practice of our invention; and

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 3.

Referring more particularly to the drawings, it will be seen that we have shown a frame **10** in which is journalled a shaft **11** upon which is carried a storage roll **12**. A mass **13** of flexible material is shown wound upon the roll **12**; and the parts are shown at a time, in the cycle of the suggested machine, very shortly after the initiation of an unwinding operation. It will be seen that the material is led from the mass **13** in a section **14** which is always tangent to the effective surface of the mass **13** (sometimes referred to as the effective surface of the storage roll) and, after passing over a control element later to be described, extends in a run **16** to mechanism, suggested at **15**, through which the material is forwarded at a constant lineal velocity to a point of use (not shown).

A trackway **17**, which may comprise a pair of parallel, horizontal racks, as shown, is supported upon the frame **10** in a plane spaced from, but substantially parallel with, the axis of the roll **12**, said trackway extending in a direction transverse to said axis. Wheels **18**, which may be toothed cogs, as shown, for meshing engagement with the said racks, support an axle **19** upon said trackway **17** for movement therealong; and a roller **20** is supported upon the axle **19** for free rotation about the axis thereof. The roller **20** constitutes the control element above referred to, sometimes called a bearing member. As shown, the roller **20** may be the conventional whip roll of a loom.

An arm **21** is mounted for oscillation about a fixed axis **22** which preferably coincides with the axis of the shaft **11**. In the illustrated embodiment of the invention, said arm is actually mounted upon a projection of said shaft; the arm being free, however, for oscillation with respect to said shaft. The arm **21** projects into proximity with the trackway **17** and, at its outer end, is bifurcated to define a slot **23**, elongated in the direction of length of the arm, and freely receiving a projecting end of the axle **19**. Thus, the roller **20** is operatively connected to the arm **21**, whereby movement of said roller along the trackway **17** will be accompanied by oscillation of the arm **21** about its journal axis **22**. A cable **24** has one end anchored to the arm **21**, passes over a pulley **25**, and supports a weight **26**, whereby said arm is yieldably biased to hold the roller **20** at the left-hand end of the trackway **17**.

It will be seen that the roller **20** bears against the inner surface of the material **14** within that sector which is defined between the point of tangency of the section **14** with the effective surface of the roll, and a plane including the axis of the roll **12** and normal to the run **16**.

A shaft indicated at **27** is driven through suitable means (not shown) at a constant ratio with respect to the forwarding means **15**. A sprocket **28** on the shaft **27** is connected, through a chain **29**, to drive a sprocket **30** on a shaft **31** of a control assembly indicated generally by the reference numeral **32**. Said control assembly is illustrated in detail in Figs. 3 and 4.

Within a frame or housing **33** is journalled a first shaft **31**. A second shaft **34** is journalled in said frame **33** upon an axis parallel with the axis of the shaft **31**; and a third shaft **35** is journalled in said frame upon an axis aligned with the axis of the shaft **34**. A sun gear **36** is fixed on the shaft **34** and a sun gear **37** is fixed on the shaft **35**. A differential housing or carrier **38** is journalled to rotate upon the axis common to the shafts **34** and **35**, and supports planetary gears **39** meshing with the sun gear **36** (Fig. 4) and planetary gears **40** meshing with the sun gear **37** and with the gears **39**.

A sprocket **41** is fixed to the shaft **31**, a sprocket **42** is fixed to the carrier **38**, and a chain **43** provides a fixed-ratio drive connection between the sprockets **41** and **42**.

The differential mechanism thus comprises a first input element **38**, a second input element **34** and an output element **35**. If the shaft **34** and the carrier **38** are driven at a common velocity and in the same direction, the shaft **35** will be driven at the same velocity in the same direction. However, any reduction in the velocity of the carrier **38** relative to that of the shaft **34** will result in a reduction in the velocity of the shaft **35**, until, when the velocity of the carrier **38** is one-half that of the shaft **34**, the shaft **35** will be held against rotation. Any further increase in the differential between the velocities of the input elements will result in rotation of the shaft **35** in the opposite direction. Thus, the speed and direction of rotation of the output element **35** are measured by the differential between the speeds of the input elements.

An expansible V-pulley, indicated generally by the reference numeral **44**, is mounted on the shaft **31**, and comprises a coned disc **45** fixed to said shaft, a mating coned disc **46** axially adjustable toward and away from the disc **45**, and a thrust bearing having a housing **47**, associated with the disc **46**. A resiliently expansible V-pulley, indicated generally by the reference numeral **48**, is mounted on the shaft **34** and comprises a coned disc **49** fixed to

said shaft, a mating coned disc 50 axially adjustable toward and away from the disc 49, and a spring unit indicated generally by the reference numeral 51, of conventional construction, tending always to press the disc 50 resiliently toward the disc 49. A V-belt 52 provides a driving connection between the pulleys 44 and 48; and it will be seen that this assembly constitutes a variable-ratio driving connection between the shaft 31 and the second input element 34 of the differential gear.

Upon a suitable pivot 53 within the frame 33 there is oscillably mounted a bell crank lever 54, one arm 55 of which is formed as a yoke engaging the bearing housing 47 on opposite sides of the shaft 31, and the other arm 56 of which is disposed in the path of an actuator element 57. Said element 57 comprises a pin or rod reciprocably mounted in a wall of the frame 33 and provided with adjustable stop collars 58 and 59 limiting its stroke, said pin projecting outside the frame 33 for a purpose later to become apparent.

A reduction gear, indicated by the reference numeral 60, comprises a worm 61 drivingly connected to the output shaft 35 of the assembly 32, and a worm wheel 62 mounted on a shaft 63 which projects from the gear housing and externally carries a sprocket 64 which, through a chain 65, is connected to drive a sprocket 66 on the shaft 11.

The arm 21 includes, or carries, a projection upon which is formed a cam surface 67 extending into cooperative engagement with the actuator 57.

When a loaded storage roll 12 is mounted in the frame 10, the arm 21, under the influence of the weight 26, will be in its extreme counter-clockwise position, in which the roller 20 on the axle 19 will be at the extreme left-hand end of the track 17. The end of the material on the roll will now be carried over the roller 20 and to the forwarding means 15, and thence to a point of use. When the forwarding means 15 is energized, the shaft 27 will likewise be driven. The parts are so proportioned and designed that the carrier 38 will thereby be driven at a velocity sufficiently less than that of the shaft 34 that the roll 12 will be driven at an angular velocity such as to maintain a predetermined degree of tension in the run 16. As material is withdrawn from the mass 13, the effective diameter of the roll is decreased. Since the roll is turning at a constant angular velocity, there is a tendency for the tension in the run 16 of material to increase. At the same time the point of tangency of the section 14 with the effective surface of the mass 13 moves gradually toward the right as viewed in Fig. 2. The combined effect of these two tendencies will be to increase the horizontal component of the force exerted upon the roller 20 by the material, whereby the tendency of the weight 26 is overcome, and the roller 20 will be moved toward the right along the trackway 17. Thereby, the arm 21 will be moved in a clockwise direction. The cam 67 is so designed that such movement of the said arm will permit the actuator 57 to rise, thereby permitting the lever 54 to move in a clockwise direction and permitting the disc 46 to move away from the disc 45, all under the influence of the spring unit 51 which, as has been said, is constantly tending to force the disc 50 toward the disc 49, thereby squeezing the belt 52 outwardly between said discs and pulling it more deeply between the discs 45 and 46. The result of such adjustment, of course, will be to reduce the speed of the input element 34, thereby reducing the differential between the speeds of the input elements 34 and 38, and increasing the speed of the output shaft 35 and of the roll 12.

This adjustment continues progressively, as the effective diameter of the mass 13 (roll 12) progressively decreases, to maintain constant tension upon the run 16 which is continuously forwarded, at a constant lineal speed, by the forwarding means 15.

It will be clear that the illustrated mechanism could be used, also, in a winding operation. In such a case, the forwarding means 15 would, of course, move the material toward, instead of away from, the storage roll at a constant velocity; and the control mechanism would operate to reduce the angular velocity of the roll 11 progressively, under the domination of variations, or rather tendencies toward variation, in the tension in the section 16 of the material. The roller 20 would move progressively from its dotted line position toward its solid line position to permit the arm 21 to move in a counter-clockwise direction, during such winding operation.

The variable-ratio drive means, of course, comprises the pulley pair 44, 48, while the constant-ratio-drive means comprises the sprockets 41 and 42. It will be clear that the sprockets 41 and 42 with the chain 43 are, in many respects, the equivalent of a pair of fixed-ratio pulleys with a connecting belt; and the expression "pulley pair," as used in the appended claims, is intended to include a pair of sprockets such as 41 and 42.

We claim as our invention:

1. Means for automatically controlling the rate of rotation of a storage roll for flexible material comprising, in combination with such a roll, a length of flexible material wound on said roll, means for forwarding said material substantially in a plane at constant lineal velocity, a differential gear including a first input element, a second input element, and an output element, means connecting input elements to control the speed of said output element in accordance with the differential between the speeds of said input elements, rotary means driven at a constant ratio with respect to said forwarding means, constant-ratio drive means connecting said rotary means to drive said first input element, variable-ratio drive means connecting said rotary means to drive said second input element, an arm mounted for oscillation about a fixed axis in a common plane with the axis of said roll, means operatively engaging said arm and bearing against the inner surface of said material at a point within the sector defined between the current point of tangency of said material with the effective surface of said roll and a plane including the axis of said roll and normal to the plane of movement of said material, means yieldably urging said arm away from said normal plane and toward said current point of tangency, means connecting said arm to vary the ratio of said variable-ratio drive means in response to movement of said arm, and means providing a driving connection between said output element and said roll.

2. Means for automatically controlling the rate of rotation of a storage roll for flexible material comprising, in combination with such a roll, a length of flexible material wound on said roll, means for forwarding said material at constant lineal velocity, a differential gear including a first input element, a second input element, and an output element, means connecting said input elements to control the speed of said output element in accordance with the differential between the speeds of the input elements, rotary means driven at a constant ratio with respect to said forwarding means, constant-ratio drive means connecting said rotary means to drive said first input element, variable-ratio drive means connecting said rotary means to drive said second input element, an arm mounted for oscillation about the axis of said roll a trackway spaced from said axis, said trackway being disposed in a plane substantially parallel with said axis and said trackway extending in a direction transverse to the direction of length of said axis, a bearing member supported on said trackway for movement therealong, bearing against the inner surface of said material at a point within the sector defined between the current point of tangency of said material with the effective surface of said roll and a plane including the axis of said roll and normal to the plane of movement of said material, said bearing member being operatively connected with

said arm, said arm being yieldably biased away from said normal plane and toward said current point of tangency, means connecting said arm to vary the ratio of said variable-ratio drive means in response to movement of said arm, and means providing a driving connection between said output element and said roll.

3. Means for automatically controlling the rate of rotation of a storage roll for flexible material comprising, in combination with such a roll, a length of flexible material wound on said roll, means for forwarding said material at constant lineal velocity, a differential gear including a first input element, a second input element, and an output element, means connecting said input elements to control the speed of said output element in accordance with the differential between the speeds of said input elements, rotary means driven at a constant ratio with respect to said forwarding means, constant-ratio drive means connecting said rotary means to drive said first input element, variable-ratio drive means connecting said rotary means to drive said second input element, an element movable oppositely to vary oppositely the drive ratio of said variable-ratio drive means, an arm mounted for oscillation about the axis of said roll, a trackway spaced from said axis, said trackway being disposed in a plane substantially parallel with said axis and said trackway extending in a direction transverse to the direction of length of said axis, a bearing member supported on said trackway for movement therealong, bearing against the inner surface of said material at a point within the sector defined between the current point of tangency of said material with the effective surface of said roll and a plane including the axis of said roll and normal to the plane of movement of said material, said bearing member being operatively connected with said arm, said arm being yieldably biased away from said normal plane and toward said current point of tangency, means on said arm operatively engaging said actuator to shift the same upon movement of said arm, and means providing a driving connection between said output element and said roll.

4. Means for automatically controlling the rate of rotation of a storage roll for flexible material comprising, in combination with such a roll, a length of flexible material wound on said roll, means for forwarding said material at constant lineal velocity, a differential gear including a first input element, a second input element, and an output element, means connecting said input elements to control the speed of said output element in accordance with the differential between the speeds of said input elements, rotary means driven at a constant ratio with respect to said forwarding means, constant-ratio drive means connecting said rotary means to drive said first input element, variable-ratio drive means connecting said rotary means to drive said second input element, an arm mounted for oscillation about the axis of said roll, a trackway spaced from said axis, said trackway being disposed in a plane substantially parallel with said axis and said trackway extending in a direction transverse to the direction of length of said axis, an axle supported on said trackway for movement therealong, a roller supported on said axle for free rotation about the axis thereof, said roller bearing against and supporting the inner surface of said material at a point within the sector defined between the current point of tangency of said material with the effective surface of said roll and a plane including the axis of said roll and normal to the plane of movement of said material, said arm being formed with a longitudinally-extending slot and said axle having operative engagement in said slot, means yieldingly urging said arm away from said normal plane and toward said current point of tangency, means connecting said arm to vary the ratio of said variable-ratio drive means in response to movement of said arm, and means providing a driving connection between said output element and said roll.

5. In a device of the class described, a frame, a storage roll for flexible material journalled in said frame, means on said frame providing a trackway spaced from the axis of said roll and extending transversely relative to said axis, an arm mounted for oscillation about the axis of said roll and extending into proximity to said trackway, a wheeled axle supported on said trackway for movement therealong and operatively connected to said arm, said arm being yieldably biased to hold said axle near one end of said trackway, a roller supported on said axle for free rotation about the axis thereof, said roller bearing against said flexible material at a point between said roll and said forwarding means and being supported thereby against the bias of said arm, a differential mechanism mounted adjacent said roll axis and including a first input element, a second input element, and an output element, means connecting said input elements to control the speed of said output element in accordance with the differential between the speeds of said input elements, a driven shaft, constant-ratio driving means connecting said shaft to drive said first input element, variable-ratio driving means connecting said shaft to drive said second input element, an actuator shiftable oppositely to vary oppositely the ratio of said variable-ratio driving means, means carried by said arm and operatively connected to shift said actuator upon movement of said arm, and means providing a driving connection between said output element and said roll.

References Cited in the file of this patent

UNITED STATES PATENTS

2,175,551	Perry	Oct. 10, 1939
2,581,328	Malcom	Jan. 1, 1952
2,608,741	Reeves	Sept. 2, 1952
2,664,724	Lambach	Jan. 5, 1954

FOREIGN PATENTS

235,025	Switzerland	Nov. 15, 1944