United States Patent

[11] 3,549,100

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[33] **Switzerland**
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[54] **REWINDING APPARATUS FOR THE SINGLE OR MULTIPLE REWINDING OF WEB-LIKE MATERIAL**
6 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **242/67.4**
[51] **Int. Cl.** **B65h 17/02**
[50] **Field of Search** 242/67.4

[56] **References Cited**
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ABSTRACT: A rewinding apparatus for the single or multiple rewinding of a web of material, such as fabric, between driven winding rollers. During any given winding operation one roller functions as the windup roller and the other as the wind-off roller, and their function reverses during each subsequent rewinding operation. An infinitely variable friction drive cooperates with each winding roller. Each friction drive incorporates a drive disk and a driven or power takeoff element, for instance in the form of a pivotably and rotatably mounted spherical segment. Regulator means serve to automatically control the friction drives in accordance with the progression of the winding operation, such regulator means being controlled by the changes in the web-length appearing between the winding rollers. The spherical segments can be pivoted by the regulator means through the same angle in order to selectively vary the point of contact of each drive disk at its associated spherical segment, and to thus also fulfill certain required proportionality relationships between the radii of the circular path of travel of the drive disks and the associated radii of the wound package of material.

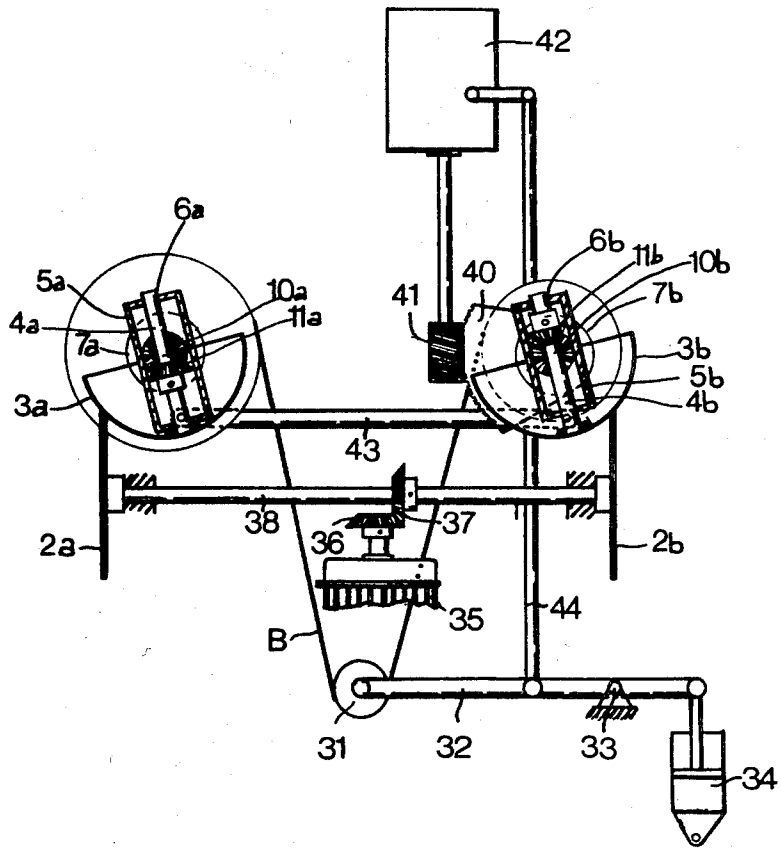

FIG. 1

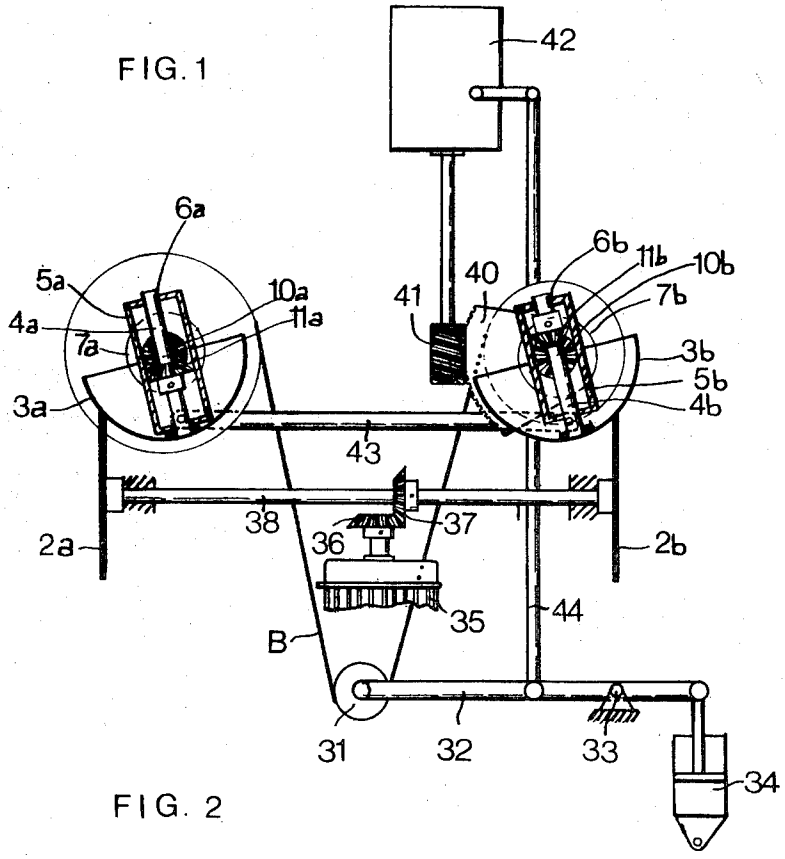

FIG. 2

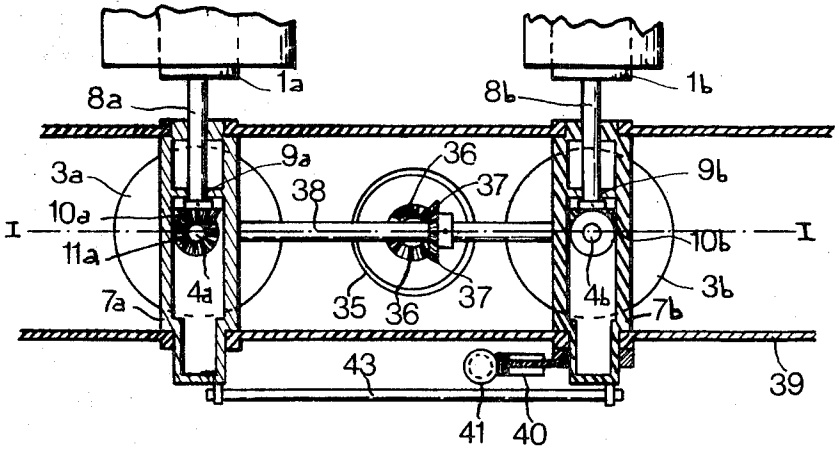

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FIG. 3

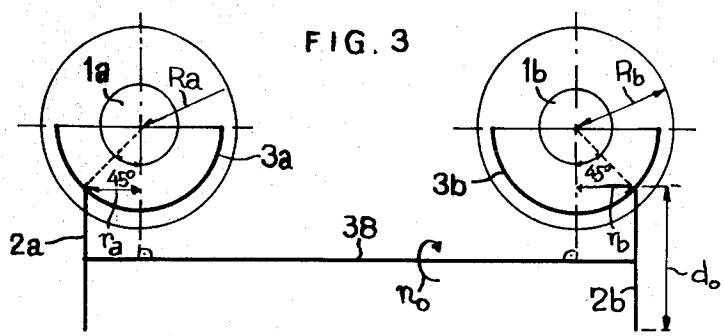

FIG. 4

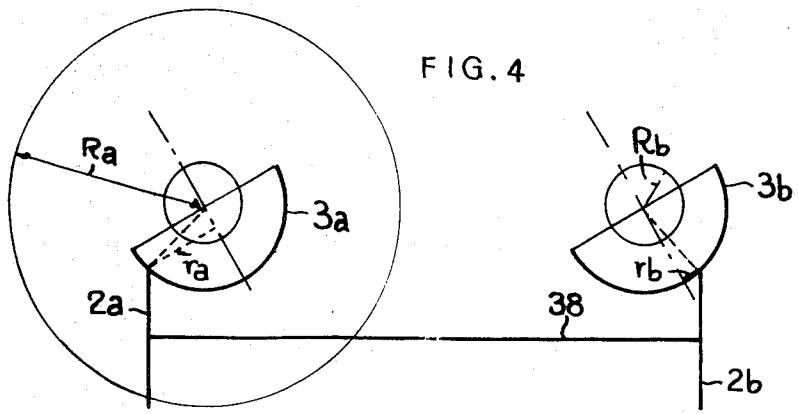

FIG. 5

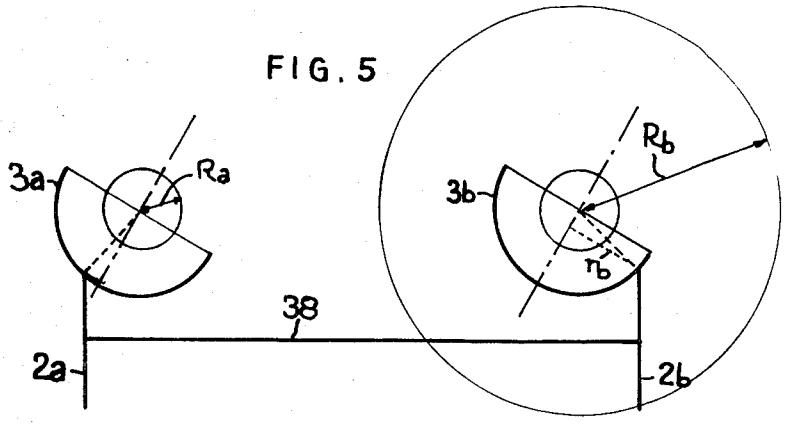

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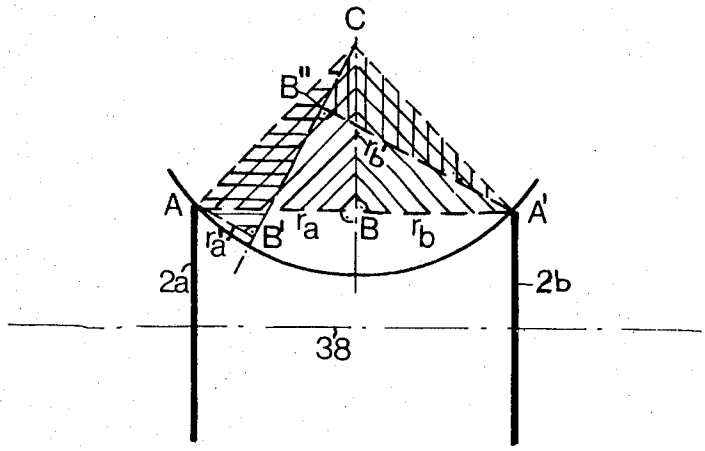
FIG. 6



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REWINDING APPARATUS FOR THE SINGLE OR MULTIPLE REWINDING OF WEB-LIKE MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to an improved rewinding machine or apparatus for the single or multiple rewinding of weblike material, especially fabric webs.

With the known full-width dyeing machines commonly referred to as jiggers, textile material, for instance, a web of fabric is unwound, generally a number of times, from one rotating roller to another rotating roller, and thus conducted through a dye bath. In so doing, one of the roller members operates in reversible function as a windup roller and the other as a wind-off roller.

As is known for this operation, it is of extreme importance that both the windup speed as well as the tension to which the material is subjected, remain constant, because both of these factors are of decisive importance for uniform dyeing. A uniform or constant tension of the material during the rewinding operation at the jigger is, however, also important for subsequent processing, because, for instance, with fluctuating tension, wound up webs of material have an irregular width which leads to skeins or hanks with uneven side surfaces.

These irregularities of the windup velocity or speed and the material tension during the course of the winding operation result from the fact that the peripheral velocity of the hank appearing at the windup roller continually increases whereas the peripheral velocity of the wound package at the other roller continually decreases during payoff.

A series of apparatuses are known to the art for obtaining the desired constant or uniform windup speed and material tension during the rewinding operation. Some of these prior art constructions operate on a purely mechanical principle with infinitely variable frictional drives which can be adjusted by control drives influenced by the rewinding operation, whereas others, however, employ a purely electrical drive with speed-and-torsion regulators or controls, or hydrostatic drives.

These known rewinding machines are, however, generally associated with the drawback that they can only approximately fulfill the requirement of uniform tension of the material and web velocity during the rewinding operation. What is particularly apparent with rewinding machines operating on a purely electrical basis is that the structural expenditure and the cost thereof is in no proper relation to the success which is obtained.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention is provide an improved rewinding apparatus which effectively overcomes the aforementioned drawbacks of the prior art structures.

Another more specific object of the present invention relates to an improved rewinding machine which insures for a constant web velocity and tension, even when working with very sensitive webs of material, and while employing the simplest technical, economical and reliable construction for such apparatus.

Still a further noteworthy object of this invention relates to an improved rewinding machine of the aforementioned type which is extremely reliable in operation, relatively uncomplicated in structure and economical to manufacture and not readily subject to breakdown.

Now, in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, there is provided the inventive rewinding apparatus for the single or multiple rewinding or weblike material from one driven winding roller to another driven winding roller, and vice versa, whereby the rewinding drive occurs by means of a drive motor via a respective infinitely variable friction drive associated with each winding roller. Furthermore, for the automatic control of the friction drives

in accordance with the progression of the winding operation, there is provided a control device which is regulated or controlled by the changes in the web-length between the winding rollers. According to the invention, each of the two friction drives which are of the same construction consists of a drive disc and a driven or power takeoff element formed by a spherical segment. The power takeoff element is pivotable about the geometric axis of the spherical segment, which axis is perpendicular to the plane containing the shaft member for the drive discs and is rotatable about a shaft member situated in this plane. The rotational axes of both power takeoff elements are always guided parallel to one another. The point of contact between the drive disc and power takeoff element at both friction drives is selected such that the radius from the pivot axis of the power takeoff element to this point of contact in the mentioned plane encloses an angle of +45° with a perpendicular connecting line between the pivot axis and the drive disc shaft in this plane at one friction drive, and at the other friction drive encloses an angle of −45°. Furthermore, by means of the control device, both power takeoff elements are pivoted through the same angle in accordance with the takeup of material through its path of travel, and thereby the relationship or ratio of the radii of the circular path of travel of both drive discs driven with the same speed and the power takeoff elements associated therewith is always maintained proportional to the relationship or ratio of the associated radii of the wound package.

Whereas, known rewinding machines, in which for instance, the one element of the infinitely variable friction drive is formed by a conical surface, required a special control drive in order to compensate, during rewinding, the difference between the course of the ratio of the rotational speed of both friction drives and the required course of the ratio of the rotational speed of the winding rollers, with the inventive rewinding machine or apparatus, such a special correction device can be dispensed with. This is so because in this instance the friction drives exhibit the same course of the ratio or relationship of the rotational speed because of their spherical segment-like power takeoff elements as the winding rollers during the rewinding with constant web speed.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood, and objects other than those set forth above, will become apparent, when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a vertical sectional view through a preferred embodiment of rewinding apparatus, taken along the line I–I of FIG. 2;

FIG. 2 is a top plan view, partly in section, of the rewinding apparatus of FIG. 1;

FIGS. 3 to 5 schematically depict different operating conditions during the rewinding operation; and

FIG. 6 graphically provides a geometric explanation of the principles of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, it will be understood that the web of material which is to be rewound is generally designated by reference character B. This web of material B is unwound from a first driven winding roller 1*a* onto a second driven winding roller 1*b* and then unwound in the reverse direction and, in known manner, is conducted between both rollers 1*a* and 1*b* through a suitable treatment liquid located in a nonillustrated vat or the like. In so doing, the web of material B is guided or trained about a pendulum or floating roller 31 secured to one arm of a lever member 32, the pivot point of which is designated by reference numeral 33. The desired tension of the web of material B between both of the winding rollers 1*a* and 1*b* is adjustable by means of a cylinder unit 34 acting upon the lever member 32.

The momentary or instantaneous radii of the web of material B wound upon both winding rollers 1*a* and 1*b* are designated by reference characters R*a* and R*b* (FIGS. 3 through 5).

Driving of both winding rollers 1*a* and 1*b* takes place by means of a suitable drive motor 35, which is common to both winding rollers 1*a* and 1*b*, and which drives a shaft member 38 through the agency of the bevel gears 36 and 37. Two similarly constructed drive plates or discs 2*a* and 2*b* are mounted upon the shaft member 38. Each of these drive discs 2*a* and 2*b* forms a respective member of two friction drives for driving the winding rollers 1*a* and 1*b*. Each of these drive discs 2*a* and 2*b* cooperates with a power takeoff element 3*a* and 3*b*, respectively, possessing the form of a spherical segment. A respective radially extending shaft 4*a* and 4*b* is secured to the inner surface of each spherical segment 3*a* and 3*b*, respectively. More specifically, these shafts 4*a* and 4*b* are mounted in such a way that they are situated in a plane which also contains the shaft member 38. In FIG. 1 this plane coincides with the plane of the drawing.

Continuing, it will be recognized that these shafts 4*a* and 4*b* each extend within a respective tubular member or pipe 5*a* and 5*b*, and are rotatably mounted therein at the bearings 6*a* and 6*b*, respectively. These tubular members 5*a* and 5*b* are each carried by a transversely extending tubular member 7*a* and 7*b*, respectively (FIG. 2), these tubular members 7*a* and 7*b* thus extending perpendicular to the previously mentioned plane. The central axis of each tubular member 7*a* and 7*b* passes through the center of the associated power takeoff element 3*a* and 3*b*, respectively. Furthermore, both of the tubular members 7*a* and 7*b* are rotatably mounted at the frame or housing 39 (FIG. 2) of the illustrated apparatus, so that each of the power takeoff elements 3*a* and 3*b* is pivotable about its diameter which is perpendicular to the previously mentioned plane containing the drive shaft 38 for the drive discs 2*a* and 2*b*.

Furthermore, respective shaft members 8*a* and 8*b* are mounted in the tubular members 7*a* and 7*b*, respectively, at the bearings 9*a* and 9*b*, respectively. A respective bevel gear 10*a* and 10*b* is seated upon the shaft members 8*a* and 8*b*. The bevel gears 10*a* and 10*b* mesh with the bevel gears 11*a* and 11*b*, respectively, seated upon the shaft members 4*a* and 4*b*, respectively. Each of the two shaft members 8*a* and 8*b* is in operable driving relation with one of both winding rollers 1*a* and 1*b*.

Additionally, the tubular member or pipe 7*b* carries a gear or toothed segment 40 externally of the power takeoff element 3*b* and with which meshes a worm 41 of a control or regulator device 42. By means of a rod member 43 which operably interconnects both power takeoff elements 3*a* and 3*b* with one another it is thus possible by means of the control device 42 to vary through the same angle the pivotal position of both spherical segments 3*a* and 3*b* about their associated pivot axes (defined by members 7*a* and 7*b*) and thus, as will be explained more fully hereinafter, to change the momentary circular path of travel of the drive discs 2*a* and 2*b* at their associated spherical segments 3*a* and 3*b*, respectively. Actuation of the control device 42 takes place in known manner through the agency of a rod member 44 engaging with the lever member 32.

A precondition or prerequisite for a uniform tension and speed of the fabric web B during its throughpassage through the treatment liquid during a rewinding operation, is that there occurs a change in the driving speed or velocity of the rollers 1*a* and 1*b* in accordance with the changing radii R*a* and R*b* of the material carried on these rollers 1*a* and 1*b*, respectively. The rotational speed is only the same for both winding rollers 1*a* and 1*b* at that moment of time in which exactly one-half of the web B is rewound from the one to the other winding roller, in other words, when R*a*=R*b*. This situation is illustrated in FIG. 3. The basic setting or adjustment of the rewinding apparatus must take place in such a manner that with the desired web tension in this situation both rollers are driven with the same speed. This presupposes that during this period of time the circular path of travel of the drive disc 2*a* at its associated spherical segment 3*a* is equal to the circular path of travel of the drive disc 2*b* at its spherical segment 3*b*. The radii of the momentary circular paths of travel are depicted in FIGS. 3 to 5 by reference characters r_a and r_b. These radii of the respective circular path of travel vary with the momentary pivotal position of the spherical segments 3*a* and 3*b* about their associated pivot axis 7*a* and 7*b* according to the equation:

$$r_a^2+r_b^2=\text{constant}$$

In FIG. 6, in which for the sake of simplicity both of the spherical segments are shown in overlying relationship, it will be recognized that this equation is satisfied when the drive discs 2*a* and 2*b*, respectively, are arranged in such a manner at their associated spherical segment 3*a* and 3*b* that the radius from the pivot axis of the relevant power takeoff element to the point of contact of the drive discs 2*a* and 2*b*, respectively, in the plane containing the shaft member for the drive discs encloses an angle with a perpendicular taken from the pivot axis to the shaft member for the drive discs disposed in this plane at one friction drive which amounts to +45° and at the other friction drive encloses an angle of −45°, and at the same time both spherical segments 3*a* and 3*b* are pivoted into a position in which their associated axis of rotation is perpendicular to the shaft member 38 for the drive discs 2*a* and 2*b*. This situation is illustrated in FIG. 3.

The sum of the volumes of material which at any time is located upon the winding rollers 1*a* and 1*b* is always constant and equals the total volume of the material to be rewound, namely:

$$V_a+V_b=\text{constant} \qquad (1)$$

In corresponding manner the end surfaces of the package or wound material located upon the winding rollers is constant:

$$F_a+F_b=(R_a^2+R_b^2)\pi=\text{constant} \qquad (2)$$

or

$$R_a^2+R_b^2=\text{constant}, \qquad (2')$$

Wherein F_a and F_b represent the areas of the end surfaces of the fabric wound upon the respective winding rollers.

Since the selected fabric velocity or speed remains constant, at this period of time there occurs the following conditions:

$$V=2\pi R_a \cdot n_a \qquad (3)$$

and

$$V=2\pi R_b \cdot n_b \qquad (4)$$

wherein, n_a represents the momentary speed of rotation of the left winding roller and n_b the momentary rotational speed of the right winding roller (FIG. 3). From this relationship it is possible to derive the following equations:

$$R_a=\frac{V}{2\pi \cdot n_a} \qquad (3')$$

and

$$R_b=\frac{V}{2\pi \cdot n_b} \qquad (4')$$

Substituting equations 3' and 4' in equation 2' results in the following:

$$\left(\frac{V}{2\pi}\right)^2 \cdot \frac{1}{n_a^2}+\left(\frac{V}{2\pi}\right)^2 \cdot \frac{1}{n_b^2}=\text{constant}$$

or, with $V=\text{constant}$:

$$\frac{1}{n_a^2}+\frac{1}{n_b^2}=\text{constant}$$

With the inventive drive the shaft member **38** is driven with a rotational speed n_o. The diameters d_o of the friction discs **2***a* and **2***b* are likewise constant.

The momentary peripheral velocity at both contact locations A of the power takeoff element **3***a* and A′ of the power takeoff element **3***b* (FIG. **6**) are equal and amount to:

$$V_o = d_o \cdot n_o$$

The thus resulting momentary rotational speed for the power takeoff element **3***a* amounts to:

$$V_o = 2r'_a \cdot n'_a \qquad (6)$$

and for the power takeoff element 3b:

$$V_o = 2r'_b \cdot n'_b \qquad (7)$$

Since, however, the power takeoff elements are directly connected or via a drive having a fixed speed reduction relationship, with the winding rollers **1***a* and **1***b*, the following equation can be written for the power takeoff element **3***a*:

$$V_o = f \cdot n_a \cdot r'_a \qquad (8)$$

and the following equation for the power takeoff element **3***b*:

$$V_o = f \cdot n_b \cdot r'_b \qquad (9)$$

Furthermore, with the same package or winding radii R_a and R_b (FIG. **6**) of the following relationship holds true:

$$\Delta ABC = \Delta A'BC$$

from which follows:

$$r_a^2 + r_b^2 = \text{constant} \qquad (10)$$

For every other pivotal position of the spherical segments **3***a* and **3***b* (FIG. **6**), the following relationship can be expressed:

$$\Delta AB'C = \Delta A'B''C$$

from which follows:

$$r'^2_a + r'^2_b = \text{constant} \qquad (11)$$

Each variation or change of the speed of the fabric material owing to an increasing package diameter at the one winding roller and decreasing package diameter at the other winding roller during the rewinding operation influences the pendulum or oscillating roller **31** and raises such. This upward movement is transmitted by means of the lever member **32** and the rod member **44** to the control device **42** and the deviation from the reference value is utilized by the worm **41** via the gear segment **40** to bring about a pivoting of the spherical segment **3***b* about the axis **7***b* and via the rod member **43** interconnecting the spherical segments **3***a*, **3***b* a pivoting of the spherical segment **3***a* through the same angle.

In FIG. **4** there is depicted the extreme situation in which the winding roller **1***b* has been unwound so that it is practically empty and almost the entire web of material B is located upon the winding roller **1***b*.

In FIG. **5** there is depicted the reverse situation where the roller **1***a* is practically empty.

Now, if from equation **8** there is derived the following equation:

$$r'_a = \frac{V_o}{f \cdot n_a} \qquad (8')$$

and from equation 9:

$$r'_b = \frac{V_o}{f \cdot n_b} \qquad (9')$$

and if these new equations 8′ and 9′ are substituted in equation 10, then there results:

$$\frac{1}{n_a^2} + \frac{1}{n_b^2} = \text{constant}$$

As a result, it should be apparent that the inventive drive completely fulfills the requirements for constant speed or velocity as such has been set forth in equation **3**.

In order to pivot the power takeoff elements **3***a*, **3***b* it would be possible to use, instead of the means consisting of the floating or pendulum roller **31** and the control device **42** depicted in the exemplary embodiment, a differential drive connected between the rotational shaft of one winding roller and that of the associated power takeoff element.

It should be apparent from the foregoing detailed description, that the objects set forth at the outset to the specification have been successfully achieved.

I claim:

1. A rewinding apparatus for the single or multiple rewinding of weblike material from one driven winding roller to another driven winding roller, and vice versa, comprising drive means for carrying out the rewinding operation, said drive means incorporating a drive motor and a respective infinitely variable friction drive associated with each winding roller, regulator means controlled by the changes in the web-length between the winding rollers for the automatic regulation of the friction drives as a function of the progression of the winding operation, both of said friction drives being similarly constructed, each friction drive incorporating a drive disc and a power takeoff element constructed as a spherical segment, shaft means for operably interconnecting said drive discs, each said power takeoff element being pivotable about the geometric axis of its spherical segment, said geometric axis being perpendicular to a plane containing said shaft means for the drive discs, a respective shaft means disposed in said plane for providing an axis of rotation for each power takeoff element, the axes of rotation of both power takeoff elements being guided parallel to one another, the point of contact between each drive disc and its associated power takeoff element for both friction drives being chosen such that a radius taken from said axis of pivoting of one power takeoff element to such point of contact in said plane encloses an angle of +45° with a perpendicular connecting line taken from said axis of pivoting to the shaft member for said drive discs located in said plane at said one friction drive and an angle of −45° at the other friction drive, said regulator means serving to pivot both power takeoff elements through the same angle in accordance with the takeup of material through its path of travel, so that thereby the ratio of the radii of the respective circular path of travel of both said drive discs driven with the same speed at the associated power takeoff element is always maintained proportional to the ratio of the associated radii of the wound package.

2. A rewinding apparatus as defined in claim **1**, further including means for controlling said regulator means.

3. A rewinding apparatus as defined in claim **2**, wherein said controlling means for said regulator means comprises a pendulum roller.

4. A rewinding apparatus as defined in claim **1**, further including tubular means provided for each power takeoff element and defining said geometric pivot axis of the associated power takeoff element, a respective shaft rotatably mounted at each tubular means and which provides the power takeoff shaft of the associated friction drive, and gear means for operably interconnecting said power takeoff shaft with said associated shaft member providing said axis of rotation of the associated power takeoff element.

5. A rewinding apparatus as defined in claim **4**, wherein said shaft members providing said axis of rotation of each associated power takeoff element are each arranged in a further respective tubular member, each said further tubular member being carried by said tubular member defining said pivot axis.

6. A rewinding apparatus as defined in claim **4**, wherein said gear means comprise bevel gears.