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WINDUP DRIVE SYSTEM UTILIZING INDUCTION MOTORS

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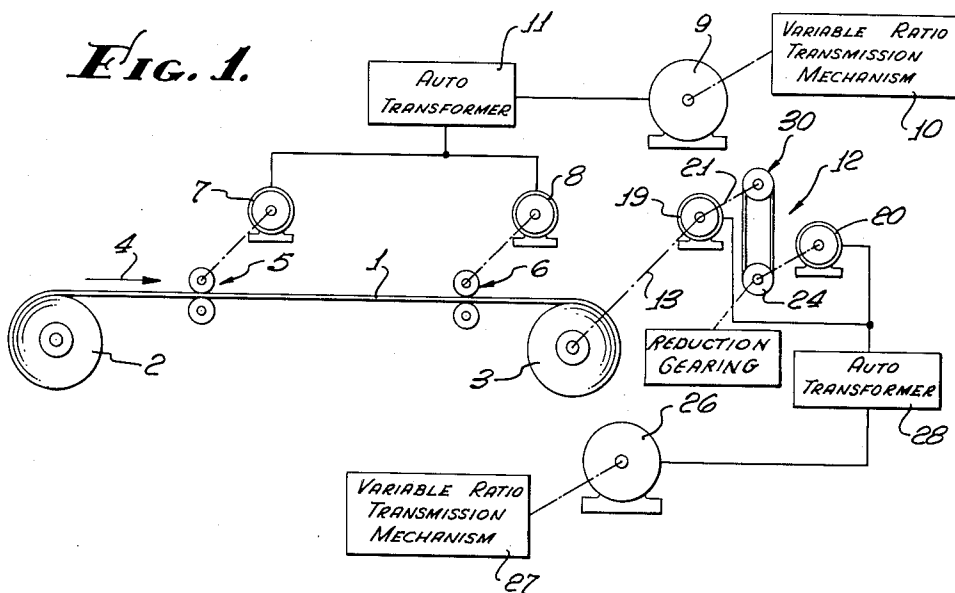


Fig. 2.

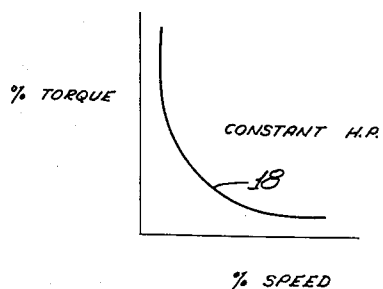


Fig. 3.

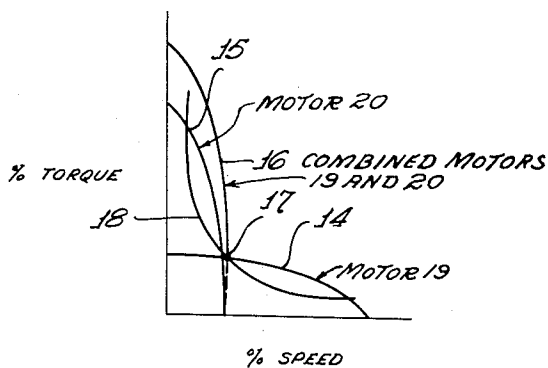
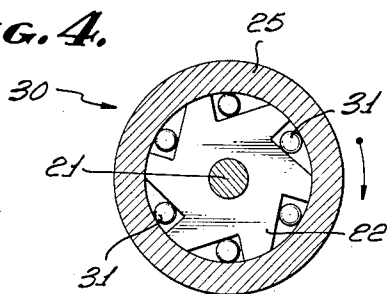


Fig. 4.



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WINDUP DRIVE SYSTEM UTILIZING INDUCTION MOTORS

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10 Claims. (Cl. 242—75.51)

This invention relates to systems in which thin sheet-like material is removed from a supply roll and wound up on a takeup roll. Such material may be made of paper, textile, plastic, or any other material capable of being unwound and rewound on rolls.

In the travel of the material from the supply roll to the windup roll, the material may be treated as desired. This application is not concerned with such treatment, but rather with the maintenance of substantially uniform tension in the material during such travel.

In order to secure such substantially uniform tension, use has heretofore been made of "dancer" rolls accommodated in a loop of the material, the positions of the rolls depending upon the depth of the loop, and in turn, initiating control apparatus to maintain such depth within relatively narrow limits. Such control apparatus involves the provision of quite complex electrical circuits and other electrical equipment that is relatively expensive.

It is one of the objects of this invention to provide a simplified and reliable system of this character, without requiring "dancer" rolls or their equivalents.

It is another object of this invention to make it possible in a simple manner to adjust the tension that is applied to the material. In actual practice, such adjustment involves an adjustment of the torque exerted by the power applied to the windup roll.

It is another object of this invention to make it possible to stop the movement of the material without danger of rupturing or tearing it. Thus, a system incorporating the invention can be so arranged that the motor means operating the windup roll can be placed at standstill or locked position, during initial threading of the material past the various rollers, or during temporary shutdown for repairs, or the like.

Assuming that the tension exerted by the windup roll is constant, the torque exerted by the motor means increases as the radius of the roll increases. If the power expended by the motor means is to remain constant, it is readily seen that the torque is inversely proportional to the speed, i.e. at maximum speed (corresponding to minimum roll radius), the value of the torque is a minimum. The curve exhibiting the relation between torque and speed is hyperbolic. An induction motor having a squirrel cage rotor does not fulfill this relationship between torque and speed.

It is therefore another object of this invention to provide a motor means that approximates within tolerable limits, the desired relationship between speed and torque of the shaft driving the windup roll.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming a part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope

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of this invention is best defined by the appended claims. Referring to the drawings:

Figure 1 is a skeletonized schematic diagram illustrating one embodiment of the invention;

Figs. 2 and 3 are graphs useful in explaining the mode of operation of the system; and

Fig. 4 is a diagrammatic representation of one form of an overrunning clutch that may be utilized in the system.

The material 1 in the form of a sheet, web, filament, or the like is shown as being unwound from a supply roll 2 onto a windup roll 3. The thickness of the material is shown greatly exaggerated in proportion to the other elements of the system. The supply roll 2 can include means for providing a mechanical drag brake.

Movement of the material 1 toward the right as indicated by arrow 4 may be effected by the aid of two sets of unwind pinch rolls 5 and 6, both adapted to be operated by alternating current induction motors 7 and 8.

Preferably the frequency of the electrical energy supplied to the motors 7 and 8 is made adjustable, as well as the electromotive force applied across these motors. In this way, a quite precise adjustment of the required pull exerted upon the material 1 can be effected.

The controls for these motors 7 and 8 may include an alternator 9 having a rotor connected to a variable ratio transmission mechanism 10 which is operated by any appropriate source of power, such as an induction motor intended to be included with the transmission mechanism 10. The speed of the alternator 9 thus may be adjusted to provide electric power at an adjusted frequency.

An adjustable autotransformer 11 may be included in the system for making it possible to adjust the electromotive force impressed upon the motors 7 and 8.

Somewhere along the travel of the material 1, treating stations may be provided, such as dipping, spraying or other steps in a treating process. Since this invention is not concerned with such treating stations, they are not included on the drawings.

The windup roll 3 is operated by the aid of a mechanism generally indicated by reference character 12. Such a windup roll must have a continuous reduction in angular speed as the winding continues, so that the linear travel of the material 1 will be uniform, independent of the diameter of roll 3. This requirement also implies that the drive shaft 13 for the roll 3 exert a torque related inversely to the speed, and that the power transmitted by the shaft 13 be substantially constant. When these requirements are met, the tension applied on the material 1 can be maintained substantially uniform.

Fig. 2 shows the ideal requirement of the relationship between the torque and the speed of the driving shaft 13. This relationship is represented by a hyperbolic curve in which the product of the abscissa and the ordinate of any point of the curve is a constant.

In the usual type of squirrel cage induction motor, the curve connecting torque and speed departs greatly from the ideal of Fig. 2. Thus, for example, as shown in Fig. 3, a curve 14 indicates a typical speed-torque curve of a high slip induction motor operating at a definite electromotive force. The lower the electromotive force, the lower in proportion are the ordinates of the points on the curve 14.

This curve 14 can be designated as representative of the torque and speed relations of the rotor, unmodified by reduction gearing.

The motor, however, can operate through a reduction gearing so as to increase the torque and reduce the speed. A typical curve of this character is shown in Fig. 3 for the short end, and is marked by reference character 15.

Now, if we assume that there are two motors, one having no reduction gearing and providing a torque-speed

characteristic corresponding to curve 14, and another motor having reduction gearing which provides the characteristics represented by curve 15, then if the torques of the two motors be added together, the resultant is a curve 16 having two branches, one represented by the right-hand portion of curve 14, and the remainder 16, corresponding to the sum of the ordinates of curves 14 and 15. Intersection point 17 joins the two branches.

By proper controls for the two motors, a graph 16-17-14 can represent a resultant departing not too greatly from the ideal hyperbolic curve 18 shown in Fig. 3. This is possible by virtue of the fact that the motors corresponding to the curves 14 and 15 can be coupled to a common load, as by the aid of an overrunning clutch, and in such a way that the motor producing the curve 15 is inactive until the speed of the motor producing the curve 14 is sufficiently reduced to a value corresponding to the speed of the motor that fulfills the requirements of curve 15. The electromotive force impressed upon the motors can be adjusted to provide an additional control.

Accordingly, shaft 13 shown in Fig. 1 is operated by a combination of two induction motors 19 and 20. The load shaft 13, rotating in a clockwise direction, is coupled to the shaft 21 of the motor 19. This shaft 21, as shown in Fig. 4, carries the inner element 22 of an overrunning clutch structure 30. The outer element 25 is operated by the motor 20, via a reduction gearing 24. As long as shaft 21 rotates faster than outer element 25, the balls or rollers 31 remain unwedged and there is no driving connection. As soon as the speed of shaft 21 is reduced to that of outer member 25, or below it, coupling is effective, and the torques of both elements 22 and 25 are cumulative.

The motors 19 and 20 are fed with power at an adjusted frequency from an alternator 26 driven by a variable transmission mechanism 27, which includes a source of power, such as an induction motor. An autotransformer 28 may be interposed to make it possible to adjust the electromotive force of the electric power supplied to the motors 19 and 20.

The overrunning clutch illustrated in Fig. 4 is merely diagrammatic. Any suitable type of overrunning clutch may be provided so long as it provides for adding the torques produced by both motors 19 and 20 upon the output shaft 13.

As the load on the shaft 13 increases, the speed drops from a maximum speed as represented by curve 14 of Fig. 3, to a value of a fraction only of the speed corresponding to the abscissa of point 17. At that time the clutch structure 30 is effective to add the torques corresponding to the ordinates of curves 14 and 15. Any further decrease in speed causes the cumulative torque to follow the curve 16. The torque thus increases quite rapidly as the speed reduces.

For example, the motors 19 and 20 can have a maximum speed near their synchronous speeds of 1800 r.p.m.; but the motor 20 can have a maximum speed corresponding to 600 r.p.m. by virtue of the speed reducer 24. The overrunning clutch structure 30 shown in Fig. 4 permits the motor 20 to run at no load until the speed of motor 19 is reduced to a speed equal to or less than the no-load speed output of motor 20.

In a system of this character, it is a simple matter to stop or lock the rotors of the motors 19 and 20 for the purpose of threading the material 1 through the apparatus, all for the purpose of making repairs or replacement. There is no danger, while the motors are inactive, that the material 1 would be ruptured or torn. Stopping the

rotors of the motors may be accomplished by built-in electromagnet brakes included in the motor structures 19 and 20.

The inventor claims:

1. A takeup mechanism for a windup roll: a plurality of induction motors; a drive connection from one of the motors to the windup roll; and an overrunning clutch connected between the other motor and the one motor, said other motor output being initially at lower speed than the said one motor, to cause the overrunning clutch to be effective only when the speed of the windup roll is reduced to a value corresponding to that of the output of the said other motor, whereby the speed-torque characteristic of the windup drive approximates the relationship that the speed is inversely proportional to the torque.
2. The combination set forth in claim 1, with the addition of means for supplying the motors with an adjustable frequency.
3. The combination as set forth in claim 1, with the addition of means for adjusting the electromotive force impressed upon the motors.
4. The combination as set forth in claim 1, with the addition of means for supplying the motors with an adjustable frequency, as well as means for adjusting the electromotive force impressed upon the motors.
5. A takeup mechanism for a windup roll: a plurality of induction motors; a drive connection from one of the motors to the windup roll; an overrunning clutch connected between the other motor and the one motor, said other motor output being initially at lower speed than the said one motor, to cause the overrunning clutch to be effective only when the speed of the windup roll is reduced to a value corresponding to that of the output of the said other motor, whereby the speed-torque characteristic of the windup drive approximates the relationship that the speed is inversely proportional to the torque; one or more sets of rollers for advancing the material; and motor drives for said rollers.
6. The combination as set forth in claim 5, with the addition of means for supplying the motor drives for the rollers with an adjustable frequency.
7. In a system for winding up material on a windup roll under substantially uniform tension by reducing the speed of the roll as the winding proceeds and inversely to the torque required to drive the roll: a plurality of induction motors, having a common output shaft for the roll; and means for so coupling the motors to the shaft that the combined torque transmitted to the shaft is substantially inversely proportional to the speed of the shaft.
8. The combination as set forth in claim 7, with the addition of a variable ratio transmission mechanism interposed between one of the motors and the shaft.
9. The combination as set forth in claim 7, in which the combined torque is rendered effective by the aid of an overrunning clutch having elements respectively coupled to the motors.
10. The combination as set forth in claim 7, in which there are output ends for each of the motors, linked in succession by the aid of an overrunning clutch.

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