

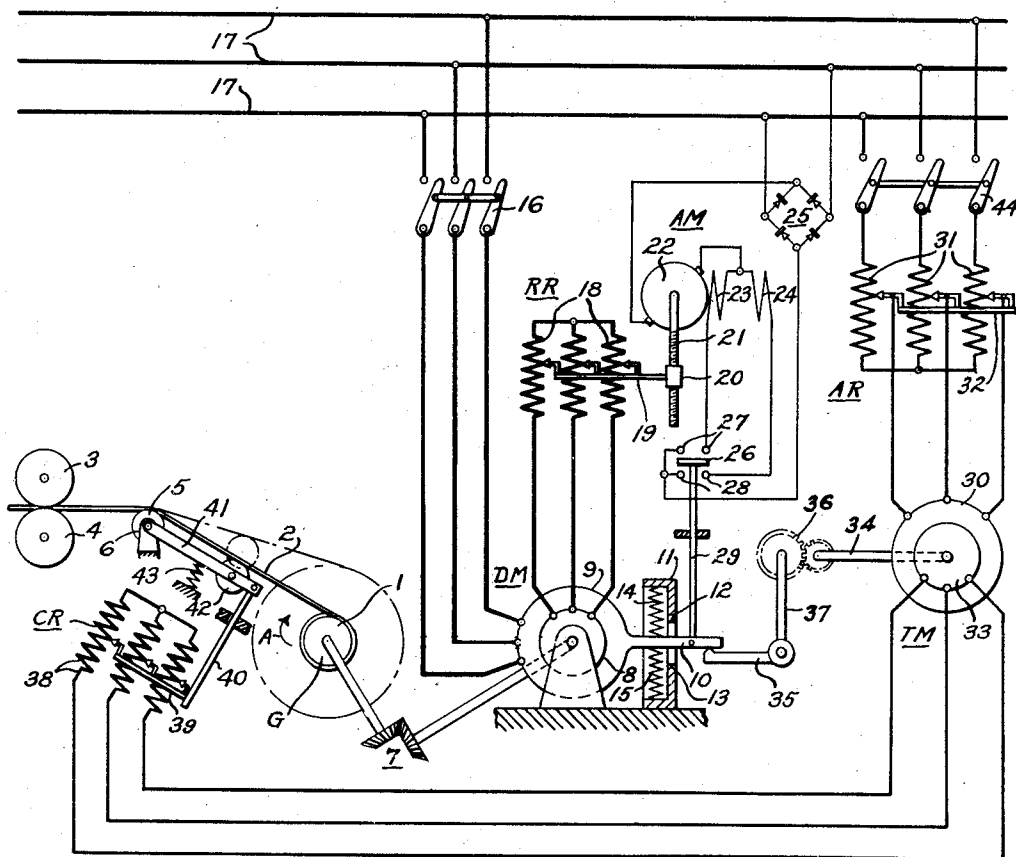
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CONTROL SYSTEM

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CONTROL SYSTEM

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My invention relates to electric drives for winding strand or sheet material onto a take-up reel.

It is an object of my invention to provide an electric drive which affords maintaining a substantially constant tension in the material to be taken up by the reel, regardless of the traveling or winding speed of the material and also regardless of the diameter of the take-up reel or the taken up portion of the material.

In conjunction with this object, it is a further aim of the invention to permit varying the tension of the material at will over a wide range of available adjustments.

It is also intended by this invention to achieve the above-mentioned objects by means of driving equipment for alternating-current operation which does not require direct-current generators, and whose drive motor can be energized directly from an alternating-current line.

According to my invention, the take-up reel or shaft is driven by means of a dynamometric motor whose rotor is connected or geared to the reel and whose stator is pivotally mounted for angular motion between two limit positions. This dynamometric motor is acted upon by a source of mechanical power which tends to prevent the dynamometric stator from moving toward one of its limit positions when the reel drive is in operation. The force or torque imposed on the stator by the counteracting power source is controlled in dependence upon the tension or other condition of the material to be taken up by the reel, so that the dynamometric stator is in a midposition between its above-mentioned limit positions when the torque of the reel drive is in accordance with the adjustment of the counteracting power source. The dynamometric stator is further connected with means for regulating the driving torque of the appertaining rotor in such a manner that this torque is reduced when the stator reaches one of its limit positions and increased when it reaches the other limit position. As a result, the drive and control system is self-adjusting and varies the driving torque of the reel in the manner necessary for maintaining the tension or other condition of the material at a substantially constant value.

According to another feature of my invention, the power source for balancing the reactive torque of the dynamometric stator consists of a torque-motor whose primary circuit contains control means for setting the tension to be regulated and whose secondary circuit is provided with a rheostat which has its adjusting means controlled in dependence upon changes in the diameter of

the amount of material taken up by the reel. The rheostat in the secondary circuit of the torque-motor is so rated that it varies the torque of the torque-motor and hence the balancing force or torque imposed on the dynamometric stator in proportion to the diameter changes of the wound-up material. As a result, the torque of the reel-drive is proportionately increased as the diameter of the wound-up material increases.

These and other objects and features of my invention will be understood from the following description of the embodiment illustrated in the drawing, showing a circuit diagram of a drive for operating a take-up reel.

In the drawing, the reel to be driven is denoted by numeral 1. The strand or sheet material 2 passes between rollers 3 and 4, and over a guide roller 5 journaled at 6, onto the reel 1. At the beginning of a winding operation, the diameter of the reeled-up portion of the material 2 is a minimum, and this diameter increases eventually to that of the circle indicated by a dot and dash line. The direction of reel rotation is denoted by the arrow A.

The reel shaft is connected, by a transmission denoted as a whole by 7, to the armature 8 of a dynamometric drive-motor DM. The stator 9 of motor DM has an arm 10. A rigid structure 11 forms stops at 12 and 13 which limit the movement of arm 10 from the illustrated mid-position in either direction. Springs 14 and 15, bearing against the arm 10, are provided for preventing hunting. The tension of these springs is preferably adjustable.

The primary or stator circuit of motor DM is connected through a switch 16 to an alternating-current line 17. The secondary or rotor circuit of motor DM is provided with a regulating rheostat RR for controlling the speed-torque characteristic. The resistors 18 of rheostat RR have a slider assembly 19 attached to a support 20 which is in threaded engagement with a feed screw 21. This screw is driven by the armature 22 of an auxiliary motor AM. Motor AM has split field windings 23 and 24 connected with a direct-current source, here represented by a line connected rectifier 25, through a contact device which is controlled in dependence upon the angular movement of arm 10. The contact device has a movable contact 26 and two groups of stationary contacts 27 and 28, respectively. Contact 26 is linked to arm 10 by means of a connecting rod 29. When arm 10 is in the illustrated midposition, both windings 23 and 24 are disconnected from source 25, so that the auxiliary motor AM

is at rest. Hence, the adjustment of regulating rheostat RR remains unchanged, so that the dynamometric motor drives the reel 1 with a speed-torque characteristic as set by the position of the slider assembly 19. When arm 10 reaches its upper limit position, contact 26 engages contacts 27 and thereby energizes the field winding 23. As a result, the auxiliary motor AM changes the adjustment of rheostat RR so as to increase the torque of the reel drive. Similarly, when arm 10 moves downwardly and causes contact 26 to engage contacts 28, the field winding 24 is energized from source 25, so that motor AM adjusts rheostat RR in the direction toward reduced reel torques.

A torque-motor TM serves as a power source for counteracting and balancing the torque of the dynamometric stator. Motor TM has a stator 30 which is immovably mounted and whose energizing circuit extends through the resistors 31 and sliders 32 of an adjusting rheostat AR fed from the alternating-current line 17 through a switch 44. The rotor 33 of motor TM has its shaft 34 geared to an arm 35 by a suitable transmission, here represented by a gear 36 and another shaft 37. The direction of rotation of rotor 33 is so chosen that it tends to move arm 35 upwardly in opposition to the reactive torque of the dynamometric stator 9.

The secondary or rotor circuit of torque-motor TM is provided with a rheostat CR. The resistors of this rheostat are denoted by 38 and the appertaining slider assembly by 39. This assembly is connected to an adjusting member 40 which, in turn, is linked to an arm 41. Arm 41 is rotatable about the journal 6 of the guide-roller 5 and is provided with an idling roller 42. A spring 43 bearing against arm 41 maintains roller 42 in engagement with the material 2. In this manner, an increase in diameter of the reeled-up portion of the material causes the slider assembly 39 to move upwardly, thereby changing the adjustment of the control rheostat CR.

The resistors 38 of rheostat CR are so rated that the current flowing through the primary circuit of the torque-motor TM is kept at a safe value, even if the adjusting rheostat AR is set for energizing the motor at maximum voltage, and even though the torque-motor remains stalled. The rate of change in adjustment effected by the slider assembly 39 is chosen in accordance with the relation of the tension of the material to its change in diameter during the reeling operation. For instance, if the diameter of the reeled up material between empty and full varies 3:1, the torque of the drive motor DM must vary in the same 3:1 ratio in going from empty to full reel. Hence, on the basis of this example, the slider assembly 39 must vary the torque of motor TM in the ratio of 3:1 during the same period of operation.

The magnitude of torque produced by motor DM is determined by the balancing torque developed by motor TM. That is, if the primary and secondary circuits of motor TM are adjusted in accordance with a certain amount of balancing torque imposed on arm 10 by arm 35, then the driving torque developed by motor DM will adjust itself automatically to a corresponding value. This self-adjustment is due to the above-described operation of the regulating rheostat RR and its motor AM. As long as the driving torque developed by motor DM is in accordance with the torque prescribed by the torque motor TM, the motor AM and the rheostat RR remain at rest.

When the driving torque of motor DM increases above the correct value, the reactive torque of arm 10 overcomes the balancing torque of arm 35 and closes contacts 28. In consequence, motor AM is operated in the direction necessary for reducing the torque of motor DM. When the driving torque of motor DM drops below the correct value, motor AM is caused to adjust rheostat RR so as to increase the driving torque.

The balancing torque of motor TM and hence the driving torque of motor DM is determined by the setting of the two rheostats AR and CR. Rheostat AR is adjusted by the operator in accordance with the tension intended to be maintained in the material 2. This setting may be chosen in accordance with the properties of the particular material to be wound up by the reel-drive, and the rheostat AR may be calibrated directly in magnitudes of tension. The setting of the control rheostat CR varies during the operation, as described previously. Hence, the torque of motor DM is not constant during the reeling operation, but varies in proportion to the increase in diameter, thereby maintaining the tension at the intended value.

It appears from the foregoing that the drive-motor DM serves also as a dynamometer whose torque is measured by the torque-motor TM. In view of the fact that the torque motor is virtually at a standstill when performing the measuring operation, the speed at which the material is delivered to the reel has no effect on the regulating function, so that a constant tension is maintained regardless of whether the material is being delivered at its maximum speed or any speed between maximum and standstill.

The system has the further advantage that its main motor (DM) as well as the torque-measuring motor TM are for alternating-current, and hence can be directly connected to an alternating-current line without requiring the interposition of direct-current generators. The auxiliary motor AM, if desired, may also consist of an alternating-current motor, although this motor is usually of fractional horsepower rating, so that it can readily be energized by direct current derived from the alternating-current line by means of simple junction or disc-type rectifiers.

It will be understood by those skilled in the art that reel-drives and control systems according to my invention can be modified in various respects without departing from the gist and essential features of the invention as set forth in the claims attached hereto.

I claim as my invention:

1. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a rotatably mounted stator, a torque-motor mechanically coupled with said stator for counteracting its rotation, control means for varying the torque of said main motor in dependence upon the angular position of said stator, and means for controlling the torque of said torque-motor in accordance with diameter variations of the wound-up material in order to maintain the tension of said material substantially at a constant value.

2. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a rotatably mounted stator, a torque-motor mechanically coupled with said stator for counteracting its rotation, control means for varying the torque of said main motor in dependence upon

the angular position of said stator, operator-actuable energizing means for selectively adjusting the energization of said torque-motor, and means for controlling the torque of said torque-motor in accordance with diameter variations of the wound-up material in order to maintain the tension of said material substantially at a value determined by the selected adjustment of said energizing means.

3. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a rotatably mounted stator movable between two end positions, means for biasing said stator toward an intermediate position, a torque-motor mechanically coupled with said stator for counteracting its rotation, control means for varying the torque of said main motor when said stator is in either of said end positions and in a direction tending to return said stator to said intermediate position, and means for controlling the torque of said torque-motor in accordance with a condition of the wound-up material in order to maintain the tension of said material substantially at a constant value.

4. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a rotatably mounted stator movable between two end positions, means for biasing said stator toward an intermediate position, a torque-motor mechanically coupled with said stator for counteracting its rotation, control means for varying the torque of said main motor when said stator is in either of said end positions and in a direction tending to return said stator to said intermediate position, operator-adjustable energizing means for providing said torque-motor with adjustable primary excitation, and secondary circuit means for varying the torque of said torque-motor in accordance with diameter variations of the wound-up material in order to maintain the tension of said material substantially at a value determined by the selected adjustment of said energizing means.

5. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a stator rotatably mounted for limited rotation between two positions and biased toward an intermediate position, adjustable impedance means for varying the speed torque characteristic of said main motor, reversible drive means for controlling the adjustment of said impedance means, means for controlling said drive means in dependence upon the position of said stator, a torque-motor having a fixed stator and a wound rotor, said rotor being mechanically coupled with said first stator so as to be capable of limited rotation for producing countertorque in opposition to the rotation of said first stator, said torque-motor having a primary circuit and a secondary circuit each containing an adjustable impedance device, means for varying one of said devices in dependence upon diameter variations of the wound-up material so as to cause said torque motor to vary said countertorque in order to maintain the tension of said material substantially at a value determined by the adjustment of said other impedance device.

6. An electric winder drive comprising reel means for winding up a material, a main motor having a rotor for driving said reel means and a rotatably mounted stator, control means for varying the torque of said main motor in de-

pendence upon the angular position of said stator, a torque-motor having an armature coupled with said stator for counteracting its rotation so as to maintain said stator at rest when the driving torque of said main motor is in accordance with the torque setting of said torque motor, said torque-motor having a primary circuit disposed for connection to an energizing current source and provided with selective control means for adjusting the energization of said torque-motor, said torque-motor having a secondary circuit provided with variable resistance means for controlling the torque of said torque-motor, and means for adjusting said resistance means in accordance with diameter variations of the material wound up on said reel means in order to maintain the tension of said material substantially at a value determined by the setting of said selective control means.

7. An electric winder drive comprising reel means for winding up a material, a dynamometric motor having a rotor for driving said reel means and a stator rotatably mounted for angular motion between two positions, said motor having a primary circuit for supplying energization and a secondary circuit for controlling the driving torque of said rotor, rheostat means forming part of said secondary circuit, reversible auxiliary drive means for adjusting said rheostat means, relay means controlled by said stator for controlling said reversible drive means in dependence upon the angular position of said stator, countertorque means mechanically connected to said stator so as to balance its rotational tendency in order to cause said reversible drive means to be at rest when the torque of said reel means is in a given proportion to the torque of said countertorque means, and means for controlling said latter torque in accordance with a condition of said material so as to maintain the tension of said material at a substantially constant value.

8. An electric winder drive comprising reel means for winding up a material, a dynamometric motor having a rotor for driving said reel means and a stator rotatably mounted for angular motion between two positions, said motor having a primary circuit for supplying energization and a secondary circuit for controlling the driving torque of said rotor, rheostat means forming part of said secondary circuit, reversible auxiliary drive means for adjusting said rheostat means, relay means controlled by said stator for controlling said reversible drive means in dependence upon the angular position of said stator so that said drive means are at rest when said stator is between said positions and operate said rheostat means in either direction when said stator is in either of said positions respectively, biasing means tending to hold said stator between said positions, a torque motor coupled with said stator for counteracting its rotation, and means for controlling the torque of said torque-motor in accordance with diameter variations of the wound-up material in order to maintain the tension of said material substantially at a value determined by the energization of said torque-motor.

9. An electric winder drive comprising reel means for winding up a material, a dynamometric motor having a rotor for driving said reel means and a stator rotatably mounted for angular motion between two positions, said motor having a primary circuit for supplying energization and a secondary circuit for controlling the driving torque of said rotor, rheostat means forming part

of said secondary circuit, reversible auxiliary drive means for adjusting said rheostat means, relay means controlled by said stator for controlling said reversible drive means in dependence upon the angular position of said stator so that said drive means are at rest when said stator is between said positions and operate said rheostat means in either direction when said stator is in either of said positions respectively, biasing means tending to hold said stator between said positions, a torque-motor coupled with said stator for

counteracting its rotation, operator-actuable energizing means for selectively adjusting the energization of said torque-motor, and means for controlling the torque of said torque-motor in accordance with diameter variations of the wound-up material in order to maintain the tension of said material substantially at a value determined by the selected setting of said energizing means.

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