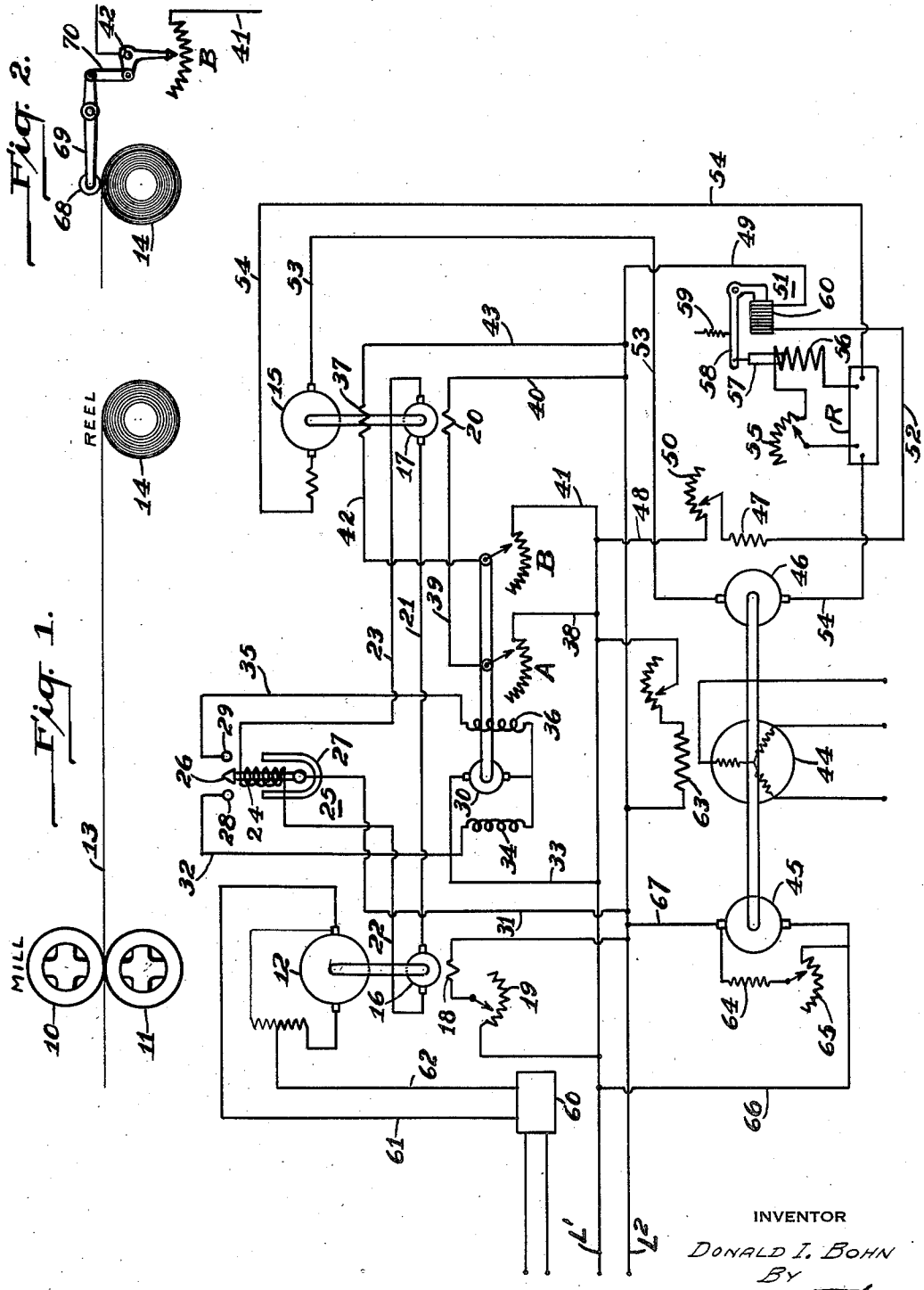
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MOTOR CONTROL SYSTEM FOR COILING MECHANISMS

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MOTOR CONTROL SYSTEM FOR COILING MECHANISMS

Donald I. Bohn, Pittsburgh, Pa., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates in general to material coiling mechanisms used in conjunction with sheet-processing and/or feeding mechanisms, such as rolling mills or the like, and in particular to electrical control systems for coiling mechanisms capable of producing constant tension on material delivered from a rolling mill.

In the operation of rolling mills, wherein the material rolled is coiled upon a rewind block or drum, the quality of the material produced is materially improved when a predetermined constant tension is exerted on the material being coiled. To satisfactorily accomplish such a result it is essential to allow for the increasing diameter of the rewind coil, and in the present forms of apparatus, slip gears or clutch mechanisms are used to adjust the torque of the coiling mechanism and to regulate the tension as the coil increases in diameter. Mechanical means of this nature, however, have not proved very satisfactory because of their low degree of accuracy and because of lost motion and sluggish operation resulting from wear of the various mechanical parts. For this and other reasons electrically controlled systems have for the most part replaced these earlier forms of mechanical devices.

The electrically controlled systems which have supplanted the above-mentioned mechanical devices operate on a common fundamental principle in that the motor driving the rewind drum or coiler and the main mill motor are coordinated, by means of the rewind motor armature receiving its voltage from a suitable generator driven by the main mill motor, to produce the required constant tension. In arrangements such as these the voltage impressed on the rewind motor armature is approximately proportional at all times to the speed of the mill motor and, assuming the excitation of the rewind motor field-magnet winding is adjusted to maintain constant current through the armature circuit, such an arrangement insures an approximate constant power input to the rewind or coiler motor. Such arrangements, however, offer numerous disadvantages in that losses in the rewind motor, particularly when the rolling mill is slowed down from normal operating speed, introduce errors in the tension exerted by the rewind or coiling mechanism and when the rolling mill is eventually stopped, the tension is entirely removed from the material unless auxiliary electrical equipment is employed to provide a separate source of power in the rewind motor circuit.

Furthermore, if such a system is provided with auxiliary equipment, which usually takes the form of relays and electrically operated contactors in the rewind motor circuit adapted to function as the main mill motor slows down, the resultant interruption in the current flow causes fluctuations in the values of torque applied to the coiler, which action produces uneven tension in the material being processed.

My present invention is directed towards overcoming the undesirable conditions existing in present coiler or rewind mechanisms and it has as its primary object the provision of means whereby the power output of the rewind motor is at all times proportional to the mill speed for any given preset tension on the material being rolled without the necessity of any electrical transition or current variation in the rewind motor armature circuit as the rolling mill is slowed down to and including zero mill speed.

A further object of my invention is to provide an electrical control system by means of which a constant tension is maintained on the material discharged from the rolling mill in such a manner that the rewind motor automatically takes up and maintains any desired preset tension on the material being rolled.

This and various other objects, as well as other novel features and advantages of the invention, will be more apparent when the following detailed description is considered in conjunction with the accompanying drawing in which:

Fig. 1 represents, in diagrammatic form, my improved arrangement of constant tension coiling mechanism;

Fig. 2 represents an illustration of a particular portion of the apparatus shown in Fig. 1.

Referring to the drawing, the invention is illustrated as applied to the control of a rewind or coiling mechanism employed in combination with a rolling mill.

The apparatus shown in the drawing comprises a rolling mill, although any suitable feeding mechanism, or the like, can quite manifestly be substituted therefor, represented as a pair of working rolls 10 and 11, to which suitable driving means, such as a compound-wound motor 12, is coupled in any well known manner. The material or stock 13 to be processed is passed between the rolls 10 and 11 in the usual fashion and is engaged on the discharge side of the rolling mill upon a coiler or rewind drum 14 of any suitable construction. The coiler is likewise provided with a suitable driv-

ing motor 15, a shunt-wound, fully compensated motor being considered preferable.

In accordance with this invention, provision is made for automaticaly controlling the operation of motor 15 in response to variations in the diameter of the reel 14, whereby the power output of the motor 15 is at all times proportional to the speed of the main mill motor 12 for any desired preset value of tension on the material 13 being processed.

In accomplishing this result separately excited pilot generators 16 and 17 of relatively small size are direct-connected to the motors 12 and 15 respectively. Generator 16 is equipped with a separately excited field-magnet winding 18, adjustable by means of a rheostat 19, whereas generator 17 is equipped with a field-magnet winding 20 the excitation control of which will be hereinafter described. These generators are similar in all respects as to their electrical characteristics and when driven at the same speed, with equal field excitation, generate equivalent voltages. As will be seen from the drawing, the pilot generators 16 and 17 are electrically connected, in opposed relationship, by means of the conductors 21, 22 and 23. The coil 24 of a suitable relay in the form of a polarized, contact-making, zero-center voltmeter 25 completes the circuit between the conductors 22 and 23. The voltmeter 25 may be of any suitable construction and is herein shown as comprising a circuit controlling bridging member 26, a permanent magnet 27, the aforementioned coil 24, and contact members 28 and 29. In operation the bridging member 26 remains midway between the contact members 28 and 29 when the voltages generated by the pilot generators 16 and 17 are equal and opposite. Any difference in the voltages generated by the pilot generators 16 and 17 energizes the coil 24, at which time the bridging member 26 is attracted by the permanent magnet 27 into contact with either one or the other of the contact members 28 and 29.

Completion of the circuit through the medium of bridging member 26 and either of the contactors 28 and 29 serves to connect a reversible, split-field, series motor 30 across the conductors L_1 and L_2. This is accomplished by means of the conductors 31, 32 and 33 through field-magnet winding 34; or 31, 35 and 33 through field-magnet winding 36 in accordance with the particular direction in which the bridging member 26 is rotated. The field-magnet windings 34 and 36 of motor 30 are oppositely wound and reverse the direction of rotation of this motor. The motor 30 is direct-connected to rheostats A and B, which are suitably designed in accordance with the characteristics of the field-magnet windings 37 and 20 of motor 15 and generator 17, respectively, the purpose of which will be hereinafter described. By means of the conductors 38, 39 and 40 rheostat A is connected across the field-magnet winding 20 of pilot generator 17 from the main leads L_1 and L_2. Similarly, by means of conductors 41, 42 and 43, field-magnet winding 37 of motor 15 is connected across the leads L_1 and L_2.

A suitable three-phase synchronous motor 44 is direct-connected to two generators, 45 and 46, generator 45 providing a constant supply of D. C. current to the conductors or busbars L_1 and L_2, whereas generator 46 provides the necessary power for the armature of the rewind or coiler motor 15. The generator 46 and the various elements included in a loop-circuit formed by this generator and the armature of motor 15 are provided for the purpose of applying a constant armature current to the motor 15 in accordance with any desired preset value of tension upon the material being processed.

Also a circuit comprising a suitable current regulator, which for purposes of illustration has been shown as a compressible carbon pile regulator 51, is connected in series with the field-magnet winding 47 of the generator 46, the purpose of which is to control the magnitude of the constant current through the armature of motor 15 for any given setting of the rheostat 55. Conductors 48, 49 and 52 complete the field circuit of generator 46 with busbars L_1 and L_2, an adjustable rheostat 50 being provided for adjustably controlling the excitation of field-magnet winding 47. The loop-circuit comprising generator 46 and motor 15 is completed through the medium of conductors 53 and 54, and a suitable shunt R of constant predetermined resistance is inserted in the conductor 54. Shunted around the shunt R is a circuit comprising the rheostat 55 and an electromagnet coil 56 which cooperates with the compressible pile regulator 51 in a manner to be described.

In the operation of the electrical control system above described, material or stock having been introduced between the rolls 10 and 11 of the rolling mill, the mill is set in operation by means of any suitable starter mechanism 60 across the leads 61 and 62 to the mill motor 12. The three-phase synchronous motor 44 direct-connected to the D. C. generators 45 and 46 is also set in motion, which action energizes the rewind system. The motor 44 is equipped with any suitable separately excited field-magnet winding 63, this excitation being shown as supplied from the conductors L_1 and L_2. Likewise, generator 45 is equipped with field-magnet winding 64 and rheostat 65, conductors 66 and 67 being provided to conduct the generated power into the busbars L_1 and L_2.

To obtain a desired torque on the rewind reel 14 the current applied to the armature of motor 15 is maintained constant for the particular torque desired. This is accomplished by means of the circuit comprising the rheostat 55 and the electromagnet coil 56 in combination with the compressible pile regulator 51 in the field-magnet winding 47 of generator 46.

For example, when the motor 15 is operating at zero speed the voltage generated by generator 46 is just sufficient to provide a current in the armature circuit of motor 15 as determined by the setting of the rheostat 55. As the mill motor 12 accelerates motor 15 also accelerates and during this period the carbon pile regulator functions to increase the excitation of field-magnet winding 47 of generator 46 to maintain a constant current through the armature of motor 15. This constant current is maintained by regulator 51 as determined by the initial setting of rheostat 55 and the electromagnet coil 56, the amount of current through this circuit being inversely proportional to the resistance of this circuit with respect to the resistance of the shunt R. The additional current through the rheostat 55 energizes the coil 56 and attracts the core 57 which, through the medium of the pivoted bar 58, relieves the pressure on the compressible pile regulator 51 against the tension of spring 59. This action permits the discs 60 of the regulator 51 to separate and thereby increases the resistance of the field circuit of the generator 46.

It will be readily seen that as the motor 15 slows down because of the increased diameter of the coil 14, generator 17 will also slow down and will generate a lower voltage than generator 16. This differentiation in the voltages generated by generators 16 and 17 causes the operation of contact bridging member 26, which as before described will place in operation motor 30 to increase the field current in field-magnet windings 20 and 37. That is, generator 17 although operating at a slower speed than generator 16 generates the same voltage as generator 16 by means of its increased field-magnet excitation. Similarly, the field-magnet winding 37 of motor 15 is strengthened as its speed decreases.

It will thus be seen that, by properly designing rheostats A and B, and by maintaining a constant current through the armature of motor 15, the power output of motor 15 will be constant for a given mill speed. These conditions will result in a constant tension on the material being processed regardless of the mill speed down to and including a full stop. The behavior of rheostat B is the same as though it were mechanically operated, as shown diagrammatically in Fig. 2, wherein a roller 68, supported upon a fulcrumed arm 69, rides in contact with the reel 14 and through the medium of a suitable link 70 actuates the rheostat B, the contactor arm of which is shown in the form of a bell crank, to cut out resistance in the filed-magnet winding 37 as the reel diameter increases. That is, rheostats A and B have definite positions for every outside diameter of the material on reel 14.

It will be seen that the electrical control system incorporated in this invention does not include auxiliary equipment in the armature circuit of the rewind motor which has heretofore caused intermittent current supply resulting in fluctuations in the torque attendant with previously employed electrical control systems.

Having thus described and explained my invention and its mode of operation, it is to be understood that the apparatus described was selected merely for purposes of illustration and that numerous variations in the form and arrangement of parts shown and described herein may be made without departing from the nature and scope of my invention except as defined in the appended claims.

I claim:

1. In an apparatus for processing strip material, a feeding mechanism, means for driving said feeding mechanism, a coiler mechanism, an electric motor for driving said coiler mechanism, a generator driven by said feeding mechanism driving means and electrically connected in opposed relationship with a similar generator driven by the coiler mechanism electric motor, said similar generators when generating different voltages being adapted to control the excitation of the coiler motor field-magnet winding, an electrical means incorporated in the coiler motor armature circuit, whereby a constant torque is developed by said coiler motor.

2. In an apparatus for processing strip material, a feeding mechanism, means for driving said feeding mechanism, a coiler mechanism, an electric motor for driving said coiler mechanism, a generator driven by said feeding mechanism driving means and electrically connected in opposed relationship with a similar generator driven by said coiler mechanism electric motor, a reversible driving means, a controlling means for said reversible driving means, said controlling means being positioned in the electrical connection between the similar generators and adapted to operate the reversible driving means when the similar generators generate different voltages, said reversible driving means being adapted to control the excitation of the coiler motor field-magnet winding, and electrical means incorporated in said coiler motor armature circuit to maintain constant current therein.

3. An apparatus for processing strip material comprising a feeding mechanism and a coiler mechanism, means for driving the feeding mechanism, an electric motor for driving the coiler mechanism, said electric motor having a field-magnet winding and an armature circuit, means operated by differentiations in the speed of the feeding mechanism and the speed of the coiler mechanism to control the excitation of the field-magnet winding, and means in the armature circuit comprising a generator adapted to provide a constant current to said coiler motor armature.

4. In an apparatus for processing strip material, a feeding mechanism and means for driving the same, a coiler mechanism and an electric motor for driving the same, electrically-operated means for controlling the strength of the electric motor field, electrically-operated means for maintaining a constant current in the armature of the electric motor, both of said electrically-operated means being adapted to maintain the power output of the coiler mechanism proportional to the speed of the feeding mechanism.

5. In an apparatus for processing strip material, a feeding mechanism and means for driving the same, a coiler mechanism and an electric motor for driving the same, similar generators driven by said feeding mechanism driving means and said coiler motor, said similar generators being electrically connected in opposed relationship and adapted when generating different voltages to control the excitation of the coiler motor, a loop-circuit comprising a generator and the said coiler motor, said loop-circuit including a current regulator for controlling the excitation of the last-mentioned generator whereby a constant current is applied to said coiler motor armature.

6. In an apparatus for processing strip material, a feeding mechanism, means for driving said feeding mechanism, a coiler mechanism, an electric motor for driving said coiler mechanism, a generator driven by said feeding mechanism driving means and electrically connected in opposed relationship with a similar generator driven by the coiler mechanism electric motor, said similar generators, when generating different voltages, being adapted to control the excitation of the coiler motor field-magnet winding, and adjustable means in said coiler motor armature circuit to maintain any preset constant current therein.

7. In an apparatus for processing strip material, a feeding mechanism, means for driving said feeding mechanism, a coiler mechanism, an electric motor for driving said coiler mechanism, a generator driven by said feeding mechanism driving means and electrically connected in opposed relationship with a similar generator driven by said coiler mechanism electric motor, a reversible driving means, a controlling means for said reversible driving means, said controlling means being positioned in electrical connection between the similar generators and adapted to

operate the reversible driving means when the similar generators generate different voltages, said reversible driving means being adapted to control the excitation of the coiler motor field-magnet winding, and adjustable electrical means incorporated in said coiler motor armature circuit adapted to maintain constant current therein.

8. In an apparatus for processing strip material, a coiler mechanism adapted to coil the strip material, said coiler mechanism being driven by an electric motor, means for exciting the electric motor filed-magnet winding in response to a differentiation between speeds of the processing apparatus and coiler, and an armature circuit for said electric motor, including adjustable electrical means for providing constant current thereto to maintain uniform torque.

9. In an apparatus for processing strip material, a feeding mechanism, means for driving said feeding mechanism, a coiler and an electric motor for driving the same, two similar generators one of which is driven by the feeding mechanism and the other of which is driven by the coiler motor, said similar generators being connected in opposed relationship and adapted to generate equal voltages for all differentiations in speed between the feeding mechanism and the coiler, an armature circuit for said coiler motor including a generator connected in loop-circuit therewith, and a resistance having a circuit shunted around the same in said loop-circuit, said last-mentioned circuit comprising a rheostat and a current regulator, said loop-circuit being adapted to maintain a constant current supply to the armature of the coiler motor for all speeds thereof.

10. In an apparatus for processing strip material, a reel for receiving and coiling the strip, said reel being driven by an electric motor, means for exciting the electric motor field-magnet winding in response to a differentiation between speeds of the processing apparatus and reel, and a loop-circuit including the motor armature and a generator, said loop-circuit being provided with a carbon pile current regulator for controlling the excitation of the generator to maintain a constant preset current through the motor armature for all speeds of the reel.

DONALD I. BOHN.