

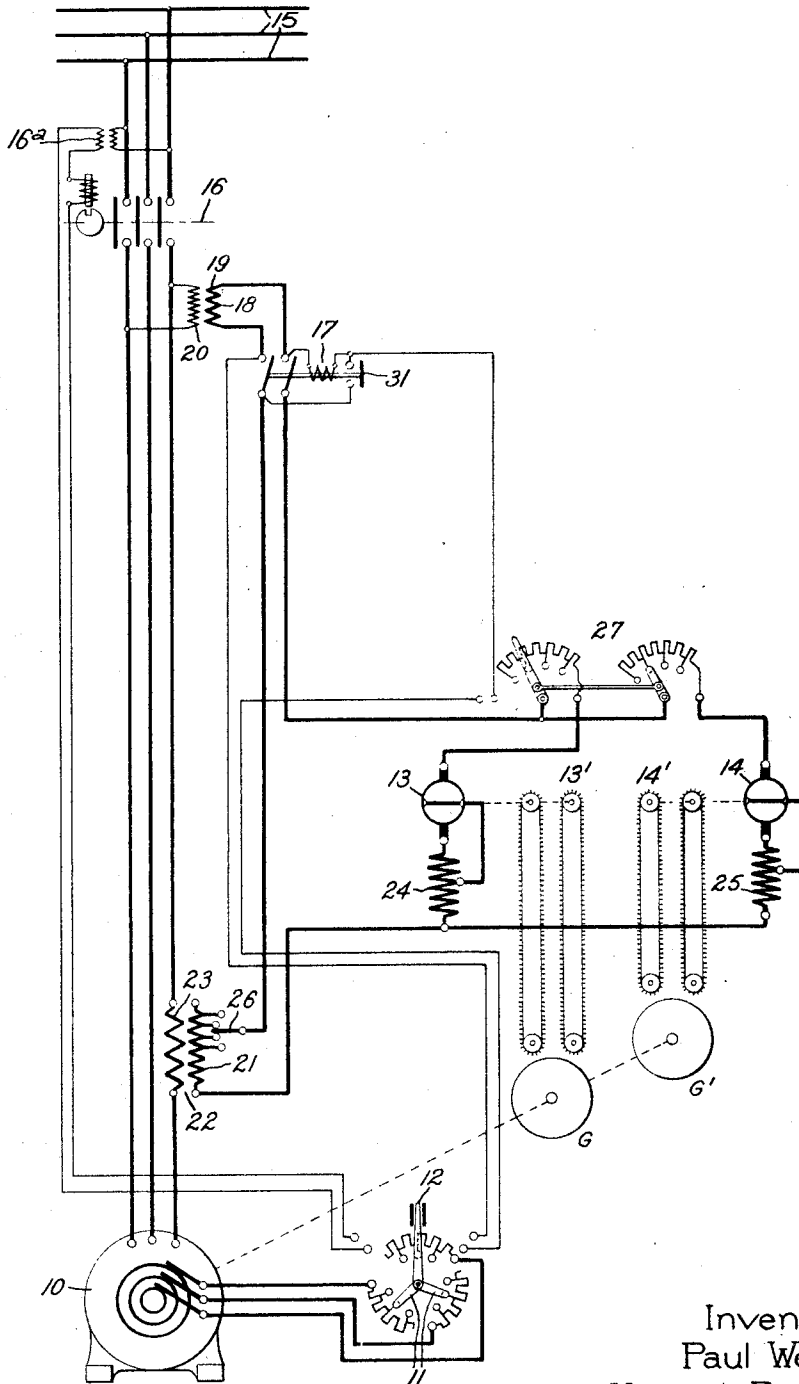
Oct. 20, 1931.

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1,828,583

MOTOR CONTROL SYSTEM

Original Filed Jan. 27, 1925



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UNITED STATES PATENT OFFICE

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MOTOR CONTROL SYSTEM

Original application filed January 27, 1925, Serial No. 5,042, and in Germany February 11, 1924. Divided and this application filed May 12, 1930. Serial No. 451,549.

This invention relates to motor control systems and more particularly to control systems for electric motor driven machines such as wood pulp grinders, saws and the like having separate motor operated feed mechanism for feeding material to the machine.

This application is a division of our application Serial No. 5,042, filed January 27, 1925 and assigned to the same assignee as this invention.

One of the objects of the present invention is the provision of a simple and effective automatic control arrangement for controlling the feeding of the material to the motor driven machines of the above character in accordance with the load on the driving motors.

While heretofore it has been proposed to automatically regulate the feed of motor driven pulp grinders, saws and the like so that the load on the driving motor is maintained at full value and as uniform as possible, such control arrangements with which we are familiar have involved the use of special electro-magnetic regulators for the feeding motors which have not always proven reliable and satisfactory in service particularly when applied to alternating current motor operated machines. When such speed regulators are applied to control a wood pulp grinder of the dual feed type in which a single grinding motor drives a pair of grinder stones each of which is fed by a separate feed motor, it has been found that the application pressure of the wood against the several grinding stones may be very different due to the unavoidable unevenness and difference in consistency of the wood. Thus the application pressure on one of the grinder stones may be very high while the pressure on the other stone is much lower. Although the load on the driving motor may be maintained constant at full value nevertheless the quantity and the consistency of the wood pulp produced by the two grinder stones will be unequal.

Therefore, a further object of the invention is to provide an improved control arrangement whereby the loads imposed on the driving motor by two separately operable

feeding motors may be automatically equalized.

Another object of the invention is to provide an automatic control arrangement whereby it is insured that the load is removed from the driving motor when machines of the above character are stopped or shut down.

In carrying the invention into effect in a preferred form of control system for a dual feed alternating current motor driven wood pulp grinder, a single phase alternating current motor of the commutator type is provided for separately driving the feed mechanism of each of the two grinder stones and the feeding motors are so designed that the output thereof remains constant independently of variations in the application pressure of the wood against the grinding wheels or changes in the rate of feed. Preferably the alternating current feeding motors are connected in multiple and are arranged to be supplied with current through the secondary winding of a transformer having the primary winding energized responsively to the load current of the driving motor in such manner that the load on the driving motor is maintained approximately constant at a predetermined value. Furthermore, in accordance with the preferred form of the invention the single phase commutator motors driving the feed mechanism are each provided with windings so arranged that the speed of each motor varies inversely with the load thereon in order to effect an equal distribution of the load between the two feeding motors.

The novel features and combinations which we believe to be characteristic of our invention are pointed out with particularity in the appended claims but for a better understanding of the invention reference is had to the following description taken in connection with the accompanying drawing in which the single figure diagrammatically illustrates a control system for an alternating current motor operated wood pulp grinding machine of the dual feed type embodying the invention.

Referring to the drawing, the driving motor 10 is of the multiphase induction type

having the speed regulating resistance 11 connected in the secondary circuit thereof and arranged to be controlled by the speed controller 12. As indicated diagrammatically in the drawing the motor 10 is mechanically connected to drive the two grinding stones G and G' of a dual feed wood pulp grinding machine. Preferably the grinding stones G and G' are mounted on opposite ends of the shaft of the motor 10 although not so shown in the drawing for the sake of clarity. Each of the feeding motors 13 and 14 is of the well known single phase commutator type and is mechanically connected as shown in the drawing to drive one of the two conveyor belts 13' and 14' which press the wood against a corresponding one of the grinding stones of the dual feed pulp grinder.

It will be observed that the driving motor 10 is connected to receive power from the high voltage three phase supply lines 15 through a suitable line switch 16 which may be of the oil break type if desired. The single phase feeding motors 13 and 14 are shown connected in multiple and are arranged to receive power through an electromagnetic line switch 17 from a suitable single phase source such as the secondary winding 18 of a transformer 19 the primary winding 20 of which preferably is connected across two of the supply lines of the motor 10 as shown in the drawing so as to be energized from one phase of supply lines 15 when switch 16 is closed. The secondary 21 of a second transformer 22 is connected in series circuit with the secondary 18 of the first transformer 19 in the supply lines of the commutator motors 13 and 14. The primary winding 23 of transformer 22 is connected in one of the supply lines of motor 10 so as to be energized responsively to the load current of motor 10. The arrangement of the transformers 19 and 22 is such that the voltage induced in the secondary winding 21 of transformer 22 is opposed to the substantially constant voltage induced in the secondary winding 18 of transformer 19. By means of this differential connection, the resultant voltage impressed upon each of the feeding motors 13 and 14 varies inversely with the load current of the driving motor 10. Thus with an increase in the load on the driving motor 10, the voltage impressed upon the feeding motors 13 and 14 is decreased so that their torque decreases and consequently the application pressure of the wood against both of the grinding wheels driven by motor 10 is correspondingly reduced. Conversely with a decrease in the load on the driving motor 10, the total resultant voltage of the transformers 19 and 22 will increase and the increased torque of the feeding motors 13 and 14 serves to increase the application pressure of the wood against both of the grinding wheels and thereby re-

store the load on the driving motor 10 to the full value. It will be evident that the variation in the voltage of the feeding motors 13 and 14 is absolutely uniform and simultaneous, and consequently the application pressure of the wood on both of the grinding wheels is varied in a corresponding manner.

In addition to this uniform regulation of the torque of feeding motors 13 and 14 by the change in the applied voltage it is desirable that the feeding speed of each motor be separately and automatically varied independently of the uniform variations in the application pressure of the wood on both grinder wheels in order to equally distribute the loads between the two grinding wheels.

Since the quality of the wood to be ground varies, the area of wood being ground varies, the grinding surface of the stone varies, and other variables occur, it will be evident that the loads represented by the respective grinding stones will also vary. In accordance with the present invention the equal distribution of the load between the two grinding wheels is accomplished by so arranging the field windings 24 and 25 of the single phase commutator motors 13 and 14 respectively that the field strength of each motor is increased with an increasing load thereon and is decreased with a decreasing load thereon. Thus with unequal loads on the grinder wheels the feeding motors 13 and 14 are unequally loaded and there is produced a decrease in the speed of the feeding motor having the greater load and a corresponding decrease in the application pressure of the wood fed by this motor while the speed of the motor having the lesser load is increased to effect a corresponding increase in the application pressure of the wood fed thereby. Any suitable form of single phase feeding motor, such, for example, as a repulsion motor, having the desired series characteristics may be employed, although as shown the motors 13 and 14 are of the Winter-Eichberg type in which the rotating member is equipped with a commutator similar to that employed in direct current machines and is supplied with current through brushes bearing thereon. As both the construction and characteristics of this type of motor are well known, further detailed description thereof is deemed unnecessary.

In order that the torque as well as the feeding speed of the commutator motors 13 and 14 may accurately respond to variation in the load on the driving motor 10, the transformer 22 may be designed for a specially large voltage drop or as shown in the drawing preferably is provided with a secondary winding having taps brought out from one end to a regulator 26. It will be understood that by suitably operating the regulator 26 to vary the number of turns in the secondary winding of transformer 22 the voltage im-

pressed upon the motors 13 and 14 may be varied, and any desired relation between the application torque of the motors 13 and 14 to the load on the driving motor 10 can be obtained as well as varied as required. In order to effectively prevent the application pressure of the wood upon the grinding wheels from exceeding a predetermined maximum value, each of the motors 13 and 14 may be mechanically connected to drive the conveyor belts of the feeding mechanism through any well known friction coupling arrangement which will serve to limit the magnitude of the torque to be transmitted.

In order to prevent improper operation of the control switch mechanism for the wood pulp grinder as well as to insure that all switching operations are performed in a predetermined sequence, the speed controlling switch mechanism 12 of driving motor 10 is electrically interlocked with the line switch 16 and the line switch 17 in the following manner. The line switch 16 is arranged to be electrically locked in the open position in which it is shown by means of the electrically controlled detent 16a to prevent the energization of the motor 10 from the supply line 15 until the switch mechanism 12 is operated to the left into the starting position. Furthermore, the operating winding of the electromagnetic line switch 17 is connected to be jointly controlled by the switch mechanism 12 of driving motor 10 and the starting switch mechanism 27 of the feeding motors 13 and 14, the arrangement being such that the closure of line switch 17 is effected only when the starting switch mechanism 27 is in the starting position and the switch mechanism 12 is operated to the right into the full speed running position.

While we have described and illustrated our invention embodied in a dual feed wood pulp grinder it will be evident that in certain of its aspects the invention may be applied readily to control a single feed wood pulp grinder. Thus with a single feed wood pulp grinder, no further changes in the arrangement described are necessary other than the elimination of one of the multiple connected feeding motors 13 and 14.

Although the invention is particularly advantageous when applied to a motor driven wood pulp grinder having alternating current feeding motors, it may also be used in connection with an alternating current motor operated wood pulp grinder employing direct current compound motors having differential field connections for operating the feed mechanism of the grinder. In such an arrangement the direct current required for operating the feeding motor may be generated by a rotary converter having direct current windings connected to supply current to the feeding motors. In accordance with the present invention the alternating

current windings of the converter may be arranged to be fed by two transformers which are differentially connected and energized in the manner previously set forth.

In accordance with the provisions of the patent statutes, we have described the principle of operation of our invention together with the apparatus which we now consider to represent the best embodiment thereof, but we would have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a motor control system, the combination of an alternating current driving motor, an electric feeding motor for applying load to the driving motor, means for energizing the feeding motor with a voltage which is automatically varied inversely with variations in the current of said driving motor comprising a transformer having a secondary winding connected to supply power to the feeding motor, and a second transformer having a primary winding connected to be energized responsively to the current of the driving motor and a secondary winding connected in series circuit with the secondary winding of said first transformer with the induced voltage of said second transformer in substantial opposition to the induced voltage in said first transformer.

2. In a motor control system, the combination of an alternating current driving motor, an alternating current feeding motor for applying load to the driving motor, alternating current power connections for the driving motor and for the feeding motor, and a transformer having a primary winding connected in the power connections of the driving motor and a secondary winding connected in the power connections of the feeding motor for automatically varying the power supplied to the feeding motor inversely as the power supplied to the driving motor varies.

3. In a motor control system, the combination of a polyphase alternating current driving motor, a single phase alternating current feeding motor for applying load to the driving motor, line switch mechanism for connecting the driving motor to a source of supply, line switch mechanism for connecting the feeding motor to a source of supply, and means for varying the voltage supplied to the feeding motor inversely as the current supplied to the driving motor varies, the said means including a transformer having a primary winding energized responsively to the load current of the driving motor and a secondary winding connected in the supply circuit of the feeding motor with the induced voltage in said secondary winding in substantial opposition to the voltage of the supply source for the feeding motor.

4. In a motor control system, the combination of an alternating current driving motor, an alternating current feeding motor for applying load to the driving motor, alternating current power connections for the driving motor, and means including a transformer having the primary winding energized responsively to the load current of the driving motor and a secondary winding connected in series circuit with the feeding motor for energizing the same with an alternating voltage which varies inversely with the load current of the driving motor, and means for controlling the same transformer to independently vary the voltage induced in said secondary winding.

5. In a motor control system, the combination of an alternating current driving motor, an alternating current feeding motor for applying load to the driving motor, means for energizing the feeding motor with a voltage which is automatically varied inversely with variations in the current of said driving motor comprising a transformer having a primary winding connected to be energized responsively to the voltage impressed upon the driving motor and a secondary winding connected to supply power to the feeding motor, a second transformer having a primary winding connected to be energized responsively to the current of the driving motor and a secondary winding connected in series circuit with the secondary winding of said first transformer with the induced voltage of said second transformer in substantial opposition to the induced voltage of said first transformer, and means for controlling said second transformer to vary the induced voltage thereof independently of variations in the current of the driving motor.

6. In a motor control system, the combination of a driving motor, a pair of feed motors arranged to separately impose load upon the driving motor, each of said feeding motors having windings arranged to vary the speed of the motor inversely with variations in the load thereof, and means for simultaneously controlling the speed of said feed motors in accordance with the load on said driving motor, whereby the load upon the said driving motor is automatically maintained at a substantially constant value and the separate loads imposed upon the driving motor by said feeding motors are automatically equalized.

7. In a motor control system, the combination of a driving motor, a pair of feed motors arranged to separately impose load upon the driving motor, each of said feeding motors being of the single phase alternating current commutator type and having windings arranged to vary the speed of the motor inversely with variations in load thereon, whereby the separate loads imposed upon said driving motor by said feeding motors are automatically equalized.

8. In a motor control system, the combination of a driving motor, a pair of single phase commutator alternating current feed motors each operatively connected to impose load on said driving motor, means for energizing said feeding motors in accordance with the load on said driving motor, and each feeding motor having windings arranged to vary the speed of the motor inversely with variations in the load thereof whereby the loads imposed on the driving motor by said feeding motors are automatically equalized.

9. In a motor control system, the combination of an alternating current driving motor, a pair of single phase commutator alternating current motors, each operatively connected to impose load on the driving motor and each of said feeding motors having field windings arranged to vary the speed of the motor inversely with variations in the load thereon, power connections for said feed motors, and means for controlling the energization of said feeding motors in accordance with the load on said driving motor comprising a transformer having a secondary winding connected in the supply lines of said feeding motors and a primary winding connected in the supply lines of said driving motor whereby the load on said driving motor is automatically maintained at a predetermined value.

10. In a motor control system, the combination of a multiphase alternating current driving motor, a pair of single phase commutator motors for separately imposing load on the driving motor, power connections for the driving motor, and means for simultaneously energizing the feeding motors with an alternating current voltage which varies inversely with the load on the driving motor, the said means comprising a source of substantially constant voltage, and a transformer having a primary winding connected to be energized responsively to the load current of the driving motor and a secondary winding connected in series with the said source and with the voltage induced in said secondary winding in substantial opposition to the voltage of said source.

11. In a motor control system, the combination of a multiphase alternating current driving motor, a pair of single phase commutator feeding motors for separately imposing load upon the driving motor, each of said feeding motors having field windings compounded to vary the speed thereof inversely with variations in the load thereon, and means for energizing said feeding motor with a voltage variable inversely in accordance with the load on said driving motor comprising a pair of transformers, one having a primary winding connected to be energized responsively to the voltage of one phase of said driving motor and a secondary winding arranged to supply power to said feeding motors in multiple circuit, the other of said transform-

ers having a primary winding energized re-
sponsively to the current in one phase of said
driving motor and a secondary winding con-
nected in the power circuit of said feeding
motors in series with the secondary of said
5 one transformer and in opposition thereto,
whereby the separate loads imposed on the
driving motor by said feeding motors is au-
tomatically equalized and the total load of
said driving motor is automatically main-
10 tained at a substantially constant value.

In witness whereof, we have hereunto set
our hands this 25th day of April, 1930.

PAUL WEISKE.

KONRAD RUPPRECHT.