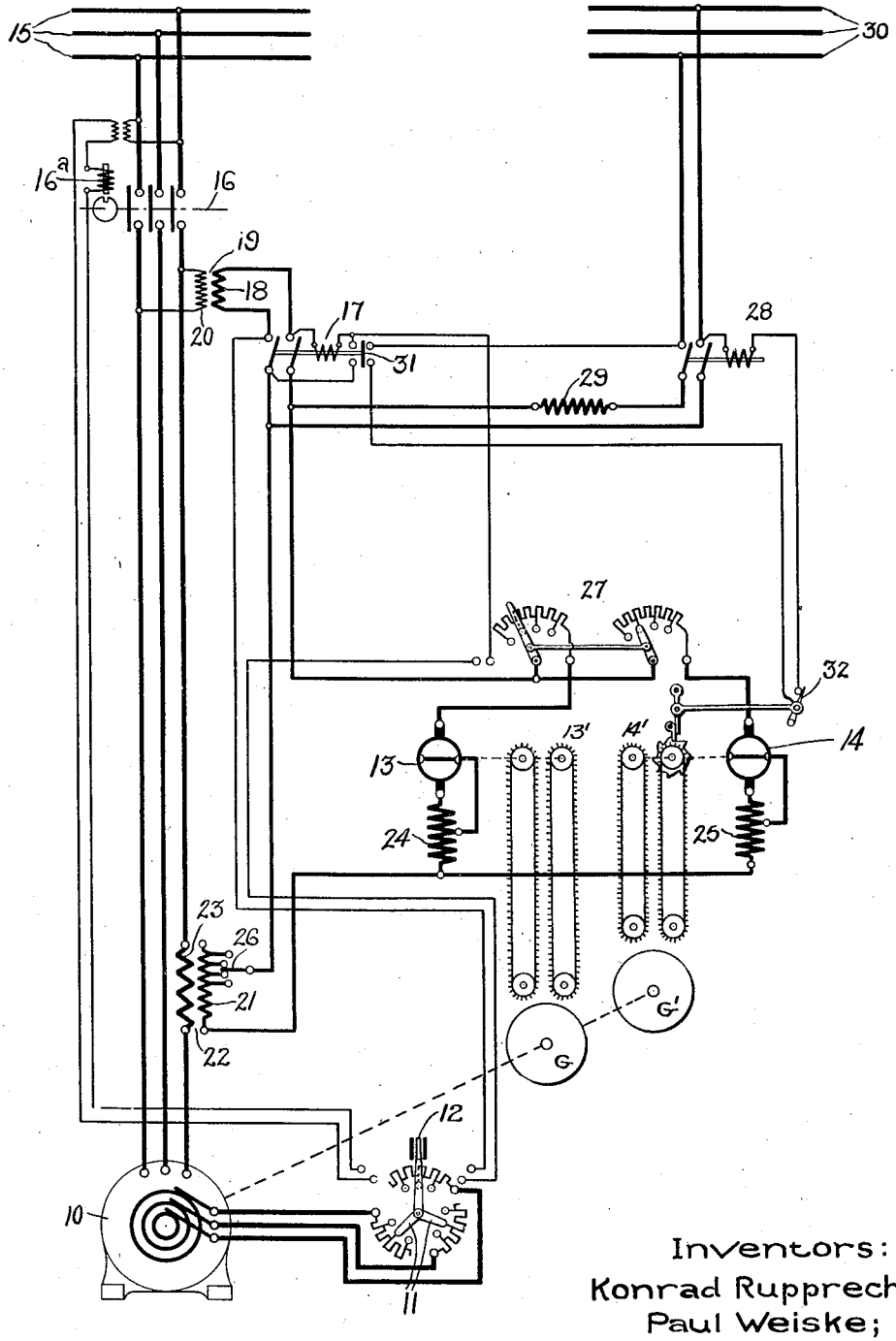
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MOTOR CONTROL SYSTEM

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MOTOR-CONTROL SYSTEM

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

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 alternating current 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 mechan-

ically 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 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 restore 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 feeeding 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 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 18 the voltage impressed 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 16*a* to prevent the energization of 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 electromagnet 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.

Upon stopping the grinder particularly when the stopping is effected automatically in consequence of an overload by a suitable overload circuit interrupter not shown in the drawing, it is desirable that the application pressure of the wood against the grinding wheels be released since otherwise upon re-starting the grinder, the grinding stone may be damaged and the starting current of driving motor 10 may reach dangerous values. While heretofore manually operated devices have been provided for unloading the grinder stones, there is always a possibility that the operating attendant may neglect to operate such devices to release the pressure of the wood against the grinding wheels.

In accordance with the present invention provision is made for removing the load from the grinding wheels automatically upon the stopping of the driving motor in a simple and reliable manner. In the preferred form of the invention illustrated in the drawing, an auxiliary line switch 28 is arranged to be automatically energized upon the opening of line switch 17 to connect the feeding motors 13 and 14 in series with the resistance 29 to the supply line 30 for operation in the direction required to remove the load from the grinding wheel. Thus upon the opening of line switch 16, the driving motor 10 is disconnected from the supply line 15 and at the same time the feeding motors 13 and 14 as well as the electromagnetic line switch are deenergized. Upon the resulting opening of line switch 17 the auxiliary contact 31 with which the switch 17 is provided closes an energizing circuit for the operating winding of auxiliary line switch 28. Thereupon auxiliary line switch 28 closes and connects the feeding motors 13 and 14 to the supply lines 30 for operation in the reverse direction. The limit switch 32 is connected in the energizing circuit of auxiliary line switch 28 and is arranged to be mechanically operated by the feeding motor 14 to interrupt energizing circuit of auxiliary line switch 28 after a predetermined operation of feeding motors 13 and 14 in the reverse direction.

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 is 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.

Certain features of our invention relating to the control of a main motor and a feed motor are claimed in our copending divisional application Serial No. 451,549 filed May 12, 1930.

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 control system for a dual feed wood pulp grinder, the combination of a motor for

driving a pair of grinder stones, a separate electric motor for feeding the wood to each grinder stone, and means responsive to the loads on said feed motors for automatically regulating the said feed motors to cause the loads imposed on the grinder stones by said feed motors to bear a predetermined relation to each other.

2. In a control system for a dual feed wood pulp grinder, the combination of a motor for driving a pair of grinder stones, a separate electric motor for feeding the wood to each grinder stone, the said feed motors being connected with each other and respectively having windings which automatically regulate the feed motors to cause the loads imposed on the grinder stones to bear a predetermined relation to each other.

3. In a control system for wood pulp grinders and the like, the combination of a driving motor and a feeding motor, 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 to apply load to said driving motor, and automatic auxiliary switch mechanism for connecting said feeding motor to a second source of supply to remove the load from said driving motor upon the opening of said line switch mechanism.

4. In a control system for a wood pulp grinder, the combination of a driving motor and a feeding motor, power connections for the driving motor, switch mechanism for connecting said feeding motor to a source of supply for operation in one direction to apply load to said driving motor, auxiliary line switch mechanism arranged to be automatically operated upon the opening of said first line switch mechanism to connect said feeding motor to a second source of supply for operation in a direction to remove the load from said driving motor, and limit switch mechanism for interrupting the power connections of the motor upon a predetermined reverse movement thereof.

5. In a control system for wood pulp grinder, the combination of a driving motor and a feeding motor, speed controlling switch mechanism for the driving motor having a starting and a full speed position, line switch mechanism for the feeding motor, means for preventing closure of said line switch mechanism until after the operation of said speed controlling switch mechanism to the full speed position, and means for connecting said feeding motor to a second source of supply for operation in a reverse direction upon the opening of said line switch mechanism.

6. In a control system, for a wood pulp grinder, the combination of a driving motor and a feeding motor, switch mechanism for connecting the driving motor to a source of supply and for controlling the speed thereof, electroresponsive line switch mechanism for connecting said feeding motor to a source of supply for operation in a direction to impose a load upon said driving motor, means for preventing closure of said line switch mechanism until after the operation of said speed controlling switch mechanism to the full speed running position, auxiliary electromagnetic line switch mechanism for connecting the feeding motor to a second source of supply for operation in the reverse direction upon the opening of said first line switch mechanism, and limit switch mechanism arranged to be actuated by said feeding motor for limiting the operation thereof in the reverse direction.

7. The combination with a plurality of grinders having a common actuating means, of independently variable feed means for the respective grinders, independently operable control means for the respective feed means and means responsive to the aggregate load on the grinders for regulating the feed means.

8. The combination with a plurality of grinders having a common driving motor therefor, of independently variable feed motors for loading the respective grinders, electrical control means for regulating said feed motors to distribute the aggregate load between the grinders, and electrical control means responsive to the load on the grinder driving motor for regulating said feed motors to maintain a substantially constant aggregate load on the grinders.

9. In combination, a plurality of grinders, a common driving motor therefor, a separate feed mechanism for each grinder, a separate electric motor for operating each of said feed mechanisms, a source of current supply for said feed motors, electrical control means for regulating the said feed motors to distribute the aggregate load between the grinders, and a regulator automatically operated in response to the load on said driving motor for controlling the current supplied to said feed motors to regulate the aggregate load on the grinders.

10. In combination, a plurality of driven elements, a motor for driving the same, a separate load applying electric motor for each of said elements, and connections between the said load applying motors for automatically preserving a predetermined relation between the loads imposed thereby on said elements.

11. In combination, a plurality of driven elements, a motor for driving the same, a separate load applying electric motor for each of said elements, means responsive to the load on said driving motor for automatically reglating the said load applying motors to maintain a predetermined load on the driving motor, and connections between the said load applying motors for automatically preserving a predetermined relation between the loads imposed thereby on said elements.

12. In combination a drive for a grinder

or the like, a plurality of grinding elements, a motor for driving the same, separate feed mechanisms associated with each of said elements, a separate electric motor for operating each of said mechanisms, means responsive to the load on said driving motor for automatically regulating the said electric feed motors to automatically maintain a predetermined load on said driving motor, and connections between said feed motors for automatically preserving a predetermined relation between the loads imposed by said feed mechanisms on said elements.

13. A wood pulp grinder drive comprising a motor for driving a plurality of grinder stones, separate feed mechanism for feeding the wood to each grinder stone, a separate electric motor for operating each of said feed mechanisms, and means for automatically regulating the said feed motors to cause the loads imposed on the said stones by said feed mechanisms to bear a predetermined relation to each other.

14. A wood pulp grinder driving comprising a motor for driving a plurality of grinder stones stones, separate feed mechanism for feeding the wood to each grinder stone, a separate electric motor for operating each of said feed mechanisms, and connections between the said feed motors whereby the speeds of said feed mechanisms may vary with reference to each other while substantially preserving a predetermined relation between the loads on said stones.

15. A wood pulp grinder drive comprising a grinder motor for driving a plurality of grinder stones, separate feed mechanism for feeding the wood to each grinder stone, a separate electric motor for operating each of said feed mechanisms, means automatically operated in response to the load on said grinder motor for regulating the said feed motors to maintain a predetermined load on the grinder motor, and connections between the said feed motors for maintaining a predetermined relation between the loads imposed on said stones by said feed mechanisms.

In witness whereof, we have hereunto set our hands this 7th day of January, 1925.

PAUL WEISKE.
KONRAD RUPPRECHT.