June 29, 1926. 1,590,854

L. ROTHERA ET AL.

CONSTRUCTION OF AND DRIVING ARRANGEMENT FOR ROLLING MILLS

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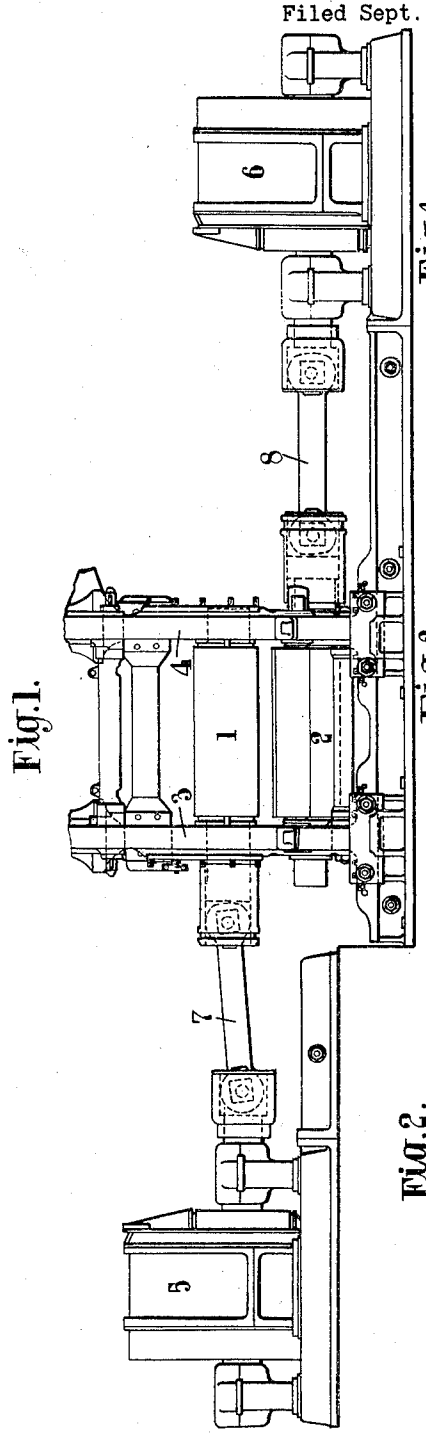


Fig. 1.

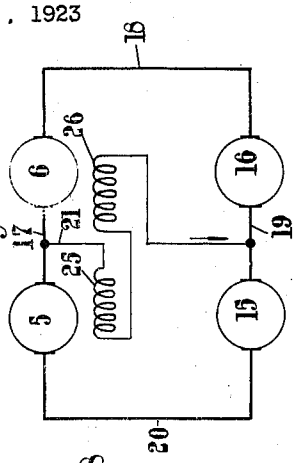


Fig. 4.

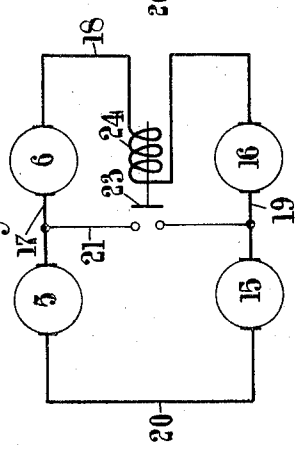


Fig. 3.

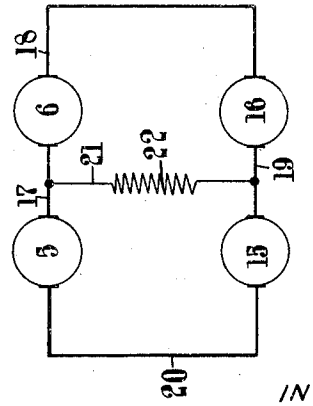


Fig. 2.

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UNITED STATES PATENT OFFICE.

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CONSTRUCTION OF AND DRIVING ARRANGEMENT FOR ROLLING MILLS.

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This invention relates to electrically driven rolling mills of the type (of which cogging mills and merchant mills are examples) adapted for rolling iron or steel in the form of straight lengths in which the mill comprises a pair of superposed parallel main rolls each of which is positively driven. The usual method of imparting motion to the two rolls in such mills is to connect both rolls by means of a pair of spindles with two pinions gearing together and arranged in a housing, one of these pinions being coupled to the shaft of the motor so that approximately half the power of the mill has to be transmitted between the pinions which with their housing form an expensive part of the mill.

In accordance with the present invention, instead of applying the electric drive at a single point to mechanically coupled rolls, each of the two main rolls or lines of rolls is driven by a separate motor or motor group without positive determination of the speed relation of the rolls during the rolling periods. An application of the invention is illustrated by Figure 1 of the accompanying drawings which shows in elevation a mill and its driving motors. Figures 2, 3 and 4 show diagrams of connections hereafter referred to.

In the arrangement shown in Figure 1 a pair of rolls 1 and 2 supported in suitable housings 3 and 4 are driven by motors 5 and 6. Motor 5 drives the upper roll 1 through the spindle 7. The motor 6 drives the bottom roll 2 through its spindle 8. The arrangement of these spindles 7 and 8 provide in known manner for vertical movement of the rolls relative to the members by which they are driven which is necessary in obtaining the adjustment of the distance between the roll centres.

Owing to the individual drives of the two rolls there is a certain amount of flexibility in regard to the relative angular speeds of the two rolls so that each can set itself to that speed relative to the metal which it naturally tends to adopt and which will generally be that speed at which the work is carried out with the minimum expenditure of energy at the driving motors. The actual relative speed of the rolls will in general be dependent upon the form of the rolls and of the sections being produced and may vary from one pass to another.

It appears that the adoption of the natural relative speeds of the rolls instead of a forced uniform speed relation will have the additional advantage of producing better material owing to the fact that the working which the metal undergoes will be more uniform from point to point in the section.

Owing to the large size of mills of the type in question at present in use, it is generally necessary with the ordinary method of driving to employ two or more motors in tandem or a double motor as the driving means. There is accordingly very little if any, extra cost involved as regards this driving means by employing two separate motors. In some instances, the cost of the motors may in fact be reduced since the necessity for the additional mechanical strengthening for the transmission of the double drive through a single shaft is avoided. In all cases the very considerable expense of the pinions and their housing is avoided.

The possibility of the individual motors adopting different speeds of rotation as required by the conditions indicated above follows from the fact that these motors are connected in series so that while the same current flows through them the voltage across the armature may be different in the two cases, thus producing an approximately uniform torque but permitting a difference in speed. This method of connection has however, the disadvantage that when there is no working connection between the shafts of the two motors they are in an unstable condition as regards their relative speeds. The condition for this instability will be present when there is no material between the rolls unless at this stage the rolls are actually in contact. Accordingly this invention also comprises the provision of means for ensuring the stability of operation of the motors during periods when there is no metal between the rolls.

The problem may be dealt with electrically by making a more or less close approximation to a three wire connection for the motors so that they are connected in series across the outer wires of the supply but have a connection between their armatures which

is arranged so as to oppose a tendency to material variation of the voltage distribution between the two machines. Examples of this are shown in the diagrams forming Figures 2, 3 and 4. They apply to the case where two motor armatures 5 and 6 are supplied by two generator armatures 15 and 16, the set of four armatures being connected in series through the wires 17, 18, 19 and 20. In each case a connection, which may be called the third wire 21, is arranged between the junction 17 of two motor armatures and the junction 19 of the two generator armatures. If the two motor armatures were supplied from a single generator armature then it would be necessary to establish by known means a point having a potential intermediate between those of the terminals of the generator to which could be connected the third wire 21. In order that the third wire connection may permit of the motors retaining sufficient freedom of speed variation during rolling, it is necessary that this connection should have an appreciable constant effective resistance or have a variable effective resistance. If the connection is of inappreciable resistance, for instance, if it were simply a heavy copper cable then the motors would be in effect coupled in parallel and would be maintained in definite speed relation under all conditions. If, on the other hand, the third wire connection were of very high resistance or were open-circuited, the motors would in effect be in series and there would be no definite speeds relation maintained in the intervals between the passes. By appropriate selection of a constant value for a resistance as indicated at 22 in Figure 2 (which can readily be carried out experimentally), it is possible to obtain an appropriately close speed relation between the rolls during light running without preventing them from adopting a different relation during the rolling.

In an alternative method the resistance may be varied between a low value during light running and a high value during passes. The limiting case of this is indicated diagrammatically in Figure 3 where a direct connection is effected by the heavy connection 21 and the contactor 23 during light running and an open circuit is produced by means of the contactor 23 during passes. In this the contactor is controlled by the current in the coil 24 which is connected in the main circuit between the generator and motor armatures. As there is very considerable difference between the values which this current has during light running and during passes and as the current in the third wire is generally comparatively small, certainty of action of the contactor is to be expected.

Instead of actually providing resistance or an open-circuiting device in the third wire connection, other means may be employed equivalent in their results to a resistance and therefore included within the meaning of the term "effective resistance." One device of this kind is a counter electromotive force inserted in the third wire and arranged so as to increase as the current in the third wire increases. This device may be formed by means of a dynamo-electric machine having its armature connected in the third wire and its field subject to the current in the third wire. This may be a machine wound as a series motor and mounted on the shaft of the generator or generators, and it will then produce a potential difference in this wire similar in effect to the potential difference due to the passage of the third wire current through a resistance. Another method of producing a similar result is to arrange that the third wire current passes through windings on the fields of the motors or generators so as to produce a compounding effect. It is preferable to arrange this compounding on the motors as shown in Figure 4. The action of the arrangement will then be as follows:—

Assuming for example that the motor armature 5 has increased in speed so as to run somewhat faster than the armature 6, there will then be a potential difference between the ends of the third wire 21 causing current to flow in the direction indicated by the arrow, that is, from the conductor 17 to the conductor 19. This current will traverse the compounding windings 25 and 26 on the motors 5 and 6 respectively and its action will be to weaken the field of the motor 5 and strengthen that of the motor 6. The resistance of the field windings in the third wire and their number of turns will be so adjusted as to permit an appropriate amount of variation in speed between the motors 5 and 6 while keeping down the current in the third wire to a value which does not involve undesirably high losses. In a reversing mill it will be necessary to provide that the connections of the compounding windings 25 and 26 are reversed simultaneously with the reversal of the current in the main circuit 17, 18, 19, 20.

The relative independence of some of the motor conditions during passes which the invention provides, permits of adjustments being made to the field strengths of the motors so as to equalize the pulls which the two rolls exert on metal passing between them and to set the speeds of the motors to definitely different values during intervals to suit different diameters of rolls. An example of the latter type of adjustment is found in the case where one roll is of larger diameter than the other when the field of the motor driving the smaller roll can be set so that this motor during intervals tends

to run at a speed greater than that of the other motor to produce approximate equality in the peripheral speeds of the rolls. This adjustment also has the effect of producing approximate equalization of the pulls exerted by the two rolls on the metal during passes. A similar type of speed adjustment can be effected by operating on the fields of the generators where a permanent third wire connection exists.

What we claim as our invention and desire to secure by Letters Patent is:—

1. An electrically driven rolling mill of a type adapted for rolling iron or steel in the form of straight lengths comprising a pair of parallel main rolls, separate electric motor means arranged to drive each member of said pair, electrical supply means, electrical connections placing the two motors in series across said supply means and means for maintaining the junction between the two motors at a potential within a limited range on each side of a determined value intermediate between the potentials of the other terminals of the motors so as to maintain an appropriate speed relation between the rolls during light running without preventing them from adopting a different relation during rolling.

2. An electrically driven rolling mill comprising a pair of main rolls, separate electric motor means arranged to drive each member of said pair, electrical supply means, electrical connections placing the two motors in series across said supply means and a connection from the junction between the two motors to a point of intermediate potential in the supply means, this connection being of an effective resistance such as to maintain an appropriate speed relation between the members of said pair during light running without preventing them from adopting a different relation during rolling.

3. An electrically driven rolling mill comprising a pair of main rolls, separate electric motor means arranged to drive each member of said pair, electrical supply means, electrical connections placing the two motors in series across said supply means and a connection from the junction between the two motors to a point of intermediate potential in the supply means, this connection being of variable effective resistance which is materially less in value during light running periods than during rolling periods.

4. An electrically driven rolling mill comprising a pair of main rolls, separate electric motor means arranged to drive each member of said pair, electrical supply means, electrical connections placing the two motors in series across said supply means and a connection from the junction between the two motors to a point of intermediate potential in the supply means, and means for maintaining this connection closed during light running and opening it during rolling.

5. An electrically driven rolling mill comprising a pair of main rolls, separate electric motor means arranged to drive each member of said pair, electrical supply means, electrical connections placing the two motors in series across said supply means and a connection from the junction between the two motors to a point of intermediate potential in the supply means, electro-magnetic means actuated simultaneously with the changing of current in the motors to open the connection during rolling and maintain it closed during light running.

6. An electrically driven rolling mill of a type adapted for rolling iron or steel in the form of straight lengths comprising a pair of parallel main rolls, a pair of separate and similar direct current electric motors one operatively connected with each of said rolls, means for electrically connecting said motors in series, a three-wire electrical generating system, means for connecting said motors across the outer wires of said system and means for connecting the junction between the said motors to the third wire of said system, the last said means containing a part of appreciable effective resistance.

In testimony whereof we affix our signatures.

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