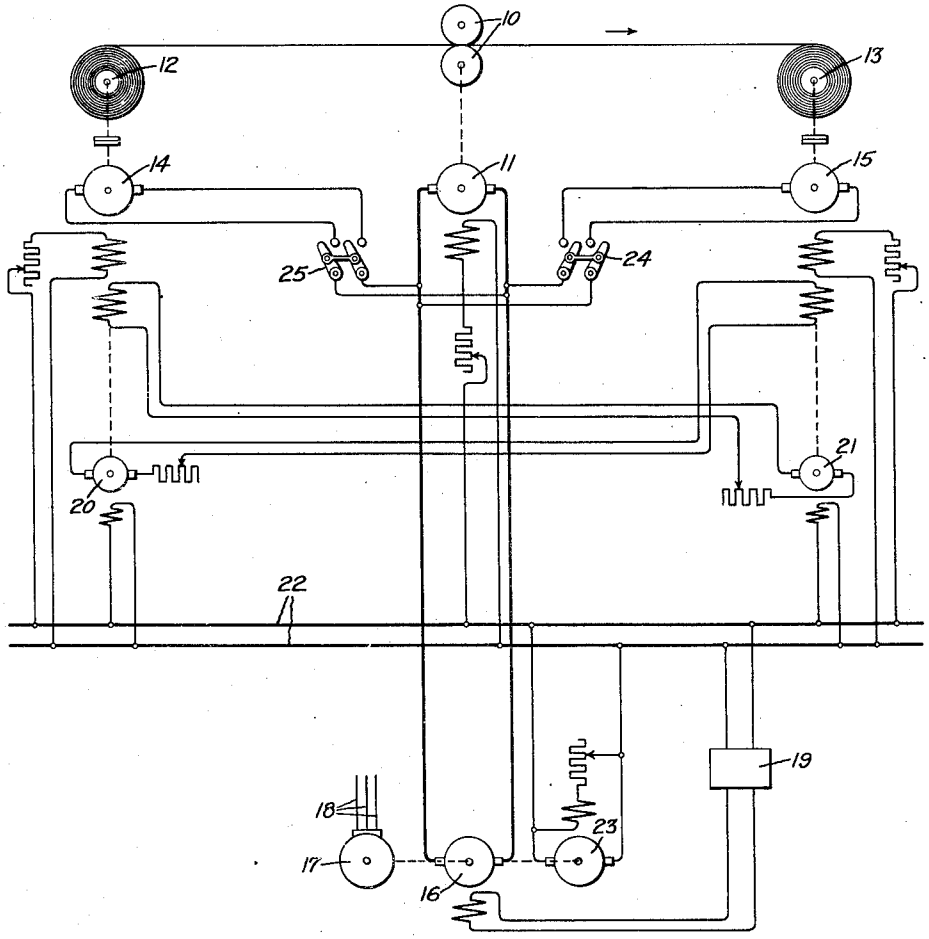
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CONTROL SYSTEM

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CONTROL SYSTEM

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This invention relates to control systems, more particularly to controls for apparatus performing operations on a strip of material and it has for an object the provision of a simple reliable and improved system of this character.

More specifically the invention relates to control systems for cold-strip rolling mills and the like in which the strip delivered from the mill rolls is wound on a drum under constant tension; the reels or drums are driven by separate machines which are controlled to render the coiling operation uniform.

Similar conditions prevail in some hot-rolling mills producing wide metal strip, with the difference, however, that in this case no tension must be put on the material when the latter is wound on the reel or drum, in order to avoid undue variation in the gauge of the hot strip. Likewise, the treated material must not be allowed to become piled up on itself on the take-up reel as a result of being taken up too slowly in relation to the angular speed of the rolls.

A short description of the operation of these rolling mills will be given first. The initial stage consists in reducing the strip in the rolling stand according to the reversing method until the thickness of the strip is sufficiently reduced to render the coiling operation possible. The drums or reels are in separate heating furnaces, disposed on opposite sides of the mill stand. As soon as the rolled strip is thin enough to be coiled, it is fed to the furnaces by operation of a throw-over switching mechanism for the purpose of reheating the strip and for coiling it on or uncoiling it from the reel concerned, in accordance with the direction in which the material is being rolled. For the reasons stated in the foregoing, it is necessary that the strip should be wound on the leading or take-up reel and unwound from the trailing or unwinding reel at a linear speed in accordance with that of the rolls. In other words, since the overall diameter of the take-up reel gradually increases in proportion as the strip is coiled thereon, the angular speed of this reel must decrease accordingly while the R. P. M. of the unwinding reel must increase at the same rate. The duty of the reels is therefore to take up and pay out the strip at a linear speed accurately equivalent to that of the rolls.

A further object of this invention is the provision of means for effecting reliable cooperation between the two reels and the rolling stand by providing that the speed of the winding reel motor as well as that of the unwinding reel motor shall be accurately controlled in accordance with the speed of the rolls, and by taking into most careful consideration the respective increase and decrease of diameter of the reels or drums. To this end, and according to the said invention, a speed indicator generator is coupled to each drum-driving motor, whereby the R. P. M. of one motor are caused to increase in the same proportion as the R. P. M. of the other motor decrease. This is obtained by suitably and alternately influencing the fields of the drum-driving motors with the aid of these generators which are high-saturation machines whose voltage, at constant excitation, increases and decreases proportionally to the speed.

In illustrating the invention in one form thereof, it is shown as embodied in a system for controlling the operation of a reversing hot strip mill.

For a better and more complete understanding of the invention, reference should be had to the following specification and to the accompanying drawing, the single figure of which is a simple diagrammatical illustration of an embodiment of my invention.

Referring now to the drawing, the rolls 10 of a reversing rolling mill are driven by a suitable reversible motor 11 and reels or drums 12 and 13 disposed in the heating furnaces are driven by means of motors 14 and 15 respectively. Although the motors 14 and 15 may be of any suitable type, they are illustrated as direct current motors supplied from a common variable voltage motor generator 16. Generator 16 is driven at a speed which is preferably substantially constant by any suitable means represented in the drawing by the alternating current motor 17, supplied from a suitable source 18. Suitable control mechanism 19, illustrated conventionally in the drawing, is connected in the field circuit of generator 16 and serves to control the magnitude and polarity of the voltage supplied to motors 11, 14 and 15. While the first reduction passes are in progress the control mechanism 19 is utilized only for starting and regulating the main mill motor 11, but at the beginning of the reeling operation, this mechanism serves the purpose of starting and controlling, in common and in Ward-Leonard arrangement, the motors 11 and 14 or 11 and 15, according as the reel 12 or reel 13 is acting as take-up reel. High saturation direct current pilot generators 20 and 21 are coupled to the reel driving motors 14 and 15 and therefore to the reels 12 and 13 respectively. The field windings of the motors 11, 14 and 15, and the generators 16, 20, and 21 are connected to the excitation supply busses 22 which in turn are supplied with a substantially constant direct voltage from the exciter 23 which is coupled to the shaft of the main drive motor 17.

In operation, as the work progresses in the direction of the arrow, the switch 24 is closed and the switch 25 is open so that the motor

15 is energized and the motor 14 is disconnected. The diameter of the reel 13 increases as the coiling of the strip progresses, while at the same time the diameter of the unwinding reel 12 decreases. This consequently involves the necessity of gradually decreasing the angular velocity of the take-up reel 13 while increasing that of the reel 12 as its diameter decreases. Since the motor 14 is disconnected, the strip is unwound from the reel 12 in proportion to the angular velocity of the mill rolls 10, thereby increasing the speed of the unwinding reel as its diameter decreases. The R. P. M. of the take-up reel 13 is altered by gradually strengthening the field of the take-up motor 15 with the aid of the pilot generator 20 which is coupled to the reel 12 and whose voltage rises proportionally to the increasing angular speed of reel 12 so that the speed of the take-up motor 15 is decreased in proportion to the increase in the speed of the unwinding reel 12. The switch 24 is opened and the switch 25 is closed when the direction of rotation and therefore the direction of travel of the strip is reversed so that the pilot generator 21 coupled to the reel 13 strengthens the field of the motor 14 (now driving reel 12 as take-up reel) which is consequently caused to slow down. Speed regulation is smooth and uniformly continuous. As regards the total excitation of the reel driving motors, it is immaterial whether the latter have two field windings, or whether they are excited by a separate machine in which one field is excited by the fundamental excitation and the second by the speed indicator generator.

This equipment is also adaptable for reversing cold strip mills where tension is maintained, either or both, between the mill and the winding or unwinding reel. Whether there is tension or not depends upon the speed of the strip and the relative field strength of the reel motors, which can be adjusted by hand or automatically with constant current regulators.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete form, it will be understood that the invention is not limited to the specific apparatus and connections which are merely illustrative, since modifications and alterations will readily suggest themselves to persons skilled in the art without departing from the true spirit of this invention or from the scope of the annexed claims.

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

1. In combination with rolling mill apparatus and the like having means for performing an operation on a strip of material, and an unwinding reel for supplying the strip to said means and a winding reel for coiling the strip delivered by said means, a separate motor for driving each of said reels, means for rendering the motor connected to the take-up reel ineffective, and a separate pilot generator driven by each of said reels and connected to the field winding of the motor driving the other of said reels thereby to vary the excitation and the speed of the motor driving the take-up reel inversely with the speed of said unwinding reel.

2. A control system for strip rolling mills and the like having an element operating on a strip of material and winding and unwinding reels therefor arranged on opposite sides of said element comprising, a motor for driving the winding reel and a motor for driving the unwinding reel, each of said motors being provided with a field winding, means for rendering the motor connected to the unwinding reel inactive a generator driven by said winding reel connected to energize the field winding of said unwinding reel motor and a second generator driven by said unwinding reel and connected to the field winding of said winding reel motor, so that the speed of said winding reel motor is varied inversely with the speed of the unwinding reel.

3. A control system for rolling mill apparatus and the like having rolls for reducing the thickness of the strip and winding and unwinding reels therefor comprising a motor for driving said unwinding reel, a motor for driving said winding reel, a motor for driving said rolls at a substantially constant speed, means for reversing the rotation of said motors, means for rendering the unwinding reel motor inactive and a pair of pilot generators each driven by one of said reels and each connected to a field winding of the motor driving the other of said reels thereby to vary the speed of the winding reel motor inversely with the speed of said unwinding reel so that the speed of the strip at the periphery of the winding reel is substantially equalized with the strip speed of said rolls.

4. A control system for a rolling mill having a winding reel and an unwinding reel disposed on opposite sides of the mill rolls, an electric motor connected to each of said reels, said motors being required to operate in predetermined speed relationship with respect to the respective speed of said rolls, and an auxiliary dynamo electric machine mechanically connected to each of said reels so that its speed varies in accordance with the speed of the reel to which it is connected and electrically connected to the field of the motor driving the opposite reel so that the dynamo electric machine connected to the unwinding reel influences the field of the motor driving the winding reel so as to produce a peripheral velocity of the winding reel equal to the peripheral velocity of the rolls.

5. A control system for reversing strip rolling mills and the like having thickness reducing rolls and a pair of reels arranged on opposite sides of the rolls so that during one pass one reel acts as a winding reel and the other acts as an unwinding reel, a motor for driving said rolls, a pair of motors each provided with a field winding, each connected to drive one of said reels, a variable voltage generator for supplying all of said motors, means for reversing the rotation of all of said motors so that during succeeding passes each of said reels acts alternately as winding and unwinding reel, a pair of pilot generators designed to generate voltages linearly proportional to their speeds, each connected to be driven by one of said reels and having its armature connected to the field winding of the motor connected to the other of said reels whereby the speed of the motor driving the winding reel is varied so that the linear speed of the strip at the periphery of the coil of the winding reel is equalized with the speed of the strip emerging from said rolls.

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