Sept. 10, 1940. W. G. COOK 2,214,577

ROLLING MILL CONTROL

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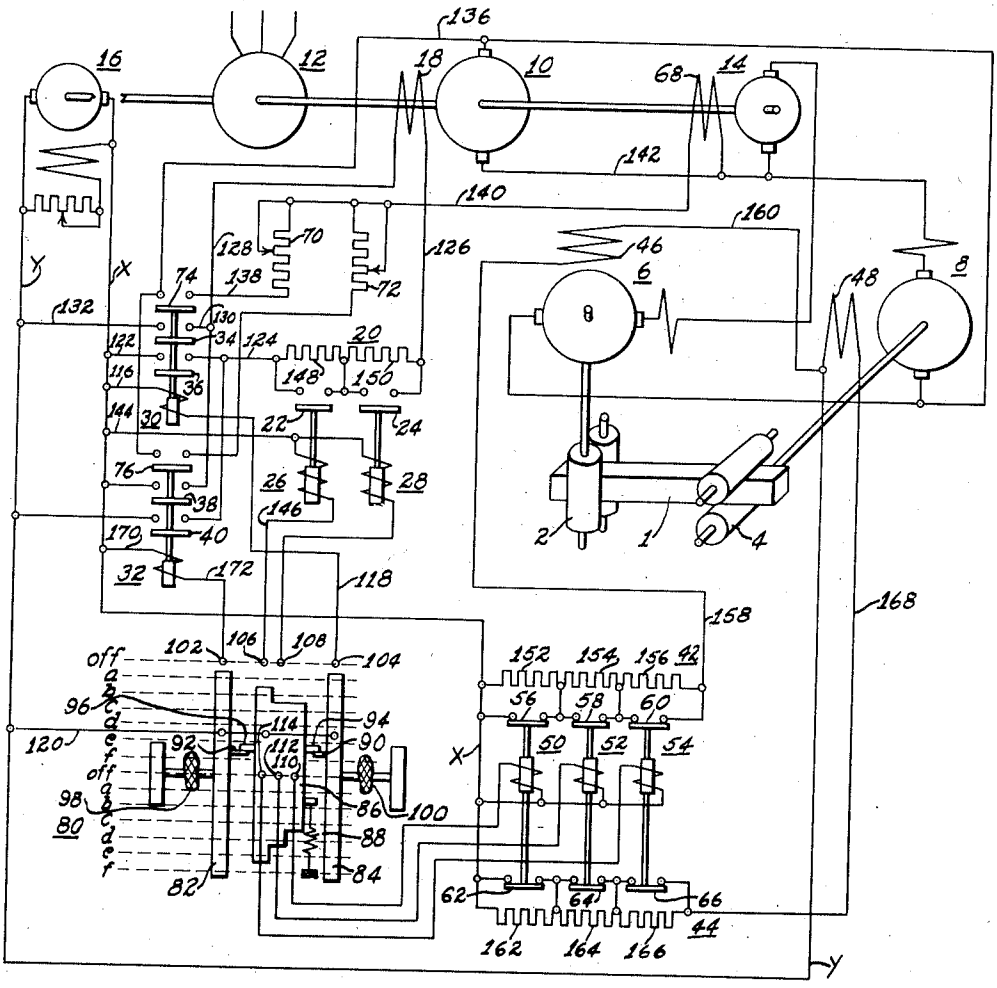


Fig. 1.

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ROLLING MILL CONTROL

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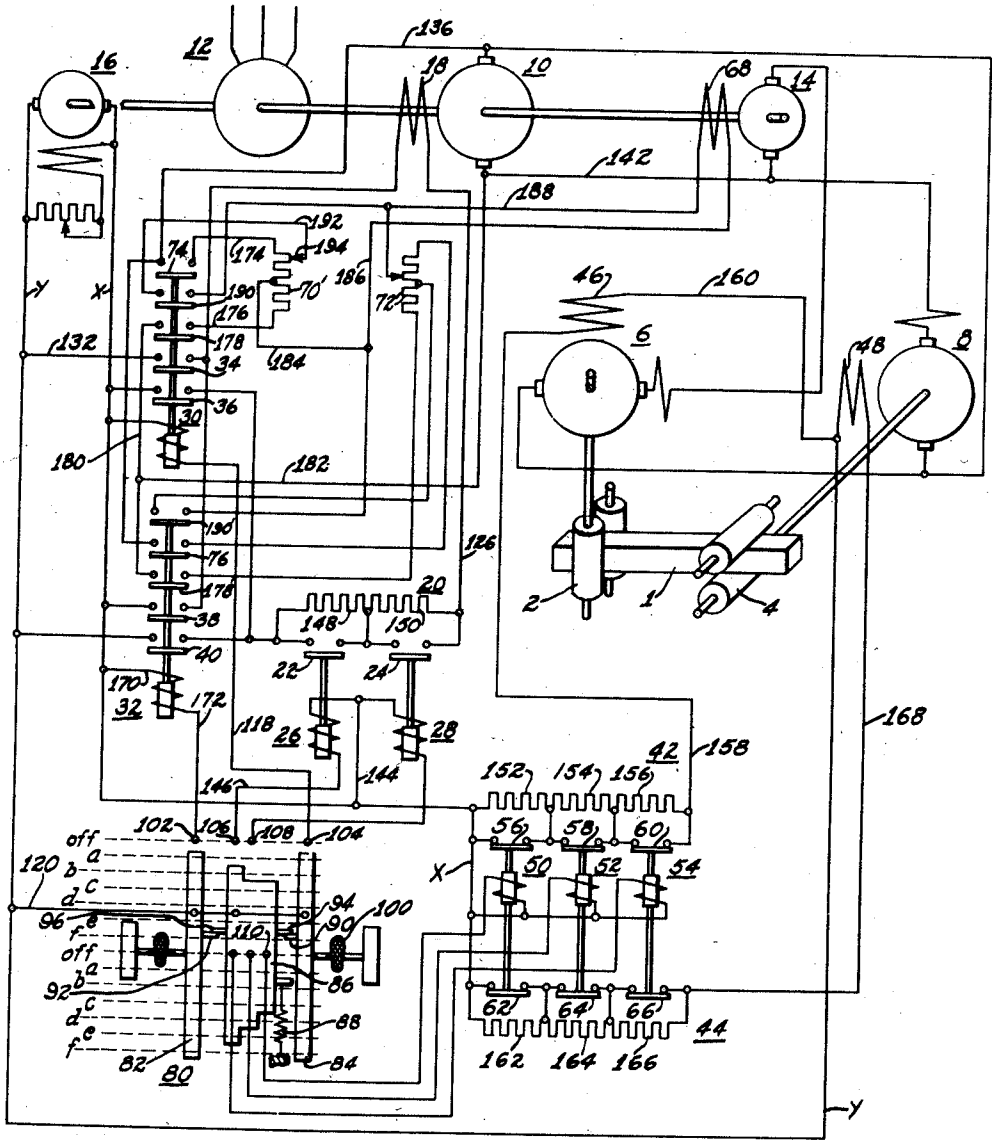


Fig. 2.

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2,214,577

ROLLING MILL CONTROL

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Application December 30, 1937, Serial No. 182,493

9 Claims. (Cl. 172—239)

My invention relates, generally, to rolling mill control systems and, more particularly, to a system of control for maintaining the desired peripheral speed relations between the main rolls and the edger rolls of slabbing or structural steel mills.

In the operation of slab rolling mills and structural steel rolling mills, the reduction of the steel is made in the main rolls which are usually horizontal rolls, and edger rolls are provided to keep the edge of the slab straight. The edger rolls are usually vertical rolls and produce very little reduction in the slab width. The edger and main rolls are mounted close to each other, and the slab is passed back and forth through the two sets of rolls and is engaged by both sets of rolls simultaneously throughout the greater portion of each pass, the slab being reduced in thickness on each pass through the main rolls.

Since the slab is reduced in thickness as it passes through the main rolls, it will be seen that the delivery speed of the slab as it leaves the main rolls will be greater than the entry speed. This difference in entry and delivery speeds depends upon the percentage reduction of the slab in the main rolls, the ratio of entry speed to delivery speed being substantially the ratio of delivery thickness to entry thickness of the slab. The peripheral speed of the main roll is substantially the delivery speed of the slab from the main roll, and both the entry speed and the delivery speed at the edger roll are substantially equal to the peripheral speed of the edger rolls.

With these conditions in mind, it will be readily seen that the peripheral speeds of the main rolls and the edger rolls will be substantially the same while the slab is passing through the mill in the direction of main roll to edger roll. However, when the slab is being passed in the direction of edger roll to main roll, the peripheral speed of the main roll will have to be greater than the peripheral speed of the edges roll, since the delivery speed from the main roll is much greater than the delivery speed from the edger roll. This difference in peripheral speeds will be a function of the degree of reduction of the slab in the main rolls.

In the operation of the slabbing mill, it is necessary that the end of the slab be started into the rolls slowly and then accelerated to operating speed. This makes it necessary that the edger rolls be accelerated at the same rate as the main rolls in order that their peripheral speeds may have the necessary ratio at all times during the rolling operation.

The main roll motors for slabbing mills are usually built to operate with a speed range from one-half to full speed by field control. This makes it necessary that the edger roll motor have a speed range much greater than that of the main motor, since the edger motor must have a speed that will correspond to the main roll motor speed when the slab is passing from the main rolls to the edger rolls, and a lower speed when the slab is passing from the edger rolls to the main rolls. The main and edger rolls may be of different diameters, and the difference in their diameters will vary as the rolls are turned down to true them up after they become worn. This necessitates a variation in the speed relations of the driving motors for the main and edger rolls, since the peripheral speeds of the rolls have the same speed relation for a given percentage reduction regardless of the roll diameters. When it is desired to change the percentage reduction, it is necessary that the speed relations of the roll motors be changed to provide the change in peripheral speed relations of the main and edger rolls. These factors all contribute to necessitate that the edger roll motor have a much greater speed range than the main roll motor.

For the most economical design, motors requiring the same speed range by field control are designed to have their fields operated along substantially the same parts of the saturation curve, and it follows that such motors have substantially the same speed and acceleration characteristics as functions of field current. If, however, two motors are designed for widely different speed ranges by field control, it will be seen that for the same speed variation, the fields of the two motors will be operated on different slopes of the saturation curve, and, therefore, will have different speed and acceleration characteristics.

It will be seen, therefore, that, using economical motor design, it is not possible to secure the desired speed and acceleration characteristics of edger and main roll motors by field control, since these motors must have widely different speed ranges.

An object of my invention is to provide a control system for the roll motors of slabbing or structural steel rolling mills which shall function to provide the desired speed and acceleration characteristics for the motors.

Another object of the invention is to provide a control system for the roll motors of a rolling mill which shall function to provide the desired field controlled speed and acceleration characteristics of the motors while compensating for the

wide difference in the speed ranges of the motors.

Another object of the invention is to provide a control system for the roll motors of a rolling mill which shall function to provide a relatively wide motor speed range for a motor having a relatively narrow speed range by field control and having a relatively high ratio of torque to armature inertia.

Another object of the invention is to provide a control system for the roll motors of a rolling mill which shall function to provide a relatively wide motor speed range for a motor having a relatively narrow speed range by field control to thus secure good commutation at the higher speeds.

A further object of the invention is to provide a control system for the roll motors of a rolling mill which shall function to provide the desired field controlled speed and acceleration characteristics of the motors while providing for the variations in the difference in speeds of the rolls occasioned by the change in direction of pass, changes in roll diameters, and changes in percentage of reduction in the rolls.

These and other objects and advantages of my invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a slabbing mill showing the cooperative relationships of the essential elements of the mill with a preferred embodiment of my invention applied thereto; and

Fig. 2 is a diagrammatic illustration of a modification of the system shown in Fig. 1.

In practicing my invention, I provide field control for the edger and main roll motors of a slabbing or structural steel rolling mill in the upper part of their speed ranges, and armature control in the lower or accelerating part of their speed ranges. An auxiliary generator whose voltage is proportional to the voltage applied to the main roll motor is connected in series circuit with the edger roll motor to give the edger motor additional armature voltage speed control to compensate for the difference in the required radial speeds of the edger and main rolls. This additional generator voltage is varied with the pass direction to provide the different ratio of peripheral speeds of the edger and main rolls for the two directions of pass, and the two booster voltages provided for the two pass directions may be varied to compensate for changes in roll diameter when the rolls are turned down to true them up after they are worn, and to compensate for changes in the percentage reduction of the slab in the main rolls.

The auxiliary generator may be a boost-and-buck, a boosting or a bucking generator depending upon the voltage rating of the edger roll motor.

Referring now to the drawings, in Fig. 1 there are shown edger rolls 2 and main rolls 4 of a slabbing mill driven by motors 6 and 8, respectively. Power for driving the motors 6 and 8 is provided by the common generator 10, which is continuously driven by the motor 12. An auxiliary generator 14 is connected to be continuously driven by the motor 12 and is electrically connected in series circuit relation with the generator 10 and the edger motor 6. The motor 8 is connected directly across the generator 10.

Excitation for the roll motors 6 and 8 and the generator 10 is provided by the exciter generator 16, which is continuously driven by the motor 12.

Speed control for the motors 6 and 8 from zero speed to approximately one-half their maximum speed is provided by varying the voltage of the generator 10 by varying the excitation of its field winding 18 by means of the variable resistance 20. The variation of the voltage of generator 10 affects the speed of both motors 6 and 8 and in addition the field excitation of generator 14 to cause the motors to run at different speeds as will be fully explained hereinafter. The variable resistance 20 is governed by contact elements 22 and 24 of relays 26 and 28, respectively. Reversal of the roll motors 6 and 8 is accomplished by reversing the polarity of the output of generator 10 by reversing the direction of current flow through its field winding 18. This is accomplished by the selector relays 30 and 32 through their contact elements 34, 36, 38 and 40, respectively.

The speed of roll motors 6 and 8 by field control from approximately one-half to maximum speed is provided by varying the excitation of the motors 6 and 8 by means of the variable resistances 42 and 44 connected in circuit with their field coils 46 and 48, respectively. The relays 50, 52 and 54 control the variable resistance 42 by means of contact elements 56, 58 and 60, respectively, and control the variable resistance 44 by means of contact elements 62, 64 and 66, respectively.

The auxiliary generator 14 is so connected in circuit with motor 6 and generator 10 that its voltage will buck that of generator 10, and the resultant potential acting upon motor 6 will be the difference between the potentials of generators 10 and 14.

The field winding 68 of the auxiliary generator 14 is connected to be energized by the generator 10 in series circuit with either variable resistance 70 or variable resistance 72. The selector relay 30 connects the variable resistance 70 in series circuit with the field winding 68 of generator 14 through its contact element 74 in one direction of pass, and the selector relay 32 connects the variable resistance 72 in this circuit by means of contact element 76 in the other direction of pass.

A controller 80 is provided for selecting the direction of pass and for selectively varying the speed of the roll motors 6 and 8. The controller 80 comprises movable contact elements 82, 84 and 86, the element 86 being biased to the position shown in the drawing by means of a spring 88 and may be moved forward against the bias of spring 88 by means of lugs 90 and 92 extending from contact elements 84 and 82, respectively, and cooperating with lugs 94 and 96 of the contact element 86. Contact elements 82 and 84 may be actuated by the usual left and right foot control pedals 98 and 100.

The controller 80 has six operating positions. In the first position *a*, either the contact element 82 or 84, depending upon the desired direction of rotation of motors 6 and 8, is moved into engagement with contact element 102 or 104 to energize selector relay 32 or 30. Further forward movement of the controller 80 by the foot pedal 98 or 100 to the position *b* will cause contact element 86 to engage contact element 106 to energize relay 26. In the next position *c*, the contact element 86 will engage contact element 108 to energize relay 28. Further movement of the controller 80 to the position *d* will move contact element 86 from engagement with contact element 110 to deenergize relay 50. In the *e* position, contact element 86 will be moved from engagement with contact element 112 to deenergize relay 52, and in the

f position, contact element **86** will be moved from engagement with contact element **114** to deenergize relay **54**.

In the operation of the device, the resistance element **70** is so adjusted to provide an excitation of the auxiliary generator **14** such as to produce a potential output of generator **14** which will give a ratio between the voltage of the generator **10** and the resultant of the voltage of the generator **10** and generator **14** equal to the ratio of the speed of main roll motor **8** and the speed of edger roll motor **6** necessary to produce substantially equal peripheral speeds of the main roll **4** and edger roll **2**, taking into account the difference in diameters of the main roll **4** and edger roll **2** and whatever gear train may be connected between the motors and the rolls driven by them.

Variable resistance **72** is so adjusted as to provide such excitation for the generator **14** as will provide a voltage output of generator **14** which will give a ratio of the voltage of generator **10** to the resultant of the voltage of generator **10** and the voltage of generator **14**, equal to the ratio of the speed of main roll motor **8** to the speed of edger roll motor **6** necessary to produce a peripheral speed of main roll **4** substantially equal to the delivery speed of the slab from the main rolls, and a peripheral speed of edger roll **2** substantially equal to the entering speed of the slab to the main roll **4**, taking into account the difference in the diameters of the main roll **4** and the edger roll **2**, whatever gearing may be between the motors and the rolls driven by them, and the percentage reduction of the slab in the main roll **4**.

When the resistance elements **70** and **72** have been properly adjusted, and assuming that the first pass is to be made in the direction of main roll to edger roll, the controller **80** is moved to the position *a* by means of foot pedal **100** to close the circuit through the selector relay **30** which extends from conductor X of the excitation source, through conductor **116**, the coil of relay **30**, conductor **118**, contact elements **104** and **84**, and conductor **120** to the conductor Y of the excitation source.

The energization of relay **30** will cause contact elements **34** and **36** of relay **30** to close an energizing circuit for the field winding **18** of generator **10** which extends from conductor X, through conductor **122**, contact element **36**, conductor **124**, variable resistance **20**, conductor **126**, field winding **18**, conductor **128**, conductor **130**, contact element **34** of relay **30**, and conductor **132** to conductor Y.

The energization of relay **30** will also cause its contact elements **74** to close an energizing circuit for the field winding **68** of the auxiliary generator **14** which extends from conductor **136** connected to one side of the generator **10**, through contact element **74**, conductor **138**, variable resistance **70**, conductor **140**, field coil **68**, and the conductor **142** connected to the other side of the generator **10**.

Under these conditions, it will be seen that the generator **10** will be excited by a small amount of field current, the amount depending upon the total resistance of variable resistance **20**, and the generator **10** will be applying a voltage to main roll motor **8** proportional to its field excitation. At the same time, the generator **14** will be generating a potential proportional to the output voltage of generator **10** and determined by the setting of the variable resistance **70**, and the potential acting upon edger roll **6** will be the difference between the potential of generator **10** and the potential of generator **14**. Under these conditions, the motors **6** and **8** will be rotating at such speeds as to provide substantially equal peripheral speeds of rolls **2** and **4**.

As the controller **80** is moved to the *b* position, relay **26** will be energized through a circuit comprising conductor X, conductor **144**, relay **26**, conductor **146**, contact elements **106** and **86** and conductor **120** to the conductor Y. The closure of relay **26** will cause its contact element **22** to short circuit a portion **148** of variable resistance **20** to increase the excitation of generator **10** by decreasing the resistance in its circuit of its field coil **18**. The increased potential output of generator **10** will cause a proportionate increase in the voltage of generator **14** and will increase the potentials applied to the motors **8** and **6** with the ratio of the potentials applied to these motors remaining substantially the same, thus increasing the speed of the rolls **4** and **2** while maintaining the peripheral speeds of rolls **4** and **2** equal.

In a like manner, the movement of the controller **80** to the position *c* will effect the energization of relay **28** and cause its contact element **24** to short circuit the portion **150** of the variable resistance **20** to further increase the voltage of generator **10** and thus increase the speeds of the motors **6** and **8**.

At this stage of the operation of the system, the voltage of generator **10** will be a maximum and in practice this potential will be approximately 700 volts. At the same time, the motors **6** and **8** will be receiving their maximum excitation from their field windings **46** and **48**, the circuit of the field winding **46** of motor **6** extending from conductor X, through contact elements **56**, **58** and **60** of relays **50**, **52** and **54**, respectively, in short circuit relation with the portions **152**, **154** and **156** of variable resistance **42**, conductor **158**, field winding **46**, and conductor **160** to conductor Y. The circuit for the field winding **48** of the motor **8** extends from conductor X through the contact elements **62**, **64** and **66** of relays **50**, **52** and **54**, respectively, in short circuit relation with the portions **162**, **164** and **166** of the variable resistance **44**, conductor **168** and field winding **48** to the conductor Y.

For further speed control of the motors **6** and **8** the controller **80** is moved to the *d* position to disengage the contact elements **86** and **110**, resulting in the deenergization of relay **50** and the removal of contact elements **56** and **62** of relay **50** from short circuit relation with the portions **152** and **162** of variable resistances **42** and **44**. This increase in resistance in circuits of the field windings **46** and **48** will cause the motors **6** and **8** to increase their speeds, and the portions of resistance **152** and **162** are so proportioned as to cause the excitations of motors **6** and **8** to vary along the same portions of their saturation curves, thus maintaining the same acceleration of motors **6** and **8** in producing the desired ratio between their resultant speeds.

In like manner, the movement of the controller **80** to the *e* and *f* positions will further decrease the excitation of the motors **6** and **8** by removing the shorting circuits from the corresponding resistance sections in their field circuits, and in like manner the corresponding resistance sections in the field circuits of motors **6** and **8** are so designed as to cause the excitations of the motors **6** and **8** to vary along the same portions of their saturation curves.

When the slab **1** has passed through both main

and edger rolls in the direction of main roll to edger roll, the right foot pedal 100 is returned to its starting position, permitting spring 88 to return contact element 86 to the normal "off" position shown in Fig. 1, resulting in the reenergization of relays 50, 52 and 54 and the deenergization of relays 30, 26 and 82. The slab is next passed through the mill in the opposite direction of edger roll to main roll 4 by reversing the direction of rotation of the roll motors 6 and 8. This is accomplished by actuating the left foot pedal 98 to move the controller 80 to the *a* position. In this position selector relay 32 is energized through a circuit comprising conductor X, conductor 170, the coil of relay 32, conductor 172, contact elements 102 and 82 and conductor 120 to conductor Y. The energization of relay 32 will cause its contact elements 38 and 40 to move to closed circuit position to close a circuit from the source of excitation through the field winding 18 of generator 10 to excite the field winding 18 with a polarity opposite to that provided by the selector relay 30, as discussed hereinbefore. The energization of relay 32 will also move its contact element 76 to closed circuit position to connect the resistance element 72 in circuit with the field winding 68 of the generator 14 in place of the resistance 70.

The controller 80 may now be moved to positions *b*, *c*, *d*, *e* and *f* in succession to accelerate the motors 6 and 8 and to provide the desired mill speed in this reverse direction, substantially as described hereinbefore, in connection with the control of the speeds of the mill by means of the right foot pedal 100. Thus it is seen six speeds are provided for the mill, three speeds by armature control by varying the potential applied to the armature of the roll motors 6 and 8, and three additional speeds by varying the field excitation of the roll motors 6 and 8. The armature voltage controlled speeds will normally be the accelerating speeds used in bringing the mill motors up to their normal base speeds and the field control speeds will be those used to secure the desired speed of rolling after the rolls have been accelerated to their base speeds.

The modification of the invention shown in Fig. 2 operates in substantially the same manner as that of Fig. 1, with the exception that potentiometer type variable resistances 70′ and 72′ have been substituted for the variable resistances 70 and 72 of the device of Fig. 1. The same reference characters have been applied to the corresponding elements in the two figures. The potentiometer type variable resistance 70′ is connected across the armature of the generator 10 by conductor 136 connected to one side of the generator 10, contact element 74 of relay 30, conductor 174, variable resistance 70′, conductor 176, contact element 178, conductor 180, and conductor 182 to the other side of the generator 10. The field winding 68 of auxiliary generator 14 is connected to be influenced by the potential drop across the variable resistor 70′ through a circuit which comprises conductor 184 connected to the midpoint of the resistor 70′, conductor 186, the field winding 68, conductor 188, contact element 190 and conductor 192 to the variable contact element 194 of the resistor 70′. It will be seen that the contact element 194 may be moved along resistor 70′ to vary the potential applied to the field winding 68, the polarity of this potential being reversed and the potential passing through zero as the contact element is moved from one side of the midpoint of the resistor 70′ to the other. By the use of this means for varying the excitation of auxiliary generator 14, the auxiliary generator 14 need not have as high a potential rating as the auxiliary generator 14 described in connection with the apparatus of Fig. 1, since the same voltage range may be produced by the generator 14 by making the range of its potential output from its maximum negative value to its maximum positive value substantially equal to the range required by the generator 14 used in connection with the device of Fig. 1 from zero to its maximum potential. Thus, for example, where the range of the potential generated by the generator 14 of the device in Fig. 1 may be required to be from zero to 400 volts, substantially the same effect may be produced by the auxiliary generator 14 of the device of Fig. 2 by merely varying its potential output from negative 200 to positive 200, thus requiring that the potential rating of the auxiliary generator 14 of the device of Fig. 2 be only one-half that of the corresponding generator of the device of Fig. 1.

The selector relay 32 is actuated when the direction of the mill is reversed and operates through its contact elements 190′, 76 and 178′ to connect the potentiometer type resistance 72′ to provide the proper potential for the field winding 68 of the generator 14. While the mill is operating in this reversed direction, the operation of the rest of the system of Fig. 2 is the same as that described in connection with that described in Fig. 1.

It is to be understood that the principle of speed control herein described may be applied to any number of motors the ratios of whose speeds it is desired to maintain constant. For instance, in case the rolls of the hereinbefore described mill are driven by individual motors, the pairs of motors for the pairs of rolls may be connected in parallel relation to secure the desired control. In a mill having more than two sets of rolls, the driving motors of which must have different speeds, the difference in speeds could be obtained by a booster for each of the motors, or all except one of the motors, each booster excitation being varied according to the desired speed ratios in accordance with the principles hereinbefore set out in detail.

It will be seen that I have provided a system of control for the edger and main roll motors of a slabbing mill which will function to provide similar speed and acceleration characteristics for the two motors through the accelerating period of the motors from zero to approximately one-half their full speeds, and through their field controlled speed range from approximately one-half to full speed to maintain the proper peripheral speed relation between the edger rolls and the main rolls while the mill is accelerating and while it is running at full speed, taking into account the difference in the diameters of the main and edger rolls, the percentage of reduction of the slab in the main roll, and the direction of pass of the slab through the mill.

In compliance with the requirements of the patent statutes, I have shown and described herein the preferred embodiments of my invention. It is understood, however, that the invention is not limtied to the precise construction shown and described, but is capable of modification by one skilled in the art, the embodiments herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a control system for maintaining a pre-

determined ratio between the speeds of a pair of motors, means for applying a first variable voltage to the motors, means for applying a second voltage in tandem with the first voltage to the second motor, means for varying the second voltage proportionately with the first voltage, and means for selectively varying the second voltage in amount and polarity.

2. In a control system for a pair of motors for producing a constant ratio between the motor speeds when they are rotating in the forward direction and a different constant ratio between the motor speeds when they are rotating in the reverse direction, a source of variable voltage, means connecting one of the motors directly to said source, a generator, means connecting the other motor to said source in series circuit relation with said generator, means for varying the voltage output of said generator proportionately with the variations of the source voltage, and means for causing the voltage output of said generator to vary different amounts as the motors are rotating in the forward and reverse directions.

3. In a control system for a pair of motors for producing a constant ratio between the motor speeds when they are rotating in the forward direction and a different constant ratio between the motor speeds when they are rotating in the reverse direction, a source of variable voltage, a generator, means connecting one of the motors directly to said source, means connecting the other motor to said source in series circuit relation with said generator, means for varying the voltage output of said generator proportionately with the variations of the source voltage, means for causing the voltage output of said generator to vary different amounts as the motors are rotating in the forward and reverse directions, and means for causing the field excitation of the motors to vary simultaneously along corresponding portions of their saturation curves.

4. In a slabbing mill in which a common generator provides a source of variable reversible voltage for reversibly driving the edger roll motor and the main roll motor at variable speeds, the combination, of an auxiliary generator connected in series circuit relation with one of the motors and the common generator, means whereby the polarity of said auxiliary generator is reversed upon reversal of the polarity of the common generator, means whereby the voltage output of said auxiliary generator varies proportionately with variations of voltage of the common generator, and means for selectively providing a different ratio of main generator voltage to auxiliary generator voltage for the two directions of rotation of the motors.

5. In a slabbing mill in which a common generator provides a source of variable reversible voltage for reversibly driving the edger roll motor and the main roll motor at variable speeds, the combination, of an auxiliary generator connected in series circuit relation with one of the motors and the common generator, means whereby the polarity of said auxiliary generator is reversed upon reversal of the polarity of the common generator, means whereby the voltage output of said auxiliary generator varies proportionately with variations of voltage of the common generator, means for selectively providing a different ratio of main generator voltage to auxiliary generator voltage for the two directions of rotation of the motors, and means for selectively providing a different ratio between the amounts of the auxiliary generator voltages in the two directions of rotation of the motors.

6. In a slabbing mill in which a common generator provides a source of variable reversible voltage for reversibly driving the edger roll motor and the main roll motor at variable speeds, the combination of an auxiliary generator connected in series circuit relation with one of the motors and the common generator, means whereby the polarity of said auxiliary generator is reversed upon reversal of the polarity of the common generator, means whereby the voltage output of said auxiliary generator varies proportionately with variations of voltage of the common generator, means for selectively providing a different ratio of main generator voltage to auxiliary generator voltage for the two directions of rotation of the motors, and means for causing the field excitation of the motors to vary simultaneously along corresponding portions of their saturation curves.

7. In a slabbing mill in which a common generator provides a source of variable reversible voltage for reversibly driving the edger roll motor and the main roll motor at variable speeds, the combination, of an auxiliary generator connected in series circuit relation with one of the motors and the common generator, means whereby the polarity of said auxiliary generator is reversed upon reversal of the polarity of the common generator, means whereby the voltage output of said auxiliary generator varies proportionately with variations of voltage of the common generator, means for selectively providing a different ratio of main generator voltage to auxiliary generator voltage for the two directions of rotation of the motors, means for selectively providing a different ratio between the amounts of the auxiliary generator voltages in the two directions of rotation of the motors, and means for causing the field excitation of the motors to vary simultaneously along corresponding portions of their saturation curves.

8. In a system for so controlling the main and edger roll motors of a slabbing mill, having a common energizing generator of variable voltage and reversible polarity, as to provide the desired motor speed relations and acceleration characteristics throughout a wide range of relative speeds of the motors, in combination, an auxiliary generator connected in series circuit relation with the edger motor and the common generator, means connecting the second motor directly across the common generator, a first variable resistance and a second variable resistance, means whereby said first resistance is connected in series circuit relation with the common generator and the field winding of said auxiliary generator when the polarity of the common generator is such as to cause the motors to rotate in the direction of slab pass from edger rolls to main rolls, means whereby said second resistance is connected in series circuit relation with the common generator and the field winding of said auxiliary generator when the polarity of the common generator is such as to cause the motors to rotate in the direction of slab pass from main rolls to edger rolls, means for so adjusting said first resistance as to cause said auxiliary generator to generate a voltage such that the ratio of the common generator voltage to the combined common generator voltage and auxiliary generator voltage will be that necessary to compensate for slab reduction in the main rolls and differences in the diameter of the main rolls and

edger rolls and to thus produce the peripheral speeds of the edger and main rolls substantially equal to the delivery speeds of the slab from the edger and main rolls during the pass from the edger rolls to the main rolls, and means for so adjusting said second resistance as to cause said auxiliary generator to generate a voltage such that the ratio of the common generator voltage to the combined common generator voltage and auxiliary generator voltage will be that necessary to compensate for differences in the diameters of the main rolls and edger rolls and to thus produce substantially equal main roll and edger roll peripheral speeds during the pass from the main rolls to the edger rolls.

9. In a system for so controlling the main and edger roll motors of a slabbing mill, having a common energizing generator of variable voltage and reversible polarity, as to provide the desired motor speed relations and acceleration characteristics throughout a wide range of relative speeds of the motors, in combination, an auxiliary generator connected in series circuit relation with the edger motor and the common generator, means connecting the second motor directly across the common generator, a first variable resistance and a second variable resistance, means whereby said first resistance is connected in series circuit relation with the common generator and the field winding of said auxiliary generator when the polarity of the common generator is such as to cause the motors to rotate in the direction of slab pass from edger rolls to main rolls, means whereby said second resistance is connected in series circuit relation with the common generator and the field winding of said auxiliary generator when the polarity of the common generator is such as to cause the motors to rotate in the direction of slab pass from main rolls to edger rolls, means for so adjusting said first resistance as to cause said auxiliary generator to generate a voltage such that the ratio of the common generator voltage to the combined common generator voltage and auxiliary generator voltage will be that necessary to compensate for slab reduction in the main rolls and differences in the diameter of the main rolls and edger rolls and to thus produce the peripheral speeds of the edger and main rolls substantially equal to the delivery speeds of the slab from the edger and main rolls during the pass from the edger rolls to the main rolls, means for so adjusting said second resistance as to cause said auxiliary generator to generate a voltage such that the ratio of the common generator voltage to the combined common generator voltage and auxiliary generator voltage will be that necessary to compensate for differences in the diameters of the main rolls and edger rolls and to thus produce substantially equal main roll and edger roll peripheral speeds during the pass from the main rolls to the edger rolls, and means for causing the field excitation of the motors to vary simultaneously along corresponding portions of their saturation curves.

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