Sept. 17, 1935. G. N. HUGHES 2,014,475

AUTOMATIC SCREW-DOWN CONTROL FOR ROLLING MILLS

Filed Jan. 12, 1932 3 Sheets-Sheet 1

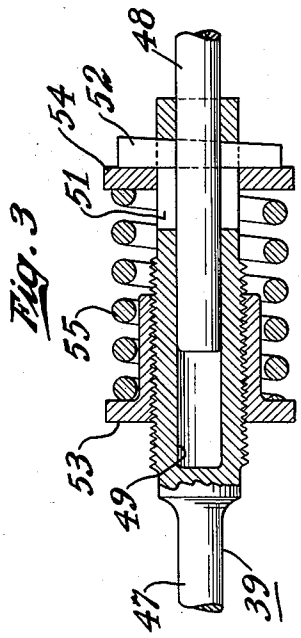


Fig. 3

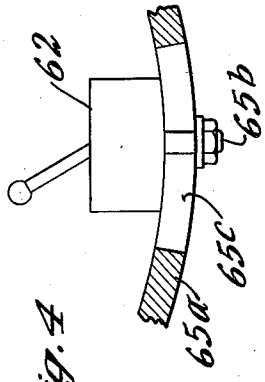
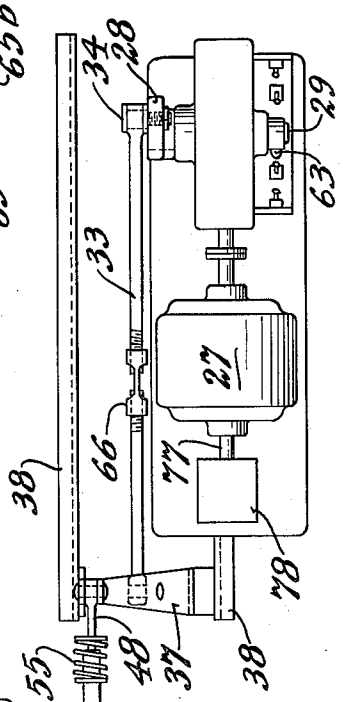


Fig. 4



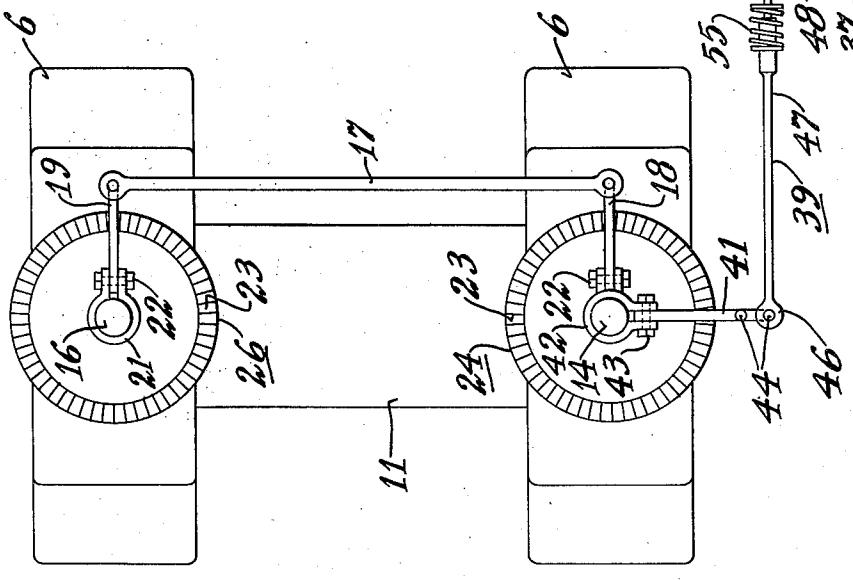


Fig. 1

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Fig. 2

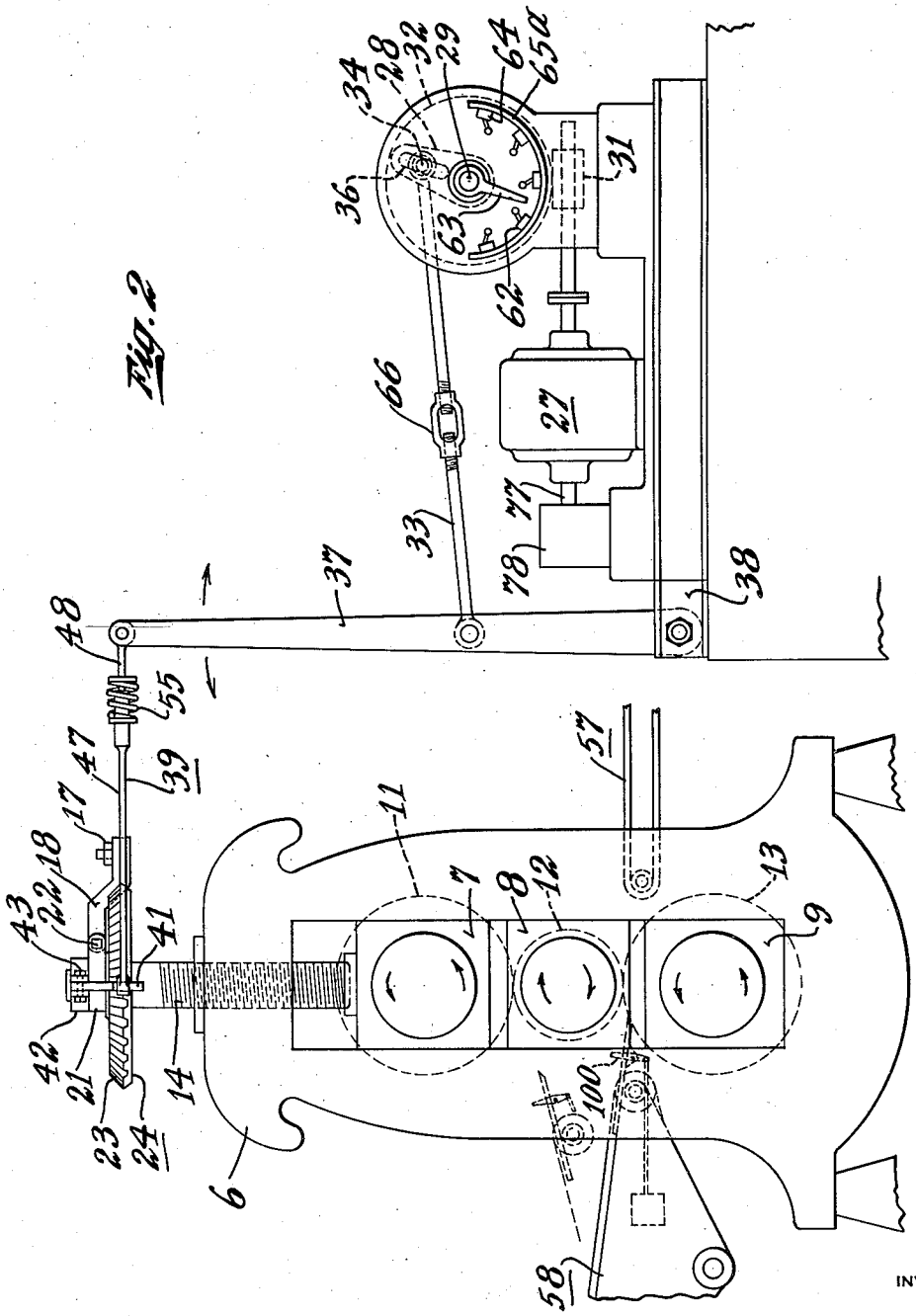

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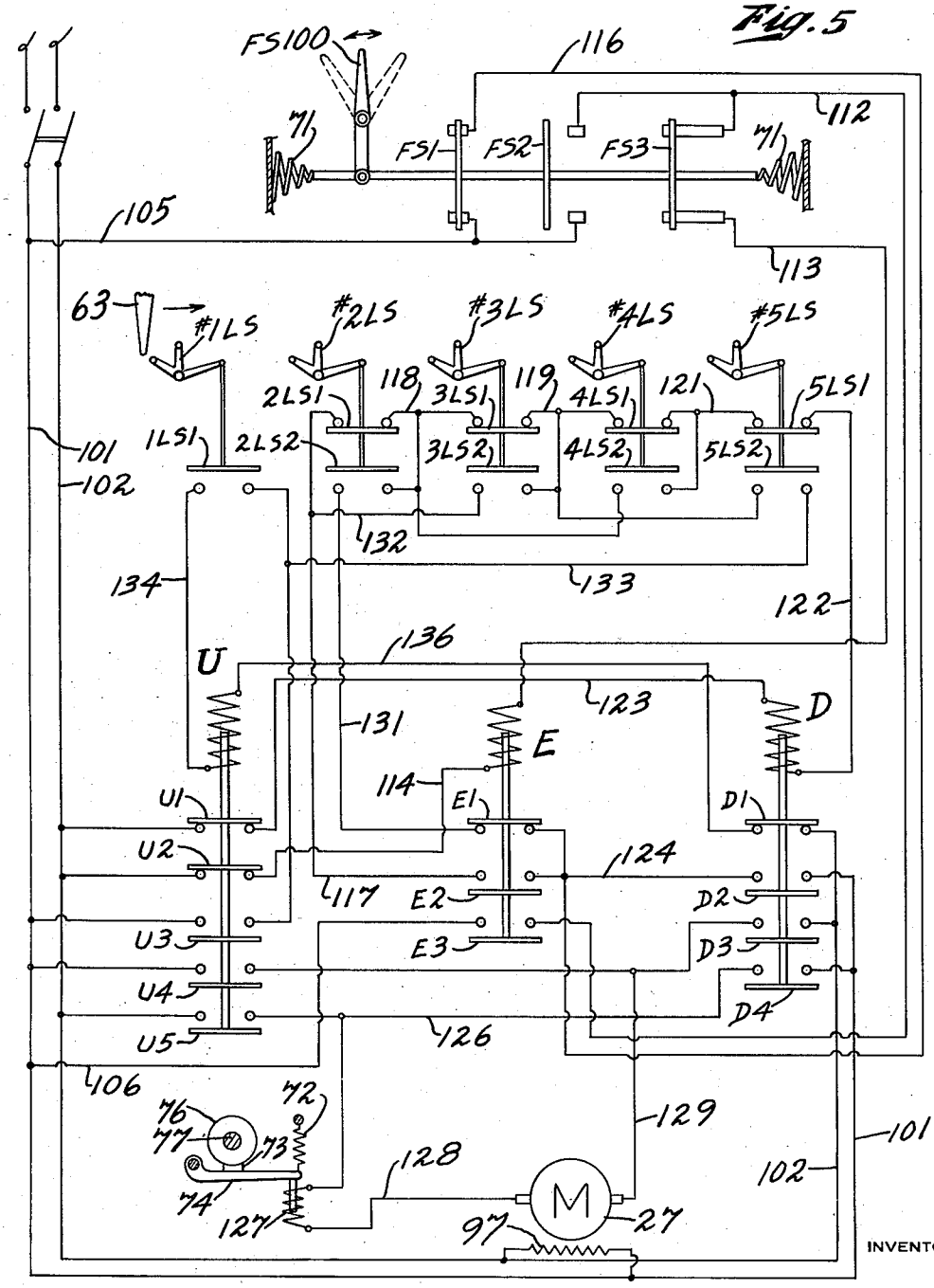
Fig. 5



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AUTOMATIC SCREW-DOWN CONTROL FOR ROLLING MILLS

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Application January 12, 1932, Serial No. 586,223

5 Claims. (Cl. 80—56)

My invention relates to sheet metal rolling mills and is concerned with improvements in screw-down mechanism for adjusting the mill rolls.

An object of my invention is to provide novel, precise and efficient means for actuating roll adjusting screws or screw-downs so that sheets, bars, or sheet packs as they pass back and forth between the rolls will control automatically the quick and accurate setting of the rolls so as to move the latter closer and closer together until the cycle of rolling operations is completed, whereupon the rolls are reset to full open position so that the same cycle of operations, or any desired variation thereof, may be resumed.

It is a further object that the automatic control of the roll adjusting means shall be coordinated with the control, by the rolled stock, of the automatic operation of the mechanical sheet catchers and feed tables to the end that the operation of the mill as a whole shall be automatically controlled by the rolled stock and a saving in labor and improvement in standardization of output obtained.

Another object of my invention is to provide a screw-down mechanism adapted to exert its greatest force upon the rolls to set them in engagement with each other for the final pass of the stock. With the increasing power available to thus set the rolls I attain an increasing accuracy of adjustment which is of greatest importance as applied to the finishing pass.

A further object of my invention is to provide means adapted to prevent the breakage of parts of the screw-down mechanism when the rolls are brought into engagement with each other for the final pass of the stock through the rolls.

A further object is to provide great flexibility and accuracy of roll adjustment by utilizing a reversible crank motion with transmission elements designed to provide for a variable crank throw and a ready change total movement of the head screws, intermediate roll positions being controlled by adjustable limit means to stop the crank for each pass position.

Briefly my invention comprises a reversible motor acting through suitable speed reduction gearing to drive a crank through a partial rotation which in turn acts through an adjustable driving rod, a lever, and a yielding connecting link to actuate the roll adjusting screws. As the stock passes through the rolls and onto the sheet catcher, it throws a switch which starts the motor. The motor circuit is broken by pass limit switches adjustably mounted in position to be automatically actuated by an arm on the crank shaft and to regulate the draft on individual passes. An electrically operated brake is wired in series with the motor circuit and acts to overcome quickly the momentum of the rotor when the circuit is broken. A switch controlled by the final discharge of the rolled stock acts to reverse the arm and reset the limit switches for the next complete cycle.

My invention further comprises the novel details of construction and arrangements of parts which in their preferred embodiment only are illustrated in the accompanying drawings which form a part of this specification, and in which:—

Fig. 1 is a plan view of a mill and the screw-down mechanism;

Fig. 2 is a side elevational view of same;

Fig. 3 is a sectional detail view of a safety coupling interposed in the connecting link;

Fig. 4 is a detail section of the adjustable mounting for a limit switch; and

Fig. 5 is a wiring diagram illustrating the manner in which the screw-down mechanism is controlled.

Referring now to the drawings for a better understanding of my invention, I show a mill frame 6 provided with bearings 7, 8 and 9, 7 and 8 being mounted for vertical movement, and rolls 11, 12 and 13 journaled in the bearings. The movement of the bearings 7 and 8 and the setting of the rolls to regulate the pass clearance, is controlled by adjustment head screws 14 and 16 which are threaded through the upper portion of the frame for engagement with the bearings 7. The rolls are driven in the direction indicated by the arrows by an electric motor (not shown).

After the screws, or screw-downs as they are commonly termed, have been properly adjusted with respect to each other, they are caused to move simultaneously by means of a tie bar 17 which is pivotally connected at the ends of tie bar arms 18 and 19. The arms are mounted on their respective screws by means of collars 21 and bolts 22 and adapted to be engaged at their outer ends between the teeth 23 formed in wheels 24 and 26 which are keyed to the screws.

The screw-downs are actuated by a reversible electric motor 27 which drives a crank arm 28 mounted on a crank shaft 29 through a worm 31 and worm gear 32. A driving rod 33 is pivotally connected at its one end to the crank arm, by means of a journal bolt 34 which is mounted in a radial slot 36 in the crank arm and can be adjusted to vary the crank throw. At its other end the rod 33 is connected to a lever 37. The lever 37 is pivotally connected at its lower end to a rigid

frame 38 and at its upper end to a connecting rod 39 which in turn is connected to a pivot arm 41 mounted on the screw 14.

The pivot arm 41 is secured to a collar 42 mounted on the screw 14 by a bolt 43 and is adapted to engage between the teeth 23 on the wheel 24 so as to rotate the screw when swung about its pivot. A pair of pins 44 are provided on the outer end of the pivot arm for engagement in an eye 46 formed on the end of the connecting rod 39, and thus I provide an additional means to vary the throw of the crank as applied to the screw-downs.

The connecting rod 39 is formed in two sections 47 and 48 yieldably connected by a safety coupling which is shown more clearly in Fig. 3 of the drawings. The end of the section 47 is enlarged and bored at 49 to receive the end of the section 48 and is slotted at 51 to receive a pin 52 secured in the section 48. The enlarged end of section 47 is threaded to receive a nut 53 which acts with a collar 54 to hold a spring 55 under compression and to resist relative axial movement between the sections.

Referring now to Fig. 2, I show a portion of a feed table 57 and a catcher table 58 which are shown and described in a copending application by A. G. Delany, filed on October 1st, 1931, Serial No. 566,230, and are adapted to act with the herein described apparatus to perform the rolling operation automatically. The stock to be rolled is carried on the feed table to the lower rolls and is received on the catcher table which returns the stock to the feed table through the upper rolls or over them as may be desired.

The motor 27 has a shunt field 97 connected across the leads 101 and 102 hereinafter described.

The motor 27 is started by a flag switch 100 which is actuated by the stock at the completion of each pass of the stock through the rolls and the motor is stopped by limit switches 62 which are opened by a control arm 63 mounted on the crank shaft 29. After the stock has completed the passes through the rolls, say by making five passes, the control arm will actuate a reversing switch 64 which sets the relay circuits so that the last operation of the flag switch 100 will reverse the motor and return the screw-down mechanism to its first position and reset the limit switches for the next cycle of passes. The limit switches 62 and 64 are adjustably mounted on a bracket 65*a* by means of bolts 65*b* passed through circumferential slots 65*c* as will be seen in Fig. 4. These switches are of standard toggle type and will remain in the position in which they are left by their control arm 63.

In setting up the screw-down mechanism, the screws 14 and 16 are adjusted to maintain the rolls parallel and are held in this adjusted position at all times by the tie bar 17 and the arms 18 and 19. The vertical movement of the screws is controlled by adjusting the journal bolt 34 along the slot 36 formed in the crank arm 28 and also by selecting the inner or outer pin 44 provided on the pivot arm 41. The initial vertical positions of the screws can be roughly adjusted by engaging the pivot arm 41 between different teeth 23 formed on the wheel 24, and a fine adjustment can be obtained by shortening or lengthening the driving rod 33 by means of a turn-buckle 66.

When rolling thin sheets of metal, the screw-downs are lowered to hold the rolls tightly in engagement with each other so I have provided the safety coupling in the connecting rod 39 to prevent the possibility of breakage or distortion of parts. As shown in Fig. 3, the section 48 is adapted to slide farther into the socket 49 against spring resistance which can be adjusted by the nut 53.

The screw-down mechanism is automatically controlled for five passes of the stock as follows, reference being had to Fig. 5 in the drawings. As the stock is carried by the feed table 57 to the lower rolls, the screws are in their raised or first position and are lowered to their second position when the flag switch 100 is actuated by the stock passing on to the catcher table 58.

When the stock strikes flag switch 100 in making the first pass it opens switch FS1, closes switch FS2, and switch FS3 remains closed, thereby energizing the set up relay E by closing a circuit through the leads 101, 105, switch FS2, lead 112, switch FS3, lead 113, relay E, lead 114, switch U2 to lead 102. When the relay E closes, a holding circuit is completed through the leads 101, 106, switch E3, lead 112, switch FS3, lead 113, relay E, lead 114, switch U2 to lead 102.

As the stock passes farther onto the catching table it eventually releases the flag switch 100 which is caused to resume its upright position by the springs 71 and to close switch FS1 and open switch FS2. When switch FS1 closes, a circuit is completed to the relay D through leads 101, 105, switch FS1, lead 116, switch E2, lead 117, switch 2LS1, lead 118, switch 3LS1, lead 119, switch 4LS1, lead 121, switch 5LS1, lead 122, relay D, lead 123, switch U1, to lead 102. When the relay D is thus energized it opens switch D1 and closes switches D2, D3 and D4. A holding circuit is then provided for the relay D through lead 101, switch D2, lead 124, switch E2, lead 117, switch 2LS1, lead 118, switch 3LS1, lead 119, switch 4LS1, lead 121, switch 5LS1, lead 122, relay D, lead 123, switch U1, to lead 102.

The closing of switch D3 and D4 complete a circuit to the motor 27 through lead 101, switch D4, lead 126, brake solenoid 127, lead 128, motor 27, lead 129, switch D3, to lead 102. The motor then acts to move the screw-downs downwardly into position for the second pass of the stock through the rolls during which, the control arm 63 actuates #1 limit switch to close switch 1LS1 and then actuates #2 limit switch to open switch 2LS1 and close switch 2LS2. When the switch 2LS1 opens, the circuit through relay D is broken causing the switches D3 and D4 to break the circuit leading to the motor 27 and to the brake solenoid 127.

When the motor circuit is broken the brake solenoid 127 is de-energized permitting a spring 72 to draw a brake shoe 73 mounted on a brake lever 74 into engagement with a brake drum 76 secured on the motor shaft 77, thereby quickly overcoming the momentum of the motor armature and bringing the screw-downs accurately to predetermined position for the next pass. The brake mechanism is mounted within a housing 78.

The screw-down mechanism is now in its second position and the stock is fed for its second pass from the catching table through the upper rolls and onto the feed table. As the stock leaves the catching table it moves the flag switch 100 to open the switches FS1 and FS3, and switch FS2 remaining open. When the switch FS3 opens, the circuit to the relay E is broken, thereby closing the switch E1 and opening the switches E2 and E3. After the stock leaves the catching table, the flag switch is restored to its upright position

by the springs 71 thereby closing switches FS1 and FS3.

The switch FS1 now closes a circuit leading to the relay D through leads 101, 105, switch FS1, lead 116, switch E1, lead 131, switch 2LS2, lead 118, switch 3LS1, lead 119, switch 4LS1, lead 121, switch 5LS1, lead 122, relay D, lead 123, switch U1, to lead 102. The relay D now acts to close the switches D3 and D4 to complete the circuit to the motor 27 as described before. After the motor has lowered the screw-downs for the third pass, the circuit leading to the relay D is broken by the control arm 63 actuating the #3 limit switch which opens the switch 3LS1 and closes the switch 3LS2. The de-energization of the relay D causes the switches D3 and D4 to open and break the motor circuit.

As the stock passes onto the catching table after the third pass, it depresses the flag switch 100 and completes a circuit to the relay E as described in connecting with the first pass of the stock onto the catching table. The relay D is energized, when the stock has passed far enough onto the catching table to permit the flag switch to assume its upright position, through the leads 101, 105, switch FS1, lead 116, switch E2, leads 117 and 132, switch 3LS2, lead 119, switch 4LS1, lead 121, switch 5LS1, lead 122, relay D, lead 123, switch U1, to lead 102. The relay D then closes the switches D3 and D4 to complete the circuit to the motor which acts to lower the screw-downs for the fourth pass. The motor is stopped by the control arm 63 striking the limit switch #4LS which opens the switch 4LS1 and breaks the circuit to the relay D which in turn opens the switches D3 and D4 to break the motor circuit.

As the stock passes off the catcher table for the fourth pass, the flag switch 100 is depressed causing the switch FS3 to open and break the circuit to the relay E. When the flag switch resumes its upright position, the relay D is energized through the leads 101, 105, switch FS1, lead 116, switch E1, lead 131, switch 2LS2, lead 118, switch 4LS2, lead 121, switch 5LS1, lead 122, relay D, lead 123, switch U1, to lead 102. The relay now closes the switches D2, D3 and D4 and opens switch D1. The switches D3 and D4 complete the circuit to the motor which lowers the screw-downs for the fifth and final pass and is stopped by the control arm 63 opening the switch 5LS1 which breaks the circuit to the relay D causing the switches D3 and D4 to open.

After the stock has passed through the rolls for the fifth or final pass, it depresses the flag switch 100, to complete a circuit to the relay E, and then passes over the catching table to a piling machine (not shown). When the flag switch 100 resumes its upright position, the relay U is energized through the leads 101, 105, switch FS1, lead 116, switch E2, leads 117 and 132, switch 3LS2, lead 119, switch 5LS2, lead 133, switch 1LS1, lead 134, relay U, lead 136, switch D1, to lead 102.

The switches U4 and U5 complete a circuit in a reverse direction through the motor armature to move the screw-downs upwardly into their raised position. As the control arm 63 travels in the reverse direction it resets each of the limit switches 5LS, 4LS, 3LS, 2LS and 1LS successively and causes the motor to stop when the #1 limit switch opens the switch 1LS1 and breaks the circuit to the relay U which in turn opens the switches U4 and U5 in the motor circuit.

The roll control mechanism is thus reset for a new cycle of passes and the adjustment of the rolls for each pass can be regulated by the position in which the limit switch for that pass is set in the bracket 65a. Also by the adjustment of limit switch 1LS the initial position of the screw-downs can be controlled. The extent of the full travel of the screw-downs can be controlled by the adjustment of the throw of the crank drive thereto in either or both ways I have provided for such an adjustment. The initial setting of the screw-downs can be controlled by the turnbuckle or by shifting the toothed wheels after releasing them from their actuating mechanisms by lifting pivot arm 41. Either screw-down may be independently set by lifting the tie bar arms 18 and 19. A greater or less number of passes may be provided for by using more or less limit switches 62 which to distinguish them in Fig. 5 are marked 1LS, 2LS etc.

The whole control mechanism for the rolls is automatic; it can be placed out of the way so as not to interfere with roll changes or repairs; it will through the brake stop the motor so quickly as to insure definite intermediate positions for pass control; and, due to the crank acting for the setting of the final pass as it closely approaches dead center position, I obtain great power for the adjustment and unusual accuracy for this most important pass as any given angular movement of the crank in this position imparts the least actuation to the mechanism for operating the screw-downs.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:—

1. In a rolling mill for rolling and re-rolling stock, said stock always passing through a given pass in the same direction having rolls and adjusting head screws therefor, means to actuate the head screws comprising a crank, a reversible motor to oscillate the crank, a transmission between said motor and crank, a series of limit switches, an arm movable with the crank to trip said switches and reset them as it oscillates, circuits containing switches and relays which are controlled by each limit switch to stop the motor, and means for controlling said circuits responsive to the movement of the rolled stock to start the motor and to reverse it.

2. In a rolling mill for rolling and re-rolling stock having adjusting head screws, driving means for the said head screws comprising a reversible motor and a crank driven thereby, and an operative connection with the said head screws, a series of limit switches controlling a series of electric circuits for starting, stopping and reversing the said motor, means integral with the said crank to actuate the said limit switches, the said switches being bodily adjustable according to any predetermined program.

3. In a rolling mill for rolling and re-rolling stock, having adjusting head screws and prime moving means for actuating the said head screws, an operative transmission between the said prime mover and the said screws comprising an adjustable throw crank driven by the prime mover,

a series of switches and associated electrical circuits for stopping, and reversing the said prime mover, stock actuated means for starting the said prime mover, and means integral with the said crank for actuating the said switches, the said switches being bodily adjustable according to any predetermined program.

4. In a rolling mill for rolling and re-rolling stock, having adjusting head screws, a reversible electric motor, a crank driven by the said motor, an operative transmission between the said crank and the said screws, stock actuated means to start the said motor, a series of adjustable limit switches with associated circuits to stop and reverse the said motor, means integral with the said crank to actuate the said switches to stop the motor at predetermined intervals of operation, the final switch in the said series operable to reverse the motor, and the said means resetting the said switches during the reverse operation of the motor.

5. In a rolling mill for rolling and re-rolling stock, a frame, rolls mounted on the frame for vertical movement, screws adapted to regulate the pass between the rolls, a crank actuated link mechanism adapted to turn the screws to regulate the class clearance between the rolls after each pass of the stock, a motor to drive the said crank, said crank actuated means being adapted to exert its maximum force in setting the rolls for the final pass of the stock, automatic means controlled by the stock being rolled for starting the crank actuated means to decrease the clearance between the rolls, and limit switches adapted to stop the forward movement of the crank actuating means in predetermined positions, one of the limit switches being adapted to set up relays to reverse the direction of travel of the crank actuated means, responsive to the final pass of the stock through the rolls to reset the screws for a new cycle of passes.

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