

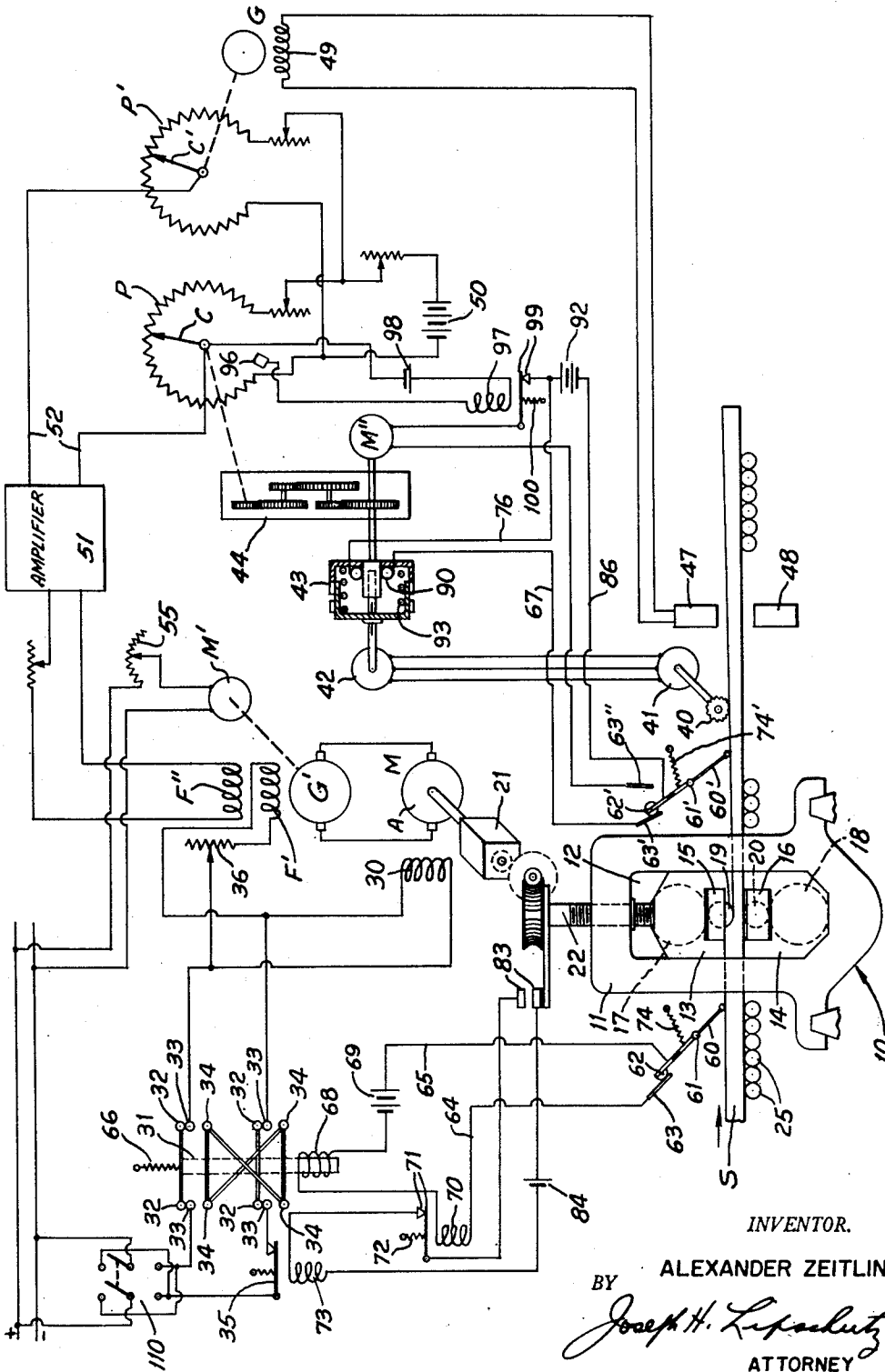
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APPARATUS FOR CONTROLLING THE ROLLING OF TAPERED SHEETS

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APPARATUS FOR CONTROLLING THE
ROLLING OF TAPERED SHEETSAlexander Zeitlin, White Plains, N. Y., assignor
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This invention relates to apparatus for controlling sheet thickness in rolling mills, presses, forges and the like. In such devices a slab of metal is sent through the mill or press and pressure is applied thereto for the purpose of thinning out the slab into a longer sheet of uniform thickness.

The present invention however, has for one of its principal objects the provision of apparatus whereby there may be automatically obtained a final product in the form of a metal strip having any desired taper in either direction.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

The accompanying drawing is in part a side elevation of a rolling mill stand and in part an electric wiring diagram, embodying the invention.

Referring to the drawing, my invention is disclosed as applied to a rolling mill stand indicated generally at 10. Such stand includes side frame members 11 and a central cutout portion 12 in which are slidably mounted bearing blocks 13 and 14 which form the bearing members for large back-up rollers 17 and 18. Other bearing blocks 15 and 16, slidable in the first bearing blocks, form the bearing members for work rollers 19 and 20. Pressure is applied to the work rollers through the back-up rollers by means of a screw-down motor M which through suitable reduction gearing 21 operates a screw 22 which applies pressure to the bearing blocks in which rollers 17 are journaled. The sheet S may be fed to the mill stand on rollers 25 and it is desired that the sheet shall leave the mill stand with a predetermined taper. The simplest method of achieving a continuous taper is either to apply continuously increasing pressure to the back-up roll 17 by causing the screw 22 to screw downwardly continuously, or to start with the gap between rollers 15 and 16 small and continuously reduce the pressure on work roll 17 by continuous rotation of screw 22 in the opposite direction. The first will give a gradually decreasing thickness to the strip as it leaves the mill stand while the second will give a gradually increasing thickness to the strip.

The problem of obtaining a uniform taper of any desired rate of increasing or decreasing thickness would be a simple one if equal increments of pressure on the work rolls resulted in linear displacement of the mill frame and if there were no slippage between the strip and the rolls. However, as is well-known in this art there are many

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factors which make the displacement of the stand non-linear, and therefore merely operating the screw-down motor in one direction or the other at a predetermined rate will not necessarily yield a strip having a uniform taper upon leaving the mill stand. The slippage also cannot be accurately predetermined.

In order to obtain such uniformity of taper at any desired rate of increase or decrease of thickness I have provided the following apparatus: The screw-down motor M is continuously energized from a suitable source of A. C. supply which energizes the motor field coil 30. The motor may be operated in either direction by means of switch 31 which in its lowered position as shown in the drawing makes contact at 32, 33 to energize the motor in one direction, and in its raised position makes contact at 33, 34 to energize the motor in the reverse direction. The energization of the motor is controlled by means of a switch 35 and the rate of speed of the motor may be controlled by a rheostat 36.

By the above described mechanism the screw-down motor will run continuously in one direction or the other, as desired, to yield a predetermined taper in one direction or the other as the strip leaves the mill stand. However, as stated hereinbefore, uniform increments of movement of the screw 22 do not yield uniform increments or decrements of mill stand pressure and it will be found that the strip as it leaves the mill will vary from the predetermined or calculated taper. Therefore it is necessary to provide means responsive to the thickness of the strip as it leaves the mill stand for controlling motor M in such direction as to vary the rate of screw-down pressure so as to compensate for such variations in thickness. For this purpose I provide means in the form of a potentiometer P having a contact arm C which is driven over the coils of P to tap a varying voltage which is a function of the length of strip which has passed out of the mill stand. Thus for example contact C may tap from zero to 50 volts in the time that 50 ft. of a strip has passed through the mill stand. In this example each increment of one volt tapped by contact arm C corresponds to a foot of movement of the strip, and since the rate of rotation of screw 22 is predetermined, each increment of voltage tapped by contact arm C corresponds to an increment of taper desired on strip S. The movement of arm C therefore represents the desired rate of taper on strip S. For this purpose it is necessary that the rate of movement of contact arm C be correlated with the rate of move-

ment of the strip or of the mill stand. Therefore there is provided a serrated roller 40 in engagement with the strip as it leaves the mill, the linear travel of roller 40 being equal to that of the strip. The movement of roller 40 is communicated to the contact arm C through a system of selsyn transmitter 41 and selsyn receiver 42 which drives through an electromagnetic clutch 43 and a reduction gear train 44 so that contact arm C will cover a predetermined angular distance on potentiometer P corresponding to the length of strip S which is leaving the mill stand.

Thus the travel of contact arm C of potentiometer P represents the desired taper. A potentiometer with constant pitch of winding would represent a linear taper. Any type of taper can be obtained by suitable design of the potentiometer winding. To find out whether the desired taper matches the actual taper and therefore whether any change in speed of motor M is necessary, there is provided a second potentiometer P' whose contact arm C' may be driven by a galvanometer G which is energized from any suitable thickness gauge, such as an X-ray receiver 47 which receives the rays transmitted through the strip S by an X-ray transmitter 48. The output of the X-ray receiver may thus control the coil 49 of galvanometer G so that the degree of movement of its armature C' is a function of the thickness of the strip as it leaves the mill. Thus, for example, as the thickness of the strip is continuously decreasing, contact arm C' will be driven continuously in the same direction as contact arm C, and the constants of the circuit may be made such that when the actual thickness is the same as the calculated thickness contact arm C' will tap the same voltage supplied by a source 50 as contact arm C. The potentiometers P and P' are connected in parallel to source 50 so that if contact arms C and C' tap the same voltage, there will be no output across the leads 52. However, if the actual thickness deviates from the calculated thickness in one direction or the other, there will be a differential voltage signal in one direction or the other which when amplified by amplifier 51 yields an output which is applied to the control of motor M in such direction as to increase or decrease the rate of operation of motor M in one direction or the other to bring the thickness of the strip back to the calculated thickness.

The output of amplifier 51 may be caused to control the speed of motor M by the following mechanism: The field coil 30 of motor M is continuously energized from the D. C. source, but the armature A may be controlled from a standard Ward-Leonard motor control. The latter comprises a D. C. excited motor M' which may be driven at a speed determined by a rheostat 55, the motor driving a generator G' whose field F' is excited from the D. C. source. The output of the generator is applied to the armature A of motor M. In order that the output of amplifier 51 shall vary the speed of motor M, the amplifier is of the type wherein the polarity of the output voltage corresponds to the polarity of the input voltage. Thus, a positive or negative voltage from the output of amplifier 51 may be applied to a field coil F'' to vary the voltage which is generated by the generator G' and applied to armature A. The connections are, of course, such that the variation applied to armature A is in the direction to tend to eliminate the differential between members C and C'.

When the rear end of the strip is about to pass through the mill it is necessary to return the screw 22 to its initial position. Thus in the case where the taper has been applied by increasing the screw-down pressure continuously, it is necessary to reverse the direction of rotation of screw 22 to raise the same. The operation of the motor is controlled as follows: When the forward end of the strip is about to enter the mill, a finger 60 pivoted at 61 rides upon the strip and is tilted in a counterclockwise direction to cause contact 62 carried thereby to engage contact 63. This energizes a coil 68 by way of leads 64, 65 and a suitable source of E. M. F. 69, to pull down switch 31 against the action of spring 66 to close the circuit through motor M at 32, 33 to cause the motor to operate in a screw-down direction. At the same time there is energized in the circuit of coil 68 a coil 70 which opens contacts 71 against the action of spring 72 to deenergize coil 73 and permit main switch 35 to close. When the end of the strip has passed finger 60, spring 74 will cause contact 62 to leave contact 63 and break the circuit through coil 68. This will permit spring 65 to raise switch 31 and close contacts 33, 34 which will reverse the direction of operation of motor M. When the motor has returned to its starting position, contacts 83 will close to permit coil 73 to be energized from source 84, the deenergization of coil 70 having permitted spring 72 to close contacts 71, and the energized coil 73 will open switch 35 to stop the motor.

When the strip has left the mill, there is energized means for returning contact arm C to its initial position. For this purpose there is provided a finger 60' adapted to ride on the strip S. Finger 60' is pivoted at 61' and carries contact 62'. When finger 60' rides on the strip, contact 62' engages contact 63' to close a circuit through coil 90 of electromagnetic clutch 43. The circuit of coil 90 includes leads 86, 76, 67 and source of voltage 92. When the strip S has left the mill, spring 74' causes contact 62' to leave contact 63' and engage contact 63''. This deenergizes coil 90 to permit spring 93 to disengage the clutch and energizes a motor M''. The latter drives the gearing 44 in a reverse direction until contact arm C engages contact 96 to close the circuit through coil 97, said circuit including source of voltage 98, to break contacts 99 against the action of spring 100. The contact arm C' will turn to the lower end of the scale by reason of the fact that the X-ray receiver receives maximum transmission from the X-ray transmitter when the strip has passed through the mill.

On starting again, a strip moves to the mill stand, and the finger 60 is tilted to cause contacts 62, 63 to engage to energize coil 68 to pull switch 31 down to make contacts 32, 33 for screw-down operation of motor M. The energization of the circuit through coils 68 and 70 breaks contact 71 to deenergize coil 73 and permit switch 35 to close. When the strip engages finger 60', contact 62' leaves contact 63' and engages contact 63'' to energize the electromagnetic clutch.

A manually operated double throw switch 110 enables the operator to actuate motor M normally as a screw-down or screw-up motor, depending upon the direction of taper desired.

The elements 60, 60', 40, 47-48 have been shown spaced substantially from the frame 11 for the purposes of better illustration, but it will be understood that in practice these ele-

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ments are positioned as close to the frame as practicable.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. Apparatus for imparting a predetermined taper to a strip of material as it passes through a rolling mill stand or the like, said mill stand having work rolls through which the strip is passed, comprising means including a motor for causing one work roll to advance toward and recede from the other work roll, said motor being adapted to operate continuously as the strip passes through the stand for applying pressure continuously in a given direction to provide continuous increase or continuous decrease in pressure between the rolls to taper the strip in the desired direction, a first actuated means actuated as a function of the speed of the strip through the work rolls, a second actuated means actuated by said first actuated means as a function of the desired taper, a third actuated means actuated as a function of the actual taper, a fourth actuated means actuated in accordance with the differential of actuation of said second and third actuated means, and a fifth actuated means actuated by said fourth actuated means for varying the rate of application of pressure applied to the strip in a direction to eliminate the differential between the second and third actuated means.

2. A device as specified in claim 1, character-

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ized by a sixth actuated means responsive to passage of the strip through the mill stand, and means actuated by said sixth actuated means for restoring said second actuated means to initial position when the strip leaves the mill stand.

3. A device as specified in claim 1, which includes a seventh actuated means responsive to passage of the strip through the mill stand, and means actuated by said seventh actuated means for restoring said work rolls to initial positions when the strip leaves the mill stand.

4. A device as specified in claim 1, which includes a seventh actuated means responsive to passage of the strip through the mill stand, and means actuated by said seventh actuated means for reversing the direction of operation of said motor when the strip leaves the mill stand.

5. A device as specified in claim 4, which includes means for stopping the motor when the rolls reach their initial positions.

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