Jan. 11, 1966 T. A. FOX 3,228,219

STRIP ROLLING

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Fig. 1.

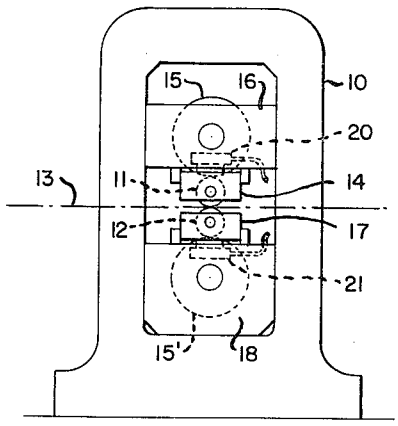


Fig. 2.

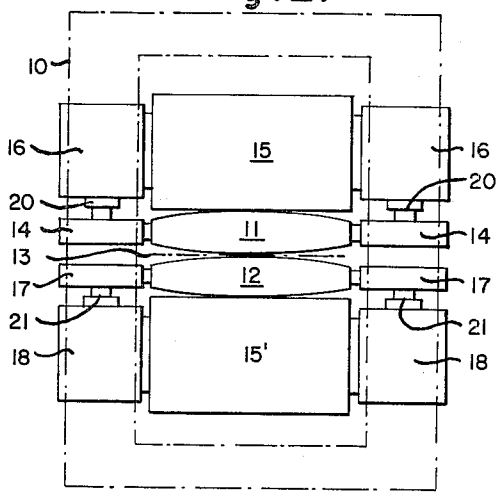


Fig. 3.

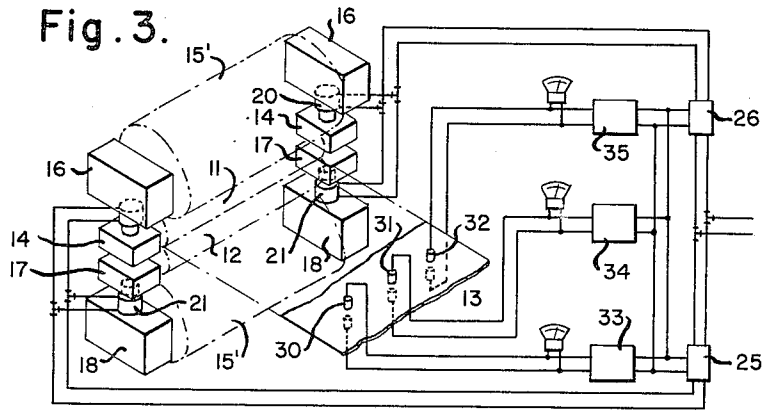
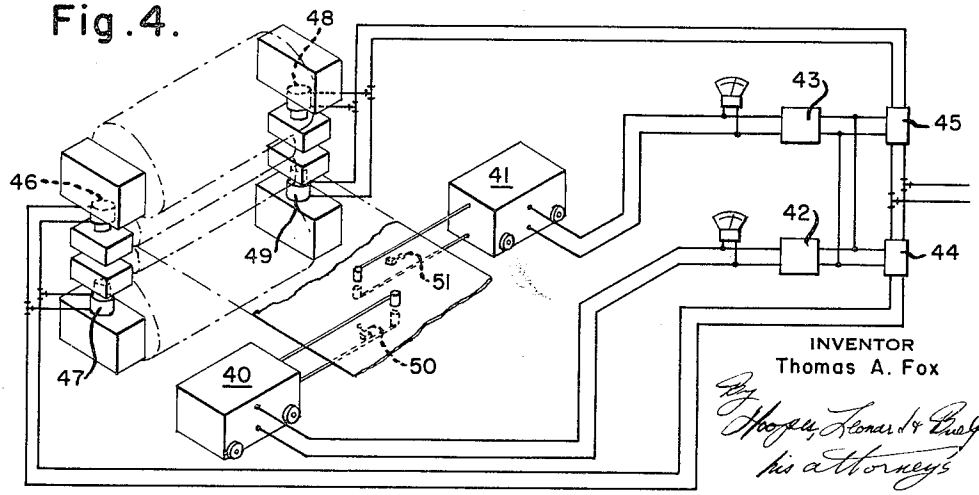


Fig. 4.



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STRIP ROLLING

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Fig. 5.

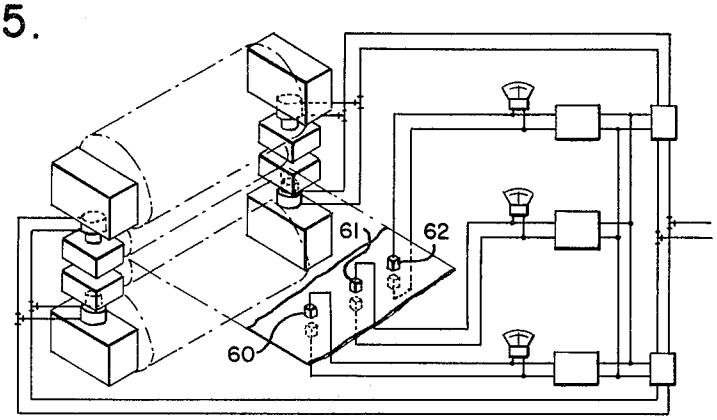


Fig. 6.

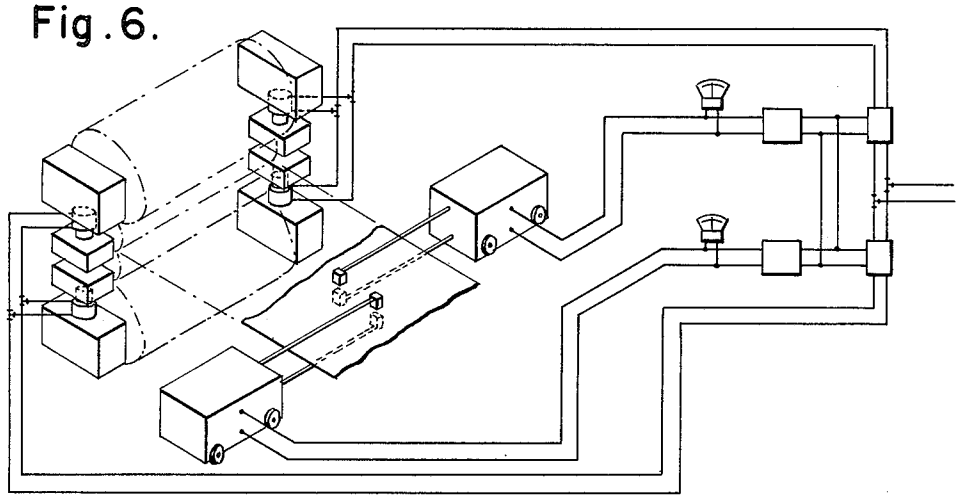
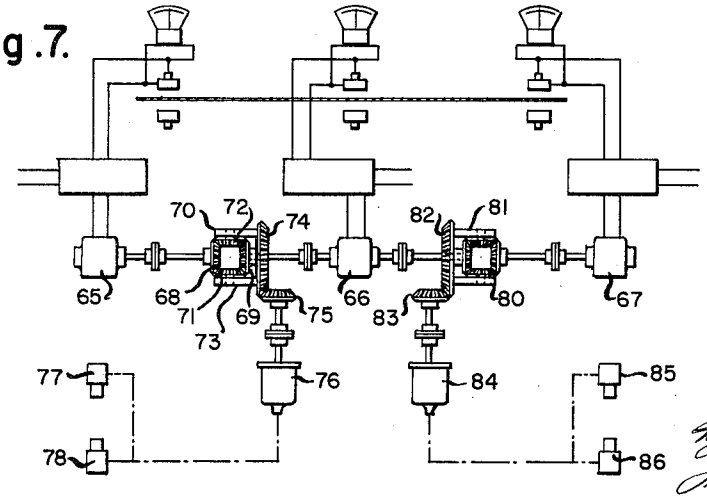


Fig. 7.



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3,228,219

STRIP ROLLING

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Filed July 14, 1961, Ser. No. 124,092
1 Claim. (Cl. 72—16)

This invention relates to strip rolling and particularly to a means for rolling strip with controlled edge to edge differential. This application is a continuation-in-part of my application Serial No. 668,989, filed July 1, 1957, now U.S. Patent 3,024,679, issued March 13, 1962.

Strip varies sharply in its dimensions from edge to edge as well as from end to end. These dimensional variations are undesirable but prior to my invention disclosed in application Serial No. 668,989, no adequate solution to any part of these difficulties had been found. The problem of controlling edge to edge contour has been particularly difficult.

I have invented means for automatically controlling edge to center differential so that strip of substantially uniform contour may be rolled.

I preferably provide a housing, a pair of work rolls in the housing on opposite sides of a pass line, said work rolls being adapted to receive strip therebetween and to exert a working force transversely to the point thereof, journals for each end of said work rolls, back-up rolls journaled in the housing adjacent each work roll, pressure means at the ends of said work rolls acting on and moving the journals of said work rolls perpendicularly to the point of the strip to cause the ends of said work rolls to move with respect to each other, so as to cause the middle thereof to engage a strip being rolled as a fulcrum and to bend said work rolls about said fulcrum to provide a desired strip contour, sensing means adjacent the exit side of said work rolls at spaced points across the strip width measuring the thickness of said strip, servo means actuated by said sensing means energizing the pressure means acting on the work roll ends whereby variations in the strip thickness leaving the work rolls is translated into pressure changes on the work roll ends in a direction perpendicular to the pass line. Preferably means are provided between the sensing means and the servo mechanism integrating the ratings of the several sensing means so as to actuate the servo mechanism upon a changing in differential thickness from center to each edge of the strip.

In the foregoing general statement I have set out certain objects, advantages and purposes of my invention. Other objects, advantages and purposes will be apparent from a consideration of the following description and the accompanying drawings in which,

FIGURE 1 is a side elevation of a rolling mill stand according to my invention;

FIGURE 2 is a front elevation of the mill of FIGURE 1;

FIGURE 3 is an isometric view of the apparatus of FIGURE 1;

FIGURE 4 is an isometric view of a second embodiment of this invention;

FIGURE 5 is an isometric view of a third embodiment of this invention; and

FIGURE 6 is an isometric view of a fourth embodiment of this invention;

FIGURE 7 is a schematic view of a control circuit for controlling the flow of fluid to the pistons of the roll housing.

Referring to the drawings, I have illustrated a roll housing 10 carrying work rolls 11 and 12 on opposite sides of a pass line 13. The upper work roll 11 is mounted in movable chocks 14 and is backed up by a back-up roll 15 mounted in chocks 16. The lower work roll 12 is mounted in movable chocks 17 and is backed up by back-up roll 15' mounted in back-up roll chocks 18. A hydraulic cylinder 20 is inserted between chocks 14 of the upper work roll and chocks 16 of the upper back-up roll. Hydraulic cylinders 21 are mounted between chocks 17 of the lower work roll and chocks 18 of the lower back-up roll. Hydraulic fluid is delivered to the cylinders 20 and 21 through control valves, one for each of the cylinders 20 and 21 of each housing from a source of hydraulic pressure. The valves to cylinders 20 and 21 are controlled by and are a part of servo mechanisms 25 and 26 respectively. Each of the servo mechanisms is connected to a sensing means which measures the thickness of the strip. The sensing means of FIGURES 1 through 3 consists of X-ray gauges 30, 31 and 32, spaced across the strip, 30 and 32 at the opposite edges and 31 at the center line of the strip. Current produced from gauges 30, 31 and 32 is delivered to amplifiers 33, 34 and 35 respectively from which it actuates the servo mechanisms 25 and 26 to deliver hydraulic fluid to the pistons to exert a force perpendicularly to the path of strip travel or to return hydraulic fluid from the pistons to maintain a constant gauge differential across the strip.

In FIGURE 4, I have illustrated a traversing X-ray gauge set up in which a traversing gauge 40 traverses the strip from the center to one edge. The traversing gauge 41 traverses the strip from the center to the opposite edge. The current produced by these gauges is delivered to amplifiers 42 and 43 actuating servo mechanisms 44 and 45 which control the fluid pressure in pistons 46 and 47 in one housing and 48 and 49 in the opposite housing. Preferably limit switches 50 and 51 are placed midway between the center of the strip and each edge to be contacted by the gauge halfway between the center and the edge so as to reverse the polarity of current from the traversing gauge. This is required because negative gauge at the edge requires a decrease in pressure to the cylinders acting on the work rolls.

In the embodiment illustrated in FIGURE 5, I have substituted magnetic gauges 60, 61 and 62 for the X-ray gauges of FIGURES 1 through 3. The operation and structure of this embodiment are otherwise identical with FIGURES 1 through 3.

In the embodiment illustrated in FIGURE 6, I have substituted traversing magnetic gauges for the traversing X-ray gauges of FIGURE 4. The structure is otherwise identical with FIGURE 4 and the operation is likewise identical.

In FIGURE 7 I have illustrated a form of control mechanism in which the amplified current coming from the X-ray gauges is delivered to constant speed motors 65, 66 and 67. Motor 65 receives current from the gauge at one edge. Motor 67 receives current from a gauge at the opposite edge of the strip and motor 66 receives current from the gauge at the center of the strip. The shafts of motors 65 and 66 are connected to pinions 68 and 69 on opposite sides of a differential 70, carrying planetary gears 71 and 72 in planetary housing 73. Housing 73 carries a pinion 74 which drives a control pinion 75 and thereby actuates a valve 76 in the line leading to hydraulic cylinders 77 and 78 (corresponding to cylinders 46 and 47 respectively of FIGURE 4) on one side of the mill. The shafts of motors 66 and 67 are connected through a similar differential 80 with a planetary housing 81 and planetary drive gear 82 which drives a control pinion 83 operating valve 84 to control the hydraulic cylinders 85 and 86 (corresponding to cylinders 48 and 49 respectively of FIGURE 4) for the opposite end of the mill stand.

In the foregoing disclosure, I have illustrated and described certain preferred embodiments of my invention.

However, it will be understood that this invention may be otherwise embodied within the scope of the following claim.

I claim:

A strip rolling apparatus comprising a pair of work rolls on opposite sides of a pass line, said work rolls adapted to receive strip therebetween and to exert a working force perpendicularly to the path thereof, journals for each end of said work-rolls, back-up rolls journaled adjacent each work roll, pressure means at the ends of said work rolls acting on and moving the journals of said work rolls perpendicularly to the path of strip travel to cause the ends of said work rolls to move with respect to each other so as to cause the midpoint thereof to engage a strip being rolled as a fulcrum and to bend said work rolls about said fulcrum to provide a desired strip contour, thickness sensing means adjacent the exist side of said work rolls at spaced points across the strip width measuring the thickness of said strip, a constant speed servo motor actuated by said sensing means, an equation differential gear box having pinion gears driven by each

adjacent motor and a planetary housing surrounding said pair of pinion gears whereby a difference in speed of the pinion gears rotates the housing, gear means on the housing, drive means for the pressure means and connections between the drive means and pressure means actuated by the gear means on the planetary housing energizing the pressure means, acting on the work roll ends whereby variations in the strip thickness leaving the work rolls is translated into pressure changes on the work roll ends.

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