Dec. 24, 1935. H. E. BALSIGER 2,025,562

CONTROL FOR SHEET ROLLING MILLS

Filed June 24, 1932 5 Sheets-Sheet 1

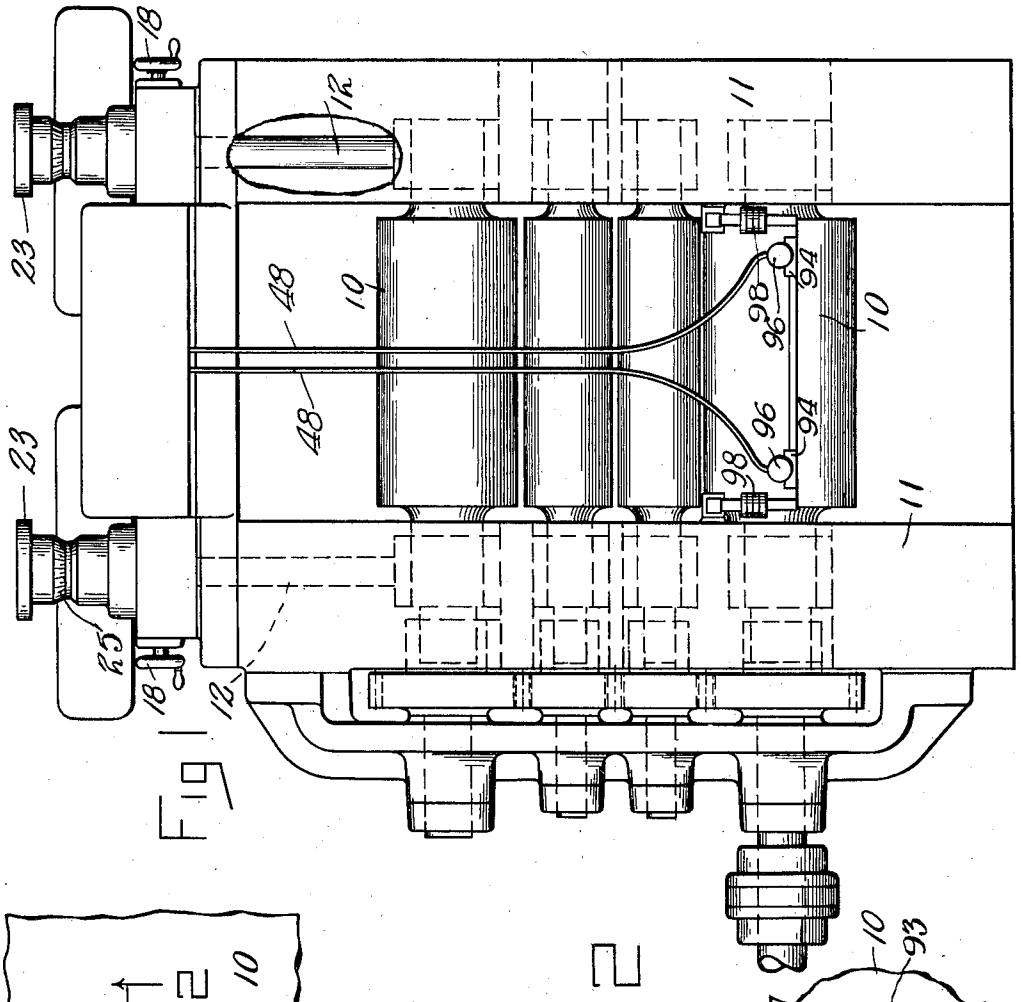


Fig. 1

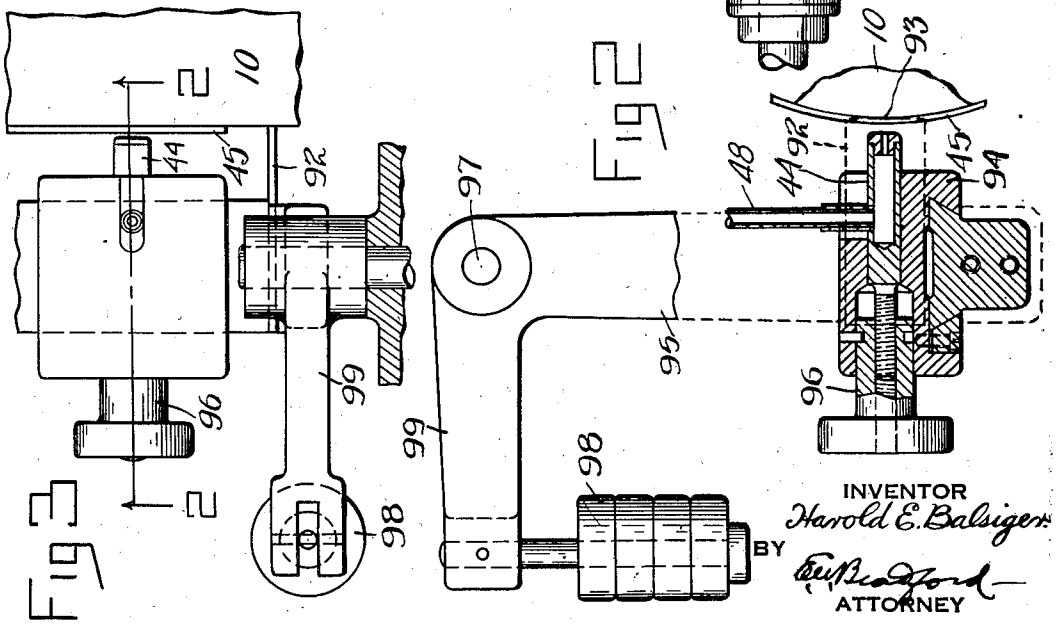


Fig. 3

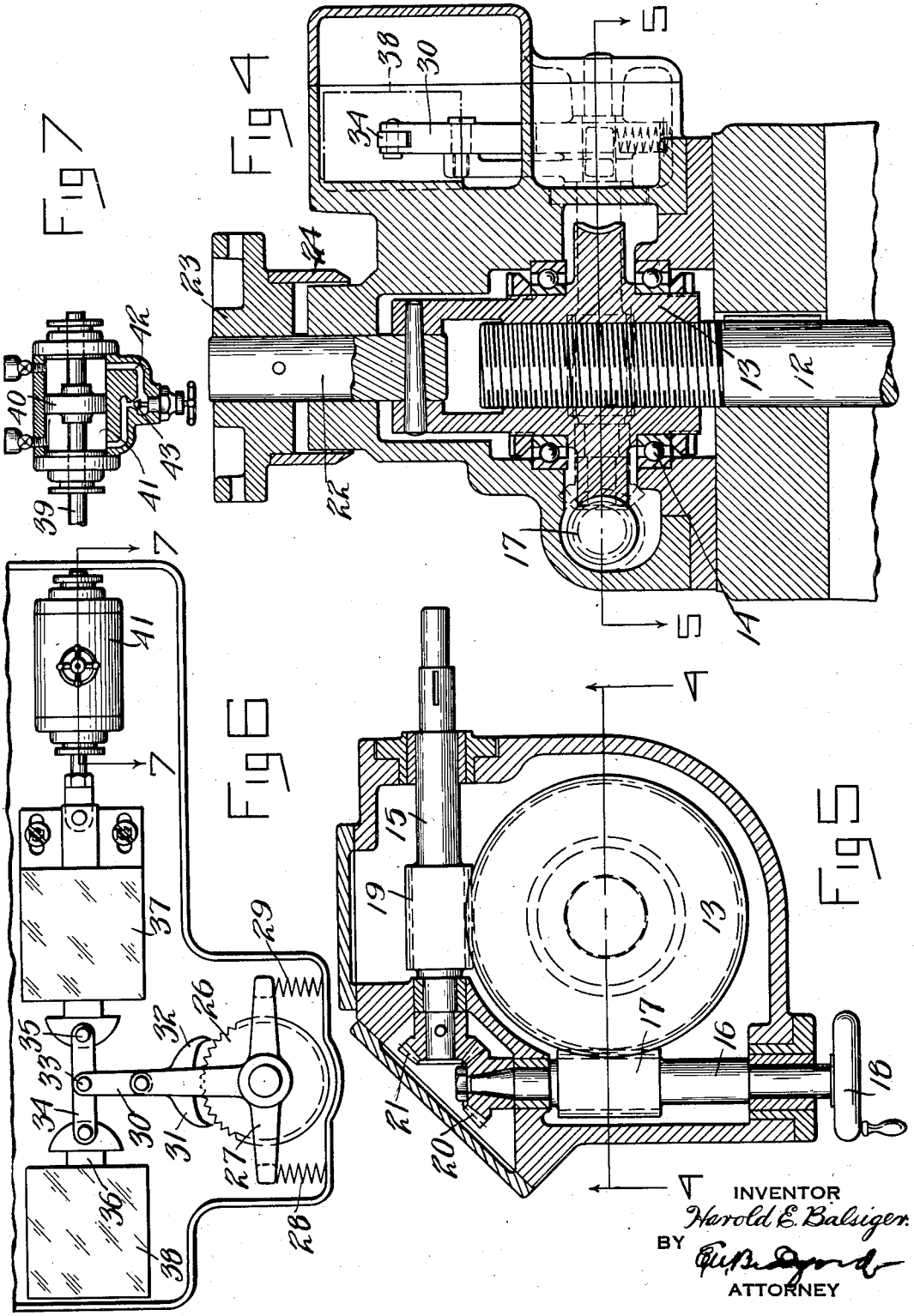
Fig. 2

INVENTOR
Harold E. Balsiger
BY
ATTORNEY

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CONTROL FOR SHEET ROLLING MILLS

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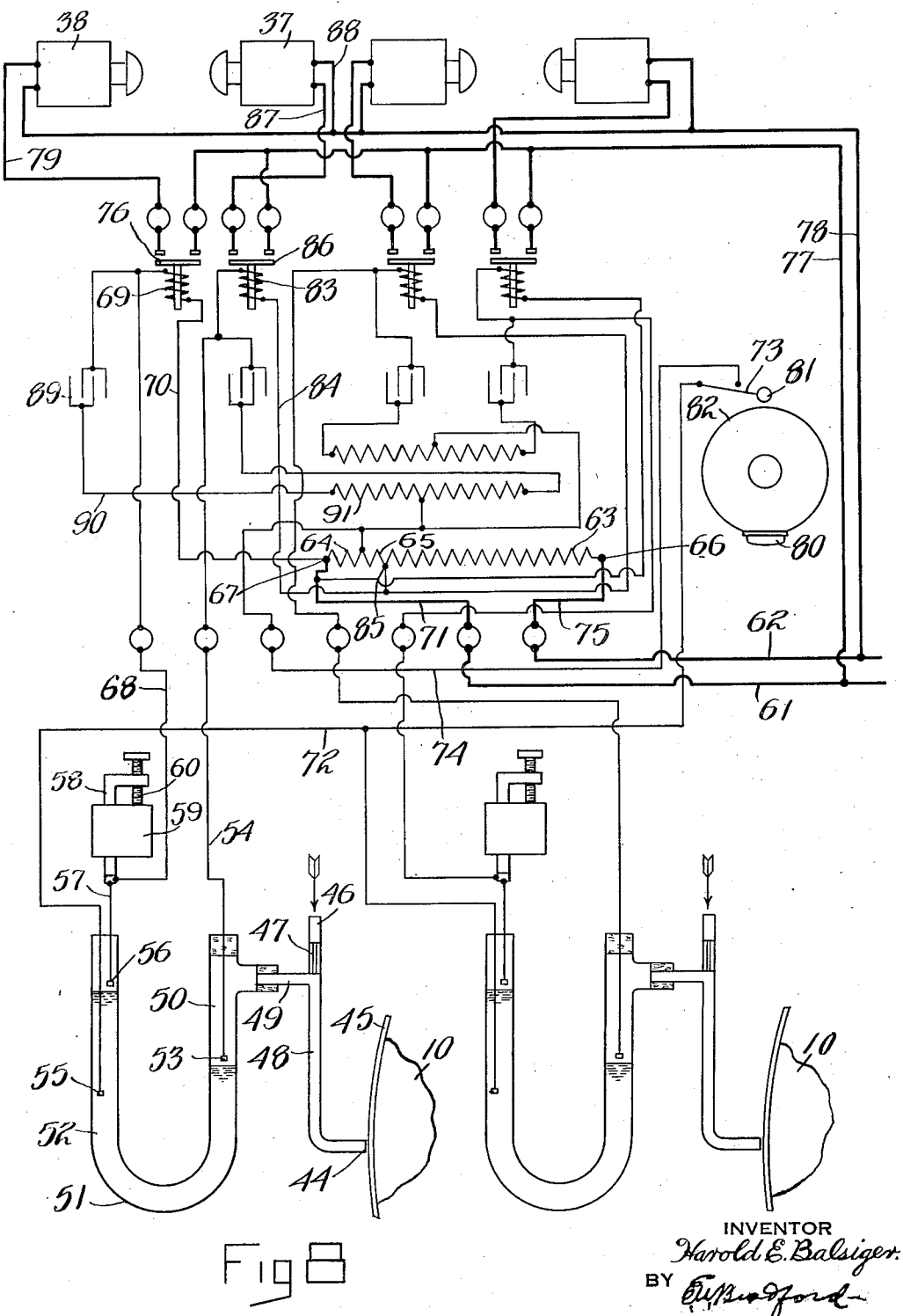


Fig 8

INVENTOR
Harold E. Balsiger.
BY
ATTORNEY

Dec. 24, 1935. H. E. BALSIGER 2,025,562

CONTROL FOR SHEET ROLLING MILLS

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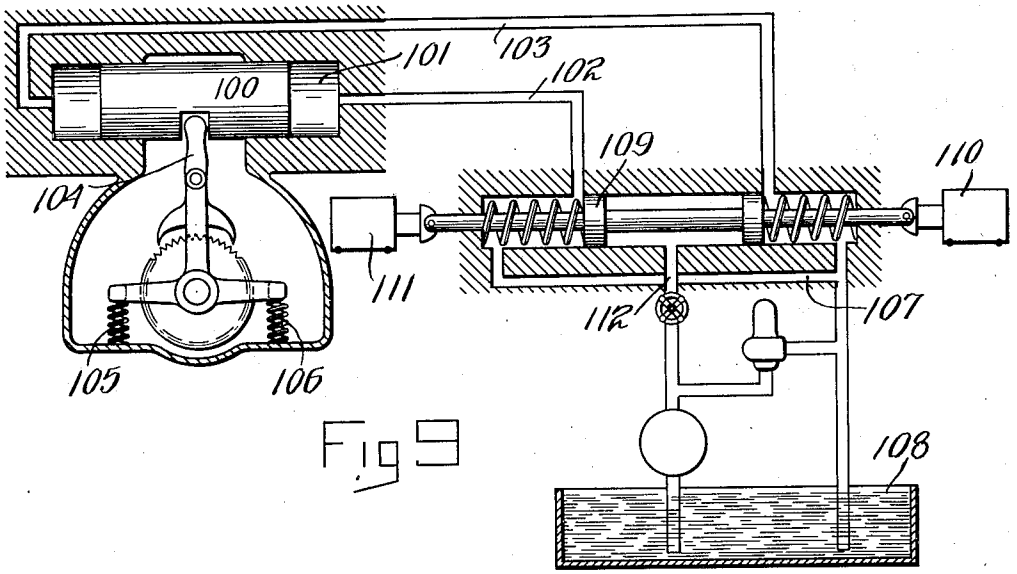


Fig 9

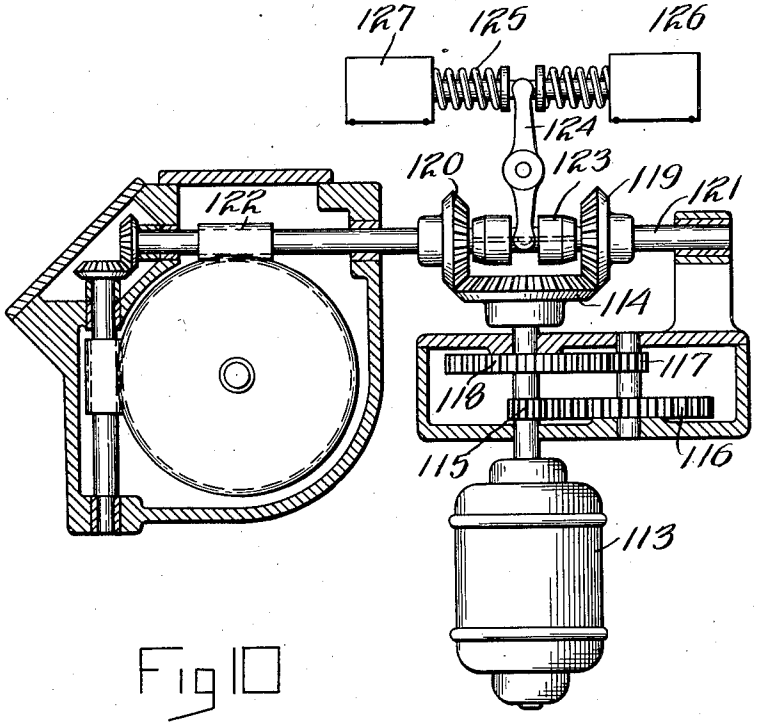


Fig 10

INVENTOR
Harold C. Balsiger
BY
ATTORNEY

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Fig 11

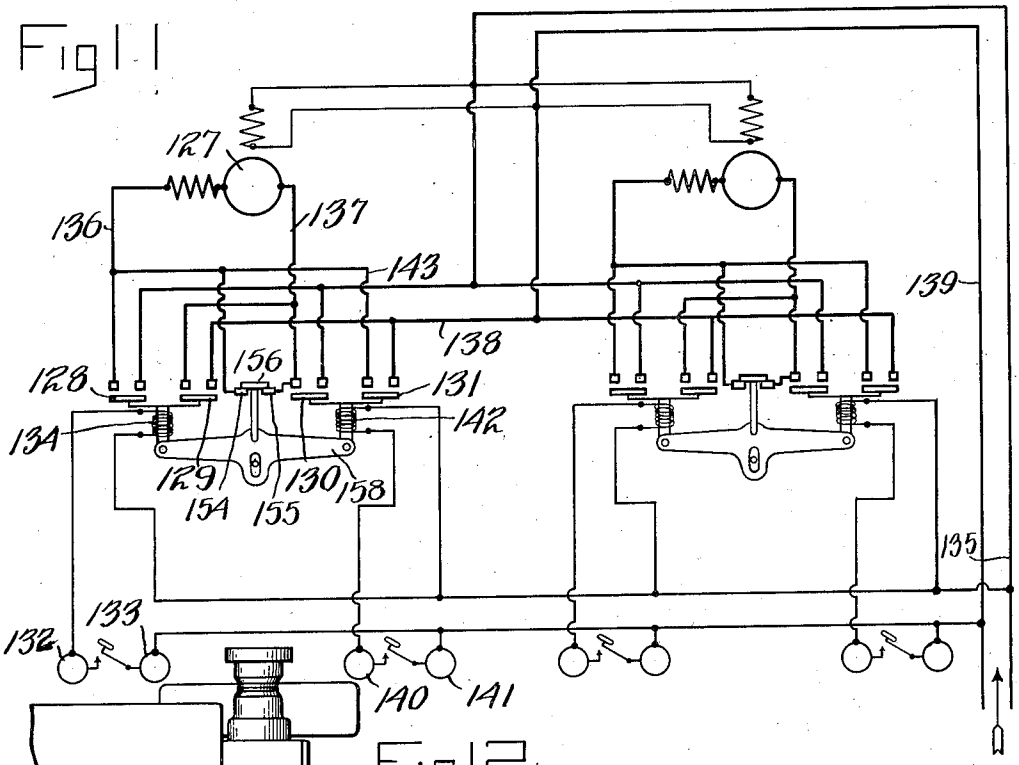


Fig 12

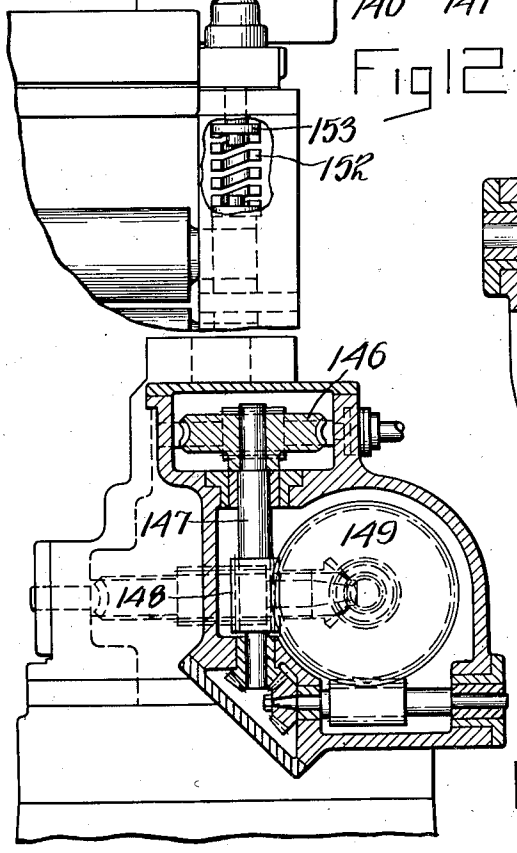


Fig 13

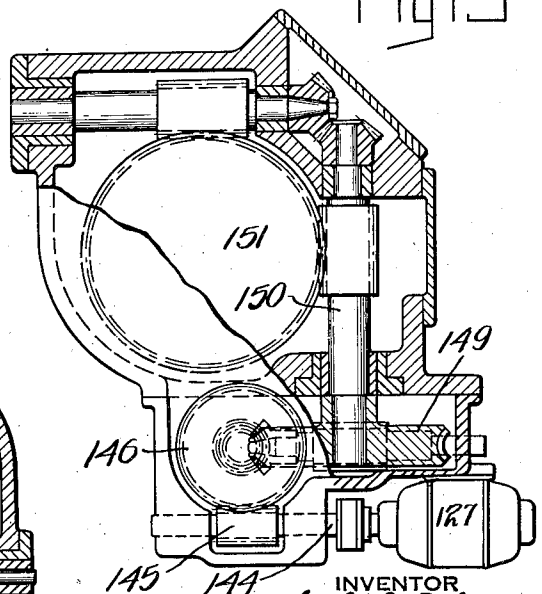


Fig 14

INVENTOR
Harold E. Balsiger.
BY
ATTORNEY

Patented Dec. 24, 1935 2,025,562

UNITED STATES PATENT OFFICE

2,025,562

CONTROL FOR SHEET ROLLING MILLS

Harold E. Balsiger, Waynesboro, Pa., assignor to Landis Tool Company, Waynesboro, Pa., a corporation of Pennsylvania

Application June 24, 1932, Serial No. 619,156

8 Claims. (Cl. 18—2)

In sheet rolling mills it is desirable to have the product which is being rolled into sheet form of a uniform thickness. This thickness is determined by the distance between adjacent rolls. Due to variations in the materials being operated on, the temperature and also for other reasons the thickness of the product coming from the rolls varies widely for any given setting of the roll. The purpose of the present invention is to provide an automatic control which is responsive to variation in the thickness of the strip to keep the thickness within predetermined limits. The object of the invention therefore is to provide automatic mechanically operated mechanism for controlling the rolls of a machine which is operating upon material to render it into sheet form.

Other objects and advantages will become apparent from the description which follows:

Referring to the accompanying drawings which are made a part hereof and on which similar reference characters indicate similar parts,

Figure 1 is a front elevation of a portion of a rolling mill showing my invention adapted to the rolls,

Figure 2, a section on line 2—2 of Figure 3, and

Figure 3, a plan view of Figure 2, both figures showing means for keeping a sizing device in contact with the work,

Figure 4 is a section on line 4—4 of Figure 5, and

Figure 5, a section on line 5—5 of Figure 4, both of these figures showing in detail means for adjusting the rolls relative to each other,

Figure 6 is a detail view showing means for operating mechanism for moving the rolls relative to each other,

Figure 7, a section of a cushioning device taken on line 7—7 of Figure 6, and

Figure 8, a diagrammatic view of the control circuits forming a part of the invention,

Figure 9 is a modified form showing hydraulic means for adjusting the rolls,

Figure 10 is still a further modified form showing a continuously operating motor with a clutch for changing the direction of operation of the rolls and for initiating operation of the direction changing means,

Figure 11 is a diagrammatic showing of a further modified form in which a reversible motor is used for operating roll adjusting means,

Figure 12 is a detail view of a modified form of roll adjusting screw, and

Figures 13 and 14 are horizontal sectional views of a modified form in which the reversible motor shown diagrammatically in Figure 11 is used for adjusting the rolls relatively to each other.

In the drawings numeral 10 indicates mill rolls of a type used for forming rubber into sheets of any suitable sort which are mounted in supports 11 and are adjustable toward and from each other by means of shafts 12. Obviously applicant's device may be applied to the adjustment of mills which form other materials into sheets. These shafts are screw threaded on their upper ends and have mounted thereon worm wheels 13, the rotation of which worm wheels will adjust the shafts vertically. The worm wheels are mounted in suitable ball bearings 14 upon the supports 11. Shafts 15 and 16 provide means for rotating the worm wheel 13. The shaft 16 is provided with a worm 17 which engages the worm wheel 13 and this shaft is manually operable by means of a hand wheel 18. The shaft 15 is provided with worm teeth 19 engageable with corresponding teeth on the worm 13 and the shaft 15 is mechanically operated by mechanism which will be later described. Shafts 15 and 16 are provided with interengaging beveled gears 20 and 21 so that each shaft is driven by the other. Secured in the hub of the worm wheel 13 is a short stub shaft 22 which carries a head 23. The hub portion 24 of the head 23 may be calibrated as shown at 25 to indicate the vertical position of the shaft 12. The outer end of the shaft 15 carries a toothed wheel 26 by means of which the shaft 15 is rotated. On the outer end of the shaft 15 also is loosely mounted a T-shaped arm 27 which is biased to a balanced position by means of springs 28 and 29 under the opposite arms so that the arms will be held normally in a given position. On the third arm of the T there is pivoted a ratchet 30 which has two dog portions 31 and 32 engageable with the teeth of the gear wheel 26. The upper end of the ratchet 30 is pivoted at 33 to a link 34 which link is attached at each end to core plungers 35 and 36 of solenoids 37 and 38.

The core 35 is attached to a piston rod 39 to which is secured a piston 40 movable in a cylinder 41. The chambers on opposite sides of the piston 40 are connected by a fluid passage 42 in which passage is a needle valve 43. The valve 43 regulates the flow of fluid from one side of the piston 40 to the other and hence cushions movement of the solenoid core. The solenoids are energized by circuits which will now be described.

A nozzle 44 is positioned adjacent the surface of the strip 45 which strip is being formed between the rolls. A line 46 is connected with some source

of pressure fluid of a constant pressure. Fluid from the line 46 flows through a restriction 47 into a pipe 48 from which latter pipe it issues through the nozzle 44 escaping between the end of the nozzle and the surface of the work on strip 45. Due to the velocity of the fluid issuing through the restriction at 47 there will be an area of reduced pressure in the pipe 49 and in the chamber 50 in one leg of a U-tube 51. This reduced pressure is the result of the Venturi action of the jet of fluid at 47. The U-tube 51 will be partially filled with some liquid such as mercury 52. One leg of the U-tube will contain a contact element 53 which is connected to a wire 54. Within the other leg of the U-tube are positioned contact elements 55 and 56. The element 55 is within the body of mercury while the contact element 56 is normally above the mercury. Element 56 is connected by wire 57 to a post 58 carried in a block 59. By means of a manually operable screw 60 the contact point 56 may be adjusted relatively to the surface of the mercury in this leg of the U-tube. Solenoids 37 and 38 are energized by the closing of contacts 53 and 55 or 56 and 55 through the body of mercury in the following manner:

High tension wires 61 and 62 are connected to any suitable source of current. This may be a high potential current which may be direct or alternating current as desired. For the purpose of convenience in describing the invention we will assume that wires 61 and 62 are direct current lines. This current is at high potential and must be reduced either by a transformer or a resistance. 63, 64 and 65 designate a series of resistors so that between point 66 and point 67 there is a total voltage drop substantially equal to the line voltage. Assume that contacts 55 and 56 have been closed by the mercury in the left leg of the U-tube the circuit then will be closed from contact 56 through wires 57, 68, coil 69, wire 70, point 67 and through wire 71 to wire 61. From contact point 55 the circuit is closed through wire 72 through switch 73, wire 74 through resistance 65, resistance 63, point 66 and wire 75 to connect with line wire 62. This energizes the coil 69 and closes the switch 76. When the switch 76 is closed the circuit is closed with lead-in lines 61 and 62 through wires 77, 78 and 79. This energizes the solenoid 38 and moves the ratchet 30 to the left to rotate the wheel 26 counterclockwise as shown in Figure 6. The circuit through the line 72 and 74 can only be closed when the switch at 73 is closed. This switch will be closed only for a short time and that is when a cam 80 engages an element 81 on the switch to lift the switch to closed position. The cam 80 is on a wheel or disk 82 which is rotated at a constant speed and continuously, and switch 73 therefore is continuously opened and closed. If contacts 56 and 55 are closed at the same time then the circuits will be set up as indicated and the solenoid 38 will be energized. The energizing will be intermittent so that the core of the solenoid will be reciprocated to rock the wheel 26 toward the left. The parts are so arranged that it will be apparent from the drawings that contacts 55 and 56 will only be closed when there is sufficient pressure in the chamber 50 to raise the column of mercury in the left leg of the U-tube. The device will be set so that fluid may issue from the nozzle 44 at a given rate and so that contacts 56 and 53 will be out of the body of mercury. If the material 45 should become thicker so that the space between the nozzle and the surface of the work decreases then fluid cannot escape as freely. This will cause pressure to build up in the tube 48 and will decrease the velocity of the fluid issuing through the restricted passage at 47. The reduced velocity at 47 will decrease the aspirating effect of the fluid in pipe 49 and hence increase the pressure in the chamber 50 to move the column of mercury in the left leg of the tube upward until it closes contact between points 55 and 56. When this occurs the material being formed is too thick. The solenoid 38 is energized at this time to rock the wheel 26 counterclockwise. The wheel 26 in turn will rotate the worm wheel 13 to move the shaft so as to bring the working rolls closer together. If the solenoid 38 were continuously energized there would be no racking of the wheel 26. It is necessary to have the circuit continuously interrupting in order to provide this racking. The cam 80 provides for intermittently breaking and closing contacts which interrupt the circuit.

Contact 53 is connected through wire 54 through coil 83.

When the sheet of material 45 becomes thinner than the predetermined amount the space between the end of the nozzle 44 and the surface of the work becomes wider so that air may issue faster from the pipe 48. This increases the velocity of the air through the restricted line 47 and the aspirating effect of the air reduces the pressure in the pipe 49 and in the chamber 50. The column of mercury arises in the right leg of the U-tube and makes contact between points 53 and 55. A circuit then is closed through line 54, coil 83, line 84, binding post 85, resistance 63 and point 66 to connect with wire 75 and to lead-in wire 62. The circuit is closed from point 55 through wire 72, switch 73, wire 74, resistance 64 and wire 71 which connects the lead-in wire 61. This circuit energizes coil 83 and closes switch 86. When 86 is closed the circuit will be closed from lead-in wires 61 and 62 through wires 77 and 78, switch 86 and wires 87 and 88 to energize solenoid 37. This actuates the plunger 35 to move it to the right as shown in Figure 6 to operate the gear wheel 26 in a clockwise direction. Of course the cam 80 will intermittently make and break the switch 73 so that the solenoid will be operated intermittently. When the gear wheel 26 is rotated clockwise worm gear 13 will be rotated so as to raise the shaft 12 and to move the rolls away from each other to increase the thickness of the sheet of material which is being formed between the rolls.

The second U-tube shown in Figure 8 is a duplicate of that just described. It is advisable to have a gaging device at each end of the roll as shown in Figure 1 so that each end of the roll may be moved independently of the other by its own sizing device and control mechanism associated therewith. The circuits are identical with those just described. It is therefore thought unnecessary to repeat the description. At 89 are shown condensers which are provided to prevent sparking between the contact points 56 and 53 and the surface of the body of mercury. The circuit through the condensers is closed through line 68, condenser 89, line 90, resistance 91, line 74 and line 72. This reduces arcing across contact points. Four such condensers are shown in circuit with each of the solenoids. The condensers all operate in the same manner so it is thought unnecessary to describe more than one.

In order to determine the thickness of the ma-

terial being formed a plate 92 (Fig. 2) is provided which rests against the periphery of the roll as shown at 93. This plate is carried on a block 94 which is adjustably supported on an arm 95. The nozzle 44 is adjustably mounted in the block 94 and may be moved toward and from the surface of the work by an adjustable nut 96. The space between the surface of the work and the end of the nozzle will at all times be just slightly in excess of the desired thickness of the work. The arm 94 is one arm of a rock arm which is pivoted at 97 to some stationary portion of the machine. Weights 98 are suspended from the other arm 99 of the rock arm and these weights maintain the plate 92 in contact with a surface of the roll.

In the modified form of construction shown in Figure 9 a piston 100 is carried in a cylinder 101 and is operated by fluid from lines 102 and 103. A lever 104 which corresponds to lever 30 in Figure 6 engages a notch in the piston 100 so that the lever is rocked upon operation of the piston. Springs 105 and 106 hold the lever in central position when pressure fluid is released from lines 102 and 103. When in the position shown in Figure 9 lines 102 and 103 are open to exhaust lines 107 through which lines pressure fluid may exhaust to a reservoir 108. When valves 109 are shifting either to the right or to the left by solenoids 110, 111, pressure fluid line 112 is put in communication with line 103 or 102 depending on whether solenoid 110 or 111 is energized. Solenoids 110, 111 correspond to solenoids 83 and 69 shown in Figure 8, which solenoids are energized when contact is made between points 53 and 55 or 56 and 55 respectively.

In Figure 10 there is provided a continuously operating electric motor 113 which drives the bevel gear 114 through speed reducing gears 115, 116, 117, 118. Bevel gear 114 meshes with corresponding bevel gears 119 and 120 which latter bevel gears are loosely mounted upon the shaft 121 which carries a worm gear 122 by means of which the roll adjusting shaft is operated. Clutch elements 123 are keyed to the shaft 121 and are shifted into engagement with beveled gears 119 and 120 by a lever 124. The lever is held in neutral position normally between springs 125. When solenoid 126 is energized the lever 124 is rocked clockwise to bring the clutch 123 into engagement with the clutch 120 so that the shaft 121 may be rotated. When solenoid 127 is energized the clutch will be brought into engagement with beveled gear 119 to rotate the shaft 121 in the reverse direction. The rolls therefore will be adjusted toward each other or from each other in accordance with whether solenoid 126 or 127 is energized. The contact points in the mercury tube will determine which of solenoids 126 or 127 is energized. When material of the correct thickness is passing between the rolls as determined by the sizing device at 44 in Figure 8 neither of the solenoids will be energized so that the lever 124 will be maintained in the neutral position by springs 125. When the thickness of the sheet varies beyond a predetermined limit, either one or the other solenoids will be energized to shift the rolls to bring the sheet back to the desired thickness.

In Figure 11 a reversible motor 127 is provided which is controlled by switches 128, 129, 130, 131. Lines 132 and 133 correspond respectively to lines 68 and 54 in Figure 8.

When the circuit is closed across lines 132 and 133 solenoid 134 is energized to close switches 128 and 129. This will close the circuit through power line 135, switch 128, through line 136, motor 127, line 137, switch 129, line 138 to lead-in line 139. This will operate the motor 127 in one direction. When the circuit is closed across lines 140 and 141 solenoid 142 will be energized to close switches 130—131 and to open switches 128 and 129. The circuit will be closed from line 135 through switch 130, line 137, motor 127, line 136, line 143, switch 131, line 138 to power line 139. When in this position it will be apparent that the terminals of the motor 127 are connected opposite to the way in which they are connected when switches 128 and 129 are closed. The motor 127 therefore will be rotated in the opposite direction in a manner which is well known. Dynamic braking is provided in the motor by contactor 156 closing circuit between contacts 154 and 155. Contactor 156 is carried on interlocking bar 158 and so proportioned that contactor 156 is opened before either the forward or reverse contactors close. The motor 127 controls adjustment of the rolls through which the sheet of material is passing. When the thickness of the sheet varies beyond predetermined limits the position of the rolls is adjusted by rotating motor 127 in one direction or the other depending on whether the sheet is too thick or too thin. The motor 127 may be connected for adjusting the rolls in the manner shown in Figures 13 and 14 in which the motor operated through a shaft 144, a worm 145 which meshes with a worm wheel 146. Worm wheel 146 is on a shaft 147 and carries a worm 148 which meshes with a worm wheel 149. The worm wheel 149 in turn is mounted on a shaft 150 which carries a worm meshing with a worm wheel 151 which latter wheel is on a shaft which adjusts the working rolls relative to each other. The worm drive connection just described provides a speed reduction between the motor 127 and the shaft which is connected to the rolls which are to be adjusted.

In the form shown in Figure 12 a spring 152 is provided to insure a yielding element to permit the rolls to separate slightly when objects beyond a predetermined thickness are carried between the rolls. The shaft 153 may be rotated in any of the manners described above. For more detailed description of some features of the device reference may be had to my copending application Ser. No. 598,498, filed March 12, 1932.

It will be obvious to those skilled in the art that various changes may be made in my device without departing from the spirit of the invention and therefore I do not limit myself to what is shown in the drawings and described in the specification, but only as indicated by the appended claims.

Having thus fully described my said invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, and a control means for said adjusting means including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, means associated with said nozzle and responsive to variations in pressure in the fluid for causing said adjusting means to separate the rolls when the sheet decreases below a predetermined desired thickness and to move the rolls toward each other

when said sheet increases above the said desired thickness.

2. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, and an electrically actuated control means for said adjusting means including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, means associated with said nozzle and responsive to variations in pressure in the fluid for controlling circuits of said control means for causing said adjusting means to separate the rolls when the sheet decreases below a predetermined desired thickness and for controlling other circuits of said control means for causing the rolls to move toward each other when said sheet increases above said desired thickness.

3. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, and an electrically actuated control means for said adjusting means including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, means associated with said nozzle and responsive to variations in pressure in the fluid for controlling circuits of said control means for causing said adjusting means to separate the rolls when the sheet decreases below a predetermined desired thickness and for controlling circuits of said control means for causing the rolls to move toward each other when said sheet increases above said desired thickness, and an intermittently operated control switch in said circuits of the control means whereby said adjusting means is operated to intermittently move the roll during the adjusting of the same.

4. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, and an electrically actuated control means for said adjusting means including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, said electrically controlled means including independent circuits operating respectively to cause said adjusting means to move the rolls toward each other or from each other, means associated with said nozzle and responsive to variations in pressure in the fluid for controlling the respective circuit for moving the rolls toward each other when the sheet increases above a predetermined desired thickness and for controlling the other respective circuit for moving said rolls away from each other when said sheet decreases below the predetermined desired thickness.

5. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, including a shaft, a pawl and ratchet mechanism for rotating said shaft in one direction or the other, means for actuating said pawl, means operating when moved in one direction for causing said pawl to operate through said adjusting means to separate the rolls and when moved in the other direction operating through said pawl to cause said rolls to operate through said adjusting means to move said rolls toward each other, and a control means for said pawl actuating means including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, and means associated with said nozzle and responsive to the variations in pressure in the fluid for causing said pawl actuating means to move in one direction when said sheet increases in thickness above a predetermined thickness and in the other direction when said sheet decreases from the desired thickness.

6. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, including a shaft, a pawl and ratchet mechanism for rotating said shaft in one direction or the other, means for actuating said pawl, a cylinder, a piston movable in said cylinder and connected to said pawl for moving it in one direction or the other, a fluid pressure means connected with the opposite ends of said cylinder, a valve for controlling the fluid pressure means, whereby fluid under pressure is selectively admitted to the opposite ends of said cylinder, and a control means for shifting said valve including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to the nozzle whereby fluid is discharged against the sheet, and means associated with the nozzle and responsive to variations in pressure in the fluid for causing said valve to shift in one direction when the sheet decreases below a predetermined desired thickness and to shift in the other direction when said sheet increases above the desired thickness.

7. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, including a shaft, a pawl and ratchet mechanism for rotating said shaft in one direction or the other, means for actuating said pawl, a cylinder, a piston movable in said cylinder and connected to said pawl for moving it in one direction or the other, a fluid pressure means connected with the opposite ends of said cylinder, a valve for controlling the fluid pressure means whereby fluid under pressure is selectively admitted to the opposite ends of said cylinder, an electrically actuated control means for shifting said valve including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, and means associated with the nozzle and responsive to variations in pressure in the fluid for establishing a circuit and causing the valve to shift in one direction upon an increase in thickness of the sheet above a predetermined thickness and for establishing a circuit to cause said valve to shift in the other direction when said sheet decreases below the predetermined desired thickness.

8. In a machine for forming material into sheet form having a plurality of rolls, means for adjusting the rolls toward and from each other to vary the thickness of the sheet, including a shaft, a pawl and ratchet mechanism for rotating said shaft in one direction or the other, means for actuating said pawl, a cylinder, a piston movable in said cylinder and connected to said pawl for moving it in one direction or the other, a fluid pressure means connected with the opposite ends of said cylinder, a valve for controlling the fluid pressure means whereby pressure fluid is selectively admitted to the opposite ends of

said cylinder, an electrically actuated control means for shifting said valve including a nozzle having a fixed position relative to the sheet, a fluid supply line connected to said nozzle whereby fluid is discharged against the sheet, and means associated with the nozzle and responsive to variations in pressure in the fluid for establishing a circuit and causing the valve to shift in one direction upon an increase in thickness of the sheet above a predetermined thickness and for establishing another circuit to cause said valve to shift in the other direction when said sheet decreases below the predetermined desired thickness, said electrically controlled circuits including an intermittently operated switch for making and breaking said circuits controlling the valve for intermittently opening and closing the valve for intermittently moving the roll in one direction until the desired thickness is obtained.

HAROLD E. BALSIGER.