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HYDRAULIC PRESSURE REGULATING SYSTEM
FOR ROLLING MILLS OR THE LIKE
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Fig. 1.

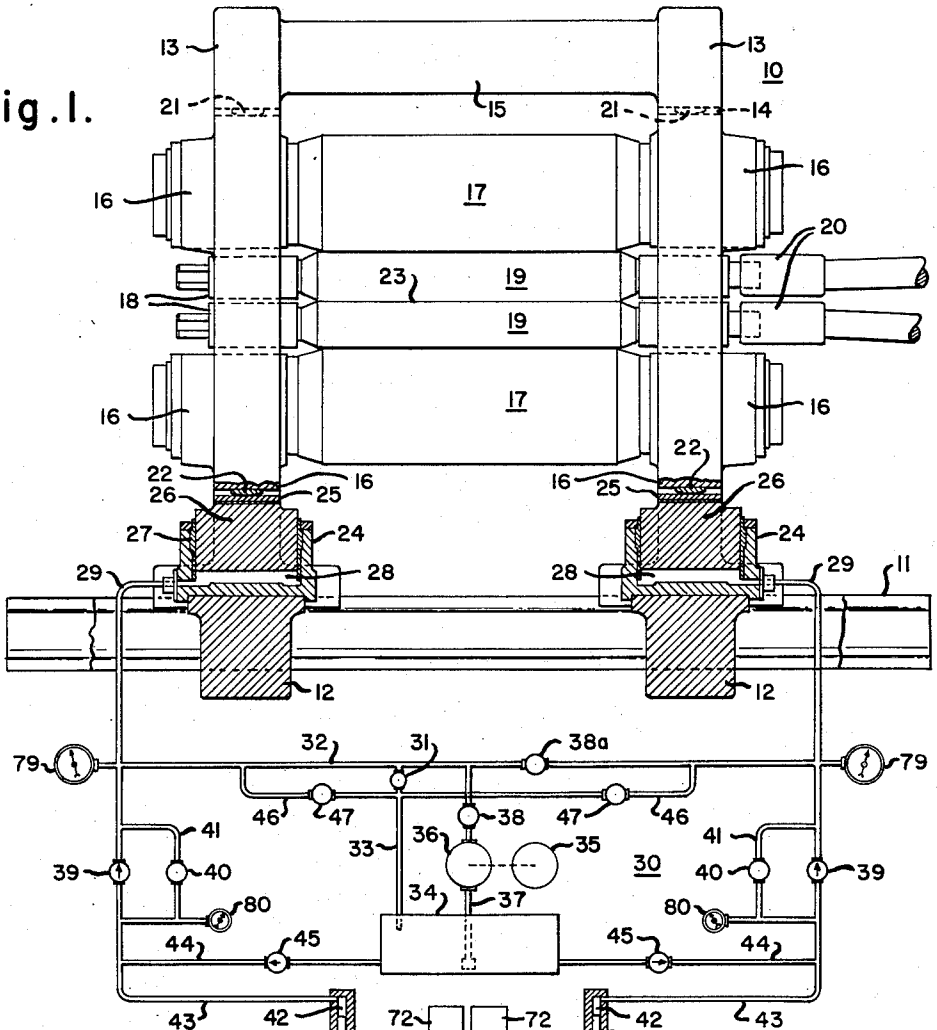
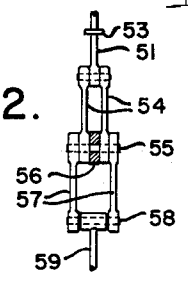


Fig. 2.



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HYDRAULIC PRESSURE REGULATING SYSTEM FOR ROLLING MILLS OR THE LIKE

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6 Claims. (Cl. 72—6)

This invention relates to a hydraulic pressure regulating system for rolls such as those mounted in a rolling mill stand, or the like. More particularly, this invention relates to means and method to maintain a selected rolling pressure hydraulically while inhibiting any letdown in that selected pressure due to leakage or otherwise in the system.

The use of hydraulic pressure applying mechanism in rolling mills, in lieu of electro-mechanical screwdowns is known as illustrated, for example, in United States Patent No. 2,056,409. However, even such prior devices had an inherent problem of pressure letdown in the system due to leakage or otherwise, particularly with pressures of an order suitable for various rolling operations on different metals. Attempts were made to supply additional hydraulic liquid to the system to maintain requisite pressures by the use of pressure control valves but that involved trying to set such valves correctly initially and then to reset them in the course of operation. The situation was sometimes further complicated when attempts were made to operate the two sides of a rolling mill at somewhat different pressures to achieve uniformity in the thickness of the sheet, strip or foil product. The general consequence was that precise selection and maintenance of hydraulic pressure in such a system heretofore was not satisfactorily achievable as a practical matter.

By means of this invention, such problems of the prior art have been overcome. Under this invention, both the initial achievement of the desired hydraulic pressure selected for rolling, or like purpose, and the supplying, preferably automatically, of incremental amounts of hydraulic liquid to prevent any letdown are obtainable with precision throughout the course of the entire rolling operation or the like, with relative ease and economy of operation and betterment of production. And, whenever the system pressure is to be changed because of work requiring such a change, that change may be made simply, rapidly and accurately with full assurance that the system will remain at the newly selected pressure despite leakage or other such elements therein which would otherwise disturb the set-up.

Other objects, features and advantages of this invention will be apparent from the following description and the accompanying drawings, which are illustrative of one schematic embodiment only, in which

FIGURE 1 is a view partly in section of a hydraulic pressure regulating system of this invention applied to a foil rolling mill in which the pressure upon each side of the mill may be independently adjusted and maintained at the respective selected pressure respectively; and

FIGURE 2 is a detailed view of linkage taken along line II—II of FIGURE 1.

Referring to the drawings, there is shown therein a mill 10 having a rigid frame supported upon foundation beams 11 beneath the front and back ends of saddles 12 rigidly connected thereto and supporting each side 13 of the frame. Each side 13 has a vertically extending window 14 therein for roll ends, chocks, bearing spacers and related members. A housing cap 15 rigidly connects the sides 13 together at the top completing the frame or housing for mill 10. Each window accommodates chocks 16 at the respective ends of backing rolls 17 and chocks 18 of respective upper and lower working rolls 19 vertically slidable in the respective windows 14. Wobblers 20 are universally connected to the adjacent ends of working rolls 19 in this embodiment to rotate said rolls at the desired speed for the particular service to be performed.

Upper bearing pads 21 and lower bearing pads 22 bear against the top and bottom of the respective chocks on each side and the vertical positions of those pads in each window 14 will determine the rolling pressure of a pass 23 between the working rolls 19 in a course of an operation on selected material. As illustrated, mill 10 is set to roll a thin strip or foil of a metal like aluminum with a selected force exerted on each side upon the lower bearing pads 22 in order to transmit that force to the backing rolls 17 and the working rolls 19 between them. The "screwdown" force thus applied to the rolls 19 is obtained preferably uniformly on each side by means of a pressure cylinder 24 positioned in the bottom of each window 14 beneath the supports 22.

Each cylinder assembly 24 has a pressure piston 26 therein with a face plate 25 on the top thereof to supportably engage its pad 22. Suitable bushing and packing means 27 surround the periphery of each piston 26 to slidably seal the space between each piston 26 and the wall of the cooperating cylinder chamber 28 in cylinder 24. Hydraulic liquid is supplied to chamber 28 through a conduit 29, such liquid acting upon the bottom of each single-acting piston 26.

The conduits 29 are illustrated as parts of a schematically depicted hydraulic liquid pressure circuit 30 which provides either identical or differentially adjusted pressure to each side at the selected value for the rolling operation to be undertaken with, further, automatic maintenance of that selected pressure or pressures, respectively, to yield the predetermined rolling force in the pass 23. When mill 10 is not in operation, normally closed valves 31 and 38*a* may be opened to drain hydraulic liquid in chambers 28 through the conduits 29, a manifold conduit 32 and a return pipe 33 leading to a storage reservoir 34 for such hydraulic liquid. Reservoir 34 preferably is normally maintained under a slight positive pressure. The withdrawal of hydraulic liquid from chambers 28 during shutdown correspondingly retracts the pistons 26 and reduces or eliminates pressure against the respective rolls 19 preparatory to a roll change, or for other purpose, before a new rolling action is to be commenced at whatever predetermined pressure or pressures respectively is wished in the respective chambers 28. During a shutdown of the whole system, the solenoid valves 74 may be inactivated by being temporarily disconnected from the controls 72 while the chambers 28 of the respective cylinders 24 are drained by the opening of valves 31 and 38*a*.

A motor 35 is connected to a pump 36 which takes its suction through a pipe 37 extending into liquid reservoir 34 and is open at its lower end adjacent to the bottom of that reservoir. Pump 36 will pump hydraulic liquid through valves 38 and 38*a* in the manifold pipe 32 and from thence through the conduits 29 into the chambers 28 at a selected prefill positioning pressure to extend the pistons 26 the requisite predetermined initial distance. During such pumping, valves 40 are open in bypass pipes 41 to prefill chambers 42 in maintenance cylinders 48 through respective pipes 43. The other branch of each bypass 41 is closed against the passage of any liquid from pump 36 by a check valve 39 and hydraulic liquid in pipes 43 is prevented from flowing through pipes 44 back into reservoir 34 by means of check valves 45 positioned therein. Valves 47 for pressure relief toward reservoir 34 are respectively provided in pipes 46 and adjusted to a desired setting normally considerably above the operating pressure for working or rolling desired for the respective chambers 28 in any operation, but well within the rupture strength of the various mill and circuit parts.

Each single-acting maintainer cylinder 48 has a plunger 49 cooperating therein, suitable packing being provided at the rod end of each plunger and cylinder. Each plunger 49 is rigidly connected to a plunger rod 51 with adjustable upper and lower collars 52 and 53 positioned thereon, respectively. The lower end of each rod 51 is pivotally secured to a link member 54. The lower end of link 54 is pivotally secured to a pin 55 and spans each side of a beam 56. The outer ends of pin 55 are pivotally linked, further, to a lower link member 57 having a cross pin 58 at the lower end thereof connecting the two sides. A piston rod 59 is pivotally secured to pin 58 between the sides of link 57. The other end of piston 59 is secured to a piston 60 in a single-acting pneumatic cylinder 61.

Each beam 56 is pivotally supported by a trunnion mount 62 on a fixed foundation. The end of beam 56 outwardly of support 62 is provided with a slidable counterweight 63 having an opening 64 through which beam 56 passes; and roller bearings may be provided between the members 56 and 63 if desired. A threaded opening 65 also extends through counterweight 63 to engage a threaded spindle 66, the outer end of which is provided with a stop 67 and the inner end of which is fastened to an armature 68 in a reversible electric motor 69 mounted on beam 56 and suitably connected to a remote control for the actuation thereof in either desired direction to move the counterweight in a corresponding direction along beam 56. Hence, with weight 63 in its predetermined position to which it has been moved by motor 69, the inner end of each beam 56 will thrust upwardly to press plunger 49 toward its fully retracted position to maintain the hydraulic liquid in the chambers 28 at the preselected operating pressure desired, usually higher than the aforesaid prefill positioning pressure, after pump 36 has been shut off and valves 31, 38, 38*a* and 40 are closed. Upon any tendency of a side of the system so maintained by the respective weight 63 to lose operating pressure due, e.g., to leakage, the plunger 49 involved will creep (upwardly as shown in FIGURE 1) from its extended toward its retracted position to precisely hold the pressure at the selected value while mill 10 is operating.

As either plunger 49 rises and reaches a predetermined position at or adjacent its fully retracted position, its respective collar 53 will engage the arm 70 of a snap-acting limit switch 71 which is thereby electrically connected, through a control 72, to energize the respective solenoid 73 of a pneumatic three-way solenoid valve 74 and open that respective valve. Compressed air from a supply pipe 75 will pass therefrom through the thus opened valve 74 into the rod end of a cylinder 61 respectively connected to that valve by a pipe 76. Adjustable speed control needle valves 77 preferably are positioned in each pipe 76 to regulate the speed of movement of the pistons 60 when valves 74 are opened, respectively. The head end of the cylinder 61 on each side is vented to atmosphere through a respective pipe 78 and the retraction of a piston 60 in its respective cylinder 61 moves its connected plunger 49 toward the fully extended position thereof, drawing additional hydraulic liquid from reservoir 34 into chamber 42 to fill it through its check valve 45 and pipes 44 and 43. Such a descent of a plunger 49 and its rod 51 causes its respective collar 52 at a predetermined position to engage the arm 70 of the snap-acting limit switch 71 on that side, which snaps back to the position shown in FIGURE 1 to actuate the corresponding control 72 to reverse its valve 74 and connect the rod end of the respective cylinder 61 through pipe 76 and vent 74*a* respectively to atmospheric exhaust. This latter action returns the plunger 49 on that side to the control of its respective beam 56 and weight 63 for selective operating pressure maintenance by the rolls without any letdown on either side in the mill system. During the relatively short period of operation of a cylinder 61

for refilling of the chamber 42 in its cylinder 48, the check valve 39 and closed valve 40 on that side of the system act to prevent a drop in the pressure in the respective chamber 28 on that side during such refilling. Valve 38*a* is also in closed condition during this operation and each side of the circuit 30 thus will operate independently to maintain the respective selected pressures, usually the same, in the chambers 28 for those respective sides.

In a prefilling operation after a roll change, for example, valves 38, 38*a* and 40 on both sides are opened and motor 35 is energized to cause pump 36 to pump hydraulic liquid into the two chambers 28 until the desired extension of the pistons 26 has taken place, whereupon valves 38 and 38*a* are closed, valve 31 already being closed. At this point, the motors 69 are energized to slide the counterweights 63 to the extreme inner positions when the motors 69 are stopped. This relieves the upward force on the plungers 49 which then extend by gravity due to the greater weight of the maintainer assembly pistons and linkage about fulcrum mount 62. This permits the cylinders 48 to fill with the liquid through valve 45 and pipes 44 and 43, on each side respectively. Valves 74 are open to exhaust in this stage to permit the pistons 60 to lower plungers 49 and the cylinders 61 to be vented at both ends. When the system has thus been filled with liquid under such pressure as the pump 36 provides, the selected operating pressure, preferably substantially exceeding the capacity of pump 36, is obtained by then actuating motors 69 to move the counterweights 63 outwardly along beams 56 until the gauges 79 show that the respective and desired operating pressure on each side has been achieved, whereupon the valves 40 are closed and the pressure in each side of the system is and remains maintained substantially constant at the selected value by the respective maintainer cylinder 48 on that side through valve 39 under the control of its beam and counterweight 63 except during any relatively short refilling periods thereof. Gauges 80 may be provided and correlated with the respective gauges 79 so that no valve 40 on a particular side is opened unless the gauges 79 and 80 on that side are in substantial agreement.

Thus, this invention operates automatically to maintain precisely the selected pressure desired for each of the pressure chambers 28, whether alike or unlike, irrespective of differences in the liquid seals on each side, or changes that may occur in the system capacity due, for example, to temperature changes. Preferably, on-off types of control will be sufficient to avoid any throttling effect and other forms of control and/or interlock may be provided. Further, a single common maintenance cylinder subassembly and beam counterweight control may be used in common for both sides of the system. And, other changes may be made in the structural features and circuitry of the illustrated embodiment and other embodiments provided without departure from the spirit of this invention or the scope of the appended claims.

I claim:

1. In a hydraulic pressure regulating system for rolls in a rolling mill stand or the like, apparatus comprising, in combination, at least one pressure cylinder in said stand, a piston in said pressure cylinder to exert a selected rolling force, means for pumping hydraulic liquid at a selected positioning pressure into said pressure cylinder to raise said piston a selected amount, valve means connected to said pressure cylinder and adapted when closed to hold said piston generally in said raised position, a maintainer cylinder in communication with said pressure cylinder through said valve means, a plunger in said maintainer cylinder, counterweight and beam means to exert a lever force upon said plunger to provide a pressure at least as high as said first-named pressure and said selected rolling force and, further, to feed liquid in said maintainer cylinder incrementally toward said pressure cylinder to maintain the same without letdown, means

responsive to a selected amount of movement of said plunger due to discharge of liquid from said maintainer cylinder in said incremental feed to cut off said communication between said maintainer cylinder and said pressure cylinder without release of pressure in said pressure cylinder, means responsive to withdraw said plunger relative to said maintainer cylinder and such last-named means to refill said maintainer cylinder, and means responsive to movement of said plunger relative to said maintainer cylinder due to said refilling to reestablish said communication upon completion of said refilling.

2. In a hydraulic pressure regulating system for rolls in a rolling mill stand or the like, apparatus comprising, in combination, a pressure cylinder positioned at the bottom on each side of said stand, a piston in each said pressure cylinder to exert a selected rolling force upwardly on each side, means for pumping hydraulic liquid at a selected positioning pressure into each pressure cylinder to raise its piston a selected amount respectively, a hydraulic liquid tank, check valve means to hold the pressure in said system when said first-named means is disconnected from said pressure cylinders, a maintainer cylinder for each side in communication with its respective pressure cylinder through said check valve means, a plunger in each said maintainer cylinder, selectively adjustable counterweight and beam means to press each said plunger respectively toward telescoping relation with its said maintainer cylinder to maintain at least said selected pressure on its respective side to provide said selected rolling force without letdown, fluid cylinder means responsive to a selected amount of movement of each said plunger due to movement of liquid out of said maintainer cylinder adapted to reverse the direction of said telescoping movement of said plunger relative to its maintainer cylinder to refill said maintainer cylinder from said tank without release of pressure in the respective said pressure cylinder, means for rendering said fluid cylinder means ineffective while the respective said maintainer cylinder is in communication with its said pressure cylinder, and means to render the respective sides of said system substantially independent of one another.

3. In a hydraulic pressure regulating system, apparatus comprising, in combination, hydraulic pressure cylinder means to exert a selective force, automatic hydraulic maintainer means connected to said presusre cylinder means to exert a selected pressure upon said pressure means and supply incremental amounts of hydraulic liquid to said pressure cylinder means as required to maintain said selected pressure without letdown, means responsive to movement of said maintainer means for operatively disconnecting said maintainer means from said pressure cylinder means to replenish hydraulic liquid in said maintainer means when it becomes depleted, without release of said selected pressure, lever means normally operatively connected to said maintainer means to exert a predetermined continuous force upon said maintainer means to provide said selected pressure when said maintainer means are operatively connected to said pressure cylinder means, and means responsive to said movement of said maintainer means to operatively disconnect said lever means from said maintainer means during such replenishment.

4. In a hydraulic pressure regulating system for rolls in a rolling mill stand or the like, apparatus comprising, in combination, hydraulic pressure cylinder means to exert a selected force upon said rolls, automatic hydraulic maintainer means to exert a selected pressure upon said

pressure cylinder means corresponding to said selected force and supply incremental amounts of hydraulic liquid to said pressure cylinder means as required to maintain said selected force without letdown, means responsive to movement of said maintainer means for operatively disconnecting said maintainer means from said pressure cylinder means to enable the volume of hydraulic liquid in said maintainer means to be replenished when it becomes depleted without release of said selected force in said pressure cylinder means, means to prevent said pressure cylinder means from exerting pressure upon said maintainer means, adjustable gravity means normally operatively connected to said maintainer means to exert a predetermined force upon said mantainer means, means responsive to said movement of said maintainer means to operatively disconnect said gravity means from said maintainer means to enable such replenishment to take place, and means to regulate the rate of such replenishment and of the operative reconnection of said gravity means to said maintainer means.

5. Hydraulic pressure regulating apparatus comprising, in combination, pressure means having a pressure cylinder and piston to exert a selected operating force when subjected to a hydraulic liquid predetermined operating pressure, maintainer means having a maintainer cylinder and plunger normally operatively connected to said pressure means and adapted to exert and maintain said predetermined operating pressure upon said pressure means, the volumetric capacity of said pressure means being many times greater than that of said maintainer means, gravity force means operatively connected to said maintainer means and adapted to press said maintainer cylinder and plunger into progressively increasing telescoping relation to maintain said predetermined operating pressure in said pressure means without letdown, means responsive to a predetermined extent of relative telescoping movement in said maintainer means to operatively disconnect said gravity force means from said maintainer means without release of said predetermined operating pressure in said pressure means and to move said maintainer cylinder and plunger relatively apart to draw additional hydraulic liquid into said system, and means responsive to a predetermined extent of said last-mentioned movement to operatively disconnect said last-named means and operatively reconnect said gravity force means to said maintainer means.

6. A hydraulic pressure regulating apparatus as set forth in claim 5, comprising, pump means adapted to supply hydraulic liquid initially to said system at a selected positioning pressure to position said piston relative to said pressure cylinder, said pump means having a capacity incapable of supplying hydraulic liquid to said system at said predetermined operating pressure.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,191,408

June 29, 1965

Paul S. Bayan

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, lines 6 to 8, strike out "withdraw said plunger relative to said maintainer cylinder and such last-named means to" and insert instead -- such last-named means to withdraw said plunger relative to said maintainer cylinder and --; column 5, line 45, for "presusre" read -- pressure --.

Signed and sealed this 22nd day of February 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents