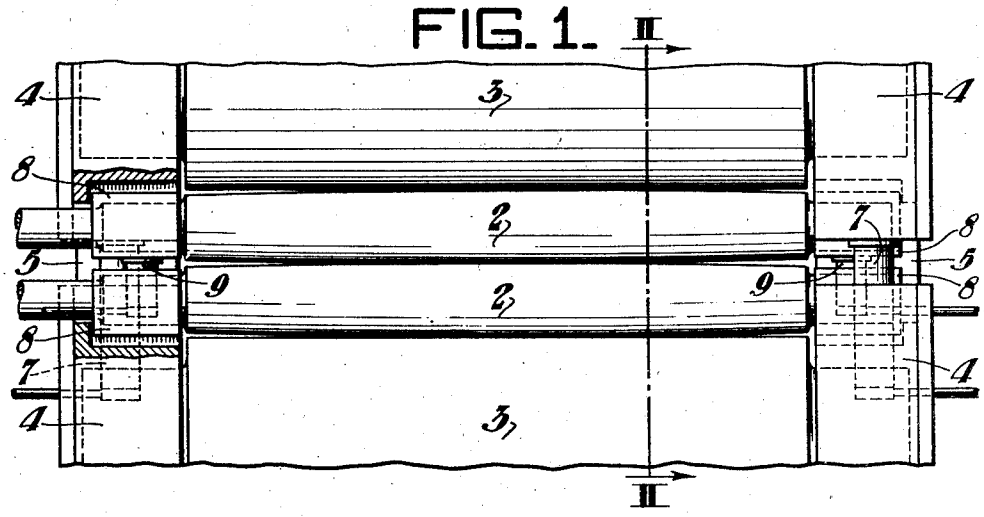
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WORKING PASS CONTROL FOR ROLLING MILLS

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FIG. 1.



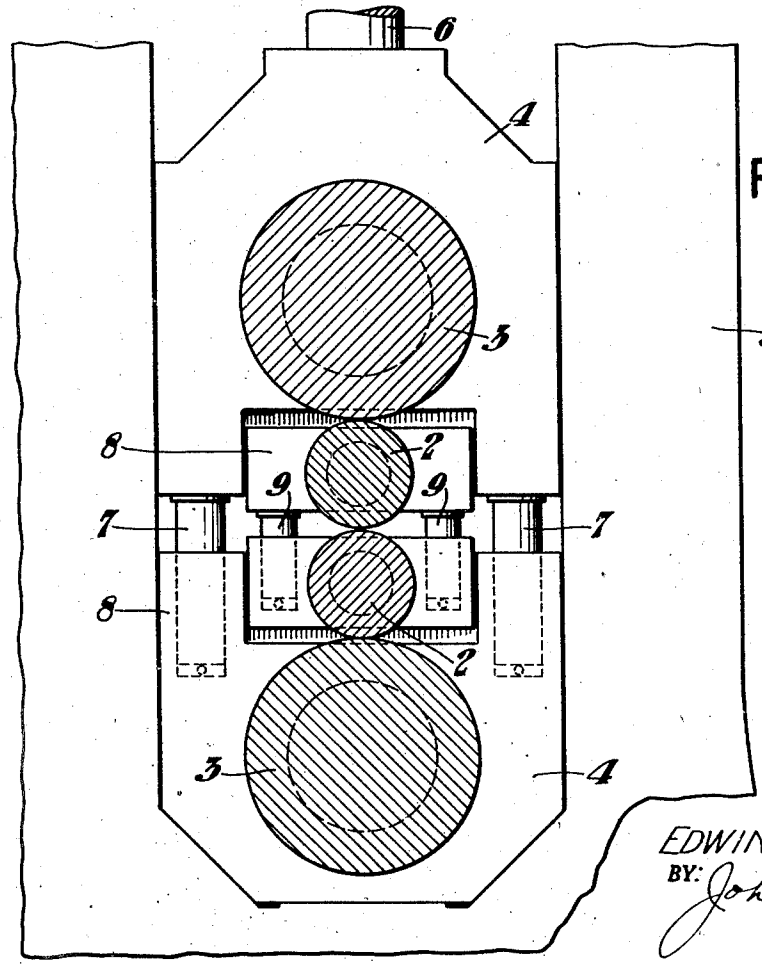


FIG. 2.

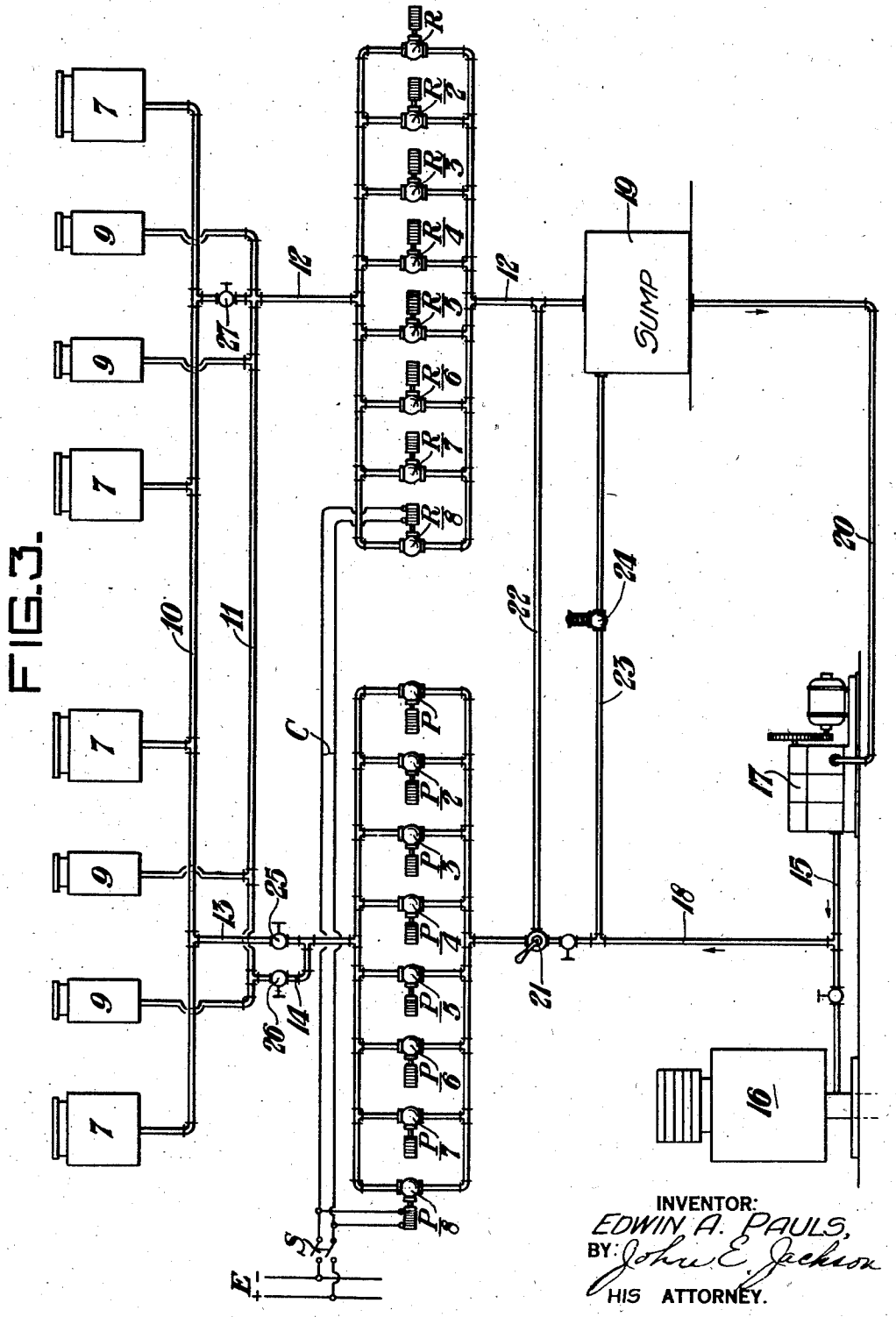
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WORKING PASS CONTROL FOR ROLLING MILLS

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FIG. 3.



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WORKING PASS CONTROL FOR ROLLING MILLS

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5 Claims. (Cl. 80—56)

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This invention relates to improvements in the art of metal rolling, and more particularly to a highly selective control of the working pass of a mill for rolling steel sheets and strip.

Initially, the working pass of a mill is defined by predetermined roll shapes, and such rolls are adjusted to the proper spacing and screw pressure for the rolling problem involved. Thus, in the rolling of flat products, such as sheet and strip, the working pass is set and shaped for a single extension or reduction, gauge, width and degree of flatness of the product.

In the four-high mill employed in cold rolling or reducing, the shapes of the work and backup rolls, the screw pressure and the hydraulic pressure maintaining the rolls apart are predetermined, and if maintained constant, should produce a uniform product. However, as the rolls wear or as the metal supplied to the rolls varies, the product will vary unless adjustment of the mill is possible to compensate therefor, since such a mill is theoretically limited to a single width, gauge, extension or reduction, and degree of flatness.

The problem of adjustment is particularly acute in temper rolling wherein the metal sheet or strip is work-hardened to the proper degree, and must result in a product possessing the required gauge, width and flatness. If the width of the product changes, the same extension or reduction and flatness cannot be attained, and some adjustment becomes necessary in order to produce a satisfactory product with the same rolls. Expedients now practiced are to shut off the hydraulic pressure upon the rolls to vary the effective rolling crown, or to apply heat, as by open gas flames to the backup rolls to shape the latter in accordance with the requirements of the sheet or strip. Variations are also sought to be met by cooling the heated backup rolls.

Such practices are principally objectionable due to their lack of flexibility. The temper mill is continually called upon to fill orders calling for sheet or strip specifying numerous gauges, widths, extensions and flatness tolerances, thereby placing fluctuating demands upon the mill, which seeks to maintain a high standard of quality at reasonable cost. From the standpoint of cost, it is both impracticable and expensive to change rolls or to change the thickness and width of the stock being rolled to meet the varying and frequent demands, and since the latter occur in individual orders without relation to other specifications or any range of standardized sizes, it is

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likewise impracticable, if not impossible, to anticipate such demands.

Consequently, the operators have experienced considerable difficulty in meeting specifications, resulting in increased costs, or in some instances, necessitating the production of a product in which one or more of the specified tolerances must be violated in order to produce a product at an acceptable price.

To these difficulties is added the fact that the open gas flame now employed for arbitrarily shaping the backup rolls is a constant fire and safety hazard, and the repeated heating and cooling is likewise detrimental to the rolls. Further when rolling sheets with the hydraulic pressure off, direct and repeated contact of the work rolls occurs between sheets, thereby marring said rolls and causing surface defects in the product.

It is a prime object of my invention to provide a rolling control, whereby the working pass of the mill may be adjusted to the requirements of the metal being rolled to obtain the desired rolled product.

My invention has in view to provide for the selective adjustment of working pass of the mill by variable pressures upon the rolls, through the hydraulic system now employed on the mill for separating the rolls and changing the same, thereby providing for the ready application of the invention to existing as well as new mills.

Additional objects and advantages will become apparent from the following description taken in connection with the accompanying drawings wherein:

Fig. 1 is an elevational view of a portion of a four-high mill upon which my invention may be practiced;

Fig. 2 is an end elevation thereof; and

Fig. 3 is a diagrammatic view showing a control apparatus applied to the mill of Figs. 1 and 2 in the practice of my invention.

Referring to the drawings, the four-high mill illustrated includes a pair of work rolls **2** and backup rolls **3**, the latter having their necks mounted in the usual bearings in chocks **4** slidable in the housing **5**. The upper chocks **4** are engaged by screw-downs **6** opposed by the pressure of hydraulic jacks **7** between the upper and lower chocks, and by the work in the pass of the mill.

The work rolls have their necks mounted in separate adjustable chocks **8** slidable in the backup roll chocks **4**, the respective upper and lower work roll chocks **8** being normally separated by hydraulic jacks **9** likewise in opposition to the

screw-downs 6, and maintaining the work rolls 2 against their respective backup rolls 3.

Fig. 1 illustrates a typical mill set-up, wherein the backup rolls 3 may be initially straight in contact with the rolls 2, which may have a selected crown. Under present practice, the pass section of such a mill remains substantially constant, unless varied by the application of heat or cold as hereinbefore stated. My improved method of control provides a multi-stage adjustment between maximum and minimum working crowns by flexing the rolls under pressure, thereby affording the operator a highly selective range of working crowns and enabling him to anticipate as well as correct for the desired finished product. Further, by maintaining the selected working crown constant, the desired uniformity of product is obtained.

In the practice of my invention, the rolls are flexed by pressure upon the roll necks, thereby taking advantage of a fulcruming action about the central vertical plane of the mill. Such action is made possible by a crown on the rolls or the crown or thicker central longitudinally extending portion of the work piece or both, whereby the rolls, acting as beams about such central fulcrum region, may be flexed to thereby vary the working pass contour.

The mill is provided with screw-downs which act as stops, defining the extent of the pass opening, and hydraulic pressure cylinders in opposition thereto, the latter being provided for the purpose of keeping the rolls apart against the screw-downs and for changing rolls. However, such a combination of pressure means, together with the resistance of the work piece, provides a suitable source of control of the flexing of the rolls to vary the pass section of the mill upon the employment of controllable hydraulic as well as screw pressures.

Thus, upon operating such a mill with a working crown as above described, it will readily be seen that the variation of the opposed screw and hydraulic pressures will effect a beam action upon the rolls, and that for any screw pressure and maximum hydraulic counter-pressure, the working pass of the mill may be adjusted from maximum to minimum with respect to the amount of adjustment of which the rolls are capable under such pressures. While the flexure of the rolls may only be of the order of from one to ten thousandths of an inch, such variations from the original roll shapes will produce a highly selective adjustment of the working pass of the mill sufficient to greatly extend and enhance the rolling range of the mill.

To accomplish these ends, the hydraulic jacks 7 and 9 are connected in hydraulic circuit with a pressure supply, the backup roll jacks 7 being connected by a common conduit 10 and work roll jacks 9 by a common conduit 11. Conduits 10 and 11 are connected with a common return conduit 12 and a supply conduit 13 connects with the conduit 10. Said conduit 13 likewise connects with conduit 11 through a by-pass 14.

Conduit 13 is supplied from a pressure-controlled supply line 15 between an accumulator 16 and pump 17 by a conduit 18 through a plurality of solenoid controlled pressure reducing valves connected in parallel. Each of said valves is set to deliver a proportion of a pressure P, which is the maximum pressure of the accumulator 16, and have been so designated in Fig. 3 by fractions of said maximum pressure, eight of such valves being shown.

Similarly, the return conduit 12 is connected with a sump 19 through a plurality of solenoid controlled relief valves, one for each of the pressure reducing valves, the relief valves being set to permit a return flow therethrough to the sump 19 in corresponding proportions of the maximum relief pressure R equal to the pressure P, said relief valves being designated by fractions of said pressure R.

The sump 19 is open to the atmosphere and is connected to the pump 17 by a supply conduit 20. An operating valve 21 is positioned in conduit 18, said valve being a three-way valve capable of opening line 18 to the pressure reducing valves, and for cutting off the latter for pumping through a by-pass conduit 22 to the return conduit 12 between the relief valves and the sump. Conduit 18 is likewise connected with sump 19 by a safety by-pass 23 containing a safety valve 24, set for the maximum pressure of the system.

The respective pressure reducing and relief valves of the same pressure capacity have their solenoids connected in an electrical circuit C for simultaneous action, as by closing the switch S connecting said circuit with a power source E. One only of said circuits is shown connecting and actuating the solenoids of pressure reducing valve P/8 and relief valve R/8. It will be readily understood that each pair of said valves of the same capacity are similarly connected and actuated by individual circuits, each having a separate control switch.

Hence, with the hydraulic system in operation at a maximum pressure of 2000 pounds, valve P/8 will admit 250-pounds to the hydraulic jacks 7 and 9, and valve R/8 will return any excess of pressure from the latter to the sump. Similarly other selective pressures from the maximum to that established by P/8 and R/8 may be obtained in the proportion and in accordance with the capacity and number of the said pairs of valves, one such pair being operated at a time.

By the incorporation of such a selective control system in the hydraulic pressure supply to the jacks, the mill may be operated in accordance with my invention, the variable pressure differential between screw and hydraulic pressures, together with the resistance of the work piece and the fulcruming action at the center of the mill, affording a wide range of working pass contours available to and readily controlled by the operator.

In order to afford further variation in the control of the mill pass section, shut-off valves 25 and 26 are provided in the supply conduit 13 and by-pass 14 respectively. By closing valve 25, the pressure control of the system may be restricted to the work rolls 2 only, through jacks 9. Similarly, upon closing valve 26, the system acts upon only the backup roll jacks 7.

It should be noted that in all but the latter mode of control and adjustment, the work rolls 2 are always under a separating pressure, preventing injurious contact therebetween when the pass is empty, as for example, between sheets.

In order to provide for changing rolls, a valve 27 is provided in the return line 12 to prevent the return flow of fluid from the backup roll jacks 7, so that upon retracting the screw-downs 6, the upper roll 3 may be raised by closing valves 26 and 27, giving full pressure to the backup roll jacks 7.

Various changes and modifications are contemplated within the scope of the following claims.

I claim:

1. In a rolling mill, the combination with fluid pressure jacks acting upon the roll necks in opposition to the screw pressure thereon, of a constant maximum fluid pressure supply for the jacks, a plurality of pressure reducing valves in said supply for delivering predetermined proportions of said maximum pressure to the jacks, a plurality of pressure relief valves coacting with the reducing valves to maintain the pressure governed by the latter valves upon the jacks, and selective means for actuating said valves to thereby adjust the pass section of the mill by the action of said pressures upon the rolls when in engagement with a work piece.

2. In a rolling mill, the combination with fluid pressure jacks acting upon the roll necks in opposition to the screw pressure thereon, of a constant maximum fluid pressure supply for the jacks, connecting means between said supply and the jacks, a series of pressure reducing valves in said connecting means for delivering predetermined proportions of said maximum pressure to the jacks, a return conduit connected to said jacks, a series of pressure relief valves in the return conduit, one relief valve for each of said pressure reducing valves, the respective reducing and relief valves having equal pressure capacities, and means for simultaneously actuating the respective reducing and relief valves to maintain a selected pressure upon the jacks to thereby adjust the pass section of the mill by the action of said pressures upon the rolls when in engagement with a work piece.

3. In a four-high mill having work rolls and backup rolls, fluid pressure jacks between and acting upon the necks of the work rolls, fluid pressure jacks between and acting upon the backup roll necks, separate fluid conduits connecting the work roll and backup roll jacks, a constant maximum fluid pressure supply, a supply conduit connecting said supply with the fluid jack conduits, a plurality of pressure reducing valves in the supply conduit each having different predetermined pressure capacities, a return conduit connected with the fluid jack conduits, a plurality of pressure relief valves in the return conduit having complemental pressure capacities with respect to the reducing valves, each reducing and relief valve of the same capacity having actuating means connected and operable for simultaneous operation of said valves to control and maintain the proportion of said maximum pressure established by said valves upon the fluid jacks, thereby providing a selective control for adjusting the pass section of the mill by the action of said pressures upon the rolls when in engagement with a work piece.

4. In a four-high mill having work rolls and backup rolls, fluid pressure jacks between and acting upon the necks of the work rolls, fluid pressure jacks between and acting upon the backup roll necks, separate fluid conduits connecting the work roll and backup roll jacks, a constant maximum fluid pressure supply, a supply conduit connecting said supply with one of the fluid jack conduits, a by-pass connecting the other fluid jack conduit with the supply conduit, shut-off valves in the by-pass and supply conduit, a plurality of pressure reducing valves in the supply conduit each having different predetermined pressure capacities, a return conduit connected with the fluid jack conduits, a plurality of pressure relief valves in the return conduit having complemental pressure capacities with respect to the reducing valves, each reducing and relief valve of the same capacity having actuating means connected and operable for simultaneous operation of said valves to control and maintain the proportion of said maximum pressure established by said valves upon the fluid jacks, thereby providing a selective control for adjusting the pass section of the mill by the action of said pressures upon the rolls when in engagement with a work piece.

5. In a four-high rolling mill, work rolls and backup rolls shaped to provide a fulcrum for said work rolls in the central vertical plane of the mill upon engagement of a work piece between the work rolls, fluid pressure jacks operable upon and between the work rolls to flex said work rolls about said fulcrum, a selective variable fluid pressure supply for the jacks, and means for maintaining the selected pressure constant upon said jacks.

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