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ROLLING MILLS

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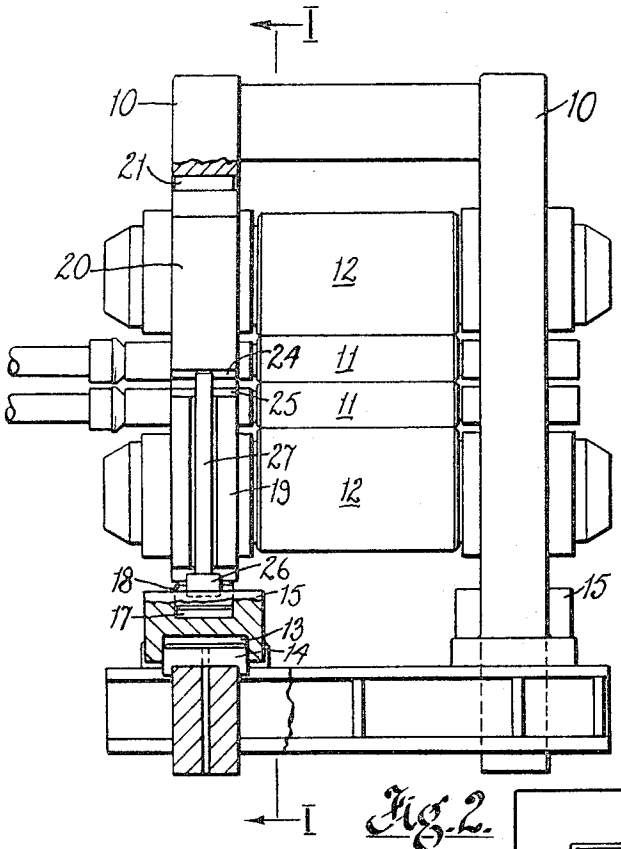

Fig. 2.

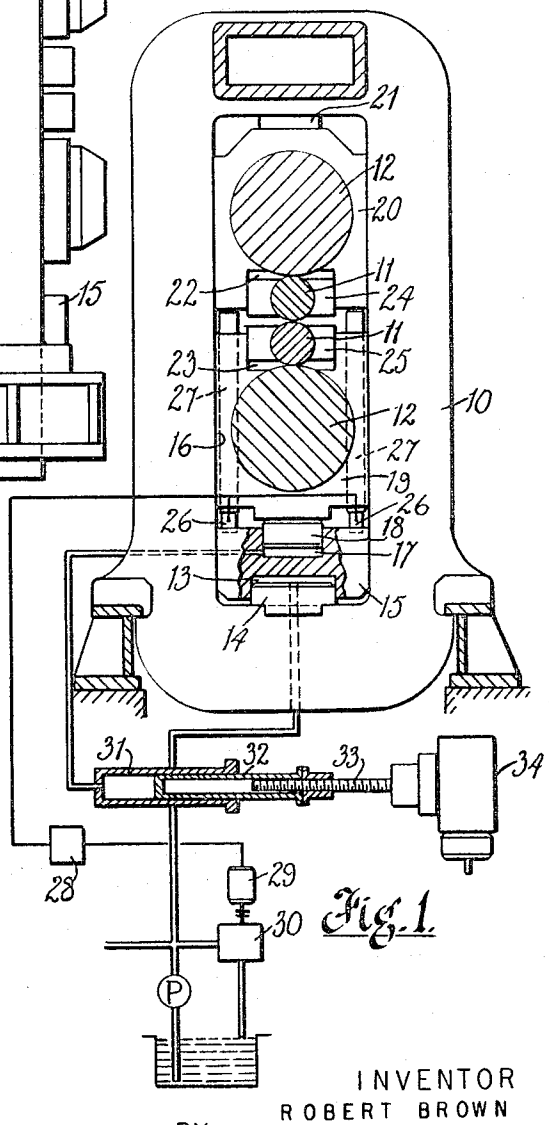

Fig. 1.

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ROLLING MILLS

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7 Claims. (Cl. 72—6)

This invention relates to rolling mills for sheet or strip material. The invention relates in particular to rolling mills for sheet or strip material having means for subjecting them to a pre-stressing force which at all times during the operation of the mill is greater than the separating force produced by the material which is in the gap between the working rolls of the mill. These rolling mills have two roll-assemblies of which each includes a working roll and may also include one or more backing rolls.

The pre-stressing force may be produced in such a mill by one or more hydraulic cylinder-and-ram units, built into the frame of the mill. Usually each of the two housings of the mill has its own hydraulic pre-stressing unit.

In a mill of this type, spacing means have to be provided for keeping the axes of the working rolls at a preset distance from each other and thereby determining the size of the roll-gap and the thickness of the material which passes therethrough. These spacing means are subjected during a rolling operation to a force which is equal to the difference between the pre-stressing force and the separating force. The separating force is known to vary frequently from one rolling operation to the next or even during one and the same operation. The reason for these variations is changes in the condition of the rolled material, e.g., changes in its temperature or hardness. Variations in the separating force result in corresponding variations in the difference between the pre-stressing force and the separating force, provided that the pre-stressing force is kept constant at all times. These variations cause the spacing means to stretch by varying amounts and thus interfere with the pre-set gap between the working rolls. This is undesirable because it leads to the production of material of uneven thickness.

A proposal has been made in British patent specification No. 955,164 which seeks to avoid this drawback. This proposal consists essentially in providing in a rolling mill of the type described means which detect variations in the separating force as they occur during a rolling operation, and means operative to adjust the pre-stressing force under the control of the output of these detecting means in such a manner that the difference between the pre-stressing force and the separating force is kept substantially constant during a rolling operation. In this way, the distance between the axes of the working rolls of the mill and the size of the gap between the working rolls is maintained substantially constant.

In the rolling mill described in British patent specification No. 955,164, the spacing means which determine the distance between the axes of the working rolls are in the form of spindles which are threaded into the bearing chocks of one roll-assembly and abut against load meters placed on top of the bearing chocks of the other roll-assembly. The spindles can be displaced for the purpose of adjusting the size of the roll-gap by an electric motor through reduction gears built into the mill. The load meters may be of the type comprising pressure-responsive cells.

The rolling mill of the present invention is similar in its major aspects to the mill described in British patent specification No. 955,164 in that there are provided in that mill means for pre-stressing the mill and for controlling the pre-stressing force in response to changes in the separating force measured by load meters, so that the difference between the two forces is substantially constant at all times, with the result that the spacing means are subjected to a substantially constant force during a rolling operation and that the size of the gap between the working rolls is maintained substantially constant as well.

The object of the present invention is to provide a rolling mill as described above which is of simpler design than that of British patent specification No. 955,164.

In accordance with the present invention, there are interposed between the bearing chocks of one roll-assembly and the load meters which indicate the difference between the pre-stressing and the separating force, plain rods which act as spacing means and which by-pass the bearing chocks of the other roll-assembly.

These spacer rods serve the purpose of keeping the first roll-assembly apart from the second roll-assembly and of transmitting the forces acting between the roll-assemblies to the load cells. Relative adjustment of the two roll-assemblies is effected not by the spacer rods but by separate means which act direct on the bearing chocks of one of the roll-assemblies. This is preferably the roll-assembly which is by-passed by the spacer rods.

The relative adjustment of the two roll-assemblies may be effected by additional hydraulic units which act direct on the bearing chocks of one of the roll-assemblies. This may be the roll-assembly whose bearing chocks are by-passed by the spacer rods. The relative adjustment of the roll-assemblies can then be changed by changing the volume of hydraulic fluid in the hydraulic adjustment units. In order to make fine adjustments, the pressure fluid is taken from a separate cylinder having a piston which can be accurately displaced in either direction, e.g., by means of a motor-driven reduction gear which acts on the piston rod.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a section along line I—I of FIG. 2.

FIG. 2 is a front elevation of a rolling mill in accordance with the present invention.

The rolling mill illustrated in the drawings comprises two housings **10** and is fitted with two roll-assemblies, each including a working roll **11** and a backing roll **12**. Means for pre-stressing the mill are arranged in the lower part of each housing and consist of a hydraulic cylinder **13** and a ram **14**. The rams form part of the housings, and the cylinders are formed in blocks **15** which are displaceable and guided in windows **16** of the respective housings **10**. Another cylinder **17** of somewhat smaller size than the cylinder **13** is formed in each block **15**, and a ram **18** is displaceable in each of the last-mentioned cylinders, a cylinder **17** and a ram **18** forming together a unit for the adjustment of the two roll-assemblies **11**, **12** relative to each other. The rams **18** support bearing chocks **19** of the lower backing roll **12**. These chocks are guided in the windows **16**. The bearing chocks **20** of the upper backing roll **12** abut from below against the upper ends of the housings **10**, blocks **21** being interposed between the bearing chocks **20** and the housings. The height of the blocks **21** may be adjustable for the initial setting of the roll-gap.

The bearing chocks **19** and **20** have recesses **22** and **23**

at their ends facing each other, and bearing chocks **24** and **25** respectively for the working rolls **11** are accommodated in these recesses.

On either side of the hydraulic pressure unit **17, 18**, pressure-responsive load cells **26** are placed on the block **15**. Plain threadless rods **27** pass freely through and extend beyond the bearing chocks **19** of the lower backing roll and rest on top of the load cells **26**. With their upper ends, the rods **27** abut against the bearing chocks **20**.

Adjustment in height of the lower working roll **11**, and therefore also of the opening between the two working rolls, is obtained by the admission or release of pressure fluid contained in the cylinders **17**. As the rods **27** pass freely through the bearing chocks **19**, the latter can move relatively to these rods during adjustment of the roll-gap.

Before rolling begins and when the rolling mill is pre-stressed by the units **13, 14**, the pre-stressing force will be transmitted from these units to the blocks **15**, from there to the load cells **26**, to the spacer rods **27**, to the bearing chocks **20**, and to the top of the housings **10**; at the same time, the reaction of the pre-stressing force will be transmitted directly from the rams **14** to the lower end of these housings. The spacer rods **27** have then to take the full pre-stressing force. As soon as rolling has started and a roll-separating force developed, the spacer rods have only to take the difference between the pre-stressing force and the roll-separating force, and this difference acts on the load meters.

The load-meters are preferably of the type having pressure-responsive cells in which changes in pressure are transformed into electric signals. These signals are utilised for controlling the pressure of the hydraulic units **13, 14** in a manner similar to that described in British patent speecification No. 955,164. The signals are fed into an amplifier **28** and from there to a servomotor **29** for a pressure relief valve **30**. This valve is in a by-pass of a hydraulic line leading from a pump P to the cylinders **13** of the hydraulic pre-stressing units. The above-described control circuit, the relief valve and the pump P are common to the units **13, 14** of both housings **10**.

An increase in the roll-separating force with a resulting decrease in the difference between the pre-stressing and the separating forces causes the pressure relief valve **30** to increase the pre-stressing force to the extent that the difference between the two forces is reduced to its former value. Conversely, a drop in the separating force with a resulting increase in the difference between the pre-stressing and separating forces leads to a corresponding drop in the pre-stressing forces. In this way, the difference between the two forces and hence the compression of the spacer rods **27** can be maintained substantially constant throughout a rolling operation. As the compression of the spacer rods is indicative of the opening between the working rolls **11**, this opening is thus kept constant.

To enable adjustment of the roll-gap to be made, the hydraulic fluid from the cylinders **17** is taken from one or more displacement cylinders **31** having a ram **32**. The ram is threaded over a spindle **33** driven by a motor **34**. Separate cylinders **31** and rams **32** may be arranged for each of the cylinders **17**. In this way, it is possible to adjust the position of the rams **32** relative to the cylinders **31** with great accuracy, and thus to regulate within close limits the amount of pressure fluid contained in the cylinders **17**. This, again, provides adjustment of the roll-gap between the working rolls **11** within close limits.

In the example shown and described, the two groups of hydraulic units **13, 14** and **17, 18** respectively are arranged in the lower part of the housings **10** where they are easily accessible for maintenance and other purposes. The pipes which supply hydraulic fluid to these units can also be kept relatively short. However, it is within the scope of the present invention to arrange the afore-mentioned units in the upper part of the housings **10**. It is also possible, for instance, to arrange the hydraulic pre-stressing units **13, 14** in the lower parts of the housings and the units **17, 18** for the adjustment of the roll-gap in the upper part, or vice versa.

The invention can also be applied to rolling mills without backing rolls. In this case, the bearing chocks for the working rolls take the place of the bearing chocks for the backing rolls in the example described.

I claim:

1. A rolling mill for rolling flat products, having two roll-assemblies each having a working roll, spacing means for maintaining a pre-set distance between said working rolls, means for adjusting the distance between said working rolls separate from said spacing means, pre-stressing means for the mill, load meters measuring the load in said spacing means, control means for varying the pre-stressing force and responsive to the output from said load meters, said spacing means being formed by rods interposed between one of the roll-assemblies and said load meters, said load meters being interposed in turn between said spacing means and said pre-stressing means and said adjusting means interposed between the other roll-assembly and the pre-stressing means.

2. A rolling mill for rolling flat products, comprising two housings, two roll-assemblies each comprising a working roll and roll-bearing means for supporting a roll-assembly in said housings, spacing means for maintaining a pre-set distance between said working rolls for the passage therethrough of the rolled product, means for adjusting the distance between said working rolls and acting directly on the roll-bearing means of one roll-assembly, pre-stressing means interposed between said adjusting means and said housings, load meters interposed between said spacing means and said pre-stressing means, and control means for varying the pre-stressing force in response to the output from said load meters, said spacing means being formed by rods abutting with one of their ends against the load meters and with the other end against the bearing means of one roll-assembly and by-passing the bearing means of the other roll-assembly.

3. A rolling mill for rolling flat products, having two housings, two superposed roll-assemblies defining between themselves a gap for the passage therethrough of the rolled product, bearing means for supporting said roll-assemblies in said housings, means for placing said housings and said bearing means under a pre-stressing force, means for adjusting the gap between said roll-assemblies and acting on the bearing means of the lower one of said roll-assemblies, rods supporting the bearing means of the upper one of said roll-assemblies and bypassing the bearing means of the lower roll-assembly, load meters measuring the load in said spacing means, and control means for adjusting the pre-stressing force in response to the output from said load meters.

4. A rolling mill according to claim **3**, in which the load meters are interposed between the spacing rods and the pre-stressing means.

5. A rolling mill for rolling flat products, having two superposed roll-assemblies defining between themselves a gap for the passage therethrough of the rolled product, bearing means for supporting said roll-assemblies in said housings, means for placing said housings and said bearing means under a pre-stressing force, said pre-stressing means comprising hydraulic cylinder-and-ram units, means for adjusting the gap between said roll-assemblies and comprising further hydraulic cylinder-and-ram units, spacing means supporting the bearing means of the upper one of said roll-assemblies and by-passing the bearing means of the lower one of said roll-assemblies, and a block in each housing, the hydraulic pre-stressing units being arranged partly on the housings and partly on said blocks, and the hydraulic adjusting units being arranged partly on said block and partly on the bearing means for the lower one of said roll-assemblies.

6. A rolling mill according to claim **5**, having load meters interposed between said spacing means and said

blocks, and control means for varying the pressure in said pre-stressing units in response to the output of said load meters.

7. A rolling mill according to claim 1, having adjusting means comprising hydraulic cylinder and ram units, and at least one metering cylinder connected to the cylinders of the hydraulic adjusting units, a ram displaceable in said metering cylinder and means for adjusting the position of said ram relative to said metering cylinder.

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