United States Patent [19]

Diolot

[11] **3,733,870**

[45] **May 22, 1973**

[54] **ROLLING MILL EMPLOYING NON-VARIABLE PRESTRESSING**

[75] Inventor: **Lucien Diolot,** Neuilly, France

[73] Assignee: **Societe Nouvelle Spidem,** Paris, France

[22] Filed: **Oct. 28, 1971**

[21] Appl. No.: **193,355**

[30] **Foreign Application Priority Data**

Oct. 28, 1970 France.....7038962

[52] **U.S. Cl.**.....**72/245**

[51] **Int. Cl.**.....**B21b 31/32**

[58] **Field of Search**.....72/245, 246, 8, 28; 100/170

[56] **References Cited**

UNITED STATES PATENTS

3,538,733	11/1970	Diolot	72/245
3,578,766	5/1971	Diolot	100/170
3,673,843	7/1972	Diolot	72/245
3,533,255	10/1970	Sims	72/8

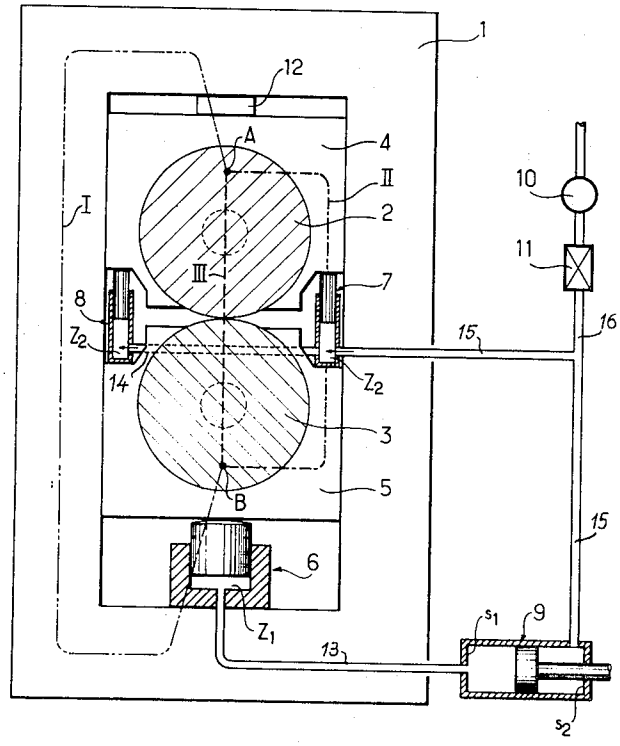
Primary Examiner—Milton S. Mehr

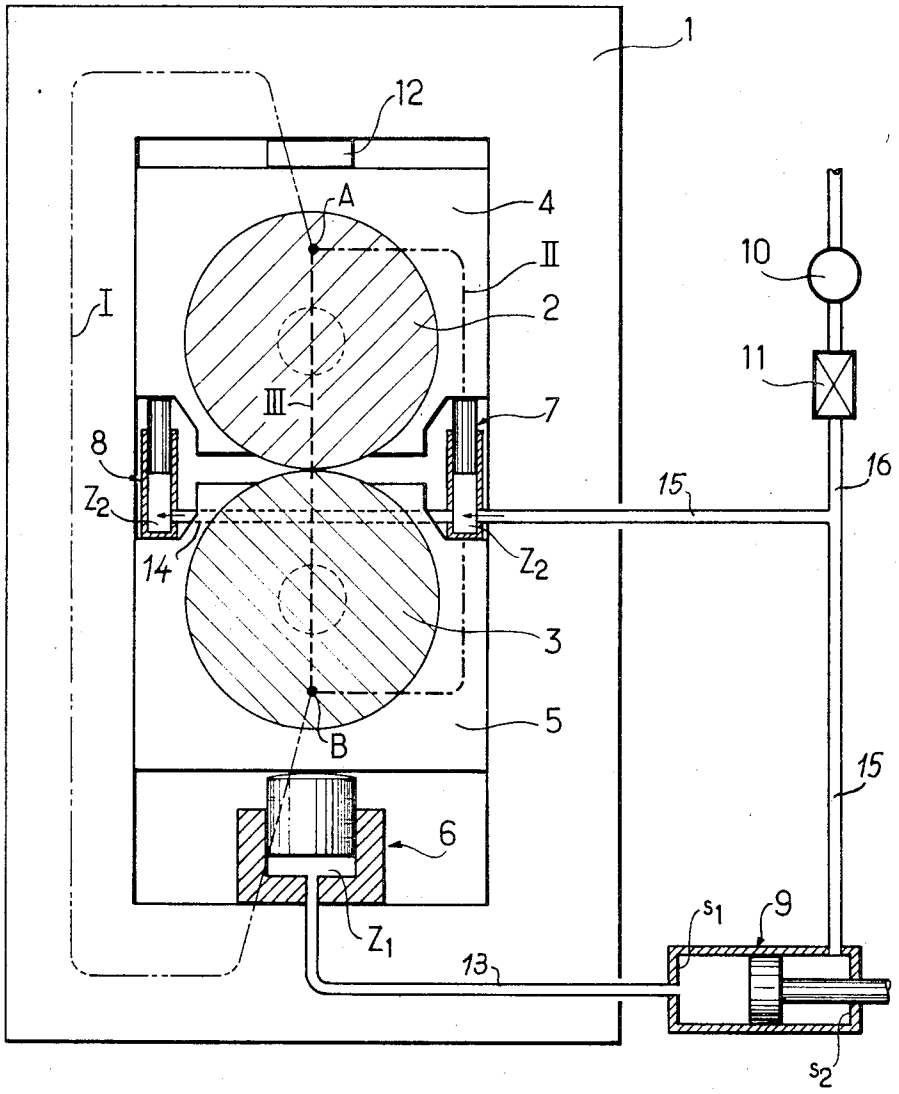
Attorney—Edwin E. Greigg

[57] **ABSTRACT**

In a rolling mill in each upright there is provided a first hydraulic jack forming part of a hydromechanical clamping system and a pair of second hydraulic jacks forming part of a prestressing device. One side of a cylinder of a plunger piston jack also forming part of the hydromechanical clamping system communicates with the pressure chamber of the first hydraulic jack, while the other side of said cylinder is in continuous communication with the pressure chambers of the second hydraulic jacks associated with the same upright.

5 Claims, 1 Drawing Figure




1
12
A
4
II
I
2
10
11
III
7
8
16
15
Z_2
14
Z_2
3
5
B
15
6
S_1
9
Z_1
13
S_2

ROLLING MILL EMPLOYING NON-VARIABLE PRESTRESSING

The present invention relates to a rolling mill equipped with a hydromechanical clamping system, with which a prestressing device is very closely associated for the purpose of maintaining the force exerted by such prestressing at a substantially constant and furthermore optimum value.

Devices wherein the systems for the clamping and prestressing of a rolling mill are associated with each other in a predetermined manner have already been described in U.S. Pats. Nos. 3,578,766 and 3,538,733. To the latter there corresponds the First Addition No. 90,470 to French Pat. No. 1,314,562.

In U.S. Patent application Ser. No. 871,905, filed Oct. 28, 1969 and entitled "Rolling Method Using Prestressing", now U.S. Pat. No. 3,673,843, there is described a rolling mill of this type which is characterized notably in that its rigidity may be substantially increased due to a working process known as the "blocked prestressing" process.

It has been found that if for the rolling of flat products one of the devices described in the last-named patent is used together with the aforenoted prestressing process as described in the same patent, the variations or deviations in the values to be regulated remain generally small. Consequently, the corresponding regulation system may readily be controlled either manually or with the aid of a motor of moderate power. However, in this particular case — since the rigidity of the rolling mill has been improved by a substantial increase in the prestressing force — in the course of a continuous manufacturing process (during which, due to wear or expansion, relatively substantial variations in the roll diameters may be produced), a slow but nevertheless perceptible increase occurs in the stroke of the prestressing jacks and, consequently, in the value of the corresponding force, because it is necessary to maintain the spacing between working rolls at a predetermined value. The result of this is that during the course of the rolling process, the force required of the control means becomes progressively more considerable, so that manual control may be found to be impossible and the electromechanical control, in turn, requires the employment of motors of comparatively high power.

It is the object of the present invention to provide an improved rolling mill of the type mentioned hereinabove to obviate, among others, the disadvantage discussed.

The rolling mill according to the present invention has the same fundamental elements as those of the rolling mill disclosed in U.S. Pat. No. 3,578,766. Thus, in the first place, for each machine upright there is provided a main clamping jack associated with a plunger jack of small section and long stroke, in such manner as to maintain captive a constant quantity of fluid within the volume constituted by the pressure chamber of the clamping jack, the working chamber of the plunger jack and the conduit system interconnecting these two chambers; in the second place, the rolling mill comprises, in each stand, a system of prestressing jacks constituted, for example, by two identical jacks disposed between the backing-up chocks.

According to the invention, a first modification introduced into the machine thus defined consists in interconnecting the two pressure chambers of the prestressing jacks associated with one and the same upright.

Further, according to the invention, the common space thus obtained is connected, by means of a conduit system of suitable section, to the pressure chamber of the plunger jack associated with the same upright. Finally, to the last-named conduit system there is connected an external pressure source which may be isolated at will from the conduit with the aid of blocking means.

Apart from the novel arrangement of the various means for actuating the rolling mill discussed hereinabove, the invention makes it possible to define a relationship between the sections of the pistons of the various jacks involved in the regulation of the rolling mill, in such manner as to optimize and, at the same time, render constant the prestressing force to be exerted.

For a better understanding of the invention, the developments to follow will be based on the detailed description of a preferred, although exemplary embodiment of the invention, taken in conjunction with the sole FIGURE which schematically shows one of the machine uprights and the clamping means associated therewith.

Reference numeral **1** designates the machine upright (or stand) containing the rolls **2** and **3** and also their chocks **4** and **5**; **6** designates the main clamping jack, **7** and **8** the prestressing jacks.

It is apparent that this arrangement, relating to a two-high rolling mill may, in the same manner, be applied to any other type of rolling mill.

Reference numeral **9** designates the plunger piston jack, which is of small section and has a long travel and which is associated through a first conduit means **13** with the clamping jack **6**. The jack **9** is subjected, as known, to the action of a regulating device, for example, an electromechanical device (not shown).

According to the invention, the pressure chambers of the jacks **7** and **8** are hydraulically interconnected by a second conduit means **14** and are connected with the cylinder of the jack **9** by a third conduit means **15**. A source of external pressure **10** communicates with the conduit means **15** through a fourth conduit means **16**. The said source may, however, be isolated from the conduit means **15** with the aid of a blocking means **11** disposed in the conduit means **16**.

The FIGURE also shows three "elastic chains" in the upright representing three force paths, as explained in detail in the aforenoted U.S. Pat. No. 3,673,843. Thus, the "long" chain I extends from the, points A and B and passes successively through a portion of the upper chock **4**, a fixed wedge **12**, the upper horizontal beam of the stand **1**, the vertical part of the stand **1**, the lower horizontal beam of the stand **1**, the clamping jack **6** and finally, a portion of the lower chock **5**. The "short" chain II extends only through the two chocks **4** and **5** and the associated prestressing jacks **7**. It is noted that for both chains I and II symmetrical traces (not shown) pass through the opposite half of the same components **1–8** and **12**. With regard to the chain III, it is rectilinear and extends through the rolls **2, 3** and the metal undergoing treatment.

For the mathematical derivation set forth hereinafter, the following definitions are given:

- K1 is the yielding coefficient of the long chain I,
- K2 is the yielding coefficient of the short chain II,
- K3 is the yielding coefficient of the "rolls and metal" chain III,
- h is the distance between the points A and B common to the three chains,

— ΔL is the momentary displacement of the plunger jack **9**,

— $s1$ is the total section of the working chamber at one side of the piston in the jack **9**, i.e., of a first compartment of the said jack which is permanently associated with the pressure chamber of the jack **6**,

— Z1 is the section of the latter chamber,

— $s2$ is the section of the working chamber at the other side of the piston in the jack **9**, i.e., of a second compartment of jack **9** and is equal to $s1$ reduced by the section of the rod of said piston; said second compartment is permanently associated with the pressure chambers of jacks **7** and **8**,

— Z2 is the section of the assembly of the two pistons of the prestressing jacks located in the same upright and interconnected in parallel and connected to that side of the pressure chamber of the jack **9** in which the active section of the piston is $s2$,

— $r1 = (s1/Z1)$ is the ratio of the hydraulic reduction between the hydromechanical regulation and the clamping,

— $r2 = (s2/Z2)$ is the ratio of hydraulic reduction between the hydromechanical regulation and the prestressing.

Having established these definitions, the invention will refer more particularly to the last two, i.e., to the ratios $r1$ and $r2$; according to the invention, it is required to make these two ratios equal to each other. This will make it possible to determine one of the sections of the pistons involved, if the three others are known.

Qualitatively, it becomes possible to appreciate the justification of the selection thus made and the consequences thereof on the basis of the considerations following hereinbelow.

It is known, notably from U.S. Pat. No. 3,673,843 that, during the clamping of the rolling mill under load, the variations designated ΔF1, ΔF2, ΔF3 which pertain to the respective forces F1, F2, F3 and which are generated in the three elastic chains of the rolling mill are interrelated according to the equation

$$\Delta F1 = \Delta F2 + \Delta F3 \qquad (a)$$

The value Δh will be employed to designate the deviation from the value h at a given instant. The said deviation may be expressed in three different ways, considering the three chains I, II and III.

Thus, in the chain I, the corresponding mode of expression will be:

$$h = (\Delta L/r1) - \Delta F1 \cdot K1 \qquad (b),$$

since the displacement ΔL must be reduced $r1$ times, but must be decreased by the yield value ΔF1 · K1 of the chain I.

In the chain II, the following equation applies:

$$L = (\Delta L/r2) + \Delta F2 \cdot K2 \qquad (c).$$

Finally, in the chain III, in the absence of external forces

$$\Delta h = \Delta F3 \cdot K3 \qquad (d).$$

Proceeding from formulas (a), (b), (c) and (d), after elimination of Δh, ΔL and ΔF3, one obtains

$$\Delta F2 = \frac{\Delta F1\left[K3\left(1-\frac{r2}{r1}\right)-K1\right]}{K3\left(1-\frac{r2}{r1}\right)-\frac{K2r2}{r1}}$$

The preceding expression is greatly simplified if it is assumed that

$$r1 = r2$$

which is the hypothesis postulated by the invention.

The corresponding value of ΔF2 then, in fact, becomes

$$\Delta F2 = (K1\ \Delta F1/K2\ K3)$$

Knowing the yielding coefficients K1, K2, K3 of the three chains I, II, III, the foregoing formula expresses the variations in the prestress F2 as a function of that of the force F1 produced in the chain I.

Now, in practice, the two coefficients K1 and K2 may be considered as being of the same order of magnitude; thus, their ratio may be considered to be 1. It thus follows that a given variation ΔF1 causes a variation ΔF2, the magnitude of which is inversely proportionate to the yielding coefficient K3 of the chain III.

This amounts to saying that, for a value of K3 sufficiently high to be considered as practically infinite, the prestressing force F2 will remain constant during a given operation, even though the clamping force F1 must vary.

The result arrived at by the foregoing derivation may be realized in practice by the particular arrangement proposed by the invention and by the judicious selection of the sections of the various jacks employed.

It is self-evident that if, using the same arrangement, equality between the ratios $r1$ and $r2$ is not achieved entirely strictly, the practical results achieved will exhibit a certain deviation relative to those obtained under the optimum conditions, the corresponding deviation being the smaller in proportion as it is brought nearer to the said optimum conditions.

A further important advantage of the invention is that it thereby becomes possible to control, by a single manipulation, i.e., by manipulation of the control rod of the plunger jack piston **9**, the entire regulation of the machine. In fact, control is obtained of the closure of the blocking means **11** isolating the pressure source **10** from the connecting conduit between the prestressing jacks **7, 8** and the plunger jack **9**; on the other hand, as known from French Pat. No. 1,213,820, which relates to hydromechanical clamping, single and adequate manipulation for simultaneously controlling regulation of the two rolling mill uprights is achieved. Thus, the said single manipulation also suffices in the case of the improved rolling mill according to the present invention.

Yet, a further advantage afforded by the invention is as follows.

The prestressing force F2 is exerted on the upstream face of the piston of the jack **9**, in the same direction as the force normally exerted on this same face due to the regulating manipulation. Thus, it thereby becomes possible to reduce the force required by the said manipulation, i.e., to reduce the power of the associated con-

trol motors by the magnitude corresponding to the prestressing force F2.

It will be possible, without departing from the scope of the invention, to modify some arrangements thereof or, alternatively, to replace some means described with reference thereto by equivalent means.

What is claimed is:

1. In a rolling mill employing hydromechanical clamping and prestressing and being of the known type that has (a) a plurality of stands, (b) at least two rolls, (c) a chock held in each stand to support each end of each roll, (d) a main clamping jack incorporated in each stand for urging said rolls towards one another and including a pressure chamber, (e) a piston plunger jack of small section and large stroke and including a hydraulic cylinder and a piston movable therein, (f) first conduit means for maintaining communication between said cylinder and the pressure chamber of said main clamping jack, (g) hydraulic fluid of constant quantity maintained captive between said jacks, (h) at least two prestressing jacks incorporated in each stand between the chocks held therein to exert a separating force thereto, each prestressing jack including a pressure chamber, (i) means supplying hydraulic fluid under pressure to the pressure chamber of each prestressing jack, (j) blocking means for arbitrarily isolating said means supplying hydraulic fluid, the improvement comprising

(A) second conduit means for maintaining communication between the pressure chambers of said prestressing jacks associated with the same stand and

(B) third conduit means for maintaining communication between the pressure chambers of said prestressing jacks and the cylinder of said piston plunger jack for maintaining the prestressing force of said prestressing jacks at an invariable magnitude.

2. An improvement as defined in claim **1,** said piston dividing said cylinder into a first compartment and a second compartment, said first compartment communicating with the pressure chamber of said main clamping jack through said first conduit means and said second compartment communicating with the pressure chambers of said prestressing jacks through said third conduit means.

3. An improvement as defined in claim **2,** wherein the ratio of the section of said first compartment to the section of the pressure chamber of said main clamping jack and the ratio of the section of said second compartment to the total section of the pressure chambers of said prestressing jacks are substantially equal to one another.

4. An improvement as defined in claim **1,** including a fourth conduit means maintaining communication between said means supplying hydraulic fluid under pressure and said third conduit means.

5. An improvement as defined in claim **4,** wherein said blocking means is disposed in said fourth conduit means.

* * * * *