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## (54) A fine adjustment device for the forming rollers of a precision rolling mill.

(57) There is disclosed a precision rolling mill which comprises a pair of forming rollers (1a, 1b) which cooperate to carry out finishing action on rolled steel strip, an eccentric shaft (2a, 2b) on which each roller is mounted, an integral support shaft (3a, 3b) projecting from each eccentric shaft, and axially movably mounted in a guide box (32), and a pair of threaded adjusters (6a, 6b; 17a, 17b) having push-type engagement with the outer ends of the eccentric shafts (2a, 2b) and the support shafts (3a, 3b). In order to enable precise adjustment to be made of the axial alignment of the rollers (1a, 1b), a reduction gear drive (16a, 15a, 18a, etc) is coupled with each of the threaded adjusters.

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# A FINE ADJUSTMENT DEVICE FOR THE FORMING ROLLERS OF A PRECISION ROLLING MILL

This invention relates to a precision rolling mill which comprises a pair of forming rollers which cooperate to carry out finishing action on rolled steel strip, in which a fine adjustment arrangement is provided to enable the axial alignment of the rollers to be adjusted in a final finish line for rolling steel strips.

In precision rolling, the shape of a steel strip product is lightly pressed to form, and therefore an accurate shape of the calibre of the rollers is necessary, as well as exact alignment of a pair of forming rollers. Referring to Figure 4 of the accompanying drawings, this shows a pair of forming rollers (1a,1b) in a precision rolling mill, in which the calibre centre 33a and 33b of the rollers are axially out of alignment by axial distance $\alpha$. When rollers are out of alignment, as shown, this tends to cause the steel strip product to cling to the flange G of the roller, thereby giving rise to the risk of damage to the rollers and/or an impaired final form of the rolled product, thereby degrading the sectional accuracy of other products.

As a factor in causing such an out-of-centre in the roller calibre in a precision rolling mill, there is a problem of precision in machinability when the calibre is formed of rollers. In machining, an error of approximately 5% cannot be avoided, and errors can arise during assembly when the roller is built onto an eccentric mounting shaft with eccentric pieces. In other words, the dimensional errors become cummulative when a faulty roller is combined with other parts.

With a view to overcoming the existing difficulties in alignment of inaccurately manufactured and assembled forming rollers, it has been proposed to provide adjusting bolts which engage with the upper and lower ends of a shaft on which the roller is mounted, which can be adjusted in order to move the roller shaft axially by screwing the adjusting bolt at one end and unscrewing the adjusting bolt at the other end of the shaft. However, with such an arrangement, it is hard to achieve high precision adjustments, and it is also inconvenient to adjust the lower adjusting bolt.

The present invention has therefore been developed primarily with a view to providing an adjustment device for a forming roller in a precision rolling mill, which can reliably adjust the required amount of axial movement of the forming roller with a high precision, whereby the deficiencies of existing equipment can be overcome, and improvement in rolling product produced by the rolling mill obtained, particularly the out-of-roundness of wire rod and steel bar products often supplied with existing equipment.

According to the invention there is provided a precision rolling mill comprising a pair of forming rollers which cooperate to carry out finishing action on rolled steel strip, mounting shafts on which the rollers are mounted, and a pair of threaded adjusters engaging one on either side of each roller in order to enable the rollers to be adjusted axially relative to each other so as to bring them into alignment for a finishing action, characterised in that a reduction gear drive is coupled with each of the threaded adjusters to enable precise axial adjustment of the rollers.

One embodiment of precision rolling mill according to the invention will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a side view of the precision rolling mill;

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Figure 2 is a plan view;

Figure 3 is a partially broken-away rear view; and

Figure 4 is, as indicated above, an illustration of axial misalignment which tends to arise with forming rollers in precision rolling mills.

Referring now to Figures 1 to 3 of the drawings, a pair of eccentric shafts 2a,2b have forming rollers 1a,1b thereon, and the shafts are mounted in a guide box 32 so as to be movable in an axial direction. The rollers 1a,1b are rotatable on the respective eccentric shafts, as shown in Figure 3 for roller 1b, via sleeve or bush 14b and bearings 13b. Supporting shafts 3a,3b are integrally formed coaxially with the eccentric shafts 2a,2b on their upper ends. The axes or centres of the eccentric shafts 2a,2b are spaced eccentrically at a required distance from those of the supporting shafts 3a,3b. In an upper gear case 23 situated above the supporting shafts 3a,3b, there are mounted adjusting screws 17a,17b that press the supporting shafts 3a,3b in an axial direction. In a lower gear case 28 located below eccentric shafts 2a,2b there are also mounted the adjusting screws 6a,6b that press the eccentric shafts 2a,2b in an axial direction. The adjusting screws 17a,17b can be interlocked for operation by associated worm/worm wheel drive mechanisms 16a,15a,18a and 16b,15b,18b respectively in the upper gear case 23, and the adjusting screws 6a and 6b can be operated by associated worm/worm wheel drive mechanisms 16a,5a,7a and 16b,5b,7b respectively in the lower gear case 28. These worm mechanisms are described in more detail below.

Worms 15a,15b are integrally formed with worm shafts 16a,16b provided in the upper gear case 23 and are in meshing relation with the worm wheels 18a,18b, which form the heads of adjusting screws 17a and 17b respectively. For this reason, the turning effort of worm shafts 16a,16b, when they are rotated, is imparted through worms 15a,16b to worm wheels 18a,18b, which in turn are rotated at reduced speed as a first stage, subsequently turning the screw shanks 19a,19b for adjusting the screws 17a,17b. The screw shanks then are rotated to move in vertical directions as the second stage, and when they move down, the eccentric shafts 2a,2b are pressed downward to move a small amount in an axial direction. Moreover, worms 5a,5b, which are integrally formed with the worm shafts 16a,16b provided in the lower gear cazse 25, transmit turning effort to the worm wheels 7a,7b of adjusting screws 6a,6b, causing the pressing parts 9a,9b above the wheels to move in vertical directions, and when the pressing parts move up, the eccentric shafts 2a,2b are made to move axially in a small amount. 21a is a lock bolt for fixing the worm shafts 16a,16b.

In Figure 1, the upper gear case 23 is fixed on the upper portion of a guide box 32 using 3 hexagonal bolts 24. 26 is a case cover which is fixed in place with a small screw 27. The eccentric shafts 2a,2b are provided at their lower portions with eccentric pieces 11a,11b and shims 12a,12b. The turning effort of the worms 5a,5b in engagement with the worm wheels of the adjusting screws 6a,6b is converted into vertical movements of the pressing parts 9a,9b by means of the threaded engagement of adjusting screws 8a,8b in the gear case 28; the pressing parts 9a,9b then push up eccentric shafts 2a,2b via thrust washers 10a,10b. Thus, rollers 1a,1b can be adjusted relative to each other into proper alignment by pushing up or pushing down the adjusting screws 17a,17b and the adjusting screws 6a,6b.

The lower gear case 25 is fixed on the bottom of guide box 32 using a hexagonal bolt 24. A delivery guide 29 projects from the guide box 32 and serves to guide steel strip products which issue from rolls 37a,37b into the guide box 32 for finishing rolling treatment by the forming rolls 1a,1b. The products are first lightly pressed to shape by guide 29, and then pass to final treatment by the forming grooves 34a,34b in the rollers 1a,1b, and issue from the guide box 32 via a sleeve guide 28 secured to the end of the box by bolts 31.

A pinion 20 is mounted in the gear case 23 and is operable to drive pinions 22a and 22b, via a centre pinion 21, in order to adjust the lateral spacing between the surfaces of the rollers 1a and 1b. The pinions 22a and 22b mesh with gears 4a and 4b respectively, which are fast with the upper ends of the supporting shafts 3a and 3b. Therefore, in this procedure, the gears 4a and 4b are rotated at reduced speed, and the distance between the surfaces of rollers 1a,1b is adjusted by making use of the eccentric relation between the eccentric shafts 2a,2b and the supporting shafts 3a,3b.

There will now be described an adjusting operation for an out-of-centre alignment of the rollers 1a,1b. Thus, as shown in Figure 4, for example, an explanation will be given for what to do for adjustment if roller 1a is out of alignment with roller 1b by axial distance $\alpha$.

After release of the lock bolt 1a, fixing the worm shaft 16a which corresponds with roller 1a, the adjusting screw 17 is raised by turning the upper worm shaft. Also, the lower worm shaft is turned to make adjusting screw 6a move upwards, thereby pushing-up the eccentric shaft 2a through the same distance as the screw 17 has moved, until adjustment of the roller 1a is completed to take-up the misalignment $\alpha$. As a result, the calibre centres 33a,33b are exactly aligned. Thereafter, the adjustment is locked by lock bolts 21a.

CLAIMS

1. A precision rolling mill comprising a pair of forming rollers (1a,1b) which cooperate to carry out finishing action on rolled steel strip, mounting shafts (2a,2b) on which the rollers are mounted, and a pair of threaded adjusters (6a,6b;17a,17b) engaging one on either side of each roller in order to enable the rollers to be adjusted axially relative to each other so as to bring them into alignment for a finishing action, characterised in that a reduction gear drive (16a,15a,18a;16b,15b,18b; 16a,5a,7a;16b,5b,7b) is coupled with each of the threaded adjusters to enable precise axial adjustment of the rollers.

2. A precision rolling mill according to claim 1, characterised in that each roller (1a,1b) is rotatably mounted on a respective eccentric shaft (2a,2b) having a projecting integral supporting shaft (3a,3b) which is axially movably mounted in a guide box (32), and in that the threaded adjusters (6a,6b,17a,17b) have push-type engagement with the outer ends of the eccentric shafts (2a,2b) and the support shafts (3a,3b).

3. A precision rolling mill according to claim 2, characterised by a rotary drive train (20,21,22a,22b) engaging with gears (4a,4b) on the supporting shafts (3a,3b) for adjusting the lateral spacing of the rollers (1a,1b).

4. A precision rolling mill according to any one of claims 1 to 3, characterised in that each reduction gear drive comprises a worm wheel reduction gear (15a,18a etc).

5. A precision rolling mill according to any one of claims 1 to 4, characterised in that each forming roller (1a or 1b) has a forming groove (34a,34b) for forming wire rod or steel bar.

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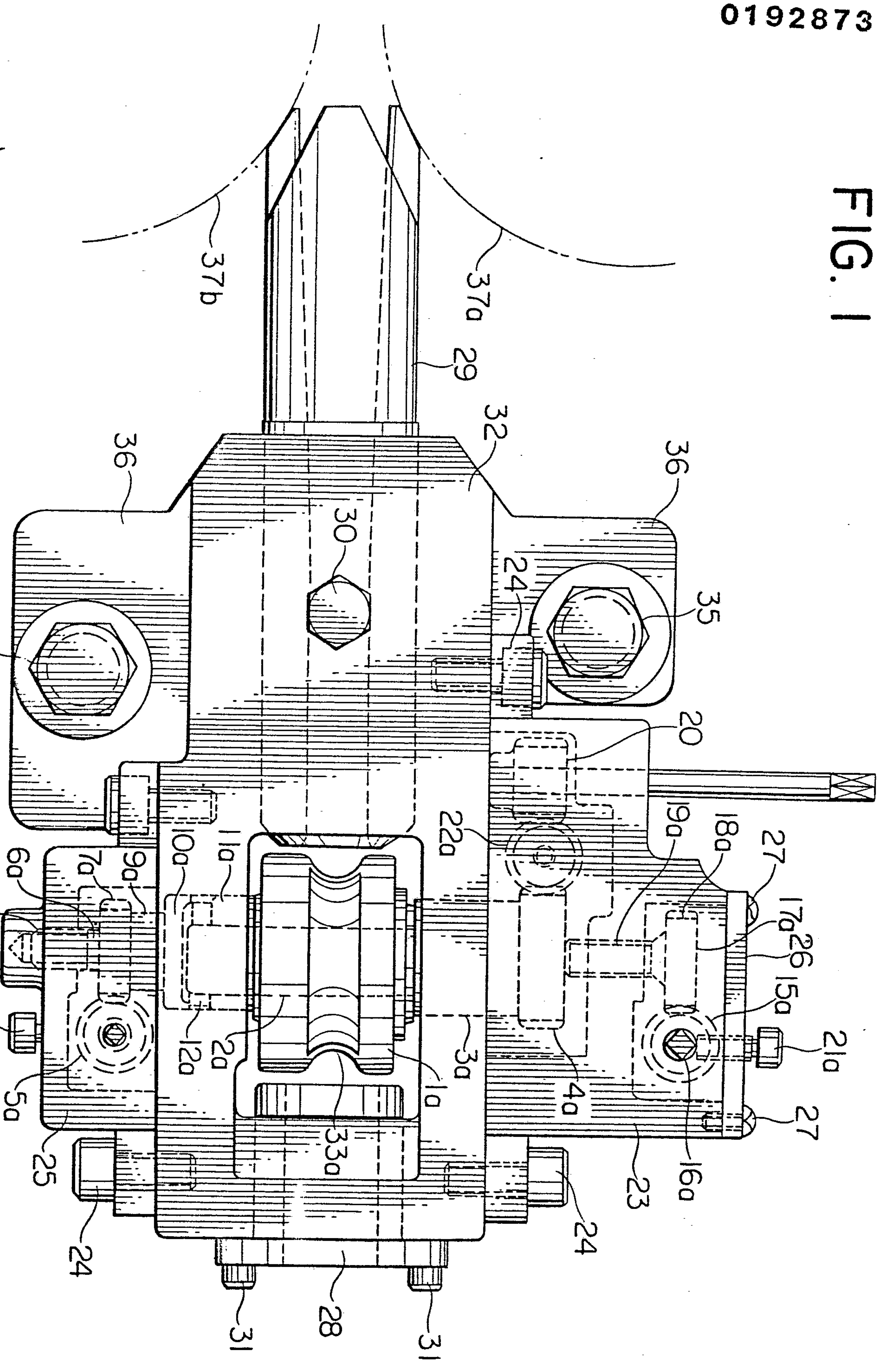


FIG. 1

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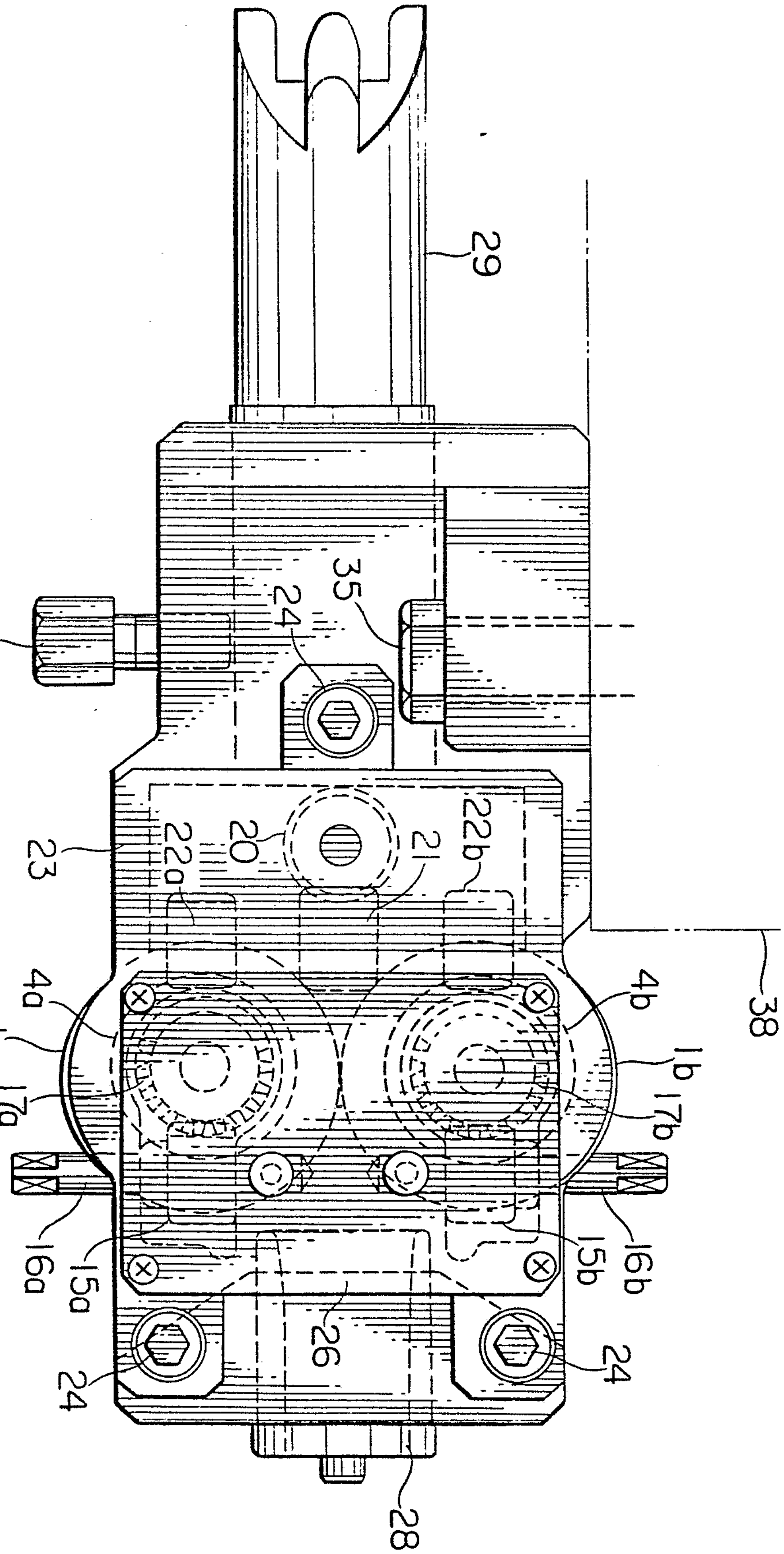
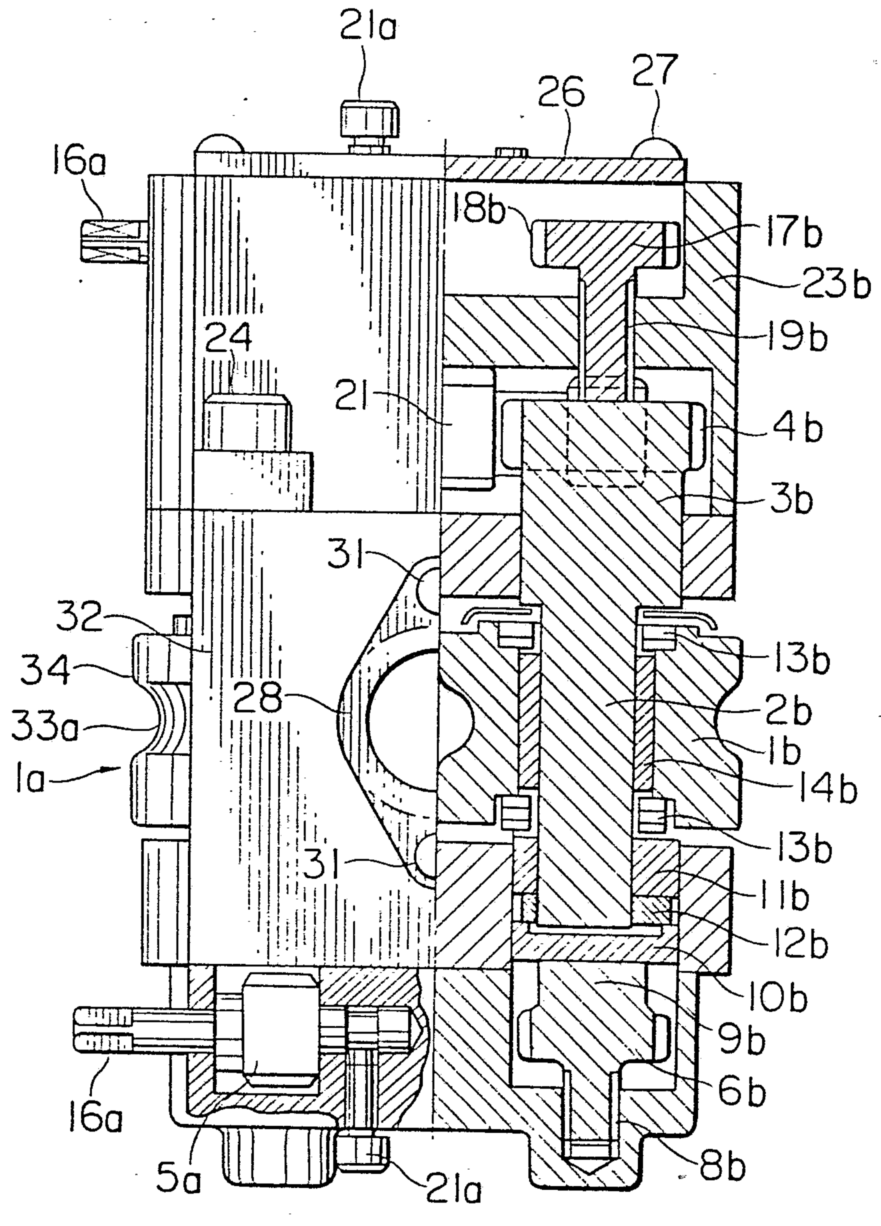



FIG. 2

FIG. 3



21a
26
27
16a
18b
17b
23b
19b
24
21
4b
3b
31
32
13b
34
28
2b
33a
1b
1a
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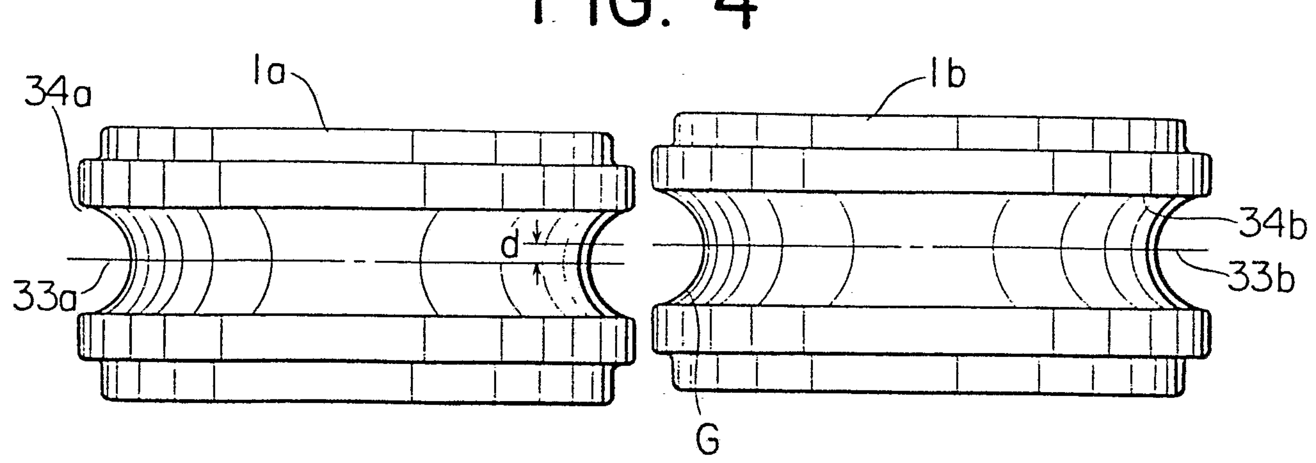
31
11b
12b
10b
9b
16a
6b
5a
21a
8b


FIG. 4



34a
1a
1b
34b
d
33b
33a
G