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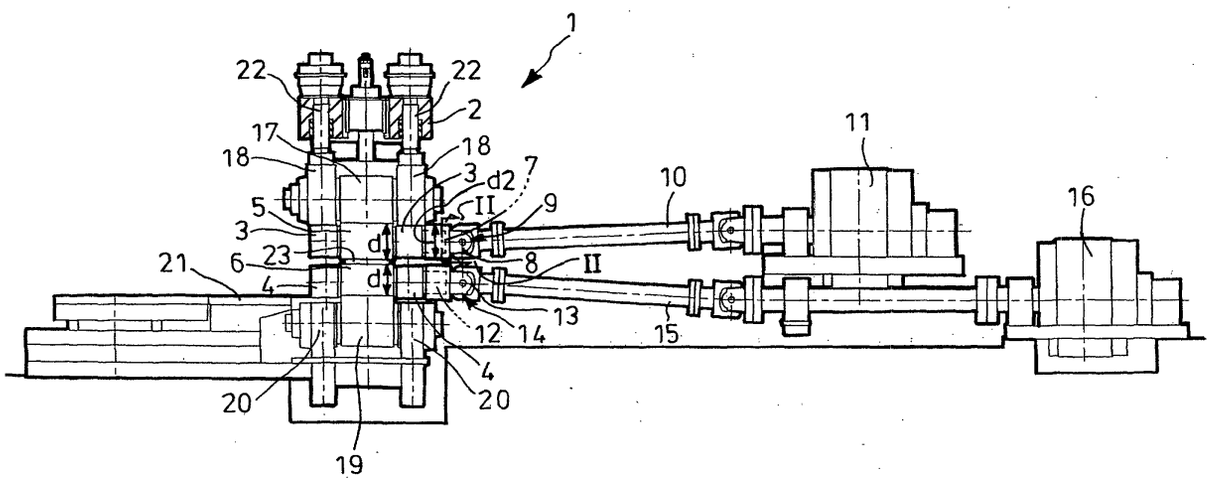
(54) Rolling mill

(57) A rolling mill (25) has a pair of upper and lower rolls (29, 30) capable of rolling a metal strip (56), and motors (38, 47) for driving the upper and lower rolls, respectively. Provided between the upper roll (29) and the upper-roll driving motor (38) and between the lower roll (30) and the lower-roll driving motor (47) are joint means (34 and 36, and 43 and 45) with diameter greater than a diameter of the rolls (29, 30). The upper- and lower-roll driving motors (38, 47) are arranged at opposite sides of the paired rolls (29, 30).

F I G. 1



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Description

[0001] The present invention relates to a rolling mill for rolling a metal strip.

[0002] Figs. 1 and 2 show a conventional rolling mill 1 in which:

Fig. 1 is a side view; and
Fig. 2 is a view looking in the direction of arrows II in Fig. 1.

[0003] The conventional rolling mill 1 comprises a pair of upper and lower rolls 5 and 6 supported in a housing 2 through upper and lower journal boxes 3 and 4, respectively. One of axial ends of the upper roll 5 has a wobbler (generally oval protrusion: Zapfen) 7 with a generally oval or partially chipped circular transverse section over which an upper coupling 9 with an coaxial connector 8 is fitted. The upper coupling 9 is universally joined through the connector 8 to an upper spindle 10 which is universally jointed, at its end away from the connector 8, to a motor 11 which drives the upper roll 5. One of axial ends of the lower roll 6 also has a wobbler 12 at the same side as that of the upper roll 5 and with a generally oval or partially chipped circular transverse section over which a lower coupling 14 with a coaxial connector 13 is similarly fitted. The lower coupling 14 is also similarly jointed through a lower spindle 15 to a motor 16 which drives the lower roll 6.

[0004] Supported in the housing 2 and above the upper roll 5 through an upper journal box 18 is an upper backup roll 17 which suppresses bending of the upper roll 5. Supported in the housing 2 and below the lower roll 6 through a lower journal box 20 is a lower backup roll 19 which suppresses bending of the lower roll 6. Rails 21 extend from the housing and away from the motors 11 and 16. Arranged above the upper journal box 18 are screw down screws 22 which press axially opposite ends of the upper backup roll 17.

[0005] When a metal strip 23 is to be rolled, the motors 11 and 16 are driven to rotate the rolls 5 and 6 through the spindles 10 and 15 and couplings 9 and 14, respectively, thereby rolling the metal strip 23 passed between the rolls 5 and 6 into a predetermined thickness. The smaller a diameter of the rolls 5 and 6 is, the more the rolling force and torque acting on the rolls are decreased advantageously for rolling of the metal strip 23.

[0006] When the rolls 5 and 6 are to be rearranged for inspection, exchange or the like after the rolling of the metal strip 23, the rolls 5 and 6 are dislodged for rearrangement by releasing the screw reduction of the backup rolls 17 and 19, disengaging the couplings 9 and 14 from the wobblers 7 and 12 of the rolls 5 and 6, respectively, and moving the rolls 5 and 6 together along the rails 21.

[0007] Demanded, however, in later years for example in the rolling of a strip 23 in steel industry are (1) improved productivity by reducing number of passes in rolling of ordinary steel, (2) rolling of high tensile strength steel and (3) rolling of ultra high tensile strength steel by low-temperature rolling. Either of (1)-(3) requires higher rolling force and torque; attempt to comply with these technical demands in the conventional rolling mill 1 would result in increased roll diameter, leading to further increase in rolling force and torque -- vicious circle. Moreover, in rolling of the strip 23 in general, the smaller the roll diameter is, the more the rolling force and torque acting on the upper and lower rolls 5 and 6 are advantageously decreased; however, reduction in diameter of rolls in the conventional rolling mill 1 would be accompanied by two disadvantages. A first disadvantage is that each of the couplings 9 and 14 has an inner space with a transverse section as shown in Fig. 2 which has a maximum diameter d1' and which is partially chipped circular for torque transmission, the inner space being smaller in transverse sectional area than a cylindrical inner space with diameter d1', leading to failure of fully exhibiting drive torque transmission ability inherently possessed by the diameter d1'. A second disadvantage is that, because of the couplings 9 and 14 being vertically aligned, the outer diameter d2' of the couplings 9 and 14 is physically smaller than the diameter d of the rolls (d2'< d) so that the spindles 10 and 15 have always restricted rolling torque transmission ability.

[0008] The invention was made in view of the above and has its object to provide a rolling mill which can transmit increased rolling torque while a diameter of rolls being retained small.

[0009] In accordance with the invention, one of axial ends of each of a pair of upper and lower rolls is provided with joint means, and motors for driving the paired rolls are arranged at opposite sides of the rolls, respectively, so that portions from the upper roll to the upper-roll driving motor are not interfered with portions from the lower roll to the lower-roll driving motor, which allows any connection of the axial end of the roll to the inner space of the joint means and allows any size of outer diameter of the joint means. As a result, the connection of the axial end of the roll to the inner space of the joint means can be improved and the outer diameter of the joint means can be increased, leading to improvement of torque transmission ability so that greater rolling torque can be transmitted with the diameter of the rolls being retained small.

[0010] In accordance with the invention, a wobbler of the roll to be connected to the joint means is not generally oval in transverse section but cylindrical or tapered so that a transverse sectional area of the inner space is made larger than that of oval, resulting in reliable transmission with no loss of torque transmission ability.

[0011] In accordance with the invention, the coupling may be formed with hydraulic flow channels for introducing liquid under pressure to the inner space of the coupling so that introduction of the liquid under pressure causes the inner space to be expanded, whereby the

connection of the axial end of the roll to the joint means can be readily released for rapid exchange of the roll and the like.

[0012] Now, embodiments of the invention will be described in conjunction with Figs. 3 to 7 in which:

Fig. 3 is a side view showing a first embodiment of a rolling mill according to the invention;
Fig. 4 is a view looking in the direction of arrows IV in Fig. 3;
Fig. 5 is a longitudinal section of a coupling in a rolling mill according to the first embodiment of the invention;
Fig. 6 is a view looking in the direction of arrows VI in Fig. 5; and
Fig. 7 is a longitudinal section of a coupling in a rolling mill according to a second embodiment of the invention.

[0013] Figs. 3 to 6 show the first embodiment. A rolling mill 25 comprises a pair of upper and lower rolls 29 and 30 supported in a housing 26 through upper and lower journal boxes 27 and 28, respectively. One of axial ends of the upper roll 29 has a protrusion 31 which is cylindrical or tapered convergent towards a tip end. Fitted over the protrusion 31 through press or shrinkage fitting is an upper adapter 34 of the joint means having a complementary inner space 32 with an inlet-side diameter d3. The adapter 34 has a wobbler 33 with a generally oval or partially chipped circular transverse section with an outer diameter d1 over which an upper coupling 36 of the joint means with an outer diameter d2 and having a coaxial connector 35 is fitted so as to be easily releasable upon rearrangement of the roll. The upper coupling 36 is universally jointed through the connector 35 to an upper spindle 37 which is universally joined, at its end away from the connector 35, with a motor 38 which drive the upper roll 29.

[0014] One of axial ends of the lower roll 30 away from the protrusion 31 of the upper roll 29 has a protrusion 40 which is cylindrical or tapered convergent towards a tip end. Fitted over the protrusion 40 through press or shrinkage fitting is a lower adapter 43 of the joint means having a complementary inner space 41 with an inlet-side diameter d3. The adapter 43 has a wobbler 42 with a generally oval or partially chipped circular transverse section with an outer diameter d1 over which a lower coupling 45 with an outer diameter d2 and having a coaxial connector 44 is fitted so as to be easily releasable upon rearrangement of the roll. The lower coupling 45 is universally joined through the connector 44 to a lower spindle 46 which is universally joined, at its end away from the connector 44, with a motor 47 which drives the lower roll 30.

[0015] Such connection of the protrusions 31 and 40 of the rolls 29 and 30 to the adapters 34 and 43 through press or shrinkage fitting, respectively, is of a degree of strength such that torque transmission can be made by frictional force; the relationship of the inlet-side diameter d3 of the adapters 34 and 43, the outer diameter d1 of the wobblers 33 and 42 of the adapters 34 and 43 and the outer diameter d2 of the couplings 36 and 45 is d2 > d1 > d3.

[0016] Supported in the housing 26 and above the upper roll 29 through an upper journal box 49 is an upper backup roll 48 which suppresses bending of the upper roll 29. Balance beams or rails 50 extend from the housing 26 away from the upper-roll driving motor 38 (or towards the lower-roll driving motor 47). Supported in the housing 26 and below the lower roll 30 through a lower journal box 52 is a lower backup roll 51 which suppresses bending of the lower roll 30. Rails 53 extend from the housing and away from the lower-roll driving motor 47 (towards the upper-roll driving motor 38). Arranged above the upper journal box 49 are screw down screws 54 for pressing axially opposite ends of the upper backup roll 48; arranged below the lower journal box 52 are automatic gauge control cylinders 55 which make fine adjustment of strip thickness.

[0017] When a metal strip 56 is to be rolled, the motor 38 is driven to rotate the roll 29 through the spindle 37, the coupling 36 and the adapter 34 while the motor 47 is driven to rotate the roll 30 through the spindle 46, the coupling 45 and the adapter 43, thereby rolling the metal strip 56 passed through the upper and lower rolls 29 and 30 into a predetermined thickness.

[0018] When the rolls 29 and 30 are to be rearranged after the rolling of the metal strip 56, the rolls 29 and 30 are removed or dislodged from opposite sides of the rolls by releasing fitting of the wobblers 33 and 42 of the adapters 34 and 43 to the couplings 36 and 45, respectively, and moving the upper roll 29 and upper backup roll 48 together along the rails 50 and the lower roll 30 and the lower backup roll 51 together along the rails 53, respectively. When the upper and lower rolls 29 and 30 are life-expired, press or shrinkage fitting of the protrusions 31 and 40 of the rolls 29 and 30 to the adapters 34 and 43, respectively, is released for replacement of the rolls.

[0019] Such provision of the adapters 34 and 43 and the couplings 36 and 45 of the joint means on the protrusions 31 and 40 of the paired rolls 29 and 30 as well as arrangement of the upper- and lower-roll driving motors 38 and 47 at opposite sides of the rolls 29 and 30 result in that portions from the upper roll 29 to the upper-roll driving motor 38 are not interfered with portions from the lower roll 30 to the lower-roll driving motor 47, which allows any connection of the protrusions 31 and 41 of the rolls 29 and 30 to the inner spaces 32 and 41 of the adapters 34 and 43, any connection of the wobblers 33 and 42 of the adapters 34 and 43 to the inner spaces 36a and 45a of the couplings 36 and 45 and any outer diameter d1 of the adapters 34 and 43 and outer diameter d2 of the couplings 36 and 45. As a result, transverse sectional areas of the protrusions 31 and 40 in connection thereof to the adapters 34 and 43 and those

of the wobblers 33 and 42 of the adapters 34 and 45 to the couplings 36 and 45 can be increased and the outer diameter d1 of the adapters 34 and 43 and outer diameter d2 of the couplings 36 and 45 can be made larger than the conventional outer diameters d1' and d2' shown in Fig. 2, thereby improving torque transmission ability and making it possible to transmit greater rolling torque while the diameter d of the rolls being kept small. More specifically, assuming that a strip with width of 2 meters is rolled by a rolling mill with diameter d of the rolls 29 and 30 being 1.05 meter, then trial calculation leads to 16,000 ton in rolling force and 1,100 ton meter in rolling torque; in comparison with one of the largest rolling mills in Japan, obtained is a rolling mill with high ability of about twice and third as much in terms of rolling force and torque, respectively. As a result, the demands of (1) improved productivity by reducing number of passes in rolling of ordinary steel, (2) rolling of high tensile strength steel and (3) rolling of ultra high tensile strength steel by low-temperature rolling can be fulfilled with greater economic advantages.

[0020] Because of the protrusions 31 and 40 of the rolls 29 and 30 connected to the adapters 34 and 43 of the joint means being not generally oval in transverse section but cylindrical or tapered, the transverse sectional area of each of the inner spaces 32 and 41 can be made grater than that of oval, resulting in reliable transmission with no loss of torque transmission ability.

[0021] Fig. 7 shows joint means in a rolling mill according to a further embodiment of the invention with the adapter 34 of the joint means according to the first embodiment being modified. In the figure, parts with the same reference numerals as those in Figs. 3 to 6 denote similar parts.

[0022] In the joint means in the rolling mill according to the second embodiment, an adapter 60 fitted to the coupling 36 or 45 and having an inner space 61 tapered convergent toward its bottom is formed with a plurality of (four in Fig. 7) hydraulic flow channels 62. The hydraulic flow channels 62 are communicated with a plurality of (four in Fig. 7) axially spaced annular grooves 63 on an inner periphery of the inner space 61 and have inflow ports 64 opened to an edge of the adapter 60. Introduction means, for example manual hydraulic pump, (not shown) arranged outside can be detachably connected to the inflow ports 64.

[0023] When the adaptor 60 connected to the roll 29 or 30 is to be removed, the introduction means is connected to the inflow ports 64 to inject a high-pressure oil on an order or 1,000 atm so that the inner space 61 is expanded to allow the adapter 60 to be removed from the protrusion 31 or 40 of the roll 29 or 30.

[0024] In this manner, the adapter 60 of the joint means is formed with hydraulic flow channels 62 which can introduce high-pressure oil. Such introduction of the high-pressure oil into the inner space 61 causes the inner space 61 to be expanded, which allows easy disassembling and removal of the adapter 60 from the protrusion 31 or 40 of the roll 29 or 30 even if the former is shrinkage-fitted to the latter and is hard to release, resulting in easy exchange of the roll 29 or 30.

[0025] The second embodiment of the invention can attain similar effects and advantages as those of the first embodiment.

[0026] It is to be understood that the invention is not limited to the above embodiments and that various changes and modifications may be made without departing from the scope and spirit of the invention. For example, the joint means may be of any structure and of any shape.

[0027] In a rolling mill for rolling a metal strip, construction is such that portions from the upper roll to the upper-roll driving motor are not interfered with portions from the lower roll to the lower-roll driving motor which allows any connection of the rolls to the inner spaces of joint means and any outer diameter of the joint means, so that connection of the rolls to the inner spaces of the joint means is improved and the outer diameter of the joint means is made larger, thereby improving torque transmission ability so that larger rolling torque can be transmitted with the diameter of the rolls being retained small.

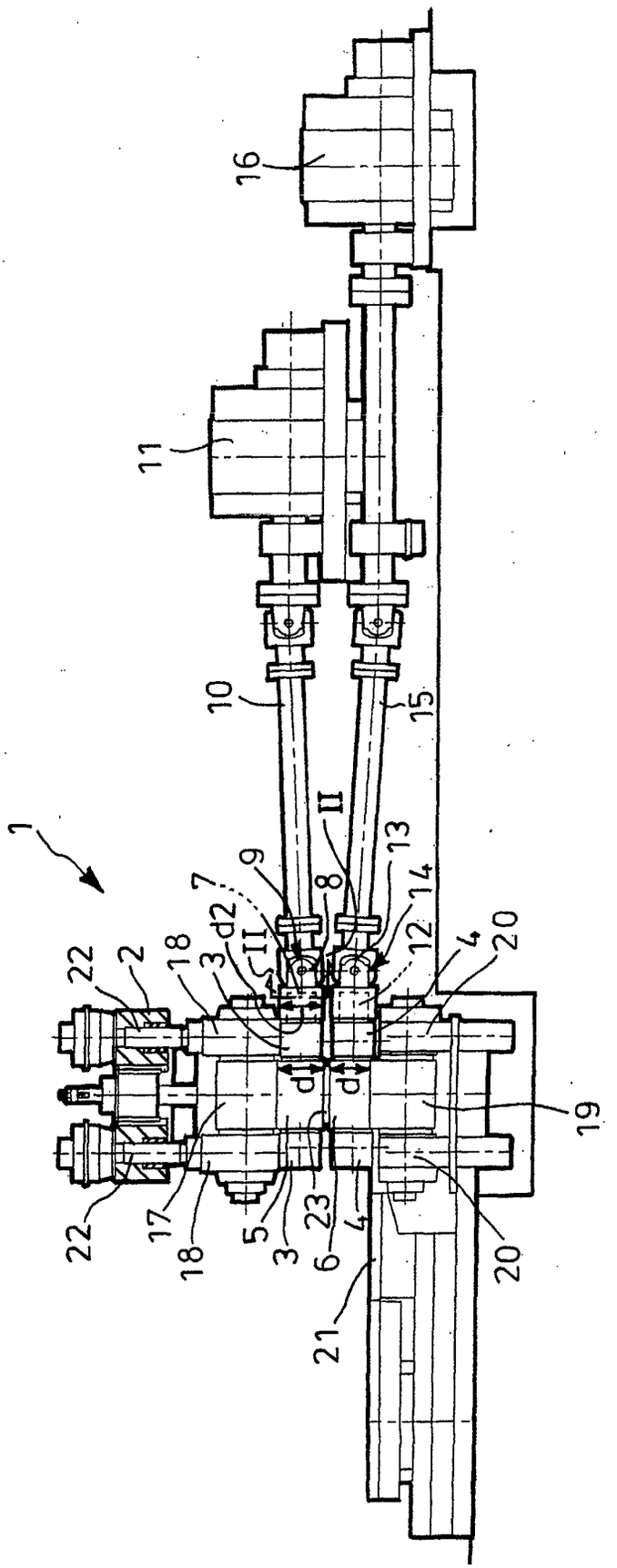
Claims

1. A rolling mill comprising a pair of upper and lower rolls (29, 30) capable of rolling a metal strip (56) and motors (38, 47) for driving the upper and lower rolls (29, 30), respectively, **characterized in that** joint means (34, 36; 43, 45) with diameter lager than that of the rolls (29, 30) are arranged between the upper roll (29) and the upper-roll driving motor (38) and between the lower roll (30) and the lower-roll driving motor (47), respectively, and that the motors (38,47) are arranged opposite sides of the rolls (29, 30).

2. A rolling mill as claimed in claim 1 wherein an axial end of each of the rolls (29, 30) is formed with a protrusion (31, 40) which is cylindrical or tapered convergent toward a tip end thereof, the mating joint means (34, 36; 43, 45) being formed with an inner space (32, 41) complementary with said protrusion, the axial end of the roll (29, 30) being connected to the joint means (34, 36; 43, 45) in a degree of strength such that torque transmission can be made by friction force.

3. A rolling mill as claimed in claim 2 wherein the joint means (60) is formed with hydraulic flow channels (62) for introducing liquid under pressure to the inner space (61).

FIG. 1


16
11
10
15
1
II
13
9
7
8
14
d2
12
4
20
22
2
18
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18
5
3
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21

FIG. 2

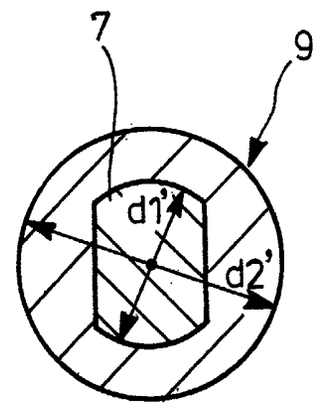
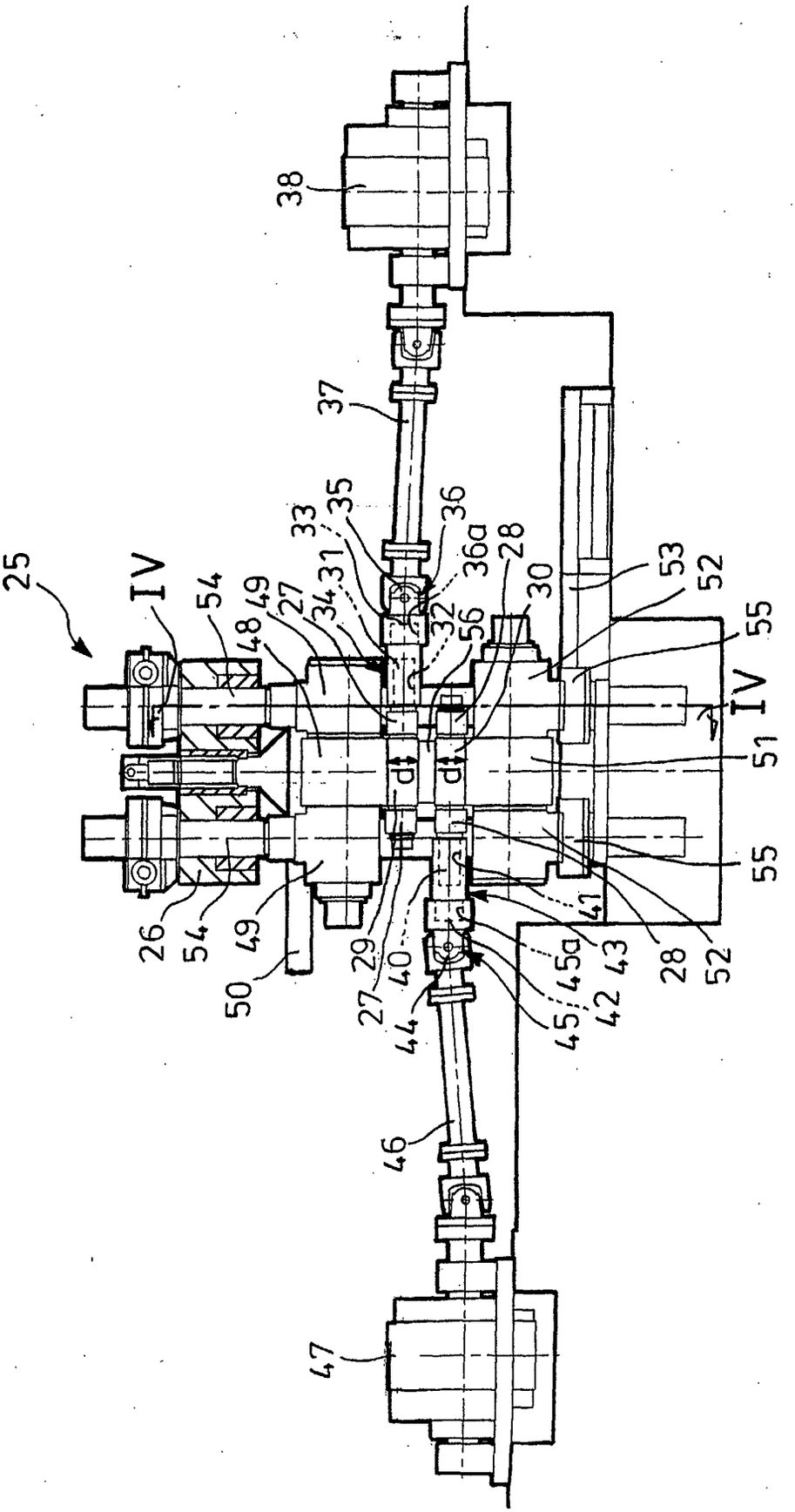


FIG. 3


38
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33
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36a
28
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32
56
30
53
52
55
25
IV
54
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48
IV
51
d1
d1
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45a
42
43
41
28
52
46
47

FIG. 4

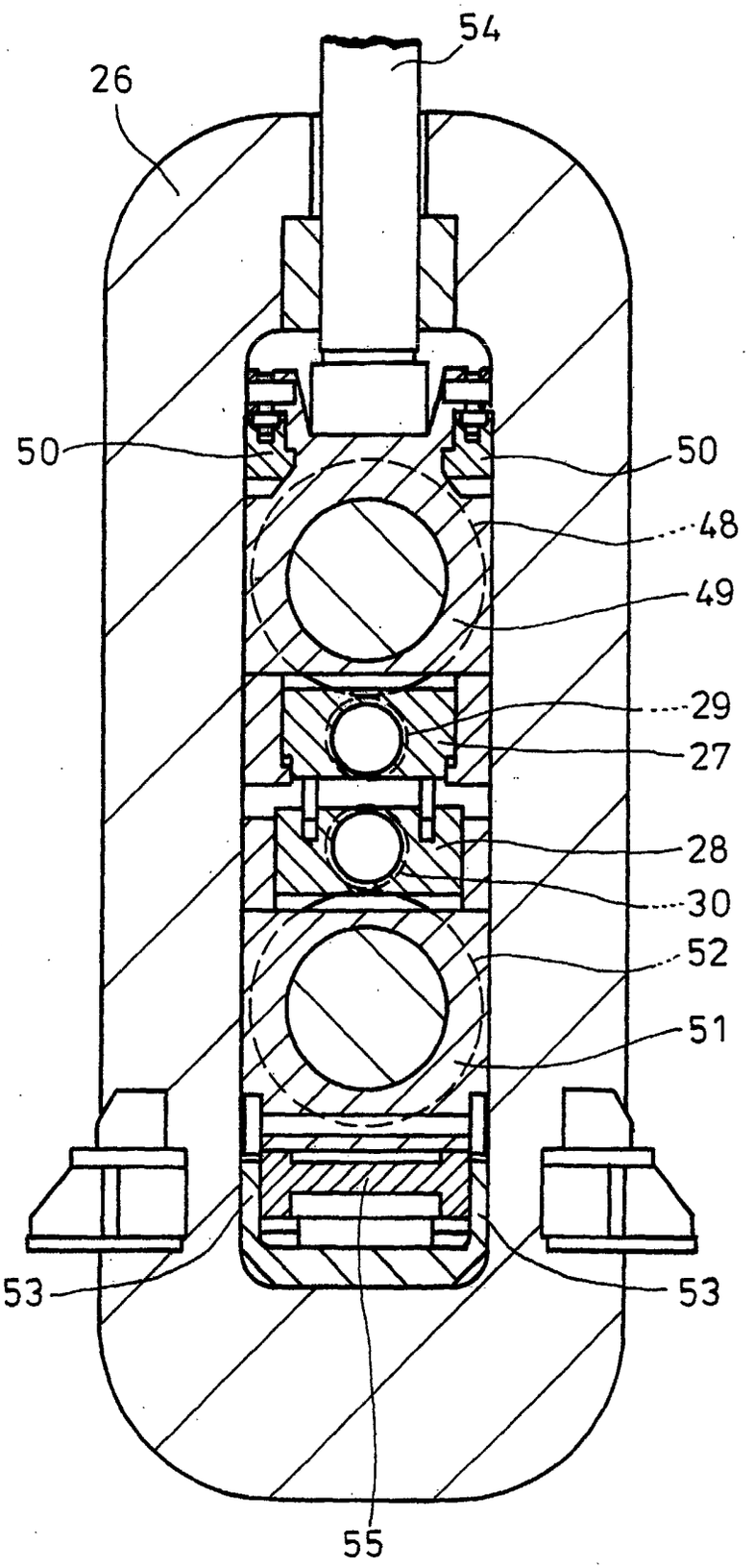

FIG. 5

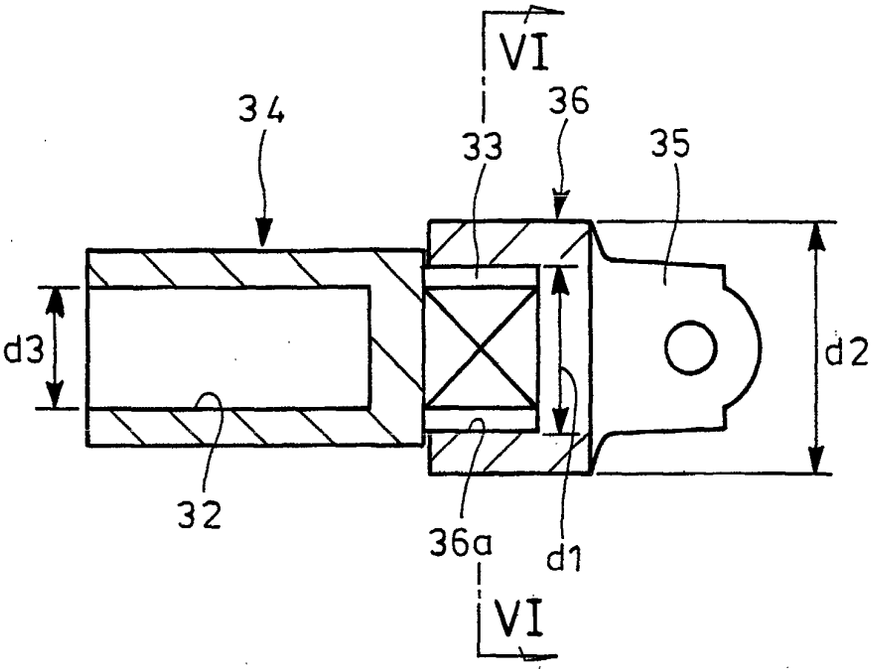

FIG. 6

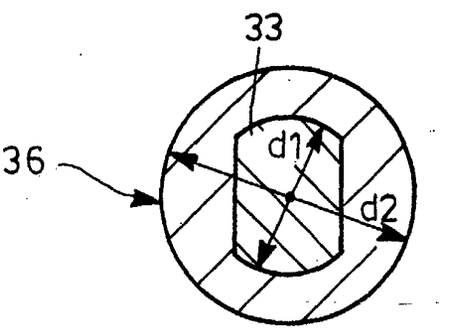

FIG. 7