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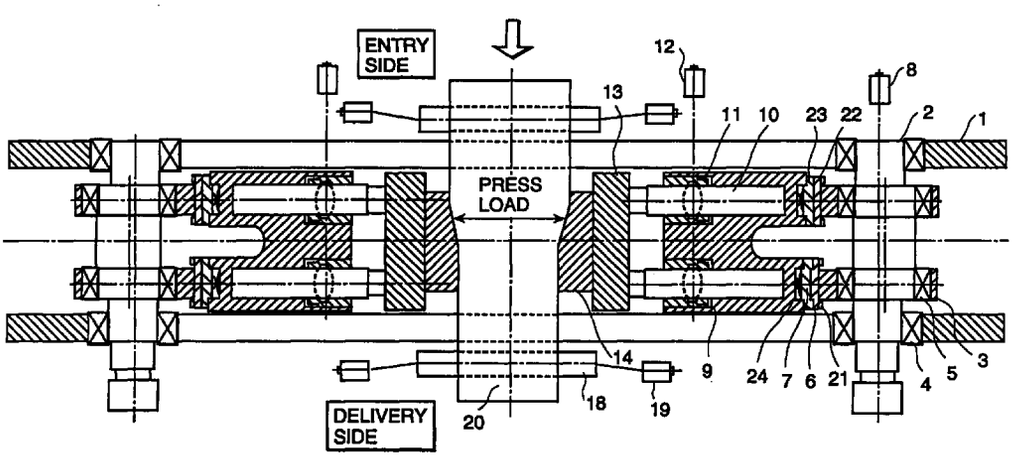
(54) Slab sizing press

(57) A slab sizing press in which a swinging motion due to rotation of two opposite crankshafts 2 is transmitted to two opposite first blocks 9 arranged inside the two crankshafts 2, at least one arm 3 is mounted rotatably on each of the two crankshafts, the tip of the arm is made to contact the first block 9 and at least one of the contact surfaces 7, 30 is made cylindrical or spherical and the other contact surface 6, 31 is made flat, and a balancing mechanism 16 pulling the first block toward the crankshaft 2 at the outside of the first block is provided.

The construction can be simplified while securing the stability of the mechanism.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a hot slab width reduction equipment and, more particularly, to a slab sizing press which reduces the width of a slab by pressing a slab side surface by a swinging motion due to rotation of crankshafts arranged to be opposite to each other.

[0002] In a conventional slab sizing press, as a means for transmitting a swinging motion due to rotation of a crankshaft to an outer block, a method of connecting the crankshaft and the outer block by a connecting rod with bearings at both ends thereof (Fig. 3 of JP B 2-50807), and a method of connecting by a connecting rod which has a bearing at the crankshaft side and a male female spherical surface (pitman) at the outer block side (Fig. 4 of JP A 5-123701) each are put into practice.

[0003] In any one of the methods, a balancing mechanism pulling the outer block toward the crankshaft to reduce a play and a width adjusting mechanism for setting an initial position of an inner block relative to the slab width are necessary.

[0004] Such a width adjusting mechanism is disclosed in JP B 2-50807 and JP A 5-123701. The mechanism in the former is provided with screws and nuts of 4 at an entry side, delivery side, upper side and lower side, that is, 8 sets in total, and the mechanism in the latter is provided with screw and nut of one per each and two sets in total.

[0005] As is required commonly on industrial machines in general, for the slab sizing press equipment it is required to be low in equipment cost, simple in construction and excellent in maintenance. A slab sizing press presses a slab side surface, using a die having a parallel portion and a tapered portion to attain a desired width thereof. In this case, in order to prevent buckling or control a plane shape of a slab, pre-formation at a preceding end of the slab and a pre-formation at the succeeding end of the slab are effected and reverse feeding press is effected in a relation to the front and rear equipment.

[0006] The center of a pressing load in the slab sizing press changes according to such a die shape and various operations and, particularly, the change being large in an entry-delivery direction is a factor of damaging the stability of the mechanism and making the construction complicated.

[0007] The conventional slab sizing press disclosed in JP A 2-50807 is provided with bearings at both ends of two connecting rods at the entry and delivery, that is, four connecting rods in total. Further, it is provided with 4 screws and nuts at the entry, delivery, upper side and lower side, that is, 8 screws and nuts in total, as a width adjustment mechanism. The stability of the mechanism to a change of a press load is high, however, the construction is complicated, so that a cost of the equipment is high and the maintenance is bad.

[0008] Further, the slab sizing press disclosed in JP A 5-123701 is provided with one connecting rod for each and two connecting rods in total, each connecting rod at the outer block side is formed in a male female spherical surface (pitman), and one screw and nut for each, two screws and nuts in total are provided as a width adjustment mechanism. The crank mechanism and width adjustment mechanism each are simple. However, the stability of the mechanism to a change of a point at which a press load is applied is low, a rotating moment is caused on the inner block and the outer block by the deviation of the press load. Therefore, a guide mechanism against the rotating moment is necessary around the outer block and the maintenance operability of the guide mechanism is bad.

SUMMARY OF THE INVENTION

[0009] By the above-mentioned problems, a slab sizing press is desired which has both of a high stability of mechanism and a simple construction, which further has a low cost and a good maintenance operability.

[0010] An object of the present invention is to attain both of stability of a slab sizing press mechanism and simplification of the construction.

[0011] A slab sizing press of the present invention is a slab sizing press which presses side surfaces of a slab by transmitting a swinging motion caused by rotation of two crankshafts opposite to each other to two opposite first blocks arranged inside the two crankshafts, and which is characterized in that at least one arm mounted rotatably on each one of the two crankshafts, a tip of the arm is in contact with the above-mentioned first block, one of the contacting surfaces is made cylindrical or spherical and the other contacting surface is made flat, cylindrical or spherical, and a balancing mechanism pulling the first block toward the crankshaft at the outside of the first block is provided.

[0012] A slab sizing press of the present invention is a slab sizing press for reducing the width of a slab, characterized by comprising a pair of eccentric crankshafts each transmitting a width reducing load, a pair of arms each mounted rotatably on the eccentric crankshaft, a pair of first blocks each rolling-contacting with the arm, a pair of second blocks each mounted so that the distance between the first and second blocks is adjustable, a pair of dies each mounted on the second block, and two distance adjusting means are provided in the slab conveying direction, each for adjusting the distance between the first and second blocks.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a plan view of an embodiment of the present invention;

Fig. 2 is a side view of the embodiment of the present invention;

Fig. 3 is a view of a conventional practical example of JP B 2-50807, provided with four screws and nuts at entry, delivery, upper and lower sides per each press half side of a presse, and eight screws and nuts in total (both sides), as a width adjustment mechanism;

Fig. 4 is a view of a conventional practical example of JP A 5-123701, provided with one screw and nut per each press half side of a press, and two screws and nuts in total (both sides), as a width adjustment mechanism;

Fig. 5 is a view of a conventional practical example of Fig. 3 in which the number of screws of the width adjustment mechanism is reduced from 4 at entry, delivery, upper and lower sides per each press half side of a press and 8 in total (both sides) to 2 at the entry and delivery per each press half side and 4 in total (both sides);

Fig. 6 is a graph of a load distribution of entry side and delivery side in a 1/10 model test machine of a slab sizing press provided with screws and nuts of 4 at entry, delivery, upper and lower sides and 8 in total;

Fig. 7 is a graph of a load distribution of upper and lower sides in a 1/10 model test machine of a slab sizing press provided with screws and nuts of 4 at entry, delivery, upper and lower sides and 8 in total; and

Figs. 8 (a) to (d) each are a rolling-contacting construction of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0014] In the present invention, noticing that a change of the center of a press load is small in an up and down direction and large in an entry and delivery direction (in a slab conveying direction), the construction is simplified without losing the stability by setting the number of screws and nuts as a width adjustment mechanism to 2 at the entry and delivery sides and 4 in total while in JP B 2-50807 the screws and nuts are 4 at the entry, delivery, upper and lower sides and 8 in total.

[0015] Here, a load distributions of entry and delivery sides and a load distribution of upper and lower sides in a 1/10 model test machine of a slab sizing press provided with screws and nuts of 4 at entry, delivery, upper and lower sides, that is, 8 in total are shown in Fig. 6 and Fig. 7, respectively.

[0016] In Fig. 6, allocation loads of an entry side screw are plotted on an abscissa and allocation loads of an delivery side screw are plotted on an ordinate. In a case where the load at the entry side is equal to that at the delivery side, points of the loads are plotted on a straight line, the center of a press load meets with the center of the press equipment. The points in Fig. 6 are deviated from the line and spreading therefrom, and it is noted that the center of the press load changes in the entry delivery direction.

[0017] On the other hand, in Fig. 7, allocation loads of an upper side screw are plotted on an abscissa and allocation loads of a lower side screw are plotted on an ordinate. It is noted that the points are on a straight line and the center of a press load does almost not change in the up and down direction.

[0018] In the slab sizing press disclosed in JP B 2-50807, screws and nuts of 4 at the entry, delivery, upper and lower sides are provided in the outer block, a press load is transmitted to the screw and nuts, the outer block, connecting rods, crankshafts and a housing in the mentioned order. In this case, a device of arrangement to insert the tip of the connecting rod between the upper and lower screw nuts is taken in order not to elongate the full length of equipment.

[0019] In the present invention also, the press load transmitting course is approximately the same, however, since the screw nuts are two at the entry and delivery, it is impossible to take any device of such arrangement as in JP B 2-50807.

[0020] Further, although it is possible to shorten the length of equipment by deviating or shifting the position of the screw nuts from the position of the connecting rod in the entry delivery direction (in the slab conveying direction), in this case, the width of equipment is widened as its adverse reaction as shown in Fig. 5.

[0021] As another device to shorten the full length of equipment, by noticing that a swing angle of the connecting rod is small and there is a balancing mechanism pulling the outer block toward the crankshaft to remove a play, a method of transmitting a press load by rolling-contact between a rolling member (cylindrical surface, spherical surface, etc.) and a flat plate at the tip of the arm is taken without taking a connection of the connecting rod and the outer block by bearings, whereby simplification of the construction is also made.

[0022] As a means for rolling-contact between the arm and the outer block, a rolling element is provided in one of contact portions between the arm and the outer block, and a sliding element sliding to the rolling element is provided on the other contact portion. In this case, rolling-contacting is also possible by making both of the contact portions into rolling elements.

[0023] Various rolling bodies are applicable. For example, as shown in Figs 8 (a) and (b), rolling elements 30 having cylindrical surface, columnar surface, spherical surface, etc. to roll can be raised. That is, they each have a curved surface which is able to effect rolling-contact.

[0024] Further, the sliding surface sliding to the rolling element, for example, is a sliding surface element 31 such as a flat plate as shown in Fig. 8 (a), however, in an allowable range in which the shape of the rolling element contacting with the sliding surface allows sliding contact, a curved surface shape can be applied. The allowable range, for example, means a play 32 of an

extent that a rolling-contacting condition can be kept in the case where any one of the rolling element 30 and the sliding surface element 31 inclines in an up and down direction while keeping a contact between the rolling element 30 and the sliding surface element 31, as shown in Fig. 8 (c). That is, as shown in Fig. 8 (d), it is sufficient if a play 32 is formed by making the curvature of the sliding surface shape larger than that of an arc shape of the rolling element 30.

[0025] In the method of transmitting a load by rolling-contact between the cylindrical surface or spherical surface which is a rolling body and a flat plane which is a sliding surface, there is some fear that a rolling-contact point deviates and a precise swinging motion due to rotation of the crankshaft may not be effected.

[0026] In order to effect a precise swinging motion due to rotation of the crankshaft, it is preferable to provide a deviation or shift preventing means. As this shift preventing means, a sector gear, stopper, pin, elastic body (spring, etc.) can be raised.

[0027] Further, in a case where the sector gear, stopper, pin or the like is used as the shift preventing means, there becomes no balancing force pulling the outer block toward the crankshaft at the time of maintenance of the equipment, there is some fear that engagement or meshing of the sector gear, pin, or stopper is disengaged. Therefore, a stopper can be provided so that the contact surface is separated beyond the engagement depth (fitting length) of the sector gear, pin or stopper.

[0028] An embodiment of the present invention is explained, referring to Fig. 1 and Fig. 2. Fig. 1 shows a plan view of a slab sizing press of an embodiment of the present invention, and Fig. 2 shows a side view of the slab sizing press of Fig. 1.

[0029] The slab sizing press comprises mainly a slab width rolling means, a slab width adjusting means and a slab conveying means.

[0030] Slab width reduction which vibrates a die 14 in a slab width direction is done mainly by a crankshaft 2 which is an eccentric shaft. The crankshaft 2 is rotatably held by bearings 4 for crankshaft provided both ends of a window of a housing 1, and rotated by a crankshaft driving motor 8. The crankshaft 2 is provided with two arms 3 at an entry and delivery (in a slab conveying direction), each of which is rotatably mounted on the crankshaft through a bearing 5 for arm.

[0031] The arms 3 each are provided, at its tip, with a flat plate 6 as a sliding surface in this embodiment. A sector gear 22 is provided as a means for preventing the flat plate from being shifted. By the flat plates 6, a pressing load can be transmitted to an outer block 9 through rolling-contact.

[0032] At a rear end of the outer block 9, rocker plates 7 are provided, each of which is a rolling element shaped cylindrical in part. Sector gears 23 are provided for the rocker plates 7, respectively, as means for preventing the rocker plates being shifted. The rocker plates 7 are in contact with the flat plates 6 with a slight play in an up and down direction.

[0033] That is, by rolling-contact between the rocker plates 7 and the flat plates 6, a press load from the crankshaft 2 which is an eccentric shaft can be transmitted to the outer block 9 through the arms 3.

[0034] In this manner, since the machine is made so that the press load is transmitted by the rolling-contact between the flat plates 6 and the rocker plates 7, conventional connecting rods, etc. are not needed, equipment construction can be made simple, and the length of the equipment can be reduced.

[0035] In this case, the flat plates 6 at the side of the arms 3 and the rocker plates 7 at the side of outer block 9 can be arranged reversely. That is, it is sufficient if in a case where a press load from the crankshaft 2 is transmitted to the outer block 9 through the arms 3, the transmission can be effected by the rolling-contact.

[0036] Further, the sector gears 22 and sector gears 23 can be replaced by stoppers, pins, springs of elastic body or the like, each of which has a shift-preventing effect.

[0037] Further, the pressing load transmitted to the outer block 9 is transmitted to the die through screws 10 and an inner block 13, and then the width of a slab 20 is reduced by the die to which the press load has been transmitted. That is, work necessary to press is given by a swinging motion caused by rotation of the crankshaft 2, whereby the side faces of the slab 20 are pressed by the die 14 to reduce the slab width.

[0038] Further, in an equipment wherein means for vibrating the die 14 in the width direction and moving the die 14 in the slab conveying direction is given and the die 14 is moved in a circle track or arc track, also, the above-mentioned rolling-contacting mechanism of the present embodiment can be applied.

[0039] Next, slab width adjustment to obtain a slab of desired width is effected by changing the distance between the inner block 13 and the outer block 9. A width adjusting mechanism therefor comprises the screws 10 and nuts 11 provided in the outer block 9. In this embodiment, 2 sets of the screws 10 and nuts 11 are provided at the entry side and delivery side (in the slab conveying direction), and they are arranged so that the center of a press load is positioned between the two screws 10 even if the central position of the press load changes in the entry and delivery direction. The screws 10 are arranged so that the height of axes of the two screws 10 is substantially the same as the height of the slab center, as shown in Fig. 2, and it is constructed so that the load is transmitted to the slab 20 stably with respect to the up and down direction.

[0040] Further, in the present embodiment, the screws 10 are pressed out or pulled out by rotation of the nuts 11 caused by wormshafts 17. The wormshafts 17 are driven by a motor 12. The tip of each of the screws 10 is in contact with the back side of the inner block 13 to transmit a pressing load. The die 14 having a parallel portion and a tapered portion is provided at the inner

side of the inner block 13.

[0041] In this manner, by rotation of the motor 12, the screws 10 are moved axially, using the nuts 11 and wormshaft 17. The movement changes a distance between the inner block and the outer block and enable slab width adjustment. By providing two sets of the screws which are means for adjusting a distance between the inner block 13 and the outer block 9 at the entry and delivery of the slab (in the slab conveying direction), the number of parts can be reduced than 4 sets of a conventional machine, the construction can be made simple and maintenance is raised. Further, the 2 sets of the means for adjusting the distance between the inner block 13 and the outer block 9 are arranged at approximately the same height as the height of the slab 20, so that the load can be stably transmitted.

[0042] Next, conveying the slab 20 is effected by pinch rollers 18 provided at the entry and delivery. The pinch rollers 18 at the entry and delivery are rotated by rotation of each of motors 19, whereby a necessary feed quantity is given to convey the slab 29 which has been pressed once.

[0043] Further, in the present embodiment, the following impulse load suppressing means is provided.

[0044] When there is some gap or play in a press load transmission course from the die 14 to the housing 1, impulse loads occur, so that in the present embodiment, an inner block balancing cylinder 16 is provided for removing the play between the inner block 13 and the outer block 9 and an outer block balancing cylinder 15 is provided for removing the play between the outer block 9 and the housing 1.

[0045] Here, the inner block balancing cylinder 16 also has a function of removing a play in a driving system of the width adjustment mechanism, and the outer block balancing cylinder 15 also has a function of removing a play in a driving system of the crankshaft 2.

[0046] Further, in the present embodiment, load cells 24 for detecting a pressing load each are provided between the outer block 9 and the rocker plate 7. A pressing load applied really can be precisely detected by the load cells 24. The load cells 24 can be positioned anywhere as long as they are between the housing 1 and the die 14.

[0047] According to the present embodiment, the following effects can be attained.

[0048] Since the rolling-contact of the flat plate and rocker plate is taken without taking a bearing system connecting an outer block and a connecting rod, the construction is made simple and the length of the equipment can be shortened.

[0049] Further, the construction can be made simple and the cost can be reduced by reducing 4 screws and nuts at the entry and the delivery to 2 screws and nuts.

[0050] By making the crew and nut of one set into two sets at the entry and delivery, the stability of the machine to a change of the center of the press load can be secured. Rotating moment applied on the inner block and the outer block can be prevented by securing the stability of machine, so that a guide mechanism for the rotating moment can be made unnecessary or simplified.

[0051] Further, since the two arms between the crankshaft and the outer block are provided at the entry and delivery sides (in the slab conveying direction), the stability of machine to a change of the center of a press load can be further improved.

[0052] Further, by preventing the rolling-contacting portion of the flat plate and the rocker plate from being deviated or shifted by the sector gears or the like and providing a pulling out prevention members for the sector gears or the like, the swinging motion by the crankshaft can be repeatedly effected and the precise motion can be secured, whereby the stability of operation can be improved.

[0053] According to the present invention, an effect of simplifying the construction while securing the stability of the slab sizing press can be attained.

Claims

1. A slab sizing press provided with a width reducing apparatus comprising an eccentric crankshaft (2), an arm (3) mounted rotatably on said eccentric crankshaft (2), a first block (9) in rolling contact with said arm (3), a second block (13) mounted so that the distance between said first and second blocks is adjustable, and a die (14) mounted on said second block (13).

2. A slab sizing press for reducing the width of a slab, comprising an eccentric crankshaft (2) transmitting a width reducing load, an arm (3) mounted rotatably on said eccentric crankshaft (2), a first block (9) contacting with said arm (3), a rolling element (7, 30) mounted on one of the contacting portions of said arm (3) and said first block, a sliding surface member (6, 31) provided on the other contacting portion, a second block (13) mounted so that the distance between said first and second blocks is adjustable, and a die (14) mounted on said second block.

3. A slab sizing press for reducing the width of a slab, comprising an eccentric crankshaft (2) transmitting a width reducing load, an arm (3) mounted rotatably on said eccentric crankshaft (2), a first block (9) contacting with said arm (3), rolling elements (7, 30) mounted on both of the contacting portions of said arm and said first block, a second block (13) mounted so that the distance between said first and second blocks is adjustable, and a die (14) mounted on said second block.

4. A slab sizing press pressing a side surface of a slab by transmitting a swinging movement caused by

rotation of two crankshafts (2) opposite each other to two opposite first blocks (9) arranged inside said two crankshafts (2), wherein at least one arm (3) is mounted rotatably on one of said two crankshafts (2), a tip of said arm (3) is contacted with said first block (9), one (7, 30) of the contacting surface is made cylindrical or spherical and the other contacting surface (6, 7, 30, 31) is made flat, cylindrical or spherical, and a balancing mechanism (16) pulling said first block (9) toward said crankshaft (2) at the outside of said first block is provided.

5. A slab sizing press according to any of claims 1 to 4, wherein means (22, 23) for suppressing deviation due to slip of the contacting surfaces of said arm tip and said block is provided, and said suppressing means is any one of a sector gear, pin, stopper and elastic member.

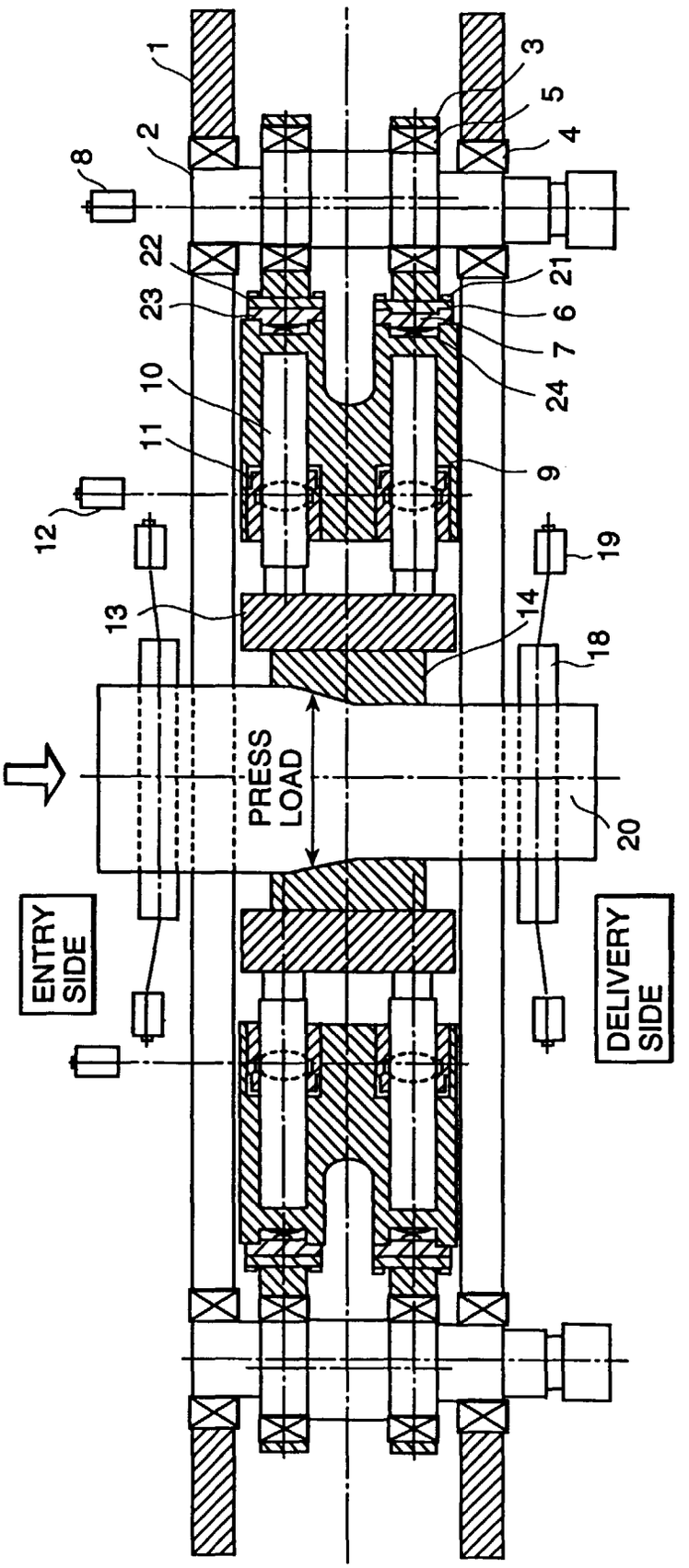
6. A slab sizing press according to any of claims 1 to 5, wherein two opposite second blocks (13) are further provided inside said first blocks (9), at least one set of screw (10) and nut (11) is provided for adjusting the distance between said second blocks (13) and said first blocks (9), and the slab is pressed by said second blocks.

7. A slab sizing press according to claim 6, wherein two sets of said screw (10) and nut (11) between said first and second blocks are provided at an entry and delivery in a slab flow direction.

8. A slab sizing press according to claim 7, wherein two of said arms (3) are arranged at the entry and delivery in the slab flow direction.

9. A slab sizing press according to claim 5, wherein a stopper is provided so that the contacting surfaces (6, 7) do not separate more than an insertion length which is the depth of a meshed portion of said sector, pin or stopper.

FIG. 1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23
24
PRESS LOAD
ENTRY SIDE
DELIVERY SIDE

FIG. 2

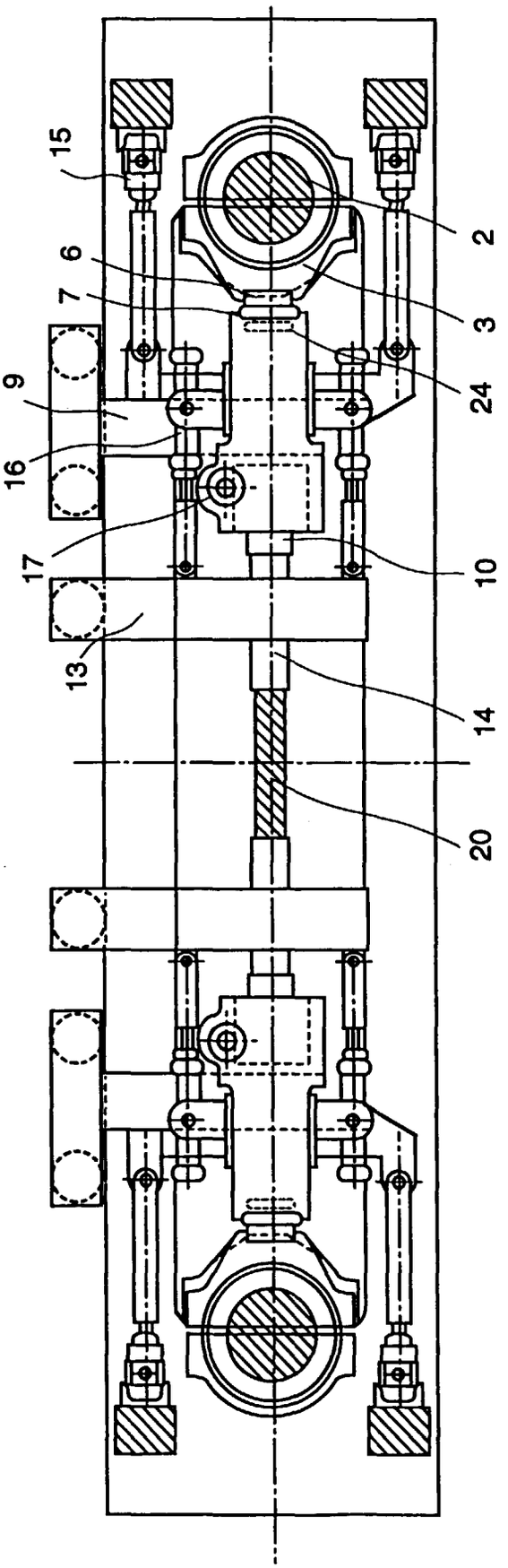

FIG. 3

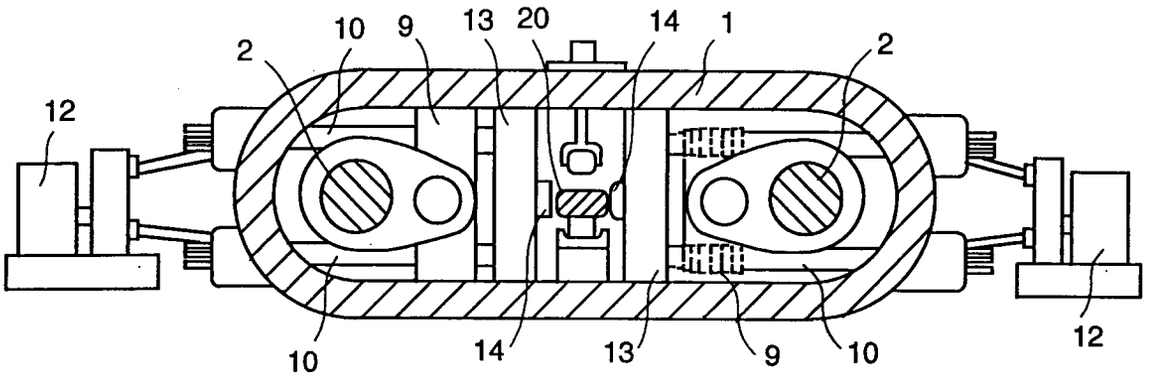

FIG. 4

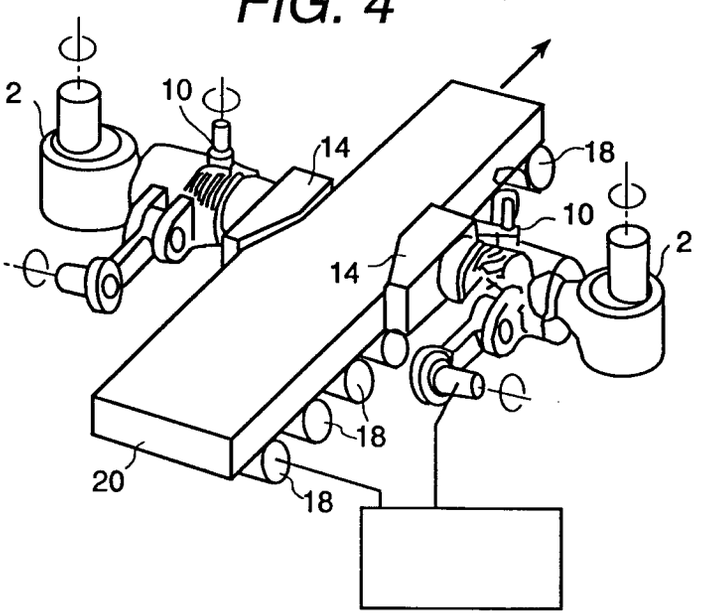

FIG. 5

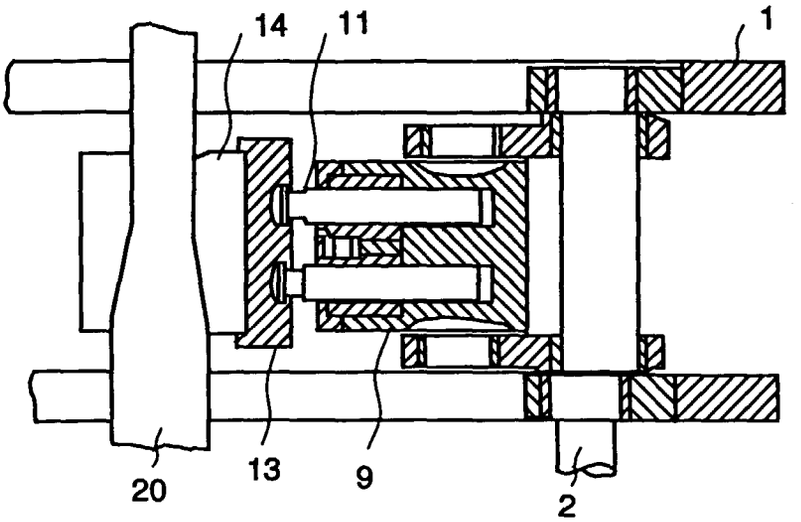

FIG. 6

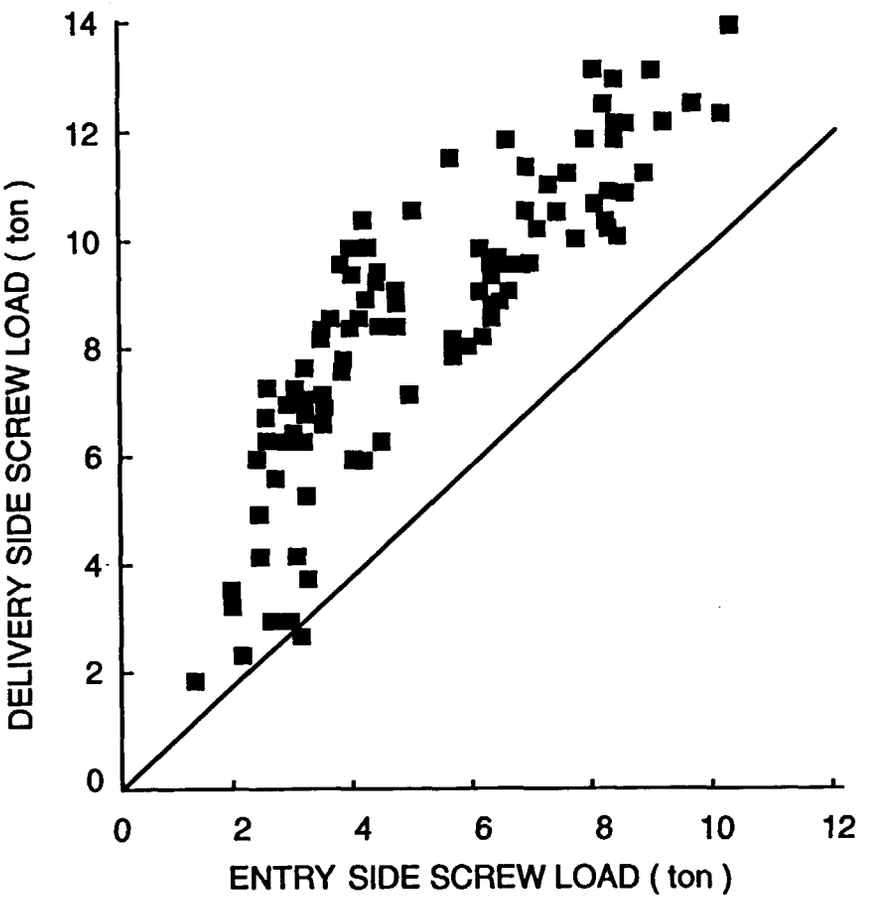
DELIVERY SIDE SCREW LOAD (ton)
ENTRY SIDE SCREW LOAD (ton)
0
2
4
6
8
10
12
14

FIG. 7

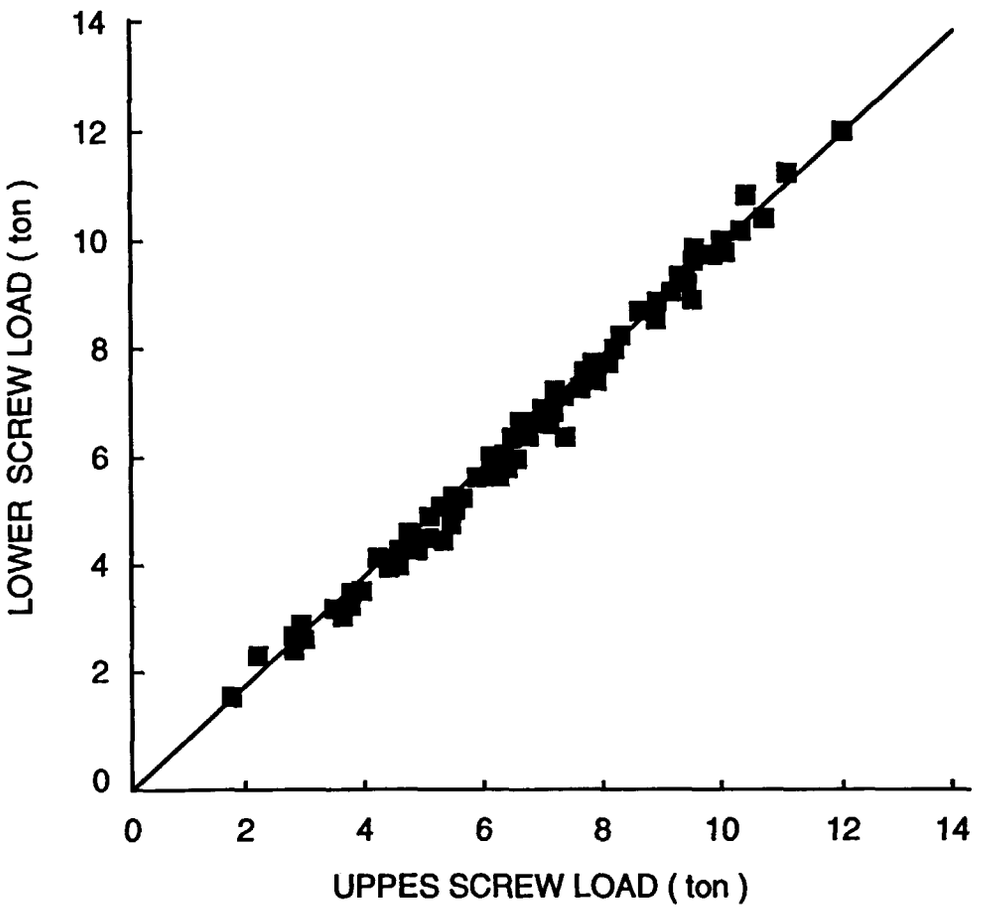

FIG.8 (a)

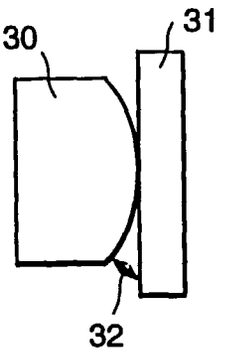

FIG.8 (b)

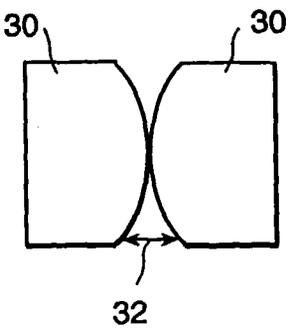

FIG.8 (c)

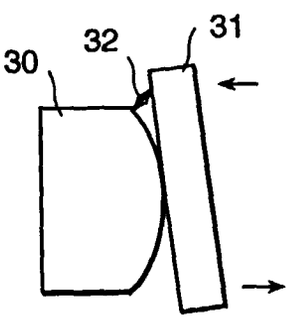

FIG.8 (d)