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(71) Applicant: **KABUSHIKI KAISHA YAMADA DOBBY
Bisai-shi, Aichi-ken (JP)**

(72) Inventor: **Yoshida, Akihiro
Gifu-shi, Gifu-ken (JP)**

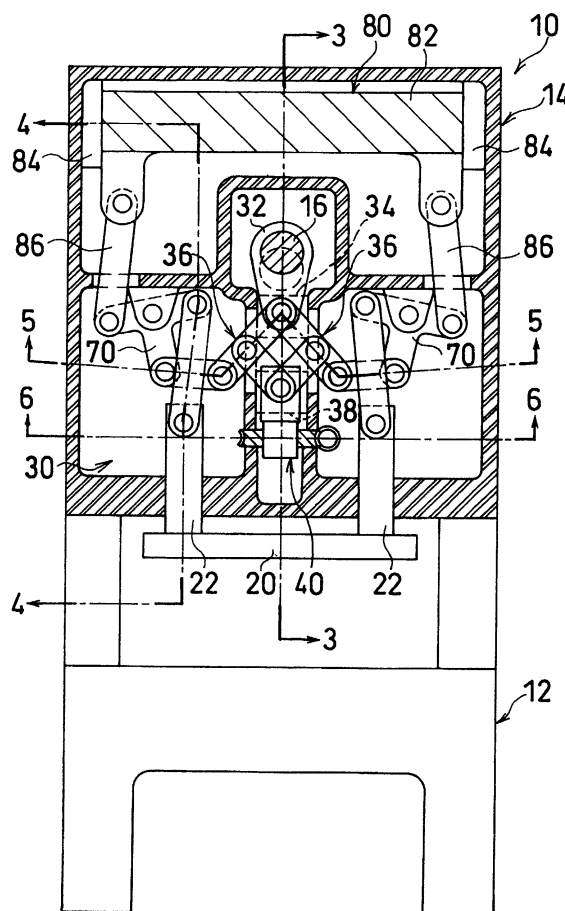
(74) Representative:

**von Samson-Himmelstjerna, Friedrich R.,
Dipl.-Phys. et al
SAMSON & PARTNER
Widenmayerstrasse 5
80538 München (DE)**

(54) **Press machine**

(57) This press machine comprises a crankshaft (16) rotatably supported on a frame (14) and a power transmission (30) for transmitting rotary motion of the crankshaft to a slide (20). The power transmission includes: a bell crank (70) supported on the frame so as to oscillate about an axis parallel to the rotation axis of the crankshaft; a connection member (72) for connecting the bell crank and the slide so that the slide can perform vertical motion with oscillation of the bell crank; a slider (38) disposed on the frame so as to move vertically; a connecting mechanism (36) connected with the crankshaft, the bell crank and the slider so that the bell crank can oscillate with rotation of the crankshaft; and a position adjusting mechanism (40) for adjusting the position of the slider vertically.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The present invention relates to a press machine which converts a rotary motion of a crankshaft supported by a frame into reciprocating motion and transmits the same to a slide.

2. Description of Prior Art

[0002] Japanese Patent Appln. Publication No. 7-55399 describes a technique of one of press machines capable of adjusting a stroke length of a slide. In this technique, rotary motion of a crankshaft is converted into vertical motion of a slide by a toggle mechanism. Consequently, in comparison with a crank press, the speed of the slide is greatly reduced in the neighborhood of a bottom dead center, as a result of which a stroke of the slide in the neighborhood of the bottom dead center is long, while a stroke of the slide in the neighborhood of a top dead center is short.

SUMMARY OF THE INVENTION

[0003] In the above-mentioned press machine, however, a highly accurate machining can be done due to the fact that the stroke in the neighborhood of the bottom dead center is long, but since the stroke in the neighborhood of the top bottom center is short, the time permitted for feeding a material into a metal mold is shortened, thereby preventing acceleration for a product which does not require such high accuracy. Further, in a press machine using a toggle mechanism, variation in acceleration of a slide in the neighborhood of the top dead center is great, which also prevents acceleration.

[0004] A press machine which converts rotary motion of a crankshaft into vertical motion of a slide by a bell crank mechanism is known (e.g., Japanese Patent Appln. Publication No. 7-121474). In this press machine, however, a stroke length of the slide cannot be changed.

[0005] It is an object of the present invention to make a stroke length of a slide changeable by using a bell crank and to enable acceleration.

[0006] The press machine according to the present invention comprises a crankshaft rotatably supported on a frame and a power transmission for transmitting rotary motion of the crankshaft to the slide. The power transmission includes: a bell crank supported on the frame so as to oscillate about an axis parallel to the rotation axis of the crankshaft; a connection member for connecting the bell crank and the slide so that the slide can perform vertical motion, following oscillating motion of the bell crank; a slider disposed on the frame so as to move vertically; a connecting mechanism connected with the crankshaft, the bell crank and the slider so that

the bell can oscillate, following the rotation of the crankshaft; and a position adjusting mechanism for adjusting a vertical position of the slider.

[0007] When a position of the slide is changed by the position adjusting mechanism, a range of angle of oscillating motion of the bell crank is changed through the connecting mechanism connected with the slide, thereby changing the vertical stroke length of the slide.

[0008] Also, the press machine using the bell crank does not cause a great difference in the stroke of the slide in the neighborhood of the bottom dead center and of the top dead center, thereby enabling acceleration.

[0009] As a result of the above, according to the present invention, the stroke length of the slide is made variable and enables acceleration.

[0010] The press machine can further comprise a balancer having a balancing weight disposed on the frame so as to move vertically and connected with the bell crank so as to move vertically by shifting its phase with respect to the vertical motion of the slide by 180°. This makes the vertical motion of the slide and the balancing weight mutually opposite, thereby offsetting unbalanced force attributable to the vertical motion of the slide and the balancing weight.

[0011] The balancing weight, which is above the bell crank and the connecting mechanism, is disposed on the frame so as to reciprocate vertically. The balancer can be further provided with a connector connected with the bell crank on the lower end side and connected with the balancing weight on the upper end side.

[0012] The bell crank has a T-like shape with three arm portions having an angle to each other such that one arm portion can be connected with the connecting mechanism, another arm portion can be connected with the connection member, and the remaining arm portion can be connected with the balancer.

[0013] The press machine can further comprise one or more weight guides for regulating the vertical motion of the balancing weight to the vertical direction. Thus, the balancing weight is prevented from reciprocating in the horizontal direction, thereby preventing horizontal vibration of the press machine attributable to reciprocation of the balancing weight.

[0014] The connecting mechanism can include: a linkage having a pair of links connected so as to perform bending and extending motion, following rotation of the crankshaft, one of the links being connected with the crankshaft and the other link being connected with the slider; and a connection link for oscillating the bell crank, following the bending and extending motion of the linkage. Thus, when the position of the slider is changed by the position adjusting mechanism, the range of the angle of bend between both link pieces is changed to change the range of oscillation angle of the bell crank.

[0015] The power transmission further includes: a second bell crank supported by the frame so as to make an oscillating motion about an axis parallel to the rotation axis of the crankshaft; a second connection member

for connecting the second bell crank and the slide so that the slide can make vertical motion, following oscillating motion of the bell crank; and a second connecting mechanism connected with the crankshaft, the second bell crank and the slider so that the second bell crank can oscillate, following rotation of the crankshaft. The connecting mechanisms can include: a first and a second linkages each having a pair of links connected so as to perform bending and extending motion, following rotation of the crankshaft, one of the links being connected with the crankshaft in common and the other of the links being connected with the slide in common; and a first and a second connection links individually made to correspond to the first and the second linkages and individually made to correspond to the bell crank, so as to oscillate the corresponding bell crank, following bending and extending motion of the corresponding linkage.

[0016] The position adjusting mechanism includes: a bracket pivotally connected with the slider; and a disk-shaped rotor disposed on the frame rotatably about an axis extending in one direction and immovably in the one direction; and a rotary mechanism for rotating the rotor. One of the bracket and the rotor can have a male screw hole, while the other can have a male screw portion screwed into the male screw hole. Therefore, since the position of the slider in the one direction can be adjusted finely, an instantaneous speed at each time point of the stroke curve and the vertical motion of the slide can be more finely adjusted depending on the type of press machining.

[0017] The press machine can further comprise a second slider disposed on the frame so as to move vertically and connected with the crankshaft and the connecting mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a partially sectioned front elevation showing an embodiment of the press machine of the present invention.

Fig. 2 is an enlarged sectional view of the neighboring part of the power transmission and the balancer of the press machine in Fig. 1.

Fig. 3 is an enlarged sectional view obtained along the line 3-3 in Fig. 1.

Fig. 4 is an enlarged sectional view obtained along the line 4-4 in Fig. 1.

Fig 5 is an enlarged sectional view obtained along the line 5-5 in Fig. 1.

Fig. 6 is an enlarged sectional view obtained along the line 6-6 in Fig. 1.

PREFERRED EMBODIMENT OF THE INVENTION

[0019] Referring to Figs. 1 through 6, a press machine 10 comprises a lower frame 12 mounting a drag and an

upper frame 14 supported on the lower frame 12. A crankshaft 16 is supported on the upper frame 14 so as to rotate about an axis extending horizontally and receives the rotation of a flywheel 18 shown in Fig. 3. The flywheel 18 is rotated by a motor (not shown) such as an electric motor.

[0020] A so-called slide 20 supporting a cope is assembled into the lower ends of a pair of connecting rod or plungers 22 which extend through the lower end portion of the upper frame 14 so as to move vertically. Both plungers 22 extend upward in parallel from both end portions of the slide 20 and are vertically reciprocated by a power transmission 30 and a bell crank 70 to be described later, following rotation of the crankshaft 16, thereby reciprocating the slide 20 vertically.

[0021] The power transmission 30 includes: a connection 32 connected with the crankshaft 16; a pair of upper sliders 34 disposed at an interval vertically so as to reciprocate vertically and connected with the connection 32 so as to perform pivotal motion; a pair of linkages 36 to be bended or extended, following the reciprocation of both upper sliders 34 and synchronously with each other; a pair of lower sliders 38 disposed on the upper frame 14 so as to be displaced vertically and pivotally connected with both linkages 36; and a position adjusting mechanism 40 for adjusting vertical positions of both lower sliders 38.

[0022] The connection 32 is pivotally connected with an eccentric portion of the crankshaft 16 and is vertically reciprocated while oscillating, i.e., swinging with rotation of the crankshaft 16. The sliders 34 and 38 are respectively received in guide portions 42 and 44 (see Fig. 3) formed in the upper frame 14 so as to move vertically.

[0023] The upper sliders 34 are vertically reciprocated, following reciprocation of the connection 32, and bend and extend both linkages 36. The lower sliders 38 are reciprocated vertically, following the bending and extending motion of both linkages 36.

[0024] Each linkage 36 has a pair of links 36a, 36b. The links 36a, 36b of each linkage 36 are connected with each other by a pivot 46 at the lower end portion of the link 36a and the upper end portion of the link 36b so as to bend.

[0025] One of the links 36a of both linkages 36 is connected at its upper end portion with the connection 32 and the upper sliders 34 by a common pivot 48 so as to pivotally move. The other of the links 36b of both linkages 36 is connected at its lower end portion with the lower sliders 38 by a common pivot 50 so as to move pivotally.

[0026] In the illustrated example, the pivots 48, 50 are provided such that their fulcrums are coincident with an axis 52 (see Fig. 2) extending vertically through the center of rotation of the crankshaft 16. It is, however, possible not to dispose the pivots 48, 50 in such a manner.

[0027] While in the illustrated example the link 36a of the linkage 36 is directly connected with the connection 32 and the upper slider 34, it is possible to connect the

link 36a of the linkage 36 with only one of the connection 32 and the upper slider 34.

[0028] The position adjusting mechanism 40 is provided with: a forked bracket 54 pivotally connected with both links 36b and the slider 38 by means of the pivot 50; a male screw 56 extending downward from the bracket 54; a worm wheel 58 screwed to the male screw; and a worm screw 60 meshed with the worm wheel 58. In place of using the bracket 54, the male screw 56 may be pivotally connected with both links 36b and the lower slider 38 by means of the pivot 50.

[0029] The male screw 56 is connected with the bracket 54 irrotatably about the axis 52. The worm wheel 58 is supported on the support portions 62, 64 of the upper frame 14 irrotatably about the axis 52 and immovably in the vertical direction. The shaft portion of the worm screw 60 rotatably extends through the upper frame 14 and has a sprocket 66 at its end portion (see Fig. 6). The sprocket 66 is rotated by a rotary mechanism (not shown) such as an electric motor.

[0030] When the sprocket 66 is rotated, the worm screw 60 is rotated to rotate the worm wheel 58 meshed with the worm screw 60, whereby the male screw 56 screwed to the worm wheel 58 is moved upward or downward to finally move the lower slider 38 upward or downward. Consequently, the worm wheel 58 acts as a rotor.

[0031] The power transmission 30 also includes: a pair of bell cranks 70 made to individually correspond to the linkages 36 and supported on the frame 14 so as to oscillate about an axis parallel to the rotation axis of the crankshaft 16; a pair of connectors or connection members 72 which are made to correspond individually to the bell cranks 70 and which connect the bell cranks 70 to a slide 20 through plungers 22 so as to have the slide 20 perform vertical motion, following the oscillation of the corresponding bell crank 70; and a pair of connection links 74 made to correspond individually to a set of the linkage 36 and the bell crank 70 to oscillate the corresponding bell crank 70, following bending and extending motion of the corresponding linkage 36.

[0032] One of the sets of the bell crank 70, the connection member 72 and the connection link 74 is made to correspond to one set of plunger 22 and the linkage 36 to be pivotally connected with one set of the plunger 22 and the linkage 36. The other set of the bell crank 70, the connection member 72 and the connection link 74 is made to correspond to the other set of the plunger 22 and the linkage 36 to be pivotally connected with the other set of the plunger 22 and the linkage 36.

[0033] Each bell crank 70 has a T-like shape having three arm portions with the same angle to each other (in the illustration, 90°) and is pivotally assembled at the branching portions of the three arm portions into the bracket 76 mounted on the frame 14.

[0034] Each bell crank 70, having one arm portion connected with the linkage 36 by the connection member 72, is oscillated by the bending and extending mo-

tion of the linkage 36. The oscillation of each bell crank 70 is transmitted to the slide 20 by the connection link 74 connected with one of the other arm portions so as to move the slide 20 vertically.

[0035] The press machine 10 further comprises a balancer 80 which balances unbalanced force attributable to the vertical motion of the slide 20. The balancer 80 includes: a balancing weight 82, the balancing weight 82 which is above the crankshaft 16, both linkages 36 and both bell cranks 70 and disposed on the upper frame 14 so as to move vertically, a plurality of weight guides 84 for restricting reciprocal motion of the balancing weight 82 to the vertical direction; and a pair of connection pieces or connectors 86 which are made to individually correspond to the bell cranks 70.

[0036] Each connector 86 is pivotally connected with the remaining arm portion of the corresponding bell crank 70 at the lower end portion by the horizontal pivot and is pivotally connected with the balancing weight 82 at the upper end portion by the horizontal pivot. The reciprocal motion of the balancing weight 82 can be restricted to the vertical direction by using one or more weight guides 84.

[0037] The pivots pivotally connecting or supporting a plurality of members such as the pivots 46, 48, 50 extend in the horizontal direction parallel to the rotation axis of the crankshaft 16. Therefore, pivotal motion of members mutually connected by each pivot or members supported by each pivot is motion about an axis extending in the horizontal direction.

[0038] In the press machine 10, since the connection 32 is reciprocally moved in the vertical direction, following rotation of the crankshaft 16, the upper slider 34 is reciprocated in the same direction. On the other hand, the lower slider 38 is not moved unless the worm wheel 58 is rotated. Consequently, the pivot 48 acts as a movable side fulcrum of the linkage 36, while the pivot 50 acts as a fixed side fulcrum of the linkage 36.

[0039] When rotation of the flywheel 18 is transmitted to the crankshaft 16, the connection 32 and the slider 34 are reciprocated vertically with the rotation of the crankshaft 16, so that both linkages 36 are bended and extended synchronously. This enables to oscillate both bell cranks 70 synchronously, thereby reciprocating the slide 20.

[0040] When both cranks 70 are oscillated, the balancing weight 82 is moved vertically, following the oscillation of both bell cranks 70. The reciprocation of the balancing weight 82 at this time is restricted to vertical reciprocation by the weight guides 84 such that, when the slide 20 is moved upward, the balancing weight 82 moves downward, and when the slide 20 is moved downward, the balancing weight 82 is moved upward. This offsets by the balancing weight 82 the unbalanced force attributable to the vertical motion of the slide 20.

[0041] The balancing weight 82 is vertically reciprocated by the bell cranks 70 through the connector 86. Therefore, despite the fact that the balancing weight 82

is connected with the bell cranks 70 which move the slide 20 vertically, horizontal displacement of the balancing weight 82 is surely prevented to prevent horizontal vibration of the press machine attributable to the reciprocal motion of the balancing weight 82.

[0042] Reciprocation of the slider 34 is regulated to the vertical direction by the guide portion 42. Consequently, bending and extending motion of both linkages 36 is correctly synchronized, thereby surely preventing horizontal vibration of the slide 20 and the balancing weight 82.

[0043] When the slider 38 is moved upward by the position adjusting mechanism 40 independently of the rotation of the crankshaft 16, the angle of bend of each linkage 36 becomes small, whereby the angle of oscillation of both bell cranks 70 becomes large, so that the slide 20 is moved downward. On the other hand, when the slider 38 is moved downward by the position adjusting mechanism 40, the angle of bend of each linkage 36 becomes large, and since the angle of oscillation of both bell cranks 70 becomes small, the slide 20 is moved upward.

[0044] When the slider 38 is moved vertically, the position of the upper slider 34 in the vertical direction does not change, so that, although the angle of bend (the magnitude of the range of bending and extending) of the linkage 36 changes, the range of bending and extending (the position of bending and extending) does not translate vertically. Therefore, the bottom dead center and the stroke length of the slide 20 can be adjusted by rotating the sprocket 66.

[0045] Since the press machine 10 employs the bell cranks 70 and the position adjusting mechanism 40, there is not caused a large difference in stroke of the slide in the neighborhood of the bottom and top dead centers in comparison with a press machine using a toggle mechanism. Therefore, although acceleration can be realized, the stroke length of the slide 20 can be changed by the position adjusting mechanism 40.

[0046] When the foregoing position adjusting mechanism 40 is employed, the amount of movement of the slider 38 with respect to the amount of rotation of the worm screw 60 is very small, so that both position of the bottom dead center and stroke length can be minutely and accurately adjusted. However, another position adjusting mechanism using a lever mechanism or the like may be employed.

[0047] If two linkages 36 and two bell cranks 70 are used as mentioned above, the reciprocation of the slide 20 and the balancing weight 82 is stabilized. Particularly, by arranging both linkages 36 to be symmetric with respect to the axis 52, disposing the bell cranks 70 on both sides thereof to be symmetric with respect to the axis 52, disposing the balancing weight 82 to be symmetric with respect to the axis 52 above the crankshaft 16 and the linkage 36, and connecting the lower side of both horizontal ends of the balancing weight 82 to the bell cranks 70, the reciprocation of the slide 20 and the bal-

ancing weight 82 is stabilized.

[0048] For stabilizing the reciprocation of the slide 20 and the balancing weight 82, it is particularly preferable to arrange one set including one of the linkages 36, one of the connection links 74, one of the bell cranks 70 and one of the connectors 86 and the other set including the other of the linkages 36, the other of the connection links 74, the other of the bell cranks 70 and the other of the connectors 86 to be symmetric with respect to the axis 52, and to arrange the slide 20 and the balancing weight 82 with respect to the axis 52.

[0049] In the foregoing embodiment, the balancer 80 is provided, but it is not always necessary to provide such a balancer 80. Also, instead of moving the slider 38 vertically, it is possible to move the slider 38 in a direction other than the vertical direction, for example, in the horizontal direction.

[0050] The present invention is not limited to the foregoing embodiments. The present invention can be variously modified without departing from its spirit. For example, only a set of one linkage 36 and one bell crank 70 may be employed.

Claims

1. A press machine comprising a crankshaft (16) rotatably supported on a frame (14) and a power transmission (30) for transmitting the rotation of said crankshaft to a slide (20),
wherein said power transmission includes: a bell crank (70) supported on said frame so as to oscillate about an axis parallel to the rotation axis of said crankshaft; a connection member (72) for connecting said bell crank and said slide so that said slide can make vertical motion, following the oscillation of said bell crank; a slider (38) disposed on said frame so as to move vertically; a connecting mechanism (36) connected with said crankshaft, said bell crank and said slider so as to oscillate said bell crank, following rotation of said crankshaft; and a position adjusting mechanism (40) for adjusting the position of said slider vertically.
2. A press machine as defined in claim 1, further comprising a balancer (80) provided with a balancing weight (82) which is disposed on said frame (14) so as to move vertically and connected with said bell crank (70) so as to move vertically, by shifting phase by 180° with respect to the vertical motion of said slide (20).
3. A press machine as defined in claim 2, wherein said balancing weight (82), which is above said crankshaft (16), said bell crank (70) and said connecting mechanism (36), is disposed on said frame so as to reciprocate vertically, and wherein said balancer (80) is further provided with a connector (86) con-

ected with said bell crank on the lower end side and with said balancing weight on the upper end side.

4. A press machine as defined in claim 2 or 3, wherein said bell crank (70) has a T-like shape with three arm portions having an angle to each other, one arm portion being connected with said connecting mechanism (36), another one arm portion being connected with said connection member (32), and the remaining arm portion is connected with said balancer (38).

5. A press machine as defined in any one of claims 1 through 4, wherein said connecting mechanism (36) includes: a linkage (36) having a pair of links (36a, 36b) mutually connected so as to perform bending and extending motion with rotation of said crankshaft (16), one of said links being connected with said crankshaft and the other of said links being connected with said slider (38); and a connection links (74) for oscillating said bell crank (70) with bending and extending motion of said linkage.

6. A press machine as defined in any one of claims 1 through 4, wherein said power transmission further includes: a second bell crank (70) supported by said frame (14) so as to oscillate about an axis parallel to the rotation axis of said crankshaft (16); a second connection member (74) connecting said second bell crank and said slide so that said slide (20) can perform vertical motion with oscillation of said second bell crank; and a second connecting mechanism (36) connected with said crankshaft, said second bell crank and said slider so that said second bell crank can oscillate with rotation of said crankshaft, and

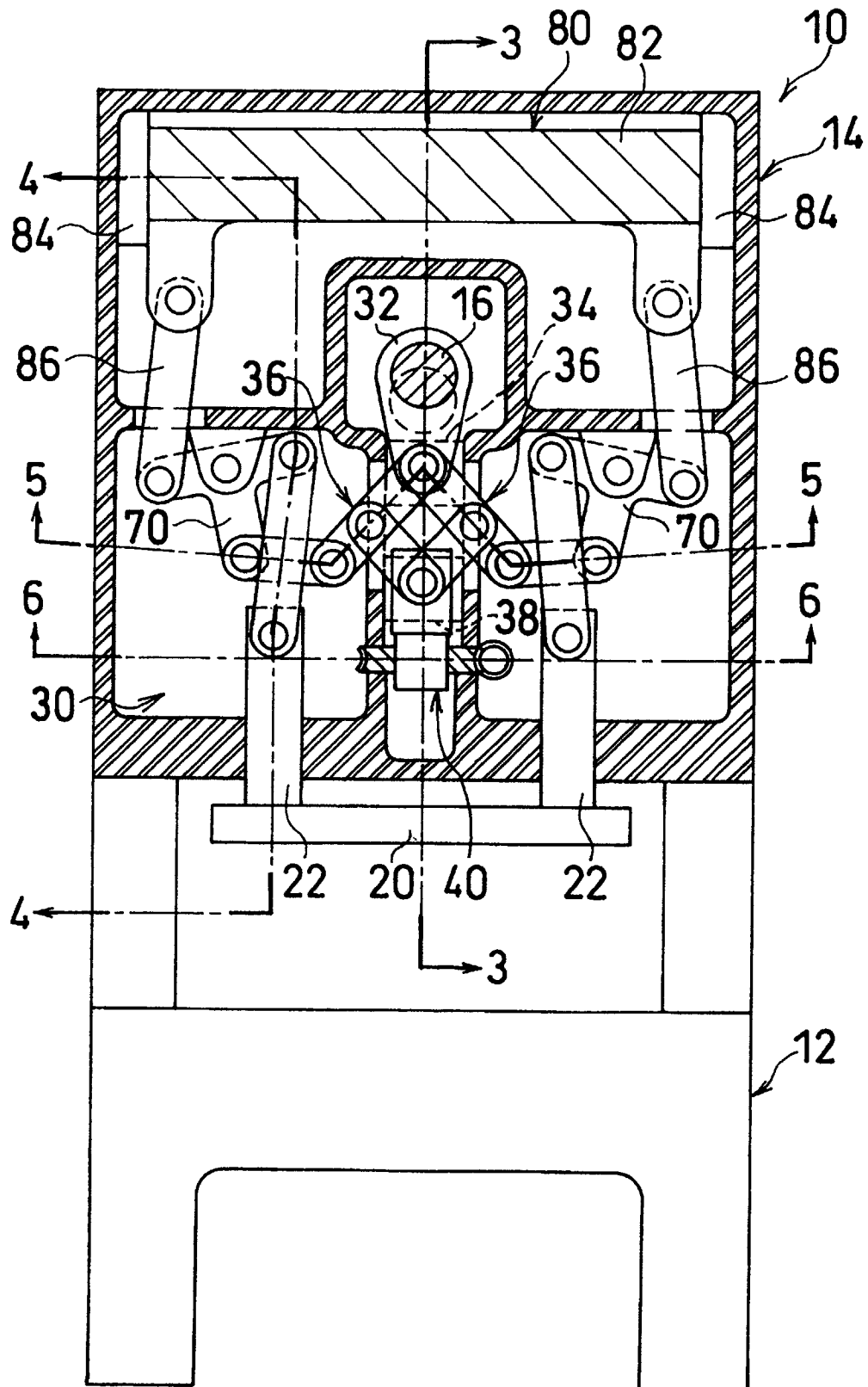
wherein said connecting mechanisms (30) include: a first and a second linkages (36) each of which has a pair of links connected so as to perform bending and extending motion with rotation of said crankshaft, one of the links being connected with said crankshaft, and the other of the links being connected with said slider; and a first and a second connection links (74) made to individually correspond to said first and second linkages and to oscillate the corresponding bell cranks with bending and extending motion of the linkages.

7. A press machine as defined in any one of claims 1 through 6, wherein said position adjusting mechanism (40) includes: a bracket (54) pivotally connected with said slider (38); a disk-shaped rotor (58) disposed on said frame (14) so as to rotate about an axis extending in one direction and not to move in said one direction; and a rotating mechanism for rotating said rotor; and wherein one of said bracket and said rotor has a female screw hole, and the oth-

er has a male screw portion screwed into said female screw.

8. A press machine as defined in any one of claims 1 through 7, further comprising a second slider (34) disposed on said frame (14) so as to move vertically and connected with said crankshaft (16) and said connecting mechanism (36).

F i g . 1



F i g . 2

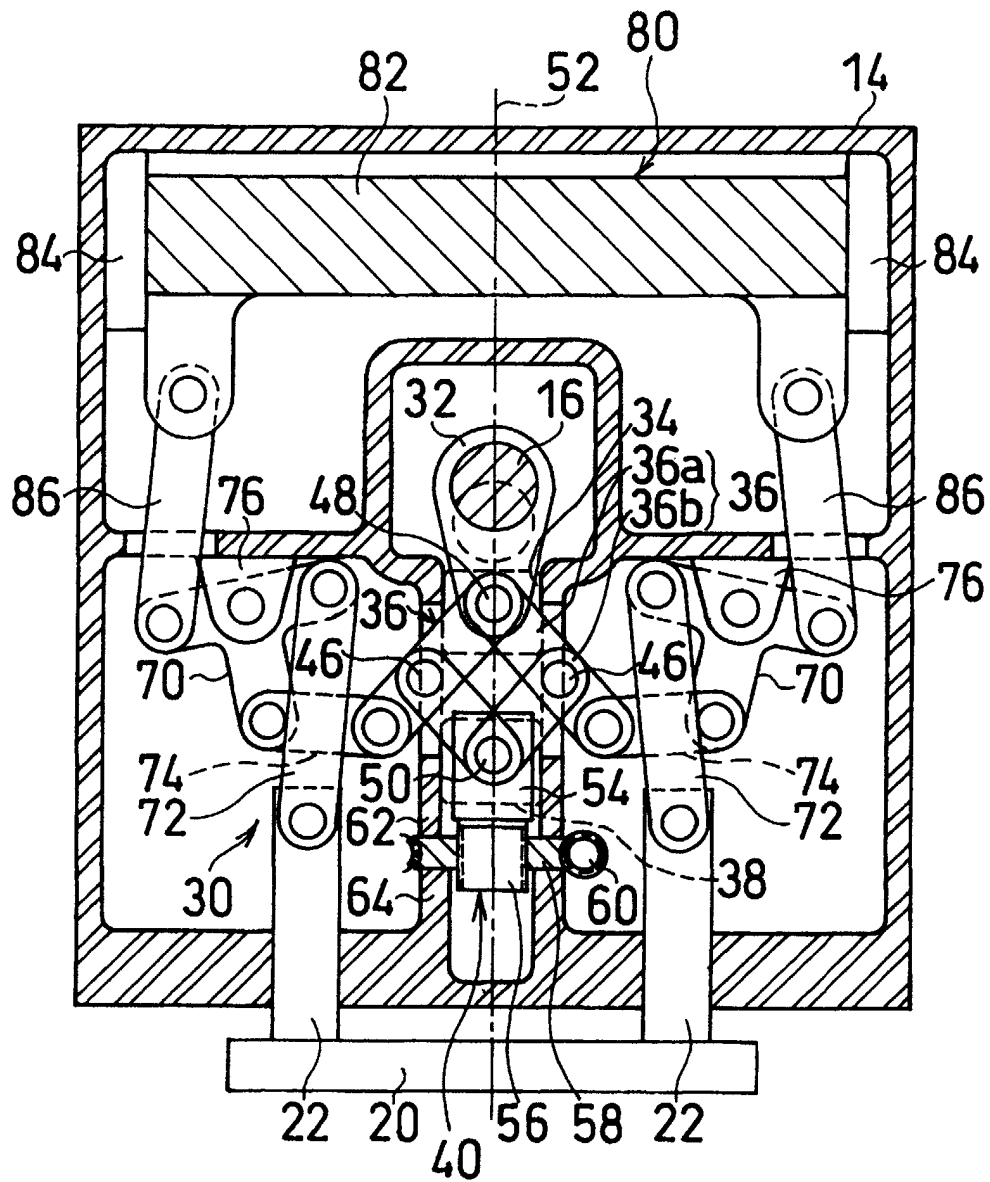


Fig. 3

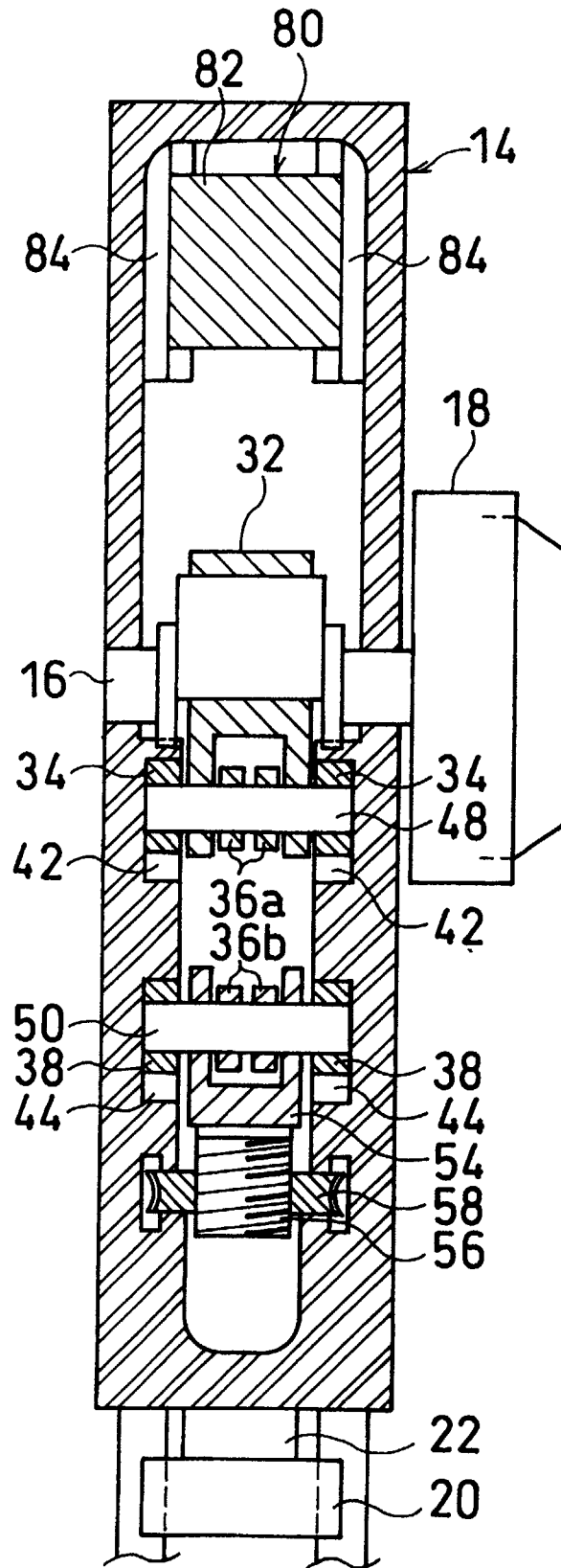


Fig. 4

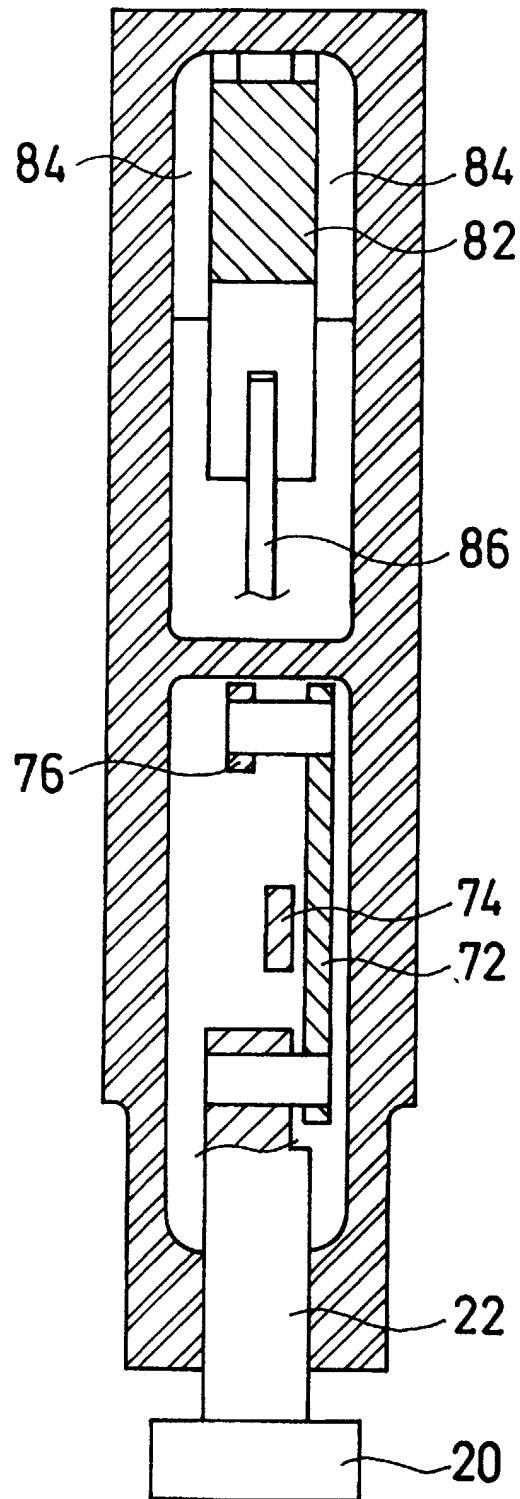
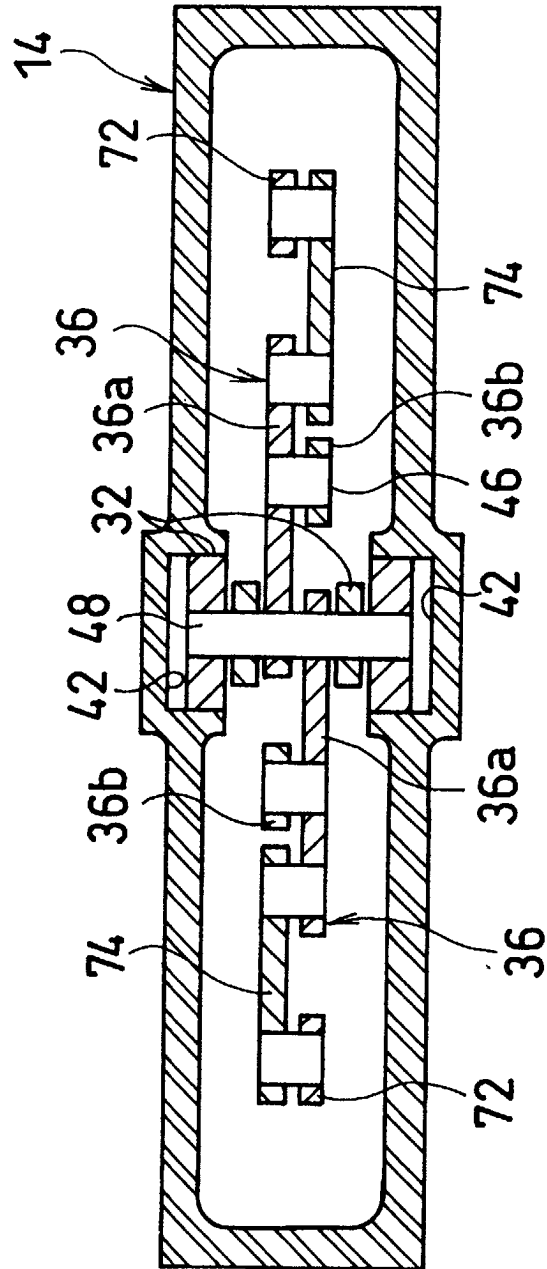


Fig. 5



F i g . 6

