A press machine comprises: a first and a second sliders (34, 40) disposed on a frame (14) at a vertical interval from each other so as to move vertically; a connection (32) connecting the first slider with an eccentric portion of a crankshaft (16); a pair of linking pieces (36a, 36b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with said first and second sliders; a pair of second linking pieces (38a, 38b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with a slide (20) and a balancing weight (56); and a position adjusting mechanism (42) for adjusting the height position of the second slider in the vertical direction, wherein either one of the first linking pieces is extended to the front end side more forward than the pivot connection point with the other to be pivotally connected with the second linking pieces.
Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The present invention relates to a power transmission for a press machine provided with a slide and a balancing weight vertically spaced apart from each other.

2. Description of Prior Art

[0002] There is a press machine provided with a slide and a balancing weight employing a toggle mechanism for a power transmission (e.g., Japanese Patent Appln. Public Disclosure No. 7-132400). This press machine uses two sets of linkages to move the slide and the balancing weight as well as a position adjusting mechanism to make a stroke length of the slide variable.

[0003] This press machine, however, has both linkages connected by a connector and uses long linking pieces pivotally supported on a frame, so that its structure is complicated.

[0004] An object of the present invention lies in simplifying the structure of the press machine having a balancing weight and capable of adjusting a stroke length of the slide.

SUMMARY OF THE INVENTION

[0005] The press machine according to the present invention comprises: a first and a second sliders disposed on a frame at a vertical interval from each other so as to move vertically; a connection for connecting the first slider with an eccentric portion of a crankshaft; a pair of first linking pieces pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with the first and the second sliders; a pair of second linking pieces pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with a slide and a balancing weight; and a position adjusting mechanism includes: a second slider disposed on the frame so as to rotate about an axis extending in one direction and not to move in the one direction; and a rotating mechanism for rotating the rotor. Either one of the second slider and the rotor has a female screw hole, while the other of the second slider and the rotor has a male screw portion screwed into the female screw hole.

[0006] When the height position of the second slider is changed, thereby changing the stroke length of the slide.

[0007] Rotation of the crankshaft is transmitted to both first linking pieces by the connection to bend and extend the first linking pieces. The bending and extending motion of the first linking pieces is transmitted to both second linking pieces by one of the first linking pieces to bend and extend the second linking pieces. By this, the slide and the balancing weight connected with the second linking pieces are reciprocated vertically at a phase difference of 180° with the bending and extending motion of the second linking pieces. As a result, unbalanced force attributable to the vertical motion of the slide and the balancing weight is offset.

[0008] If one of the first linking pieces is extended to the front end side more forward than the pivot connection point with the other to be pivotally connected with the second linking piece, the linking piece pivotally connected with the frame can be reciprocated and the stroke length of the slide.

[0009] The pivot connection point of both second linking pieces may be a floating connection point not supported on the frame, and the slide as well as the balancing weight may be disposed on the frame immovably in the horizontal direction, and further, one of the second linking pieces may be pivotally connected with a plunger extending from the slide.

[0010] In a preferred embodiment, the position adjusting mechanism includes: a second slider disposed on the frame so as to move vertically; a disk-shaped rotor disposed on the frame so as to rotate about an axis extending in one direction and not to move in the one direction; and a rotating mechanism for rotating the rotor. Either one of the second slider and the rotor has a female screw hole, while the other of the second slider and the rotor has a male screw portion screwed into the female screw hole.

[0011] The pivot connection point of both second linking pieces is changed, thereby changing the stroke length of the slide.

[0012] The press machine further comprises: a pair of third linking pieces pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with the first and second sliders; a pair of fourth linking pieces pivotally connected with each other so as to bend and such that one and the other are respectively pivotally connected with the slide and the balancing weight. Either one of the third linking pieces can be extended to the front end side more forward than the pivot connection point with the other to be
pivoted with the fourth linking pieces. By doing so, the slide and the balancing weight are connected with the linkage at two positions, thereby stabilizing the movements of the slide and the balancing weight.

[0013] The frame preferably has a guide portion for regulating reciprocation of the balancing weight to the vertical direction. This also makes reciprocation of the balancing weight to the vertical direction, thereby stabilizing the vertical motion of the balancing weight.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0014] Fig. 1 is a partially sectioned front elevation showing one embodiment of the press machine according to the present invention.

[0015] Fig. 2 is a partially enlarged sectional view of the power transmission and the balancer of the press machine in Fig. 1.

[0016] Fig. 3 is an enlarged sectional view taken along the line 3-3 in Fig. 1.

[0017] Fig. 4 is an enlarged sectional view taken along the line 4-4 in Fig. 1.

[0018] Fig. 5 is an enlarged sectional view taken along the line 5-5 in Fig. 1.

[0019] Fig. 6 is an enlarged sectional view taken along the line 6-6 in Fig. 1.

**PREFERRED EMBODIMENT OF THE INVENTION**

[0020] Referring to Figs. 1 - 6, the 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 a horizontally extending axis and receives rotation of a flywheel 18 shown in Fig. 3. A so-called slide 20 supporting a cope is assembled into the lower end of a pair of plungers 22 extending through the lower end portion of the upper frame 14 so as to move vertically.

[0021] Both plungers 22 are extended upward in parallel from both end portions of the slide 20 and are reciprocated vertically by a power transmission 30 which converts rotation of the crankshaft 16 into vertical reciprocation. Thereby, the slide 20 is vertically reciprocated.

[0022] The power transmission 30 comprises: a connection 32 connected with the crankshaft 16; a pair of sliders 34 disposed on the upper frame 14 so as to reciprocate vertically and pivotally connected with the connection 32, i.e., so as to move pivotally; a pair of linkages 36 which are bended and extended synchronously with each other, following the reciprocation of the slider 34; a pair of linkages 38 which are made to individually correspond to the linkages 36 to be bended and extended, following the bending and extending motion of the corresponding linkages 36; a pair of sliders 40 disposed on the upper frame 14 so as to displace vertically and pivotally connected with both linkages 36; and a position adjusting mechanism 42 for adjusting the position of the sliders 40 in the vertical direction.

[0023] The connection 32 is connected with an eccentric portion of the crankshaft 16 and is reciprocated vertically with rotation of the crankshaft 16. The sliders 34, 40 are disposed in a guide portion 44 formed in the upper frame 14 so as to move vertically. Both sliders 34 are reciprocated vertically, following the reciprocation of the connection 32. The sliders 40 are not reciprocated vertically by bending and extending motion of both linkages 36.

[0024] Each linkage 36 is provided with a pair of linkages 36a, 36b. The linking pieces 36a, 36b of each linkage 36 are bendedly connected with each other by a pivot 46 at the central portion of the linking piece 36a and the upper end portion of the linking piece 36b. One linking piece 36a extends to the more downward side than the pivot connection point of the linking pieces 36a, 36b and is pivotally connected with the linkage 38 at the lower end portion.

[0025] One of the linking pieces 36a of both linkages 36 is pivotally connected with the connection 32 and the slider 34 at the upper end portion by a common pivot 48. The other of the linking pieces 36b of both linkages 36 is pivotally connected with the slider 40 at the lower end portion by a common pivot 50.

[0026] In the illustrated example, the pivots 46, 48, 50 are set such that their pivotal points coincide with an axis 52 (see Fig. 2) extending vertically through the center of rotation of the crankshaft 16, but it is not always necessary to arrange the pivots 46, 48, 50 in such a manner.

[0027] Also, in the illustrated example, the linking piece 36a of the linkage 36 is directly connected with the connection 32 and the slider 34, but it is possible to pivotally connect the connection 32 and the slider 34, and to connect the linking piece 36a of the linkage 36 with only one of the connection 32 and the slider 34.

[0028] Each linkage 38 is provided with a pair of linking pieces 38a, 38b. The linking pieces 38a, 38b are bendedly connected with each other at the lower end portion of the linking piece 38a and the upper end portion of the linking piece 38b by the pivot 54.

[0029] Both linking pieces 38a are connected at their upper end portion with a balancing weight 56 disposed on the upper frame 14 by a pivot 58 so as to move vertically. Each linking piece 38b is pivotally connected at its lower end portion with the plunger 22 by a pivot 60.

[0030] Each linkage 38 is connected with the lower end portion of the linking piece 36a of the corresponding linkage 36 at the pivot connection point of both linking pieces 38a, 38b by the pivot 54.

[0031] The balancing weight 56 is disposed in a guide portion 62 formed on the upper frame 14 so as to move vertically and is positioned above the linkages 36, 38 and the crankshaft 16, thereby balancing unbalanced force attributable to vertical motion of the slide 20.

[0032] The position adjusting mechanism 42 is provided with: a forked bracket 70 pivotally connected with
both linking pieces 36b and both sliders 40 by the pivot 50; a male screw 72 extending downward from the bracket 70; a worm wheel 74 screwed into the male screw 72; and a worm screw 76 meshed with the worm wheel 74. In place of employing the bracket 70, the male screw 72 may be pivotally connected with both linking pieces 36b and both sliders 40.

[0033] The male screw 72 is connected with the bracket 70 so as not to rotate about the axis 52. The worm wheel 74 is supported on support portions 78, 80 of the upper frame 14 so as to rotate about the axis 52 and not to move vertically. The axis portion of the worm screw 76 rotatably extends through the upper frame 14 and has a sprocket 82 at an end portion (see Fig. 5). The sprocket 82 is rotated by a rotating mechanism not shown such as an electric motor.

[0034] When the sprocket 82 is rotated, the worm screw 76 is rotated, the worm wheel 74 meshed with the worm screw 76 is rotated, the male screw 72 screwed into the worm wheel 74 is moved upward or downward, and finally the slider 40 is moved upward or downward.

[0035] In the press machine 10, the sliders 34 are reciprocated in the same direction with vertical reciprocation of the connection 32, following rotation of the crankshaft 16. The slider 40, however, is not moved unless the worm wheel 74 is rotated.

[0036] In view of the above, the pivot 48 acts as a movable side fulcrum of the linkage 36, and the pivot 50 acts as a fixed side fulcrum of the linkage 36. Further, since the linking pieces 38a and 38b are connected respectively with the balancing weight 56 and the plunger 22, the pivots 58, 60, together with the pivot 54, act as floating fulcrums not supported on the frame 14.

[0037] The pivots 46, 48, 50, 54, 58 and 60 extend horizontally in 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 a motion about a horizontal axis.

[0038] 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, so that both linkages 36 are bended and extended synchronously. By this, both linkages 38 are bended synchronously, as a result of which the slide 20 and the balancing weight 56 are synchronously reciprocated in the opposite directions.

[0039] The axis of the pivot 46 is at the midpoint between the axes of the pivots 48, 54 at both ends of the linking piece 36a, and the distance from the axis of the pivot 46 to the axis of the pivot 48 is the same as the distance between the axes of the linking pieces 44 at both ends of the linking piece 44. Consequently, when the slider 34 is reciprocated, the pivot 54 is horizontally reciprocated, and the pivots 58, 60 disposed in the linking pieces 38a, 38b connected by the pivot 54 are synchronously reciprocated upward and downward by the same amount in the opposite directions to each other. Therefore, the slide 20 and the balancing weight 56 are simultaneously reciprocated upward and downward by the same amount in the opposite directions to each other, thereby balancing the vertical movement of the slide 20 and the balancing weight 56.

[0040] Reciprocation of the slide 20 is restricted to the vertical direction because reciprocation of the plungers 22 is regulated to the vertical direction by the frame 14. Reciprocation of the balancing weight 56 is restricted to vertical reciprocation by the guide portion 62.

[0041] Consequently, though the pivots 54, 58, 60 are floating connection points not supported on the frame 14, horizontal displacement of the slide 20 and the balancing weight 56 is surely prevented, horizontal oscillation of the press machine attributable to the reciprocal motion of the slide 20 and the balancing weight 56 is prevented, and vertical motion of the slide 20 and the balancing weight 56 is stabilized.

[0042] Reciprocation of the slider 34 is regulated to the vertical direction by guide portions 44. Consequently, bending and extending motion of both linkages 36, 38 is correctly synchronized, thereby surely preventing horizontal oscillation of the slide 20 and the balancing weight 56.

[0043] Independently of rotation of the crankshaft 16, when the slider 40 is moved upward by the position adjusting mechanism 42, an angle of bend of each linkage 36 becomes small, thereby making an angle of bend of each linkage 38 great, so that the slide 20 is moved downward. On the other hand, when the slider 40 is moved downward, the angle of bend of each linkage 36 becomes great, thereby making the angle of bend of each linkage 38 small and moving the slide 20 upward.

[0044] When the slider 40 is moved upward or downward, the position of the slider 34 in the vertical direction is not varied, and, therefore, the angle of bend of the linkage 36 is varied, but the range of bending and extending does not translate in the vertical direction. Consequently, by rotating the sprocket 82, the position of a bottom dead center and a stroke length of the slide 20 can be adjusted.

[0045] The position of the bottom dead center of the slide 20 may be adjusted by detecting it by an arbitrary detector, comparing the detected value with a predetermined reference value, and rotating the sprocket 82 so that the detected value can become the reference value. The stroke length of the slide 20 can be set by rotating the sprocket 82 beforehand by a predetermined amount.

[0046] If the above-mentioned position adjusting mechanism 42 is used, an amount of movement of the slider 40 is very small with respect to the amount of rotation of the worm screw 76, both the position of the bottom dead center and the stroke length can be adjusted minutely and accurately. It is, however, possible to use another position adjusting mechanism.

[0047] If four linkages 36, 38 are used as mentioned above, reciprocation of the slide 20 and the balancing weight 56 is stabilized. Particularly, by disposing both
linkages 36 symmetrically with respect to the axis 52, disposing the linkages 38 on both sides thereof symmetrically with respect to the axis 52, and connecting the undersides of both horizontal end portions of the balancing weight with the linkages, reciprocation of the slide 20 and the balancing weight 56 is stabilized.

In order to make reciprocation of the slide 20 and the balancing weight 56 more stabilized, it is particularly preferable to arrange one of the linking pieces 36a, 36b, 38a, 38b and the other of the linking pieces 36a, 36b, 38a, 38b symmetrically with respect to the axis 52. However, it is possible, for example, to employ only one set of linkages 36, 38.

The present invention is not limited to the above embodiments. The present invention can be variously modified without departing from its gist.

Claims

1. A power transmission for a press machine for transmitting rotation of a crankshaft (16) to a slide (20) and a balancing weight (56) which are vertically spaced apart and moving said slide and said balancing weight vertically at a phase difference of 180°, comprising:

   a first and a second sliders (34, 40) vertically spaced apart from each other and disposed on a frame (14) so as to move vertically;
   a connection (32) connecting said first slider with an eccentric portion of said crankshaft;
   a pair of first linking pieces (36a, 36b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with said first and second sliders;
   a pair of second linking pieces (38a, 38b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with said slide and said balancing weight; and
   a position adjusting mechanism (42) for adjusting the height positions of said second sliders in the vertical direction;

   wherein either one of said first linking pieces (36a, 36b) is extended to the front end side more forward than the pivot connection point with the other to be pivotally connected with said second linking pieces (38a, 38b).

2. A power transmission as defined in claim 1, wherein the pivot connection point of both second linking pieces (38a, 38b) is a floating connection point not supported on said frame (14).

3. A power transmission as defined in claim 1 or 2, wherein said slide (20) and said balancing weight (56) are disposed on said frame (14) so as not to move horizontally.

4. A power transmission as defined in any one of claims 1 through 3, wherein one of said second linking pieces (38a, 38b) is pivotally connected with a plunger (22) extending from said slide (20).

5. A power transmission as defined in any one of claims 1 through 4, wherein said position adjusting mechanism (42) includes: a disk-shaped rotor (74) 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; wherein either said second sliders (40) or said rotor (74) has a female screw hole, and the other of said second sliders and said rotor has a male screw portion screwed into said female screw portion.

6. A power transmission as defined in claim 5, wherein the distance from the pivot connection point of both first linking pieces (36a, 36b) to the pivot connection point of said one of the second linking pieces (38a, 38b) and the slide (20) is equal to the distance from the pivot connection point of both first linking pieces to the pivot connection point of said second linking pieces and said second slider (40).

7. A power transmission as defined in any one of claims 1 through 6, further comprising: a pair of third linking pieces (36a, 36b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with said first and second sliders (34, 40); and
   a pair of fourth linking pieces (38a, 38b) pivotally connected with each other so as to bend, of which one and the other are respectively pivotally connected with said slide and said balancing weight; and
   wherein either one of said third linking pieces is extended to the front end side more forward than the pivot connection point with the other to be pivotally connected with said fourth linking pieces.

8. A power transmission as defined in claim 1, wherein the pivot connection point of both second linking pieces (38a, 38b) is a floating connection point not supported on said frame (14).
Fig. 2