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DYNAMIC BALANCER FOR A PRESS

Technical Field

The present invention relates to a dynamic balancer for compensating the inertia force generated by the vertical reciprocating motion of a slide of the press.

Background

As the slide of a press makes vertical reciprocating motion, the resultant inertia force can cause vibration in the press depending on the size (mass) of the slide, the number of strokes (stroke per minute (spm)), etc., thus affecting the results of the press operation. In order to prevent this, it has been customary to use a dynamic balancer (DB) that has a mass approximately equal to the mass of the slide and operates in an opposing manner.

Fig. 1 shows a dynamic balancer according to the prior art. In Fig. 1, the frame of a press 100 comprises a crown 101, a bed 103, four columns 102, and tie rods (not shown) that pass through crown 101, columns 102 and bed 103 to tie them together. A slide 104 is provided underneath crown 101 (above bed 103) to be able to reciprocate vertically due to it being guided along guideposts 105. A bolster 106 is affixed to the top surface of bed 103 facing the bottom surface of slide 104. The bottom die of a press die (not shown) is affixed to the top surface of bolster 106, while the upper die is affixed on the bottom surface of slide 104. In press 100, workpieces are processed (pressed) by the dies (upper die and lower die), which are not shown in the drawing, as slide 104 makes vertical strokes.

The vertical stroke of slide 104 is driven by a drive mechanism 110, which is built into crown 101. Drive mechanism 110 is provided with a crankshaft 111, which is rotatably supported by bosses 112a and 112b. A flywheel 113 is affixed to the right end of crankshaft 111. Flywheel 113 is driven by a motor (not shown) to make rotations, while the flywheel's rotating energy is transmitted to crankshaft 111 by means of a clutch-and-brake device 114 provided on flywheel 113.

A slide-drive eccentric part 111a is provided in the middle of crankshaft 111. The end of connecting rod 115 having the greater dimensions is rotatably connected to slide-drive eccentric part 111a via a bushing 116. On the other hand, a plunger 108 is provided on slide 104 via a die height adjusting device 107, and is guided by a plunger guide 109 free to stroke vertically. The end of connecting rod 115 having the smaller dimensions is connected to plunger 108.

Speaking of height adjusting device 107, a threaded portion 108a at the bottom end of plunger 108 meshes with the inner circumference of a worm wheel 107a, and worm wheel 107a is allowed to rotate freely within a horizontal plane while it is kept in place by a retainer 107c. The outer circumference of worm wheel 107a is in mesh with a worm shaft 107b. Worm shaft 107b is driven by a motor (not shown) to rotate. Therefore, when worm shaft 107b rotates to drive worm wheel 107a, slide 104 (worm wheel 107a) moves up or down relative to plunger 108 (threaded portion 108a). Thus, die height (shown as DH in Fig. 1) is adjusted.

Drive mechanism 110 is provided with a dynamic balancer 120. Dynamic balancer 120 is provided with DB (dynamic balancer) drive eccentric parts 111b and 111c located next to slide-drive eccentric part 111a on crankshaft 111. DB-drive eccentric parts 111b and 111c are provided in an opposite phase with slide-drive eccentric part 111a. Large ends of DB connecting rods 121a and 121b are rotatably connected to DB-drive eccentric parts 111b and 111c via bushings 122a and 122b. On the other hand, a balancer weight 123 is provided above dynamic balancer 120 (drive mechanism 110). Balancer

weight 123 is guided to move up and down by means of a guide pin 124. A connecting pin 125 connects the small end of DB connecting rod 121 and balancer weight 123. The mass of balancer weight 123 is approximately equal to the total weight of slide 104 and all of the members attached to slide 104 (die height adjusting device 107, etc.).

Press 100 (drive mechanism 110, dynamic balancer 120, etc.) constituted as described above generates vertical strokes of balancer weight 123 opposing vertical strokes of slide 104. In other words, the inertia forces generated by the vertical strokes of slide 104 are cancelled by the inertia forces generated by the vertical strokes of balancer weight 123 because balancer weight 123 has a mass approximately equal to that of slide 104 and operates in opposition to slide 104.

The dynamic balancer devices of the prior art suffer from a number of disadvantages. For example, in case of a press of the prior art, it has to have eccentric parts at three points of the crankshaft despite the fact that it is a single point press. Such a crankshaft having three eccentric parts is difficult to manufacture (perform machining) and costly to manufacture. Moreover, since it has DB-drive eccentric parts on both sides of the slide-drive eccentric part, the large end (slide-drive eccentric part) of the connecting rod that connects to the plunger (slide) has to be built larger than those for the DB-drive eccentric parts. As the diameter of the bore of the large end (slide-drive eccentric part) becomes larger, the circumferential speed on the bore increases. This results in turn in temperature rise and lubrication breakdown in the particular part so that it is detrimental to the increase of the number of slide strokes per minute. One alternative idea to avoid the increase of the large end (slide-drive eccentric part) of the connecting rod is to build the large end of the connecting rod with a splitting structure, but it will cause an increase in the manufacturing cost and make the press heavier.

Summary

One object is to provide a dynamic balancer for a press that is light and suitable for increasing the operating speed of the press and for reducing the manufacturing cost, as for example by reducing the number of components to achieve a cost reduction.

A dynamic balancer for a press is provided and includes a DB-drive eccentric part mounted on a crank shaft to operate in an opposite phase with a slide-drive eccentric part; and a DB connecting rod for connecting to said DB-drive eccentric part on its large end and connecting to a balancer weight on its small end; wherein said balancer weight is formed in such a way as to be able to swivel around a pivot provided on one end thereof and to have said balancer weight's center of gravity approximately positioned on a plumb line that passes through said slide's center of gravity.

The configuration of the present dynamic balancer requires only one each of the slide-drive eccentric part and the DB-drive eccentric part on the crankshaft. The number of connecting rods (DB connecting rods) to be connected to the balancer weight is reduced from two to one is a result of the present configuration. The balancer weight is formed to be able to swivel and includes various members (hardware) for this purpose (pivot pin, etc.), but importantly, it eliminates the balancer weight guide device, etc., so that, as a whole, it can reduce the number of parts and the manufacturing cost of the entire dynamic balancer.

Moreover, it is not necessary to increase the diameter of the slide drive-eccentric part or to split the large end of the connecting rod in consideration of assembling the connecting rod that connects to the slide onto the crankshaft (slide-drive eccentric part), as there is no eccentric part on one side of the crankshaft. Since there is no need to increase the diameter of the slide-drive eccentric part, it becomes extremely advantageous in increasing the operating speed of the press; in addition, since it is not necessary to split it, the press weight can be reduced.

Although the balancer weight swivels, the center of gravity of the balancer weight is always approximately in line with the plumb line through the center of gravity of the slide. Consequently, the inertia forces of the slide and the balancer weight cancel each other, thus providing the benefit of suppressing the vibration of the press due to the slide's stroke as in the prior art.

Therefore, the present dynamic balancer not only can reduce the manufacturing cost of the dynamic balancer (press) in comparison with the press of the prior art, but also can provide a dynamic balancer for a press suitable for increasing the operating speed of the press and reducing the weight of the press.

In another aspect, the present dynamic balancer includes a DB connecting rod that is the same member as the connecting rod that drives the slide. This arrangement makes it possible for the connecting rod that connects to the slide to share a common part with the connecting rod that connects to the balancer weight. By sharing a part, the cost of manufacturing the part can be reduced due to a mass production effect. Therefore, this arrangement can provide a dynamic balancer for a press that further reduces the manufacturing cost as well as realizing the other aforementioned advantages.

Brief Description of the Drawing Figures

Fig. 1 is a front elevational sectional view of a conventional press;

Fig. 2 is a front elevational sectional view of a press according to a first embodiment;

Fig. 3 is a top plan view of a portion of the press of Fig. 2 illustrating the dynamic balancer;

Fig. 4 is a sectional, enlarged view of a portion of the press of Fig. 2 illustrating the dynamic balancer;

Fig. 5 is a top plan view of a dynamic balancer according to a second embodiment for use in a press, such as the press of Fig. 2; and

Fig. 6 is a sectional, enlarged view of the dynamic balancer of Fig. 5.

Detailed Description of Preferred Embodiments

Figs. 2-4 illustrate a first embodiment. In order to simplify or omit the description of this first embodiment, the parts and portions of the press that are similar to those of conventional press 100 shown in Fig. 1 according to the prior art are identified using the same reference numbers. Fig. 2 is a overall front view of a press 200 according to the first embodiment of the present invention. Fig. 3 is a top view of a dynamic balancer shown in greater detail in Fig. 4.

In Figs. 2-4, a crankshaft 211 of a drive mechanism 210 is provided with a slide-drive eccentric part 211a. The large end of a connecting rod 212 is connected to slide eccentric part 211a via a bushing 213. A dynamic balancer 220 is provided above a crown 101 (drive mechanism 210). The dynamic balancer 220 is provided with a DB-drive eccentric part 211b on the crankshaft 211 adjacent to slide-drive eccentric 211a and in an opposite phase with slide-drive eccentric part 211a. The large end of a DB connecting rod 221 is rotatably connected to DB-drive eccentric part 211b via a bushing 222.

A balancer weight 223 is provided above dynamic balancer 220 (crown 101). Further, a bracket 224 is affixed on the left side face of a left inner plate 101a of crown 101 and a pivot pin 225 is affixed to bracket 224. The balancer weight 223 is slidably connected to pivot 225 via bushing 226. In other words, balancer weight 223 is supported by pivot pin 225 (bracket 224) to be able to swivel around it. Balancer weight 223 thus constituted is connected to the small end of the DB connecting rod.

Consequently, dynamic balancer 220 makes swiveling action up and down pivoted by pivot pin 225 in an opposite phase with slide 104 by pivoting about a pivot pin 205.

The balancer weight 223 is formed in such a way that its mass is approximately equal to that of a slide 104, etc. (including die height adjusting device 107,

etc.), and the position of its center of gravity on a horizontal plane (x-y plane) is approximately equal to that of the center of gravity of slide 104, etc., on a horizontal plane (x-y plane). In other words, the center of gravity of balancer weight 223 is located approximately on a plumb line that passes through the center of gravity of the members (slide 104, etc.) of which the inertia force is to be canceled. The center of gravity of slide 104, etc., is normally on the center of the press. Therefore, the center of gravity for the balancer weight 223 is arranged to be at the point G shown in Figs. 3 and 4. Consequently, the inertia forces generated by the vertical strokes of slide 104 are cancelled as the balancer weight 223 swivels in an opposite phase with the vertical strokes of slide 104.

By constructing dynamic balancer 220 in this manner, only two eccentric parts are needed on crankshaft 211. Therefore, connecting rod 212 that connects with slide 104 can be assembled from the side (right side on the drawing) where DB-drive eccentric part 211b is not provided. While it is necessary in the dynamic balancer of the prior art to enlarge the diameter of the slide-drive eccentric part or to split the large end of connecting rod 212 in order to make it possible to assemble connecting rod 212 because there are DB-drive eccentric parts on both sides of the slide-drive eccentric part, it is not necessary to have those special arrangements in this embodiment and the slide-drive eccentric part 211a can have the same diameter as that of the DB-drive eccentric part 211b. In other words, the embodiment makes it possible to reduce the slide-drive eccentric diameter compared to the prior art design or to make connecting rod 212 lighter, so that it can provide a dynamic balancer suitable for a press that runs at a faster operating speed.

Moreover, it is possible to use the same diameter for DB-drive eccentric part 211b and slide-drive eccentric part 211a, so that DB connecting rod 221 for DB-drive can share the common part with connecting rod 212, thus making it possible to reduce the manufacturing cost due to part sharing.

The second embodiment having these effects is shown in Figs. 5 and 6. Fig. 5 is a top view of the dynamic balancer of Fig. 6 which illustrates an enlarged sectional

view of the press to illustrate the dynamic balancer of this embodiment. Comparable parts and areas in Fig. 5 are denoted with the same reference numerals as in the previous embodiment in order to simplify or omit unnecessary description.

In this embodiment, the bracket 224 (pivot pin 225) is provided on a front plate 101c of the crown 101. Other than the fact that the pivot for the swivel motion of a balancer weight 323 is on the front of press 300, the action is similar to that of the first embodiment (Figs. 2-4). According to the this second embodiment, a connecting rod that connects to the slide can share the same part with the DB connecting rod that connects to the balancer weight, so that it is possible to realize a further cost reduction through mass production of the common part in addition to realizing the advantages of the first embodiment.

The present devices overcome the disadvantages associated with the conventional devices and provide a number of advantages not attainable with the conventional constructions. For example, according to the present devices, the same diameter can be used for both the slide-drive eccentric part and the DB-drive eccentric part, so that the diameter of the slide-drive eccentric part can be reduced. This results in the reduction of the circumferential speed of the slide-drive eccentric part, so that it becomes extremely advantageous from the standpoint of temperature rise and lubrication problems when it is attempted to increase the operating speed of the press (slide). Therefore, it provides a dynamic balancer that is suitable for faster operation of a press. Moreover, since the number of the eccentric parts is reduced from three in the prior art to two, the manufacturing cost for the crankshaft can be reduced. Since the number of the DB connecting rods is also reduced from two to one, the manufacturing cost of the press can be further reduced.

While the invention has been particularly shown and described with

reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details can be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A dynamic balancer for a press comprising:
a dynamic balancer-drive eccentric part mounted on a crank shaft to operate in an opposite phase with a slide-drive eccentric part that is also mounted on the crank shaft; and
a dynamic balancer connecting rod for connecting to a first end of the dynamic balancer-drive eccentric part, with an opposing second end of the connecting rod for connecting to a balancer weight; wherein
the balancer weight is formed in such a way as to be able to swivel around a pivot provided at one end thereof and to have a center of gravity of the balancer weight approximately positioned on a plumb line that passes through the center of gravity of a slide.
2. A dynamic balancer for a press according to claim 1, further including a bracket coupled to a support structure, the bracket having a pivot pin coupled thereto with the balancer weight being supported by the pivot pin so as to permit pivotal movement of the balancer weight about the pivot pin.
3. A dynamic balancer for a press according to claim 1, wherein the first end has greater dimensions than the second end.
4. A dynamic balancer for a press according to claim 1, wherein the dynamic balancer-drive eccentric part and the slide-drive eccentric part are the only eccentric parts mounted on the crank shaft.

5. A dynamic balancer for a press according to claim 1, wherein the dynamic balancer connecting rod connects to the balancer weight at an end thereof which is opposite the one end where the balancer weight swivels around the pivot.

6. A dynamic balancer for a press according to claim 1, wherein a diameter of the slide-drive eccentric part is substantially equal to a diameter of the dynamic balancer-drive eccentric part.

7. A dynamic balancer for a press according to claim 1, wherein the balancer weight swivels in such a manner that compensates reciprocating motion of the slide so that the center of gravity of the balancer weight is substantially aligned with an axis passing through the center of gravity of the slide.

8. A dynamic balancer for a press according to claim 1, wherein the dynamic balancer connecting rod is the same member as the connecting rod that drives the slide.

9. A dynamic balancer for a press comprising:
a dynamic balancer-drive eccentric part mounted on a crank shaft to operate in an opposite phase with a slide-drive eccentric part that is also mounted on the crank shaft; and

a dynamic balancer connecting rod for connecting to a first end of the dynamic balancer-drive eccentric part, with an opposing second end of the connecting rod for connecting to a balancer weight; wherein

the balancer weight is formed in such a way as to be able to swivel around a pivot provided at one end thereof and the balancer weight is constructed and arranged relative to a slide such that the dynamic balancer compensates an inertia force generated by

vertical reciprocating motion of the slide and a position of a center of gravity of the balancer weight along a horizontal plane (x-y plane) thereof is approximately equal to a center of gravity of the slide along a horizontal plane (x-y plane) thereof.

10. A dynamic balancer for a press according to claim 9, further including a bracket coupled to a support structure, the bracket having a pivot pin coupled thereto with the balancer weight being supported by the pivot pin so as to permit pivotal movement of the balancer weight about the pivot pin.

11. A dynamic balancer for a press according to claim 9, wherein the first end has greater dimensions than the second end.

12. A dynamic balancer for a press according to claim 9, wherein the dynamic balancer-drive eccentric part and the slide-drive eccentric part are the only eccentric parts mounted on the crank shaft.

13. A dynamic balancer for a press according to claim 9, wherein the dynamic balancer connecting rod connects to the balancer weight at an end thereof which is opposite the one end where the balancer weight swivels around the pivot.

14. A dynamic balancer for a press according to claim 9, wherein a diameter of the slide-drive eccentric part is substantially equal to a diameter of the dynamic balancer-drive eccentric part.

15. A dynamic balancer for a press according to claim 9, wherein the dynamic balancer connecting rod is the same member as the connecting rod that drives the slide.