ABSTRACT

A press of the opposite die type has a hydraulically actuated main piston in a pressure cylinder operably mounted in a supporting press table. A main bolster carries the lower die and is mounted on the piston. A hydraulically actuated ejector is inserted coaxially in the main piston. A floating bolster carries the upper die that has an annular cutting protrusion opposite to the lower die and that reciprocates through a short stroke movement. A hydraulically actuated break-out punch that is coaxially positioned in the floating bolster cooperates with the ejector to cut off a blank from a workpiece held by the die members.

1 Claim, 8 Drawing Figures
SHEARING PRESS OF OPPOSING DIE TYPE

This invention relates to a press for shearing work to obtain fine and smooth sheared surfaces. More specifically, the invention relates to a press of the opposing die type which comprises an upper die formed with an annular bottom surface protrusion and an ordinary lower die located opposite to said upper die. Both dies are located in a working space wherein a workpiece is shorn in such a way that the workpiece is subjected to a compressive deformation while being held between said opposing dies. Subsequently a break-out punch cuts out or knocks out a blank from the workpiece to complete the shearing operation.

Shearing operations generally in use cause more or less crowding (edge sinking), fracture or burr on the sheared surface. The rough conditions of the resulting edges of the product are definitely not desirable.

Recently some excellent shearing processes have been devised to obtain fine and smooth sheared edges of plates that are free from the crowding, burr and other defects. Metal working machines for commercial operation of those processes have also been developed. Typical of those machines are the fine blanking press introduced by Schmidt Co. and the shearing press of Essa Co. They both fall under the category of presses designed for such fine shearing operations. However, the former encounters difficulties with shearing materials of relatively low ductility and is incapable of adequately controlling the burring of the workpiece in the shearing process. The latter is limited in use to shearing of workpieces where the shaving depth or length is very short.

The press according to the present invention overcomes the foregoing difficulties of the existing fine shearing presses. The instant press can shear plates without producing any fracture on the sheared edges and can produce fine and smooth surfaces free from crowding and burr.

The instant press is operated on the concept of increasing the hydrostatic pressure that is exerted on the entire region of the workpiece to be subjected to plastic deformation, especially in the vicinity of the tool edges, and accomplishing the shearing by a cutting mechanism.

The present invention will be better understood from the following detailed description taken in conjunction with the accompanying drawings.

FIGS. 1 to 4 are sequential views of essential parts of a press of the opposing die type for carrying out the shearing of a workpiece in accordance with the present invention: FIG. 1 shows a main piston ascending so that the lower die is in contact with the workpiece and a floating bolster is thereby raised; FIG. 2 shows the tool edge of the lower die cutting in the workpiece; FIG. 3 shows the workpiece being deformed in accordance with the mode of plate compression, with the die having protrusion beginning to cut in; and FIG. 4 shows a break-out punch coming down to a point where the sheared workpiece is knocked out; and

FIGS. 5 to 8 are sequential views illustrating the construction and operation of a press of the opposing die type according to the present invention: FIG. 5 shows the main piston ascending with the workpiece placed on the lower die; FIG. 6 shows the workpiece brought up into contact with the upper die having a protrusion on its bottom surface thereof, with the floating bolster raised, FIG. 7 shows the workpiece being further cut in principally by the tool edge of the lower die; and FIG. 8 shows the workpiece being punched off by the descending break-out punch.

Of these figures, FIGS. 1 to 4 sequentially illustrate the shearing principles of the present invention.

Referring now to FIG. 1, a lower die a is shown with a workpiece b to be shorn placed thereon and raised together by a main piston (not shown) into contact with an upper die d formed with the protrusion e having a flat seat on its lower end. Also provided are a break-out punch f and an ejector j, which are respectively driven by a break-out piston and an ejector piston not shown.

FIG. 2 shows that plastic deformation has been caused in the workpiece b under pressure exerted by the main piston and the die a has slightly risen with respect to the workpiece b. In this case, a plane of shear deformation g is formed along the line connecting the tool edge of the die a and the outer tool edge of the die d with the protrusion, and the cutting in the workpiece progresses solely from the tool edge side of the die a by the cutting mechanism.

FIG. 3 shows a more advanced stage than in FIG. 2. The distance between the upper surface of the die a and the lower end surface of the die d with the protrusion is now less than the breadth of the flat portion h or annular land on top of the protrusion e. The plastic deformation of the workpiece progresses generally in conformity with a mechanism similar to the mechanism of compressive working of flat plates. At this point, the die d with the protrusion as well as the die a has already begun cutting in the workpiece h.

In the stage following the compressive deformation of such a flat plate, the resistance of the material to the plastic deformation is so quickly increased that eventual separation by shearing force of the workpiece becomes impossible. However, if the break-out punch e is lowered in the advanced stage of the above process, the product will be easily separated out. FIG. 4 shows that a product i has been punched off into the lower die by the ejector j being urged downwardly by the break-out punch e which in turn is driven downwardly by a break-out piston (not shown) following the full progress of plate compression.

On the press of the present invention, the shearing is accomplished through the four steps of working. When one cycle of operation is followed by another, the ejector f rises, pushing the break-out punch e, or, alternatively, the ejector f ascends after the break-out punch e has risen up. At the same time, the lower die descends and the blank and scrap are taken out. Then, a new workpiece is placed on the upper surface of the lower die, and the operation cycle above described is repeated.

As described above, the press of the opposing die type according to the present invention accomplishes shearing in an operation cycle of four steps, that is:

1. The step of placing a workpiece on the lower die and holding the same under a certain pressure between the upper die and the lower die;
2. The step of causing plastic deformation in the workpiece by a cutting mechanism;
3. The step of effecting plastic deformation on the basis of the mechanism of flat compression of plate; and
4. The step of breaking out the product.

Thus the press of the present invention has a construction and functions which permit the four process
steps above listed to be carried out perfectly and effectively.

To illustrate it more concisely, a hydraulically actuated press of the opposite die type according to the present invention comprises broadly an upper die unit and a lower die unit that cooperate with each other. In particular, the lower unit includes a press table that defines the lower limit of a working space in which the cutting operation is performed, said table having a central recess in the top thereof and defining a pressure cylinder chamber therein;

a main piston being mounted for vertically slidable movements within said cylinder chamber and having a central depression;

c a central apertured main bolster fixedly coaxially supported on said main piston;

c a central apertured lower die member coaxially mounted on said main bolster; and

c an ejector coaxially mounted within said central depression and extending upwardly through the apertures of said main bolster and said lower die member.

Further, in particular, the upper die unit includes a central apertured upper die member coaxially positioned in a cooperative relationship with said lower die member;

said upper die member having an annular protrusion formed integrally therewith on its bottom portion thereof;

c a central apertured floating bolster coaxially disposed opposite to and cooperating with said main bolster, said floating bolster being floatable over a short stroke movement of the piston;

c said upper die member being fixedly mounted to the underside of said floating bolster;

c a central apertured press crown coaxially associated with said floating bolster, said press crown defines the upper limit of said working space; and

c a break-out punch coaxially mounted within the apertures of said upper die member, said floating bolster and said press crown and extending downwardly therethrough to operatively cooperate with said ejector. In addition, hydraulic means are associated with said ejector and said break-out punch for producing upward and downward pressures thereof; and

stop means are provided on said upper and lower units to limit said stroke movement.

The upper and lower die members are adapted to receive a workpiece therebetween from which a blank is to be cut. The lowermost end of the stroke movement establishes the position of said workpiece for coming into contact with said protrusion of said upper die member and finally cutting off said blank.

FIGS. 5 to 8 are sectional views of essential parts of a press embodying the present invention in different states of a blanking cycle. Throughout these figures, reference number 1 indicates the press housing and numeral 2 indicates the press table that constitutes the lower limit of the working space provided by the press housing. The press table 2 defines a main cylinder 4 therein, and a main piston 5 is vertically slidingly inserted in the main cylinder 4. A main bolster 6 is fixedly supported by the main piston 5, and on the main bolster 6 is provided a lower die or die member 7. The main piston 5 supports an ejector 8 coaxially therewith. Hydraulic oil passes through a passage 11 formed along the axis of the main piston to work against the bottom surface of the ejector 8. An inlet port 9 is formed for the hydraulic oil that works against the bottom surface of the main piston 5. Another inlet 10 is formed for the hydraulic oil that applies hydraulic pressure to the space above a flange 12 of the main piston 5. To limit the amount of upward movement of the main piston 5 there is mounted a stopper 13 on the piston. A workpiece to be blanked is indicated at 23.

On the other hand, the press crown 3 which defines the upper limit of the working space of the press carries a floating bolster 14 coaxially therewith and in such a manner that the bolster can be moved a short distance up and down like a piston as opposed to the main bolster 6. Between the bolster 14 and the press crown 3 there is defined a pressure chamber 18 so that the upper surface of the floating bolster 14 may be kept under hydraulic pressure. An upper die or die member 15 is formed integrally with an annular protrusion from its underside opposite to the lower die 7. Coaxially with and through the floating bolster 14 and the upper die 15, a break-out punch 16 is inserted. A piston 17 is provided to move the break-out punch 16 upwardly and downwardly. Ports 20, 21 are provided to admit hydraulic oil into either the upper or lower space around the piston 17. Still another port 19 is formed to supply hydraulic oil to the pressure chamber 18 of the floating bolster 14. The stroke of the break-out piston 17 is limited by a stopper 22.

Now the operation of the press in accordance with this invention will be explained with reference to the drawings. In FIG. 5 a workpiece 23 is shown as resting on the lower die 7. To be more exact, the product obtained by the immediately preceding blanking cycle has been forced out of the press together with the scrap by the ejector 8 raised by the hydraulic oil supplied through the passage 11, and the new workpiece to be blanked now lies in position on the lower die.

Hydraulic oil passes through the ports 19 and 19 into the cylinder 4 and the pressure chamber 18, respectively, to apply upward and downward pressure on the main piston 5 and the floating bolster 14, with the result that the main piston 5 is raised and the floating bolster 14 is seated at its lowermost end of stroke.

FIG. 6 shows that the main piston 5 has risen together with the workpiece 23 so that the workpiece 23 comes into contact with the upper die 15 with the protrusion and lifts the floating bolster 14 in defiance of its depressing force, until the floating assembly is closely contacted and in this way the workpiece 23 is held under a constant pressure between the upper and lower dies. This state corresponds to the state of FIG. 1 which illustrates the operating principles on which the press of the invention is based.

As the supply of hydraulic oil is continued from the state above described, plastic deformation is caused in the workpiece sandwiched between the vertically opposing dies 7 and 15, as shown in FIG. 7. First, as already illustrated in FIG. 2, a plane of shearing deformation is produced along the material line connecting the tool edge of the lower die 7 and the outer tool edge of the die 15 with the protrusion. In accordance with the mechanism of cutting, cutting-in proceeds chiefly from the tool edge side of the lower die 7. Further, with the decrease of the distance between the upper and lower dies 7 and 15 to a value less than the breadth of the annular top land of the protrusion of the upper die 15 as
illustrated in FIG. 3, plastic deformation occurs on the basis of the mechanism of flat compression of plate. Upon arrival of the plastic deformation of the workpiece at a predetermined level, the stopper 13 in thread engagement with the main piston 5 comes up into contact with the press table 2 and the main piston is kept from further ascent. During the progress of the plastic deformation the ejector 8 descends relative to the main piston while holding the workpiece 23 under a constant pressure.

FIG. 8 shows a blank product separated out into the lower die 7 by the downward movement of the break-out punch 16 in continuation of the state above described. When the workpiece has been compressed by a mechanism generally conforming to the mechanism of flat plate compression to a predetermined amount as illustrated in FIG. 3, hydraulic oil is supplied through the port 20 so that the product 24 is separated out from the rest of workpiece by the break-out punch 16 under the action of the break-out piston 17. This state corresponds to that illustrated in FIG. 4. The downward stroke of the break-out punch 16 is not limited by the stopper 22.

The press of the invention performs blanking through the operational steps above explained. Then, the hydraulic oil is drained through the ports 9 and 20, while supplying hydraulic oil through the ports 10 and 21. This lowers the main cylinder 5 and, at the same time, raises the break-out punch 16 away from the product 24. Meanwhile, the ejector 8 ascends to push the product out of the lower die 7, and the product 24 is taken out of the press, thus completing one cycle of blanking operation.

As explained above, the press of opposing die type according to the present invention holds the workpiece under pressure between the upper and lower dies, causes plastic deformation in the workpiece on the basis of the mechanism of cutting and the mechanism of compression, and finally cuts off the blank by the break-out punch to obtain a product of desired shape. During the process the bolster provided in the press crown gives enough force to the upper die to hold the workpiece under pressure. For this purpose the bolster is required to be freely movable in the axial direction over some distance of its stroke. In the embodiment shown, the bolster can be moved upwardly or downwardly about 2 millimeters by supplying hydraulic oil to the pressure chamber thereover thereby producing a depressing force. In place of the hydraulic oil, an annular plate spring or the like may be used in the pressure chamber to achieve a similar effect.

Also, where it is possible to attain sufficient cutting-in by the upper and lower dies to shorten the length of the workpiece to be cut off by the break-out punch, the hydraulically operated break-out piston as used in the 55 embodiment above described may be replaced by a spring having the required stretchability or an elastic material such as rubber.

The arrangement of the embodiment shown may be reversed so that the die formed with the protrusion is associated with the main bolster and the other die is attached to the floating bolster. It is further possible to allow the ejector punch 8 to do the breaking out and allow the break-out punch 16 to push out the product. Since the use of the shearing press according to the present invention reduces crowding and permits fine shearing without the possibility of fracture and burring, the press of the invention represents a substantial contribution to the field of fine press working of parts.

I claim:

1. A hydraulically actuated press of the opposite die type comprising in combination:
   a lower unit including a press table that defines the lower limit of a working space in which cutting is performed, said table having a central recess in the top thereof and defining a pressure cylinder chamber therein;
   a main piston being mounted for vertically slidable movements within said cylinder chamber and having a central depression;
   a central apertured main bolster fixedly coaxially supported on said main piston;
   a central apertured lower die member coaxially mounted on said main bolster; and
   an ejector coaxially mounted within said central depression and extending upwardly through the apertures of said main bolster and said lower die member;
   an upper unit including a central apertured upper die member coaxially positioned in a cooperative relationship with said lower die member;
   said upper die member having an annular protrusion formed integrally therewith on its bottom portion thereof;
   a central apertured floating bolster coaxially disposed opposite to and cooperating with said main bolster, said floating bolster being floatable over a short stroke movement of the piston;
   said upper die member being fixedly mounted to the underside of said floating bolster;
   a central apertured press crown coaxially associated with said floating bolster, said press crown defining the upper limit of said working space; and
   a break-out punch coaxially mounted within the apertures of said upper die member, said floating bolster and said press crown and extending downwardly therethrough to operatively cooperate with said ejector; and in addition,
   hydraulic means associated with said ejector and said break-out punch for producing upward and downward pressures thereof; and
   stop means on said upper and lower units to limit said stroke movement;
   said upper and lower die members adapted to receive a workpiece therebetween from which a blank is to be cut;
   the lowermost end of the stroke movement establishing the position of said workpiece for coming into contact with said protrusion of said upper die member and finally cutting off said blank.

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