

April 6, 1965

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3,176,569

PUNCHING APPARATUS

Filed May 14, 1962

2 Sheets-Sheet 2

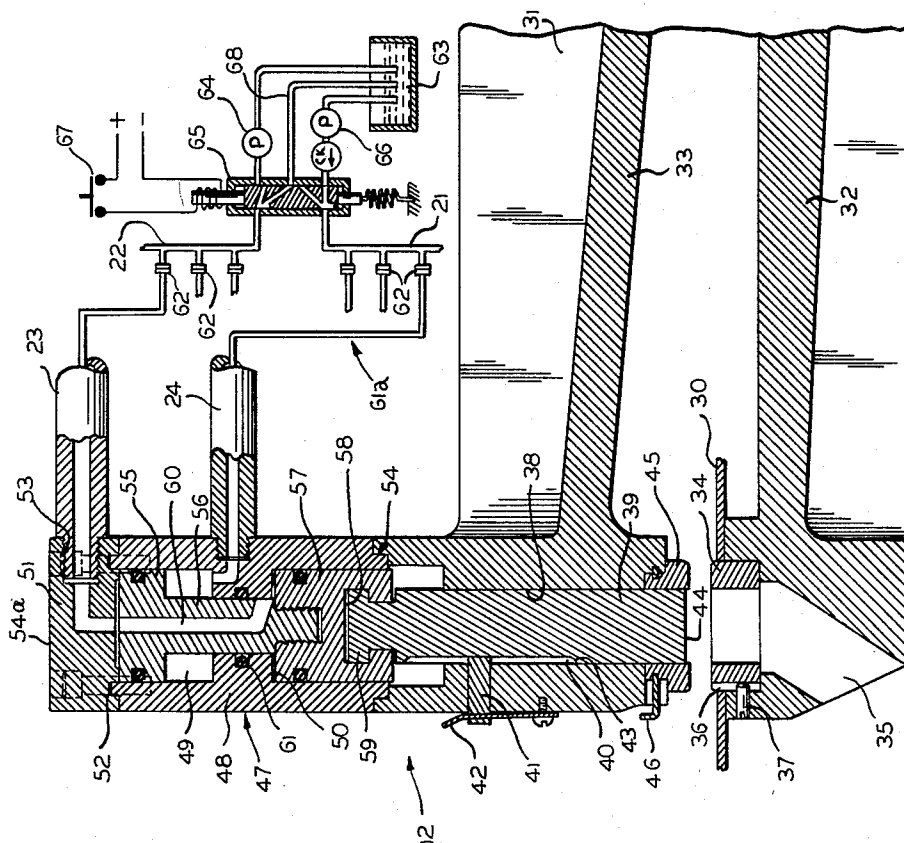


FIG. 4

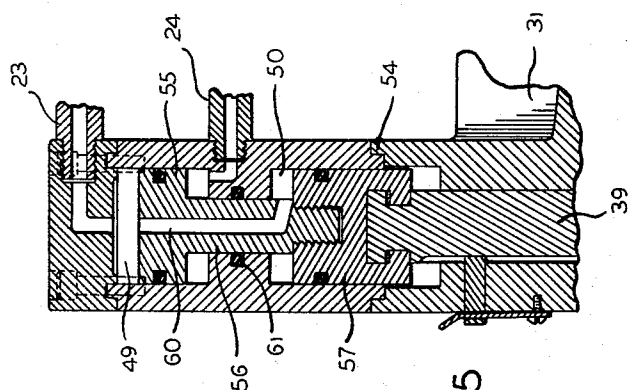


FIG. 5

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3,176,569

PUNCHING APPARATUS

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Filed May 14, 1962, Ser. No. 194,484

11 Claims. (Cl. 83-559)

This invention relates generally to punching apparatus, and more specifically to an improved press and punching unit, the press having no moving parts, and the punching unit being of the unitized or sub-press type.

Although the principles of the present invention may be included in various types of punching apparatus, a particularly useful application is made in a device adapted to receive and to support a relatively large number of variously positionable unitized or sub-press type of punching units which are individually adapted to produce round or shaped holes or other special types of formations, notches, and the like. Prior art devices have required the utilization of relatively large presses having many moving parts to drive a group of unitized punch assemblies, the same requiring heavy footings, and oftentimes requiring that the building housing such press have its roof raised to accommodate the vertical extent thereof.

The present invention contemplates the provision of a press having bolster plates of a size such as found in heavy duty presses, the press requiring a minimum amount of ceiling clearance, footings, and cost, there being no moving parts in the main structure of the press. In combination therewith, the individual punching units provided are self-powered and are associated with and supported by the press which provides the necessary reactive forces so that the upper part of the frame of each individual punching unit does not become subjected to the operating force thereof.

Accordingly, it is an object of the present invention to provide an improved punching apparatus.

Another object of the present invention is to provide a press which has no moving parts.

Yet another object of the present invention is to provide a self-powered unitized punching unit.

A still further object of the present invention is to provide punching apparatus which employs a minimum of separate parts.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is a front elevational view, partly in cross-section, of a punching apparatus provided in accordance with the principles of the present invention;

FIGURE 2 is a cross-sectional view of the structure of FIGURE 1, taken along line II-II thereof;

FIGURE 3 is an end elevational view showing a modified form of reaction press;

FIGURE 4 is an enlarged cross-sectional view of the self-powered punching unit shown in end elevation in FIGURE 1 and in side elevation in FIGURE 2, and including a schematic fluid operating circuit; and

FIGURE 5 is a fragmentary portion of FIGURE 4 showing certain parts in an operating position.

As shown on the drawings:

The principles of this invention are particularly useful when embodied in a punching apparatus such as illustrated in FIGURE 1, generally indicated by the numeral 10. The punching apparatus 10 includes a rigid reac-

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tion press 11, on which there is supported a selected number of selectively arranged self-powered punching units of the unitized or sub-press type, each indicated by the numeral 12.

The reaction press 11 includes a pair of rigid spaced plates 13, 14, referred to herein as bolster plates, to each of which appropriate stiffening braces and webs 15 are attached as by welding. In this embodiment, the lower bolster plate 13 with its stiffening means 15 is identical to the upper bolster plate 14 with its stiffening means 15, they being assembled with one inverted from the other. The plates 13 and 14 are disposed in spaced parallel relation to each other, the magnitude of such spacing being determined by a plurality of spacers 16 received therebetween. A suitable footing, legs, or base 17 is provided for the lower bolster plate 13, the plates 13 and 14 being secured together in rigid fixed spaced relation. In this embodiment, a plurality of tie rods 18 passes through appropriate pads and apertures in each of the plates 13 and 14, as well as individually through one of the spacers 16, a nut 19 being provided on at least one end thereof. While the bolster plates 13 and 14 have been illustrated herein as being relatively long and narrow so that only one tie rod 18 has been provided for at each end, it is to be understood that if either of the weldments comprising the bolster plates 13, 14 are made wider, the number of tie rods 18 and spacers 16 may be increased to insure relative rigidity and stability of the bolster plates 13 and 14.

As best seen in FIGURE 2, there may be provided an extension bracket 20 having an upper surface coplanar with the upper surface of the bolster plate 13 so as to enable the positioning of punching units 12 in a more rearwardly disposed position. Immediately below the upper surface of the bolster plate 13, there is provided a pair of manifolds 21, 22 connected to a suitable supply of pressurized fluid, such as described below, and each having a series of quick disconnect self-sealing fluid couplings of a known type, to which a pair of pressure hoses 23, 24 may be connected, such hoses being also connected to the punching unit 12. It is understood that there would be such a pair of hoses for each punching unit 12.

The detailed form of the reaction press illustrated in FIGURE 1 and FIGURE 2 is capable of some variation. As shown in FIGURE 3, an upper bolster plate 25 and a lower bolster plate 26 are respectively supported on the upper arm 27 and the lower arm 28 of a series of heavy C-shaped members generally indicated at 29, one of which is illustrated, and each comprising a heavy sheet-like element through which the manifolds 21, 22 pass, and between which the pressure hoses 23, 24 extend. The lower bolster plate 26 may again be provided with the extension bracket 20.

The individual self-powered punching units 12 may be disposed as shown on the lower bolster plates 13 or 26 in any selected arrangement, and their relative spacing may be obtained by use of conventional clamping or holding means (not shown). However, no such holding means is strictly needed since a template 30 may embrace the outer periphery of the lower tool element in the punching units 12 as shown in FIGURES 1 and 4, thereby maintaining relative spacing. The template 30 may be left in place when a workpiece W is fed into the individual punching units 12.

A representative self-powered punching unit 12 is illustrated in greater detail in FIGURE 4. The punching unit 12 includes a C-shaped frame 31, preferably of a unitary construction, having a lower arm 32 and an upper arm 33 extending thereover. The lower arm 32 is provided with an upwardly directed recess receiving a die 34

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which projects upwardly from the lower arm 32 so that its outer periphery may engage the template 30 as described before. The die recess communicates with a slug chute 35. Where the opening in the die 34 is of non-circular configuration, the die 34 is provided with a keyway 36 which receives a key 37.

The upper arm 33 is provided with a guide opening 38 which is concentric with the die 34, and which directly slidably guides a punch 39. Where the tip of the punch, namely its cutting edge, is non-circular, the body of the punch 39 is provided with an elongated keyway 40 which receives a key 41 slidably guided in the upper arm 33 and held in an inward position by a key spring 42. Preferably the keyway 40 terminates to define an abutment 43 which precludes total removal of the punch 39. The lower end of the punch 39 may have any desired configuration or size within the limits of the size of the guide opening 38. In the illustrated embodiment, these are the same. However, when the cutting edge indicated at 44 comprises a tip of reduced area, it is advantageous to employ therewith a stripping button 45 of annular configuration having an internal size and shape complementary to that of the cutting edge 44. The stripping button 45 is removably secured to the upper arm 33 by a manually releasable snap ring 46.

The punching unit 12 further includes a fluid powered operating head 47 of an actuator type which is carried by the frame or base 31. The operating head 47 includes a fluid cylinder 48 having internal means defining a first chamber 49 and a second chamber 50. The fluid cylinder 48 includes a cap 51 which is rigidly secured to the body of the cylinder 48 and has a static sealing connection therewith provided by a gasket 52. The cylinder 48 is adapted in its cap 51 to be connected as at 53 to the hose 23, and the cylinder 48 is adapted at the other end of the chamber 49 to be connected to the pressure hose 24.

The upper end of the cylinder 48 of the operating head 47 includes an upwardly directed surface 54a which is directed to be engaged by the lower surface of the bolster plate 14 when pressure is applied to the fluid line 23. The lower or opposite end of the cylinder 48 and the upper end of the frame 31 are provided with means defining a telescopic sliding connection therebetween indicated generally at 54. The connection 54 thus includes in this embodiment a recess in the arm 31 and a complementary portion in the lower end of the cylinder 48 slidably received therein.

In the upper chamber 49, there is provided a first piston 55 which has a rod 56 extending therefrom, and to which is ultimately connected the punch 39 which may be drivably advanced or retracted thereby.

Also connected to the rod 56, and disposed in the second chamber 50, is a second piston 57. The piston 57 and the punch 39 are jointly provided with means defining a connection therebetween which in this embodiment includes a T-slot and T-head respectively carried by the piston 57 and the punch 39, the T-slot being indicated at 58 and the T-head at 59. Thus the means 58, 59 comprise a driving connection capable of pushing and pulling the punch 39, the connection being slidably disengageable when the operating head 47 and punch 39 are out of the frame 31.

The chamber 50 is provided with a fluid connection for admitting fluid under pressure to the high pressure side of the piston 57. Such connection communicates with or is common with the high pressure side of the piston 55, and hence the high pressure line or hose 23. In the instant embodiment, that fluid connection constitutes a fluid passage 60 lying jointly in the piston 55 and the rod 56.

It is evident that the cylinder 48, the pistons 55 and 57, and the punch 39 may be removed as a unit, such as for changing or sharpening the punch. It is further evident that such removal is effected by a sliding movement,

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and in this embodiment enables disengagement of the T-slot and T-head driving connection 58, 59.

Where a thin workpiece is to be punched, the operating pressure delivered through the line 23 and acting only on the piston 55 may be adequate to drive the punch 39 through the workpiece. However, when lesser driving pressures are available, or when a thicker workpiece is to be punched, the force which can be obtained from the piston 55 alone may not be adequate. Under such a condition, it further would be impractical to increase the actual area of the piston 55, since doing so would prevent one punching unit 12 from being moved over immediately adjacent to another punching unit 12 so that their frames 31 would touch each other. Stated otherwise, increasing the diameter of the cylinder 48, to accommodate a larger area piston 55, to a size greater than the width of the frame 31 would be impractical since the minimum spacing between holes made by adjacent punching units 12 would thereby also be increased. Accordingly, the second piston 57 serves to increase the effective diameter of the piston 55 during the power stroke, no such added area being needed for the return stroke.

Since the low pressure side of the piston 55 should be distinctly separate from the high pressure side of the piston 57, there is provided a seal 61 which slidably engages the outside diameter of the rod 56 to insure against leakage between the low pressure side of the chamber 49 and the chamber 50.

To operate the punching unit by means of fluid pressure, there is provided an appropriate fluid system, an example of which is diagrammatically indicated at 61a. The high pressure hose 23 is connected to one of several quick disconnect couplings 62 on the manifold 22 which is the high pressure manifold, and the low pressure hose 24 is connected to one of the quick disconnect couplings 62 on the low pressure manifold 21. In this embodiment, fluid is withdrawn from a reservoir 63 by a high pressure pump 64 of the constant pressure type, and is normally blocked by the slide of a solenoid-actuated spring-returned six-way valve 65. At this time, fluid is withdrawn at a lower pressure by a constant pressure pump 66 which communicates with the low pressure manifold 21, thereby pressurizing the low pressure side of the piston 55 and holding the same in the retracted position illustrated in FIGURE 4. Under this condition the chamber 50, the passage 60, and the upper end of the chamber 49 are vented through the line 23 to a return line 68.

When a switch 67 is closed, the valve 65 is actuated to its opposite extreme to admit a higher operating fluid pressure from the pump 64 to the manifold 22, and thence through the line 23 to the upper or high-pressure side of the piston 55, and through the passage 60 to the upper or high pressure side of the piston 57, and hence the chamber 50. This higher operating pressure thus acts against the combined effective areas of the pistons 55 and 57 to drive the punch 39 in a downward direction or power stroke. As soon as the punch 39 meets with a resistance, there is a tendency for the high fluid pressure to effect a raising or lifting of the cylinder 48, but such movement is reacted to against the surface 54 by the bolster plate 14. A continued build up of pressure thus drives the punch 39 through the workpiece. During this operating stroke, the low pressure side of the piston 55 is vented through the hose 24 to the return line 68, and the lower pressure side of the piston 57 is vented to the atmosphere through the connection 54, with a piston to frame dashpot effect.

After the power stroke has been completed, the switch 67 may be released, and doing so causes the valve 65 to return to the illustrated position. This admits a lower returning lifting stripping pressure to the manifold 21 and the hose 24, such pressure appearing solely at the lower side of the piston 55 as best seen in FIGURE 5. This fluid pressure causes the piston 55 to return which

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drives fluid at the upper end of the chamber 49 out through the line 23, thereby creating a tension in the rod 56 which returns the piston 57 and the punch 39. The return of the piston 57 forces fluid out of the second chamber 50 through the passage 60 into the first chamber 49 where it is expelled with the other fluid through the line 23. Since neither the telescopic connection 54 nor the fit between the punch 39 and the frame 31 is pressure tight, air is readily admitted to the low pressure side of the piston 57.

Although the reciprocable tool has been indicated as being a punch 39, it is evident that the instant invention may be employed with any pair of tools wherein one of them reciprocates with respect to the other.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A punching apparatus comprising:

- (a) a rigid reaction press; and
- (b) a fluidly actuated punching device rigidly supported by said press only at a single surface thereof, said device during punching being further engageable at an opposite surface thereof with said rigid press for reaction thereby, said device being removable from and replaceable in said rigid press as a single unit.

2. A unitized punching unit comprising:

- (a) a rigid frame;
- (b) a die supported on a lower part of said frame;
- (c) a punch reciprocably guided directly by said frame in alignment with said die;
- (d) a separate fluid cylinder slidably carried on said frame and adapted to be connected to a pressurized fluid supply, said cylinder having an exterior end surface remote from said frame and adapted to be engaged and reacted on during application of fluid pressure;
- (e) a piston in said cylinder;
- (f) means defining a T-slot and T-head driving connection between said piston and said punch; and
- (g) means by which said cylinder, said piston, and said punch are slidably jointly removable as a unit from said frame to enable disengaging said driving connection.

3. A unitized punching unit comprising:

- (a) a rigid frame adapted to support a pair of coactive tool means, one of which is reciprocably supported thereby;
- (b) a separate fluid cylinder adapted to be connected to a pressurized fluid supply, said cylinder having an upper exterior surface adapted to be reacted on during application of fluid pressure;
- (c) means defining a freely slidable telescopic connection between the lower end of said cylinder and said frame; and
- (d) a piston in said cylinder adapted to be connected to the reciprocable one of said tool means.

4. A unitized punching unit comprising:

- (a) a rigid frame adapted to support a pair of coactive tool means, one of which is reciprocably supported thereby;
- (b) a separate fluid cylinder slidably carried on said frame and having a pair of aligned piston chambers therein, one of said chambers being adapted at one end to be connected to a first supply of pressurized fluid and adapted at the other end to be connected to a second alternative supply of lower pressurized fluid, said cylinder having an exterior end surface remote from said frame and adapted to be reacted on during application of fluid pressure;
- (c) a first piston in said one chamber, said piston

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having a rod extending slidably into the other chamber;

- (d) a second piston in said other chamber connected to said rod and adapted to be connected to the reciprocable one of said tool means; and
 - (e) means communicating the high pressure side of said second piston in said other chamber with said one end of said first chamber, the low pressure side of said second piston being at all times substantially at atmospheric pressure.
5. A unitized punching unit comprising:
- (a) a rigid frame;
 - (b) a die supported on a lower part of said frame;
 - (c) a punch reciprocably guided directly by said frame in alignment with said die;
 - (d) a separate fluid cylinder movably carried on said frame and having a pair of aligned piston chambers therein, one of said chambers being adapted near the end more remote from the other chamber to be connected to a first supply of pressurized fluid and adapted at the other end to be connected to a second alternative supply of lower pressurized fluid, said cylinder having an exterior end surface remote from said frame and adapted to be reacted on during application of fluid pressure;
 - (e) means defining a freely slidable telescopic connection between the lower end of said cylinder and said frame;
 - (f) a first piston in said one chamber, said piston having a rod extending slidably into the other chamber;
 - (g) a second piston in said other chamber connected to said rod;
 - (h) means defining a T-slot and T-head driving connection between said second piston and said punch;
 - (i) means defining a passage interconnecting the high pressure sides of said piston, the low pressure side of said second piston being normally at all times substantially at atmospheric pressure; and
 - (j) means by which said cylinder, said pistons, and said punch are slidably jointly removable as a unit from said frame to enable disengaging said driving connection.

6. A punching apparatus comprising:

- (a) a rigid reaction press; and
- (b) a punching device having a frame, said device being supported only at said frame and such support being provided by a single surface of said press, said device including a fluid actuator operating head movable with respect to said frame and directed to be provided with a reactive force by an opposite surface of said press, said device being removable from said press as a single unit.

7. A punching apparatus comprising:

- (a) a rigid reaction press;
- (b) a plurality of punching devices, each having a frame, said devices being supported only at its said frame and such support being provided by a single surface of said press, each of said devices including a fluid actuator operating head movable with respect to said frame and directed to be provided with a reactive force by an opposite surface of said press, each of said devices being removable from said press as separate single units; and
- (c) fluid pressure manifold means adapted to be selectively pressurized, and connected fluidly to the fluid actuator operating heads of said devices.

8. A punching apparatus comprising:

- (a) a rigid reaction press;
- (b) a rigid frame supported by a single surface of said press;
- (c) a die supported on a lower part of said frame;
- (d) a separate fluid cylinder slidably carried on said frame in spaced relation to said die and adapted to be connected to a pressurized fluid supply, said

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- cylinder being directed to be provided, in response to its operation, with a reactive force by an opposite surface of said press;
- (e) a reciprocable punch;
- (f) a piston in said cylinder connected to said punch; 5 and
- (g) means by which said cylinder, said piston, and said punch are jointly removable from said frame as a unit.
9. A unitized punching unit comprising: 10
- (a) a frame adapted to be rigidly supported; and
- (b) a separate fluid actuator operating head assembly, comprising a cylinder and a piston slidably mounted therein for relative punch-operating movement in a linear direction, said actuator assembly being slidably carried on said frame for free movement as a unit in said direction, and having an external end surface perpendicular to said direction, and directed to be provided with a reactive force in response to movement of said actuator assembly as a unit on said frame in said direction, and thereby enabling said actuating assembly to deliver its punch-operating thrust. 15
10. A unitized punching unit comprising:
- (a) a rigid frame adapted to support a pair of coactive tool means, one of which is reciprocably guided by said frame; 25
- (b) a separate fluid cylinder slidably carried on said frame for movement in the direction of tool reciprocation and adapted to be connected to a pressurized fluid supply, said cylinder having an external end surface remote from said frame and adapted to be engaged and reacted on during application of fluid pressure to limit said movement; and 30
- (c) a piston in said cylinder adapted to be connected to the reciprocable one of said tool means and to reciprocate the same. 35

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11. A unitized punching unit comprising:
- (a) a rigid frame;
- (b) a die supported on a lower part of said frame;
- (c) a separate fluid cylinder slidably carried on said frame in spaced relation to said die and adapted to be connected to a pressurized fluid supply, said cylinder being directed to be provided with a reactive force in response to its operation;
- (d) a reciprocable punch;
- (e) a piston in said cylinder connected to said punch; and
- (f) means by which said cylinder, said piston, and said punch are jointly removable from said frame as a unit.

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