

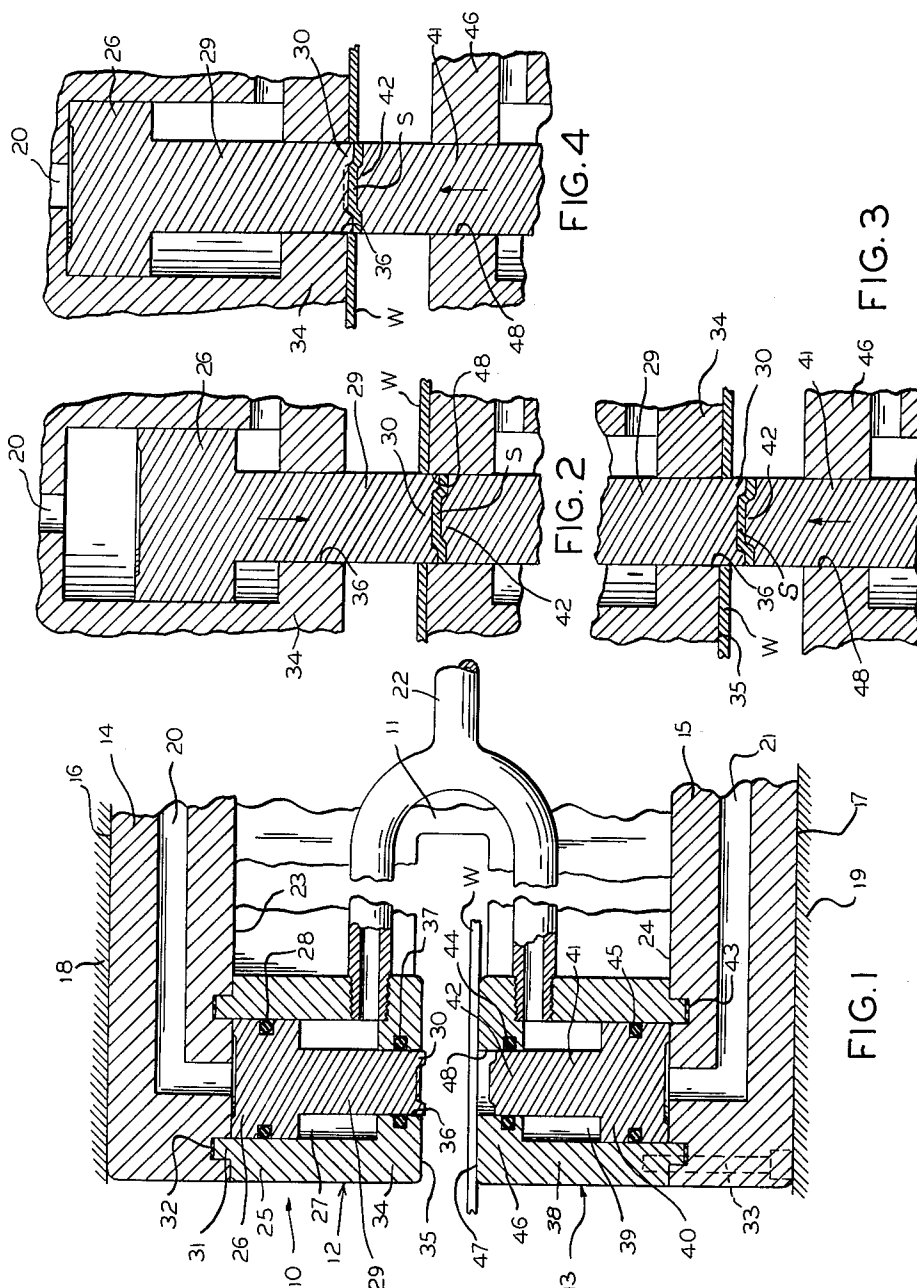
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D. DANIELS
MEANS FOR PUNCHING

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2 Sheets-Sheet 1



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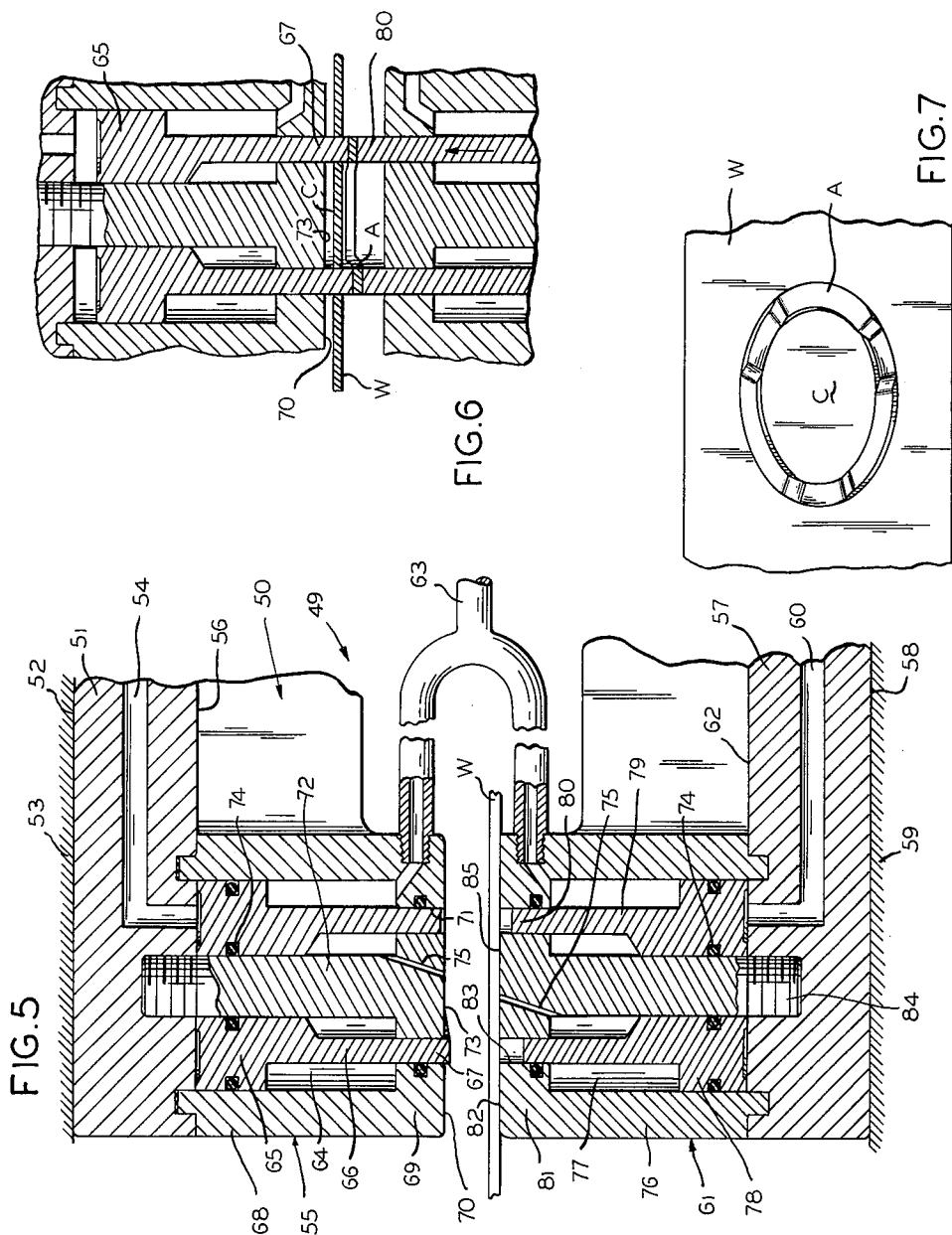
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MEANS FOR PUNCHING

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This invention relates generally to punching apparatus of the unitized or sub-press type, and more specifically to an improved means for making knock-out structures.

Although the principles of the present invention may be included in various devices of the unitized or sub-press type of punch, a particularly useful application is made in a punching apparatus which is adapted to construct knock-out structures in a sheet of material. In particular, when such devices have been previously provided, they have been characterized by their use of a relatively large number of components to make up the same.

The present invention contemplates the utilization of an extremely small number of parts, several of which may be fabricated from the same original part or blank part. The present invention further contemplates that the punching device be of the self powered type so that no external ram is needed to operate the same.

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 punching apparatus which employs a minimum number of parts.

Yet another object of the present invention is to provide a means for fabricating knock-out structures.

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 fragmentary cross-sectional view of a punching apparatus provided in accordance with the principles of the present invention;

FIGURES 2-4 are enlarged fragmentary views, partly diagrammatic, illustrating the sequence of operations of the elements of the structure of FIGURE 1;

FIGURE 5 is a cross-sectional view of a slightly modified form of the invention shown in FIGURE 1;

FIGURE 6 is a fragmentary view, partly diagrammatic, illustrating the operation of the device of FIGURE 5; and

FIGURE 7 is a perspective view of a knock-out structure provided in a fragmentarily illustrated sheet of material by the apparatus of FIGURE 5.

As shown on the drawings:

The principles of this invention are particularly useful when embodied in a punching unit such as illustrated in FIGURE 1, generally indicated by the numeral 10. The punching unit 10 includes a rigid frame 11 which supports an upper fluid actuator operating head 12 and a lower fluid actuator operating head 13.

The frame 11 is here illustrated as being of the unitary or C-frame type and includes an upper arm 14 and a lower arm 15. The arms 14 and 15 are respectively provided with an upper reaction surface 16 and a lower reaction

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surface 17 against which rigid reaction means schematically indicated at 18 and 19 may react. The arms 14 and 15 are respectively provided with fluid passages 20 and 21 each adapted to be connected to a source of pressurized fluid. At their other ends, the fluid passages 20 and 21 respectively communicate with the operating heads 12 and 13. A further line 22 is also adapted to be connected to a source of fluid pressure, and divides as illustrated, and communicates with both of the operating heads 12 and 13. The upper arm 14 has a side 23 which is opposite to the reaction surface 16, and against which the operating head 12 is disposed. Similarly, the lower arm 15 has a side 24 which is opposite to the reaction surface 17, and against which the operating head 13 is disposed.

The upper operating head 10 includes a cylinder 25 and a piston 26 disposed within a chamber 27 in the cylinder 25. The piston is provided with a seal such as an O-ring 28 which divides the chamber 27 into two separate sub-chambers, the upper one of which communicates with the passage 20, and the lower one of which communicates with the line 22. The operating head 10 further includes a piston rod 29, the same comprising in this embodiment an integral part of the piston 26, and a tool which in this embodiment comprises a punch 30 integral with the piston rod 29. At the opposite end of the cylinder 25, there is provided an annular portion 31 which is received within an annular groove in the side 23 of the upper arm 14, there being a sealing gasket 32 at the bottom of the groove. The cylinder 25 is secured to the upper arm 14 by a number of screws such as the screw 33 illustrated in the lower arm 15 extending into the lower operating head 13. The upper cylinder 25 further includes a rod-end 34 which has a lower surface 35 which comprises a stripping surface into which an aperture opens, the aperture being defined by guide means 36 which serve as a guide for the rod 29 and punch 30. As explained below, the guide means 36 also comprises a stationary die. The rod-end 34 of the cylinder 25 is also provided with an O-ring 37 which seals the lower part of the chamber 27 by acting between the rod-end 34 of the cylinder 25 and the piston rod 29.

The lower actuator head 13 similarly includes a cylinder 38 having a chamber 39 within which is disposed a piston 40. Connected to the piston 40, such as integrally, is a rod 41, and connected to the rod 41, such as integrally, is a tool 42 which here thus comprises a fluidly driven punch. The chamber 39 is sealed at its lower end by a gasket 43 and at its upper end by a gasket 44 which comprises an O-ring, the chamber 39 being divided into two sub-chambers by an O-ring 45 in the piston 40. Thus the upper part of the chamber 39 communicates with the line 22, and the lower part communicates with the passage 21. The cylinder 38 has a rod-end 46 having an outer upwardly directed surface 47 which normally supports a workpiece W as shown. The support surface 47 is intersected by an aperture defined by guide means 48 which guide the rod 41 and the tool or punch 42. The guide means 48 also comprise the main die of this embodiment.

While the tools or punches 30 and 42 are normally both movable, under certain circumstances, it may be desired to move only one of them, whereby one or the other may also comprise stationary tooling. The working ends of the tools 30 and 42 are complementally shaped throughout the area defined by their cutting edges so as

to be able to coact jointly with each other on a portion of the workpiece W. To this end, the instant tools 30 and 42 are provided with an undulated periphery wherein undulations of the tool 30 extend both below the surface 35 and up into the guide means 36 whereby a portion of the edge of the guide means 36 at such point serves as a die.

In order to operate the punching unit 10, fluid pressure is first applied to the line 22 to retract the pistons 26 and 40 to the positions illustrated in FIGURE 1 for insertion of the workpiece W. Thereafter, fluid pressure is admitted only to the passage 20 which moves the piston 26 downwardly as shown in FIGURE 2, thereby expelling fluid from the line 22. This movement continues until the punch 30 coacting with the die or guide means 48 punches a slug S out of the workpiece W as shown in FIGURE 2. It is to be noted that the slug breaks entirely free and out of the workpiece W before the slug engages the tool 42. Further movement of the punch 30 causes it to coact with the punch 42 to form the slug S into any desired shape. Since the tool 30 can enter the die or guide means 48, it is evident that there must be the usual tool clearances therebetween. The forming operation performed on the slug S is thus carried out at a location where the slug S is surrounded by tooling which is slightly larger than the punch which created it. It has been found that the forming operation and/or continued downward pressure on the slug S by the punch 30 causes a slight growth in the over-all size of the slug S without materially reducing its thickness.

When the operation diagrammatically illustrated in FIGURE 2 has been completed, pressure is released from the passage 20 and is applied to the passage 21 which effects an upward movement of the piston 40 and the tool 42, thereby raising the slug S, the workpiece W which is clinging to the outside of the punch 30, and the punch 30. Fluid expelled from the chamber 39 passes into the lower portion of the chamber 27, and the raising of the piston 26 expels fluid from the passage 20. The upward movement continues until the movement of the workpiece W is arrested. Continued movement in the upward direction driven by the piston 40 and the rod 41 causes the slug S to be reseated in the aperture in the workpiece W which constitutes its point of origin. The extent of such reseating is determined by the effective length of the combined piston 26, rod 29, and tool 30. In this embodiment, that length has been so selected that the central portion of the slug S has been returned to a position where it is coplanar with the workpiece W, whereby the various undulations in the slug S project from opposite sides of the sheet of material that constitutes the workpiece W. During the reseating operation, the punch 42 and the die 36 serves as an assembling punch and die. Thereafter, the fluid pressure at the passage 21 is released and pressure is applied to the line 22 to return the components to the position illustrated in FIGURE 1. If the workpiece W should tend to stick with a portion of the slug S projecting into the die 36, such tendency can be minimized or avoided by removing an extremely small amount of material from the die or guide means 36 immediately adjacent to the surface 35, the same being illustrated in FIGURE 4 in an exaggerated manner.

Where it is desired to construct a knock-out structure such as shown in FIGURE 7, the device of FIGURE 1 may be slightly modified for such purpose. Referring to FIGURE 7, there is disclosed a sheet of material which comprises a workpiece W having a central slug C coplanar with the workpiece W, and an annular slug A of undulated form disposed therebetween. The undulated annular slug A has portions or undulations which extend alternately above and below the surfaces of the sheet of material that comprises the workpiece W. It is evident that where the central slug and the annular slug comprise a unitary piece, the structure of FIGURE 1 may be utilized to construct

the same. However, where these slugs are defined by a complete line of severance therebetween, the punches, rods, and pistons of the FIGURE 1 form must be made hollow axially to provide internal guide and die means therein. Such a modification of the FIGURE 1 structure is illustrated in FIGURE 5.

The punching unit of FIGURE 5 is generally indicated at 49 and includes a frame 50 having a rigid upper arm 51 on which there is an upwardly directed reaction surface 52 for engaging outside rigid reaction means schematically indicated at 53. The upper arm 51 has a fluid passage 54 which communicates with a fluid actuator operating head 55 which is secured to a side 56 of the arm opposite to the reaction surface 52.

In like manner, the frame 50 further includes a rigid lower arm 57 having a downwardly directed reaction surface 58 engageable with external outside reaction means schematically indicated at 59. The arm 57 further includes a passage 60 which communicates with a lower fluid actuator operating head 61 secured to a side 62 of the arm 57 opposite to the reaction surface 58. The operating heads 55 and 61 also have means for connecting each of them to a common pressure line 63.

The upper operating head 55 includes a chamber 64 within which there is disposed an axially hollow piston 65 having an integral axially hollow rod 66 to which there is secured, such as integrally, a tool 67, which here comprises an annular fluidly reciprocally driven punch, the inner periphery or edge of which also serves as a die as explained below. The chamber 64 is defined primarily by a cylinder 68 which has a rod-end 69 terminating in an outer cylinder surface 70 which extends up to and adjacent to the tool 67, and in which there is provided a recess which defines an external guide member 71 to guide the rod 66 or punch 67, the fixed guide 71 also serving to define the outer edge portion of an annular die. The operating head 55 further includes a further fixed guide means 72 secured to the upper arm 51 and extending through the piston 65, rod 66, and tool or punch 67, and terminating at its lower end in a support face 73 coplanar with the surface 70 and serving therewith as a stripping surface. The guide means 72 is thus fixed and the outer periphery of the member 72 adjacent to the surface 73 serves as an internal guide member for the rod 66 and tool 67, and also defines the inner edge portion of an annular die along with the guide means 71, and still further also serves as a fixed punch as explained below. Suitable seals, such as O-rings and gaskets are provided for the operating heads 55 and 61 as explained for FIGURE 1, these further including a seal 74 of the O-ring type to prevent leakage along the stationary central guide member 72. The interior of the hollow piston rod 66 on the low pressure side of the O-ring 74 may be vented as at 75.

The lower operating head 61 similarly includes a cylinder 76 defining a chamber 77 within which is disposed an axially hollow piston 78 having an integral axially hollow rod 79 to which is secured a tool 80, the tool 80 here comprising a fluidly reciprocally driven annular punch which also serves as a movable die. Similarly, the cylinder 76 is provided with a rod-end 81 having a workpiece supporting surface 82 intersected by guide means 83 which externally guide the rod 79 or punch 80, which means 83 define the outer portion of an annular die, being generally similar to the guide means 71. The operating head 61 further includes an internal fixed guide member 84 secured to the lower arm 57 and terminating at its upper end in a support face 85, the outer periphery of which is defined by means which serve as an internal fixed guide for the punch 80, and rod 79, which serve as a fixed punch, and which further serve to define the inner edge portion of an annular die along with the means 83. The support face or backup surface 85 is coplanar with the outer adjacent surface 82 on the cylinder 76.

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The working ends or faces of the tools 67 and 80 are complementary to each other and are shaped to form opposite sides of the annular slug A of FIGURE 7.

The operation of this unit is the same as that described for FIGURE 1. Pressure is admitted to the line 63 which retracts the portions 65 and 78 to the position illustrated to enable the admission of a workpiece W supported on the surface 82. Thereafter, this pressure is released and a high working pressure is applied to the passage 54 thereby advancing the piston 65 so that the annular punch 67 passes through the workpiece W, and coacts with the annular die defined at 83 to create an annular slug A. Further advancement of the piston 65 causes the working ends of the tools 67 and 80 to bend or form the annular slug A to the desired configuration wherein it is slightly enlarged on its outside diameter and formed to a slightly reduced hole size at its inside diameter. During this operation, the guide member 84 served as a punch along with the inside diameter of the annular punch 67 which then served as a die to thereby create the slug C which is forced upwardly into the hollow punch or die 67.

Thereafter, pressure is relieved from the passage 54 and admitted to the passage 60 to effect raising of the pistons 78 and 65 jointly with the annular slug A trapped therebetween, with the workpiece W clinging to the outside of the punch 67, and with the central slug C clinging to the interior to the punch 67, all as illustrated in FIGURE 6. This upward movement continues until the workpiece W engages the stripping surface 70 and the central slug C engages the support face 73. Further upward movement of the annular punch 80 drives the annular slug A into the workpiece W and around the central slug C, pushing the punch 67 ahead of it as it goes. The extent of such movement is limited by the effective length of the punch 67 determined by bottoming of its piston 65. Thereafter, pressure is relieved from the passage 60 and applied to the line 63 to return the annular punches to the position illustrated in FIGURE 5 as described previously. In view of the undulations in the annular member or slug A, some portions thereof extend upwardly above the plane of the surfaces 70 and 73 whereby the fixed annular die defined therebetween coacts with the punch 80 to serve as an assembling punch and die.

It is thus evident that the central plug C and the annular slug A are first blanked by punching, and that thereafter the annular slug is formed such as with undulations, its outside diameter being increased and its inside diameter being decreased while the same is entirely detached from both the central slug C and the workpiece W. Further, it is evident that thereafter the annular slug A is resealed after having been formed, with its undulations extending out of the surfaces of the workpiece W to a partial extent, and that the slugs C and A are returned to their point of origin.

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 unit comprising:

- (a) a frame having a stationary upper arm and a stationary lower arm disposed in fixed spaced relation to each other;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each of said surfaces being disposed to be reacted on by a stationary outside means;
- (c) a cylinder fixedly secured to one of said arms and having a chamber therein adapted to be connected to a fluid pressure supply;

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- (d) a piston reciprocally disposed in said chamber;
- (e) a rod secured to said piston and extendible outwardly of said cylinder, the outer end of said rod comprising a tool fluidly driven by said piston;
- (f) a fixed position tool supported by the other of said arms; and
- (g) one of said tools comprising a punch, and the other of said tools comprising a die coactive with said punch to alter the configuration of a workpiece.

2. A punching unit comprising:

- (a) a rigid frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each of said surfaces being disposed to be reacted on by a stationary outside means;
- (c) a pair of cylinders respectively fixedly secured in a stationary position to said stationary arms, each of said cylinders having a chamber therein adapted to be individually connected to a fluid pressure supply, each of said cylinders having a rod-end with an aperture defined by rod-guiding means, each of said rod-guiding means comprising a die;
- (d) a pair of pistons respectively disposed in said chambers; and
- (e) a pair of rods respectively secured to said pistons and respectively guided by said rod-guiding means and extendible outwardly of the respective cylinders, the outer end of each of said rods comprising a punch coactive with each other on opposite sides of a workpiece to alter its configuration and also coactive with said rod-guiding means of the other punch to further alter the configuration of the workpiece.

3. A punching unit comprising:

- (a) a frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each disposed to be reacted on by a stationary outside means;
- (c) a cylinder fixedly secured in a stationary position to one of said arms and having a chamber therein adapted to be connected to a fluid pressure supply;
- (d) an axially hollow piston reciprocally disposed in said chamber and opening at one end into said chamber;
- (e) an axially hollow rod secured to said piston and extendible outwardly of said cylinder, the outer end of said rod including an annular tool fluidly driven by said piston;
- (f) a fixedly supported member secured to said one arm and disposed within said piston and rod and fluidly sealing the interior of said rod from said chamber; and
- (g) an annular tool supported by the other of said arms and coactive with said fluidly driven annular tool.

4. A punching unit comprising:

- (a) a frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each disposed to be reacted on by a stationary outside means;
- (c) a cylinder fixedly secured in a stationary position to one of said arms and having a chamber therein adapted to be connected to a fluid pressure supply;
- (d) an axially hollow piston reciprocally disposed in said chamber and opening at one end into said chamber;

- (e) an axially hollow rod secured to said piston and extendible outwardly from the outer adjacent surface of said cylinder, the outer end of said rod including an annular tool fluidly driven by said piston;
- (f) a fixedly supported member secured to said one arm and disposed within said piston and rod and fluidly sealing the interior of said rod from said chamber, and having a backup surface coplanar with said outer cylinder surface; and
- (g) an annular tool supported by the other of said arms and coactive with said fluidly driven annular tool.
5. A punching unit comprising:
- (a) a frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each disposed to be reacted on by a stationary outside means;
- (c) a pair of cylinders respectively fixedly secured in stationary positions to said arms, each of said cylinders having a chamber therein adapted to be individually connected to a fluid pressure supply, each of said cylinders having a rod-end with an aperture defined by rod-guiding means, each of said rod-guiding means comprising an outer portion of an annular die;
- (d) a pair of hollow pistons respectively disposed in said chambers and each opening at one end into such chamber;
- (e) a pair of axially hollow rods respectively secured to said pistons and respectively guided by said rod-guiding means and extendible outwardly of the respective cylinders, the outer end of each of said rods comprising a punch coactive with each other on a workpiece and also coactive at its outer periphery with said rod-guiding means of the other punch, the inner periphery of each annular punch comprising a movable die; and
- (f) a pair of fixed guide means for said annular punches and respectively secured to said arm and extending through said piston, rod and cylinder of each frame arm and respectively fluidly sealing the interior of said rods from said chambers, and each also comprising both an inner portion of the annular die for the movable punch and also a fixed punch for the movable die.
6. A fluid-operated punching unit comprising:
- (a) a frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed external surface comprising a rigid part of said upper arm and a downwardly directed external surface comprising a rigid part of said lower arm, each adapted to be engaged and to be reacted on by a stationary outside reaction means during application of fluid pressure to preclude deflection of said arms;
- (c) a fluid actuator operating head rigidly secured to one of said arms and disposed at a side opposite to said reaction surface thereof and adapted to reciprocally support and drive a first punching tool; and

- (d) the other of said arms being adapted to support a second punching tool, in a position to coact with said first punching tool, on a side opposite to said reaction surface thereof.
7. A fluid-operated punching unit comprising:
- (a) a frame having a stationary upper arm and a stationary lower arm;
- (b) an upwardly directed external surface comprising a rigid part of said upper arm and a downwardly directed external surface comprising a rigid part of said lower arm, each of said surfaces being adapted to be engaged and to be reacted on by a stationary outside reaction means during application of fluid pressure to preclude deflection of said arms; and
- (c) a pair of fluid actuator operating heads respectively rigidly secured to said arms and disposed at sides opposite to said reaction surfaces thereof, and each of said heads reciprocally drivingly supporting a punching tool coactive on a workpiece with the punching tool of the other operating head to alter the configuration of the workpiece in response to one stroke of said fluid actuators.
8. A punching unit comprising:
- (a) a frame having a stationary upper arm and a stationary lower arm disposed in fixed spaced relation to each other;
- (b) an upwardly directed surface comprising a rigid part of said upper arm and a downwardly directed surface comprising a rigid part of said lower arm, each of said surfaces being disposed to be reacted on by a stationary outside means;
- (c) a punch tool and a die tool coactive with each other to alter the configuration of a workpiece;
- (d) means for fluidly driving and for movably supporting at least one of said tools on one of said stationary arms; and
- (e) means operative to support the other of said tools on the other of said stationary arms in a predetermined position for coaction with said one of said tools.

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