

April 27, 1943.

L. E. WALTON

2,317,869

COMBINATION HYDRAULIC AND RUBBER DIE

Filed April 15, 1941

2 Sheets-Sheet 1

Fig. 1.

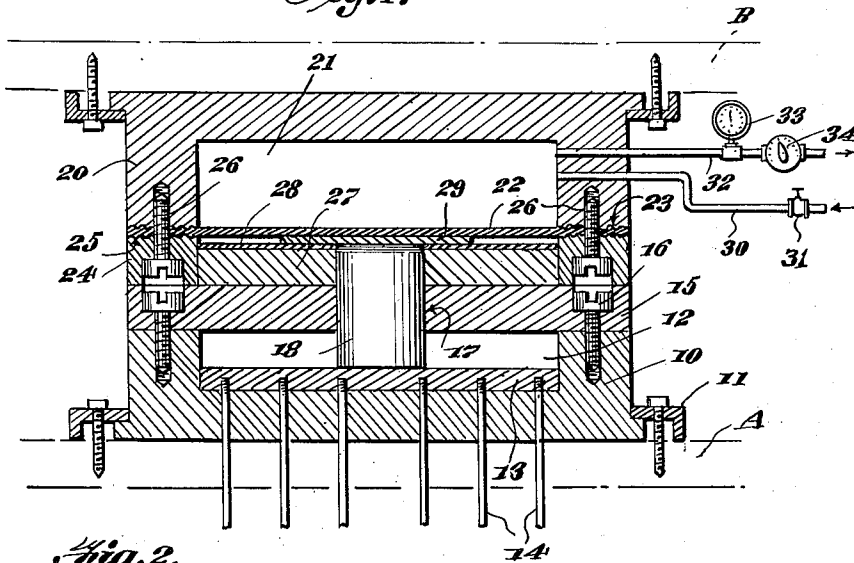


Fig. 2.

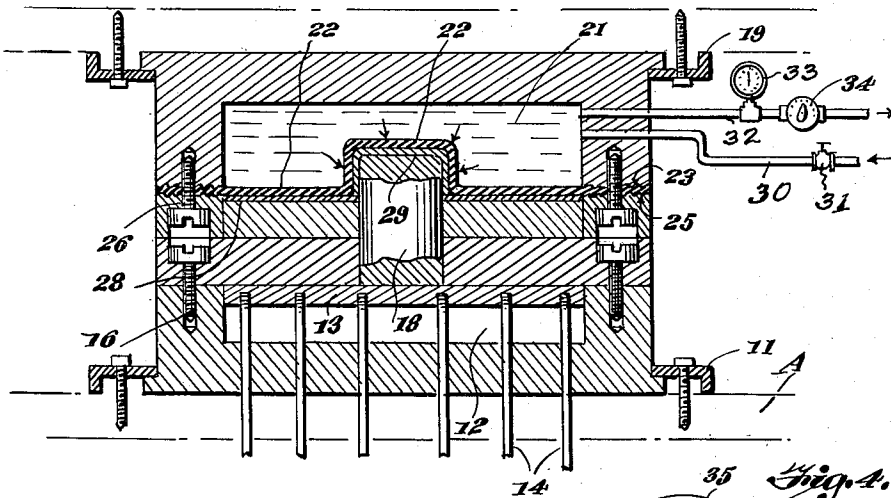
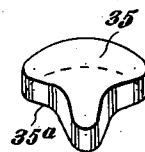


Fig. 4.



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2 Sheets-Sheet 2

Fig. 3.

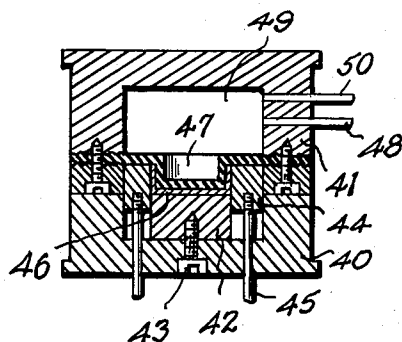
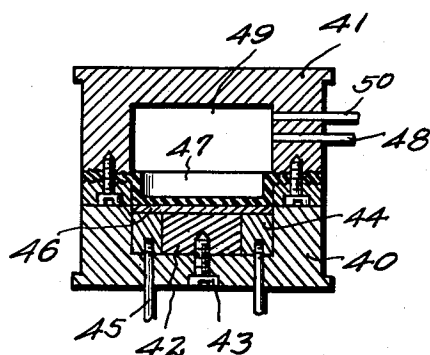


Fig. 5.



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UNITED STATES PATENT OFFICE

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COMBINATION HYDRAULIC AND RUBBER DIE

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5 Claims. (Cl. 113-44)

This invention relates to an apparatus for shaping sheet metal and other material in the nature of a combination hydraulic and rubber die, and has for one of its objects the production of a simple and efficient means for facilitating the shaping of material through the medium of uniform hydraulic pressure acting upon a flexible diaphragm in conjunction with a forming die of a desired shape.

A further object of this invention is the production of a simple and efficient hydraulic die or shaping device having one rigid shape-forming member which is movable into an hydraulic chamber where the hydraulic pressure in the chamber is utilized as a companion shaping means co-acting with the rigid shape-forming member to press or form an object into a desired shape from a flat sheet of material.

Other objects and advantages of the present invention will appear throughout the following specification and claims.

In the drawings:

Figure 1 is a vertical sectional view of the hydraulic die, the parts being shown in position before commencing operation;

Figure 2 is a vertical sectional view of the hydraulic die, the parts being shown in a forming position;

Figure 3 is a vertical sectional view of a modified form of die;

Figure 4 is a perspective view of one typical form pressed or stamped by means of my new apparatus;

Figure 5 is a vertical sectional view of the structure shown in Figure 3 showing the parts in a position prior to shaping the work sheet.

By referring to the drawings, it will be seen that A designates a suitable support, upon which support A is mounted the punch-carrying section 10 of the die, this section being secured to the support A by a suitable clamping means 11 of any desired type. The punch-carrying section 10 is provided with a socket 12 formed in the upper face within which the lift pad or lift member 13 is mounted, the lift pad or member 13 being engaged by the lifting pins 14. The pins 14 may be secured to the pad 13 by being threaded therein or secured in any suitable or desired manner. The lift pad or member 13 is of sufficient size to occupy only a portion of the space within the socket 12 so as to allow the pad to move upwardly a desired distance to press or punch the metal or other object from the flat sheet of material hereinafter described. The punch-carrying section 10 supports a punch-guiding plate 15, which

plate 15 is secured to the punch-carrying section 10 by means of suitable anchoring screws 16 which are preferably countersunk in the upper face of the guiding plate 15. The guiding plate 15 is provided with a suitable aperture 17 to snugly receive the punch 18 of a suitable shape. The simplest type of punch 18 is illustrated in Figures 1 and 2, but it should be understood that any desired shape of punch may be used without departing from the spirit of the invention, in which event the aperture 17 is shaped to conform to the shape of the punch 18.

A co-acting section 20 is mounted above the section 10 as shown, and is anchored in any suitable or desired manner to a suitable support B by means of a suitable clamp 19 of a desired type. The co-acting section 20 is provided with a compartment 21 adapted to receive liquid, air or suitable hydraulic pressure. A rubber or other flexible diaphragm 22 extends across the lower edge of the co-acting section 20 and the edge of this diaphragm 22 engages the serrated lower edges 23 of the section 20 near the side edges of the section 20. A diaphragm-retaining portion 24 also having a serrated surface 25 for engaging the edges of the diaphragm 22 is adapted to firmly clamp the diaphragm 22 in firm engagement with the section 20, suitable anchoring screws 26 being employed to hold the diaphragm-retaining portion 24 in clamping engagement with the edge of the diaphragm 22.

A spacer member 27 is carried below the diaphragm 22 and rests upon the guiding plate 15 and is held against lateral movement by the diaphragm-retaining portion 24. This spacer member 27 may be formed of wood, such as maple, plastic material, or other suitable material which may be found of advantage. A work-supporting sheet 28 fits upon the top face of the spacer member 27, and is preferably formed of smooth sheet iron or other metal to withstand surface friction. The spacer member 27, or the nest as it may be called, supports the sheet 28. This sheet 28 normally extends flush with the outer end of the punch 18, thereby providing a rigid support for the entire area of the flat blank sheet 29 against which the great pressure of the flexible diaphragm or shape-forming member 22 is exerted before and while the flat blank sheet 29 is being shaped.

A sheet 29, which is the sheet to be formed or shaped rests upon the work-supporting sheet 28, as shown in Figure 1. An inlet line 30 having a suitable control valve 31 forms a communication between a source of hydraulic supply and

the compartment 21 so that a suitable support of hydraulic pressure may be admitted into the compartment 21. A pressure gauge-supporting pipe 32 also communicates with the compartment 21 and carries a gage 33 and a pressure regulator 34 of suitable type. The gauge 33 is adapted to indicate the pressure within the compartment 21 and the pressure regulator 34 is adapted to be set to permit pressure to be automatically relieved from the compartment 21 when the pressure within the compartment 21 exceeds a selected degree.

The operation of the device is as follows:

The sheet 29 which is to be formed into a desired shape, such for instance as indicated at 35 in Figure 4 as a typical example, is placed in a flat position upon the work-supporting sheet 28 and in contact with the upper end of the punch 18. The co-acting section 20 is then brought into position over the section 10, as shown in Figure 1 and the pipes 30 and 32 are suitably connected to permit of such movement. When the parts are in the position shown in Figure 1 the rubber or flexible diaphragm 22 will lie snugly over the sheet 29 which is metal or of any suitable material which is adaptable for such work, and the desired hydraulic pressure is admitted into the compartment 21 and this pressure is maintained and increased as desired throughout the operation by means of the automatically actuated pressure regulator 34, which pressure regulator is of a conventional type or may be of a special design.

Suitable mechanism of a conventional type, such as is now employed is utilized for raising the lift pad or member 13 by lifting and contacting the pins 14 and this lift pad or member 13 is raised to the position shown in Figure 2 against the hydraulic pressure within the compartment 21, the hydraulic pressure being uniform at every point within the compartment 21 and not concentrated at any particular point upon the surface of the sheet 29, and as the punch 18 moves into the compartment 21 for the purpose of shaping the sheet 29, the hydraulic pressure within the compartment 21 will be automatically relieved through the pressure regulator 34 so as to prevent the hydraulic pressure from being increased too much as the punch 18 is moved into the compartment 21. In other words the plunger 18, as it enters the compartment 21 will cause the hydraulic pressure when it has reached the proper point within the compartment 21 to be automatically released through the pressure regulator 34 in this way maintaining controlled hydraulic pressure during the entire operation and thereby permitting the metal or material of the sheet 29 to shrink or expand and properly form around and follow the contour of the punch 18 to provide a proper and desired shape, the flexible nature of the rubber diaphragm 22 conforming at all times to the forming shape of the punch 18 and permitting the shrinkage and expansion of the material in the sheet 29 without fear of wrinkling, cracking or splitting the forming parts of the material of the sheet 29 while the sheet 29 is being shaped.

One of the important features of the present invention is the fact that the punch starts in a position flush with the sheet 28 and then passes into the compartment 21 which contains hydraulic pressure and that this pressure is automatically controlled to a predetermined degree through the medium of automatic relief of the pressure in a proper ratio to the movement of the

punch into the hydraulic containing compartment 21. Furthermore, it should be noted that there is only one rigid forming member in the nature of the punch 18 and that the co-acting member 20 is provided with a hydraulic containing compartment into which the punch 18 and the sheet 29 to be formed move. The sheet 29 which is to be formed contacts the under face of the rubber or flexible diaphragm 22 which diaphragm 22 will yield under pressure of the punch 18 and the hydraulic pressure within the compartment 21 will uniformly press the sheet 29 around and in contact with the punch 18 until the desired shape is acquired. Due to the fact that uniform pressure is exerted upon every point of the sheet 29 before and also while the punch 18 moves into the compartment 21, it has been possible to shape a form such as form 35 indicated in Figure 4 and provide a right-angle flange 35^a without splitting the flange as now very often occurs in forming such articles and at the same time the blank sheet may expand and shrink to form the curves and inverted curves, the uniform pressure allowing the metal to flow in its shrinking or expanding without excessive pressure being applied to one point and thereby checking the flow. The yieldable diaphragm in conjunction with the hydraulic pressure and the automatic release of the pressure as described above are important elements which make this operation above described possible.

It will be understood that the punch 18 which constitutes one rigid member is provided with a curved side to form a part such as is illustrated in Figure 4. A second rigid member in the nature of the spaced member 27 with its work-supporting sheet 28 surrounds the curved side or sides of the first mentioned rigid member or punch 18. The outer end of the punch 18 normally extends flush with the sheet 28 of the second rigid member. The flexible diaphragm or shape-forming member 22 overlies the rigid members. The lift pad or member 13 maintains the punch or first mentioned rigid member flush with the second rigid member. The flexible shape-forming member 22 provides means for applying initial pressure uniformly over the entire area of the flat blank 29, which blank 29 overlies both rigid members and extends between the flexible-shape-forming member and the rigid members while the outer faces of the rigid members are in a flush position. The lifting pins 14, through the medium of the member 13 move the rigid member or punch 18 axially relative to the other rigid member to shape the blank to the contour of the curved side of the punch 18 while pressure is transmitted through the flexible shape-forming member 22 against the blank 29 during the shaping thereof.

By means of the present invention flanges may be formed upon the product, and these flanges will be made smooth and straight without wrinkles and without breaking.

In Figure 3, there is shown a modified form of the invention wherein 40 designates the punch-carrying section and 41 designates the hydraulic co-acting section. In the form shown in Figure 3 a stationary punch 42 is anchored in position by a retaining screw 43 in the bottom of the section 40. A draw ring 44 is slidably mounted vertically within the section 40 and around the stationary punch 42, and is actuated by suitable lift pins 45 similar to the pins 14. The metal sheet to be formed is indicated by the numeral 46 and rests upon the punch 42 and

ring 44, and a rubber pressure-controlled diaphragm 47 is carried by the lower face of the contacting section 41 in a manner similar to the diaphragm 22. An inlet line 48 communicates with the hydraulic compartment 49 of the section 41 similar to the pipe 30, and an exhaust pipe 50 also communicates with the compartment 49 similar to the pipe 32. This pipe 50 carries a pressure gauge 51 and an automatic pressure regulator and release 52 similar to that described in Figures 1 and 2. Figure 3 shows a slightly modified form of the device for shaping sheet metal, the shaping in this instance being performed by the movement of the draw ring 44 inwardly into the compartment 49 against the pressure-controlled diaphragm 47.

It should be understood that the form shown in Figure 3 merely illustrates the operation of a die which employs a draw ring 44, the ring 44 being carried by the section 40 and being movable into the compartment 49 against the pressure-controlled or pressure-actuated diaphragm 47. The action is identical with the structure shown in Figures 1 and 2, the ring 44 moving into the compartment 49 in place of the shape-forming member 18 moving into the compartment 21.

It should be understood that I have provided a combination hydraulic and rubber die for shaping sheet metal and the like, which is flexible to the extent that the device may be used to form various shapes, open or closed, having angle sides or contours along the sides, and may also be used to emboss or press material into any shape to conform to the contour of the punch. It has been found possible to utilize zinc, hardwood, or plastic in forming the punches due to the fact that the hydraulic pressure is distributed so as to distribute the load evenly and any projections due to the peculiar nature of design or pattern are not overburdened with pressure at any particular point. It should be borne in mind that when metal or other material is being formed or pressed, the pressure is evenly divided over the entire area of contact, and the pressure follows the points of yield, and because of this fact the metal or fabric or other material will be properly pressed into the cavities or around the projections to a desired shape.

The use of expensive or mammoth machinery is not required, and this type of tool illustrated may be operated by a hydraulic press of conventional design or any means of reciprocating action machinery or hand device. It has been found that only a punch is needed if material is to be formed to the outside of the punch, and only a die is needed if the material is to be expanded into the inner side of the form of the pattern. It should be understood that under no circumstances is the material squeezed while forming, nor is the material unnecessarily stretched, but the material yields at points where it is vitally important that the material be kept to its normal thickness and this is not true in the conventional type of die now generally used. Furthermore, by means of the type of structure employed, no friction marks are present after the form has been pressed, such as are quite apparent where steel punches and dies are used. The material which is being formed yields only as the hydraulic pressure forces the material to conform to the contour of the punch.

It should be further understood that any number of punches may be used in relation to the size of the mechanism because the present combination die may be made of any size that may occupy

the entire area of the press in which it is to be used. For instance, if the table of the press is 4 x 6 feet, this die may be made of the same size being 4 x 6 feet outside dimensions, and the inside dimensions would be smaller only due to the thickness of the walls. The rubber diaphragm plus the liquid, air or other hydraulic pressure act around the entire area of the die, a maximum space within the tool may be used by providing a plurality of forms or punches to work within the space since the hydraulic pressure will act uniformly around the entire area and around each punch and in the space surrounding the punch.

It has been found that by using the present device, it is possible to save metal because the diaphragm plus the hydraulic pressure automatically take the place of a pressure pad and no extra material is needed for a draw operation because the ratio of pressure and resistance upon the flanges of the blanks of the material being formed remains practically constant in relation to the area which is being formed and the pressure may be withdrawn to provide the right pressure as the punch moves into the hydraulic compartment.

Where a metal or steel conventional draw die is used, the pressure of the pressure pad increases and multiplies rapidly due to the fact that as the ram of the press descends the ratio of compression increases in the spring action, and as the metal narrows from under the pressure pad the area of contact lessens. Because of this fact the ratio of grip is growing during the operation and inasmuch as the metal is practically reaching its peak of elasticity, pressure is increasing instead of decreasing, causing the material which is being formed to suffer terrific strain and the result is fractured or separated grains of material. By means of the present device, these dangers may be eliminated. My present combination die positively eliminates the punishments of the material above mentioned and permits the material to be formed along or across the grain because shrinkage takes place simultaneously with the stretching, and at no time is the metal confined or held or guided. It is permitted to yield and shift from side to side to suit the elements of form due to the flexibility of the diaphragm and the uniform hydraulic pressure which is automatically controlled at a predetermined degree as the punch moves into the hydraulic compartment.

It is desired to emphasize the fact that one of the essential features of this invention is that initial pressure is exerted upon the diaphragm, such as the diaphragm 22 or the diaphragm 47, to hold down the blank to be formed and prevent wrinkles in the blank when, immediately after the initial charge, the punch ascends into the compression chamber. It should be noted that the pressure in the compression chamber increases as the punch or shape-forming member ascends or moves into the compression chamber, this being necessary to properly form the part desired. When pressure reaches a predetermined point, the automatic relief valve relieves the pressure. The amount of pressure used will depend upon the metal used and the contours formed.

It should be understood that by means of the structure illustrated, the blank is held down firmly upon the support so as to prevent wrinkles from forming in the work sheet, the work sheet being initially held firmly upon the support and the shape-forming member then being moved

against the pressure. Furthermore, as the shape-forming member moves into the pressure compartment the pressure naturally increases within the compartment and at the same time the pressure equalizes at all points on the entire area of the blank regardless of whether a male or female shape-forming part is moved into the compartment for shaping the blank. It should be noted that there is provided a traveling shape-forming member in the nature of a punch which is a very essential and unique element in this invention. Its action in conjunction with the hydraulic pressure behind the diaphragm provides the means for increasing and at the same time equalizing the pressure, the pressure then being relieved when it reaches a predetermined degree. Furthermore, it is desired to point out that by means of the present device, my invention eliminates the necessity of heat treatment since the desired shapes may be formed "S. T." (tempered) directly, whereas existing methods form in "S. O." (soft), which requires heat treatment. The present invention saves metal and eliminates trimming operation since it employs no pressure pads which use surplus metal. The blanks may be made of proper developed size and the parts formed to the full development. Furthermore, the present device eliminates the costly steel dies since only a punch or shape-forming member need be built which costs very little due to the rubber diaphragm which is acted upon by pressure to co-operate with the shape-forming member to shape the sheet.

Having described the invention, what I claim as new is:

1. A die of the class described comprising a shape-forming section, a co-acting section having a hydraulic pressure-containing compartment, a rigid movable shape-forming member carried by said first mentioned section and movable into said hydraulic pressure-containing compartment, and a yieldable diaphragm closing said compartment and adapted to be acted upon by hydraulic pressure in said compartment, a diaphragm-retaining member carried by the co-acting section, and said shape-forming member being adapted to engage a sheet to be shaped for moving said sheet into said compartment and against said diaphragm and hydraulic pressure in a manner whereby the hydraulic pressure upon said diaphragm will engage the entire area of said sheet and force said sheet evenly into shape-forming contact with said shape-forming member to conform to the contour of said shape-forming member, a spacer interposed between said diaphragm and said first mentioned section, and a metal surface friction-resisting plate engaging the spacer and adapted to support a sheet to be shaped between the spacer and the diaphragm, the spacer and plate being adapted to fit within the diaphragm retaining member when the sections of the die are brought together.

2. A die of the class described comprising a rigid member having a curved side, a second rigid member surrounding the curved side of said first mentioned rigid member, a flexible shape-forming member overlying the rigid members, means for maintaining the outer faces of said rigid members flush, means for applying initial pressure uniformly over the entire area of a flat blank

overlying both rigid members and between the flexible shape-forming member and the rigid members while the outer faces of the rigid members are in the flush position, and means for moving one of the rigid members axially relative to the other rigid member to shape the flat blank to the contour of the curved side of the first mentioned rigid member while transmitting pressure through the flexible shape-forming member against the blank during the shaping thereof.

3. A die of the class described comprising a rigid member having a curved side, a second rigid member surrounding the curved side of said first mentioned rigid member, a flexible shape-forming member overlying the rigid members, means for maintaining the outer faces of said rigid members flush, means for applying initial pressure uniformly over the entire area of a flat blank overlying both rigid members and between the flexible shape-forming member and the rigid members while the outer faces of the rigid members are in the flush position, means for moving one of the rigid members axially relative to the other rigid member to shape the flat blank to the contour of the curved side of the first mentioned rigid member while transmitting pressure through the flexible shape-forming member against the blank during the shaping thereof, and means for relieving pressure of the flexible shape-forming member in ratio to the relative movement of one of the rigid members and the flexible shape-forming member.

4. A die of the class described comprising a rigid punch having a curved side, a rigid nest member surrounding the curved side of said punch, a flexible shape-forming member overlying the rigid punch and said rigid nest member, means for maintaining the outer faces of said rigid punch and rigid nest member flush, means for applying initial pressure uniformly over the entire area of a flat blank overlying both the punch and nest member and between the flexible shape-forming member and the punch and nest member while the outer faces of the punch and nest member are in a flush position, and means for moving the punch axially of the nest member to shape the flat blank to the contour of the curved side of the punch while transmitting pressure through the flexible shape-forming member against the blank during the shaping thereof.

5. A die of the class described comprising a rigid member having a curved side, a second rigid member having a curved inner side surrounding the curved side of said first mentioned rigid member, a flexible shape-forming member overlying the rigid members, means for maintaining the outer faces of said rigid members flush, means for applying initial pressure uniformly over the entire area of a flat blank overlying both rigid members and between the flexible shape-forming member and the rigid members while the outer faces of the rigid members are in the flush position, and means for moving the second rigid member axially of the first mentioned rigid member and against the flexible shape-forming member to shape the flat blank to the contour of the curved side of the second mentioned rigid member while transmitting pressure through the flexible shape-forming member against the blank during the shaping thereof.

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