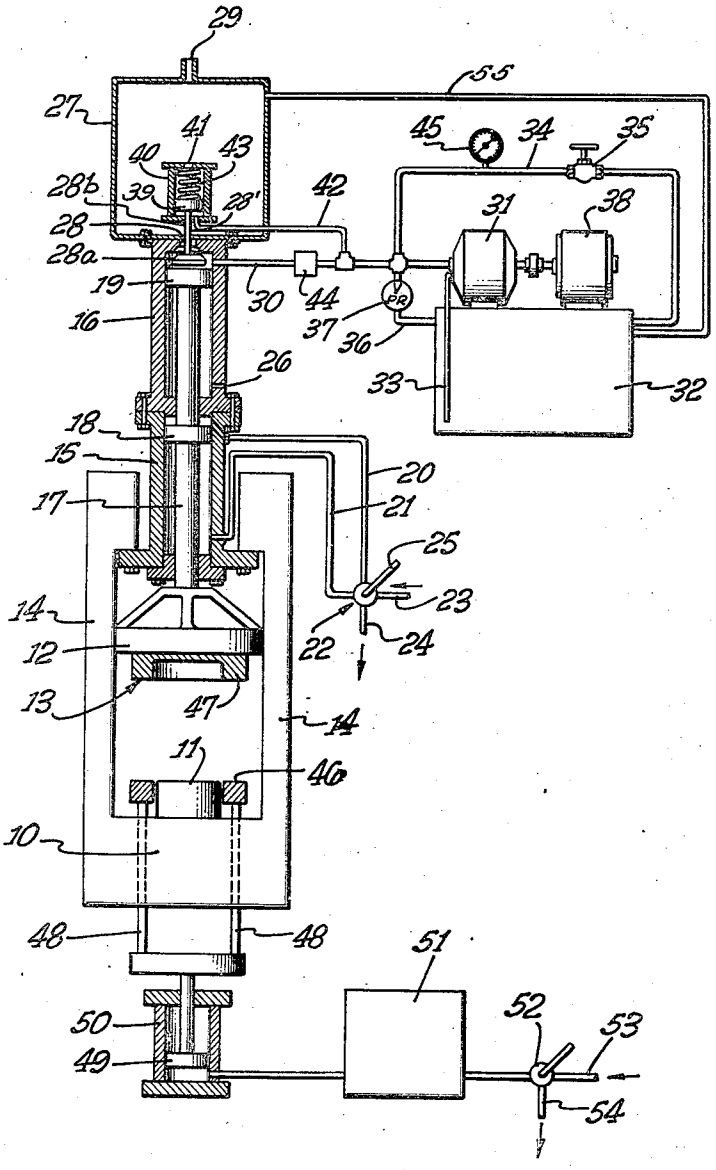
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APPARATUS FOR DIE-FORMING SHEET MATERIAL

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APPARATUS FOR DIE-FORMING SHEET MATERIAL

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This invention relates to the die-forming of sheet metal and similar materials and has as a general object to facilitate and reduce the time required for such operations.

Another object is to provide apparatus selectively controllable to function either as a hammer to strike a workpiece with forming dies, or as a press to slowly force the dies against the workpiece.

At present, both hammers and presses are employed in the die forming of sheet metal, the choice depending upon the nature of the metal, its thickness, and the nature and extent of the deformation to be produced. With some materials, stainless steel for example, hammers have been used to a great extent, because of the speed of operation and the fact that the impact of a blow is most effective in conforming the metal exactly to the shape of the dies. However, it is often necessary when die-forming sheet metal in a hammer to gradually shape the material with successive blows while inserting cushioning pads of rubber or other soft material between the dies and the work during the initial blows until the sheet is pre-formed into a condition where it is ready for the final heavy blow or blows that conform it exactly to the dies. The insertion and removal of the pads requires considerable time and reduces the rate of production.

In accordance with the present invention, I eliminate the need of pads by combining both press and hammer action in a single machine, initially pressing the dies against the sheet to pre-form it and then striking the sheet with the dies to finish it. Various types of mechanisms may be employed to obtain both press and hammer action in the same machine, one of which comprises hydraulic actuation for pressing, and pneumatic actuation for hammering. The hydraulic cylinder is vented through a relatively large valved opening into an adjacent supply reservoir, when the machine is being pneumatically actuated as a hammer, to reduce the resistance of the hydraulic fluid to rapid reciprocation of the movable bed or platen of the machine. Hydraulic actuation is eminently well suited for a pressing operation because it makes it easy to move the platen slowly but with great force. On the other hand, pneumatic operation is better suited for hammer operation because of the free flowing and elastic properties of air.

A full understanding of the invention may be had from the following detailed description of a specific embodiment of the invention as illustrated in the single figure of the drawing.

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There is shown in the drawing a schematic diagram of a hammer-press having a bed 10 adapted to support a stationary die 11, and a movable platen 12 having secured thereto a movable die 13. The platen may be guided for vertical reciprocation by guides 14 rising from the bed 10 and the upper ends of these guides 14 may support a pneumatic or air cylinder 15, which in turn supports a hydraulic cylinder 16, positioned immediately thereabove. A piston rod 17 connects at its lower end to the platen 12, and extends upwardly therefrom through the air cylinder 15 and into the hydraulic cylinder 16. A piston 18 is fixed to the rod within the air cylinder, and a piston 19 is fixed to the upper end of the rod within the hydraulic cylinder, so that the two pistons, the piston rod and the movable platen and die reciprocate in unison in response to the application of pressure fluid to either cylinder, the pressure fluid applied to the lower cylinder 15 being air and that applied to the upper cylinder 16 being hydraulic fluid, which will hereinafter be referred to as liquid.

Pressure air can be admitted to or exhausted from the upper end of the air cylinder 15 through a pipe 20, and to and from the lower end of the cylinder through a pipe 21. Pipes 20 and 21 extend to a four-way control valve 22 of conventional design which serves to supply pressure air from a supply line 23 to either of pipes 20 and 21 and at the same time exhaust air from the other pipe to an exhaust line 24, in response to movement of a valve handle 25. It is possible by proper manipulation of the handle 25 to reciprocate the platen 12 with great rapidity, to strike the upper die against a work sheet with the resultant large force of impact due to the momentum of the platen and die.

The piston 19 reciprocates in the cylinder 16 when the device is being used as an air hammer in the manner described, but it does not introduce serious resistance because the lower end of the cylinder 16 is permanently vented to the atmosphere through a vent 26, and the upper end is vented to a liquid supply tank 27 through a large aperture 28, the tank 27 being positioned immediately above the hydraulic cylinder 16 so as to reduce the resistance to flow of the liquid into and out of the cylinder. The upper end of the tank 27 may be vented to atmosphere through a vent 29 to prevent the pressure of the liquid in the tank rising above atmospheric.

When the machine is to be actuated as a hydraulic press, the vent 28 is closed by a valve 28a, and pressure liquid is admitted into the upper end

of the hydraulic cylinder through a pipe 30 from a pump 31 driven by an electric motor 38, which may run continuously during the operation of the machine. The pump draws liquid from a reservoir 32 through a suction pipe 33, and normally the liquid discharged from the pump is by-passed back to the reservoir through a pipe 34 containing a control valve 35. A second by-pass line or pipe 36 containing a relief valve 37 prevents the pressure in the pump discharge pipe from rising above a safe value.

The valve 28a is automatically closed when pressure liquid is supplied to the upper end of the hydraulic cylinder. Thus the valve is connected to the lower end of a piston rod 28', the upper end of which rod is connected to a piston 39 in a cylinder 40 positioned in the tank 27. The upper end of the cylinder 40 is vented to the tank 27 through a vent 41, and the lower end of the cylinder is connected by a pipe 42 to the pipe 30. A spring 43 is compressed between the upper end of the cylinder 40 and the piston 39 to normally maintain the valve 28a in lower, open position. To insure that sufficient pressure will be developed in the pipe 42 to close the valve 28a when liquid is supplied to the upper end of the hydraulic cylinder through the pipe 30, a restriction device 44 which may be a relief valve is inserted in the pipe 30 on the cylinder side of its juncture with pipe 42. The device 44 is preferably set to open at a pressure only slightly higher than that required to close valve 28a against the force of spring 43, so as not to introduce an unnecessary pressure drop between the pump and the hydraulic cylinder.

Any desired pressure up to the capacity of the pump 31 may be applied to the pipe 30 by manipulating the valve 35 to limit the by-pass of liquid therethrough, the pressure being indicated by a pressure gauge 45. During operation of the machine as a hydraulic pressure, the valve 22 is moved into a neutral position in which the two pipes 20 and 21 are either connected directly to each other or to the discharge pipe 24, so that the air cylinder does not resist the movement of the platen 12.

Although it is not always essential to the use of the invention, a clamping member 46 may be provided surrounding the stationary die 11 for clamping the edges of a worksheet against the shoulder 47 of the upper die and causing the worksheet to be stretched rather than merely bent as it is deformed to the shape of the dies. The clamping member is supported on posts 48 extending down through guide apertures provided therefor in the bed 10, and connected at their lower ends to a piston 49 in an air cylinder 50. The cylinder 50 is vented to atmosphere at its upper end but is connected at its lower end to a pressure chamber 51 in which a suitable air pressure may be maintained by means of a valve 52 associated with a pressure-supply line 53 and exhaust line 54. In operation, the clamping member 46 moves down with the die 47 after being contacted by the die, while maintaining a gripping force against the margin of the worksheet.

In the practice of the invention, after placing the work sheet on the lower die 11 and adjusting the handle 25 of the air valve 22 into neutral position, the valve 35 is partially closed to throttle the flow of liquid through the by-pass pipe 34 sufficiently to build up a desired pressure in the pipe 30. This pressure first produces a flow of

liquid through the pipe 42 into the cylinder 43 to close the valve 28a, after which the liquid flows into the upper end of the cylinder 16 to force the piston 19 and the platen downward to press a worksheet between the dies to partially shape it. Thereafter, the valve 35 is opened, which releases the pressure in the hydraulic cylinder and in the cylinder 43, permitting the valve 28a to open. By then manipulating the air control valve handle 25, the platen can be oscillated rapidly up and down to strike the worksheet between the dies with the hammer strokes necessary to accurately finish it.

All liquid admitted into the hydraulic cylinder through the pipe 30 is subsequently discharged into the tank 27, so an overflow pipe 55 is provided from tank 27 back to the main reservoir 32.

It is feasible in a medium size machine of the type described to develop a pressing force of 100 tons or more with a hydraulic cylinder 16 of reasonable size and with a pump 31 of relatively small size, since it is not at all necessary that the pump have a large volumetric capacity. In contrast, it is impractical to develop much more than 5 tons force with air alone. It is to be noted that, if desired, time can be saved in the initial pressing operation by first lowering the upper die into contact with the worksheet with air, and thereafter applying the pressure liquid to the hydraulic cylinder.

Although for the purpose of explaining the invention a particular apparatus that may be used, and its operation have been described in detail, it will be obvious to those skilled in the art that many departures from the exact construction shown may be made without departing from the invention, which is to be limited only to the extent set forth in the appended claims.

I claim:

1. Apparatus of the type described comprising: a bed member for supporting a first die; a platen for supporting a second complementary die; pressure liquid actuating means for moving said platen toward said bed through a stroke sufficient to fully form a workpiece between said dies, said means including a pump of high pressure but low volume characteristics; and compressed air actuating means for reciprocating said platen with relatively small force and relatively great speed toward and away from said bed through a stroke sufficient to fully form a workpiece between said dies; said pressure liquid actuating means including a piston and cylinder, and means for venting said cylinder during actuation of said platen by said compressed air means.

2. Apparatus of the type described comprising: a bed member for supporting a first die; a platen for supporting a second complementary die; an air cylinder above said platen; a hydraulic cylinder above said air cylinder and in alignment therewith; a pair of pistons in said respective cylinders; a single piston rod connected to both said pistons and to said platen; means for selectively supplying pressure air to either end of said air cylinder and exhausting air from the other end; means for supplying liquid to the upper end of said hydraulic cylinder; means for normally venting the upper end of said hydraulic cylinder during operation of said air cylinder; and means responsive to supply of liquid to the upper end of said hydraulic cylinder for closing said venting means.

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