Jan. 31, 1956 P. H. TAYLOR 2,732,898

COMPRESSIBLE LIQUID STRIPPING UNIT

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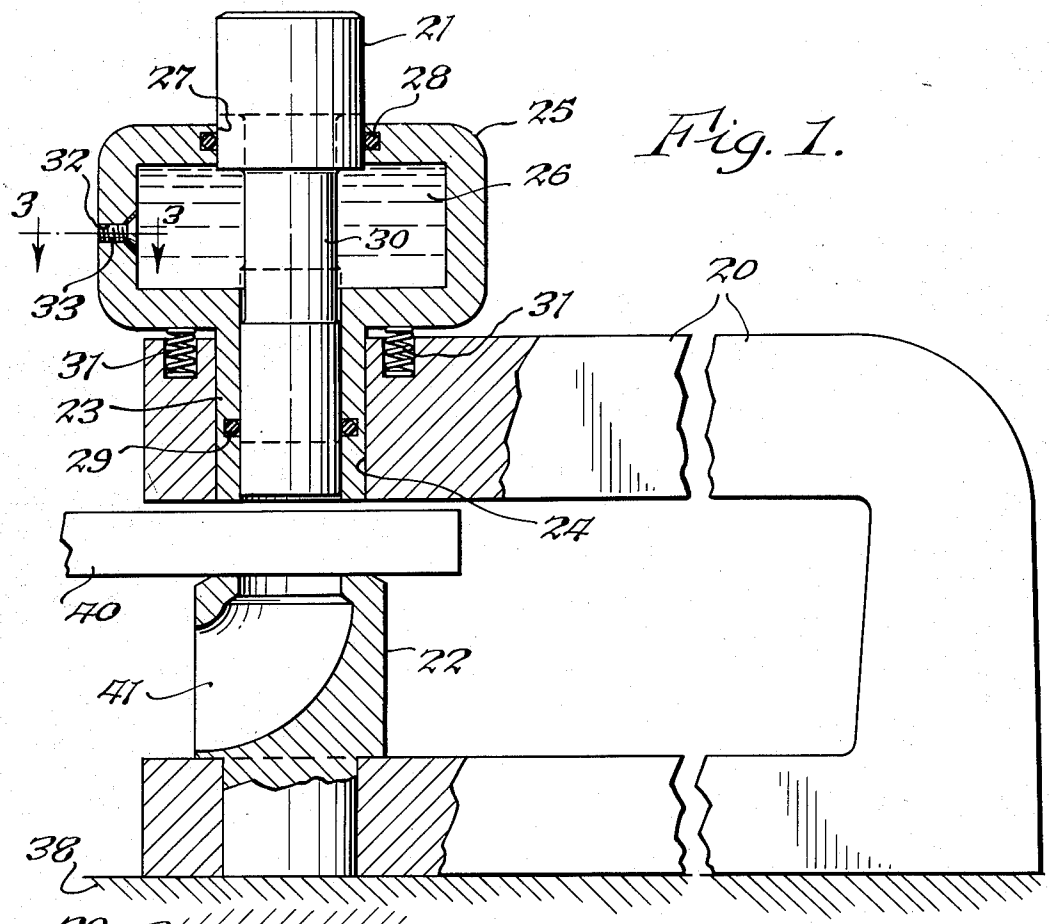


Fig. 1.

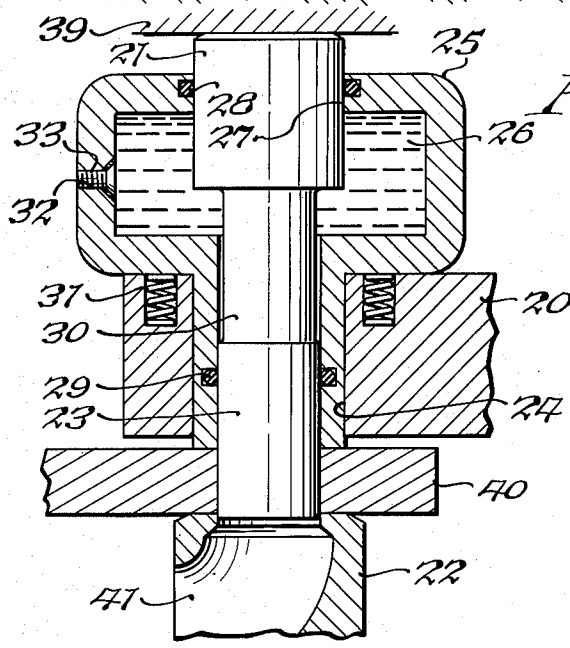
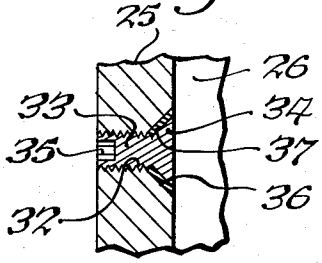


Fig. 2.

Fig. 3.



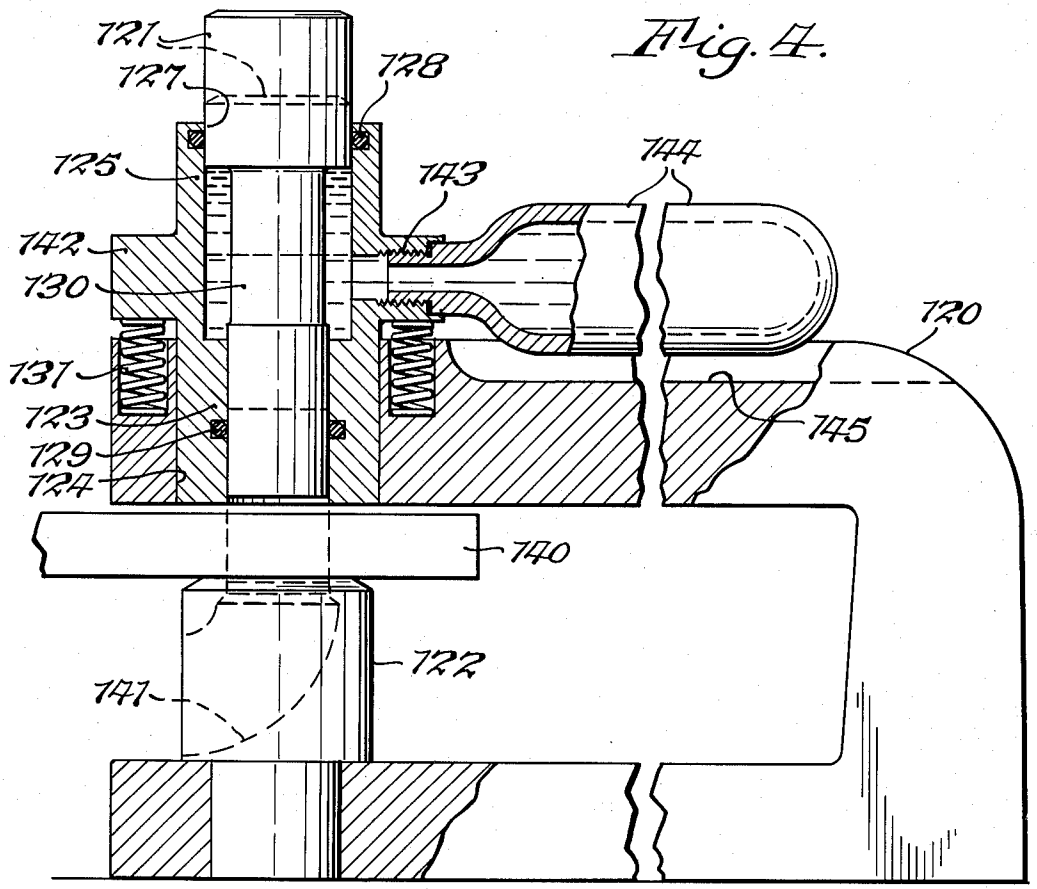
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Fig. 4.



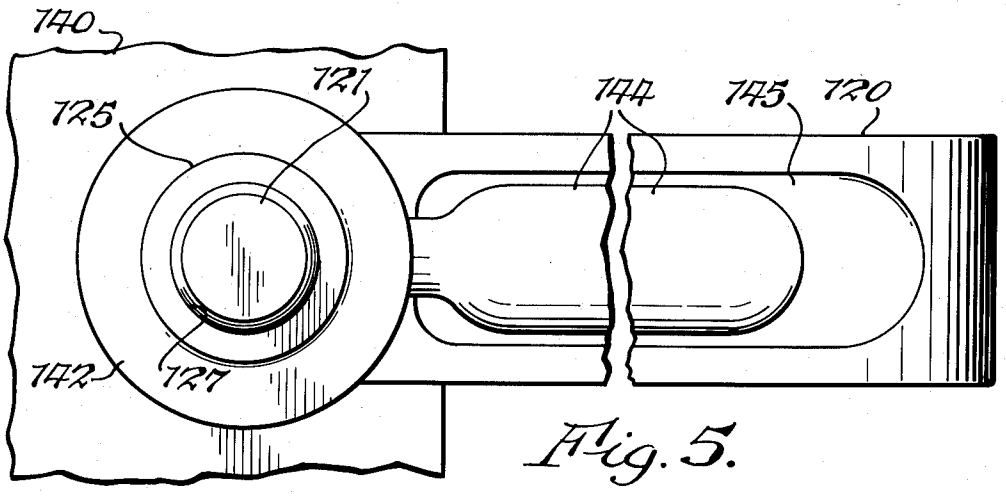


Fig. 5.

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COMPRESSIBLE LIQUID STRIPPING UNIT

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8 Claims. (Cl. 164—94)

This invention relates to a work-performing instrumentality of the type characterized by a resilient means in which energy is stored during working strokes of the instrumentality so that such energy may be availed of upon completion of the working strokes to restore, or aid in restoring, the instrumentality, or parts thereof, to their original positions; and more particularly the invention is concerned with an instrumentality of the kind generally described wherein the resilient means is a compressible fluid.

The resilient means of the invention is characterized by features which enable it to be readily adapted to various kinds of instrumentalities. Highly beneficial results may be obtained when incorporated in instrumentalities in which the space available is limited and in instrumentalities in which the forces to be stored and released are substantial. The resilient means of the invention may, for example, be employed to particular advantage in punching and perforating apparatus of the kind wherein the punch and die elements are associated in a self-contained, or unit, assembly so that the movable element may be actuated by the ram of a standard press, the resilient means in such case being operative to return the movable element to its original position during the return stroke of the ram and in so doing strip the work from the punch.

Heretofore, it has been the usual practice to employ mechanical springs for developing the forces required in stripping the work from a punch after a working stroke of the latter. The use of mechanical springs for this purpose has imposed highly objectionable limitations with respect to the thickness and character of the material which may be punched, or perforated, as the availability of the apparatus for the purpose contemplated is, of necessity, dependent upon the capacity of the stripping apparatus to withdraw the punch after the punching, or perforating strokes. Because of this limitation, it has been impractical heretofore, for example, to perforate metal stock substantially over ¼" thick. It has also been impractical to exceed a hole diameter much larger than 2" without involving the use of costly stripping apparatus. In the case of large punches, a large spring surrounding the punch is unsatisfactory for stripping because in the larger diameters, a given wire size of spring provides a soft spring which has insufficient stripping capacity unless pre-loaded to a substantial degree. Pre-loading of itself is objectionable as it imposes severe stresses on the punch and stripping apparatus.

The use of mechanical springs for stripping purposes has other objections, a serious one being that such springs require considerable space and hence increase the height of the punch column. They also add to the width of the assemblies and thereby prevent the forming of holes as close together as would otherwise be possible. Mechanical springs have the further objection that they are subject to fatigue and frequently to breakage, particularly if the ram of the press by which the movable element of the punching, or perforating, assembly is to be actuated

is permitted to overtravel to an extent such as to cause bottoming upon one another of the various convolutions of the spring.

The invention contemplates the use of a fluid medium, preferably an oil or other suitable liquid, which is compressed and reduced in volume during the working stroke of the work-performing instrumentality, whereby to store energy in said medium which may be released by permitting the latter to expand, and in so doing return the work-performing instrumentality to its normal position upon completion of the working stroke. The use of oil as the compressible fluid has the advantage that it may be subjected, for example, to a pressure of 50,000 p. s. i., the volume of the oil thereby being reduced approximately 13%, although the volume of silicone and other oils may be reduced as much as 26% by the same pressure, As the maximum permissible force for compressing a mechanical spring will not ordinarily exceed 1,000 p. s. i., it will be readily appreciated that the resilient means of the invention is available to provide stripping forces, within the same space, far exceeding any such forces as can be obtained with the use of a mechanical spring. Although, for various reasons, the gain ratio may not be as high as 50 to 1, an overall gain of some 8 or 10 to 1 can be readily attained. In other words, it is possible by using a fluid medium in the manner contemplated to readily develop stripping forces 800% to 1,000% greater than can be developed by a mechanical spring within the same space limitations.

The principal object of the invention is to provide a resilient means of the character generally described which may be availed of to store energy in such a manner that high work-performing forces may be developed within a minimum of space.

Another object is to provide a resilient means which may be associated with punching and perforating apparatus in such a manner that much thicker stock may be punched, or perforated, than has heretofore been possible when the stripping forces have been provided by mechanical springs.

A still further object is to provide a resilient means which may be associated with a work-performing instrumentality in such a manner that the force developed will be directly proportional to the force required to restore the instrumentality to its original condition upon completion of a working stroke.

A still further object is to provide a resilient means which is linear in action and which requires no pre-loading.

A still further object is to provide a punching and perforating apparatus wherein the desired high stripping forces may be developed with a short punch column so that the punch column may be stiff and strong.

A still further object is to provide a punching and perforating apparatus in which the reservoir for the compressible fluid occupies unused space and does not dictate the height of the punch column.

A still further object is to provide a punching or perforating apparatus having a novel design and arrangement of the parts, whereby to provide for simplicity and economy in construction and insure dependability in operation.

The invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a side elevational view, partially in section, of a self-contained, or unit, perforating assembly embodying the features of the invention;

Figure 2 is a fragmentary, sectional view illustrating the relation of the parts upon completion of a working stroke of the punch and prior to the return of the parts to their original positions, as shown in Figure 1;

Figure 3 is an enlarged detail sectional view taken along line 3—3 of Figure 1;

Figure 4 is a view, similar to Figure 1, of a modified form of perforating assembly; and

Figure 5 is a top plan view of the assembly shown in Figure 4.

The features of the invention are illustrated in connection with a perforating tool. The latter, as shown in Figure 1, is in the form of a self-contained, or unit, assembly and includes a holder **20** in the form of a C-frame for mounting the punch or plunger and die elements **21** and **22**, respectively, in aligned operative relation, the punch **21** being carried by the upper arm of the C-frame and the die **22** being carried by the lower arm. The punch **21** is guided for axial movement in a guiding and stripping sleeve **23** which, in turn, is guided for axial movement in a bore **24** formed in the upper arm of the C-frame.

The sleeve **23** is in the form of a reduced neck, or extension, on a cylinder or housing **25**, the latter being considerably larger in diameter than the sleeve **23** and being formed to provide a reservoir for a body of fluid **26** such as oil, for example. The top wall of the cylinder **25** is formed with an opening **27** which is axially aligned with the bore in the sleeve **23** and through which the head of the punch **21** extends. Thus in its axial movements, the bit portion of the punch is guided by the sleeve **23** while the head portion is guided by the walls of the opening **27**, there being suitable sealing elements **28** and **29** in the guiding regions for preventing the escape of fluid from the cylinder **25** between the punch and the guiding walls. Intermediate the bit and head portions of the punch, the shank **30** of the latter is of reduced diameter, whereby during the working strokes of the perforating apparatus the head portion of the punch on entering the cylinder **25** compresses the fluid medium therein. Springs **31** which are carried by the upper arm of the C-frame provide a yieldable seat for the cylinder **25** and are operative normally to hold the cylinder in the elevated position shown in Figure 1, in which position the lower end of the guiding and stripping sleeve **23** is retracted to the plane of the under side of the upper arm.

Preferably, the cylinder **25** is formed with a port **32** through which the compressible fluid may be introduced and entrapped air may be permitted to escape. As best shown in Figure 3, a threaded plug **33** having a conical head **34** normally closes the port **32**, the outer end of the shank of the plug being formed with a multi-sided socket **35** into which a suitable tool may be inserted for turning the plug and the head of the plug cooperating with a countersunk seat **36** formed in a side wall of the cylinder. A suitable rubber sealing ring **37** may be interposed between the head of the plug **33** and the seat **36**, as illustrated. Preferably the mating threads on the plug **33** and the walls of the port **32** have substantial clearance in order to enable compressible fluid medium to be introduced into the cylinder **25** (for replenishing purposes) by causing it to flow between the mating threads. If desired, the shank of the plug **33** may be formed with flat sides to provide larger passages when the plug is loosened. In connection with the foregoing, it will be understood that sealing of the port **32** is obtained by the head of the plug, the seat with which the head cooperates and the sealing element therebetween. The construction disclosed has the advantage that the pressures developed in the cylinder **25** during the working strokes of the punch act on the plug to increase its effectiveness so that the higher the pressures developed the tighter the seal provided.

The perforating tool described is adapted to be employed and actuated in the same general manner as the perforating tool disclosed in the George F. Wales Patent 1,955,866, assigned to our interests, that is to say it, or a plurality of similar tools, are adapted to be correlated in such a manner with respect to a work-piece and the bed and ram of a standard press that the movement of the ram of the press may be utilized to effect the working strokes of the tools and thereby punch, perforate, or otherwise shape or deform, the work-piece as desired. In the drawings, the bed of the press is indicated at **38** in Figure 1, the ram at **39** in Figure 2 and a work-piece to be perforated at **40**, the latter being shown in operative relation with respect to the punch and die of the tool.

Normally the parts of the tool occupy the positions shown in Figure 1, in which positions the fluid **26** supports the punch **21** in a fully retracted (elevated) position and the springs **31** support the cylinder **25** in a position in which the guiding and stripping sleeve **23** is also retracted (elevated).

Upon operation of the press, the ram of the latter engages the head of the punch **21** and moves the punch in the direction of the work-piece, the stroke of the ram being adjusted so that it will move the punch **21** from the normal position shown in Figure 1 to the position shown in Figure 2. In the latter figure, the punch is shown driven through the work-piece and at the limit of its working stroke, the slug punched out of the work-piece having been ejected through the slug clearance passage **41** in the die **22**. The displacement of the head of the punch being greater than that of the shank portion, the movement of the punch, during the initial part of the working stroke of the punch, will be transmitted through the fluid **26** to the cylinder so that the latter moves with the punch until the end of the guiding and stripping sleeve **23** engages the work-piece. Thereafter, during the continued movement of the punch and while the cylinder is arrested by the engagement of the guiding and stripping sleeve with the work-piece, the head of the punch is forced into the cylinder **25** by the ram of the press, compressing the fluid **26** to reduce it in volume and store energy therein. Figure 2 shows the positions of the parts of the tool upon completion of the working stroke of the punch. Upon completion of the working stroke of the punch, the ram of the press returns to its retracted position. As this occurs, the compressed fluid **26** is permitted to expand. Thereby the punch is restored to the retracted position shown in Figure 1, the work-piece being stripped from the end of the punch as this occurs and the springs **31**, acting against the under side of the cylinder **25**, being operative to return the guiding and stripping sleeve to its retracted position.

A second embodiment of the invention is illustrated in Figures 4 and 5. In this embodiment the cylinder **125** which carries the guiding and stripping sleeve and provides the chamber for the compressible fluid is of substantially the same diameter throughout its full height. Hence in the region of the fluid chamber, the perforating tool is considerably narrower than in the embodiment first described. An annular flange **142** on the cylinder cooperates with the springs **131** to normally hold the cylinder elevated. A threaded port **143** is formed in the flange **142** to receive the threaded neck of a pressure container **144**, the latter communicating through said port with the fluid chamber in the cylinder **125** and extending laterally over the upper arm of the C-frame which is indented as indicated at **145** to accommodate the larger body portion of the pressure container. The container **144** may be of standard design and contains the greater portion of the compressible fluid. This embodiment, therefore, has the advantage that the maximum width of the perforating tool is substantially less than the perforating tool first described and hence the tool is particularly adaptable to operations which involve the punching of closely spaced holes, or perforations. A further advantage of importance is that the volume of the reservoir for the compressible fluid may be readily varied by substituting pressure containers of different sizes. In other respects, the construction of the perforating tool and its mode of operation are substantially the same as in Figure 1.

From the foregoing, it will be apparent that the punching apparatus described has the advantage that stripping forces may be developed by the movement of the punch which far exceed any such forces as may be developed

within the same space, by conventional mechanical springs. Much thicker stock may, therefore, be punched, or perforated, than has heretofore been possible. In this connection, it will be apparent that in the embodiments of the invention illustrated, the working stroke of the punch and the stripping forces required will depend upon the thickness and character of the stock to be punched, or perforated, and that the parts of the perforating tool may be so designed with reference to the particular type of compressible fluid to be employed that the required stripping forces may be readily developed incident to the working strokes of the punch.

The features of the invention have been illustrated in connection with a perforating tool wherein the parts are in the form of a self-contained, or unit, assembly. Reference is also made to the availability of the invention for use in connection with work-performing instrumentalities generally. It will be understood that such references are intended by way of examples only and that the punch, the compressible fluid and the container therefor constitute, in effect, a fluid spring and, as such, may be employed to advantage in many and varied applications as a substitute for mechanical springs.

I claim as my invention:

1. An energy storing and releasing device comprising an housing having a chamber formed therein, a compressible liquid filling the unoccupied space in said chamber, a plunger mounted to reciprocate in said housing, said plunger having an enlarged head reciprocable in said chamber and through an opening in one end wall of said housing and projecting outwardly of said opening, said head being closed against passage of liquid therethrough, said plunger having a shank projecting from one side of said head through said chamber and through a second opening in the end wall of said housing opposite said first named end wall opening, said second opening being in diameter less than said first named opening and being aligned axially with said first named opening, said shank being closed against passage of liquid therethrough and being of smaller diameter than said head, the walls of said first and second openings having bearing surfaces for guiding said head and said shank respectively during reciprocation of said plunger, and sealing means in the walls of said first and second openings for sealing the liquid in said housing to prevent leakage of the liquid both along said shank and along said head, whereby, upon application of an external force to said head, said head is caused to move into said chamber and in so doing to compress said liquid so that upon release of said force, said liquid will expand to restore said piston to its initial position.

2. In a punching apparatus, a chamber filled with a compressible liquid, a sleeve secured to one end wall of said chamber, a punch having a shearing edge at one end, an enlarged head at its opposite end to which a punching force may be applied, and a shank connecting said head with said shearing edge, said shank being reciprocable through an opening in said one end wall and in said sleeve, said head being reciprocable in an opening in the opposite end wall of said chamber that is axially aligned with the first-named opening, said head normally being closed against passage of liquid therethrough and projecting outwardly beyond the said opposite end wall, the second-named opening having an internal diameter substantially equal to the external diameter of said head to guide said head throughout the stroke of said punch, the bore of said sleeve having an internal diameter equal substantially to the external diameter of said shank to guide said shank throughout the stroke of said punch, and means for sealing the liquid in said chamber against leakage along said shank and head, said liquid being compressible during the punching stroke and operating upon completion of the punching stroke to restore said punch to its original position.

3. In a punching apparatus, a support, a sleeve reciprocally mounted on said support, a cylinder integral with said sleeve and overlying said support, a punch reciprocable in said sleeve and said cylinder and having a shank which has a shearing edge at one end and which reciprocates through said sleeve and through an opening in one end of said cylinder, said punch having an enlarged head at its opposite end which normally projects through an opening in the opposite end of said cylinder so that force may be applied thereto to effect a working stroke of the punch, a compressible liquid filling said cylinder, and means for sealing the liquid in said cylinder against leakage both along said shank and along said head, whereby upon application of force to said head, said punch, said sleeve and said cylinder are moved together until said sleeve engages the work, and thereafter the liquid is compressed during the remainder of the working stroke of the punch, and the liquid expands upon completion of said working stroke to return said punch to its original position, and means interposed between said cylinder and said support for returning said cylinder to its original position.

4. In a punching apparatus, a C-frame having upper and lower spaced arms disposed one above the other, a die carried by the lower of said arms, a stripper sleeve reciprocable in said upper arm, a cylinder secured to said sleeve and overlying said upper arm, a punch having an enlarged head at one end and a shank projecting axially beyond one side of said head, said shank having a shearing edge at its projecting end and being reciprocable in said cylinder and through an opening in the lower end of said cylinder and through said stripper sleeve, said head being reciprocable through an opening in the opposite end of said cylinder and normally projecting beyond the latter opening to permit application of an external force thereto, said two openings and the bore of said stripper sleeve being axially aligned and said punch being aligned with said die, a compressible liquid filling said cylinder, means for sealing the liquid in said cylinder both against leakage along said shank and along said head, whereby upon application of force to said head both said punch and said cylinder are moved together until said sleeve engages the work and thereafter the liquid is compressed during the remainder of the working stroke of the punch so that upon release of said force the liquid expands and the punch is returned to original position, and means for returning said cylinder to its original position.

5. In a punching apparatus, a C-frame having upper and lower spaced arms disposed one above the other, a die carried by the lower of said arms, a stripper sleeve reciprocable in said upper arm, a cylinder secured to said sleeve and disposed to overlie said upper arm, a punch having an enlarged head at one end and a shank projecting axially beyond one side of said head, said shank having a shearing edge at its projecting end and being reciprocable in said cylinder and through an opening in the lower end of said cylinder and through said stripper sleeve, said head being reciprocable through an opening in the opposite end of said cylinder and normally projecting beyond the latter opening to permit application of an external force thereto, said two openings and the bore of said stripper sleeve being axially aligned and said punch being aligned with said die, a compressible liquid filling said cylinder, means for sealing the liquid in said cylinder both against leakage along said shank and along said head, whereby upon application of force to said head both said punch and said cylinder are moved together until said sleeve engages the work and thereafter the liquid is compressed during the remainder of the working stroke of the punch so that upon release of said force the liquid expands and the punch is returned to original position, and resilient means interposed between said upper arm and said cylinder for returning said cylinder to its original position.

6. In a punching apparatus, a support, a tubular stripper reciprocable in said support, a chamber secured to said stripper to reciprocate therewith, a punch reciprocable through said chamber and said stripper, said punch having

a shearing edge at one end adapted to be projected beyond the adjacent face of the stripper to effect a punching operation on a punching stroke of said punch, and said punch having an enlarged head at its opposite end extending through and normally projecting externally beyond the opposite end of said chamber and to which a punching force may be applied, a compressible liquid filling said chamber, means for sealing said liquid in said chamber, whereby on a punching stroke both the punch and the stripper move together until the stripper engages the work and then the liquid is compressed while the punch completes its working stroke, said liquid expanding upon completion of a working stroke of the punch to strip the punch from the work, and spring means interposed between said chamber and said support for returning said stripper to original position.

7. In a punching apparatus, a frame having spaced upper and lower arms, a die carried by said lower arm, a cylinder carried by said upper arm and reciprocable axially therein, a punch reciprocable in said cylinder in cooperating relation with respect to said die and having an enlarged head extending out of an opening in one end wall of said cylinder and to which force is applied to effect a working stroke of said punch, said punch having a shank portion of reduced diameter below said head and extending through said cylinder and out of an opening in the opposite end wall of said cylinder, said punch having a shearing edge on the end of its shank portion which projects through the latter opening, and a laterally-extending container located over said upper arm and secured to said cylinder at one side thereof to communicate with said cylinder, said cylinder and said container together constituting a closed reservoir, a body of compressible liquid filling said reservoir so that it is compressed by said head during a working stroke of said punch, said liquid expanding upon completion of a working stroke to return said punch to its original position, said upper arm being indented on its upper surface to accommodate said container, and resilient means for returning said cylinder to its original position.

8. In a punching apparatus, a frame having spaced upper and lower arms, a die carried by said lower arm,

a cylinder, a tubular stripper carried by said upper arm and reciprocable therein and secured to the lower end wall of said cylinder, a punch having an enlarged head at one end that is reciprocable through an opening in the upper end wall of said cylinder and that normally projects outwardly beyond said upper end wall and to which an external force may be applied, said punch having a shank portion of smaller diameter than said head that extends through said cylinder and through an opening in said lower end wall of said cylinder and into said stripper, the last-named opening being aligned with the first-named opening and being coaxial with the bore of said stripper, said punch having a shearing edge at the lower end of its shank portion that has cooperating relation with respect to said die, and a laterally-extending container located over said upper arm and removably secured to said cylinder at one side thereof to communicate with said cylinder, said cylinder and said container together constituting a closed reservoir, a body of compressible liquid filling said reservoir so that it is compressed by said head during a working stroke of said punch, said liquid expanding upon completion of a working stroke to return said punch to its original position, said upper arm being indented on its upper surface to accommodate said container, and resilient means interposed between said lower end wall of said cylinder and said upper arm for returning said stripper to its original position.

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