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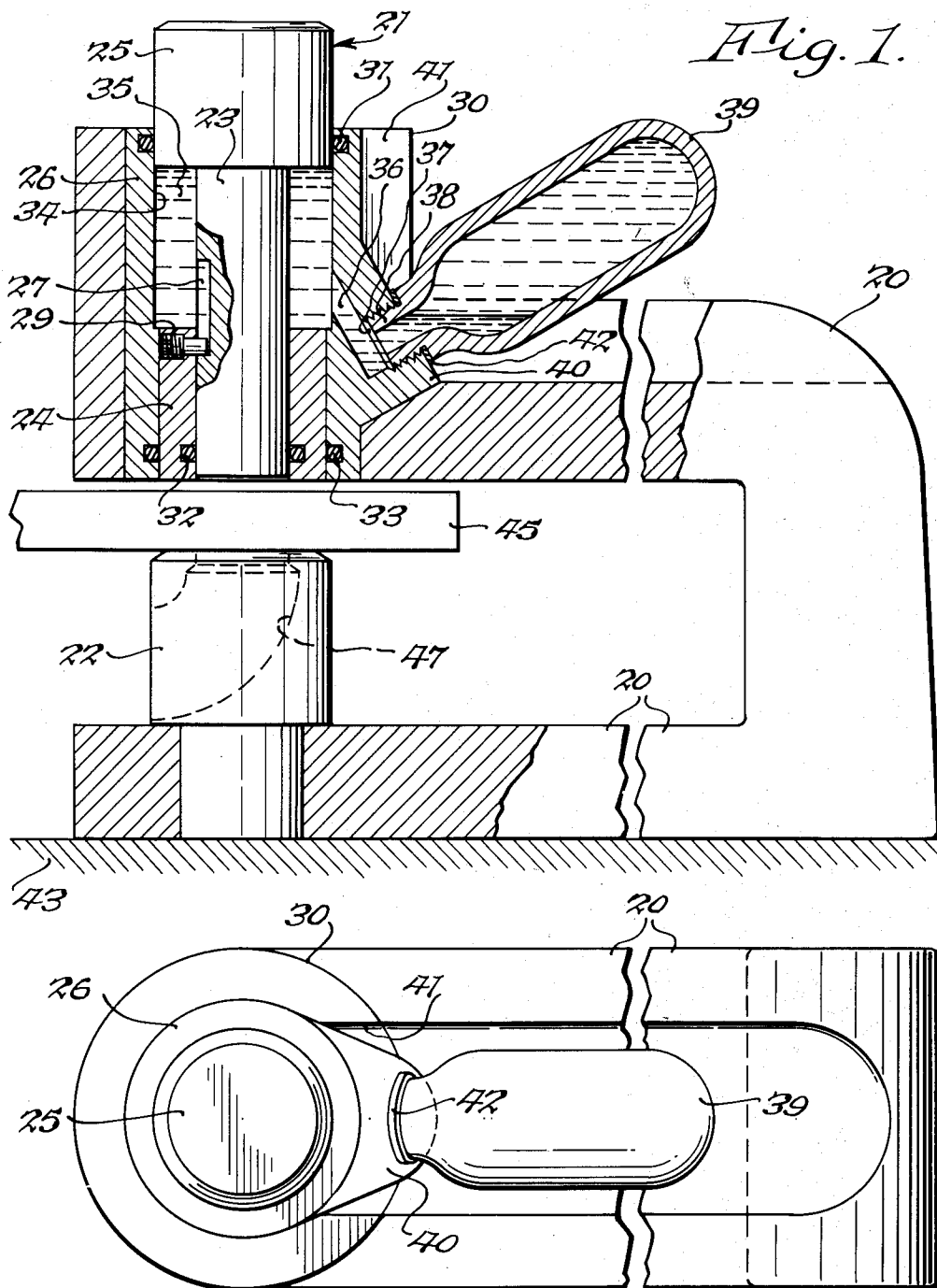
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2,716,451

OIL SPRING STRIPPING UNIT

Filed Sept. 19, 1950

2 Sheets-Sheet 1



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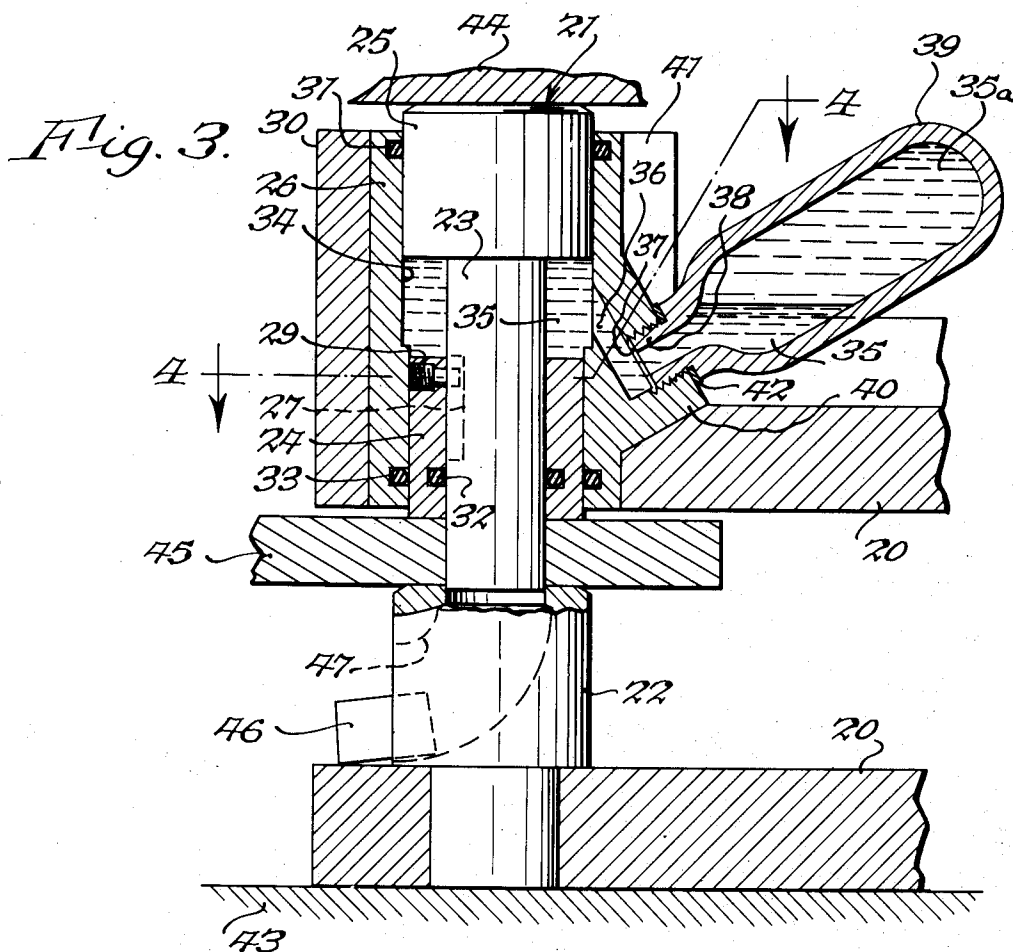
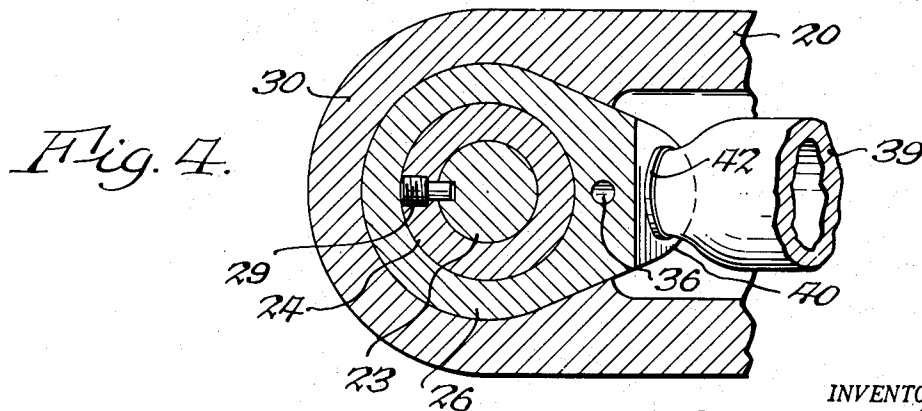
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2 Sheets-Sheet 2



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1

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OIL SPRING STRIPPING UNIT

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Application September 19, 1950, Serial No. 185,605

12 Claims. (Cl. 164—110)

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 1/4" 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 large 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, as-

2

sembly is actuated is permitted to over-travel to an extent such as to cause bottoming upon one another of the various convolutions of the springs.

In my co-pending application Serial Number 185,604, filed September 19, 1950, I have disclosed a self-contained perforating assembly having a cylinder in which a fluid medium is compressed and reduced in volume during the working stroke of the punch so that upon completion of the working stroke, the fluid medium may be permitted to expand to withdraw the punch from the work-piece being perforated while returning the punch to a retracted position. Oil and silicone fluids are mentioned in the said application as possessing qualities which adapt them particularly for use as the compressible fluid, it being pointed out in this connection that oil has a compressibility of about 13% by volume at 50,000 p. s. i. while the silicone fluids have a compressibility of approximately 26% at such pressure, although the compressibilities of different oils and different silicone fluids may also vary. The silicones of lighter viscosities, for example, are more highly compressible than those of heavier viscosity. Other factors being the same, therefore, the silicone fluids would ordinarily be preferable over oil primarily because the necessary stripping, or other, forces required could be developed in a much smaller body of fluid, this being particularly desirable, for example, in self-contained perforating apparatus in which utilization of a minimum of space may be of particular importance. It has been found, however, that silicone fluids generally have a deteriorating action upon the seals which are employed to prevent the escape of fluid between the movable and stationary parts which compress the fluid, such seals having a considerably shorter life than those in apparatus in which oil has been employed as the compressible medium.

One of the principal objects of the present invention, therefore, is to provide a work-performing, or energy storing, instrumentality of the character generally described wherein fluids of high compressibility such as the silicones may be employed in such a manner as to avoid the objection above noted as well as other objections which may attend the use of such fluids when the latter have direct contact with the relatively movable and stationary parts which compress the fluids to develop the required forces.

A further object is to provide a work-performing, or energy storing, instrumentality which is so designed that fluids of high compressibility and low volume may be employed.

A still further object is a work-performing, or energy storing, instrumentality wherein provision is made for employing fluids of high compressibility such as the silicone fluids while at the same time insuring that the relatively movable and stationary parts which compress the fluid and the seals associated therewith will be properly lubricated.

A still further object is a work-performing, or energy storing instrumentality which is adapted to accommodate different fluid mediums at one and the same time in such a manner as to enable the most desirable characteristics of each fluid medium to be availed of.

A still further object is to provide a perforating unit which includes a stripping member and wherein the compressible fluid medium is utilized to retract both the punch and the stripping member upon completion of the working stroke of the punch.

A still further object is to provide perforating apparatus of the character described wherein the compressible fluid, although not under an initial pre-load, may be pre-loaded at the outset of the working stroke.

A still further object is to provide perforating ap-

paratus wherein the cylinder in which the compressible fluid is accommodated does not move with the punch.

A still further object is to provide perforating apparatus which is so designed that inertia forces in the reserve chamber, due to the acceleration of the punch assembly, are avoided.

A still further object is a novel design and arrangement of the parts of the apparatus, whereby to provide for simplicity, economy, compactness and high strength in construction.

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 top plan view of said assembly;

Figure 3 is a view similar to Figure 1, portions of the holder, or frame, being omitted, showing the relation of the parts as a working stroke is completed; and

Figure 4 is a horizontal section taken along line 4—4 of Figure 3.

The features of the invention are illustrated in connection with a perforating tool. The latter, as shown, 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 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 shank, or bit carrying portion, 23 of the punch 21 is guided for axial movement in a guiding and stripping sleeve 24 while the lower portion of the head 25 of the punch is guided for similar movement in the upper end of a liner sleeve 26. The lower portion of the sleeve 26 has a bore of smaller diameter than the portion of the bore which guides the head 25 and provides a guide for the guiding and stripping sleeve 24, the shank portion of the punch being formed with a longitudinally-extending slot 27 for accommodating the end of a set screw 29 which is carried by the guiding and stripping sleeve 24. The holder 20 may be in the form of an aluminum casting and the liner sleeve 26 may be a ferrous, high-melting point metal and united to the holder in the same operation in which the latter is cast, the sleeve 26 in such case being located within the bore of a cylindrical neck 30 formed on the upper arm of the holder. The guiding and stripping sleeve 24 and punch 21 are operatively associated as an assembly before being introduced into the liner sleeve 26.

An O-ring 31 provides a seal between the head of the punch and the liner sleeve while a similar ring 32 provides a seal between the bit portion of the shank of the punch and the guiding and stripping sleeve 24; and a third O-ring 33 provides a seal between the guiding and stripping sleeve 24 and the liner sleeve 26.

The head of the punch is substantially larger in diameter than the shank. Hence between the head of the punch and the upper end of the guiding and stripping sleeve, the shank of the punch and the inner wall of the liner sleeve define a chamber 34 for a compressible fluid 35. At the lower end of the chamber 34, a passage 36 extends downwardly and outwardly, terminating in an upwardly extending port 37, the walls of the port being threaded to receive the threaded neck 38 of a pressure container 39 and the passage and port referred to being formed in a lateral enlargement 40 on the liner sleeve 26. The port 37 is accessible through a slot 41 in the side wall of the neck 30, which slot accommodates the lateral enlargement 40. The container 39, which may be of a standard type, is supported by the liner sleeve so that it extends angularly upwardly from its neck as illustrated, a suitable washer 42 preferably being employed to provide a tight seal between the container and the passage which leads to the chamber 34. The chamber 34 and the container 39 provide

a closed reservoir for the body of fluid which is to be compressed.

The perforating tool described is adapted to be employed 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 workpiece as desired. In the drawings, the bed of the press is indicated at 43, the ram at 44 (Figure 3) and a work-piece to be perforated at 45, 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 35 supports the punch and guiding and stripping sleeve in fully retracted (elevated) positions, the lower end wall of the slot 27 in the shank of the punch engaging the inner end of the set screw and the end of the bit portion of the punch shank being elevated slightly above the plane occupied by the end of the guiding and stripping sleeve.

Upon operation of the press, the ram of the latter engages the head of the punch and moves the punch in the direction of the work-piece, the stroke of the ram being predetermined so that it will move the punch from the normal (retracted) position shown in Figure 1 to the fully extended position shown in Figure 3. In the latter figure, the punch is shown driven through the work-piece and at the limit of its working stroke, the slug 46 punched out of the work-piece having been ejected through a slug clearance passage 47 in the die 22. The displacement of the head of the punch being greater than 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 35 to the guiding and stripping sleeve 26 so that the latter moves with the punch until its end engages the work-piece. Thereafter, during the continued movement of the punch and while the guiding and stripping sleeve is arrested by its engagement with the work-piece, the head of the punch is forced further into the cylinder provided by the neck 30 and the liner sleeve 26, compressing the fluid in the chamber 34 and container 39 to reduce it in volume and store energy therein. The lost-motion connection provided by the set screw 29 and the slot 27 permit continued movement of the punch after the guiding and stripping sleeve has been arrested.

Figure 3 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 positions. As this occurs, the fluid in the chamber 34 and container 39 is permitted to expand, thereby withdrawing the punch from the work-piece against the resistance offered to such withdrawal. The compressible fluid has not completely expanded at the time the bit portion of the punch is withdrawn from the work-piece as the portion of the bore of the liner sleeve 26 in which the head of the punch reciprocates is of larger diameter than the portion of the bore in which the guiding and stripping sleeve 24 reciprocates. As the compressible fluid acts against a greater area of the head of the punch than of the guiding and stripping sleeve, the punch, when released by the ram of the press, will be elevated by the expanding fluid until the end wall of the slot 27 engages the end of the set screw 29. Thereafter, the guiding and stripping sleeve will move with the punch until the fluid in the chamber 34 and container 39 is completely expanded, assuming no pre-load is desired, at which time the punch and guiding and stripping sleeve reach their fully retracted positions.

It will be noted that as the bit of the punch is with-

drawn slightly within the guiding and stripping sleeve 24, the movement of the punch, after the guiding and stripping sleeve engages the work-piece during a working stroke, places an initial pressure on the compressible fluid to pre-load the latter and insure complete withdrawal of the punch from the work-piece upon completion of the perforating operation, it being apparent that the amount of pre-load may be predetermined in accordance with the character of perforating operation contemplated.

Preferably, and in accordance with the invention, the fluid in the chamber 34 is one having good lubricating characteristics and one which will not have a deleterious action upon the seals 31, 32 and 33. Castor oil, for example, is particularly suitable. Castor oil, however, has a relatively low compressibility factor. A second fluid 35a, silicone, for example, which possesses a high compressibility factor is employed in connection with the fluid 35, the fluid of high compressibility having a lower specific gravity than the fluid 35, being immiscible with the latter and occupying the pressure container 39. Since the two fluids will not intermix and will maintain their identity as separate bodies, the silicone fluid will not enter the chamber occupied by the castor oil and hence cannot come into contact with the seals 31, 32 and 33. Any pressure, however, which is applied to the fluid in the chamber 34 will be transmitted to the fluid in the container 39.

The construction described has the advantage that frequent replacement of the seals is avoided while at the same time the amount of compressible fluid medium employed is substantially reduced, it being apparent that during a working stroke of the punch the two fluid mediums provide a single compressible body and that most of the reduction in the volume of said body which attends said stroke takes place in the fluid in the container 39 which is selected because of its higher compressibility factor.

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 each instance 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 fluids 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, however, that such references are intended by way of examples only and that the punch, the compressible fluids and the reservoir 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. In a punching apparatus, a cylinder having a bore which is larger at one end than at the other, a stripping sleeve reciprocable in the end of the cylinder of reduced bore, a reciprocable punch having a piston-like head guided in the end of said cylinder of larger bore and a shank portion which is guided in said stripping sleeve, the face of said head which is opposed to said sleeve being of greater area than the opposed end face of said sleeve, said cylinder, punch and stripping sleeve forming a closed chamber filled with a body of liquid, and a lost-motion connection between said shank portion and said

stripping sleeve, the movement of said punch during a working stroke being transmitted by said liquid to said sleeve to first extend the latter into engagement with the workpiece and thereafter compressing said body of liquid so that upon completion of said working stroke said body of liquid may expand to retract said punch and said lost-motion connection serving to retract said sleeve after partial retraction of said punch.

2. A work-performing instrumentality including, a chamber filled with a liquid which has good lubricating properties, a container removably secured to said chamber and providing a second chamber for a liquid which is of a different specific gravity from the first liquid and which is highly compressible, said chambers communicating with one another, when said container is secured to the first chamber, at their bottoms to provide a closed reservoir filled with said liquids, and a member movable in said first chamber in response to a force applied thereto to compress said first mentioned liquid, said bodies of liquid being in contact so that forces of compression applied to said first mentioned liquid are transmitted to said second liquid, whereby upon release of the forces of compression, the forces released by said second liquid, as it is permitted to expand, will be transmitted to said first mentioned liquid, and thence to said member to move said member in the opposite direction.

3. In a punching apparatus, a chamber, a reciprocable stripper sleeve, a punch having an enlarged piston-like head at one end which is reciprocable in said chamber and a shank portion of reduced diameter which reciprocates in said sleeve, the face of said head which is opposed to said sleeve having a greater area than the opposed face of said sleeve, a body of liquid interposed between said head and said sleeve and filling said chamber, a second chamber connected to the first chamber at the bottoms of the two chambers through a narrow neck, said second chamber containing a liquid of lesser specific gravity but of greater compressibility than the liquid contained in the first chamber, and the liquid in the first chamber having better lubricating qualities than the liquid in the second chamber, said two chambers constituting together a closed reservoir and being filled with said two liquids, and means for sealing the liquids in the two chambers, whereby the movement of said head during a working stroke of the punch is transmitted through said liquids to said sleeve until said sleeve engages the work and thereafter compresses said liquids so that upon completion of said working stroke said liquids may return said punch to original position, and a lost-motion connection between said punch and said sleeve for returning said sleeve to original position when said punch is returned to original position.

4. In a punching apparatus, a cylinder, a stripper sleeve reciprocable in one end of said cylinder, a punch having an enlarged head reciprocable in the other end of said cylinder and having a shank portion reciprocable in said sleeve, the opposed faces of said head and sleeve having different areas, the area of the face of the head being the greater, a chamber communicating with said cylinder through a narrow neck at the bottoms of both cylinder and chamber, said cylinder being filled with a liquid of good lubricating properties, said chamber being filled with a liquid of lesser specific gravity but greater compressibility than the first-named liquid, said cylinder and chamber constituting a closed reservoir filled with said liquids, means for sealing the liquids in said reservoir, and a lost-motion connection between said punch and said sleeve, whereby the movement of said head during a working stroke of said punch is transmitted through said liquids to said sleeve until said sleeve engages the work and thereafter compresses said liquids so that upon completion of said working stroke said liquids may return said punch to original position, said lost-motion connection operating after partial return of said punch to original position to cause return movement of said sleeve

with said punch whereby sleeve and punch are returned together to their original positions.

5. A device of the character described comprising a cylinder filled with a body of liquid having good lubricating qualities, a chamber filled with liquid, the liquid in said chamber comprising a body of liquid which is highly compressible but which has a lower specific gravity than the first-named body of liquid and which is immiscible with said first-named body of liquid, said cylinder and chamber communicating with one another adjacent their bottoms, and a piston movable under pressure in one direction in said cylinder to cause the body of liquid therein to transmit pressure to the second body of liquid to compress the same, whereby upon release of the pressure on said piston the forces released by said second body of liquid, as it is permitted to expand, will be transmitted to the first body of liquid to move said piston in the opposite direction.

6. In a punching apparatus, a cylinder, a piston reciprocable in said cylinder and having an enlarged head normally protruding beyond one end of said cylinder, a member closing the opposite end of said cylinder, said piston having a reduced shank portion reciprocable through a guide opening in said member, said cylinder being filled between said head and said member with a body of liquid of good lubricating quality, and a chamber communicating with said cylinder and filled with a body of compressible liquid having a different specific gravity from the first liquid, whereby upon application of force to the piston head to move said head inwardly of said cylinder the pressure is transmitted to the second body of liquid, so that upon release of said force, said piston head is moved outwardly again.

7. In a punching apparatus, a cylinder, a piston reciprocable in said cylinder and having an enlarged head normally protruding beyond one end of said cylinder, a member closing the opposite end of said cylinder, said piston having a reduced shank portion reciprocable through a guide opening in said member, said cylinder being filled between said head and said member with a body of compressible liquid of good lubricating quality, and a chamber filled with a body of a more compressible liquid, said chamber communicating at its bottom with said cylinder, said piston being movable in one direction in said cylinder upon application of an operating force to said head to compress the first body of liquid and to transmit the forces of compression to the second body of liquid, whereby upon release of the forces of compression the forces released by said second body, as it is permitted to expand, will be transmitted to the first body of liquid to move the piston in the opposite direction, and sealing means for preventing escape around said shank portion of the first-named liquid.

8. In a punching apparatus, a chamber, a guiding and stripping sleeve reciprocable in said chamber, a punch having an enlarged head and a shank portion of reduced diameter, said punch being reciprocable in said chamber and said shank portion being reciprocable through the bore of said stripping sleeve, said chamber being filled between said head and said sleeve with a body of compressible liquid whereby during a working stroke of said punch said body of liquid will be compressed so that upon completion of said working stroke said body of liquid can expand to return said punch to its original position, the face of said stripping sleeve opposed to said head having a smaller area than the opposed face of said head, and means for sealing the liquid in said chamber, said punch having a lost motion connection with said sleeve, said lost motion connection permitting the punch to move relative to the sleeve on the punching stroke after the sleeve has engaged the work to complete the punching operation, and said lost motion connection permitting the return movement of said punch before the punch causes return of the sleeve through said connection.

9. In a punching apparatus, a cylinder, a stripping

sleeve reciprocable in one end of said cylinder, and a reciprocable punch having a piston-like head which occupies the opposite end of said cylinder and a shank portion which is guided in said sleeve, the face of said head opposed to said sleeve being of larger area than the opposed face of said sleeve, said cylinder, head and sleeve forming a closed chamber filled with a body of compressible liquid which is compressed by the head of said punch during a working stroke, whereby upon completion of said working stroke said body of liquid can expand to return said punch to its original position, and the shank portion of said punch having a lost motion connection with said sleeve.

10. In a punching apparatus, a cylinder having a bore which is larger at one end than at the other, a stripping sleeve reciprocable in the end of the cylinder of smaller bore, a reciprocable punch having a head guided in the end of the cylinder of larger bore and a shank portion which is reciprocable in said stripping sleeve, the face of said head which is opposed to said sleeve being of greater area than the opposed face of said sleeve, said cylinder, head and stripping sleeve forming a closed chamber filled with a body of compressible liquid, the movement of said punch during a working stroke being transmitted by said liquid to said sleeve to first extend said sleeve into engagement with the workpiece and thereafter compressing said body of liquid so that upon completion of said working stroke said body of liquid can expand to return said punch to its original position, and the shank portion of said punch having a lost-motion connection with said sleeve to return said sleeve to its original position when said punch is returned.

11. In a punching apparatus, a chamber filled with a liquid which has good lubricating qualities, a second chamber filled with a liquid which has a different specific gravity from the first liquid and which is highly compressible, said chambers communicating with one another at their bottoms to provide a closed reservoir filled with said liquids, a guiding and stripping sleeve reciprocable in the first chamber, and a punch having a head portion reciprocable in the first chamber and a shank portion reciprocable in said sleeve, the face of said head portion opposed to said sleeve having a greater area than the opposed face of said sleeve, said punch being operable during a working stroke to compress the first named liquid, said bodies of liquid being in contact so that forces of compression applied to said first named liquid are transmitted to said sleeve until said sleeve engages the workpiece and then to the second named liquid so that upon completion of the working stroke the forces released by the second-named liquid as it is permitted to expand will be transmitted to said first-named liquid and thence to said punch to return said punch to its original position, means constituting a lost-motion connection between said shank portion and said sleeve for returning said sleeve to original position, and sealing means for preventing escape of the first-named liquid around said shank portion and said sleeve.

12. In a punching apparatus, a C-frame having upper and lower generally parallel arms, a die member carried by the lower arm, a cylinder provided in said upper arm, a stripping sleeve reciprocably mounted in the lower end of said cylinder, a punch element having an enlarged head reciprocable in said cylinder and a shank portion of reduced diameter reciprocable in said sleeve in registry with said die member, a lost motion connection between said shank portion and said sleeve, the face of said head opposed to said sleeve having a greater area than the opposed face of said sleeve, said head, sleeve and cylinder forming a chamber filled with a body of compressible liquid of good lubricating qualities, a container disposed above said upper arm and at one side of said cylinder and being removably secured to said cylinder at its lower end to communicate with said chamber, said container being filled with a body of liquid which is more highly compressible than the first body of liquid and of different specific

gravity from the first body of liquid, and means for sealing against leakage of the first liquid along said shank portion and along said sleeve.

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