April 3, 1956 P. H. TAYLOR 2,740,475

PERFORATING APPARATUS HAVING A STRIPPING MEDIUM MOUNTED WITHIN A CHAMBER IN THE PUNCH MEMBER

Filed Jan. 8, 1953 2 Sheets-Sheet 1

Fig. 6.

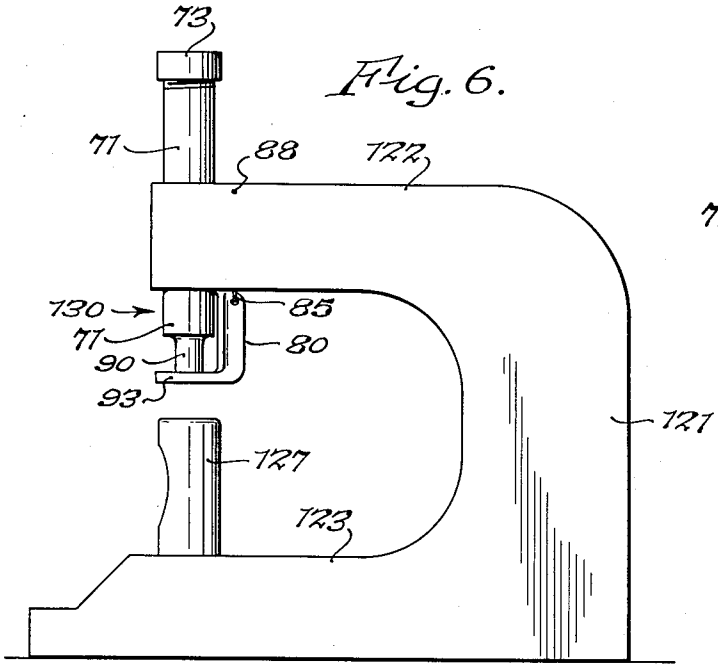


Fig. 9.

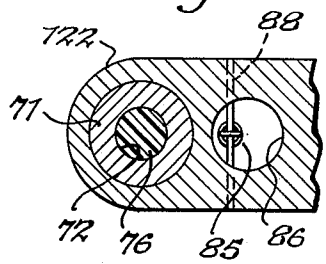


Fig. 10.

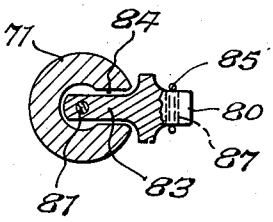


Fig. 7.

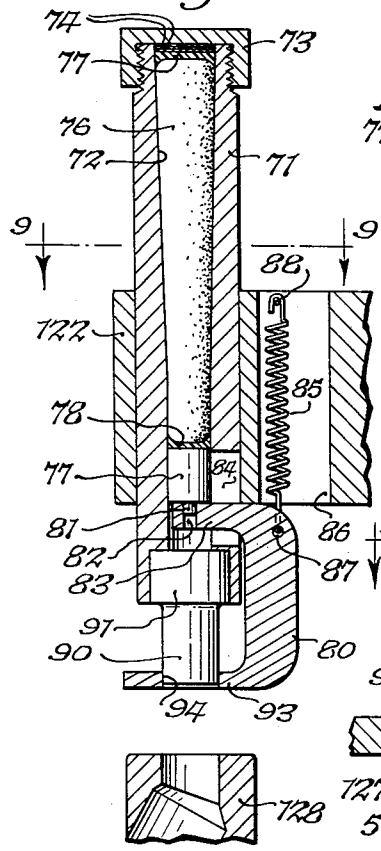


Fig. 8.

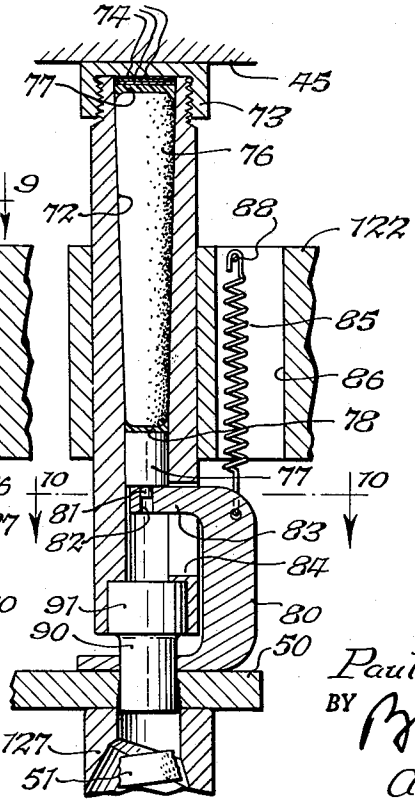
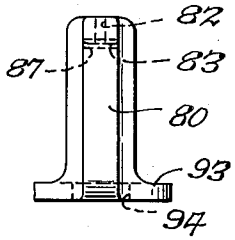


Fig. 11.



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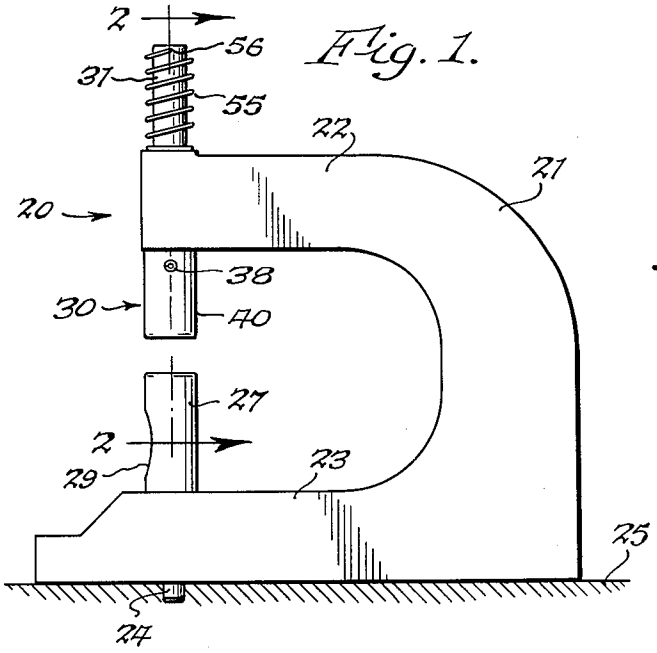


Fig. 1.

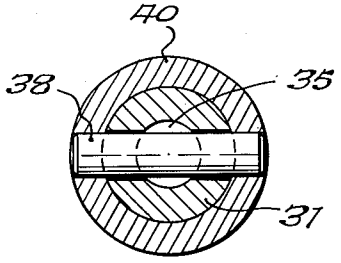


Fig. 4.

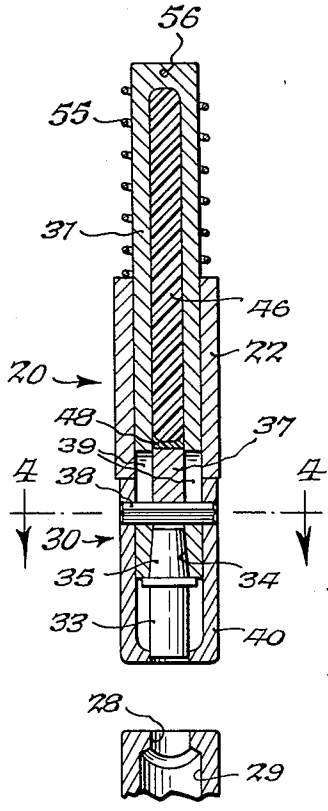


Fig. 2.

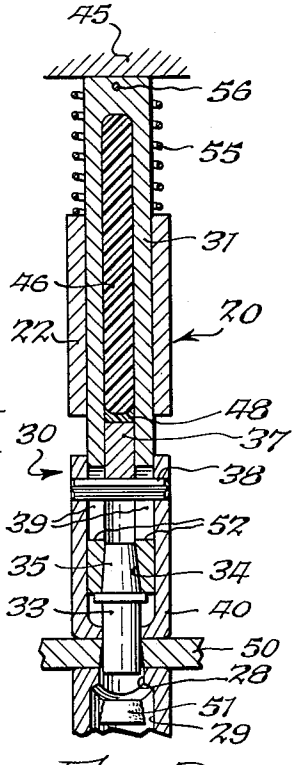


Fig. 3.

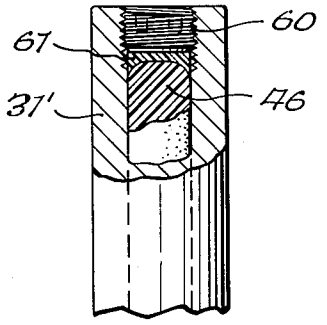


Fig. 5.

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2,740,475

PERFORATING APPARATUS HAVING A STRIPPING MEDIUM MOUNTED WITHIN A CHAMBER IN THE PUNCH MEMBER

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Application January 8, 1953, Serial No. 330,197

29 Claims. (Cl. 164—110)

The present invention relates to perforating implements, and more particularly to self-contained perforating implements such as may be used singly or in multiples in a conventional punch press for punching holes in sheet metal and similar materials.

Self-contained perforating units have been universally adopted by industry for use especially where it is desired to punch a number of holes simultaneously in sheet metal or similar materials. The individual perforating devices are either secured to a template, or mounted adjustably on bed rails in a press, so that they can be placed in a pattern corresponding to the pattern of holes which it is desired to punch in a work piece, and so that they can be actuated simultaneously by the press ram on the downward, working stroke of the ram to punch the desired holes in the work piece. Devices of this type have the advantage that each unit contains both a punch and die, and that these are mounted in alignment. In addition, in this type of perforating apparatus the work-stripping means also forms part of the perforating unit. Hence, if anything goes wrong with a unit, it can be removed as a unit and replaced as a unit. Thus, the downtime of presses, in which these devices are used, is reduced to a minimum. Furthermore, these perforating implements are adaptable to either long or short production runs, which is also a major advantage.

Self-contained perforating units have been made in a number of different forms. In a perforating device such as disclosed in the Wales U. S. Patent No. 1,955,866, granted April 24, 1934, and assigned to the assignee of the present application, the downward working stroke of the press ram stores energy in a wound steel wire spring, which forms part of the perforating unit; and this spring operates to withdraw the punch from the work after the perforating stroke is completed. The work, which these perforating implements can do, is limited, however, by the capacity of the steel spring used for stripping. To punch maximum thicknesses of stock material a heavy steel stripping spring has to be used. Such a spring increases the overall width of the perforating unit which in turn limits the closeness perforating units can be positioned to one another, thereby limiting the closeness at which adjacent holes can be punched in a single perforating operation. As a result the stripping units of perforating implements such as disclosed in the Wales patent mentioned are frequently overloaded with the result that early failure occurs. It is also necessary with perforating units such as disclosed in the Wales patent mentioned to sharpen the punch frequently, or to assist sticking punches to strip by striking the work with a mallet, because the nature of the loads on the stripping spring made it impossible to strip a dull punch from a workpiece.

Another disadvantage of the underforce spring in the existing perforating unit is that in large setups, where from four hundred to one thousand perforating implements are employed, sometimes one punch will stick and release upon withdrawal of the ram, and the punch will spring out of its holder and lay crosswise over the work-

piece, press bed or perforating unit. The operator, not seeing this, brings the ram down for the next operation and this often results in spoiled work, damaged perforating holders, and in some instances a damaged press. At times, also, this will result in an operator making an entire production run without discovering that one hole is not being punched in the work. In many instances this has resulted in the necessity for drilling that hole in the entire production run from a fixture by locating from a previously punched hole.

Another limitation on perforating units, such as shown in the Wales patent mentioned, has been the necessity of limiting the material to be punched to one-eighth inch thickness if a standard punch press was to be used, since, where work of more than one-eighth inch thickness was to be punched, stripping requirements demanded springs of such size that a single stripping spring would be impractical for standard press shut-heights. Therefore, special types of punch presses had to be designed, where it was desired to punch material of more than one-eighth inch thickness on given hole centers with a perforating implement such as disclosed in the Wales patent above mentioned. With such machines it has been possible, using perforating implements such as shown in the Wales patent mentioned, to punch sheet metal of one-quarter inch thickness with the desired closeness of the hole centers. Such machines, however, are expensive.

The closeness of the hole centers and the thickness of the material which could be punched was, therefore, ordinarily governed by the best stripping spring punch compromise which could be made between the holder width and the necessary stripping force. This means that for many jobs two or three operations were necessary to punch holes on given centers in a material of a given thickness.

To overcome this difficulty, perforating units were developed, such as disclosed in Wales U. S. Patent No. 2,326,588, granted August 10, 1943, in which a series of springs are arranged in tandem above the holder. However, this arrangement of spring mechanism makes the punch element extremely fragile, and thin, and subject to considerable bending because of its long columnar nature. These units, furthermore, are of greater height than can be used in a press having a standard shut height, which means that their use has been confined to large expensive presses with greater open height. In addition, such units are costly because they require accurate and delicate assembly. Long punches such as have been described above also create difficulty in manufacture because the body section must be tough while the perforating end must be glass hard to resist abrasion from the wearing of the material as the punch is forced therethrough. This has always presented a problem in heat treatment as the punches must first be heated to the proper temperature, quenched in oil, water, or air, as the material requires, and then the body behind the punch tip must be drawn back to a tough condition while the perforating end is maintained to the proper hardness for perforating. This offers a chance for two errors in production which are costly and difficult to avoid. In the first instance, punch steels by nature are not generally adapted to be tough but are rather adapted to be hard to resist abrasion; and the drawing back of one section to a tough condition is extremely difficult, hazardous and costly. If the punches are drawn too much the tip which must do the perforating, gets soft; and it will not function properly. If the transition between the heat treated and drawn section occurs at the reduced section of the punch where it meets the tip, failure of the punch tip will most surely result, since the molecular structure of the material through this section is different and its tendency to bond is less. Here again a compromise is gener-

ally in order, as one must choose a tool steel which is only as tough when drawn back as is necessary to do the work, while the tip must be reasonably hard to perforate the material which it is desired to perforate. Aside from the heat treat standpoint, such long punches which are made out of tool steel, at best a difficult to machine alloy, are costly and expensive because the material itself is more expensive and the labor and heat treat techniques involved are much more expensive. In addition, when the punch tip fails the entire punch assembly must be dispensed with, which is a costly replacement item.

To overcome the deficiencies of the self-contained perforating units using mechanical springs as the stripping means, perforating units were devised utilizing compressible liquids to effect stripping. Units of this type are disclosed in my pending U. S. patent applications Serial Nos. 185,604, now Patent No. 2,732,898, and 185,606, filed September 19, 1950. With these perforating units it is possible to achieve greater stripping forces, and hence to perforate material up to three-quarter inch thickness on the same hole centers as could be punched with the prior perforating units, using mechanical springs, which were limited to punching sheet metal of a thickness of one-quarter inch. In addition, the perforating units of these applications can be mounted within the shut height of standard presses. Obviously, these devices are much more efficient since narrower holder widths and smaller shut heights are permitted. These units are much more suited to closer center application and to punching heavier stock in smaller presses. Perforating units, such as disclosed in applications above mentioned, however, are more costly than the individual perforating units employing mechanical springs as the stripping means. Hence, the perforating units, using liquid springs, such as shown in my applications above mentioned, are ordinarily used only for perforating heavy duty materials such as those between one-quarter inch and three-quarter inch thickness.

One object of the present invention is to provide a perforating unit which can be manufactured at a cost less than the cost of the perforating units using liquid as the stripping medium, and yet which can perforate metal sheets of a thickness such as can be punched with the liquid spring units, and which can be used within the shut height of standard punch presses.

Another object of the invention is to provide a perforating unit of the character described which will continue in satisfactory operation for a longer period than self-contained perforating units as heretofore made, and which is reliable, and which will have a stripping spring pressure even in excess of that required.

Another object of the invention is to provide a self-contained perforating unit which may be used with either punch presses of normal shut heights or with punch presses of special design having larger shut heights, thereby reducing the inventory of punch units required and providing a single unit which will serve two purposes and which is more or less universal in its adaptability.

Another object of the invention is to provide a perforating unit which can be made of smaller width than units of prior design, and still punch and strip materials of greater thickness.

Another object of the invention is to provide a self-contained perforating unit in which the stripping forces are more than adequate for the job, and which need not, therefore, be overloaded, as has been the practice with mechanical spring units heretofore.

Another object of the invention is to provide a self-contained perforating unit which has stripping forces more than adequate for the job with the result that the punch does not need to be sharpened as frequently as heretofore and with the further result that mallets or other types of percussion implements do not have to be used to assist in stripping the work from the punches when stuck.

A further object of the invention is to provide a self-contained perforating unit which will have a life many times that of perforating units employing mechanical springs.

Another object of the invention is to provide a perforating unit of the character described in which the load-carrying capacity of the stripping means can quickly be brought up to normal should loss of load occur for any reason. When a steel spring loses load, this is due almost always to failure of the spring itself, and no adjustment can be made by spacers or otherwise to restore the load-carrying capacity of the spring.

Another object of the invention is to provide a self-contained perforating unit in which the resilient stripping means is adjustable as to force while maintaining the same stroke and overall travel of the punch.

Another object of the invention is to provide a perforating unit in which the life of the punch will be considerably greater than the punch life of conventional perforating units.

Another object of the invention is to provide a perforating unit which has increased strength and much less side deflection under load than conventional perforating units. Most punch failures occur at the moment that stripping begins because the punch has been deflected in the punching operation, and because this deflection is suddenly released with a snap as the press ram is withdrawn. This deflection causes excessive punch breakage.

Another object of the present invention is to provide a perforating unit in which the punch-supporting member has greater rigidity than the conventional units.

Another object of the invention is to provide a self-perforating implement in which the member that supports the punch may be guided directly in a holder without stripping means being interposed between that member and the holder.

A further object of the invention is to provide a perforating unit having an inserted type punch, which will reduce punch costs.

Another object of the invention is to provide a perforating unit in which the insert type punch is joined to the main body of the punch at the point where conventional punches generally fail so that much less punch failure will result since the punch is already split from the main body at the transition point where stress concentration occurs.

A further object of the invention is to provide a self-contained perforating unit in which the perforating implement is a small replaceable insert, which is mounted within a tough shock-resistant structural member adapted to transmit the force of the press thereto while containing the resilient stripping means.

Another object of the invention is to provide a composite punch in which the punch body is made of an alloy capable of being drawn in heat treatment to a maximum of toughness, and the punch tip is separate from the punch body and can be made of any suitable alloy for maximum hardness, both parts being adapted thereby to mass production in separate controlled production processes. In prior solid punches, a compromise between a good punching alloy and a good punch support alloy must be made, because the tip and body of the punch are integral with one another and the punch must be subjected to a separate drawing operation after heat treatment in an effort to impart toughness to the body of the punch while maintaining hardness at its tip, without adequate assurance that either quality is achieved.

Another object of the invention is to provide a perforating implement in which the stripping medium strengthens the punch.

Another object of the invention is to provide a perforating implement in which the stripping medium is mounted in a chamber in a structural member of little structural strength rather than on the periphery of that member,

thereby to provide a stable structural member for transmission of the perforating force to the punch.

Another object of the invention is to provide a perforating implement using a compressible solid as the stripping element and in which the solid is mounted within a chamber provided in a tubular member that carries the punch.

Another object of the invention is to reduce the mass of the punch and stripping spring assemblage so that the natural frequency which can be attained is much higher than that of a conventional punch with the result that the punch and stripping spring assemblage can be reciprocated at higher speeds.

A further object of the invention is to provide a stripping medium of reduced weight and volume so that its mass is substantially less than that of stripping means used in conventional punches with the result that the cycling frequency can be higher than with a conventional punch and stripping spring.

Another object of this invention is to provide a punch comprising a structural punch column which may be made from standard steel tubing and a short economical screw-machine-manufactured plug or punch insert bit, in place of a long solid bar of costly tool steels as required in present punches for use in self contained perforating implements.

Another object of the invention is to provide a combined perforating punch and stripping member of reduced mass, so that if the punch would stick in the workpiece and then break free after the withdrawal of the punch ram, the generated force from said mass accelerated by said spring medium will apply less force to the restraining means on said perforating assemblage or to the press ram, whichever it may engage first than is the case with conventional perforating units, whereby damage is minimized.

Still another object of the invention is to provide a self-contained perforating implement so constructed that none of the forces of stripping the work from the punch are transmitted through the holder.

A still further object of the invention is to provide a self-contained perforating implement in which means is provided for preventing the perforating assemblage from jumping out of the holder in event the punch sticks in the work during a perforating operation.

Still another object of this invention is to provide a self-contained perforating implement employing quick disconnect anti-jump means so that the punch may be rapidly removed for sharpening.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the drawings:

Fig. 1 is a side elevation of a self-contained perforating unit constructed according to one embodiment of this invention;

Fig. 2 is a section through this unit taken on the line 2—2 of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a section similar to Fig. 2 but showing the moving parts of the unit at the end of the working stroke of the punch;

Fig. 4 is a section on the line 4—4 of Fig. 2, looking in the direction of the arrows;

Fig. 5 is a fragmentary side elevation, partly broken away, showing the upper part of a punch holder made according to a modification of the invention and having means for adjusting the stripping preload;

Fig. 6 is a side elevation, similar to Fig. 1, illustrating a further embodiment of this invention;

Fig. 7 is a fragmentary vertical section through this unit on an enlarged scale;

Fig. 8 is a section, similar to Fig. 7, but showing the moving parts of the unit at the end of the working stroke;

Fig. 9 is a fragmentary section taken on the line 9—9 of Fig. 7, looking in the direction of the arrows;

Fig. 10 is a section on the line 10—10 of Fig. 8, looking in the direction of the arrows; and

Fig. 11 is a detail view showing in rear elevation the structure of the novel stripping means of the perforating unit of Figs. 6 to 10 inclusive.

Referring first to the embodiment of the invention shown in Figs. 1 to 4 inclusive, 20 denotes the perforating implement generally. This implement comprises a C-frame 21 having upper and lower arms 22 and 23, and having a pilot pin 24 projecting downwardly from its base, whereby the perforating implement may be located in a precision-located pilot hole in a template base 25 of the press upon which the perforating implement is being used. Mounted on the lower arm 23 of the frame is a die member 27. This die member may be of conventional construction, having a die opening 28 (Fig. 2) therein and being relieved below said die opening, as indicated at 29, to provide a discharge passage or chute to the outside through which the slugs punched from the work are discharged.

Mounted in the upper arm 22 of the frame is the punch assembly 30. This is mounted in axial alignment with the die member. This assembly comprises a cylindrical, tubular member 31 that is closed at its upper end and that has a punch bit 33 mounted in its lower end. The tubular member 31 has a conical bore portion 34 at its lower end and the punch bit 33 has a correspondingly tapered conical portion 35 which fits with a press-fit tightly into this conical portion 34 of the tubular member.

Reciprocably mounted in the tubular member 31 above the punch bit 33 is a piston 37. This piston bears at its lower end on a pin or crossbar 38 which passes through diametrically opposed slots 39 in the tubular member 31 and engages at its opposite ends in apertures in a tubular stripping collar 40.

The tubular punch member 31 holds a cylindrical, compressible solid member 46 made of a solid plastic material of high compressibility, such as a hard silicone, nylon, polystyrene, etc. The columnar member 46 bottoms at its upper end in the tubular member 31 and engages at its lower end against a sealing member 48 that in turn engages against the upper end of the piston 37.

The punching force is transmitted from the ram 45 (Fig. 3) through the tubular member 31 to the punch bit 33. During a working stroke, the stripping member 40 moves with the punch 33 and the tubular punch member 31 until it strikes the sheet metal plate or other workpiece 50 (Fig. 3) which is to be perforated, being driven by tubular punch member 31, compressible solid 46, seal 48, piston 37 and pin 38. On the further downward stroke of the punch, effecting the perforating operation, the solid member 46 is compressed and reduced in volume through action of stripper collar 40, pin 38, piston 37 and seal 48, with the result that, when the ram 45 moves upwardly on its return stroke, releasing the pressure from the tubular member 31, the solid member 46 will expand to its former volume, forcing the tubular member 31 upwardly to withdraw, that is, to strip the punch 33 from the workpiece 50.

The stripping movement of the punch continues until the lower end 52 of the slot 39 in the tubular member 31 strikes or stops the pin 38. The punch assemblage 30 is then returned to its upper position shown in Fig. 3 by a coil lifter spring 55 which surrounds the tubular member 31 and is fastened at one end 56 in the tubular member and rests at its other end on the upper arm 22 of the frame 21.

In the punch assemblage 30, the punch member, instead of being a slender perforating implement surrounded by a tubular stripper, comprises a tubular member, which is cored out so that the core, or slender, low-strength inner portion has been removed and replaced by a compressible solid member 46. This compressible solid member strengthens the tube as well as serving as the

stripping medium. The punch assemblage in the perforating unit illustrated in Figs. 1 to 4 inclusive, then, comprises a closed tubular member 31 having the strength and rigidity normally associated with cylindrical members of the same diameter and length.

The punch bit 33 itself is made of a material adapted to homogeneous heat treatment so as to have efficient perforating properties and be structurally strong and resist abrasion. The compressible solid member 46 is highly efficient in operation; and the stripping member 40 is light weight. Therefore higher punch velocities can be obtained with the perforating punch assemblage of the present invention because of the reduced mass.

Fig. 3 shows positions of the parts upon completion of the perforating operation, the punch member 33 having perforated the workpiece 50, removing the slug 51 therefrom, and the stripping collar 40 has been moved upwardly with reference to the tubular member 31 so that the pin 38 has energized the piston 37 which in turn has compressed or reduced the volume of the compressible solid member 46. Upon withdrawal of the press ram, as stated above, stripping collar 40 acts against the workpiece 50 to withdraw the punch element 33, after which, due to lifter spring 55, the apparatus again assumes a position such as shown in Fig. 2, the elevating or lifting spring 55 having lifted the assemblage 30 enough to permit the removal or replacement of work thereunder.

The mating tapers 34 and 35 of the tubular member 31 and of the punch element 33, respectively, are a locking taper, the punch element being initially forced tightly into the tubular member 31. On each succeeding operation the punch element is driven still more tightly into the tubular member and it cannot become disengaged therefrom by the normal stripping load. The reason for this is that the tapers, in addition to being locking, have a larger ratio of area to the load between the punch than to the thickness of the material which is to be punched by the assemblage, which guarantees that the surface friction between the tapers is greater than the friction between the punch and the hole so that the punch element will be securely held in the tubular member. However, by use of a suitable tool, the punch element can be removed readily from the tubular member for replacement when it becomes dull or should it be broken.

The pin 38, which transmits the stripping loads, is preferably a tubular member consisting of a rolled plate which, when embedded and forced into the aligned apertures in collar 40, locks therein and by virtue of its elasticity seeks to regain its shape, thus holding it the more securely in position. This member is shown in greater detail in the cross section of Fig. 4 which illustrates how the pin is lodged tightly in the external collar 40 to be engaged by the piston 37. Obviously a rectangular pin or any other suitable pin can be used in place of pin 38 illustrated.

While the compressible solid member 46 is shown as a long cylindrical member, it will be noted that, when the apparatus is at rest, the punch element 33 is withdrawn up within the stripping collar 40 a slight amount (Fig. 2) so that upon initial operation of the device the stripping member 46 will be distorted initially or preloaded before the workpiece is engaged, the solid member 46 being compressed on engagement of stripper 40 with the work. While this is satisfactory in most cases, it is sometimes necessary to preload the stripping medium either by initial distortion or compression before any travel takes place. To this end a modified form of tubular member may be employed, such as shown in Fig. 5. Here a tubular member 31' is employed that is threaded internally at its upper end to receive an adjusting screw 60 which bears against a nylon seal 61 which, in turn, bears against the compressible solid member 46. It will be obvious that the member 60 can be threadedly adjusted in the tubular member 31' so as to preload the compressible solid member 46, while still maintaining the same punch stroke, since the cylindrical member 31' may be made of the same length as the tubular member 31, both being of the same length with respect to the shut height of the perforating unit. It will further be obvious that member 31' can be made of stainless steel tubing, cutting the cost of machinery.

A further modification of the invention is shown in Figs. 6 to 11 inclusive. In order to obtain increased volume for perforation of a thicker piece of material, the compressible member in this embodiment of the invention is a tapered member 76. The use of such a member permits of increase in the volume of compressible material while maintaining the area which engages the piston. The tapered member 76 tapers from its upper end downwardly to its lower end and at its lower end is of substantially the same diameter as the diameter of the cylindrical compressible member 46 shown in the embodiment of Figs. 1 to 3 inclusive. The tapered compressible member permits of longer stroke loads for a given volume and piston force. Because of the enlarged portion and tapered section of the compressible solid member with its increased volume the perforating unit illustrated here is capable of perforating approximately twice the thickness of material as is the perforating unit shown in Figs. 1 to 5. This is because the increased volume of the compressible solid member permits a longer stroke with a greater force than is permissible with the device of Figs. 1 to 5. A unit made according to this embodiment of the invention may be shorter, narrower and still develop much greater stripping force with longer spring life than conventional units with single steel wire springs.

In this embodiment of the invention the perforating unit comprises a C-frame 121 having an upper arm 122 and a lower arm 123. The lower arm carries a die 127 which may be of conventional construction. Mounted in the upper arm 122 is a tubular member 71. This member has a conical bore 72 which contains the correspondingly conically shaped compressible solid member 76. This compressible member is made, like member 46, of a compressible plastic, such as a hard silicone, or the like. The upper end of the tubular member 71 is sealed by a cap 73 which threads adjustably onto the tubular member 71. Interposed between the cap and the solid member 76 are a variable series of washers 74 and a nylon seal 77. The compressible solid 76 bears at its lower end against a nylon seal 78 which, in turn, seats against the upper end of a piston 77.

In this form of the invention the stripper member comprises a C-shaped member 80 which seats on a projection 81 formed on the lower end of the piston 77. This projection engages in a hole 82 formed in the upper arm 83 of the C-member 80. The upper arm 83 of the C-member extends through a slot 84 in the tubular member 71. Because of the increased loading of the unit of Figs. 6 to 11, it is desirable that the tubular member 71 be not cut or slotted in two places, since this tends to weaken the structure through which the compressible or punching loads are carried. Accordingly, the tubular member 71 is slotted at one side only as indicated at 84, the C-frame member 80, being inserted through the slot 84 to fit over the protuberance 81 on the piston 77 so that it is locked to the piston and cannot move relative thereto with respect to the axis of the punch.

The C-frame 80 is held in engagement with the piston 77 by a coil spring 85 which is mounted within a hole 86 in the upper arm 122 of the perforating unit, and which engages at one end in a hole 87 in the stripper member and at its other end over a pin 88 that is secured in the upper arm 122 of the C-frame. This spring operates to elevate the punch as well as to hold the member 80 in engagement with the piston member 77. The C-frame can readily be removed by pulling it down off the protuberance 81 of the piston 77, and sliding it to the right in Fig. 7.

Because of the high loads which must be transmitted through this C-member 80, I prefer to make it of general

I-beam type construction in cross-section as is shown in detail in Figs. 10 and 11. In this way the excessive high loads can be carried around the body member 71 for the purposes described.

The punch 90 in this embodiment of the invention is formed with a cylindrical surface 91 at its upper end, which is of somewhat larger diameter than its operating portion and which has a press fit in the lower end of the tubular member 71. The lower arm 93 of the stripper 80 has a hole 94 through it which is axially aligned with the axis of the tubular member 71 and through which the punch 90 can move on its working and return strokes.

By varying the thickness or the number of washers 74 the compressible solid member 76 can be preloaded as desired.

It will be noted that the C-frame stripper 80 and its counterpart stripper 40 of Fig. 2 are larger than the bore in the upper arm 22 or 122 of the perforating unit in which the tubular members 31 and 71, respectively, are mounted. This prevents the punching assemblies 30, or 130, respectively, from jumping out of their respective holders. If the punch jumps after failure to strip, which has occurred in prior existing units, the ram is sometimes lowered again causing failure of the press, work and tools. It cannot occur with the anti-jump provision of the present invention.

The operation of the punch in this embodiment of the invention is substantially the same as previously described. In its descent, the ram 45 of the press strikes the cap 73, moving the tubular member 71, punch 90 and stripper member 80 downwardly. The stripper member 80 moves with the punch and the tubular member 71, against the resistance of the spring 85. When the stripper member 80 engages the upper face of the work 50, its downward movement is arrested, but the downward movement of the ram continues to drive the punch through the work. In this continued downward movement, the solid member 76 is compressed in volume, as shown by a comparison of Figs. 7 and 8, and the punch is driven through the work to perforate the work and punch a slug 51 therefrom. When the ram reverses its movement, returning upwardly, the compressed solid member 76 is free to expand to its former volume again, withdrawing the punch from the work. Then the spring 85 is free to return the punch assemblage, also, to its upper position, the parts assuming the positions shown in Fig. 7.

As is evident, in the perforating units described the heavy coil stripping spring heretofore required in conventional perforating units, is eliminated. With the novel construction of the present invention closer hole centers can be punched; and sheets of given thickness can be punched on smaller presses, or sheets of greater thickness than heretofore possible can be punched on conventional size presses. In addition because of the reduced mass of the punch assemblage, higher speed presses can be used.

While the invention has been described in connection with several different embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member and extending above and below said other arm, said punch member being hollow and having a shearing portion at its lower end, a compressible stripping means mounted in the hollow portion of said hollow punch member, a stripping member positioned between said two arms, said punch member being reciprocable in said stripping member, said stripping member being normally positioned adjacent to and below the lower end of the shearing portion of said punch member, and means connecting said stripping member to said compressible stripping means to compress said compressible stripping means on the punching stroke of said punch member.

2. A self-contained perforating unit comprising a holder, a punch member mounted on said holder and having a shearing portion at its lower end, said punch member being hollow and closed at its upper end, a compressible solid material positioned in the hollow portion of said punch member, a sealing member sealing said solid material against extrusion from the lower end of said punch member, a stripping member in which said punch member is reciprocable, said stripping member being positioned to engage the work on the perforating stroke of the perforating unit, a piston acting against said seal and means connecting said stripping member through said punch member to said piston to compress said solid material after said stripping member has engaged the work, whereby on release of the punching force, said compressible solid material will expand to strip the punch member from the work.

3. A combination punch and stripping assemblage comprising a punch member having a bore closed at one end and having a shearing portion at one end, a compressible solid material positioned in the bore of said punch member, at least one sealing member sealing said solid material against extrusion from said punch member, a piston member acting against said sealing member, and a stripping member external of said punch member and in which said punch member is slidable, said stripping member being connected to said piston to compress said compressible material upon relative movement between said stripping member and said punch member on the punching stroke of said punch member, thereby to apply a stripping force to said punch member upon completion of said punching stroke, and adjustable means for preloading said compressible material whereby to vary the preload of said solid material for different stripping conditions.

4. A self-contained perforating unit comprising a C-frame, a die member mounted on the lower arm of said C-frame, a punch member mounted to reciprocate in a bore formed in the upper arm of said C-frame in axial alignment with said die member, said punch member having a shearing portion at its lower end, a lifting spring interposed between said C-frame and said punch member for elevating said punch member to provide work feed clearance between said punch member and said die member, a stripping member in which said punch member is slidable, said stripping member having a lost motion connection with said punch member to limit the upward, lifting movement of said punch member and to permit said punch member to effect the perforating operation after said stripping member has engaged the work on the perforating stroke of the perforating unit, and a compressible stripping medium in said punch member, means for connecting said stripping member and said compressible stripping medium to compress said compressible stripping medium upon relative movement between said stripping member and said punch member on the perforating stroke of said perforating unit, whereby upon withdrawal of the punching force said stripping medium will expand to withdraw the punch member from the work.

5. A perforating punch assemblage comprising a punch member having a bore closed at one end, said punch member having a shearing portion at one end, a compressible solid material within said bore and adapted to support said punch member against deflection and to provide the force for stripping said punch

member from the work after a perforating stroke, and stripping means relative to which said punch member is slidable, said stripping means including a stripping member positioned to engage the work on the perforating stroke of said perforating unit, said stripping member being operatively connected with said compressible material to compress said compressible material after said stripping member has engaged the work and during the perforating operation of said punch member, whereby upon release of the punching force, said compressible member expands to strip said punch member from the work.

6. A perforating punch assemblage comprising a punch member having a bore closed at its upper end, said punch member having a shearing portion at its lower end, a compressible solid material in said bore adapted to support said punch against lateral deflection and to provide the stripping force, and a stripping member in which said punch member is slidable and normally positioned adjacent to and below the lower end of said punch member, said stripping member being operatively connected to said compressible material to compress said compressible material when said stripping member engages the work on the perforating stroke of said punch assemblage, whereby to strip said punch member from the work upon completion of said stroke, said stripping member being tubular and surrounding and supporting said punch member against outward deflection.

7. A combination punch and stripping assemblage comprising a cylindrical member for transmitting the punching force and having a bore which is closed at one end, a punch secured to the lower end of said cylindrical member, a compressible solid material in said bore and adapted to stiffen said cylindrical member against lateral deflection but yieldable on compression to provide a resilient stripping force, and a stripping member positioned to engage the work on a perforating stroke of said punch, said member having a lost-motion connection with said punch to move therewith on the first part of said perforating stroke but to permit said punch to effect the punching operation after said stripping member has engaged the work, said stripping member being connected to said compressible solid material to compress said material during the punching operation.

8. A combination punch and stripping assemblage comprising a punch supporting member having a bore which is closed at one end, an insertable punch bit mounted in the other end of said bore, a compressible solid material mounted in said bore between said punch bit and said one end of said punch supporting member, a stripping member having a lost-motion connection with said punch supporting member and positioned to engage the work on the perforating stroke of said assemblage, and means connecting said stripping member to said compressible material to compress said material on a working stroke of said punch, whereby said material will strip the workpiece from the punch upon release of the punching load applied thereto.

9. A self-contained perforating unit comprising a holder, a stripper member, a tubular punch member which is closed at one end and which has a shearing portion at its opposite end, said punch member being reciprocable in said holder and in said stripper member, a compressible material mounted in the bore of said punch member, and lost-motion means connecting said punch member to said stripper member so that the two members move together on a working stroke of the punch until the stripper member engages the work and so that thereafter on continuation of said working stroke said compressible material is compressed so that when said punch member is relieved of the punching force, said compressible material will return the punch to initial position.

10. A self-contained perforating unit comprising a holder, a tubular punch member which is closed at its upper end and which is reciprocable in said holder, an inserted punch bit secured in the lower end of said punch member, a compressible member mounted in the bore of said tubular member between its upper end and said punch bit, a tubular stripper member surrounding said punch member and in which said punch member and said punch bit are reciprocable, said stripper member being normally positioned adjacent to and below the lower end of said punch bit, lost-motion means operatively connecting said tubular punch member to said stripper member, and means operatively connecting said stripper member to said compressible member to compress said compressible member upon relative motion between said punch member and said stripper member on the punching stroke of said unit.

11. A self-contained perforating unit comprising a holder, a tubular punch member which is closed at its upper end and which is reciprocable in said holder, an inserted punch bit secured in the lower end of said punch member, a piston, a compressible member mounted in the bore of said tubular member and interposed between said piston and the upper end of said tubular member, a stripper member in which said punch member is reciprocable, said stripper member being normally positioned adjacent to and below the lower end of said punch bit, a lost-motion connection between said stripper member and said punch member, and means operatively connecting said piston to said stripper member to compress said compressible member on the punching stroke of said punch member after said stripper member has engaged the work.

12. A self-contained perforating unit comprising a holder having an upper arm and a lower arm, a die member mounted on said lower arm, a tubular punch member which is closed at its upper end and which is mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable stripper member mounted below said upper arm and through which said punch member reciprocates, a compressible member mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means connecting said compressible member with said stripper member to transmit motion from the punch member to the stripper member during part of a working stroke of the punch member and to compress said compressible member when said stripper member engages the work during a further part of said working stroke, whereby upon release of the punching force said compressible member will expand to return said punch member to initial position and strip said punch bit from the work, and means for returning said stripper member to initial position, said stripper member being so disposed that said upper arm acts as a stop limiting its return movement.

13. A self-contained perforating unit comprising a holder having an upper arm, and a lower arm, a die member mounted on said lower arm, a tubular punch member which is closed at its upper end and which is mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable stripper member mounted below said upper arm and through which said punch member reciprocates, a compressible solid member mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means connecting said compressible member with said stripper member to transmit motion from said punch member to said stripper member during part of a working stroke of the punch member and to compress said compressible member when said stripper member engages the work during a further part of said working stroke, whereby upon release of the punching force said compressible member will expand to return said punch member to initial position and strip said punch bit from the work, and means for returning said stripper member to initial position, said stripper member being so disposed that it engages said upper arm

on its return movement, whereby said upper arm acts as a stop limiting the return movement of said stripper member.

14. A self-contained perforating unit comprising a holder having an upper arm, and a lower arm, a die member mounted on said lower arm, a tubular punch member mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable stripper member mounted below said upper arm and through which said punch member reciprocates, a compressible solid material mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means confining said solid material at its upper end, a seal confining said solid material at its lower end, a piston slidable in said bore and engaged by said seal, means extending through a slot in said punch member to operatively connect said stripper member with said piston so that said compressible material is compressed upon relative movement between said stripper member and said punch member on the working stroke of said punch member, and spring means connecting said stripper member to said upper arm to constantly urge said stripper member to return to its initial position, said stripper member being so disposed that it engages said upper arm on its return movement, whereby said upper arm acts as a stop limiting the return movement of said stripper member.

15. A self-contained perforating unit comprising a holder having an upper arm and a lower arm, a die member mounted on said lower arm, a tubular punch member mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable stripper collar mounted below said upper arm and surrounding said punch member, a compressible solid material mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means confining said compressible material at its upper end, a seal confining said compressible material at its lower end, a piston slidable in said bore and engaged by said seal, a pin extending through an elongate slot in said punch member and connecting said piston to said stripper member to compress said compressible material upon relative movement between said stripper member and said punch member on the working stroke of said punch member, and spring means disposed above said upper arm and abutting at one end against said upper arm and connected at its other end to said punch member to return said stripper member to initial position.

16. A self-contained perforating unit comprising a holder having an upper arm and a lower arm, a die member mounted on said lower arm, a tubular punch member mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable C-shaped stripper member mounted below said upper arm and in which said punch member is reciprocable, a compressible solid material mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means confining said compressible material at its upper end, a seal confining said compressible material at its lower end, a piston slidable in said bore and engaged by said seal, said stripper member having its upper arm extending through an elongate slot in said punch member, a pin connecting the upper arm of said stripper member with said piston to compress said compressible material upon relative movement between said stripper member and said punch member on the working stroke of said punch member, and a spring connecting said stripper member with the upper arm of said holder to constantly urge said stripper member to return to its initial position, said stripper member being so disposed that it engages said upper arm on its return movement, whereby said upper arm acts as a stop limiting the return movement of said stripper member.

17. A self-contained perforating unit comprising a holder having an upper arm, and a lower arm, a die member mounted on said lower arm, a tubular punch member mounted reciprocably in said upper arm in axial alignment with said die member, a reciprocable stripper member mounted below said upper arm and through which said punch member reciprocates, a compressible solid material mounted in the bore of said tubular member, a punch bit inserted in the lower end of said bore, means confining said solid material at its upper end, a seal confining said solid material at its lower end, a piston slidable in said bore and engaged by said seal, means extending through a slot in said punch member to operatively connect said stripper member with said piston to compress said compressible material upon relative movement between said stripper member and said punch member on the working stroke of said punch member, and spring means connecting said stripper member to said upper arm to constantly urge said stripper member to return to its initial position, said stripper member being so disposed that it engages said upper arm on its return movement, whereby said upper arm acts as a stop limiting the return movement of said stripper member, said confining means being adjustable for preloading said solid material.

18. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being hollow and having a shearing portion at its lower end and being closed at its upper end, a compressible solid mounted in the hollow portion of said hollow punch member, a stripper member positioned to engage the work and in which said punch member is slidable, a lost-motion connection between said stripper member and said punch member, and means connecting said stripper member to said compressible solid for transmitting stripping forces between said compressible solid and said stripper member.

19. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being hollow and having a shearing portion at its lower end and being closed at its upper end, a compressible solid mounted in the hollow portion of said hollow punch member, a stripper member positioned to engage the work and in which said punch member is slidable, a lost-motion connection between said stripper member and said punch member, and means connecting said stripper member and said compressible solid for transmitting stripping forces between said compressible solid and said stripper member, and means for preloading said compressible solid.

20. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being hollow, a compressible solid material mounted in the hollow portion of said punch member and confined therein at both its upper and its lower ends, a punch bit inserted in the lower end of said punch member, a stripper member positioned to engage the work and in which said punch member is slidable, a lost-motion connection between said stripper member and said punch member, and means connecting said stripper member to said compressible material for transmitting stripping forces between said compressible material and said stripper member.

21. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being hollow, a compressible solid material mounted in the hollow portion of said punch member and confined therein at both its upper and its lower ends, a punch bit inserted in the lower end of

said punch member, a stripper member positioned to engage the work and in which said punch member is slidable, and means connecting said stripper member and said compressible material for transmitting stripping forces between said compressible material and said stripper member, and means for preloading said compressible material.

22. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a tubular punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being closed at its upper end, a compressible solid mounted in the bore of said punch member and confined at its upper end by the closed upper end of said tubular member, means confining the lower end of said compressible solid, a punch bit inserted in the lower end of said punch member, a stripper member positioned to engage the work and in which said punch member is slidable, and means interposed between said punch bit and the last-named means for operatively connecting said stripper member to said compressible solid to compress said compressible solid upon relative movement between said stripper member and said punch member on the working stroke of said perforating unit.

23. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a tubular punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, said punch member being closed at its upper end, a compressible solid mounted in the bore of said punch member and confined at its upper end by the closed upper end of said tubular member, means confining the lower end of said compressible solid, a punch bit inserted in the lower end of said punch member, a stripper member positioned to engage the work and in which said punch member is slidable, and means extending through an elongate slot in said punch member and interposed between said punch bit and said last-named means for operatively connecting said stripper member to said compressible solid to compress said compressible solid upon relative movement between said stripper member and said punch member on the punching stroke of said perforating unit.

24. A self-contained perforating unit comprising a C-frame, a die member carried by one arm of said C-frame, a tubular punch member mounted to reciprocate in the other arm of said C-frame in axial alignment with said die member, a cap threaded on the upper end of said punch member to close the upper end of its bore, a compressible solid mounted in the bore of said punch member and confined at its upper end by said cap, a seal confining said compressible solid at its lower end in said bore, a punch bit inserted in the lower end of said bore, a reciprocable stripper member positioned to engage the work and in which said punch member is slidable, and means interposed between said seal and said punch bit for operatively connecting said stripper member to said compressible solid to compress said compressible solid upon relative movement between said stripper member and said punch member on the punching stroke of said perforating unit.

25. A self-contained perforating unit comprising a holder having upper and lower arms, a die member carried by one arm of said holder, a tubular punch member mounted to reciprocate in the other arm of said holder in axial alignment with said die member, said tubular member being closed at its upper end and having a bore portion which is conical and larger at its upper end than at its lower end, a compressible conical solid member mounted in said bore portion, said bore having a cylindrical portion joining the lower end of said conical portion, a cylindrical piston reciprocable in the cylindrical portion of said bore, a punch bit secured to said tubular member below said piston, a stripper member in which said tubular punch member and said punch bit are slidable, and means connecting said piston to said stripper member to compress said compressible member upon relative movement between said stripper and said punch member on the punching stroke of said perforating unit.

26. A perforating punch assemblage of reduced mass comprising a tubular punch body, a punch insert fastened in said tubular body at one end thereof, and stripping means mounted both within and without said punch body, said punch body being reciprocable in the outside stripping means and being connected to said outside stripping means by a lost-motion connection, said outside stripping means being positioned to engage the work on a working stroke of said assemblage, and the inside stripping means being compressible and being connected to the outside stripping means to be compressed upon relative movement between said outside stripping means and said punch body on the working stroke of said assemblage.

27. A perforating punch assemblage comprising a support, a tubular punch body reciprocable in said support, a pair of spaced plug members for closing a portion of said tubular body at opposite ends thereof, at least one of said plug members being slidable in said body, a compressible solid positioned between said plug members in said body, a punch insert secured in said punch body at one end thereof, and stripping means surrounding said body and in which said body is slidable, and a lost-motion connection connecting said stripping means to said punch body, said stripping means being operatively connected to one of said plugs to compress said compressible solid upon relative movement between said stripping means and said punch body on the working stroke of said punch body.

28. A perforating punch assemblage comprising a support, a tubular punch body reciprocable in said support, a punch bit secured in one end of the bore of said body and having a locking tapered fit in said bore, compressible stripping means mounted in said body, a stripper positioned to engage the work and in which said body is slidable, a lost-motion connection between said stripper and said body, and means connecting said stripping means to said stripper to compress said stripping means on relative motion between said stripper and said body on the working stroke of said body.

29. A perforating punch assemblage comprising a support, a tubular punch body reciprocable in said support, a hardened punch bit secured in the lower end of the bore of said body and having a locking tapered fit in said bore, a compressible solid mounted in said bore above said punch bit, means closing the upper end of said bore, a stripper positioned to engage the work and in which said body is slidable, a lost-motion connection between said stripper and said body, and means connecting said compressible solid to said stripper to compress said compressible solid upon relative movement between said stripper and said punch body on the working stroke of said punch body.

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