Sept. 10, 1940. C. C. BROWN 2,214,320

CASING PERFORATOR

Filed Jan. 11, 1940 4 Sheets-Sheet 1

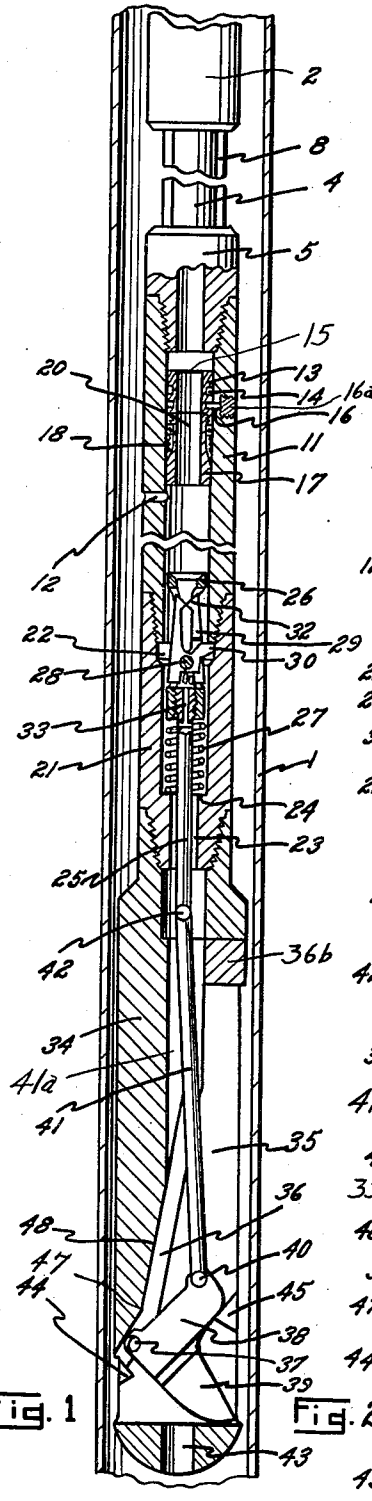

Fig. 1

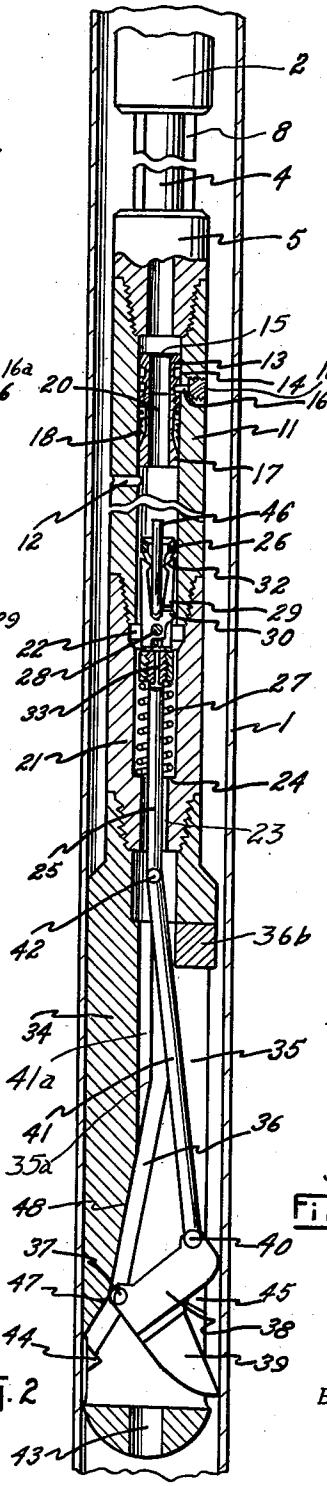

Fig. 2

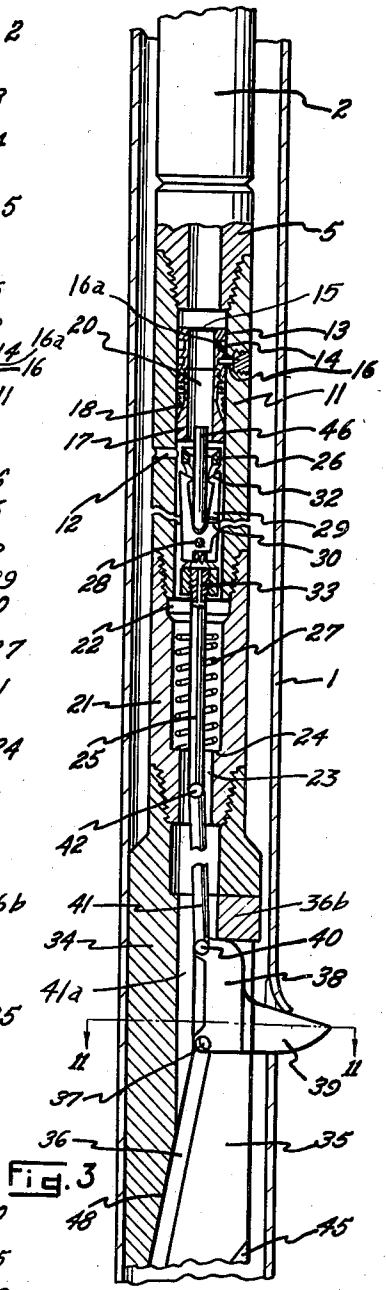

Fig. 3

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CASING PERFORATOR

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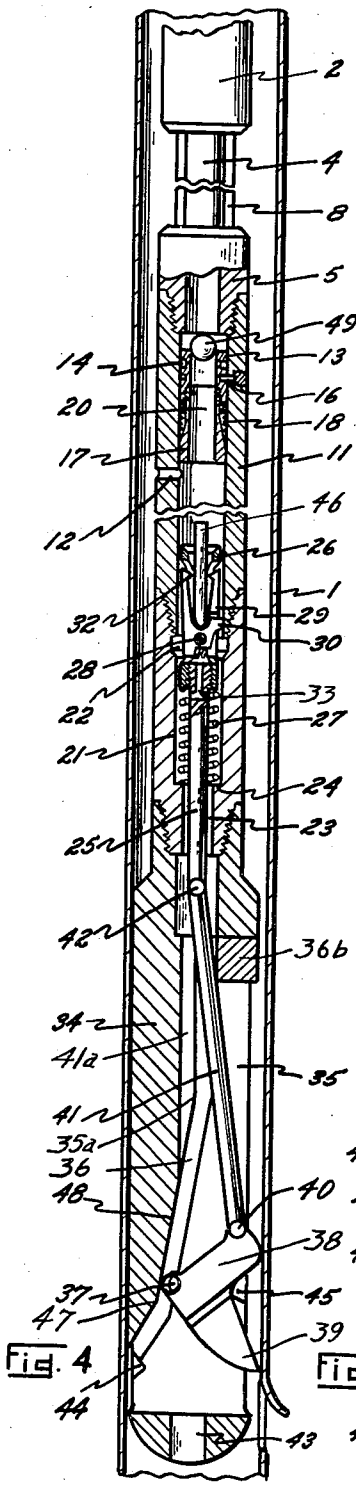

Fig. 4

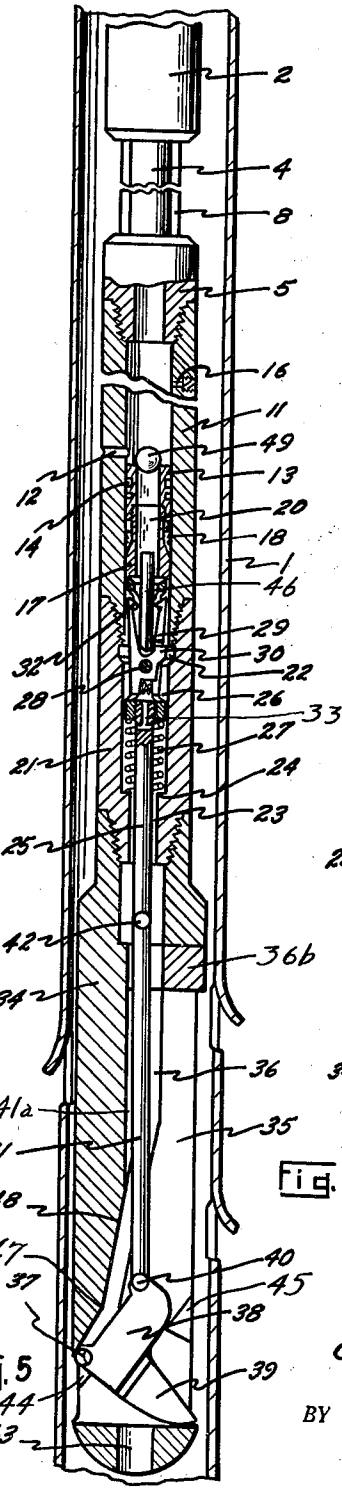

Fig. 5

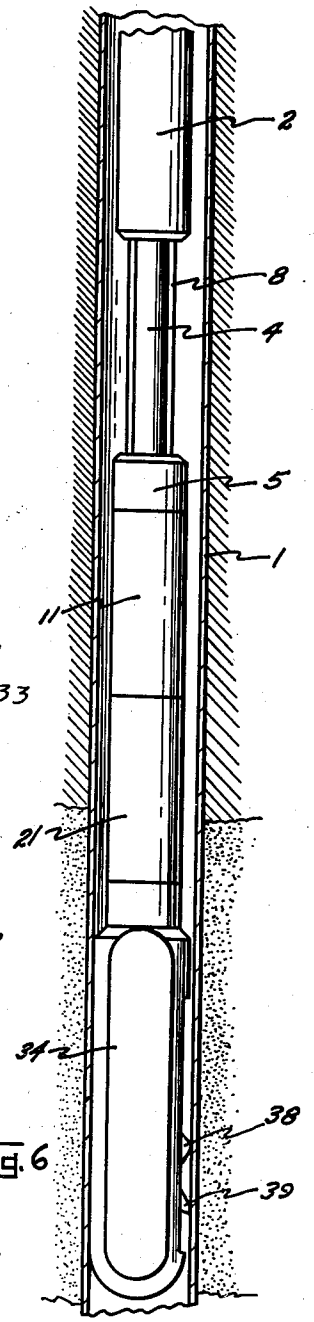

Fig. 6

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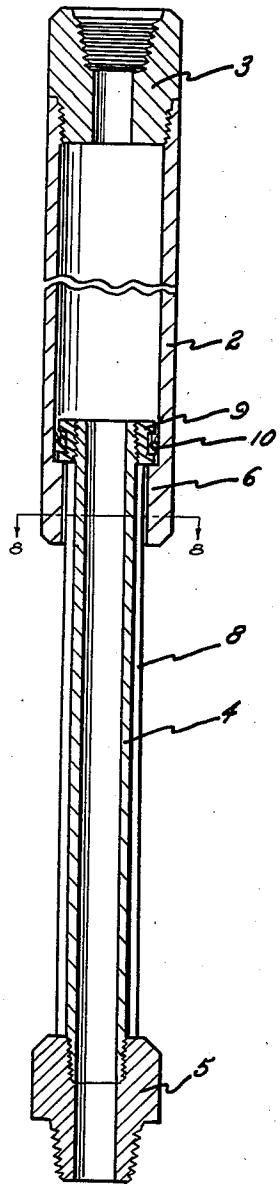

Fig. 7

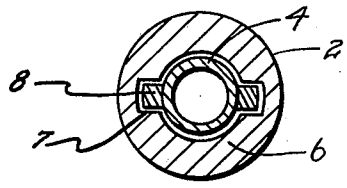

Fig. 8

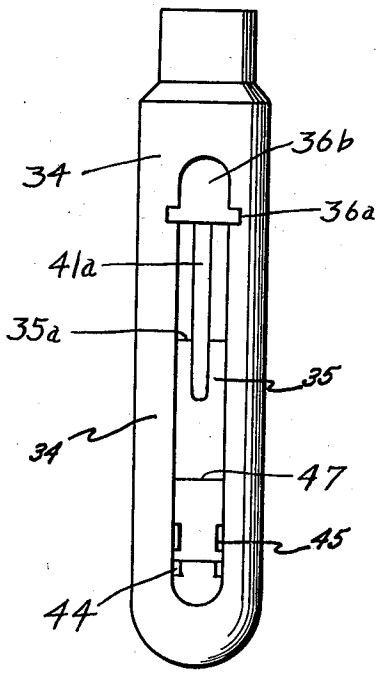

Fig. 9

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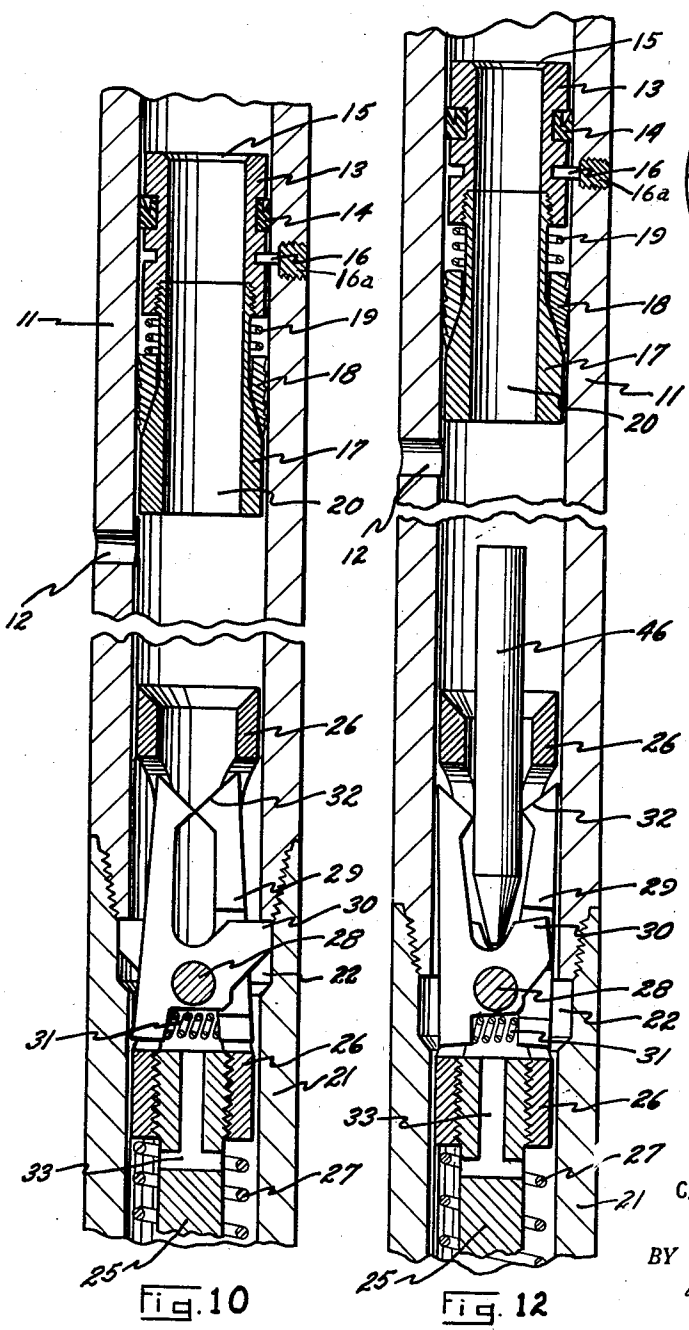

Fig. 10

Fig. 12

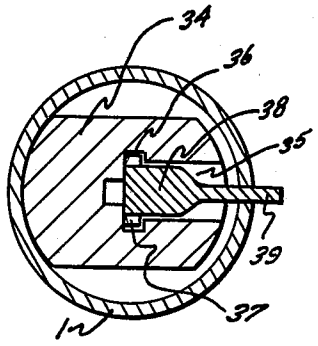

Fig. 11

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UNITED STATES PATENT OFFICE

2,214,320

CASING PERFORATOR

Cicero C. Brown, Houston, Tex.

Application January 11, 1940, Serial No. 313,324

11 Claims. (Cl. 164—0.4)

This invention relates to a casing perforator, and has for its general object the provision of a mechanical device for perforating well casing, which device may be operated at the will of the operator and will not be susceptible of operation accidentally.

In the completion of oil and gas wells it frequently becomes desirable to perforate the casing of the well at some point or points above the lower end of the well for the purpose of testing and possibly producing oil or gas from formations known to exist at those points. Various means have been devised for so perforating the casing, including shooting devices for shooting holes in the casing and mechanical means for mechanically forcing a knife or similar projection through the casing. In many instances the mechanical perforations have been found to be more efficient in production of oil or gas or similar substances than have those formed by shooting. However, previous mechanical devices for perforating the pipe have been uncertain in their operation and subject to many defects. Among the defects encountered one of the most serious has been that at times the mechanical perforating means has been actuated at some point in the well other than where perforation was desired, and a perforation of considerable size thus formed accidentally. This is a very serious matter because such a perforation at an undesired point might easily ruin a well of great value.

It is an object of this invention to provide a device for producing mechanical perforations which device will be positive in its operation and cannot operate accidentally.

Another object of this invention is to produce a device of the type set forth which cannot operate to produce perforations while it is being lowered into a well until such time as the operator positively actuates the device for that purpose.

Another object of this invention is to produce a device of the type set forth which can be reset before being removed from the hole so that it cannot be made to operate thereafter.

Another object of this invention is to provide a device by which perforations in the pipe can be made closer together than with previous devices.

Another object of this invention is to provide a device with which perforations can be made closer to the bottom of a pipe or well than has been possible with devices heretofore employed.

Another object of this invention is to produce a device of the type set forth which may be released and caused to operate at any point within a well without necessity for first lowering the same to the bottom of the well.

Another object of this invention is to produce a device of the character set forth which will permit of circulation of fluid through the well at all times during its use and at any time while it is being inserted into or removed from the hole.

Another object of this invention is to provide a device which cannot be reset or rendered inoperative accidentally.

Another object of this invention is to provide a device of the character referred to which may be operated to produce as many perforations as may be desired on one trip into a well.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein is set forth by way of example one embodiment of this invention.

In the drawings:

Fig. 1 is a vertical cross section through a device constructed in accordance with this invention showing the parts of the same in the position which they occupy when being lowered into a well.

Fig. 2 is a similar view of the same device showing the parts in the position they occupy after being released for operation.

Fig. 3 is a view similar to Figs. 1 and 2, illustrating the position of the parts as they appear just as a perforation is completed.

Fig. 4 is a similar view illustrating the position of the parts as the same appear after being retracted following the making of a perforation and just prior to resetting the device so that it cannot again be operated.

Fig. 5 is a similar view illustrating the device after it has been reset.

Fig. 6 is a view illustrating a well in vertical cross section and showing the device constructed in accordance with this invention in side elevation therein and in position for perforating the casing.

Fig. 7 is a vertical cross section through a jar constituting a part of the operating means for this invention.

Fig. 8 is a horizontal cross section through the device shown in Fig. 7 taken along the line 8—8 thereof.

Fig. 9 is a side elevation of the member which forms the lower portion of the perforating tool shown in Figs. 1 to 6 inclusive, in which member the perforating knife is carried.

Fig. 10 is an enlarged view in vertical cross section illustrating a portion of the interior of

the perforating device and showing the same in the original position which it would occupy when being lowered into a well.

Fig. 11 is an enlarged horizontal cross section through the perforating knife taken along the line 11—11 of Fig. 3.

Fig. 12 is a view similar to Fig. 10 but showing the parts released and ready for performing the perforating operation.

In Fig. 1 the device is shown being lowered into a casing 1 which it is desired to perforate. In operation the device would be lowered on a drill stem or other suitable tubular member. There is interposed between such tubular member and the perforating tool a jar which is shown more in detail in Figs. 7 and 8. This jar consists of a cylindrical part 2 having a fitting 3 at its upper end whereby it may be connected to the drill stem or other tubular member, and a plunger 4 likewise provided with a fitting 5 at its lower end and whereby it may be connected with the perforating tool. It will be understood that this jar may be interposed in the drill stem itself at some point above the perforating tool if so desired.

The lower end of the cylindrical member 2 has an inwardly extending flange 6 with slots or key ways 7 formed therein and the plunger member 4 has longitudinally extending keys 8 provided theron for engagement with the key ways 7. At its upper end, there is threaded to the plunger 4 a piston-like element 9 having a suitable packing 10 thereabout adapted to form a seal between the element 9 and the interior of the cylindrical member 2.

To the lower end of the jar just described there is connected a second cylindrical part 11 having a lateral opening 12 therefrom intermediate its ends. Within the upper end of this member there is mounted a piston 13 having a packing 14 thereabout and provided with a valve seat 15 at its upper end adapted to receive a ball valve or other similar device for a purpose presently to be set forth. Below the sealing ring 14 there is provided a suitable shear pin 16 adapted to hold the piston in the position illustrated in Fig. 10. The hole through which the shear pin is inserted is threaded to receive a pipe plug 16*a* to prevent leakage about the pin. The piston has connected to its lower end a mandrel 17 having slips 18 downwardly pressed by means of a spring 19 to prevent upward movement of the piston 13. The piston and mandrel are provided with an opening 20 therethrough and the mandrel terminates at a point above the lateral opening 12.

The cylindrical member 11 has threaded to its lower end still another member 21 whose upper end is cylindrical and is counter bored at 22. The lower end of this member, however, is provided with an opening 23 of reduced diameter and at the upper end of this opening of reduced diameter is an upwardly facing shoulder 24.

Slidably mounted within the member 21 is an upper operating shaft 25 having a latching head 26 threaded to its upper end. Between this latching head and the shoulder 24 there is interposed a spring 27 which normally tends to urge the operating shaft and its connected parts in an upward direction. Pivotally carried by the latching head on a pivot 28 are the latching dogs 29 each having a part 30 adapted to engage within the counter bored portion 22 of the element 21 and about the lower end of the cylindrical member 11 to latch the upper operating shaft in its lowermost position. A spring 31 interposed between these latching members normally urges them into latching position. The latching members are beveled at their upper ends 32 for a purpose presently to be set forth.

The upper operating shaft 25 is provided adjacent its upper end with a passage 33 through which fluid may be pumped downwardly through the lower end of the tool.

Threaded to the lower end of the element 21 is the knife carrying head 34. This head has a slot 35 extending inwardly from one face thereof. The upper end portion of this slot is of uniform depth, but beginning at an intermediate point 35*a* of its length the depth of the slot increases gradually, and adjacent its lower end increases at a still more rapid rate until at its lower end it forms an opening entirely through the member 34. Formed in the opposite side walls of this slot 35 adjacent its bottom and following along its bottom, there is a pair of opposed channels or tracks 36 adapted to receive the guide pins 37 on the body 38 which carries the perforating blade or knife 39. These tracks are open to the exterior of the head 34 at 36*a* to permit the insertion of the pins 37 and the body 38, these open ends being closed after assembly by a block 36*b*. The blade or knife 39 with its body 38 forms an L-shaped member, the upper end of which is pivotally connected at 40 with a lower actuating shaft 41. The upper end of the shaft 41 is pivotally connected at 42 with the upper actuating shaft 25 hereinbefore referred to. The bottom of the slot 35 is grooved at 41*a* to receive the shaft 41. The lower end of the member 34 is provided with an opening 43 through which slush may be pumped.

On referring to Fig. 11, it will be seen that the body 38 of the knife or perforating member 39 is relatively thick so as to substantially fill the slot 35, whereas the perforating portion 39 of this member is relatively very thin so as to easily produce a perforation in the casing 1.

With reference to Fig. 1, it will be noted that there is a lug 44 on each side of the slot 35 adapted to be contacted by the heel or lower portion of the perforating element when in its lower position. So long as the operating shafts 25 and 41 are held down, it will be seen that these lugs 44, of which there is one on either side wall of the slot 35, will prevent the knife 39 from moving outwardly toward the inner wall of the casing 1 so long as the projections 37 remain within the grooves 36. It will also be seen that when in this position, the knife cannot swing so as to permit the heel of its body member to travel upwardly within the groove 36 because of the lugs 45 which contact the forward and upper end of the knife carrying body. The knife is thus held in the position shown in Fig. 1 so long as the shafts 25 and 41 are prevented from upward movement.

In operation, the device will be lowered into the hole with the parts positioned as shown in Figs. 1 and 10. As heretofore explained, the latches 30 with the parts in this position prevent upward movement of the operating shafts 25 and 41, and thus hold the knife in the position shown in Fig. 1. When the point lowest in the well is reached where it is desired to make a perforation, there will be dropped into the drill stem a tripping element in the form of a tapered-nose weight 46. This weight is of a size capable of passing through the jar and through the piston and mandrels 3 and 17. This member will enter the latching head 26 and wedge between the tapered upper ends 32 of the latching elements 29 to wedge these upper ends apart. This will cause the latching

parts 30 to be retracted, thus releasing the operating shafts 25 and 41 for upward movement.

Upon upward movement, the perforating blade will move to the position shown in Fig. 2 with both its perforating and its upper end in engagement with the casing wall and with its heel just above the point 47 at which the grooves 36 change their direction to a sharper angle with respect to the axis of the entire device. During this movement the blade will be moved toward projected position by the portions of the grooves 36 below the point 47, and because these portions are inclined with respect to the axis of the body at a relatively large angle, the mechanical advantage will be small and the movement of the blade rapid. The entire tool is then lowered and the body of the tool tends to slide downwardly with respect to the perforating blade, thus forcing the blade outwardly by virtue of its contact with the sloping wall 48 and the corresponding sloping portion of the grooves 36. As the body of the tool is lowered, the blade will perforate the casing as shown in Fig. 3, and will eventually be guided to the position illustrated in that figure with its end projecting out through the casing. During this perforating operation, because the said portions of the grooves 36 are at a relatively small angle to the body, the mechanical advantage will be great and the movement of the blade relatively slow.

After the first perforation has been made, the tool may be raised and the blade will be retracted by virtue of the same sloping portion or grooves 36 engaging the parts 37 on the blade. However, the blade will not be retracted to such an extent that it will not contact the wall of the casing. Instead, it will simply be dragged out of the perforation which it has formed and moved to a higher point in the casing. Immediately when the blade has been retracted from the perforation, it may be turned to a different rotary position by rotating the drill stem on which it is hung, this rotation being imparted to the body of the tool by virtue of the keys 8 in the jar, and the tool again lowered to make a second perforation. The perforations may of course be made one directly above the other if desired, and as many perforations may be made as desired.

The purpose of the jar hereinbefore described is to permit of a hammering action upon the body of the tool so as to move it either in forcing it downwardly to form the perforation or in moving it upwardly to retract the blade therefrom.

After the desired number of perforations have been made and the operator wishes to remove the tool from the well, he may drop into the well a ball valve 49 or similar device such as shown in Fig. 4. This valve is of a size to seat upon the valve seat 15 in the upper end of the piston 13. With the valve so seated, pressure may be applied to fluid in the drill stem by means of the customary pumps, and this pressure will cause the shearing of the pin 16 and the downward movement of the piston 13. This downward movement will cause the lower end of the mandrel 17 to contact the latching head 26, forcing this latching head downwardly until the upper end of the piston 13 passes the lateral opening 12 in the member 11. The fluid under pressure may then pass out through the opening 12 and the pressure of the fluid will thus be relieved, informing the operator that the resetting operation is complete. It will be appreciated that the downward movement of the latching head 26 will also cause downward movement of the operating shafts 25 and 41 and will cause the perforating knife to again assume the position shown in Figs. 1 and 5. In this position it cannot contact the inner wall of the casing and cannot be operated to cause a perforation of the casing. It is particularly noted that in the downward movement of the perforating blade, the parts 37 will follow the grooves 36 until the heel of the perforating element contacts the lugs 44. This will prevent further downward movement of the heel of the perforator, and further downward movement of the shaft 41 will cause the perforator to swing about the members 37 as a pivot until the upper end of the body of the perforator blade strikes the lugs 45. These lugs will then serve as a stop against further downward movement and the entire assembly will be locked in inoperative position. It will be seen that when the parts are in such position upward movement of the piston 13 will be prevented by means of the slips 18 and the tool as a whole may be moved upwardly or downwardly within the well as desired without causing any perforation of the casing.

The foregoing is of extreme importance not only because of the ever present danger that the tool might be lowered slightly in removal from a well during the disconnection of a section of the drill stem, and an undesired perforation of the casing accidentally made, but also, in the event a perforation of the casing penetrates a high pressure area unexpectedly, the tool may be reset in the manner described and heavier fluid may be pumped down through the tool and out through the opening 12 to overcome the pressure from the formation and prevent a blow out. In fact, one of the very noteworthy features of the device described is that at any time heavy fluid may be pumped down through the tool in order to increase the hydrostatic head of fluid in the well and prevent a blow out. The resetting feature makes it possible not only to pump such fluid to depths at and above the last perforation, but actually at points much below the last perforation if found necessary. It positively eliminates any accidental puncturing of the casing and the grave dangers which accompany such accidental puncturing.

From the foregoing it will be seen that a tool has been provided which carries out all of the objects and advantages sought by this invention and which is positively under the control of the operator at all times.

Having described my invention, I claim:

1. In a casing perforator, a body, a perforator blade carried by said body and movable to and from projected operative position, means for initially latching said blade in retracted inoperative position, and means adapted to be passed downwardly from the surface of the ground to release said latching means and permit said blade to be moved to projected operative position.

2. In a casing perforator, a body, a perforator blade carried thereby and movable to and from projected operative position, and means for permanently latching said blade in retracted inoperative position.

3. In a casing perforator, a body, a perforator blade carried thereby and movable to and from projected operative position, means for initially latching said blade in retracted inoperative position, means for releasing said latching means, and means movable downwardly into said body for moving said blade back to retracted inoperative position after it has moved to its projected operative position.

4. In a casing perforator, a body, a perforator blade carried thereby and movable to and from projected operative position, means for releasably latching said blade in retracted inoperative position, and means for permanently latching said blade in retracted inoperative position.

5. In a casing perforator, a body, a blade carried by said body and movable to and from projected operative position with respect to said body, and means movable downwardly through said body for retracting said blade to inoperative position and holding it in inoperative position so that the perforator may be moved upwardly and downwardly within said casing without producing perforations therein.

6. In a casing perforator, a body, a tubular means for suspending said body and actuating the perforator, a perforating blade carried by said body and movable to and from projected operative position with respect to said body, and fluid pressure operated means within said body for moving said blade from projected operative position to retracted inoperative position.

7. In a casing perforator, a body having a fluid passage therethrough, a tubular member for suspending said body and actuating the perforator, a blade carried by said body and movable to and from projected operative position with respect to said body, a piston within said body and movable downwardly with respect thereto to retract said blade to inoperative position, said piston having a fluid passage longitudinally therethrough, means initially holding said piston against downward movement with respect to said body, means adapted to close the opening through said piston when it is desired to retract said blade to inoperative position whereby fluid pressure exerted downwardly through said tubular member will cause downward movement of said piston to retract said blade, and means for preventing upward movement of said piston, said body having a lateral opening therefrom above the lowermost position of said piston, whereby when said piston is in its lowermost position fluid may be pumped downwardly through said tubular member and through said lateral opening.

8. In a casing perforator, a body having a fluid passage therethrough, a tubular member for suspending said body and actuating the perforator, a blade carried by said body, said body and said blade having a cooperating guide and slide whereby said blade is slidably mounted in said body for vertical movement with respect thereto, said guide and slide being shaped to move said blade radially outwardly upon downward movement of said body with respect to said blade, resilient means carried by said body for urging said blade upwardly with respect to said body, and releasable means for latching said blade in its lowermost position with respect to said body.

9. In a casing perforator, a body having a fluid passage therethrough, a tubular member for suspending said body and actuating the perforator, a blade carried by said body and movable to and from projected operative position with respect to said body, said body and said blade having a cooperating guide and slide shaped to cause radial outward movement of said blade with respect to said body upon an upward movement of said blade with respect to said body, means carried by said body adapted to abut said blade when said blade is moved to its lowermost position to hold said blade positively retracted into inoperative position within said body.

10. In a casing perforator, a body having a guide therein, said guide extending downwardly within said body in a substantially longitudinal direction for a portion of its length, then downwardly at a relatively acute angle with respect to the axis of said body, and terminating in a portion disposed at a less acute angle to said body, a blade carried by said body and having a slide thereon for slidingly and pivotally mounting said blade on said guide, said blade being of L-shape with said slide disposed at the angle thereof and a cutting portion of said blade at the lower end thereof, an abutment on said body for limiting the downward sliding movement of said slide, and a second abutment on said body for limiting the swinging movement of said blade about said slide when said slide is in its lowermost position, whereby said blade will be stopped in its lowermost position with its cutting portion positively retracted into said body, and means for moving said blade to its lowermost position.

11. In a casing perforator, a body having a fluid passageway therethrough, a blade carried by said body and movable upwardly with respect to said body into projected operative position and downwardly within said body into retracted inoperative position, means within said body normally urging said blade upwardly into operative position, other means initially latching said blade in its lower inoperative position with respect to said body, means adapted to be passed downwardly through said body to release said latching means, a piston within said body above said latching means and having an opening therethrough, means adapted to be passed down through said body for closing said opening through said piston, whereby fluid pressure above said piston may cause it to move downwardly and engage said latching means to move said blade to retracted inoperative position, means for releasing fluid pressure above said piston when said piston has so moved downwardly to retract said blade, and means carried by said piston for preventing upward movement thereof after the piston has been moved downwardly.

CICERO C. BROWN.