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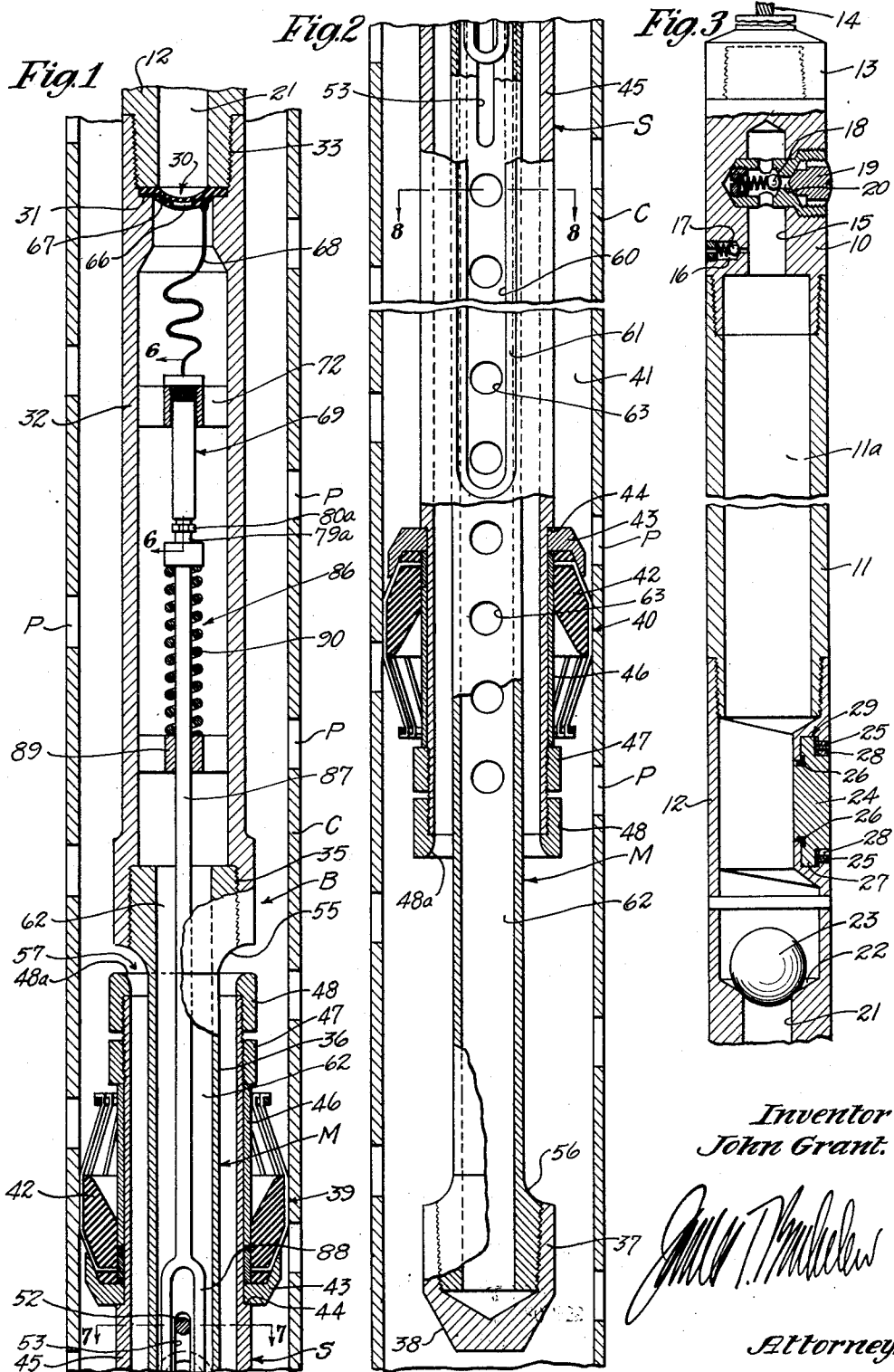
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2,098,494

APPARATUS FOR CLEANING WELLS

Filed July 20, 1935

3 Sheets-Sheet 1



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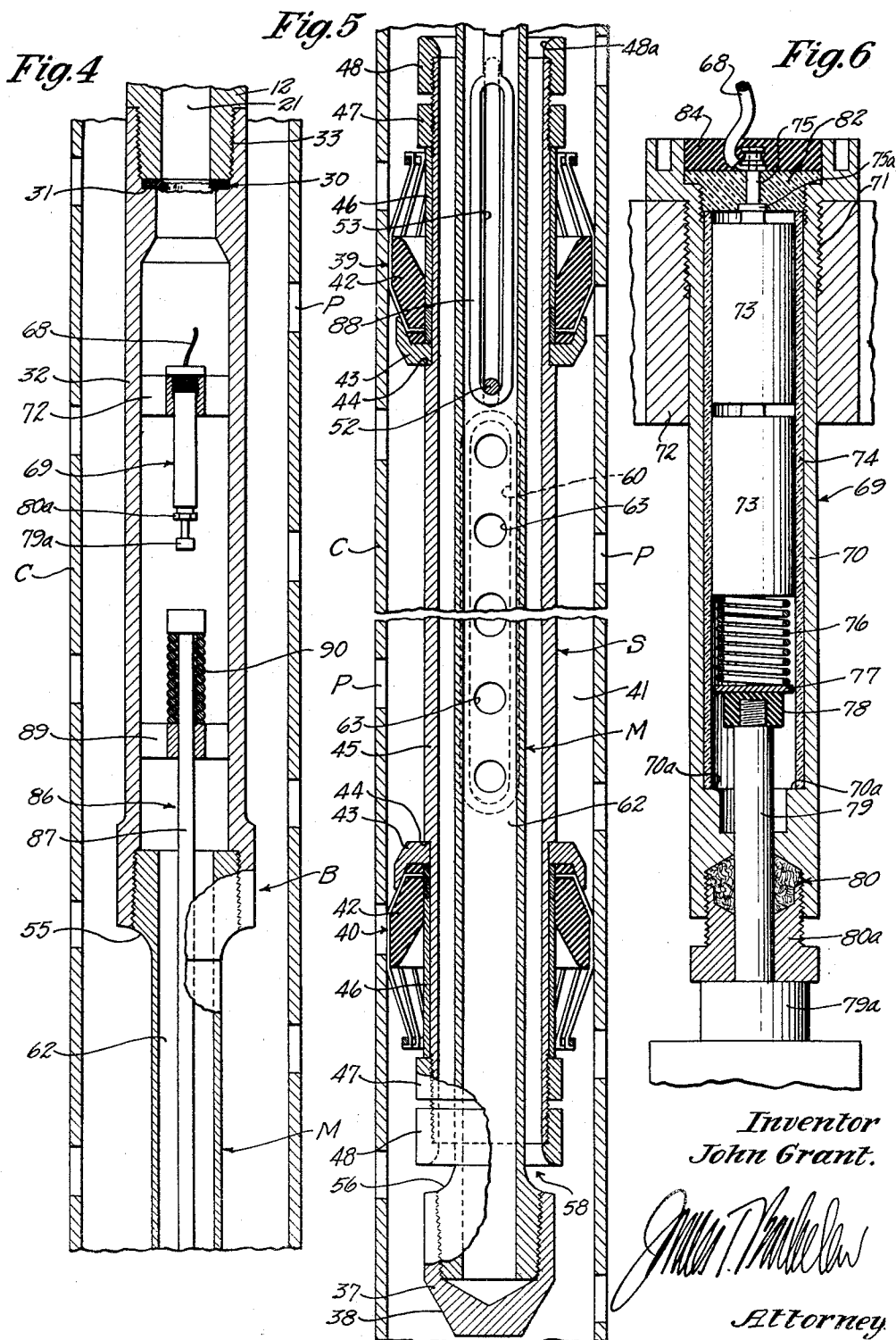
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3 Sheets-Sheet 2



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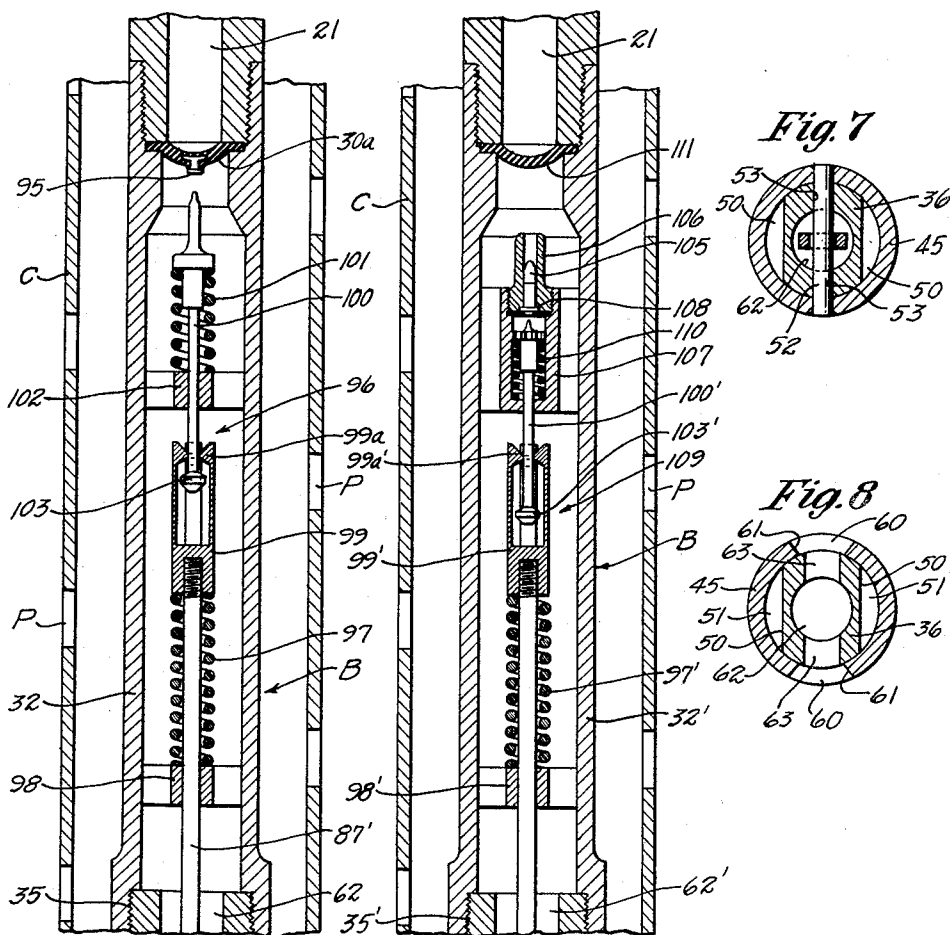
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Fig. 9

Fig. 10



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UNITED STATES PATENT OFFICE

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APPARATUS FOR CLEANING WELLS

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20 Claims. (Cl. 166—19)

This invention deals generally with apparatus which operates by the sudden release of well pressure into a low pressure or charge receiving chamber lowered into the well, to induce into said chamber a flow of well fluid carrying with it solid particles or bodies which it is desired to remove from the well or from the well pipe perforations. Apparatus of this general type, and to all of which the invention is broadly applicable, includes "suction-type" fishing tools, bailers, and well cleaners for removing from the well screen perforations clogging particles, sand or other obstructing bodies.

The type of apparatus referred to above may be described generally as comprising a normally closed low pressure chamber contained within a tubular body portion of the apparatus or within the pipe on which the apparatus is suspended, and which is lowered, while closed, to the depth at which the operation is to be carried out. The low pressure chamber closure usually consists of a valve or member, such as a frangible disk, adapted to be opened or broken, as the case may be, to admit a charge of well fluid to the chamber. The present invention relates particularly to apparatus of this type utilizing a frangible member as the charge receiving chamber closure.

Heretofore, in such apparatus using a frangible member or disk as the closure, the closure opening means has consisted of a breaking member projected against the disk, or against which the disk is impacted. In spite of provisions made for bringing the disk and breaking member forcibly into engagement, it is frequently found that due to various conditions existing in the well, it is difficult to break the disk. In fact, where the apparatus is not adapted to deliver repeated blows against the disk, it becomes necessary where the disk remains unbroken after one operation of the breaking member, to withdraw the apparatus from the well, reset the disk breaking mechanism, and repeat the operation.

One of the primary objects of the invention is to provide a breaking means for the frangible closure that will insure complete shattering of the latter in a single operation. The invention is characterized from past practice in that it utilizes an explosive for breaking the closure to place the charge receiving chamber into communication with the well. As will hereinafter appear, the invention is adaptable to various structural forms with respect to the particular way in which the explosive is used to rupture the disk. Preferably, the explosive is applied directly to the disk, and fired by suitable means such as an electric current

or by a firing pin projected against the explosive. On the other hand if desired, the explosive may be located extraneous to the disk and utilized indirectly to supply the disk breaking force, by firing a projectile against the disk.

The above mentioned and various additional features and objects of the invention, as well as the details of certain typical and illustrative forms, will be more fully understood from the description to follow. Throughout the description reference is made to the accompanying drawings, in which:

Fig. 1 is a longitudinal section showing the upper portion of the well cleaning apparatus below the charge receiving chamber;

Fig. 2 is a downward continuation of Fig. 1 illustrating the lower portion of the apparatus;

Fig. 3 is a sectional view showing the body portion containing the charge receiving chamber;

Figs. 4 and 5 are sectional views similar to Figs. 1 and 2, respectively, but showing the parts in changed position after the charge receiving chamber has been opened;

Fig. 6 is an enlarged fragmentary section on line 6—6 of Fig. 1, showing the switch mechanism;

Figs. 7 and 8 are sections taken on lines 7—7 and 8—8 of Figs. 1 and 2, respectively;

Fig. 9 is a fragmentary section showing a variational form of disk breaking mechanism; and

Fig. 10 is a view similar to Fig. 9 showing a further variant form of the invention.

As has been previously mentioned, the invention is particularly well adapted, but not limited, to cleaning devices for dislodging foreign matter from the perforations of well casing. Accordingly, for the purpose of illustrating a typical embodiment of the invention, I have shown in the accompanying drawings a perforation cleaner positioned within a perforated casing or screen C having any suitable type of perforations, as here conventionally illustrated at P.

The cleaner construction may be regarded generally as comprising relatively longitudinally movable body and sleeve portions B and S, the lower portion of the body being in the form of a mandrel M extending through the sleeve S, as will hereinafter more fully appear. Threadably connected body or casing sections are indicated at 10, 11 and 12 (see Fig. 3), section 10 serving as a head or top closure for the charge receiving or low pressure chamber 11a. Coupling 13 is threadably connected to section 10 and serves as a means whereby the body may be attached

to a suspension element, for example cable 14. Section 11, here shown as longitudinally contracted, may be of any desired length; and may be sectional. A 40 ft. length gives the charge receiving chamber 11a a capacity ample for most operations.

Section 10 has a reduced axial bore 15 from which extends a transverse passage 16 controlled by a spring-closed, outwardly opening valve generally indicated at 17. The function of this valve is merely to relieve high pressure in the charge receiving chamber as the tool is raised into zones of lower pressure. To facilitate unloading chamber 11a, after the latter has received a charge and the cleaner is removed from the well, there is provided an inwardly opening, spring-closed dump relief valve 18. This valve is fully described in the copending application of W. C. Erwin, et al., on Well bailers, Ser. No. 667,439, filed April 22, 1933, which has matured into Patent No. 2,059,629, granted Nov. 3, 1936. It will suffice here to state that screw plug 19 normally closes passageway 20. When chamber 11a is to be unloaded, plug 19 is removed and passageway 20 is then adapted to put the chamber into communication with the atmosphere when the lower pressure in the chamber (as created by dumping the fluid) is of a value allowing spring-closed valve 18 to open under atmospheric pressure.

Body section 12 has a reduced diameter bore 21 which may be considered as the inlet opening of chamber 11a, shoulder 22 at the upper end of bore 21 presenting an upwardly facing seat to take a foot valve 23. Section 12 is also provided with a removable dump door 24, the construction and mounting thereof being fully described in the copending application, Ser. No. 667,439. The door is opened by loosening screws 25 (which normally press the door inwardly to compress gasket 26 and provide a fluid-tight seal), rotating the door to clear lugs 27 from overhanging lips 28, and then sliding it transversely to clear it from way 29. It will be understood that the structure thus far described comprises no part of the present invention other than as it may be regarded as a typical and convenient type of low pressure chamber construction to which the present chamber opening mechanism may be applied. It is also to be understood that the expression "normally closed low pressure chamber" appearing in the claims, is not intended to limit the invention to the use of a chamber that is closed at both its upper and lower ends, but rather to define broadly a chamber that is at least closed at one end to normally exclude the well fluid.

Low pressure chamber 11a normally is closed by a disk 30 clamped between the lower end of body section 12 and shoulder 31 within body section 32 threadedly connected at 33 with section 12. Disk 30 may be made of any suitable frangible material, such as glass or other ceramic composition, and may conveniently have a downwardly concave shape, as illustrated. It will suffice to note at this point that disk 30 normally provides a fluid-tight bottom closure for the charge receiving chamber 11a, and that the cleaner is lowered in the well with chamber 11a empty. After the cleaner has been lowered to the depth of the well zone to be cleaned, the cleaning operation is then performed by breaking disk 30 to allow a sudden rush of well liquid through the casing perforations P and openings

in sleeve S into the low pressure chamber 11a, as will later be more fully explained.

The lower end of section 32 is threadably connected at 35 with the reduced diameter lower tubular section 36 of the body, previously referred to as the mandrel portion M. The lower end of this mandrel section 36 is closed by a shoe 37, the bottom of which is tapered at 38 to facilitate passing any obstructions that might be encountered when the cleaner is being lowered. The sleeve structure S comprises a pair of longitudinally spaced packers, generally indicated at 39 and 40, which by engagement with the casing C, confine between them an annular space 41 through which suction is applied to the casing perforations P opposite the space when the charge receiving chamber is opened, as hereinafter described. As typical, the packers 39 and 40 are shown each to comprise a cup leather or rubber 42 confined within a supporting annulus 43 clamped against shoulder 44 on the sleeve tube 45 by spacer sleeves 46, the latter in turn being held in place by nuts 47. The packers engage the casing with sufficient tightness to hold the sleeve assembly against substantial vertical movement in the casing during operation of the cleaner, as will later appear. Nuts 48 having rounded end surfaces 48a, are threaded on the upper and lower ends of tube 45.

As best illustrated in the cross section view of Fig. 8, opposite sides of the mandrel portion 36 of the body are flattened at 50 to form with sleeve 45, longitudinal by-pass passages 51 extending the full length of the sleeve. Between passages 51, the mandrel 36 has a fairly snug and substantially fluid-tight sliding fit with sleeve 45. As best illustrated in Fig. 7, a pin 52 terminating in sleeve 45 extends through vertical slots 53 in the mandrel 36. Relative longitudinal movement between the body and sleeve assembly occurs within the limits of engagement of nut 48 on the upper end of sleeve 45 with the lower end of body portion 32, see Fig. 1, and the engagement of nut 48 on the bottom of the sleeve with the mandrel shoe 37, as shown in Fig. 5. During such relative longitudinal movement between the mandrel and sleeve, pin 52 travels vertically within slots 53.

The mandrel 36 is chamfered at 55 and 56 at both the upper and lower extremities of beveled surfaces 50 so that in the uppermost and lowermost positions of the mandrel relative to the sleeve 48, the by-pass passages 51 will remain in open communication with the interior of the casing through the openings at 57 and 58, see Figs. 1 and 5, formed by the chamfers 55 and 56. Opposite sides of the intermediate portion of sleeve 45 between packers 39 and 40 have longitudinal slots 60, see Fig. 2, the edges of which are beveled as indicated at 61. Through these slots, suction is communicated to the surrounding space 41 between the packers by way of the mandrel bore 62 and a series of mandrel ports 63 registering with the sleeve slots 60. Some of the uppermost ports 63 may be in registration with slots 60 when the mandrel is in its uppermost position relative to the sleeve, see Figs. 1 and 2, but when the mandrel has been raised to its uppermost position, as shown in Figs. 4 and 5, all the ports 63 are brought into register with the slots 60. The illustrated construction embodied in the mandrel and sleeve assembly is more particularly and somewhat more extensively dealt with in a copending application, Ser. No. 22,297 filed May 20, 1935, by James J. Santiago on Well cleaning device (G), and reference may be had to this ap-

plication for further details of this general type of well cleaner construction.

In the form of the invention illustrated in Fig. 1, the low pressure chamber closure 30 is opened to admit a well fluid charge by an explosive element fired electrically under control of a suitable switch mechanism, the latter being operated by vertical movement of the suspension means 14. Here the disk 30 carries an explosive cap 66 which may be embedded in or otherwise carried directly by the disk itself. The cap is placed in an electric circuit comprising a conductor 67 grounded by contact with shoulder 31, and an insulated wire 68 connecting with a switch device generally indicated at 69. Any suitable form of switch may be used, hence the type illustrated is to be regarded merely as typical. As shown in detail in Fig. 6, the switch 69 comprises an hermetically sealed body 70 threaded at 71 into and supported by a spider 72 integral with the cleaner body section 32. The tubular switch body 70 contains one or more batteries 73 placed within a liner 74 of suitable insulating material. The insulated conductor wire 68 connects with a terminal 75 against the lower end 75a of which the batteries are maintained in engagement by coil spring 76 supported on a metallic switch disk 77 placed on the upper insulated end 78 of rod 79. The latter is movable vertically within the body 70 and extends through a packing gland, conventionally illustrated at 80, which prevents the entry of well liquid to the interior of the switch cylinder. If desired, the tubular body 70 may contain a suitable non-conductive fluid. The terminal 75 extends through a bushing 82 of insulating material, and the connection between wire 68 and the terminal 75 is insulated by a non-conductive material 84 contained within the upper interior of the body 70 above bushing 82.

A switch actuating mechanism, generally indicated at 86, operates to close the switch and thereby fire the explosive cap 66, by upward movement of the suspension means 14 and body B, and as a result of relative longitudinal movement between the body and the sleeve S. The switch operating mechanism 86 comprises a rod 87 carrying on its lower end a looped stirrup 88 through which pin 52 extends. The rod and stirrup are supported on spider 89 by a coil spring 90 which normally holds the rod 87 in the elevated position of Fig. 1, in which position the rod engages and holds the switch rod 79 in raised position with the head 79a engaging the packing gland bushing 80a. Spring 90 thus is sufficiently strong to compress spring 76 and keep the switch open until rod 87 is pulled down to release rod 79 and allow the contact disk 77 to be moved down, under the influence of spring 76, into engagement with shoulder 70a to close the circuit. Although spring 76 is weaker than spring 90, the former will be sufficiently strong to overcome the frictional resistance to downward movement of rod 79 offered by the packing gland 80.

In operation, the body B and sleeve S assembly is inserted within the casing C with the upper portion of the body above section 32, removed. When inserted in the casing, the mandrel M and sleeve S will have the relative position shown in Figs. 1 and 2, with rod 87 engaging the head 79a of the switch rod 79, holding the switch in open position as shown in Fig. 6. Disk 30 is inserted within the upper end of body section 32 with the conductor 68 connecting the explosive cap 66 with the switch 69. The upper body portion con-

taining the low pressure chamber and comprising sections 10, 11 and 12, is next threaded into the upper end of section 32 and the joint at 33 taken up to clamp the disk 30 in place. The apparatus is then lowered in the well to the depth of the zone to be cleaned, the packers 39 and 40 offering sufficient resistance to downward movement of the sleeve S to maintain the parts in the relative positions of Figs. 1 and 2.

Pin 52 and the stirrup 88 provide a lost motion connection between the sleeve S and rod 87 in order that if for any reason the sleeve should tend to drop relative to the mandrel M while the apparatus is being lowered, the cap 66 will not become prematurely fired to open the low pressure chamber, before the tool is in proper position for the cleaning operation. Thus, by virtue of this lost motion connection, sleeve S is capable of downward movement from the position of Figs. 1 and 2 a distance corresponding to the distance between pin 52 and the lower end of stirrup 88, before rod 87 is pulled down.

When the apparatus has been lowered to the proper depth, cap 66 is fired to break the disk 30 and open the low pressure chamber by upward movement of the suspension means 14 and elevation of the body B. As the body moves upward relative to the sleeve, the lower end of stirrup 88 is brought into engagement with pin 52, whereupon rod 87 is held against further upward movement. Since rod 79 is maintained in engagement with the upper end of rod 87 by the action of spring 76, continued elevation of the body causes shoulder 70a to be raised into contact with disk 77. This contact completes the electric circuit, exploding the cap 66 and breaking disk 30, with the result that the low pressure chamber 11a is suddenly placed in communication with the body passage 92 and mandrel bore 62. Further upward movement of the body brings the lower end of the mandrel into engagement with the bottom of sleeve S and the parts into the relative positions of Figs. 4 and 5.

The mandrel ports 63 have thus been brought into registration with slots 60 in the sleeve, and by reason of the pressure differential between the formation pressure at the outside of the casing, and the pressure in the charge receiving chamber 11a, there is induced a sudden flow of well fluid through the casing perforations P into space 41 between the packers, and thence through ports 63 into the mandrel bore 62. The well liquid charge flows upwardly through passage 92, bore 21, past foot valve 23 into chamber 11a, and continues to flow into the low pressure chamber until a substantial pressure balance exists, whereupon valve 23 seats to trap the charge in the chamber. The apparatus then is removed from the well, and the door 24 removed to dump the charge.

In addition to providing a means for insuring sudden and complete opening of the charge receiving chamber, the explosion of element 66 has a further advantage in that the combination of the explosive force, followed by the sudden suction effect upon opening the low pressure chamber, is of particular effectiveness in dislodging clogging particles from the casing perforations. When the cap explodes, the expansive force produces a sudden downward surge of fluid within the body, out through ports 63 into space 41, and through the casing perforations, the effect of which is to loosen and displace the clogging particles outwardly in the direction of the fluid surge. However, this surge is immediately fol-

lowed by an equally sudden surge in the opposite direction due to the effect of the low pressure chamber being put into communication with space 41, with the result that the clogging particles, immediately after they are loosened by the outward fluid surge, are drawn into the perforations by the oppositely acting impulse.

Fig. 9 shows a variational form of the invention similar in all respects to the previously described form except as to the means for firing the explosive cap. Here the disk 30a carries an explosive cap 95 which is exploded by a spring loaded firing mechanism, generally indicated at 96, actuated as a result of upward movement of the body B relative to the previously described sleeve assembly. Stirrup carrying rod 87', corresponding to rod 87 in the first described form, normally is supported in a position corresponding to that of Fig. 1, by coil spring 97 seating on spider 98 and bearing against a tubular latch 99 attached to the upper end of the rod. Latch 99 operates to releasably engage and cock the firing pin 100 which is supported by spring 101 on spider 102.

Upon upward movement of the body B, the parts remain in the positions shown in Fig. 9 until the lower end of stirrup 88 (referred to in Fig. 1) engages pin 52, whereupon continued upward movement of the body brings the spring finger detents 99a of latch 99 into engagement with the end enlargement 103 of the firing pin, holding the latter against upward movement and compressing spring 101. After spring 101 is compressed and the firing pin cocked, further upward movement of the body releases the enlargement 103 from the latch, causing the firing pin to be projected against the cap 95 to explode the disk and open the low pressure chamber through inlet 21 into communication with the casing perforations, all in the manner previously explained.

Fig. 10 shows a second variational form of the invention in which the disk is broken by a projectile fired by an explosive extraneous to the disk, as distinguished from the previously described forms in which the explosive is carried directly by the disk. Here the projectile 105 inserted within barrel 106 threaded into the upper end of spider 107, is fired by an explosive cap 108 which is exploded by a firing mechanism 109 generally similar to the firing mechanism of Fig. 9. Upon upward movement of the body B, latch 99' engages the enlargement 103' on the firing pin 100', causing spring 110 to be compressed to cock the firing pin. When released by the latch 99', the firing pin 100 is projected against the cap 108 and the projectile 105 fired against the disk 111 to break it and open the low pressure chamber.

I claim:

1. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, said means including a wall containing a well fluid inlet opening, an inlet closure applied directly to said wall and across said opening, and explosive means adapted to be fired to open said closure for the entry of a well fluid charge to the chamber.

2. In oil well apparatus of the character described, means forming a low pressure chamber, said means including a wall containing a normally closed inlet passage extending therethrough, explosive means adapted to be fired to open said passage for the entry of a well fluid charge to the chamber, and means for firing said explosive means.

3. In oil well apparatus of the character de-

scribed, walls forming a normally closed low pressure chamber, explosive means adapted to be fired to open said chamber for the entry of a well fluid charge, and means normally contained in the apparatus and operating automatically to trap said charge in the low pressure chamber.

4. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, said means including a wall at the lower end of said chamber and containing a normally closed, vertically extending inlet passage extending therethrough, explosive means adapted to be fired to open said passage for the entry of a well fluid charge to the chamber, and passage means for firing said explosive means.

5. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, explosive means adapted to be fired to open said chamber for entry of a well fluid charge, and spring actuated means for firing said explosive means.

6. In oil well apparatus of the character described, a body including means forming a normally closed low pressure chamber, a cable suspending said body in the well, a closure adapted to be opened to admit a well fluid charge to said chamber, and explosive means adapted to be fired to open said closure.

7. In oil well apparatus of the character described, walls forming a normally closed low pressure chamber and containing a well fluid inlet, a frangible closure inserted in said inlet and adapted to be opened to admit a well fluid charge to said chamber, and explosive means adapted to be fired to break said closure.

8. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, a closure adapted to be opened to admit a well fluid charge to said chamber, and explosive means adapted to be fired to open said closure, the last mentioned means comprising an explosive carried by said closure.

9. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, a closure adapted to be opened to admit a well fluid charge to said chamber, an explosive carried by said closure, and electrically operated means for firing said explosive to open the closure.

10. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, a closure adapted to be opened to admit a well fluid charge to said chamber, an explosive carried by said closure, and means adapted to be projected against said explosive to cause it to fire and open said closure.

11. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, a suspension means on which the apparatus is lowered in the well, explosive means adapted to be fired to open said chamber for the entry of a well fluid charge, and means operable by movement of said suspension means to fire said explosive means.

12. In oil well apparatus of the character described, means forming a normally closed low pressure chamber, a suspension means on which the apparatus is lowered in the well, explosive means adapted to be fired to open said chamber for the entry of a well fluid charge, and means operable by upward movement of said suspension means to fire said explosive means.

13. In well cleaning apparatus adapted to be lowered within a perforated section of well tubing, an apertured tubular member adapted to be

lowered within said perforated well tubing, a pair of spaced tubing engaging packers carried by said member beyond its apertured portion, explosive means within the apparatus and adapted to be fired to dislodge clogging particles from the tubing perforations by creating a sudden outward flow of fluid through the aperture of said member and through said perforations, and means for firing said explosive means.

14. In well cleaning apparatus of the character described, a body forming a normally closed low pressure chamber, an apertured tubular member extending below the body and adapted to be lowered within a perforated section of well tubing, the interior of said tubular member being communicable with said chamber, a tubing engaging packer carried by said member, and explosive means within the apparatus adapted to be fired to open said low pressure chamber for the entry of well fluid through said perforations and apertured member into the chamber.

15. In well cleaning apparatus of the character described, a body forming a normally closed low pressure chamber, an apertured tubular member extending below the body and adapted to be lowered within a perforated section of well tubing, the interior of said tubular member being communicable with said chamber, a tubing engaging packer carried by said member, a frangible closure for said chamber at the lower end of said body, and explosive means within the apparatus for breaking said closure.

16. In well cleaning apparatus of the character described, a body forming a normally closed low pressure chamber, a relatively vertically movable apertured tubular member extending below the body and adapted to be lowered within a perforated section of well tubing, the interior of said tubular member being communicable with said chamber, a tubing engaging packer carried by said member, and explosive means within the apparatus adapted to be fired by virtue of relative vertical movement between said body and tubular member to open said low pressure chamber for the entry of well fluid through said perforations and apertured member into the chamber.

17. In well cleaning apparatus of the character described, a body forming a normally closed low pressure chamber, a relatively vertically movable apertured tubular member extending below the body and adapted to be lowered within a perforated section of well tubing, the interior of said tubular member being communicable with said

chamber, a tubing engaging packer carried by said member, a frangible closure for said chamber, explosive means within the apparatus for breaking said closure, and means operable by relative movement between said body and tubular member to fire said explosive means.

18. In well cleaning apparatus adapted to be lowered within a perforated section of well tubing, a body containing means operable to dislodge clogging particles from the tubing perforations by creating a sudden outward flow of fluid there-through, a cable suspending said body in the well, and means for communicating to the inside of said perforated section of tubing an abnormally low pressure to induce a sudden inward flow of fluid through said perforations immediately after the operation of the first mentioned means, the last mentioned means being controllable by movement of said cable.

19. In well cleaning apparatus adapted to be lowered within a perforated section of well tubing, a suspension means on which the apparatus is lowered in the well, means operable by movement of the suspension means to dislodge clogging particles from the tubing perforations by creating a sudden outward flow of fluid there-through, means for communicating to the inside of said perforated section of tubing an abnormally low pressure to induce a sudden inward flow of fluid through said perforations immediately after the operation of the first mentioned means, and means confining the communication of said abnormally low pressure to a portion only of the tubing perforations.

20. In well cleaning apparatus adapted to be lowered within a perforated section of well tubing, a tubular member having normally open apertures adapted to be exposed directly to the casing perforations, means operable to dislodge clogging particles from the tubing perforations by creating a sudden outward flow of fluid through said apertures and perforations, means for communicating to the inside of said perforated section of tubing an abnormally low pressure to induce a sudden inward flow of fluid through said perforations immediately after the operation of the first mentioned means, means confining the communication of said abnormally low pressure to a portion only of the tubing perforations, and means for trapping the fluid drawn inwardly through said perforations, for removal to the ground surface.

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