March 9, 1937. C. H. SWEET 2,073,126

WELL CLEANING SYSTEM

Filed June 17, 1935

Fig. 1

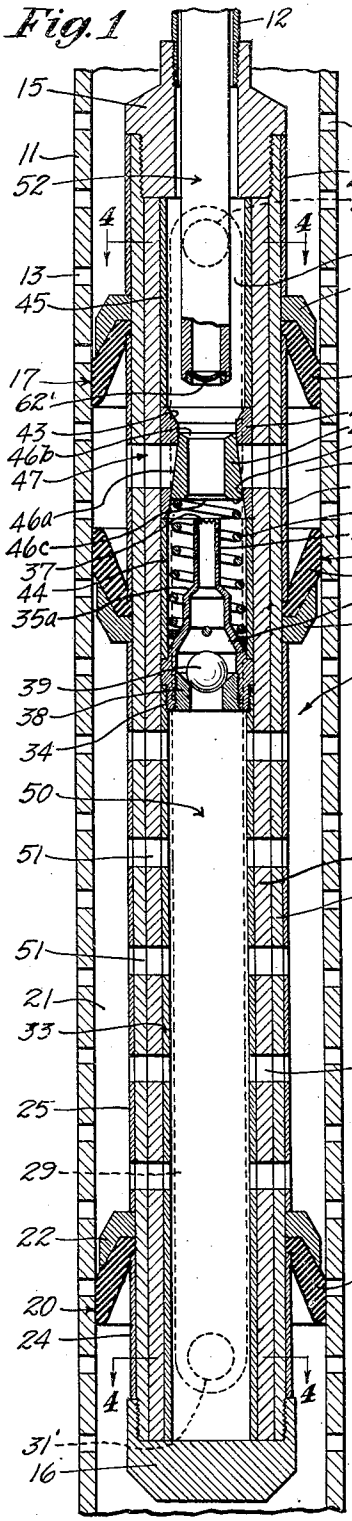


Fig. 2

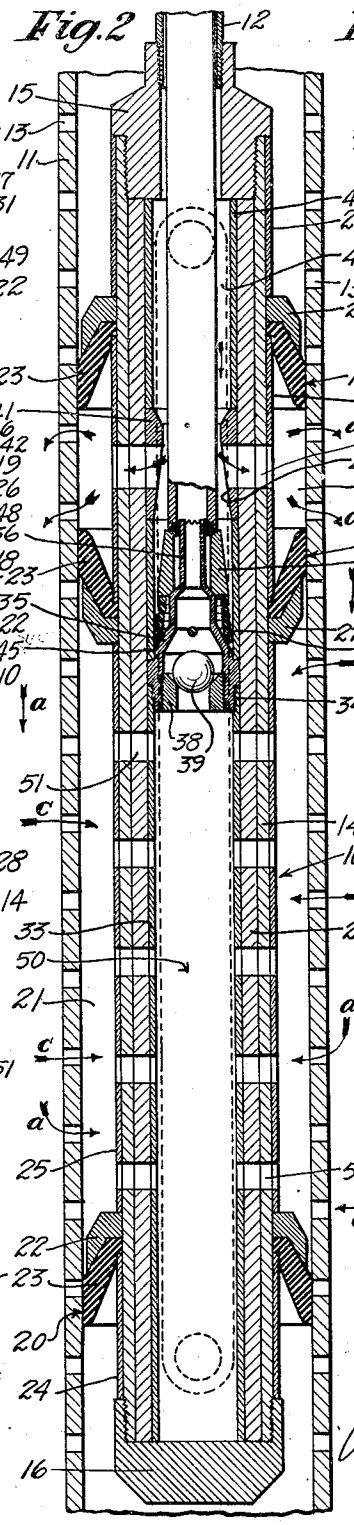


Fig. 3

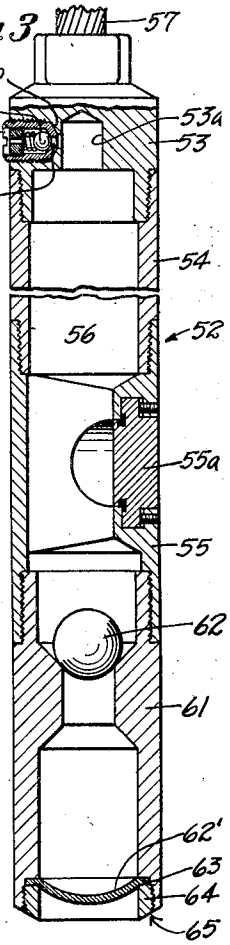
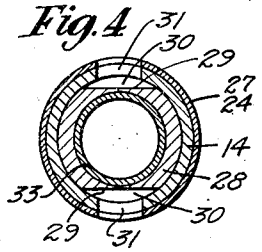


Fig. 4



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WELL CLEANING SYSTEM

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Application June 17, 1935, Serial No. 26,912

15 Claims. (Cl. 166—19)

This invention has to do generally with well cleaning devices and is more particularly concerned with such devices wherein there is provided a low-pressure or charge-receiving chamber with a normally closed inlet adapted to be opened at predetermined points in the well, whereby the well fluid, under relatively high pressure, charges that chamber with sand or other foreign matter adjacent the inlet, or sets up such pressure actions or high velocity fluid movements as to dislodge foreign matter which may be offering obstruction to free passage of fluid through fissures in the formation or perforations in the well casing.

In the operation of cleaners of the general type with which the invention is concerned, upon opening the low-pressure or charge-receiving chamber, well fluid is drawn mainly in a lateral or substantially horizontal direction through the section of the perforated casing being cleaned, from the surrounding formation; that is to say, there is induced a cross flow, as distinguished from flow in a vertical direction, through the well sands into the perforations. The present system retains this characteristic feature as regards the induced flow of well fluid through the formation, but combines therewith an added feature and improvement giving rise to an operating (sand flushing) condition not present in prior well cleaning systems or devices, so that not only is the efficiency of the perforation cleaning operation improved, but also the porosity of the formation sands and productiveness of the well, are greatly increased. Thus, one of my principal objects is to provide a system for cleaning the casing perforations, and at the same time to thoroughly flush the interstitial spaces of the sands in the surrounding formation. In accordance with the invention, this object is accomplished by inducing in additon to a horizontal flow of well fluid through the formation into the casing perforations, a circulation of flushing fluid through the sands in a generally vertical, preferably downward, direction. In this manner, the interstitial spaces in the formation sands are subjected to a very effective washing action occurring simultaneously with the induced flow through the casing perforations.

The invention in its preferred form, provides for the maintenance of an hydraulic column within the pipe on the lower end of which the apparatus is lowered in the casing, and a valvular control whereby simultaneously with the opening of the charge receiving chamber, the hydrostatic column so maintained is permitted to flow outwardly through the casing perforations into the formation above the particular section being cleaned, and then downwardly through the sands around the said section in a direction generally crosswise to the laterally flowing well fluid being drawn through the casing perforations. After being drawn downwardly through the sands around the casing by the induced suction, the flushing fluid from the hydrostatic column is taken in through the casing perforations along with the well liquid.

The invention embodies numerous additional features of operation, as well as further objects and details in connection with a preferred form of apparatus for performing the cleaning operation as described above. All these, however, will be fully understood from the following detailed description of the invention in one of its typical and preferred forms.

Reference is had throughout the description to the accompanyinug drawing, in which:

Fig. 1 is a longitudinal sectional view of the apparatus showing the bailer lowered to a position above the valve;

Fig. 2 is a view similar to Fig. 1, showing the positions of the parts after the bailer closure has been opened;

Fig. 3 is a sectional view illustrating a typical form of bailer; and

Fig. 4 is a section on lines 4—4 of Fig. 1.

In the drawing, I have shown a tubular assembly generally indicated at 10, lowered within the well casing 11 on the lower end of a pipe string 12 which, as will be understood, extends upwardly within the casing to the ground surface. Generally speaking, the purposes of the tubular assembly 10 are to form a confined zone within a particular section of the perforated casing to be cleaned in order that upon opening the bailer closure, as will hereinafter appear, intense and localized pressure differential may be applied to the casing perforations 13 surrounding that zone; and also to provide a means in the nature of an abutment capable of coacting with the bailer to open the bailer closure and thereby induce an inward flow of well fluid through the casing perforations 13. It may be mentioned at this point that well cleaning systems involving the use of a tubular assembly or abutment adapted to be lowered to predetermined position within the casing in advance of a bailer containing a charge receiving chamber, broadly constitute the subject matter of a copending application Ser. No. 26,916, filed June 17, 1935 by John Grant on Well cleaning system.

The assembly 10 comprises a tubular body 14 connected at its upper end by coupling 15 with the pipe string 12 and carrying on its lower end a screwthreaded shoe 16. The body 14 carries a pair of packers 17 and 18 at conveniently spaced points, the packers having substantially fluid tight engagement with the casing 11 and forming a confined annular spacing 19 around the upper portion of the body. I preferably, although not always necessarily, provide a third packer 20 at a distance below packer 18 so as to confine a second annular space 21 around the lower portion of the body. It will be understood of course that the packers may be of any suitable construction and may be mounted on the body in any convenient manner. As a typical illustration, each packer assembly is shown to comprise a cup-shaped supporting member 22 containing a cup leather or rubber 23, bearing against the casing, members 22 and 23 of the several packers being clamped together and held in predetermined spaced arrangement by spacer sleeves 24, 25, 26 and 27 placed around the body 14 and clamped between coupling 15 and shoe 16, as illustrated.

In order to facilitate raising and lowering the assembly 10 within the well liquid standing in the casing 11, and to overcome the fluid resistance that would otherwise be offered by reason of the close engagement between the packers of the wall of the casing, suitable means may be provided for by-passing the well liquid around or past the several packers. As a convenient means for forming the by-pass, insert within the body 14 a tube 28 bearing terminally against coupling 15 and shoe 16, and having, as shown in Fig. 4 opposite flattened surfaces 29 forming by-pass passages 30 extending longitudinally from ports 31 in body 14 and spacer sleeve 27 above packer 17, to similarly arranged ports 31′ at points below the lowermost packer 20. Thus as the assembly 10 is lowered within the casing, the well fluid by-passes the packers by flowing relatively upwardly through passages 30, and oppositely during withdrawal of the apparatus from the well.

Within the lower interior of tube 28 is inserted a tubular liner 33, to the upper end of which is threaded at 34 an upwardly projecting disk breaking member 35, the latter having a reduced diameter portion 36 with a toothed upper end 37 adapted to engage and break the bailer disk, as will presently appear. A seat 38 for the ball check valve 39 is screwed into the lower end of member 35, valve 39 rising from its seat to permit the upward flow of fluid through the disk breaking member into the bailer during the cleaning operation. A valve seat 41 having an upwardly tapered bore 42 and shoulder at 43 is clamped in position above the disk breaking member 36, between liners 44 and 45.

A tubular valve 46 having a tapered seating surface 46*a* and an inwardly beveled upper end surface 46*b* controls the passage of fluid through ports 47 extending through the valve seat 41, tube 28, body 14 and spacer sleeve 26. The valve is normally supported and held in its closed position of Fig. 1 by coil spring 48 seating at its lower end on the disk breaking member 35. Valve 46 is capable of downward movement against the resistance of spring 48 and in telescoping relation to the disk breaking member 36, sufficiently to place space 19 via ports 47 in open communication with space 49 and the interior of the pipe string 12.

The cleaning operation involves the application of a sudden and violent suction or pressure differential to the casing perforations 13 between packers 18 and 20, via body passage 50, ports 51, and the surrounding space 21. Such pressure differential preferably is obtained by lowering within the pipe string 12 a device, such as a bailer, having a normally closed empty charge receiving chamber adapted to be opened as a result of lowering engagement with the closure opening member 36 in the tubular assembly 10. It is to be understood that the invention is not limited to the use of any particular type or form of charge receiving device or bailer, and that any suitable apparatus of that character may be used within the purview of the invention. A particular and specific form of bailer has been shown merely for the purpose of completeness in describing the invention.

The bailer, generally indicated at 52, comprises a series of threadedly connected sections 53, 54 and 55 (see Fig. 3) section 53 serving as a top closure for the low pressure or charge receiving chamber 56. Section 53 is attached to a suspension element, for example cable 57 by means of which the bailer is raised and lowered in the pipe string 12. Section 54, here shown as longitudinally contracted, may be of any desirable length, although a forty foot length gives chamber 56 a capacity ample for most operations.

Section 53 has a reduced axial bore 53*a* from which extends a transverse passage 58 controlled by spring closed, outwardly opening relief valve 59. The function of this valve is merely to relieve high pressure in the charge receiving chamber 56 as the bailer is raised into zones of lower pressure. To facilitate unloading chamber 56, the apertured screw plug 59*a* threaded into the valve seat 60 may be removed, together with the valve 59, so as to relieve the lowered pressure in chamber 56 (caused by dumping the fluid) by bleeding in air through passage 58. Pressure relief and air bleed valves of this general character for use in well cleaners or bailers, are more particularly dealt with in the copending application of W. C. Erwin et al. on Well bailers, filed April 22, 1933, Ser. No. 667,439.

A removable dump door 55*a* is provided in section 55 of the bailer body, the construction and mounting of this door being fully described in said copending application, Ser. No. 667,439, and requiring for present purposes no further description other than to mention its removability to dump the charge from chamber 56 following a cleaning operation and after the bailer has been elevated to the ground surface. Screwed into and depending from section 55 is a tubular section 61, and seating within this section is a foot valve 62 which raises to permit the upward flow of the charge into chamber 56, and thereafter seats to trap the charge in the chamber for removal from the well. The charge receiving chamber is normally closed at its lower end by a frangible disk 62′ clamped between body shoulder 63 and a retaining ring 64 threaded into the lower end of section 61. The lower end of the body and ring 64 are beveled at 65 at an angle corresponding to the bevel 46*b* on the upper end of valve 46 in order that when lowered into engagement with the valve, the bailer and valve will have a substantially fluid-tight fit.

In performing a cleaning operation, tubular assembly 10 is first lowered within the casing on pipe string 12 to the depth of the particular portion of the casing to be cleaned. At this stage,

the positions of the valve parts will be as illustrated in Fig. 1. The bailer 52 then is lowered within the pipe string 12, down through coupling 15 into space 49 and into engagement with the upper end 46b of valve 46, the bailer being guided and centered into contact with the valve by inclined shoulder 43 of the valve seat. The downward force operates to unseat valve 46, moving it down against the resistance of spring 48 to place ports 47 in communication with space 49 and the pipe string 12. Continued downward movement of the bailer to the position of Fig. 2 brings disk 62' into engagement with the upper toothed end 37 of the breaking member 36, causing the disk to become broken and the charge receiving chamber 56 of the bailer to be brought into communication, through the disk breaking member 35, with passage 50 therebelow. It will be understood that the bailer 52 may be lowered rapidly, and that the downward momentum of the bailer at the point at which disk 62' is brought into engagement with the breaking member 36, will be sufficient to insure rupturing the disk.

Immediately upon breaking the disk, a sudden pressure differential is imposed between the outside and inside of the casing between packers 19 and 20, with the result that there occurs a sudden rush of well fluid through the perforations 13, acting to dislodge and carry into space 21 particles clogging the perforations. The fluid is drawn through openings 51 into the passage 50, and thence upwardly through the valve seat 38 and disk breaking member 35 into the charge receiving chamber 56. After the full charge has been taken in, and a substantial pressure balance exists between the chamber 56 and the formation pressure acting to force the charge into the chamber, valve 62 seats to trap the charge in the bailer. It will be noted that by reason of the engagement between the lower end of the bailer and the upper end of valve 46, and between face 46c on the bottom of the valve and shoulder 35a of the disk breaking member, the upward suction into the bailer is through, rather than around the disk breaking member.

I have previously referred to the distinctive characteristic of the invention in producing a downward washing circulation of fluid from the pipe string through the formation around the casing perforations being cleaned, as well as a direct lateral drawing in of well fluid from that formation. The washing action referred to is made possible by putting space 49 and the interior of the pipe string 12 into communication with the formation surrounding the section of the casing 11 between packers 18 and 20, via spacing 19 and ports 47, upon opening of valve 46. Thus immediately after disk 62' has become broken, and with the parts in the positions shown in Fig. 2, the upward suction into the charge receiving chamber applied to the casing perforations 13 between packers 18 and 20 produces, in addition to a lateral inflow of fluid from the surrounding formation through the casing perforations, a circulation of well fluid standing within pipe string 12, downwardly through space 49, then out through ports 47, space 19 and the casing perforations between packers 17 and 18, into the surrounding well sands. The fluid then flows downwardly, flushing and washing through the formation between the levels of packers 17 and 20, and is drawn in through perforations 13 between packers 18 and 20, along with the well fluid being taken in from that zone.

Thus in addition to cleaning the perforations 13, I am able to effectively open and increase the well production and normal fluid flow through the formation interstitial spaces by reason of the downward washing action of the fluid being drawn from the fluid column standing in the pipe string and the simultaneously induced horizontal cross-flow into the perforations from the formation. The arrows *a* in Fig. 2 indicate the path of fluid flow from the pipe string out through ports 47 and space 19, and the downward flushing circulation, indicated by the arrows *a*; the direction of the horizontal cross-flow being represented by the arrows *c*.

In order to maintain a maximum fluid head in the pipe string, and thereby increase the effectiveness of the washing fluid circulating down around the casing, the pipe 12 may, if desired, be filled with liquid to the ground surface, so that upon opening valve 46 and the charge receiving chamber 56, there will exist a maximum pressure differential acting to draw the flushing fluid from space 19 down around the casing and into ports 51.

At the completion of the cleaning operation, the bailer is withdrawn from the well and the charge dumped in the manner previously explained. After a new disk 62' has been placed in the bailer, the latter may again be lowered to perform another cleaning operation with the tubular assembly 10 remaining in substantially the same position, or after one or a number of individual cleaning operations, the assembly may be shifted vertically within the casing to bring the packers opposite a successive section of the casing to be cleaned.

I claim:

1. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on the body above said apertures, means for draining the liquid column in said pipe above said body outwardly through a port in said body, so that the liquid thence flows out through the casing perforations above said packer, and suction operated means for simultaneously drawing liquid inwardly into the body through the casing perforations below said packer.

2. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of packers carried on the body above and below said apertures, means for draining the liquid column in said pipe above said body outwardly through a port in said body, so that the liquid thence flows out through the casing perforations above the upper packer, and suction operated means for simultaneously drawing liquid inwardly into the body through the casing perforations between said packer.

3. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of vertically spaced packers carried on the body above said apertures, means for draining the liquid column in said pipe above said body outwardly through a port in said body, so that the liquid thence flows out through the casing perforations between said packers, and suction operated means for simultaneously drawing liquid inwardly into the body through the casing perforations below the lower packer.

4. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of packers carried on the body above said apertures, a packer on the body below said apertures, and a port through which fluid is discharged from within the body, outwardly between the first mentioned packers.

5. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of packers carried on the body above said apertures, a packer on the body below said apertures, a port through which fluid is discharged from within the body, outwardly between the first mentioned packers and a valve normally closing said port.

6. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of packers carried on the body above said apertures, a packer on the body below said apertures, a port through which fluid is discharged from within the body, outwardly between the first mentioned packers, a valve normally closing said port, said valve being adapted to be opened by engagement with a bailer lowered within said pipe, and yielding means supporting the valve.

7. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a pair of packers carried on the body above said apertures, a packer on the body below said apertures, a port through which fluid is discharged from within the body, outwardly between the first mentioned packers, a valve normally closing said port, said valve being adapted to be opened by engagement with a bailer lowered within said pipe, yielding means supporting the valve, and a check valve within the body below the last mentioned valve.

8. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on the body above said apertures, means for causing the liquid column in said pipe above said body to flow outwardly through a port in said body and through the casing perforations above said packer, suction operated means for simultaneously drawing liquid inwardly into the body through the casing perforations below said packer, and valve means for controlling the outward flow of fluid through said port.

9. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on the body above said apertures, means for causing the liquid column in said pipe above said body to flow outwardly through a port in said body and through the casing perforations above said packer, and thence to be then drawn inwardly into the body through the casing perforations below said packer, and valve means for controlling the outward flow of fluid through said port, said valve means comprising a valve movable vertically within the body, and yielding means supporting the valve.

10. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on the body above said apertures, means for causing the liquid column in said pipe above said body to flow outwardly through a port in said body and through the casing perforations above said packer, and thence to be then drawn inwardly into the body through the casing perforations below said packer, and valve means for controlling the outward flow of fluid through said port, and a bailer closure opening means within said body.

11. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on the body above said apertures, means for causing the liquid column in said pipe above said body to flow outwardly through a port in said body and through the casing perforations above said packer, and thence to be then drawn inwardly into the body through the casing perforations below said packer, and valve means for controlling the outward flow of fluid through said port, said valve means comprising a tubular valve movable vertically within the body, yielding means supporting the valve, and a bailer closure opening means within said body and in telescoping relation with said valve.

12. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on said body above said apertures, a bailer adapted to be lowered within said pipe and having a closure adapted to be opened to admit well liquid to a chamber within the bailer, means on said body cooperating with the bailer to open said closure, and means whereby opening of the closure causes the liquid column in said pipe above said body to flow outwardly through a body port and the casing perforations above said packer, and to be thence drawn inwardly through the casing perforations below said packer.

13. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on said body above said apertures, a bailer adapted to be lowered within said pipe and having a closure adapted to be opened to admit well liquid to a chamber within the bailer, means on said body cooperating with the bailer to open said closure, and means whereby opening of the closure causes the liquid column in said pipe above said body to flow outwardly through a body port and the casing perforations above said packer, and to be thence drawn inwardly through the casing perforations below said packer, and upwardly within said body into the bailer.

14. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on said body above said apertures, a bailer adapted to be lowered within said pipe and having a closure adapted

to be opened to admit well liquid to a chamber within the bailer, means on said body cooperating with the bailer to open said closure, means whereby opening of the closure causes the liquid column in said pipe above said body to flow outwardly through a body port and the casing perforations above said packer, and to be thence drawn inwardly through the casing perforations below said packer, and a valve normally closing said port and adapted to be opened by engagement by said bailer.

15. In well cleaning apparatus, the combination comprising a pipe lowered within the well casing, a tubular body attached to the lower end of said pipe and having apertures opposite the casing perforations, a packer carried on said body above said apertures, a bailer adapted to be lowered within said pipe and having a closure adapted to be opened to admit well liquid to a chamber within the bailer, means whereby opening of the closure causes the liquid column in said pipe above said body to flow outwardly through a body port and the casing perforations above said packer, and to be thence drawn inwardly through the casing perforations below said packer, a tubular valve normally closing said port and adapted to be moved downwardly by engagement by the bailer to open the port, yielding means supporting said valve, and a bailer closure opening means projecting upwardly within the body in telescoping relation with said valve.

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