Dec. 1, 1959 J. D. CHESNUT 2,915,124

JET TYPE BAILER WITH GAS GENERATING MECHANISM

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FIG. 1

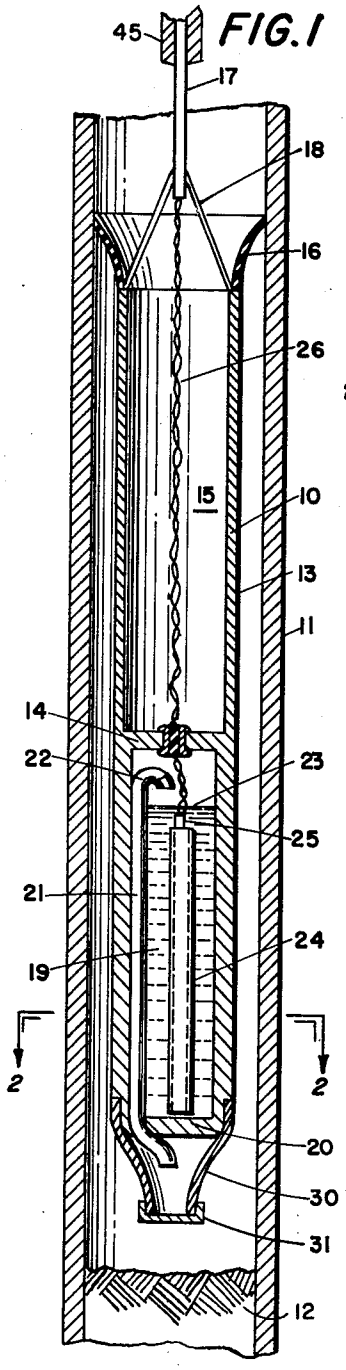


FIG. 2

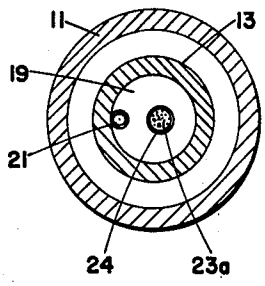


FIG. 4

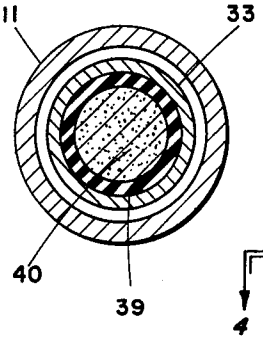
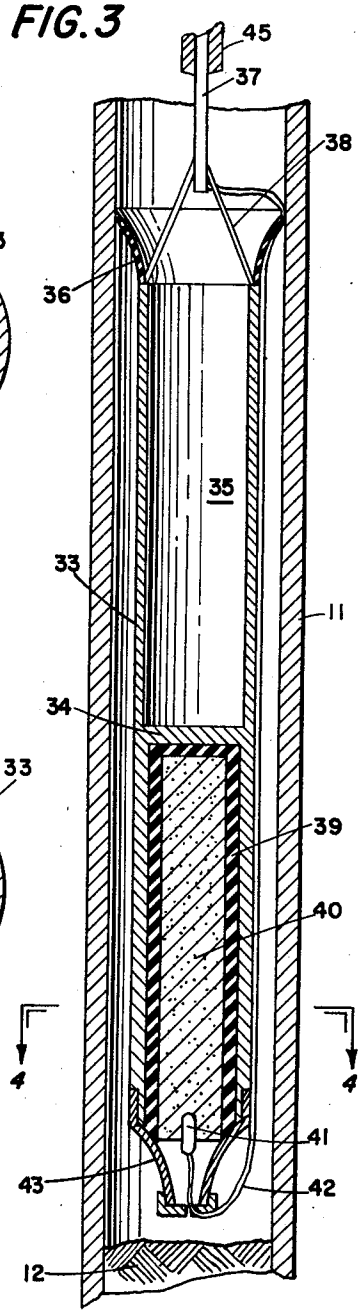


FIG. 3



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JET TYPE BAILER WITH GAS GENERATING MECHANISM

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FIG. 5

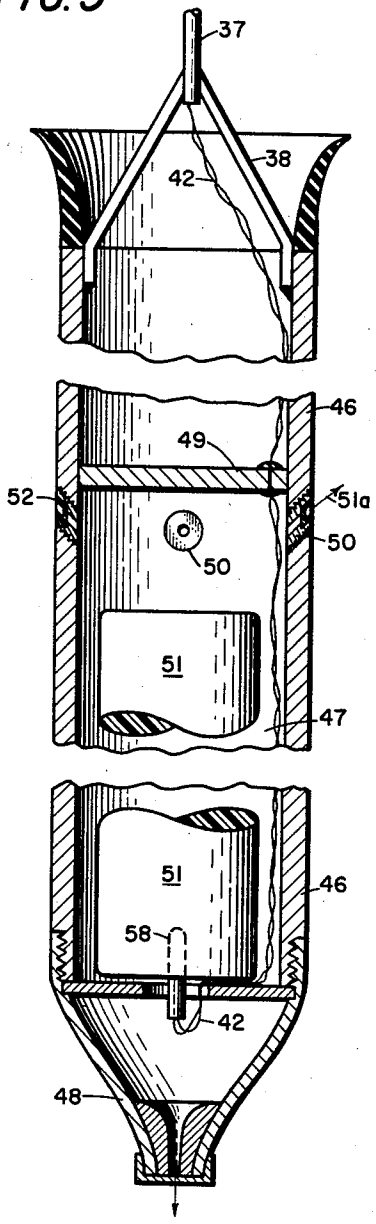
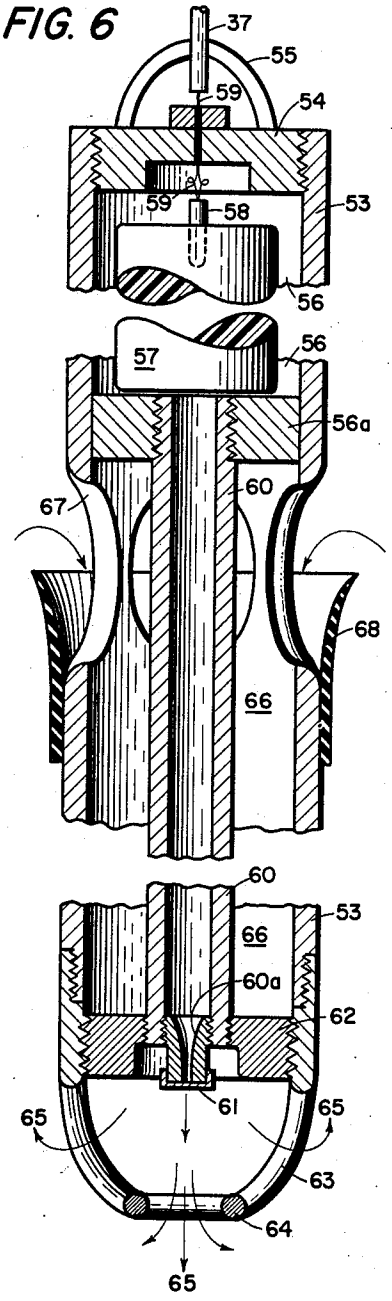


FIG. 6



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JET TYPE BAILER WITH GAS GENERATING MECHANISM

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FIG. 7

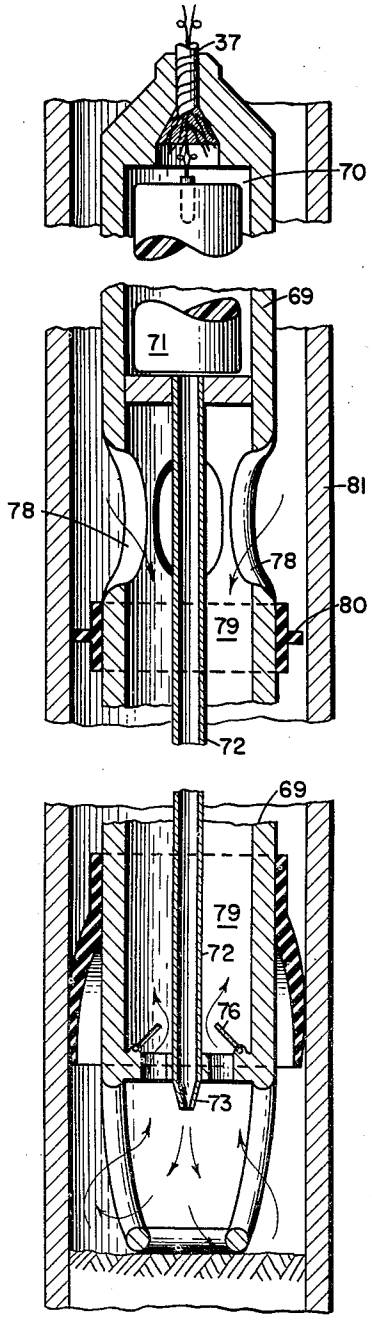


FIG. 8

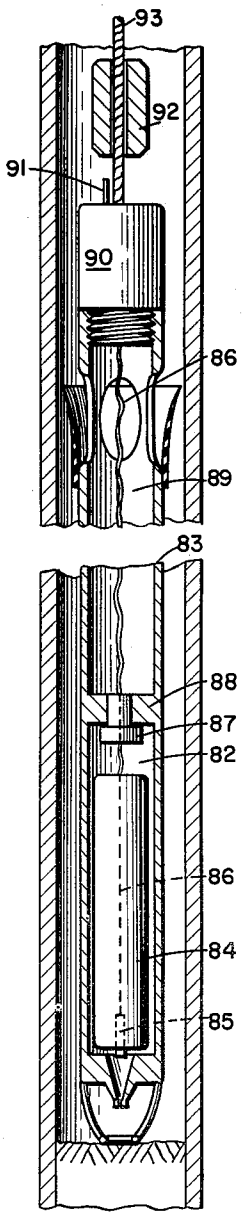


FIG. 9

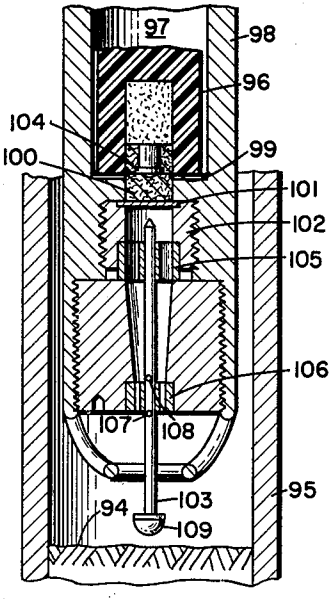
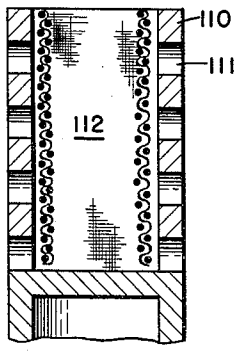


FIG. 10



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2,915,124

JET TYPE BAILER WITH GAS GENERATING MECHANISM

John D. Chesnut, Newport Beach, Calif., assignor to Aerojet-General Corporation, Azusa, Calif., a corporation of Ohio

Application June 1, 1956, Serial No. 588,770

11 Claims. (Cl. 166—63)

This invention relates to oil well tools, and in particular to a bailer for removing debris or other materials from a well bore.

An object of the invention is to provide a bailer with powerful, self-contained jetting means which provide a fluid jet for dislodging debris in a well bore and moving it into a container in the bailer.

It is an optional object of this invention to provide such a jetting device in which the combustion process of a heating charge which generates the fluid jet is substantially independent of well submergence pressures.

This invention is carried out in combination with a bailing device having upper and lower compartments. One compartment is open at its upper end and closed at its lower end so as to hold debris and the like which may be dumped into it. A feature of the invention resides in the provision of a jetting device so disposed and arranged as to discharge fluid toward the bottom of a well, thereby causing the fluid and debris which it entrains to rise above the bailer and thereafter drop into it for removal from the well.

A further feature of the invention resides in the provision of a discharge nozzle for discharging said vapor into the well whereby an optimum force can be obtained from the fluid jet.

An optional feature of this invention resides in the provision of a self-combustible charge of the type frequently known as propellant, which contains within itself the materials necessary for the generation of hot gases. With the use of such a self-combustible material, there need be no dependence on outside sources such as the atmosphere for combustion reactants.

A further optional feature which may be utilized if desired resides in the provision of a self-contained fuel which upon combustion produces only heat and solid materials, and therefore can be enclosed in a rigid jacket so that its combustion processes are independent of well submergence pressures. Such a heat source can be utilized to vaporize a liquid for creating pressure to discharge a jet of fluid.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings, of which:

Fig. 1 is an elevation, partly in cross-section, of a bailer according to the invention;

Fig. 2 is a cross-section taken at line 2—2 of Fig. 1;

Fig. 3 is a side elevation partly in cross-section showing an alternate form of the invention;

Fig. 4 is a cross-section taken at line 4—4 of Fig. 3;

Fig. 5 illustrates another embodiment of the invention wherein there are jets directed both upwardly and downwardly;

Fig. 6 illustrates another embodiment of the invention wherein the gas generating chamber is at the top of the bailer instead of at the bottom;

Fig. 7 illustrates an embodiment similar to Fig. 6 except that the bailer compartment is filled from the lower and upper ends instead of the upper end;

Fig. 8 illustrates an embodiment of the invention wherein ignition of the propellant is accomplished by a self-contained battery and switch actuated by dropping a "go-devil" down the well;

Fig. 9 illustrates an embodiment of the invention wherein ignition of the propellant is accomplished by a self-contained battery and switch actuated by a striker pin upon contact with a bridge in the well; and

Fig. 10 illustrates a bailer body which is perforated at its lower end and provided with a removable screen liner.

Referring to Fig. 1, there is shown a bailer **10** suspended near the bottom of a well casing **11** having debris **12** at the bottom thereof. It is the purpose of the bailer to remove the debris from the well bore.

The bailer comprises a generally cylindrical case **13** open at its upper end, with a partition **14** across the case at a point intermediate the ends. This partition creates a compartment or container **15** which has its open end pointed upward. To the upper rim of the case there is attached a flexible cup **16**, the outer flanges of which extend upwardly and outwardly from the case and bear against the well casing.

A wire line **17** attached to a handle **18** on the bailer suspends the bailer in the well.

Below the partition **14** there is provided a closed vaporizing compartment or chamber **19**. This chamber is created below the partition **14** by barrier **20**. An eductor tube **21** has an inverted U **22** on its upper end in the vaporizing chamber, and passes through the lower barrier **20**. Vaporizable liquid **23** is placed in this vaporizing chamber **19**.

A self-combustible heating charge **23***a* which generates heat and no gases in its combustion process is shown enclosed in a fluidtight jacket **24**. This jacket is made strong enough to isolate the charge from the submergence pressures which surround it. There are many solid substances which undergo an exothermal reaction to produce heat and solid substances. A preferred charge comprises an intimate mixture of powdered metallic aluminum and iron oxide in substantially stoichiometric proportion, which reacts exothermally according to the following equation:

$$2Al+Fe_2O_3 \rightarrow Al_2O_3+2Fe+heat$$

It will be observed that no gases are formed, but only solids, and that no pressure is thus exerted on the reactants to affect their combustion rate. It will be further observed that this charge **23***a* is self-contained in the sense that no substances from outside the charge are required for the reaction.

Other non-gassing materials, such as thermit and equivalent mixtures, can also be used. In many instances it will be desirable to reduce the amount of heat produced in burning. This can be done by incorporating inert material such as dixie clay into the heating charge mixture. The particular heating charge employed in this invention is not considered critical. All such modifications of the ingredients of the charge are considered within the skill of the art and within the scope of this invention.

A squib **25** is embedded in the upper end of the charge. An electric firing line **26** leads to the squib from the surface for igniting the squib and starting the reaction of the charge.

A nozzle **30** is fixed to the lower end of the casing **13**, and eductor tube **21** discharges fluid from the vaporizing chamber into the nozzle.

A frangible diaphragm **31** is placed across the end of the nozzle **30** to exclude liquids therefrom until pressure is built up by the charge.

The bailer of Fig. 3, also shown lowered into a well

casing 11, has an outer case 33. This case is divided at some midpoint by partition 34 so as to provide a container 35 with an open upper end. A flexible cup 36 is provided at the top of the case, the outer end of its flange making contact with the wall of the well casing.

An insulated electric conductor line 37 suspends the bailer by means of a handle 38. Below the partition 34 and within the shell there is placed a layer of insulation 39 such as asbestos; and within the lining of insulation there is a charge 40 of a self-combustible fuel. These self combustible fuels are gas forming, and are known principally as propellants, and are capable of producing volumes of gas many times greater than solid volume. This gas generation is obtained entirely from materials contained within the charge itself, and does not require substances from outside the charge such as atmospheric oxygen. A squib 41 is inserted in the bottom end of the charge 40 and an electric igniter line 42 leads from the squib to the surface of the well for igniting the charge 40 by setting off the squib.

An example of a suitable gas-forming propellant material for this bailer is a mixture comprising approximately 25% asphalt and 75% potassium perchlorate.

A nozzle 43 is fixed to the lower end of the shell 33 with its open end discharging downwardly toward the bottom of the well bore.

The operation of the bailer of Fig. 1 will now be described. The bailer is first lowered into the well by paying out the line 17. It will be let down to a level so that the nozzle is spaced slightly above the debris to be removed from the bottom of the well. Before combustion of the charge is begun, the unit in the well stands as shown in Fig. 1, with the outer flange of the flexible cup 16 making a continuous contact with the well casing. It will be observed that the shell 13 is of lesser diameter than that of the well casing so as to leave an annular space between the bailer and the well casing. When it is desired to bail the debris from the bottom of the well, an electric current is sent through line 26 and the self-combustible fuel charge begins its exothermal reaction. This vaporizes at least some of the liquid in the vaporizing chamber 19. As the liquid is vaporized the vapors rise and pass through the eductor tube and into the discharge nozzle. After a sufficient pressure is developed the frangible diaphragm is broken and the fluid departs from the nozzle in a strong fluid jet toward the debris which agitates and entrains the debris in the well. The fluid, entrained debris, and liquids in the well are thereby caused to rise through the annular space between the bailer and the well casing.

When the entrained debris reaches the flexible cup, the flanges of the cup are forced inwardly and permit the material to rise above the upper edge of the bailer. When the pressure is insufficient to continue lifting material from the bottom of the well, this material settles, and its weight forces the flanges of the flexible cup against the walls of the casing. This material will thereupon be funneled so as to drop into the container 15 which will retain them. Then the bailing device may be lifted to the top of the surface by the wire line, and the debris is thus removed.

The operation of the bailer of Fig. 3 is substantially similar, the squib 41 being fired by an electric current through line 42. This ignites charge 40 which generates quantities of gases which are discharged through the nozzle 43 so as to entrain the debris, and carry it above the upper margin of the bailer. Fluids in the well also aid in this entrainment. Then when the debris falls, it is caught in the container 35 by the funneling action of the cup. The bailer can be lifted from the well by the wire line 37.

A salient advantage of the bailer of Fig. 1 is the utilization of a self-combustible mixture which produces only heat and solid products of combustion. It is possible to enclose this type of combustion charge in a rigid jacket and thus isolate the charge from the effects of well submergence pressures. The jacket need only be strong enough to resist well submergence pressures, since no gaseous products are generated by the combustion which would create an internal pressure. Because of this isolation, the rate of combustion is entirely independent of submergence conditions and an optimum burning rate is thereby achieved for this device.

With the device shown in Fig. 3, the propellant material is exposed to well submergence pressures which tend to cause some deterioration of the heating reaction. However, it will generally be found that such deterioration is moderate, and that the operation of this bailer will be entirely satisfactory for all practical purposes.

The downwardly directed jets from the nozzles 30 and 43 exert an upward thrust which tends to move the bailer up the hole and away from the debris 12. Generally, the weight of the bailer body is sufficient to prevent upward movement of the bailer. However if it is desired to provide additional precaution against upward movement of the bailer, this can be accomplished in several ways. For example, weights or "sinker bars" 45 may be placed on the lines 17 and 37. Another method of accomplishing the desired result is to provide additional nozzles 50 which exert a downward thrust, as shown in Fig. 5.

Referring to Fig. 5, the bailer body 46 is similar to that shown in Fig. 3 with the combustion chamber 47 at the lower end of the body 46, terminating in a downwardly directed nozzle 48 and closed at its upper end by a barrier 49. The combustion chamber 47 is provided, preferably at its upper end, with one or more upwardly directed nozzles 50 which impart a downward thrust to the bailer when gas is discharged through the nozzles 50 from the burning propellant 51, as indicated by the arrows 51*a*. The outlets from the nozzles may be sealed against the entrance of well fluid into the combustion chamber 47, while the bailer is being run into the well, by means of cup-shaped seals 52, of the type commonly used for this purpose.

Fig. 6 illustrates another embodiment of the invention wherein the combustion chamber and propellant charge are located at the upper end of the bailer body instead of at the lower end, as in Figs. 1–5. The top of the bailer body 53 is closed by a cover 54 to which the lifting handle 55 may be attached. A combustion chamber 56 is formed within the bailer body 53, the cover 54 and a bottom plate 56*a*. The propellant charge 57 is contained within the chamber 56 and is ignited by any suitable means, such as the igniter 58 and electric wires 59 which extend through the cover 54 and are connected to an electric hoisting line 37.

Gas generated by burning the propellant charge 57 is conducted downwardly through the bottom plate 56*a* through a tube 60 which extends to the lower end of the bailer body 52 and terminates in a nozzle 60*a* which is initially sealed by a removable cover 61. The lower end of the tube 60 passes through a closure plate 62 which serves as the bottom of the bailer body.

The lower end of the bailer body 53 is provided with a stand-off nose preferably in the form of an open cage 63 having a ring-shaped foot piece 64 at the lower end thereof. The purpose of the cage 63—64 is to keep the nozzle 60*a* spaced a proper distance above the target (which is the debris in the well) and at the same time to allow the debris to be circulated upwardly as indicated by the arrows 65.

Since the tube 60 extends throughout the middle and lower portion of the bailer body 53, there is provided an annular space 66 within the bailer body to receive debris which is moved upwardly by the jet force issuing from the nozzle 60*a*. The entrance to the space 66 is near the top of the bailer body and below the plate 56*a* and may

be in the form of windows 67 formed in the wall of the bailer body.

In order to insure that debris raised by the jet from nozzle 60 will enter the windows 67, it is preferred to provide a guide in the form of a flexible cup 68, facing upwardly, and positioned around the bailer body at the lower side of the windows 67. Thus, debris moving upwardly, as indicated by the arrows 65, will be constrained to move inwardly through the windows 67 as the bailer body is moved upwardly in the well.

Fig. 7 illustrates still another embodiment of the invention in which the bailer is loaded from the bottom instead of from the top. The bailer body is indicated schematically at 69. The propellant chamber 70 is at the top and contains the propellant 71. A tube 72 leads from the propellant chamber 70 to a discharge nozzle 73, in a manner similar to that illustrated in Fig. 6. The lower end of the bailer body 69 is closed by a bottom plate 74 containing a series of holes or inlet ports 75. The inlet ports are covered by upwardly opening check valves 76. A downwardly facing rubber cup 77 surrounds the lower end of the bailer body and serves to direct debris into the inlet ports 75. The upper portion of the bailer body 69 is provided with one or more openings 78, below the propellant chamber 70, which serve both as a vent to permit debris to enter the bailer chamber 79 and as an inlet to permit debris which has moved above the bailer to drop down into the bailer chamber 79. A flexible guide collar 80 serves to deflect debris from above the bailer inwardly through the opening 78.

In use, as the bailer 69 is run into a well, fluid from below the bailer by-passes upwardly through the inlet ports 75 and the openings 78. After the bailer chamber 79 has been filled with debris the bailer is lifted, causing the check valves 76 to close, trapping the debris in the bailer chamber 79. On the upward trip, fluid in the well by-passes the flexible cup 77 and the flexible guide collar 80. The latter does not make a fluidtight seal with the well casing 81.

The bailers illustrated in Figs. 1 through 7 are shown as being suspended from insulated electric lines 37 through which electric current is caused to flow from a source (not shown) at the top of the well to the igniter attached to the propellant. This arrangement is not essential to the operation of the invention. Bailers are usually operated from stranded steel cables (which do not conduct electric current) because of the greater strength of such cables as compared to electric conductor lines. If it is desired to operate the bailers of the present invention by means of non-conductor cables, it becomes necessary to furnish different means for igniting the propellant. Such means may comprise an electric battery with mechanical means for closing the circuit, or a percussion type detonator, as shown schematically in Figs. 8 and 9.

Fig. 8 illustrates one form of battery type igniter in which the circuit is closed by dropping a weight or "go-devil" from the top of the well. The propellant chamber 82 is shown as being at the lower end of the bailer body 83, although it could be at the top of the bailer body without departing from the spirit of the invention. The propellant is indicated at 84 with the igniter 85 at the lower end thereof, although it could be at the upper end. The lead wire 86 from the igniter is shown in dotted lines extending through the body of the propellant, passing upwardly through a stuffing box 87 in the floor 88 of the bailer chamber 89, upwardly through the interior of the chamber 89 and into the lower end of a chamber 90 which contains a battery and a percussion type switch, not shown, but well known in the art. Extending upwardly out of the chamber 90 is a striker pin 91, so positioned that when a striker weight or "go-devil" 92 is dropped from the top of the well on the suspension line 93, downward movement of the striker pin 91 closes the switch in chamber 90 causing electric current from the battery to flow through line 86 to the igniter 85.

Fig. 9 illustrates still another form of the invention in which the igniter is actuated by a percussion device which strikes the top of the bridge 94 formed by the debris in the well casing 95. A propellant charge 96 is positioned in the lower end of a combustion chamber 97 formed on the lower end of the bailer body 98 which corresponds to 46 of Fig. 5. The propellant is supported on annular seat 99 around an opening 100 which is normally closed by a frangible sealing disc 101. The disc may be secured in place by any suitable means such as a threaded hollow plug 102. A striker pin 103 is mounted for axial movement with respect to the disc 101 and the hollow plug 102. The upper end of the pin 103 is pointed or otherwise adapted, upon upward movement, to break the frangible disc 101 and to strike a percussion cap 104 mounted in the lower end of the propellant charge 96, to ignite same. The pin 103 is restrained and guided by any suitable means. For example, a spider bushing 105 may be formed in the hollow plug 102 and a second spider bushing 106 may be positioned below the plug 102 to provide vertically spaced guides for the pin 103. The pin 103 is constrained against accidental upward or downward movement by any suitable means such as the shear pins 107 and 108. The lower end of pin 103 is preferably provided with an enlarged head 109 adapted to strike upon and to be impeded by the top of the bridge 94 formed by debris in the well casing 95, thus causing the pin 107 to be sheared, the disc 101 to be pierced and the cap 104 to be detonated.

In Figs. 1 through 9, the chamber which receives the debris from the well is shown as being open at the upper end having imperforate sides and bottom. However, since this type of bailer is intended for the removal of solids rather than liquids, it may be preferable to provide perforations in the sides and/or bottom of the chamber to permit liquid to escape while retaining the solids.

Fig. 10 illustrates one type of such a chamber 110 having a series of perforations 111 in the walls thereof which may be either round holes or slots of various sizes. It is preferred to make the holes or slots 111 the largest size likely to be used, say one quarter of an inch in width. If the solids to be removed from the well can pass through quarter inch slots, a screen mesh liner 112, in the form of a cylinder, can be inserted within the lower portion of chamber 110. A mesh size for the screen liner can be chosen to suit the particular type of bailing job being performed. Thus it is possible to sieve out fine said while allowing oil to pass back into the well

There is thus provided by this invention a bailer with a self-contained, powerful jetting means for dislodging debris from the bottom of a well, and depositing said debris in a container in the boiler itself.

Modifications of this invention will be evident to persons skilled in the art, particularly with regard to the selection of the jetting charges herein and in the means of setting them off. Therefore, this invention is not to be limited to the embodiments shown in the drawings and described in the description which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

I claim:

1. A well bailer comprising: a hollow case; a partition dividing said case into upper and lower compartments; the upper of said compartments being normally closed; a body of gas generating propellant in said upper compartment; ignition means for said propellant; conduit means extending from the interior of said upper compartment through the lower end of said lower compartment; a downwardly directed nozzle discharging to the exterior of the bailer on the lower end of said conduit means; means for removably closing said nozzle against the entrance of well fluids; and a well fluid inlet adjacent the upper end of said lower compartment.

2. A well bailer comprising: a hollow case, a partition dividing said case into upper and lower compartments;

the upper of said compartments being normally closed; conduit means extending from the interior of said upper compartment through the lower compartment and terminating in a downwardly directed nozzle; means for removably closing said conduit against the entrance of well fluids; gas generating means in said upper compartment; means for actuating said gas generating means; an inlet port in the lower portion of said lower compartment; an inwardly opening check valve in said inlet port; and a second port in the upper portion of said lower compartment communicating with the interior and exterior of said compartment.

3. A well bailer as defined in claim 2 including a deflector member on the exterior of said lower compartment adjacent the lower end thereof, tending to prevent upward flow of well fluid around the exterior of said lower compartment while directing such fluid into the inlet ports in the lower end of said lower compartment.

4. A well bailer comprising: a hollow case; a flexible funnel-like cup affixed to the upper margin of said case and flaring upwardly and outwardly from said case; a partition across said case creating a container at the upper end of the bailer having an open upper end adapted to receive debris which is dumped therein; a source of fluid under pressure disposed in said case and below said partition; and a nozzle at the lower end of said case; whereby discharge of fluid through the nozzle and into a well dislodges debris from the bottom of said well and lifts the debris above the flexible cup, the flexible cup guiding the debris into the container when the debris drops.

5. A well bailer comprising: a hollow case; a first partition in said case creating a container at the upper end of the bailer with an open upper end adapted to receive debris dumped therein; a second partition below said first partition creating a vaporizing chamber between said partitions; a heating charge in said vaporizing chamber for vaporizing liquid contained therein; a nozzle fixed to the bottom of said case; conduit means interconnecting said vaporizing chamber and said nozzle, whereby heat from the heating charge vaporizes some of the liquid in said vaporizing chamber, and a jet of fluid is thereupon discharged into the well bore to dislodge debris from the bottom of said bore and lifts the debris above the container so that the debris will drop into the container when no longer lifted by the discharged fluid.

6. Apparatus according to claim 5 in which a flexible funnel-like cup is affixed to the upper margin of the case, said cup extending upwardly and outwardly from said case, whereby the flexible cup is deflected by the rising entrained debris to permit the debris to rise above the upper margin of the container, and also acts as a funnel to direct the debris into the container as the debris falls when no longer supported by the fluid.

7. Apparatus according to claim 5 in which a fluidtight jacket is provided to enclose the heating charge and isolate said charge from surrounding pressures, said heating charge comprising a mixture of substances capable of undergoing a self-contained non-gaseous exothermal reaction.

8. Apparatus according to claim 7 in which the charge comprises an intimate mixture of metallic aluminum and iron oxide in substantially stoichiometric proportion.

9. A well bailer comprising: a hollow case, a flexible funnel-like cup affixed to the upper margin of said case and flaring outwardly and upwardly from said casing; a partition across said case creating a container at the upper end of the bailer with an open upper end adapted to receive debris which is dumped therein; a nozzle at the lower end of said case; and a self-contained gas-generating charge in said case beneath said partition and above said nozzle; whereby gas generated by said charge is directed in a fluid jet by the nozzle toward the bottom of a well, and dislodges debris from the bottom of said well, thereby lifting the debris above the flexible cup, the flexible cup guiding the debris into the container when the debris drops.

10. Apparatus according to claim 9 in which said charge comprises a propellant material.

11. A well bailer comprising: a hollow case; a partition dividing said case into upper and lower compartments; one of said compartments being adapted to receive debris from a well; deflector means mounted on said case and extending toward the wall of the well to deflect debris into the debris receiving compartment; the other of said compartments being normally closed; a body of gas generating propellant in said closed compartment; ignition means for said propellant; and discharge nozzle means communicating with the interior of said closed compartment and disposed adjacent the lower end of the bailer body.

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