Oct. 20, 1959 V. D. HANES ET AL 2,909,225

JET TYPE BAILER WITH GAS GENERATING MECHANISM

Filed June 1, 1956 2 Sheets-Sheet 1

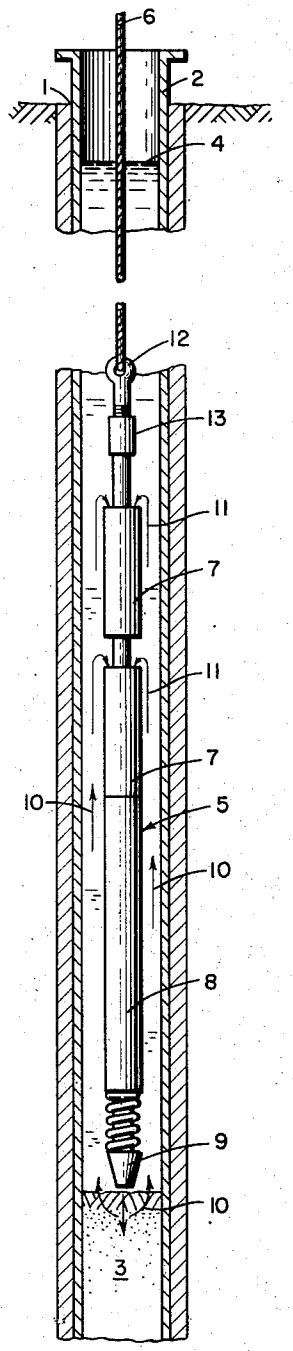


Fig. 1

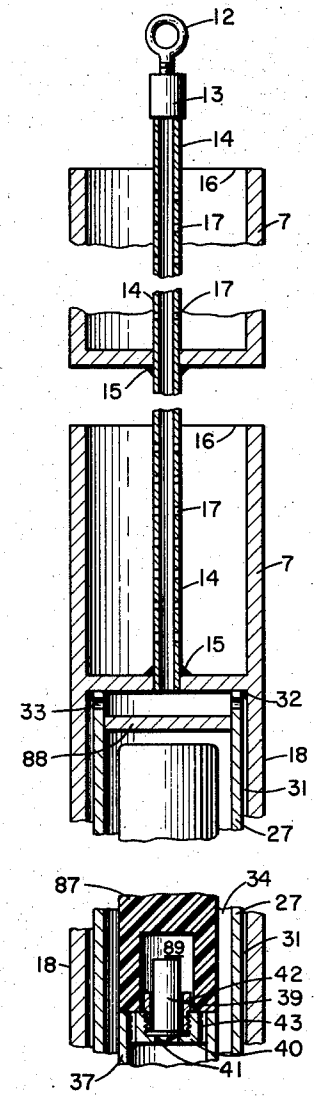


Fig. 2

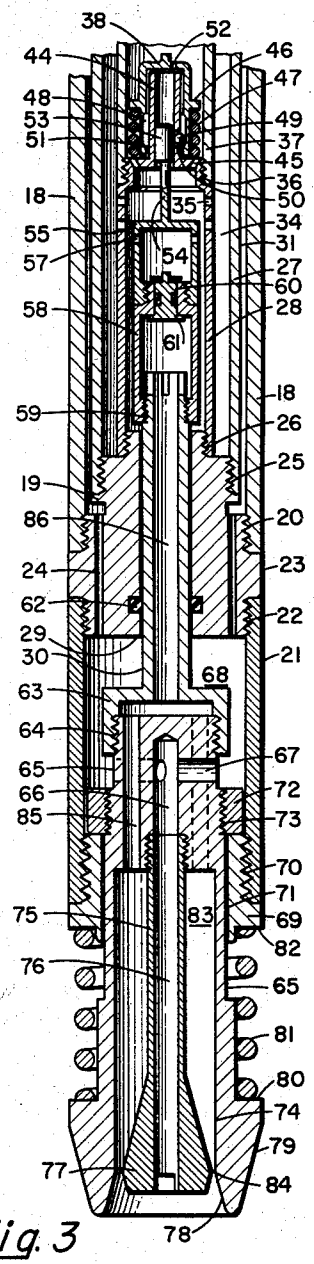


Fig. 3

INVENTOR.
VAUGHN D. HANES
JOHN D. CHESNUT

BY

D. Gordon Angus

ATTORNEY.

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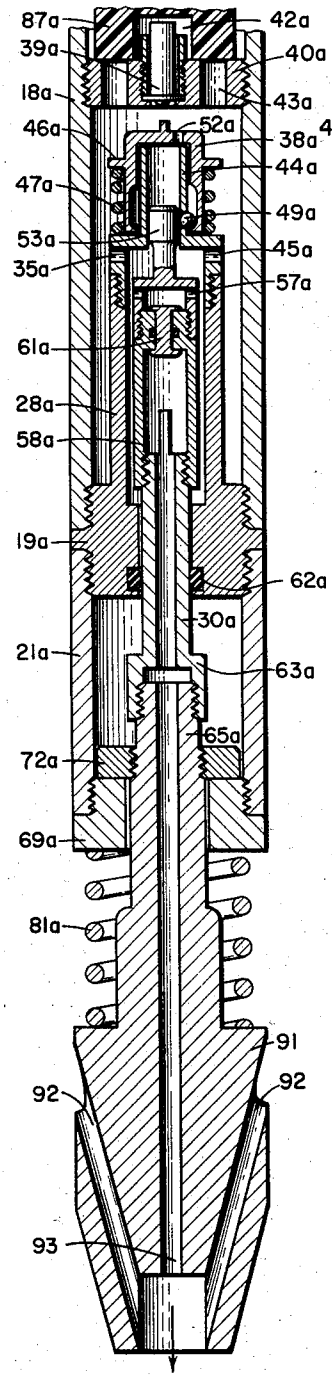


Fig. 4

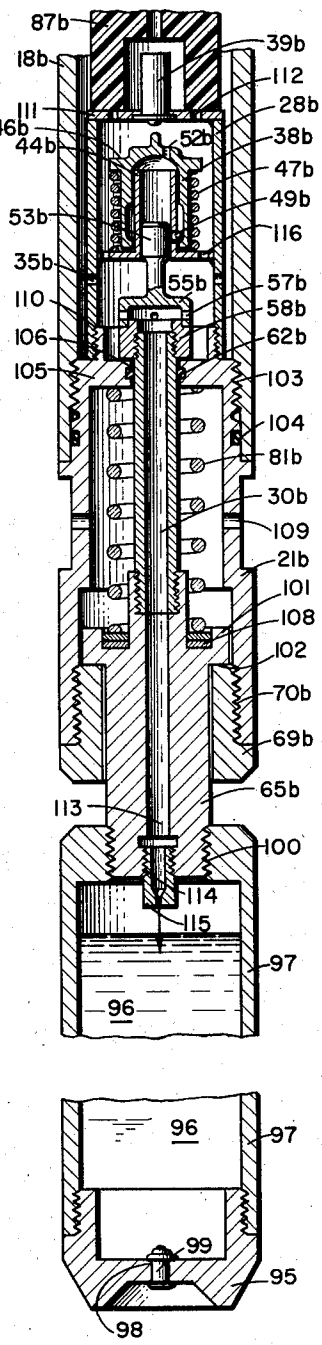


Fig. 5

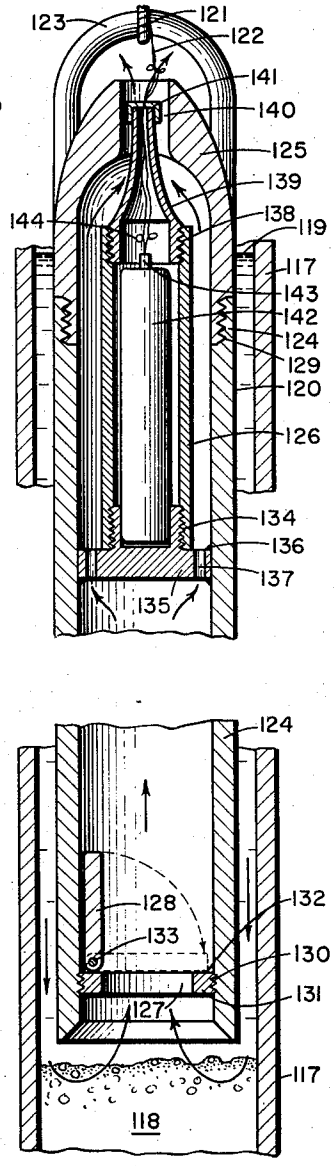


Fig. 6

INVENTOR.
VAUGHN D. HANES
JOHN D. CHESNUT

BY D. Gordon Angus

ATTORNEY.

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JET TYPE BAILER WITH GAS GENERATING MECHANISM

Vaughn D. Hanes, Covina, and John D. Chesnut, Newport Beach, Calif., assignors to Aerojet-General Corporation, Azusa, Calif., a corporation of Ohio

Application June 1, 1956, Serial No. 588,826

6 Claims. (Cl. 166—63)

This invention relates to oil well tools. More particularly, the invention relates to well bailers of the type wherein a fluid jet is directed against debris in the well to cause the debris to move upwardly in the well to a point above the open top of the bailer so that subsequent upward movement of the bailer in the well will cause the debris to be collected within the bailer body. Bailers of this general type are disclosed in the following copending patent applications: Serial No. 588,770, filed June 1, 1956, by John D. Chesnut; and Serial No. 588,827, filed June 1, 1956, by Vaughn D. Hanes.

Jet bailers of the type disclosed in the aforementioned patent applications depend upon the kinetic energy in the jet for their operation. Kinetic energy may be defined by the equation

$$E_k = \frac{MV^2}{2}$$

where M is the mass and V^2 is the square of the velocity of the jet. Inasmuch as the jets employed in the bailers above referred to are composed entirely of gaseous fluids (generated by the combustion of suitable propellants) such jets have a relatively low kinetic energy although their velocities may be high.

It is an object of the present invention to provide a jet for a jet bailer, which has greater kinetic energy, obtained by increasing the mass of the jet while maintaining approximately the same velocity of the jet. This object is achieved by providing a jet which consists of a combination of liquid and gaseous particles, the liquid particle having a much greater density than the gaseous particles.

It is a further object of the invention to provide an all-liquid jet for a jet bailer of the type wherein the propulsive force is generated by gaseous means.

Other objects and advantages will be evident from the following description and drawings illustrating several embodiments of the invention.

Fig. 1 is a schematic view showing a bailer embodying the present invention positioned within a well.

Fig. 2 is an elevation, in cross section, showing the upper portion of the bailer shown in Fig. 1.

Fig. 3 is an elevation, in cross section, of the lower portion of the bailer shown in Fig. 2.

Fig. 4 is an elevation, in cross section, of another embodiment of the bailer.

Fig. 5 is an elevation, in cross section, of still another embodiment of the invention.

Fig. 6 is an elevation, in cross section, of still another embodiment of the invention.

Referring to Fig. 1, the numeral 1 indicates a well bore which may be lined with a well casing 2. Within the casing 2 (or within the well bore 1, if the bore hole is not cased) is a bridge or obstruction 3 formed of sand or other debris. The well will normally contain fluid to some level 4 above the bridge 3. A bailer 5 is suspended within the well, slightly above the bridge 3, by means of a hoisting line 6 extending to the top of the well. The principal parts of the bailer 5 are a body having: one or more upwardly facing buckets 7; a propellant combustion chamber 8; a downwardly directed nozzle 9 and ignition means (not shown) for the propellant. Debris 3, dislodged by the fluid jet issuing from the nozzle 9 moves upwardly as indicated by the arrows 10 to some point above the buckets 7. Upward movement of the bailer 5 causes the dislodged debris to enter the upper ends of the buckets 7 as indicated by the arrows 11, where the debris is trapped for removal from the well.

Fig. 2 illustrates in more detail a bailer of the type indicated in Fig. 1. The bailer 5 is provided with some suitable means for attachment to the hoisting line 6, such as the eye bolt 12 and nipple 13 which is secured to the upper end of a drainage tube 14. Mounted on the drainage tube 14, which will be shown to provide a fluid inlet to the bailer body, are one or more buckets or cups 7 which are secured by any suitable means such as the welding indicated at 15. Preferably there are several such buckets 7, spaced apart, with their upper ends 16 open, to receive debris. Each bucket may be several feet in length. The drainage tube 14 is provided with a series of small drainage holes 17 which lead from the interior of each bucket 7 into the interior of the drainage tube 14. The purpose of these drainage holes 17 is to permit liquid to pass from the buckets 7 into the tube 14 while filtering out the solid debris.

The lower end of the drainage tube 14 communicates with the interior of a tubular housing 18 which may be an extension of the lowermost bucket 7, as shown, or may be a separate member. The lower end of the housing 18 (Fig. 3) contains a perforated closure plug 19 which is attached to the lower end of the housing 18 by any suitable means, such as the threads 20. The lower end of the plug 19 is threadedly connected to the upper end of a tubular shell 21 as indicated at 22. A wrench space 23 may be provided between the threads 20 and 22. A series of axially directed drain holes 24 extend through the plug 19 near the outer periphery thereof.

The upper end of the plug 19 is provided with suitable means such as the threaded, stepped bosses 25 and 26 for attaching thereto a pair of tubular housings 27 and 28. The plug 19 is provided with a central bore 29 which receives a slidable tube 30 therein. The tubular housing 27 is spaced inwardly of the housing 18 to provide an annular fluid channel 31 therebetween. The upper end of tubular housing 27 (Fig. 2) is adjacent the lower end of the drainage tube 14 and is preferably braced by tack welding to the bottom of the lowermost bucket 7 as indicated at 32. Ports 33 in the walls of the housing 27 permit the interior of the drainage tube 14 to be in open communication with the annular fluid channel 31 and with the drain holes 24 in the plug 19 (Fig. 3).

The lower end of the tubular housing 28 (Fig. 3) is spaced inwardly from the housing 27 to form an annular gas passage 34 between the housings 27 and 28. The upper portion of the housing 28 is provided with a series of gas inlet ports 35 in the walls thereof. The upper end of the housing 28 is threaded as indicated at 36 to receive an extension cap 37 which houses a cup-shaped firing pin 38 and supports a percussion cap cartridge 39. For this latter purpose the extension cap 37 is provided with a cover member 40 having a central opening 41 adapted to receive a threaded bushing 42 which receives and retains the percussion cartridge 39. The cover member 40 is also provided with one or more ports 43 for the passage of gas therethrough.

The upper end of the housing 28 (Fig. 3) is provided with an upwardly extending tubular support 44 on which the cup-shaped firing pin 38 is slidably mounted. Ports 45 formed in the base of the tubular support 44 permit the passage of gas therethrough. The wall of the firing pin 38 is provided with an outwardly extending flange 46 which rests upon the top of a helical spring 47 which is normally held in a compressed condition. The lower end of the spring 47 rests upon the upper surface of the base of the tubular support 44. The inner surface of the cup-shaped firing pin 38 is counterbored intermediate its ends as indicated at 48 to receive a portion of ball detent 49 which is housed with an opening 50 in the side wall of the support 44. The lower end of the counterbore 48 terminates in an upwardly facing shoulder 51 which supports the ball detent 49 in its normal, latched position, as shown in Fig. 3. An opening 52 may be provided in the top of the cup-shaped firing pin 38.

Housed slidably within the tubular extension 44 is a plunger 53 which normally prevents the ball detent 49 from moving out of the counterbore 48. The plunger 53 is supported by a neck 54 of sufficiently smaller diameter than the plunger 53 so that when the plunger 53 moves upwardly far enough to bring the neck portion opposite the ball detent 49, the ball is permitted to move inwardly a distance sufficient to permit the shoulder 50 on the firing pin 38 to clear the ball 50 and permit the compressed spring 47 to expand suddenly, causing the firing pin 38 to strike the percussion cap 39 and initiate the firing thereof. The neck member 54 is supported on a downwardly facing cup-shaped extension member 55 having ports 57 in the walls thereof. The cup-shaped member 55 is loosely supported on the upper end of a tubular valve member 58, the lower end of which is threadedly connected to the upper end of the tube 30 as indicated at 59. The upper end of the tubular valve member 58 is provided with a central opening 60 which receives a frangible blow-out plug 61 which normally seals the interior of the tube 30 against the passage of fluid therethrough in either direction.

The slidable tube 30 is provided, intermediate its ends, with sealing means, such as the O ring 62, for sealing the space between the exterior of the tube 30 and the central bore 29 in the closure plug 19. The lower end of the tube 30 has an enlarged head 63 which forms a female coupling which is internally threaded as indicated at 64. A tubular nozzle member 65 is threadedly attached at its upper end to the coupling 63 at 64. The nozzle member 65 is provided with central, axially disposed passageway 66 which communicates at its upper end with a laterally extending passage 67, the outer end of which communicates with a chamber 68 formed within the shell 21 between the closure plug 19 and a bushing 69 which latter is threadedly secured to the lower end of the shell 21 as indicated at 70. The bushing 69 is provided with a central bore 71 through which the nozzle 65 extends. The nozzle 65 is restrained downward movement (from the position shown in Fig. 3) by means of a stop nut 72 which is threadedly secured to the nozzle 65 as indicated at 73. The lower end of the nut 72 normally rests upon the upper end of the bushing 69, as shown in Fig. 3.

The central bore 66 of the nozzle 65 has an enlarged counterbore 74 in its lower portion. Within the counterbore 74 and spaced from the walls thereof is a tube 75 which is threadedly secured to the upper interior portion of the nozzle 65 in alignment with the axial passageway 66, as indicated at 76. The lower portion of the tube 75 is preferably enlarged to form a somewhat pear-shaped head 77. The head 77 is of slightly smaller diameter than the counterbore 74, the latter being flared outwardly and downwardly at its lower end, as indicated at 78. The lower portion of the nozzle 65 is preferably enlarged to form a head 79 which is provided with an upwardly facing shoulder 80. A helical, compressible spring 81 surrounds the nozzle 65 and bears against the upwardly facing shoulder 80 and against the downwardly facing surface 82 of the bushing 69, to normally maintain the parts in the positions shown in Fig. 3. The space between the outside of the tube 75 and the interior wall of the counterbore 74 forms an annular channel 83 which communicates at its lower end with a restricted passage 84 formed between the head 77 and the counterbore 74. The upper end of channel 83 communicates with the lower end of a vertical passage 85 in the upper portion of the nozzle 65. The upper end of passage 85 communicates with the lower end of the passage 86 through the tube 30.

Seated upon the top of cover member 40 is a propellant charge 87 (Fig. 2) within the housing 27 which is closed at its upper end by any suitable means, such as the partition 88. The propellant charge 87 is shown as a solid propellant, of cylindrical shape and having a recess 89 in its lower end to receive the percussion cartridge 39. The type of propellant and its configuration is not an essential part of the present invention.

The operation of the device shown in Figs. 1, 2 and 3 is as follows: with the parts in the positions shown in Figs. 1 and 2 the bailer 5 is attached to the hoisting line 6 and is lowered into the well until the nozzle (9 in Fig. 1 and 65, 77 and 79 in Fig. 3) contacts the top of the bridge formed by the debris 3. The weight of the bailer parts 7 and 8 (Fig. 1) causes these parts to slide downwardly on the nozzle 9—65 compressing the spring 81. The relative upward movement of the nozzle member 65, thus effected, pushes up the associated parts, 30, 58, 55, 54 and 53 until the plunger 53 is above the ball detent 49. The ball 49 then moves inwardly against the neck 54, freeing the firing pin 38 which is snapped upwardly by the spring 47. The top of the firing pin 38 strikes the percussion cap in the cartridge 39, causing it to ignite, and, in turn, ignites the propellant 87. High pressure gas generated by the burning propellant (which contains sufficient oxygen for combustion) passes downwardly through the passage 34, the ports 35, the ports 43 and 45, and 57 into the interior of the cup-shaped member 55 (Fig. 3). When the gas pressure has built up sufficiently to overcome the frangible blow-out plug 61, the passage 60 is opened, permitting the gas to pass downwardly through the tubular valve member 58, the tube 30, the passages 85, 83, 84 and downwardly against the debris 3, dislodging a portion of the debris and causing it to move upwardly in the well bore. There is usually fluid in the well to a point above the top of the bailer. In this event, the suction created in the lower end of the tube 75 by the high velocity gas passing out of the restricted orifice 84 tends to pull well liquid downwardly from above and to commingle the liquid with the high velocity gas jet, thus greatly increasing the specific gravity of the combined liquid and gas jet over the gas jet alone. Liquid entering the tube 75 is supplied through the drain holes 17 (Fig. 2) in the tube 14 within the buckets 7. Liquid from the interior of the tube 14 flows downwardly through ports 67, into the top of the passage 66 and thence into the top of the tube 75, issuing from the lower end of tube 75 and commingling with the jet of gas issuing from the nozzle 78—79.

By the time the propellant 87 has been expended, a sufficient volume of debris 3 will have been raised to a point above one or more of the buckets 7 to fill the buckets. Filling is accomplished by raising the bailer 5 upwardly through the dislodged debris. The upwardly facing buckets 7 tend to become filled with both debris and well liquids. Since it is not the intention to use bailers of the jet type for the removal of liquids, it is

desirable that as much of the liquid as possible be separated from the debris leaving only debris in the buckets **7**. This is accomplished by providing drain holes for liquid in the buckets **7**. The drain holes may be in the walls of the tube **14**, as shown in Fig. 2, or they may be in the walls or floor of the buckets, not shown. The well liquid which drains through the ports **17** into the tube **14** flows downwardly and into the nozzle **9**, as described above. Fig. 4 illustrates another embodiment of the invention wherein the well fluid which is entrained in the gas jet issuing from the nozzle **91** is sucked into the nozzle through inlets or ducts **92** formed in the nozzle around the main jet of gas issuing from the central passage **93**. The construction of the bailer shown in Fig. 4 is generally similar to that shown in Figs. 2 and 3 with the omission of the inner housing **27** of Fig. 3 which serves to form the liquid passage **31** which is unnecessary with the construction shown in Fig. 4. In Fig. 4 parts which are similar to those of Fig. 3 are given the same numbers with an *a* added. No further description of the construction and operation of the device shown in Fig. 4 is deemed necessary.

Fig. 5 illustrates another embodiment of the invention wherein the jet issuing from the nozzle **95** is composed entirely of liquid. The liquid is forced through the jet nozzle by means of high pressure gas generated by the burning of a propellant **87***b*. Parts having functions similar to the corresponding parts of Figs. 3 and 4 are given similar numbers with a *b* added. The liquid which is to be ejected through the nozzle **95** is contained in a reservoir **96** within a tubular chamber portion of the bailer body **97**, to the lower end of which is attached the nozzle **95**. The nozzle **95** has a small, downwardly directed orifice **98** which is normally sealed by a frangible plug **99**. The upper end of the reservoir chamber **97** is threadedly attached to the lower end of a tubular member **65***b* as indicated at **100**. Member **65***b* is provided at its upper end with an enlarged head **101** having a downwardly facing shoulder **102** which rests upon the upper end of a threaded bushing **69***b* which is attached to the lower end of a tubular shell **21***b* as indicated at **70***b*. The tubular shell **21***b* is threadedly attached at its upper end to a tubular housing **18***b* as indicated at **103**. Suitable sealing means, such as the O ring **104**, is provided in member **21***b* to seal the space between members **21***b* and **18***b*. The upper end of the tubular shell **21***b* is closed by a transverse wall **105** having a central bore **106** through which the tube **30***b* extends slidably. Sealing means such as the O ring **62***b* seals the space between the tube and the wall **105**. A helical compressible spring **81***b* is interposed between the top of member **21***b* and the under side of the transverse wall **105** to maintain the members **65***b* and **21***b* normally in the extended position shown in Fig. 5. Spacer washers **108** may be placed under one end of the spring **81***b*, if desired, to adjust the compression of the spring. Relief ports **109** are provided in the wall of the shell **21***b* communicating with the chamber which encloses the spring **81***b*.

A tubular housing **28***b* is threadedly secured to wall **105** at **110**. The upper end of housing **28***b* terminates in a plate **111** which supports a charge of propellant **87***b*. Plate **111** is perforated as indicated at **112** to permit the passage of gas therethrough. Mounted within the housing **28***b* is a tubular support member **44***b* on which a cup-shaped firing pin **38***b* is slidably mounted and supported on a helical compressed spring **47***b*. A ball detent **49***b* latches the firing pin releasably in the position shown in Fig. 5. A plunger **53***b* is mounted on the upper side of a downwardly facing cup-shaped member **55***b* which is loosely supported on a tubular member **58***b* on the upper end of the tube **30***b*. The lower end of the passageway **113** through the tubular member **65***b* is threaded as indicated at **114** to receive a threaded orifice bushing **115** which constricts the outlet from passageway **113** in order to maintain a back-pressure on the propellant **87***b* while the propellant is burning.

Operation of the bailer shown in Fig. 5 is as follows: The bailer is lowered into the well with parts in the position shown in Fig. 5. When the nozzle **95** strikes the top of the debris in the well its downward motion is arrested but the tubular members **18***b* and **21***b* continue to move downwardly, compressing the spring **81***b*, releasing the ball detent **49***b*, permitting the firing pin **38***b* to snap upwardly to fire the percussion cartridge **39***b*. The cartridge **39***b* ignites the propellant charge **87***b*. High pressure gas generated by the burning of the propellant **87***b* moves downwardly through ports **112**, **116**, **35***b*, **57***b*, through the tube **30***b*, the passageway **113**, and through the orifice bushing **115** into the reservoir **96** which is filled with liquid such as oil or water. When the pressure within reservoir **96** has risen sufficiently to cause shearing of the frangible plug **99** the jet orifice **98** is opened, permitting the liquid within the reservoir to be forced out through the orifice **98** in the form of a high velocity jet having a large kinetic energy. The dislodging of the debris by the jet and its removal by the bailer proceeds in the manner described in connection with the bailers shown in Figs. 1 through 4.

Fig. 6 illustrates still another form of the invention wherein the gaseous jet is directed upwardly instead of downwardly and wherein the debris is sucked into the lower end of the bailer body instead of being jetted upwardly to be picked up by buckets on the upper portion of the bailer. Although the suction effect on the debris in the well is less than the jetting force developed by the bailers of Figs. 1–5, the device of Fig. 6 has the advantage of placing the entrance to the bailer body close to the debris to be removed so that it is not necessary to raise the debris to a point above the top of the bailer body.

In Fig. 6 the well casing is indicated at **117** with a body of debris **118** therein. Well liquid **119** fills the casing **117** to some point above the bailer **120**. The bailer **120** is supported by a hoisting line **121**. An insulated electric conductor line **122** extends downwardly from the top of the well to an igniter in the bailer **120**. The bailer is attached to the lower end of the hoisting line **121** by any suitable means such as the bail **123**.

The bailer **120** comprises a main body member **124**, a nozzle member **125**, a propellant combustion chamber **126** and an inlet port **127** having a downwardly closing check valve **128**. The nozzle member **125** is attached to the lifting bail **123** by any suitable means and is threadedly attached to the upper end of the tubular body member **124** as indicated at **129**. The lower end of the tubular body member **124** is threaded internally as indicated at **130** to receive a threaded ring **131** which provides an annular seat **132** for a flapper valve **128** which is hingedly mounted on the ring **131** as indicated at **133**. The propellant combustion chamber **126** is preferably in the form of a tubular housing which is threadedly supported at its lower end, as indicated at **134**, on a spider member **135** which serves as a closure for the lower end of the combustion **126**. The spider member **135** is secured to the bailer body **124** by any suitable means such as welding as indicated at **136**. Fluid passages **137** extend through the spider **135**. The upper end of the tubular combustion chamber **126** is threaded internally, as indicated at **138**, to receive a tubular nozzle **139**. The upper end of nozzle **139** extends upwardly within the opening in nozzle **125** and is of lesser diameter than the opening so as to provide an annular passageway **140** between the two nozzles. The upper end of nozzle **139** is normally sealed against the entrance of well fluid **119** by any suitable means such as the cap **141**. A body of propellant **142** is shown within the combustion chamber **126**. The propellant is provided with an igniter **143** to which are attached the electric lead wires **144**. The leads **144** extend through

the cap **141** and are connected to the conductor line **122**.

The operation of the bailer shown in Fig. 6 is as follows: The bailer is lowered into the well until it rests upon the debris **118**. It is then raised slightly, to the approximate position shown in Fig. 6, and the electric circuit **122—144** is energized, thus igniting the igniter **143** and the propellant **142**. As gas pressure develops within the combustion chamber **126** the seal cap **141** is blown off of the nozzle **139** and a high pressure, high velocity, gas jet issues from the nozzle **139**. This gas jet passing through the opening in nozzle **125** creates a suction which pulls well liquid upwardly through the annular passageway **140** between the nozzles **125** and **139**. This suction also pulls well liquid upwardly through the bailer body **124** and through the inlet port **127**. The well liquid tends to pick up debris from the bridge **118** and pull it into the bailer body where it is trapped above the flapper valve **128** when the bailer is pulled upwardly by the hoisting line **121**.

The several embodiments of the invention described above are representative only and the invention is not to be limited thereto but is of the scope defined by the appended claims.

We claim:

1. A jet bailer comprising: a bailer body having a fluid inlet in the bottom thereof; a downwardly closing check valve in a debris-receiving chamber above said fluid inlet; a combustion chamber within said bailer body; a fluid passage from said debris-receiving chamber past said combustion chamber; a gas-receiving nozzle on the upper end of said combustion chamber and directed upwardly and exteriorly of said bailer body; a liquid-receiving nozzle on the upper end of said bailer body communicating with said fluid passage and surrounding said gas-receiving nozzle; and means for generating gas pressure in said combustion chamber.

2. A jet bailer which comprises a bailer body having an open bucket at its upper end, a first chamber within said body, gas generating materials within said first chamber, a second chamber in said body to contain liquid, a first nozzle for exhausting gases from said first chamber into said second chamber, a second downwardly directed nozzle at the bottom of said bailer body communicating with said second chamber for exhausting said liquid, and ignition means for igniting said gas generating material.

3. In a bailer having open buckets mounted thereon, the combination comprising: A bailer body; a combustion chamber arranged within said body; a gas discharge nozzle forming a part of said body, said nozzle being directed downwardly and exteriorly of said body; means providing communication between said combustion chamber and said gas discharge nozzle; a liquid discharge nozzle positioned within the gas discharge nozzle, whereby liquid exiting from the liquid discharge nozzle will be entrained in the gas stream exiting from the gas discharge nozzle; and inlet means providing communication between said liquid discharge nozzle and the exterior of said bailer body.

4. A jet type bailer comprising: A bailer body; an axial drainage tube extending through said body; upwardly facing open buckets mounted on and around said drainage tube, said buckets having drainage ports extending through the walls of said drainage tube within said buckets; a combustion chamber arranged within said body; a gas discharge nozzle forming a part of said body, said nozzle being directed downwardly and exteriorly of said bailer body; means providing communication between said combustion chamber and said gas discharge nozzle; a means providing a liquid flow path from the interior of said drainage tubes to said gas discharge nozzle.

5. A jet bailer comprising: A bailer body having an inlet; a combustion chamber arranged within said body; a gas discharge nozzle forming a part of said body, said gas discharge nozzle being directed downwardly and exteriorly of said bailer body; means providing communication between said combustion chamber and said gas discharge nozzle; a liquid passageway having an inlet and an outlet associated with said gas discharge nozzle, said inlet being arranged in communication with said bailer body inlet and said outlet being arranged in communication with the outlet of said gas discharge nozzle, whereby liquid exiting from the passageway will be entrained in the gas stream exiting from the gas discharge nozzle.

6. In a bailer, the combination comprising: A bailer body having an inlet; an open bucket mounted on said body; a combustion chamber arranged within said body; a reservoir for liquid arranged within said body; means providing communication between said reservoir and said combustion chamber; a discharge nozzle forming a part of said body, said nozzle being arranged to communicate with the lower end of said reservoir and said nozzle being directed downwardly and exteriorly of said body and said reservoir; and frangible means normally closing said nozzle, but adapted to be dislodged to permit a high velocity jet of liquid to discharge from the nozzle when sufficient pressure is exerted thereon.

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