Oct. 31, 1944. J. C. MASON 2,361,558

HYDRAULIC SURGE METHOD

Filed Nov. 30, 1940 2 Sheets-Sheet 1

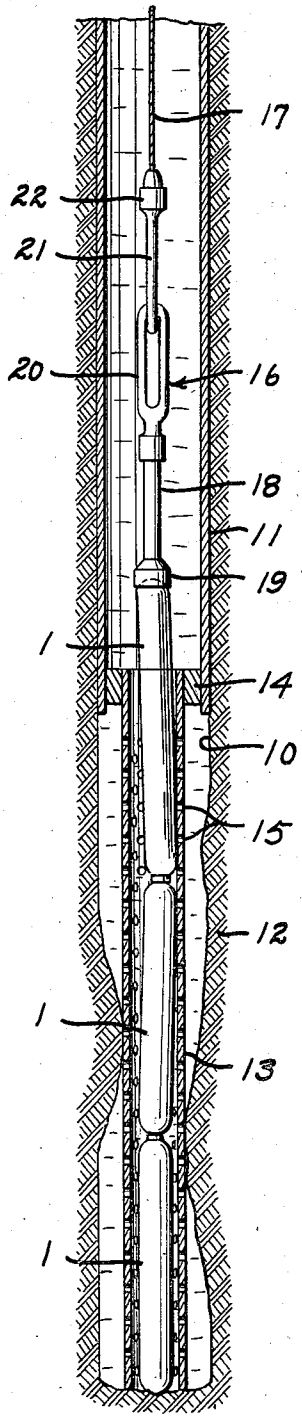


Fig. 3.

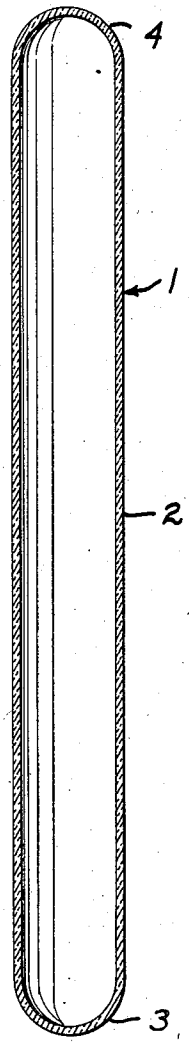


Fig. 1.

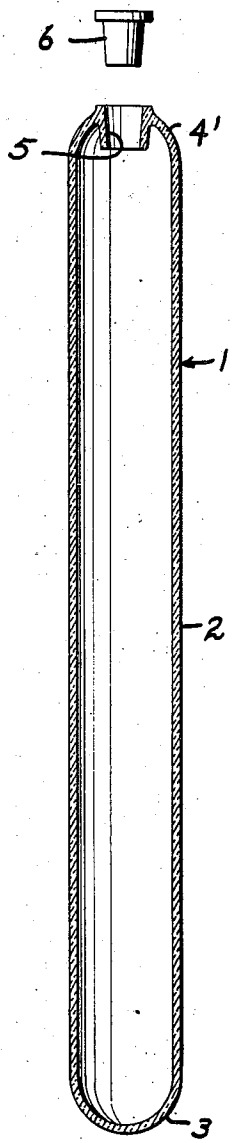


Fig. 2.

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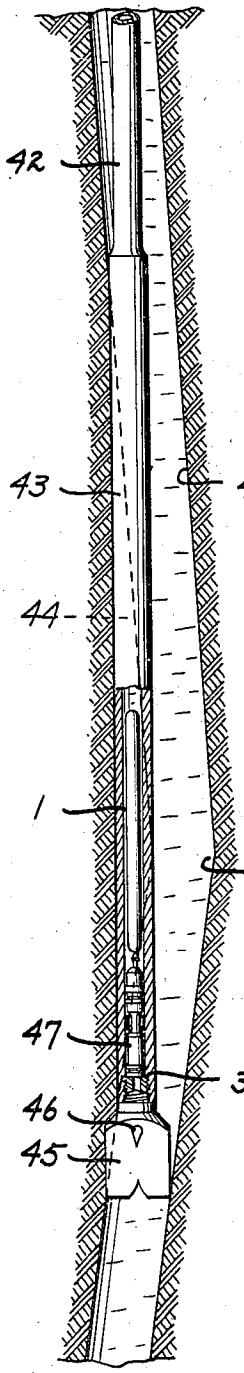


Fig. 5.

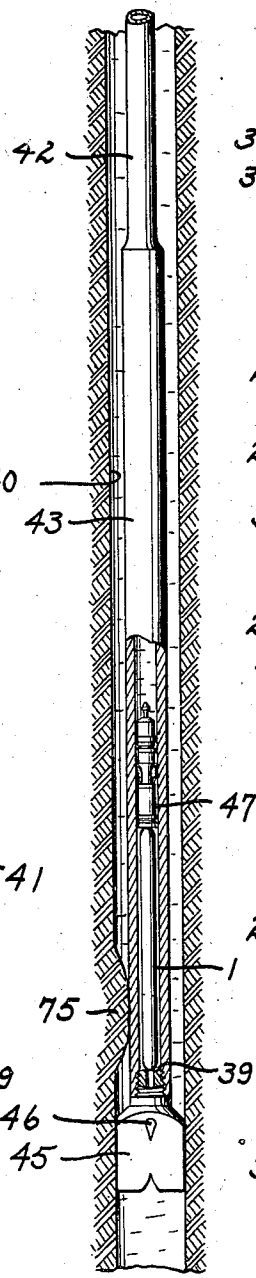


Fig. 6.

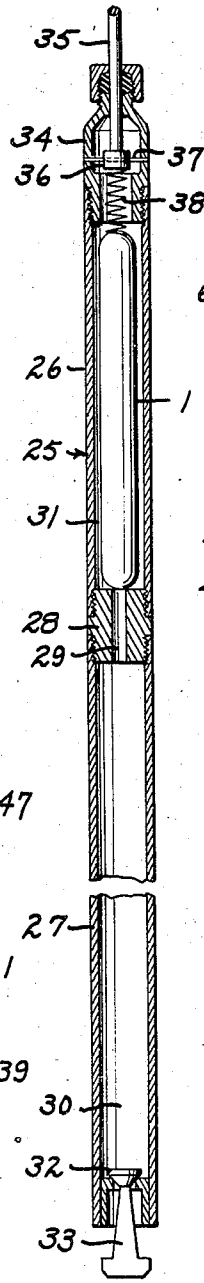


Fig. 4.

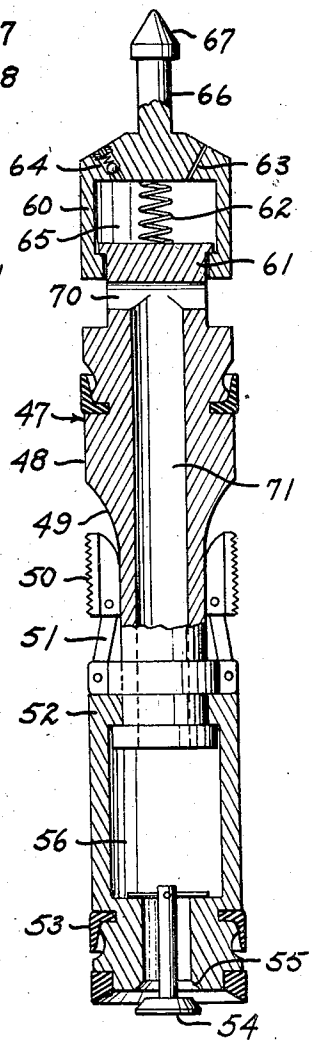


Fig. 7.

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HYDRAULIC SURGE METHOD

James C. Mason, Houston, Tex.

Application November 30, 1940, Serial No. 368,043

1 Claim. (Cl. 255—1.8)

This invention relates to oil well operations and tools and more particularly to hydraulic surge devices for use in drilling and production operations of oil wells.

In the drilling of deep wells and in maintaining the production of completed wells difficulties are frequently experienced from sedimentation, caving, etc., whereby tools or pipe strings become stuck in the well, screens become clogged, etc. Also tool parts are often dropped or lost in the well bore. In event of the occurrence of any of these difficulties it is desirable to bring about such operative steps as will overcome the effect of sedimentation or caving or to retrieve parts from the well, as the case may be.

It is the primary object of the present invention to provide a method and instrumentality for creating a hydraulic surge in the fluid within the well bore in a manner to effect desired action to obviate the encountered difficulty.

Another object is to provide a hollow frangible container which is capable of withstanding the extreme in pressure within a well.

Another object is to provide a pressure resistant hollow frangible container and to break such container while under the high pressure of liquid within a well so that the liquid column in the well is accelerated downwardly as it fills the space occupied by the container. Thereafter the velocity head of the liquid creates an intense surge during the deceleration of the liquid column whereby release of a member stuck in the well is effected or desired cleaning action is brought about.

Still another object is to provide a frangible pressure resistant container for effecting cleaning action within the well bore.

A further object is to provide a frangible container which may be lowered within a pipe string within a well and shattered to create a liquid surge and resultant beneficial impact upon the pipe string.

The foregoing objects together with other objects will be more fully apparent from the following description considered in connection with the accompanying drawings in which:

Fig. 1 is a sectional view of a frangible container utilized in the practice of the invention;

Fig. 2 is a sectional view illustrating a modified form of the container shown in Fig. 1;

Fig. 3 is a sectional view through a well illustrating the manner of using the container of Fig. 1 or Fig. 2 for producing a cleaning surge within a screen within a well;

Fig. 4 is a sectional view through a cleaning tool utilizing the invention;

Figs. 5 and 6 are sectional views through well bores illustrating the manner of using the invention for releasing a drill pipe stuck within a well bore;

Fig. 7 is a vertical sectional view through a packer which may be used in accordance with the disclosure of Figs. 5 and 6.

The invention is primarily concerned with the provision and use of a frangible container which is capable of withstanding extremely high pressures such as those encountered at considerable depths in earth bores having a column of liquid therein. Such a container is shown at 1 in each of Figs. 1 and 2. The container of Fig. 1 comprises a cylindrical portion 2 which is closed at its ends by the semispherical end portions 3 and 4. This container is frangible and is of such material and wall thickness as to withstand pressures of several thousand pounds per square inch since pressures of such magnitude are encountered in many wells which are drilled in accordance with well drilling practice.

I have found that a "Pyrex" glass container having walls three-sixteenths of an inch in thickness serves very satisfactorily. It is to be understood that while a specific material and dimensions thereof have been recited, the invention is not confined thereto since it is apparent that other glasses or other frangible material such as modern frangible synthetics may be utilized and with such wall thickness as to withstand the pressure to which the container is subjected.

Attention is likewise directed to the fact that the container 1 may be of any suitable length. However, in view of the facts that the container is frangible and it is intended that the container shall be lowered within a tubular bore which may variously incline at different points throughout the length of the bore, it is preferable that a container shall not be excessive in length, a length of forty-eight inches having been found entirely satisfactory. If it is desired that the displaced volume shall be greater than that of a single container of relatively limited length, a plurality of such containers may be used in a manner hereafter described and without loss in effectiveness.

The container shown in Fig. 2 differs from that in Fig. 1 in that the upper end 4 thereof is provided with a tapered opening 5 of which the walls have a ground fit with the stopper 6 which may be of the same or a different material than that of the remainder of the container. By using a ground fit between the stopper 6 and the con-

tainer 1 there is provided a container which may be opened or closed if desired. At the same time such container is free from leakage that would reduce or destroy the effectiveness thereof.

One manner of using the container shown in Figs. 1 and 2 is illustrated in Fig. 3 wherein there is shown a bore hole 10 within which is set a casing 11. This casing terminates above the producing formation 12 and a screen 13 is set in the lower end of the casing by means of a packer element 14. This screen is provided with a plurality of perforations 15 so that fluids entering the well bore from the formation 12 are strained as they enter the casing 11 preliminarily to withdrawal from the well. During continued production of the well the perforations 15 become clogged and it is desired that the perforations be subjected to cleaning action. Preferably such action is brought about by a surge of fluid from the interior to the exterior of the screen so that the clogging material is displaced outwardly and the passages for the entry of fluids to and through the screen are thus reopened.

In accordance with the invention one or more of the containers shown in Fig. 1 or Fig. 2 are placed within the liquid in the casing 11. Such containers are filled with a gaseous fluid, generally air, which may be at or somewhat above atmospheric pressure. Preferably, however, the pressure within the containers is subatmospheric and the closer an absolute vacuum is approached the more effective will the container be in performing its desired operation. It is to be understood, however, that so long as there is a differential pressure between the exterior and the interior of the container, a surge action will be produced in accordance with the invention.

The containers 1 tend to float within the liquid within the well bore 10 and accordingly the containers are lowered to operating condition by means of a combined sinker bar and jar 16 lowered upon a cable 17. The lower end 18 of the bar is provided with a head 19 which engages the uppermost of the containers. As the unit 16 is lowered within the well the containers are likewise lowered to the desired position.

The upper end of the bar 18 is made in the form of a link 20 which has a loose connection with a similar link 21 having the cable connection 22 at its upper end.

When the desired lowering of the containers 1 and the sinker bar 16 has been effected an impact may be imparted to the uppermost container by a quick movement or jerk applied to the cable 17. The impact imparted to the container in addition to the liquid pressure upon the container initiates fracture thereof and such fracture is followed by the shattering of the container and such shattering progresses rapidly under the continued pressure. At the same time the liquid column in the well is accelerated downwardly under its own weight.

The nethermost container or containers may have been fractured simultaneously with the fracture of the upper container. In any event all of the containers are fractured during the rapid occurrence of the succession of events as the liquid column accelerates downwardly to fill the void created by the fractured containers. Such void is quickly filled with the moving liquid but in the meantime the static head of the liquid column is converted into a velocity head.

The kinetic energy of the column of liquid must be dissipated in order to again bring about static conditions in the well. Such dissipation of energy occurs during the ensuing violent surge during which the liquid is forced through the openings 15 whereby obstructing debris in these openings and the fluid passages in the adjacent formation is dislodged and the formation fluids may again freely flow through the previously clogged passages.

The invention may also be utilized in the manner illustrated in Fig. 4 for removing debris from within a well, as for example, removing the container material from the bottom of the screen 13 in Fig. 3 and, as well, sand and other debris therein. It is to be noted, however, that the quantity and nature of the material comprising the container 1 offers little necessity for the removal of such material from the well since such material is relatively small in volume and is reduced to relatively small pieces when fracture of the container is effected.

The cleaner 25 of Fig. 4 is a barrel-like structure or casing comprising upper and lower nipples or pipes 26 and 27 which are interconnected at their inner ends by a coupling 28 having a restricted bore 29 to control the rate of flow of fluid from the lower chamber 30 to the upper chamber 31. The lower end of the cleaner is closed by a valve 32 having a projection 33 adapted to engage the debris within the well. This valve closes when the cleaner is lifted and thus entraps debris within the chamber 30.

The surge chamber 31 is adapted to receive one or more of the containers 1 and is closed at its upper end by a closure head 34 into which a lifting rod 35 extends. A collar 36 on the lower end of the rod 35 is attached to the head 34 by means of a shear pin 37 whereby the entire assembly is supported during the lowering of the assembly within a well bore. A compression spring 38 is interposed between the collar 36 and the upper end of the container 1 to steady the container and minimize the possibility of breakage prior to the instant at which operation of the device is desired.

When the assembly 25 lands upon the bottom of the well the pin 37 is broken and the rod 35 and collar 36 moves downwardly to engage and initiate fracture of the container 1. The liquid column about the tool then surges downwardly and carries debris through the valve 32 into the chamber 30 as the space previously occupied by the container 1 is filled with the well liquid. The bore 29 in the collar 28 is of sufficient dimension that the rate of ingress of liquid to the chambers is such as to produce efficient intake of debris to the chamber 30.

Another manner of using the invention is illustrated in Figs. 5, 6 and 7. In Fig. 5 is shown a bore hole 40 which changes in direction at 41 during drilling whereby the drill string 42 and drill collar 43 tend to produce a groove 44 in the side of the well bore opposite the deflection point 41.

When it is desired to withdraw the drill stem 40, the drill collar 43 and the bit 45 from the well there is a tendency for the bit to engage the earth formation at the lower end of the groove 44 and in this manner the drill stem may become stuck within the well bore 40.

Under such circumstances a surge impact tending to loosen the drill string 42 and the associated bit 45 is effected by lowering within the drill string one or more of the containers 1 which are fractured within the drill string proximate the bit 45. This fracturing of the container or

containers initiates downward movement of the fluid within the drill pipe 42. As soon as the moving liquid fills the void created by the fracture of the container 1 the moving column of liquid creates a surge which produces an impact upon the drill pipe assembly and hence tends to dislodge the assembly from engagement within the groove 44.

When the container or containers 1 are fractured liquid may also enter the ports 46 in the bit 45. Likewise liquid is exhausted from these ports when the surge takes place and in this manner the effectiveness of the moving liquid is decreased. In order to avoid this condition, in some cases, it is necessary to provide a closure within the drill stem below the container 1. Such closure is shown as a retrievable packer 47 which is shown in detail in Fig. 7.

This packer comprises a body member 48 provided with tapered surfaces 49 upon which the slips 50 are adapted to ride and move outwardly into engagement with a surrounding tubular member.

The slips 50 are attached by means of links 51 to a tubular member 52 which is adapted to slide upon the lower end of the body 48 whereby the slips 50 may ride upon the surface 49. The lower end of the member 52 is provided with a lipped ring 53 and also a valve 54 of which the latter may move upwardly and engage seat 55 to close the entrance to the chamber 56 within the member 52.

A head 60 is slidable upon the reduced upper end 61 of the body 48 and is normally held upwardly by means of a spring 62. This head has a bleeder passage 63 and a valve passage 64 to control the escape of fluid from within the chamber 65. An upward projection 66 has an enlargement 67 which is adapted to be engaged by a suitable overshot, not shown, so that the packer may be removed from within the drill pipe 42.

When the packer 47 is to be used in the manner shown in Fig. 5, it is placed within the drill pipe and drilling fluid is pumped downwardly. The movement of the packer assembly is such that the valve 54 remains open and at the same time the spring 62 is of such strength that the head 60 is held upwardly so that fluid circulates through the packer by way of transverse passage 70 and base 71 thence through the valve at the bottom of the tubular member 52, at the same time the packer assembly offers sufficient resistance to the flow of drilling fluid that the assembly is moved downwardly to desired position. This movement ceases when the assembly reaches the shoulder 39 at the upper end of the bit 45.

Attention is directed to the fact that the packer 47 is so constructed that fluid may be continuously circulated downwardly through the drill stem 42 and thence upwardly in the bore 40. Accordingly the container or containers 1 may be lowered to the position shown in Fig. 5 by pumping or by the use of the sinker bar construction shown in Fig. 3. In either event the shattering of the container may be effected by impact with the packer or barrier 47. Alternately, if the sinker bar 16 is used, fracturing or shattering may be effected by such bar at a point above the barrier 47 and preferably, though not necessarily, proximate thereto.

The column of liquid within the drill string 42 is then accelerated downwardly and the resulting surge moves the head 60 of the packer downwardly to cover the port 70 so that the continuing surge produces a violent downward impact which is effective in jarring the drill string loose. Circulation through and rotation of the drill string may then be resumed as the string is withdrawn from within the well bore 40.

In Fig. 6 the invention is shown as used in producing an up jar to assist in releasing the drill string 42 and associated elements from engagement produced by the caved area 75. When this mode of operation is used the container 1 is placed within the drill string 42 and is forced downwardly with and in advance of the packer 47. When the container 1 engages the shoulder 39 at the upper end of bit 45, shattering of the container is initiated and fluid within the well bore about the string 42 accelerates downwardly and enters the passages 46 to fill the void created by the shattered container.

When the void has become filled with the entering liquid there is a tendency for the liquid to continue its movement. This causes the valve 54 of the packer or barrier 47 to move upwardly into engagement with its seat 55 whereby the continuing surge lifts the tubular member 52 and forces the slips 50 into engagement with the walls of the drill collar 43. The remainder of the kinetic energy in the moving column of liquid is effective in producing the desired upward impact to assist lifting force applied to the drill string 42 in relieving the condition created by the caving 75.

The foregoing description of the invention is illustrative only and it is not intended that the invention shall be limited to the specific details of construction and technique disclosed. Broadly the invention comprehends a novel instrumentality for creating a hydraulic surge within a well bore and utilizing such surge in a manner to overcome difficulties which are experienced during drilling operations and in the production of oil wells.

What is claimed is:

A method of setting up a sharp surge of liquid in a well bore to release stuck pipe or effect a cleaning action on a well screen which comprises the steps of closing a pressure resistant frangible container at the surface so that it contains only a gaseous compressible fluid positioning such container at the desired elevation in the well bore so as to displace an equal volume of liquid with the volume of the compressible fluid in the container, and fracturing the container so as to create a low pressure area in the liquid in the well to effect a surge of liquid from all directions by the compression of the gaseous fluid by the liquid of the well.

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