Feb. 4, 1936. W. G. LANE 2,029,491

GUN TYPE FORMATION TESTER

Filed Aug. 25, 1934

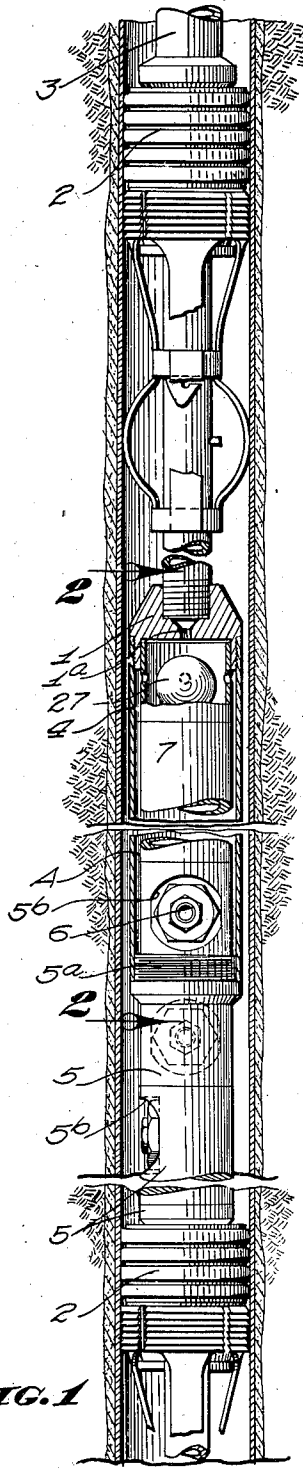


FIG. 1

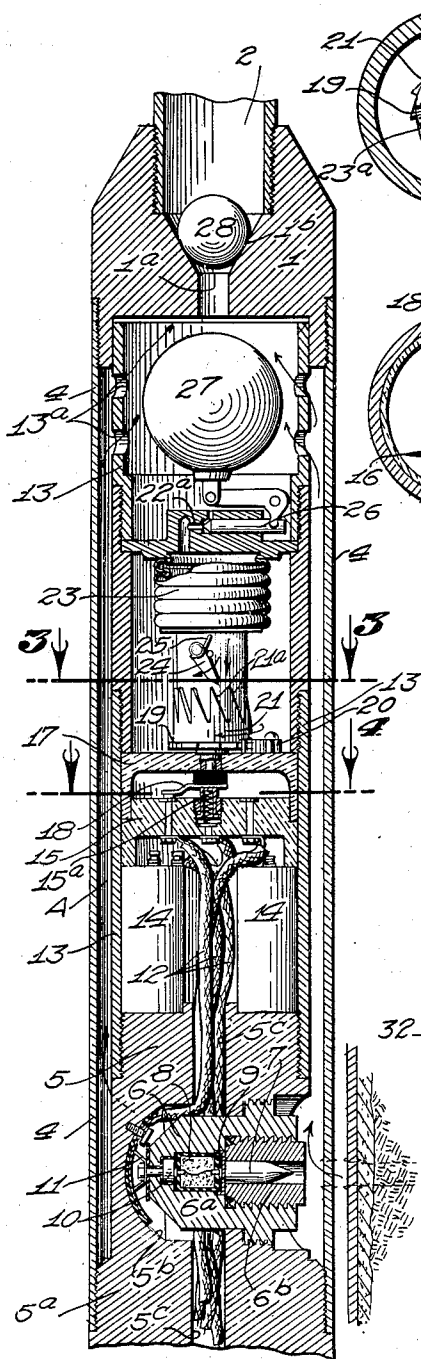


FIG. 2

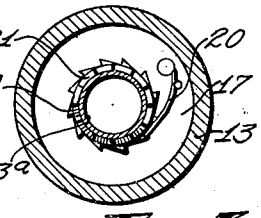


FIG 3

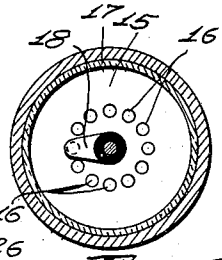


FIG. 4

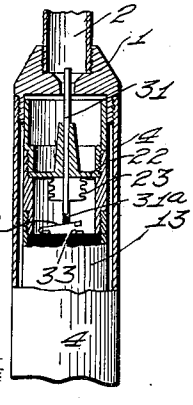


FIG 5

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GUN TYPE FORMATION TESTER

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Application August 25, 1934, Serial No. 741,409

14 Claims. (Cl. 166—1)

My invention relates to gun-type formation testers, and the present application is a continuation in part or division of my co-pending application for: Method and means for controlling deep well gun-fire for perforating casing; Serial Number 648,049; filed Dec. 20, 1932.

The objects of my invention are:

First, to provide a formation tester which is particularly designed to make formation tests through a well casing or several casings if necessary;

Second, to provide a formation tester which fires a projectile or several projectiles through the well casing and thereafter receives the sample through the perforation so made;

Third, to provide a formation tester which is so arranged that the well bore may be readily packed off above and below the point at which the test is to be made so that the only sample obtained must necessarily come into the casing from the formation through the perforations made by the formation tester, thereby insuring the collection of unadulterated samples;

Fourth, to provide a formation tester which, though employing the use of explosives and projectiles, is entirely safe and foolproof in its operation;

Fifth, to provide a gun-type formation tester which may be run in on standard tubing or the like and utilizes other conventional well equipment for its operation; and

Sixth, to provide a formation tester of this class in which the damage to the well casing consists merely in one or more relatively small round perforations that may be readily cemented up if improperly located or otherwise undesirable, thereby providing a formation tester which does not interfere with subsequent drilling or other operations in the well bore.

With these and other objects in view as may appear hereinafter, attention is directed to the drawing, in which:

Figure 1 is a fragmentary, partial, sectional, partial elevational and substantially diagrammatical view of my formation tester in position within a well bore. Figure 2 is an enlarged fragmentary longitudinal sectional view thereof taken substantially through 2—2 of Figure 1; Figure 3 is a transverse sectional view substantially through 3—3 of Figure 2; Figure 4 is another transverse sectional view through 4—4 of Figure 2, and Figure 5 is a reduced substantially diagrammatical view of a modified arrangement for operating only one gun unit.

The formation tester is supported by a head block 1 from a suitable packer 2 which is in turn supported from a tubing string 3. A passage is provided from the tubing string through the packer and block to the interior of the formation tester.

A shell 4 is screw-threaded by its upper end to the head block. Said shell is cylindrical in form and constructed as light as possible yet sufficiently heavy to withstand considerable hydrostatic pressure. The lower end of the shell is screw-threaded to a flange 5a of a gun body 5. Said gun body is cylindrical in form and somewhat smaller in diameter than the interior of the shell 4. The upper end of the gun body protrudes into the shell, while the lower portion extends below. The gun body 5 is provided with a plurality of laterally directed sockets 5b, each of which receives a gun unit 6 and one of which is above the flange 5a and within the shell 4.

Each gun unit comprises a chamber body 6a which is adapted to screw into a socket 5b, and a gun barrel 6b which screws into and is carried by the chamber body 6a. The gun barrel 6b is relatively short, is directed laterally and receives a projectile 7 designed to pierce metal. The chamber body is provided with a cylindrical chamber inwardly of the gun barrel which receives a cartridge 8. Between the explosive containing cartridge 8 and gun barrel is a fire delaying plate 9 which causes the pressure within the cartridge to build up before force of the charge is delivered to the projectile, thereby obtaining the necessary velocity within the extremely short distance available.

Each cartridge 8 is provided with a fusible wire extending from end to end. One end of the wire is adapted to be grounded when the cartridge is in position, while the opposite end of the wire engages an insulated contact pin 10. The inner walls of each socket 5b are enlarged to clear the corresponding chamber body and provide space for a suitable insulated contact means 11 adapted to be engaged by a contact pin 10 when the gun unit is screwed into the gun body. The gun body 5 is provided with a longitudinal bore 5c therethrough connecting the several sockets 5b. Said bore contains insulated wires 12 one leading to each contact means 11 from the upper end of the gun body.

The above described arrangement of gun body, gun units, cartridge and wiring therefor is shown in detail in my copending application for: Well casing perforator; filed Nov. 12, 1932, Serial No. 642,410.

Above the gun body 5 and within the shell 4

is mounted a cylindrical housing 13 formed of separable sections which contain the controlling and operating devices for the several gun units. The housing 13 is spaced inwardly from the walls of the shell 4 to define therewith an annular passage, designated A. The first of the housing sections encloses a plurality of batteries 14 which are held in place by a suitable insulated disk 15. The batteries may be conventional dry cells and one side of the source of energy provided thereby is grounded to the gun body. The other side is connected to a suitable terminal 15a protruding through the disk 15. The several wires 12 are connected to a plurality of contacts 16, arranged in a circle and protruding through the disk 15.

Above the disk 15 a second disk 17 journals a shaft which supports a sweeper 18, engageable with the terminal 15a and having a contact arm for connecting any one of the contacts 16 with the batteries 14. The upper end of the sweeper shaft carries a ratchet wheel 19 having radiating teeth engaged by a spring pawl 20 to permit movement of the sweeper in one direction only. Above the rachet wheel the shaft also carries ratchet ring or sleeve 21, the teeth 21a of which are directed axially upwardly. One side of each tooth 21a is helical while the other side extends parallel with the axis of the ring.

A pair of the housing sections 13 support a partition member 22 from which depends a bellows diaphragm 23. The lower end of the diaphragm 23 carries a stem 23a which fits within and is guided by the ratchet sleeve 21. Above the ratchet sleeve or ring 21 the stem 23a carries a pawl 24 which is arranged upon downward axial movement to fit between adjacent teeth 21a and turn the ratchet sleeve sufficiently to shift the sweeper from one contact 16 to the next. Upon upward movement the pawl 24 clears the teeth 21a and a spring 25 urges the pawl into a position to engage or pass between the next pair of teeth 21a. Thus successive expansions and contractions of the bellows diaphragm 23 advances the sweeper around the contacts 16 so that the several gun units are fired successively.

The partition member 22 is provided with a port 22a communicating with the interior of the bellows diaphragm 23 and controlled by a needle valve 26. Said needle valve is connected by a suitable link and lever arrangement to a float 27 in such a manner that the port is open unless liquid should enter the housing 7 above the partition 22. The upper portion of the housing 13 above the partition 22 is open to a bore 1a through the head block 1 and is provided with apertures 13a in its side walls so as to provide a means of communication from the passage A into the tubing string 3.

With this arrangement successive accumulations and releases of air pressure within the tubing string 3 operates the bellows diaphragm and thereby causes the gun units to fire successively; but should liquid accumulate in the tubing string, the float 27 causes the port 22a to be closed and further operation is prevented. The gun units are so connected that the uppermost gun unit which is within the shell 4 fires last. Upon discharge of this gun unit, the shell 4 is pierced and well fluid from below the packer 2 is permitted to enter the tubing string.

In order to entrap the sample of well fluid thus obtained, a ball 28 may be dropped down the tubing string and seats on a valve face 1b formed in the bore 1a of the head block.

In many instances it is only necessary to carry one gun unit, this one being disposed within the shell 4. If only one gun unit is used, the controller mechanism may be simplified, for example, as shown in Figure 5. A pin 31 is mounted in the bore 1a of the head block in a position to be engaged by the ball 28. The lower end of the pin extends through the partition 22 and bellows diaphragm 23 and terminates in an insulated end 31a which engages a contact 32 to urge it against a contact 33 so as to connect the gun unit with the batteries 13.

It is sometimes desirable to obtain as pure samples as possible and to be positive that the sample is obtained through the perforations made by the gun. To facilitate this a second packer 2 may be placed below the gun body as shown fragmentarily in Figure 1. With this arrangement the space between the two packers is entirely sealed from the remaining portion of the well bore to form an isolated region into which the fluids from the formation enter.

I claim:

1. A gun type formation tester comprising: a sample receiving means; and an initially sealed gun and projectile instrumentality for unsealing said sample receiving means and forming an avenue of communication from a surrounding formation into said sample receiving means said instrumentality and said sample receiving means forming a tool entity adapted to be lowered or raised in a well bore.

2. A gun type formation tester comprising: a sample receiving means; an initially sealed gun and projectile instrumentality for unsealing said sample receiving means and forming an avenue of communication from a surrounding formation into said sample receiving means; and a device for re-sealing said sample receiving means.

3. A gun type formation tester comprising: a sample receiving means; an initially sealed gun and projectile instrumentality for unsealing said sample receiving means and forming an avenue of communication from a surrounding formation into said sample receiving means; and a remotely controlled operating means for said instrumentality said instrumentality and said sample receiving means forming a tool entity adapted to be lowered or raised in a well bore.

4. The combination with a sample receiver and a packer; of a projectile firing gun arranged to puncture said receiver below said packer and penetrate the surrounding formation to provide an avenue of communication from said formation to the interior of said receiver.

5. A formation tester comprising; a packer arranged to fit within a well bore and divide the same into an upper and a lower zone; a sample receiver extending into said lower zone; and a gun unit connected therewith and disposed so as to fire a projectile in a manner to puncture said receiver, penetrate the surrounding formation and provide an avenue of communication from the formation to the receiver through said lower zone.

6. A formation tester comprising; a packer arranged to fit within a well bore and divide the same into an upper and a lower zone; a sample receiver extending into said lower zone; a gun unit connected therewith and disposed so as to fire a projectile in a manner to puncture said receiver, penetrate the surrounding formation and provide an avenue of communication from the formation to the receiver through said lower zone;

and valve means for entrapping fluid samples in said receiver.

7. In combination; a packer adapted when set to divide a well casing into upper and lower zones; and a gun means suspended from said packer in said lower zone; said gun means arranged to drive a projectile through the surrounding well casing.

8. In combination; a packer adapted when set to divide a well casing into upper and lower zones; a gun means suspended from said packer in said lower zone; said gun means arranged to drive a projectile through the surrounding well casing; and a formation testing device for collecting a sample of well fluid admitted into the lower zone through the perforation made by said projectile.

9. A formation tester comprising: packer means providing a region sealed from the zones above and below said packer means; a gun unit disposed so as to fire a projectile from said region into the surrounding formation; and a receiving device arranged to receive fluid introduced into said region from the path made by said projectile.

10. A formation tester comprising: packer means providing a region sealed from the zones above and below said packer means; a gun unit disposed so as to fire a projectile from said region into the surrounding formation; and a sample receiver including a passage defining means extending into said region but normally sealed therefrom; said passage defining means traversing the path of said projectile whereby, upon discharge of said projectile an avenue of communication is made from the surrounding formation to said sample receiver.

11. A formation tester comprising: a gun unit adapted to be lowered into a well bore arranged to fire a projectile through a well casing into a surrounding formation; a sample receiving means having an inlet in proximity to said gun unit; and packer means for minimizing the introduction of fluids into said sample receiving means from sources other than the avenue provided by said projectile.

12. In combination; a packer for dividing a well bore into two zones; and gun means connected with the packer for firing a projectile into the formation surrounding the well bore to open one of said zones to flow of fluids from said formation along the path formed by said projectile.

13. A gun type formation tester comprising: a gun means adapted to be lowered into a well bore and fire a projectile into the adjacent formation to form a fluid channel from the formation into the well bore; and means for entrapping for withdrawal fluid entering the well bore from said channel and having an intake port connectible with said channel, said gun means and entrapping means forming a tool entity adapted to be lowered as a unit into a well bore.

14. In combination; a packer for dividing a well bore into two zones; gun means connected with the packer for firing a projectile into the formation surrounding the well bore to open one of said zones to flow of fluids from said formation along the path formed by said projectile; and means for entrapping for withdrawal, fluid entering the perforated zone and having an intake passage connectible with said fluid receiving zone, said means adapted to be lowered with said packer and gun means and forming a tool entity therewith.

WILFRED G. LANE.