Feb. 16, 1965 U. E. VOETTER 3,169,578

FORMATION TESTERS

Filed July 16, 1962

Fig. 2

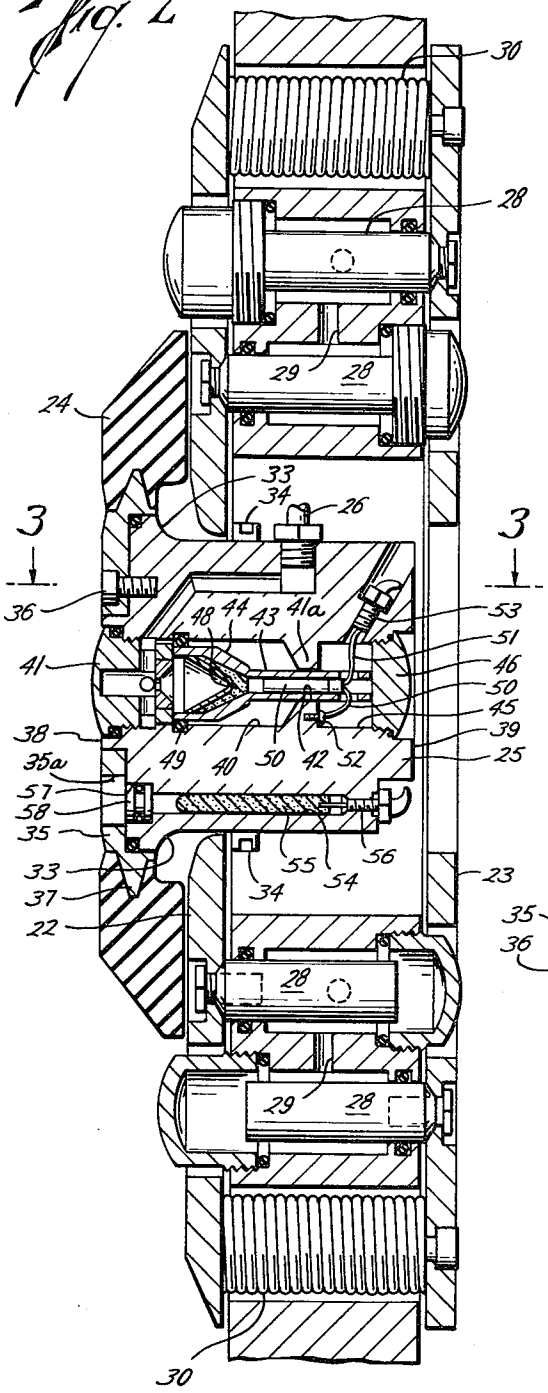


Fig. 1

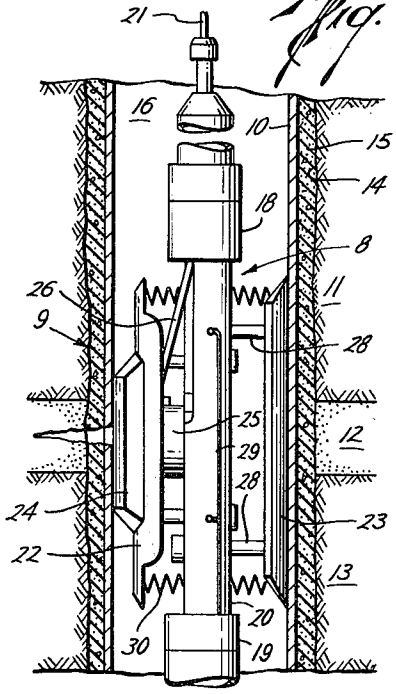
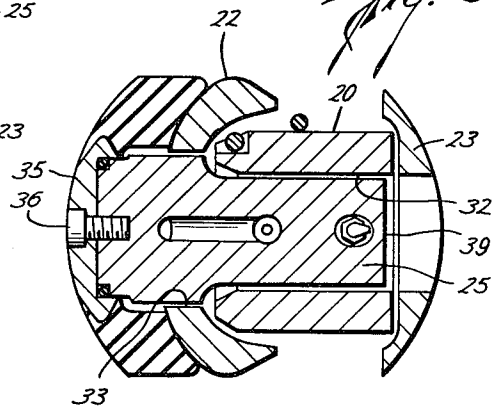


Fig. 3



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FORMATION TESTERS

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This invention relates to improved formation testing apparatus and more particularly pertains to means for safely loading explosive devices in formation testers.

Formation testers typically include a back-off shoe and a sealing pad which are respectively urged into opposing sides of the well bore, the sealing pad engaging the sidewall and isolating a formation or area of interest. A gun block is secured to the sealing pad and generally has explosive perforating apparatus such as a shaped charge which, when detonated, produces a penetration in the isolated area of which formation fluid may be recovered. Reference may be made to Patent No. 2,674,313 issued to Lawrence S. Chambers in which such type of apparatus is more completely described.

Where shaped charges are used in formation testers a considerable problem of safety is always presented. This is because the shaped charge requires a blasting cap for detonation and a blasting cap is an extremely dangerous and sensitive element requiring cautious handling for safety.

It is accordingly an object of the present invention to provide new and improved means permitting safe loading of explosives in formation testing apparatus.

Apparatus in accord with the present invention comprises, in combination with a formation tester apparatus, a gun block having forward and rearward, aligned chambers separated by a barrier, the barrier having an opening therethrough adapted to receive a tubular extension from a shaped charge device. A cover is provided to enclose a shaped charge device in the forward chamber. After the shaped charge is enclosed in the forward chamber, a blasting cap is inserted into the tubular extension of the shaped charge tube through the rearward chamber. After positioning the blasting cap in igniting relationship to the explosive in the shaped charge, the conductor wires of the cap are connected to the firing circuit and a closure member or cover inserted in the rearward chamber.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention both as to its organization and manner of operation, together with further objects of the advantages thereof, may best be understood by way of illustration and example of certain embodiments when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side view of a portion of the apparatus embodying the present invention shown in an operative position in a cased well bore;

FIG. 2 is a cross-section of the apparatus embodying the present invention drawn to large scale and shown retracted; and

FIG. 3 is a cross-section taken along line 3—3 of FIG. 2.

In FIG. 1 of the drawings, a fluid sampler 8 incorporating a sealing apparatus 9 embodying the present invention is shown disposed in a casing 10 which traverses earth formations 11, 12 and 13 where formation 12 is the one of interest and from which a fluid sample is to be obtained. The annulus between casing 10 and the bore 14 is filled with the customary cement 15 while the casing 10 contains fluid 16 to provide a hydrostatic control pressure in the well.

The fluid sampler 8 comprises upper and lower pressure resistant housing sections 18, 19 connected together in

longitudinally spaced relation by a block member or carrier 20. The apparatus thus far described is suspended in the casing 10 by a cable 21 which, in connection with a winch (not shown) located at the surface of the earth, is employed to lower and raise the apparatus in the casing in a customary manner.

The block member 20 provides a carrier for a pack-off shoe 22 or support member and a back-up shoe 23, the shoes being shown in an extended position so that a sealing member 24 associated with the pack-off shoe 22 is in engagement with the casing 10. The sealing apparatus 9 includes a gun block 25 containing explosive means hereinafter explained. The gun block 25 is affixed to the sealing member 24 and the explosive means is adapted to perforate the casing, cement and formation so that formation fluids may flow through the gun block and through a sample-conveying tube 26 to the sample-receiving chamber (not shown) in housing 18. Hydraulic piston and cylinder arrangements 28 (FIG. 2) are provided to extend the respective shoes 22, 23 relative to the block member 20 and are connected via hydraulic lines 29 to hydraulic actuating means (not shown) in housing section 19. The sample-receiving chamber (not shown) in housing 18 and the hydraulic actuating means in housing 19 may be, for example, of the type shown in the aforesaid Chambers patent. Springs 30 connected to the shoes 22, 23 facilitate retraction of the shoes toward the block member 20 when the hydraulic arrangements 28 are deactuated.

As best shown in FIGS. 2 and 3, block member or carrier 20 is elongated and has a generally square cross section in a plane perpendicular to the longitudinal axis of the member. The shoes 22, 23 are elongated and positioned centrally of the member 20, the shoes being horizontally curved about a longitudinal axis of the block member 20 with inner surfaces adapted to conform about the block member 20 and outer cylindrically curved surfaces to conform to the curvature of a casing.

Block member 20 has an elongated opening 32 (FIG. 3) centrally located between shoes 22, 23 so as to face each shoe, the opening 32 being adapted to receive the gun block 25. Pack-off shoe 22 similarly has an elongated rectangular opening 33 (FIG. 2) disposed adjacent to block opening 32, the shoe opening 33 being adapted to loosely receive the gun block 25. The rear end portion of the gun block 25 is received within the block opening 32 while the forward portion of the gun block 25 extends outwardly of the pack-off shoe 22.

The gun block 25 is sized to be loosely received in the openings 32 and 33 while the forward portion of the gun block 25 has shoulder portions to limit rearward movement of the block 25 relative to the shoe 22. To limit movement of the gun block 25 relative to the pack-off shoe 22 in an opposite direction, abutment means such as screws 34 may be received by the gun block 25, the outward extension of the screws being sufficient to engage the rearward surface of the pack-off shoe 22. Thus, it will be seen that gun block 25 is loosely mounted in the pack-off shoe 22 and may have limited relative movement with respect thereto.

The forward portion of the gun block receives a rectangular face plate member 35 having a cylindrically curved outer surface (FIG. 3). Means such as screws 36 (only one shown) are provided to removably secure the face plate 35 to the gun block 25. The edge surfaces 37 of the face plate 60 extend or taper outwardly about the rectangular periphery of the face plate and are V shaped and adapted to be received within a corresponding V shaped recess in a rectangular aperture formed in the sealing member 24. The sealing member 24 may be suitably bonded to the edge surfaces 37 of face plate 35 in

a well-known manner to form an integral sub-assembly.

The sealing member 24 is preferably constructed of a relatively thick and elongated sheet of elastic material such as rubber and is cylindrically curved in a manner conforming to the pack-off shoe 22. The dimensions of the sealing member are such that it coextends laterally over the forward surface of the pack-off shoe 22 and longitudinally over the large portion of the shoe. Sealing member 24 has a thickness which is generally twice that of the shoe 22 and has a relative hardness, for example, of 55 Shore durometer. In the unstressed position of the sealing member 24, its inner surface may bear against the pack-off shoe 22 or be slightly separated therefrom.

The gun block 25 has forward and rearward wall surfaces 38, 39. A forward bore or chamber 40 which is threaded at one end to receive a cap member 41 extends inwardly from the forward wall surface 38 about two-thirds of the spacing between surfaces 38, 39 to a barrier section 41 in the gun block. Barrier section 41 has a bore 42 of reduced diameter which receives a tubular extension 43 of a shaped charge device 44. A rearward bore or chamber 45 which is aligned with forward bore 40 is threaded at its open end to receive a cap member 46. Rearward bore 45 extends inwardly to barrier section 41*a*. The shaped charge device 44 has a generally hollow and conically shaped housing or container arranged to receive an explosive charge and liner 48 in a well-known manner. Means such as an O ring 49 are provided to centralize the charge device 44 in the bore 40. A high explosive initiator such as a blasting cap 50 for the explosive charge is received within the tubular extension 43 through the rearward opening 45. The ignition wires 50, 51 are respectively connected to electrical ground at 52 and a pressure sealed igniter 53 in the gun block 25, the igniter 53 being connected to a firing circuit (not shown) at the surface in a well-known manner.

Gun block 25 is also provided with a "get-away" device which permits equalization of pressures across the sealing member 24 after a fluid sample has been taken. The device consists of a bore 54 containing an explosive charge 55 into which an electrical igniter 56 extends. The bore 54 opens into an enlarged bore 57 in the gun block and a cut-away portion 35*a* of the face plate 35, the bore 57 receiving a closure member 58. By igniting the charge 55 in the customary manner from the surface, the explosion expels the closure member 58 and the igniter 56 permiting the pressures on either side of the sealing member 24 to be equalized.

When the described apparatus is taken to the well site, it does not contain the blasting cap 50 and the shaped charge 44 may also be carried separately for safety purposes. At the well site, the shaped charge device 44 is inserted into opening 40 and cover 41 attached in place. The tubular extension 43 of charge device 44 extends through barrier 41*a* in the gun block. The blasting cap 50 can now be inserted from the rear of the gun block into the tubular extension 43. To insert the blasting cap, a safety inserting tool such as a thick-walled cylinder and plunger can be used so that the blasting cap is inserted with no danger to the loader. The blasting cap wires can then be connected to the firing circuit while the safety tool is still connected to the extension 43. Thus, if the blasting cap should ignite, the charge will fire away from the loader. The rear cover 46 may then be inserted into opening 45.

In operation, the device is passed through a casing or borehole to the level to be tested in a customary manner, the sealing apparatus being in a collapsed position, as shown in FIGS. 2 and 3. At the level of interest, the hydraulic motive means in housing 19 are actuated so that the shoes 22, 23 are urged outwardly of the block member 20. As the pack-off shoe 22 moves outwardly relative to the block member 20, the forward face of the shoe engaging the rearward face of the sealing member

carries the sealing member 24 towards the casing or borehole wall and compresses the sealing member 24 between the shoe and the casing. Compression of the sealing member 24 is facilitated by the relative movement between the sealing member 24 and the pack-off shoe 22.

After a seal has been made, the explosive of the charge device 44 is detonated producing a perforating jet which passes through the cap member 41 penetrating the casing 10, cement 15 and the formation. Thereafter, a fluid sample may flow through the cap member and through conduit 26 to the sample-receiving chamber in housing 18.

After the sample has been taken by the sample-receiving section in housing 18, the pressure in the pistons and cylinders 28 is relieved and the "get-away" charge 55 is fired which permits equalization of pressure across the sealing member 24 so that the shoes retract towards the housing. Should the hydrostatic pressure be insufficient to retract the shoes, the springs 30 may facilitate retraction of the shoes 22, 23 towards the housing. Thereafter, the apparatus is retrieved and the fluid sample may be analyzed.

The particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. In combination with formation tester apparatus having formation sealing means adapted for sealing engagement with the wall of a well bore, a gun block having forward and rearward wall surfaces, said gun block having forward and rearward openings extending inwardly and terminating short of one another to form a solid barrier in said gun block, a guide opening through said barrier, shaped charge means sized for reception in said forward opening and having a tubular extension sized to be received in said guide opening, said solid barrier having sufficient thickness to withstand explosive forces developed by said shaped charge means; cover means for enclosing said shaped charge means in said forward opening; blasting cap means sized for reception in said tubular extension through said rearward opening; and cover means for closing said rearward opening.

2. The apparatus of claim 1 wherein said forward and rearward openings are aligned with one another.

3. The apparatus of claim 1 and further including igniter means in said gun block connectable with said blasting cap.

4. In combination with formation tester apparatus having formation sealing means adapted for sealing engagement with the wall of a well bore, a gun block having forward and rearward wall surfaces, said gun block having forward and rearward openings extending inwardly and terminating short of one another to form a barrier in said gun block, a guide opening through said barrier, shaped charge means sized for reception in said forward opening, tubular extension means coupled to said shaped charge means, said extension means being sized for reception in said guide opening, said barrier having sufficient thickness to withstand explosive forces developed by said shaped charge means, cover means for enclosing said shaped charge means in said forward opening; blasting cap means sized for reception in said tubular extension means through said rearward opening; and cover means for closing said rearward opening.

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