Feb. 8, 1938. C. W. VOGT ET AL 2,107,655

TESTER

Filed Feb. 17, 1936 3 Sheets-Sheet 1

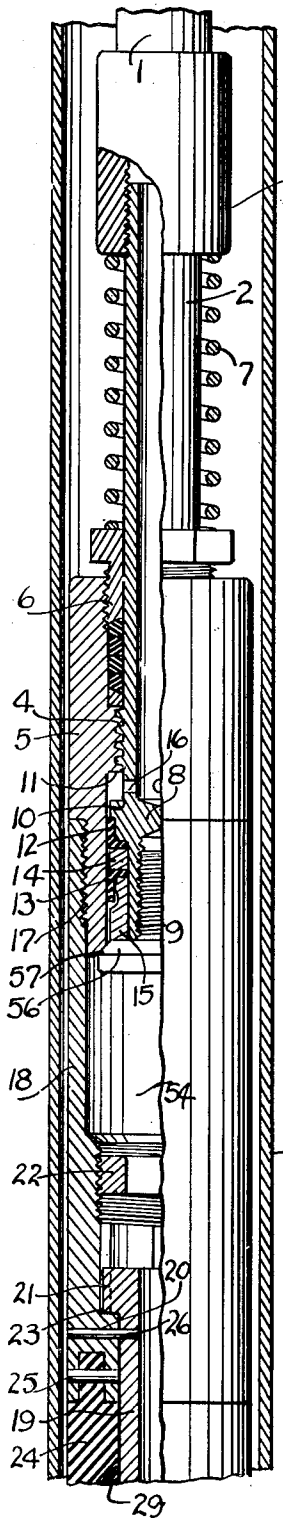


Fig. 1.

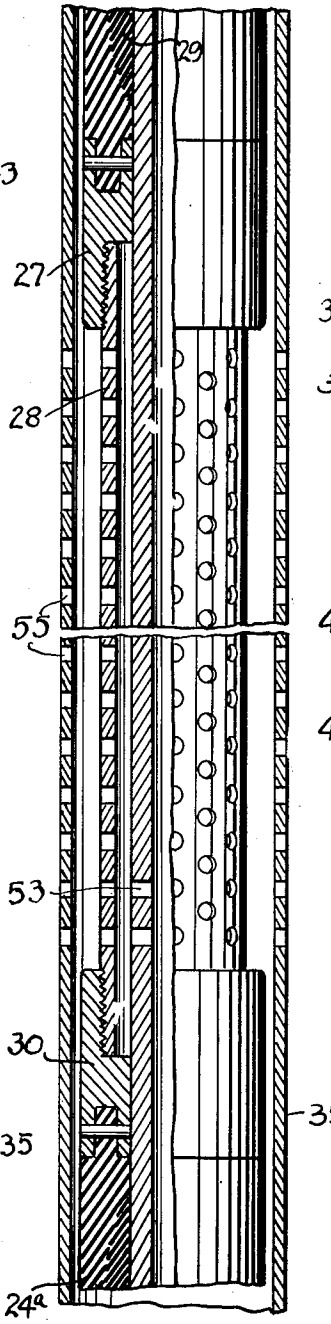


Fig. 2

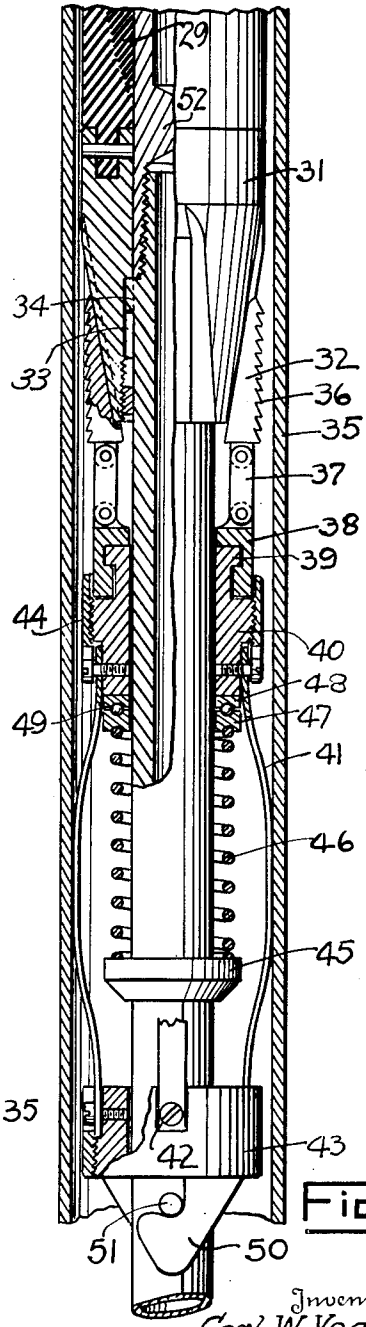


Fig. 3.

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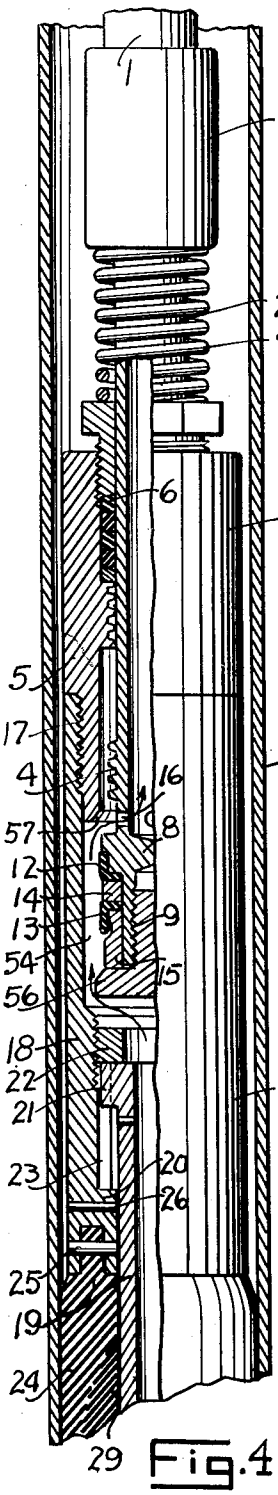


Fig. 4.

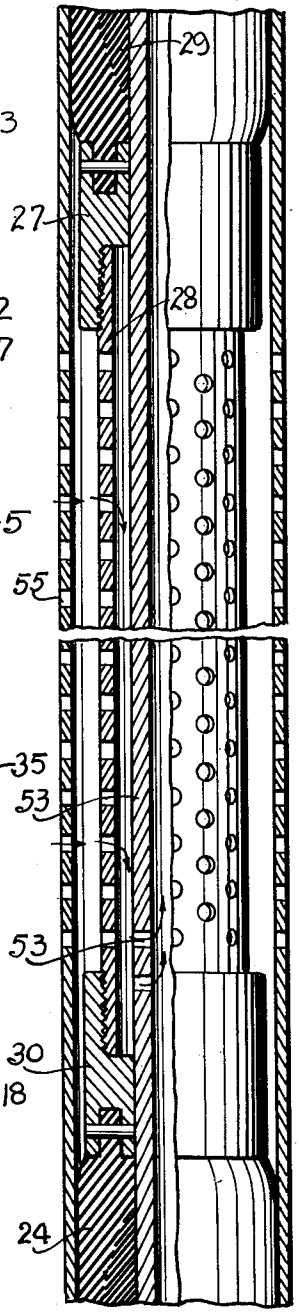


Fig. 5.

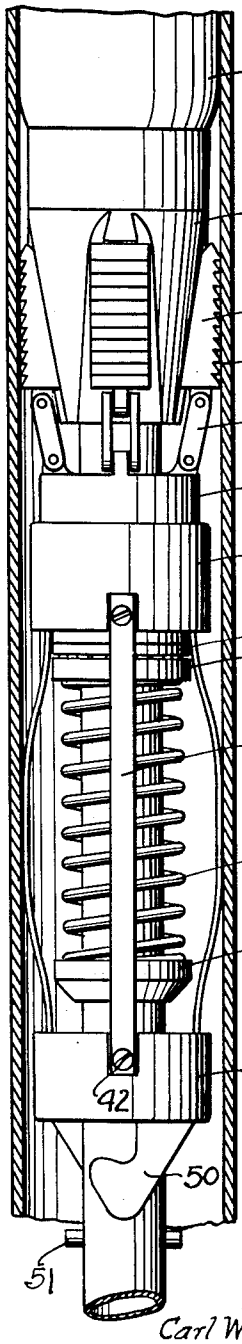


Fig. 6.

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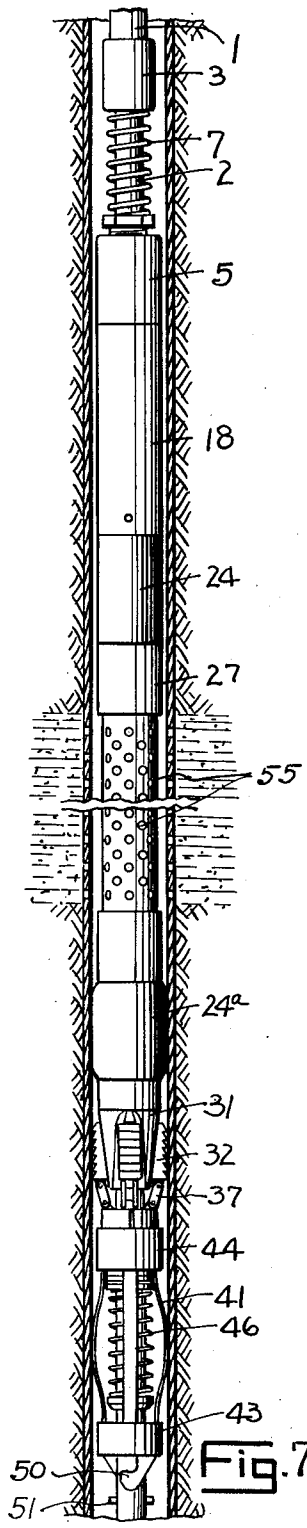


Fig. 7.

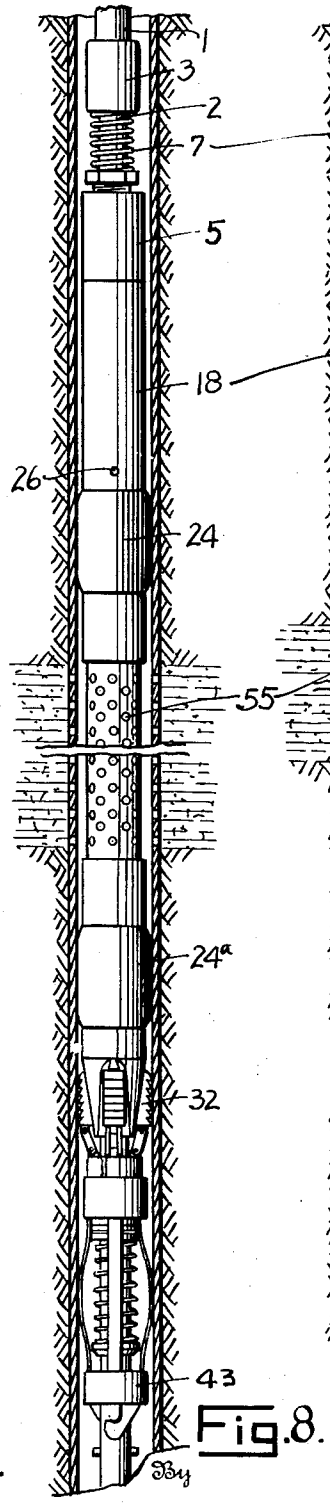


Fig. 8.

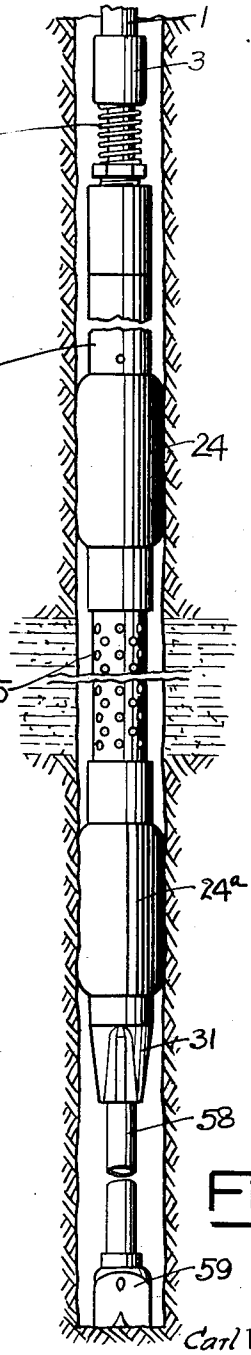


Fig. 9.

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Patented Feb. 8, 1938 2,107,655

UNITED STATES PATENT OFFICE

2,107,655

TESTER

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Application February 17, 1936, Serial No. 64,196

7 Claims. (Cl. 166—1)

Our invention relates to well testers employed in making tests of the productivity of formations encountered in deep well drilling.

To avoid the necessity of cementing casing, setting strainers, and cleaning a well before a test is made for the presence of oil or gas in the formation, it has become common to make tests with a drill stem tester. This sort of device includes a drill stem with a closure for the lower end thereof, said closure being capable of opening and closing at the lower end of the well to take in and retain a sample of the fluid from the adjacent formation. In most of these devices it is necessary to set upon the bottom of the hole to operate this device so as to open and take in a sample. A rat hole is commonly drilled ahead of the main bore of the well and a packer is set at the upper end of the rat hole to prevent the entrance of fluid from above, then a test is made below the packer.

It is an object of this invention to provide a tester which can take a sample of the formation without the necessity of drilling a rat hole ahead of the well bore.

It is also an object to provide a tester which can make a test at any desired elevation in the well to determine whether fluid is entering the well at that point and to obtain a sample thereof.

It is also desired to provide a tester which will operate in an open hole at various elevations therein.

It is a further object to employ the device in cleaning strainers or perforated pipe by a suction through the openings of the strainer or pipe from within the device. This may be done at any elevation. Also, we desire to be able to flush fluid outwardly for cleaning purposes.

It is a further object to provide a tester which may make tests at a plurality of elevations at one insertion into the well.

Our invention resides in the novel construction and operation of our device which adapts it to the making of tests quickly and cheaply at any desired point in the well. We are enabled to test different strata throughout the length of the well bore and to determine whether or not fluid is entering and the character of said fluid.

In the drawings herewith Figs. 1 to 3 are upper, intermediate and lower end views respectively, partly in elevation and partly in longitudinal section, of an embodiment of our invention, the device being in closed position as it is when being introduced into the well.

Figs. 4 to 6, inclusive, are similar views but showing the device in expanded, operative position.

Fig. 7 is a longitudinal section of a well with the device shown in side elevation therein and the lower packer expanded.

Fig. 8 is like Fig. 7 but with the upper packer also expanded.

Fig. 9 shows the device modified and equipped for use in an open, encased hole.

The device is adapted for lowering into the well at the end of a drill stem or pipe 1. It includes an upper barrel 2 connected with the stem 1 by a threaded collar 3. The barrel is threaded at its lower end at 4 with a coarse thread to engage within a special coupling 5. A seal is formed above the threaded connection by a stuffing box 6, formed in the coupling about the barrel. A coiled spring 7 is compressed between the collar 3 and the coupling 5, the purpose of which will later be explained.

The barrel is extended beyond the threaded connection 4 and is closed by a transverse partition 8 beyond which is a threaded box 9. The outer diameter of the barrel is increased below the external thread 4 to provide an upwardly presented shoulder 10 spaced slightly below an internal shoulder 11 on the coupling. Below the shoulder 10 the external diameter is reduced to form a seat for a packing member including cups 12 and 13 presented in upward and downward directions respectively and spaced apart by a ring 14 and clamped in place by a lower ring 15 on the barrel. This sealing member engages the inner surface of the coupling and acts to prevent the passage of fluid past the same. Above the partition 8 are a plurality of lateral openings 16 to permit entrance of fluid when the seal 12, 13 is released.

The coupling 5 is connected at 17 to a setting collar or sleeve 18 formed at its lower end to engage about a mandrel 19. There is an inwardly projecting flange 20 on the setting collar engaging below a flange 21 upon the mandrel. Above the mandrel a stop ring 22 is screwed within the collar to limit the upward movement of the mandrel in the collar. The mandrel is keyed at 23 to the setting collar to prevent relative rotation.

A packer sleeve 24 is secured to the lower end of the setting sleeve by a tongue and groove connection. Through pins 25 hold the parts together. To hold the packer from downward movement on the mandrel a frangible pin 26 is employed. This pin will only be sheared or broken by a strong pressure upon the collar. The

lower end of the packer sleeve is connected to a supporting packer collar 27 screwed upon the upper end of a perforated nipple or strainer 28 which is spaced somewhat from the mandrel slidable therethrough. The packer sleeve is preferably of rubber or similar flexible material and may have a hard rubber supporting portion indicated by the heavy section lines at 29.

The strainer 28 is connected at its lower end to a lower packer sleeve 24a through the packer collar 30. Said packer sleeve is mounted at its lower end upon an expanding collar 31, the lower end of which is tapered downwardly. Pipe engaging dogs 32 have a slidable mortise and tenon connection on said tapered area. The expander collar slides upon the mandrel and a keyway 33 thereon engages over a key 34 on the mandrel to prevent rotation of said collar on the mandrel.

The dogs 32 have outer downwardly inclined teeth to engage the outer casing 35 of the well. Said dogs are connected by links 37 to a ring 38 made in sections and having a swivel engagement over the flange 39 at the upper end of the dog support 40.

Said dog support is slidable on the mandrel and has its lower end reduced somewhat. To the reduced lower end are secured a plurality of bowed spring arms 41 which are connected at their lower ends at 42 to a latching collar 43. These arms frictionally engage the casing 35 and resist rotation of the support 40 in the casing. A sleeve 44 on the dog support serves to retain the ring 38 in position.

A flange 45 is formed on the mandrel below the support 40 and a compression spring 46 mounted on the flange bears at its upper end against a ring 47 which forms the lower raceway for antifriction bearings 49 below the ring 48. This spring tends to move the dogs upwardly on the tapered expander 31. The latching collar 43 has at its lower end a hooked arm 50 which may engage below a pin 51 upon the mandrel and thus hold the dogs and supporting collar from upward movement. The hook can be released by a relative rotation of the mandrel to move the pin 51 from above the hook.

The mandrel is tubular and has a partition at 52 therein which closes the passage therethrough at about the level of the expander collar 31. There are a plurality of openings in the wall of the mandrel at 53 spaced above the partition and adapted to allow passage of fluid from the strainer 28 into the mandrel and upwardly to the chamber 54 in the interior of the setting collar 18.

It sometimes occurs that a producing formation is passed up in drilling a well for the reason that the driller expects much greater production further down. If he later wishes to test the formation which was passed by at levels above the lower end of the well it is common to perforate the casing at the desired level, but no proper test of the formation can be readily made by old equipment. To test the production after the casing has been perforated, as shown at 55, the device is lowered in the well to a position adjacent the perforations with one packer above and the other below the perforations 55. The mandrel is then rotated to move the pin 51 from above the hook 50 and the spring 46 throws the dogs 52 upwardly upon the expander so that the dogs engage the casing as shown in Fig. 6.

The device is then supported on the supporting dogs and downward pressure exerted to expand the lower packer 24a. When this has been done, further pressure will break the pin 26 and allow the collar 18 to move downwardly to expand the upper packer.

The operator will then screw downwardly upon the stem 1 and the barrel will unscrew at 4 and the further downward movement of the barrel will move the sealing members 12 and 13 into the chamber and unseat the valve 56 from the seat 57 and when the openings 16 in the mandrel are exposed fluid entering through the lower openings 53 will flow upwardly into the chamber 54 and through said openings 16 to the barrel. As the interior of the stem 1 and barrel 2 are empty gravity will cause a strong movement of the fluid into the stem. If gas pressure in the formation is present the gas also will find a vent upwardly through the barrel and the stem. If the gas pressure is strong enough from the formation into the testing device it may be sufficient to flow the fluid directly through the device as thus anchored. If, however, it is considered desirable the device may be released and drawn upwardly to the surface with the sample therein. After the barrel has been unscrewed and moved downwardly it may be reciprocated so as to agitate the contents of the well and thus assist in initiating the flow of fluid upwardly.

The upward movement of the stem 1 and barrel 2 will first move the sealing members 12 and 13 upwardly into the lower end of the coupling 5 and again seal the device. If desired, the threads 4 on the barrel may be again re-engaged but as the lefthand movement of the stem and barrel is necessary to re-engage these threads it is possible to withdraw the device without any re-threading of the barrel within the coupling. It will be seen that the sealing member will engage within the lower end of the coupling without screwing up the threads 4. An upward movement of the setting collar 18 will release the pressure on the packer which will then be again contracted and released. The lower packer will also be released in a similar manner and when the expanding collar 31 is moved upwardly the dogs also will be released and the complete device may be removed from the well.

In Fig. 7 we have shown the device with the lower packer 24a expanded and the upper packer 24 still in contracted position. In Fig. 8 the upper packer is also expanded, it being understood that the pin 26 will be sheared off before the upper packer is set.

In Fig. 9 we have shown how the device may be used in an open hole without casing therein. As it will be usually impossible to set the dogs 32 firmly against the earth wall of the open hole we prefer to support the device upon a length of drill stem 58 which is secured to the lower end of the expanding collar 31. This length of drill stem will be as long as is necessary to support the device at the level where the test is to be taken. We prefer to place a drill bit 59 of ordinary construction at the lower end of the drill stem 58 to act as a pilot in getting to the bottom of the hole with the device.

The packers 24 and 24a are similar in construction to the packers employed in casing but are preferably made a little longer so that a better seal with the irregular walls of the well bore may be made. It will be obvious that a test made with the device constructed as shown in Fig. 9 will be practically identical with that of the other previously described embodiment of the invention. It will not be necessary to expand the anchoring dogs but the subsequent steps of taking the test will be identical.

It will now be seen that it is possible with our device to make tests of the formation at any desired level in the well. Strata encountered in drilling the well where production is thought to be present may be tested at any time after the well has been completed by perforating the casing adacent the producing sand and making a test with this device.

Another important use of our device is due to the action of the device when the seal is disengaged to make the test. It will be understood that when the device is lowered into the well the interior of the stem is dry. There is no liquid therein. There will ordinarily, however, be liquid in the hole outside of the stem and when the passage into the previously sealed portion of the stem is opened there will, of course, be a rush of liquid or other fluid into the stem due to the head of liquid above the openings. This has a suction effect upon the casing adjacent the openings which tends to draw inwardly from the outer portion of the well any mud or other material tending to clog the openings in the pipe. We are, therefore, not only able to obtain a sample of the producing fluid but this sample is drawn inwardly with such force that we are enabled to clear the openings in the pipe so that producing fluid may freely enter to the well. If one action of the device is insufficient to thoroughly clean the openings in the casing it will be possible to make a second test after the pipe has been emptied of the charge which enters.

This device may also be employed in testing the casing for leaks. It very frequently happens in deep wells that pressure of the surrounding formation and the wear upon the casing in introducing it into position and other similar circumstances may cause the casing to leak. Such leaks can not be repaired without first locating the leaks. We can with this device set the packers above and below the point where the leak is supposed to be and make a test to determine whether fluid is entering the casing. This is an important use to which our device is adapted. The further advantages of the device will be obvious to those skilled in the art.

What is claimed as new is:

1. A well tester including a tubular stem, a chamber at the lower end thereof, means to seal the entrance of fluid to said chamber releasable on the relative downward movement of said stem to open said chamber, a tubular mandrel below said stem and connected therewith, a plurality of spaced packers on said mandrel, a perforated nipple between said packers, means adjustable to support said packers and nipple at any desired level, and means actuated by the downward pressure of said stem when said supporting means is operated to set said packers.

2. In a well tester a tubular stem adapted to be inserted into a well casing, means to seal the lower end thereof, a chamber below said seal, there being openings from the outside to said chamber, packers above and below said openings, means to expand said packers to pack against said casing, means to release said seal to receive fluid from between said packers through said chamber into said stem, said stem being closed and said packers released upon upward movement of said stem.

3. In a well tester a tubular stem adapted to be inserted into a well casing, means to seal the lower end thereof, a chamber below said seal, there being openings from the outside of said chamber, packers above and below said openings, a support for said packers, means to engage said support with said casing, means to expand said packers to pack against said casing, means to release said seal to receive fluid from between said packers through said chamber into said stem, said stem being closed and said packers released upon upward movement of said stem.

4. A device of the character described including a tubular stem adapted to be inserted into a well, a barrel on said stem, a coupling detachably connected with the lower end of said barrel, a seal at the lower end of said barrel in said coupling, a mandrel below said coupling, a plurality of packers on said mandrel, there being openings to said mandrel between said packers, means to engage with the well and support said packers whereby they may be expanded, and means to release said seal to receive into said barrel a sample of fluid from between said packers through said openings.

5. A device of the character described including a tubular stem adapted to be inserted into a well, a barrel on said stem, a coupling detachably connected with the lower end of said barrel, a seal at the lower end of said barrel in said coupling, a mandrel below said coupling, a plurality of packers on said mandrel, there being openings to said mandrel between said packers, means to engage with the well and support said packers whereby they may be expanded, and means actuated by the downward movement of said barrel into said coupling to release said seal to receive into said barrel a sample of fluid from between said packers through said openings.

6. A device of the character described including a tubular stem adapted to be inserted into a well, a barrel on said stem, a coupling detachably connected with the lower end of said barrel, a seal at the lower end of said barrel in said coupling, a mandrel below said coupling, a plurality of packers on said mandrel, there being openings to said mandrel between said packers, means to engage with the well and support said packers whereby they may be expanded, and means to release said seal to receive into said barrel a sample of fluid from between said packers through said openings, said seal being again made operative to close said barrel by the upward movement of said barrel in said coupling.

7. A tubular stem, a barrel at the lower end thereof, a coupling having a sealing connection with said barrel to close off entrance of fluid thereto, a mandrel below said coupling, upper and lower packers on said mandrel, there being openings to said mandrel between said packers, means to set said packers at any desired level in the well, means responsive to the downward screwing of said barrel in said coupling to release said seal and permit fluid to flow through said openings to said barrel, said seal being closed by a direct upward pull upon said stem and barrel.

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