

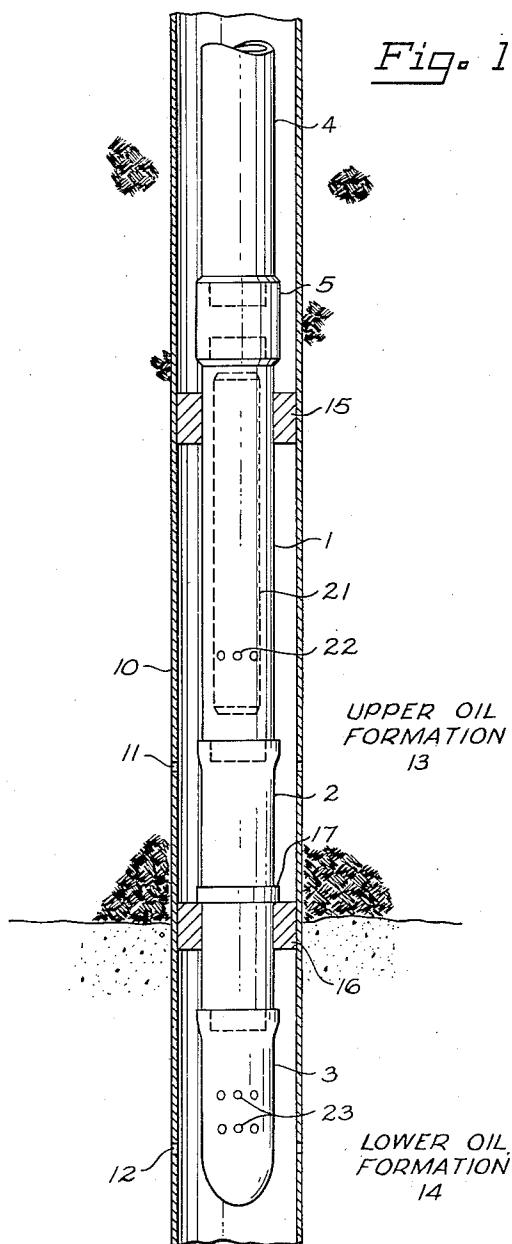
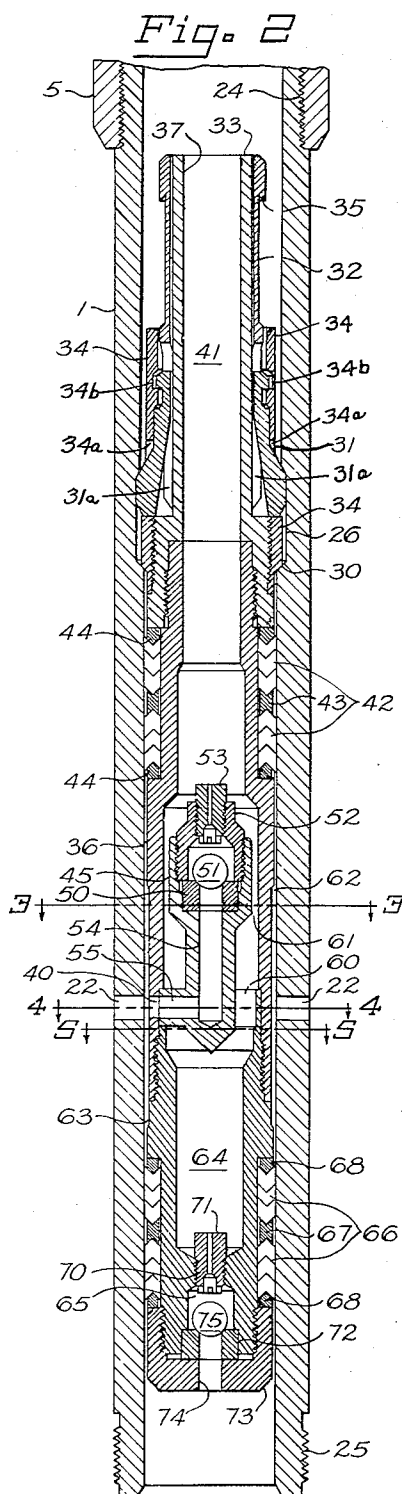
June 17, 1958

I. L. AULT
WELL FLOW DEVICE

2,839,144

Filed July 22, 1953

2 Sheets-Sheet 1



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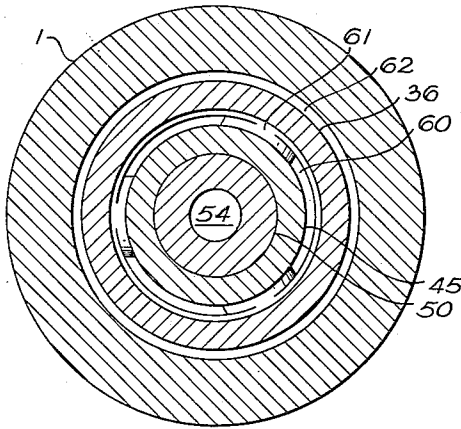


Fig. 3

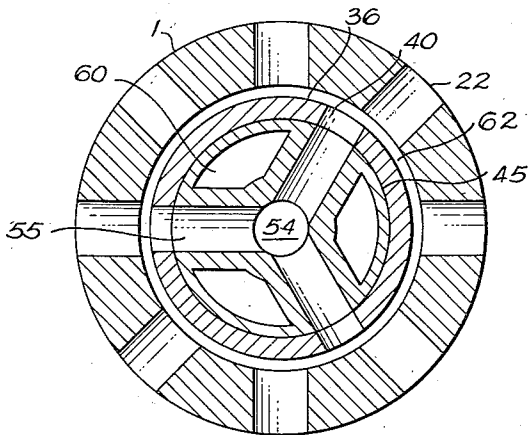


Fig. 4

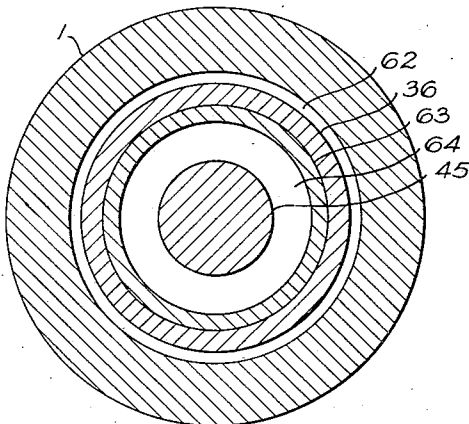


Fig. 5

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2,839,144

WELL FLOW DEVICE

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Application July 22, 1953, Serial No. 369,626

1 Claim. (Cl. 166—148)

This invention relates to downhole devices used in the flowing of oil from subterranean oil-bearing formations and relates more particularly to a downhole device used to provide simultaneous controlled flow of oil into a single production tubing string from two separate subterranean oil-bearing formations penetrated by the bore of a well.

It has been suggested that the production of two oil-bearing formations may be accomplished by flowing the oil from one of the formations through the regular production tubing and by flowing the oil from the other formation through the annulus between the production tubing and the casing. However, this procedure is often unsatisfactory inasmuch as standards of safety and State regulations frequently do not allow production of oil through the annulus. The pressures of the oil-bearing formations are often high, resulting in having high pressures present in the annulus which are difficult to control in the event of a casing failure. This is especially true in the case of offshore wells where the casing must extend from the bed of the body of water up through the water to a producing platform above the surface of the water. This portion of the casing above the bed is subject on the outside surface to hydrostatic pressures only, which provide little lateral support to this part of the casing. A casing failure which occurs here is much more difficult to control if the annulus is carrying high pressure oil than would be a similar break in a section of casing surrounded by an earth formation. Also, a casing failure here would cause dangerous collections of oil to form on the surface of the water around the well.

It is an object of this invention to provide a device for controlled simultaneous flow of oil from two producing formations into a single production tubing. It is another object of this invention to provide a dual flow device for oil wells which may be readily inserted into and removed from oil well production tubing by means of a wire line. It is another object of this invention to provide a dual flow device for oil wells which will eliminate the dangers inherent in flowing oil through the annulus between the production tubing and the casing of an oil well.

In accordance with the invention, there is provided a cylindrical shaped housing having upper ports, lower ports, and means for connecting the housing to the lower end of a string of production tubing. Removably secured within the housing is a choke and check valve unit, hereinafter referred to as the unit, for controlling simultaneous flow from two producing formations comprising a lower choke and check valve in fluid communication with the lower ports of the housing and with a lower chamber or central flow path, an upper choke and check valve in fluid communication with the upper ports of the housing and with the lower end of an upper chamber or central flow path, the upper end of which is in fluid communication with the production tubing, and fluid communication means connecting the lower chamber with the upper chamber. There is provided near the upper end of the unit a locking device permitting it to be secured in operating position

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within the housing. The unit may be introduced into and removed from the housing through the production tubing by means of a wire line.

The invention will be more readily understood by a reading of the following specification taken in conjunction with the accompanying drawings.

In the drawings Figure 1 is a diagrammatic representation of one form of my invention in operating position in an oil well having two oil-producing formations. Figure 2 is an axial section of my invention showing the unit located in operating position within a portion of the housing. Figure 3 is a transverse section taken along the line 3—3 of Figure 2. Figure 4 is a similar view taken along the line 4—4 of Figure 2. Figure 5 is a similar view taken along the line 5—5 of Figure 2.

Referring to the drawings, the housing of the unit, which comprises tubular members 1, 2, and 3, is secured to the lower end of production tubing string 4 by means of internally threaded coupling 5. Casing 10 is provided with upper perforations 11 and lower perforations 12 which permit oil to pass into the interior of casing 10 from upper oil formation 13 and lower oil formation 14, respectively. Conventional type packers 15 and 16 are used to form a seal between the housing and the interior of casing 10 at the points above the upper oil formation and between the upper and lower oil formations, respectively. These packers may be set in any suitable manner known to the art which will form an effective seal between the housing and the casing. Tubular member 2 is provided with annular shoulder 17 permitting member 2 to seat against packer 16 allowing packer 16 to assist in vertically supporting the housing and production tubing. Reference number 21 denotes the unit, shown diagrammatically in Figure 1 in its proper operating position within tubular member 1 of the housing and shown in detail in Figure 2. A plurality of ports 22 are provided through the wall of tubular member 1 to permit flow of well fluids into the interior of the housing from within the portion of casing 10 adjacent to the upper producing formation. Tubular member 3 similarly is provided with ports 23 through its wall to permit the flow of well fluids into the interior of the housing from within the portion of casing 10 adjacent to the lower producing formation. Due to the complete lack of consistency of the vertical positioning of oil-producing formations, it is quite possible that formations 13 and 14 might be either close to each other or spaced quite some distance apart. In order to provide for this variable spacing, threaded connections are provided between members 1 and 2 and 2 and 3 to permit a member 2 of any length to be placed between the tubular members 1 and 3 as necessitated by the relative positions of the two producing formations. Ordinarily member 2 may comprise one or more sections of conventional production tubing. If more than one section of tubing is required for member 2, it will be apparent that shoulder 17 must be provided on the section which passes through packer 16.

Figure 2 shows in detail the unit locked in operating position within tubular member 1. Tubular member 1 is provided with external screw threads 24 at its upper end for securing to coupling 5 and with external screw threads 25 at its lower end for securing to tubular member 2. Tubular member 1 contains internal annular locking recess 26 which terminates at its lower end in annular shoulder 30 serving to support the unit 21 in member 1 and allow it to be locked in place during operation. A plurality of locking dogs 31, shown in Figure 2 in locked position, engage recess 26 to secure the unit in operating position and are movable laterally so that the unit may be removed in an upward direction from the housing. Dogs 31, positioned in longitudinal slots 31a provided in dog

carrier 32, which is movably secured on carrier mandrel 33, are held in said slots by locking mandrel 34 having a threaded connection at its lower end to the lower end of mandrel 33. Locking mandrel 34 is provided with longitudinal slots 34a which permit the lower outer portions of dogs 31 to project through said locking mandrel into engagement with recess 26 when locked position is desired. Locking mandrel 34 is further provided near its upper end with an internal annular recess 34b into which the upper ends of locking dogs 31 fit to hold the dogs in position vertically. Supporting of dogs 31 at their upper ends within recess 34b permits the dogs to move about their point of support in order that the lower portion of the dogs may move laterally through slots 34a. This latter movement of the lower portion of the dogs allows them to be moved outwardly into recess 26. Referring to Fig. 2, there is a small amount of space between the outer surface of carrier 32 and the inner surface of mandrel 34. This space permits a small moment arm to be exerted on the upper ends of dogs 31 when carrier 32 is urged downward so that the upper ends of slots 31a engage the upper ends of dogs 31 and through this moment arm cause the lower portions of the dogs to move outwardly into recess 26. Dog carrier 32 is provided with annular shoulder 35 permitting the securing of a fishing head for raising and lowering the unit and locking and unlocking dogs 31. The means described for locking the unit in operating position are conventional and well known to those skilled in the art as disclosed, for example, in U. S. Patent No. 2,571,478, which issued October 15, 1951, to H. C. Otis for a Well Device. It is to be understood that any other suitable locking means may be used which will permit easy introduction into and removal of the unit from the housing through the production tubing from the surface.

Packing mandrel 36, threadedly engaging the lower end of carrier mandrel 33, has a plurality of ports 40 near its lower end. Mandrel 36 in its lower portion serves as a housing for the upper choke and check valve and in its upper portion in cooperation with internal axial bore 37 in carrier mandrel 33 serves to form upper chamber or flow path 41. Fluid tight packing is provided between the outside of mandrel 36 and the interior of member 1 by means of V-type packing 42, female packing ring 43, and male packing rings 44. Positioned within mandrel 36 in its lower portion in the upper choke and check valve comprising valve body 45, ring type valve seat 50, ball check 51, choke body 52, and choke 53. Valve body 45 has vertical bore 54 connecting with a plurality of lateral, radial ports 55, body 45 being located within the mandrel 36 such that ports 55 coincide with ports 40 in mandrel 36. Body 45 also is provided at its lower end with a plurality of vertical ports 60 positioned at points between ports 55 but not connected with ports 55. Annulus 61 is formed between body 45 and the internal surface of mandrel 36 whereby fluids may flow from ports 60 around the upper choke and check valve into upper chamber or flow path 41. Another annulus 62 is formed between the exterior of mandrel 36 and the interior of member 1. Fluids enter annulus 62 from upper formation 13 through ports 22 and flow from annulus 62 through ports 40 and 55 into bore 54 and up around ball check 51 through choke 53 into chamber 41. Ball check 51 prevents the back flow of fluids from chamber 41.

Body 63, threadedly connected to the lower end of mandrel 36, is counterbored at its upper end to form lower chamber or flow path 64 and at its lower end to form valve chamber 65. Secured between body 63 and member 1 is fluid tight packing which comprises V-type packing 66, female packing ring 67, and male packing rings 68. A screw threaded bore 70 is provided in body 63 connecting chamber 65 and chamber 64 and is adapted to receive choke 71. Ring type valve seat 72 is held in place in the lower end of body 63 by closure member 73

which is threadedly connected to body 63 and contains central aperture 74 to permit fluids to pass therethrough into the lower choke and check valve. Ball check 75 rests loosely on seat 72 within chamber 65 allowing flow of fluids in an upward direction through the lower choke and check valve but preventing the back flow of liquids therethrough.

The first step in the introduction of my well flow device into an oil well bore is the assembly of tubular members 1, 2, and 3 of the tool housing. The proper length for tubular member 2 must be chosen to insure that ports 22 are adjacent to upper formation 13 and ports 23 are adjacent to lower formation 14. The connection of member 1 by means of coupling 5 to the lowermost section of production tubing string 4 is made and the string is then lowered into the well bore, and packers 15 and 16 are set in a conventional manner. At the surface a conventional well head, including a stuffing box and a lubricator, is connected to tubing string 4 and casing 10 to provide for the control of fluid flow from the well at the surface. Packers 15 and 16 are of the type generally illustrated in U. S. Patent No. 2,005,955, issued January 25, 1935, to Renouf for a Well Packer and Patent No. 2,618,340, issued November 18, 1952, to Lynd for a Well Packer. Shoulder 17 on member 2 is set firmly against packer 16. Care must be taken that tight seals are provided by packers 15 and 16 between casing 10 and members 1 and 2, respectively, and that the housing is properly located so ports 22 will be adjacent to upper formation 13 and ports 23 are adjacent to lower formation 14. Packer 15 must prevent fluids and other foreign matter from entering from above into the interior of casing 10 adjacent to the upper oil-producing formation. Packer 16 is used to prevent the migration of fluids between the upper and the lower oil producing formations as these formations will more than likely be under different pressures. Having production tubing string 4 and the housing set in place, the choke and check valve unit 21 may now be lowered through the lubricator, stuffing box, and tubing string 4 into operating position. This is accomplished by engaging shoulder 35 on unit 21 with a fishing head secured to a wire line and lowering the unit downward through production tubing string 4 until mandrel 34 rests on shoulder 30. With downward force on the upper end of dog carrier 32, there is a force exerted on the upper ends of dogs 31 by the upper ends of slots 31a in carrier 32. This force on the upper ends of dogs 31 causes the dogs to rotate about their point of contact with recess 34b in mandrel 34, moving the lower ends of the dogs outwardly to engage locking recess 26.

With my well flow device in operating position within the well bore, flow of the well may be permitted by operation of the necessary valves on the well head. Well fluids from lower formation 14 flow into casing 10 through ports 12 and then into lower tubular member 3 through ports 23. The fluids then flow upward through aperture 74, around ball check 75 which is raised off seat 72 by the oil pressure, and into chamber 65. From chamber 65 the fluids flow through choke 71, into chamber 64, through ports 60 and annulus 61 into chamber 41. Well fluids from upper formation 13 flow into casing 10 through ports 11 and into annulus 62 through ports 22. From annulus 62 the fluids flow through ports 40 and 55 into bore 54, upward around ball check 51 through choke 53 into chamber 41 where they mix with fluids from the lower formation. From chamber 41 the mixture of fluids from the upper and lower formations flows upward into production tubing string 4 and on to the surface.

Chokes 53 and 71 are removable so that the proper sizes may be chosen which will make the pressures of the fluids from the upper and lower formations as nearly equal as possible as they arrive in chamber 41 and sufficiently below the pressures in both the upper and lower formations to insure flow from both formations. This is necessary to prevent a tendency of the fluids of the

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formation having the higher pressure to back flow toward the formation having the lower pressure and thus cause a cessation of flow from it.

Unit 21 may easily be removed from the housing by lowering a fishing head secured to a wire line through production tubing string 4 and engaging shoulder 35 of unit 21 with the fishing head.

Having thus described my invention, it will be understood that such description has been given by way of illustration and example and not by way of limitation, reference for the latter purpose being had to the appended claim.

I claim:

An oil well flow control assembly for simultaneously flowing well fluids from an upper and a lower producing formation into a single string of production tubing, said assembly comprising a tubular housing connectable at its upper end to the lower end of a production tubing, said housing having upper ports for admission of well fluids from an upper producing formation and lower ports for admission of well fluids from a lower producing formation and an annular locking recess therein near the upper end thereof, a tubular body having lower and upper central flow passages and radial ports intermediate said lower and upper central flow passages, said tubular body being introduceable into and removable from said housing through production tubing, locking means secured to the outside of said tubular body engageable with said annular recess in said housing, a lower choke secured in the lower end of said tubular body within said lower flow passage to control the flow of fluids into said assembly from a lower producing formation, a lower check valve

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secured in the lower end of said tubular body below said lower choke to prevent back flow of fluids into a lower producing formation from above said lower check valve, a valve body positioned within said tubular body at the lower end of said upper flow passage, the outside of said valve body being spaced apart from the inside of said tubular body to form an annular flow passage around said valve body, an upper choke secured to the upper end of said valve body, an upper check valve secured within said valve body below said upper choke, means provided with radial and axial ports secured within said tubular body and connected to the lower end of said valve body to provide fluid communication between the interior of said valve body and said radial ports of said tubular body and fluid communication between the lower end of said annular flow passage and said lower flow passage in said tubular body, annular packing means around said tubular body above said radial ports in said tubular body to form a fluid-tight seal between the outside of said tubular body and the inside of said housing, annular packing means around said tubular body below said radial ports in said tubular body to form a fluid-tight seal between the outside of said tubular body and the inside of said housing, and an annular shoulder around the upper end of said locking means to permit the engagement of a fishing head with the upper end of said oil well flow control assembly.

References Cited in the file of this patent

UNITED STATES PATENTS

2,531,258	Cranfill	Nov. 21, 1950
2,618,339	Glover	Nov. 18, 1952
2,642,803	Morris et al.	June 23, 1953