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2,187,487

BRIDGE PLUG

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Fig. 1.

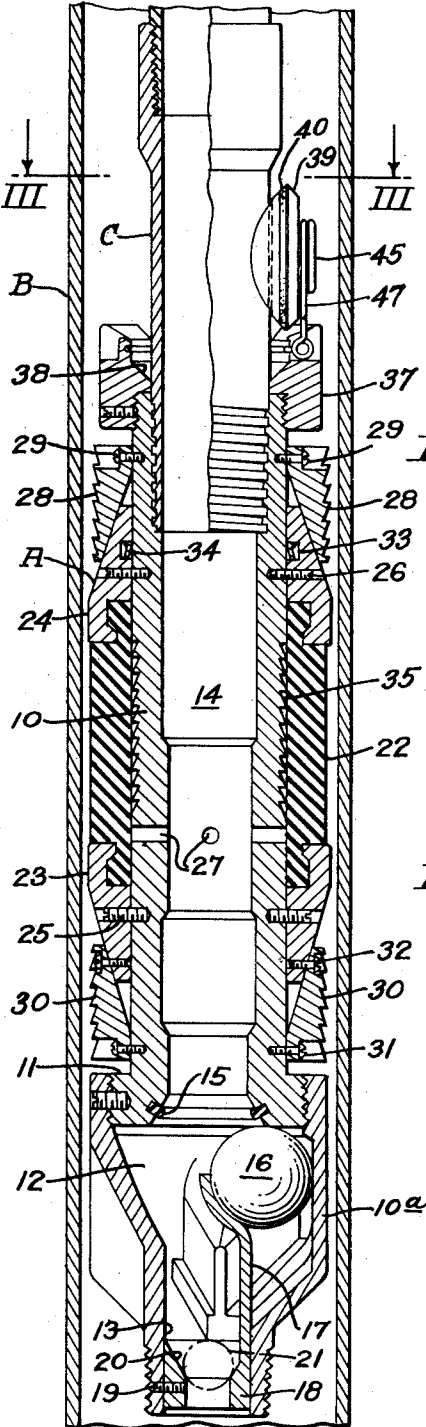


Fig. 2.

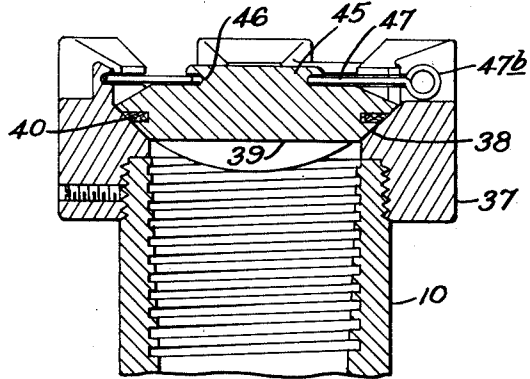


Fig. 3.

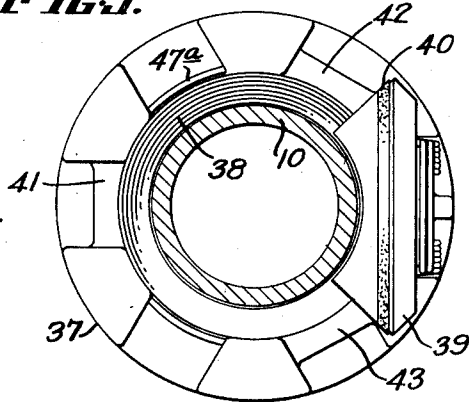
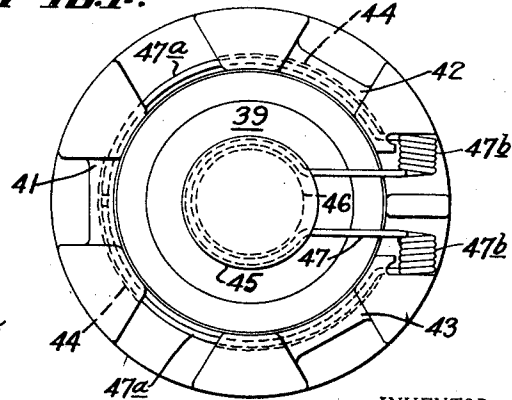


Fig. 4.



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BRIDGE PLUG

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4 Claims. (Cl. 166—13)

This invention relates generally to well devices of the character commonly known as cement retainers by reason of their predominate use in the cementing of oil wells but which are also utilized as well packers for various other purposes.

Various specific forms of cement retainers or packers have heretofore been employed to pack off at selected elevations between a run-in string of tubing and a well casing to confine the flow of cement, fluid, or gas pumped down the run-in string and through the retainer or packer, and when it is desired to completely seal the well casing against downward flow of cement, fluid or gas past the set retainer or packer, it has been a general practice to insert and pump down the run-in string of tubing a ball valve which, upon arrival at the set retainer or packer, seats in the flow passage thereof to close said passage and thus converts the set device into a bridge plug. The inserting of a bridging ball in the run-in string of course involves a stopping of the circulation pumps and a disconnecting of the string at the derrick floor, the pumps then being re-connected to the run-in string after the ball has been inserted and the circulation re-established to pump the bridging ball down to the set retainer or packer, and since the time consumed in pumping said ball down to its seat may and often does amount to as much as five minutes per thousand feet of depth, it follows that considerable time and expense is involved in the use of an inserted bridging ball. Further, in certain oil fields, where very heavy viscous mud is encountered, a bridging ball of the above character, the proper seating of which depends entirely upon its own weight and the movement of the circulation fluid, often fails to engage its mating seat with the degree of accuracy necessary to completely close the flow passage of the device.

The principal object of the present invention is to provide an improved device of the character referred to which may be detachably connected to the lower end of a string of tubing or the like and lowered into a well casing and set therein at any desired elevation and in which there is provided a bridging means normally restrained in ineffective position and automatically operable to immediately bridge the flow passage of the device upon a disconnecting and withdrawal of the lower end of the run-in string from engagement with the set device, thus eliminating the necessity of using an inserted bridging ball or other inserted element with the resulting interruption of the circulation and disconnecting of the run-in string at the derrick floor.

In general, the cement retainer or packer comprises a tubular packing device adapted to be run-in a well casing at the lower end of a string of tubing by which it may be manipulated by an operator at the derrick floor, and it includes in its structure operable slips for anchoring the device firmly in the surrounding casing at a desired location, and an expansible packing means or sealing element for sealing off the annular space between the exterior of the device and the wall of the casing, the slips and the packing means being operated by fluid pressure and by manipulation of the run-in string and the automatic bridging means being released by a withdrawal of the run-in string from the set device.

In cementing operations employing the tubing method, the cement slurry is pumped down the run-in string and through the set retainer to discharge into the well casing below said retainer and flow around the lower end of the casing, or through perforations formed therein, to form a seal between the casing and the well bore, and since the device may also function as a bridge plug after the run-in string is disconnected from the set retainer to release the bridging means, it becomes possible to conduct a cementing operation above the set bridge plug, in which operation cement slurry is pumped down the disconnected run-in string or down the casing itself to discharge through perforations or cement discharge ports formed in the casing above the set bridge plug. The device may be set above an exhausted oil sand and gas under pressure may be pumped down the run-in tubing in a repressuring operation, and since it may be used purely as a bridge packing to seal off the interior of a well casing at any point above bottom, it may be employed to effect a complete shut-off of high pressure gas below a producing oil sand.

One form of embodiment of the invention is exemplified in the following description and illustrated by way of example in the accompanying drawing, in which:

Fig. 1 is a longitudinal section through a portion of a well casing and through the device of the present invention with the parts in the positions they assume when the device is being run-in the casing.

Fig. 2 is an enlarged longitudinal section of the upper portion of the device showing the bridging valve in the closed position it will assume after the run-in string has been disconnected from the set device.

Fig. 3 is an enlarged transverse section taken on the line III—III of Fig. 1.

Fig. 4 is a plan view of the parts shown in Fig. 2.

The cement retainer or packer illustrated in Fig. 1 of the drawing, is, insofar as the body and its run-in string, the packing and slip mechanisms, and the disabling and release means for the back-pressure valve is concerned, of the type disclosed in the United States Letters Patent No. 2,121,051 issued June 21, 1938, to myself and Thomas M. Ragan, to which Letters Patent reference may be had for a more complete description of these portions of the present device.

The device A, in the condition shown in Fig. 1, will be lowered into the well casing B by a run-in string C having a screw-threaded lower end which engages in the upper screw-threaded end of the axial flow passage of the tubular body member 10, said screw-threads being preferably left-hand threads of square form. The body member 10 has an enlarged lower end providing an annular abutment shoulder 11 and secured thereto is a body member 10a providing a valve chamber 12 and a lower bore 13, the flow passage through the device comprising the lower bore 13, the valve chamber 12 and the upper bore 14 of the body member 10.

At the lower end of the upper bore 14 is an annular valve seat 15 and disposed in the valve chamber 12 is a buoyant back-pressure valve ball 16 adapted to cooperate with said seat when released, but normally held to one side of said chamber in open position, as shown in Fig. 1, by an arm 17 extending upwardly from a tubular trip sleeve 18 initially held in position in the lower bore 13 by a shear pin 19. By thus holding the back-pressure valve open, the device may be run-in the casing and moved up or down therein without causing a swabbing action. Said trip sleeve 18 has an interior trip valve seat 20 which is adapted to be engaged by a ball trip valve 21, as shown.

A sleeve packing 22, formed of rubber or other suitable pliable material, surrounds the medial portion of the body 10 and is connected at its lower end to a lower cone 23 which slidably fits said body while its upper end is connected to an upper cone 24 likewise slidably fitting said body. Normally these cones 23 and 24 are connected to the body 10 by shear pins 25 and 26, respectively, the pins 25 of the lower cone having a greater shear value than the pins 26 of the upper cone so that a lesser pressure is required to release the upper cone than that required to release the lower cone. One or more lateral ports 27 direct fluid under pressure from the bore 14 to in back of the packing sleeve 22 to expand the same.

"Up-pressure" slips 28 are normally connected to the body 10 by shear pins 29 and "down-pressure" slips 30 are normally connected to the body by shear pins 31 and to the lower cone 23 by shear pins 32.

It will be noted that the interior bore of the upper cone 22 has formed therein an annular groove 33 which receives a ratchet latch 34 in the form of a split contractile ring, tooth-shape in cross-section and adapted to engage annular serrations forming on the exterior surface of the body 10 a series of ratchet teeth 35, said teeth and latch forming a one-way ratchet means which will retain the upper cone 22 latched to the body in operated position.

Attached to the upper end of the body 10 is an annular collar 37 serving as an abutment to limit the upward movement of the "up-pressure" slips 28. The bore of this collar is formed to pro-

vide a tapered valve seat 38 adapted to be engaged by a bridging valve 39 having a similarly tapered valving face grooved to accommodate a packing ring 40. The upper end of the collar 37 is angled inwardly and downwardly and is downwardly notched at intervals to form upright limbs 41, 42 and 42 separated by spaces of substantial width, this construction facilitating a flushing of settled mud from the valve seat by the circulation as the run-in string is disconnected and elevated from the device. The inner wall of each of these upright limbs is provided with an arcuate groove 44, the three grooves in effect constituting a substantially circular groove extending around the valve seat. The upper surface of the valve disc 39 has formed thereon a central button 45 of mushroom shape which provides a circular groove 46.

The bridging valve 39 is pivotally connected to the collar 37 and is automatically closed by a spring 47 of the "mouse-trap" type. The opposite anchored ends 47a of the spring are semi-circular in form and are snapped into the respective grooves 44 of the upright limbs 41, 42 and 43 and the coiled portions 47b thereof are disposed between the limbs 42 and 43, the central portion of the spring being engaged in the groove 46 beneath the central mushroom button 45 of the bridging valve. The valve is thus pivotally mounted on the collar 37 by the spring 47 which actuates it, this arrangement permitting an easy removal and replacement of the valve and its spring.

As this valve is conditioned for a running-in of the device into the well casing, it is restrained in open position by engagement with the side of the lower end portion of the run-in string C, as shown in Fig. 1.

When the retainer or packer has been positioned in the well casing at the desired point, the trip ball 21 is pumped down the run-in string C and will pass the restrained back-pressure valve 16 to seat in the trip sleeve 18 and close the flow passage at this point. Fluid pressure is then created in the run-in string and in the flow passage of the device and becomes effective through the lateral ports 27 to expand and elongate the packing sleeve 22 and shear the pins 26 of the upper cone 21, moving said cone upwardly with sufficient force to shear the pins 29 of the upper slips 28. With the shearing of the slip pins 29 said upper slips will engage the abutment collar 37 and, by reason of the co-engaging angled surfaces of the cone and slips, will be moved outward radially into gripping engagement with the casing wall. The pump pressure is then relieved and the run-in string is subjected to an upward strain sufficient to move the body 10, the lower cone 23, the lower slips 30, and the lower end of the packing sleeve 22 relative to the now stationary upper end of the packing sleeve, so as to compress the packing sleeve into sealing condition against the casing wall until it will compress no further, whereupon, continued relative movement will shear the pins 25 of the lower cone 23, causing the abutment shoulder 11 to engage the lower slips 30, and then shear the pins 31 and 32 and move said lower slips upwardly and outwardly into gripping engagement with the casing wall.

The device being thus properly set, the fluid pressure will be built up to a degree sufficient to shear the pin 19 of the trip sleeve 18 and eject said sleeve and trip ball from the device so as to

release the buoyant back-pressure ball 16 for engagement with its seat 15.

The device is then ready for a repressuring operation in which gas under pressure is pumped down the run-in string and through the set packer, or for a cementing operation in which cement slurry is pumped down the run-in string and through the set cement retainer, the back-pressure valve 16, in either instance, preventing reverse flow into the set device of gas or cement, as the case may be.

The run-in string may then be disconnected from the set device, due to the left-hand screw connection between the two, and the run-in string may then be elevated from engagement with the device to release the bridging valve 39 which will immediately be automatically closed by its actuating spring 47, as shown in Fig. 2. This converts the packing device into a bridge plug which completely seals the interior of the well casing.

As a bridge plug the device may be employed for various packing off purposes and may be used in cementing operations wherein it is desired to flow cement slurry into the well casing above the set bridge plug for discharge through perforations in the casing wall, such cement being pumped down through the disconnected tubing string or through the casing itself.

Although I have herein disclosed a specific type of packing device embodying in its structure the automatic bridging valve which renders the combination capable of accomplishing the objects of the present invention, it will be obvious that such automatic bridging valve may be incorporated in the structure of other types of packers or cement retainers which provide a flow passage and which are run-in a well by a means capable of being disconnected and withdrawn from the set device in a manner to release said valve for automatic operation to close said flow passage.

From the foregoing it will be evident that I have provided a cement retainer or packer which includes a means normally rendered ineffective by the run-in string and which will automatically function with a withdrawal of said run-in string from the set device to convert said device into a bridge plug.

While I have disclosed a preferred form of my invention, it is to be understood that various changes may be made therein by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A bridging valve comprising an annular collar adapted for attachment to a well packing device and to be lowered therewith down a well casing, said collar being formed to provide a valve seat surrounding its bore and being laterally grooved internally above said seat, a valve disc

adapted to engage the valve seat to close said bore, and a spring tending to maintain said valve closed, said spring providing an anchoring portion of circular form having a snap-ring engagement in said groove, coiled portions disposed on one side of said bore and forming a pivot for said valve, and a medial portion connected to and forming a lever arm for said valve.

2. A bridging valve comprising an annular collar adapted for attachment to a well packing device and to be lowered therewith down a well casing, said collar having a bore formed to provide an inwardly and downwardly tapered valve seat surrounding said bore, a valve disc similarly tapered and adapted to engage the valve seat to close said bore, and spring means pivotally mounting said valve disc on said collar and tending to maintain said valve closed, said collar above said valve seat being downwardly notched at circularly spaced intervals to facilitate a flushing of said valve seat.

3. A bridging valve comprising an annular collar adapted for attachment to a well packing device and to be lowered therewith down a well casing, said collar being formed to provide a valve seat surrounding its bore and being laterally grooved internally above said seat, a valve disc adapted to engage the valve seat to close said bore and having a central mushroom-shaped button on its upper side providing a circular external groove, and a single spring tending to maintain said valve closed, said spring providing an anchoring portion of circular form having a snap-ring engagement in said internal groove, coiled portions disposed on one side of said bore and forming a pivot for said valve, and a medial portion forming a lever arm for said valve and having a circular portion engaging said button in the external groove thereof.

4. In an apparatus of the character disclosed, the combination of a tubular body providing a flow passage and adapted to be detachably connected to the lower end of a string of tubing or the like and lowered into a well casing, said body having an annular valve seat surrounding the upper end of said flow passage and an internal groove above said seat, anchoring means and packing means associated with said body, means for actuating said anchoring means to gripping engagement with the casing and for causing said packing means to pack off the space between said body and the casing wall, a valve disc adapted to engage the valve seat to close said bore, and a spring tending to maintain said valve closed, said spring providing an anchoring portion of circular form having a snap-ring engagement in said groove, coiled portions disposed on one side of said bore and forming a pivot for said valve, and a medial portion connected to and forming a lever arm for said valve.

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