Sept. 8, 1953 R. C. BAKER 2,651,367

PLUG DEVICE FOR WELL CONDUITS

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Fig. 1.

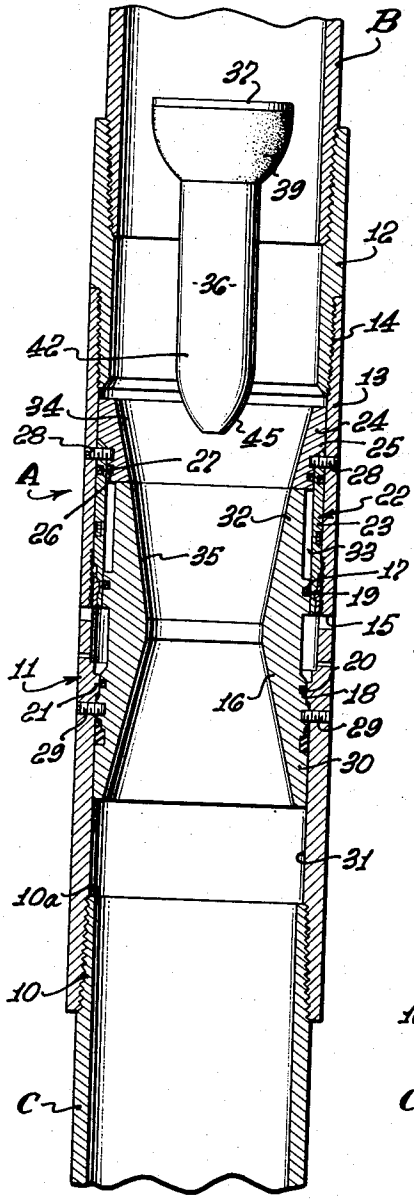


Fig. 2.

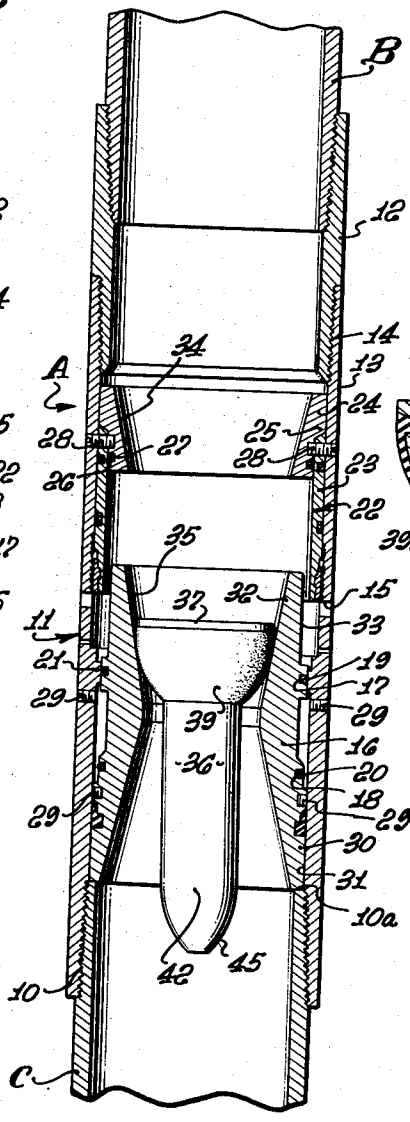
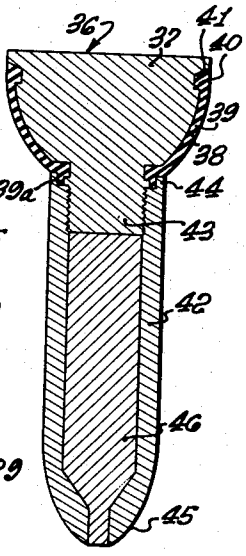


Fig. 3.



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PLUG DEVICE FOR WELL CONDUITS

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Original application January 12, 1948, Serial No. 1,843. Divided and this application November 14, 1949, Serial No. 127,186

11 Claims. (Cl. 166—1)

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The present invention relates to plugs or valves adapted to gravitate through well casings, liners and similar conduits disposed in a well bore. This application is a division of my application for "Ported Cementing Apparatus," Serial No. 1,843, filed January 12, 1948, now Patent No. 2,602,510.

Plugs or valve devices are used in connection with well conduits, such as casing strings, for the purpose of closing the string against flow of fluid therethrough. A plug may gravitate through the fluid in the well casing into engagement with a companion valve seat therein. As an example, the seat may be provided on a sleeve valve member initially closing a casing side port. Upon engagement of the plug with the seat, the sleeve valve member may be shifted hydraulically to a port opening position.

Under some operating conditions, as in the cementing of a casing string in a well bore, it is desirable for the plug or valve to gravitate through the well casing fluid in a rapid manner. It is also desirable to insure proper engagement of the plug or valve member with its cooperable seat, to prevent leakage therearound.

Accordingly, an object of the invention is to provide an improved plug or valve member capable of fast descent through a well conduit into engagement with a companion seat on a sleeve valve or the like.

Another object of the invention is to provide a plug or valve member which tends to assume a vertical position to assure its proper engagement with its companion seat within a well conduit.

A further object of the invention is to provide a plug or valve member that can fit snugly within its cooperable seat, and which does not project above the seat.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through a ported casing apparatus, with its ports closed and a setting plug or valve member descending toward its companion seat in the apparatus;

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Fig. 2 is a view similar to Fig. 1, with the plug or valve member seated and the ports open;

Fig. 3 is an enlarged longitudinal section through the plug or valve member.

The plug or valve member is illustrated in the drawings in connection with a ported casing apparatus described and claimed in my above-identified parent application. As shown in the drawings, a casing collar A is provided at an intermediate point in a string of casing positioned in a well bore. The upper end of the collar may be threadedly attached to an adjacent upper casing section B, while its lower end may be similarly secured to the upper pin 10 of a lower casing section C. The collar is so positioned in the casing string as to insure its location in the well bore at the point where it is desired to eject cement slurry, or other cementitious material, from the casing string into the surrounding well annulus.

The main portion of the collar A consists of a tubular member 11, which, as disclosed in the drawings, is made of two parts 12, 13 to facilitate assembly of the apparatus. The upper threaded bore portion 12, which is secured to the upper casing section B, is suitably attached, as by means of coengaging threads 14 to the lower portion 13 of the tubular member. For the purpose of discharging fluids from the interior of the casing string and collar to the exterior thereof, the tubular member is provided with one or more lateral ports 15. These ports, however, are closed against passage of fluids when the casing string is run in the well bore. They can be opened to permit cement slurry and other fluids to be discharged therethrough; and they can be again closed to prevent further passage of fluids between the interior and exterior of the collar.

In order to accomplish the above-noted purposes, a lower sleeve valve member 16 is disposed in the tubular member 11. This sleeve valve member is provided with spaced ring grooves 17, 18 carrying suitable side seals 19, 20 such as rubber "O" rings, for preventing leakage of fluids in both longitudinal directions around the exterior of the sleeve and out through the ports 15. The lower seal ring 20 is engageable with an inturned flange 21 on the tubular member 11, whereas the upper seal ring 19 is engageable with the inner surface of an upper sleeve valve member 22, which is initially maintained above the ports 15, but which can be shifted downwardly to close these ports. This upper member is made of two parts, including a lower tubular sleeve 23, preferably made of a difficultly drillable material, such as steel and a readily drillable upper por-

tion 24, of magnesium, aluminum, and the like, piloted within the steel member, and having a shoulder 25 engaging the upper end of the latter. Leakage between these two portions is prevented by a suitable side seal 26, such as an "O" ring, located in an external groove 27 in the drillable portion and engaging the inner wall of the steel portion 23.

As indicated above, the upper sleeve valve member 22 is disposed initially in an upper position clear of the ports 15 (see Fig. 1). The two portions 23, 24 of this valve are held together and in their upper location by one or more frangible devices, in the form of shear screws 28, extending through them and through the tubular member 11. Disruption of the screws 28 enables the upper sleeve valve member 22 to be shifted downwardly to a position closing the ports 15.

The lower sleeve valve member 16 is nested or piloted within the upper sleeve valve member 22, with its side seals 19, 20 disposed on opposite sides of the ports 15. The lower member 16 is held in such position initially by one or more shear screws 29 extending through the tubular member 11 and threaded into the lower sleeve member. These shear screws dispose the lower seal ring 20 in contact with the inturned flange 21, preferably a short distance above the lower end of the latter. Below the flange 21, the lower sleeve valve has an enlarged diameter portion 30 for slidable engagement with the enlarged bore 31 of the tubular member.

The upper portion 32 of the lower sleeve valve is reduced in external diameter to provide an annular space 33 in conjunction with the upper sleeve valve 22 through which cement slurry, and other fluent substances, may flow when the lower sleeve valve has been shifted downwardly to port opening position. The lower sleeve valve 16 preferably abuts the drillable portion 24 of the upper sleeve valve, in order to hold the overall dimensions of the combined sleeve valve structure to a minimum.

The central bore 34 through the upper drillable portion 24 of the upper sleeve valve is preferably tapered inwardly in a downward direction, merging smoothly into a corresponding bore 35 in the lower sleeve valve 16. In fact, the lower bore 35 forms a continuation of the upper bore 34.

The collar A is made up in the casing string with the parts occupying their initial position as disclosed in Fig. 1. The upper sleeve valve 22 is disposed above the ports 15, and the lower sleeve valve 16 is located in its upper position, with its seals 19, 20 on opposite sides of the ports. As a result, any fluids pumped down through the casing string will pass through the convergent bores 34, 35 in the upper and lower sleeve valve members to some lower point in the casing string, such as a casing shoe (not shown), from which the fluids are ejected into the well bore surrounding the casing. If the collar is employed in connection with a multiple stage cementing operation, a charge of cement slurry may be pumped down the casing string for ejection from the casing shoe. A flexible top cementing plug (not shown) of the character disclosed in my Patent No. 2,370,833 may be used at the upper end of the cement slurry, and this plug will be capable of passing through the convergent bores 34, 35 of the upper and lower sleeve members 24, 26 without shearing the screws 28, 29, the convergent wall of the bores 34, 35 facilitating inward compression of the flexible or rubber plug.

Following the discharge of the lower quantity of cement slurry from the casing, it is desired to open the ports 15 in the collar and discharge a second quantity of cement slurry through these ports for upward passage around the casing string. A tripping device, in the form of a plug or valve member 36, is pumped down the casing string, or is allowed to gravitate through the fluid in the casing string into engagement with the tapered wall 35 of the lower sleeve (see Fig. 2). This plug is of such dimensions as to pass through the upper sleeve 24, but is of greater diameter than the minimum diameter through the lower sleeve 16, to insure its seating in the latter and its closing of the tapered bore 35.

In the specific form illustrated in the drawings, the lower plug 36 includes an upper head 37 having a lower, generally spherical surface 38 on which a spherical seal 39 of rubber, or similar material, is mounted. This seal is secured to the head 37 by disposing its upper inner flange 40 within a companion external head groove 41, and by clamping its lower end between the upper end of a depending shell 42 and the head. The shell is threaded onto a depending pin or neck 43 of the head 37, an upward projection 44 of the shell clamping the lower seal portion against the head and confining its longitudinally extending terminal portion 39a between the extension 44 and the neck 43.

In addition to its clamping of the spherical seal 39 to the plug head 37, the shell 42 serves to increase the weight of the plug per unit of frontal area, to insure its rapid gravitation through the well fluid. Thus, the shell depends from the head to any desired extent, with its lower end 45 rounded to provide a nose or guide portion. The shell is weighted by filling its interior with lead 46, or a corresponding material, which is preferably readily drillable. The shell 42 and head 37 may be made of aluminum or magnesium to enable their ready disintegration under the action of a drill bit, when the bore of the casing string is to be cleared of all obstructions following the cementing operation.

The lower plug member 36 gravitates rapidly through the fluid in the well bore until the head seal 39 engages the tapered wall 35 in the lower sleeve 16 in leakproof relation. The fluid in the casing above the collar and plug 36 may then be subjected to pressure of an amount sufficient to overcome the shear value of the lower screws 29, disrupting them and shifting the lower sleeve 16 downwardly to a position in which its upper seal ring 19 is disposed below the ports 15 (see Fig. 2). Downward movement of the lower sleeve is limited by its engagement with a suitable stop, which, in the present instance, is provided by the upper end 10a of the lower casing section C.

Cement slurry, or other fluids, may now be pumped down the casing string, passing over the upper end of the lower sleeve 16 and through the annular space 33 between it and the upper sleeve 22, for discharge through the collar ports 15. After the desired quantity of cement slurry has been thus ejected through the collar, it is desired to close the ports by shifting the upper sleeve 22 downwardly. This latter purpose may be achieved by placing a top cementing plug (not shown) at the upper end of the charge of cement slurry, and causing it to engage the tapered wall 34 of the upper drillable portion 24 of the upper sleeve valve member 22, closing the bore

through the drillable portion and allowing the fluid in the casing thereabove to be pressurized to an extent sufficient to shear the upper screws **28** and shift the upper sleeve **22** downwardly over the ports **15**, as explained in my parent application above referred to.

The provision of the forward extension **42** on the plug head **37**, and the partial or complete filling of this extension with the weighting material **46**, insure the rapid descent of the lower plug **36** through the fluid in the well casing. The spherical surface of the head **38** and the spherical-like seal **39** also insure the proper seating of the plug in leakproof engagement in the lower sleeve valve member **16**, and guards against leakage between the plug and sleeve when pressure is applied for the purpose of disrupting the shear pins **29** and shifting the lower sleeve valve member downwardly to a position opening the ports **15**. The heavy forward extension **42, 46** tends to maintain the valve device in a vertical position during its descent through the well casing B, and also upon engagement of the seal **39** with the companion seat **35** in the sleeve valve member **16**. Thus, there is very little tendency for the plug member to assume an inclined position, which, if extensive enough, might disrupt the desired sealing engagement between the spherical seal member **39** and the seat **35**.

The forward extension **42, 46** not only possesses the above-mentioned advantages, but it also extends in a downward direction through the lower sleeve valve **16**, obviating any plug projections above the sleeve valve member **16**. Because of this arrangement, the plug does not interfere with a top cementing plug (not shown), or any other parts may be moved down through the casing into engagement with the upper sleeve valve **22**.

The inventor claims:

1. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing seating surface, and an extension extending downwardly from said head and surface, the center of gravity of said plug being substantially below the lower end of said surface, said extension having a lesser diameter than said valve head.

2. A plug adapted for downward movement in a well conduit, including a valve head having a seating surface, a hollow extension extending downwardly from said head and terminating in a lower guide tapering in a downward and inward direction, and a weighting material in said extension, said extension and lower guide having a lesser diameter than said valve head.

3. A plug adapted for downward movement in a well conduit, including a valve head having a lower generally spherical shaped sealing surface, and an extension extending downwardly from said head, said extension having a lesser diameter than said valve head.

4. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing elastic seal thereon, and an extension extending downwardly from said head and seal, the center of gravity of said plug being substantially below the lower end of said seal, said extension having a lesser diameter than said valve head.

5. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing elastic seal thereon, and an extension extending downwardly from said head and seal and clamping said seal to said head, the center of gravity of said plug being below said seal, said extension having a lesser diameter than said valve head.

6. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing seating surface, and an extension threaded on and extending downwardly from said head and surface, the center of gravity of said plug being substantially below the lower end of said surface, said extension having a lesser diameter than said valve head.

7. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing lower surface and an elastic seal on said lower surface, a hollow extension threaded on and extending downwardly from said head and clamping said seal to said head, and weighting material in said extension.

8. A plug adapted for downward movement in a well conduit, including a head having a downwardly facing substantially spherically curved lower surface and a substantially spherically curved elastic seal on said lower surface, and an extension extending downwardly from said head and securing said seal to said head.

9. A plug adapted for downward movement in a well conduit, including a head having a downwardly facing substantially spherically curved lower surface and a substantially spherically curved elastic seal on said lower surface, a hollow extension threaded on and extending downwardly from said head and clamping said seal to said head, and weighting material in said extension.

10. A plug adapted for downward movement in a well conduit, including a valve head forming the upper terminal portion of the plug and having a downwardly facing seating surface, and an extension extending downwardly from said head and surface, the specific gravities of the materials of said head and extension and the relative dimensions of said head and extension being such that the center of gravity of said plug is substantially below the lower end of said seating surface, said extension having a lesser diameter than said valve head.

11. A plug adapted for downward movement in a well conduit, including a valve head having a downwardly facing seating surface, a hollow extension extending downwardly from said head and terminating in a lower guide tapering in a downward and inward direction, and a weighting material in said extension, said extension and lower guide having a lesser diameter than said valve head.

REUBEN C. BAKER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,606,206	Boynton	Nov. 9, 1926
1,641,915	Boynton	Sept. 6, 1927
2,196,652	Baker	Apr. 9, 1940
2,374,169	Boynton	Apr. 24, 1945
2,493,650	Baker et al.	Jan. 3, 1950