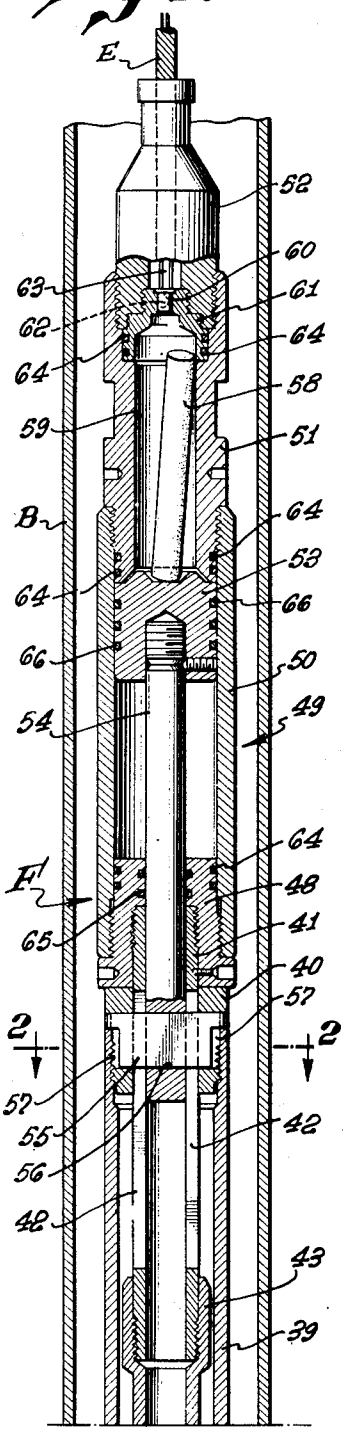
Sept. 29, 1953 R. C. BAKER 2,653,666

DUMP BAILER AND BRIDGE PLUG

Filed March 21, 1949 2 Sheets-Sheet 1

Fig. 1.



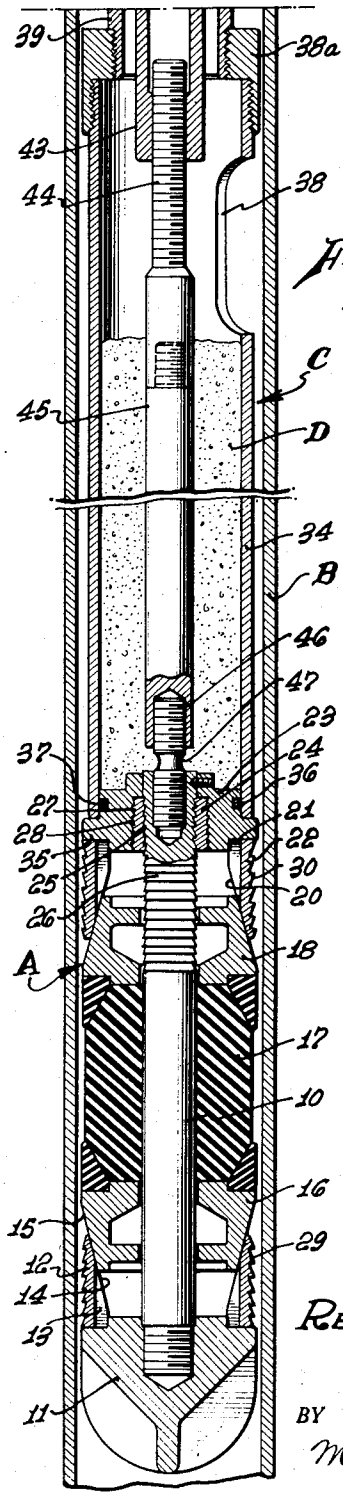


Fig. 1a.

Fig. 2.

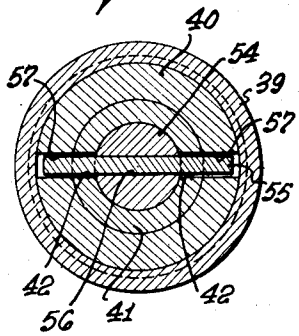


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Fig. 3.

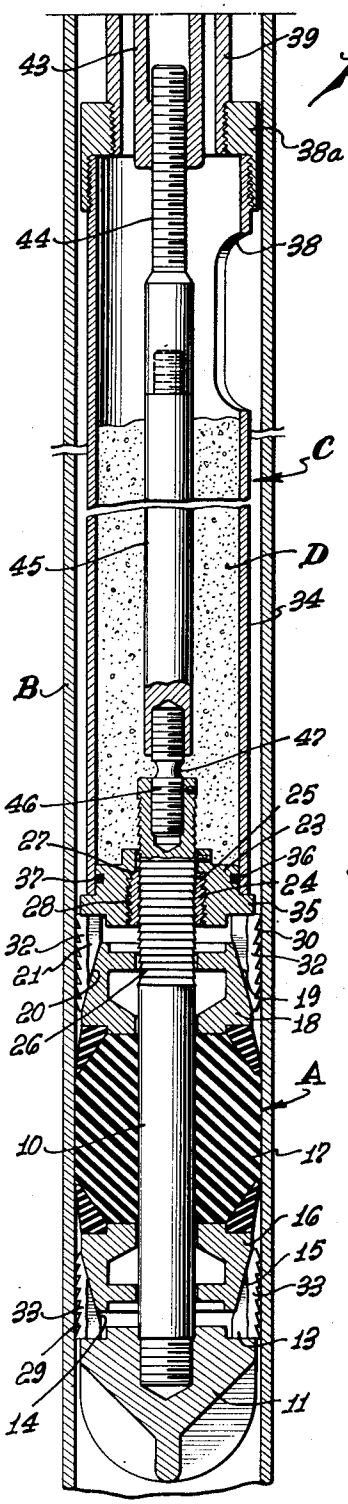


Fig. 4.

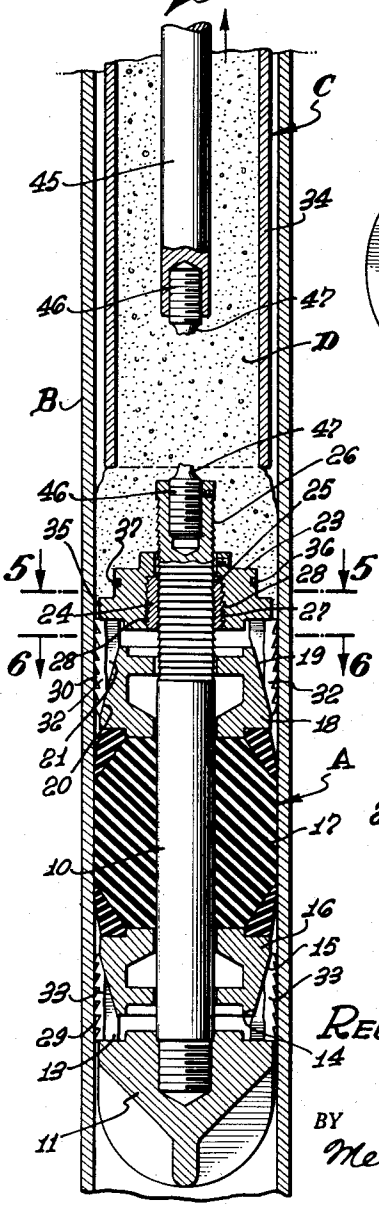


Fig. 5.

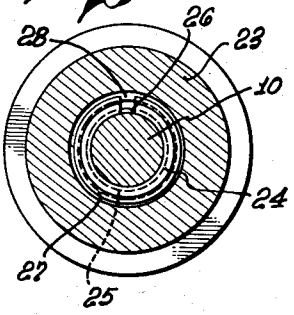
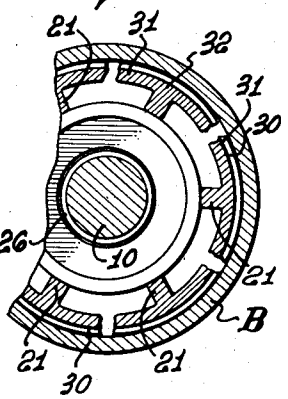


Fig. 6.



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DUMP BAILER AND BRIDGE PLUG

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Application March 21, 1949, Serial No. 82,499

5 Claims. (Cl. 166—13)

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The present invention relates to well apparatus particularly useful in the performance of plugging and cementing operations in well bores.

An object of the present invention is to provide a bridge plug and dump bailer apparatus, in which the plug can be set positively in a well bore, and cementitious material within the bailer deposited upon the set plug as a result of a single run of the equipment in the well bore.

A further object of the invention is to provide a combination bridge plug and dump bailer apparatus that can be run together in a well bore, and in which the plug may be set fully in the well bore prior to the release of cementitious material from the bailer.

Another object of the invention is to provide a combination bridge plug and dump bailer apparatus that can be run together in a well bore, in which full setting of the plug automatically releases the cementitious contents of the bailer for deposit upon the plug. In this connection, the cementitious contents preferably cannot be released from the bailer until the plug is set fully in the well bore.

Yet a further object of the invention is to utilize a dump bailer in the setting of a plug in a well bore.

Still another object of the invention is to provide a dump bailer and bridge plug combination capable of being lowered in a well bore on a wire line, and in which the bailer assists in setting the plug in the well bore.

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:

Figures 1 and 1*a* together constitute a longitudinal section of the apparatus disposed within a well casing or similar conduit, with the parts arranged for lowering the apparatus through the well bore, Fig. 1*a* constituting a lower continuation of Fig. 1;

Fig. 2 is an enlarged cross-section taken along the line 2—2 on Fig. 1;

Fig. 3 is a view similar to Fig. 1*a*, illustrating the well packer or bridge plug anchored in the well casing;

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Fig. 4 is a partial longitudinal section similar to Fig. 1*a*, illustrating the bridge plug set in the well casing, and cementitious material from the bailer being deposited thereon;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 4;

Fig. 6 is an enlarged cross-section taken along the line 6—6 on Fig. 4.

The apparatus disclosed in thhe drawings includes a well packer or bridge plug portion A adapted to be set in a well bore, as within a string of well casing B. It also includes a dump bailer portion C adapted to contain a charge of cementitious material D, such as cement slurry or synthetic resin, to be dumped upon the bridge plug. This combination of equipment may be lowered in the well bore on a suitable running-in string E. As disclosed in the drawings, this running-in string is preferably a wire line attached to the upper end of a setting tool F, which has the function of setting the bridge plug A in the well casing B in conjunction with the dump bailer C itself. Actually, the dump bailer C may be considered as constituting a part of the setting tool F.

The bridge plug A closes the lower end of the dump bailer C to confine the charge of cementitious material D therewithin. In the specific apparatus illustrated in the drawings, it is preferred that the bridge plug continue to close the lower end of the dump bailer until after the plug has been fully anchored in packed-off condition within the well casing B. When fully set by the setting tool F and dump bailer C, the bridge plug is automatically released from the setting tool, which may then be elevated to raise the dump bailer C from the plug A and allow the charge of cementitious material D to be deposited upon the anchored plug.

The specific bridge plug disclosed is described and claimed in the application of John R. Baker and Martin B. Conrad, entitled "Well Packer and Bridge Plug for Well Bores," Serial No. 80,836, filed March 11, 1949. It is to be understood, however, that other specific bridge plugs can be used than the one now to be described.

The bridge plug A includes a central elongate body 10 having a lower abutment and guide 11 threaded, or otherwise secured, on its lower end. A lower slip sleeve 12 engages this abutment, being provided with inwardly directed ribs 13 that have tapered surfaces 14 cooperating with a com-

panion tapered surface 15 on the exterior of a lower expander member 16 slidably mounted on the body 10. A packing sleeve structure 17 surrounds the body 10, with its lower end engaging the lower expander 16, and with its upper end engaging an upper expander 18 that is slidable along the body. This upper expander has an outer tapered surface 19 engageable with companion tapered surfaces 20 on a plurality of ribs 21 extending inwardly from an upper slip sleeve 22, which surrounds the upper expander. This slip sleeve 22 engages an abutment 23 that is slidable along the body 10. This abutment contains a split, contractile lock ring 24 having inner annular teeth 25 adapted to coact with corresponding teeth 26 on the upper end of the body 10. The lock ring also possesses external cam faces 27 cooperating with companion inclined cam faces 28 in the slidable abutment member 23.

The lock arrangement is such as to permit relative downward movement of the abutment 23 along the body 10, and upward movement of the body within the abutment 23, but to prevent such relative movements in a reverse direction. In effect, the locking arrangement 24 to 28 constitutes a one-way clutch.

The inner surfaces 14 of the lower slip sleeve 12 converge downwardly, cooperating with a corresponding taper 15 on the lower expander 16. This lower sleeve also possesses external wickers 29 facing in a downward direction, so as to become embedded in the well casing B and prevent downward movement of the bridge plug A therewithin. The upper expander 18 and upper slip sleeve 22 are arranged in the opposite direction, their companion tapered surfaces 19, 20 converging in an upward direction. The wickers 30 on the upper slip sleeve 22 face in an upward direction, so as to become embedded in the wall of the well casing B, and prevent upward movement of the bridge plug therewithin.

The bridge plug A is set by moving the upper abutment 23 downwardly along the body 10, and by then moving the body upwardly. This action, as described in detail hereinbelow, serves to wedge the upper and lower slip sleeves 22, 12 over their respective expanders 18, 16, fracturing them along their thin wall sections 31 (Fig. 6) into upper and lower segments 32, 33, and allowing movement of such segments longitudinally of their respective expanders and radially outwardly into anchoring engagement with the well casing B. Such relative movements of the upper abutment 23 and packer body 10 also foreshortens the packing sleeve 17 and expands it outwardly into sealing engagement with the well casing.

The bridge plug A serves to close the lower end of the dump bailer C. This dump bailer includes an outer, generally cylindrical barrel 34, which may consist of one or more tubular sections, depending upon the length of the barrel desired. The lower end of the barrel rests upon a shoulder 35 formed on the movable abutment 23, the abutment itself fitting partly within the barrel and containing a suitable seal ring 36, such as a rubber O ring, within a ring groove 37, which sealingly engages the inner wall of the barrel 34. The upper end of the barrel has a window or opening 38 through its side wall, through which the cementitious material D may be dumped into the interior of the barrel, prior to lowering of the equipment into the well casing.

Actually, the dump bailer barrel 34 forms part

of the apparatus for setting the well packer A in the well bore. Thus, the upper end of the barrel is threaded into an adapter ring 38a, which, in turn, is threadedly secured onto a setting sleeve 39 screwed onto a setting ring 40. This ring is disposed around the exterior of a tubular mandrel 41 having opposed elongate slots 42 through its wall. The lower end of the tubular mandrel 41 is threaded into the upper end of a tubular extension 43, which is threaded onto the upper pin 44 of a tension member 45 extending downwardly through the barrel 34 and coaxially thereof. This tension member may consist of several rod sections threadedly connected together, depending upon the length of the barrel. The lower rod section 45 is threaded onto the upper end of a tension stud 46, whose lower end is threaded into the lower end of the bridge plug or packer body 10. The intermediate portion 47 of the stud is reduced in diameter, to insure pulling apart of the stud at that point, as described below.

Initially, the setting ring 40 is disposed adjacent the lower head 48 of a pressure cylinder 49, into the lower end of which the upper end of the tubular mandrel 41 is threaded. A cylinder sleeve 50 is threadedly secured to the lower head 48, with its upper end threadedly attached to an upper cylinder head 51. This upper head is threaded onto a cable head 52, to which the wire line running-in string E is suitably secured in a known manner.

A piston 53 is slidable within the cylinder 49, and has a piston rod 54 secured to it, which depends through the lower head 48 into the tubular mandrel 41. The downward movement of the piston 53 and piston rod 54 within the cylinder 49 is to be transmitted to the setting ring 40 and setting sleeve 39. To accomplish this purpose, a cross-piece 55 extends through a transverse slot 56 at the lower portion of the piston rod 54, projecting in opposite directions through the tubular mandrel slots 42 into opposed slots 57 in the setting ring 40. Thus, the downward movement of the piston rod 54 is transmitted to the setting ring 40 and sleeve 39 through the cross-piece 55 without interference from the tubular mandrel 41, inasmuch as the cross-piece can slide along the elongate slots 42 in the latter.

A gas under pressure is developed in the upper portion of the cylinder 49, in order to move the piston 53 downwardly and the cylinder 49 relatively upwardly, in effecting the setting of the plug A in the casing B and the release of the cementitious contents D of the dump bailer C. This gas pressure may be obtained through the relatively slow combustion of a power charge 58, such as a railway flare, initially resting on top of the piston 53 and within a combustion chamber 59 formed in the upper cylinder head 51. Combustion of the charge 58 is initiated by firing a blank cartridge 60 contained within a gun barrel 61 threaded into the cable head 52. This cartridge may have a filament 62 electrically connected to the conductive core 63 of the wire line E, by means of which current may be caused to pass through the filament 62 for the purpose of exploding the cartridge 60, which will ignite the upper end of the power charge 58 and institute its combustion. This power charge contains its own source of oxygen to support combustion.

The gun barrel 61 and cylinder heads 48, 51 contain suitable seal rings 64 to prevent leak-

age from the cylinder 49, whereas leakage along the piston rod 54 is prevented by suitable rod seal rings 65 in the lower head 48 engaging the exterior of the piston rod. Similarly, leakage along the exterior of the piston 53 is prevented by providing suitable piston rings 66 on its exterior slidably sealing with the wall of the cylinder sleeve 50.

The apparatus is made up at the top of the well bore, with the parts occupying the relative positions illustrated in Figs. 1 and 1a. That is, the plug A closes the lower end of the dump bailer C, with the slip sleeves 12, 22 unbroken and in retracted positions. The piston 53 is at the head end of the cylinder 49.

A charge of cement slurry D, or other cementitious material, is deposited through the barrel opening 38 into the latter, to fill the latter to the desired height. The equipment is then run in the well casing B to the desired point at which the well packer A is to be set therewithin, and at which the charge of cement slurry is to be deposited on top of the set well packer or bridge plug. When this point is reached, current is caused to pass through the cartridge filament 62, causing explosion of the cartridge and ignition of the upper end of the power charge 58. This charge begins to burn, developing a gas pressure in the cylinder 49 and urging the piston 53 in a downward direction. This downward movement is transmitted through the piston rod 54, crosspiece 55, setting ring 40, setting sleeve 39, adapter ring 38a and dump bailer barrel 34 to the upper packer abutment 23. Reactively, the cylinder 49 tends to move upwardly, this upward motion or pull being transmitted through the tubular mandrel 41, its extension 43, the tension member 45 and tension stud 46 to the packer body 10.

The gas pressure in the cylinder 49 increases in a comparatively gradual manner (for example, several seconds), until the wedging force exerted on the upper slip sleeve 22 by the abutment 23, wedging it downwardly over the uper expander 18 is sufficient to fracture this sleeve into a plurality of segments 32, whereupon the segments are moved downwardly over the upper expander 18 and outwardly into firm anchoring engagement with the wall of the well casing B. When wedged outwardly in this manner, further downward movement of the piston 53 is precluded. Accordingly, as the gas pressure in the cylinder 49 continues to increase, as a result of continued combustion of the power charge 58, the cylinder 49, tubular mandrel 41, its extension 43, tension member 45, tension stud 46 and body 10 are moved upwardly, shifting the lower abutment 11 towards the upper expander 18 and upper abutment 23. This action foreshortens the packing sleeve 17 and compresses it laterally into sealing engagement with the well casing B.

A continuation of this upward strain on the packer body 10 and its lower abutment 11 then exceeds the force required to fracture the lower slip sleeve 12, this sleeve being wedged upwardly over the lower expander 16 until it breaks into a plurality of segments 33 and moves laterally outwardly into anchoring engagement with the well casing B.

As the gas pressure in the cylinder 49 continues to increase, the upper and lower slip segments 32, 33 and the packing sleeve 17 are urged more strongly against the casing B. During the relative downward movement of the upper abutment 23 and the relative upward movement of the body 10 therewithin, the split lock ring 24 merely ratchets over the teeth 26 on the body 10. The lock ring teeth 25 and the body teeth 26, however, engage one another to prevent reverse movement between the upper abutment 23 and body 10, holding the packer parts firmly expanded against the well casing, as disclosed in Fig. 3.

When the gas pressure developed in the cylinder 49 increases to a value sufficient to overcome the tensile strength of the reduced diameter section 47 of the tension stud 46, the latter pulls apart, as disclosed in Fig. 4, allowing the setting tool F and dump bailer C to be elevated away from the fully anchored packer A. Such elevating movement removes the upper end of the packer from its position closing the lower end of the dump bailer barrel 34, and allows the cementitious contents D of the barrel 34 to be deposited upon the set bridge plug (see Fig. 4). The contents D drop out of the barrel as the wire line E is elevated, in order to elevate the cylinder 49, which, in turn, will cause the lower head 48 to engage the piston 53 and elevate the latter, the piston rod 54, cross-piece 55, setting ring 40, setting sleeve 39, adapter ring 38a and barrel 34 to the extent at which assurance is had that all of the cementitious material in the barrel has been dumped upon the bridge plug A. This cementitious material will harden and form a cast plug within the well casing B on top of the bridge plug. The setting tool F and dump bailer C may now be removed from the well casing by elevating the wire line E.

It is, accordingly, apparent that a dump bailer and bridge plug apparatus has been disclosed which enbales a well packer or plug A to close the barrel 34 of the dump bailer C, and yet to be of such proportions as to be capable of resisting relatively high pressures when set in the well casing. The dump bailer C actually forms part of the mechanism F for setting the plug in the well casing. Its contents D are not released until the plug has been fully set in packed-off condition within the casing, inasmuch as the tension stud 46 does not part until this condition has been achieved. Such stud must part before the plug A can crease serving as a closure for the lower end of the dump bailer barrel 34. The mode of closing the lower end of the barrel permits the use of a plug having parts that do not require much lateral movement in obtaining their full expansion against the well casing. As a result, the plug parts may be made of more ample dimensions, with attendant increase in the strength of the plug itself. The plug preferably is made of readily drillable materials, to enable the hardened cementitious material D and plug A to be drilled out at a future time, if desired.

I claim:

1. In apparatus of the character described: a cylinder adapted to be lowered in a well bore on a wire line; a piston in said cylinder; means for developing a fluid force in said cylinder for operation upon said piston and cylinder; a container for cementitious material operatively connected to said piston and having an outlet; a plug body coaxial with said container; an abutment slidable along said body and engaging said outlet to close said outlet in conjunction with said body; normally retracted expansible means around said body engageable and actuatable by said abutment; and means including releasable instrumentalities operatively connecting said cylinder to said body, said instrumentalities when released freeing said cylinder from said body, whereby upward movement of said cylinder elevates said

container outlet from said abutment to open said outlet.

2. In apparatus of the character described: a cylinder member adapted to be lowered in a well bore on a wire line; a piston member in said cylinder member; means for developing a fluid force in said cylinder-member for operation upon said piston member and cylinder member; a container for cementitious material operatively connected to one of said members and having an outlet; a plug body coaxial with said container; an abutment slidable along said body and engaging said outlet to close said outlet in conjunction with said body; normally retracted expansible means around said body engageable and actuatable by said abutment; and means including releasable instrumentalities operatively connecting the other of said members to said body, said instrumentalities when released freeing said other of said members from said body, whereby upward movement of said cylinder member elevates said container outlet from said abutment to open said outlet.

3. In apparatus of the character described: a container for cementitious material adapted to be lowered in a well bore on a wire line and having an outlet; a plug body coaxial with said container; an abutment slidable along said body and engaging said outlet to close said outlet in conjunction with said body; normally retracted expansible means around said body engageable and actuatable by said abutment; means engaging said body and operatively associated with said container for shifting said body upwardly and said container downwardly to expand said normally retracted expansible means outwardly; said shifting means including a releasable connection operatively associated with said body, said connection when released freeing said shifting means from said body, whereby upward movement of said shifting means elevates said container outlet from said abutment to open said outlet.

4. In apparatus of the character described: a container for cementitious material adapted to be lowered in a well bore on a wire line and having an outlet; a plug body member coaxial with said container; an abutment member slidable

along said body member and engaging said outlet to close said outlet in conjunction with said body member; normally retracted expansible means around said body member engageable and actuatable by said abutment member; means engaging said body member and operatively associated with said container for shifting said body member upwardly and said container downwardly to expand said normally retracted expansible means outwardly; said shifting means including a releasable connection operatively associated with one of said members, said connection when released freeing said shifting means from said one of said members, whereby upward movement of said shifting means elevates said container outlet from said abutment member to open said outlet.

5. In apparatus of the character described: a container for cementitious material adapted to be lowered in a well bore on a wire line and having an outlet; a plug body member coaxial with said container; an abutment member slidable along said body member and engaging said outlet to close said outlet in conjunction with said body member; normally retracted expansible means around said body member engageable and actuatable by said abutment member; means engaging said body member and operatively associated with said container for shifting said body member and container longitudinally with respect to each other to expand said normally retracted expansible means outwardly; said shifting means including a releasable connection operatively associated with one of said members, said connection when released freeing said shifting means from said one of said members, whereby upward movement of said shifting means elevates said container outlet from said abutment member to open said outlet.

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