Dec. 14, 1954 C. WARE 2,696,886

CASING BRIDGING PLUG

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Fig. 1

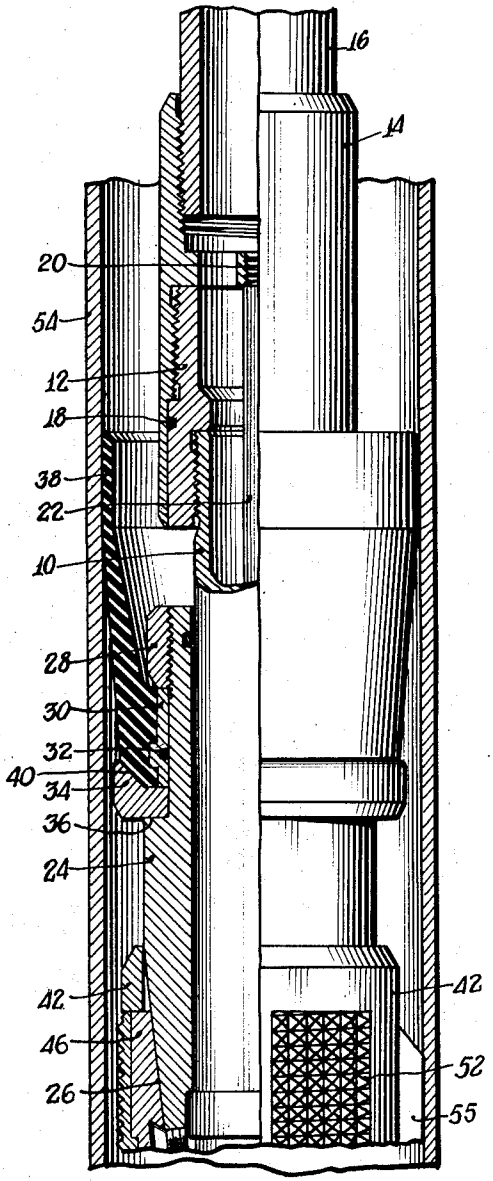


Fig. 1A

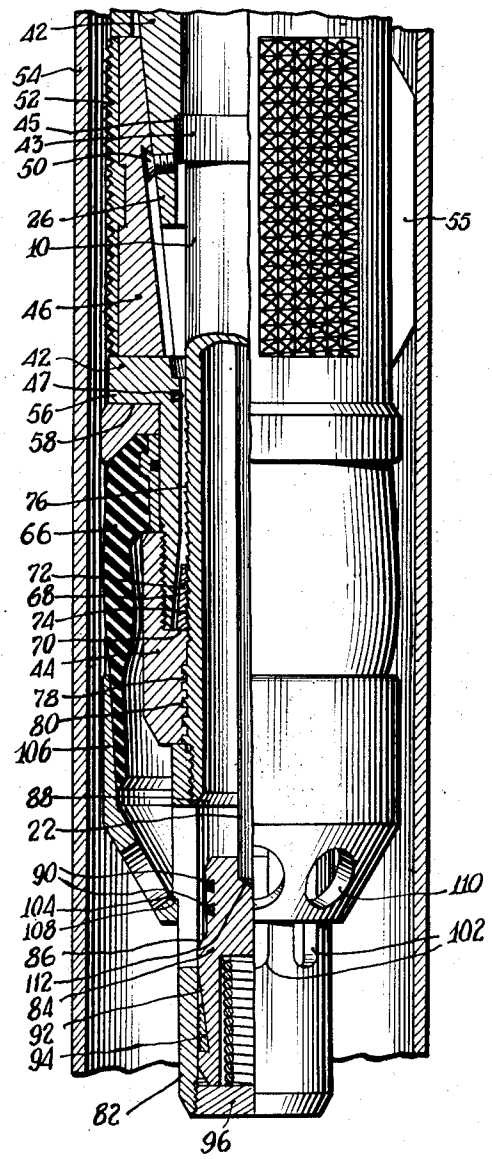


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Fig. 2

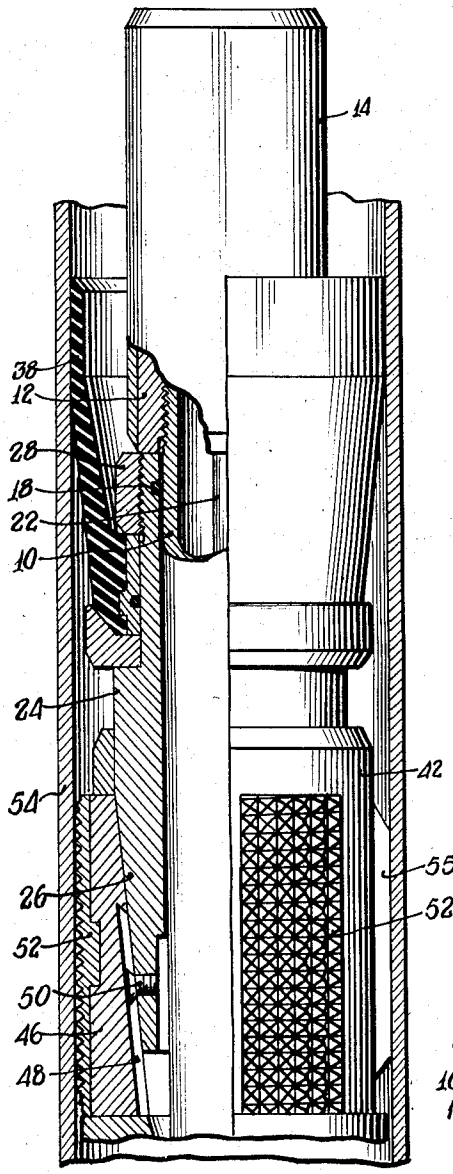



Fig. 2A

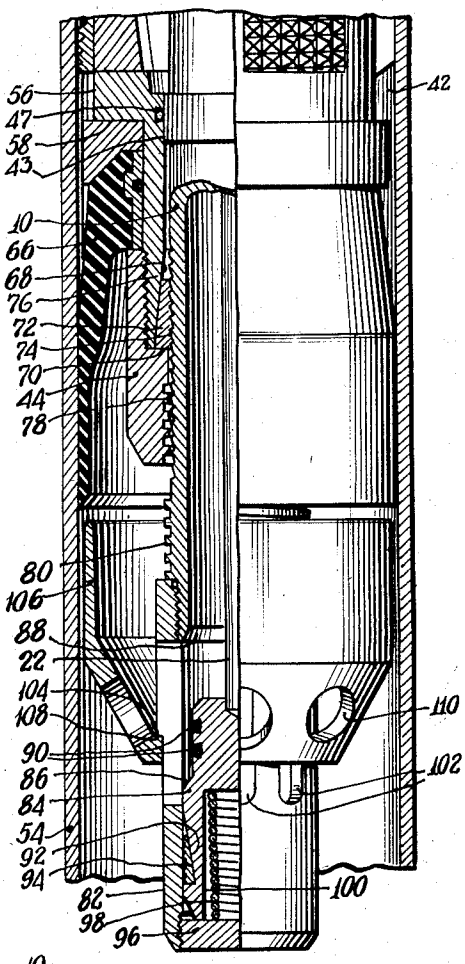
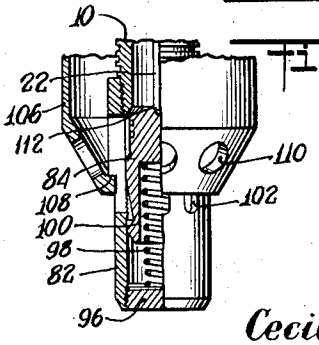



Fig. 3

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# CASING BRIDGING PLUG

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7 Claims. (Cl. 166—124)

This invention relates to a casing bridging plug for oil wells and more particularly to a bridging plug having improved packer means and embodying an improved arrangement of parts whereby setting of the device in the well is facilitated.

The invention has for an important object the provision of a bridging plug having upwardly and downwardly opening oppositely disposed cup-type packing elements, and including releasable means for preventing damage to the downwardly opening element caused by encountering irregularities in the well casing while the plug is being moved in the casing.

Another object of the invention is to provide a bridging plug embodying means for maintaining the plug in open condition to allow circulation of fluid therethrough, which means is operable upon setting of the plug and disconnection of the circulating tube therefrom to close the plug against upward circulation of fluid therethrough.

The invention may best be understood from the following detailed description of a preferred embodiment of the same when considered with the annexed drawings in which—

Figure 1 is an elevational view partly in cross-section showing the upper end of the bridging plug and the relationship of the parts thereof when the plug is inserted in the casing;

Figure 1–A is an elevational view partly in cross-section showing the lower end of the bridging plug under the same conditions as in Figure 1;

Figure 2 is a view similar to that of Figure 1, showing the relationship of the parts after the bridging plug has been set in the well casing;

Figure 2–A is a view similar to Figure 1–A, showing the bridging plug in set condition in the well casing; and

Figure 3 is an elevational view partly in cross section, showing a portion of the lower end of the bridging plug in closed condition after disconnection and removal of the circulating tube therefrom.

As shown in the drawings, wherein like reference numerals indicate like parts throughout the several views, the bridging plug has a tubular mandrel **10**, provided at its upper end with external threads by which the mandrel is attached to a safety coupling device comprising a lower member **12** and an upper member **14**.

The lower coupling member **12** is threaded internally at its lower end for the attachment of the mandrel **10** thereto and is externally threaded at its upper end for attachment to the upper coupling member **14**. The upper coupling member **14** is internally threaded for attachment to the lower coupling member, and for attachment at its upper end to the end of a tubular string of pipe indicated at **16** in Figure 1. Mediate its ends the lower coupling member may have an exterior groove **18**, for the reception of packing, such as an O-ring, to form a fluid seal with the inner surface of the upper coupling member. The upper coupling member is provided with an internal perforated web **20**, having a central threaded opening for the attachment thereto of a rod **22**, for a purpose later to be made apparent. The upper coupling member **14** has a cylindrical lower end portion which fits over the lower coupling member to form a fluid seal therewith by means of the groove **18** having an O-ring as previously described.

The above described coupling arrangement is intended to permit disconnection of the bridging plug from the tubular string should this be necessary.

A slip-expander or cone **24** surrounds the upper end



portion of the mandrel **10**, and is formed with a tapering lower portion **26**. At its upper end the slip expander is externally threaded for the attachment thereto of a top bushing **28**. A cup ring **30** surrounds the slip-expander **24**, which ring may be internally grooved, as at **32** to receive packing such as an O-ring to form a fluid seal between the expander and the ring. The ring **30** is held between the top bushing **28** and a top shoe **34** which surrounds the expander and engages an external shoulder **36** thereon.

An upwardly-opening cup-type packing element **38** surrounds the cup ring **30**, and the shoe **34** has a downwardly and inwardly tapering wall **40** which engages the lower portion of the packing element **38** to retain the same tightly in engagement with the cup ring. The cup ring may be molded into the resilient material of the packing element, so that the packing element may be placed in position on the expander by removing the top bushing **28**, slipping the shoe **34** and then the ring and packing element on the expander and then replacing the top bushing.

There is a slip cage **42** surrounding the mandrel **10**, which cage is externally threaded at its lower end for the attachment thereto of the internally threaded upper end of a bottom bushing **44**. Slips comprising slip blocks **46**, are disposed in openings at spaced intervals about the periphery of the slip cage, for lateral movement in the cage. The slip blocks have downwardly and inwardly tapered inner surfaces for engagement with a corresponding surface on the expander, whereby the slip blocks may be moved outwardly of the cage. Each of the slip blocks has a longitudinal groove **48** therein, which may be under cut to receive the head of a screw **50**, by which the slip block is moveably attached to the expander.

There is a ring **43** fixed on the mandrel **10** and engageable with an internal shoulder **45** on the expander **24** to prevent the downward movement of the expander and premature setting of the slips in engagement with the casing before the plug has been positioned in the desired location, and the mandrel and ring moved to the position seen in Figures 2 and 2–A.

An internal groove **47** is also provided in the slip cage for the reception of an O-ring or the like with which the ring **43** has sealing contact when in the position shown in Figure 2–A.

Slip inserts **52** are carried by the slip blocks, which inserts are outwardly toothed for engagement with the well casing, indicated at **54**, to anchor the bridging plug in the well. Friction blocks **55**, of conventional construction are also carried by the slip cage, and provided with means, not shown, whereby the friction blocks are urged outwardly into engagement with the well casing to resist turning of the bridging plug in the casing.

The slip cage **42** has a thickened portion **56**, mediate its ends providing a downwardly facing shoulder **58**. A cup ring **60** similar to the cup ring **30**, previously described, surrounds the slip cage, and this ring may also be internally grooved, as at **62** to receive packing such as an O-ring to form a fluid seal between the ring and the cage.

About the slip cage, in engagement with the shoulder **58** thereof, there is a bottom shoe **64**, similar to the shoe **34**, and the ring **60** is held between this shoe and the upper end of the bottom bushing **44**. A downwardly opening cup-type packing element **66** surrounds the cup ring **60** and is retained thereon by the aid of the bottom shoe **64** in the same manner as in the case of the packing element **38** on the ring **30**, previously described.

At its lower end the slip cage **46** has a downwardly and outwardly tapered inner wall portion **68** and the bottom bushing **44** is provided with an internal upwardly facing shoulder **70** forming a seat for an outwardly tapering locking nut **72** seated thereon inside the cage. The locking nut has inwardly directed internal teeth **74** thereon which mesh with opposed external teeth **76** formed on the tubular mandrel **10**, for a purpose later to be made apparent.

Internal threads **78** are also provided on the lower end of the bottom bushing **44** which intermesh with external threads **80** near the lower end of the tubular mandrel, in the condition of the plug shown in Figures 1 and 1–A.

A valve cage **82** is attached to the lower end of the tubular mandrel **10** by a suitable threaded connection, and carries therein a valve **84**, which has an external annular seat engaging portion **86**, adapted to seat on a valve seat **88** formed on the lower end of the mandrel. External annular grooves **90** may be provided in the valve **84** for the reception of packing such as O-rings to form a fluid seal between the tubular mandrel **10** and the valve. An exterior, downwardly-widening, tapered groove **92** is also formed in the valve **84**, in which an upwardly tapered valve lock is seated, which has external teeth **94** serving to grippingly engage the inside of the valve cage to resist downward movement of the valve therein, when the valve is in closed position, as best seen in Figure 3.

A removable plug **96** may be provided closing the lower end of the valve cage, for convenience in assembling the parts, and to form a seat for a resilient member **98** in the form of a coil spring which enters a recess **100** in the bottom of the valve, and is effective to urge the valve toward its closed position. Slotted openings **102** may also be formed in the valve cage to permit passage of fluid therethrough. About the valve cage, and operatively engageable with an external shoulder **104** thereon, there is a cup protector **106**, which is open at its upper end to receive the lower end of the packing element, when the plug is in the condition shown in Figures 1 and 1–A. The cup protector serves to depress the lower portion of the packing element **66** toward the mandrel **10**, so that the packing element will not be damaged by encountering irregularities in the casing when the plug is inserted therein. The cup protector has an inwardly directed portion **108**, which is engaged by the shoulder **104** of the valve cage upon downward movement thereof to move the protector downwardly and release the packing element **66**. Openings **110** are also formed in the cup protector for the passage of fluid therethrough.

In the condition of the bridging plug shown in Figures 1 and 1–A, the rod **22** extends downwardly from the safety coupling upper member **14** through the mandrel **10** and engages the valve **84** in a recess **112** therein, pressing the valve downwardly against the spring **98** to open position. The plug is inserted in the well in this condition, with the cup protector **106** over the open end of the packing element **66**, and the plug attached to the lower end of a tubular string of pipe **16**.

When the plug has been lowered to the desired depth, circulation may take place downwardly through the string **16** and through the plug, emerging through the openings **102** in the valve cage and openings **110** in the cup protector into the casing below the plug. Fluid may also pass upwardly in the casing about the plug past the packing elements **66** and **38**.

The plug may be set in the well by rotating the tubular string to uncouple the threads **80** of the mandrel **10** from the threads **78** of the bottom bushing **44**, the friction blocks **55** holding the slip cage against rotation. The mandrel may then be moved downwardly to engage the lower end of the coupling member **12** with the expander **24**, thereafter forcing the expander downwardly and moving the slips into anchoring engagement with the casing. Downward movement of the mandrel **10** also carries the valve cage **82** downwardly engaging the shoulder **104** thereof with the inwardly directed portion **108** of the cup protector, and moving the cup protector downwardly to release the packing element **66**, as seen in Figure 2–A. Circulation of fluid upwardly in the casing is then prevented by the packing element **66**.

As the mandrel **10** moves downwardly the teeth **74** of the tapered locking nut **72** slip past the teeth **76** of the mandrel, so that any upward movement of the mandrel will cause the nut to lock against the tapering wall **68** of the slip cage, and the tubular string may then be released from the plug by appropriate rotation to disconnect the safety coupling from the mandrel.

As best seen in Figure 3, upon removal of the tubular string from the plug, the rod **22** will be elevated with the string and the valve **84** will then be seated, closing the mandrel **10** so that circulation through the plug can no longer take place. When the valve moves upwardly into seated position the valve lock is carried upwardly therewith and grips the inside of the valve cage to prevent subsequent unseating of the valve by pressure in the casing from above the plug.

From the above description of the structure and manner of use of the invention it will be apparent that an improved bridging plug is provided, which can be readily inserted in the well, is capable of being easily manipulated to perform a number of different functions, and by which various well cementing operations can be conveniently carried out.

The invention has been disclosed in connection with one preferred embodiment of the same but it will be understood that this is intended by way of example only, and various modifications can be made in the construction and arrangement of the parts within the scope of the appended claims.

What is claimed is:

1. A bridging plug for wells comprising, a tubular member adapted to be connected to a string of pipe for movement with said string, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander around the member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith, said member being rotatable in the cage to release said connecting means and being movable downwardly in the cage when released therefrom, means on the cage frictionally engageable with the casing to hold the cage stationary in the casing during such rotation and downward movement of the member, means on the member engageable with the slip expander to move the expander downwardly with the member to expand the slips into gripping engagement with the casing to anchor the cage in the casing, packing means carried by the expander and the cage and engageable with the casing to seal the casing against the flow of fluid past the plug in either direction, a downwardly opening valve carried by the member, means carried by the member and cooperable with the valve and member to yieldingly move the valve toward a position to close said member, and means on the valve engageable with the member to hold the valve in said closed position.

2. A bridging plug for wells comprising, a tubular member, coupling means releasably connecting the member to a string of pipe for movement with the string and releasable by rotation of the string relative to the member, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander around the member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith, said member being rotatable in the cage to release said connecting means and being movable downwardly in the cage when released therefrom, means on the cage frictionally engageable with the casing to hold the cage stationary in the casing during such rotation and downward movement of the member, means on the member engageable with the slip expander to move the expander downwardly with the member to expand the slips into gripping engagement with the casing to anchor the cage in the casing, packing means carried by the expander and the cage and engageable with the casing to seal the casing against the flow of fluid past the plug in either direction, a downwardly opening valve carried by the member, yieldable means carried by the member and cooperable with the valve and member to urge said valve toward a position to close the member, means carried by the coupling means and engageable with the valve to hold the valve in open position and means carried by the valve and engageable with the member upon closing of the valve to retain the valve in closed position.

3. A bridging plug for wells comprising, a tubular member adapted to be connected to a string of pipe for movement with said string, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander around the member engageable with the slips and movable longitudinally of the cage to expand the slips, releasable means connecting the cage to the member for movement therewith, said member being rotatable in the cage to release said connecting means and being movable downwardly in the cage when released therefrom, means on the cage frictionally engageable with the casing to hold the cage stationary in the casing during such rotation and downward movement of the member, the slip expander to

move the expander downwardly with the member to expand the slips into gripping engagement with the casing to anchor the cage in the casing, an upper packing element on the expander and engageable with the casing to seal the casing against the flow of fluid downwardly between the plug and the casing, a lower packing element carried by the cage and engageable with the casing to seal the casing against upward flow of fluid between the plug and casing, said member having an internal valve seat a valve movably carried by the member and positioned for movement into engagement with the seat to close the member against flow of fluid through the member and out of engagement with the seat to open the member, means in the member releasably engageable with the valve to hold the valve in open position and releasable therefrom to permit movement of the valve into engagement with the seat and means carried by the valve and engageable with the member upon closing of the valve to retain the valve in closed position.

4. A bridging plug for wells comprising, a tubular member, coupling means releasably connecting the member to a string of pipe for movement with the string and releasable by rotation of the string relative to the member, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander around the member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith, said member being rotatable in the cage to release said connecting means and being movable downwardly in the cage when released therefrom, means on the cage frictionally engageable with the casing to hold the cage stationary in the casing during such rotation and downward movement of the member, means on the member engageable with the slip expander to move the expander downwardly with the member to expand the slips into gripping engagement with the casing to anchor the cage in the casing, an upper packing element on the expander and engageable with the casing to seal the casing against the flow of fluid downwardly between the plug and the casing, a lower packing element carried by the cage and engageable with the casing to seal the casing against upward flow of fluid between the plug and the casing, said member having an internal valve seat a valve movably carried by the member in position for movement into engagement with said seat to close the member and out of engagement with the seat to open the member, resilient means carried by the member and positioned to coact with the valve and member to urge the valve toward said seat, means on the valve engageable with the member upon closing of the valve to retain the valve in closing position and means carried by the coupling means and engageable with said valve and coupling means upon opening movement of the valve to hold said valve in a position opening the member.

5. A bridging plug for wells comprising, a tubular member, coupling means releasably connecting the member to a string of pipe for movement with the string and releasable by rotation of the string relative to the member, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander around the member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith, said member being rotatable in the cage to release said connecting means and being movable longitudinally in the cage in either direction when released therefrom, means on the cage frictionally engageable with the casing to hold the cage stationary in the casing during such rotation and longitudinal movement of the member in the cage, means on the member engageable with the slip expander to move the expander downwardly upon downward movement of the member in the cage to expand the slips into gripping engagement with the casing to anchor the cage in the casing, packing means carried by the cage and sealingly engageable with the casing, and means on the member engageable with the cage upon upward movement of the member in the cage to hold the member against rotation in the cage during rotation of the string to release said coupling means.

6. A bridging plug for wells comprising, a tubular member, coupling means releasably securing the member to a string of pipe for movement with the string, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander between the slips and tubular member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith, said releasable means being releasable upon rotation of the member in one direction to allow the member to move longitudinally relative to the cage when released therefrom, means on the member engageable with the expander to move the expander downwardly with the member to expand the slips into engagement with the well casing, packing means on the expander and on the slip cage and sealingly engageable with the casing and locking means carried by the tubular member and engageable with the slip cage upon upward movement of the member to lock the member against rotation in the cage, said coupling means being rotatable upon rotation of the string of pipe when the member is locked against rotation in the cage to release the coupling from the member, said member having an internal valve seat a valve carried by the tubular member and moveable to a closed position in engagement with the seat to close the member against flow of fluid through the member and to an open position out of engagement with the seat to open the member, and means carried by the coupling and engageable with the valve and coupling upon opening movement of the valve to hold the valve in open position.

7. A bridging plug for wells comprising, a tubular member, means releasably securing the member to a string of pipe for movement with the string, a slip cage around the member and slidable longitudinally relative thereto, casing-engaging slips carried by the cage and movable into and out of engagement with a surrounding well casing, a slip expander between the slips and tubular member and movable longitudinally of the cage to engage and expand the slips, releasable means connecting the cage to the member for movement therewith said releasable means being releasable upon rotation of the member to allow the member to move downwardly longitudinally relative to the cage when released therefrom, means on the member engageable with the expander to move the expander downwardly with the member to expand the slips into engagement with the casing, a downwardly opening cup-shaped packing element carried by the slip cage and sealingly engageable with the casing, sleeve means carried by the tubular member and initially engageable over the packing element to hold the packing element out of engagement with the casing, means on the member engageable with said sleeve means upon downward movement of the member in the cage to move said sleeve means downwardly to release said packing element, said tubular member having an internal valve seat, a valve movably carried by the tubular member and movable to one position to engage the seat to close the member against flow of fluid therethrough and to another position out of engagement with the seat to open the members to permit such flow, and means carried by the valve and engageable with the member and valve when the valve is closed to retain said valve in closed position.

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