Aug. 16, 1955 G. A. BOUVIER 2,715,441

BRIDGING PLUG

Filed May 24, 1951 3 Sheets-Sheet 1

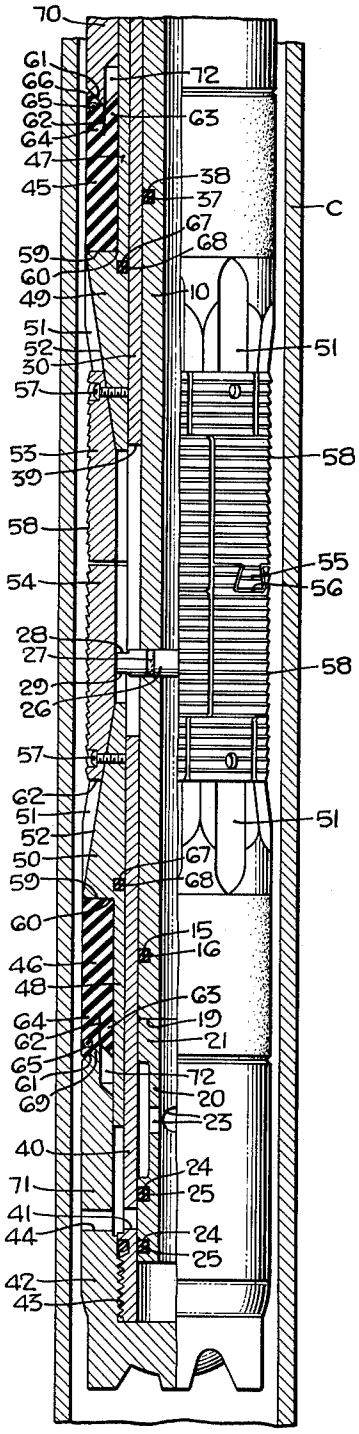

FIG. 1b.

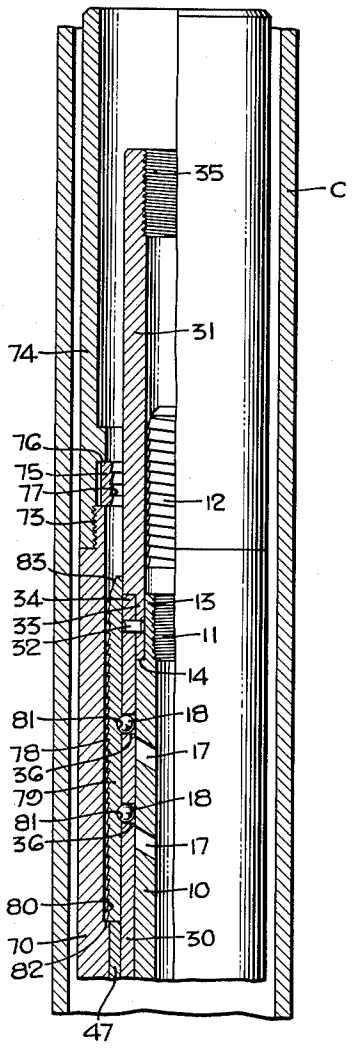

FIG. 1a.

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BRIDGING PLUG

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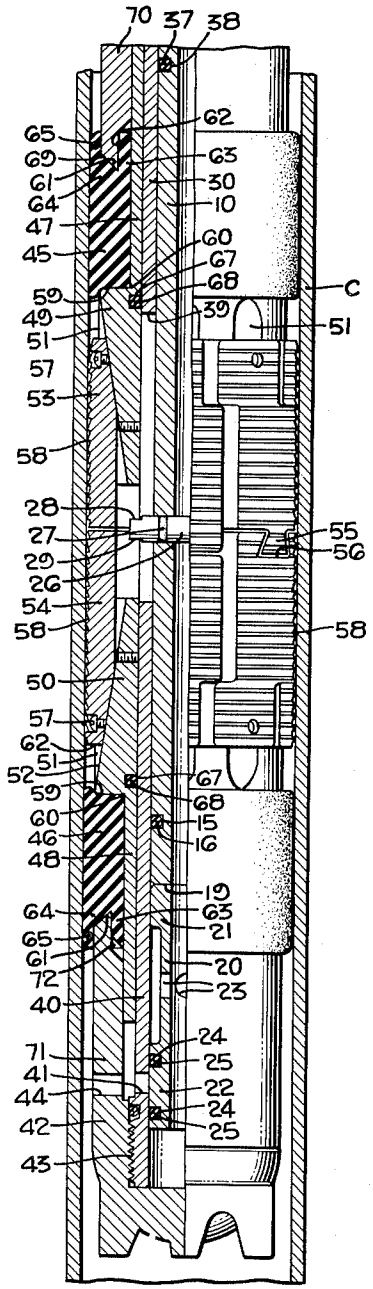

FIG. 2b.

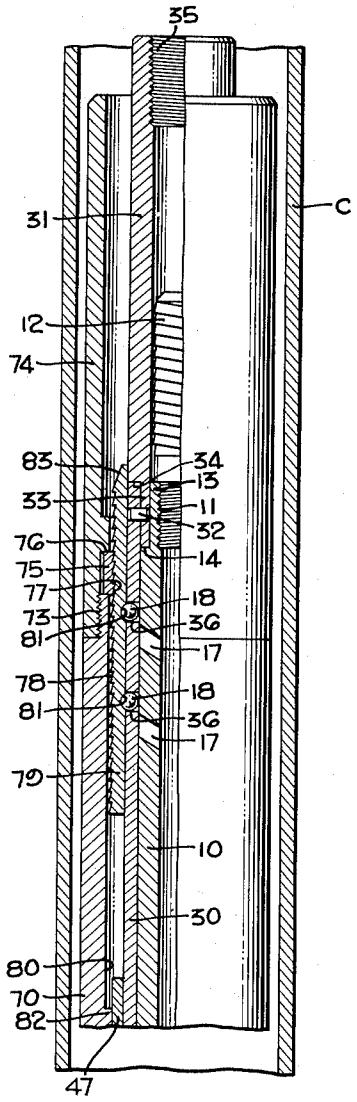

FIG. 2a.

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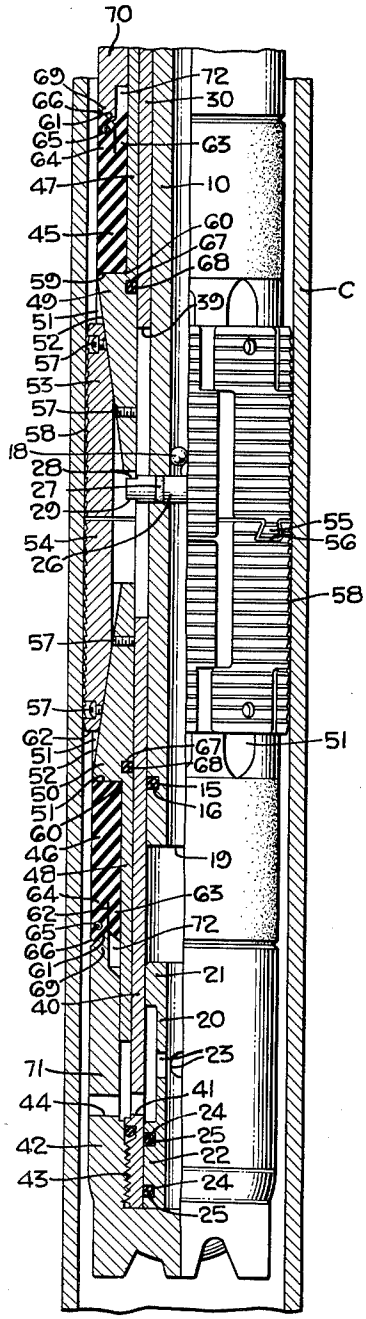

FIG. 3b.

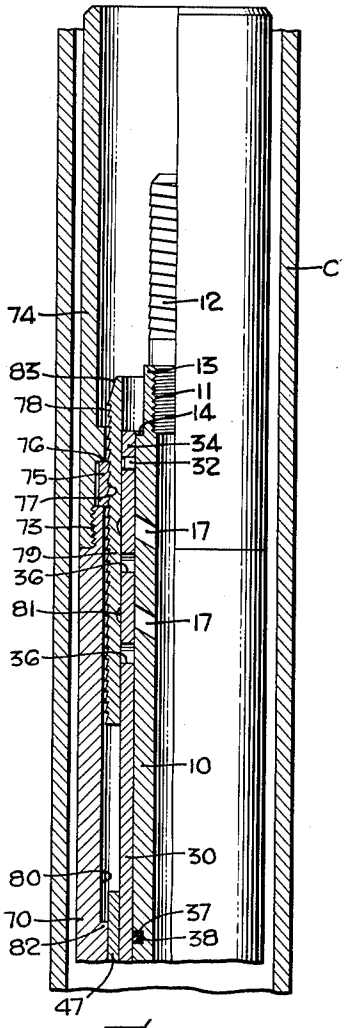

FIG. 3a.

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2,715,441

BRIDGING PLUG

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Application May 24, 1951, Serial No. 228,088

9 Claims. (Cl. 166—127)

This invention relates to bridging plugs for packing well boreholes and casings, and more particularly to retrievable bridging plugs which may be withdrawn from the borehole or casing after they have served their desired packing function.

Bridging plugs and like well packing devices have long been employed, particularly in the oil and gas well industry, for isolating predetermined well sections so that fluid may be drawn therefrom without contamination from other sections of the well. Frequently such devices are applied after a period of productive operation as, for instance, where an original section of a well has ceased to be sufficiently productive and where it is desired to put another section of the well on production. Since such procedure may be repeated a number of times throughout the total productive life of a well, such operations may involve several settings of successive bridging plugs and the destruction of the packing function of previously installed bridging plugs.

Heretofore, it has been common practice to destroy the previously located packer or bridging plug by a drilling operation Obviously such procedure is time-consuming and expensive, and the loss or destruction of the bridging plug represents a substantial item in the cost of operation.

Bridging plugs of the type now employed are usually characterized by the provision of rigid casing or borehole engaging slips or anchors which secure the plug in position, in addition to flexible packing elements which seal the well against fluid flow exteriorly of the plug. In the setting of such devices, the slips and packings are expanded outward against the casing or borehole as a result of relative longitudinal movement between certain parts thereof. As a consequence of such longitudinal movement of the parts of the bridging plug, primarily of the slips, during radial expansion, slippage friction is encountered, which not only tends to injure and in some instances destroy the efficiency of the slips and packing, but also requires the application of undesirable forces before full and efficient setting and sealing of the plug are accomplished. Where the release of the bridging plug from its setting instrumentality is force-responsive, it will be evident that in some instances the predetermined releasing force may be required in resisting the aforementioned friction before setting is fully accomplished, and in some cases the plug will be released in only partially set position so that fluid leakage past the plug may ensue.

It is, accordingly, an object of the present invention to provide a bridging plug in which many of the undesirable and limiting features, heretofore prevalent in bridging plugs and the like packer apparatus, have been eliminated.

More specifically, it is among the objects of the present invention to provide a novel and improved bridging plug which, after having been set in a well, may be readily and quickly released and retrieved from the well. In accomplishing this objective, the construction and arrangement of the present plug are such that no parts need be destroyed or detached in releasing the bridging plug from its set condition, and no subsequent operations are required for withdrawing parts or broken fragments, nor is any drilling operation required to restore the well bore or casing to its original obstruction-free condition.

A further object of the invention is to provide a new and improved bridging plug in which the operating movements of the slips and/or the flexible packing elements in setting and releasing the plug are substantially radial so as to minimize coincidental longitudinal frictional dragging movement of the slips or packers against the well bore or casing during the setting operation and thus to avoid consequent damage to the slips or packers and premature release of the plug from its setting device.

Another and principal object of the invention is to provide a bridging plug which may be released and retrieved from a well bore by means of standard wire line fishing tools, and such release and recovery can be accomplished relatively quickly and inexpensively.

These and other objects, advantages, and features of novelty will be evident hereinafter.

In the drawings, which show, by way of illustration, a preferred embodiment of the invention, and in which like reference characters designate the same or similar parts throughout the several views:

Figures 1*a* and 1*b* are longitudinal views, partly in section, of the upper and lower joined portions of the bridging plug assembly as it appears just prior to being set in a well borehole or casing;

Figures 2*a* and 2*b* are views of the apparatus of Figures 1*a* and 1*b*, showing the bridging plug after being set in a well casing; and

Figures 3*a* and 3*b* are views of the apparatus of Figures 2*a* and 2*b*, showing the arrangement of parts of the bridging plug just after the initial releasing step preparatory to its withdrawal from the casing.

The apparatus, as adapted for use in a well casing, is as follows:

A central, open-ended, tubular ram **10** is provided, having internal threads **11** at the upper end thereof, which receives in threaded engagement therewith an externally wickered extension **12**, the external diameter of which is less than the external diameter of the main body of the ram. The upper end portion of the ram **10** is of reduced external diameter, as shown at **13**, thereby forming shoulder **14**. Below the shoulder **14**, the ram **10** is formed with a uniform cylindrical external surface which extends nearly the full length of the tool but terminates in a lower open end **19**. Suitable annular packing grooves may be provided in the external surface of the ram, as indicated by the circumferential groove **15**, in which may be located packing rings, such as the O ring shown at **16**. A plurality of sets of circumferentially spaced, upwardly diverging passages **17** extend through the wall of the ram at a location a short distance below the shoulder **14**, to provide for release and escape of mandrel-securing or locking balls **18** in a manner hereinafter more fully described. The lower, open end **19** of the tubular ram **10** is, in the operation of the device, adapted to make abutting engagement with the upper open end of a sleeve valve element **20** in a manner to balance internal and external fluid pressures, as hereinafter described.

The sleeve valve element **20** is provided with upper and lower annular terminal lands **21** and **22**, respectively, of external diameter conforming to that of the body of the ram **10**. Between the lands **21** and **22** of the valve **20**, ports **23** are provided extending through the wall to the interior passage of the valve **20**. A pair of annular packing grooves **24** and O rings **25** are arranged on the

circumferential surface of the lower land 22 and in the position shown in Figures 1*b* and 2*b* straddle the port 41 to seal it off from the interior of the valve 20 and the interior of the plug ram 10. It may be noted that, since the ram 10 and valve member 20 are initially in engagement only by end-to-end contact, the ram may partake of vertical movement independently of the valve member, but may actuate the valve by movement in a downward direction. As indicated in Figures 1*b* and 2*b*, the valve 20 is in its upper position abutting the lower end 19 of the ram 10 when the plug is lowered into position and while the plug is set in the casing in packing position. As noted in Figure 3*b*, the valve is forced to its lower position when the ram is moved downwardly relative to the body of the plug in preparation for retraction and release of the elements of the plug.

Intermediate the ends of the ram 10, a transverse pin 26 extends through diametrally opposite apertures in the ram wall. Sealing rings 27 serve to form a fluid seal between the pin and the ram walls. The outer ends of the pin 26 are formed with upper and lower, flat actuating surfaces 28 and 29, respectively, which are adapted to be brought into contact with the inner ends of the slip cones, in a manner to be described hereinafter, to release the same, and upon withdrawal of the tool the upper surface 28 applies the retrieving force.

Slidably mounted on the ram is a mandrel 30 of tubular form, its internal diameter conforming to the external diameter of the ram so as to provide a running fit of the ram within the mandrel. The upper end of the mandrel 30 is releasably secured to a tubular setting tool adapter 31 through the medium of a plurality of radial shear pins 32. The lower end of the adapter 31 has a sleeve portion 33 of reduced external diameter fitting within the top portion 34 of the mandrel 30 and through which the shear pins 32 are set. The sleeve portion 33 of the adapter 31 also fits over the before-mentioned reduced portion 13 of the ram 10 and in abutment with the shoulder 14 thereof. The upper end portion of the setting tool adapter is internally threaded at 35 to receive an actuating member of a setting tool (not shown). In close proximity to, but normally spaced longitudinally from, the before-mentioned escape passages 17 of the ram 10, the wall of the mandrel is provided with a plurality of radial ball-retaining apertures 36 extending therethrough in which the lock balls 18 are normally retained in locking engagement with shallow annular grooves 81 formed on the inside surface of a latch sleeve 79. It is to be understood that the apertures 36 constitute two spaced sets of ball receivers equal in number and circumferential spacing and arrangement to the passages 17 of the ram 10. The lock balls 18 are of greater diameter than the thickness of the wall of the mandrel by an amount equal to the depth of the grooves 81, as a result of which the balls 18 are held in locking engagement with the grooves 81 by the ram 10.

The internal surface of the mandrel is sealed with respect to the external surface of the ram by the use of an O ring 37 mounted in an internal circumferential groove 38. Obviously, any desired number and arrangement of grooves and O rings, such as shown at 37 and 38 and at 15 and 16, may be provided. Intermediate the ends of the mandrel 30, a pair of longitudinal slots are provided, as shown at 39, through which the pins 26 extend. The slots 39 are of sufficient width and length to permit reception of the pins 26 and to permit sliding movement of the pins lengthwise of the slots. It will be noted that the thickness of the mandrel 30 in relation to the extension of the cylindrical portions of the pins is such as to provide for the projection of the heads of the pins with their flat surfaces 28 and 29 outwardly from the external surface of the mandrel.

The lower end 40 of the mandrel 30 is ported, as shown at 41, to provide communication with the ports 23 of the sleeve valve 20 when the sleeve valve is in its lowermost position. The lower end of the mandrel is closed by a bull plug 42 threaded thereon, as indicated at 43. The bull plug is ported, as shown at 44, in registration with the ports 41 to permit equalization of pressure above and below the plug when the valve is open. (See Figure 3*b*).

The casing or well bore engaging and packing structure of the present bridging plug comprises a pair of similar but oppositely facing sets of anchoring means, sealing packing elements, and actuating devices. Each set comprises a sleeve or annular shaped, resilient packing element, a slip cone and a group of slips on the cone. The upper and lower one of said elements 45 and 46, respectively, are mounted upon sleeve members 47 and 48 extending outwardly from the base ends of their respective cones 49 and 50. The upper and lower cones are disposed in longitudinally spaced and oppositely arranged relation on the external surface of the mandrel 30 and are free to slide longitudinally thereover during the setting and releasing operations. Each cone is provided with a set of longitudinally extending, circumferentially spaced, dovetailed, slip-receiving grooves indicated at 51, the base surfaces 52 of which are inclined laterally with respect to the axis of the plug to provide for radial movement of the slips when the cones move longitudinally with respect thereto. The upper group of slips, here shown as comprising six in number, are identified by the numeral 53, while the like-numbered companion group of lower slips are identified by the numeral 54. The lower or base end of each upper slip 53 is provided with a downwardly directed dovetail extension 55, which engages within a conforming dovetail recess 56 in the upper or base end of the subjacent lower slip 54. In this manner, the slips are joined together in base-to-base abutment with one another to constitute substantially a single casing-engaging means but comprising independently operable, articulated sets of slips insofar as radial displacement thereof is concerned.

As will be noted from the drawings, each slip is substantially L-shaped in external elevational view, providing an interlacing relation between adjacent slips of each set. As indicated, each slip is temporarily secured to its cone by a shear screw 57, the packer being thus held in its original unset position as shown in Figures 1*a* and 1*b* during transportation and positioning of the plug in the well prior to its setting. At the beginning of the setting operation, the relative sliding movement of the cones with respect to their slips, shears the screws 57, permitting continued relative longitudinal sliding movement to force the slips radially outward against the well casing C, the wickers 58 of the slips thereby being forced into engagement with the well casing C to anchor the plug in position and to preclude longitudinal movement thereof.

Each of the packing elements 45 and 46 is provided with an inwardly facing, squared end 59, which abuts a squared shoulder 60 formed at the base end of the slip cone or at the juncture of the head of the slip cone and its cylindrical extension. The opposite outer ends of the packing elements are each formed with an inwardly extending V groove, the apex 61 of which communicates with a coaxial, longitudinally extending slit 62 which forms relatively movable inner and outer flexible lips 63 and 64, respectively. An encircling spring ring 65 is embedded in the outer extremity of the outer lip 64 to restrain the outer lip against accidental expansion or outward flaring displacement during movement of the plug through fluid in the well. The outer lip 64 of each packing element is also provided with a bevel 66 in order to avoid a sharp or feathered edge which might engage the well bore or casing and cause premature setting and possible damage to the sleeve during the running of the plug into the well. The inner surfaces of the packing elements snugly fit the external surfaces of the cylindrical extensions 47 and 48 of the slip cones.

As hereinbefore noted, the slip cones **49** and **50**, with their integral cylindrical extensions **47** and **48**, are mounted for longitudinal sliding movement upon the mandrel **30**, grooves and O rings **67** and **68**, respectively, being provided in the bores of the slip cone bodies to seal the same with respect to the mandrel. The packing elements **45** and **46** are actuated, and through them the associated cone elements are moved, by upper and lower packing expander sleeves **70** and **71**, respectively, the upper and lower circumferential beveled actuating surfaces **69** thereof being in registration and pressed in abutment with the inwardly slanting end surfaces of the outer lips **64** of the packing elements. Inwardly of each beveled surface **69**, the ends of the expander sleeves **70** and **71** are counterbored, as shown at **72**, to provide annular recesses between the expander sleeves and the mandrel for receiving the inner lips **63** of the packing elements when the packing elements are compressed longitudinally.

The lower packing expander sleeve **71** is formed as an integral, upward extension of the bull plug **42**, and is thus rigidly secured to the mandrel **30** and moves therewith. The upper end of the upper expander sleeve **70** is provided with an externally threaded portion **73**, which is coupled to the lower internal threads of an expander extension sleeve **74**.

In an annular recess formed between the upper end of the upper packing expander sleeve **70** and an inwardly extending shoulder **76** of the extension **74** is contained a split latch ring **75**. The inner surface of the latch ring **75** is formed with upwardly facing, helical wickers or buttress threads, as shown at **77**, which are adapted to engage external, downwardly facing wickers or buttress threads **78** formed on the exterior surface of the beforementioned latch sleeve **79**, which in turn is longitudinally slidable within a counterbore **80** formed in the upper end of the upper packing expander sleeve **70**. The latch sleeve **79** normally slides longitudinally within the upper packing expander sleeve together with the mandrel **30** by virtue of the locking engagement therebetween formed by the lock balls **18** seating within the annular grooves **81** of the latch sleeve and the apertures **36** in the mandrel. In such position of the sleeve, when locked by the balls **18** and while the plug is unset, as shown in Figures 1*a* and 1*b*, its lower end rests upon shoulder **82** at the end of the counterbore **80** of the expander sleeve **70** and upon the upper end of the cylindrical extension **47** of the upper slip cone member **49**, as shown. At the upper end of the latch sleeve **79**, a bevel **83** is formed to assist in guiding the sleeve through the split latch ring **75** when the plug is set.

When the bridging plug of the present invention is to be lowered into a well bore or the well casing C, the parts are arranged in the manner shown in Figures 1*a* and 1*b*. The packing expander sleeves **70** and **71** are fully separated, the packings **45** and **46** are relaxed, and the slips **53** and **54** are retracted, their adjacent ends being interlocked as before described, while their opposite, tapered ends are disposed upon the inclined surfaces **52** of the actuating grooves **51** of the slip cones **49** and **50**. The slips and cones are retained in this relationship during the "running-in" operations by the use of the shear screws **57**. It will be noted that, in this position, the mandrel **30**, with its expander sleeve **71**, is in its fully extended position with respect to the upper packing expander sleeve **70** and its adapter extension **74**.

In the use of the device, the setting tool adapter **31**, to which the tubular mandrel sleeve **30** is secured by the shear pins **32**, is attached to the inner, upwardly movable tension element of a suitable setting tool such as that hereinafter mentioned, while extension **74** of the upper packing expander **70** is placed in abutment with an outer and downwardly movable compression element of the same setting tool. Setting tools of a wide variety of types and variously actuated may be employed in the use of the present invention. While explosive, fluid pressure, or mechanically powered setting tools may be employed, one particularly adaptable setting tool is illustrated in United States Patent No. 2,326,404, in which a fluid pressure actuated cylinder and piston are employed. When such a setting tool is employed, the extension **74** is placed in end-to-end contact with a cylinder, shown at **12** in the patent, while the adapter **31** is attached to the central pull rod shown at **13** in the said patent, the attachment usually being through a suitable shear pin or frangible rod connection to release the connection and limit the setting force applied to the plug. An example of a suitable force limiting connection which may be threaded into the adapter **31** is shown at **16**, **17** of the Patent No. 2,382,770. Obviously, various other conventional types of connecting means may be employed, and such connection may be direct, or the setting tool may, if desired, be located in the well string some distance above the plug. Since various actuating instrumentalities and connecting means may be employed, no particular type is here disclosed; each has its own advantages, and all are commonly known in the art and familiar to those skilled therein. Suffice it, therefore, to say that the extension **74** and the adapter **31** are suitably secured to a setting tool which, upon operation, will move the extension **74** and the adapter **31** longitudinally relative to one another. Preferably, such movement is equal and opposite with respect to the plug as a whole.

When the plug, with the parts in the relative positions shown in Figures 1*a* and 1*b*, is connected with a setting tool, it is lowered into the well bore or casing upon the setting tool to the point where the bridging or pack-off is desired. When it is desired to set the plug, the setting tool is actuated in such manner as to force the extension **74** downwardly and simultaneously therewith lift the adapter **31** upwardly. Such relative, equal and opposite movement of the extension **74** and adapter **31** first causes a longitudinal compression of the packings **45** and **46**. Since both the cones **49** and **50**, with their cylindrical extensions **47** and **48**, are free to slide longitudinally upon the surface of the mandrel **30**, and since the inner end of each packing element bears against the shoulder **59** formed between its conical portion and its cylindrical extension, the longitudinal pressure applied to the packing elements will be delivered to the cones. Some preliminary expansion of the packers, resisted by engagement thereof with the casing C, may take place prior to longitudinal movement of the cones. Initially, relative movement of the cones is precluded by the shear screws **57**, which secure the slips to the cones. However, upon the exertion of a predetermined force, the screws **57** are sheared, permitting the cones to move toward each other. By virtue of the seating of the slips within the sloping grooves **51** of the slip cones, such relative movement of the slip cones toward each other will force the slips outwardly in a radial direction into gripping engagement with the well casing and thus securely anchor the plug.

Among the important features of operation of the present invention is the fact that, since the sets of slip cones are moved longitudinally toward each other equally and oppositely with respect to the position of the plug, the movement of the slips, as an incident to such relative motion, is purely radial, without longitudinal movement thereof with respect to the well bore or casing. Similarly, the expansion of the packing elements, both preliminarily, as just referred to, and finally, as will now be described, is primarily radial, with a minimum of longitudinal movement relative to the inside surface of the casing. Obviously, such freedom from longitudinal movement of the slips relieves the slips and packing elements from friction and wear and permits a full and efficient setting operation with minimum exertion of setting forces and without substantial movement from a predetermined location in the casing.

Another important feature of the invention is the use of separate but articulately joined sets of upper and lower

slips. By such arrangement of the slips, independent freedom of movement between the articulated slips of each set is permitted, as well as independent freedom of action between the articulated sets of slips. Thus, the slips may move in conformity with varying surface conditions of the well bore or casing.

As the setting operation is completed by the continued longitudinal movement of the extension **74** and the adapter **31** relative to one another, the slips are forced radially outward to engage the well bore or casing until such radial movement is prevented by such engagement, whereupon continued movement of the slip cones is blocked, and further movement is taken up by further expansion of the packing sleeves, which are thereby deformed and expanded outwardly into sealing engagement with the surrounding casing to positively preclude passage of well fluid in either direction past the plug. It will be noted that in the setting movement, the ram **10** and the valve **20** are carried upwardly with the mandrel **30** due to the frictional relation therebetween, and thus the position of the passages **17** relative to the balls **18** will not be changed during the before-described setting operation, nor will the position of the valve **20** with respect to the ports **41** and **44** be altered. It will be understood, of course, that the setting forces required will not be sufficient to shear the pins **32**, and thus the mandrel **30** will move upwardly with the adapter **31**. During such movement, the balls **18** remain in locking engagement with the annular grooves **81** in the latch sleeve **79** to carry the sleeve upwardly with the mandrel. As a result of such motion, the wickered or threaded latch ring **75** and the latch sleeve **79** are ratcheted together into latching engagement with one another with the result that opposite movement of the sleeve and latch ring relative to one another is thereafter prevented by engagement between the wickers or threads, and, upon completion of the setting of the plug, the coupling between the expander sleeves **70** and **71** through the latch ring **75**, latch sleeve **79**, and mandrel **30** retains the plug in set position until releasing action takes place, as hereinafter described.

The setting operation is terminated when the resistance to further radial expansion of the slips and packing elements, by engagement with the surrounding casing C, exceeds the shearing strength of the sheer pins **32**, thereby releasing the mandrel **30** from the tool adapter sleeve **31**. Thereafter the setting tool to which the plug was attached, together with the adapter sleeve **31**, is free to be removed, leaving the plug in set condition, the setting of the plug being maintained by the retention of the parts in set position through the interengagement of the wickers or threads of the split latch ring **75** and the latch sleeve **79**.

When it is desired to release the plug to retrieve it from the well, an overshot tool is run into the well on either pipe or a wire line or cable, such tool having jaws which will pass down over and grippingly engage the wickers of the extension **12** of the ram **10**. For releasing the plug, the overshot, suitably weighted or provided with suitable jars if lowered on a wire line, is first moved downwardly to force the ram **10** downwardly within the tubular mandrel **30**, whereby the valve **20** is also moved downwardly within the lower end of the mandrel **30** to a position where the ports **44** and **41** of the bull plug and mandrel are in communication with the ports **23** of the valve **20**, as shown in Figure 3*b*, thus permitting equalization of well pressures above and below the bridging plug by flow of fluid in either direction through the passage extending through the ram **10**. After such pressure equalization has been made, the ram **10** is lifted by the overshot tool upwardly within the mandrel **30** to a position where the escape passages **17** are brought opposite the lock apertures **36**, permitting the lock balls **18** to move out of locking engagement with grooves **81** in latch sleeve **79** and drop therefrom through the escape passages **17** to the bottom of the plug, thus releasing the latch sleeve **79** from the mandrel **30**. Upon such release of the latch sleeve, the setting sleeves **70** and **71** are free for relative movement longitudinally away from one another, under which condition the plug and packing elements will assume the positions shown in Figures 3*a* and 3*b*. Continued upward movement of the arm **10** carries the face **28** of the pin **26** upward into engagement with the lower end of the upper slip cone **49**, forcing the upper cone to move upwardly from under the upper slips **53**, permitting the slips to disengage the well casing. After such release of the upper slips, the lower cone may be similarly but oppositely moved by downward movement of the ram **10** sufficient to bring the surface **29** of the pin **26** down against the upper end of the lower slip cone **50** to drive the cone **50** downwardly out from under the lower slips **54**. If desired, this procedure may be reversed, first releasing the lower cone **50** and then the upper cone **49**, in the manner just described. After the release of both slip cones, the ram **10** may then be further raised, bringing the pin **26** up against the lower end of the slip **49** and continuing this upward motion until the slips **53** have moved down their dovetailed grooves in the slip cone **49** to their lowermost positions, at which point they will jam against the outer end of pin **26** and remain suspended from the lower end of the slip cone. Further upward movement will carry the lower slips **54**, which are suspended from the upper slips by the dovetailed connections shown at **55**, **56**, upward out of engagement with the casing, after which the plug is free to be retrieved from the well borehole by continued upward movement of the overshot tool.

While the bridging plug of the present invention is primarily intended to be retrieved in the manner described, nevertheless the parts are arranged and designed to be made of soft metal, such as brass or cast iron, so as to provide for the removal of the plug by drilling, if necessary.

As the plug is retrieved by upward pull from an overshot tool after release of the slips and packings in the manner hereinbefore described, the entire assembly is free to move upwardly together without breakage of any parts or detachment thereof. Thus the plug is fully retrievable as a whole and may be repeatedly used. After being retrieved, it is only necessary to replace the parts in the positions shown in Figures 1*a* and 1*b* and reinsert the shear pins **32** and the slip shear screws **62** after relocating the lock balls **18** in their grooves **81**.

It is to be understood that the foregoing is illustrative only, and that the invention is not limited thereby, but may include various changes and modifications within the scope of the present claims.

What is claimed is:

1. Apparatus of the character described, comprising in combination: a mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel with the apex ends thereof adjacent one another; a sleeve member extending coaxially from the base end portion of each of said slip cones; an annular packing element on each of said sleeve members; slips carried by each of said cones, said slips on opposite ones of said cones being positioned in base-to-base abutment with one another and thereby adapted to be moved radially together into contact with a surrounding casing upon longitudinal movement of said slip cones toward one another on said mandrel; annular packing expanding means slidably mounted on said mandrel, engageable with one end of one of said packing elements; annular packing expanding means fixed to said mandrel, engageable with one end of the other of said packing elements; means to move the slidably mounted packing expanding means on said mandrel toward the fixed packing expanding means to expand said packing elements and to move said slip cones toward one another on said mandrel to set said slips; and releasable locking means to lock said slidable packing expanding means to said mandrel against

retrograde movement therein when said packing means and slips are in set position.

2. Apparatus of the character described, comprising in combination: a mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel with the apex ends thereof adjacent one another; a sleeve member extending coaxially from the base end portion of each of said slip cones; an annular packing element on each of said sleeve members; slips carried by each of said cones, said slips in opposite ones of said cones being positioned in base-to-base abutment with one another and thereby adapted to be moved radially together into contact with a surrounding casing upon longitudinal movement of said slip cones toward one another on said mandrel; annular packing expanding means slidably mounted on said mandrel, engageable with one end of one of said packing elements; annular packing expanding means fixed to said mandrel, engageable with one end of the other of said packing elements; means to move the slidably mounted packing expanding means on said mandrel toward the fixed packing expanding means to expand said packing elements and to move said slip cones toward one another on said mandrel to set said slips; releasable locking means to lock said slidable packing expanding means to said mandrel against retrograde movement therein when said packing means and slips are in set position; and releasing means longitudinally slidably contained in said mandrel to effect release of said locking means.

3. Apparatus of the character described, comprising in combination: a mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel with the apex ends thereof adjacent one another; a sleeve member extending coaxially from the base end portion of each of said slip cones; an annular packing element on each of said sleeve members; slips carried by each of said cones, said slips on opposite ones of said cones being positioned in base-to-base abutment with one another and thereby adapted to be moved radially together into contact with a surrounding casing upon longitudinal movement of said slip cones toward one another on said mandrel; annular packing expanding means slidably mounted on said mandrel, engageable with one end of one of said packing elements; annular packing expanding means fixed to said mandrel, engageable with one end of the other of said packing elements; means to move the slidably mounted packing expanding means on said mandrel toward the fixed packing expanding means to expand said packing elements and to move said slip cones toward one another on said mandrel to set said slips; releasable locking means to lock said slidable packing expanding means to said mandrel against retrograde movement therein when said packing means and slips are in set position; releasing means longitudinally slidably contained in said mandrel to effect release of said locking means; and means movable by said releasing means into engagement with the apex ends of said cones to move said cones longitudinally in opposite directions on said mandrel tending to release said slips.

4. Apparatus of the character described, comprising in combination: a mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel; a pair of annular packing elements on said mandrel, each packing element abutting the base end of one of said slip cones; slips carried by each of said cones, said slips extending between said slip cones in rear end abutment with one another to transfer longitudinal force therethrough from one slip cone to the other; a first expander sleeve fixed to said mandrel and positioned in abutment with the outer end of one of said packing elements; a second expander sleeve slidably mounted on said mandrel, engageable with the outer end of the other of said packing elements to expand said packing elements and set said slips; releasable locking means to lock said second expander sleeve in set position upon said mandrel; and means slidable within said mandrel to effect release of said locking means and said slips and permit said packing elements to contract, said last means including means selectively engageable with said slip cones by longitudinal motion thereof relative to said mandrel, to move said cones to slip-disengaging positions.

5. Apparatus of the character described, comprising in combination: a mandrel; a pair of spaced slip cones slidably mounted on said mandrel; a pair of packing elements on said mandrel, each packing element abutting the base end of one of said slip cones; slips carried by each of said slip cones; a first expander sleeve fixed to said mandrel and positioned in abutment with the outer end of one of said packing elements; a second expander sleeve slidable on said mandrel and engageable with the outer end of the other of said packing elements to expand said packing elements and said slips upon movement thereof on said mandrel toward said first expander sleeve; releasable locking means to lock said second expander sleeve against retrograde movement on said mandrel relative to said first expander sleeve with said slips in set position and said packing elements expanded, said locking means including a latching sleeve on said mandrel and a coacting interlockingly coengageable latch ring on said second expander sleeve; releasable means releasably securing said latching sleeve against longitudinal movement on said mandrel; and means to release said releasable means thereby releasing said latching sleeve for longitudinal movement on said mandrel.

6. Apparatus of the character described, comprising in combination: a tubular mandrel; a pair of spaced slip cones slidably mounted on said mandrel; a pair of packing elements on said mandrel, each packing element abutting the base end of one of said slip cones; slips carried by each of said slip cones; a first expander sleeve fixed to said mandrel and positioned in abutment with the outer end of one of said packing elements; a second expander sleeve slidable on said mandrel and engageable with the outer end of the other of said packing elements to expand said packing elements and said slips upon movement thereof on said mandrel toward said first expander sleeve; releasable locking means to lock said second expander sleeve against retrograde movement on said mandrel relative to said first expander sleeve with said slips in set position and said packing elements expanded, said locking means including a latching sleeve on said mandrel and a coacting interlockingly coengageable latch ring on said second expander sleeve; releasable means releasably securing said latching sleeve against longitudinal movement on said mandrel; means to release said releasable means thereby releasing the latching sleeve for longitudinal movement on said mandrel, said means to release including a tubular ram longitudinally movable within said mandrel and initially attached thereto; a pressure equalizing port in the wall of said mandrel; and a valve for said port in said mandrel, said tubular ram being operable to actuate said valve to open position to place said port into communication with the interior of said ram.

7. Apparatus of the character described, comprising in combination: a tubular mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel with their apex ends adjacent; a pair of packing elements on said mandrel, each packing element abutting the base end of one of said slip cones; slips carried on said slip cones, said slips extending between said slip cones in rear end abutment with one another to transfer longitudinal force therethrough from one of said slip cones to the other; a first expander sleeve fixed to said mandrel and positioned in abutment with the outer end of one of said packing elements; a second expander sleeve slidable on said mandrel and engageable with the outer end of the other of said packing elements; and locking means to lock said second expander sleeve and said mandrel together to maintain longitudinal compressive force between said expander sleeves through said series of packing elements, slip cones and slips, said locking means including a tubular ram longitudinally shiftable

within said tubular mandrel and having a ball escape passage through the wall thereof, a latch sleeve slidably carried on said mandrel, a recess formed in the surface of the bore of said latching sleeve, an aperture in the wall of said mandrel, and a ball having a diameter greater than the thickness of the wall of said mandrel and retained in seated position in said latching sleeve recess and said aperture by said ram but adapted to escape through said escape passage when said ram is shifted within said mandrel to a position in which said escape passage is in registry with said aperture.

8. Apparatus of the character described, comprising in combination: a tubular mandrel; a pair of oppositely facing, longitudinally spaced slip cones slidably mounted on said mandrel with their apex ends adjacent; a pair of packing elements on said mandrel, each packing element abutting the base end of one of said slip cones; slips carried on said slip cones, said slips extending between said slip cones in rear end abutment with one another to transfer longitudinal force therethrough from one of said slip cones to the other; a first expander sleeve fixed to said mandrel and positioned in abutment with the outer end of one of said packing elements; a second expander sleeve slidable on said mandrel and positioned in abutment with the outer end of the other of said packing elements; locking means to lock said second expander sleeve and said mandrel together to maintain longitudinal compressive force between said expander sleeves through said series of packing elements, slip cones and slips, said locking means including a latch sleeve longitudinally slidable on said mandrel, a latch ring fixed against longitudinal movement on said expander sleeve, said latch sleeve and said latch ring being adapted to ratchet together into concentric locking engagement with one another by longitudinal motion of said second expander sleeve and said mandrel relative to one another in a manner to apply compressive force through said packing elements when said latch sleeve is locked to said mandrel, and means releasably locking said latch sleeve to said mandrel; and means slidable within said mandrel to release said last-named means releasably locking said latch sleeve to said mandrel to free said latch sleeve for longitudinal sliding motion on said mandrel.

9. Apparatus according to claim 8 and a port extending through said first expander sleeve and into said mandrel; a valve member initially closing said port and movable by said means slidable within said mandrel to open said port to thereby establish a fluid pressure equalization by-pass channel extending through said packing elements.

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