Jan. 7, 1969 A. H. ALEXANDER ET AL 3,420,305

WELL TOOLS

Filed Oct. 26, 1966 Sheet 1 of 2

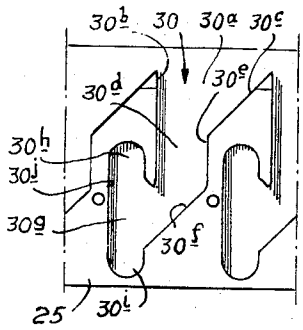


Fig. 3-A

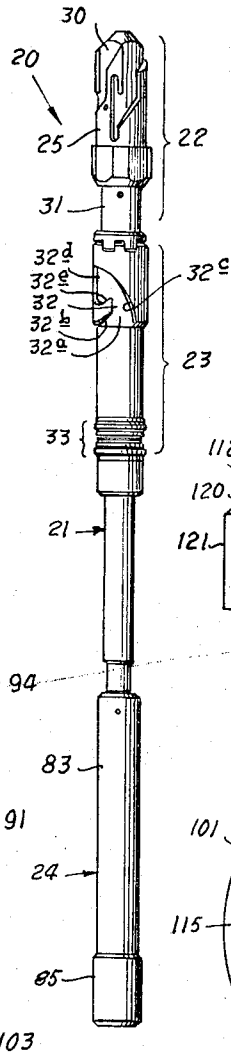


Fig. 1

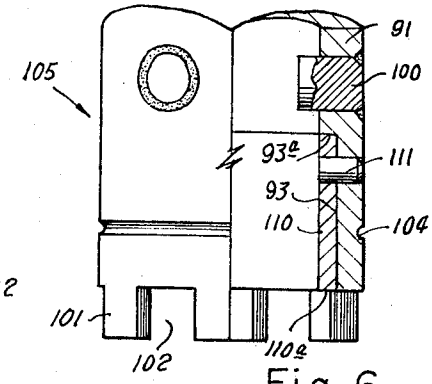


Fig. 6

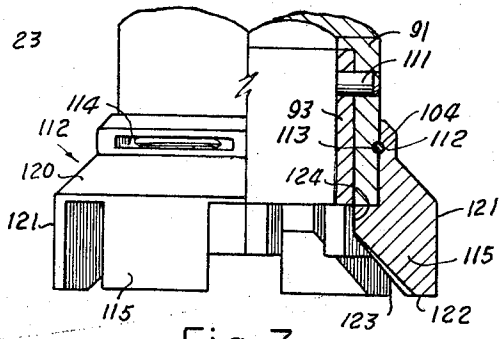


Fig. 7

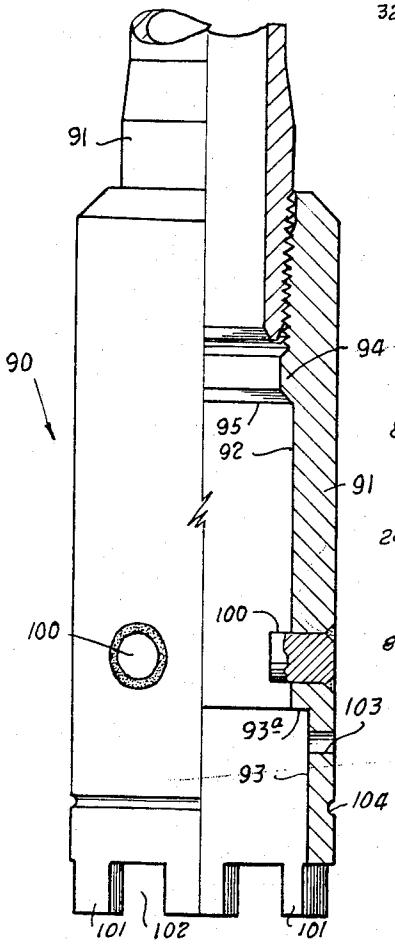


Fig. 5

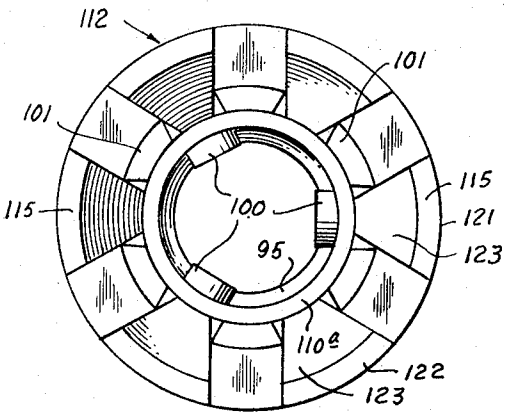


Fig. 8

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WELL TOOLS

Filed Oct. 26, 1966 Sheet 2 of 2

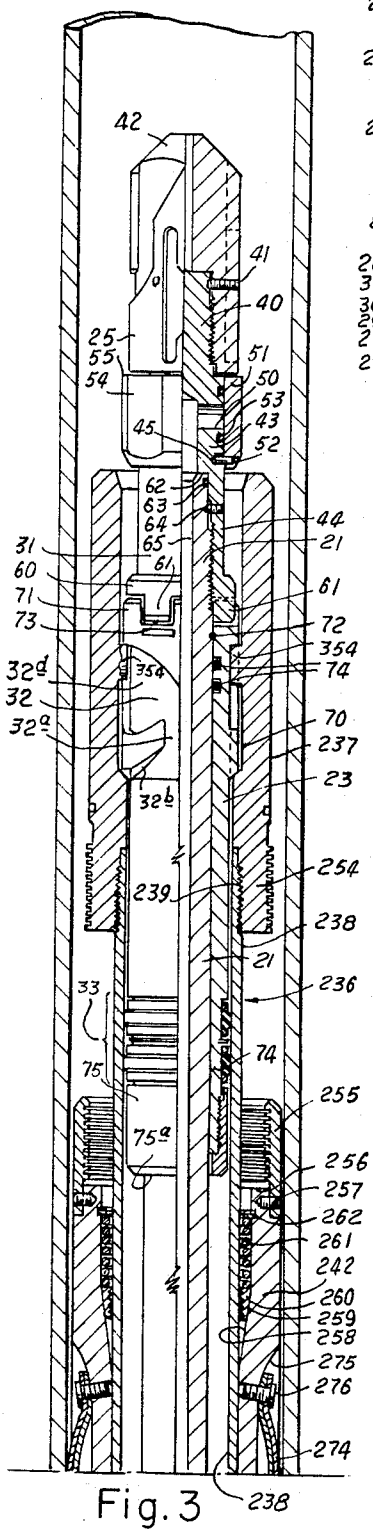


Fig. 3

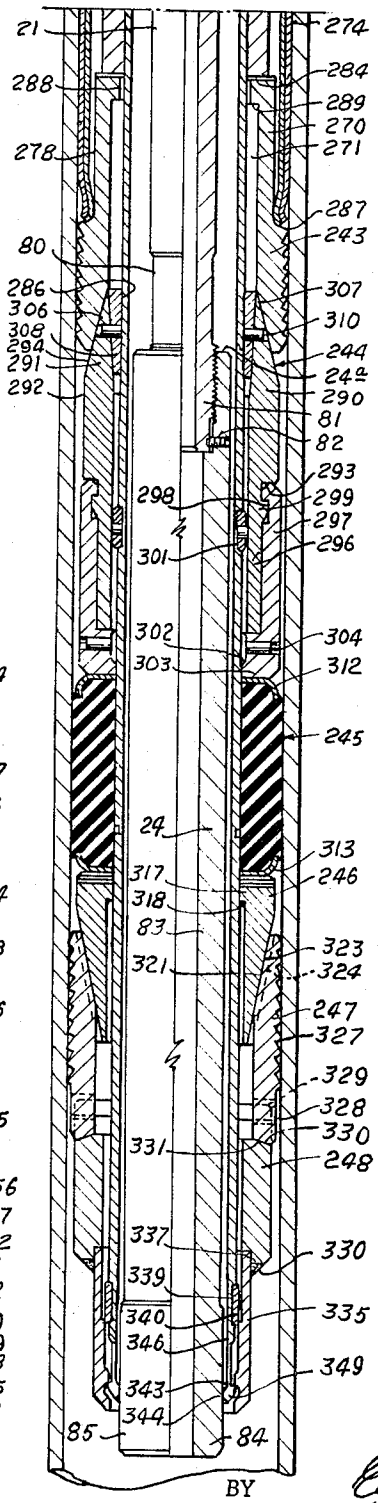


Fig. 4

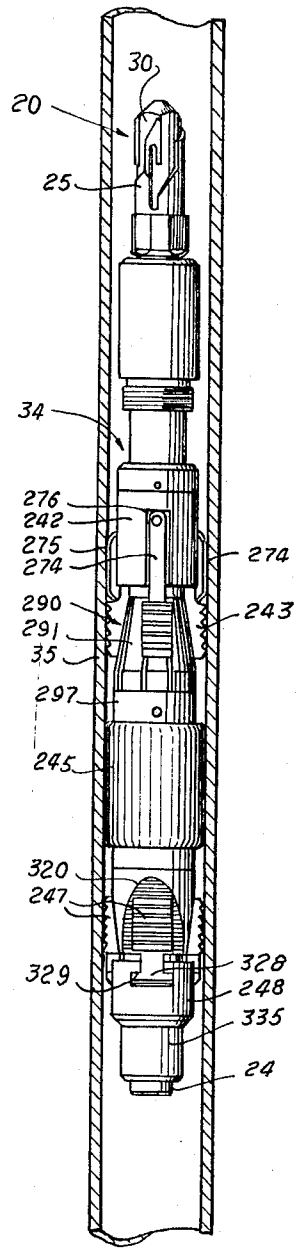


Fig. 2

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3,420,305

WELL TOOLS

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U.S. Cl. 166—114 26 Claims
Int. Cl. E21b *33/128*

This invention relates to well tools and more particularly to apparatus for sealing the bore through well packers.

It is an object of the invention to provide a new and improved apparatus to temporarily seal a flow passage.

It is another object of the invention to provide a new and improved well tool for temporarily plugging a flow passage in a well bore.

It is another object of the invention to provide a new and improved well tool releasably engageable in the bore of a well packer for plugging the flow passage through the well packer defined by such bore.

It is a further object of the invention to provide a new and improved bridge plug for insertion into and removal from a well packer locked in a well bore.

It is another object of the invention to provide a well packer bridge plug which has means for equalizing fluid pressure across the packer and plug precedent to release and withdrawal of the plug from the packer.

It is a further object of the invention to provide a well packer bridge plug having means for locking the packer against release in a flow conductor.

It is a further object of the invention to provide a bridge plug of a well packer which may also be used as a pulling tool for the packer.

It is still another object of the invention to provide a well packer bridge pug which may be shifted from a locked position in a well packer in a flow conductor to a position for removing the well packer and back to a further position at which the bridge plug is disengaged from the packer leaving the packer locked within the flow conductor.

It is another object of the invention to provide a running tool for installing a bridge plug in the bore of a well packer.

It is a further object of the invention to provide a pulling tool for removing a bridge plug from locked relationship within the bore of a well packer.

It is still a further object of the invention to provide a bridge plug for a well packer which includes means for releasably engaging the bridge plug in a well packer, means for releasably coupling a running and pulling tool to the bridge plug, means for effecting fluid communication through the bridge plug for pressure equalization purposes, sealing means for sealing around the plug within the bore of a well packer, and means providing external locking surfaces for engaging locking means in the well packer to lock the packer against release from an expanded sealed position within a flow conductor.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a longitudinal view in elevation of a bridge plug embodying the invention as it appears both for installation in a packer and when locked within the packer for sealing the bore through the packer;

FIGURE 2 is a longitudinal view in elevation and section of the bridge plug of FIGURE 1 in operational position within a well packer which is locked in sealing engagement within a well casing;

FIGURES 3 and 4 taken together constitute an enlarged longitudinal view in elevation and section of the bridge plug at its locked sealed position within the well packer as shown in FIGURE 2;

FIGURE 3–A is a fragmentary roll-out view of a portion of the head of the bridge plug showing two of the J-slots in the head;

FIGURE 5 is a further enlarged view in section and elevation of a running tool for the bridge plug;

FIGURE 6 is a fragmentary view in section and elevation of a pulling tool employed in removing the bridge plug from a packer;

FIGURE 7 is a fragmentary view in elevation and section showing a centralizer on the pulling tool of FIGURE 6; and

FIGURE 8 is a bottom end view in elevation of the centralizer supported on the pulling tool as shown in FIGURE 7.

Referring to the drawings and in particular to FIGURE 1 a bridge plug **20** embodying the invention includes a tubular mandrel **21** connected along its upper end into a head portion **22** through a releasably locked movable sleeve **23**. A lower locking sub **24** is secured on the lower end of the mandrel. The head portion **22** has a locking head **25** provided with upwardly opening circumferentially spaced J-slots **30** used in supporting the bridge plug from running and pulling tools during installation and removal of the plug. The head is secured on the mandrel **21** by a connector **31**. The sleeve **23** has a plurality of external downwardly opening J-slots **32** for releasably locking the bridge plug within a packer and supports an annular seal assembly **33** for sealing around the plug within the packer. The bridge plug is releasably engageable within a packer **34** locked within a well casing **35** for sealing the packer bore, FIGURE 2, and also may be used as a pulling tool for removing the packer from the casing.

Referring to the enlarged view of the upper portions of the bridge plug and packer, FIGURE 3, the head **25** is threaded on a reproduced upper end portion **40** of the connector **31** and held against rotation on the connector by a plurality of circumferentially spaced set screws **41** threaded through the head against the connector. The head has an upwardly convergent or tapered upper end surface **42** which aids in guiding a handling tool, such as a running or pulling tool, on the bridge plug head when such a tool and the bridge plug are telescoped together and coupled for running or pulling the plug.

The J-slots **30** formed on the head are illustrated in further detail in the roll-out view of FIGURE 3–A. Each of the J-slots **30** has an upwardly opening mouth portion **30*a*** defined by a vertical surface **30*b*** and a guide surface **30*c*** sloping downwardly toward the vertical surface. The mouth portion opens into an intermediate vertical portion **30*d*** defined between the vertical surface **30*b*** and another vertical guide surface **30*e***. The lower end of the intermediate section is defined by a downwardly sloping guide surface **30*f***. The intermediate portion opens into a vertical locking portion **30*g*** having an upper locking portion **30*h*** and a lower locking portion **30*i***. The closed side of the locking portion is defined by a vertical surface **30*j***.

The upper portion **40** of the connector **31** is solid and externally threaded for connection into the head **25**. The connector is enlarged along intermediate and lower portions **43** and **44**, respectively, and provided with a downwardly opening bore **45** extending through only the lower and intermediate portions of the connector. The intermediate portion of the connector is provided with a lateral flow passage or port **50** communicating with the bore **45** for pressure equalization across the plug, as dis-

cussed hereinafter. An external valve sleeve **51** which is slidable on the intermediate and lower portions of the connector is secured by a plurality of shear pins **52** to the connector over the port **50** sealing the port until pressure equalization across the bridge plug is desired. O-rings **53** are supported around the intermediate portion of the connector to seal between the internal surface of the sleeve and the connector when the sleeve is at its upper position as in FIGURE 3 above and below the port **50**. The sleeve **51** has a plurality of circumferentially spaced, longitudinal, flat external surface portions **54** to facilitate telescoping a pulling tool over the bridge plug head in a fluid filled well bore, as discussed hereinafter. The outside diameter of the sleeve **51** is greater than the outside diameter of the head **25** so that a portion of the upper end surface of the sleeve defines a shoulder **55** for engagement by a pulling tool to shear the pins **52** for driving the sleeve downwardly to uncover the port **50** for equalizing pressure across the plug prior to removing it from the packer. The lower end portion of the portion **44** of the connector bore is enlarged providing a downwardly extending annular tubular flange **60** having circumferentially spaced downwardly projecting lugs **61**. The connector bore is threaded along its lower end portion to the upper end portion of the mandrel **21** with the upper end surface of the mandrel engaging a downwardly facing internal annular shoulder **62** within the connector bore at the junction of its intermediate and lower end portions thereby limiting the extent to which the connector telescope downwardly over the mandrel. An O-ring seal **63** carried in an external annular recess in the mandrel seals around the mandrel within the connector. The connector is held against rotation on the mandrel by a plurality of circumferentially spaced socket head set screws **64** extending through the connector into engagement with the mandrel below the O-ring **63**. The bore **45** of the connector opens into the upper end of a longitudinal bore **65** through the mandrel **21**.

The sleeve **23** is enlarged along an upper end portion **70** in which the downwardly opening J-slots **32** are formed. The upper end of the enlarged portion **70** of the sleeve is provided with a plurality of circumferentially spaced upwardly extending lugs **71**. The lugs **61** and **71** are circumferentially spaced so that the lugs **61** are received between the lugs **71** with the lugs **71** being received between the lugs **61** thus effecting an intermeshing relationship, FIGURE 3, so that when either the connector or sleeve is rotated the other of the members is driven or rotated simultaneously. When the connector and sleeve **23** are spaced apart longitudinally the connector is free to rotate independently of the sleeve. Thus the lug functions as a clutch means.

The sleeve **23** is slidable on the mandrel **21** and locked against longitudinal movement on the mandrel by a shear wire **72** disposed within longitudinally aligned circumferentially extending recesses around the mandrel and within the sleeve. The mandrel has an external annular recess which is half-circular in cross section while the sleeve similarly has an internal annular circumferentially extending recess half-circular in cross section so that when aligned as in FIGURE 3 a circular recess is provided to receive the shear wire **72**. The shear wire is inserted into the aligned recesses through a slot **73** provided through the mandrel **21**. The shear wire is installed within the aligned recesses by inserting one of its ends through the slot **73** into the recesses and pushing the wire until a sufficient length of it has been inserted through the slot to occupy substantially the entire length of the aligned mandrel and sleeve recesses.

A pair of O-rings **74** are disposed within internal annular spaced recesses within the sleeve **23** to provide a seal between the sleeve and the mandrel **21**. The external annular seal assembly **33** is supported on a reduced lower end portion **76** of the sleeve **23** by an annular internally threaded retainer ring **75**. The seal assembly provides a seal between the internal wall surface defining the bore **238***a* through the packer **34** and the sleeve of the bridge plug.

The J-slots **32** in the sleeve **23** each has a downwardly opening generally vertical mouth portion **32***a* and defined by curved downwardly divergent surfaces **32***b* and **32***c* to provide a wide slot mouth to facilitate guiding internal lugs of the packer into the generally horizontal slot portion **32***d* of which extends in a clockwise manner around the sleeve as viewed from above the sleeve. The horizontal portion **32***d* of each of the J-slots is defined at its lower end by an upwardly facing shoulder **32***e* which serves to engage packer lugs to hold the bridge plug against upward movement relative to the packer.

The mandrel **21** is reduced in external diameter along a lower intermediate portion **80** for engagement by a tool such as a pipe wrench. Any surface damage to the mandrel surface by the wrench along the portion **80** does not damage the O-rings **74** as the sleeve **23** is moved on or off the mandrel during assembly and disassembly of the bridge plug. The O-rings do not engage the outer surface of the mandrel portion **80** in sliding the sleeve **23** so that any surface in regularities along the portion **80** caused by the pipe wrench do not tear the O-rings. The mandrel is externally threaded along a lower end portion **81** connected within the locking sub **24**. A plurality of circumferentially spaced socket head set screws **82** are threaded through the locking sub into engagement with the mandrel **21** below the threads on its lower end portion **81** to prevent accidental uncoupling of the locking sub from the mandrel.

The locking sub **24** is a tubular member of substantially uniform diameter somewhat less than the internal diameter of the bore **238***a* of the packer **34** over a major portion **83** of the length of the sub. The sub is increased in external diameter along a shorter lower end portion **84** providing an external cylindrical locking surface **85** functioning to lock the packer **34** against longitudinal movement, as explained below. The upper end surface **24**a of the locking sub is engageable with the lower end face **75***a* of the retainer **75** limiting the upward movement of the mandrel through the sleeve **23**. The provision of the portion **83** of the locking sub **24** having a slightly reduced diameter below that of the lower locking portion **84** facilitates the movement of the bridge plug within the packer while also providing a surface portion along which a tool such as a pipe wrench is engaged for assembly and disassembly of the bridge plug. Since the surface of the portion **84** is spaced apart within the surface defining the packer bore, a burr or scar of the portion **84** by the wrench may generally pass through the packer without also damaging the inner surfaces of the packer.

The bridge plug is installed in the packer by a running tool **90** supported on the lower end of a tubing string **91**. The running tool **90** comprises a tubular body or sleeve **91** which has an internal graduated bore including a central portion **92** which receives the head **25** of the bridge plug and an enlarged lower end portion **93** adapted to receive the valve sleeve **51** positioned immediately below the head **25**. The member **91** has an internal annular flange **94** providing an upwardly convergent internal annular shoulder surface **95** engageable by the tapered upper end surface **42** on the bridge plug head to limit the upward movement of the bridge plug into the running tool. A plurality of circumferentially spaced radial inwardly projecting lugs **100** are secured through the member **91** into its bore portion **92**. The lugs **100** are receivable in the J-slots **30** of the bridge plug to permit support and rotation of the bridge plug by the running tool. A lower end portion of the tubular member **91** has a plurality of circumferentially spaced downwardly extending arcuate fingers **101** which are spaced to define downwardly opening slots **102** to facilitate telescoping the running tool downwardly over the bridge plug head. The slots **102** provide space for the passage of debris and other solid particles

which may be in drilling fluid around the bridge plug as the lower portion of the tubular member is telescoped over the valve sleeve **51**. The slots **102** are especially useful when the tubular member **91** is converted to a pulling tool, as described below, for removing the bridge plug. The member **91** has one or more laterally extending holes **103** and an external annular half circular circumferentially extending recess **104** both of which function when the tubular member **91** is converted to a pulling tool.

FIGURE 6 illustrates the conversion of the running tool to provide a pulling tool **105** utilized for uncoupling the bridge plug from the packer and lifting the bridge plug from the packer and casing **35**. The pulling tool comprises the running tool **90** modified by an internal sleeve **110** secured within the bore portion **93** of the member **91** by one or more pins **111** pressed into the lateral holes **103** of the member **91** and aligned holes the internal sleeve. The upper end surface **110***a* of the sleeve **110** engages the internal annular downwardly facing shoulder **93***a* at the junction of the bore portions **92** and **93** in the member **91**. The lower end surface **110***b* of the sleeve **110** is engageable with the shoulder **55** on the upper end of the valve sleeve **51** for forcing the sleeve downwardly to uncover the pressure equalizing port **50**, as discussed hereinafter.

FIGURES 7 and 8 illustrate a centralizer **112** supported on the running tool **105** for guiding the running tool into a flow conductor which is sufficiently larger in diameter than the bridge plug head that the running tool in the form shown in FIGURE 6 might miss the head when engaging the running tool on the bridge plug for pulling the plug. The centralizer is an annular member which telescopes upwardly over the lower end portion of the member **91** on which it is locked by an annular lock wire **113** disposed within the external annular recess **104** and an internal annular recess **112***a* provided within the centralizer aligned with the recess **104** when the centralizer is positioned as shown in FIGURE 7 on the member **91**. The lock wire is inserted into the aligned recesses through a circumferentially extending slot **114** in the centralizer opening into its recess **113**. One end of the lock wire is fed through the slot **114** into the aligned recesses and the wire is then forced into the aligned recesses until it substantially encompasses the member **91** within the centralizer interlocking the centralizer and tubular member **91**. The centralizer includes a plurality of radial circumferentially spaced guide fingers **115** spaced apart to receive the fingers **101** on the lower end of the tubular member **91**. The centralizer has upper downwardly divergent annular surface **120** adjoining vertical side surface **121** of the fingers **115**. The side surfaces **121** engage the inside wall of a flow conductor to guide the pulling tool as it is inserted into the conductor toward the bridge plug. Each of the fingers **115** has a bottom arcuate edge portion **122** and an upwardly and inwardly sloping arcuate surface portion **123** which is engageable with the upper end surface **42** on the bridge plug to aid in guiding the pulling tool over the top of the bridge plug. The fingers each extend radially inwardly over the lower end surface of the tubular member **91** between the fingers **101** and are provided with an upwardly facing arcuate flange surface portion **124** which limits the upward movement of the centralizer on the tubular member. When the surfaces **124** on the fingers **115** engage the lower end surface portion of the tubular member between the fingers **101** the recesses **104** and **112***a* are aligned to receive the locking wire **113**.

The packer **34** is further illustrated and described along with other packers with which the bridge plug is preferably employed at pages 3790–3791 of the Composite Catalogue of Oil Field Equipment and Services, 1966–67 edition, published by World Oil, Houston, Tex. In the reference, the packer **34** is illustrated and identified on page 3790 as a "rotation set Otis Perma-Trieve packer." When locked in the packer as illustrated in FIGURES 3 and 4 of the drawings the bridge plug **20** is disposed within the packer as the "seal unit" illustrated and positioned in the packer at page 3790 of the reference. The packer **34** is also illustrated, described, and claimed in a U.S. patent application of Thomas D. Elliston, No. 479,966, filed on Aug. 16, 1965.

Referring to FIGURES 2 through 4, the packer **34** includes a tubular mandrel **236** having a top of head section **237** and an elongate main section **238** whose top end portion is threaded into the lower end portion of the head section as at **239**. The main mandrel section has mounted thereon an upper slip carrier **242**, a plurality of upper slips **243** mounted on the upper slip carrier for radial movement between inner retracted and outer expanded positions, an upper expander assembly **244** for expanding the upper slips, a packing or seal element **245**, a lower slip expander **246**, a plurality of lower slips **247** and a lower slip carrier **248**.

The lower externally threaded end portion **254** of the top mandrel section is receivable in the similar internally threaded tubular connector **255** whose lower portion is telescoped over the reduced top end **256** of the upper slip carrier and is secured thereto by means of screws **257** which extend through suitable apertures of the connector into outwardly opening threaded bores of the slip carrier. The upper slip carrier has an internal inwardly and downwardly extending cam surface **258** which is engageable with the similarly inclined outer surfaces **259** of a plurality of wedge ring segments **260** which are provided with internal upwardly facing teeth. The wedge shaped ring sections are biased downwardly to cause their internal teeth to engage the external surface of the main mandrel section to prevent downward movement of the main mandrel section relative to the upper slip carrier by a spring **261** disposed about the main mandrel section and within the upper slip carrier. The lower end portion of the spring engages the upper surfaces of the wedge ring segments and its upper end portion engages the bottom surface of a split retainer ring **262** whose outer portions are received in an internal annular recess of the upper slip carrier.

The upper substantially T-shaped handle portions **270** of the upper slips **243** extend upwardly into the enlarged lower end portion **271** of the bore of the slip carrier and are held releasably against outward movement by a plurality of circumferentially spaced bow springs **274** whose upper end portions are receivable in the external longitudinal recesses **275** of the slip carrier and are rigidly secured thereto by means of screws **276**. The lower portions of the longitudinal recesses **275** open inwardly into the lower enlarged bore portion **271** of the slip carrier. The lower end portions of the bow springs extend inwardly into the bore of the slip carrier and engage the outer surfaces **278** of the slips to resiliently hold them in their retracted positions. The intermediate or middle portions of the bow or drag springs **274** extend radially outwardly of the packer to engage the internal surfaces of the well casing **35** for a purpose to be described below.

The slip carrier adjacent its lower end is provided with an internal annular flange, not shown, which provides an upwardly facing shoulder which is engageable with lower shoulders of circumferentially outwardly extending sections of the slips, not shown, to prevent accidental downward disengagement of the slips from the slip carrier. Upward movement of the slips relative to the slip carrier is limited by the engagement of the top surfaces of the slips with the downwardly facing annular shoulder **284** of the slip carrier. The slips at their lower end portions have internal downwardly and outwardly inclined cam surfaces **286** and with external upwardly facing teeth or serrations **287**. The slips at their upper ends are provided with internal flanges **288** which provide downwardly facing shoulders **289** for a purpose to be described below.

The expander assembly **244** includes an expander **290** having a plurality of circumferentially spaced upwardly extending resilient fingers **291** which are provided with external bosses **292**. The bosses have downwardly facing shoulders **293** and upwardly and inwardly inclined top shoulders **294** which are engageable with the internal cam surfaces **286** of the upper slips. The lower end portion of the expander below the shoulders **293** of the bosses **291** is receivable in the upwardly opening annular recess **296** of the tubular expander carrier **297** of the expander assembly. The expander carrier has an internal annular recess **298** in which are receivable the external catch bosses **299** of the fingers. The catch bosses have upwardly and outwardly extending lower cam shoulders which cam the fingers inwardly as the lower portion of the expander is telescoped inwardly into the expander holder and whose upwardly facing shoulders engage the downwardly facing shoulder defining the upper end of the recess **298** to prevent upward movement of the expander from the tubular holder.

The expander holder is held against upward movement on the main mandrel section prior to expansion and locking of the packer by a split stop ring **301** whose inner portions are received in an external annular recess of the main mandrel section and whose bottom end shoulder engages the upwardly facing internal annular shoulder **302** provided by an internal flange **303** of the expander holder. The expander holder is releasably secured prior to slip expansion against downward movement relative to the main mandrel section by one or more shear pins **304** which extend through suitable apertures in the expander holder into suitable lateral ports or bores of the stop ring **301**.

The upper ends of the fingers of the expander **290** are held in their expanded position by a wedge ring **306** whose outer surface **307** extends upwardly and outwardly and engages the similarly upwardly and outwardly extending inner cam surfaces **308** of the collet fingers. The wedge ring is releasably secured to the fingers by shear pins **310** which extend through suitable apertures in the collet fingers into radial apertures of the wedge ring.

The tubular resilient packing element **345**, made of a suitable plastic, rubber or the like is disposed between upper and lower back-up rings **312** and **313** made of a relatively soft metal such as lead. The upper back-up ring **313** is disposed between the annular bottom end surface of the expander holder **297** and the top end surface of the packing element and the lower back-up ring is disposed between the lower end of the packing element and the annular top end surface of the lower slip expander **246**. The lower slip expander is releasably secured, before movement to locking position, to the main mandrel section by one or more shear pins **315** which extend through suitable lateral apertures of the lower expander into suitable lateral ports or bores of the main mandrel section **238**. The lower expander is provided at its upper end with an internal annular flange **317** which provides an annular downwardly facing stop shoulder **318** for a reason to be described.

The lower slip expander has upwardly and outwardly extending planar cam surfaces **320** engageable with the inner planar surfaces **321** of the lower slips **247** and with dovetail grooves **323** in which are slidably received the similarly sloped tongues **324** of the slips. The tongue and groove connection of the slips with the lower expander prevents outward movement of the slips except upon upward movement of the slips relative to the expander.

The lower slips have downwardly facing serrations or teeth **327** and T-shaped handles **328** at their lower ends which are received in slots **329** of the lower slip carrier **248** of similar configuration. The T-handle prevents circumferential displacement of the lower ends of the slips while permitting their radial outward movement. The bottom ends of the T-shaped slots are defined by downwardly and outwardly extending shoulders **330** of the lower slip carrier which are engageable with the lower bottom end surfaces **331** of the slip carrier handles whereby upon upward movement of the slip carrier relative to the slips, the lower slips are cammed outwardly due to the camming engagement of these cam surfaces.

Upward movement of the lower slip expander **246** relative to the lower slip carrier is limited by one or more longitudinal bolts, not shown, circumferentially spaced between the slips **247**, whose lower ends are threaded in suitable upwardly opening bores of the lower slip carrier and are secured in desired adjusted position thereon by nuts threaded on the bolts against the upper surface of the lower slip carrier. Lock washers may be interposed between the nuts and the lower slip carrier. Enlarged heads of the bolts are slidably disposed in longitudinal downwardly opening bores of the lower slip expander. The engagement of the bolt heads with the annular upwardly facing shoulders in the bores of the lower slip expander limits upward movement of the expander relative to the bolts and therefore to the lower slip carrier. The lower slip carrier is releasably held in its lower initial position, relative to the lower expander by shear pins which extend through the bores and engage the top surfaces of the bolts.

The lower slip carrier **248** includes a lower tubular latch section **335** whose upper end is received in a downwardly opening annular recess **337** of the slip carrier rigidly secured thereto in any suitable manner as by weld **338**. The lower slip carrier is held against upward movement on the main mandrel section by a split stop ring **339** whose inner portions are received in an external annular recess of the main mandrel section and whose bottom end shoulder engages an upwardly facing annular stop shoulder **340** of the latch section provided by a reduction of the internal bore of the latch section. An internal annular flange **343** adjacent the bottom end of the latch section is provided with an internal annular recess **344**.

The lower end portion of the main mandrel section is provided with a plurality of downwardly opening circumferentially spaced slots **346** which define a plurality of circumferentially spaced resilient collet fingers **349**. The collet fingers at their lower ends are provided with heads having internal and external bosses. The external bosses which are receivable in the internal recess **344** of the latch section **335** have upper and lower shoulders which extend convergently outwardly, the upper shoulders being engageable with a downwardly facing shoulder of the latch section of the slip carrier defining the upper end of the internal recess **344** to hold the main mandrel section of the packer mandrel against upward movement relative to the lower slip carrier when the collet fingers are in their normal positions illustrated in FIGURE 4.

The top or latch section **237** of the packer mandrel **34** is provided with a pair of diametrically opposed inwardly extending lugs **354** by means of which the packer is releasably securable to a running and setting tool which is connectable to the lower end of a flow conductor or string or tubing. Also, the lugs **354** are receivable in the J-slots **32** of the bridge plug for connecting the bridge plug in the packer and for lifting the packer by means of the bridge plug.

The packer secured by its lugs **354** on a suitable running tool supported from a string of tubing, not shown, is lowered into the casing **35** with the upper and lower slips and the packing element in their retracted positions. As the bow springs **274** move into the casing their intermediate portions are flexed resiliently inwardly and thereafter frictionally engage the internal surfaces of the well casing as the packer is lowered therethrough. When the packer is at the location in the casing where it is desired that it be set and anchored, the tubing string is rotated in a counterclockwise direction, as seen from above, and the engagement of vertical shoulders of the running tool J-latch section defining ends of horizontal portions of the

J-slots with the side surfaces of the lugs **354** of the top packer mandrel section causes the packer mandrel **237** to rotate relative to the upper slip carrier **242**. Rotation of the upper slip carrier is resisted by the bow springs **274** which engage the internal surfaces of the well casing. The threaded end portion of the top mandrel section is disengaged from the tubular connector **255** of the upper slip carrier **242** by such rotation. Once the top mandrel section is disconnected from the upper slip carrier, an upward movement is imparted to the tubing string and therefore to the running tool, whereupon the running tool lifts the packer mandrel **236**. The bow springs **274** resist upward movement of the slip carrier and the packer mandrel moves upwardly relative to the upper slip carrier, the wedge ring segments **260** permitting such upward movement of the packer mandrel section **238** relative to the upper slip carrier since their internal teeth face upwardly. The cam surfaces **259** and **258** of the wedge ring segments and of the upper slip carrier extend upwardly and outwardly so that any upward movement imparted to the wedge ring segments tends to move them upwardly against the force exerted by the spring **261** and out of binding engagement with the external surface of the main latch mandrel section **238**. Upward movement of the packer mandrel also causes upward movement of the upper expander assembly **244**, the packing element **234**, the lower slips **247** and the lower slip carrier **248**.

As the packer mandrel is thus moved upwardly relative to the upper slip carrier and the upper slips, the upper cam or expander surfaces **294** of the bosses **292** of the upper slip expander **290** move into engagement with the cam surfaces **286** of the upper slips and move the slips outwardly and into gripping and anchoring engagement with the well casing. When the slips are in fully expanded position and cannot move further outwardly, upward movement of the upper expander assembly **244** is arrested and continued upward movement of the packer mandrel now causes the shear pins **304** to shear and the packing element **245** to be compressed longitudinally and expanded into sealing engagement with the well casing. When the packing element has been fully compressed and moved into sealing engagement with the well casing, the shear pins **315**, which are of greater shear strength than the pins **304**, are sheared. Continued upward movement of the packer mandrel causes the pins in the lower slip expander at the heads of the bolts connecting the slip expander with the lower slip carrier to shear and the lower slip carrier and the lower slips **247** to be moved upwardly relative to the expander **247** and radially outwardly and into gripping and anchoring engagement with the well casing. The upper slips then hold the upper expander assembly **244** against upward movement in the well casing and the lower slips hold the lower slip expander **246** against downward movement in the well casing. The packer mandrel is now held against downward movement relative to the upper slip carrier by the action of the wedge ring segments **260** so that the packer is now in the anchored and sealing position in the well casing as illustrated in FIGURES 2–4.

So long as either no pressure differential is applied longitudinally across the packer or if such a differential is applied the collet fingers **349** are held in the recess **344**, the packer remains in its anchored and sealing position in the well casing. As explained below, the bridge plug holds the collet fingers when it is in the packer as illustrated. The packer may be retrieved only by allowing the collet fingers to collapse inwardly out of the recess **344**.

The bridge plug is inserted into and locked in the packer by means of the running tool **90** supported from the tubing string **91**. The running tool and the bridge plug are coupled together at the surface by inserting the head **25** of the bridge plug into the member **91** of the running tool so that the lugs **100** of the running tool are guided into the J-slots **30**. The lugs are first received in the mouth portion **30***a* of the J-slots, and, if the lugs are aligned with the intermediate portions **30***b*, they will move downwardly until a lower edge surface portion of each of the lugs engages the lower guide surface **30***f* of its J-slot. If the lugs are somewhat out of alignment with the portion **30***b* of the J-slots, the lugs engage the upper guide surfaces **30***c* which guides each of the lugs into the intermediate portion **30***d* of its J-slot. The lower guide surface **30***f* of each J-slot guides each lug into the locking portion **30***g* of the J-slot as the running tool is rotated clockwise relative to the bridge plug as viewed from above the plug. The running tool is rotated clockwise until the lugs each engage the vertical surface **30***j* of the locking portion of its J-slot which prevents further relative rotation of the running tool and bridge plug. The running tool is then lifted, or stated otherwise the bridge plug is moved slightly away from it, moving each lug **100** into the upper portion **30***h* of its J-slots as the bridge plug is suspended from the running tool for lowering on the tubing string **91** through the casing **35** to the packer within the casing.

The bridge plug is lowered into the packer passing downwardly in the bore **238***a* of the packer until the internal lugs **354** within the head **237** of the packer enter the bridge plug J-slots **32**. The downward movement of the bridge plug causes the packer lugs to engage the curved surfaces **32***c* of the J-slots with the camming action of the lugs and curved J-slot surfaces **32***c* rotating the bridge plug counterclockwise as it is forced downwardly until the lugs of the packer each enter the locking portion **32***d* of its J-slot. The rotation of the bridge plug counterclockwise holds the running tool lugs in the J-slot portion **30***g* of the plug head **25** thereby preventing disengagement of the running tool. The downwardly divergent surface **32***b* and **32***c* readily guide each lug into its J-slot. As the seal assembly **33** on the bridge plug effects tight sealing engagement in the bore **238***a* of the mandrel **238** of the packer the bridge plug must be forced downwardly to its locked position in the packer. Thus, as the tubing string **91** and running tool **90** have their weight placed on the bridge plug to force it downwardly, the lugs **100** of the running tool move downwardly into the lower locking portions **30***i* of the J-slots on the bridge plug head. The valve sleeve **51** of the bridge plug is received within the enlarged lower bore portion **93** of the running tool so that when the lugs reach the lower end of their travel in the lower locking portions **30***i* of the J-slots the sleeve **51** is not driven downwardly on the connector **31** but rather the shear pins **52** remain intact with the sleeve being held over the pressure equalizing port **53**.

As the bridge plug is forced downwardly through the packer to its locked position of engagement of the lugs **354** in the J-slots **32**, the lower packer slips **247** hold the lower slip expander **246** against downward movement in the well casing thus holding the packer at its locked position within the casing. The lower enlarged end portion **84** of the locking sub on the bridge plug mandrel moves within the collet fingers **349**, FIGURE 4, with the locking surface **85** on the sub engaging the inner bosses of the collet fingers holding them at their positions in the recess **344** thereby locking the packer and bridge plug assembly against longitudinal movement in the casing responsive to forces either upwardly or downwardly effected by a pressure differential applied across the packer. The J-slot lower surfaces **32***e* at the lower ends of the locking portions of the J-slots **32** are engageable with the lower surfaces of the lugs **354** in the packer and preventing the bridge plug from being disengaged from the packer unless the bridge plug is rotated clockwise as viewed from above. The length of the locking surface **85** on the enlarged portion **84** of the locking sub of the bridge plug is correlated with the length of the locking portion **32***d* of the J-slots **32** on the bridge plug sleeve so that the collet fingers **349** are held in their normal locked position whether the packer lugs **354** are at their upper or lower

extreme positions in the locking portions of the J-slots **32**.

At this locked position of the bridge plug in the packer fluid flow is prevented through the packer bore. The seal assembly **33** around the sleeve **23** of the bridge plug sealingly engages the internal surface defining the bore **238***a* through the packer while the solid upper end portion **40** of the connector **31** along with previously described seals between the various components of the bridge plug prevent flow through the bridge plug at the relative positions such components illustrated in FIGURES 3 and 4. With the bridge plug fully locked sealing the packer bore the running tool is withdrawn to the surface.

The running tool **90** is rotated counterclockwise as viewed from above as it is lifted so that the lugs **100** are raised upwardly in the J-slots **30** while being rotated so that the lugs are directed out of the J-slots by the guiding surfaces **30***f* and **30***c* as the lugs move upwardly. In rotating the running tool counterclockwise any corresponding rotation of the bridge plug simply forces the packer lugs more tightly in the J-slots **32** insuring against accidental uncoupling of the bridge plug from the packer while disengaging the running tool. The running tool is withdrawn by the tool tubing string from the casing **35** leaving the packer sealed by the bridge plug so that it withstands pressure differential in either longitudinal direction while permitting no fluid flow through it. So long as the bridge plug remains at its fully locked position illustrated in FIGURES 3 and 4 various desired well operations may be carried out within the casing above the packer and bridge plug combination without fluid flow occurring past the packer within the casing between the spaces below and above the packer. Such well operations are well known and not within the scope of this application. For example, however, the well may be acidized above the packer without affecting the well below the packer.

The bridge plug is removed from the packer with the pulling tool **105** supported by the tubing string **91**. If the internal diameter of the casing **35** is large enough that the pulling tool may miss the bridge plug the centralizer **112**, FIGURES 7 and 8, is secured as illustrated on the pulling tool to insure engagement of the tool with the bridge plug.

The pulling tool is lowered downwardly in the casing until its tubular member **91** telescopes downwardly over the head **25** of the bridge plug. The tapered upper end surface **41** of the bridge plug head facilitates guiding the pulling tool downwardly over the head. If the centralizer **112** is employed the lower finger surfaces **123** aid in cooperation with the surface **42** to guide the pulling tool over the head. The lugs **100** of the pulling tool enter the J-slots **30** with the guide surfaces **30***c* and **30***f* of the J-slots guiding the running tool in a clockwise manner as viewed from above into the locking portions **30***g* of the J-slots. The proportions of the running tool and the bridge plug head are so related that before the lugs **100** enter the locking portions of the J-slots **30** the lower end surface **110***b* of the sleeve **110** within the pulling tool engages the upper end shoulder **55** on the valve sleeve **51** of the bridge plug. Downward force on the pulling tool forces the sleeve **51** downwardly against the resistance of the shear pins **52** shearing the pins so that the sleeve is forced downwardly on the connector **31** uncovering the pressure equalizing port **50**. With the sleeve **51** displaced from over the port **50** fluid is free to flow from below the packer through the locking sub and locking mandrel **21** of the bridge plug into the connector bore outwardly through the equalizing port **50** around the running tool into the space within the casing above the bridge plug and packer. As will be obvious from FIGURE 3, the internal diameter of the sleeve **110** is sufficiently larger than the diameter of the connector at the port **50** that fluid may readily flow from the port into the sleeve **110** and downwardly within the sleeve between the lower end of the running tool and the upper end of the released sleeve **51** so that pressure equalization is effected between the spaces above and below the packer. If a pressure differential does exist across the packer and bridge plug combination it is essential that such differential be relieved before unlocking the bridge plug from the packer during the procedure of removing the bridge plug.

As the pulling tool moves downwardly against the valve sleeve **51** the lugs **100** are guided into the locking portions **30***g* of the J-slots **30**. The tubing string and pulling tool are rotated in a clockwise direction with the lugs **100** of the pulling tool engaging the vertical J-slot surfaces **30***j* of the bridge plug head thereby rotating the bridge plug counterclockwise as is viewed from above. The rotation of the head **25** and the connector through the lugs **61** and **71** turns the sleeve **23** relative to the locked packer. The packer lugs **354** guide the sleeve **23** by coacting with the edge surface defining the J-slots **32** until the lugs engage the slot surfaces **32***c* which guide the sleeve until the lugs are in the mouths **32***a* of the slots when the plug is lifted upwardly out of the packer. The clockwise movement of the pulling tool tightens its engagement on the head of the bridge plug so that it is not accidentally uncoupled.

After removal of the bridge plug from the packer the packer may then be released and withdrawn from the well casing or in the alternative the packer may be left in locked position within the casing for future well operations in which event, generally, a seal unit as illustrated at page 2790 of the Composite Catalogue of Oil Field Equipment and Services, supra, is inserted into the packer to lock the packer in position in accordance with the procedures outlined in the reference.

The structure of the bridge plug **20** permits its use for retrieval of the packer **34** at the time the bridge plug is withdrawn from the casing. The pulling tool **105** with the centralizer **112**, if necessary, is engaged on the bridge plug and the sleeve **51** displaced downwardly as described above with pressure equalization effected across the packer and bridge plug through the port **50**. After the pulling tool is forced downwardly until its lugs are in the locking portions **30***g* of the J-slots, the tool is then lifted directly upwardly without rotation so that the lugs **100** are raised into the upper locking portions **30***h* of the J-slots **30** whereby an upward force is applied by the pulling tool lugs to the head **25** of the bridge plug. Since the bridge plug is not rotated the packer lugs **354** remain within the locking portions **32***d* of the bridge plug J-slots **32** engaging the lower locking surfaces **32***e* of the J-slots preventing withdrawal of the bridge plug from the packer. The lifting force on the bridge plug head is transmitted through the connector **31** to the mandrel **21**. Since the sleeve **23** is being held against upward movement within the packer the upward force on the bridge plug mandrel shears the wire **72** releasing the mandrel for upward movement relative to the sleeve **23** of the bridge plug. The head, connector, and mandrel of the bridge plug are lifted by the pulling tool relative to the sleeve **23** until the upper end surface **24***a* on the locking sub **24** of the plug engages the lower end surface **75***a* of the retainer **75** on the lower end of the sleeve **23** of the bridge plug. The upward movement of the bridge plug mandrel and its lower locking sub withdraws the locking surface **85** on the enlarged lower end portion **84** from within the collet fingers **349** so that the collet fingers are no longer supported with their external bosses within the recess **344**. When the upper end of the locking sub engages the lower end of the retainer **75** further upward force on the bridge plug is transmitted through the sleeve **23** and the lower end surfaces **32***e* of the J-slots **32** to the packer lugs **354**. Upward force on the packer lugs is transmitted through the head **237** to the packer mandrel **238**. The packer mandrel is moved upwardly with the pulling tool and bridge plug relative to the lower slip carrier since the external bosses of the collet fingers **349** are now free to

move inwardly. The camming engagement of the upper shoulders of the external collet finger bosses with an annular upper shoulder defining the upper end of the annular recess **344** of the latch section **335** of the lower slip carrier cams the lower ends of the fingers inwardly out of the recess.

Upward movement of the packer mandrel now causes the top shoulder of the stop ring **301** to engage the bottom annular shoulder of the wedge ring **306** and, as the upward movement of the packer mandrel is continued, the shear pins **310** are sheared and the wedge ring **306** is moved upwardly from between and out of engagement with the internal cam surfaces **308** of the expander fingers **291** thus freeing the upper ends of the fingers for inward movement. The fingers, which inherently tend to move inwardly from the outer positions in which they are held by the latch ring, move inwardly. As the upward movement of the packer mandrel is continued, the wedge ring moves upwardly relative to the upper slips and when it moves past an intermediate point thereof, the bow springs **274** tend to pivot the lower ends of the slips inwardly out of anchoring engagement with the well casing. As the upward movement of the packer mandrel is continued, the top shoulder of the wedge ring moves into engagement with the downwardly facing shoulders **289** provided by the inner flange **288** of the upper slips and the upper slips and their carrier **242** are now moved upwardly with the packer mandrel. When the slips **243** move out of anchoring relation with the well casing and upwardly relative to the expander fingers, the expander assembly **244** is free to move upwardly relative to the mandrel and is so moved by the resilient packing element **245** which now tends to return to its original retracted position. As the upward movement of the packer mandrel is continued, the top shoulder of the lower stop ring **339** moves into engagement with the downwardly facing internal annular shoulder **318** of the lower slip expander **246** and moves it upwardly therewith relative to the lower slips. Such upward movement of the lower slip expander with the mandrel now causes the lower slips to be moved inwardly to their retracted positions due to the tongue and groove connections between the slips and the lower slip expander. Once the lower slips are at their retracted positions they cannot move further inwardly due to the engagement of their inner surfaces with the main packer mandrel section **238.** The lower slip carrier **248** moves upwardly with the slips due to the engagement of their lower T-shaped handle portions **328** with the carrier. The packer is then free to move upwardly through the well casing and is removed from the well by lifting the string of tubing and the running tool to the surface. The packer is lifted to the surface by the bridge plug which is being supported from the pulling tool on the lower end of the tubing string whereby the bridge plug functions as a pulling tool for the packer.

After the shear wire **72** has been sheared for the purpose of using the bridge plug to retrieve the packer and before sufficient upward force has been applied to the released bridge plug mandrel **21** to unlock the packer, the bridge plug may be disengaged from the packer and retrieved, leaving the packer in locked sealed condition in the casing. Under such conditions after the shear wire **72** is severed and the bridge plug mandrel is lifted partially upwardly by the pulling tool the upwardly moving components of the bridge plug, that is, the head **25**, the connector **31**, and the mandrel **21** with its lower locking sub **24** are moved back downwardly by the pulling tool and thus returned to the relative positions illustrated in FIGURES 3 and 4. The lugs **61** on the lower end of the connector **31** are again meshed with the upwardly extending lugs **71** on the sleeve **23.** The drill tubing string may be slowly rotated to insure the meshing of the lugs subsequent to which the tubing string is rotated in a clockwise direction as viewed from above so that the sleeve **23** is turned clockwise due to the clutch function of the lugs **61** and **71.** The clockwise movement of the sleeve **23** moves the sleeve relative to the packer lugs **354** to position the packer lugs at the downwardly opening mouth portions **32***a* of the J-slots **32.** The tubing string, pulling tool, and bridge plug are then lifted to retrieve them from the well casing leaving the packer locked in sealed relationship in the casing as previously discussed.

After preparation such as the re-dressing of certain component surfaces as needed and replacement of the various shear pins, both the bridge plug and the packer are reuseable.

It will now be seen that a new and improved well tool for plugging a flow passage in a flow conductor has been described and illustrated.

It will also be seen that the well tool is releasably engageable in the bore of a well packer for plugging the flow passage through the packer defined by the packer bore.

It will be further seen that a new and improved bridge plug for insertion into and removal from a well packer locked in a well bore has been described and illustrated.

It will be further seen that the bridge plug includes means for equalizing fluid pressure across the packer and the plug prior to withdrawing the plug from the packer.

It will also be seen that the bridge plug includes locking surfaces which engage locking means in the packer to lock the packer against release from locked and sealed engagement within a well casing responsive to a force applied to the packer wtihin the casing.

It will be further seen that the bridge plug is adapted to function as a pulling tool for the packer.

It will be further seen that the bridge plug is movable from a locked position in a well packer to a position for functioning as a pulling tool to retrieve the packer from the well casing and is returnable to a position prior to release of the packer at which the bridge plug is removable from the packer leaving the packer in locked sealed engagement in the well casing.

It will be further seen that a running tool for the birdge plug has been described and illustrated.

It will also be seen that a pulling tool for removing a bridge plug from engaged relationship within the bore of a well packer has been described and illustrated.

It will also be seen that the bridge plug includes a head portion having means for releasable engagement in a well packer, means for releasable engagement of a running and pulling tool with the head portion of the bridge plug, means for fluid communication through the bridge plug for pressure equalization purposes, sealing means around the plug for sealing within the bore of a well packer, and means providing locking surfaces for engaging locking means in a well packer to prevent release of the packer from a locked condition within a well casing when the bridge plug is secured therein.

While the bridge plug has been described in terms of its specific application to a particular series of well packers it is to be understood that it is not intended that the bridge plug be limited to use with such packers. The plug is equally operable with any well packer or tool having a flow passage therethrough and provided with suitable means for engaging the bridge plug such as the internal lugs described and illustrated in the well packer **34.**

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. Apparatus for sealing a flow passage of a flow conductor comprising: a packer having means for anchoring it in sealing position within the flow conductor and having a longitudinal flow passage therethrough; a closure member insertable in said flow passage of said packer and

having a flow passage therethrough closable at one end; means on said closure member sealing between said closure member and said packer closing off flow therebetween; means for releasably locking said closure member within said flow passage of said packer; valve means slidable on said closure member closing said closeable end of said member and movable to a position to open said closeable end of said flow passage of said closure member to permit flow therethrough; and means for releasably coupling said closure member with means for inserting and withdrawing said closure member from said flow passage of said packer; said slidable valve means on said closure member being movable longitudinally thereon between closed and open positions to permit flow through said closure member while said closure member is releasably coupled in sealing position in said packer flow passage.

2. Apparatus as set forth in claim 1 and means on said closure member and said packer coengageable to release said packer from anchored sealing position in said flow conductor after said flow passage through said closure member has been opened, to permit removal of said packer from said flow conductor.

3. Apparatus adapted to be releasably locked in a flow passage of a packer for sealing said passage at a first position and for permitting limited flow through said passage at a second position, said apparatus comprising: elongate mandrel means having a longitudinal flow passage therein; closure means slidable on said mandrel closing said flow passage at one end; seal means supported on said mandrel means for sealing between said mandrel means and said flow passage of said packer between the open and closed ends of the flow passage of said mandrel means; means on said mandrel means engageable with said packer for releasably locking said mandrel means in said flow passage of said packer; said slidable closure means on said mandrel means being movable from a position closing said one end of said flow passage to a position opening said flow passage to permit flow through said flow passage of said mandrel means for effecting pressure equalization across said packing means and said packer; means on said mandrel means for releasably locking said mandrel means in said flow passage of said packer; means on said mandrel means for releasably coupling said mandrel means with an inserting and removing apparatus for inserting and removing said mandrel means in said flow passage of said packer; means on said mandrel means coacting with said packer means for releasably holding said packer means in anchored sealing position in said flow conductor; and sleeve means slidable on said mandrel means having said means for releasably locking said mandrel means in said flow passage of said packer disposed thereon, whereby said mandrel means may be moved longitudinally relative to said packer while said locking means on said sleeve is in locking engagement with said mandrel to permit said means on said mandrel means coacting with said packer to hold said packer in locked position to be released to permit said packer to be released for movement from said flow conductor.

4. Apparatus as defined in claim 3 and running and retrieving means engageable with said means for releasably coupling said running and releasing tool with said mandrel means for actuating said mandrel means to open said flow passage through said mandrel means and to release said packer from said anchored position in said flow conductor.

5. Apparatus as defined in claim 3 wherein said closure means closing said flow passage of said mandrel means at said one end comprises a sleeve slidable on said mandrel means, and sealing means is provided between said sleeve and said mandrel means on opposite sides of said opening from said flow passage of said mandrel to the exterior thereof for sealing off said flow passage to close the same when said sleeve is disposed in surrounding relationship to said annular packing.

6. Apparatus of the character set forth in claim 3 wherein clutch means is provided on said mandrel means and said sleeve having said locking means thereon whereby said sleeve may be rotated to free said locking means to permit said closure means to be romoved from said flow passage of said packer.

7. A well tool for sealing a flow passage through a well packer comprising: mandrel means having a bore open at a first end and closed at a second end; sleeve means supported for slidable movement on said mandrel means; seal means secured around said sleeve means between ends of said bore of said mandrel means; means on said sleeve means for releasably locking said tool within said well packer; locking surface means on said mandrel means for engaging locking means within said packer for preventing release of said packer from said well casing; means for transmitting torque from said mandrel means to said sleeve means; means for effecting an opening into said bore of said mandrel means on the side of said seal means toward said closed end of said bore of said mandrel means; and means for releasably coupling said mandrel means with means for installing and removing said well tool.

8. A well tool as defined in claim 7 wherein said means for transmitting torque between said mandrel means and said sleeve means comprises a clutch engaged at one position of said mandrel means relative to said sleeve means and disengaged at another position of said mandrel means relative to said sleeve means.

9. A well tool as defined in claim 8 including shear means between said mandrel means and said sleeve means holding said clutch engaged.

10. A well tool for sealing a flow passage through a well packer comprising: mandrel means having a longitudinal bore open at one end of said mandrel means defining a flow passage along a substantial portion of said mandrel means; sleeve means slidably supported on said mandrel means; seal means on said sleeve means for sealing around said well tool within said packer; means on said sleeve means for releasably locking said well tool in said packer; locking surface means on said mandrel means for operably engaging locking means in said well packer for holding said packer against release from a locked and sealing position within a flow conductor; clutch means associated with said mandrel means and said sleeve means for transmitting torque between said mandrel means and said sleeve means at one position of said mandrel means relative to said sleeve means and for permitting rotation of said mandrel means relative to said sleeve means at another position of said mandrel means; means associated with said mandrel means for effecting fluid communication into said bore of said mandrel means to permit fluid flow through said bore from one side to the other side of said seal for effecting pressure equalization across said well tool preliminary to removal of said well tool from said well packer; and means for coupling said well tool to means for inserting said well tool into and for removing said well tool from said packer.

11. A well tool as defined in claim 10 wherein said sleeve means is adapted to be releasably held against move-means on said mandrel means at a position wherein said clutch means is in engaged relationship for transmitting torque between said mandrel means and said sleeve means.

12. A well tool as defined in claim 11 wherein said means for effecting fluid communication into said bore of said mandrel means is actuatable by a pulling tool adapted to be coupled on said well tool for withdrawing said tool from said packer.

13. In combination with the well tool of claim 10, a well packer having a longitudinal bore therethrough adapted to receive said well tool and including locking means for holding said packer against release within a flow conductor said locking surfaces on said mandrel means engaging said locking means of said packer to pre-

vent release of said packer, internal surfaces defining said flow passage through said packer engageable by said seal means on said sleeve means, and coupling means within said packer for releasably engaging said locking means on said sleeve means of said well tool.

14. In combination with the well tool of claim **10** an apparatus for inserting said well tool into said well packer comprising: sleeve means adapted to be connected with a tubing string and telescopically engaged on said well tool; and means supported by said sleeve means for engaging said locking means on said well tool.

15. The apparatus of claim **14** wherein said means for engaging said locking means on said well tool comprises inwardly extending lug means.

16. The apparatus of claim **5**, and a running tool for inserting said apparatus into a flow conductor comprising: tubular means adapted at one end to be secured on a tubing string and provided with a bore for receiving an end portion of said mandrel means including an enlarged lower end recess for receiving said closure sleeve on said mandrel means to retain said closure sleeve at a closed position on said well tool when said running tool is fully telescoped over said well tool upper end portion; and internal lug means in said tubular means for engaging said coupling means on said mandrel means.

17. The combination of claim **16** adapted to remove said mandrel means from said flow conductor including internal sleeve means supported in said lower end recess of said tubular means providing an end edge surface engageable with said closure sleeve on said mandrel means for displacing said closure sleeve from closed position to open position as said tubular means is telescoped over said mandrel means to a locking position thereon.

18. The combination of claim **17** including centralizer means supported on the free end portion of said tubular means for guiding said tubular means in a flow conductor.

19. A bridge plug for closing a flow passage through a well packer and for removing said packer from a flow conductor, said packer having structure defining a flow passage therethrough, means comprising lugs extending into said flow passage for releasable engagement of said bridge plug with said packer, and locking means exposed to said flow passage longitudinally spaced from said lugs for holding said well packer in a locked sealed position in a flow conductor, said bridge plug comprising: a mandrel having a longitudinal bore defining a flow passage open at one end of said mandrel and closed near the other end of said mandrel; means provided along the end portion of said mandrel through which said mandrel flow passage opens providing a locking surface engageable with said locking means of said packer for holding said locking means at a locked position within said packer for holding said locking means at a locked position within said packer to prevent release of said packer within said flow conductor while said bridge plug is engaged therein in closed relationship; a sleeve on said mandrel adapted to slide relative thereto whereby said mandrel is movable in said sleeve between a first position at which said locking surfaces on said mandrel engage said locking means in said packer and a second position at which locking surfaces on said mandrel are disengaged from said locking means of said packer; an annular seal assembly supported on said sleeve for sealing around said bridge plug within said flow passage of said well packer; external locking slot means on said sleeve to receive said lugs in said packer for releasably locking said bridge plug within said packer; means for releasably locking said sleeve on said mandrel at a position relative to said mandrel whereby said locking surfaces on said mandrel engage said locking means in said well packer; port means in said mandrel for communicating with said closed end of said flow passage through said mandrel; a valve sleeve releasably locked over said port means and actuatable by a pulling tool for equalizing pressure across said bridge plug by permitting fluid flow through said bridge plug past said annular seal assembly; clutch means associated with said mandrel and said sleeve for transmitting torque between said sleeve and said mandrel, said clutch means being engaged at a first position of said mandrel when said sleeve is locked on said mandrel and being disengaged at a second position of said mandrel relative to said sleeve to a position when said mandrel is disengaged from said sleeve; and a head member connected with said mandrel and provided with slot means for receiving lugs on running and pulling tools for supporting said bridge plug during installation and removal.

20. A bridge plug as defined in claim **19** wherein said clutch means comprises circumferentially spaced lugs on said sleeve extending toward said head member and circumferentially spaced lugs on said mandrel between said sleeve and said head member extending toward said sleeve, said sleeve and said mandrel lugs being adapted to intermesh for transmitting torque from between said mandrel and said sleeve and to be moved into spaced disengaged relation permitting relative rotation between said mandrel and said sleeve.

21. A bridge plug as defined in claim **19** wherein said valve sleeve is releasably engaged on said mandrel by shear means and seal means are supported between said valve sleeve and said mandrel on opposite sides of said port means communicating with said bore through said mandrel.

22. A bridge plug as defined in claim **19** wherein said sleeve means is provided with external downwardly opening J-slots and said head member is provided with external upwardly opening J-slots.

23. A bridge plug for closing a longitudinal flow passage through a packer in a flow conductor, said packer including locking lugs projecting into said flow passage and locking means around said flow passage in spaced relation to said lugs for holding said packer at a locked sealed position within said flow conductor, said bridge plug comprising: a tubular mandrel having a longitudinal bore providing a flow passage through said mandrel; a locking sub secured on one end of said mandrel, said locking sub having a flow passage extending therethrough communicating said flow passage in said mandrel and having an external locking surface engageable with said locking means in said packer for holding said locking means in locked relationship to prevent release of said packer from sealed locked relationship in said flow conductor while said locking surfaces on said mandrel engage said locking means in said packer; a sleeve positioned concentrically around said mandrel in slidable relationship thereto; seal means around said mandrel within said sleeve for sealing between said sleeve and said mandrel; locking slot means on said sleeve adapted to receive said lugs of said packer for releasably locking said bridge plug within said packer; an annular seal assembly on said sleeve for sealing around said bridge plug within said packer when said bridge plug is releasably locked within said packer; shearable means releasably locking said sleeve on said mandrel at a position whereby when said bridge plug is locked in said packer said locking surface of said locking sub is positioned within said locking means of said packer, said shearable means being adapted to shear to permit longitudinal movement of said mandrel in said sleeve for moving said locking sub locking surfaces out of locking relationship with said locking means of said packer; a tubular connector secured on the other end of said mandrel whereby said sleeve is positioned between said connector and said locking sub on said mandrel, said connector having a bore opening at one end into said bore through said mandrel and having a closed opposite end to prevent flow through said mandrel and said connector when said bridge plug is locked in sealed relationship in said packer, said connector having a lateral pressure equalization port opening into said bore of said connector for permitting fluid communication through said bridge plug past said annular seal assembly under

predetermined conditions; a valve sleeve positioned over said connector for covering said equalization port and slidable along said connector; seal means on opposite sides of said pressure equalization port for sealing between said connector and said valve sleeve when said valve sleeve is positioned over said port; means for releasably holding said valve sleeve against movement on said connector over said port; said sleeve being engageable by a pulling tool for moving said sleeve to uncover said pressure equalization port preliminary to disengagement of said bridge plug from said packer to equalize fluid pressure across said packer before said disengagement; clutch means associated with said sleeve on said mandrel and said connector at adjacent ends of said sleeve and said connector for transmitting torque between said connector and sleeve when said clutch means is engaged, said clutch means being engaged when said sleeve on said mandrel is releasably locked on said mandrel; a head secured on said connector adjacent to said valve sleeve, said head being provided with slots for releasable engagement of running and pulling tools for installation and removal of said bridge plug.

24. A bridge plug as defined in claim **23** wherein said slots on said sleeve comprise downwardly opening J-slots and said slots on said head comprise upwardly opening J-slots.

25. A bridge plug as defined in claim **24** wherein said clutch means comprises circumferentially spaced lugs on said sleeve extending toward said connector and circumferentially spaced lugs on said connector extending toward said sleeve, said lugs being adapted to intermesh for transmitting torque between said connector and said sleeve when said sleeve is at an end position on said mandrel adjacent to said connector and being adapted to being moved to spaced disengaged relationship permitting said connector and said mandrel to rotate relative to said sleeve.

26. A bridge plug as defined in claim **25** wherein said valve sleeve is larger in diameter than said head providing a shoulder surface facing said head for engagement by a handling tool for moving said valve sleeve on said connector to a position for uncovering said equalizing port to permit pressure equalization across said bridge plug when engaged in sealed relationship in said packer.

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