Jan. 21, 1969 C. C. BROWN 3,422,899

WELL PACKER

Filed Nov. 9, 1966 Sheet 1 of 3

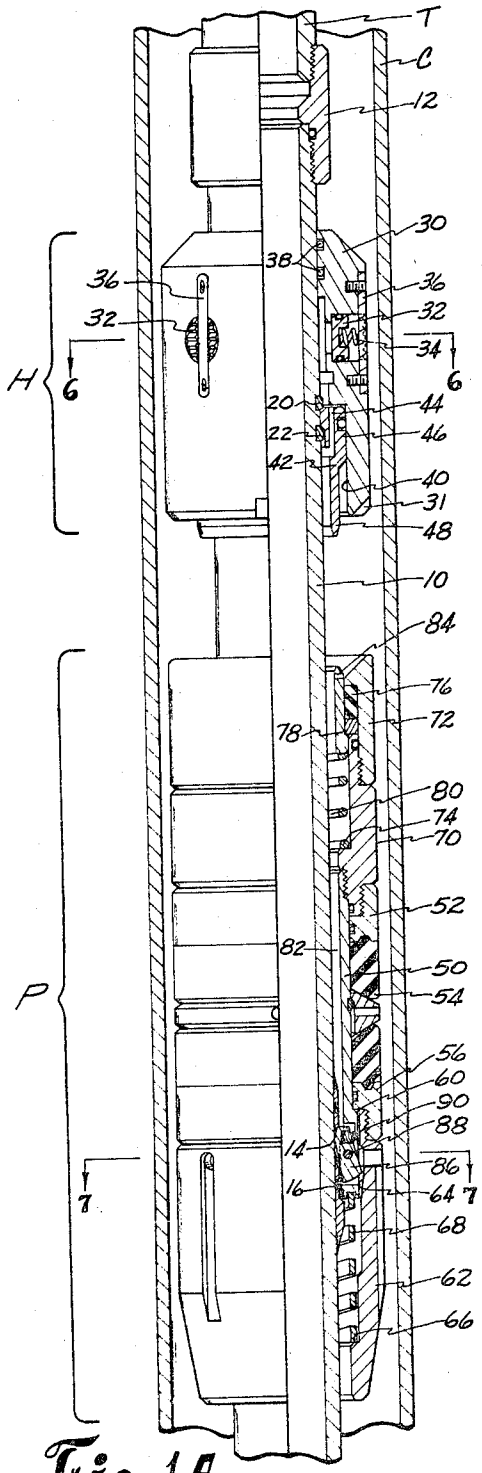


Fig. 1A

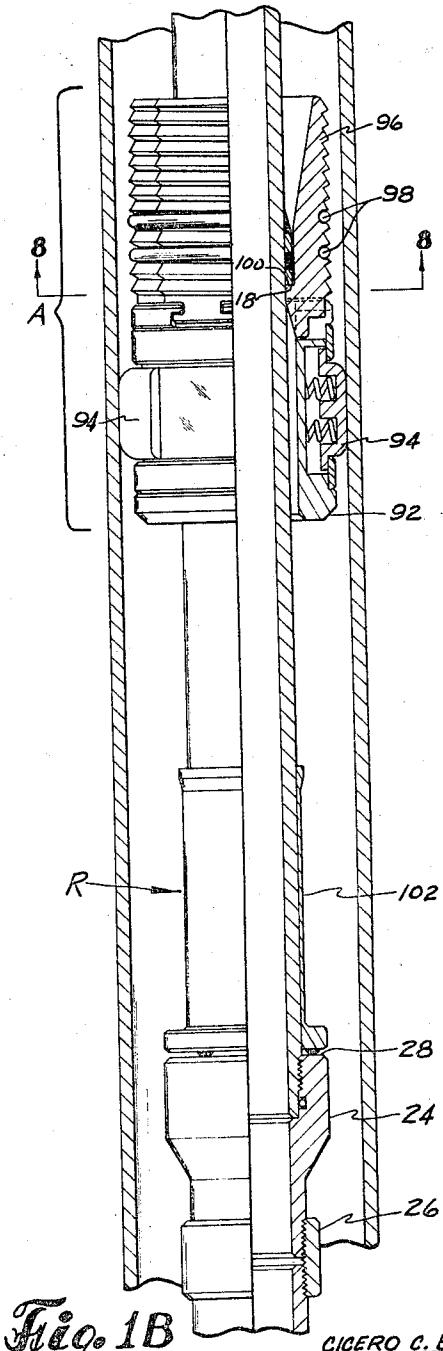


Fig. 1B

CICERO C. BROWN
INVENTOR.

BY Vincent Martin
Joe E. Edwards
Jack K. Spriggs
ATTORNEYS

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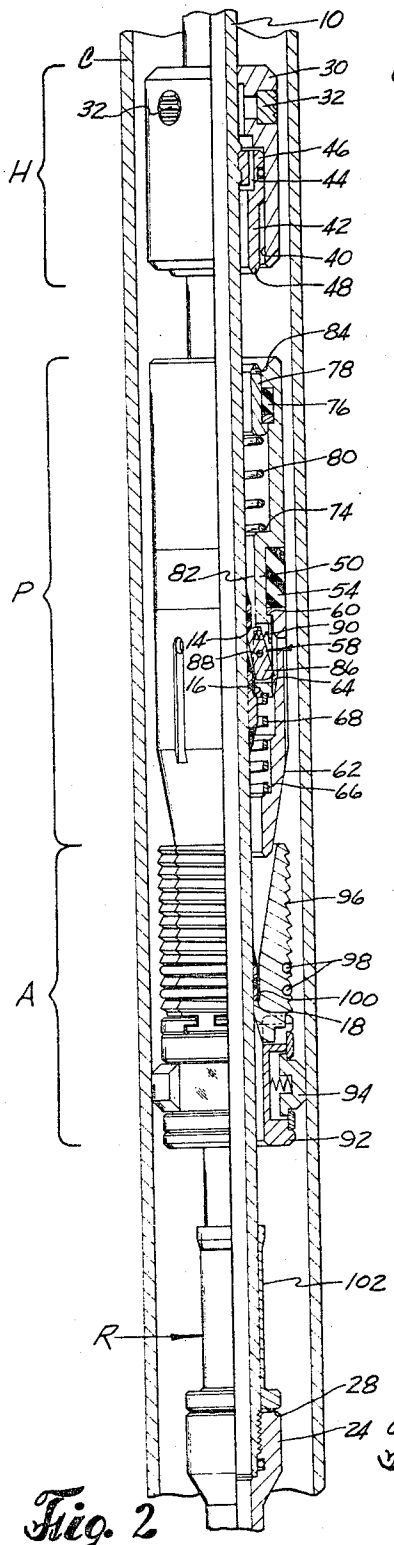


Fig. 2

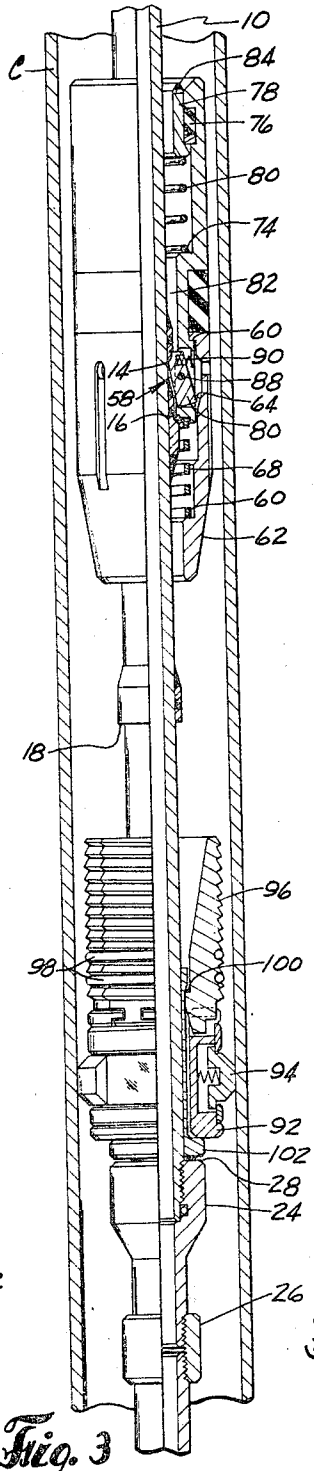


Fig. 3

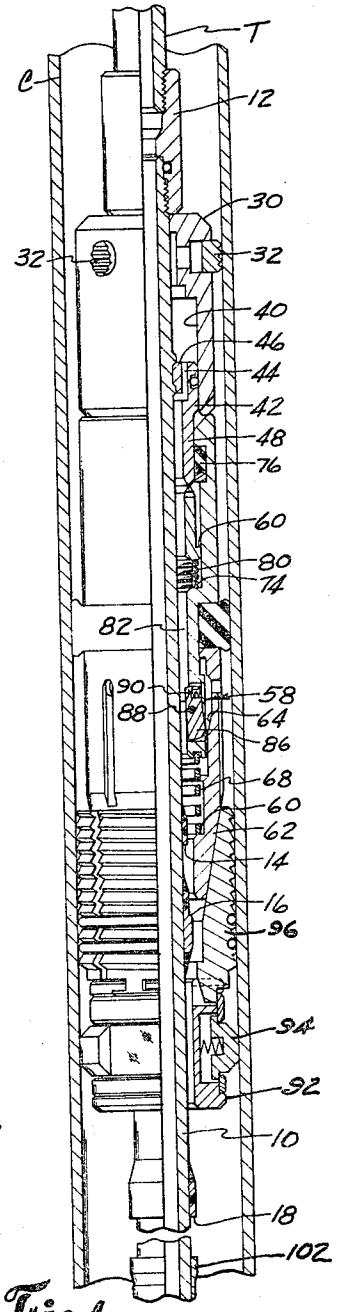


Fig. 4

CICERO C. BROWN
INVENTOR.

BY J. Vincent Martin
Joe E. Edwards
Jules L. Spriggs

ATTORNEYS

Jan. 21, 1969 C. C. BROWN 3,422,899

WELL PACKER

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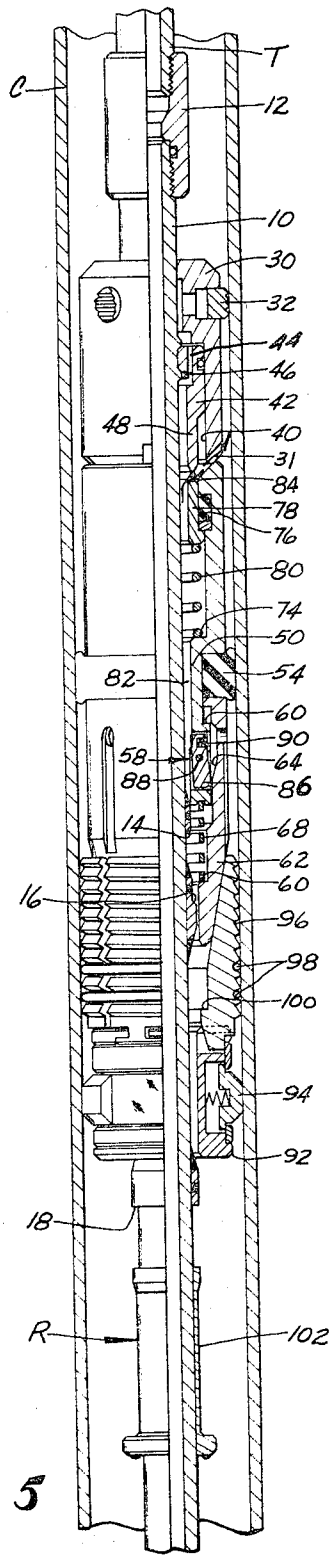


Fig. 5

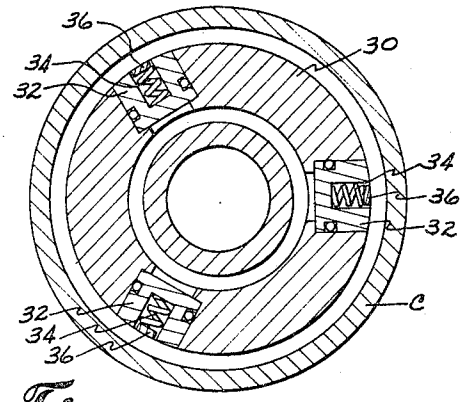


Fig. 6

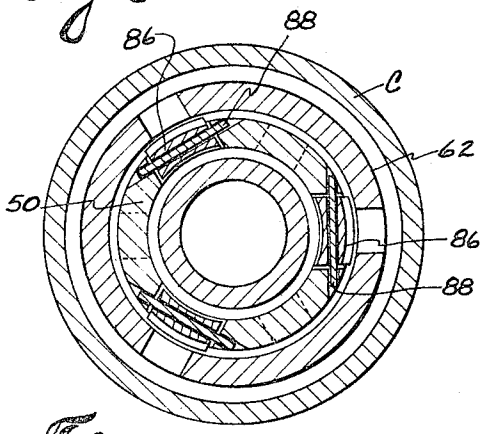


Fig. 7

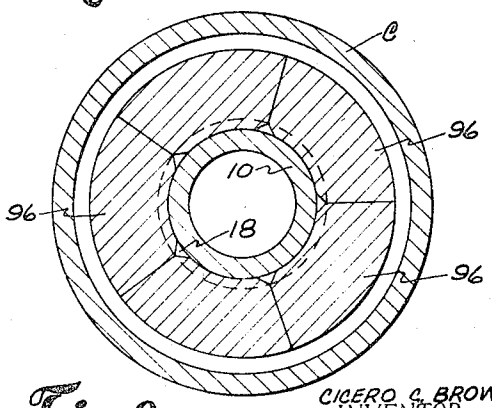


Fig. 8

CICERO C. BROWN
INVENTOR.

BY J. Vincent Martin
Joe E. Edwards
Jack R. Springgate
ATTORNEY

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3,422,899

WELL PACKER

Cicero C. Brown, 8490 Katy Road, Houston, Tex. 77024

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17 Claims
U.S. Cl. 166—129
Int. Cl. E21b 23/06

ABSTRACT OF THE DISCLOSURE

A well packer having a tubular support, a packing assembly releasably connected to the tubular support and defining a bypass passage, a holddown assembly secured to the tubular support and adapted to close the bypass passage, an anchoring assembly having gripping elements which gripping elements releasably connect the anchoring assembly to the tubular support and means for releasing the connection of the gripping elements to the tubular support.

The present invention relates to an improved well packer adapted for use in a well bore.

An object of the present invention is to provide an improved well packer which can be set in a well bore and includes a by-pass of the packing assembly which may be opened and closed without unsetting the packing assembly.

Another object of the present invention is to provide an improved well packer with a by-pass of the packing assembly which may be opened or closed and when closed, the fluid pressure forces are used to maintain the set position of the well packer.

A further object is to provide an improved well packer which may be set, unset and reset within a well bore without rotation of the well string on which the packer is mounted.

Another object is to provide an improved well packer which utilizes pressure differentials to maintain the set position of the well packer and can be easily released from set position and reset at another position within a well bore.

A further object is to provide an improved well packer which is weight set and remains set with a minimum of tubing weight on the packer regardless of the pressure differentials to which the packer is exposed.

A still further object is to provide a well packer with a piston controlled by-pass having a sealing assembly adapted to seal against the piston and which, because it is protected from exposure to well fluids, has a greatly extended life.

Another object is to provide an improved well packer having an anchoring assembly which is held in unset position during running by releasable engagement with the tubular support of the well packer.

These and other objects and advantages of the present invention are hereinafter set forth and explained in the following specification wherein the preferred form of the well packer as shown in the drawings is described and wherein:

FIGURES 1A and 1B are detailed partial longitudinal sectional views of the preferred form of well packer of the present invention. FIGURE 1B is the lower continuation of FIGURE 1A.

FIGURE 2 is a similar sectional view showing the well packer as it is run into a well bore.

FIGURE 3 is another similar sectional view of the well packer after the tubing has been raised to accomplish release of the anchoring assembly from the tubular support.

FIGURE 4 illustrates the well packer in set position with the by-pass closed.

FIGURE 5 illustrates the well packer in set position with the by-pass open.

FIGURE 6 is a transverse sectional view of the hold-down assembly taken along line 6—6 in FIGURE 1A.

FIGURE 7 is a transverse sectional view of the packing assembly taken along line 7—7 in FIGURE 1A and showing the details of the latching dogs.

FIGURE 8 is a transverse sectional view of the anchoring assembly taken along line 8—8 in FIGURE 1B.

As illustrated in FIGURES 1A, 1B and 2, the well packer is run into a well bore, such as within the casing C, supported by the tubing string T. The well packer includes the upper hold-down assembly H, the packing assembly P, the anchoring assembly A and the release means R, all mounted around and supported on tubular support **10** as hereinafter described.

Tubular support **10** is suitably connected to the tubing string T by the coupling **12** and forms an extension thereof. The tubular support **10** is provided with three external shoulders, the downwardly facing shoulder **14**, the upwardly facing shoulder **16** and the lower downwardly facing shoulder **18**, and snap rings **20** and **22** to operably support the assemblies of the well packer thereon. The lower end of tubular support **10** is connected to the lower extension of tubing string T by the collar **24** and the coupling **26**. The collar **24** defines the upwardly facing shoulder **28** normally supporting the releasing means R.

The hold-down assembly H includes the body **30** which surrounds and is slidable on tubular support **10**. Pressure responsive gripping means, such as, gripping buttons **32**, are positioned within recesses in body **30** and are biased inwardly by the springs **34** which are supported by the strips **36** mounted on the exterior of body **30**, each of the strips **36** spanning one of the button recesses. The interior of body **30** in cooperation with the exterior of tubular support **10** defines a communication from below the body to the inner surface of the gripping buttons **32**. The gripping buttons **32** are sealed against the interior of the recesses in which they are mounted so that they move radially outward into gripping position responsive to the pressure of fluids on their inner surface.

The upper portion of the interior surface of body **30** includes seals, such as, O-rings **38**, to provide a seal against the exterior of tubular support **10**. The lower interior of body **30** defines the cylinder **40** in which balance piston **42** is positioned. Body **30** is slidable on tubular support **10** between coupling **12** and piston **42**. Balance piston **42** is annular in shape and is secured to the exterior of tubular support **10** by the snap rings **20** and **22**. The exterior of balance piston **42** is sealed against cylinder **40**. Balance piston **42** defines a restricted passageway **44** which communicates through the head **46** of piston **42** to the inner surface of gripping buttons **32**. The depending skirt **48** of said balancing piston **42** is spaced from both the exterior of tubular support **10** and the wall of cylinder **40**. The piston **42** functions as a means of closing the packing assembly by-pass, a means directing pressure from below the packing assembly P when set, to the gripping buttons **32** and a means providing a balancing force downward to offset the pressure force on the tubing string, as hereinafter more fully explained.

The packing assembly P surrounds the tubular support at a position below and spaced from the hold-down assembly H. The packing assembly P includes the packing sleeve **50**, the upper end of which is connected to the upper abutment ring **52** as shown; the packing element **54** which may take any desired form surrounding the sleeve **50**, such as, the dual elements separated by the packing follower as shown in FIGURE 1A or a single packing element as shown in FIGURES 2, 3, 4 and 5; a lower abut-

ment ring **56**; and the means **58** for releasably connecting the packing assembly P to the tubular support **10**. The packing sleeve **50** supports the ring **56** on its shoulder **60** when the packing element **54** is relaxed. Movement of abutment ring **56** toward abutment ring **52** compresses the packing element **54** longitudinally and forces it radially outward into sealing engagement with the interior surface of casing C. Expander cone **62** is connected to the ring **56** and is adapted to set the anchoring assembly A as hereinafter explained. The upper interior surface **64** of expander cone **62** is tapered downwardly and inwardly to provide a camming release of the means **58**. The shoulder **66** on the interior of expander cone **62** supports one end of spring **68**. The spring **68** also engages the lower end of packing sleeve **50** to urge expander cone **62** and abutment ring **56** downwardly with respect to sleeve **50**. Both packing sleeve **50** and expander cone **62** are provided with passages therethrough to assure that the by-pass around packing assembly P is not blocked or restricted by the seating of the lower end of packing sleeve **50** on the shoulder **16** and by the engagement of the expander with the anchoring assembly A.

The upper end of packing sleeve **50** is extended by the rings **70** and **72** as shown in FIGURE 1A but is, for purpose of clarity, shown in the remainder of the figures to be a single sleeve of similar configuration. The ring **70** defines the upwardly facing shoulder **74**. The packing seal **76** is positioned in an interior recess in ring **72** and the packing protector **78** is movably positioned within the rings **70** and **72**, surrounding the tubular support **10** and is normally urged by the spring **80** which is supported on shoulder **74** into sealing engagement with the packing seal **76**. It should be noted that the entire packing assembly P is spaced from the exterior of the tubular support **10** to provide the by-pass passage **82** which communicates across the packing assembly P. The upper edge of protector **78** defines the slots **84** and the lower edge of body **30** defines the slots **31** which allow opening of the by-pass around the packing assembly P when the packing assembly is set as hereinafter explained.

The connecting means **58** includes, in the preferred form best shown in FIGURE 7, three dogs **86** pivotally positioned in windows in packing sleeve **50** by the pins **88** and having their upper edges urged inwardly by the springs **90**. In running position as shown in FIGURE 1A, the upper inner edge of dogs **86** engages the shoulder **14** to hold the packing assembly P in its desired position on tubular support **10**.

When the well packer is run into the well casing C, the by-pass **82** is open allowing fluids in the well to flow therethrough and around the exterior of the packing assembly to increase the speed at which the well packer may be run into the desired position in the well casing C. As the packing assembly P is set, the lower outer edge of dogs **86**, by engagement with the surface **64** on the expander cone **62**, causes the dogs to be pivoted so that they clear shoulder **14**. With the dogs in this position, the tubular support **10** is free to move downwardly through the packing assembly P whereby setting is accomplished. The engagement of the lower end of sleeve **50** on the shoulder **16** supports the packing assembly P on the tubular support **10**.

The anchoring assembly A includes the body **92** in which are mounted a plurality of friction means, such as the spring loaded wiper blocks **94**, and the gripping elements **96** which are connected to the body **92** by the usual T slot connections so that the gripping elements **96** may be urged outwardly into pipe gripping position by the expander cone **62**. Means such as springs **98** are provided to normally urge the gripping elements **96** inwardly to maintain the engagement between the shoulder **100** on the interior of gripping elements **96** with the shoulder **18** on tubular support **10** and thus maintain the anchoring assembly A in running position until released for setting.

The illustrated releasing means R which is adapted to coact with the anchoring assembly A to release it from its running position is a sleeve **102** surrounding and slidable on the lower end of tubular support **10** and supported in running position on the shoulder **28** of collar **24**. The upper end of the sleeve **102** is enlarged to have substantially the same outer diameter as the shoulder **18**. The exterior of sleeve **102** is tapered from such enlargement downwardly and inwardly to the outer diameter of the remainder of sleeve **102**.

Release of the anchoring assembly A is accomplished by lifting the tubing string to move the sleeve **102** through the anchoring assembly A to the position illustrated in FIGURE 3. Upward movement of tubular support **10** does not move anchoring assembly A upward since it is held in position by the frictional engagement of the wiper blocks **94** with the interior of casing C. Once the upper enlargement on sleeve **102** has passed through the shoulder **100** on gripping elements **96**, the anchoring assembly A is released and may be set by lowering the tubing string T. During lowering, shoulder **18** engages the upper end of sleeve **102** and moves the enlarged portion of sleeve **102** through the shoulder **100** on gripping elements **96**. The taper on sleeve **102** moves the gripping elements **96** outwardly so that shoulder **18** readily passes therethrough. Once the shoulder **18** has passed through the shoulder **100** on the gripping elements **96**, the sleeve **102** is free to slide downwardly on the tubular support **10** and stops when it engages the shoulder **28** on collar **24**. The engagement of the shoulder **100** with the taper on sleeve **102** also functions to hold the sleeve **102** in engagement with the shoulder **18** until sleeve **102** is forced therethrough by shoulder **18**.

In operation, the well packer is run into a well bore on the tubing string T with the various components and assemblies positioned as illustrated in FIGURES 1A, 1B and 2; FIGURE 2 being substantially similar but showing the complete structure in one view for ease of comparison with FIGURES 3, 4 and 5.

When the well packer is positioned at the desired level in the well casing C for setting, the anchoring assembly A is first released by lifting the tubing string T as hereinbefore described. Thereafter the tubing string T is lowered and the expander cone **62** engages the inner tapered surfaces of the gripping elements **96** to urge them outwardly into pipe gripping engagement with the interior of casing C. The wiper blocks **94** provide sufficient resistance to the movement of the anchoring assembly A during this action to assure that the gripping elements **96** are set by the expander cone **62**. The resistance offered to the movement of the expander cone **62** on the inner surface of the gripping elements **96** moves the packing sleeve **50** and dogs **86** downwardly with respect to the expander cone **62** and the inner surface **64** engages the dogs **86** to pivot them out of engagement with the shoulder **14**.

The continued lowering of the tubing string then is relatively free until the hold-down assembly H comes into contact with the packing assembly P. The lower end of the body **30** contacts the upper end of packing sleeve **50** at approximately the same time that the lower end of the skirt of balance piston **42** contacts the upper edge of the packing protector **78**. Since the body **30** is free to slide a short distance with respect to the tubular support **10**, the skirt **48** first moves the packing protector **78** down and as it does so, it moves into engagement with packing seal **76** to close the communication of the by-pass passage **82** with the exterior portion of the well packer and provides communication to the gripping buttons **32** through the restricted passageway **44**. With further downward movement of the tubing string T, the coupling **12** engages body **30** and forces it and sleeve **50** downwardly to thereby set the packing element **54** by moving the upper abutment downwardly while the lower abutment is held against downward movement by the gripping elements **96**. Thus, the well packer is in set position as illustrated

in FIGURE 4 with the by-pass passage closed and communication established from below the packing assembly P to the gripping buttons **32**.

In this set position, a greater pressure below the packing element **54** than above is exerted through the by-pass passage **82**, the restricted passageway **44** to the inner surface of the gripping buttons **32** and to the upper surface of the head **46** of the balance piston **42**. This pressure urges the gripping buttons **32** outwardly into gripping engagement with the interior of casing C to prevent movement of the well packer upwardly and also by virtue of the greater area of the upper surface of head **46**, exerts a force downwardly which is preferred to be at least equal to the pressure force exerted upwardly on the balance piston **42** and on the tubular support **10**. This balancing of the pressure forces by balance piston **42** and the holding of the gripping elements **32** eliminates the need for having excessive tubing weight exerted on the well packer to maintain its set position.

When the pressure above the packing element **54** is greater than the pressure below, this pressure is exerted against the element **54** to tend to set it tighter against the interior of casing C and also is transmitted to expander cone **62** to wedge it tighter against the interior of gripping elements **96**. It should be noted that the teeth on gripping elements **96** are faced in a downwardly direction so that they resist any downward movement when set against the casing C. Therefore, the well packer of the present invention when set, remains in set position when exposed to pressure differentials and utilizes such pressure differentials to maintain the set position.

In many installations, it is desired to be able to open a by-pass around a well packer while the packer remains set. This is readily accomplished in the well packer of the present invention by lifting the tubing string T only a sufficient distance to position the balance piston **42** against the upper end of the cylinder **40** in the body **30**. In this position, the skirt **48** of the balance piston **42** is withdrawn from engagement with the packing seal **76** and at the same time, the packing protector **78** is urged upwardly by the spring **80** to engage the packing seal **76** and maintain engagement with the lower end of skirt **48**. Since piston skirt **48** and the lower edge of body **30** are provided with slots, the by-pass is opened to communicate to the exterior of the well packer above the packing element **54**. This opening of the by-pass is clearly illustrated in FIGURE 5 and the flow of fluids from below the packing element **54** is shown by the arrows. When the by-pass has ben opened with the packing element **54** in set position, the pressures thereacross are equalized and there are no forces tending to unset the packing element or the gripping members. During the lifting of the tubing string T to open the by-pass, the set position is maintained by the pressure on the inner surface of the gripping buttons **32** until the by-pass is fully opened.

With the well packer in set position, it is released by lifting the tubing string T. The initial portion of the upward movement of tubular support **10** opens the by-pass as hereinbefore described, to equalize fluid pressure across packing element **54**. Continued lifting moves the shoulder **16** into engagement with the lower edge of packing sleeve **50** and lifts sleeve **50** to remove the upper abutment from supporting the longitudinal compression of packing element **54**. Additionally, the spring **68** exerts a force on the packing sleeve **50** tending to move it upwardly with respect to expander cone **62**. Further upward movement causes shoulder **60** on packing sleeve **50** to engage and pull expander cone **62** out from under the gripping elements **96**. When sleeve **50** picks up expander cone **62**, the lower edge of dogs **86** are free from contact with surface **64** and are urged inwardly to engage shoulder **14**. Upon the removal of expander cone **62** from under gripping elements **96**, the springs **98** cause the gripping elements **96** to retract so that shoulders **100** are positioned to engage shoulder **18** on tubular support **10**. Thus, the well packer has been returned to the position illustrated in FIGURE 2. If it is desired to lower the well packer in the well bore, it may be done by lowering the tubing string T. The well packer can then be set at any desired level in accordance with the setting procedure previously described. If it is desired to set the well packer at a higher level or to pull it from the well bore, the tubing string T is raised and the well packer assumes the position illustrated in FIGURE 3, with the release sleeve **102** within the anchoring assembly A. The well packer may be set from such position by lowering the tubing string T when the well packer is positioned at the desired level. It sets as previously set forth since the anchoring assembly A has been moved to a position for setting.

From the foregoing it may be seen that the improved well packer of the present invention is readily run into a well bore, set, unset and moved to another position for setting. The well packer also includes provision for the opening and closing of the by-pass around the packing assembly and for communicating fluid pressure below the packing element to the hold-down gripping elements when the by-pass is closed. Further the balance piston by exposing a greater head area to fluid pressure, provides a balancing force to offset pressure forces on the tubing and the lower side of the balance piston resulting from the fluid pressures below the packing assembly and thereby eliminates the necessity of maintaining substantial tubing weight on the well packer to hold its set position.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A well packer, comprising

a tubular support,

a packing assembly mounted on said tubular support and including a packing element positioned between an upper abutment and an expander cone,

means releasably connecting said packing assembly to said tubular support,

an anchoring assembly mounted on said tubular support and including gripping elements and friction means,

means on said gripping elements for releasably engaging said tubular support,

means for releasing said gripping elements from engagement with said tubular support responsive to a longitudinal reciprocation of said tubular support, and

means mounted on said tubular support and adapted to engage said upper abutment on said packing assembly after said gripping elements are disengaged from said tubular support whereby said expander cone moves with said tubular support to engage and set said gripping elements and said packing element is compressed into set position between said upper abutment and said expander.

2. A well packer according to claim **1**, wherein said releasable engaging means includes

an external shoulder on said tubular support, and

an internal shoulder on said gripping elements adapted to normally engage said external shoulder on said tubular support.

3. A well packer according to claim **2**, wherein said releasing means includes

a sleeve slidably mounted on said tubular support, and

means on said tubular support for moving said release sleeve into engagement with said gripping elements to disengage said internal shoulder on said gripping elements from said external shoulder on said tubular support.

4. A well packer according to claim **1**, wherein said connecting means includes

an external shoulder on said tubular support,
a dog,
means mounting said dog on said packing assembly,
said dog being normally urged to engage said external shoulder, and
means moving said dog out of engagement with said external shoulder during setting of said packing element.

5. A well packer according to claim **4**, wherein said moving means includes
a tapered surface on said expander cone engaging said dog during setting to move said dog out of engagement with said external shoulder.

6. A well packer, comprising
a tubular support,
a packing assembly surrounding said tubular support and spaced therefrom to define a by-pass passage,
means releasably connecting said packing assembly to said tubular support,
an anchoring assembly mounted on said tubular support and having gripping elements adapted to be moved outwardly into pipe-gripping position responsive to a lowering of said tubular support,
releasable means preventing the setting of said anchoring assembly, and adapted to release responsive to a lifting of said tubular support, and
holddown means secured to said tubular support and adapted to close said by-pass passage responsive to a lowering of the tubular support after said packing assembly and said anchoring assembly are set whereby said holddown means is actuated responsive to the pressure in said by-pass passage when said by-pass passage is closed.

7. A well packer according to claim **6**, wherein said means closing said by-pass passage includes
a piston surrounding and connected to said tubular support, and
a packing seal surrounding one end of said by-pass passage,
said piston adapted to engage said packing seal in sealed relationship responsive to longitudinal movement of said tubular support after said packing and anchoring assemblies have been set.

8. A well packer according to claim **7**, including
a protector slidably mounted to sealingly engage said packing seal, and
means resiliently urging said protector into engagement with said packing seal whereby said packing seal is protected from well fluids.

9. A well packer according to claim **6**, including
a gripping button assembly mounted on said tubular support and having gripping buttons adapted to move radially outward into gripping position responsive to fluid pressure on the inner surface of said buttons,
said means closing said by-pass passage defines a passage to provide communication from said by-pass passage to the inner surface of said buttons whereby said buttons are exposed to and actuated by the fluid pressure from the side of said packing assembly opposite to said gripping button assembly.

10. A well packer according to claim **6**, wherein
said holddown means closing said by-pass passage defines slots whereby lifting of said holddown by said tubular support opens said by-pass passage through said slots while maintaining said packing and anchoring assemblies in set position.

11. A well packer according to claim **9**, wherein said means closing said by-pass passage includes
an annular piston, and
an internal packing seal supported on the interior of said packing assembly surrounding said by-pass passage,
said annular piston having a head portion and a depending skirt portion,

the depending skirt portion of said piston adapted to engage and seal in said internal packing seal.

12. A well packer according to claim **11**, wherein
said head of said piston defines a passage to provide the communication between said by-pass passage to said gripping buttons.

13. A well packer according to claim **11**, wherein
the outer diameter of said head portion of said piston being larger than the outer diameter of said depending skirt portion whereby when said piston is in position closing said by-pass passage, the pressure force on said head of said piston more than balances pressure forces on said piston and said tubular support to maintain the set position of said packing and anchoring assemblies.

14. A well packer, comprising
a tubular support having an upper and a lower external shoulder,
a packing assembly having a packing element positioned between an upper abutment and a lower expander cone,
means releasably connecting said packing assembly to said upper shoulder on said tubular support,
an anchoring assembly including gripping elements and friction means,
said gripping elements releasably engaging said lower shoulder on said tubular support, and
means releasing said gripping elements from said lower shoulder responsive to a lifting and lowering of said tubular support,
the lowering of said tubular support after release of said gripping elements moving said expander cone under said gripping elements to set them in pipe-gripping position and to move said upper abutment down to set said packing element between said expander cone and said upper abutment.

15. A well packer according to claim **14**, including
a hold-down button assembly secured to and surrounding said tubular support above said packing assembly and having gripping buttons adapted to move to gripping position responsive to fluid pressure to resist upward movement of said tubular support,
said packing assembly defining a by-pass passage communicating from below to above said packing element, and
means associated with said hold-down assembly adapted to close said by-pass passage when said anchoring and packing assemblies are set and to provide communication from said by-pass passage to said gripping buttons whereby said gripping buttons are moved to gripping position when the fluid pressure below said packing exceeds the fluid pressure above said passage.

16. A well packer according to claim **15**, wherein
said means closing said by-pass passage also is adapted to open said by-pass passage without unsetting said anchoring and packing assemblies.

17. A well packer according to claim **15**, wherein
said by-pass closing means, when closed, exerts a downward pressure force on said tubular support greater than the upward pressure force on said tubular support.

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JAMES A. LEPPINK, *Primary Examiner.*

U.S. Cl. X.R.

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