United States Patent [19]

Rodgers

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[54] **BLOW OUT PREVENTER**

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[52] **U.S. Cl.** **166/121,** 166/135, 166/217

[51] **Int. Cl.** **E21b 33/12,** E21b 23/00

[58] **Field of Search** 166/192, 212, 217, 224, 166/135, 121; 137/533

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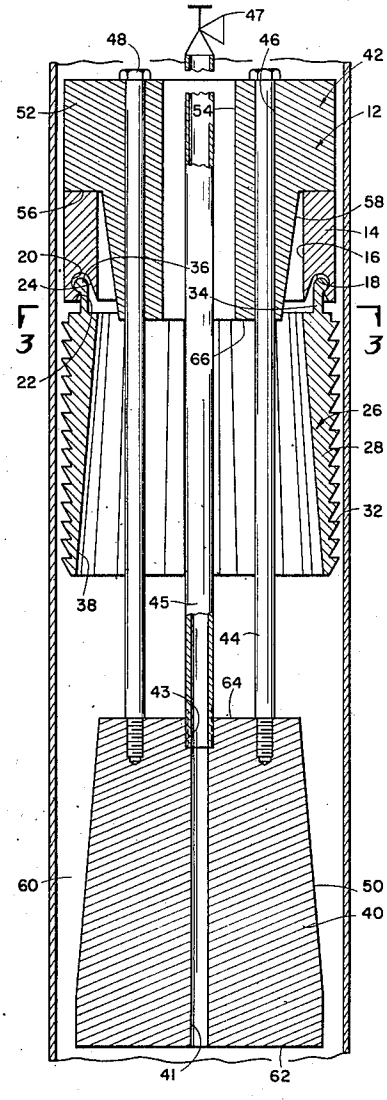
Primary Examiner—James A. Leppink

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[57] **ABSTRACT**

A blow out preventer for producing oil and/or gas wells and comprising a carrier member adapted to be anchored in the well casing at a preselected position below the well tubing and above the uppermost fluid producing subsurface formation. A locking wedge assembly is carried by the carrier member and includes a plurality of slip members hingedly secured to the carrier member selectively engagable with the inner periphery of the well casing. A ram wedge is movably suspended in a normal position below the wedge assembly and hangs from a release knock-out member normally disposed above the carrier member. When a pressure surge occurs in the well casing below the blow out preventer, the ram wedge is moved upwardly into engagement with the wedge assembly for engaging the slips with the outer periphery of the well casing for blocking off the fluid passageway in the well casing and precluding transmitting of the pressure surge to the surface of the well.

6 Claims, 5 Drawing Figures



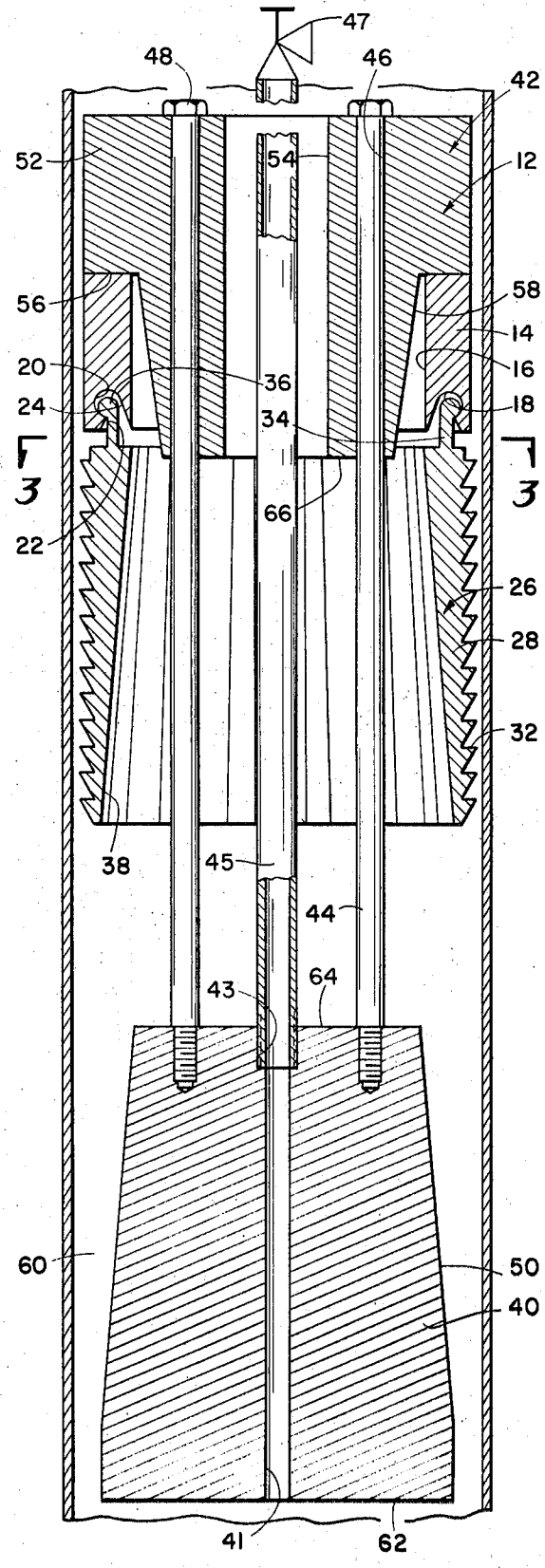


Fig. 1

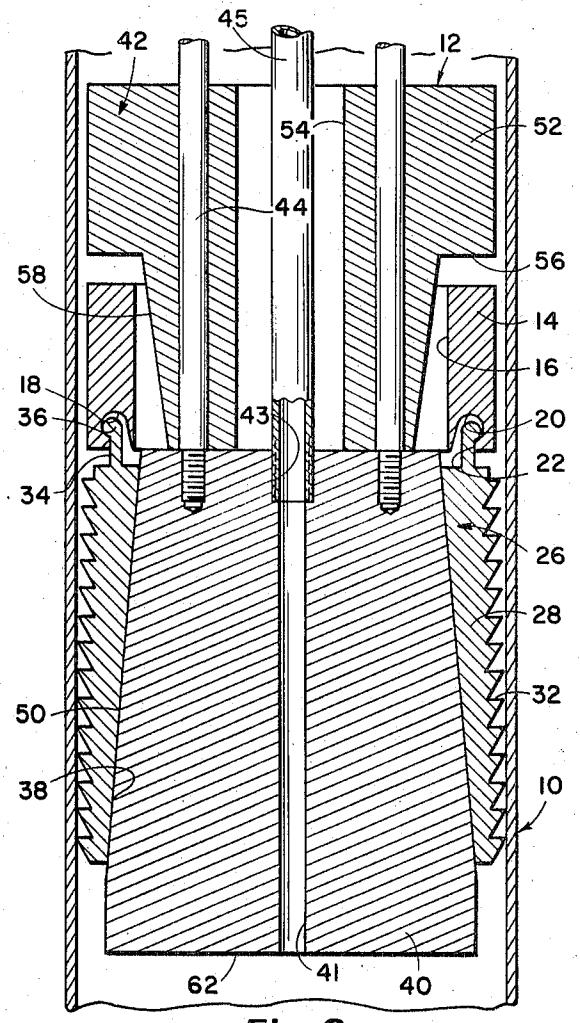


Fig. 2

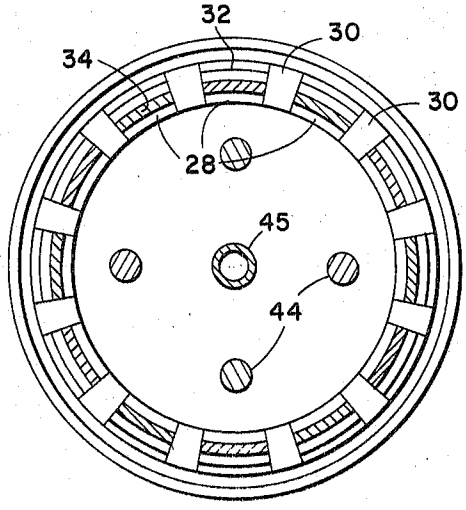


Fig. 3

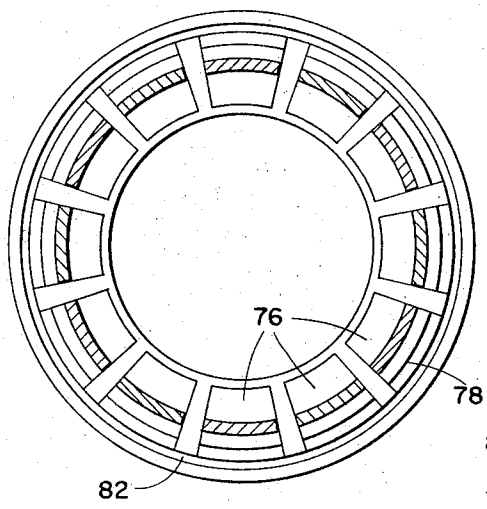

76
78
82

Fig. 5

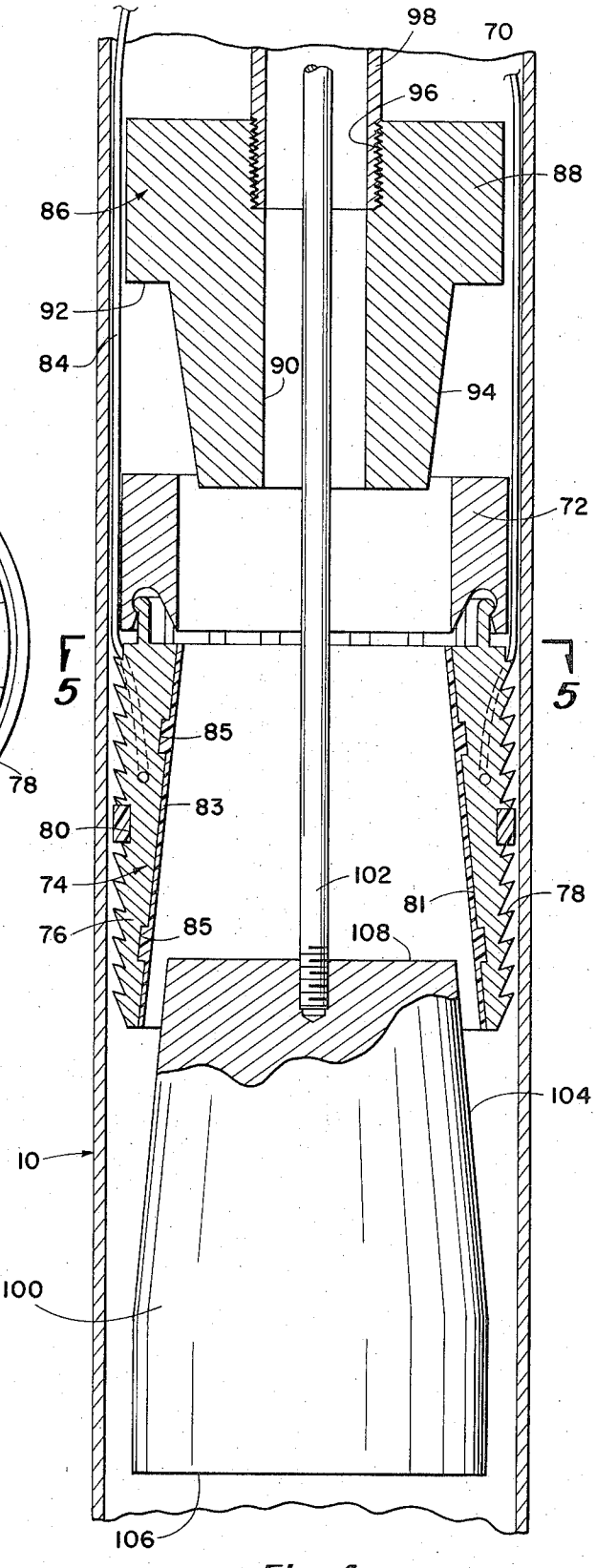

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100
106

Fig. 4

BLOW OUT PREVENTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to improvements in oil well blow out preventers and more particularly, but not by way of limitation, to a blow out preventer for producing oil and/or gas wells and having a pressure block automatically responsive to pressure surges in the well bore therebelow for blocking the fluid passageway until normal pressure conditions are restored in the well bore.

2. Description of the Prior Art

In the oil and/or gas producing industry, a producing well bore is normally provided with a well casing which extends downwardly in the well bore into communication with at least one fluid containing subsurface formation. A well tubing is normally disposed within the well casing extending downwardly from the surface of the well bore to a termination point above the producing formation. The well fluid is normally directed to the surface of the well bore through the well tubing by a pumping operation, or the like, and thence is directed to a suitable storage area. The fluid pressure in the lower portion of the well bore may suddenly and unexpectedly become excessively great, and it is desirable to preclude the transmission of the excessive pressure to the surface of the well. Consequently, it is common practice to provide a safety valve or blow out preventer in the well casing below the well tubing and above the uppermost subsurface producing formation for temporarily closing off communication with the well tubing when excessive pressure conditions occur. Many of the devices presently available are difficult to install in the well bore, particularly considering that the site of the installation may be many thousands of feet below the surface of the ground. Other available devices of this type are difficult to reopen subsequent to the restoration of the normal pressure conditions in the well bore therebelow.

SUMMARY OF THE INVENTION

The present invention contemplates a novel blow out preventer for producing oil and/or gas wells and adapted to be readily installed in a well casing below the lower end of the well tubing and above the uppermost producing formation in the well bore. The novel blow out preventer is provided with a carrier member adapted to be anchored in the well casing at the desired location for supporting the blow out preventer in the well casing. A wedge assembly is secured to the carrier member and is provided with a plurality of slip members hingedly or pivotally depending from the carrier member for selective engagement with the inner periphery of the well casing. A release knock-out is disposed in the well casing above the carrier member and a pressure block or ram wedge is suspended from the release knock-out in a normal position spaced below the wedge assembly whereby normal flow of well fluid may be provided through the blow out preventer during normal fluid production operations. The pressure block or ram wedge is vertically movable within the well bore with respect to the release knock-out and wedge assembly, and is automatically responsive to a pressure surge or pressure increase in the well bore therebelow for moving upwardly into sealing engagement with the wedge assembly for moving the slips into a biting engagement with the outer periphery of the well casing and blocking off or sealing off the communication with the well tubing to preclude transmitting of the excessive pressure upwardly to the surface of the well. When the normal pressure conditions have been restored in the well bore below the pressure block or ram wedge, the release knock-out may be utilized for removing the ram wedge from the sealing engagement with the wedge assembly and permitting the normal flow of the well fluid for resuming the fluid production operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional elevational view of a blow out preventer embodying the invention disposed within a well casing and depicting the normal position thereof during normal well fluid producing operations.

FIG. **2** is a sectional elevational view of the blow out preventer shown in FIG. **1** depicting the sealed or blocked position thereof during excessive pressure conditions in the well casing therebelow.

FIG. **3** is a sectional view taken on line **3—3** of FIG. **1.**

FIG. **4** is a sectional elevational view of a modified blow out preventer embodying the invention disposed within a well bore in the normal position thereof during normal well fluid producing operations.

FIG. **5** is a sectional view taken on line **5—5** of FIG. **4.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in detail, and particularly FIGS. **1, 2,** and **3,** reference character **10** generally indicates a well casing, or the like, having a blow out preventer **12** disposed in the lower portion thereof, below the well tubing (not shown) and above the uppermost subsurface fluid producing formation (not shown). The blow out preventer **12** comprises a substantially cylindrical carrier ring **14** having a central bore **16** extending therethrough. An annular groove **18** is provided in the lower end of the carrier member **14,** as viewed in the drawings, and is concentrically disposed with respect to the bore **16.** The groove **18** extends substantially longitudinally in the carrier ring **14** and is provided with a rounded portion **20** interposed between a substantially straight shoulder **22** and a tapered shoulder **24** to provide a hanger section for supporting a locking wedge assembly generally indicated at **26** and which extends longitudinally downwardly therefrom as shown in FIGS. **1** and **2.** In addition, the carrier member **14** is preferably provided with suitable anchor means (not shown) such as yieldable friction dogs (not shown), releasable slip member (not shown), or the like, on the outer periphery thereof for engagement with the inner periphery of the well casing **10** to securely anchor the ring **14** therein.

The locking wedge assembly comprises a plurality or circumferentially spaced slips **28** having yieldable spacers **30** interposed therebetween. The slips **28** are preferably constructed from a suitable metallic material, and the spacers are constructed from any suitable yieldable material, such as rubber, neoprene, or the like, and are bonded to the adjacent slips **28** in any well known manner. The slips **28** are of a substantially wedge-shaped cross-sectional configuration, as particularly shown in FIG. **3,** and the outer periphery of each slip **28** is provided with a plurality of longitudinally

spaced teeth or serrations 32. In addition, each slip is provided with an axially extending arcuate rib member 34 having a hanger member 36 on the outer end thereof which is substantially bulbous or spherical in cross-sectional configuration for engagement with the bulbous or rounded portion 20 of the recess or groove 18 in the carrier member 14. In this manner each slip 28 is pivotally or hingedly supported in the recess or hanger section 18.

The inner periphery 38 of the wedge assembly 26 is tapered outwardly and downwardly, as viewed in FIGS. 1 and 2, and may be either a smooth seating surface, or may be provided with a suitable yieldable material (not shown) bonded thereto or otherwise secured thereto to provide a seating and sealing surface for a purpose as will be hereinafter set forth.

A pressure block or ram wedge 40 is supported movably with respect to the carrier ring 14 and wedge assembly 26 and in the normal position thereof is susended at a position spaced below the wedge assembly 26, as shown in FIG. 1. The ram wedge 38 is carried by a release knock-out block 42 which is loosely disposed in the well casing 10 above the carrier member 14, and in the normal position thereof rests on the upper surface of the carrier ring 14 as shown in FIG. 1. The ram wedge 40 is suspended from the release knock-out 42 by a plurality of longitudinally extending rods 44. The rods 44 extend slidably through longitudinal bores 46 provided in the release knock-out 42 and have one end threadedly secured to the ram wedge 40 and the opposite end thereof provided with a head member or stop member 48 for limiting the movement of the rods 42 with respect to the release knock-out in one direction.

The ram wedge 42 is of a solid construction, and is provided with an upwardly and inwardly tapered portion 50 on the outer periphery thereof adapted for engagement with the tapered inner periphery 38 of the locking wedge assembly 26. The tapered portion 50 of the ram wedge 40 is preferably of a greater length than the tapered portion 38 of the locking wedge assembly for a purpose as will be hereinafter set forth.

The release knock-out 42 comprises a main body portion 52 having a central bore 54 extending longitudinally therethrough in open communication with the well casing 10 and the well tubing (not shown). An annular shoulder 56 is provided on the body 52 which is engagable with the carrier ring 14 in the normal position of the release knock-out, as shown in FIG. 1. The outer periphery 58 of the body 52 is tapered inwardly and downwardly below the shoulder 56, as viewed in FIGS. 1 and 2, and the maximum diameter of the tapered element 58 is preferably smaller than the inner diameter of the ring 14 to preclude interference therebetween. The tapered portion 58 is also preferably of a size smaller than the diametrical size of the inner periphery of the wedge assembly 26.

The bore 41 is threaded at 43 for receiving one end of a tube or conduit 45 therein. The tube 45 extends upwardly through the wedge assembly 26 and bore 54 of the release knock-out 42 and to the surface of the well bore. A suitable bleed off valve or pressure release valve 47 is provided in the proximity of the upper end of the conduit 45 for selectively bleeding off fluid pressure below the ram wedge 40 for a purpose and in a manner as will be hereinafter set forth.

When it is desired to install the blow out preventer 12 in the well casing 10, the blow out preventer 12 may be lowered within the well casing in any well known manner (not shown) to the desired position therein. The blow out preventer is normally disposed in the well casing 10 at a position spaced below the lower end of the well tubing (not shown) and above the uppermost fluid producing subsurface formation (not shown) of the well bore (not shown). The carrier ring 14 is anchored to the well casing 10 in any suitable manner (not shown) as is well known for supporting the blow out preventer 12 in the casing. During the normal operation for producing well fluid from the well bore, the well fluid normally passes or travels upwardly through the well casing 10 and into the well tubing (not shown) for delivery to the surface of the well. During this operation, the blow out preventer 12 is normally in the position shown in FIG. 1, with the release knock-out 42 resting on the upper end of the carrier ring 14, and the ram wedge 40 suspended below the wedge assembly 26. The well fluid may move upwardly through the annular chamber 60 between the ram wedge 40 and the inner periphery of the well casing 10, through the interior of the wedge assembly 26 and through the bore 54 and into the well tubing for continued passage to the surface of the well in the usual manner.

In the event of a sudden pressure surge or excessive pressure occurs in the well bore below the blow out preventer 12, the pressure acting on the lower surface 62 of the pressure block or ram wedge 40 causes the ram wedge to move upwardly in the well casing 10 and engage the tapered inner periphery 38 of the wedge assembly 26, as shown in FIG. 2. The upward movement of the ram wedge 40 causes the tapered portion 50 thereof to engage the tapered portion 38 of the wedge assembly 26 is a manner for moving the slips 28 outwardly into a biting engagement with the inner periphery of the well casing 10, thus cooperating with the carrier ring 14 for locking the blow out preventer 12 securely within the well casing. In addition, the upward force on the ram wedge 40 exerts a sealing pressure of the tapered surface 50 against the tapered surface 38 for precluding leakage of fluid therebetween.

As hereinbefore set forth, the tapered surface or portion 50 is preferably of a greater length than the tapered portion 38, thus assuring an efficient sealing pressure between the ram wedge 40 and the locking wedge assembly 26. As the slips 28 move outwardly into the biting engagement with the inner periphery of the well casing 10, yieldable spacers 30 expand simultaneously therewith and sealingly engage the inner periphery of the well casing for precluding leakage of fluid between the wedge assembly 26 and the well casing.

As the ram wedge 40 moves upwardly in the well casing 10, the rods 44 and conduit 45 move simultaneously therewith and slide upwardly with respect to the release knock-out 42, thus permitting a freedom of movement for the ram wedge 40. As the ram wedge 40 is forced upwardly within the wedge assembly 26, the upper end 64 of the ram wedge 40 will engage the lower end 66 of the tapered portion 58 of the release knock-out 42 thus raising the release knock-out to a position spaced from or out of engagement with the carrier ring 14, as clearly shown in FIG. 2. The blow out preventer 12 thus efficiently seals or blocks the interior fluid passageway of the lower portion of the well

casing and precludes the passage of the well fluid into the well tubing. Of course, the blow out preventer **12** will remain in the sealed position until it is desired to reopen the fluid passageway, such as subsequent to restoring of the normal pressure conditions in the well casing **10** below the blow out preventer **12.**

The pressure in the well casing below the blow out preventer **12** may be bled off or relieved in any well known manner. As particularly shown herein, the conduit **45** and bleed off valve **47** are provided for selectively releasing or relieving the pressure below the ram wedge **40.** It will be apparent that the bore **41** in the ram wedge **40** is open to the portion of the well casing therebelow, and provides communication between the conduit **45** and the lower portion of the well bore. Of course, any excessive pressure in the well bore beneath the blow out preventer **12** will be communicated upwardly through the conduit **45.** In order to relieve or bleed off this excess pressure, the bleed off valve **47** may be opened in any well known manner for bleeding off the pressure and restoring normal pressure conditions to the lower portion of the well casing. It is to be noted that there is no intention of limiting the invention to this particular method and means of restoring the normal pressure conditions in the well casing below the blow out preventer **12.**

When it is desired to resume the normal well fluid production, or for any other reason it is desired to reopen the fluid passageway through the well bore, suitable jarring means (not shown) may be utilized in the well known manner for exerting a jarring downward force on the release knock-out **42** for knocking the pressure block or ram wedge **40** downwardly and out of sealing engagement with the locking wedge assembly **26.** The knocking action or jarring action will break the sealing pressure between the tapered surfaces **38** an **50,** and permit the ram wedge **40** to drop downwardly in the well casing to the normal position thereof shown in FIG. **1.** Of course, the rods **44** move simultaneously with the ram wedge **40,** and as the head or stop members **46** engage the release knock-out **42,** the release knock-out will move downwardly simultaneously therewith until the release knock-out is in engagement with the carrier ring **14.** The slips **28** may remain in engagement with the inner periphery of the well casing **10.** However, the yieldable spacers **30** may contract to the normal position thereof with sufficient force to retract the slips **28** from engagement with the well casing, or, if desired, additional means (not shown) may be provided for facilitating release of the slips **28** from the biting engagement with the inner periphery of the well casing when the blow out preventer **12** is returned to the normal position thereof.

Referring now to FIGS. **4** and **5,** a generally similar blow out preventer **70** is shown which comprises a carrier ring **72** substantially identical to the carrier ring **14** and having a locking wedge assembly **74** secured thereto in substantially an identical manner as the locking wedge assembly **26.** The locking wedge assembly **74** is generally similar to the wedge assembly **26** and comprises a plurality of circumferentially spaced slips **76** of substantially wedge-shaped cross-sectional configuration, as shown in FIG. **5,** and having a plurality of longitudinally spaced teeth or serrations **78** provided on the outer periphery thereof. An annular groove **80** is provided on the outer periphery of each slip **76** and preferably substantially centrally disposed with respect to the length thereof. A yieldable or resilient band **82** is disposed around the outer periphery of the slips **76** and is preferably bonded or otherwise secured to the annular groove **80.** The band **82** may be constructed from any suitable flexible or yieldable material, such as rubber, neoprene, or the like. In addition, if desired, a release cable **84** may be provided for each slip **76,** with one end of the cable **84** being secured to the respective slip **76** in any well known manner (not shown) and the opposite end thereof being accessible at the surface of the well. Manual pressure or pulling of the cables **84** will be transmitted to the respective slips **76** for a purpose as will be hereinafter set forth. The inner periphery of the slips **76** are outwardly and downwardly tapered to provide a substantially conical inner periphery **81** for the wedge assembly **74.** In addition, the inner periphery of each slip **76** is preferably provided with a suitable yieldable material **83** bonded or otherwise secured thereto. If desired, a plurality of longitudinally spaced grooves **85** may be provided on the inner periphery of each slip **76** for receiving the yieldable material **83** therein for facilitating the bonding of the material **83** to the slips **76,** as is well known.

A release knock-out member **86,** generally similar to the release knock-out **42** is disposed in the well casing **10** and normally spaced above the carrier ring **72,** as clearly shown in FIG. **4.** The release knock-out **86** comprises a main body portion **88** having a central bore **90** extending longitudinally therethrough to provide a fluid passageway. An annular shoulder **92** is provided on the body **88** for engagement with the carrier ring **72** in order to limit the downward movement of the release knock-out **86** and the outer periphery of the body **88** is tapered downwardly and inwardly as shown at **94** and below the shoulder **92,** as viewed in FIG. **4,** generally similar and for the same purpose as the tapered portion **58** of the knock-out member **42.** The upper end of the bore **90** is threaded as shown at **96** for threaded engagement with the lower end of a hollow rod **98** which is suitably suspended from the surface of the well bore and extends downwardly in the well tubing into the proximity of the blow out preventer **70.**

A pressure block or ram wedge **100** generally similar to the ram wedge **40,** is suspended in a normal position spaced below the carrier ring **72** andout of engagement ith the wedge assembly **74,** as shown in FIG. **4.** The ram wedge **100** is carried by an elongated rod **102** which extends upwardly through the wedge assembly **74,** carrier ring **72,** release knock-out **88** and hollow rod **98.** The rod **102** may extend to the surface of the well bore and is provided with a suitable means (not shown) for limiting the downward movement thereof for limiting the downward movement of the ram wedge **100.** The outer periphery of the ram wedge **100** is provided with an upwardly and inwardly tapered portion **104** which is complementary to the outwardly and downwardly tapered inner periphery **81** of the wedge assembly **74.** The tapered portion **104** is preferably of a greater length than the tapered portion **81** for a purpose as will be hereinafter set forth.

The operation of the blow out preventer **70** is generally similar to the operation of the blow out preventer **10.** The carrier ring **72** may be anchored in the well tubing **10** in any suitable or well known manner, and is preferably disposed below the well tubing (not shown) and above the uppermost subsurface fluid producing

forming (not shown). The normal position of the blow out preventer **70** is substantially as shown in FIG. **4**, and during the normal fluid producing operation, the well fluid moves upwardly through the blow out preventer **70** and into the well tubing for passage therethrough to the surface of the well.

When a pressure surge or excessive pressure occurs in the well bore below the blow out preventer **70**, the pressure acting on the lower surface **106** of the ram wedge **100** causes the ram wedge to move upwardly in the well casing and then sealingly engage the inner periphery **81** of the wedge assembly **74**. The tapered portion **104** cooperates with the tapered portion **81** for moving the slips **76** into a biting engagement with the inner periphery of the well casing **10** for securely locking the blow out preventer **70** therein and for efficiently sealing the well casing for precluding the transmitting of the increased well pressure to the well tubing. The ram wedge remains in the sealing position until such a time as it is desired to reopen the blow out preventer for resuming the well fluid producing operation.

When it is desired to resume the fluid producing operation, the release knock-out **86** may be lowered in a jarring type action for striking the upper end **108** of the ram wedge **100** for knocking the ram wedge out of the sealing engagement with the wedge assembly **74**. This may be accomplished by lowering the rod **98** in any well known manner for bringing the knock-out member **86** into engagement with the ram wedge a sufficient number of times and with sufficient force for dislodging the ram wedge and permitting the ram wedge to drop to the normal position therefore.

From the foregoing it will be apparent that the present invention provides a novel blow out preventer for producing oil and/or gas well for precluding the inherent dangers from pressure surges in the well bore. The novel blow out preventer comprises a locking wedge assembly which may be anchored in the well casing below the well tubing and above the uppermost fluid producing formation. A ram wedge is suspended in the well casing in a normal position spaced with respect to the locking wedge assembly in such a manner as to precluding interference with the normal fluid producing operation. However, upon an excessive increase of pressure in the well below the blow out preventer, the ram wedge automatically sealingly engages the locking wedge assembly for temporarily sealing off the well casing and precluding transmitting of the excessive pressure to the well tubing. When normal pressure conditions have been restored in the well below the blow out preventer, a release knock-out member may be easily utilized for knocking the ram wedge away from the sealing engagement with the locking wedge assembly and restoring the normal operation conditions within the well.

Whereas the present invention has been described in particular relation to the drawings attached hereto, it should be understood that other and further modification, apart from those shown or suggested herein, may be made within the spirit and scope of this invention.

What is claimed is:

1. A blow out preventer for fluid producing wells having a well casing disposed therein and comprising a locking wedge assembly disposed within the well casing and selectively engagable therewith, means anchored in the well casing for supporting the locking wedge assembly therein, pressure responsive ram wedge means suspended within the well casing in a normal position with respect to the locking wedge assembly for precluding interference with the normal fluid producing operation of the well and movable to a sealing and locking position with respect to the locking wedge assembly upon a pressure surge in the well casing therebelow, release knock-out means disposed in the well casing above the locking wedge assembly and independently movable with respect thereto for selectively releasing the ram wedge from the sealing engagement with the locking wedge assembly, said locking wedge assembly including a plurality of circumferentially spaced slip members hingedly secured to the anchoring means for alternate radially outward and radially inward movement, said slips being engagable by the ram wedge in one position thereof for radially outward movement into biting engagement with the inner periphery of the well casing to secure the ram wedge in the sealing position during high pressure conditions in the well casing therebelow.

2. A blow out preventer as set forth in claim **1** wherein said locking wedge assembly also includes yieldable means interposed between the adjacent slip members and bonded thereto, the inner periphery of the locking wedge assembly being downwardly and outwardly tapered for engagement by the ram wedge in said one position thereof.

3. A blow out preventer as set forth in claim **1** wherein the locking wedge assembly also includes yieldable means interconnected between the slips, each of said slips being provided with longitudinally spaced serrations on the outer periphery thereof for selective engagement with the inner periphery of the well casing, said locking wedge assembly being provided with a downwardly and outwardly tapered inner periphery, and including rod means secured to the ram wedge and slidably secured to the release knock-out means for movably securing said ram wedge in the well casing, said ram wedge being provided with an upwardly and inwardly tapered portion on the outer periphery thereof for engagement with the tapered inner periphery of the locking wedge assembly in said one position of the ram wedge.

4. A blow out preventer as set forth in claim **1** wherein rod means is carried by the ram wedge and slidably secured to the release knock-out means for slidably suspending the ram wedge in the well casing whereby said ram wedge moves freely upward in the well casing upon a pressure increase therebelow for sealingly engaging the locking wedge assembly.

5. A blow out preventer as set forth in claim **1** wherein the locking wedge assembly also includes yieldable means interposed between the slip members and bonded thereto, the outer periphery of each of said slip members being provided with longitudinally spaced serrations for engaging the inner periphery of the well casing in the radially outward position thereof, said locking assembly being provided with a downwardly and outwardly tapered inner periphery engagable by the ram wedge in said one position thereof.

6. A blow out preventer as set forth in claim **5** wherein the ram wedge is provided with an upwardly and inwardly tapered portion on the outer periphery thereof complementary to the tapered inner periphery of the locking wedge assembly for sealing engagement therewith during high pressure conditions in the well casing therebelow.

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