Oct. 16, 1951 H. C. OTIS 2,571,478

WELL DEVICE

Filed June 10, 1949 4 Sheets-Sheet 1

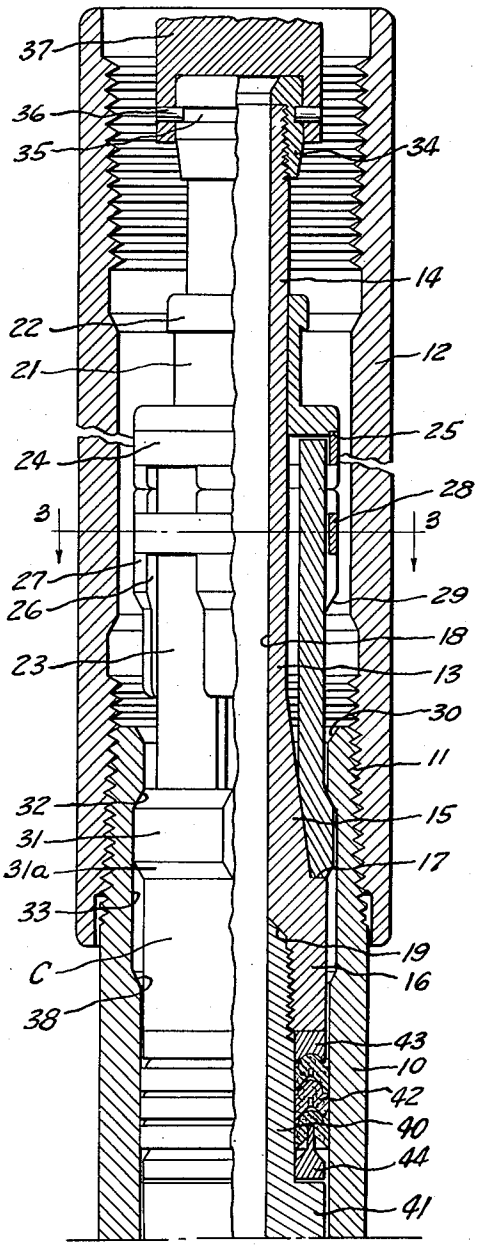


Fig. 1

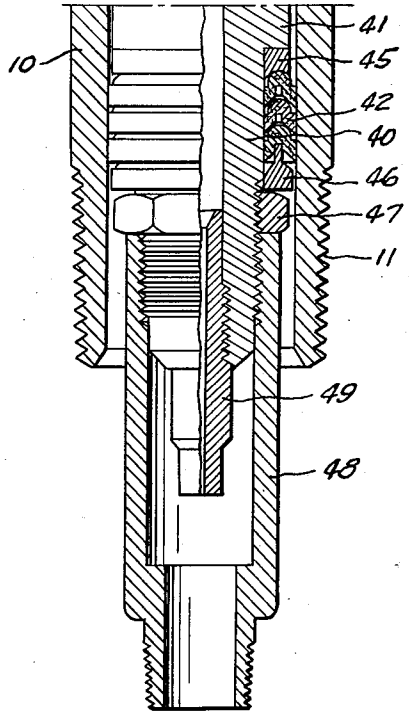


Fig. 2

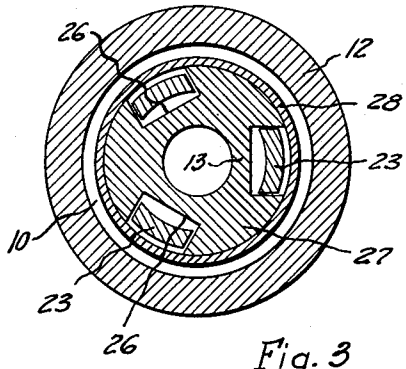


Fig. 3

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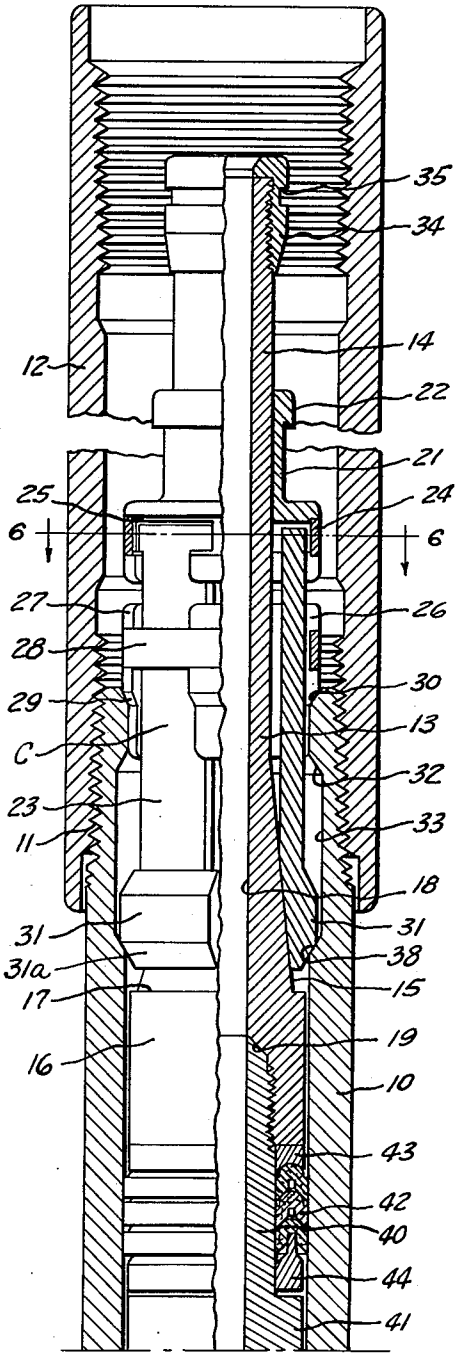


Fig. 4

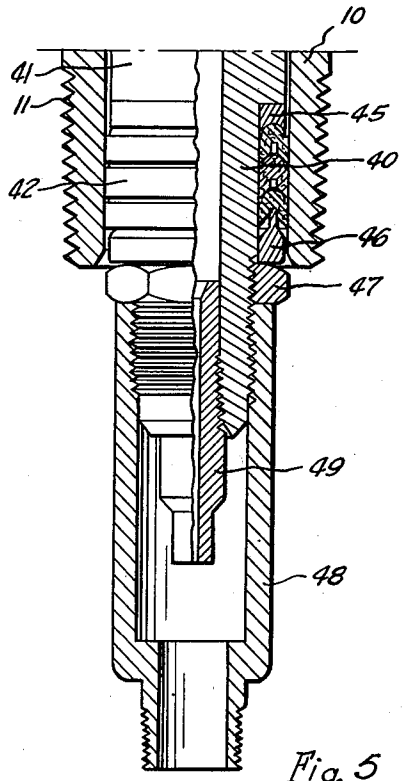


Fig. 5

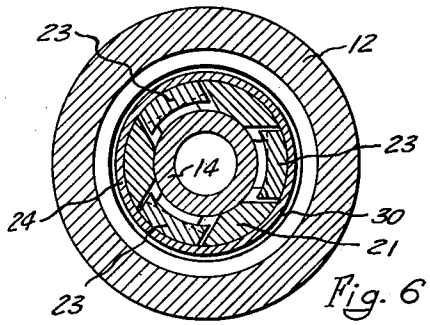


Fig. 6

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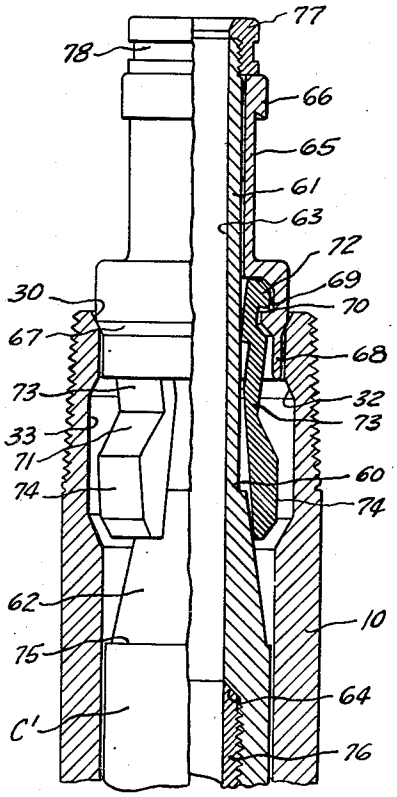


Fig. 8

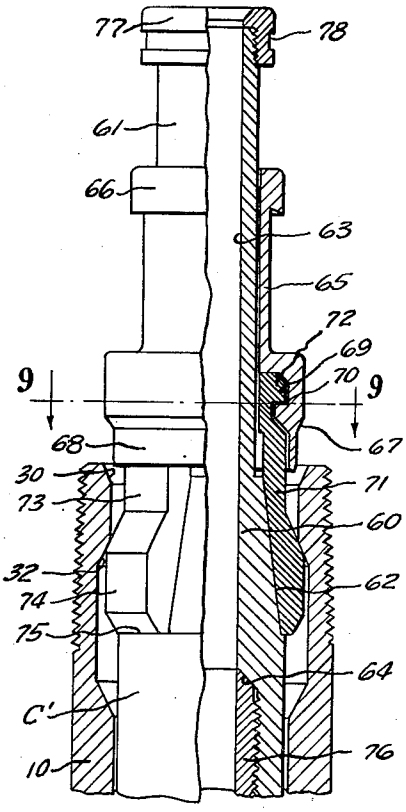


Fig. 7

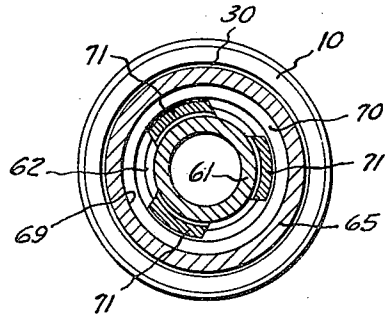


Fig. 9

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WELL DEVICE

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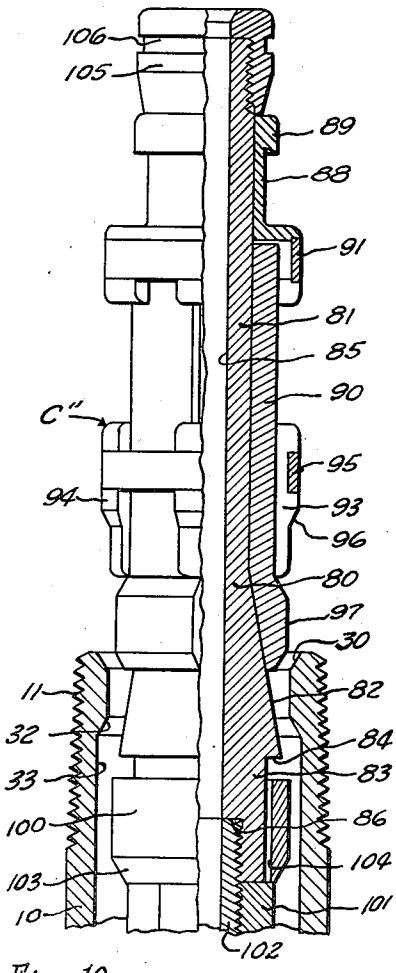


Fig. 10

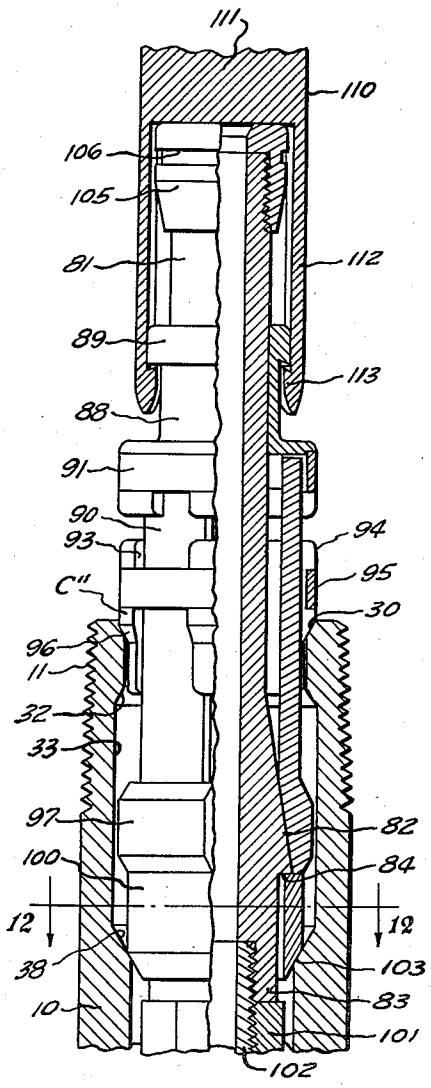


Fig. 11

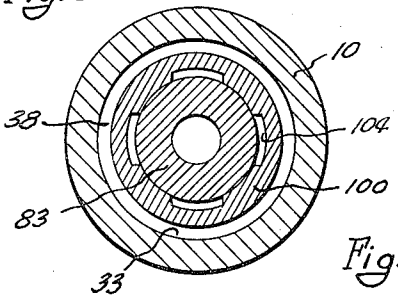


Fig. 12

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Patented Oct. 16, 1951

2,571,478

UNITED STATES PATENT OFFICE

2,571,478

WELL DEVICE

Herbert C. Otis, Dallas, Tex.

Application June 10, 1949, Serial No. 98,253

32 Claims. (Cl. 166—2)

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This invention relates to new and useful improvements in well devices, and is in part a continuation of my co-pending application, Serial No. 642,182, filed January 19, 1946, now abandoned.

Removable subsurface carrier and locking devices of the type illustrated in the patents to Herbert C. Otis, No. 2,144,850, issued January 24, 1939, and 2,246,811, issued June 24, 1941, have been used for supporting and positioning removable subsurface flow control and safety devices in deep, high-pressure oil and gas wells. These devices are adapted to be lowered into and removed from the well flow conductor "under pressure" by means of a suitable running or pulling tool connected to a small flexible steel measuring line. It has frequently been difficult to determine whether the carrier and locking device has been released from locked position in the landing nipple in deeper wells because of the flexibility and "stretch" of the small steel line. Also, high bottom hole temperatures and pressures frequently cause the sealing elements of the carrier and locking devices to become vulcanized or stuck to the wall of the nipple and thus prevent ready movement of the device in the nipple. Furthermore, accumulations of sand, corrosion or other extraneous matter frequently cause the locking members to become stuck or "frozen" in locked position. As a result, removal of the devices from the well bore is extremely difficult in some instances.

It is, therefore, one object of this invention to provide an improved removable carrier and locking device arranged to be lowered into a well flow conductor and locked in place therein for supporting a well flow control or safety device.

A particular object of the invention is to provide an improved mechanism for locking and unlocking the carrier, whereby positioning and releasing action is assured.

A further object of the invention is to provide an improved carrier and locking device wherein the carrier is arranged to undergo a limited longitudinal movement while locked in place in the conductor, such movement being in response to either fluid pressure or to actuation by means lowered into the conductor and operated from the surface.

An important object of the invention is to provide an improved carrier and locking mechanism wherein the carrier is arranged to be positively locked in place in a nipple in a well flow conductor and wherein there is provided means

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for positively causing movement of the locking mechanism toward releasing position.

Another object of the invention is to provide an improved removable carrier and locking mechanism having locking elements expansible into locking position in an elongate recess in a landing nipple arranged to be connected in a well flow conductor and wherein the locking elements may be positively moved so as to free them in the event they become stuck or frozen in expanded position by sand, corrosion or the like.

A still further object of the invention is to provide a device of the character described wherein the operation of freeing the locking elements may be performed by means of a flexible line mechanism operable from the well surface.

Still another object of the invention is to provide a device of the character described wherein the carrier cannot be engaged for removal from the conductor until the locking elements have been initially moved toward releasing position.

A further object of the invention is to provide a device of the character described wherein the locking mechanism may be positively moved to fully retracted releasing position, and wherein such movement is necessary prior to engagement of a retrieving tool with the device so that the device cannot be removed from the landing nipple until such movement of the locking means has been effected.

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

Figure 1 is a view, partly in elevation and partly in section, of the upper portion of a carrier and locking mechanism constructed in accordance with the invention, showing the same locked in place in the landing nipple,

Figure 2 is a similar view of the lower portion of the same,

Figure 3 is a horizontal cross-sectional view taken on the line 3—3 of Figure 1,

Figure 4 is a view, similar to Figure 1, showing the locking elements of the device initially moved toward releasing position,

Figure 5 is a view, similar to Figure 2, of the lower portion of the device,

Figure 6 is a horizontal cross-sectional view taken on the line 6—6 of Figure 4,

Figure 7 is a view, partly in elevation and partly in section of the upper portion of still another modified form of carrier and locking device, and

showing the locking mechanism in locking position,

Figure 8 is a view, similar to Figure 7, showing the locking mechanism of the device moved to releasing position,

Figure 9 is a horizontal cross-sectional view taken on the line 9—9 of Figure 7,

Figure 10 is a view, partly in elevation and partly in section, of the upper portion of a modified form of carrier and locking device, and showing the locking elements in retracted position,

Figure 11 is a view, similar to Figure 10, showing the locking elements initially moved toward releasing position, and

Figure 12 is a horizontal cross-sectional view taken on the line 12—12 of Figure 10.

In the drawings, the numeral 10 designates an elongate cylindrical housing, which may take the form of an elongated nipple having screw threads 11 at each end. This nipple may be connected in the well flow conductor in any suitable manner, but it is preferable that an elongate, thick-walled flow coupling 12 be provided at the upper end of the nipple for reducing the possibility of damage to the flow conductor as a result of flow turbulence above a carrier and locking mechanism C which is adapted to be positioned in the housing. It is to be understood that the invention is not to be limited to use in a well flow conductor, such as well tubing, but may be used in drill pipe or drill stems, or in casing or the like, as well.

The carrier C includes a locking mandrel 13 having an elongated neck 14 at its upper end extending upwardly from a frusto-conical shank 15, which latter constitutes an expanding element. The shank extends upwardly from a cylindrical head 16 and an upwardly facing shoulder 17 is formed between said shank and head. The mandrel is provided with an axial bore 18 which is enlarged at the lower end to provide a bevelled shoulder 19, and internal screw threads are formed in the enlarged portion of the bore below said shoulder. The head 16 is slightly smaller in diameter than the bore of the nipple 10 so as to slide freely thereinto.

A dog supporting collar 21 has a sliding fit on the neck 14 and is provided with an annular undercut flange 22 at its upper end. A plurality of locking dogs 23 having T-shaped upper ends are suspended from correspondingly T-shaped radial slots formed in the lower portion of the collar and are confined within said slots by means of a retaining band 24 secured within an annular groove 25 formed in the periphery of the collar 21. The dogs are provided with elongate shanks which extend through vertical slots 26 formed in an annular stop flange 27 on the mandrel at the upper end of the shank 15. Lateral displacement of the dog shanks from the vertical slots 26 is prevented by a retaining band 28 secured within an annular groove formed in the periphery of the stop flange.

An inclined shoulder 29 is formed on the stop flange and is adapted to engage an inclined seat 30 at the upper end of the nipple, the carrier being supported thereby when inserted in the nipple. Of course, other means for supporting the carrier in the nipple may be provided and used, if desired.

The locking dogs 23 have bosses 31 with stop bevels 31*a* at their lower ends, which bosses are arranged to engage under an annular shoulder 32 formed at the upper end of an elongate annular locking recess 33 formed near the upper end of the bore of the nipple. When the dogs are at the lower end of the frusto-conical shank 15 they are supported upon the shoulder 17 and expanded for engagement with the locking shoulder 32, whereby the carrier C is securely locked against upward displacement in the nipple. When the dogs are at the upper end of the flared frusto-conical shank they are retracted and the carrier may enter and be withdrawn from the housing or nipple 10. Upward travel of the locking dogs is limited by a retaining collar 34 which is mounted on the upper end of the carrier neck 14.

The retaining collar 34 has an external annular groove 35 formed therein which is adapted to receive the ends of shear members or rivets 36 extending through lateral openings in a running tool 37, whereby the carrier may be releasably connected to a flexible line lowering mechanism so as to be lowered into and positioned within the landing nipple in the flow conductor, as will be hereinafter explained.

The lower portion of the carrier C includes an elongate tubular packing mandrel 40 having screw threads on its upper end to provide for connecting the same with the lower end of the locking mandrel 13. The extreme upper end of the packing mandrel is bevelled to engage the shoulder 19 to provide a seal between the locking mandrel and the packing mandrel. The packing mandrel is formed with an external annular flange 41 at its mid-portion and a plurality of rings of V-type, or chevron type, packing 42 are mounted on the mandrel between the flange 41 and the lower end of the locking mandrel. A follower or back-up ring 43 engages the lower end of the locking mandrel to provide a support for the packing. A spacer ring 44 having an upstanding cylindrical flange thereon is supported upon the flange 41 and engages the under side of the lowermost packing ring to support the same in position for sealing between the packing mandrel and the bore of the housing nipple.

A similar set of packing rings 42 is mounted upon the mandrel below the flange 41. These packing rings are confined between a back-up ring 45 engaging the under side of the flange 41 and a supporting ring 46, similar to the ring 44, which is supported upon a lock nut 47 screw-threaded onto the lower end of the packing mandrel.

The packing rings may be made of fabric impregnated with rubber, asbestos with a plastic binder, or other suitable compositions, and are preferably of a diameter substantially equal to or slightly less than the bore of the landing nipple, whereby they may readily enter the same. Well fluid pressure entering the bore of the housing is packed off by the sealing engagement of the packing rings with the wall of the bore of the housing. While the sealing rings are illustrated in position to seal off fluid pressures from below the carrier, it is obvious that they may be mounted so as to seal off pressures from above or from both above and below the carrier, if desired.

Various types of well fluid flow control or safety devices may be attached to the lower end of the carrier packing mandrel for controlling the flow of fluids through the conductor. For the sake of simplicity, however, a tubular valve cage 48 is illustrated as screw-threaded onto the lower end of the packing mandrel below the lock nut 47 and a changeable flow controlling bean or orifice member 49 is screw-threaded into the lower end of the bore of the mandrel. The flow of well fluids through the carrier C is controlled by the orifice in this bean. Obviously, well fluids

flowing up the well flow conductor will be packed off by the sealing engagement of the packing rings 42 with the bore of the housing and the exterior of the packing mandrel and, thus, the well fluids will be directed through the bean into the bore of the carrier, from which they may flow upwardly within the well flow conductor. If desired, the bean 49 may be replaced with a suitable valve member (not shown) for controlling or completely shutting off the flow through the bore of the carrier.

In use, the carrier is lowered into the well flow conductor by means of a flexible line lowering mechanism (not shown) having a running tool 37 connected to its lower end. The running tool has an inverted bowl which is adapted to telescope the retaining collar 34, as illustrated in Figure 1, and be releasably secured to such collar by the rivets or shear members 36. As the carrier moves downwardly, the valve cage 48 will first enter the upper end of the nipple or housing 10, followed successively by the packing rings 42 on the packing mandrel and the head 16 on the locking mandrel. The lower stop bevels 31a on the bosses 31 of the locking dogs will next engage the seat 30 at the upper end of the nipple, whereby the dog assembly will be arrested in its downward movement while the locking mandrel moves downwardly into the bore of the nipple. As the locking mandrel moves downwardly, the dog bosses will tend to ride upwardly on the inclined shank 15, whereby they will be moved to retracted position. Such movement will be aided by the tendency of the bevelled bosses to ride inwardly down the inclined seat 30.

By the time the dog assembly is elevated to substantially the position shown in Figure 10, the dogs will have moved inwardly sufficiently to permit the bosses 31 to freely enter the upper end of the bore of the nipple. As soon as the bosses enter the upper end of the locking recess 33, the dog assembly is no longer supported and the dogs will thereupon slide downwardly on the shank 15, whereby the bosses will be expanded into the locking recess. The downward movement of the carrier is limited by the engagement of the shoulder 29 with the seat 30 at the upper end of the nipple. Downward movement of the dog assembly is limited by the engagement of the bosses with the upwardly facing shoulder 38 at the lower end of the locking recess. The carrier will then assume the position illustrated in Figures 4 and 5, with the stop flange 27 supported on the upper end of the housing nipple and the dog bosses resting upon the shoulder 38 in the locking recess.

An upward pull on the running tool 37 will then cause upward movement of the locking mandrel 13 and permit further relative movement of the dogs downwardly with respect to the shank 15, whereby the dogs are fully expanded into locking position. In such position, upon continued upward movement of the running tool, the bosses 31 will be supported on the shoulder 17 on the mandrel and will engage the annular locking shoulder 32 to securely lock the carrier against upward displacement from within the housing nipple 10.

Further upward pulling or jarring of the running tool will cause the rivets or shear members to be fractured and thus disconnect the running tool from the carrier. The running tool may then be removed from the well flow conductor, leaving the carrier locked in place in the nipple.

In some instances, it may be desirable simply to drop the carrier into the housing nipple in the flow conductor in place in the well. In such case, the carrier will enter the housing nipple and assume substantially the position illustrated in Figures 4 and 5. Then, as well fluid pressure is applied against the sealing rings, the carrier assembly will obviously tend to be moved upwardly with respect to the nipple to the position shown in Figures 1 and 2. In such position, the dogs are moved outwardly on the shank 15 to engage the shoulder 17 at the upper end of the head 16, and the bosses will engage the annular locking shoulder at the upper end of the locking recess. Thus, the carrier is securely locked in the housing nipple against upward displacement therefrom.

It will therefore be seen that the dogs may be expanded into the locking recess and the carrier securely locked in the housing nipple either mechanically or by the well fluid pressure.

The length of the locking recess 33 allows ample clearance above and below the bosses to minimize the exactness otherwise necessary to lock the dogs and carrier in the nipple. This clearance also provides for limited movement of the carrier in the nipple and permits the carrier to be elevated, either mechanically or by the well fluid pressure acting thereagainst, whereby the dogs are moved to their fully expanded locking position and retain such position during limited movement of the carrier in the housing nipple.

In order to remove the carrier from the housing nipple, it must be moved downwardly to the position shown in Figures 4 and 5. The fluid pressures above and below the carrier are first equalized, after which the downward movement of the carrier is easily accomplished by means of the flexible line lowering and raising mechanism (not shown). Any suitable retrieving tool may be connected to the lower end of the lowering and raising mechanism, but it is preferable that a tool similar to that illustrated in the patent to Herbert C. Otis, No. 1,898,261, issued February 21, 1933, be used. Such a retrieving tool will engage over the elongate neck 14 of the locking mandrel and is adapted to engage the undercut flange 22 at the upper end of the supporting collar 21 to lift the same. The retaining collar 34 at the upper end of the mandrel neck will be engaged by the retrieving tool, whereby a downward force may be applied to the mandrel to move the same downwardly within the housing nipple.

As the carrier is moved downwardly toward the position illustrated in Figure 4, it will be seen that the bosses on the locking dogs will engage the upwardly facing shoulder 38 at the lower end of the locking recess and the dogs and the dog supporting collar 21 will be moved upwardly a short distance with respect to the flared frustoconical shank 15, while the locking mandrel is moved downwardly until the stop shoulder 27 engages the seat at the upper end of the housing nipple. This relative movement of the locking dogs and dog supporting collar with respect to the locking mandrel is obtained, in this form of the invention, by predetermining the length of the annular locking recess 33 to cause the bosses to engage the shoulder 38 before the mandrel stop shoulder engages the upper end of the nipple.

Obviously, should the locking dogs or the supporting collar become stuck or frozen in the expanded position illustrated in Figure 1, for any

reason, the motion of the dogs and collar relative to the locking mandrel, obtained in the manner just described, will positively cause an initial freeing movement of said dogs and collar. Once freed for movement, the dogs may readily be moved to full retracted position to permit removal of the carrier from the housing nipple.

Or, conversely, should the locking dogs and supporting collar become stuck in the position illustrated in Figure 4, the mandrel may be moved upwardly to the position shown in Figure 1 to cause an initial downward releasing movement of the dogs. The mandrel may then be moved back down to the position illustrated in Figure 4 to permit removal of the carrier from the nipple.

Once the dogs and collar have been freed, as hereinabove described, an upward pull on the retrieving tool will move the dog supporting collar upwardly with respect to the locking mandrel to raise the dog bosses to the position shown in Figure 10. In such position the dog bosses are fully retracted and the carrier may be lifted from within the housing nipple and upwardly through the well conductor to the surface.

From the foregoing, it will be seen that an improved removable carrier and locking device has been provided which is arranged to be lowered into a well flow conductor and locked in place therein for supporting a well flow control or safety device. The carrier and locking mechanism is also so arranged that the locking dogs and supporting collar may be positively moved toward releasing position in the event such members become stuck or frozen in expanded locking position for any reason. It will further be seen that the carrier and locking mechanism may be readily operated by means of a flexible line mechanism from the well surface to free the locking mechanism. Also, the carrier may be either dropped into the well conductor to seat and be locked in the housing nipple or lowered thereinto by means of a flexible line lowering mechanism, and may undergo a limited longitudinal movement in the nipple while locked therein.

A modified form of the invention is illustrated in Figures 7 through 9. In this form, the carrier and locking device C′ includes a locking mandrel 60 having an elongate neck 61 at its upper end extending upwardly from a frustoconical shank or expanding element 62. The mandrel is provided with an axial bore 63 which is enlarged at its lower end to provide a shoulder 64, and internal screw threads are formed in the enlarged portion of the bore.

A dog supporting collar 65 has a loose sliding fit on the neck 61 and the collar is provided with an annular undercut flange 66 at its upper end. The lower portion of the collar is enlarged in diameter and provided with a downwardly facing seat or stop shoulder 67, and a depending annular skirt 68 is formed integral with the lower end of the collar. The lower portion of the bore of the collar is enlarged and provided with an internal annular recess 69 and an upwardly facing shoulder 70 at the lower end of said recess, and a plurality of locking dogs 71 having outwardly projecting heads 72 at their upper end are suspended from said dog collar. The heads of the dogs are positioned within the enlarged bore 69 of the dog collar and the lower ends of the heads are arranged to be supported on the upwardly facing shoulder 70, whereby the dogs are suspended from the collar. The thickness of the dogs and the heads are such that the heads cannot be displaced from the enlarged bore 69, being confined in said bore between the cylindrical neck of the mandrel and the dog supporting collar. The dogs have relatively short shanks 73 which extend downwardly below the lower end of the skirt 68 on the dog collar, and bosses 74 are formed on the extreme lower ends of the dogs. The dogs are arranged to be expanded by the expander section 62 of the mandrel to move the bosses 74 into the locking recess 33 of the housing so that the bosses engage under the shoulder 32 at the upper end of such locking recess.

For limiting upward movement of the mandrel with respect to the locking dogs and dog collar, an upwardly facing stop shoulder 75 is formed at the lower end of the expander section of the mandrel, and this shoulder engages the lower ends of the dogs when the bosses on the dogs are in engagement with the downwardly facing lock shoulder 32 in the manner shown in Figure 7, whereby the mandrel is securely locked in place in the housing against upward displacement.

The upper end of an elongate tubular packing mandrel 76 is screw-threaded into the enlarged lower end of the bore of the locking mandrel 60, and the upper end of the packing mandrel engages the seat 64 for sealing between the packing mandrel and the locking mandrel to prevent fluid leakage therethrough.

The skirt 68 at the lower end of the dog supporting collar is arranged to readily enter the upper end of the bore of the housing or nipple, and said skirt will position the dog collar substantially in axial alignment upon the upwardly facing stop shoulder or seat 30 at the upper end of the housing. Thus, the downward movement of the locking mechanism, comprising the dog collar and the dogs suspended therefrom, is stopped or arrested when the seat 67 on the collar engages the upwardly facing stop shoulder at the upper end of the housing in the manner shown in Figure 8. With the dog collar and dogs so supported on the upper end of the housing, the bosses 74 of the dogs are positioned in registry with the locking recess in the housing, and the lock mandrel may be moved upwardly to move the wedge expander section upwardly between the dogs to expand the bosses of the dogs into position for engaging the downwardly facing lock shoulder at the upper end of the locking recess.

Downward movement of the mandrel with respect to the locking mechanism is limited by the engagement of a stop or retaining nut or collar 77 which is screw-threaded onto the upper end of the neck 61 of the lock mandrel with the upper end of the dog supporting collar 65. This stop nut or collar permits the mandrel to be moved downwardly with respect to the locking mechanism a sufficient distance to move the expander wedge section downwardly below the dogs to permit the dog bosses to be retracted so they may pass into and out of the upper end of the bore of the landing nipple or housing. The stop nut 77 has an external annular groove 78 in its periphery which is adapted to receive the ends of shear members or rivets extending inwardly through lateral openings in the running tool (not shown) by means of which the device is releasably connected to a flexible line lowering mechanism so as to be lowered into and positioned within the tubing nipple or housing in the well flow conductor.

In use, the carrier is lowered into the well flow conductor by means of the flexible line lowering mechanism (not shown) in the same manner as was the carrier of the form first described. As the carrier moves downwardly, the packing mandrel will first enter the upper end of the housing, followed by the expander section at the lower end of the lock mandrel. The bevel on the lower end of the bosses 74 of the dogs may engage the seat 30 at the upper end of the nipple, whereby the locking assembly will be temporarily arrested in its downward movement. As the locking mandrel continues to move downwardly, the dog bosses tend to ride upwardly on the inclined expander section 62 whereby they may move to a retracted position which permits the bosses to freely enter the upper end of the bore of the nipple. As soon as the bosses enter the upper end of the housing, the locking assembly is no longer supported by the seat 30 and the dogs and collar will thereupon slide downwardly on the mandrel until the downwardly facing shoulder 67 on the dog collar engages the upwardly facing seat 30 on the housing to arrest further downward movement of the locking mechanism and to position the dog bosses in registry with the locking recess 33. The mandrel 60 may move on further downwardly until the stop collar or nut 77 engages the upper end of the dog collar, as shown in Figure 8, to stop further downward movement of the mandrel with respect to the locking mechanism.

An upward pull on the running tool connected to the upper end of the lock mandrel will move the lock mandrel upwardly until the expander section engages the dogs and expands the same until the lower ends of the dogs engage the upwardly facing shoulder 75 at the lower end of the wedge, whereupon the dogs are lifted upwardly until the bosses 74 engage the downwardly facing lock shoulder 32 in the locking recess in the housing to securely anchor the carrier against upward displacement from within the housing or nipple. Further upward pulling or jarring of the running tool will cause the rivets or shear members to be fractured and disconnect the running tool from the carrier, after which the running tool may be removed from the well flow conductor, leaving the carrier locked in place in the nipple.

Of course, the carrier may also simply be dropped into the housing or nipple in the flow conductor in place in the well in substantially the same manner as was set forth for the form of the invention previously described.

In order to remove the carrier from the housing, the mandrel and locking mechanism must be moved downwardly to the position shown in Figure 8. The pressures above and below the carrier are first equalized, after which the downward movement of the carrier is effected by means of the flexible line lowering and raising mechanism in the manner previously described.

As the carrier is moved downwardly toward the position shown in Figure 8, it will be seen that the downwardly facing shoulder 67 on the dog collar of the locking mechanism will engage the upwardly facing seat 30 at the upper end of the housing to arrest or stop further downward movement of the locking mechanism. With the dogs and dog supporting collar so held against downward movement, the lock mandrel 60 is movable further downwardly to move the expander section 62 below the dogs to permit the dog bosses to be moved to retracted position. The downward movement of the lock mandrel is limited by the engagement of the stop nut or collar 77 at the upper end of such mandrel with the upper end of the dog collar.

This downward movement of the mandrel may be effected in any suitable manner, but is preferably done by means of a retrieving tool of the same character as that previously described, which is arranged to drive the mandrel downwardly until the hooks at the lower ends of the supporting elements of the retrieving tool can engage under the undercut shoulder 66 at the upper end of the dog collar, whereupon the retrieving tool may be lifted to lift the carrier from within the bore of the landing nipple or housing and upwardly through the bore of the well flow conductor.

If desired, the length of the depending supporting elements of the retrieving tool may be such that the hooks which engage under the undercut shoulder 66 cannot so engage under such shoulder until the lock mandrel 60 has been forced downwardly with respect to the locking mechanism through substantially the full downward permissible movement of the mandrel relative to the locking mechanism. Therefore, if the dogs and supporting collar have become stuck or frozen in the expanded locking position, they must undergo a freeing or retracting movement with respect to the mandrel before the catch members on the lower end of the retrieving tool can engage under the undercut shoulder to lift the carrier from the well. Thus, when the retrieving tool is engaged with the undercut shoulder, the operator can know that the dogs are in retracted position and the device should be removable from within the housing.

It will thus be seen that, in addition to the advantages enumerated for the form of the invention first described, an improved carrier has been provided in which the downward movement of the locking mechanism is arrested or stopped by engagement of a shoulder on the dog collar of the locking mechanism with the upwardly facing stop seat 30 on the upper end of the housing, and that the mandrel may then undergo a limited further downward movement with respect to the locking mechanism until the retaining nut 77 engages the upper end of the dog supporting collar to stop downward movement of the mandrel and carrier in the housing. It will also be seen that the device is constructed and arranged in such a manner that a retrieving tool may be prevented from engaging and supporting the carrier until the mandrel has been moved downwardly as aforesaid, so that the locking mechanism is freed and the dog bosses are assured of being in retracted position to permit the carrier to be lifted upwardly out of the housing.

Another form of the invention is illustrated in Figures 10 through 12. In this form, the carrier and locking device C'' includes a locking mandrel 80 having an elongate neck 81 at its upper end extending upwardly from a frusto-conical shank or expanding element 82. A reduced cylindrical stem 83 depends from the lower end of the shank, and a downwardly facing shoulder 84 is formed between said shank and stem. The mandrel is provided with an axial bore 85 which is enlarged at its lower end to provide a shoulder 86, and internal screw threads are formed in the enlarged portion of the bore.

A dog supporting collar 88 has a sliding fit on the neck 81 and is provided with an annular undercut flange 89 at its upper end. A plurality

of locking dogs 90 having T-shaped upper ends are suspended from correspondingly T-shaped radial slots formed in the lower portion of the collar and are confined within said slots by a retaining band 91 secured within an annular groove formed in the periphery of the collar. The dogs have elongate shanks which extend through vertical slots 93 formed in an annular stop flange 94 which surrounds the base of the neck 81 at the upper end of the shank 82. Lateral displacement of the dog shanks from the slots is prevented by a retaining band 95 secured within an annular groove on the stop flange.

An inclined shoulder 96 is formed on the stop flange and is adapted to engage the inclined seat 30 at the upper end of the housing nipple, the carrier being supported thereby when inserted into the housing nipple.

The locking dogs 90 have bosses 97 at their lower ends which are arranged to engage under the locking shoulder 32 at the upper end of the locking recess 33 in the housing. For supporting the dogs at the lower end of the frusto-conical shank 82, a stop or supporting ring 100 is slidably mounted upon the cylindrical stem 83 of the mandrel and is retained thereon by the shoulder 84 and a lock nut 101 which is screw-threaded onto the upper end of an elongate tubular packing mandrel 102, similar to the packing mandrel 40 of the form first described, which is screw-threaded into the enlarged lower portion of the bore of the locking mandrel. It will be seen that the supporting ring 100 is slidable through a short distance longitudinally on the stem 83.

The supporting ring has a bevelled seat 103 formed on its lower end for engaging the shoulder 38 at the lower end of the locking recess 33 in the housing. The diameter of the supporting ring, however, is such that it will readily enter the upper end of the bore of the housing nipple. Fluid courses 104 are provided in the bore of the supporting ring for preventing accumulations of sand or other matter from limiting movement of the ring on the stem.

From the foregoing, it will be seen that when the dogs are at the lower end of the frusto-conical shank 82 they are supported on the upper end of the supporting ring and expanded for engagement with the locking shoulder 32 in the locking recess, whereby the carrier C'' may be securely locked against upward displacement from the housing nipple. When the dogs are at the upper end of the frusto-conical shank they are retracted and the carrier may enter and be withdrawn from the housing.

Upward travel of the locking dogs and the dog supporting collar is limited by a retaining collar 105 which is mounted on the upper end of the carrier neck 81. The retaining collar has an external annular groove 106 formed therein which is adapted to receive the ends of shear members or rivets 36 extending through the lateral openings in the running tool 37, whereby the carrier may be releasably connected to a flexible line lowering mechanism so as to be lowered into and positioned within the landing nipple in the well flow conductor in the manner already described.

Other parts of the carrier and locking mechanism are the same as those of the form of the invention first described.

In use, the carrier is lowered into the well flow conductor by means of the flexible line lowering mechanism (not shown) in the manner set forth for the form first described. As the carrier moves downwardly, the packing mandrel will first enter the upper end of the housing nipple, followed by the supporting ring 100 and the frusto-conical shank 82. The bevels on the lower ends of the bosses 97 will engage the seat 30 at the upper end of the nipple, whereby the dog assembly will be arrested in its downward movement, while the locking mandrel moves further downwardly into the bore of the nipple. As the locking mandrel moves downwardly, the dog bosses will tend to ride upwardly on the inclined shank 82, whereby they will be moved to retracted position. Such movement will be aided by the tendency of the dog bosses to ride inwardly down the inclined seat 30.

By the time the dog assembly is elevated to substantially the position shown in Figure 10, the dogs will have moved inwardly sufficiently to permit the bosses 97 to freely enter the upper end of the bore of the nipple. As soon as the bosses enter the upper end of the locking recess 33, the dog assembly is no longer supported and the dogs will thereupon slide downwardly on the shank, whereby said bosses will be expanded into the locking recess. The downward movement of the carrier is limited by the engagement of the shoulder 96 with the seat at the upper end of the nipple. Downward movement of the dog assembly is limited by the engagement of the supporting ring 100 with the upwardly facing shoulder 38 at the lower end of the locking recess. The carrier will then assume the position illustrated in Figure 11, with the stop flange supported upon the upper end of the housing nipple and the dog bosses resting upon the supporting ring within the elongate locking recess.

An upward pull on the running tool will then cause the locking mandrel to move upwardly, and such upward movement permits the dogs and supporting ring to move downwardly with respect to the shank, whereby the dogs are fully expanded into locking position. In such position, upon continued upward movement of the running tool, the bosses will be supported upon the ring 100 and will engage under the locking shoulder 32 to securely anchor the carrier against upward displacement from within the housing nipple. Further upward pulling or jarring of the running tool will cause the rivets or shear members to be fractured and thus disconnect the running tool from the carrier, whereupon the running tool may be removed from the well flow conductor, leaving the carrier locked in place in the nipple.

Of course, the carrier may also simply be dropped into the housing nipple in the flow conductor in place in the well in substantially the same manner as set forth for the form of the invention previously described.

In order to remove the carrier from the housing, it must be moved downwardly to the position shown in Figure 11. The fluid pressures above and below the carrier are first equalized, after which the downward movement of the carrier is easily accomplished by means of the flexible line lowering and raising mechanism (not shown) in the manner previously described.

As the carrier is moved downwardly toward the position shown in Figure 11, it will be seen that the supporting ring 100 will engage the upwardly facing shoulder 38 at the lower end of the locking recess and will be moved upwardly a short distance with respect to the flared frusto-conical shank 82 of the locking mandrel while

said mandrel is moved downwardly until the stop shoulder **96** engages the seat **30** at the upper end of the nipple. This upward movement of the supporting ring also causes upward relative movement of the locking dogs and supporting collar with respect to the mandrel, thus moving the dogs toward releasing or retracted position. Obviously, should the locking dogs or supporting collar have become stuck or frozen in the expanded position for any reason, the motion of the dogs and collar relative to the locking mandrel, obtained by the upward forcing action of the supporting ring just described, will positively cause an initial freeing movement of the dogs. Once freed for such movement, the dogs may readily be moved to full retracted position to permit removal of the carrier from the housing nipple.

Or, conversely, should the dogs become stuck in the position illustrated in Figure 11, the mandrel may be moved upwardly to cause the bosses to engage the locking shoulder **32** and thus move the dogs and supporting ring downwardly with respect to the mandrel. The mandrel may then be moved back down to the position shown in Figure 11 to permit removal of the carrier from the housing.

After the dogs have been so freed, an upward pull on the retrieving tool which is engaged with the undercut flange **89** will move the dog supporting collar **88** upwardly with respect to the mandrel to raise the dogs to the position illustrated in Figure 10. In such position the dog bosses are fully retracted and the carrier may be lifted from within the housing nipple and upwardly through the well conductor to the surface.

In many instances it may be desirable to prevent engagement of the retrieving tool with the carrier until it is assured that the locking dogs and collar are not stuck or frozen in the locking position. This result may be obtained by so controlling the length of the catch members of the retrieving tool that such catch members will not engage under the undercut shoulder on the dog supporting collar until the initial freeing movement of the locking dogs have been effected. Such an arrangement is illustrated in Figure 11, but the same result may be secured with respect to the form of the invention first described.

For simplicity, a retrieving tool **110** having a solid body **111** with depending hook-like catch members **112** is shown in the drawings, but other suitable types of retrieving tools may be used. The body **111** is arranged to engage the upper end of the retaining collar **105** to position the inwardly facing hooks **113** of the catch members at the proper point for engaging under the flange **89** on the dog supporting collar of the carrier.

As will clearly be seen in the drawings, the hooks cannot engage under the flange **89** until the dogs and dog supporting collar have been moved upwardly with respect to the locking mandrel **80** to the position shown in Figure 11. This prevents supporting engagement of the retrieving tool with the carrier until the initial freeing movement of the locking dogs with respect to the locking mandrel has been effected. Therefore, the dogs must undergo the freeing movement before the supporting collar can be engaged by the retrieving tool for the purpose of releasing the carrier from the housing nipple, thus assuring that the dogs are free to be moved to fully retracted position to permit such releasing of the carrier.

From the foregoing, it will be seen that, in addition to the advantages enumerated for the form of the invention first described, an improved carrier has been provided which has a supporting ring arranged to engage a shoulder in the housing for positively causing initial movement of the locking dogs toward released position. Such an arrangement may be desirable in certain cases to provide for a more positive freeing movement of the dogs, in that a straight upward thrust is applied to the dogs rather than a thrust directed at an angle. This particular arrangement is also adapted for use in converting carrier and locking devices of the types illustrated in the Otis patents, Nos. 2,144,850 and 2,246,811, hereinabove referred to, to provide for the relative motion of the locking dogs toward releasing position. It will also be seen that means has been provided for preventing engagement of the retrieving tool with the carrier until the locking dogs have been initially freed and moved toward releasing position. Other advantages of the modified form are the same as those set forth for the form first described.

The foregoing description of the invention is explanatory only, and changes in the details of the constructions 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 I claim and desire to secure by Letters Patent is:

1. A well device including, an elongate tubular housing having an internal annular locking recess, a downwardly facing annular shoulder at the upper end of said recess, an elongate carrier positionable in said housing and having an axial flow passage therethrough and expander means extending along a portion of its length, a dog collar slidable longitudinally on the carrier, dogs expansibly suspended from the dog collar and having bosses at their lower ends, an upwardly facing stop shoulder at the lower end of the locking recess and engageable with the bosses on the dogs for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier for expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means, the carrier being movable downwardly a limited distance with respect to the locking means when the dog bosses are in engagement with the upwardly facing stop shoulder at the lower end of the locking recess, and means on the carrier for engaging the locking means after such limited movement to prevent further downward movement of the carrier with respect to the locking means.

2. A well device including, a tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, a carrier positionable in said housing and having an expander section and a reduced cylindrical section thereabove, locking means slidable on the carrier and comprising a dog collar slidable on the cylindrical section and dogs expansibly suspended from the collar and slidable from retracted to expanded position on the expander section, bosses on the dogs, an upwardly facing stop shoulder on the housing spaced from the lock shoulder of the locking recess and engageable with the locking means on the carrier for limiting downward movement of the locking means in the housing and to position the dog

bosses in registry with the locking recess, and means on the carrier limiting the longitudinal sliding movement of the locking means on said carrier and spaced to permit the carrier to move further downwardly with respect to the locking means when said locking means is in engagement with said upwardly facing stop shoulder to cause movement of the locking means and the dogs toward retracted position on the expander section, said carrier being movable upwardly with respect to the locking means to expand the dog bosses into locking engagement with the lock shoulder in the locking recess.

3. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, an elongate carrier positionable in said housing and having a central expander section and an integral axially aligned cylindrical section thereabove and having an axial bore, locking means comprising a dog supporting collar slidable on the cylindrical section of the carrier and dogs expansibly suspended from the collar and slidable on the expander section, bosses on the lower ends of the dogs, an upwardly facing shoulder at the lower end of the expander section of the carrier engageable by the dogs for limiting downward movement of the dogs on the carrier, an upwardly facing stop shoulder on the housing spaced from the lock shoulder of the locking recess and engageable with the locking means for limiting downward movement of the collar and dogs in the housing and to position the bosses in registry with the locking recess, said carrier being movable upwardly with respect to the locking means to expand the dog bosses into locking engagement with the downwardly facing lock shoulder in the locking recess, the shoulder at the lower end of the expander section engaging the expanded dogs to limit further upward movement of the carrier in the housing, the carrier being movable downwardly with respect to the locking means when the locking means is in engagement with the upwardly facing stop shoulder on the housing, and a collar on the upper end of the cylindrical portion of the carrier arranged to engage the upper end of the dog collar to limit downward movement of the carrier with respect to the dog collar and dogs.

4. A well device of the character set forth in claim 3 and including, packing on the carrier below the expander section and engageable with the bore wall of the housing below the locking recess for sealing between the carrier and housing below the locking recess.

5. A well device including, a tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, a carrier, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs expansibly suspended from the collar, bosses on the lower ends of the dogs, an upwardly facing stop shoulder on the housing spaced from the locking shoulder of the locking recess and engageable with the locking means on the carrier for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier for expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means, means on the carrier limiting the longitudinal sliding movement of the locking means on said carrier and spaced to permit the carrier to move downwardly with respect to the locking means when said locking means is in engagement with the upwardly facing stop shoulder on the housing, a retrieving tool having engaging means engageable with the dog supporting collar of the locking means for lifting said locking means to unexpanded position, and means on the retrieving tool engageable with the upper end of the carrier for preventing engagement of the engaging means with the dog supporting collar until after the carrier has been moved downwardly a limited distance with respect to the locking means when the locking means is in engagement with the upwardly facing stop shoulder on the housing.

6. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end and an upwardly facing seat at its lower end, an elongate carrier positionable in said housing, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs expansibly suspended from the collar, bosses on the lower ends of the dogs and arranged to engage the upwardly facing seat in the locking recess to limit downward movement of the locking means in the housing and to position the bosses in registry with the locking recess, a dog expander section on the carrier arranged to expand the dog bosses into engagement with the lock shoulder in the locking recess upon upward longitudinal movement of the carrier relative to the dogs and collar, an upwardly facing stop shoulder on the housing spaced from the locking recess, a downwardly facing stop shoulder on the carrier positioned to engage said upwardly facing housing stop shoulder after the carrier has undergone a limited downward movement with respect to the locking means when the dog bosses are in engagement with the upwardly facing seat in the locking recess, such movement of the carrier causing upward relative movement of the locking means with respect to the carrier.

7. A well device including, an elongate tubular housing having an internal annular locking recess, a downwardly facing annular shoulder at the upper end of said recess, an elongate carrier positionable in said housing and having an axial flow passage therethrough, locking means comprising a dog collar slidable longitudinally on the carrier and dogs expansibly suspended from the dog collar and having bosses at their lower ends, an upwardly facing stop shoulder at the lower end of the locking recess and engageable with the bosses on the dogs for limting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier for expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means, the carrier being movable downwardly a limited distance with respect to the locking means when the dog bosses are in engagement with the upwardly facing stop shoulder at the lower end of the locking recess, and a stop shoulder on the housing spaced from the locking recess and engageable with the carrier after such limited downward movement for preventing further downward movement of the carrier with respect to the locking means.

8. A well device including, an elongate tubular housing having an internal annular locking re-

cess with a downwardly facing lock shoulder at its upper end and an upwardly facing seat at its lower end, an elongate carrier positionable in said housing, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs expansibly suspended from the collar, bosses on the lower ends of the dogs, a dog expander section on the carrier arranged to expand the dog bosses into engagement with the lock shoulder in the locking recess upon upward longitudinal movement of the carrier relative to the dogs and collar, downwardly facing stop means movably carried by the carrier disposed to engage the upwardly facing seat in the locking recess to limit downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, an upwardly facing stop shoulder on the housing spaced from the locking recess, a downwardly facing stop shoulder on the carrier positioned to engage the upwardly facing stop shoulder on the housing after the carrier has undergone a limited downward movement with respect to the locking means when the stop means on the locking means is in engagement with the upwardly facing seat in the locking recess to cause upward relative movement of the locking means with respect to the carrier.

9. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end and an upwardly facing seat at its lower end, an elongate carrier positionable in said housing and having an axial flow passage therethrough, said carrier having a central expander section and an integral axially aligned reduced cylindrical section at its upper end above the expander section, locking means slidable on the carrier and comprising a dog collar slidable on the upper cylindrical section of the carrier and dogs expansibly suspended from the dog collar and slidable on the expander section of the carrier, bosses on the lower ends of the dogs and engageable with the upwardly facing seat at the lower end of the locking recess in the housing for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, said carrier being further movable downwardly with respect to the locking means after the dog bosses have engaged the upwardly facing seat to move said expander section toward position releasing the dog bosses from said locking recess, and an upwardly facing stop shoulder on the housing spaced from the locking recess and engageable with the carrier for limiting further downward movement of the carrier with respect to the locking means, said carrier being movable upwardly with respect to the locking means to expand the bosses at the lower ends of the dogs into locking engagement with the downwardly facing lock shoulder in the locking recess.

10. A well device of the character set forth in claim 9 and including, packing on the carrier below the expander section for sealing between the carrier and the bore wall of the housing below the locking recess.

11. A well device including, an elognated tubular housing having an integral annular locking recess with a downwardly facing lock shoulder at its upper end, an elongate carrier mandrel positionable in said housing and having a flow passage therethrough and formed with a downwardly divergent expander section and a cylindrical section above the expander section, locking means slidable on the carrier mandrel and comprising a dog collar slidable on the cylindrical section of the mandrel and dogs suspended from the dog collar and expansibly and retractably slidable along the expander section of said mandrel, bosses at the lower ends of the dogs, a stop collar on the upper end of the cylindrical section of the mandrel for engaging the dog collar to limit downward movement of the mandrel with respect to the locking means, and stop means on the carrier mandrel and housing engageable with each other for arresting downward movement of the locking means prior to engagement of the stop collar on the mandrel with the upper end of the dog supporting collar.

12. A well device including, a tubular housing having an internal annular locking recess with a downwardly facing locking shoulder at its upper end, an elongated mandrel adapted to be positioned and locked in said tubular housing, said mandrel having locking means slidable longitudinally of the mandrel, said locking means comprising a dog supporting collar and dogs expansibly suspended from the collar, bosses on the lower ends of the dogs, an upwardly facing stop shoulder on the tubular housing spaced from the locking shoulder of the locking recess and engageable with the locking means on the mandrel for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the mandrel for expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the mandrel with respect to the locking means, and means on the mandrel limiting the longitudinal sliding movement of the locking means on said mandrel and positioned to permit the mandrel to move downwardly with respect to the locking means when said locking means is in egagement with the upwardly facing stop shoulder on the housing to move the expander means toward position releasing the locking means from the locking recess.

13. A well device including an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end and an upwardly facing seat at its lower end, an elongate tubular carrier mandrel positionable in said housing and having a frusto-conical expander section and a cylindrical section thereabove, locking means slidable on the carrier mandrel and comprising a dog collar slidable on the cylindrical section of the mandrel and dogs expansibly and retractably suspended from the dog collar and slidable along the expander section of said mandrel, bosses on the lower ends of the dogs, a supporting ring slidable on the carrier mandrel below the expander section and providing an upwardly facing shoulder engageable by the lower ends of the dogs for limiting downward movement of the dogs on the mandrel, said supporting ring being engageable with the upwardly facing seat at the lower end of the housing locking recess upon downward movement of the mandrel with respect to the housing to arrest downward movement of the locking means, said mandrel being further movable downwardly with respect to the supporting ring and locking means after the downward movement of the locking means has been arrested by said supporting ring, and a stop member on the mandrel engageable with the

housing for limiting downward movement of the mandrel with respect to the locking means.

14. A well device including an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, an upwardly facing stop shoulder on the housing spaced above the locking recess, an elongate carrier mandrel positionable in said housing and having a frusto-conical expander section and an axially aligned cylindrical section thereabove, locking means slidable on the mandrel and comprising a dog-supporting collar slidable on the cylindrical section and dogs suspended from the collar and slidable along the frusto-conical expander section, bosses on lower ends of the dogs, an external downwardly facing stop shoulder on the dog collar engageable with the upwardly facing stop shoulder on the housing for arresting downward movement of the locking means with respect to the housing and to position the dog bosses in registry with the locking recess below the lock shoulder, said dog bosses being expansible into locking engagement with the lock shoulder upon upward movement of the mandrel expander section with relation thereto, said mandrel being movable downwardly with respect to the locking means while such locking means is arrested against downward movement to permit the expander section to be moved below the dog bosses, and a stop collar on the upper end of the mandrel above the dog supporting collar for limiting downward movement of the mandrel with respect to the locking means.

15. A well device including an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end and an upwardly facing seat at its lower end, an elongate tubular carrier member positionable in said housing and having a frusto-conical expander section and a cylindrical section thereabove, locking means slidable on the carrier mandrel and comprising a dog collar slidable on the cylindrical section of the mandrel and dogs suspended from the carrier and slidable along the expander section of said mandrel, bosses on the lower ends of the dogs, a supporting ring slidable on the carrier mandrel below the expander section and providing an upwardly facing shoulder engageable by the lower ends of the dogs for limiting downward movement of the dogs and collar on the mandrel, said dog bosses being expansible into locking engagement with the lock shoulder of the locking recess upon upward movement of the mandrel expander section with relation to said dogs, said mandrel being movable downwardly of the housing to cause the supporting ring to engage the upwardly facing seat at the lower end of the locking recess to arrest downward movement of the supporting ring and locking means, said mandrel being further movable downwardly with respect to the supporting ring and locking means after downward movement of the locking means has been arrested by said supporting ring, a downwardly facing top shoulder on the carrier mandrel independent of the locking means and supporting ring, and an upwardly facing stop seat on the housing spaced from the locking recess and engageable by the downwardly facing stop shoulder on the mandrel to limit further downward movement of the mandrel with respect to the locking means and housing.

16. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, an elongate carrier positionable in the housing, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs swingably suspended from the collar, external bosses on the lower ends of the dogs, stop means on the housing and the carrier engageable with each other to limit downward movement of the locking means in the housing and to position the dog bosses opposite the locking recess, expander means on the carrier for engaging the dogs and expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means while the bosses are positioned opposite the locking recess, and longitudinally spaced shoulders on the carrier limiting the longitudinal movement of the locking means on said carrier and permitting the carrier to move downwardly with respect to the locking means when the stop means on the housing and carrier are engaged with each other to limit downward movement of the locking means.

17. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, an elongate carrier positionable in the housing, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs swingably suspended from the collar, external bosses on the lower ends of the dogs, an upwardly facing stop shoulder on the housing spaced longitudinally from the locking shoulder of the locking recess and engageable with the locking means on the carrier for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier extending along a portion of its length for engaging the dogs and expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means while the bosses are in registry with the locking recess, and longitudinally spaced shoulders on the carrier limiting the longitudinal movement of the locking means on said carrier and permitting the carrier to move downwardly with respect to the locking means when said locking means is in engagement with the upwardly facing stop shoulder on the housing.

18. A well device including, a carrier, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by the collar and having external locking bosses at their lower ends, longitudinally spaced shoulders on the carrier limiting upward and downward movement of the locking means on the carrier, a tubular housing having an internal locking recess with a downwardly facing lock shoulder therein, said carrier being positionable in said housing, an upwardly facing stop seat on the housing spaced longitudinally from the lock shoulder, a stop member movably carried by the carrier and engageable with the housing stop seat for limiting downward movement of the locking means in the housing and positioning the bosses below the lock shoulder of the locking recess, and limit stops on the carrier and housing engageable with each other to limit downward movement of the carrier in the housing, the stop member on the carrier engaging the housing stop seat while the limit stops are spaced

from engagement with each other, whereby the carrier may move downwardly with respect to the locking means after engagement of the stop member on the carrier with the housing stop seat.

19. A well device including, a bored housing having an internal locking recess, a carrier insertable into the housing bore and having an expander section extending along a portion of its length, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs carried by the collar and expansibly and retractably slidable along the expander section of the carrier, bosses on the dogs, stop means on the housing engageable with the locking means to arrest longitudinal movement of the locking means with respect to the housing and to register the bosses with the locking recess in the housing, said bosses being expansible into the locking recess by said expander section upon longitudinal movement of the carrier in one direction with relation thereto, and spaced stop means on the carrier limiting the longitudinal sliding movement of the locking means on the carrier and spaced to permit the carrier to move longitudinally with respect to the locking means after longitudinal movement of the locking means has been arrested by the stop means on the housing.

20. A well device including, a tubular housing having an internal annular locking recess with a downwardly facing lock shoulder at its upper end, a carrier positionable in the housing, expander means on the carrier extending along a portion of its length, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs swingably suspended from the collar, external bosses on the lower ends of the dogs, an upwardly facing stop shoulder on the housing spaced longitudinally from the locking shoulder of the locking recess, a stop member movably carried by the carrier and engageable with the upwardly facing stop shoulder on the housing for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier for engaging the dogs and expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means while the bosses are in registry with the locking recess, and longitudinally spaced shoulders on the carrier limiting the longitudinal sliding movement of the locking means on said carrier and permitting the carrier to move downwardly with respect to the locking means when said locking means is held against downward movement by the engagement of the movable stop member on the carrier with the upwardly facing stop shoulder on the housing.

21. A well device including, an elongate tubular housing having an internal annular locking recess with a downwardly facing locking shoulder at its upper end, an elongate carrier positionable in the housing, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs swingably suspended from the collar, external bosses on the lower ends of the dogs, an upwardly facing stop shoulder on the housing spaced longitudinally from the locking shoulder of the locking recess and engageable with the locking means on the carrier for limiting downward movement of the locking means in the housing and to position the dog bosses in registry with the locking recess, expander means on the carrier for engaging the dogs and expanding the dog bosses into locking engagement with the downwardly facing shoulder in the locking recess upon upward movement of the carrier with respect to the locking means while the bosses are in registry with the locking recess, longitudinally spaced shoulders on the carrier limiting the longitudinal movement of the locking means on said carrier and permitting the carrier to move downwardly with respect to the locking means when said locking means is in engagement with the upwardly facing stop shoulder on the housing to move said expander means toward position releasing the locking means from the locking recess, and sealing means on the carrier below the locking means for sealing between the carrier and the bore wall of the housing below the locking recess.

22. A well device including, a housing having an internal locking recess therein, a carrier insertable in the housing and having an expander section extending along a portion of its length, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by the collar and expansibly and retractably slidable along the expander section of the carrier, bosses on the dogs, spaced opposed stop means on the carrier for engaging the locking means to limit longitudinal movement of the carrier with respect to the locking means, and stop means on the housing engageable with the locking means for arresting downward movement of the locking means with respect to the housing and to register the bosses with the locking recess in said housing, said bosses being expansible into the locking recess upon longitudinal movement of the carrier in one direction with relation thereto, the engagement of the stop means on the housing with the locking means arresting downward movement of the locking means prior to engagement of the carrier stop means with the locking means.

23. A well device including, a bored housing having an internal locking recess, a carrier insertable in the housing bore and having an expander section extending along a portion of its length, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by the collar and expansibly and retractably slidable along the expander section of the carrier, bosses on the dogs, stop means on the housing engageable with the locking means for arresting downward movement of the locking means and to position the bosses in registry with the housing locking recess, said bosses being expansible into said locking recess upon upward movement of the carrier with respect to the locking means, and stop means on the carrier for engaging the locking means to limit downward movement of the carrier with respect to the locking means and initially spaced from the locking means to permit the carrier to move downwardly with respect to the locking means after downward movement of the locking means has been arrested by the stop means on the housing.

24. A well device including, a tubular housing having an internal locking recess, a carrier insertable in said housing and having an expander section extending along a portion of its length, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by said collar expansibly and retractably slidable on the expander section, stop means on the carrier for engaging the locking means to limit downward movement of the carrier with respect to

the locking means, and a stop shoulder on the housing engageable with the locking means to arrest downward movement of said locking means prior to the engagement of the stop means on the carrier with the locking means to permit the carrier to move downwardly with respect to the locking means after downward movement of the locking means in the housing has been arrested by the housing stop shoulder to cause upward relative movement of the locking means with respect to the carrier.

25. A well device including, a housing having an internal locking recess, a carrier insertable into said housing and having an expander section extending along a portion of its length, locking means slidable longitudinally on the carrier and comprising a dog supporting collar and dogs expansibly and retractably carried by said collar, bosses on the dogs, a stop shoulder on the housing engageable with the dog collar of the locking means to arrest downward movement of said locking means in the housing and to register the bosses with the locking recess in said housing, said dog bosses being expansible by the expander section into locking engagement with the locking recess upon upward movement of said carrier expander section with relation thereto, and stop means on the carrier above the dog supporting collar and engageable with said dog supporting collar for limiting downward movement of the carrier with respect to the locking means, said carrier stop means being initially spaced from the locking means to permit the carrier to move downwardly with respect to the locking means while the locking means is held against downward movement by engagement of the housing stop shoulder with the dog collar to cause freeing movement of the dog bosses.

26. A well device including, a housing having an internal annular locking recess, an annular downwardly facing shoulder at the upper end of said recess, a carrier adapted to enter said housing and having an expander section thereon, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by said collar and expansibly and retractably slidable on the expander section and having bosses expansible by said expander section of the carrier into the recess of the housing, stop means on the carrier for engaging the housing to arrest downward movement of the carrier with respect to the housing and to position the bosses in registry with the locking recess, the expander section on the carrier expanding the bosses into the locking recess, the expanded bosses being engageable with the downwardly facing shoulder in the locking recess to prevent removal of the carrier from the housing, a supporting ring slidable on the carrier for limiting downward movement of the dogs, and a seat at the lower end of the locking recess engageable by the supporting ring upon downward movement of the carrier with respect to the housing, the carrier being further movable downwardly while the supporting ring is in engagement with the seat to move said expander section downwardly with respect to the dogs and bosses so that the dogs and bosses are initially moved toward releasing position with respect to the locking recess.

27. A well device including, a tubular housing having an internal locking recess, a carrier insertable into said housing and having an expander section extending along a portion of its length, locking means slidable on the carrier and comprising a dog supporting collar and dogs carried by the collar and expansibly and retractably slidable along the expander section of said carrier, bosses on the dogs, stop means on the housing engageable with the locking means for arresting downward movement of the locking means and to position the dog bosses in registry with the housing locking recess, said bosses being expansible into said locking recess upon upward movement of the carrier with relation thereto, stop means on the carrier initially spaced from and engageable with the locking means to limit downward movement of the carrier with respect to the locking means and to permit the carrier to move downwardly with respect to the locking means after downward movement of the locking means has been arrested by the housing stop means, a retrieving tool having engaging means engageable with the dog supporting collar of the locking means for lifting the locking means and carrier from the housing, and means on the retrieving tool engageable with the upper end of the carrier for preventing engagement of the engaging means with the dog supporting collar until after the carrier has been moved downwardly with respect to the locking means substantially the full distance permitted prior to engagement of the stop means on the carrier with the locking means.

28. A well device including, a housing having an internal locking recess, a carrier insertable into the housing and having an expander section thereon, locking means slidable on the carrier and comprising a dog supporting member and dogs carried by said supporting member and expansibly and retractably slidable on the expander section of the carrier, stop means on the carrier for engaging the locking means to limit longitudinal movement of the carrier with respect to the locking means, and stop shoulders on the carrier and housing engageable with each other upon longitudinal movement of the carrier with respect to the housing to cause longitudinal freeing movement of the locking means on the carrier prior to engagement of the carrier stop means with the locking means to permit the carrier to be removed from the housing after having been locked therein.

29. A well device including, a tubular housing arranged to be connected in a well flow conductor and provided with a vertically elongated annular locking recess therein, a carrier having an axial flow passage extending therethrough arranged to enter the housing, a packer on the carrier, locking means slidably mounted on the carrier above the packer and out of the flow passage and comprising a dog supporting collar and dogs expansibly and retractably carried by the collar and having bosses thereon, expander means on the carrier for displacing the bosses of the locking means into the locking recess when the carrier and locking means are moved vertically in one direction, and opposed stop shoulders on the housing and on the carrier engageable with each other upon movement of the carrier in the opposite direction to cause initial longitudinal freeing movement of the dogs of the locking means along the carrier toward releasing position, said locking means being further movable to retracted position to permit withdrawal of the carrier from the housing.

30. A well device including, a housing having an internal annular locking recess, an annular downwardly facing shoulder at the upper end of said recess, a carrier adapted to enter said housing, locking means slidable on the carrier and comprising a dog supporting collar and dogs

expansibly and retractably carried by the collar and having bosses, expander means on the carrier for expanding the dog bosses into the locking recess, stop means on the carrier for engaging the housing to arrest downward movement of the carrier in the housing and to position the bosses in registry with the locking recess, upward movement of the carrier and expander means thereon expanding the dogs into the locking recess to prevent removal of the carrier from the housing, and a seat at the lower end of the locking recess engageable by the bosses on the dogs upon downward movement of the carrier with respect to the housing, such engagement initially moving the bosses toward releasing position with respect to the recess.

31. A well device including, a housing having an internal annular locking recess, a carrier having an expander section thereon and positionable in the housing, locking means slidable on the carrier and comprising a dog supporting member and dogs carried by the supporting member and expansibly and retractably slidable on the expander section, stop means on the housing engageable with the locking means upon downward movement of the carrier in the housing to initially move the locking means toward retracted position, retrieving means having engaging means engageable with the locking means to move such locking means to full retracted position to permit the carrier to be released from the housing, and means on the retrieving means

engaging the carrier and precluding such engagement of the locking means by said engaging means until said locking means has been initially moved toward retracted releasing position.

32. A well device including, a housing having an internal locking recess, a carrier insertable into the housing and having an expander section thereon, locking means slidable on the carrier and comprising a dog supporting member and dogs carried by said supporting member and expansibly and retractably slidable on the expander section of the carrier, a stop member on the carrier for engaging the locking means to limit downward movement of the carrier with respect to the locking means, and stop means on the carrier and housing engageable with each other for arresting downward movement of the locking means prior to engagement of the carrier stop member with the locking means.

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