

Sept. 21, 1965

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3,207,222

LOCKING DEVICE AND RUNNING TOOL THEREFOR

Filed Jan. 30, 1962

2 Sheets-Sheet 1

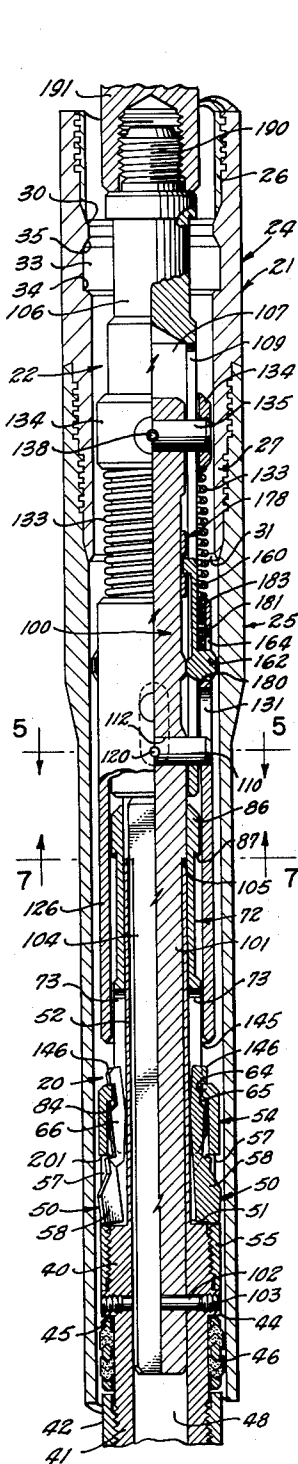


Fig. 1

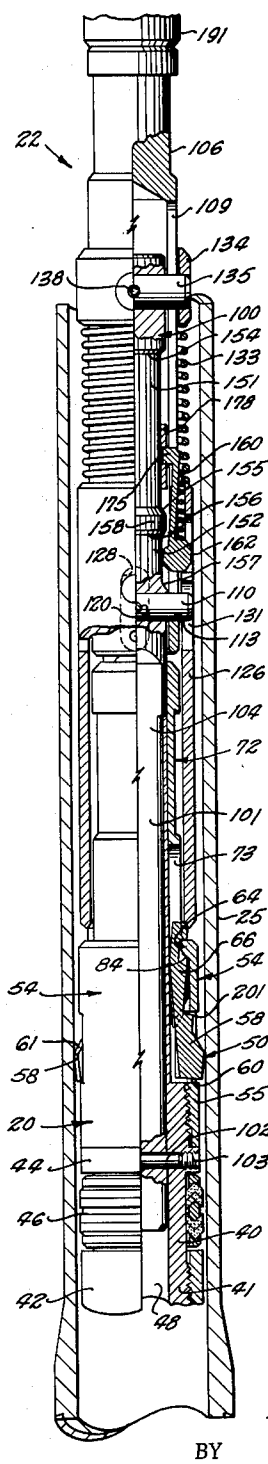


Fig. 2

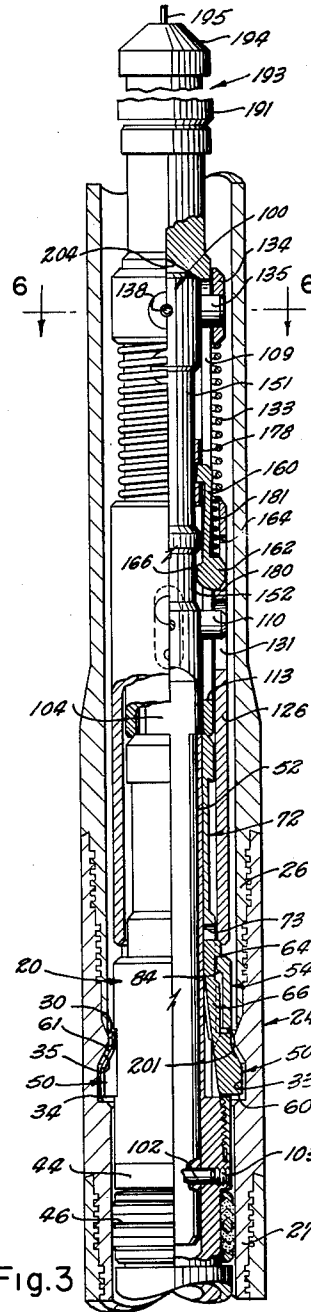


Fig. 3

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2 Sheets-Sheet 2

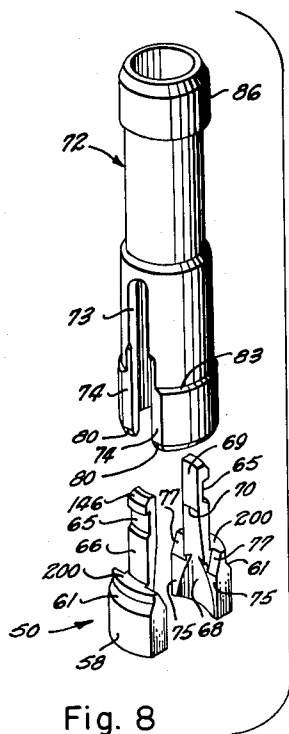


Fig. 8

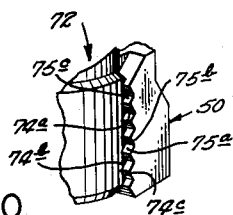


Fig. 10

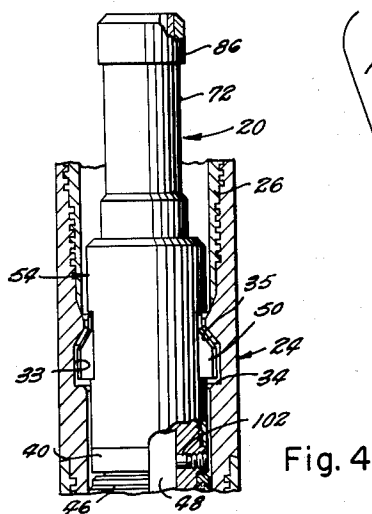


Fig. 4

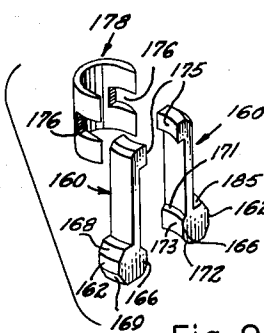


Fig. 9

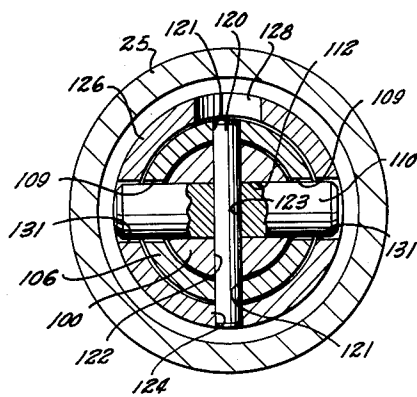


Fig. 5

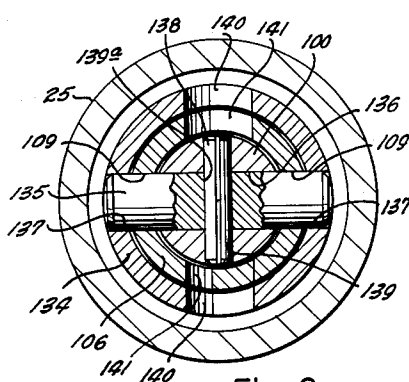


Fig. 6

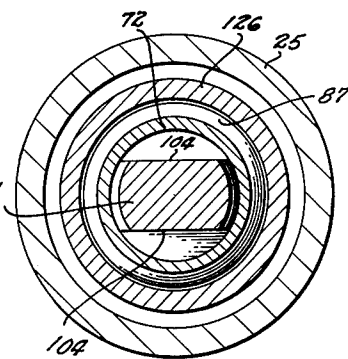


Fig. 7

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LOCKING DEVICE AND RUNNING TOOL THEREFOR

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16 Claims. (Cl. 166—136)

This invention relates to well tools and more particularly to locking devices adapted to be removably positioned and locked in a well flow conductor and to running tools for locating and locking the locking devices in a well flow conductor at a preselected position.

An object of this invention is to provide a new and improved locking device which can be selectively located and locked at any one of a plurality of longitudinally spaced locations in a well flow conductor.

Another object is to provide a new and improved locking device which may be positively locked in a selected position in a well flow conductor and which will withstand pressure differentials acting in either upward or downward directions in the well flow tubing.

Another object is to provide a locking device which may be locked in any one of a plurality of longitudinally spaced locations in a well flow conductor and a running tool for moving the locking device through the flow conductor to a selected location and then locking the locking device at such location whereupon the running tool may then be removed from the well flow conductor leaving the locking device at the selected location.

Another object is to provide a locking device having locking dogs and lock means for positively locking the dogs in expanded positions in a selected recess whereby the locking device will resist forces tending to move it in either direction in the well flow conductor.

Still another object is to provide a locking device wherein the dogs and the lock means therefor have means for preventing movement of the lock means from locking engagement with the dogs when an upwardly acting pressure differential in the well flow conductor exists across the locking device.

Still another object is to provide a locking device and a running tool therefor, the locking device being of relatively simple economical construction and having a minimum number of operating parts and the running tool being provided with all requisite components necessary to locate and lock the locking device so that the locking device may be of simple construction and design and have a minimum number of parts, the running tool being reusable to locate and lock any number of locking devices in well flow conductors.

Still another object is to provide a locking device and a running tool therefor which are of such structure that the engagement of the running tool and the locating device with the internal surfaces of the well flow conductor is held to a minimum during both the locating and the locking of the locking device in a selected recess of the well flow conductor and also during the removal thereof from the well flow conductor whereby the running tool and the locating device will not tend to mar the inner surfaces of the well flow conductor or to scrape off any protective coating covering the internal surfaces thereof.

A further object is to provide a locking device which may be located and locked in any one of a plurality of longitudinally spaced locking recesses of a well flow conductor, the locking device having expansible locking means or dogs which are receivable in any selected one of the recesses.

A still further object is to provide a locking device,

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of the type described above, wherein the locking dogs are held in retracted position during the movement of the locking device to the selected recess so that the locking device has no components which engage the inner wall of the well flow conductor during the movement of the locking device through the well flow conductor to the selected recess.

Another object is to provide a running tool for a locking device having expansible locking means, such as dogs, which are receivable in any one of a plurality of longitudinally spaced internal recesses of the well flow conductor wherein the running tool is provided with means for moving the dogs of the locking device into expanded positions and into a selected recess.

A further object is to provide a running tool of the type described wherein the running tool is provided with expansible actuating means or locating means, such as dogs, engageable with a downwardly facing obstruction of the well tool upon upward movement of the running tool therethrough to place the running tool into operative position to bias and move the locking dogs of the locking device into the selected recess above such downwardly facing obstruction of the well flow conductor.

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

FIGURE 1 is a vertical, partly sectional view of the locking device and running tool embodying the invention showing the component parts thereof as they appear during downward movement of the device and tool in a well flow conductor to a selected recess thereof;

FIGURE 2 is a view similar to FIGURE 1 showing the component parts of the running tool and the locking tool in the positions assumed thereby when the locking dogs of the locking device are biased by the running tool for movement toward expanded positions;

FIGURE 3 is a view similar to FIGURE 1 showing the various components of the running tool and of the locking device at the stage of operation wherein the dogs of the locating device have been locked in expanded position in a selected recess of the well flow conductor and wherein the running tool is in position to be released from the locating device by an upward force imparted thereto;

FIGURE 4 is a vertical partly sectional fragmentary view showing the locking device located in position in the well flow conductor;

FIGURE 5 is a sectional view taken on line 5—5 of FIGURE 1;

FIGURE 6 is a sectional view taken on line 6—6 of FIGURE 3;

FIGURE 7 is a sectional view taken on line 7—7 of FIGURE 1;

FIGURE 8 is a perspective exploded view of the dogs and the dog locking sleeve of the locking device;

FIGURE 9 is a perspective exploded view of the locating dogs of the running tool and their carrier; and,

FIGURE 10 is a fragmentary perspective view showing a modified form of the locking dogs and locking sleeve of the locking device.

Referring now to the drawings, the locking device 20 is movable through the well flow conductor 21 by means of the running tool 22 to be releasably locked thereby in position in any one of a plurality of longitudinally spaced landing nipples 24 which are connected to and between the usual adjacent sections 25 of the flow conductor which constitute sections or portions of the well flow conductor.

Each of the landing nipples has an upper internally threaded upper end portion in which is received the re-

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duced externally threaded lower portion 26 of the well flow conductor section 25 located immediately thereabove and has a lower reduced externally threaded portion 27 which is received in the upper internally threaded portion of the well flow conductor section 25 immediately below the landing nipple. Each of the landing nipples has an internal diameter which is slightly smaller than the internal diameter of the usual sections 25 of the flow conductor and thus provides an upper inwardly and downwardly beveled shoulder 30 and a lower downwardly and outwardly beveled annular shoulder 31 which extend into the bore or flow passage of the flow conductor. Each landing nipple has an internal annular recess 33 which provides an abrupt annular upwardly facing lock shoulder 34 and an annular upwardly and inwardly extending shoulder 35.

The locking device 20 includes a tubular mandrel 40 whose lower end portion 41 is threaded whereby any suitable well tool such as an equalizing sub, a safety valve, bottom hole regulator, or the like, may be connected to the locking device by means of any suitable connector sub 42 or the like. The mandrel has an external annular flange 44 which provides an annular downwardly facing shoulder 45 which limits the upward movement of a seal assembly 46 on the mandrel. Downward movement of the seal assembly 46 is limited by the upper end of the connector sub 42. The seal assembly 46 is provided to seal between the mandrel and the well flow conductor above the well tool supported by the locking device so that any flow of fluids must take place through such well tool and the internal bore or longitudinal flow passage 48 of the mandrel of the locking device.

A pair of locking dogs 50 are movably secured to the mandrel above the annular upwardly facing shoulder 51 provided by the reduced upper section 52 of the mandrel by means of a dog carrier or supporting means 54 whose lower end portion 55 is threaded to the mandrel above the annular flange 44 thereof. The dog carrier has a pair of opposed elongate slots or windows 57 through which extend the external bosses 58 at the lower ends of the locking dogs. The dog bosses are provided with abrupt downwardly facing ends or shoulders 60 which are adapted to engage the lower shoulder 34 of a locking recess of a landing nipple 24 and with outwardly and downwardly beveled upper shoulders 61 which are adapted to engage the upper shoulder 35 of a locking recess of a landing nipple.

The dog carrier also has an internal annular dog holding flange 64 at its upper end which is received in the external recesses 65 adjacent the upper ends of the upwardly extending handle portions 66 of the dogs. The holding flange 64 is of lesser height or width than the recesses 65 of the handle portions 66 so that the dogs are free to move pivotally between the inner retracted positions as illustrated in FIGURE 1 and the expanded positions illustrated in FIGURES 3 and 4.

The dogs have arcuate internal surfaces 68 whose curvature conforms to the curvature of the external surface of the reduced portion 52 of the mandrel and which engage the mandrel when the dogs are in the retracted positions illustrated in FIGURE 1 wherein the bosses 58 thereof do not extend outwardly of the dog carrier. The upper arcuate internal surfaces 69 at the upper ends of the handle portions 66 of the dogs extend upwardly and outwardly from the arcuate surfaces 68 to provide a pivot edge 70 engageable with the external surface of the reduced portion about which the dogs may pivot between their retracted and expanded positions. The pivot edges 70 are disposed inwardly of the upper and lower ends of the dogs to permit such movement. The upper surfaces 69 abut the external surfaces of the reduced upper portion of the mandrel when the dogs are in the fully extended positions illustrated in FIGURES 3 and 4.

The locking dogs are locked in their expanded positions by a lock sleeve 72 slidably disposed about the reduced up-

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per portion 52 of the mandrel. The lock sleeve is of such internal diameter as to have a snug fit with the mandrel so that it is frictionally held in an upper position on the mandrel when initially assembled thereon. The lower portion of the lock sleeve has a pair of longitudinal spaced slots 73 in which are receivable the locking dogs. The lower portions of the lock sleeve adjacent each slot 73 are provided with vertical lock shoulders 74 which are engageable with the lock surfaces 75 of the dogs when the lock sleeve is in the lower locking position on the mandrel illustrated in FIGURE 3. The dogs are provided with downwardly and inwardly extending cam surfaces 77 above each of the lock surfaces 75 which are engageable by the downwardly and inwardly extending cam surfaces 80 of the lock sleeve below each of the lock surfaces 74. The engagement of these cam surfaces as the lock sleeve is moved downwardly on the mandrel will cause the dogs to move outwardly towards their expanded positions if they are not in their fully expanded positions when the lock sleeve is moved downwardly on the mandrel.

The lower end portion of the lock sleeve is enlarged to provide the upwardly facing shoulder 83 which engages the downwardly facing internal annular shoulder 84 of the holding flange 64 of the dog carrier to limit upward movement of the lock sleeve relative to the dog carrier and therefore also to the mandrel 40 since the dog carrier is rigidly secured to the mandrel. Downward movement of the lock sleeve on the mandrel is limited by the engagement of its lower end with the annular shoulder 51 of the mandrel.

The upper end of the lock sleeve is provided with an external annular flange 86 which provides an undercut or downwardly and outwardly beveled shoulder 87 which may be engaged by a retrieving tool when it is desired to remove the locking device, and any well tool secured thereto, from the well flow conductor.

The running tool 22 includes an elongate main body 100 having a lower section 101 which telescopes into the bore or flow passage 48 of the locking device mandrel 40. The main body is releasably secured to the mandrel by a shear pin 102 which extends through suitable aligned apertures or bores in the mandrel and in the main body of the running tool. The shear pin may be held against displacement by screws 103 threaded in enlarged outer portions of bore of the main mandrel.

The lower portion 101 of the main body has opposed flat sides 104 which extend upwardly past the upper end of the mandrel 40 of the locking device when the main body is secured to the mandrel to provide flow passages which open outwardly above the upper end of the lock sleeve when the main body of the running tool is secured to the mandrel 40 by the shear pin 102. Downward movement of the main body into the mandrel is limited by the engagement of the downwardly facing shoulders 105 of the lower portion of the main body with the upper end of the mandrel. A top sub or upper telescoping drive member 106 has a downwardly facing bore 107 in which is telescoped the upper portion of the main body.

A pair of elongate longitudinal slots 109 of the top sub receive opposite ends of the control pin 110 disposed in a suitable transverse bore 112 of the main body. The engagement of the opposite ends of the control pin 110 with the upwardly facing surfaces or shoulders 113 defining the lower ends of the slots 109 therefore limits downward movement of the main body relative to the top sub.

The top sub 106 of the running tool is held in the upper position on the main body illustrated in FIGURES 1 and 2 by a shear pin 120 which extends through aligned bores 121, 122, 123 and 124 in the top sub, the main body, the transverse pin 110 and a dog actuator sleeve 126, respectively. The actuator sleeve is disposed about the top sub and extends downwardly over and about the locking device. A large elongate slot 128 of the actuator

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sleeve is disposed oppositely of the bore 124 thereof to facilitate assembly of the shear pin 120 and to insure that if any portion of the shear pin 120 extends outwardly of the top sub into the slot 128, it will not be engaged by the surfaces defining the elongate slot. Since the shear pin 120 extends only into and is engaged only by the surfaces defining only one bore 124 of the actuator sleeve and since it extends into and is engaged by surfaces defining the two bores 121 of the top sub, it will be apparent that when a longitudinally acting force is applied to the actuator sleeve, the shear pin 120 will shear at one end to permit longitudinal movement of the actuator sleeve relative to the main body before any such longitudinally acting force will cause shearing of both ends of the shear pin 120 to permit relative longitudinal movement between the top sub and the main body of the running tool. Opposite end portions of the transverse pin 110 extend outwardly into the slots 131 of the actuator sleeve to limit downward movement of the actuator sleeve relative to the main body by engaging the surfaces of the actuator sleeve defining the upper ends of the slots.

The actuator sleeve is biased downwardly by a spring 133 disposed above the actuator sleeve whose lower end bears against the upper end of the actuator sleeve and whose upper end bears against a retainer ring 134 slidably disposed about the top sub and rigidly secured to the main body by a transverse pin 135 which extends through a transverse bore 136 of the main body and the slots 109 of the top sub into the suitable bores 137 of the retainer ring. The pin 135 is held against displacement by a roll pin 138 which extends through the bore 139 of the main body disposed at right angles to and intersecting the bore 136 and the bore 139a of the pin. The retainer ring and the top sub have aligned access apertures 140 and 141 which permit assembly of the roll pin on the main body and the transverse pin 135.

The lower end of the dog actuator sleeve has an annular downwardly and outwardly beveled shoulder 145 adapted to engage the downwardly and outwardly beveled shoulders 146 on the upper ends of the dogs 50 of the locking device so that downward movement of the actuator sleeve relative to the dogs will result in inward pivotal movement of the upper ends of the dogs and consequent outward movement of the lower ends thereof.

The main body of the running tool above the control pin 110 is provided with upper and lower annular grooves 151 and 152. The upper groove is defined by upper and lower outwardly divergent annular shoulders 154 and 155 and the lower groove is defined by the outwardly divergent annular upper and lower shoulders 156 and 157. It will be apparent that the upper and lower grooves are spaced by the annular flange 158 which provides the shoulders 155 and 156.

A pair of locator dogs 160 are disposed in the elongate slots 109 of the top sub and have outer bosses 162 which extend outwardly through the apertures or windows 164 of the actuator sleeve. The dogs also have inner bosses 166 which extend inwardly and are adapted to be disposed within either the upper groove 151 or the lower groove 152 of the main body. The outer bosses have outwardly convergent upper and lower shoulders 168 and 169 and the inner bosses have inwardly convergent upper and lower shoulders 171 and 172 and an arcuate inner surface 173 therebetween which is adapted to abut the main body. The upper ends of the dogs 160 have inwardly extending flanges or hooks 175 which are received in the slots 176 of the dog carrier 178. The dog carrier 178 forms an arc of not more than 180 degrees so that the free ends of the dog carrier may be slipped about the main body. The dog carrier once assembled on the main body is disposed between the main body and the top sub so that it cannot be displaced.

The locator dogs are biased downwardly toward the upwardly facing shoulders 180 defining the lower bound-

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aries of the apertures 164 of the actuator sleeve by a spring 181 disposed about the locator dogs and the top sub and in an upwardly opening recess 183 of the actuator sleeve. The locator dog biasing spring 181 has an upper end portion which bears against the lower end of the actuator sleeve spring 133 and a lower end portion which bears against the upwardly facing shoulders 185 of the external bosses of the locator dogs.

It will be apparent that the locator dogs are in the intermediate position illustrated in FIGURE 1 wherein their inner surfaces 173 are aligned with and bear against the flange 158 of the main body when the shear pin 120 holds the actuator sleeve in the upper position on the main body shown in FIGURE 1. In this position the outer bosses 162 of the locator dogs project outwardly of the actuator sleeve through the apertures 164 thereof. When the lower shoulders 169 of the dogs engage an upwardly facing obstruction during the downward movement of the running tool, further downward movement of the running tool will cause the main body to move downwardly relative to the locator dogs against the resistance of the spring 181. The locator dogs then become aligned with the upper groove 151 and are moved by the camming action of their lower shoulders to inner retracted positions wherein the inner bosses are disposed in the upper groove 151 and out of engagement with the upwardly facing obstruction. The locator dogs thus permit downward movement of the running tool past such upwardly facing obstructions as the shoulders 30 and 34 of the landing nipples. Once past such obstructions, the locator dogs are again moved to expanded positions by the spring 181.

Upward movement of the running tool when the dogs are in the intermediate position illustrated in FIGURE 1 will cause engagement of the upper cam shoulders 168 of the dogs with downwardly facing obstructions, such as the lower shoulders 31 of the landing nipples. Once the upper shoulders of the locator dogs are engaged with the downwardly facing obstructions, further upward movement imparted to the top sub and to the main body will cause the shear pin 120 to shear to permit upward movement of the top sub and the main body relative to the actuator sleeve, since the lower ends of the dogs bear against the upwardly facing surface 180 of the actuator sleeve and thus prevent its upward movement. When the top sub and main body move upwardly relative to the dogs and the actuator sleeve and the lower groove 152 is moved into the alignment with the inner bosses of the locator dogs, the dogs move inwardly to their retracted positions, FIGURE 2, and now permit further upward movement of the running tool. Once the shear pin 120 is sheared to permit movement of the actuator sleeve relative to the main body, the force of the spring 133 is effective to move the actuator sleeve downwardly relative to the main body to cause the inner shoulder 145 of the actuator sleeve to engage the upper shoulders 146 of the locking dogs. The force of the spring 133 and the camming action of the shoulders is then effective to bias the locking dogs outwardly toward their expanded positions.

The top sub has an upper reduced threaded end portion 190 by means of which the running tool may be connected to the lower connector sub 191 of a set of flexible line tools 193 which may include the usual sinker bar and jar assembly by means of which downward and upward jars may be imparted to the top sub of the running tool. The assembly of flexible line tools 193 of course has an upper connector sub 194 by means of which the assembly is connected to the lower end of a flexible line 195 by means of which the well tools may be moved through a well flow conductor.

When it is desired to position and lock a well tool in position below a selected one of the longitudinally spaced landing nipples 24 of the well flow conductor 21 by means of the locking device 20, the top sub 196 of the running tool 100 is moved upwardly on the main body 101 and

the actuator sleeve 126 is moved upwardly on the top sub, against the force exerted by the spring 133, to the positions illustrated in FIGURE 1. The shear pin 120 is inserted in place to releasably hold the top sub and the actuator sleeve stationary upon the mandrel. The lower reduced portion 101 of the main body of the running tool is then inserted or telescoped into the mandrel 40 of the locking device until its downwardly facing shoulder 105 engages the upper end of the mandrel. The transverse apertures at the lower ends of the main body and the mandrel are then aligned and the shear pin 102 is inserted therethrough and secured against displacement therefrom by means of the screws 103. The tool to be locked in position is secured to the lower end of the mandrel 40, and the reduced threaded top portion 190 of the top sub is connected to the lower connector sub 191 of the flexible line tool assembly 193 so that this assemblage of well tools may be lowered into the well flow conductor 21 with the various components of the running tool and the locking device in the positions illustrated in FIGURE 1. The well flow conductor 21 may be a conventional tubing string having one or more of the landing nipples 24 connected therein.

The locking dogs 50 of the locking device are now in the retracted positions due to the friction between the lateral sides thereof and the sides of the dog carrier defining the windows or slots 57 and also due to the friction between their lower ends and the shoulders defining the lower ends of the slots 57 of the dog carrier. The outer bosses 58 of the locking dogs are thus held out of engagement with the internal surfaces of the flow conductor as the locking device is moved downwardly therethrough.

It will be noted that the actuator sleeve is now in its upper position and out of contact with the upper ends of the dogs 50 so that the spring 133 of the running tool is not effective to bias the locking dogs 50 outwardly toward their expanded position. The locator dogs 160 are now held in the expanded positions illustrated in FIGURE 1 due to the engagement of their inner bosses 166 with the annular external flange 158 of the main body of the running tool. The outer bosses 162, of the locator dogs do not project outwardly through the apertures 164 a sufficient distance to engage the internal surfaces of the usual flow conductor sections 25 but do extend outwardly a sufficient distance to engage the upwardly facing shoulders 30 and 34 of the landing nipples 24 during downward movement of the running tool through the well flow conductor and the lower downwardly facing shoulders 31 of the landing nipples 24 during upward movement of the running tool through the well flow conductor.

The seal assembly 46 is of smaller diameter than the bore of the usual tubing flow conductor sections 25 so that it does not engage such surfaces and is not worn by such engagement but is of such diameter that it will engage and seal with the internal surfaces of the landing nipples when disposed therein.

As the assemblage of well tools is lowered through the well flow conductor, the upwardly and outwardly beveled lower shoulders 169 of the outer bosses of the locator dogs 160 engage such upwardly facing obstructions in the well flow conductor as the shoulders 30 and 34 of the landing nipple. Upon such engagement of the outer bosses of the locator dogs with the landing nipple, further downward movement of the locator dogs is arrested but downward movement of the main body and the actuator sleeve continues due to the weight of the assembly of well tools connected to the main body. Such further downward movement of the main body is of course resisted by the spring 181 but since this spring is weak, its resistance is readily overcome by the weight of the locking device and of the other well tools connected to the main body of the running tool. As a result, the external annular flange 158 of the main body moves downwardly below the inner bosses of the locator dogs

when the downward movement of the locator dogs is arrested, and the dogs are freed to move inwardly into the upper external recess 151 of the main body. When the external flange 158 moves downwardly below the inner bosses of the locator dogs, the camming engagement of the lower beveled shoulders 169 of the outer bosses with such upwardly facing obstruction cams the lower ends of the locator dogs inwardly so that the locator dogs will also continue such downward movement past such internal obstruction. It will be noted that the inner edges of the lower shoulders 34 of the locking recess of the landing nipples are beveled inwardly and downwardly to facilitate such inward camming of the locator dogs. When the running tool has moved downwardly past such internal obstruction, for example, down below a landing nipple and past its lower downwardly facing shoulder 31, the spring 181 is effective once again to move the locator dogs downwardly to the position illustrated in FIGURE 1, the camming engagement of the lower shoulders of the inner bosses 166 of the locator dogs with the shoulder 155 of the external flange 158 causing the locator dogs again to move to their outwardly extending positions illustrated in FIGURE 1 wherein the outer bosses of the locator dogs again extend outwardly of the actuator sleeve. The apertures or windows 164 of the actuator sleeve are of course of sufficient length or height to permit such longitudinal movement of the dogs relative to the actuator sleeve.

It will be apparent that during such downward movement of the well tools through the well flow conductor, the locking dogs 50 of the locking device do not engage any of the internal surfaces of the flow conductor or of any landing nipples through which they pass so that the locking dogs do not mar the internal surfaces of the flow conductor nor scrape any protective coating covering such internal surfaces which may be provided to protect the flow conductor against corrosive effects of the well fluids.

It will be apparent that the locator dogs 160 also do not drag against or scrape the internal surfaces of the usual sections 24 of the flow conductor and only engage the internal surfaces of the landing nipples. Since the spring 181 is relatively weak, the locator dogs do not engage even the internal surfaces of the landing nipples with any considerable force so that locator dogs also do not mar the internal surfaces of the landing nipples or scrape off the protective coating covering the internal surfaces of the landing nipples. The landing nipples themselves may of course be made of metal more resistant to corrosion than the steel of which the usual flow conductor sections 25 are made.

During downward movement of the running tool and the locator device through a well flow conductor, well fluids are permitted to bypass the seal assembly 46 by moving upwardly through the flow passage 48 of the mandrel 40 of the locking device between the mandrel and the flat sides 104 of the reduced portion 101 of the main body, then outwardly through the space between the lower end of the upper sub 106 and the upper end of the expander sleeve 72, and then through the apertures 131 of the outer sleeve, and also upwardly and outwardly between the top sub 106 and the actuator sleeve, to the annular space between the actuator sleeve and the internal surfaces of the flow conductor.

The assemblage of well tools is lowered until the locking device mandrel 40 is located preferably just below the landing nipple 24 in which it is desired to locate and lock the locking device. The assemblage of well tools is then lifted until upward movement of the locator dogs 160 is stopped by the engagement of the upper beveled shoulders 168 with the downwardly facing shoulder 31 of the landing nipple. Since the lower ends of the locator dogs now engage the shoulders 180 defining the lower ends of the apertures 164 of the actuator sleeve, upward movement of the actuator sleeve is also stopped. An upward

force of sufficient magnitude now applied through the flexible line 195 and the flexible line tools 193 to the top sub 106 will cause upward movement of the top sub and of the main body 100 of the running tool since the control pin 110 now engages the lower shoulders 113 of the top sub which define the lower ends of the slots 109 thereof. Such upward movement of the top sub in the main body causes the shear pin 120 to shear at one place between the top sub 106 and the actuator sleeve 126. The shear pin 120 does not shear at the points between the main body and the top sub since this would require a much greater force since it would have to be sheared at two places. Once the shear pin 120 is sheared between the top sub and the actuator sleeve, the force of the spring 133 is effective to move the actuator sleeve downwardly from the position illustrated in FIGURE 1 to the position illustrated in FIGURE 2 wherein its internal annular beveled shoulder 145 engages the downwardly and outwardly beveled shoulders 146 at the upper ends of the locking dogs 50 and the camming action between these shoulders pivots the upper ends of the dogs about the pivot edges 70 inwardly to move the lower end portions of the dogs and their bosses 58 outwardly toward their expanded positions until the bosses 58 engage the inner surfaces of the well flow conductor section 25 below the landing nipple 24. Downward movement of the actuator sleeve 126 relative to the main body of the running tool also causes movement of the locator dogs downwardly on the main body due to the force exerted by the spring 181. The camming action between the beveled upper shoulders 168 of the outer bosses of the locator dogs and the downwardly and outwardly beveled shoulder 31 and such downward movement of the locator dogs relative to the main body causes the inner bosses 166 of the locator dogs to be disposed downwardly below the external flange 158 of the main body and to move inwardly into the lower recess 152 of the main body so that the locator dogs are then disposed in their retracted positions wherein their outer bosses do not protrude outwardly of the actuator sleeve and will not thereafter engage or drag on the internal surfaces of the landing nipple 24.

The various components of the running tool 22 and the locking device 20 are then in positions illustrated in FIGURE 2 with the locking dogs 50 biased outwardly to their outer positions by the force of the spring 133 and the camming engagement of the beveled shoulder 145 of the actuator sleeve with the upper shoulders 146 of the locking dogs. Upward movement is then imparted to the running tool and the locking device to raise the locking device above the landing nipple in which it is to be locked. During such upward movement through the landing nipple, the downwardly and outwardly beveled shoulders 61 of the locking dogs 50 engage such downwardly facing obstructions as the downwardly facing shoulders 31 and 35 of the landing nipple and the camming action therebetween moves the dogs inwardly toward their retracted position against the resistance of the spring 133, the actuator sleeve being raised relative to the locking dogs due to the camming action between its lower shoulder 145 and the upper shoulders 146 of the locking dogs as the locking dogs move toward their retracted positions.

When the locking device is moved to a position just above the selected landing nipple 24, the assemblage of well tools is again lowered, the locking dogs sliding along the internal surfaces of the well flow conductor section 25 immediately above the landing nipple and moving inwardly to their retracted positions when they engage the upper downwardly and inwardly beveled shoulder 30 of the landing nipple due to the camming action therebetween and then moving outwardly due to the action of the spring 133 into the landing recess 33 of the landing nipple when the bosses 58 of the locking dogs become aligned with the recess 33. When the locking dogs move

outwardly into their expanded positions in the recess 33, their lower shoulders 60 will engage the abrupt upwardly facing annular shoulder 34 of the landing nipple and further downward movement of the locking dogs is therefore arrested. As a result, since the upper shoulders 200 of the bosses 58 of the locking dogs engage the shoulders 201 of the dog carrier 54 defining the upper ends of the slots or windows 57 and prevent downward movement of the dog carrier and therefore of the mandrel 40, the locking dogs stop any further downward movement of the locking device.

Downward jars or forces are then imparted to the upper drive member or top sub 106 of the running tool by means of the flexible line tools 193 to force the top sub downwardly relative to the main body 100 of the running tool. Such downward movement of the top sub occurs when the downward jars shear the pin 120 at the two places between the main body and the top sub. Downward movement of the top sub 106 causes engagement of its lower end with the upper end of the lock sleeve 72 of the locking device 20. As the lock sleeve 72 moves downwardly on the mandrel 40, if the dogs for some reason are not in their fully expanded position, the cam shoulders 80 of the lock sleeve engage the cam shoulders 77 of the locking dogs to move them further outwardly to fully expanded position. The lock sleeve is then moved further downwardly to position its lock shoulders 74 adjacent the shoulders or surfaces 75 of the locking dogs to prevent inward movement of the locking dogs toward retracted positions. When the top sub moves to its lowermost position relative to the main body 100 of the running tool, the downwardly facing surface 204 defining the upper end of its bore engages the upper end of the main body whereupon no further downward movement of the top sub may take place.

The locking device is now locked against both upward and downward movement in the landing nipple 24 of the well flow conductor since the dogs are now held in their expanded positions with their bosses 58 projecting into the annular locking recess 33 of the landing nipple, upward movement of the dogs and the mandrel being stopped by the engagement of the upper shoulders 61 of the dogs with the downwardly facing upper shoulder 35 of the landing nipple and downward movement of the locking device being prevented by the engagement of the lower shoulders or ends 60 of the locking dogs with the upwardly facing shoulder 34. The running tool and the flexible line tool assembly 193 is now raised to cause the top sub 106 to move upwardly relative to the main body until further upward movement of the top sub relative to the main body is arrested due to the engagement of the upwardly facing shoulders 113 defining the lower ends of the slots 109 with the control pin 110. Upward jars imparted to the main sub through the flexible line tool assembly 193 now cause the shear pin 102 to shear to free the main body of the running tool from the mandrel 40 of the locking device and the running tool may then be withdrawn upwardly from the well flow conductor leaving the locking device locked in position in the landing nipple 24 with its seal assembly 46 in sealing engagement with the landing nipple below the dogs.

When it is desired to remove the locking device and any well tools 42 supported thereby from the well flow conductor any suitable pulling tool, such as the Otis type B pulling tool illustrated and described on page 4358 of the Composite Catalog of Oil Field Services and Equipment, 1960 edition, is lowered into the well flow conductor by means of the flexible line tool assembly 193 until the pulling tool contacts the locking device and engages the undercut downwardly facing shoulder 87 of the lock sleeve provided by the external annular flange 86 thereof. Upward movement imparted to the pulling tool and the flexible line tool assembly 193 then causes first upward movement of the lock sleeve on the main

mandrel so that the locking surfaces 74 of the lock sleeve are moved upwardly above the internal surfaces 75 of the locking dogs so that the dogs are freed for inward movement toward their retracted positions. Continued upward movement of the lock sleeve then causes its external shoulder 83 to engage the downwardly facing shoulder 84 of the internal flange 64 of the dog carrier so that continued upward movement of the pulling tool will then result in upward movement being imparted to the dog carrier and therefore to the main mandrel 40. The camming engagement between the upper shoulders 61 of the locking dogs with the upper shoulder 35 of the landing nipple now cams the dogs inwardly to their retracted positions to permit upward movement of the locking device out of the landing nipple. Once the dogs are cammed inwardly into their retracted positions, they will not of course drag on the internal surfaces of the well flow conductor as the locking device is removed from the well since they are not biased toward their expanded positions.

It will be apparent that once the shear pin 120 is sheared between the actuator sleeve 126 and the top sub 106 to free the actuator sleeve for downward movement relative to the main body and the mandrel of the locking device to cause it to bias the locking dogs outwardly, the locking device may be positioned and locked in any one of a number of identical landing nipples of the well flow conductor which are located above the downwardly facing obstruction engaged by the locator dogs of the running tool which cause such shearing of the shear pin by raising the locator device through any landing nipple below such selected landing nipple to a position above such selected one of the landing nipples and then moving it downwardly until the locking dogs move into alignment with the locking recess 33 of the seal and expand thereinto.

In a preferred form of the locking device, the lock sleeve 72 and the locking dogs 50 have interengaging laterally projecting teeth 74a and 75a instead of the coengageable vertical planar locking surfaces 74 and 75, respectively. The downwardly facing surfaces 75b of the teeth 75a of the dogs and the upwardly facing surfaces 74b of the teeth 74a of the lock sleeve may incline inwardly and upwardly at the same angle as the upper shoulders 61 of the locking dogs and the upper shoulders 35 of the locking recesses of the landing nipples. The upwardly facing surfaces 75c of the teeth 75a of the locking dogs and the downwardly facing surfaces 74c of the teeth 74a of the lock sleeve are inclined downwardly and inwardly so that the engagement of these surfaces as the lock sleeve moves downwardly on the mandrel will move the locking dogs outwardly to their fully expanded positions should they tend to move inwardly during such downward movement of the lock sleeve relative to the dogs. It will be noted that if an upwardly acting pressure differential exists across the locking device when the locking dogs are in their expanded positions in the locking recess 33 of a landing nipple, the locking device is held in an upper position in the landing nipple by such pressure differential with the upper downwardly and outwardly inclined shoulders 61 of the locking dogs in engagement with the downwardly and inwardly inclined shoulder 35 of the landing nipple. The camming action between these surfaces will thus bias or force the dogs inwardly toward their retracted position and against the lock sleeve so that the teeth 74a and 75a are held in tight engagement. Should an operator now attempt to remove the locking device upwardly by exerting an upward force on the lock sleeve, the engagement of the upwardly and inwardly inclined surfaces 75b and 74b of the dogs and of the lock sleeve will prevent upward movement of the lock sleeve and the operator is thus warned that an upwardly acting pressure differential exists across the locking device. He can then take proper steps to equalize the pressure differential

across the locking device before attempting removal of the locking device. When no upwardly acting pressure differential exists across the locking device, the locking device may be in a lowermost position in the landing nipple with the shoulders of the lower ends 60 of the locking dogs engaging the upwardly facing shoulder 34 of the landing nipple to prevent downward movement of the locking device in the well flow conductor against the force of gravity. The locking dogs are easily moved outwardly into fully expanded position upon upward movement of the lock sleeve due to the camming engagement of the surfaces 75b and 74c of the locking dogs and of the sleeve so that the lock sleeve may be moved upwardly relative to the dogs to permit inward movement of the locking dogs toward retracted positions after the lock sleeve has been moved upwardly out of engagement with the locking dogs. It will therefore be apparent that the provision of the lock sleeve and the locking dogs with interengaging serrations or teeth provides a safety lock for the locking device which will prevent unlocking of the locking device from the landing nipple when a high upwardly acting pressure differential exists across the locking device. If the locking device were released for upward movement in the presence of such upwardly acting pressure differential, a high upward velocity would be imparted to the locking device once the lock sleeve had moved to its upper inoperative position with consequent danger of damage to the pulling tool, the flexible line, the flexible line tools by means of which the pulling tool is lowered into the well flow conductor, and to the well flow conductor itself, and also with danger of bodily harm to the operators at the surface of the well in the event the velocity is of such degree as to cause forcible ejection of the flexible line and the tools or parts thereof through the upper end of the well flow conductor.

It will now be seen that a new and improved locking device has been illustrated and described which has locking dogs 50 receivable in a lock recess 33 of a well flow conductor, but which has no means for biasing the locking dogs outwardly toward expanded position so that the locking dogs do not move toward expanded position during movement of the locking device through the well flow conductor.

It will further be seen that the locking device is provided with a lock means, such as the lock sleeve 72, for locking the dogs against movement from expanded toward retracted position.

It will also be apparent that the lock sleeve and the locking dogs may be provided with interengaging serrations or teeth 74 and 75 which hold the lock sleeve in locking engagement with the locking dogs when an upwardly acting pressure differential exists across the locking device.

It will also be seen that a running tool for the locking device has been illustrated and described which includes a biasing means, the actuator sleeve 126 and the spring 133, which are releasable to bias the dogs of the locking device toward expanded position after the running tool has been located below a selected downwardly facing obstruction, such as the lower shoulder 31 of the landing nipple, by means of the locator dogs 160 of the running tool.

It will further be seen that the locator dogs of the running tool do not engage the internal surfaces of the well flow conductor except at the selected sections or landing nipples thereof which provide upwardly and downwardly facing obstructions engageable by the locator dogs.

It will further be seen that the locating dogs are moved inwardly to retracted position after they have located the locking device at a selected section or landing nipple of the well flow conductor and released the actuator sleeve for movement to a position biasing the locking dogs of the lock device toward expanded position.

It will further be seen that the locking device is provided with a minimum number of operative components

and that all biasing and locating functions are performed by the running tool.

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

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

1. A locking device including: a mandrel; a dog carrier secured to said mandrel and having a portion in spaced relation thereto; a plurality of locking dogs disposed between said mandrel and said dog carrier and held by said dog carrier against displacement from said mandrel, said dog carrier having laterally outwardly opening apertures, said dogs having outwardly extending bosses at their lower ends movable outwardly of the dog carrier through said apertures, said dogs having pivot means intermediate their upper and lower ends engageable with the mandrel whereby the lower ends of said dogs may be pivoted about said pivot means between retracted positions wherein the bosses do not extend outwardly of said dog carrier and expanded positions wherein the said bosses extend outwardly of said dog carrier.

2. In combination with the locking device of claim 1, a running tool including: a main body having a lower portion releasably securable to said mandrel; an upper member releasably securable in an upper position relative to said main body and movable downwardly relative to said main body to engage said lock sleeve to move said lock sleeve from its initial position to its locking position; an actuator sleeve carried by said main body; means releasably holding said actuator sleeve in an initial upper position on said body, said actuator sleeve being movable downwardly relative to said main body, said actuator sleeve having means engageable with said dogs for moving said dogs toward their expanded positions upon downward movement of said actuator sleeve relative to said main body; and means for biasing said actuator sleeve downwardly relative to said main body, said means releasably holding said actuator sleeve in said initial upper position including locator means carried by said mandrel and said actuator means engageable with a downwardly facing obstruction of a well flow conductor upon movement of said running tool upwardly through the well flow conductor for releasing said actuator sleeve for downward movement relative to said main body from its initial upper position, said upper member of said running tool being movable downwardly to engage said lock sleeve to move it to locking position when subsequent downward movement of said locking device is arrested by engagement of the locking dogs with an upwardly facing obstruction of a well flow conductor.

3. A locking device including: a mandrel; a dog carrier secured to said mandrel and having a portion in spaced relation thereto; a plurality of locking dogs disposed between said mandrel and said dog carrier and held by said dog carrier against displacement from said mandrel, said dog carrier having laterally outwardly opening apertures, said dogs having outwardly extending bosses at their lower ends movable outwardly of the dog carrier through said apertures, said dogs having pivot means intermediate their upper and lower ends engageable with the mandrel whereby the lower ends of said dogs may be pivoted about said pivot means between retracted positions wherein the bosses do not extend outwardly of said dog carrier and expanded positions wherein the said bosses extend outwardly of said dog carrier; and a lock sleeve slidably mounted on said mandrel for movement from an initial upper position to a lower locking position, said lock sleeve having a lower portion movable between said dog carrier and said mandrel, said lower portion of said lock sleeve and said dogs having

means coengageable when said lock sleeve is in said lower position to prevent movement of said dogs toward said retracted positions.

4. A locking device including: a mandrel; a dog carrier secured to the said mandrel and having an upper portion in spaced relation thereto; a plurality of locking dogs disposed between said mandrel and said dog carrier having upper ends extending upwardly of said dog carrier, said dog carrier having laterally outwardly opening apertures, said dogs having outwardly extending bosses at their lower ends movable outwardly of the dog carrier through said apertures, said dogs having pivot means intermediate their upper and lower ends engageable with the mandrel whereby the lower ends of said dogs may be pivoted about said pivot means between retracted positions wherein the bosses do not extend outwardly of said dog carrier and expanded positions wherein said bosses extend outwardly of said dog carrier, said locking dogs having cam means at their upper ends whereby said dogs may be pivoted towards said expanded positions; and a lock sleeve slidably mounted on said mandrel for movement from an initial upper position to a lower locking position, said lock sleeve having a lower portion movable between said dog carrier and said mandrel, said lower portion of said lock sleeve and said dogs having means coengageable when said lock sleeve is in said lower position to prevent movement of said dogs toward said retracted positions.

5. A running tool for a well tool including: a main body having an upper portion and a lower portion, said lower portion being releasably secured to a well tool; an upper drive member releasably secured in upper position on said main body and movable downwardly relative to said main body from an upper position thereon to engage a well tool secured to said lower portion; an actuator sleeve carried by said main body disposed outwardly of said upper portion releasably held in an initial upper position relative to said main body and movable downwardly relative to said body, and locator means carried by said main body and engageable with a downwardly facing obstruction of a well flow conductor upon upward movement of said running tool through the well flow conductor for releasing said actuator sleeve for downward movement relative to said main body from its said initial upper position.

6. A running tool for locating and locking a well tool in a well flow conductor including: a main body having an upper drive member carried by said body for limited longitudinal movement relative thereto between an upper position and a lower position relative to said body; a first means releasably securing said upper drive member to said main body; an actuator sleeve carried by said main body and movable longitudinally relative to said main body from an initial upper position; second means releasably securing said actuator sleeve in its initial upper position; means for biasing said actuator sleeve downwardly relative to said main body; and locator means carried by said main body and engageable with a downwardly facing obstruction of a well flow conductor upon upward movement of said running tool through the well flow conductor for causing said second means to release said actuator sleeve for downward movement relative to said main body from its initial upper position, said first means releasing said upper drive member for downward movement relative to said main body when downward movement of the main body is subsequently arrested.

7. A running tool for locating and locking a well tool in a well flow conductor including: a main body having an upper drive member carried by said body for limited longitudinal movement relative thereto between an upper position and a lower position relative to said body; a first means releasably securing said upper drive member to said main body; an actuator sleeve carried by said main body and movable longitudinally relative to said main body from an initial upper position; second means releas-

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ably securing said actuator sleeve in its initial upper position; means for biasing said actuator sleeve downwardly relative to said main body; and locator means carried by said main body and engageable with a downwardly facing obstruction of a well flow conductor upon upward movement of said running tool through the well flow conductor for causing said second means to release said actuator sleeve for downward movement relative to said main body from its initial upper position, said first means releasing said upper drive member for downward movement relative to said main body when downward movement of the main body is subsequently arrested, said second means releasing said actuator sleeve upon the application of a smaller force upwardly to the main body than the downward force applied to said upper drive member necessary to cause the first means to release the upper drive member for downward movement relative to said main body.

8. A locking device for use in a well flow conductor having an internal recess including: a mandrel; carrier means on said mandrel; expansible means mounted on the carrier means for movement between retracted position adjacent said mandrel and expanded position wherein said expansible means is receivable in an internal recess of a well flow conductor; and a lock means carried by said mandrel for movement between an initial upper inoperative position and a lower locking position, said lock means and said expansible means having means coengageable when the lock means is in its lower position for preventing movement of said expansible means from expanded position to retracted position, said coengageable means of said lock means and said expansible means preventing movement of said lock means from its lower position towards its upper position when said expansible means are disposed in an internal recess of a well flow conductor and an upwardly acting pressure differential exists in the well flow conductor across said locking device, said coengageable means comprising laterally outwardly extending teeth on said lock means having outwardly convergent upper and lower surfaces and inwardly extending teeth on said expansible means having inwardly convergent upper and lower surfaces.

9. A locking device for use in a well flow conductor having an internal recess providing an upper upwardly and inwardly extending cam surface including: a mandrel; a carrier sleeve mounted on and spaced circumferentially from said mandrel; expansible means mounted between said sleeve and said mandrel for movement between retracted position adjacent said mandrel and expanded position wherein said expansible means is receivable in an internal recess of a well flow conductor, said expansible means having an upper downwardly and outwardly extending cam surface engageable with the cam surface of the well flow conductor when said expansible means is in said expanded position in the recess of the flow conductor; and a lock means carried by said mandrel for movement between an initial upper inoperative position and a lower locking position, said lock means and said expansible means having means coengageable when the lock means is in its lower position for preventing movement of said expansible means from expanded position to retracted position, said coengageable means comprising laterally outwardly extending teeth on said lock means having outwardly convergent upper and lower surfaces and inwardly extending teeth on said expansible means having inwardly convergent upper and lower surfaces, said coengageable means of said lock means and said expansible means preventing movement of said lock means from its lower position towards its upper position when said expansible means are disposed in an internal recess of a well flow conductor and an upwardly acting pressure differential exists in the well flow conductor across said locking device causing the engagement between said cam surfaces to bias said expansible means toward said lock means.

10. A locking device for use in a well flow conductor

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having an internal recess including: an elongate mandrel; a plurality of locking dogs; means on said mandrel supporting said locking dogs for movement relative to said mandrel between a retracted position and an expanded position wherein the dogs are engageable within the internal recess of said well flow conductor, said locking dogs and said means on said mandrel supporting said locking dogs releasably holding said locking dogs in said retracted position; and a lock sleeve disposed on said mandrel for movement between an initial upper position and a lower locking position, said lock sleeve when in said lower locking position engaging said dogs for holding said dogs in expanded positions engaged in the recess of said well flow conductor; means on said mandrel for connecting said mandrel to a running and setting tool; and means on said lock sleeve engageable with said running and setting tool, whereby said lock sleeve is movable longitudinally relative to said mandrel by said running and setting tool to positively dispose said lock sleeve in locking engagement with said dogs.

11. A locking device of the character set forth in claim 10 wherein said means for connecting said mandrel to a running and setting tool comprises means releasable upon the application of a predetermined force thereto to release said mandrel and from said running and setting tool.

12. In combination: a locking device including a mandrel having laterally movable dog means thereon movable between retracted position and expanded position, and lock sleeve means movable on said mandrel longitudinally thereof between a position in locking engagement with said dog means holding said dog means in expanded position relative to said mandrel and a position out of locking engagement with said dogs permitting said dog means to move to retracted position relative to said mandrel; and a running and setting tool for setting said locking device in a well conductor having an internal locking recess therein, said running and setting tool including first means connecting said mandrel to said running and setting tool whereby said locking device is movable by said running and setting tool in a well flow conductor, second means engageable with said lock sleeve means and movable relative to said mandrel for moving said lock sleeve means relative to said mandrel, and sensing means on said running and setting tool engageable with the well flow conductor for sensing the locking recess in said conductor, whereby actuation of said running and setting tool to move said lock sleeve means relative to said mandrel of said locking device may be effected to move the dog means of the locking device into engagement in said recess of said flow conductor, said first means connecting said running and setting tool with said mandrel being releasable to permit said running and setting tool to be disconnected from said locking device and removed from said flow conductor.

13. In a well having a flow conductor therein, a plurality of longitudinally spaced tubular housings having internal annular locking recesses formed therein, each of said tubular housings having means at its opposite ends for connecting it in a well flow conductor, and a locking device including a mandrel having laterally movable locking dog means thereon movable between retracted position and expanded position relative to said mandrel, and a lock sleeve movable on said mandrel longitudinally thereof between a position in locking engagement with said dog means holding said dog means in expanded locking position and a position out of locking engagement with said dogs permitting said dog means to move to retracted position relative to said mandrel; and a running and setting tool for setting said locking device in one of said housings in said well conductor having an internal locking recess therein, said running and setting tool including first means connecting said mandrel to said running and setting tool whereby said locking device is mov-

able by said running and setting tool in a well flow conductor, second means engageable with said lock sleeve and movable relative to said first means for moving said lock sleeve relative to said mandrel, and sensing means on said running and setting tool engageable with the well flow conductor for sensing said tubular housings in said conductor, whereby actuation of said running and setting tool to move said lock sleeve relative to said mandrel of said locking device may be effected to move the locking dog means of the locking device into engagement in the locking recess of the housing in said flow conductor sensed by said sensing means, said first means connecting said running and setting tool with said mandrel being releasable to permit said running and setting tool to be disconnected from said locking device and removed from said flow conductor.

14. A locking device for use in a well flow conductor having an internal recess including: a mandrel; a plurality of locking dogs; means supporting said locking dogs on said mandrel, each of said locking dogs being mounted for pivotal movement about a point intermediate the ends thereof between a retracted position wherein the upper end of the dog is spaced outwardly of the mandrel and the lower end of the dog is adjacent the mandrel and expanded position wherein the upper end of the dog is adjacent the mandrel and the lower end of the dog is spaced outwardly of the mandrel, each of said dogs having an external boss on the lower end thereof movable into the internal recess of the well flow conductor when the dog is pivoted from its retracted position to its expanded position about said point; a lock sleeve disposed on said mandrel for movement between an initial upper inoperative position and a lower locking position, said lock sleeve and said dogs having means coengageable when the lock sleeve is in its lower position for preventing pivotal movement of the dogs from their expanded positions toward their retracted positions; and a running tool including a main body having a lower portion, means for releasably securing said lower portion to said mandrel; and upper drive member on said main body; means releasably securing said drive member to said main body in an upper position thereon, said drive member being movable downwardly on said main body to engage said lock sleeve to move said lock sleeve from its initial position to its locking position, and actuator sleeve carried by said body, means releasably holding said actuator sleeve in an initial upper position of said body, said actuator sleeve being movable downwardly relative to said body, said actuator sleeve having means engageable with said dogs for moving said dogs toward their expanded positions upon downward movement of said actuator sleeve relative to said main body, means for biasing said actuator sleeve downwardly relative to said main body, said means releasably holding said actuator sleeve in said initial upper position including locator means engageable with a downwardly facing obstruction of a well flow conductor upon movement of said running tool upwardly through the well flow conductor for releasing said actuator sleeve for downward movement relative to said main body from its initial upper position, said upper drive member of said running tool being movable downwardly to engage said lock sleeve to move it to locking position when subsequent downward movement of said locking device is arrested by engagement of the locking dogs with an upwardly facing obstruction of the well flow conductor, said locator means comprising a plurality of dogs carried by said main body having external bosses extendable outwardly through lateral apertures provided in said actuator sleeve, said actuator sleeve and said locator dogs having coengageable means for limiting downward movement of said locator dogs relative to said actuator sleeve; means biasing said locator dogs downwardly relative to said actuator sleeve, said locator dogs being mounted on said main body for movement be-

tween an intermediate position wherein said bosses extend outwardly through said apertures of said actuator sleeve and upper and lower positions wherein said external bosses of said locator sleeve are disposed inwardly of said actuator sleeve, said locator dogs being disposed in said intermediate position when said actuator sleeve is in its upper position relative to said main body and being movable to said upper position relative to said actuator sleeve and said main body upon engaging upwardly facing obstructions of the well flow conductor, said coengageable means of said locator dogs and of said actuator sleeve limiting downward movement of said locator dogs relative to said actuator sleeve whereby said actuator sleeve is released for downward movement relative to said main body when said locator dogs engage downwardly facing obstructions during upward movement of the running tool in a well flow conductor.

15. A locking device for use in a well flow conductor having an internal recess including: a mandrel; supporting means on said mandrel; expansible means mounted on the supporting means for lateral movement between retracted position adjacent said mandrel and expanded position wherein said expansible means is receivable in an internal recess of a well flow conductor; means on said mandrel engageable with said expansible means for moving said expansible means from retracted position toward expanded position; said supporting means and expansible means having coengageable means releasably holding said expansible means against movement from said retracted position toward said expanded position; and a lock means carried by said mandrel for movement between an initial upper inoperative position and a lower locking position, said lock means and said expansible means having means coengageable when the lock means is in its lower position for preventing movement of said expansible means from expanded position to retracted position, said coengageable means of said lock means and said expansible means preventing movement of said lock means from its lower position towards its upper position when said expansible means are disposed in an internal recess of a well flow conductor and an upwardly acting pressure differential exists in the well flow conductor across said locking device.

16. A locking device for use in a well flow conductor having an internal recess providing an upper upwardly and inwardly extending cam surface including: a mandrel; supporting means on said mandrel; expansible means mounted on the supporting means for movement between retracted position adjacent said mandrel and expanded position wherein said expansible means is receivable in an internal recess of a well flow conductor; means on said mandrel engageable with said expansible means for moving said expansible means from retracted position toward expanded position, said supporting means and said expansible means having coengageable means releasably holding said expansible means against movement from said retracted position, said expansible means having an upper downwardly and outwardly extending cam surface engageable with the cam surface of the well flow conductor when said expansible means is in said expanded position in the recess of the flow conductor; and a lock means carried by said mandrel for movement between an initial upper inoperative position and a lower locking position, said lock means and said expansible means having means coengageable when the lock means is in its lower position for preventing movement of said expansible means from expanded position to retracted position, said coengageable means of said lock means and said expansible means preventing movement of said lock means from its lower position towards its upper position when said expansible means are disposed in an internal recess of a well flow conductor and an upwardly acting pressure differential exists in the well flow conductor across said locking device causing the engagement be-

tween said cam surfaces to bias said expansible means
toward said lock means.

References Cited by the Examiner

UNITED STATES PATENTS

2,644,527 7/53 Baker ----- 166—123

2,798,559	7/57	Fredd -----	166—125
2,871,947	2/59	Fredd -----	166—214
2,940,525	6/60	Fredd -----	166—215
2,991,835	7/61	Schwab -----	166—214

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