Aug. 13, 1963 J. W. TAMPLEN 3,100,532

WELL TOOLS FOR PLUGGING A WELL FLOW CONDUCTOR

Filed Aug. 19, 1959 3 Sheets-Sheet 1

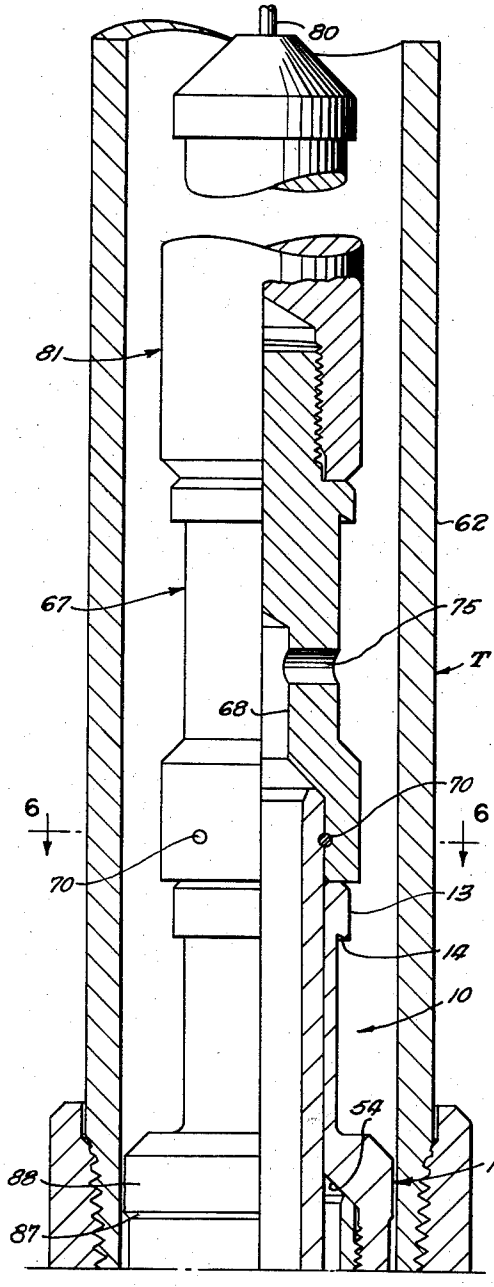

Fig. 1

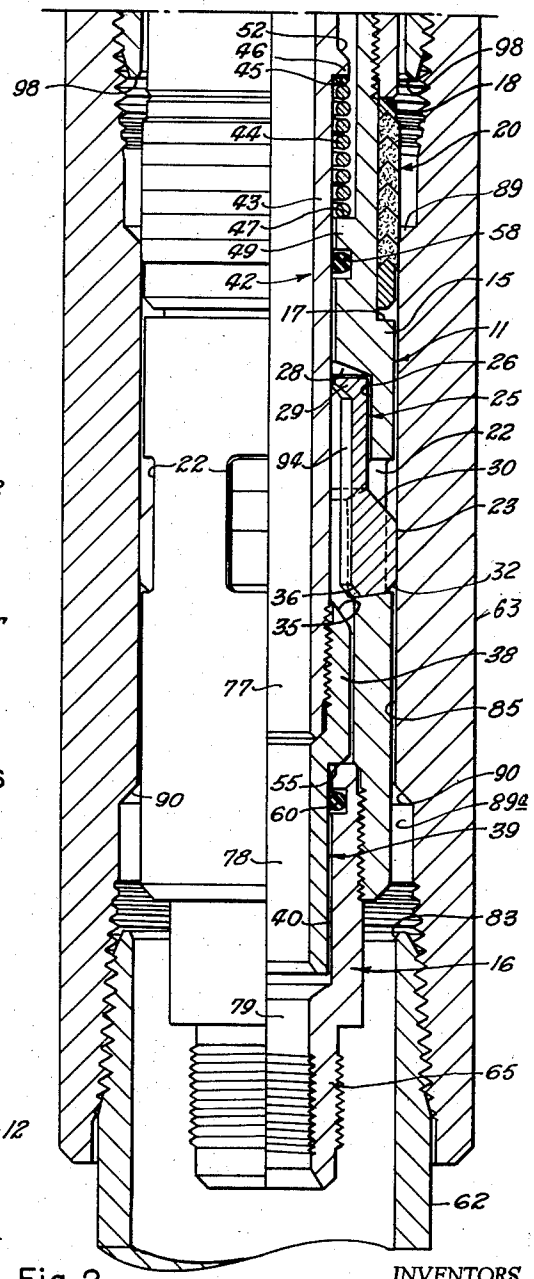

Fig. 2

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WELL TOOLS FOR PLUGGING A WELL FLOW CONDUCTOR

Filed Aug. 19, 1959 3 Sheets-Sheet 2

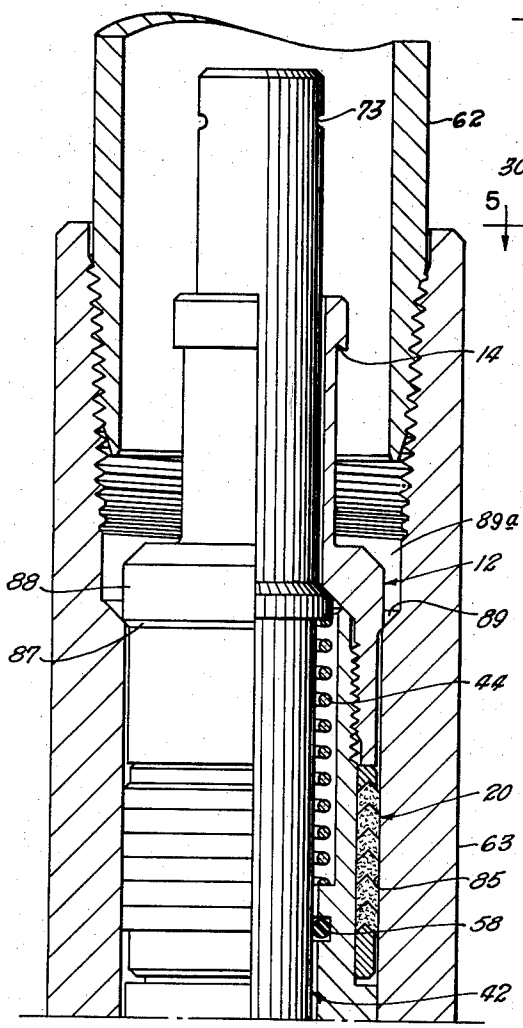

Fig. 3

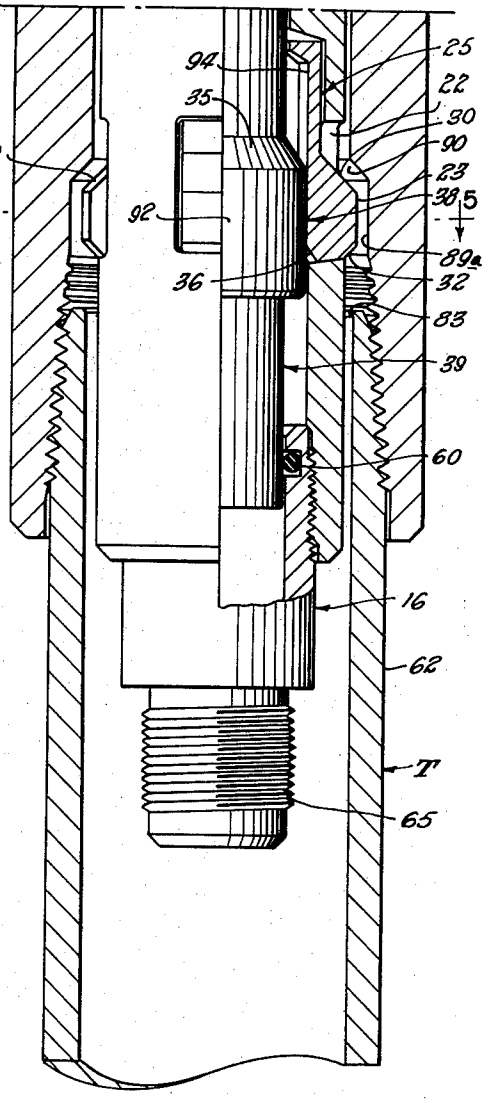

Fig. 4

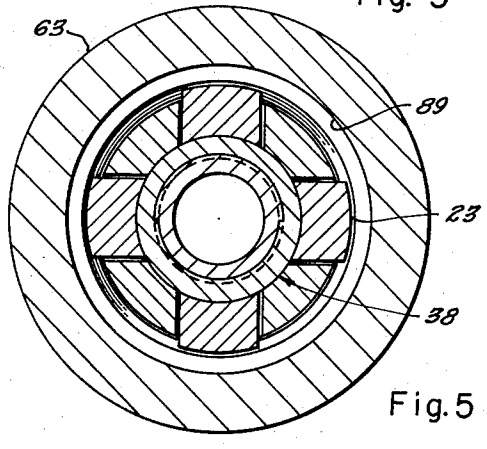

Fig. 5

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WELL TOOLS FOR PLUGGING A WELL FLOW CONDUCTOR

Filed Aug. 19, 1959 3 Sheets-Sheet 3

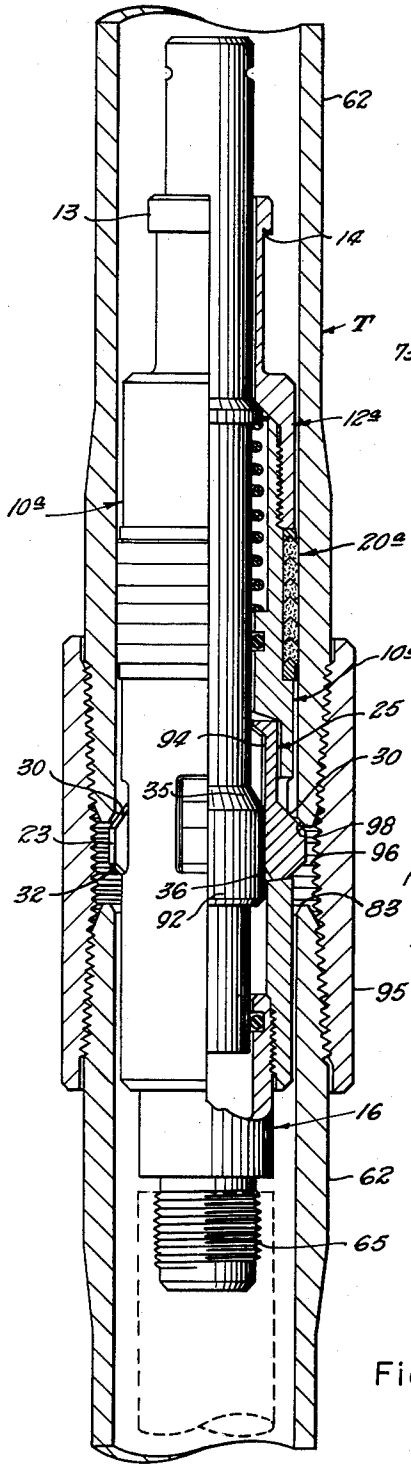

Fig. 7

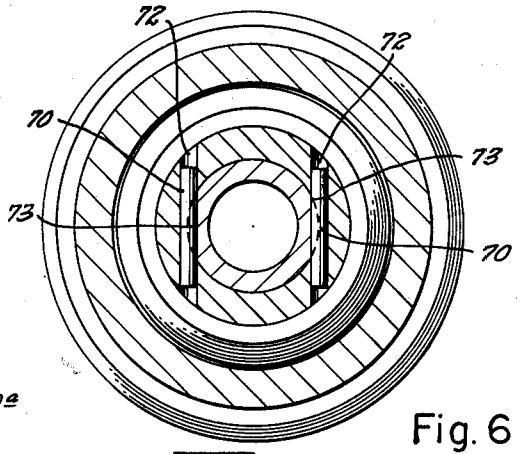

Fig. 6

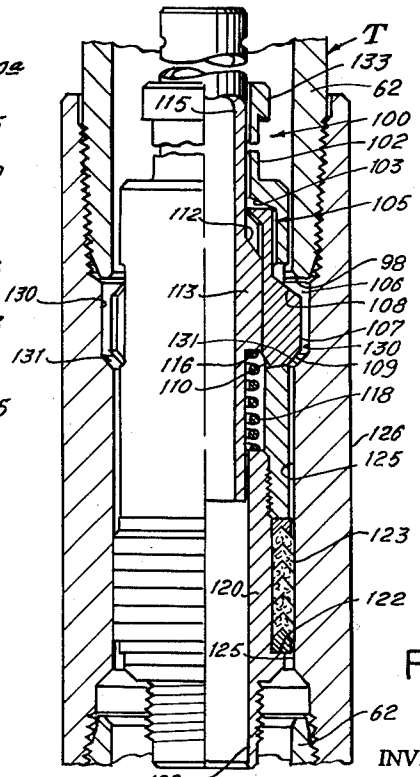

Fig. 8

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3,100,532
WELL TOOLS FOR PLUGGING A WELL FLOW CONDUCTOR

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12 Claims. (Cl. 166—125)

This invention relates to well tools and more particularly to a well tool for plugging a well flow conductor at a preselected position in the well flow conductor.

An object of this invention is to provide a new and improved well tool for plugging a well flow conductor.

Another object is to provide a well tool for plugging a well flow conductor which has seal means for sealing between the well flow conductor and the well tool and locking means expansible into engagement with the well flow conductor to prevent longitudinal movement of the well tool in the well flow conductor.

Still another object is to provide a well tool for plugging a well flow conductor having locking means which are expansible into engagement with the well flow conductor to limit movement of the well tool in the well flow conductor and having means for locking the locking means in expanded positions.

A further object of this invention is to provide a well tool for plugging a well flow conductor having an outer tubular mandrel provided with locking dogs which are movable outwardly through lateral apertures of the tubular mandrel toward expanded positions into engagement with the well flow conductor and an inner mandrel provided with a cam means engageable with the locking dogs which is resiliently biased to tend to move the locking dogs into expanded positions.

A still further object is to provide a well tool for a well flow conductor having a locking means engageable with the well flow conductor to lock the well tool in position which is capable of supporting the well devices in such manner that the weight of the well devices does not tend to move the locking means out of locking engagement with the well flow conductor.

A still further object of the invention is to provide a well tool for plugging a well flow conductor which is of simple economical construction and operation.

Additional objects and advantages of the invention will be readily 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 vertical partly sectional view of the upper portions of the well tool embodying the invention showing it connected to a running tool by means of which it is being lowered through a well flow conductor;

FIGURE 2 is a view similar to FIGURE 1, being a continuation thereof, showing the lower portions of the well tool;

FIGURE 3 is a vertical partly sectional view of the upper portions of the well tool showing the well tool locked in operative position in a landing nipple of a well flow conductor;

FIGURE 4 is a view similar to FIGURE 3, being a continuation thereof, showing the lower portions of the well tool;

FIGURE 5 is a sectional view taken on line 5—5 of FIGURE 4;

FIGURE 6 is a cross-sectional view taken on line 6—6 of FIGURE 1;

FIGURE 7 is a vertical partly sectional view of a modified form of the well tool showing it in locked position in a well flow conductor; and,

FIGURE 8 is a fragmentary vertical partly sectional view of another modified form of the well tool showing it in locked position in a well flow conductor.

Referring now to the drawings, the well tool 10 embodying the invention includes a tubular main mandrel 11 having an upper section or top sub 12 provided with a reduced upper portion having an external annular flange 13. The external flange provides an under cut annular shoulder 14 which may be engaged by pulling tools when it is desired to remove the well tool from the well flow conductor. The tubular mandrel also includes an intermediate section or housing 15 and a bottom section or bottom sub 16. The top sub 12 is threaded on the upper end of the housing 15 while the bottom sub is threaded into the lower end of the housing.

The intermediate portion of the housing 15 is reduced to provide an upwardly facing shoulder 17 which is spaced below the shoulder 18 provided by the lower end of the top sub. A seal assembly 20, which may be of the chevron type, is disposed on the housing and is held thereon between the shoulders 17 and 18. The housing is provided with a plurality of lateral apertures 22 through which are adapted to extend the bosses 23 of the dogs 25. The upper end portions of the dogs are received in an internal annular recess 26 of the housing which provides an upwardly and inwardly extending annular shoulder 28 against which the upper ends of the dogs abut. The dogs have inwardly extending flanges 29 at their upper ends. The bosses are provided with downwardly and outwardly extending upper shoulders 30 and upwardly and outwardly extening lower shoulders 32 whereby the lower ends of the dogs are cammed inwardly, when free to move inwardly, upon meeting downwardly or upwardly facing obstructions in a well flow conductor, respectively.

The lower ends of the dogs are moved outwardly toward expanded positions, wherein the bosses 23 extend outwardly of the housing, by a downwardly and outwardly extending annular cam shoulder 35 upon its engagement with the downwardly and outwardly extending inner shoulders 36 of the dogs 25. The upwardly facing cam shoulder 35 is provided by the enlarged upper portion 38 of the expander member 39 whose lower reduced portion telescopes in the enlarged upper portion of the bore 40 of the bottom sub 16. The dog expander constitutes a lower section of an inner mandrel 42 whose upper section 43 is threaded in the enlarged upper portion of the bore of the dog expander.

The inner mandrel is biased upwardly in the outer tubular mandrel toward the position illustrated in FIGURES 3 and 4 by a spring 44 disposed about the upper section of the inner mandrel. Opposite ends of the spring abut a downwardly facing shoulder 45 provided by an external annular flange 46 of the upper section of the inner mandrel and the upwardly facing annular shoulder 47 provided by the internal annular flange 49 of the housing 15.

The upper downwardly and outwardly extending shoulder 52 of the external flange 46 of the upper section of the inner mandrel is adapted to engage the internal downwardly facing annular shoulder 54 of the main mandrel to limit upward movement of the inner mandrel in the main mandrel. Downward movement of the inner mandrel relative to the main mandrel is limited by the engagement of the downwardly facing annular shoulder 55 of the dog expander 39 with the upper end of the bottom sub 16.

The housing 15 of the tubular main mandrel is provided with an internal annular recess in which is disposed a sealing means, such as an O-ring 58, which seals between the inner mandrel and the tubular main mandrel above the lateral apertures 22 of the main mandrel. A similar internal annular recess is provided in the bottom sub in which

is received the sealing means or O-ring 60 which seals between the dog expander and the bottom sub below the lateral apertures 22 of the outer tubular mandrel.

The provision of the internal annular recess 26 in the housing permits pivotal movement of the dogs about their upper ends between the retracted position shown in FIGURE 2 and the expanded positions shown in FIGURE 4 wherein the bosses 23 extend outwardly of the housing. The internal flanges 29 of the dogs abut the inner mandrel to guide such pivotal movement of the dogs.

When it is desired to position any suitable well device, not shown, in a well flow conductor such as the tubing string T formed of tubing sections 62 and a landing nipple 63 connected in the tubing string and forming a portion thereof, the well device is secured to the lower reduced threaded end 65 of the bottom sub and a running tool 67 is secured to the upper end of the inner mandrel 42. The upper end of the inner mandrel telescopes into the bore 68 of the running tool and is secured therein by a pair of shear pins 70 which extend through aligned apertures 72 of the running tool and the transverse external slots 73 of the inner mandrel adjacent the upper end thereof. The running tool may be provided with a suitable lateral port 75 which communicates with the bores 68, 77, 78, and 79 of the running tool 67, the upper section 43, the expander 39 and the bottom sub 16. The upper end of the running tool may be secured to a flexible line 80 through the usual line equipment 81 interconnected between the externally threaded upper end of the running tool and the flexible line.

When the assembly of the running tool and of the well tool 10 is lowered through the tubing string T, the bosses 23 of the dogs 25 engage the internal wall surfaces of the tubing string during such downward movement whereby the dogs are maintained in the retracted positions illustrated in FIGURE 2, the frictional engagement of the bosses tending to hold the main mandrel in an upper position on the inner mandrel. The inner mandrel moves further downwardly in the main mandrel whenever downward movement of the main mandrel is arrested, due to the engagement of the lower shoulders 32 of the dogs with such upwardly facing obstructions as the upper ends 83 of tubing sections at each collar recess of the tubing string, to move the camming surface 35 of th expander out of engagement with the downwardly and outwardly extending shoulders 36 of the dogs to permit inward movement of the dogs to the retracted positions after they have moved into expanded position in any such collar recess. The engagement of the lower end of the running tool with the upper end of the top sub then transmits a downwardly acting force to the main mandrel and to the dogs so that the cam shoulders 32 of the dogs, which are in engagement with the upwardly facing obstruction, then cam the dogs to their retracted positions to permit further downward movement of the well tool in the tubing string. The spring 44, however, continuously biases the main mandrel downwardly on the inner mandrel during such downward movement of the anchoring and sealing device through the tubing string.

When the anchoring and sealing device enters into the landing nipple 63, which is provided with an internal sealing surface 85 of smaller diameter than the internal diameter of the tubing string sections, the seal assembly 20 engages the sealing surface 85 to seal between the main mandrel and the landing nipple. Downward movement of the anchoring and sealing device is then continued until the downwardly facing annular stop shoulder 87 of the top sub provided by the external annular flange 88 thereof engages the upwardly facing upper annular shoulder 89 of the landing nipple. At this time the bosses 23 of the dogs are aligned with the enlarged bore 89*a* of the landing nipple below the downwardly and outwardly extending lower shoulder 90 thereof and are thus free to move into their expanded positions as illustrated in FIGURE 4. Upward jars are then imparted through

the running tool to the inner mandrel to move it upwardly relative to the main mandrel. Such upward movement of the inner mandrel relative to the main mandrel is assisted by the force exerted by the spring 44 and causes the cam shoulder 35 of the expander 39 to engage the internal downwardly and outwardly extending inner shoulders 36 of the dogs to cam the dogs outwardly into the expanded positions illustrated in FIGURE 4 and thereafter to move the locking surface 92 upwardly and inwardly of the internal surfaces 94 of the dogs to lock the dogs in their expanded positions. Upward jars are then imparted to the running tool 67 to cause the shear pins 70 to shear thus freeing the running tool from the well tool which is then left in position locked against movement in either longitudinal direction in the tubing string T.

At this time the seal assembly 20 engages the sealing surface 85 of the landing nipple to prevent flow of fluids between the anchoring and sealing device and the landing nipple. The O-rings 58 and 60 prevent flow of fluids between the exterior and the interior of the housing above the lateral apertures 22 and between the exterior of the housing and the bore 79 of the bottom sub 16 below the lateral apertures 22 of the housing. The well tool 10 now holds in the tubing string any well device connected to the reduced lower portion 65 of the bottom sub 16 and seals the tubing string thereabove. The well tool is held against longitudinal movement either upwardly or downwardly in the tubing string since upward movement of the well tool is stopped by the engagement of the upper shoulders 30 of the dogs with the downwardly facing lower shoulder 90 of the landing nipple and downward movement thereof is arrested by the engagement of the downwardly facing shoulder of the upper sub with the upwardly facing shoulder 89 of the landing nipple.

It will be noted that the inner mandrel 42 is held in its upper position in the main mandrel by the force of the spring 44 so that the locking surface 92 of the dog expander is in engagement with the internal surfaces 94 of the dogs which are thus held or locked against movement from their expanded positions.

It will further be noted that the weight of any well device supported by the well tool 10 will not influence the dog expanding and locking operations of the inner mandrel 42 since any such control device is secured to the lower end of the bottom sub of the main mandrel and thus does not exert any downwardly acting force on the inner mandrel.

When it is desired to remove the well tool 10 and the well device connected thereto from the tubing string or well flow conductor, a suitable pulling tool, such as the one illustrated in the patent to H. C. Otis et al., No. 2,508,285, may be lowered into the tubing string by means of a flexible line to first engage the upper end of the inner mandrel 42 to move it downwardly relative to the main mandrel whereby the locking surface 92 is moved below the dogs which are thus freed to move inwardly. The pulling tool then engages the undercut shoulder 14 of the top sub 12 of the main mandrel while holding the inner mandrel in such lower position in the main mandrel whereby an upward pull imparted to the pulling or retrieving tool will then pull the well tool upwardly through the tubing string. The dogs then move inwardly upon meeting such upwardly facing obstructions as the downwardly facing shoulder 90 of the landing nipple and the downwardly facing shoulders 98 at the lower ends of the tubing sections due to the camming action of the downwardly and outwardly extending upper shoulders 30 of the dogs.

It will now be apparent that a new and improved well tool for plugging a well flow conductor has been illustrated and described which includes an outer or main mandrel 11 provided with a downwardly facing shoulder 87 adapted to engage an upwardly facing shoulder 89 of a well flow conductor and with locking means or dogs 25

adapted to extend outwardly of the mandrel to engage a downwardly facing shoulder 90 of the well flow conductor to anchor the well tool in a selected position in the well flow conductor against longitudinal movement therein.

It will also be seen that the main mandrel is provided with seal means 20 for sealing between the well flow conductor and the main mandrel when the main mandrel is locked against movement in the well flow conductor.

It will further be seen that seal means are provided between the inner mandrel and the main mandrel above and below the lateral apertures 22 of the main mandrel through which the bosses of the dogs may extend whereby flow of well fluids past the well tool may take place only through the central bore of the anchoring and sealing device which comprises the bores 79, 78 and 77 of the bottom sub 16, the expander 39 and the upper section 43, respectively, when the external seal means or sealing assembly 20 of the main mandrel is in sealing engagement with the well flow conductor.

It will further be seen that the well tool includes an inner mandrel having an expander means, such as the cam shoulder 35, for moving the locking means into expanded position and a locking means or surface 92 for locking the locking means in expanded position when the inner mandrel is moved to an upper position in the main mandrel.

It will further be seen that the inner mandrel is biased upwardly relative to the main mandrel by the spring 44 whereby the spring tends to move the inner mandrel upwardly relative to the main mandrel to cause the cam shoulder 35 to move into engagement with the lower ends of the dogs and move the bosses outwardly through the lateral apertures 22 of the main mandrel into anchoring engagement with downwardly or upwardly facing obstruc engagement with downwardly or upwardly facing obstructions of a well flow conductor in which it is located whenever the bosses of the dogs move into alignment with an internal recess of the well flow conductor.

It will further be seen that the inner mandrel and the locking surface 92 are held in their upper positions preventing movement of the well tool in the well flow conductor until the inner mandrel is moved downwardly by an external force applied thereto relative to the main mandrel so that the well tool is locked against movement in either direction in the well flow conductor until the inner mandrel has been moved downwardly relative to the main mandrel.

In FIGURE 7 is illustrated a well tool 10*a* which differs from the well tool 10 in that the top sub 12*a* of its main mandrel is not provided with the external annular flange 88 and its sealing assembly 20*a* is of larger external diameter than the sealing assembly 20 whereby the sealing assembly engages the internal walls of the tubing sections 62 of the tubing string T. The adjacent ends of the tubing sections are connected in the usual way by coupling collars 95. Adjacent ends of the adjacent tubing sections are spaced to form the collar recesses 96 so that the well tool 10*a* may be located and locked in position at any collar recess of a tubing string which is not provided with the landing nipple 63.

In use, the well tool 10*a* is connected to the running tool 67 in the same manner as the well tool 10 and lowered through the tubing string. The upwardly extending lower shoulders 32 of the bosses 23 of the dogs 25 arrest the movement of the main mandrel each time they engage such upwardly facing obstructions as the shoulders 83 of the upper ends of the tubing sections whereupon the running tool moves the inner mandrel downwardly in the main mandrel 11 to move the locking surface 92 and the cam shoulder 35 downwardly of the dogs 25 to permit the dogs to move into their inner retracted positions. The engagement of the lower end of the running tool with the upper end of the main mandrel then moves the main mandrel downwardly, the engagement of the shoulders 32 and 83 of the dogs and of the tubing section camming the dogs inwardly into retracted positions to permit such further downward movement of the well tool. When the well tool is located at the desired collar recess 96 wherein it is desired to anchor it, an upward pull is imparted to the inner mandrel through the running tool when the dogs are aligned with the desired collar recess to cause the expander cam shoulder 35 to engage the downwardly and outwardly extending inner shoulders 36 of the dogs to cam the dogs outwardly to position the bosses 23 of the dogs in the collar recess. Continued upward movement of the inner mandrel then moves the locking surface 92 of the expander inwardly of the dogs 25 and into engagement with their inner surfaces 94. The dogs are then locked in expanded positions and the engagement of their upper shoulders 30 with the lower end 98 of the upper tubing section at the collar recess then prevents upward movement of the anchoring and sealing device 10*a* in the tubing string while the engagement of their lower shoulders 32 with the upwardly facing shoulder 83 of the upper end of the lower tubing section at the collar recess arrests downward movement of the anchoring and sealing device in the tubing string. The well tool is thus anchored in position in the tubing string with the seal assembly 20*a* in sealing engagement with the internal wall surfaces of the tubing string above such collar recess 96.

The running tool is then detached as described above from the inner mandrel and removed from the tubing string leaving the well tool 10*a*, and whatever well device is connected to the bottom sub 16, anchored in position in the tubing string.

When it is desired to remove the well tool 10*a* from the well flow conductor, a suitable pulling tool, such as the pulling tool illustrated in the patent to H. C. Otis et al., No. 2,508,285, is lowered through the tubing string to first engage the upper end of the inner mandrel and move it downwardly relative to the main mandrel whereby the locking surface 92 of the expander is moved below the dogs to free them for inward movement toward retracted position and then to engage the undercut shoulder 14 provided by the external flange 13 of the top sub 12*a*. An upward pull then imparted to the top sub through the pulling tool causes the well tool to move upwardly in the tubing string, the engagement of the downwardly, and outwardly sloping upper shoulders 30 of the dogs and the downwardly and outwardly sloping shoulder 98 of the upper tubing section camming the dogs inwardly to retracted position to permit such upward movement of the anchoring and sealing device through the tubing string. The upper shoulders 30 of the dogs cam the dogs inwardly in a similar manner upon meeting any other downwardly facing obstructions in the tubing string during such upward movement of the anchoring device through the tubing string.

In FIGURE 8 is illustrated another modified form of the well tool wherein the well tool 100 includes a main mandrel 102 having an enlarged lower bore portion which provides a downwardly facing annular shoulder 103 engageable by the upper ends of the dogs 105 and having a plurality of lateral apertures 106 through which the bosses 107 of the dogs may extend outwardly of the main mandrel. The dogs 105 are similar in all respects to the dogs 25 of the well tools 10 and 10*a* described above and have upper downwardly and outwardly extending shoulders 108 and lower upwardly and outwardly extending shoulders 109. The dogs are also provided with inner upwardly and inwardly extending shoulders 110 at their lower ends which are adapted to be engaged by the downwardly and outwardly extending annular cam shoulder 112 of an annular external lock flange 113 of the inner mandrel 115. The lock flange of the inner mandrel provides an abrupt downwardly facing lower shoulder 116 which is engaged by the upper end of a spring 118 disposed about the inner mandrel below the lock flange. The lower end of the biasing spring 118 engages the up-

per end of a seal mandrel section 120 threaded into the lower end of the main mandrel and constituting a portion thereof whereby the inner mandrel is biased upwardly toward the position illustrated in FIGURE 8 by the spring 120.

The seal mandrel section is provided with an external annular flange which provides an upwardly facing shoulder 122 and a seal means or assembly 123, which may be of the chevron type, is disposed on the seal mandrel between the lower end of the main mandrel and the upwardly facing shoulder 122 of the seal mandrel section. The seal means is adapted to engage a seal surface 125 of a landing nipple 126 connected in a tubing string T between the tubing sections 62 to seal between the plug and the tubing string. The seal mandrel section may be provided with a reduced lower end portion 128 which may be threaded whereby any suitable well device may be connected to the main mandrel of the well tool 100.

The landing nipple 126 is provided with a lock recess 130 which provides a downwardly and inwardly sloping annular shoulder 131 adapted to be engaged by the lower shoulders 109 of the dogs 105 to limit downward movement of the main mandrel, and therefore of the well tool 100 in a tubing string when the dogs are in the expanded positions illustrated in FIGURE 8. The upper shoulders 108 of the dogs of course are adapted to engage the lower end or shoulder 98 of the upper tubing section threaded into the upper end of the landing nipple 126 to prevent upward movement of the well tool in the tubing string when the dogs are in their expanded positions.

The recess 130 may be of such length that the shoulder 131 of the landing nipple is spaced a farther distance from the downwardly facing shoulder 98 of the tubing section than are the adjacent upper and lower ends of adjacent tubing sections at the usual collar recesses. The bosses 107 of the dogs 105 are of greater length than the longitudinal length of the usual collar recesses 96 of a tubing string, such as the one illustrated in FIGURE 7, so that the bosses will span or bridge the usual collar recesses while passing there past and will not therefore be able to move outwardly toward the expanded positions into the usual collar recesses. However, the lock recess 130 is of greater length than the bosses 107 so that the bosses 107 will move outwardly into the lock recess 130 of the landing nipple 126 when aligned therewith. As a result the internal diameter of the landing nipple may be made substantially equal to the internal diameter of the tubing sections 62 so that a plurality of such landing nipples 126 may be connected in a tubing string and the well tool or plug 100 may be locked in position in any selected one of such landing nipples.

In use, the plug 100 may be lowered into a tubing string provided with one or more landing nipples 126 by means of any suitable running tool, such as the running tool 81 illustrated in FIGURE 1, which is releasably secured to the upper end of the inner mandrel and which has a lower end which is adapted to engage the upper flanged end of the main mandrel to limit downward movement of the inner mandrel. The bosses 107 of the dogs 105 engage the internal wall surfaces of the tubing string and are held in retracted positions above the lock flange 113, the frictional engagement of the bosses tending to hold the main mandrel in an upper position on the inner mandrel against the resistance of the spring 118. Since the dogs are of greater length than the usual coupling recesses of the tubing string, they do not move outwardly thereinto when passing each such coupling recess of the tubing string. When the bosses 107 of the dogs 105, however, are in alignment with the lock recess 130 of a landing nipple 126, the dogs move outwardly into such lock recess and further downward movement of the main mandrel is then arrested by the engagement of their downwardly facing shoulders 109 with the upwardly facing shoulder 131 of the landing nipple. The dogs then assume the position illustrated in FIGURE 8 wherein the force of the spring 118 then tends to move the inner mandrel 115 upwardly.

If it is desired that the plug 100 be left positioned in the first landing nipple 126 which it encounters, upward jars are imparted to the inner mandrel to cause the lock flange 113 to move inwardly of the lock dogs 105 and lock them in the expanded positions illustrated. The shear pin by which the running tool is secured to the upper end of the inner mandrel, in the same manner as it may be secured to the inner mandrel of the tool 10 illustrated in FIGURES 1 and 2, may then be sheared by upward jars imparted to the running tool to release the running tool from the inner mandrel. The plug is then left in position in the landing nipple 126 with its seal means 123 sealing between the main mandrel and the landing nipple. Any suitable well device of course may be secured to the threaded lower reduced end portion 128 of the seal mandrel to be supported by the well tool 100.

Should it be desired that the plug 100 be moved below the first landing nipple 126 it encounters and to some other landing nipple of the tubing string disposed therebelow, the inner mandrel is moved further downwardly in the main mandrel after the bosses 107 of the dogs engage the upwardly facing shoulder 131 of such first landing nipple 126 encountered so that the cam shoulder 112 moves out of engagement with the upwardly and inwardly facing inner shoulders 110 of the dogs and the engagement of the lower end of the running tool with the upper end of the main mandrel then transmits a downwardly acting force to the main mandrel and to the dogs so that the lower cam shoulders 109 of the dogs, which are now in engagement with the downwardly and inwardly extending annular shoulder 131 of the landing nipple, cam the dogs to their retracted positions to permit further downward movement of the well tool in the tubing string. The spring 118 of course continuously biases the main mandrel downwardly on the inner mandrel during such downward movement of the anchoring and sealing device through the tubing string. The well tool is then lowered in this manner past any other landing nipples 126 which may be connected in the tubing string until it enters into the lock recess 130 of the selected landing nipple whereupon the dogs are locked in their expanded positions as described above and the running tool is detached from the inner mandrel for removal from the tubing string.

The well tool 100 may be removed in a similar manner as the tools 10 and 10*a* by a suitable pulling tool which first moves the inner mandrel downwardly to cause its lock flange 113 to move out of engagement with the dogs and position the cam shoulder 112 thereof below the inner shoulders 110 of the dogs so that the dogs are free to move to retracted positions and then engages the undercut flange 133 on the upper end of the main mandrel whereupon upward movement imparted to the running tool then causes the main mandrel to move upwardly. The upper downwardly and outwardly extending cam shoulders of the dogs 105 then cam the dogs inwardly upon meeting such obstructions as the downwardly facing shoulders 98 of the lower ends of tubing sections at each lock recess 130 of any landing nipple during upward movement of the well tool during such removal operations.

It will now be seen that the well tool 100, like the well tools 10 and 10*a*, may support a well device on the main mandrel itself so that the weight thereof will not influence the dog expanding and locking operations of the inner mandrel 115 since it does not exert any downwardly acting force on the inner mandrel.

It will further be seen that the dogs 107, if of greater lengths than the lengths of the usual coupling recesses of the tubing string, may be used as locating devices to indicate when the well tool has entered into a landing nipple 126 which provides a lock recess of sufficient

length to permit expansion of the dogs thereinto since the dogs will then expand into such lock recess and will tend to prevent downward movement of the well tool therethrough.

It will further be seen that no seal means need be provided between the inner and main mandrels of the well tool **100** since any well device connected to the reduced portion **128** of the inner mandrel will control flow therethrough and past the seal means **123** since the seal means is below the lateral apertures of the main mandrel.

It will further be seen that if desired the bosses **23** of the dogs **25** of the well tool **10***a* may be similarly made of sufficient length to bridge or span the usual coupling recesses **96** of a tubing string, if the tubing string is provided at a selected location or locations with an elongated coupling which causes the shoulders **83** and **98** of the tubing sections it connects to be spaced farther apart than normally at the usual coupling recesses, whereby the dogs will then serve to locate such preselected coupling recess formed by the special elongated coupling.

It will further be seen that the well tool **100** may similarly be located in a preselected coupling recess of greater length than the normal coupling recess which is formed by a specially elongated or lengthened coupling of a tubing string. In this case the tubing string would not be provided with a landing nipple **126**.

It will now be seen that several forms of a well tool have been illustrated and described which may be anchored in preselected positions in the tubing string regardless of whether the tubing string is provided with a landing nipple to plug or seal the tubing string above any suitable well device which is supported by the well 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 well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device which is to be supported by the well tool in a well flow conductor; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being lowerable through a well flow conductor by means detachably securable to said inner mandrel; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel moving upwardly with said inner mandrel as said inner mandrel moves from said lower position toward said upper position; and means on said inner mandrel movable with said inner mandrel and engageable with said locking means for holding said locking means in expanded position when said inner mandrel is in said upper position, said locking means having means engageable with an upwardly facing shoulder of a well flow conductor at each recess for moving said locking means to retracted position upon downward longitudinal movement of the main mandrel in the well flow conductor when said inner mandrel is in said lower position.

2. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel being movable with said inner mandrel when said inner mandrel moves from said lower position toward said upper position, said well tool being movable through said well flow conductor by means detachably securable to said inner mandrel; and means on said inner mandrel movable with said inner mandrel and engageable with said locking means for holding said locking means in expanded position when said inner mandrel is in said upper position, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said bosses having cam shoulders for camming said dogs inwardly upon engagement with shoulders of a well flow conductor at each recess upon longitudinal movement of the main mandrel in the well flow conductor when said inner mandrel is in said lower position.

3. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means adjacent its lower end for securing well devices to said main tubular mandrel which are to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into an internal recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable through a well flow conductor by means detachably secured to said inner mandrel; and coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel being movable with said inner mandrel on upward movement of said inner mandrel from said lower position toward said upper position, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said dogs having cam shoulders engageable with shoulders of the well flow conductor at each recess for camming said dogs inwardly to retracted position upon longitudinal movement of the main mandrel in the well flow conductor when said inner mandrel is in said lower position.

4. A well tool for use in a well flow conductor including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means is engageable with the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel being movable with said inner mandrel upon upward movement of said inner mandrel from said lower position toward said upper position; and means on said inner mandrel movable with said inner mandrel upon movement of said inner mandrel from said lower position toward said upper position and engageable with said locking means for holding said locking means in expanded position when said inner mandrel is in said upper position, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said dogs having cam shoulders adapted to engage upwardly and downwardly facing shoulders of the well flow conductor at each recess to move said dogs to retracted positions upon longitudinal movement of the main mandrel in the well flow conductor when the inner mandrel is in said lower position.

5. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said mandrel and movable relative to said mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable longitudinally through a well flow conductor by means detachably secured to the inner mandrel; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel being movable with said inner mandrel upon upward movement of said inner mandrel from said lower position toward said upper position; and means biasing said inner mandrel toward said upper position in said main mandrel, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said dogs having cam shoulders engageable with upwardly and downwardly facing shoulders of the well flow conductor for camming the dogs inwardly of said main mandrel upon longitudinal movement of the main mandrel through the well flow conductor when the inner mandrel is in the said lower position.

6. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable longitudinally through a well flow conductor by means detachably secured to said inner mandrel; and coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said inner mandrel being movable with said inner mandrel upon upward movement of said inner mandrel from said lower position toward said upper position, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said dogs having cam shoulders engageable with the shoulders of the recesses of the well flow conductor for camming the dogs inwardly of the main mandrel upon longitudinal movement of the main mandrel through the well flow conductor when the inner mandrel is in said lower position, said dogs having internal flanges at their upper ends, said main mandrel having internal annular recess, said dogs being received in said annular recess.

7. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said coengageable means on said inner mandrel being movable with said inner mandrel upon upward movement of said inner mandrel from said lower position toward said upper position, said well tool being movable through said well flow conductor by means detachably securable to said inner mandrel, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said dogs having cam shoulders engageable with shoulders of the well flow conductor at each recess for camming said dogs inwardly to retracted position upon longitudinal movement of the mandrel in the well flow conductor when said inner mandrel is in said lower position, said dogs having internal flanges at their

upper ends, said main mandrel having an internal annular recess, said dogs being received in said annular recess, said internal recess communicating with said lateral apertures; seal means for sealing between said inner mandrel and said main mandrel above and below said lateral apertures; and seal means on said main mandrel for sealing between the main mandrel and the well flow conductor.

8. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor and engages the upper and lower shoulders at the recess to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable through a well flow conductor by means detachably securable to said inner mandrel; means on said inner mandrel movable with said inner mandrel; means on said locking means engageable with said means on said inner mandrel for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said locking means having means engageable with the shoulders of a well flow conductor at each recess for moving said locking means to retracted position upon longitudinal movement of the main mandrel in the well flow conductor when said inner mandrel is in said lower position; and seal means on said main mandrel for sealing between the main mandrel and the well flow conductor.

9. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses, each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder having a plurality of vertically spaced recesses, a selected one of said recesses being of greater length than the others, including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means is engageable in said selected one of said recesses of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor, said locking means being of greater length than the lengths of the others of said recesses of the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable through said well flow conductor by means detachably securable to the said inner mandrel; means on said inner mandrel movable with said inner mandrel; and means on said locking means engageable with said means on said inner mandrel for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position.

10. A well tool for use in a well flow conductor having a plurality of vertically spaced recesses, a selected one of said recesses being of greater length than the others, including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means is engageable with the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position; and coengageable means on said inner mandrel and movable with said inner mandrel; and means on said locking means engageable with said means on said inner mandrel for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said main mandrel having a plurality of lateral apertures, said locking means including dogs having bosses adapted to extend outwardly of said main mandrel through said lateral apertures to engage the well flow conductor, said bosses being of shorter length than of said selected one of said recesses of said well flow conductor.

11. A well tool for use in a well flow conductor having a plurality of vertically spaced recesses, at least one of said recesses being of greater length than the others, including: a main tubular mandrel having means for securing a well device to said main tubular mandrel which is to be supported in a well flow conductor by the well tool; locking means carried by said main mandrel and movable relative to said main mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means is engageable in said selected one of said recesses of the well flow conductor to prevent longitudinal movement of the main mandrel in the well flow conductor, said locking means being of greater length than the lengths of the others of said recesses of the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position; coengageable means on said inner mandrel movable with said inner mandrel; and means on said locking means engageable with said means on said inner mandrel for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position.

12. A well tool for use in a well flow conductor having a plurality of longitudinally spaced annular recesses each providing an upper downwardly facing shoulder and a lower upwardly facing shoulder including: a main tubular mandrel having means for securing a well device which is to be supported in a well flow conductor by the well tool; locking means carried by said mandrel and movable relative to said mandrel between a retracted position wherein said locking means does not prevent longitudinal movement of the main mandrel through the well flow conductor and an expanded position wherein said locking means extends into a recess of the well flow conductor and is engageable with the upper and lower shoulders defining the recess to prevent longitudinal movement of the main mandrel in the well flow conductor; an inner mandrel mounted in said main mandrel for limited longitudinal movement relative thereto between an upper position and a lower position, said well tool being movable through a well flow conductor by means attachable to said inner mandrel; coengageable means on said inner mandrel and said locking means for moving said locking means to said expanded position upon upward movement of said inner mandrel from said lower position toward said upper position, said means on said

inner mandrel moving upwardly with said inner mandrel as said inner mandrel moves from said lower position toward said upper position; said locking means having cam means engageable with an upwardly facing shoulder of a well flow conductor at each recess for moving said locking means into said retracted position upon downward longitudinal movement of the main mandrel in the well flow conductor when said inner mandrel is in said lower position; and means biasing said inner mandrel toward said upper position in said main mandrel.

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