

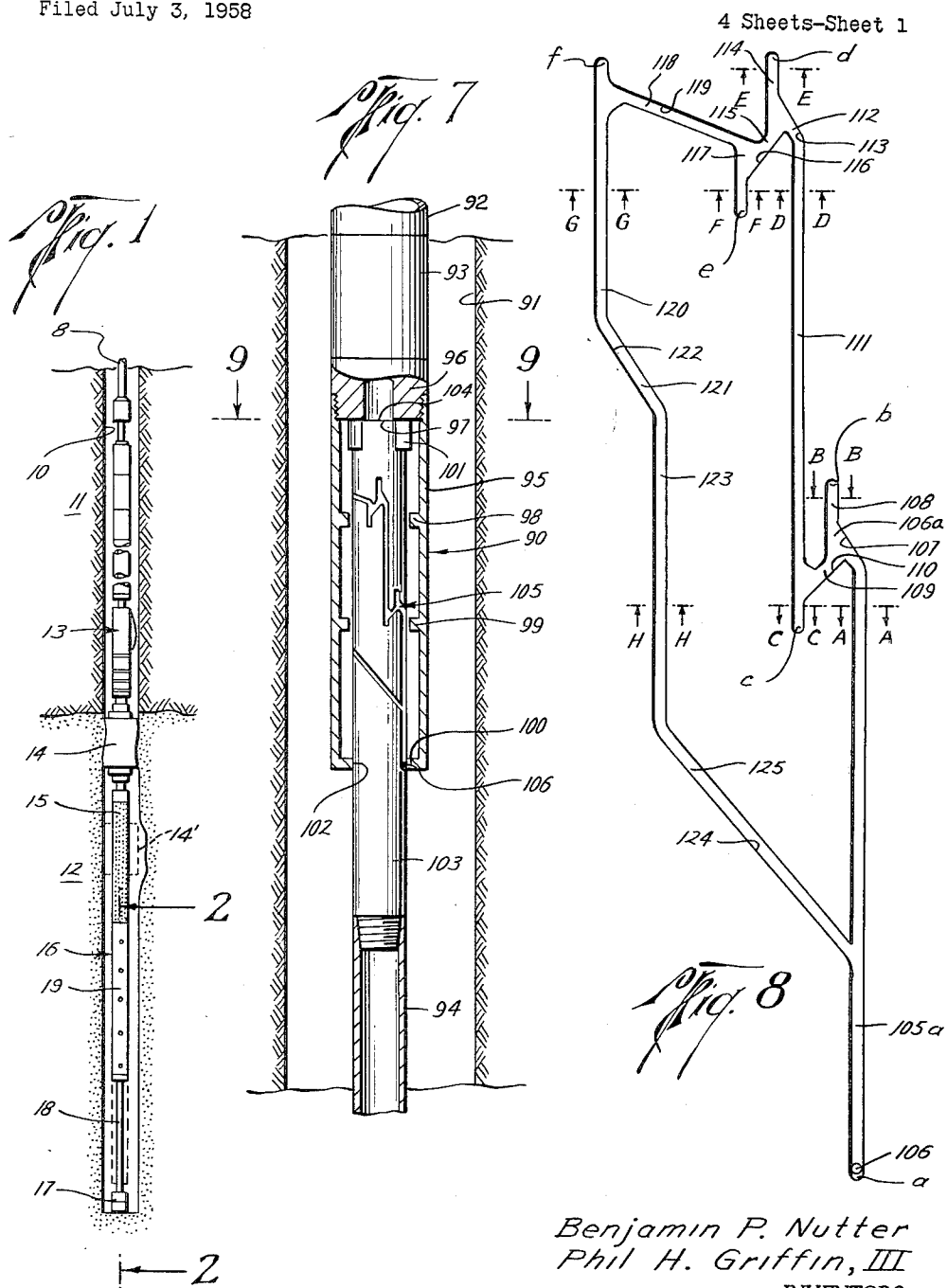
May 29, 1962

B. P. NUTTER ETAL

3,036,641

ADJUSTABLE ANCHORS

Filed July 3, 1958



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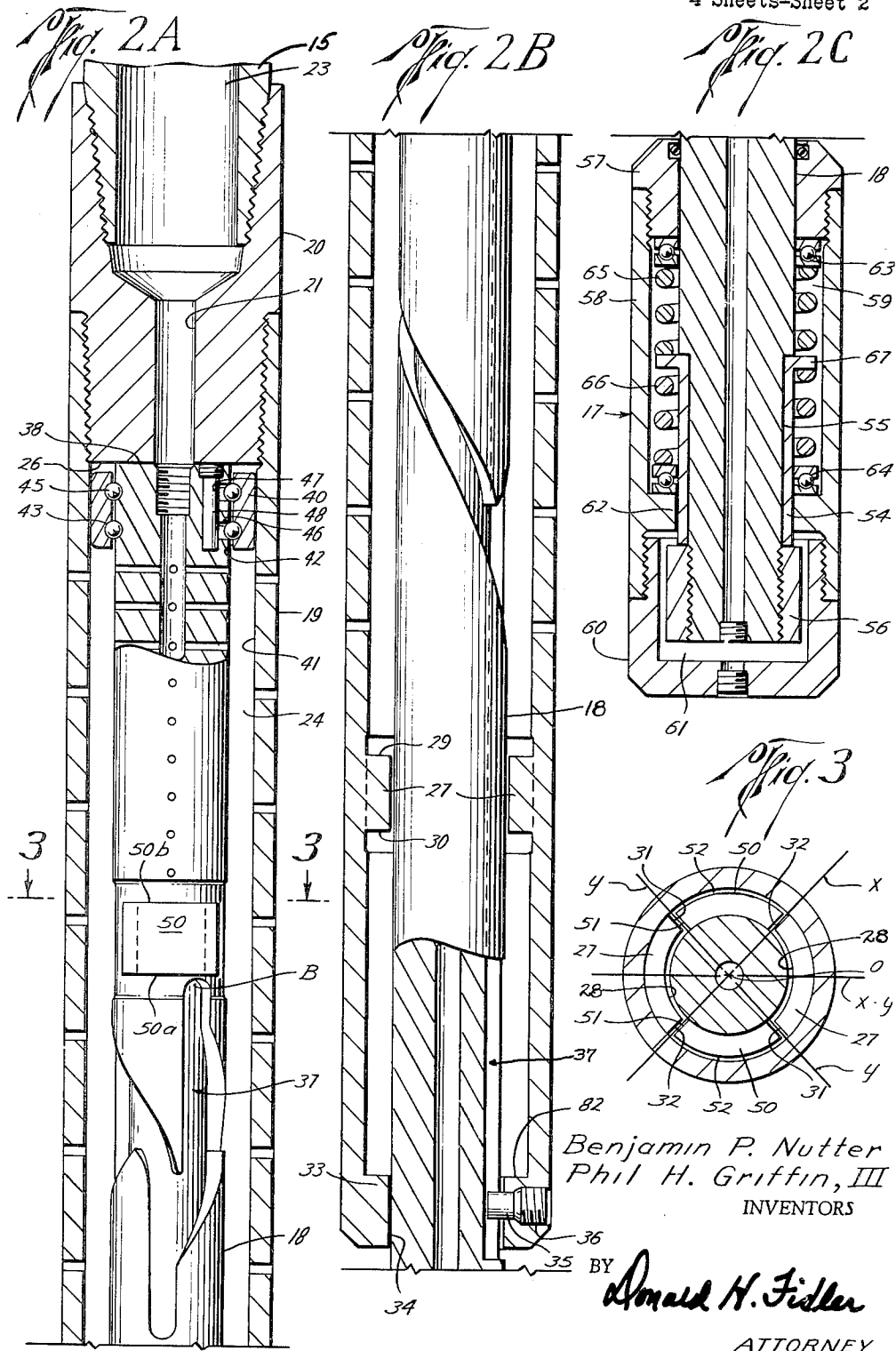
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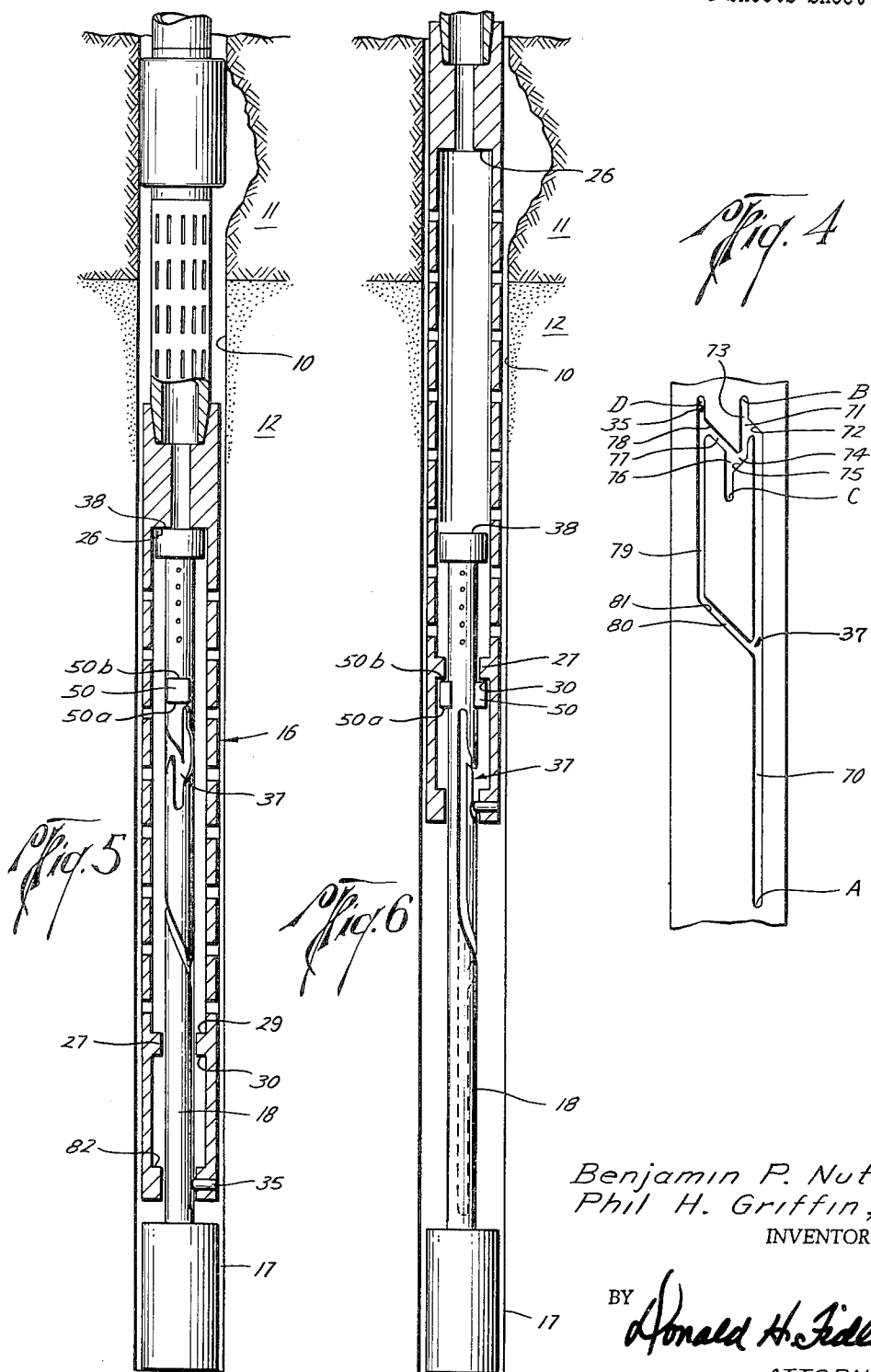
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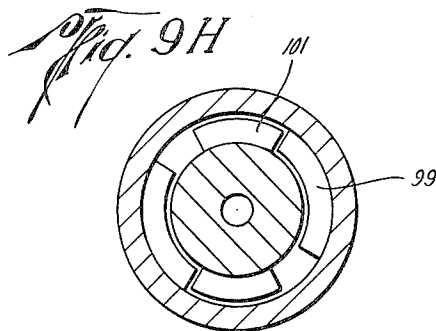
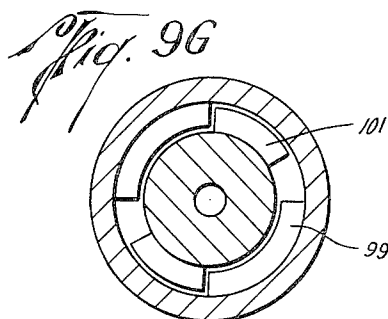
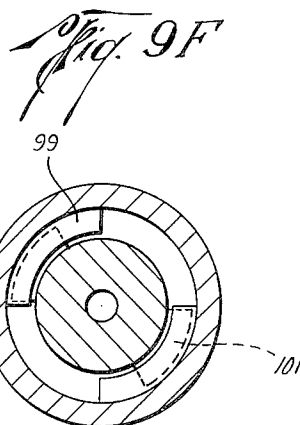
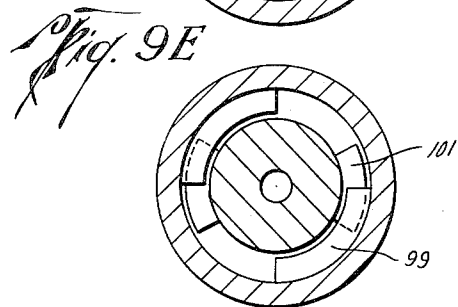
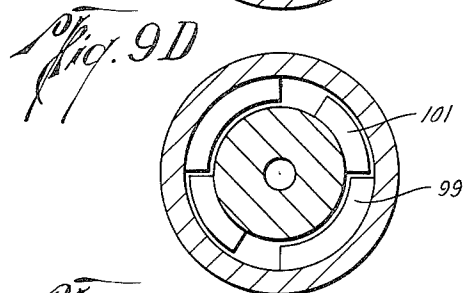
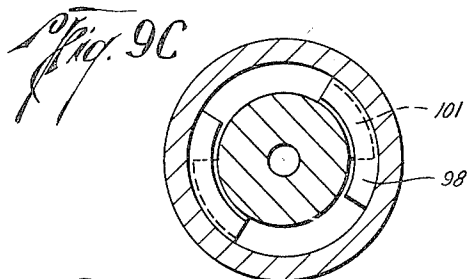
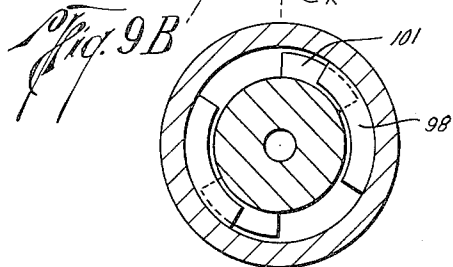
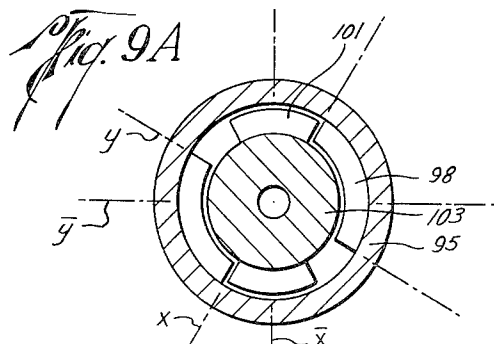
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ADJUSTABLE ANCHORS

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10 Claims. (Cl. 166-243)

This invention relates to well tools and, more particularly, pertains to new and improved adjustable anchors for use with a drill string which allows the position of an element in the string to be varied without removal from the well or borehole.

In certain types of drill stem testing and other borehole operations, it is desirable to set a packer a given distance from the bottom of the borehole. Generally, in this situation, a length of anchor pipe is connected below a packer and the packer is connected to the lower end of a string of drill pipe. The entire assembly is then lowered into the borehole until the anchor engages the bottom of the borehole. The packer may then be expanded by applying a setting force. If the packer fails to seal off the borehole, perhaps due to irregularities in the borehole wall or caving of soft formations, the entire drill string must be removed to substitute a different length anchor.

In the event a packer initially fails to seal, a second try with the packer at a different level is usually desired. Adjustable anchors have been used heretofore for this purpose which require both longitudinal and rotational manipulation of the upper end of the drill string for their operation. Since, in a large number of drill string operations, other tools may be included in the drill string which are operative upon rotation of the drill string, manipulation of the anchor may undesirably interfere with or effect premature operation of other tools which may be present in the string.

It is, therefore, an object of this invention to provide a new and improved adjustable anchor.

Another object of this invention is to provide a new and improved adjustable anchor for use in a drill string which is operative by longitudinal movement of the drill string.

It is a further object of this invention to provide a new and improved adjustable anchor for use in a drill string to enable selective positioning of a packer at predetermined, vertically-spaced positions by longitudinal movement of a tubing string without requiring the application of rotational movement of the string at the surface.

According to the invention there is provided a pipe string, an adjustable length device and an anchor member which is secured relative to the borehole. The adjustable length device includes a pair of telescopically-arranged members which are adapted to be moved longitudinally relative to one another between two longitudinal positions, a co-operating index means operably connected between the telescopic members and responsive to relative longitudinal movement to rotate the telescopic members relative to each other between two positions of rotative orientation where the index means allows further relative longitudinal movement when the telescopic members are in one position of rotative orientation, means to releasably secure the telescopic members against relative longitudinal movement in a position of rotative orientation, and a swivel connection to permit the telescopically-arranged members to be relatively rotated.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation together with further objects and advantages thereof, may best be understood by way of illustration

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and example of certain embodiments when taken in connection with the accompanying drawings in which:

FIG. 1 illustrates in plan view a typical arrangement of elements on a drill string including an adjustable anchor embodying the present invention, all shown disposed in a portion of a borehole;

FIGS. 2A, 2B and 2C represent, in partial longitudinal cross section, the successive upper, intermediate and lower portions, respectively, of a portion of the apparatus shown in FIG. 1 taken along line 2-2 of FIG. 1 and illustrating a preferred embodiment of the present invention;

FIG. 3 is a cross-sectional view taken long lines 3-3 of FIG. 2A;

FIG. 4 is a plan representation of an index slot as may be utilized in apparatus embodying the invention;

FIG. 5 is a longitudinal, sectional view of apparatus illustrated in FIGS. 2A, 2B and 2C drawn to a smaller scale and showing the apparatus in collapsed position;

FIG. 6 is a representation like FIG. 5, but illustrates the apparatus in an expanded position;

FIG. 7 is similar to FIG. 5 but illustrates another embodiment of the present invention;

FIG. 8 is a plan representation of another form of index slot utilized in the apparatus of FIG. 7;

FIGS. 9A-9H are cross-sectional views of a portion of the apparatus taken along lines 9-9 of FIG. 7 at various operating positions of the apparatus designated A-A through H-H in FIG. 8.

In FIG. 1 of the drawing there is shown an assembly of elements suspended at the lower end of a drill string shown in a borehole 10 which traverses earth formations 11 and 12. The array of elements includes, in descending order, a testing tool 13; a packer 14; a perforated pipe section 15 and an adjustable anchor 16 embodying the present invention. The tool 13 may be, for example, a testing tool for testing formation pressure and flow in well known manner, a tool for acidizing, or other desired equipment for use in a borehole.

The anchor 16 includes an anchor shoe or member 17 adapted to engage the bottom of borehole 10, a mandrel 18 having a lower portion rotatably mounted in the anchor shoe 17, and a tubular housing 19 which telescopically receives the upper portion of the mandrel 18.

Turning now more specifically to the adjustable anchor 16 as illustrated in FIG. 2A, the lower end of the tubular perforated pipe 15 is threadedly received in an upper box of a coupling sub 20 while the upper end of the housing 19 is threadedly coupled to the lower pin end of the sub 20. A central opening 21 in the sub fluidly connects the interior 23 of pipe 15 to the interior space 24 of housing 19, while by virtue of the threaded connection between housing 19 and sub 20, the bottom surface 26 of sub 20 comprises an upper abutment portion of the housing as will hereinafter become more apparent. As seen in FIG. 2B, disposed within the interior space 24 intermediate of the length of the housing are a pair of opposed, inwardly-projecting mandrel splines 27 whose inner surfaces 28 conform generally, but are spaced from, the cylindrical outer surface mandrel 18. The splines 27 have upper and lower surfaces 29 and 30 defining abutments whose purpose will be more apparent from the discussion to follow.

As seen in FIG. 3, the splines 27 have vertical end surfaces 31 and 32 lying in vertical planes that intersect along longitudinal axis "O" and lie within opposed quadrants of vertical planes "X" and "Y" that intersect along axis "O". The planes "X" and "Y" are oriented at 90° with respect to each other. The spaces between the abutment portions 27 are then defined between adjacent vertical end surfaces 31 and 32 and an inner wall portion of the housing 19.

The lower end of the housing has an inwardly-flanged

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end portion 33 with a central opening 34 therein which slidably receives the mandrel 18. A follower pin 35 is threadably received in a radial opening 36 in the flange 33 and has a portion thereof projecting into the opening 34 so as to be received within a mandrel index slot system generally indicated at 37. It will be noted that the positionment of pin 35 is in longitudinal plane "X—Y" (FIG. 3) which bisects the quadrants containing the splines 27 for reasons which will hereinafter become more apparent.

The upper surface 38 of the mandrel 18 (FIG. 2A) defines an upper mandrel abutment portion which is adapted to engage the lower surface 26 of the sub 20 so that the housing and mandrel are suitably supported in a "collapsed" position. The upper end of the mandrel 18 is rotatably and slidably supported within interior space 24 of housing 19 by a cylindrical bearing sleeve 40 which has a cylindrical outer bearing surface slidably engaging the inner wall 41 of housing 19 and has a cylindrical inner surface 42 agreeable in size to the diameter of the mandrel 18. The mandrel and inner surface 42 have complementary semicircular grooves 43 therein for receipt of ball bearings 45 which rotatably mount the sleeve 40 with respect to the mandrel 18. An opening 46 extends between each groove and a transverse longitudinal bore 47 to allow insertion of the ball bearings. Threaded pin 48 is provided for the bore to retain the ball bearings 45 in the grooves 43.

Positioned below the sleeve 40 on the mandrel are outwardly projecting mandrel splines 50 which are constructed to co-operate with the splines 27 (FIG. 3). They have vertical end surfaces 51 lying in vertical planes that intersect along axis "O" and disposed within opposed quadrants of the aforementioned planes "X" and "Y." Outer surfaces 52 of splines 50 conform to and are adapted to be received within the interior space 24. It will be noted that in a collapsed position the mandrel splines 50 are in different quadrants than the housing splines 27 (FIG. 3) so that the mandrel splines 50 can pass through the spaces between the housing splines 27.

The lower end of mandrel 18 (FIG. 2C) which extends into the shoe 17 has a supporting collar 54 secured to a mandrel portion 55 of reduced diameter by means of a bumper sleeve 56 threaded to the lowermost end of the mandrel. The shoe 17 includes an upper retaining collar 57 threaded to the upper end of a tubular member 58. A portion of member 58 has an inner diameter larger than the outer diameter of mandrel 18 thereby defining an annular chamber 59. Threaded to the lower end of member 58 is a bottom plug 60 having a well portion 61 therein slightly larger than the outer dimensions of bumper 56 permitting longitudinal movement of the bumper. Upward movement of bumper 56 is restricted by means of a flange 62 projecting inwardly from tubular body 58 while downward movement is restricted by the inner bottom surface of plug 60.

To rotatably support the mandrel 18 thrust bearings 63 and 64 are positioned within the annular chamber 59 in engagement with the upper surface of flange 62 and the lower surface of retaining sleeve 57, respectively. Compression springs 65 and 66 are received about the mandrel 18 within chamber 59 to engage the bearings 63 and 64, respectively and the lower and upper surfaces of a flange 67 extending from collar 54. In this manner, the mandrel 18 is resiliently suspended to allow easy rotation of the mandrel. In addition, bumper sleeve 56 is allowed to bear against the flange 62 or the bottom plug 60 when an obstruction is encountered during ascent or descent of the device thereby protecting the thrust bearings 63, 64 against unnecessarily large loading.

In FIG. 4 the mandrel indexing slot system 37 is illustrated in a plan view to facilitate understanding and explanation although it will be understood that the slot system lies in the cylindrical wall of the mandrel 18. Index slot system 37 is comprised of a slot 70 (hereinafter re-

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ferred to as "expanding" slot) extending longitudinally of the mandrel from a lowermost "collapsed" end pocket "A" to a first inclined shunting slot 71 where one side of the slot 71 forms a cam surface 72 extending to an uppermost end pocket "B." A first transfer slot 73 extends longitudinally downward from the uppermost end pocket "B" to a second inclined shunting slot 74 having one of its sides forming a cam surface 75. Surface 75 is of generally opposite inclination to the first inclined cam surface 72 and slot 74 is connected by a longitudinal portion of a second transfer slot 76 to an "extended position" end pocket "C" extending vertically downward. An upper extension of slot 76 extends longitudinally from the "extended position" end pocket "C" to a third inclined shunting slot 77 whose upper surface forms a cam 78 which is inclined similarly to the first cam surface 72 and which extends to an upper reversing end pocket "D." Pockets "B" and "D" are terminated short of the lower surface 50a of the mandrel splines 50 (FIG. 2A) for reasons which will hereinafter become apparent. A slot 79 (hereinafter referred to as a "collapsing" slot) extends longitudinally in downward direction from the upper reversing end pocket "D" for a given distance, which will be more fully explained later, to a fourth inclined shunting slot 80 whose lower surface forms a cam surface 81. The inclination of surface 81 is similar to that of the first and third cam surfaces 72, 77 and extends to a junction with an intermediate section of the expanding slot 70. Slots 70 and 79 are spaced angularly 180° from each other and lie in a diametral plane so that when the mandrel and housing are in the relative position as shown in FIG. 3, the diametral plane coincides with plane "X—Y." It will be appreciated that the alignment of slots 70, 79 therefore causes the mandrel splines 50 to be aligned with the spaces between the housing splines 27.

To place the tool 16 in operation it is assembled in the above-described relationship below a packer and to a bottom section of perforated drill pipe and then lowered into the borehole by successively connecting lengths of drill pipe. The longitudinal spacing of upper pockets "B" and "D" of the index slot system 37 from the lowermost surfaces 50a of the mandrel spline 50 with respect to the longitudinal spacing of follower pin 35 in the flange 33 from the innermost surface 82 of the flanged section 33 is such that surfaces 50a of mandrel splines 50 bear against the upper surface 82 of flange 33, hence supporting the weight of mandrel 18 and shoe 17. It will therefore be apparent that pin 35 may be in either pocket "B" or "D" during descent of the tool. For purposes of explanation, the operation starting point will be assumed from the position where pin 35 is located in pocket "D" as shown in FIG. 4.

With the pin 35 in pocket "D" when the shoe 17 engages the bottom surface of borehole 10, the housing will continue downwardly, hence separating the engaging surfaces 50a, 82 and allowing pin 35 (of the housing) to be guided down collapsing slot 79 (of the mandrel). The positioning of mandrel 18, by virtue of the presence of pin 35 in slot 79, allows the mandrel splines 50 to pass through the housing splines 27 (FIG. 3) and thereafter, engagement of the pin 35 with cam surface 81 of the slot 80 causes the mandrel 18 to be rotated 180° in a clockwise direction until the pin 35 enters slot 70. Continued downward movement will bring the upper surface 38 (the upper abutment portion) of the mandrel into engagement with the lower surface 26 of sub 20 (the upper housing abutment) and the device will be in a collapsed position as shown in FIG. 5. As shown in dashed line construction 14' in FIG. 1, if the packer is adjacent to a washed out section of the borehole, the borehole cannot be effectively packed off. Hence, it is desirable to locate the packer at another elevation without removing the string of tools from the well.

It should be noted that the 180° angular rotation of

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the mandrel again aligns the mandrel splines 50 with respect to the spaces between the housing splines 27 (FIG. 3). Hence, when it is desired to expand the device, the housing is raised allowing pin 35 to follow expanding slot 70 and the mandrel splines 50 will pass through the spaces of the housing splines 27. When the mandrel splines 50 are below the housing splines 27, engagement of the pin 35 with cam surface 72 of inclined slot 71 angularly rotates the mandrel 45° in a counterclockwise direction until the pin is in pocket "B." Thereafter, lowering of the housing causes pin 35 to follow slot 73 and engages inclined surface 75 of slot 74. The camming action further angularly rotates the mandrel 45° in a counterclockwise direction until pin 35 arrives in slot portion 76 and further lowering causes the pin to dwell in pocket "C." Thus the mandrel splines 50 are rotated in a counterclockwise direction through 90° when they are located below the housing splines 27. This allows the upper surface 50b of splines 50 to be in position to engage the lower surfaces 30 of the housing splines 27 and the device is then in an expanded position as shown in FIG. 6.

To change positions, the housing 19 is longitudinally raised so that when pin 35 engages cam surface 78 of the slot 77 the mandrel 18 is rotated and mandrel splines 50 are then rotated through 90° in a counterclockwise direction and pin 35 dwells in pocket "D." In this condition, the lower surfaces 50a of mandrel splines 50 engage upper surface 82 of the flange 33 and the mandrel splines 50 are again aligned with the spaces between the housing splines 27. Thereafter, the above-described sequence may be repeated to collapse the device.

It will now be appreciated that the foregoing description illustrates an upper member which is movable longitudinally relative to a lower member, that the upper and lower members are relatively rotatable and that an indexing means provides a continuous guiding function between selective positions so that the members may be secured in selected positions. Therefore longitudinal movement only of the drill string allows the length of the drill string to be varied and a packer to be set at predetermined vertically spaced positions in the borehole.

From the foregoing it will be apparent that by marking the drill pipe, then raising and lowering the drill pipe, an operator may determine whether the device is expanded or collapsed. If the device was first in expanded position, the marked pipe will be situated a given distance lower in the borehole or if the device was first in collapsed position, the marked pipe would be situated in a higher position in the borehole. Hence, the operator can determine whether the apparatus is collapsed or expanded, and can set the device in either position. Further, the apparatus can be repeatedly expanded and collapsed.

Turning now to FIG. 7, another embodiment of the invention is shown in an adjustable anchor generally indicated at 90. An array of elements are shown suspended in a borehole 91 including a lower end of a drill pipe 92, a swivel member 93, the adjustable anchor 90, and the upper end of a drill pipe 94 which may be suitably threadedly coupled together. The swivel member 93 is adapted to rotate freely with respect to the drill pipe 92 and anchor 90. At its upper end the housing 95 of the anchor is threadedly connected to a pin end of a sub 96 of the swivel member 93.

A portion of sub 96 extends into housing 95 and has a lower surface 97 defining an upper abutment portion. Two sets of opposed, inwardly-projecting splines 98, 99 are spaced longitudinally from one another between the upper end of the housing and an inwardly-projecting flange 100 at the lower end of housing 95. Splines 98 and 99 are adapted to co-operate with a pair of opposed, outwardly-projecting mandrel splines 101 in a manner similar to the previously described embodiment and which will be hereinafter more completely described. Flanged section 100 has a central opening 102 for slidably receiving the mandrel 103 which is telescopically received within the hous-

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ing 95. The upper surface 104 of the mandrel 103 and splines 101 abuts the lower surface 97 of the sub 96 in a collapsed position of the apparatus. A mandrel indexing slot system 105 is disposed in a longitudinal direction downwardly of the mandrel splines 101. A follower pin 106 in flange 100 projects into the central opening 102 to be slidably received within the mandrel indexing slot system 105.

The above-described intermediate housing splines 98, 99 as shown in FIG. 9A and FIG. 9D are similar to the above-described housing splines 27 of FIG. 3. However, lower splines 99 are displaced angularly 30° with respect to the upper splines 98. The mandrel splines 101 extend in a sector of slightly less than 60° (FIG. 9A). The relationship of the location of pin 106 to the splines and slot system 105 is such that the mandrel splines 101 will pass through the housing splines 98, 99 in certain longitudinal positions of the housing 95 relative to the mandrel 103 which will hereinafter become more apparent.

Indexing slot system 105 on mandrel 103 is displayed in a plan view in FIG. 8 to facilitate explanation of the slot system while FIGS. 9A-9H show the mandrel splines 101 in successive positions with respect to the respective housing splines 98, 99. FIGS. 9A-9H also illustrate the mandrel as rotating with respect to the housing to simplify the explanation, however, it will be understood that in the apparatus of FIG. 7 that the housing rotates relative to the mandrel with the mandrel being secured by a bottom anchor against rotation. In FIG. 8 a slot 105a extends longitudinally from a lowermost pocket a to an inclined slot 106a having one side which acts as a cam surface 107 for the pin 106 to an upper pocket b. In position a, the mandrel splines 101 are in abutment with the lower surface 97 of sub 96 so that the housing and mandrel are in one relative position. Pin 106 is aligned with the slot 105a in the plane $\bar{y}$ (FIG. 9A) so that upon upward movement of the housing, the mandrel splines 101 pass between the housing splines 98. Thus, pin 106 moves from pocket a along slot 105a and the mandrel spline 101 will be guided through the housing splines 98 (FIG. 9A) until the mandrel splines 101 are above the housing splines 99, but below housing splines 98. Further upward movement of the drill string 92 causes the engagement of cam surface 107 and pin 106 thereby rotating the housing counterclockwise until the pin 106 reaches slot 103. After a total angular rotation of 30° (FIG. 9B) pin 106 goes to pocket b.

Pocket b is connected by slot 108 to a reversely inclined slot 109 having its lower side 110 forming a cam which extends to the lower portion of a vertical slot 111 provided with a pocket c at its lower end. Hence, if the drill string 92 is lowered the pin 106 and cam surface 110 will rotate the housing counterclockwise for another 30° to bring the lower surfaces of housing splines 98 into contact with the upper surfaces of mandrel splines 101 (FIG. 9C). The engagement of the splines 101, 98 provide means to secure the housing and mandrel in another relative position.

Longitudinal slot 111 extends upwardly from the lower pocket c to an inclined slot 112 having its uppermost side forming a cam surface 113 to a pocket d. Hence, if the drill string is again raised, pin 106 would follow slot 111 in an upward direction and the lower housing splines 99 would pass the mandrel splines 101 (FIG. 9D) due to the angular displacement of the housing splines 99 with respect to the housing abutment portions 98 and pin 106 engaging cam surface 113 would cause the housing to be rotated counterclockwise for 30° until pin 106 is guided into an upper portion of a slot 114 and pocket d. The rotation of the housing positions the mandrel splines 101 between the lower housing splines 99 (FIG. 9E) and the lower flanged end 100 of the housing.

The lower portion of longitudinal slot 114 leads to an

inclined slot 115 having a lowermost side acting as a cam surface 116 which extends to a lower portion of a slot 117 and a pocket *e*. Hence, downward movement of the drill pipe causes the engagement of pin 106 with cam surface 116 to rotate the housing counterclockwise and bring the lower surfaces of the lower housing splines 99 into engagement with the upper surfaces of the mandrel portions 101 (FIG. 9F). The splines 101, 99 therefore provide means to secure the housing and mandrel in another selected position.

The upper portion of longitudinal slot 117 extends upwardly from pocket *e* to an inclined slot 118 having an uppermost side forming a cam surface 119 extending to the upper portion of a slot 120 and a pocket *f* so that a longitudinal movement of the pipe string causes the engagement of the pin 106 with cam surface 119 and rotation of the housing 95 counterclockwise for 120° to allow the mandrel abutment portions 101 to be aligned between the spaced lower housing abutments 99 (FIG. 9G).

The lower portion of the downwardly-extending longitudinal slot 120 extends from pocket *f* to an inclined slot 121 having a lowermost surface forming a camming surface 122 so that when the drill string is moved downwardly, the mandrel splines 101 will again pass between the lower housing splines 99 (FIG. 9G). Thereafter engagement of pin 106 and cam surface 122 rotates the housing in a clockwise direction for 60° and the inclined slot 121 allows the pin 106 to be directed into a longitudinal slot 123. Slot 123 aligns the mandrel splines 101 so that they pass between the upper housing splines 98 (FIG. 9H) and is connected to an inclined slot 125 having a lower side wall cam surface 124 so that when the pin 106 engages the cam surface 124, the housing is rotated 120° clockwise back to the junction of slot 124 with longitudinal slot 105a and pin 106 is guided downward to the pocket *a*.

The operation of the device of FIGS. 7-9 is thought apparent from the foregoing, particularly since the embodiment is similar in principle and operation to the device disclosed in FIG. 1. Therefore, further recitation of operation would be cumulative to the disclosure and is not recited herein.

Although the above apparatus employs a full rotational swivel, it will readily be apparent that a swivel having a limited angular movement may be employed.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. In apparatus for use in a well bore including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor member, said device including a pair of telescopically-arranged members adapted to be moved longitudinally relative to one another between at least two longitudinal positions and adapted to be rotatable relative to one another, cooperating index means operatively connected between said telescopic members and responsive to relative longitudinal movement therebetween to rotate said telescopic members with respect to one another between at least two positions of rotative orientation, said index means permitting further relative longitudinal movement when said telescopic members are in at least one of the positions of relative orientation, means for releasably restraining said telescopic members against relative longitudinal movement when said telescopic members are in a position of relative orientation, and a swivel connection operatively connected in the array of elements including the pipe string,

the anchor member and the said adjustable length device to permit said telescopically-arranged members to be relatively rotated.

2. In apparatus for use in a well bore and including a pipe string and an anchor shoe for engaging a wall portion of the well bore: an adjustable length device adapted to be connected between the pipe string and the anchor shoe, said device including a pair of telescopically-arranged members adapted to be moved longitudinally relative to one another between at least two longitudinal positions and adapted to be rotatable relative to one another, cooperating index means operatively connected between said members and responsive to relative longitudinal movement therebetween to rotate said members with respect to one another between at least two positions of rotative orientation, said index means permitting further relative longitudinal movement when said members are in at least one of the positions of relative orientation, means for interengaging said members to prevent relative longitudinal movement in one direction when said members are in a position of relative orientation, and a swivel connection operatively connecting said anchor shoe and one of the said members to permit said member to rotate relative to said shoe.

3. In apparatus for use in a well bore and including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor member including a pair of telescopically-arranged members adapted to be moved longitudinally relative to one another between two longitudinal positions and adapted to be rotatable relative to one another, one of said telescopic members including a first longitudinal slot having one end portion defining a first location, a first shunting slot having one end connected to the opposite end portion of said first longitudinal slot and inclined relative thereto, a second shunting slot having one end portion connected to the opposite end of said first shunting slot and inclined relative to said first longitudinal slot in an opposite sense to said first shunting slot, a third shunting slot inclined relative to said first longitudinal slot similar to said first shunting slot and having one end portion connected to the opposite end of said second shunting slot, said last-mentioned connection defining a second location; a second longitudinal slot having one end portion connected to the opposite end portion of the said third shunting slot, a fourth shunting slot inclined similar to said first shunting slot and connected at one end portion to the opposite end portion of the said second longitudinal slot, the opposite end of said fourth shunting slot connected to an intermediate portion of said first longitudinal slot, a follower pin connected to the other of said telescopic members, said slots and said pin conjointly defining a cooperating index system operatively connected between said telescopic members and responsive to relative longitudinal movement between said telescopic members to rotate said telescopic members with respect to one another between two positions of rotative orientation, said index system permitting further relative longitudinal movement when said telescopic members are in at least one of the positions of relative orientation; means for releasably restraining said telescopic members against relative longitudinal movement when said telescopic members are in a position of relative orientation; and a swivel connection operatively connected in the array of elements including the pipe string, the anchor and the said adjustable length device to permit said telescopic members to be relatively rotated.

4. In apparatus for use in a well bore and including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor member including a tubular housing, a mandrel telescopically received in said housing, said housing being adapted to be moved longitudinally relative to said man-

drel between at least two longitudinal positions and adapted to be rotatable relative to said mandrel; cooperating index means operatively connected between said housing and mandrel and responsive to relative longitudinal movement of said housing to permit relative rotation of said mandrel with respect to said housing between at least two positions of rotative orientation, said index means permitting further relative longitudinal movement when said mandrel and housing are in at least one of the positions of relative orientation; splines on said housing and said mandrel having co-acting opposed surface portions defining abutment means for releasably restraining said housing and mandrel against relative longitudinal movement when said housing and mandrel are in a position of relative orientation and arranged to mesh in another position of relative orientation to permit relative longitudinal movement between said housing and said mandrel, and a swivel connection operatively connected in the array of elements including the pipe string, the anchor member and the adjustable length device to permit said housing and mandrel to be relatively rotated.

5. In apparatus for use in a well bore and including a pipe string and an anchor shoe for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor shoe including a tubular housing, a mandrel telescopically received in said housing, said housing adapted to be moved longitudinally relative to said mandrel between two longitudinal positions and adapted to be rotatable relative to said housing; said housing including an upper abutment portion and splined abutment portions intermediate the length of said housing, said mandrel having abutment portions including a splined portion, said mandrel abutment portions adapted to be releasably secured against at least one of said housing abutment portions in said two longitudinal positions, said mandrel having a first longitudinal slot having one end portion defining a first location, a first shunting slot having one end connected to the opposite end portion of said first longitudinal slot and inclined relative thereto, a second shunting slot having one end portion connected to the opposite end of said first shunting slot and inclined relative to said first longitudinal slot in an opposite sense to said first shunting slot, a third shunting slot inclined relative to said first longitudinal slot similar to said first shunting slot and having one end portion connected to the opposite end of said second shunting slot, said last-mentioned connection defining a second location, a second longitudinal slot having one end portion connected to the opposite end portion of said third shunting slot, a fourth shunting slot inclined similar to said first shunting slot and connected at one end portion to the opposite end portion of the said second longitudinal slot, the opposite end of said fourth shunting slot connected to an intermediate portion of said first longitudinal slot, a follower pin in said housing, said slots and said pin conjointly defining a cooperating index system, said pin, said first longitudinal slot and said mandrel spline portions being aligned with respect to said housing spline portions so that in response to relative longitudinal movement between said housing and mandrel between said two longitudinal positions the said mandrel spline portions will mesh with said housing spline portions when said pin is in said first or fourth longitudinal slots and will engage when said pin is in said second locating position, and a swivel connection operatively connected in the array of elements including the pipe string, the anchor shoe and the adjustable length device to permit said members to be relatively rotated.

6. In apparatus for use in a well bore and including a pipe string, an anchor member arranged for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and anchor member, said device including a pair of telescopically-arranged members adapted to be moved longitudinally relative to one another between at least two

longitudinal operating positions and adapted to be rotatable relative to one another, a first abutment portion on at least one of said telescopic members; means to releasably restrain said telescopic members against longitudinal movement when said telescopic members are in a first relative rotational position thereby to define one longitudinal operating position including cooperating abutment portions on each of said telescopic members, said cooperating abutment portions permitting relative longitudinal movement of said telescopic members when said telescopic members are in a second relative rotational position so that one of said cooperating abutment portions is engageable with said first abutment portion thereby to define another longitudinal operating position; cooperative index means connected between said telescopic members and responsive to relative longitudinal movement of said telescopic members to effect relative rotation thereof between said first and second relative rotational positions whereby said telescopic members may be selectively restrained by said abutment portions in at least one of said longitudinal operating positions, and a swivel connection operatively connected in the array of elements including the pipe string, the anchor member and the adjustable length device to permit said telescopic members to be relatively rotated.

7. An adjustable length device for use with a drill string in a borehole comprising: a pair of telescopically-arranged members adapted to be connected in a drill string; at least one of said members having a first abutment portion, each of said members further having cooperating abutment portions which are arranged to releasably restrain said members against longitudinal movement in one direction when said members are in a first relative rotational position thereby to define one operating position but permitting relative longitudinal movement of said members in the said one direction when said members are in a second relative rotational position so that one of said cooperating abutments is engageable with said first-mentioned abutment thereby to define another operating position; one of said members including a first longitudinal slot having one end portion defining a first location, a first shunting slot having one end connected to the opposite end portion of said first longitudinal slot and inclined relative thereto, a second shunting slot having one end portion connected to the opposite end of said first shunting slot and inclined relative to said first longitudinal slot in an opposite sense to said first shunting slot, a third shunting slot inclined relative to said first longitudinal slot similar to said first shunting slot and having one end portion connected to the opposite end of said second shunting slot, said last-mentioned connection defining a second location; a second longitudinal slot having one end portion connected to the opposite end portion of said third shunting slot, a fourth shunting slot inclined similar to said first shunting slot and connected at one end portion to the opposite end portion of the said second longitudinal slot, the opposite end of said fourth shunting slot connected to an intermediate portion of said first longitudinal slot, and a follower pin connected to the other of said members, said slots and said pin conjointly defining a cooperating index system operatively connected responsive to relative longitudinal movement between said members to rotate said members with respect to one another between two positions of rotative orientation, said index system permitting further relative longitudinal movement when said members are in at least one of the positions of relative orientations.

8. In apparatus for use in a well bore and including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between said pipe string and the anchor member, said device including a pair of telescopically-arranged members adapted to be moved longitudinally relative to one another between at least three longitudinally spaced positions and adapted to be rotatable

relative to one another, cooperating index means operably connected between said telescopic members and responsive to relative longitudinal movement therebetween to rotate said telescopic members with respect to one another between at least three positions of rotative orientation, said index means permitting further relative longitudinal movement when said telescopic members are in at least one of the positions of relative orientation, means for releasably restraining said telescopic members against relative longitudinal movement when said telescopic members are in a position of relative orientation, and a swivel connection operatively connected in the array of elements including the pipe string, the anchor member and the said adjustable length device to permit said telescopically-arranged members to be relatively rotated.

9. In apparatus for use in a well bore and including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor member including a tubular housing, a mandrel telescopically received in said housing, said housing adapted to be moved longitudinally relative to said mandrel between three longitudinally spaced positions, said mandrel and said housing adapted to be rotatable relative to one another, said mandrel having a continuous slot system for relatively orienting said housing and said mandrel to define positions of rotative orientation including at least three longitudinal spaced slots disposed about the outer surface of the said mandrel and connecting slots between end portions of said longitudinal slots, and a follower pin connected to said housing, said slots and said pin conjointly defining a cooperating index system operatively connected between said housing and mandrel and responsive to relative longitudinal movement between housing and mandrel to rotate said housing and mandrel with respect to one another between three positions of rotative orientation, said index system permitting further relative longitudinal movement when said housing and mandrel are in at least one of the positions of relative orientation; splines on said housing and mandrel having co-acting opposed surface portions defining abutment means for releasably restraining said housing and mandrel against relative longitudinal movement in at least two of said relatively oriented positions of said housing and mandrel and arranged to mesh in at least two of said relatively oriented positions; and a swivel connection operatively connected in the array of elements including the pipe string, the anchor member and the said adjustable length device to permit relative rotation between said housing and said mandrel upon longitudinal movement of said housing relative to said mandrel.

10. In apparatus for use in a well bore and including a pipe string and an anchor member for engaging a wall portion of the well bore, an adjustable length device adapted to be connected between the pipe string and the anchor member including a tubular housing, a mandrel telescopically received in said housing, said housing adapted to be moved longitudinally relative to said mandrel between three longitudinally spaced positions, said mandrel and said housing adapted to be rotatable relative to one another, said mandrel having a first longitudinal slot having one end portion defining a first loca-

tion, a first shunting slot inclined relative to said first longitudinal slot and having one end portion connected to the opposite end portion of said first longitudinal slot, a second shunting slot inclined relative to said first longitudinal slot in an opposite sense and having one end portion connected to the opposite end portion of said first shunting slot, a second longitudinal slot having one end portion connected to the opposite end of said second shunting slot and extending upwardly therefrom, a third shunting slot inclined similar to said first shunting slot and having one end portion connected to the opposite end portion of said second longitudinal slot, a fourth shunting slot inclined similarly to said second shunting slot and having one end portion connected to the opposite end portion of said third shunting slot, a fifth shunting slot inclined similar to said first shunting slot and having one end portion connected to the opposite end portion of said fourth inclined slot, a third longitudinal slot having one end portion connected to the opposite end portion of said fifth shunting slot and extending downwardly therefrom, a sixth shunting slot inclined similar to said first shunting slot and having one end portion connected to the opposite end portion of said third longitudinal slot, a fourth longitudinal slot having one end portion connected to the opposite end portion of said sixth shunting slot and extending downwardly therefrom, a seventh shunting slot inclined similar to said first shunting slot and having one end portion connected to the opposite end portion of said fourth longitudinal slot and having an opposite end portion connected intermediate of said first longitudinal slot, and a follower pin connected to said housing, said slots and said pin conjointly defining a cooperating index system operatively connected responsive to relative longitudinal movement between housing and mandrel to rotate said housing and mandrel with respect to one another between three positions of rotative orientation, said index system permitting further relative longitudinal movement when said housing and mandrel are in at least one of the positions of relative orientation; splines on said housing and mandrel having co-acting opposed surface portions defining abutment means for releasably restraining said housing and mandrel against relative longitudinal movement when said housing and mandrel are in at least two of said relatively oriented positions and arranged to mesh in at least two of said relatively oriented positions; and a swivel connection operatively connected in the array of elements including the pipe string, the anchor member and the said adjustable length device to permit relative rotation between said housing and said mandrel upon longitudinal movement of said housing relative to said mandrel.

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