Oct. 3, 1967 M. B. CONRAD 3,344,862

COMBINED TUBING ANCHOR COLLAR LOCATOR AND SWIVEL

Filed March 1, 1965 3 Sheets-Sheet 1

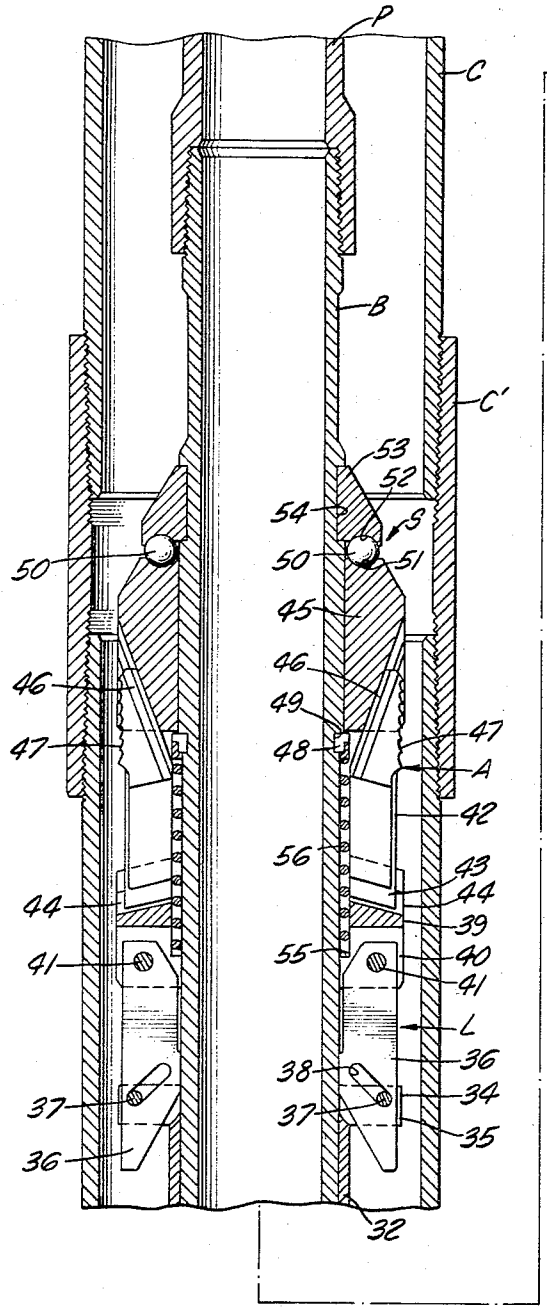

FIG. 1.

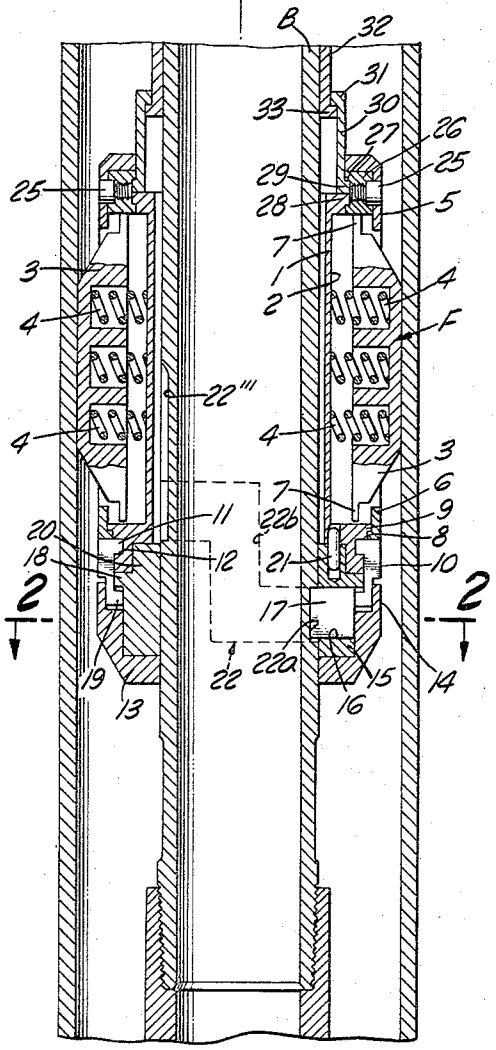

FIG1a

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COMBINED TUBING ANCHOR COLLAR LOCATOR AND SWIVEL

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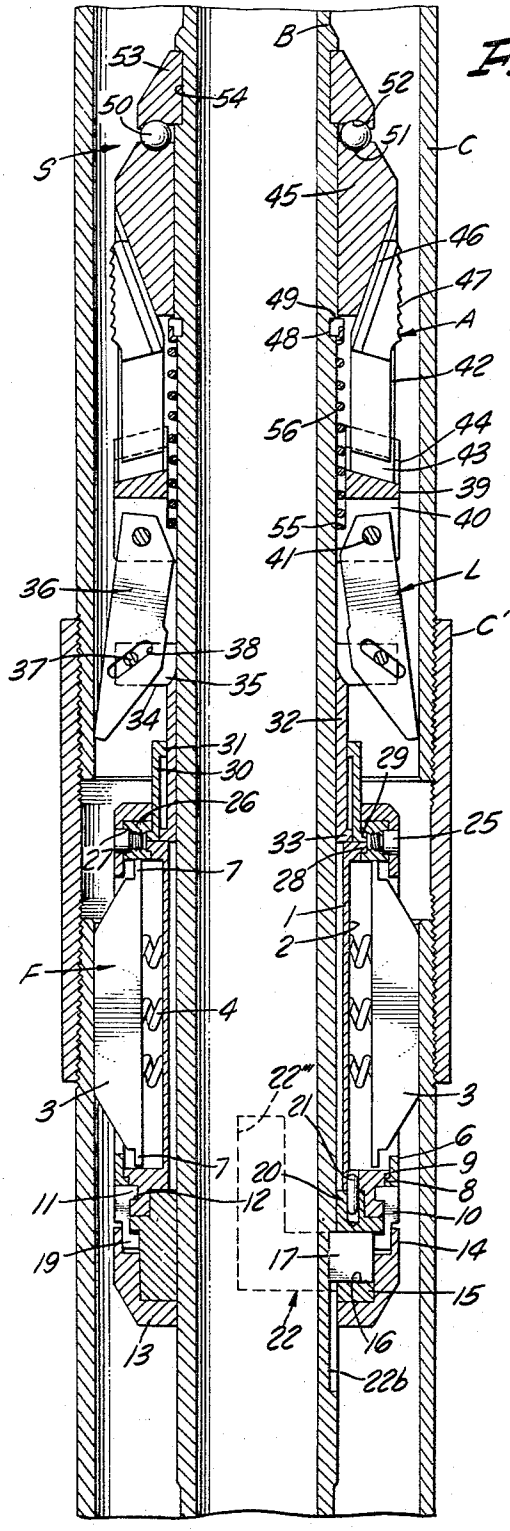
FIG. 4.



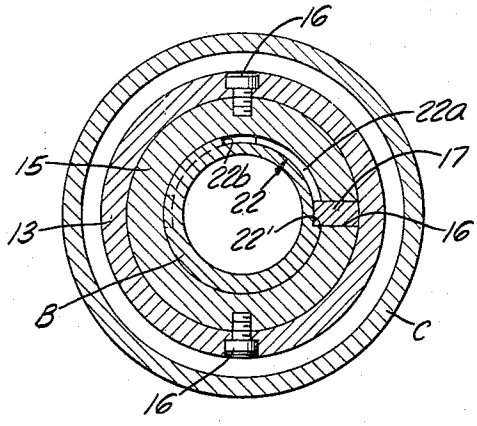


FIG. 2.

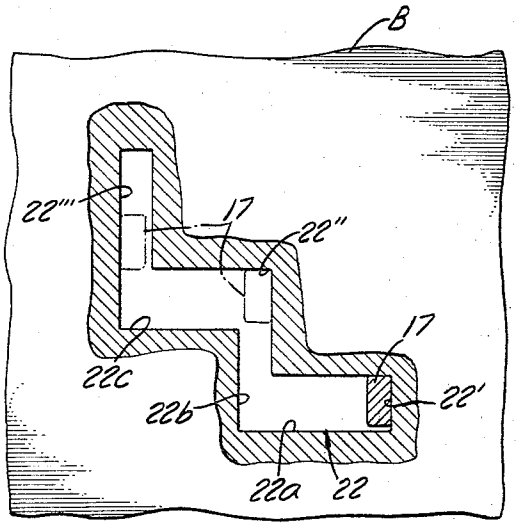


FIG. 3.

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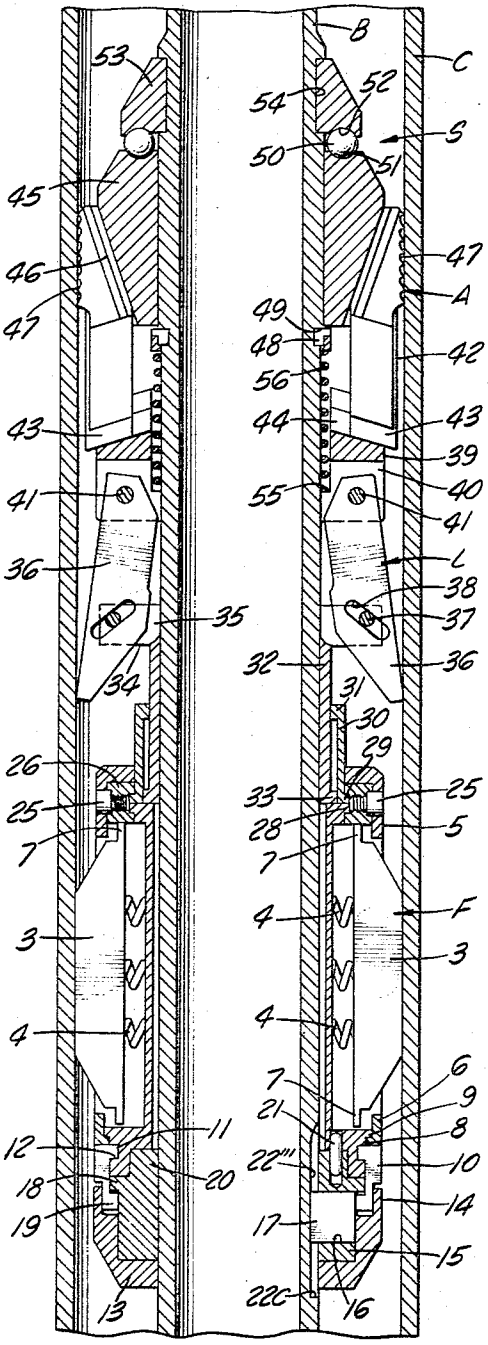

FIG. 6.

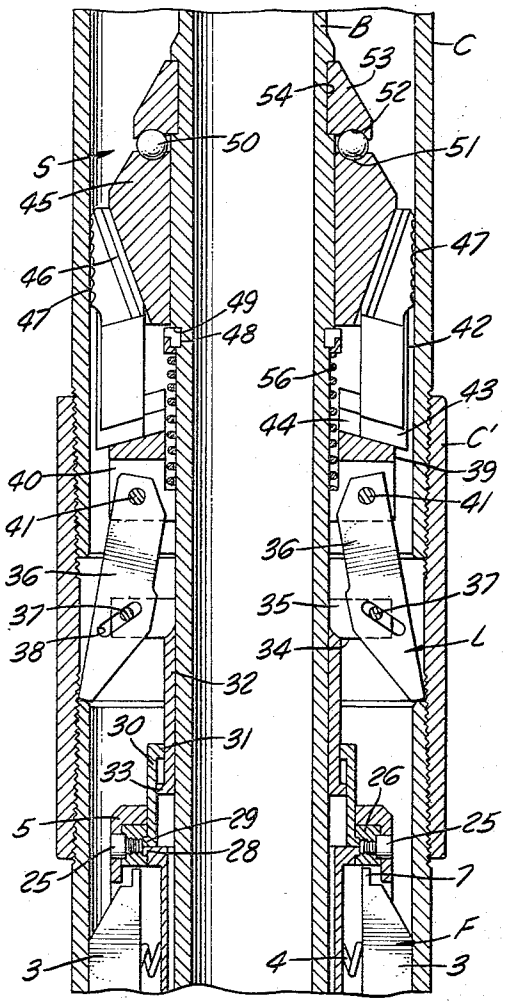

FIG. 5.

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COMBINED TUBING ANCHOR COLLAR LOCATOR AND SWIVEL

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13 Claims. (Cl. 166—216)

ABSTRACT OF THE DISCLOSURE

A tubular device is carried on a string of pipe and lowered into a well casing made up of casing joints connected by external collars. The tubular device carries expansible fingers for locating a collar, control means for expanding the fingers, means to anchor the device to the casing, and a swivel connection between the device and the anchor means, so that a casing cutting tool carried by the device may be rotated without longitudinal movement.

The present invention relates to well tools, and more particularly to a well tool useful in hydraulic cutting or casing notching operations in which a cutting fluid, such as a sand laden fluid, is injected through a nozzle or nozzles in a generally radial direction into engagement with the well casing at a cutting velocity.

In certain well operations, such as the hydraulic fracturing of the subterranean formation, it is desired that the fracturing fluid pressure be applied to the formation at a particular location or locations. To this end, it has been the practice to perforate the well casing at such locations either by bullets, shaped charges, or by the erosive action of fluid pumped from the top of the well. In certain instances it is desired to cut an annular notch through the casing and outward into the formation so as to facilitate fracturing the formation in a single plane.

In the conduct of such perforating or notching operations employing cutting fluids, it is important that the plane of perforation or cut be located relative to a known reference point in the well bore, such as a casing collar, that the cutting tool be held in a selected position without working longitudinally during the cutting operation, and that the cutting tool be capable of revolution in the bore so that a full circular notch or a number of such notches may be cut.

Accordingly, the objectives of the present invention involve the provision of a device adapted to be installed in a string of pipe through which treating and/or cutting fluid may be pumped, such device having means for positively locating a casing collar so that the location of the device in the well bore will be known, such device also having means for anchoring the same in the well bore; and such device also having means enabling revolution of the cutting tool or device in the well bore to enable cutting a full-circular notch in the casing and the earth formation.

More particularly, the invention contemplates the provision of a tubular body adapted for connection in a string of pipe to form a part thereof and having mechanisms for locating a collar, that is, the gap between the adjacent ends of the connecting collar, and indicating the location of the collar by preventing downward movement of the pipe string, and for anchoring the pipe string at a desired locaton relative to such collar. In addition, the structure is preferably such that the pipe string and the tubular body may be revolved so that a fluid jet cutting tool beneath the body may be revolved to cut annularly, the anchored device preventing longitudinal movement of the cutting tool otherwise caused by the surges of fluid passing through the pipe string and cutting tool.

A further object of the invention is to provide a combined collar locator, anchor, and swivel assembly as referred to above, wherein friction means carried by the body and engageable with the well casing are adapted to hold stationary relative to the casing a control slot in the body and movable between: a first position at which the mechanism may be run into a well bore; a second position at which the body is released for longitudinal movement relative to the friction means, to allow operation of the collar locator means and the anchor means, to cause temporary anchoring of the pipe string against downward movement in the casing to indicate location of the collar; and a third position at which the anchor means is operative to anchor the body during the pumping of cutting fluid through the body.

Other objects and advantages of the invention will be hereinafter described, or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

In the accompanying drawings:

FIG. 1 is a longitudinal sectional view through a collar locator, anchor and swivel device made in accordance with the invention and in a well casing;

FIG. 1*a* shows a continuation of the lower end of FIG. 1.

FIG. 2 is a transverse sectional view as taken on the line 2—2 of FIG. 1*a*;

FIG. 3 is a planar projection of a portion of the tool body illustrating the control slot form;

FIG. 4 is a fragmentary longitudinal sectional view showing the tool of FIG. 1 and FIG. 1*a* in condition for locating a casing collar;

FIG. 5 is a view corresponding to FIG. 4, but showing the tool in engagement with the casing at a collar; and

FIG. 6 is a view corresponding to FIGS. 4 and 5, but showing the tool anchored in the casing.

Like reference characters in the several views of the drawings and in the following description designate corresponding parts.

Referring to FIG. 1, the tool herein shown as illustrative of the invention, is adapted to be run into a well bore having casing C therein, such casing being composed of sections connected by casing collars C' in the usual manner. Hence, the tool includes an elongate tubular body B having means for threadedly connecting the same at its ends in a string of pipe P.

Spaced longitudinally of the body B are casing engaging friction means F, casing collar locator means L, casing engaging anchor means A, and swivel means S.

The friction means F includes a friction drag block carrier **1** which encircles the body and is provided with a number of, for example six, drag block receiving slots **2**, in which are drag block **3** spring loaded outwardly for frictional engagement with the casing as by a number of springs **4**. At opposite ends of the drag blocks they are retained in the grooves by retainer rings **5** and **6** which extend into overlying relation to the ends of the slots **2** for engagement by tongues **7** on the ends of the drag blocks.

Lower retainer ring **6** has an internal flange **8** in abutment with a shoulder **9** on the drag block carrier, and a split ring **10** holds the ring **6** in place on the carrier **1**. The segments of split ring **10** have inner flanges **11** which are disposed in an annular groove **12** in the drag block carrier. A cup-like member **13** having a rim or skirt **14** disposed about the segments of ring **10** holds such segments in place in interlocked engagement with the drag block carrier **1**.

A control key carrier **15** of an annular form is disposed about the body within the cap **13**, and the cap **13** is secured to the key carrier **15** by means of recessed cap screws **16** (see FIG. 2). Key carrier **15** has an opening **16** in which a key block **17** is disposed, and the key carrier together with the cap **13** are retained connected

to the drag block carrier **1** by an outwardly projecting flange **18** on the key carrier **15** opposed by inwardly projecting flanges **19** on the segments of split ring **10**. An axially inwardly extended portion **20** of the key carrier **15** extends into an annular recess in the adjacent end of drag block carrier **15**, and pin means including a dowel **21** interengaged in openings in the drag block and key carriers, interconnects the carriers against relative rotation. Thus, the key **17** is effectively carried by the friction means.

The body B, as is best understood upon reference to FIG. 3, is provided with a control slot generally denoted **22** which, in combination with key **17**, may be characterized as V-slot means, inasmuch as the key **17** is movable in the slot to control the relative positioning of the body within the friction means. Slot **22** includes: an end **22'** at which pin **17** may be positioned in a first position for running and retrieving the tool; a circumferentially extended portion **22*a*** leading to a longitudinally extended portion **22*b*** at an end **22''** of which the key **17** may be located in second position for seeking collars with the collar locator means L; and a further circumferentially extended section **22*c*** leading from section **22*b*** to a second longitudinally extended section **22'''** along which the key **17** may assume a third position for allowing the tool to be anchored, all as will more fully appear hereinafter.

At the upper or inner end of the drag block carrier **1**, the drag block retainer ring **5** is connected by cap screws **25** to the segments of a split ring **26** having an inner peripheral groove **27** in which are disposed in abutting relation an outwardly projecting flange **28** on carrier **1** and an outwardly projecting flange **29** on a split connector sleeve **30**. This sleeve **30** is spaced from the body B and has at its end opposite flange **29** an inwardly extending flange **31** within which is slidably disposed a tubular member **32**.

The lower end of member **32** has a connector flange **33** engageable with the connector flange **31**, so that the member **32** is connected to the friction means for limited relative longitudinal or telescoping movement. At the upper end of member **32** are a number of support lugs **34** disposed in circumferentially spaced relation and slotted at **35** to accommodate collar locator fingers **36** of the collar locator means L. Means in the form of a pin **37** extending through an angularly disposed slot **38** in the respective fingers **36** and connected to the lugs **34**, are provided so that movement of the fingers **36** longitudinally in opposite directions will cause the lower extremities of the fingers to be projected and retracted.

At the upper ends of the fingers **36** they are pivotally connected to an annular slip carrier ring **39** having slots **40** for reception of the fingers, pivot pins **41** suitably mounting the fingers **36** or the slip carrier. This slip carrier is disposed about body B for relative longitudinal movement when the tool is being used to seek a collar, when the collar is located, and when the tool is to be anchored.

Carried by the slip carrier **39** are a suitable number of slips or anchor elements **42** having T-heads **43** shiftable laterally of the carrier **39** in complemental T-slots in the latter. The upper portions of slips **42** are wedge-shaped and are shiftably connnected to an expander cone **45** by a dove-tailed connection at **46**. This wedge-shaped portion of each slip is wickerd or provided with teeth **47** adapted to bite into the casing upon expansion of the slip elements, such expansion being responsive to upward movement of slips **42** relative to cone **45**.

The cone **45** is revolvably mounted upon the body B between a retainer ring **48**, seating in a groove **49** in the body below the cone **45**, and the swivel means S which is constituted by suitable bearings such as balls **50** engaged in an annular race **51** in the upper end of the cone **45** and opposing race **52** in an annular split retainer **53** which is suitably attached in a groove **54** in the body B.

Interposed between a suitable abutment on the body B, such as the ring **48**, and an abutment on the slip carrier **39**, such as a shoulder **55**, is a coiled spring **56** which, upon downward movement of body B relative to the friction means F, will resiliently bias the locator fingers **36** outwardly, as will hereinafter be more fully described.

In the use of the tool described above, it is run into a well in the condition shown in FIG. 1, i.e., with the control key **17** in a first position engaged with the end **22'** of section **22*a*** of control slot **22**. Under such circumstances, it will be noted that the various instrumentalities along the body are stretched out, the distance between the key and cone **45** being such that the slips **42** and locator fingers are retracted and the member **32** engages connector **30** at the coengageable flanges **31** and **33**.

When the tool has been run into a well to the approximate location of a casing collar C', the running in string is rotated to move the body B relative to the friction means F until the key **17** is disposed in the longitudinally extended section **22*b***, at which the body is free to move downward relative to the friction means until the key abuts with end **22''** of the section **22*b*** and is in a second position.

Such conditioning of the tool causes the member **32**, the fingers **36**, and slips **42** to assume the relationship shown in FIG. 4, wherein the distance between the friction means and the abutment ring **48** has been reduced an amount greater than the distance that the member **32** may move before engaging the upper end of the drag block carrier **1** so that the spring **56** is compressed so as to resiliently bias the fingers **36** downwardly, resulting in outward movement of the lower ends of the fingers into engagement with the casing C. Under such circumstances, the pipe string may be lowered, the fingers sliding along the casing wall until a gap in the casing is reached at the collar C', at which point the fingers **36** will be forced by spring **56** outwardly into the gap to engage the end of the casing as shown in FIG. 5.

Upon engagement of the fingers **36** in a casing collar C' as shown in FIG. 5, downward movement of the slips **42** along with the body will be prevented and the fingers **36** will thus cause the slips to be expanded as the cone **45** continues to move downward. Such expansion of the slips will arrest downward movement of the tool and the pipe string, thus indicating the location of the collar C'. Assuming for the present purposes that the tool is to be anchored at a location above the collar as located the pipe string may be raised to the desired extent, thus stretching the tool to the condition of FIG. 1, and thereafter the string will be lowered until the key **17** contacts end **22''** of J-slot section **22*b***, and thereafter rotated until the key **17** is in engagement with the longitudinal wall **22'''** of J-slot **22**. In this third position, the body is free to move downward a sufficient distance that the cone **45** will engage and expand the slips **42** so that they will anchor the tool against the well casing.

Thereafter, the desired hydraulic pumping operation may be performed, and if the operation involves rotation of a cutting tool, the body will be free to rotate on the swivel means **5**, the friction means revolving with the body B and swiveling relative to member **32** at the connector **30**.

Upon completion of the pumping operation, the tool may be again released by lifting up on the pipe string and moved to another location or retrieved. Alternatively, the tool may be conditioned as shown in FIG. 1 and moved to a lower location or retrieved.

While the specific details of the invention have been herein shown and described, changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A casing collar locator, comprising: an elongate tubular body adapted to be connected in a string of pipe to be run into a cased well, friction means on said body

and frictionally engageable with the well casing, expansible casing collar locator means on said body, movable control means carried by said friction means and said body interconnecting the same in one position of said control means to cause movement of said friction means and said body longitudinally as a unit and for permitting longitudinal movement of said body relative to said friction means upon movement of said control means to a second position, means for expanding said collar locator means into engagement with the casing wall upon such longitudinal movement of said body, and anchor means expansible into engagement with said casing wall upon further movement of said body longitudinally relative to said expanded collar locator means, said anchor means comprising cooperative slip and cone means connected to said body and to said collar locator means.

2. A casing collar locator, comprising: an elongate tubular body adapted to be connected in a string of pipe to be run into a cased well, friction means disposed about said body and frictionally engageable with the well casing, expansible anchor means carried by said body and movable into and out of anchoring engagement with the casing upon relative longitudinal movement of said body and said anchor means, casing collar locator means interposed between said anchor means and said friction means and expansible for engagement with said casing upon movement of said body from one position to a second position relative to said friction means, control means connecting said friction means to said body operable to enable movement of said body to said second position, and means for enabling movement of said body longitudinally relative to said collar locator means, said collar locator means being connected to said anchor means to cause said relative movement of said body and said anchor means upon longitudinal movement of said body relative to said collar locator means.

3. A collar locator as defined in claim 2, wherein said means for enabling longitudinal movement of said body relative to said collar locator means includes a telescopic connection between said friction means and said collar locator means.

4. A collar locator as defined in claim 2, wherein said means for enabling longitudinal movement of said body relative to said collar locator means includes a telescopic swivel connection between said friction means and said collar locator means, and including a swivel connection between said body and said anchor means.

5. A collar locator as defined in claim 2, wherein said control means comprises a key and a slot in which said key is disposed, said slot having a first circumferential section and a second longitudinally extended section.

6. A collar locator as defined in claim 2, wherein said control means includes means operable to enable movement of said body to a third position relative to said friction means to cause expansion of said anchor means.

7. A casing collar locator, comprising: an elongate tubular body adapted to be connected in a string of pipe to be run into a cased wall, friction means disposed about said body and frictionally engageable with the well casing, control means for retaining said body in a first position and operable to allow longitudinal movement of said body to a second position relative to said friction means, collar locator means on said body expansible to engage said casing, means holding said collar locator means retracted when said body is in said first position, means for causing expansion of said collar locator means upon movement of said body to said second position, and anchor means expansible to anchor with said casing upon further longitudinal movement of said body relative to said expanded collar locator means, said means for holding said collar locator means retracted including means connecting said collar locator means to said anchor means, and means connecting said anchor means to said body.

8. A casing collar locator, comprising: an elongate tubular body adapted to be connected in a string of pipe to be run into a cased well, casing engaging friction means mounted on said body for relative rotation and longitudinal movement of said body, control means interconnecting said body and friction means for longitudinal movement as a unit and operable upon such relative rotation to permit such longitudinal movement from a first position to a second position, a cone revolvable on said body in spaced relation to said friction means, swivel bearing means on said body and engaged with said cone, laterally expansible casing engaging collar locator means and casing engaging anchor means respectively swivelly connected to said friction means and shiftably connected to said cone, means holding said locator means and said anchor means retracted from engagement with said casing when said body is in said first position, means for causing lateral expansion of said locator means into engagement with said casing upon movement of said body to said second position and for causing further expansion of said locator means upon registry with a casing collar, said anchor means being expansible by said locator means and said cone upon further movement of said body longitudinally in one direction relative to a collar into which said locator means are expanded.

9. A collar locator as defined in claim 8, wherein said control means includes means for enabling longitudinal movement of said body to a third position relative to said friction means to move said cone relative to said anchor means and expand said anchor means into engagement with said casing.

10. A collar locator as defined in claim 8, wherein said means for holding said locator means retracted includes a member swivelly connected to said friction means and cooperative cam means on said member and said locator means for causing retraction of said locator means upon longitudinal movement of said body in one direction, and said means for causing expansion of said locator means includes cam means on said member and said locator means and means resiliently urging said locator means in a direction to cause expansion of said locator means.

11. A casing collar locator, comprising: a longitudinally extended body adapted to be connected in a pipe string to be run into a cased well, rotary thrust bearing means at one end of said body, casing engaging friction means at the other end of said body, control means interconnecting said body and said friction means for relative rotation and longitudinal movement, an expander cone revolvable on said body and engaged with said thrust bearing means, laterally expansible anchor slips engaged with said cone, a slip carrier ring disposed about said body and connected to said slips, a spring engaged between said body and said ring to urge the latter longitudinally away from said cone to resiliently hold said slips retracted, locator fingers pivoted at one end on said ring, a connector disposed about said body and swivelly and telescopically connected to said friction means, and means on said connector and said locator fingers for camming said fingers laterally with respect to said body upon longitudinal movement of said body relative to said connector.

12. A casing collar locator as defined in claim 11, wherein said means for camming said fingers includes a pin and diagonal slot respectively on and in one of said connector and fingers.

13. A casing collar locator, comprising: an elongate tubular body adapted to be connected in a string of pipe to be run into a cased well, friction means on said body and frictionally engageable with the well casing, expansible casing collar locator means on said body, movable control means carried by said friction means and said body interconnecting the same in one position of said control means to cause movement of said friction means and said body longitudinally as a unit and for permitting longitudinal movement of said body relative to said friction

means upon movement of said control means to a second position, means for expanding said collar locator means into engagement with the casing wall upon such longitudinal movement of said body, anchor means expansible into engagement with said casing wall upon further movement of said body longitudinally relative to said expanded collar locator means, said anchor means including a cone on said body and expansible slips engageable with said cone and connected with said collar locator means, and including a swivel connection between said cone and said body and a swivel connection between said friction means and said collar locator means.

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