

April 21, 1942.

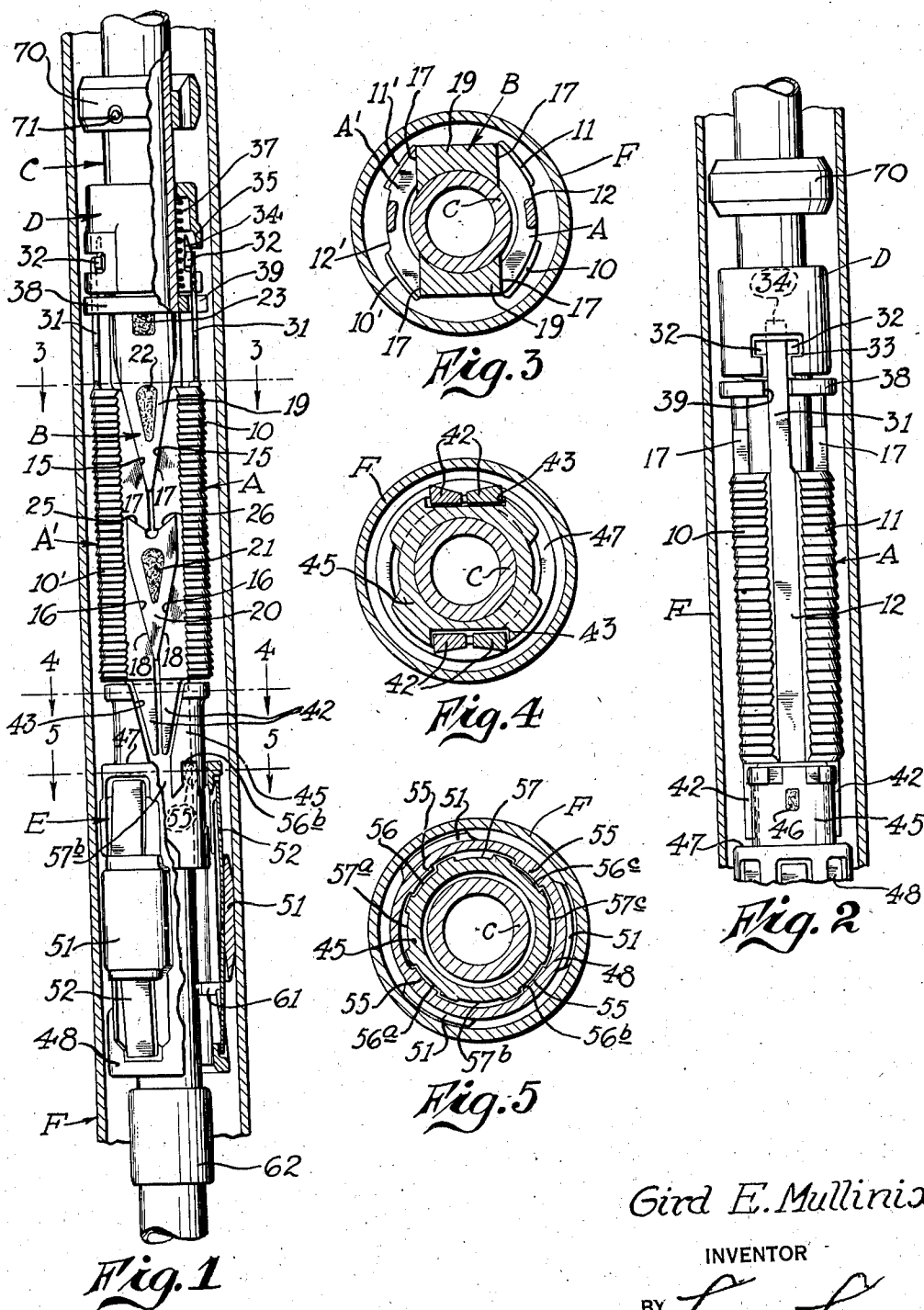
G. E. MULLINIX

2,280,076

PIPE ANCHOR

Filed Jan. 16, 1940

2 Sheets-Sheet 1



Gird E. Mullinix

INVENTOR

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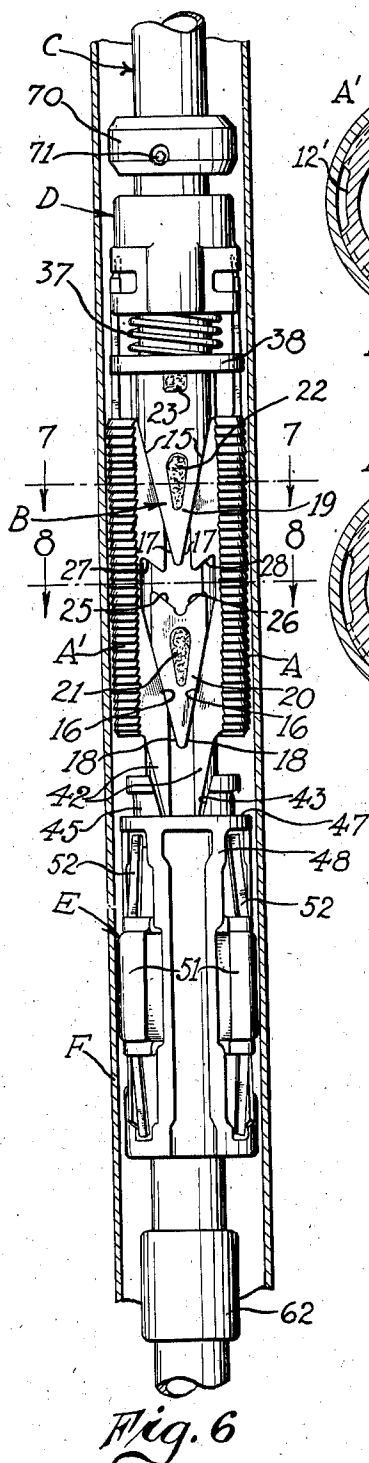
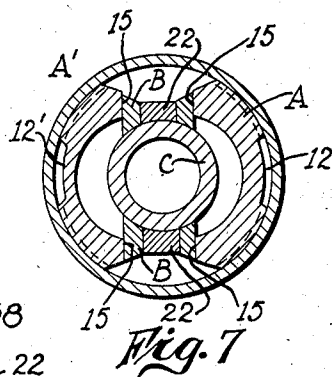
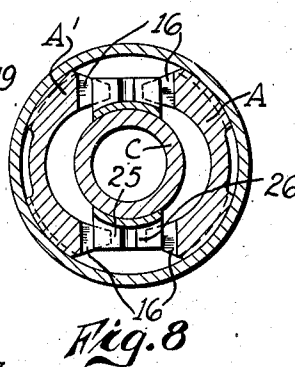
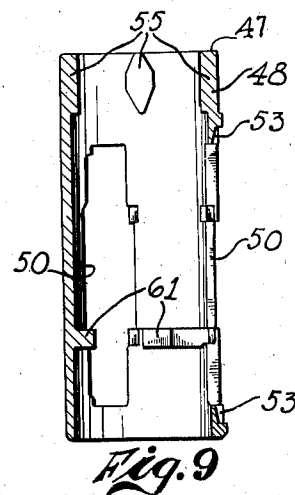
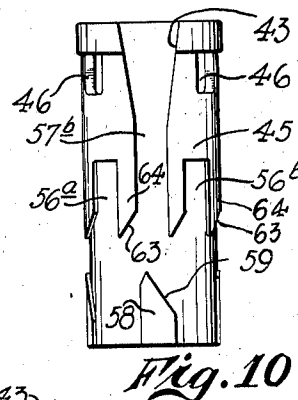
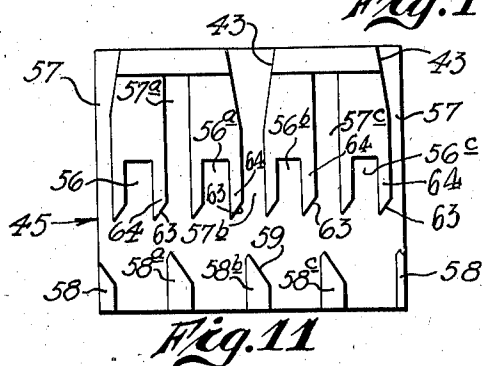
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UNITED STATES PATENT OFFICE

2,280,076

PIPE ANCHOR

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Application January 16, 1940, Serial No. 314,057

1 Claim. (Cl. 103—219)

This invention relates generally to tubing catchers and anchors of the type commonly in use to support tubing in a well and to automatically grip the well casing and prevent the string of tubing from dropping should it part above the catcher or be accidentally released at the surface.

A principal object of this invention is to provide a tubing catcher and anchor which consists of a minimum number of parts necessary to accomplish its intended function, and which is therefore simple and positive in operation and economical to construct.

A further object is to provide a device of the above type which is insensitive to minor forces tending to set the slips prematurely, but which automatically grips the casing without delay in the event the tubing and catcher start to fall freely. While a string of tubing is being lowered into the well, it frequently occurs that the tubing catcher is actuated by upward surges of gas through the well liquid, or by too rapid lowering of the tubing, and the slips on the catcher engage the casing and anchor the tubing prematurely. On the other hand, if the catcher is constructed so that it is unaffected by the above conditions tending to set it prematurely, it usually responds only sluggishly to a sudden free drop of the tubing, in which case the tubing acquires sufficient momentum to cause the slips on the catcher to seriously damage the casing when they finally take hold and interrupt the free fall of the tubing.

The sensitivity of a tubing catcher to conditions tending to set the slips prematurely is an inverse function of that portion of the weight of the slips which is unsupported by the actuator spring—i. e., the greater the unsupported weight, the less sensitive the device is to premature setting. On the other hand, the sensitivity of the device to free fall of the tubing is a direct function of the ratio of spring-supported weight to unsupported weight—that is, the stronger the actuator spring with relation to the total weight of the slips, the more nearly instantaneous will be the response to gravity acceleration of the tubing when it falls freely. In the present instance these mutually antagonistic factors have been balanced in such a manner that the possibility of inadvertent setting of the slips is reduced to a minimum, but without sacrificing sensitivity to free fall.

A still further object of the invention is to provide a construction wherein the minimum total cross-sectional area of the fluid passages

around and through the tubing catcher is greatly increased over that of prior tubing catchers. An increase in fluid passage area serves a twofold purpose—it facilitates the lowering of the tubing string and catcher into the well by reducing the possibility of premature setting of the slips by surges of gas, and it lowers the frictional resistance to flow of well fluid during pumping and thereby reduces the pumping head.

A still further object is to provide a simplified and improved anchor mechanism for manually setting the slips to anchor the tubing in the well at any desired elevation therein.

Other objects and advantages of the invention will be apparent from the following detailed description of a preferred embodiment, taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a view in side elevation, showing the device being lowered into a well with the slips in retracted position;

Fig. 2 is a side elevation taken at right angles to Fig. 1;

Figs. 3, 4 and 5 are cross-sectional views taken substantially on lines 3—3, 4—4 and 5—5, respectively, of Fig. 1;

Fig. 6 is a view similar to Fig. 1 but showing the slips in operative position after having been manually set by the anchor mechanism;

Figs. 7 and 8 are cross-sectional views taken substantially on lines 7—7 and 8—8, respectively, of Fig. 6;

Fig. 9 is a central longitudinal sectional view of the anchor cage;

Fig. 10 is a view in side elevation of the anchor sleeve; and

Fig. 11 is a development of the outer surface of the anchor sleeve.

Referring to the drawings, it will be observed that the tubing catcher comprises generally a plurality of pipe-gripping slips A and A' movably mounted on a mandrel head B which is rigidly secured to a nipple C, a slip actuator D slidably mounted on the nipple C and connected with the upper ends of the slips, and anchor mechanism E mounted on the nipple below the slips and having means frictionally contacting the well casing F. This general arrangement of the essential elements of the catcher is similar to that shown in U. S. Letters Patent No. 1,921,547 issued August 8, 1933, to N. K. Smith and R. K. Hertel.

In the aforementioned patent there are three casing-gripping slips equally spaced circumferentially about the body of the tubing catcher,

this arrangement having been adopted as more or less standard practice because of the uniform distribution of pressure applied to the casing. In some instances four slips are employed. In the instant case, however, only two slips are provided, and are mounted for movement upwardly and radially outwardly in diametrically opposite directions. Referring to Figs. 2 and 3, it will be observed that the outer surface of the slip A has two circumferentially spaced series of downwardly directed serrations 10 and 11, separated by a longitudinally extending groove 12. In a similar manner, slip A' is provided with serrations 10' and 11' separated by a groove 12'. Each slip thus constitutes in effect two separate slips, and the two slips A and A' provide 4 spaced pipe-gripping portions simulating the gripping action of a four-slip catcher.

The slips are adapted to be moved upwardly and outwardly into engagement with the well casing F, and to this end each slip is provided with stepped tapered wedging surfaces 15 and 16 formed on the lateral edges thereof. These surfaces are adapted to engage corresponding wedging surfaces 17 and 18, respectively, on the head B. As shown most clearly in Fig. 6, the head B comprises upper and lower downwardly converging wedge portions 19 and 20, secured to the nipple C as by welding at 21, 22, and 23. The lower wedge portion 20 terminates at its upper extremity in a pair of shoulders 25 and 26 converging downwardly and inwardly at a relatively flat angle, and forming seats adapted to be engaged respectively by the downwardly facing seating surfaces 27 and 28 at the lower extremities of the wedge surfaces 15 on the slips. When the slips are retracted into the position shown in Fig. 1, they are supported against further downward movement by the engagement of the seating surfaces 27 and 28 with the shoulders 25 and 26, and, as will be more fully explained hereinafter, the downward and inward taper of the shoulders 25 and 26 assists in maintaining the slips retracted from the wall of the casing.

Formed integral with and extending upwardly from each slip is a suspension rein 31, on the upper extremity of which is a pair of laterally extending lugs 32 (Fig. 2) forming a T-head engaging a T-slot 33 in the side wall of the actuator D. An upwardly and inwardly beveled projection 34 extends upwardly from the T-head in telescopic relation to a similarly beveled inner wall portion 35 on the actuator to limit the outward movement of the rein and hence of the slip. As is customary in tubing catchers of this general type, the actuator D is mounted on a coil compression spring 37 of a strength sufficient to support a portion of the weight of the slips. The spring is interposed between a shoulder on the actuator and a collar 38 formed at the upper end of the head B. Slots 39 are provided in the collar, through which the reins 31 extend and by which they are laterally guided.

The slips A and A' are adapted to be manually actuated from the inoperative position shown in Figs. 1, 2 and 3 into the casing gripping position shown in Figs. 6, 7 and 8 by engagement of the anchor E with depending fingers or tail-pieces 42 formed integral with and extending downwardly from the slips. It will be observed that one such tail-piece depends from each side of each slip, and that they are tapered downwardly and inwardly at the same angle with respect to the pipe axis as the wedging faces 15, 16, 17 and 18. As shown most clearly in Fig. 4, each pair of adja-

cent tail-pieces is partially confined within a recess 43 formed in an anchor sleeve 45 secured to the nipple C as by welding at 46 (Fig. 2). The side walls of the recess 43 converge downwardly in parallelism with the outer lateral edges of the tail-pieces 42, and serve to guide the latter and thus maintain the wedge surfaces 15 and 16 on the slips at all times in substantial engagement with the wedge surfaces 17 and 18 on the head B.

As shown most clearly in Figs. 2 and 4, the tail-pieces project a substantial distance radially outwardly of the outer wall of the anchor sleeve 45, whereby the lower extremities of the tail-pieces are disposed in the path of upward movement of the upper surface 47 of an anchor cage 48 forming part of the anchor mechanism E. When the tubing nipple C and the stationary parts of the catcher are manipulated from the surface in a predetermined manner, to be described in detail hereinafter, the nipple C, head B, and slips A and A' are moved downwardly relative to the anchor sleeve 48 until the tail-pieces 42 engage the upper surface 47 of the anchor cage. Thereafter, continued downward movement of the nipple and head B results in relative movement between the head and the slips since further downward movement of the slips is arrested by the anchor cage. The slips are thus constrained to move outwardly by the wedge portions 19 and 20 on the head B into the casing-gripping position shown in Fig. 6.

Referring now to the details of the anchor mechanism E, it will be observed that it is in all essential respects generally similar to that shown and described in the copending application of Richard K. Hertel, Serial No. 208,225, filed May 16, 1938, Patent No. 2,221,797 of Nov. 19, 1940, and particularly the embodiment shown in Figs. 12 and 13 therein. The anchor cage 48 is in the form of a cylindrical shell having a plurality of lateral openings 50 in the side wall thereof (herein three in number), as shown most clearly in Fig. 9. An anchor shoe 51 is mounted in each of the openings 50 for radial movement relative to the cage, each shoe being resiliently urged outwardly into frictional engagement with the inner wall of the well casing F by a slightly bowed steel spring 52 having its ends received in recesses 53 in the outer wall of the cage above and below the openings 50.

A plurality of guide lugs 55 are formed on the inner wall of the anchor cage 48 adjacent the upper end thereof, and, as shown in Figs. 5 and 9, in the present instance four lugs are provided, being equi-angularly spaced about the inner periphery of the cage. The lugs 55 are adapted to be selectively received within relatively short channels 56, 56^a, 56^b, and 56^c, or to engage relatively long channels 57, 57^a, 57^b, and 57^c formed in the outer wall of the anchor sleeve 45 secured to the nipple C, to selectively retain the anchor cage 48 out of operative engagement with the tail-pieces 42 on the slips, or to permit the anchor sleeve to engage the tail-pieces to move the slips into gripping engagement with the well casing.

As shown most clearly in Fig. 11, which is a development of the outer surface of the anchor sleeve 45, the short channels 56, 56^a, 56^b and 56^c alternate with the long channels 57, 57^a, 57^b and 57^c, the channels of each group being angularly spaced apart 90° to correspond to the spacing of the guide lugs 55 on the anchor cage 48. Two of the long channels 57 and 57^b merge into the downwardly converging recesses 43 in which the tail-pieces 42 on the slips are confined, while the

other two long channels 57^a and 57^c terminate below the upper surface of the anchor sleeve to limit the upward movement of the anchor cage 48 relative to the anchor sleeve 45. Disposed directly beneath the long channels 57, 57^a, 57^b and 57^c are stop lugs 58, 58^a, 58^b and 58^c, the upper surfaces of which are beveled to provide cam surfaces 59 for a purpose to be hereinafter described.

The above-described anchor mechanism enables the slips to be both set and released by rotation of the tubing in one direction, accompanied by raising and lowering of the tubing. This is a decided advantage over prior anchor mechanisms requiring rotation of the tubing in one direction to set the slips and rotation in the opposite direction to release them, since in the latter case there is always the danger of unscrewing a tubing coupling.

When the string of tubing is being lowered into the well with the tubing catcher incorporated therein, the anchor cage 48 tends to move upwardly relative to the anchor sleeve and slips, due to the frictional engagement of the anchor shoes 51 with the well casing resisting downward movement of the anchor cage. This relative upward movement of the anchor cage is prevented, however, by engagement of the guide lugs 55 on the anchor cage with the short channels 56, 56^a, 56^b and 56^c on the anchor sleeve. The cage is thus held in the position shown in Figs. 1 and 2. It will be observed that in this position the upper surface 47 of the anchor cage is spaced downwardly from the lower ends of the slip tail-pieces 42, and the slips are supported in their lowermost position by engagement of the seating surfaces 27 and 28 on the slips with the upwardly facing shoulders 25 and 26 on the lower wedge portion 20 of the head B.

In the event the string of tubing should part above the catcher or should be accidentally released at the surface while being run in or pulled from the well, the acceleration of the nipple C and head B due to gravity will relieve the actuator spring 37 of the weight of the slips, and the spring forces the actuator D and the slips upwardly relative to the head, causing the slips to move outwardly into gripping engagement with the casing and bringing the tubing string to rest. I have found that by making the slips relatively heavy and by supporting only a small proportion of their weight by the spring 37, the possibility of inadvertent setting of the slips while running in is greatly reduced without decreasing their sensitivity to free fall of the tubing. It will be understood, however, that any desired proportion of the weight of the slips may be supported by the spring.

When it is desired to anchor the tubing in the well at a pre-selected elevation therein, the tubing is raised slightly and rotated in a right-hand direction through a partial revolution and then lowered. During the raising operation the anchor cage 48 remains stationary due to frictional engagement with the casing, causing the guide lugs 55 on the cage to move downwardly in the channels 56, 56^a, 56^b and 56^c. The downward movement of the cage relative to the anchor sleeve 45 is limited by engagement of inwardly projecting shoulders 61 on the cage with the upper surface of the lower tubing coupling 62, the relation between these elements being such as to position the guide lugs 55 between the lower stop lugs 58, 58^a, 58^b and 58^c on the anchor sleeve when the latter is raised. When the tubing is rotated, the stop lugs on the

sleeve move to the left, as viewed in Figs. 10 and 11, into engagement with the guide lugs and thus position the latter directly beneath the downwardly facing cam surfaces 63 on the ribs 64 which separate the channels 56 and 57 formed on the anchor sleeve. Upon subsequent lowering of the tubing, the guide lugs 55 move upwardly relative to the sleeve 45 and contact the cam surfaces 63 and are guided thereby into the long channels 57, 57^a, 57^b and 57^c. In this position they are free to move upwardly to enable the upper surface 47 of the anchor cage to engage the lower ends of the slip tail-pieces 42 and force the slips upwardly and outwardly into gripping engagement with the well casing.

When it is desired to pull the tubing from the well, it is only necessary to raise the tubing to cause the head B to release the slips and allow them to drop back to the retracted position shown in Figs. 1 and 2. If, however, it is desired to lower the tubing and reset the slips at a lower elevation in the well, it is only necessary to first raise the tubing a slight distance and then lower it to the desired elevation and repeat the sequence of steps described above. During the raising operation, the guide lugs 55 move downwardly out of the channels 57, 57^a, 57^b and 57^c and into contact with the upwardly facing cam surfaces 59 on the stop lugs 58, 58^a, 58^b and 58^c. It will be observed from Fig. 9 that the guide lugs 55 are substantially diamond-shaped, and, as shown in Figs. 10 and 11, the upper extremities of the stop lugs 58 are disposed to the left of the center of the channels 57, whereby the guide lugs 55 necessarily engage the cam surfaces 59 when they move downwardly from the channels 57. The guide lugs are thus cammed to the right and into a position directly beneath the short channels 56, 56^a, 56^b and 56^c, into which they move upon subsequent lowering of the tubing. The tubing string may then be lowered to the new setting and again anchored.

It will be observed with particular reference to Fig. 1 that so long as the tail-pieces 42 on the slips are engaged in the recess 43 the outward movement of the upper reins 31 on the slips is limited by engagement of the projections 34 with the wall 35 of the actuator D. To disassemble the slips from the head they must be raised sufficiently to disengage the tail-pieces 42 from the recesses 43, and then the lower ends of the slips are swung outwardly about the T-heads 32 on the upper reins to permit the projections 34 to clear the wall 35. When the slips are assembled, however, the upward movement of the slips is limited by engagement of the actuator D with a collar 70 adjustably secured to the nipple C by a set screw 71.

A tubing catcher constructed in accordance with the foregoing description affords an exceedingly simple and rugged device composed of but relatively few parts. Because of the long, heavy slips, the possibility of the slips being raised and expanded into contact with the casing by surges of gas while running the tubing into the well is greatly reduced, and the long gripping surfaces on the slips afford adequate gripping area to reduce the unit pressure exerted against the casing to a point well below the safe limit. By providing two widely separated gripping areas on each slip, the casing is gripped at four substantially equally spaced points, thereby avoiding distortion of the casing. The advantages of a four-slip catcher are thus embodied in a two-slip catcher with a consequent reduction

in the number of parts and a substantial increase in fluid passage area.

The provision in the slips of the center groove is particularly useful when the catcher is employed in casing of larger inside diameter than normal. Thus when an ordinary 2-slip catcher is used in casing of slightly larger diameter than that for which the catcher was designed, the slips engage the casing only at their centers so that force is applied by the catcher to the casing substantially at two diametrically opposite points. This has a marked tendency to distort the casing. On the other hand, with my construction when the catcher is used in casing of oversize internal diameter, each half of each slip will engage the casing, giving a 4-point contact instead of a 2-point contact, and the distortion effect on the casing is greatly reduced.

While I have shown and described in detail what is now considered to be a preferred embodiment of the invention, it is to be understood that this is solely for illustrative purposes, and that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claim.

I claim:

A pipe anchor comprising a body; pipe-gripping slips mounted thereon for movement rela-

5 tive thereto from contracted to expanded positions; slip-actuating means comprising an anchor cage slidably and rotatably mounted on said body and having an upper plane surface adapted to operatively engage said slips; friction means associated with said cage and frictionally resisting sliding and rotary movement of said cage relative to an extraneous object; and cooperating means on said body and cage for selectively 10 either maintaining said cage out of engagement with said slips or permitting said upper plane surface on said cage to engage and actuate said slips into expanded positions, said last-named means comprising a first channel and a second 15 channel in the outer wall of said body, said first channel opening downwardly and terminating in a shoulder at its upper end at a point below the lower extremities of said slips when the latter are in contracted position, said second channel also 20 opening downwardly but extending upwardly a substantial distance above the upper end of said first channel, and a guide lug projecting inwardly from said anchor cage below said upper plane surface thereon, said guide lug being selectively engageable with said first channel or said second 25 channel by axial movement of said body and rotation thereof in a single angular direction.

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