July 10, 1962 R. C. DAVIS 3,043,372

ANCHORING DEVICE

Filed March 2, 1959 3 Sheets-Sheet 1

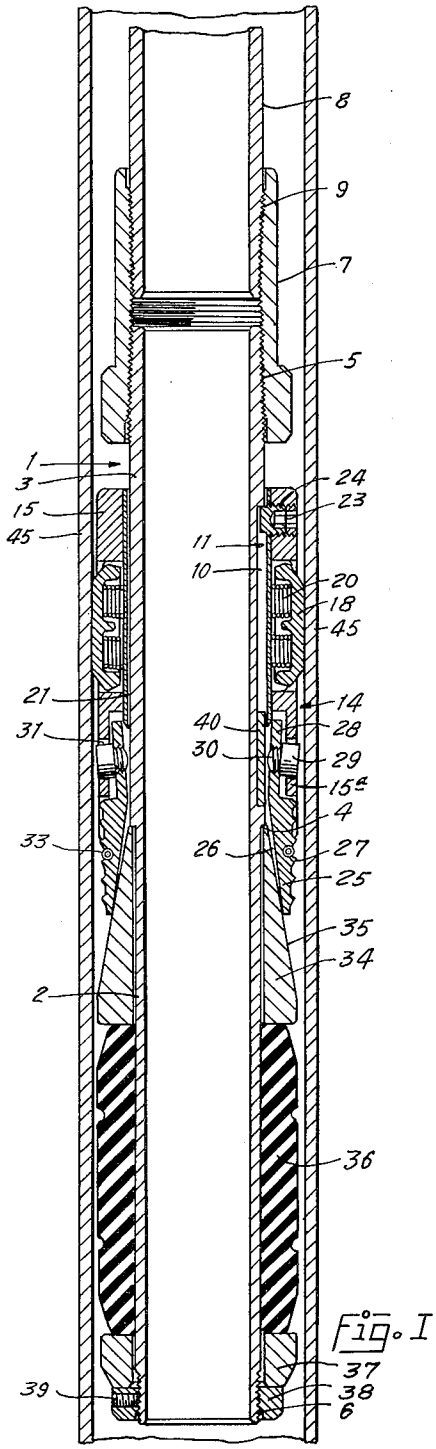

Fig. I

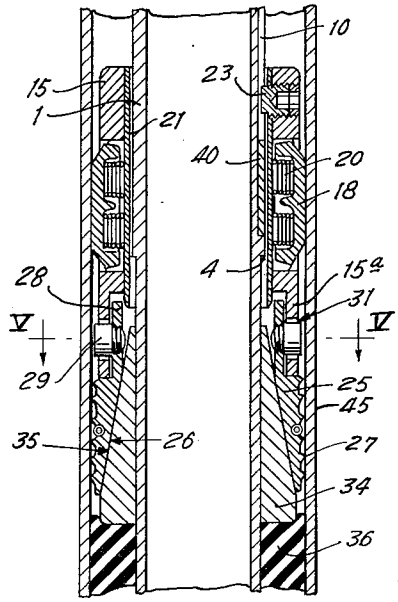

Fig. II

INVENTOR
Roy C. Davis

BY James Hillier and Howard E. Moore

ATTORNEYS

July 10, 1962 R. C. DAVIS 3,043,372

ANCHORING DEVICE

Filed March 2, 1959 3 Sheets-Sheet 2

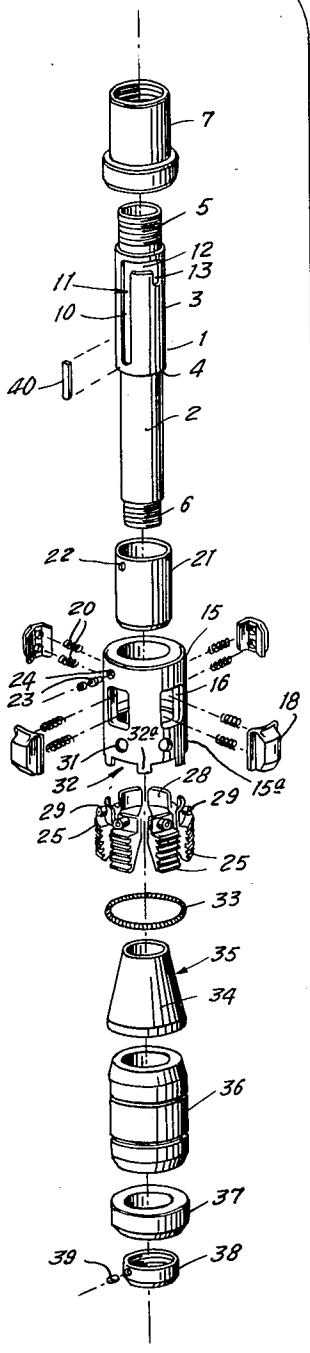

Fig. III

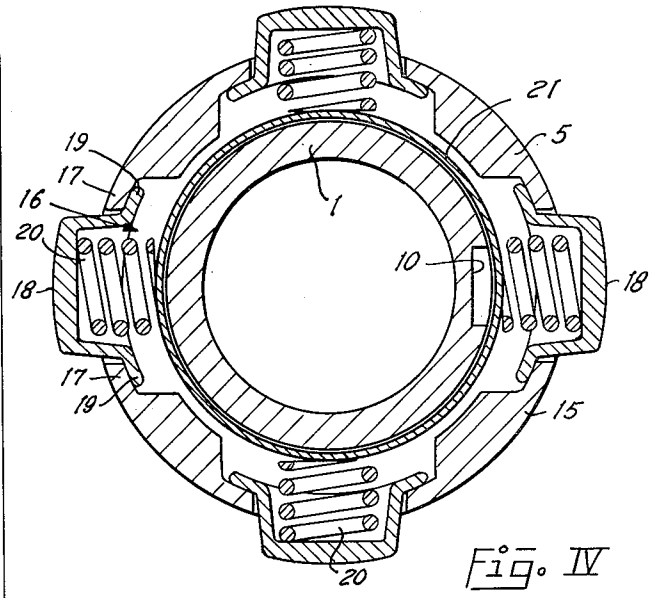

Fig. IV

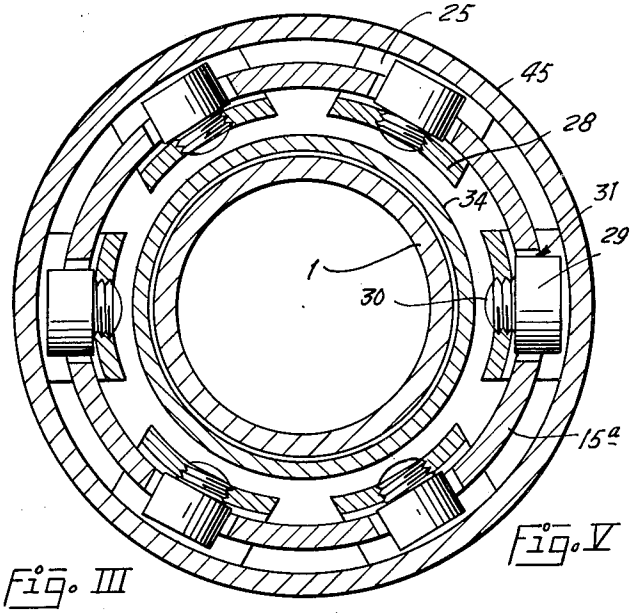

Fig. V

INVENTOR

Roy C. Davis

BY Howard E. Moore

ATTORNEYS

July 10, 1962 R. C. DAVIS 3,043,372

ANCHORING DEVICE

Filed March 2, 1959 3 Sheets-Sheet 3

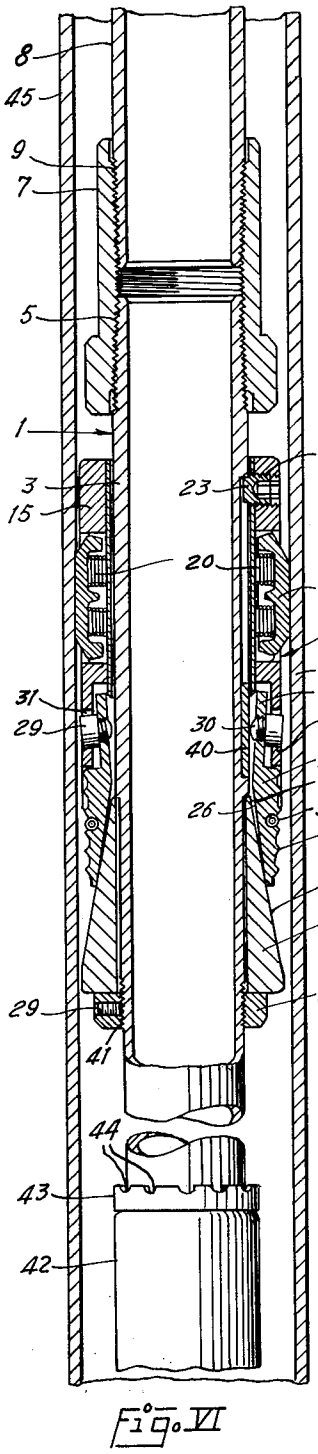

Fig. VI

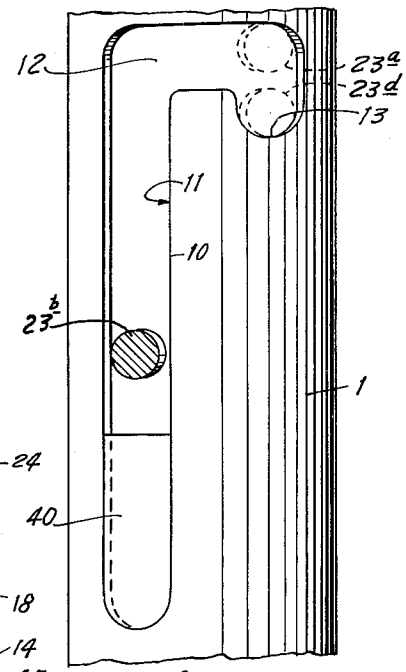

Fig. VII

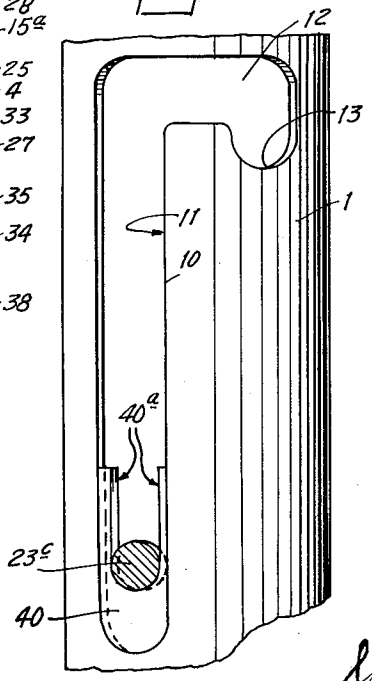

Fig. IX

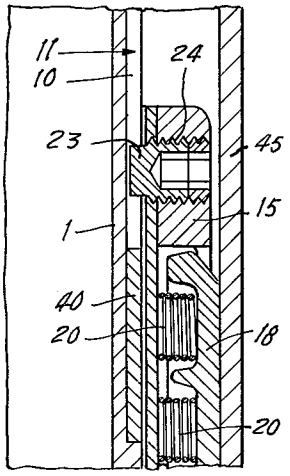

Fig. VIII

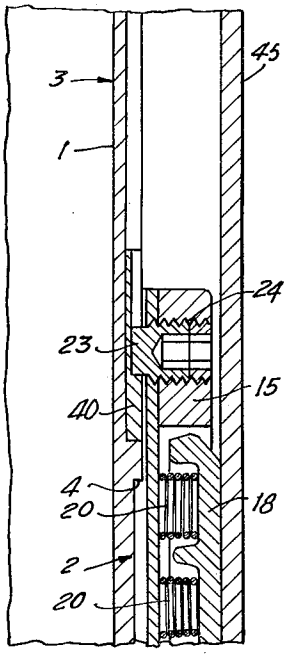

Fig. X

INVENTOR

Roy C. Davis

BY Saus Ain Mier and Howard E. Moore

ATTORNEYS

United States Patent Office

3,043,372
Patented July 10, 1962

3,043,372

ANCHORING DEVICE

Roy C. Davis, Dallas, Tex., assignor to The Guiberson Corporation, Dallas, Tex., a corporation of Texas

Filed Mar. 2, 1959, Ser. No. 796,479
8 Claims. (Cl. 166—140)

This invention is concerned with a device for anchoring packers, tailpipes and other equipment in the casing of an oil or gas well. A particular feature of the invention is concerned with a means for releasing such an anchor from the well casing to retrieve same from the well in the event the releasing mechanism therein becomes stuck or inoperable in such a manner that the slidable connection between the anchor cage and the mandrel will not be accidentally broken so as to leave parts of the anchor assembly in the well. However, there are other advantages of the construction described, as will be explained hereinafter.

The improvements comprehended by this invention are particularly concerned with a so-called "tension" type anchor which is set by an upward pull on the tubing string to which the anchor is attached. Such an anchor is particularly desirable for setting and anchoring a packer used in water flood injection, acidizing and fracturing wherein pressure is applied to the formation below the packer and in pumping installations. In such uses the anchor and packer are released, after such operations, and retrieved from the well on the tubing.

In some instances it has been found that the anchor, and/or the packer carried thereby, cannot be released for various reasons, such as the mandrel becoming frozen to the anchor cage or the packer, or by reason of foreign material becoming compacted against the various operating elements of the anchoring device or packer.

In such instances the anchoring device must be released from the packer, or other well tool which may be attached therebelow, to allow the removal of the tubing from the well.

To permit such procedure the tubing is attached to the anchoring device and/or packer by means of a shearable element which may be broken by exerting a pre-determined upward pull on the tubing. Such upward pull usually consists of force of from 40,000 to 60,000 lbs. and such force must be in excess of any force expected to be used for the setting of the anchor and/or packer.

Since this excessive shearing force is transmitted through the tubing string to the shearable element, and since the tubing string is usually several thousand feet in length, the exertion of such force upon the tubing string stretches and elongates same prior to the breaking of the shearable element, storing up elastic energy in the tubing string, so that when the shearable element breaks, the tubing string relaxes and retracts similar to an expanded spring. Such elastic retraction of the tubing string causes the mandrel, which is attached to the tubing string, and extends through the anchoring device and/or packer, to move upwardly rapidly with relation to the anchoring device and packer.

The anchor cage of the anchoring device is slidably keyed to the mandrel by means of a gudgeon pin extending through the wall of the anchor cage and slidably entering an elongated J-slot formed in the wall of the mandrel. Due to the inertia of the anchor cage and the slips, which are set against the casing, and the frictional forces existing between the drag pads on the anchor cage and the casing, the gudgeon pin remains stationary as the mandrel moves rapidly upwardly with great force, as explained above. In many instances, the bottom of the J-slot will strike the gudgeon pin with such force as to either shear off the gudgeon pin or the bottom of the J-slot, thus releasing the anchor cage from the mandrel, leaving the

metal parts of the anchor cage and slips in the well, causing a complicated and expensive fishing or drill-out procedure.

One of the objects of the invention is to overcome the above recited problem by providing means for cushioning and absorbing the impact energy between the gudgeon pin and the lower end of the J-slot in such an anchoring device to thereby prevent the gudgeon pin or the lower end of the J-slot from being sheared off in the manner hereinbefore described.

In accomplishing this purpose a quantity of deformable or malleable material, such as lead, babbitt, brass, solder, copper or rubber, is positioned in the lower end of the J-slot so that when the gudgeon pin strikes such deformable material the deformation and displacement of said material will absorb the energy resulting from the upward movement of the mandrel by the elastic retraction of the tubing string, and thus prevent the separation of the anchor cage and slips from the tubing string.

It is also thought that the anchor and/or packer assembly described herein is novel and advantageous in that the overall length has been shortened, the number of parts have been reduced, and it is simple and easy to assemble and positive in its operation.

It is, therefore, a primary object of this invention to prevent the separation of the anchor cage and slips carried thereby from the mandrel in such an anchoring device upon detachment of the mandrel from the anchoring device and/or packer by disruption of a shearable element.

Another object of the invention is to provide means for absorbing the impact between the gudgeon pin, attached to the anchor cage, and the lower end of the J-slot provided in the wall of the mandrel upon upward movement of the mandrel with relation to the gudgeon pin resulting from elastic retraction of the tubing string upon breaking a shearable element attaching the tubing string to the anchor cage and/or packer.

Another object of the invention is to provide such an anchor device which is compact, has relatively few parts, and is relatively short so as to reduce the upward pull required for setting the anchoring device.

A general object of the invention is to provide such an anchoring device which may be disconnected from the packer or other tool attached therebelow, eliminating the danger of leaving portions of the anchoring device in the well.

Other and further objects of the invention will become apparent upon reading the detailed specification hereinafter following and by referring to the drawings annexed hereto.

Suitable embodiments for carrying out the invention are shown in the drawings, showing it used in connection with the anchoring of a packer in the casing and in connection with the anchoring of a tailpipe in the casing, illustrating the manner of use and the function and operation of the devices.

In the drawings:

FIGURE I is a cross-sectional, elevational view of the anchoring device having a packer attached therebelow, showing the slips and packer in relaxed condition as the anchoring device and packer would appear while being lowered into the casing on a string of tubing;

FIGURE II is a fragmentary, cross-sectional, elevational view showing the anchoring device set in the casing, with the slips thereon in engagement with the wall of the casing, and the packer sleeve expanded into sealing engagement with the wall of the casing;

FIGURE III is an exploded view showing the various parts of the anchoring device and packer in perspective;

FIGURE IV is a transverse, cross-sectional view taken

through the anchor cage and friction pads, illustrating the mounting of the friction pads in the windows provided in the wall of the anchor cage, the spring means for urging the friction pads outwardly, and the flanges on the friction pads engageable with the wall of the anchor cage to limit outward movement of the friction pads with relation to the anchor cage;

FIGURE V is a transverse, cross-sectional view taken on the line V—V of FIGURE II;

FIGURE VI is a cross-sectional, elevational view of a modified form of the anchoring device, wherein the packer sleeve has been eliminated, and the anchoring device is used for the purpose of anchoring a tailpipe or other tool in the casing;

FIGURE VII is an enlarged side elevational view of the mandrel, showing the J-slot with deformable material in the lower end thereof and showing the different positions of the gudgeon pin in the J-slot while the anchoring device is being lowered into the well, when it is set, and when it is being retrieved from the well without recourse to the action of the shearable member;

FIGURE VIII is a fragmentary cross-sectional, elevational view showing the position of the gudgeon pin in the J-slot when the anchoring device is set;

FIGURE IX is an enlarged side elevational view of the mandrel showing the J-slot in the wall thereof, and illustrating a gudgeon pin embedded in the deformable material in the lower end of the J-slot, as it would appear after the mandrel has been released from the expander head and/or packer by breaking the shearable element; and

FIGURE X is a fragmentary, cross-sectional, elevational view showing the gudgeon pin embedded in the deformable material in the lower end of the J-slot after release of the mandrel by breaking the shearable element.

In the drawings numeral references are employed to designate the various parts shown, and like numerals indicate like parts throughout the various figures of the drawings.

The numeral 1 indicates a tubular body or mandrel which includes a section of reduced diameter 2 and section of enlarged diameter 3, providing an annular, downwardly facing shoulder 4 thereon.

The mandrel 1 is terminated at the upper end by an exteriorly threaded portion 5, and is terminated at the lower end by an exteriorly threaded portion 6.

An interiorly threaded coupling 7 joins the threaded end 5 of the mandrel 1 with the threaded end 9 of tubing string 8, which extends to the earth's surface.

A J-slot, indicated generally at 10, is formed in the outer surface of the enlarged diameter 3 of the mandrel 1, said J-slot including a longitudinal portion 11, a horizontal portion 12, and a downwardly extending slot 13.

The anchor assembly, indicated generally at 14, includes a tubular anchor cage 15 which is slidably disposed on the enlarged portion 3 of the mandrel 1. The anchor cage 15 has formed through the wall thereof a plurality of substantially square windows or ports 16. As shown in FIGURE IV the ports 16 are surrounded by walls 17 of reduced thickness. There is positioned in each of the ports 16 for inward and outward movement a friction pad 18. Each friction pad 18 has an outwardly extending flange 19 on each side thereof which are arranged to contact the reduced wall portion 17 to limit the outward movement of the friction pads in the ports 16. A spring retaining sleeve 21 is positioned about the enlarged portion 3 of the mandrel 1 and there is a pair of coil springs 20 interposed between the inner side of each friction pad 18 and the spring retainer sleeve 21. The springs 20 normally urge the friction pads 18 outwardly of the anchor cage 15.

A hole 22 is provided through the wall of the spring retainer sleeve 21 through which the inner end of a gudgeon or guide pin 23 extends into the J-slot 10. The gudgeon pin 23 is threadedly engaged in a passage 24 provided through the wall of the anchor cage 15. The gudgeon pin 23 not only supports the spring retainer sleeve with relation to the anchor cage 15, but provides a slidable attachment between the anchor cage 15 and the mandrel 1.

A plurality of slips, indicated generally at 25, are hingedly connected to the lower end of the anchor cage 15, each of said slips having a beveled surface 26 on the inner side thereof and a plurality of radially disposed teeth 27 on the outer surface thereof. Each slip 25 includes a relatively thin extension 28 on the upper end thereof, to each of which extensions 28 is threadedly attached a circular lug 29, such threaded attachment being indicated at 30.

A plurality of holes 31 are provided through the lower wall 15*a* of the anchor cage 15, such lower wall 15*a* being reduced in thickness to permit the extensions 28 to have clearance for pivotal movement between such wall and the outer surface of the mandrel 1. The lugs 29 are considerably smaller in diameter than the diameter of the holes 31, and one of such lugs is inserted in each of said holes to pivotally suspend the slips 25 to the anchor cage 15. It will be seen that the lugs 29 are free to pivot laterally in the holes 31 to permit the slips 25 to move outwardly to sufficient extent to allow the teeth 27 on the outer sides thereof to penetratingly engage the well casing 45.

The lower end of the anchor cage 15 is slotted as indicated at 32 and the upper end of each of the slip bodies 25 is disposed in a slot 32 and is free to move inward and outward. The slots 32 space the slips 25 from each other and prevent lateral movement thereof by reason of their engagement with the downwardly extending sides 32*a* of said slots.

An expander head 34 is slidably mounted on the reduced section 2 of the mandrel 1, and the upper end thereof is abutted against the downwardly facing shoulder 4. The expander head 34 has a tapered exterior surface 35 which contacts, and is arranged to co-act with, the tapered surfaces 26 on the inner sides of the slip bodies 25 so as to cause the slip bodies 25 to move outwardly against the inner wall of the casing 45 as the expander head 34 is pulled upwardly along such tapered surfaces when the packer sleeve is expanded and set.

The slip bodies 25 are held inwardly against the expander head 34 by means of a garter spring 33 which extends about the slip bodies, said garter spring being elastic to permit the slip bodies to be expanded outwardly, and being arranged to contract the slip bodies when the anchor and packer are relaxed for removal from the well.

A packer sleeve 36, which is made of elastic material, such as rubber or neoprene composition, is slidably mounted about the reduced section 2 of the mandrel 1, the upper end thereof being abutted against the lower end of the expander head 34 and being supported on the mandrel by a thimble 37 (FIG. I) which is held in place by a shear nut 38, threadedly engaged to the lower end of the mandrel 1. The shear nut 38 is secured in position against rotation by a set screw 39 which passes therethrough and is set against the mandrel 1.

The shear ring 38 is frangibly connected to the lower end of the mandrel 1, because the threads therein are arranged to be stripped upon the exertion of a pre-determined force thereagainst to thereby disconnect the mandrel 1 from the packer to permit the mandrel to be drawn upwardly to retrieve the mandrel, and the anchor cage suspended thereto, from the well, leaving the packer sleeve 36 and expander head 34 therein, in the event the anchoring device or packer becomes stuck or inoperable to such an extent as to prevent the normal retraction of the anchoring device and packer in the manner hereinafter described.

A quantity of deformable or malleable, shock-absorb-

ing material 40, such as lead, brass, solder, rubber or the like is deposited in the lower end of the longitudinal portion 11 of the J-slot 10 to absorb the impact between the gudgeon pin 23 and the lower end of the J-slot in the event of emergency disconnection of the mandrel 1 from the packer in the manner herein described.

The anchoring device and packer are assembled in the manner shown in FIGURE I and attached to the lower end of the tubing string 8 and lowered into the casing 45 as the tubing string is progressively made up at the surface. As the anchoring device and packer assembly is lowered the friction pads 18 slide along the inner wall of the casing, and are frictionally pressed thereagainst by the springs 20.

While the assembly is being lowered, the gudgeon pin is disposed in the horizontal portion 12 of the J-slot 10, and will normally ride at the upper end of the J-slot as indicated at 23*a* (FIGURE VII).

When the assembly has been lowered to the position where it is desired that the packer be set, the tubing string is rotated to the left to bring the gudgeon pin 23 into alignment with the longitudinal portion 11 of the J-slot 10. The tubing string is then pulled upwardly. The friction pads 18 have sufficient frictional engagement with the wall of the casing to hold the anchor cage in place as the mandrel 1 moves upwardly with relation thereto. The longitudinal portion 11 of the J-slot moves along the gudgeon pin 23. The upward movement of the mandrel with relation to the anchor cage assembly 14 causes the expander head 34 to co-act with the slip bodies 25 to push the slip bodies outwardly into anchoring engagement with the well casing wall. Continued upward pull on the tubing string causes further upward movement of the mandrel 1 and shortens and expands the elastic packer sleeve 36 into sealing engagement with the wall of the well casing 45, thus setting the anchor and packer in the casing in the condition shown in FIGURE II. It will be noted that the gudgeon pin 23 has moved downwardly in the J-slot to a position just above the deformable cushioning material 40, as indicated in FIGURE II and at 23*b* in FIGURE VII.

When it is desired to retract the anchor assembly and packer for removal from the well, the procedure just described is reversed. The tension on the tubing string 8 is relaxed to allow the tubing string to move downwardly thereby moving the mandrel 1 downwardly, causing the J-slot 10 to move downwardly with relation to the gudgeon pin 23, thereby bringing the gudgeon pin into alignment with the horizontal portion 12 of the J-slot. The tubing string is then rotated to the right, moving the gudgeon pin 23 into the horizontal portion 12.

The packer sleeve 36 is relaxed by this procedure allowing the slip bodies 25 to retract out of engagement with the wall of the casing. The tubing string is then withdrawn from the casing, bringing with it the anchor assembly and packer.

As the anchor and packer assembly are being withdrawn from the casing the gudgeon pin 23 will normally ride in the downwardly disposed slot 13 in the J-slot 10, as indicated at 23*d*, which prevents the rotation of the mandrel 1 with relation to the anchor cage 15 while the assembly is being withdrawn from the well, thereby preventing accidental setting of the anchor and packer while being withdrawn.

The above description is the normal operation of retrieving the anchor assembly and packer from the well.

However, as previously explained, in some instances the anchor assembly or packer may become stuck or inoperable to such an extent as to prevent relative movement between the mandrel and the anchor cage to relax the anchor assembly and packer. In such instances it is necessary to disconnect the mandrel from the packer in order to permit the upward movement of the mandrel to allow retraction of the slips of the anchor assembly to permit it to be withdrawn from the wall. In such event an excessive upward force, greater than that required to set the anchor and packer, is applied to the tubing string, such upward force being sufficient to shear the threads in the shear ring 38, thereby freeing the mandrel from the packer and permitting the packer sleeve to relax and the expander head 34 to move downwardly to thereby permit the slip bodies 25 to retract, thus permitting the anchor assembly to be withdrawn from the well on the mandrel.

As previously explained, when the shear ring 38 is released, the elastic retraction of the tubing string causes the mandrel to move upwardly very rapidly, and the gudgeon pin 23 strikes the deformable cushioning material 40 with considerable force and is embedded therein, as shown in FIGURES IX and X, and as indicated at 23*c* in FIGURE IX.

The deformable material 40 is displaced upwardly in the J-slot as indicated at 40*a*. Such deformable material 40 cushions and absorbs the impact of the gudgeon pin and prevents the gudgeon pin from striking the lower end of the J-slot, thereby eliminating the possibility that the gudgeon pin or the lower end of the J-slot might be sheared off to allow the anchor assembly to be freed of connection with the mandrel and thereby leave the anchor assembly in the well.

In FIGURE VI there is shown the anchoring device, hereinbefore described, employed for the purpose of anchoring a tail pipe or other tool in the casing 45, such tail pipe or other tool (not shown) being suspended therebelow, either directly or on a section of tubing (not shown).

In this form the mandrel has formed thereon male threads 41, spaced from the lower end thereof, and the shear ring 38 is engaged with such threads and abutted directly against the lower end of the expander head 34. The upper end of the expander head 34 is abutted against the shoulder 4. The lower end of the mandrel 1 is coupled to a tail pipe or other tool (not shown) by means of an enlarged threaded collar or coupling 42.

It will be noted that the anchoring device is identically the same in construction as that previously described with the exception that the packer sleeve 36 is eliminated and the shear ring 38 is moved to a position in abutment with the expander head.

The anchoring device is run, set and relaxed for retrieval in the same manner as was described hereinbefore.

When the anchoring device has been relaxed and the tubing string is pulled upwardly under normal conditions, the entire assembly, including the anchoring device and tailpipe or other tool suspended therebelow, may be withdrawn from the well as a unit.

However, in the event the anchoring device becomes inoperable or stuck to such an extent as to prevent the normal relaxation of the anchoring device, it is necessary to shear the ring 38 from the mandrel 1 by an excessive upward force exerted on the tubing string, as hereinbefore explained, to allow the disengagement of the expander head 34 from the slips 25 to thereby permit the slips to retract out of engagement with the casing wall.

In such event the mandrel would move rapidly upward with relation to the anchoring device by reason of the recoil action of the tubing, as previously explained, causing the coupling 42 to strike the ring 38 which in turn strikes the expander head 34 with great force. This impact would, in most instances, damage the coupling 42, even to the extent of breaking it off, with the subsequent loss of the coupling 42 and all equipment attached therebelow in the hole, or drive the expander head 34 upwardly under the slips 25, causing the anchoring device to be broken and jammed into engagement with the casing to such an extent that it could not be retrieved on the tubing.

For the purpose of preventing these eventualities, a ring of deformable, shock-absorbing material 43, such as

lead, babbitt, brass, rubber or the like is cast or molded about the upper end of the coupling 42 in order to cushion and absorb the impact between the expander head 34 and the coupling 42, such ring being slotted about its upper side, as indicated at 44, to permit more ready deformation thereof.

Of course, the deformable material 40 is disposed in the J-slot 10 to cushion and absorb the impact between the lower end of the J-slot and the gudgeon pin 23, as previously described.

An important function of the collar or coupling 42 is that upon shearing the frangible ring 38 all parts released from the mandrel such as the ring 33 and expander head 34 are caught and suspended on the coupling and retrieved from the well thereon, thereby eliminating same as obstructions in the well. Such a collar 42 could also be used in connection with the form shown in FIG. I by simply extending the mandrel 1 below the packer and attaching such collar 42 thereon in suitable spaced relation below the packer 36. Thereby such collar would catch, and allow retrieval of, the parts 34, 35, 37 and 38 when the ring 38 is broken from the mandrel 1.

It will thus be seen that I have provided improvements in an anchoring device of the type described which is simple in construction, relatively short. requires less upward pull to set, and safety features are incorporated therein which permit the emergency disconnection of the mandrel from the anchor assembly in such a manner as to prevent the disconnection of the anchor assembly from the supporting mandrel therefor, prevents the jamming of the anchoring device in the casing upon such emergency disconnection of the mandrel from the anchor assembly, and allows retrieval of all loose parts upon emergency disconnection of the mandrel from the anchor assembly.

It will be understood that other and further forms of my invention may be devised without departing from the spirit and scope of the appended claims.

I claim:

1. In an anchoring device, a tubular body; a J-slot formed in the wall of the body having a longitudinally extending portion; an anchor cage slidably disposed on the body; a pin extending from the wall of the anchor cage into the J-slot for slidably joining the anchor cage to the body; a plurality of slips pivotally suspended to the lower end of the anchor cage and having tapered surfaces on the inner sides thereof; an expander head disposed about the body and having a tapered surface thereon engagable with the tapered surfaces on the slips; frangible means attached to the body for supporting the expander head in engagement with the slips; and a quantity of deformable material in the lower end of the longitudinal portion of the J-slot to absorb the impact between the pin and the lower end of the J-slot when the frangible means is broken by an upward pull on the body.

2. The combination called for in claim 1 wherein the frangible means comprises a ring threadedly engaged to the body in abutment with the expander head.

3. The combination called for in claim 1 wherein the frangible means comprises a ring threadedly engaged with the body; and an elastic packer sleeve is disposed about the body between the ring and the expander head.

4. The combination called for in claim 1 wherein a collar greater in diameter than the body is connected to the body in spaced relationship below the expander head.

5. The combination called for in claim 1 wherein a collar greater in diameter than the body is connected to the body in spaced relationship below the expander head; and a ring of deformable material is disposed about the body adjacent the upper end of the collar.

6. The combination called for in claim 1 wherein the frangible means comprises a ring threadedly engaged to the body in abutting relationship to the expander head; a collar greater in diameter than the body attached to the lower end of the body in spaced relationship below the ring, and a quantity of deformable material is disposed about the body at the upper end of the collar.

7. In an anchoring device, a tubular body; a longitudinal slot in the wall of the body; an anchor cage slidably disposed on the body; a pin extending from the wall of the anchor cage into the slot for slidably joining the anchor cage and the body; a plurality of slips pivotally suspended to the anchor cage and having tapered surfaces on the inner sides thereof; an expander head disposed about the body and having a tapered surface thereon engageable with the tapered surfaces on the slips; frangible means attached to the body for supporting the expander head in engagement with the slips; and a quantity of deformable material in the lower end of the slot to absorb the impact between the pin and the lower end of the slot when the frangible means is broken.

8. In an anchoring device; a tubular body; an anchor cage slidably mounted on the body, a plurality of slips hingedly suspended to the anchor cage having tapered surfaces on the inner sides thereof; an expander head carried by the body, having a tapered surface on the outer side thereof engageable with the conical surfaces on the slips; means frangibly connected to the body for holding the head in engagement with the slips; a collar greater in diameter than the body attached to the body in spaced relationship to the head; and a quantity of deformable material on the end of the collar facing the head to absorb the impact between the collar and the head when the frangible means is broken.

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