July 10, 1956 G. G. HEBARD ET AL 2,753,941

WELL PACKER AND TUBING HANGER THEREFOR

Filed March 6, 1953 2 Sheets-Sheet 1

Fig. 1.

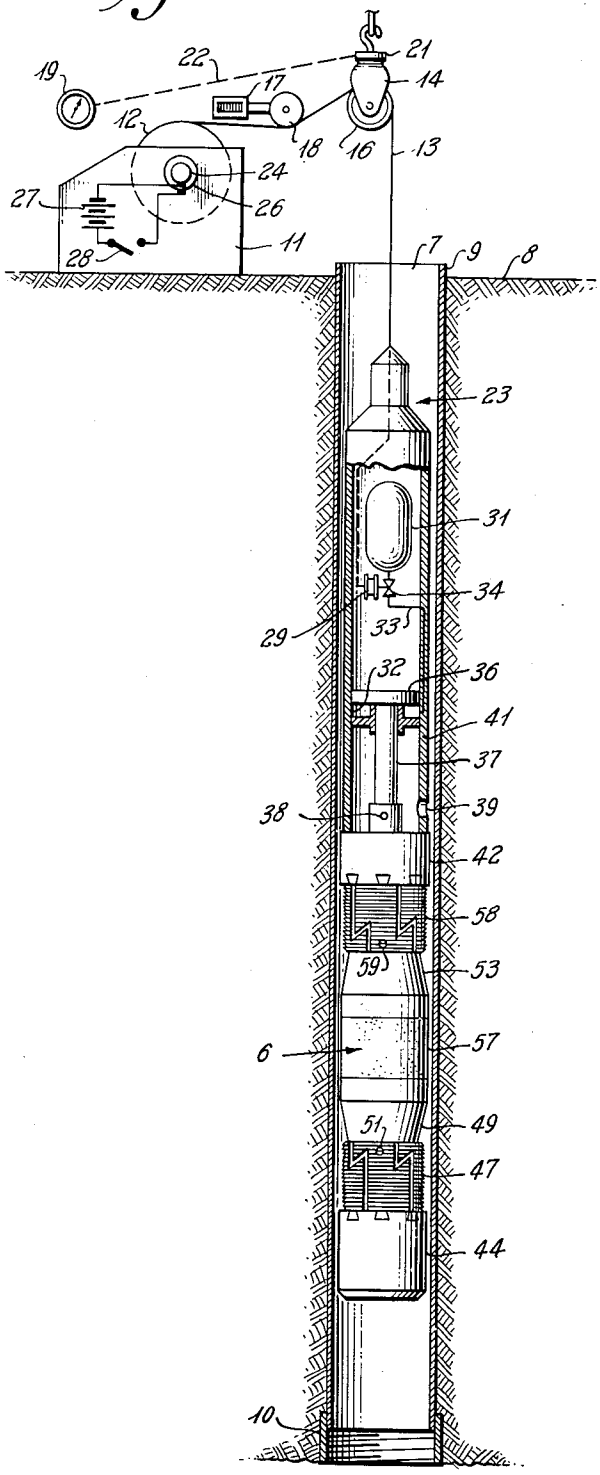
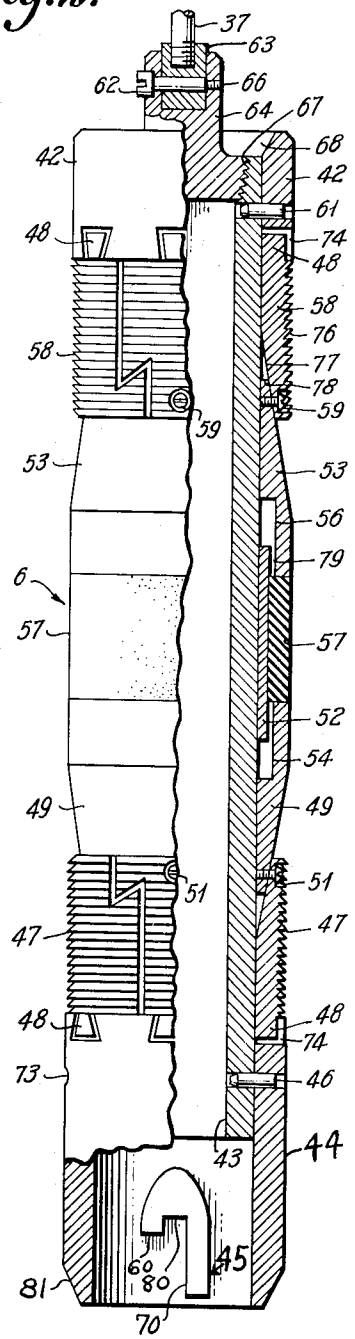


Fig. 2.



INVENTORS
G. G. Hebard and
E. S. Miles
BY
Hudson & Young
ATTORNEYS

July 10, 1956 G. G. HEBARD ET AL 2,753,941

WELL PACKER AND TUBING HANGER THEREFOR

Filed March 6, 1953 2 Sheets-Sheet 2

Fig. 3.

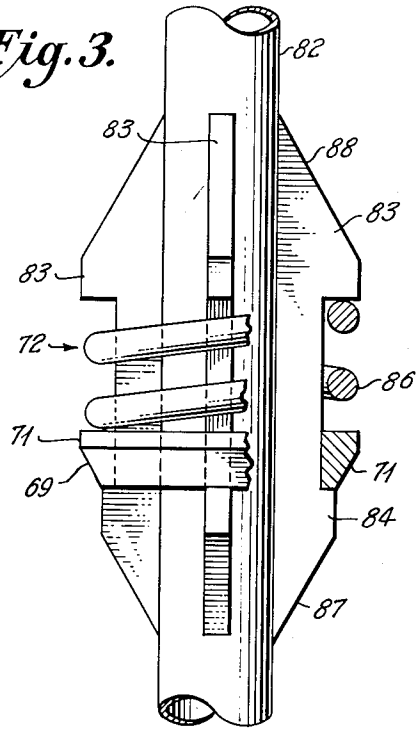


Fig. 4.

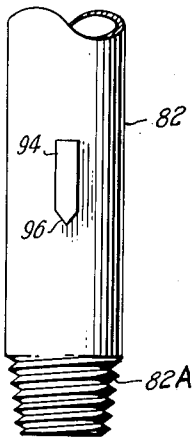


Fig. 6.

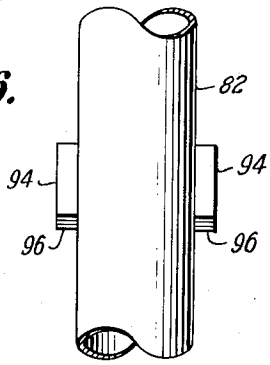


Fig. 5.

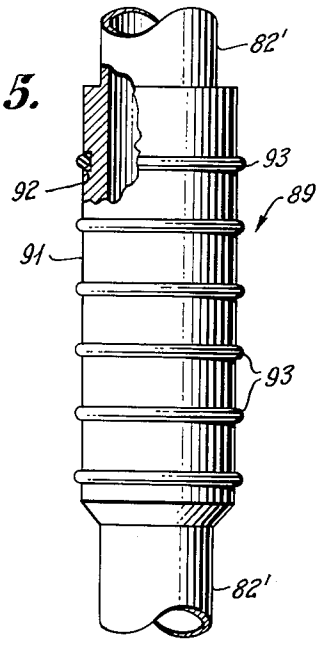
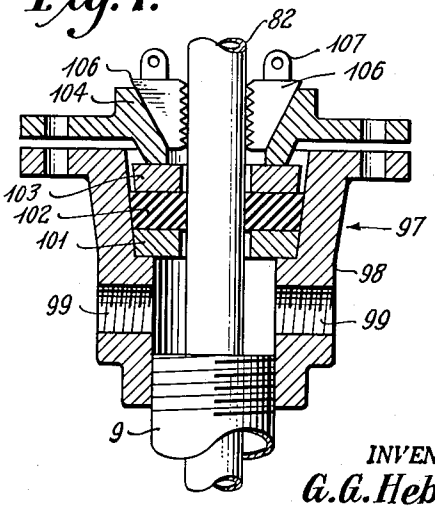


Fig. 7.



INVENTORS
G. G. Hebard and
E. S. Miles
BY
Hudson & Young
ATTORNEYS

United States Patent Office

2,753,941

Patented July 10, 1956

2,753,941

WELL PACKER AND TUBING HANGER THEREFOR

Glen G. Hebard and Elburt S. Miles, Bartlesville, Okla., assignors to Phillips Petroleum Company, a corporation of Delaware

Application March 6, 1953, Serial No. 340,762

11 Claims. (Cl. 166—123)

This invention relates to a well tool and proceses employing the same. In some specific aspects it relates to well tools adapted to be fixed in the well pipe, or casing, where they act as a tubing anchor for pipe or casing, to tubing elements adapted to engage such anchors and to processes employing the same.

In the present invention it has been found better to support all of the weight of the tubing, and some additional weight due to tension placed in the tubing by stretching the same, at the top of the well and have the anchor pulling the lower end of the tubing down so that the entire tubing, between the casing head at the top of the well and the anchor, is in tension, which reduces vibration and resulting wear due to flow of fluids through the tubing.

When the well ceases to flow, this tubing and packer are removed and tubing provided with a pump at its lower end is substituted. No packer is desired, as during pumping it is preferred to remove gas through the annulus around the tubing. This deep well pump is generally operated by sucker rods coming from the top of the well, but even if operated by electric current, a rotating shaft, or a column of pressure fluid, the operation of such a pump at the bottom of a long tubing only supported at its top would cause undue vibration, failure due to fatigue, and loss of power. While some improvement is effected by also partly supporting the tubing at the bottom of the well by an anchor, which will pass gas up the annulus, we have found it to be better to have the anchor place negative support, that is tension, on the tubing, which reduces vibration still further.

In the prior art these flowing and pumping operations have been done with entirely separate supporting means, which is expensive and disadvantageous especially as such supporting means soon become very hard to remove. In the present invention the same anchoring means is used at all times and need never be removed. It can be removed by drilling it out, however.

The prior art tubing anchors are secured to the tubing, and must be removed therewith when the tubing is removed from the well for any purpose, such as repair or replacement or parts in the well.

One object of the present invention is to provide a detachable connection between a well tubing and a fixed tubing anchor in the casing so that the tubing can be stretched in tension between said anchor and the casing head, and then removed when desired.

One object of the present invention is to provide a new and useful well tool and provide processes for using the same.

Another object is to provide an improved tubing anchor for use in flowing and pumping wells.

Another object is to provide such a support to which the tubing is not attached.

Another object is to provide a well tubing support system comprising a well casing head tubing support at the top of a well and a tubing anchor at the bottom of the well.

Another object is to make such a support completely drillable.

A further object is to be able to set such an anchor and remove its body, leaving a suitable anchor having a much larger diameter central passage than is possible with the devices of the prior art.

Further objects are to provide a simple, rugged and easily operated anchor which is designed to simplify well operations in any well in which it is used.

Numerous other objects and advantages will be apparent to those skilled in the art upon reading the accompanying specification, claims and drawings.

Figure 1 is a cross-sectional schematic view of a well containing a casing in which the well tool of the present invention is being set by the means shown.

Figure 2 is a quarter sectioned elevational view of a well tool embodying the present invention with parts broken away to show details of construction.

Figure 3 is a fragmentary elevational view of a tubing and a tubing hanger adapted to be used in combination with the well tool of Figure 2, with a portion of the ring broken away to show details of construction.

Figure 4 is a fragmentary elevational view of the lower portion of the tubing shown in Figure 3.

Figure 5 is a fragmentary elevational view of a packer which is attached to the tubing between Figures 3 and 4 when it is desired to pack between the tubing and the well tool of Figure 1, but which is omitted when it is desired to allow gas to pass between them, with parts broken away to show details of construction.

Figure 6 is a view of Figure 4 rotated 90° about the longitudinal axis of pipe 82, and omitting the threads 82A, which are not always necessary.

Figure 7 is an elevational view of a casing head and tubing support for the top of the well of a type useful in the present invention.

In Figure 1 a well tool, generally designated as 6, is being run in a well 7 in the ground 8 which well contains a casing 9. Casing 9 may be the only casing in well 7, or there may be several concentric strings of casing (not shown) with 9 as the innermost, in which case casing 9 need not extend to the well surface as shown. The casing 9, or other outer casing strings (not shown) may be provided with the usual well casing head equipment such as 97 shown in Figure 7. Such arrangements are well known to those skilled in the art of well servicing operations.

Casing 9 may be in a number of sections secured together by casing collars 10, which are usually external as shown, but may be internal (not shown) as known in the prior art.

Similarly all other features of the usual well servicing derrick, rig, or mobile unit are not shown, except draw works, or winch 11, containing means to rotate drum 12 to raise and lower electric cable 13 wound thereon, crown block 14 supporting sheave 16 over the well 7, depth measuring revolution counter 17 driven by drive pulley 18 during movement of cable 13 by contact therewith, and weight indicator 19 actuated by weighing means 21 by a telemetering system indicated by dotted line 22. All the parts in this paragraph, along with the well tool setting device generally designated as 23, are old and well known in the prior art for setting well tools similar to 6 in well casings similar to 9.

The end of electric cable 13 on drum 12 has its electrical conducting elements electrically connected to slip rings 24, 26 which rotate with drum 12, and a battery 27, or other suitable direct or alternating current electrical power source may be connected to said slip rings by brushes when switch 28 is closed to actuate a solenoid 29, or other suitable motor, in the setting tool 23. It is obvious that while a two wire system is shown, a single

wire system using the ground as a return may be employed if desired.

The setting tool 23 is supported on the other end of cable 13 and well tool 6 is supported by tool 23.

Setting tool 23 is shown containing a tank 31 of compressed gas connected to cylinder 32 by conduit 33, the flow of gas therethrough being controlled by valve 34 actuated by solenoid 29. When gas is admitted to cylinder 37 it raises piston 36 and piston rod 37 relative to the wall of cylinder 32.

The well tool 6 is secured to piston rod 37 by means of a pin 38, or other suitable connection, which may be installed, or removed, when desired, through a pin access hole 39 in the skirt 41 of setting tool 23, which skirt 41 engages the upper tubular member 42 of well tool 6 as shown in Figure 1.

In Figure 2 the well tool 6, embodying the present invention is shown in considerably more detail than in Figure 1. Well tool 6 comprises in combination a removable body 43, a first tubular member 44 surrounding and slideably mounted on said body and secured thereto by a first frangible connection 46, said first connection being designed to part at a first predetermined force, a first plurality of slips 47 surrounding and slideably mounted on said body and movably mounted at 48 on said first member, a first tubular cone or tubular wedge member 49 surrounding and slideably mounted on said body and secured to said first plurality of slips by a second frangible connection 51, said second connection being designed to part at a second predetermined force less than said first force, a rigid tube 52 surrounding and slideably mounted on said body, a second tubular cone or tubular wedge member 53 surrounding and slideably mounted on said body, recesses 54 and 56 in said first and second cones slideably receiving said rigid tube in telescoping relationship, a resilient tube 57 surrounding and slideably mounted on said rigid tube between said cones, a second plurality of slips 58 surrounding and slideably mounted on said body, a third frangible connection 59 securing said second plurality of slips to said second cone, said third frangible connection being designed to part at a third predetermined force less than said first force, a second tubular member 42 surrounding and slideably mounted on said body and secured thereto by a fourth frangible connection 61, said fourth frangible connection being designed to part at a fourth predetermined force greater than either said second force or said third force, and a final frangible connection 62 on said body adapted to be connected to one part of a setting tool 23 of the type having a first part 37 which is moved in a direction longitudinally of the well relative to a second part 41, said final frangible connection being designed to part at a final predetermined force greater than any of the previously mentioned forces, said second tubular member being adapted to be engaged by a second part 41 of said setting tool movable relative to said first part.

The various elements, such as tubular member 44, have been described as slideably mounted on other elements, such as member 43, which they obviously are, in order to carry out the movements described below, under the subtitle "Operation." While they can be quite loose on each other, this does not mean that they are necessarily freely slideable, because some of them can be rather tight on each other, so long as they can be forced, or stripped in telescopic relation to each other by forces less than those which would shear any of the frangible pins 61, 59, 51 or 46 out of their regular turn. Obviously at least the central portion of resilient tube 57 need not slide relative to rigid tube 52 and if the ends of 57 deform enough they need not either.

While a particular specific setting tool 23 has been shown, both for illustrative purposes and because it is actually preferred to use the same, there are other generic setting tools available in the prior art having two parts relatively movable to each other in a direction longitudinal of the well which can be employed in practicing the present invention. The specific setting tool 23 is not a joint invention of the present inventors and is not claimed per se in the present case, but the generic setting tool is claimed herein as described in this paragraph, as an element in a new combination with the other elements, such as Figure 2 or as that which is needed to carry out a process step in a process claim.

In the preferred construction shown in Figure 2, piston rod 37 has a piston-yoke cylindrical member 63 beveled around the edge of its lower end for easy insertion and having a hole for receiving screw-pin 62, which member 63 is received in a cylindrical socket in connector 64 and secured therein by pins 62 passing through the holes and screwed into a threaded passage 66 in member 64. Preferably pin 62 is frangible and can be sheared by tension on 63 much greater than that necessary to shear pins 46 and 61 and remove body 43 from the well. If it is desired to rely on always recovering body 43 in this manner, pin 62 need not be frangible, but it is wise to make it weaker than piston rod 37 and cable 13 if convenient, just in event the unexpected happens. While member 64 could be made integral with removable body 43, it is preferably separable and connected thereto by screw threads at 67. Tubular member 42 is preferably provided with a conical seat 68 to receive and support the conical surface 69 of ring 71 of the tubing hanger guide generally designated as 72 in Figure 3.

The preferred means of connecting members 42 and 44 to body 43 is by frangible pins 61 and 46, which may be single pins, or several may be used as indicated by a second pin hole 73 in member 43. Pins 61 and 46 may be the same, or of different strength, and preferably have a tapered nose for ease of insertion and corrugated or otherwise enlarged or roughened tail to retain them in place. The preferred means of movably mounting slips 58 and 47 on member 42 and 44 is by means of integral dove tail lugs 48 on the slips held loosely in similarly shaped dovetail slots 74 in the members.

Slips 47 and 58 are preferably cylindrical segments preferably made of cast iron having saw teeth cut in their outer faces and being beveled at 77 to act as wedges when driven between cones 49 and 53 and casing 7. Every part shown in Figure 2 (with the possible exception of parts 37 and 63 which are quite certain to be removable in any event, and part 57, which must be made of some resilient highly distortable material, such as rubber or some synthetic rubber-like polymeric material such as neoprene) should be made of cast iron, or other drillable material, such as brass, bronze or aluminum, and of course parts 37 and 63 could also be drillable material, but need not be as they will always be removable. The edges of slips 47 and 58 can be straight, but preferably are zig-zag and overlap as shown for mutual support and mutual wedging action.

Cones 49 and 53 have an outer conical surface engaging beveled surface 77 of slips 47 or 58 and are preferably beveled at adjacent edge 78 to insure ease of movement on body 43, but beveling 78, like all the other preferred details of construction, is not essential but is merely preferred.

Preferably there is a space 79 both horizontally as well as vertically spacing rigid tube 52 from the cones 49 and 53.

The lower end of tubular member 44 may be beveled at 81, or rounded, to aid in avoiding catching on obstructions, if so desired. On the inner surface of the first tubular member 44 are one or more, preferably two, raised inverted J members 45, which extend inwardly into contact with members 94 when tubing 82 is inserted. The first tubular member 44 will be seen to extend below the body 43, and the J bosses are on the interior wall of said tubular member below said body. The members 94 pass below shorter arm 60, are rotated into contact

with longer arm 70 and then raised up into slot 80 when tension is placed on tubing 82.

In Figure 3 is shown a tubing hanger guide generally designated as 72 for guiding the tubing and enabling the operator to tell when the upper end of wing 94 is below shorter arm 60 and the wing 94 may be rotated clockwise (when viewed from the top) to engage longer arm 70, and when tension is placed on pipe 82 wing 94 will rise into slot 80 between the arms 60 and 70 and be locked in place. The space between the coils of spring 86 is of less length than arm 70 so that wing 94 cannot get below the lower end of 70. The hanger 72 is made strong enough to aid some in temporarily supporting the lower end of a tubing 82 on well tool 6 when the latter is first set in the well. This hanger is very simple, and can obviously be made in other similar forms or designs, without departing from the invention. A ring 71 surrounding tubing 82 is guided for sliding movement longitudinally of the same by a plurality of radial fins 83, leaving a corresponding number of arcuate holes for the passage of gas between the ring and tubing. Fins 83 have a shoulder overhanging spring 86 and a shoulder 84 below ring 71 to retain them. A portion of ring 71 is broken away to show this and the cross-section of said ring. Ring 71 has a conical surface 69 which rests on and preferably fits conical seat 68 of member 42 of Figure 2. Ring 71 is slidable on fins 83, and is biased down by helical compression spring 86 and fins 83 may be tapered for guiding past obstructions, or centering in seat 68, by tapered end surfaces at 87 and 88.

In Figure 4 is shown the lower end of tubing 82, which may be threaded at 82A in case further sections are attached. While tubing anchor 6 is used near the lower end of tubing 32, it is not necessarily used at the very end, but may have a considerable length of tubing extending below it. Tubing 82 is connected at its upper end to the lower end of tubing 82 of Figure 3, or to the lower end of tubing 82' of Figure 5, depending on whether the packer generally designated as 89 in Figure 5 is used or not.

In Figure 5 the tubing 82' is intended to connect at its top to tubing 82 of Figure 3 and at its bottom to tubing 82 of Figure 4, when the structure of Figure 5 is used. The packer 89 has a cylindrical surface 91 which is adapted to be inserted inside of rigid tube 52 and cones 49 and 53 of Figure 2 after body 43 has been removed. Surface 91 has one or more annular grooves 92 therein in which packing elements, preferably resilient deformable O rings 93, are positioned. Rings 93 are preferably made of rubber, or some rubberlike polymerized synthetic material, such as synthetic rubber or neoprene, and are designed to contact the inner surfaces of grooves 92 and parts 49, 52 and 53 preferably without filling grooves 92 completely, as O rings seal best against high pressure under such conditions. Other more conventional packing means of the prior art (not shown) may be employed in place of rings 93.

Figure 6 is merely a 90° rotated view of Figure 4, except that threads 82A have been omitted to show they are not necessary, especially when the anchor 6 is located near the bottom of the tubing string 82.

The upper end of the tubing string 82 is supported by some means capable of placing tension on the tubing while supporting the same, such as the boll weevil type casing head 97 of Figure 7. This casing head 97 consists of a bowl 98 secured to the top of casing 9 by suitable means, such as threads as shown, or welding (not shown) having one or more gas line connections 99 on one or both sides. In bowl 98 is a supporting ring 101 of metal, a rubber packing ring 102 (or ring of other suitable packing material) and a packing follower ring 103 of metal. Acting to hold down ring 103 and compress packing 102 is a slip bowl 104 having a conical seat therein in which wedges, or slips, 106 are placed to support the top of tubing 82. Slips 106 may be provided with handles, or eyes, 107 for convenience in handling.

Operation

Tool 6 is positioned at a predetermined proper position in casing 9 as shown in Figure 1 by lowering the same in well 7 by means of draw works 11, sheave 16, cable 13, setting tool 23 and associated parts, the depth being noted on depth meter 17. Switch 28 is then closed and current from electrical power source 27 actuates motor 29 to open valve 34. Gas under pressure in tank 31 then flows through conduit 33 into cylinder 32 where it moves piston 36 and piston rod 37 upwardly relative to skirt 41.

Piston rod 37 being secured at 62 to body 43 and skirt 41 pressing down on member 42, a shearing force is first placed on shear pin 61, which shears off at a predetermined tensile force, which may for example be 8,000 pounds between body 43 and ring 42. Actually, pin 61 can be eliminated from the tool, if desired, as it is unnecessary if everything goes well, its only real function being to hold ring 42 still in case something unexpected occurs, such as if it were decided to raise the tool 6 again before setting the same and ring 42 accidentally hung up momentarily under some obstruction, such as a shoulder on casing 9 where it connected to a casing collar 10. This should not happen, but it would be embarrassing and damaging if ring 42 moved down under some such small force and set slips 52 prematurely before the tool 6 were properly positioned, and for this reason it is preferred to have shear pin 61 as shown.

Pin 61 having sheared, or never having been present at all, tubular member 42 moves downward forcing slips 58 downward and transmitting pressure on cone 53, packing ring 57, cone 49, slips 47 and ring 44 through frangible machine screws 59 and 51. At the same time body 43, through pin, or pins, 46, places an upward equal and opposite opposing force of reaction on ring 44. Frangible means 51 and 59 are designed to part at a much lower predetermined force than pins 46, parting at 2000 pounds tensile force for example. Slips 58 and cone 53, and slips 47 and cone 49 telescope and wedge together between tube 43 and casing 9 and packer 57 is compressed and deformed outwardly into contact with casing 9 forming a gas tight packing between tube 43 and casing 9. At the same time packer 57 acts as a resilient spring urging cones 49 and 53 apart and under their respective slips 47 and 58 to maintain them wedged against the casing even after the body 43 has been removed, which removal comes later.

If space 79 is provided around tube 52 some edges of packer 57 will also be deformed into it, in which preferred embodiment of the invention the parts 49, 52, 53 and 57 are even more firmly locked together and the gas tight packing effect is enhanced.

When a much greater predetermined tensile force, for example 8,000 pounds, is generated between collar 44 and body 43 by piston 36 in cylinder 32, the lower frangible pins 46 and the pin in hole 73 shear. While a single pin 46 can be used, several are preferred to avoid any tendency to cant or tilt ring 44 before slips 47 have set evenly. When several pins are used in place of a single pin 46, the total shearing force of each pin should be less, so that the total force to release 43 from 44 remains the same, 8,000 pounds being given above as an example. Similarly if more pins are used at 61 the total shearing force should remain the same as when one pin is used. Similarly, if more than one pin 51 or 59 is employed at their respective levels, the total shearing force at each level should remain unchanged, being given above as 2,000 pounds as an example. When pins 46 and the pin in 73 have sheared, body 43 is free to move upwardly, and can be removed up out of well 7 by reeling in cable 13 on drum 12, leaving parts 42, 58, 53, 57, 52, 49, 47 and 44 set in the well permanently,

although being made of drillable material they can be removed when necessary.

Pin 62 never shears if all goes as expected. Sometimes unforeseen difficulties occur, and that is why pin 62 is provided, and why parts 44, 62 and 64 are made of drillable material. Pin 62 can be made to shear only at the greatest tension cable 13 can take within its elastic limit, or can be made to shear above this value near the elastic limit of a cable (not shown) on a fishing tool (not shown) which can be engaged with the projection on the top of the setting tool 23, preferably the former.

In the absence of the unforeseen, when pipe 46 and the pin in 73 shear at 8,000 pounds, body 43 is easily hoisted out without shearing pin 62. Obviously as pin 62 does not shear off before pins 46 and 73 go, pin 62 in the example given should shear well above 8,000 pounds.

If well 7 is a flowing well, with sufficient pressure in the formation to flow oil to the surface, the tubing 82, 82' of Figures 3, 4 and 5 is assembled and lowered until packer 89 on tubing 82' is inside and contacting sleeve 52, while ring 71 is resting on shoulder 68, which places some compression in spring 86 and makes the load decrease on weight meter 19 as a signal. Spring 86 is compressed enough to allow the top of wings 94 to pass under shorter arm 60 of the inverted J boss 45 by clockwise rotation of 82 as viewed from above into contact with longer arm 70. The tubing string 82 is then raised in casing head 97 of Figure 7 by hoisting on the drawworks 11 and cable 13 so that the desired amount of stretch, or tension, is placed in tubing 82 and then slips 107 are jammed down tight in bowl 104, and, as cable 13 is slackened, the slips 107 take this tension load of the tension in tubing 82 stretching the tubing between bowl 104 and boss 45 on sleeve 44 of anchor 6. Spring 86 has some, or all, of its compression load relieved. This stretch in tubing 82 greatly reduces vibration in the same due to flowing oil.

When well 7 ceases flowing, or if it is a pumping well to start with, the tubing 82 is run as shown in Figures 3 and 4, but not using the structure of Figure 5, the usual deep well pump (not shown) is placed in tubing 82, and the setting and stretching of the tubing 82 between bowl 104 and boss 45 is the same as described in the last paragraph. The vibration due to pumping is greatly reduced by this stretch, and the gas can pass up the annulus between casing 9 and tubing 82 through 52 and arcuate spaces between fins 83, out gas lines attached to 99 for use or other disposal as desired. Or gas can be added at 99 and forced down the well to repressure it if desired.

Because there is no body 43 to take up space inside the device 6 when it is set, it is possible to run larger casing, tubing, and tools of all kinds including drilling tools, cleanout tools and fishing tools (not shown) through parts 42, 58, 53, 52, 49, 47, and 44, or hang larger tubing 82 on seat 68, or have more gas space between tubing 82 and casing 9, than in the prior art devices, and yet the whole tool 6 can be drilled out without difficulty anytime it is desired to remove it. Also tool 6 can be used during the flowing life of the well and remain in place during the pumping life.

A specific embodiment of the invention has been illustrated and described but obviously the invention is not limited thereto.

Having described our invention, we claim:

1. A tool adapted to be set in a pipe comprising in combination a removable body, a first tubular member surrounding and slideably mounted on said body and extending below the same, said first tubular member being secured to said body by a first frangible connection, said first connection being designed to part at a first predetermined force, a first plurality of slips surrounding and slideably mounted on said body and movably mounted on said first member, a first tubular wedge member surrounding and slideably mounted on said body and secured to said first plurality of slips by a second frangible connection said second connection being designed to part at a second predetermined force less than said first force, a rigid tube surrounding and slideably mounted on said body, a second tubular wedge member surrounding and slideably mounted on said body, recesses in said first and second wedge members slideably receiving said rigid tube in telescopic relationship, a resilient tube surrounding said rigid tube between said wedge members, a second plurality of slips surrounding and slideably mounted on said body, a third frangible connection securing said second plurality of slips to said second wedge member, said third frangible connection being designed to part at a third predetermined force less than said first force, a second tubular member supported on said second plurality of slips and surrounding and slideably mounted on said body and secured thereto by a fourth frangible connection, said fourth frangible connection being designed to part at a fourth predetermined force greater than either said second force or said third force, a final frangible connection on said body adapted to be connected to one part of a setting tool of the type having a first part which is moved in a direction longitudinally of the well relative to a second part, said final frangible connection being designed to part at a final predetermined force greater than any of the previously mentioned forces, said second tubular member being adapted to be engaged by said second part of said setting tool movable relative to said first part, and at least one inverted J boss on the interior wall of said first tubular member below said body.

2. A tool adapted to be set in a pipe comprising in combination a removable body, a first tubular member surrounding and slideably mounted on said body and extending below the same, said first tubular member being secured to said body by a first frangible connection, said first connection being designed to part at a first predetermined force, a first plurality of slips surrounding and slideably mounted on said body and movably mounted on said first member, a first tubular wedge member surrounding and slideably mounted on said body and secured to said first plurality of slips by a second frangible connection, said second connection being designed to part at a second predetermined force less than said first force, a rigid tube surrounding and slideably mounted on said body, a second tubular wedge member surrounding and slideably mounted on said body, recesses in said first and second wedge members slideably receiving said rigid tube in telescopic relationship, a resilient tube surrounding said rigid tube between said wedge members, a second plurality of slips surrounding and slideably mounted on said body, a third frangible connection securing said second plurality of slips to said second wedge member, said third frangible connection being designed to part at a third predetermined force less than said first force, a second tubular member supported on said second plurality of slips and surrounding and slideably mounted on said body, a final frangible connection on said body adapted to be connected to one part of a setting tool of the type having a first part which is moved in a direction longitudinally of the well relative to a second part, said final frangible connection being designed to part at a final predetermined force greater than any of the previously mentioned forces, said second tubular member being adapted to be engaged by said second part of said setting tool movable relative to said first part, and at least one inverted J boss on the interior wall of said first tubular member below said body.

3. A tool adapted to be set in a pipe comprising in combination a removable body, a first tubular member surrounding and slideably mounted on said body and extending below the same, said first tubular member being secured to said body by a first frangible connection, said first connection being designed to part at a first predetermined force, a first plurality of slips surrounding and slideably mounted on said body and movably mounted on

said first member, a first tubular wedge member surrounding and slideably mounted on said body and secured to said first plurality of slips by a second frangible connection, said second connection being designed to part at a second predetermined force less than said first force, a rigid tube surrounding and slideably mounted on said body, a second tubular wedge member surrounding and slideably mounted on said body, recesses in said first and second wedge members slideably receiving said rigid tube in telescopic relationship, a resilient tube surrounding said rigid tube between said wedge members, a second plurality of slips surrounding and slideably mounted on said body, a third frangible connection securing said second plurality of slips to said second wedge member, said third frangible connection being designed to part at a third predetermined force less than said first force, a second tubular member supported on said second plurality of slips and surrounding and slideably mounted on said body and secured thereto by a fourth frangible connection, said fourth frangible connection being designed to part at a fourth predetermined force greater than either said second force or said third force, a connection on said body adapted to be connected to one part of a setting tool of the type having a first part which is moved in a direction longitudinally of the well relative to a second part, said second tubular member being adapted to be engaged by said second part of said setting tool movable relative to said first part, and at least one inverted J boss on the interior wall of said first tubular member below said body.

4. A tool adapted to be set in a pipe comprising in combination a removable body, a first tubular member surrounding and slideably mounted on said body and extending below the same, said first tubular member being secured to said body by a first frangible connection, said first connection being designed to part at a first predetermined force, a first plurality of slips surrounding and slideably mounted on said body and movably mounted on said first member, a first tubular wedge member surrounding and slideably mounted on said body and secured to said first plurality of slips by a second frangible connection, said second connection being designed to part at a second predetermined force less than said first force, a rigid tube surrounding and slideably mounted on said body, a second tubular wedge member surrounding and slideably mounted on said body, recesses in said first and second wedge members slideably receiving said rigid tube in telescopic relationship, a resilient tube surrounding said rigid tube between said wedge members, a second plurality of slips surrounding and slideably mounted on said body, a third frangible connection securing said second plurality of slips to said second wedge member, said third frangible connection being designed to part at a third predetermined force less than said first force, a second tubular member supported on said second plurality of slips and surrounding and slideably mounted on said body, a connection on said body adapted to be connected to one part of a setting tool of the type having a first part which is moved in a direction longitudinally of the well relative to a second part, said second tubular member being adapted to be engaged by said second part of said setting tool movable relative to said first part, and readily engaged and disengaged connection means on said first tubular member below said body for engagement with corresponding means on a well tubing.

5. The combination of claim 4 with said pipe, in which the rigid tube is proportioned with enough space between its ends and the ends of the recesses in said wedge members before any frangible connection parts, and said resilient tube is so proportioned relative to the internal diameter of said pipe, that when said frangible connection parts said resilient tube will pack off between said pipe and said rigid tube before each end of said rigid tube engages its respective wedge member at the end of the respective recess with which it has telescopic relationship, upon telescoping of said slips into wedging engagement between said wedge members and said pipe.

6. The combination of claim 4 in which said rigid tube is spaced from said wedge members in said recesses both horizontally and vertically by said resilient tube.

7. The combination of claim 4 in which said second tubular member has a conical seat in its upper portion adapted to receive a tubing hanger so that said tool can be used as a tubing anchor.

8. The combination of claim 5 in which said second tubular member has a seat adapted to receive a tubing hanger after the adjacent plurality of slips have set between the pipe and adjacent wedge member, and said rigid tube has an internal surface adapted after said removable body has been removed to seal against a packer on a tubing supported by said hanger.

9. A tubing hanger comprising in combination a tubing, a plurality of radial fins secured to said tubing, upper and lower sets of shoulders in each fin, an annular supporting ring slidably mounted on said fins between said shoulders, and a helical compression spring biasing said ring against one set of said shoulders.

10. The combination of claim 9 in which said ring has a conical downwardly and inwardly tapering surface, and said fins are beveled upwardly and downwardly from adjacent said upper and lower shoulders respectively inwardly to the surface of said tubing.

11. The combination of claim 9 in which said tubing below said ring and fins is formed with an enlarged cylindrical section, annular grooves in said enlarged section, and resilient packing rings mounted in and extending out of said grooves.

References Cited in the file of this patent

UNITED STATES PATENTS

2,188,589	Armentrout	Jan. 30, 1940
2,227,912	Pranger	Jan. 7, 1941
2,241,561	Spencer	May 13, 1941
2,332,749	Page	Oct. 26, 1943
2,345,873	Hart	Apr. 4, 1944
2,358,122	Yancey	Sept. 12, 1944
2,383,453	Crickmer	Aug. 28, 1945