

March 1, 1949.

C. C. BROWN ET AL
BUMPER SUBSAFETY JOINT

2,463,353

Filed June 6, 1944

5 Sheets-Sheet 1

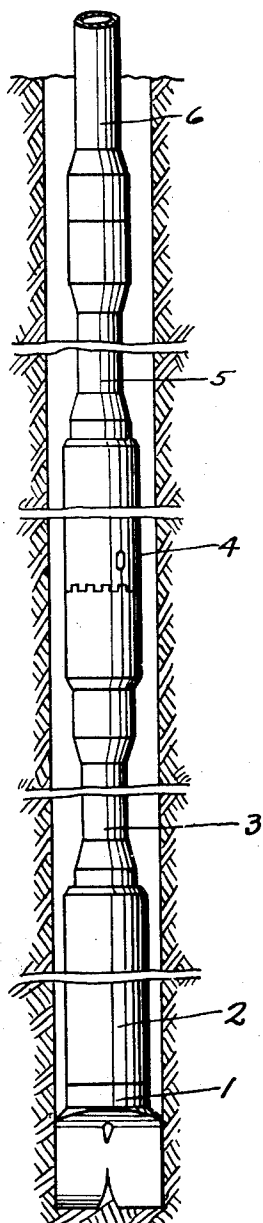


Fig. 1.

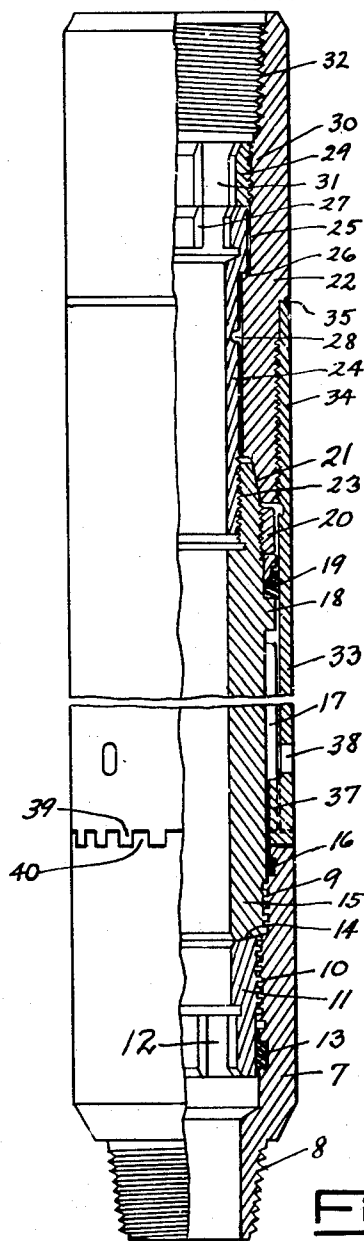


Fig. 2.

C. C. BROWN
GEO. MC CRAY. INVENTORS.
F. L. SCOTT JR.

BY *J. Vincent Martin*
and
Ralph H. Browning
ATTORNEYS

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5 Sheets-Sheet 2

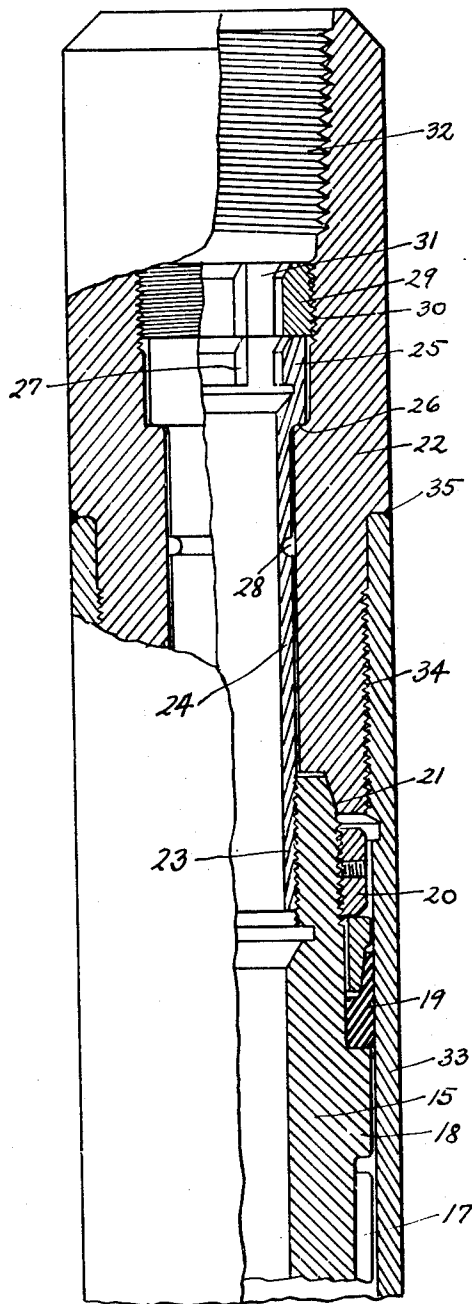


Fig. 3.

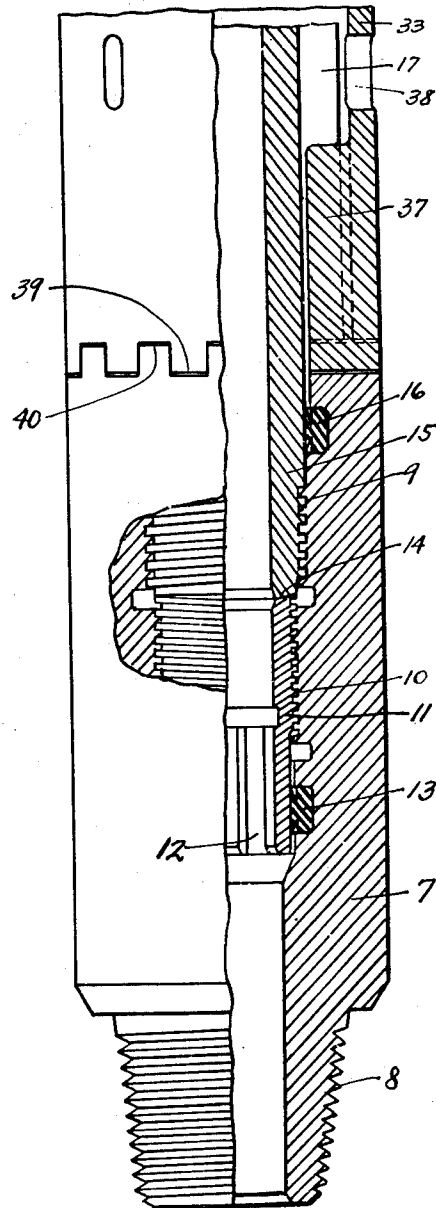


Fig. 4.

C. C. BROWN
GEO. ME CRAY INVENTORS
F. L. SCOTT JR.

BY *J. Vincent Martin*
and
Ralph R. Browning
ATTORNEYS

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5 Sheets-Sheet 3

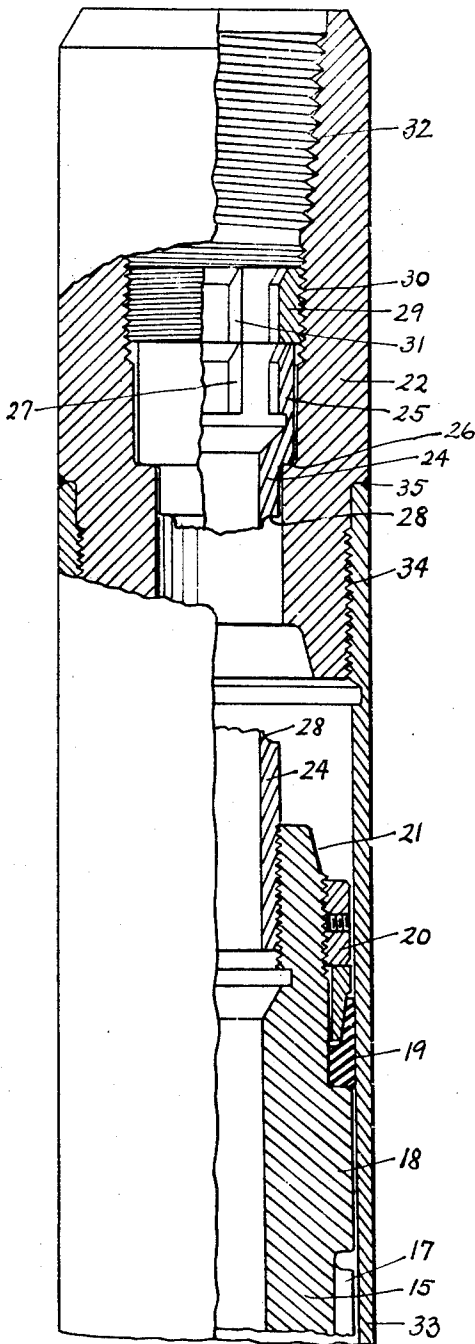


Fig. 5.

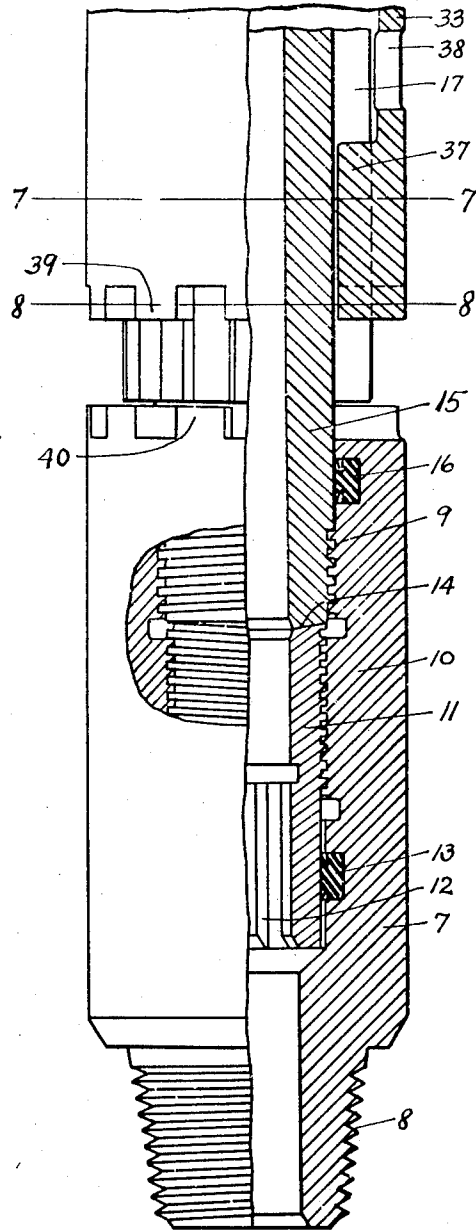


Fig. 6.

C. C. BROWN
GEO. McCRAY, INVENTORS.
F. L. SCOTT, JR.

BY *J. Vincent Martin*
and
Ralph H. Browning
ATTORNEYS

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5 Sheets-Sheet 4

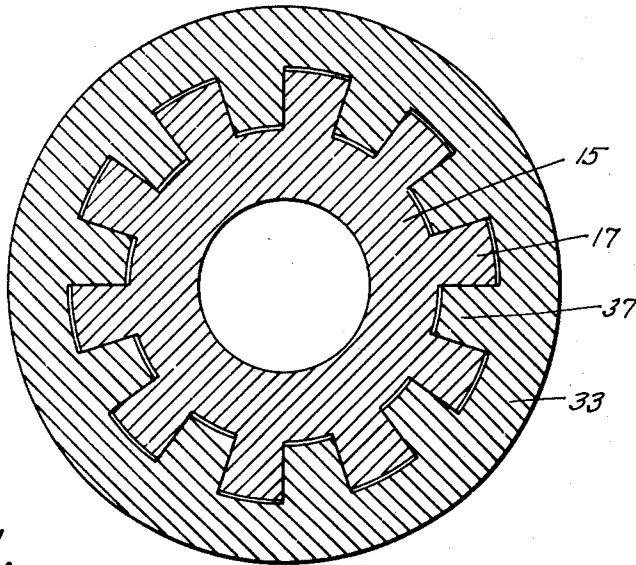


Fig. 7.

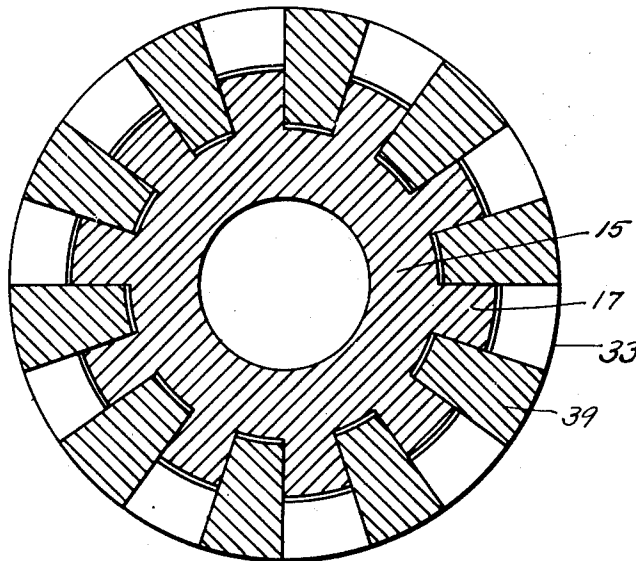


Fig. 8.

C. C. BROWN
GEO. MCCRAY, INVENTORS.
F. L. SCOTT, JR.

BY *J. Vincent Martin*
and
Ralph H. Browning
ATTORNEYS

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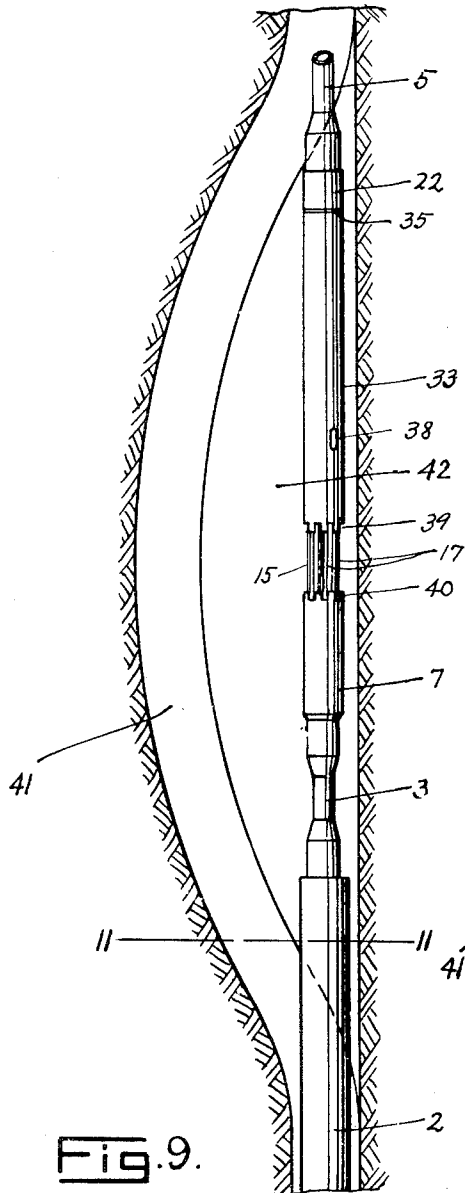


Fig. 9.

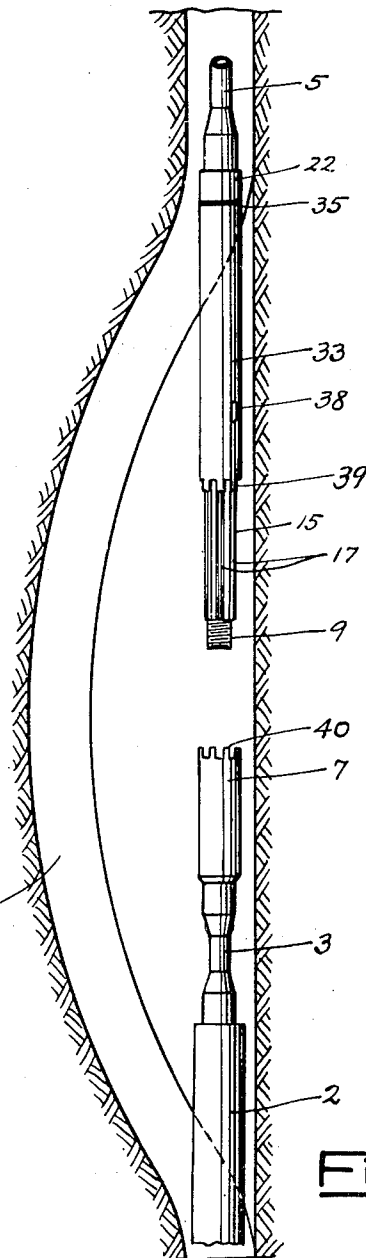


Fig. 10.

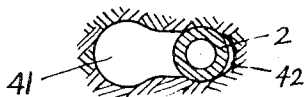


Fig. 11.

C. C. BROWN
GEO. MC CRAY INVENTORS.
F. L. SCOTT JR

BY *J. Vincent Martin*
and
Ralph H. Browning
ATTORNEYS

UNITED STATES PATENT OFFICE

2,463,353

BUMPER SUB SAFETY JOINT

Cleero C. Brown, Houston, George McCray, Alvin,
and Floyd L. Scott, Jr., Houston, Tex., assign-
ors to Brown Oil Tools, Inc., Houston, Tex., a
corporation of Texas

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5 Claims. (Cl. 255—27)

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This invention relates generally to deep well apparatus, and particularly to bumpers and safety joints.

It will be found particularly useful in connection with rotary drill stems, but it may also be used in connection with tubing and other strings.

A rotary deep well drill seldom, if ever, drills a truly vertical hole or a hole following predetermined curves. The usual hole is quite crooked, as a result of which the drill stem often becomes stuck in the hole and its removal is difficult and at times impossible.

Various devices have heretofore been provided to jar the stuck portion of the drill stem to loosen it so that the entire drill stem and bit may be removed from the hole. Devices have also been provided to permit severance of the drill stem at a point above the stuck portion, to the end that the sections of the drill stem above the stuck portion may be removed.

The devices for jarring the pipe loose are known in the art as jars or bumpers, and the devices for severing the pipe above the point at which it cannot be jarred loose are known in the art as safety joints.

One of the objects of this invention is to provide a new and improved bumper including elements which normally constitute a strong and rigid section of the drill stem during drilling operations, and which, in the event the drill stem becomes stuck in the hole, may be rendered movable with respect to each other by a predetermined upward pull on the drill stem, so that the stuck portion of the stem may be jarred loose.

Another object of this invention is to provide a new and improved safety joint to permit severance of the drill stem should it be impossible to jar loose the stuck section, the joint including members normally connected together to provide a rigid union during drilling operations, but which will not become locked together but on the contrary may be readily disengaged to permit severance of the drill stem when desired.

This invention also has for its object the provision of a new and improved combined bumper and safety joint assembly which may be readily assembled and disassembled and which when assembled will normally constitute a strong and rigid part of the drill stem during drilling operations but which may readily and certainly be operated in the event the drill stem becomes stuck first to jar the stuck portion of the drill stem in an effort to effect its release, and in the event that is unsuccessful then to sever the pipe

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at a point above the stuck portion to permit the removal of that part of the drill stem thereabove.

A further object of the invention is to provide new and improved means to seal the operable elements and members of this new device and thereby prevent injury to the parts by the mud laden fluid which is usually pumped through the drill stem.

It is also an object of this invention to provide a device of this general type including a new and improved common means for preventing the premature operation of the bumper and for preventing the premature disconnection of the releasable elements of the safety joint.

Another object is to provide such a device in which the stresses and strains of drilling will not be allowed to act upon the common means for preventing operation of the jar and gradually weaken it due to fatigue, and in which the common means for preventing the premature operation of the jar and safety joint cannot be released unless and until the drill stem has become stuck in the hole.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings in which one embodiment of the invention has been shown by way of illustration and example.

In the drawing:

Fig. 1 is a view illustrating the lower portion of the drill stem with a drill bit on the lower end thereof, the same being positioned in a hole being drilled in an earth formation.

Fig. 2 is an enlarged view partly in longitudinal cross section and partly in side elevation illustrating the bumper and safety joint constructed in accordance with this invention.

Fig. 3 is a view similar to the upper portion of Fig. 2 but on a substantially larger scale and having additional parts broken away and shown in cross section for purposes of illustration.

Fig. 4 is a view similar to Fig. 3 but showing the lower portion of the construction illustrated in Fig. 2.

Fig. 5 is a view similar to Fig. 3 but showing the parts in the relation which they bear to each other after the means for holding the bumper and safety joint inoperative has been released and the device is in position for use as a bumper and for release of the safety joint when desired.

Fig. 6 is a view similar to Fig. 5 but showing the lower portion of the device.

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Fig. 7 is a transverse cross section taken along the line 7—7 of Fig. 6.

Fig. 8 is a transverse cross section taken along the line 8—8 of Fig. 6.

Fig. 9 is a view showing the lower portion of a drill stem having a device constructed in accordance with this invention incorporated therein, and illustrating the manner in which the lower portion of the drill stem may become stuck in a well hole during the process of removal of the drill stem from the hole.

Fig. 10 is a view similar to Fig. 9 but illustrating the apparatus after operation of the safety joint for the purpose of disconnecting the upper portion of the drill stem from the lower portion thereof.

Fig. 11 is a transverse cross section taken along the line 11—11 of Fig. 9.

Referring now more in detail to the drawings, the numeral 1 in Fig. 1 designates the usual rotary type of drilling bit which in the customary manner is mounted on the lower end of a drill collar or drill collars 2. These drill collars are carried preferably by a short length of drill pipe 3 and on the upper end of such length of drill pipe there is mounted a device 4 constructed in accordance with this invention, the details of which will presently be described.

Secured to the upper end of the device 4 is another length of drill pipe 5 and other lengths 6 may be added thereto in order to make up the remainder of the drill stem extending to the surface of the earth.

Referring now more in detail to the device constructed in accordance with the present invention, there is shown in Figs. 2 to 8 inclusive the details of construction thereof. It will be seen that there is an element or section 7 which has a threaded pin 8 on its lower end adapted to be secured to the lower length of drill stem 3 and which is provided on its upper inner surface with two threaded zones 9 and 10. One of the zones 9 or 10, (the zone 9 in the case of a tool for use with a drill stem adapted to be rotated clockwise in drilling) is threaded with a right-hand thread, whereas the other zone 10 is threaded with a left-hand thread. It will be noted that the threaded zone 9 is slightly larger in diameter than the threaded zone 10. A locking means in the form of a ring or nut 11 of a size to fit within the threaded zone 10 and having threads on its outer surface adapted to cooperate with the threads 10 is provided with internal slots 12 by which it may be threaded into the connection 7 within the threaded zone 10. Beyond its threads and adjacent its lower end, this ring 11 is provided with a smooth outer zone adapted to receive and cooperate with the sealing ring 13 carried in a suitable groove within the element 7 so as to prevent fluid from being forced into the space between the ring 11 and the element 7 from the lower end of the ring 11.

On its upper end the ring 11 is provided with a flared seat 14 adapted to receive and closely seat against the tapered end of the mandrel or tool section 15. This mandrel 15 is threaded externally adjacent its lower end to engage the threads 9 within the element 7, and above such threads is provided with a smooth zone adapted to cooperate with the sealing ring 16 carried within a suitable groove in the element 7. The tapered surfaces on the upper end of the ring 11 and the lower end of the pin 15 are adapted to form a sealing connection against each other, and this connection taken with the sealing ring 13 and

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the sealing ring 16 is adapted to protect the threaded zones 9 and 10 from contact with and erosion by the drilling fluid which is pumped through the drill stem during the drilling operation. The tool sections 7 and 15 form safety joint connecting members.

Above the element 7 the pin member 15 is extended upwardly a substantial distance and provided on its outer surface with splines 17. Above the splines 17 it has a part of relatively large diameter shown at 18 which provides an upwardly facing shoulder against which is disposed a sealing ring 19 held in place by a nut 20 threaded on the exterior of the pin member 15. The purpose of this sealing ring 19 will presently be explained.

On its upper end, the pin member 15 is provided with an external surface which is slightly tapered toward its end and adapted to receive and wedgingly engage within the correspondingly tapered end portion of the upper connection 22.

Internally, the upper end of the pin member 15 is threaded at 23 to receive the lower threaded end of the holding means in the form of a frangible member or sleeve 24 having on its upper end a head 25 with a downwardly facing external shoulder 26 adapted to engage a corresponding shoulder within the upper connection 22. Slots or splines are provided on the interior of this sleeve 24 within the head 25 as shown at 27, so that a suitable wrench may be inserted to tighten this sleeve into the threads 23 and against the shoulder 26 and thus hold the pin member 15 in tight engagement with the upper connection 22 at the tapered zone 21. The sleeve 24 is provided with a weakened section formed in any suitable manner such as by means of the external groove 28, this groove being of such depth as to predetermine the stress necessary to break the sleeve at this point.

In order to prevent the accidental loosening of the sleeve 24 during drilling operation, an externally threaded ring 29 is engaged with suitable threads 30 provided for the purpose and tightened against the head 25 of the ring 29. The ring 29 is provided with grooves or splines internally thereof as shown at 31 so that it may be tightened into place. It will be noted that the pitch of the threads 30 is substantially different from that of the threads 23 by which the sleeve 24 is threaded into the pin 15, thus greatly increasing the locking effect of the ring 29 because of the fact that in order to back out of its threaded connection 23 the sleeve 24 would have to turn at a different rate from that at which the ring 29 would have to turn to permit such backing out. There would therefore have to be sliding between the lower end of the ring 29 and the upper end of the sleeve 24 in order for this to occur.

The upper end of the upper connection 22 is internally threaded at 32 for the purpose of receiving the upper portion of the drill stem.

Externally adjacent its lower end the upper connection 22 has connected thereto a sleeve 33, the same being threaded onto the upper connection as shown at 34 and this threaded connection being sealed in any suitable manner by means of cement such as shown at 35 or by any other suitable means so as to prevent leakage between the upper connection 22 and the sleeve 33.

Adjacent its lower end, the sleeve 33 is provided with inwardly extending splines 37 adapted to interengage with the splines 17 on the pin member 15, whereby rotation of the sleeve 33

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will be caused to produce rotation of the pin member 15, but whereby reciprocating movement between these two parts will not be interfered with. In order to permit free reciprocating movement without any hydraulic lock between these parts an opening 38 is provided in the sleeve 33 above the upper ends of the splines 37. The upper connection 22 and the sleeve 33, taken together provide a tool section constituting one of the bumper jarring elements which may be referred to as the hammer, while the tool sections 7 and 15, taken together prior to the release of the safety joint, constitute the other bumper jarring element which may be termed the anvil.

On the lower end of the sleeve 33 and providing a continuation of the lower end of each of the splines 37 are a plurality of clutch teeth 39 which project downwardly and are adapted to engage and fit snugly between the upwardly projecting corresponding clutch teeth 40 on the upper end of the element 7. It will be seen that when the clutch teeth 39 and 40 are interengaged they will form a jaw clutch engagement between the sleeve 33 and the element 7 so that the sleeve 33 may be employed to drive the element 7 directly in rotary movement in either direction. It will further be seen that the sleeve 33 will be held in its lowermost position with respect to the element 7 so that the teeth 39 and 40 will be held in engaging relationship with each other so long as the pin 15 is engaged within the safety joint box element 7 and the sleeve 24 is tightened into its threads 23. It will further be seen that when the tapered surfaces on the upper end of the ring 11 and the lower end of the pin element 15 are in tight engagement with each other after having been brought into such tight engagement by means of a wrench engageable with the splines or slots 12 previously mentioned, such engagement will not interfere with the ready release of the pin member 15 from the safety joint box member 7 because when the pin member 15 is rotated toward the left to disengage it from the box member 7, a similar rotation of the ring 11 will be permitted within its left-hand thread 10, this rotation tending to move the ring 11 downwardly and away from the pin 15. Thus, there will be no necessity for frictional sliding of one of these tapered surfaces over the other.

In the assembly of the device above described, the sealing ring 19 will first be secured in place on the pin member 15 by means of the nut 20 and the pin member 15 will then be placed into the sleeve member 33 from the upper end thereof. Thereupon the upper connection 22 will be threaded into the upper end of the sleeve 33 by means of the threads 34, and the cementitious material 35 applied or other sealing means employed to form a seal between these parts and prevent their ready disengagement from each other. At this point it is advisable to insert the sleeve 24 through the upper connection 22 and tighten it into the threads 23 to draw the tapered joint 21 together and then place a gauge mark on the outer surface of the pin section 15 at the lower end of one of the teeth 39 to serve as a guide in threading the pin section 15 into the box section 7. Sleeve 24 must then be removed to permit the pin 15 to be extended beyond the sleeve 33 so that it can be screwed into box 7.

The ring 11 will then be threadedly engaged with the threaded zone 10 within the safety joint box element 7 and screwed downwardly to the

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lower end of the threaded engagement, after which the pin member 15 will be inserted into the box element 7 and screwed into the same until the gauge mark on the pin section is fairly visible between two of the teeth 40, being stopped at such a position that the teeth 39 and 40 will interengage with each other. The sleeve 33 will then be moved toward the box element 7 until the teeth 39 and 40 are fully interengaged.

With the teeth 39 and 40 fully engaged with each other the sleeve 24 will then be introduced from the upper end of the upper connection 22 and threadedly engaged at 23 with the pin 15 and then tightened so as to draw the tapered surfaces at 21 into tight engagement with each other and fairly rigidly hold the pin member 15 in engagement with the upper connection 22. The ring 29 will then be inserted and tightened against the head 25 of the sleeve 24 to hold the sleeve against accidental displacement, after which the ring 11 will be tightened against the lower end of pin 15 to lock the pin rigidly against screwing further into the box 7 but without offering great resistance to its ready removal from the box 7 once the teeth 39 and 40 are disengaged from each other.

It will be seen that when the device just described is assembled in the manner outlined, it will support a load which does not exceed the strength of the weakened section 28 of the sleeve 24, and this section will be so designed that it will support a load somewhat exceeding the weight of the drill stem which is to be connected to the lower end of this device. So long as the sleeve 24 remains intact and in the position illustrated in Figs. 2, 3 and 4, the teeth 39 and 40 will be held in engagement with each other so that torque may be transmitted from the upper connection 22 through the sleeve 33 to the safety joint box element 7 by means of the teeth 39 and 40. It will be noted that whereas the threads 9 and 10 would not interfere with the left-hand rotation of the pin element 15 for the reasons above stated, they will definitely lock the pin element 15 against right-hand rotation within the box element 7 because such right-hand rotation would tend to move the element 15 and the ring 11 toward each other and they would thus come into locking engagement with each other. It will further be seen that torque may be transmitted from the sleeve 33 through the interengaging splines 17 and 37 to the pin element 15 and thence through the threaded engagement 9 and 10 to the box element 7. Thus, all portions of the device with the exception of the sleeve 24 tend to contribute to the transmission of torque from the upper connection 22 to the safety joint box element 7.

It is to be noted, however, that the sleeve 24 will be substantially protected from all such stresses due to torque and also due to bending stresses encountered in drilling operations because the weight of the drill stem upon the upper connection 22 will tend at all times to more fully engage the tapered surfaces at 21 and thus relieve any tension on the sleeve 24 rather than placing additional tension thereon. At the same time, the tight engagement of the tapered surfaces 21 and the relatively long sleeve 33 will tend to remove any bending stresses from the sleeve 24 and cause them to be transmitted directly from the pin element 15 to the upper connection 22 without passing through the sleeve 24.

It has been found that in drilling operations with the device described but without the presence of the ring 29 there was some tendency for the sleeve 24 to back out and eventually become disengaged prematurely, but that with the locking ring 29 in place this tendency was overcome.

It will further be seen that leakage from the interior of the drill stem and of the device illustrated and described will be prevented by the tight tapered engagement at the point 21, and by the sealing ring 19 adjacent thereto. Furthermore, the leakage from the lower portion of the device will be effectively prevented by means of the sealing rings 13 and 16 and the engagement between the tapered surfaces at 14. It is further to be noted that these last sealing means effectively prevent the access of the drilling fluid to the threaded zones 9 and 10 of the safety joint, and this is of great importance because of the fact that it is imperative that these threads be readily operable when it is desired to disconnect the upper portion of the drill stem from the lower end thereof.

Reference is now had to Figs. 9, 10 and 11 in which are illustrated the conditions under which many times a drill stem will become stuck in a well.

Despite the taking of all possible precautions and the use of suitable drill collars and other apparatus available, well holes are seldom drilled exactly straight. Rather, they usually bend and twist about in their downward course to a greater or less extent even though they may not deviate from the desired drilling direction by any very great distance. During the drilling operation the drill stem readily follows such crooks and curves in the well hole because a long length of drill stem though made of steel is relatively quite flexible. However, during the rotation of the drill stem in drilling it tends to wear more against the inside of a curved portion such as illustrated at 41 and to straighten up such curved portion of the hole as drilling proceeds. It will be noted, however, that this straightening up operation is carried out by wear of the side of the drill stem against the side wall of the hole, and that the drill stem is of substantially less diameter than either the drill bit or the drill collars. Thus, when the drill stem tends to straighten the hole it forms a relatively narrow slotted portion such as illustrated at 42 in the drawing and after a long time the drill stem will be found to extend through this slotted portion in which it will operate satisfactorily but which slotted portion is narrower than the diameter of the drill bit and drill collars.

It will be obvious that when an attempt is made to remove from such a hole a drill stem of the nature set forth, the drill collars and drill bit will tend to be drawn upwardly into the narrow portion 42 of the hole which is ordinarily referred to as a key seat. Inasmuch as they are of too great diameter to pass through this relatively narrow portion of the hole there is great likelihood that they will become stuck therein rather than being deflected sideways through the curved portion 41 of the hole which is of larger diameter.

With a device constructed in accordance with the present invention incorporated into the drill stem a short distance above the drill collars, it is possible to cope with such a situation in the following manner:

Before exerting an upward pull on the drill

pipe sufficient to break the sleeve 24 at the point 28, it may be possible by placing the weight of the upper end of the drill stem on the lower portion thereof, through merely slacking off on the hoisting apparatus at the surface of the earth, to loosen the drill stem from the key seat and then work it out by gradually rotating it while lifting it in order to cause it to work its way past the key seat 42. However, if the drill stem does not come loose by virtue of its own weight being placed upon it the bumper operation to jar the stem loose may be effected. This is effected by pulling upwardly on the drill stem until sufficient force is exerted to break the sleeve 24 at the point 28. When this occurs, it will be seen that the sleeve 33 will be left free to move upwardly with respect to the pin element 15 and with respect to the box element 7, thereby separating the teeth 39 and 40. These teeth, however, will be retained in alignment with each other because of the locking effect of the ring 11 upon the pin element 15. The upper portion of the drill stem may then be lifted to the extent of movement of the sleeve 33 upon the pin element 15 and suddenly dropped to cause the lower end of the sleeve 33 to hammer against the upper end of the box element 7, and the lower end of the upper connection 22 to hammer against the upper end of the pin element 15. This hammering can be repeated any desired number of times in an effort to hammer the lower portion of the drill stem loose from its stuck position within the key seat 42.

If it be found impossible to loosen the stuck lower portion of the drill stem from within the key seat 42, then the safety joint operation may be effected to cause a severance of the pipe above the stuck portion. To effect such severance, the operator will then rotate the upper portion of the drill stem to the left while the sleeve 33 is being held in some position above its lowermost position so that the teeth 39 and 40 will be disengaged from each other. With these teeth disengaged from each other the pin 15 will be free to turn within the box element 7 except for the engagement with the ring 11, but as above stated, this engagement will not substantially hinder left-hand rotation of the pin 15 within the box 7 because such rotation will tend to move apart the elements 15 and 11. It will be readily apparent that by continued rotation to the left the upper portion of the drill stem may thus be readily disconnected from the lower portion thereof by disengagement of the pin element 15 from the box element 7 at the threaded engagement 9. The upper portion of the drill stem with the sleeve 33 may then be removed from the hole as illustrated in Fig. 10.

After such disengagement and removal it is possible to run a different sort of tool known as a washover fishing tool (not shown in this application) into the well and wash down over the upper end of the stuck drill pipe until it is released from its stuck position.

While the elements may be readily and certainly operated as above indicated when a pipe becomes stuck, they are assembled and held together to form a strong and rigid part of the pipe during drilling operation. Thus it will be seen that as long as the sleeve 24 remains intact, the pin element 15 will be held in tight engagement at 21 with the upper connection 22, and that this will hold the sleeve 33 in its lowermost position with respect to the pin element 15, in which position the teeth or dogs 39

and 40 will be in full engagement with each other. This engagement between the dogs 39 and 40 will prevent relative rotation of the sleeve 33 and the box element 7, and inasmuch as the pin element 15 and the sleeve 33 cannot rotate with respect to each other because of the interengagement of the splines 17 and 37, this engagement between the dogs 39 and 40 will prevent disengagement of the pin element 15 from the box element 7. The sleeve 24 will thus hold the sleeve 33 and the pin element 15 against relative sliding engagement with each other until the sleeve 24 has been broken, and thus there can be no hammering of the lower end of the sleeve 33 against the upper end of the box member 7 until after the sleeve 24 has been broken. Likewise, there can be no disengagement of the lower end of the pin element 15 from the box element 7 until after the sleeve 24 has been broken.

On the other hand, the sleeve 24 cannot be broken merely by the weight of the drill collars and drilling tools suspended therefrom because it is so designed as to support considerably more than the weight of such parts. It cannot be broken during the drilling operation because during the drilling operation weight is placed upon the drilling tool from above due to the upper portion of the drill stem and the device constructed in accordance with this invention will be in compression during the drilling operation. There will thus be no tension available to break the sleeve 24. Likewise, the sleeve 24 cannot become fatigued due to bending stresses during the drilling operation because of the tapered engagement at 21 and because of the remainder of the construction which substantially removes from the sleeve 24 all of the stresses and strains of drilling.

There has therefore been provided a tool which is capable of accomplishing all of the objects and advantages set forth in connection with this invention.

Having described our invention, we claim:

1. A bumper sub and safety joint with a fluid passageway therethrough having telescoping tubular sections adapted for relative longitudinal and rotative movement, cooperating jarring elements carried by said sections, a clutch between said sections preventing their relative rotation when engaged, and a tubular frangible member mounted between the sections to hold them against relative longitudinal movement, said member serving as both a frangible means for holding the sections in telescoped relationship and as a portion of the fluid passageway through the joint.

2. A device as in claim 1 in which the mounting of the tubular frangible member comprises a threaded connection with one section and cor-

responding shoulders between the member and the other section, said shoulders adapted to abut on telescoped assembly of the tool and a lock-nut threaded to said last section and engaging said member.

3. A bumper sub and safety joint with a fluid passageway therethrough having telescoping tubular sections adapted for relative longitudinal and rotative movement, cooperating jarring elements carried by said sections, a clutch between said sections preventing their relative rotation when engaged, a tubular frangible member mounted between the sections to hold them against relative longitudinal movement, said member serving as both a frangible means for holding the sections in telescoped relationship and as a portion of the fluid passageway through the joint, and a tapered wedge-like joint between the sections adapted to transmit the bending stresses directly between the sections when they are telescoped thus relieving the frangible member from said stresses.

4. In a bumper sub and safety joint having telescoping sections adapted for relative longitudinal and rotative movement, a clutch between the sections operable on engagement to hold the sections against relative rotation when they are telescoped and a tubular frangible member holding the sections in telescoped relationship with the clutch engaged the improvement which resides in a tapered wedge-like joint between the sections adapted to transmit the bending stresses directly between the sections when the sections are telescoped thus relieving the frangible member therefrom.

5. A device as in claim 4, wherein the wedge-like joint comprises an internal annular tapered shoulder on one section and an external annular tapered shoulder on the other section, said shoulders adapted to fit snugly when the sections are telescoped and the clutch engaged.

CICERO C. BROWN.
GEORGE McCRAY.
FLOYD L. SCOTT, JR.

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