

Dec. 6, 1960

E. KOPPL

2,963,101

JOINT CONSTRUCTION AND JARRING TOOL

Filed April 1, 1957

5 Sheets-Sheet 1

Fig. 1.

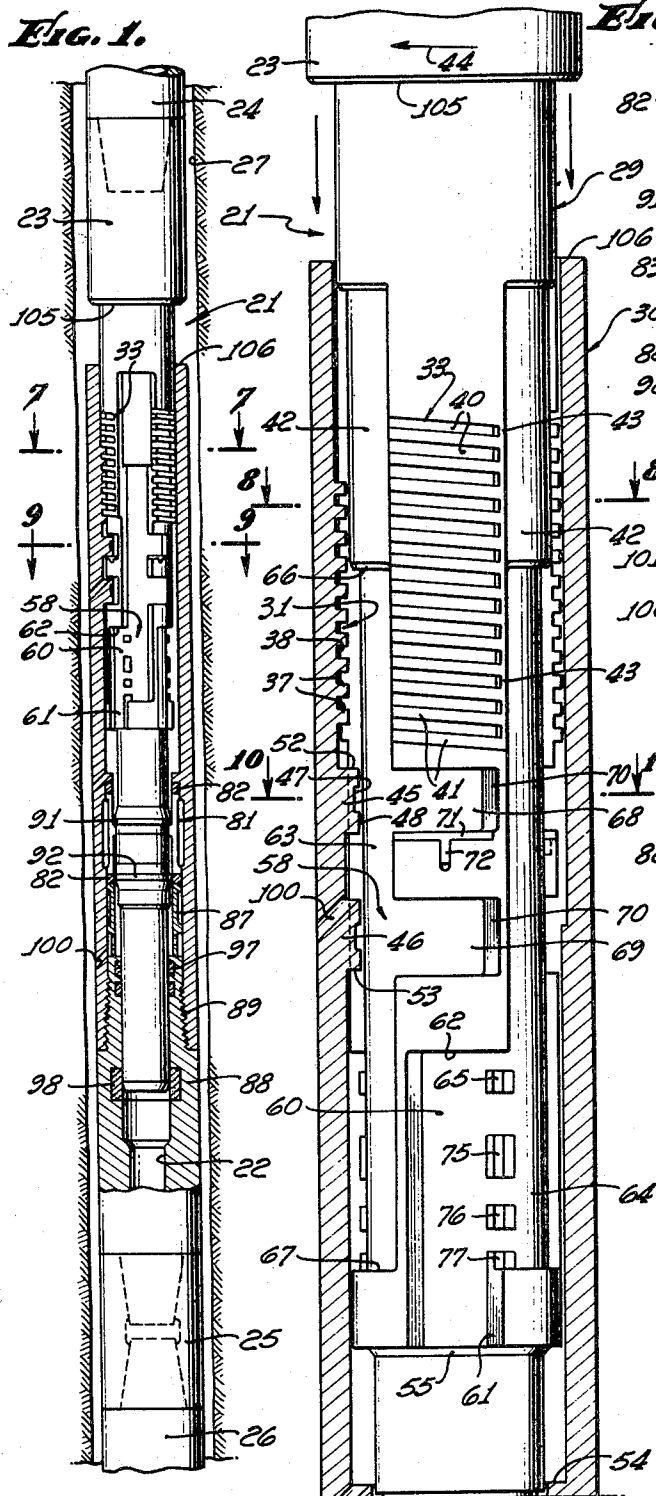


Fig. 2.

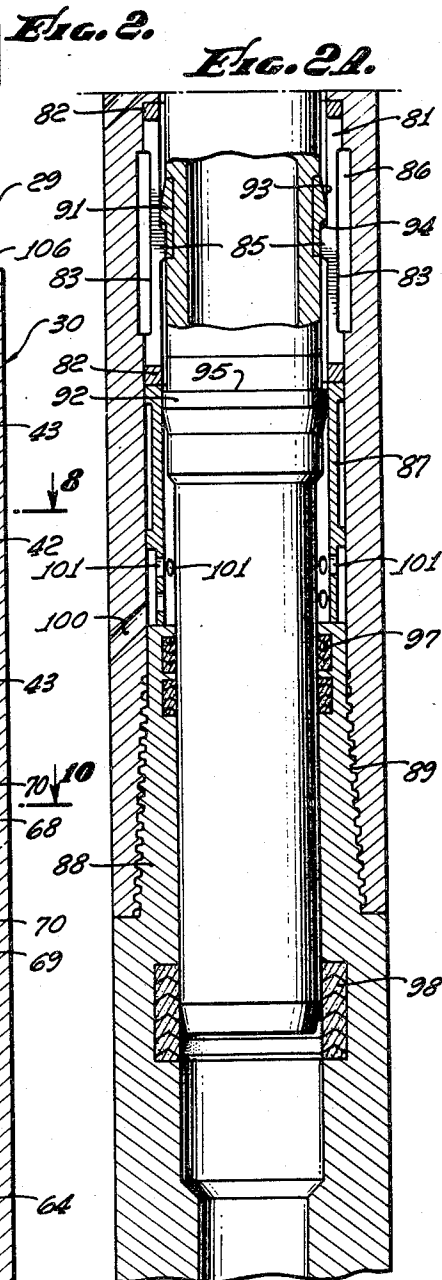


Fig. 2A.

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FIG. 3A.

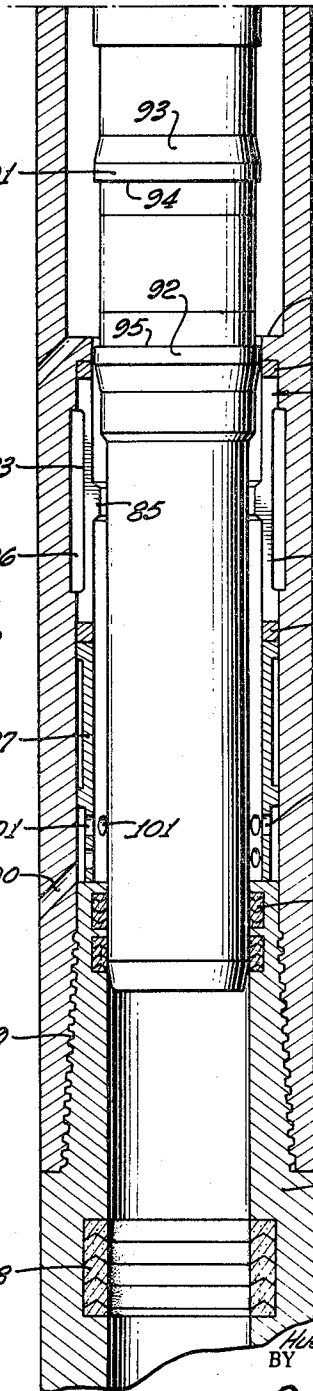


FIG. 4.

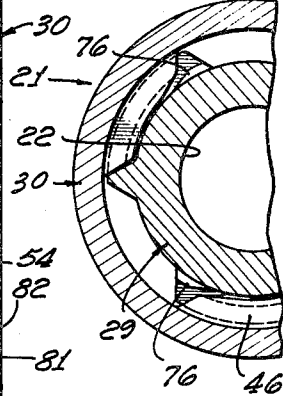


Fig. 5.

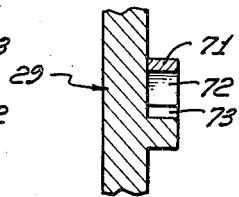
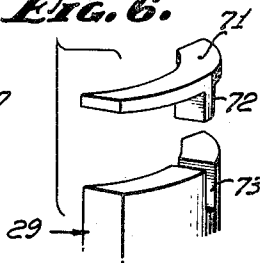


FIG. 6.



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FIG. 7.

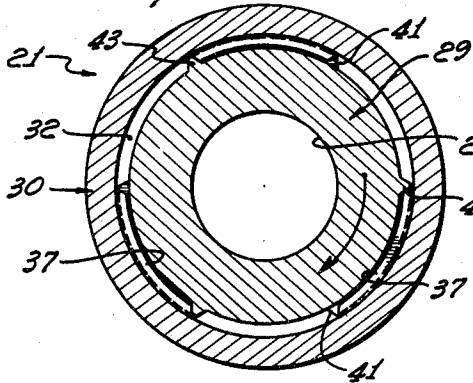


FIG. 8.

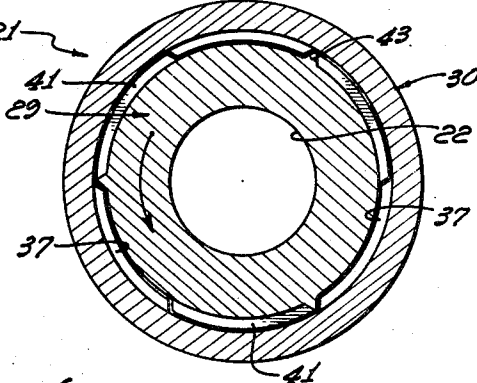


FIG. 9.

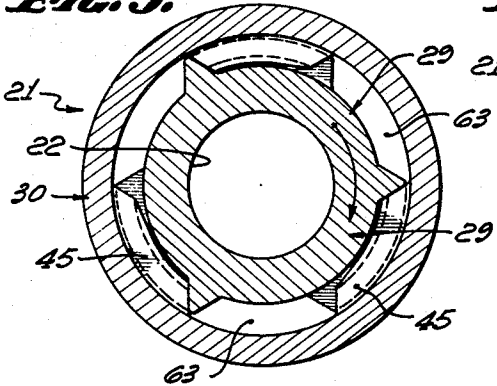


FIG. 10.

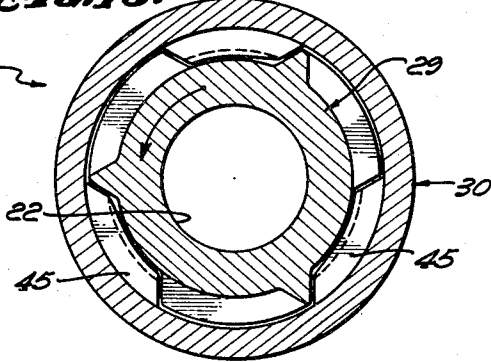
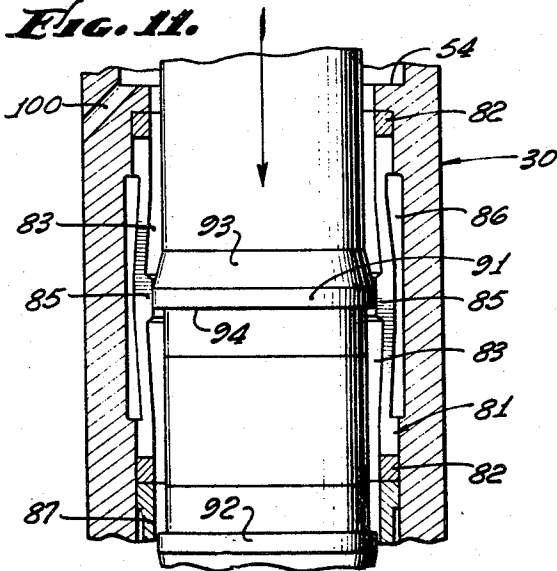


FIG. 11.



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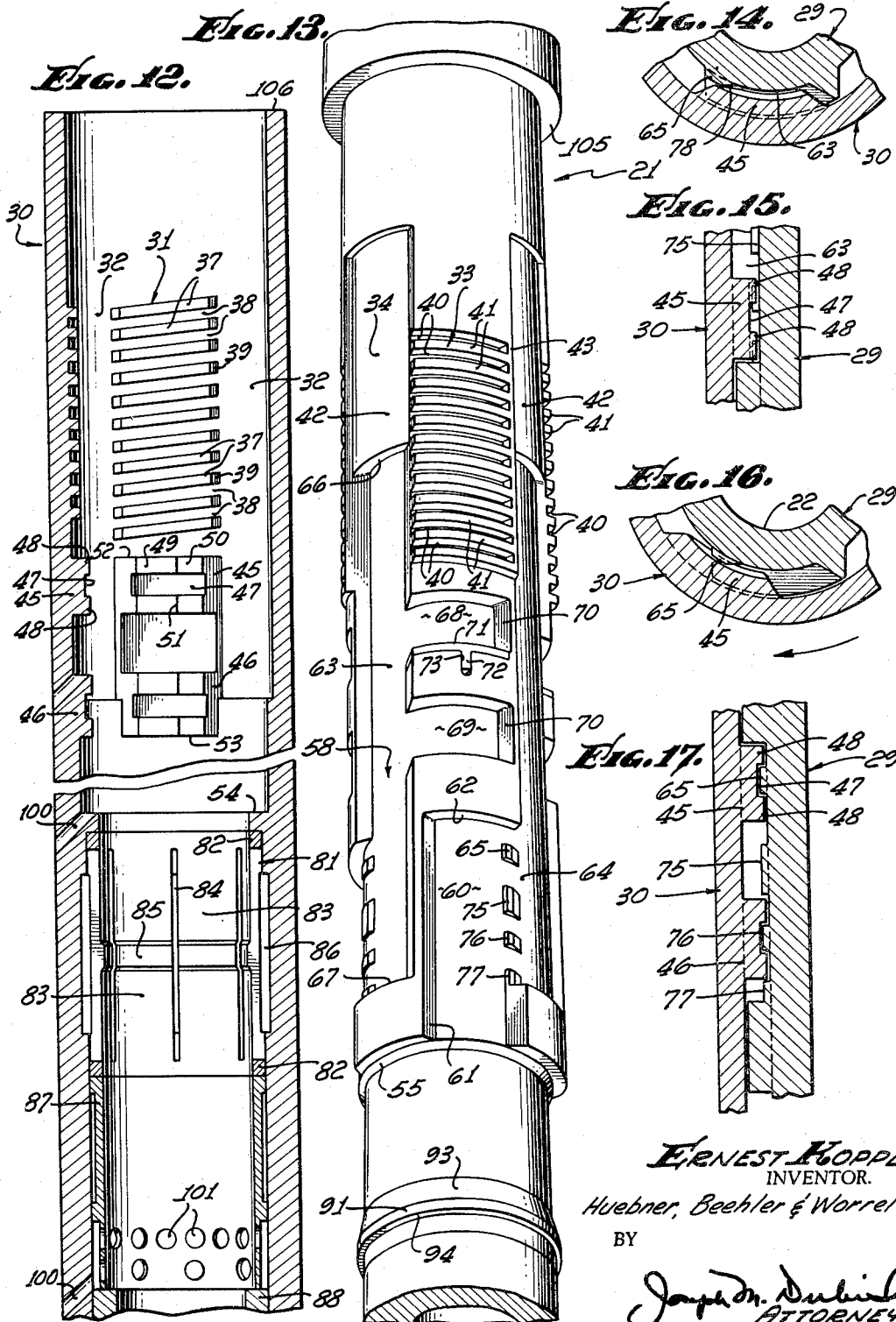
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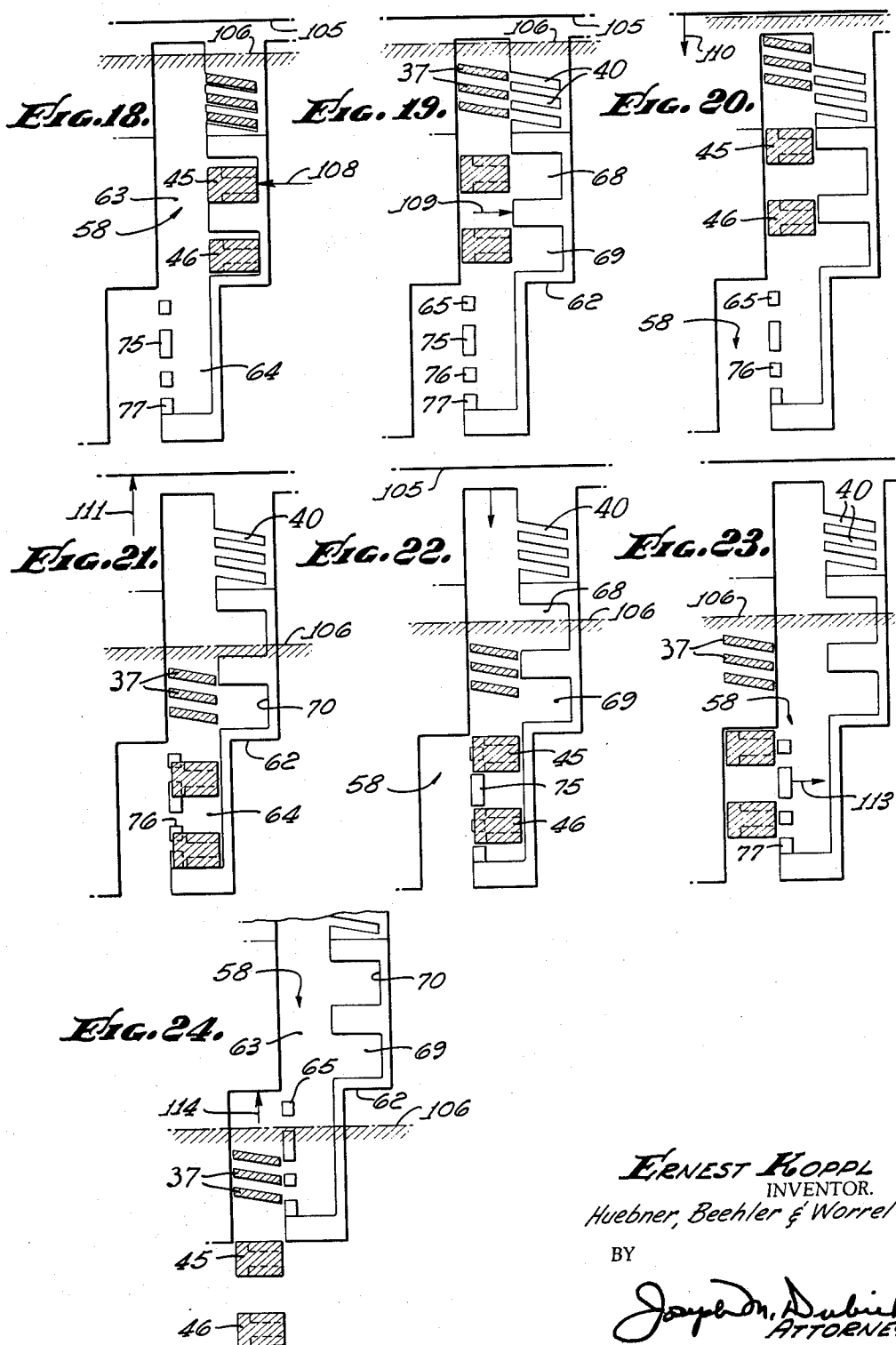
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JOINT CONSTRUCTION AND JARRING TOOL

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Filed Apr. 1, 1957, Ser. No. 649,829

5 Claims. (Cl. 175—294)

This invention relates to improvements in releasable joints, broadly, for interconnecting sections of rods, pipes and the like, and to improvements in jarring tools for use in drilling wells.

For a description of a tool of the general type to which this invention relates, reference is made to my co-pending application, Serial No. 431,066, now Patent No. 2,819,877, which illustrates and describes a releasable joint and jarring tool combination for well operations.

It is an object of this invention to provide a screw thread joint for interconnecting two sections of a pipe or rod which joint is adapted to be disconnected by the application thereto of a rotary strain or torque of a predetermined maximum value applied in a direction to unscrew one section from the other.

Another object of this invention is to provide a joint of the above mentioned character for use in a string of several sections of a pipe or rod, said sections being interconnected with screw-threads, the joint of this invention serving to insure disconnection of the string at that joint rather than at any other place of connection of the sections.

It is a further object of this invention to provide a joint of the above mentioned character adapted for use in a drill string to disconnect the drill string at a location deep in a well, the joint providing for tight interengagement of the parts at a plurality of places spaced apart longitudinally of the drill string, thus to stabilize the joint and prevent relative movement of the parts which otherwise would result in excessive wear as the drill string gyrates during drilling operations.

Another object of the invention is to provide a joint of the above mentioned character and connected to a jarring tool for use in well operations such that should a well string or the like containing the tool become stuck in a well, the joint may be disconnected and the jarring tool operated to free the stuck string, and upon completion of the jarring operation, the joint may be reset for continuing the well operations without requiring withdrawal of the string from the well.

Still another object of this invention is to provide a jarring tool having hammer surfaces and anvil elements and locking means for retaining these parts in operative association and against inadvertent removal of the anvil elements from association with the hammer surfaces.

A further object of this invention is to provide a joint construction and jarring tool for use in well operations and of such construction that should it become impossible to free a stuck string in a well, the more intricate and valuable parts of the tool may be disconnected from the stuck part of the string and retrieved from the well.

Further objects and advantages of the invention will appear during the course of the following part of this specification wherein the details of construction and mode of operation of a specific embodiment of the invention are described with reference to the accompanying drawing, in which:

Fig. 1 is an elevation, partly in central vertical section,

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of a well tool embodying the invention, the same being shown positioned in a well and with its parts interengaged as for a drilling operation;

Figs. 2 and 2A are enlarged longitudinal sections of the upper and lower portions, respectively, of the tool, the male member part of the tool being shown in elevation, and the parts of the tool being shown in a position where the joint parts of the tool have been disengaged just prior to a jarring operation;

Figs. 3 and 3A are enlarged longitudinal sections, with parts being shown in elevation, corresponding to Figs. 2 and 2A respectively; but for Figs. 3 and 3A, the parts of the tool are shown in their relative positions at the time of completion of an up-jar operation;

Fig. 4 is a fragmentary cross-section on an enlarged scale taken along line 4—4 on Fig. 3;

Fig. 5 is an enlarged fragmentary longitudinal section taken along line 5—5 on Fig. 3;

Fig. 6 is an exploded view in perspective of those parts of the tool shown in Fig. 5;

Figs. 7 and 9 are enlarged cross-sections taken along lines 7—7 and 9—9, respectively, on Fig. 1;

Figs. 8 and 10 are enlarged cross-sections taken along lines 8—8 and 10—10, respectively, on Fig. 2;

Fig. 11 is an enlarged fragmentary sectional and part elevational view of that part of the tool appearing in the upper portion of Fig. 2A;

Fig. 12 is a longitudinal central section through the female-member-part of the tool;

Fig. 13 is a perspective view of the greater portion of the male-member-part of the tool;

Figs. 14 and 15 are fragmentary cross-section and longitudinal section, respectively, through the tool and showing the locking means of this invention for retaining the parts of the tool in association with each other against inadvertent release;

Figs. 16 and 17 are views corresponding to Figs. 14 and 15 respectively, and showing the parts in their relative positions during the operation of removing one part of the tool from the other; and

Figs. 18 to 24 inclusive are diagrammatic illustrations of the tool as projected on a flat surface to represent the relative positions of the parts of the tool during the various operations thereof; Fig. 18 being the drilling position, Fig. 19—joint disengagement position, Fig. 20—down-jar-ready position, Fig. 21—up-jar-position, Fig. 22—alignment for removal position, Fig. 23—removal ready position, and Fig. 24—removal position.

For purposes of illustration, the invention is shown in the form of a section 21 of a drill string having an axial bore 22 extending therethrough for conveying drilling fluid or for passing tools and the like down in the drill string during drilling operations. At its upper end there is an enlargement 23 for screw-threaded connection to a drill-string-section 24, and at its lower end the section 21 is screw-threaded into a nipple 25 for connection to a drill-string-section 26. The threads in the nipples throughout the drill string are uni-directional, i.e., they are all either right-hand threads or all left-hand threads, whereby the joints for the sections tend to become tight when the string is rotated in one direction, as for drilling, and are susceptible to becoming loose or disconnected when a strong torque is applied to the string in an opposite direction. For convenience in description, it is assumed herein that the threads for forming the section joints are all right-hand threads, i.e. rotation of the string in a clockwise direction from the top of the well will tighten the section joints. The drill string is shown positioned in a well 27.

Drill string section 21 constitutes a well tool embodying the invention, and it comprises a tubular male member 29 receivable in a tubular female member 30 which con-

stitutes the lower part of the well tool. Proximate the upper end of the female member and projecting inwardly from the inner wall thereof, is a series of circumferentially spaced apart and axially directed raised screw thread portions 31, three in number in the illustrated embodiment, each such portion constituting a longitudinally disposed column of coarse screw threads (see Fig. 12). Spaces 32 exist between adjacent thread portions thus forming a separated or interrupted screw thread section in the female member. Around the male member 29 are three circumferentially arranged raised screw thread portions 33 (see Fig. 13) having spaces 34 between adjacent thread portion to provide an interrupted screw thread section adapted to engage the interrupted screw thread section on the female member. The arcuate dimension or width of the thread portions 31 and 33 is slightly less than that of the spaces between the thread portions (see Figs. 7 and 8). Thus the male and the female members may be interconnected by inserting the member 29 into the bore of the female member with the thread portions of the male member in alignment with respective spaces between the thread portions on the female member (see Fig. 19), and then rotating the male member within the female member to interengage the threads.

The individual screw threads of each column 31 of threads for the female member are designated by numeral 37. These appear as slightly pitched lugs projecting inwardly from the inside wall of the female member, and define recesses 38 between adjacent lugs respectively. In Fig. 12, the left hand end faces of the threads or lugs 37 are designated by numeral 39, and these ends serve as abutment ends as will appear shortly. The screw threads of the columns 33 of threads for the male member constitute slightly pitched recesses 40 defining lugs or threads 41 between adjacent recesses. In the spaces 34 between respective pairs of columns 33 of threads, the male member is recessed, as at 42, to accommodate the upper portions of the thread columns 31 respectively, whereby the individual lugs or threads 37 of the female member may be aligned for registry with respective recesses 40 to interengage the screw threads. As viewed in Fig. 2, the right hand end of each of the recesses 40 is closed by an abutment surface or stop 43 against which the end faces 39 of the threads 37 abut, thereby to limit relative rotation of the members in a thread-interengaging direction as will be explained more fully hereinafter.

The threads 37 and 41 are pitched upwardly in a direction which is clockwise when viewed as from the top of the well, and they become interengaged by rotating the upper end of the string in a clockwise direction as indicated by arrow 44 which appears in the top of Fig. 2. Below the lowermost threads 41 on the male member, that member is of reduced outside diameter by a radial dimension slightly greater than the thickness (radial dimension) of the threads 37 on the female member whereby the male member may be rotated in the female member when the male member is positioned in the female member to a depth at which the lowermost threads 41 of the male member are above the uppermost threads 37 on the female member.

Spaced below the interrupted threads on the female member and projecting inwardly from the inside wall of that member are three sets of anvil elements, each such set constituting an upper anvil element 45 and a lower anvil element 46. These sets are aligned longitudinally with thread columns 31, respectively, as appears best in Fig. 12. Each anvil element is U-shaped in vertical section, having a horizontally extending recess 47 formed therein and defined between two legs 48 of the U-shaped anvil element. The inwardly facing end of each such leg constitutes a concave surface 49 and a radially-outwardly-inclined surface 50, which surfaces meet along an edge 51. The upper end face or shoulder 52 of the upper anvil element 45 and the lower end face

or shoulder 53 of the lower anvil element 46 constitute anvil surfaces.

Below the anvil elements and projecting inwardly from the inside wall of the female member is an annular shoulder 54. The male member is further reduced in outside diameter in that length thereof which extends below the shoulder 54, the place at which such next reduction in diameter begins being designated by numeral 55 and appearing as a downwardly directed annular face.

Formed in the outside surface of the male member and extending upwardly from the annular face 55 are three channels 58 adapted to accommodate movement of respective sets of anvil elements in the channels. These channels are of stepped configuration having horizontally extending portions thereof by which the channels extend part way around the male member. The channels are similar to each other in size and shape. One appears in full in Fig. 1, while each of Figs. 18-24 diagrammatically illustrate a full channel in flat projection.

Each channel comprises a longitudinally disposed portion or leg 60 extending upwardly from the reducing annular face 55, which defines an opening 61 for the channel. Leg 60 terminates at its upper end in a shoulder 62 which is spaced longitudinally of the male member from the lowermost threads 40 by distance great enough such that when the anvil surface 53 abuts the shoulder 62, the interrupted screw thread columns 33 of the male member will be disposed entirely above the thread columns of the female member. To the right of leg 60 is another longitudinally extending portion or leg 63 which is in communication with the leg 60 through a horizontal leg or connecting portion 64 having a plurality of inclined lugs 65 formed therein. The upper end of leg 63 is defined by a shoulder or hammer surface 66 and the lower end of that leg is defined by a shoulder or hammer surface 67. Extending from the right hand side edge of the leg 63 are two pockets or recessed portions 68 and 69 having end shoulders 70. These pockets receive the anvils 45 and 46 respectively, when the thread columns of the male and female members are interengaged. The pockets 68 and 69 are wider than the anvils to accommodate relative movement in a longitudinal or axial direction of the anvils in those recesses, resulting from the pitch of the screw threads 37 and 41.

Numeral 71 designates a shim positioned upon the lower edge or shoulder of the recess 68. This shim has a key 72 received in a key-way 73 extending downwardly from the recess 68 for securing the shim in place. The shim is machined to a thickness such that as the male member is rotated to engage its screw threads 41 into the screw thread recesses 38 of the female member, the lower face or shoulder of the anvil 45 will seat upon the shim and cause the screw threads 41 to wedge tightly up against the screw threads 37 on the female member and thus secure the male member in the female member. Furthermore, the thickness of the shim is such that the abutment ends 39 of the female screw threads will abut against respective stops 43 in the ends of the recesses of the male screw threads when a torque or rotary strain of predetermined value, e.g. 7,000 ft. lbs., is exerted on the male member in a screw thread interengaging direction. Such predetermined value is preferably appreciably less than the minimum rotational strain needed to disconnect any of the section joints throughout the string. Thus it is seen that this invention provides a screw thread joint construction for interconnecting two sections of a pipe, rod, or the like, which joint is adapted to be disconnected by the application of a rotational strain of predetermined value applied in a direction to unscrew one section from the other.

The screw-thread joint of the male and female members is made further secure and stable according to this invention by forming the pockets 68 and 69 of such dimensions that the anvils will abut against the end shoulders 70 of the pockets when the screw threads 37 engage

the stops 43. In well drilling operations, a drill string twists and gyrates in passing down through diverse layers of earth formations. Such gyration of the drill string subjects all joints in the string to forces which tend to cause one member of a joint to pivot on or in the other member, with the result that the joined members wear away against each other. By providing a plurality of abutments spaced longitudinally of the tool, the parts of the joint of this invention are thereby maintained stable in their tightened positions, thus eliminating or at least greatly reducing wear in the parts.

It is to be noted too that the shoulder of anvil 45 which seats against the shim 71 is protected from wear and damage by the presence of anvil 46. As will be made clear in the description set forth hereinafter of the mode of operation of the well tool, it is the anvil 46 which strikes against a hammer surface during an up-jar operation, and the seating shoulder of anvil 45 is not utilized in any way during a jarring operation.

Referring again to the lugs 65 in the horizontal connecting passage 64 of the channels, these lugs extend radially outwardly from the bottom wall of the channel, and serve to prevent inadvertent relative movement of the anvils out from the channel legs 63 into the outlet channel legs 60. There are four of such lugs in the illustrated embodiment, the uppermost lug being designated by numeral 65, and the remaining lugs being numbered 75, 76, and 77 respectively. These lugs are spaced apart longitudinally of the male member. As appears best in Fig. 14 each of these lugs has an inclined surface 78 which faces in a horizontal direction into the channel leg 63. The angle of inclination of the faces 78 is preferably about 25° and not greater than about 45° and is the supplement of the angle of inclination (taken radially outwardly) of the faces 50 on the anvils. Should a counter-clockwise strain be exerted on the male member at a time when the anvils are disposed in channel legs 63 and horizontally aligned with the lugs in the horizontal connecting passage 64, the anvil faces 50 will engage the lug faces 78 and prevent movement of the anvils out from the channel legs 63.

It is important that the interengaging faces 50 and 78 of the anvils and lugs respectively be inclined as described in order to provide wedging action between them. A clockwise strain exerted on the male member when the surfaces 50 and 78 are interengaged is expended as an inconsequential force tending to expand the female member radially outwardly. Were these interengaging faces substantially perpendicular rather than being inclined, the lugs 65 etc. would be easily sheared off as a result of the magnitude of the strains encountered in well operations.

Lugs 65 and 76 are each of a dimension, measured in a direction longitudinally of male member, such that they will slide within the recesses 47 of the anvils 45 and 46 respectively. Stated otherwise, the spaces immediately above and below each of the lugs 65 and 76 are wide enough to permit passage of the legs 48 of the anvils 45 and 46 respectively between those spaces. Also the inclined ends of these lugs extend into the legs 63 of the channels thereby to increase the area at which they are integral with the bottom surfaces of the channels, thus to increase their strength.

Below the annular shoulder 54 is a spring cage 81 comprising upper and lower end rings 82 and a circumferentially arranged series of longitudinally extending and spaced apart spring strips 83 which are integral at their respective ends with the rings 82, as appears best in Fig. 12, the spaces between adjacent spring strips being designated by numeral 84. Midway between the end rings, each spring strip has an inwardly projecting lug or catch 85, the series of such catches appearing as a segmented annular ring. There is an annular recess 86 formed in the female member to accommodate outward flexing of

the spring strips during operation of the tool as is described hereinafter.

Upward axial movement of the cage 81 in the bore of the female member is prevented by the annular shoulder 54 against which the top ring of the cage abuts. A spacing sleeve 87 below the cage keeps it up in abutment with shoulder 54, the spacing sleeve being retained in the bore by a tubular plug 88 forming the lower end of the female member, i.e. constituting the lower end of the drill string section 21. The plug type element 88 is connected as by screw threads 89 to the upper tubular portion of the female member, to form the female member as a socket for receiving the male member, such socket having the tool bore 22 extending axially through the plug end 88.

Referring to Figs. 2A and 3A, the male member has an upper annular collar 91 and a lower annular collar 92 around it. These collars are received in complementary recesses formed in the male member (see Fig. 2A) to maintain the collars axially immovable on the male member. The upper collar 91 has a conical upper surface 93 and a downwardly facing shoulder 94. The lower collar 92 is formed similarly as the collar 91, but is disposed in inverted position on the male member, whereby its shoulder 95 faces upwardly. The shoulders 94 and 95 define the upper and lower extremities of an annular groove around the male member. This groove is of such width that it will receive the spring cage catches 85 and allow for relative longitudinal movement (about 3 to 10 inches) of the catches in the groove.

The male member extends downwardly below the collar 92 to fit snugly into the tubular plug end 88 of the female member, there being several sealing rings 97 and 98 recessed in the inside wall of the bore of the plug end 88 to make the tool tight against leakage of drilling fluid and the like. Also the female member is provided with a plurality of fluid and dirt outlet ports 100, these being directed outwardly and downwardly from places in the female member where a shoulder extends inwardly from the female member, as, for example, from the upper surface of shoulder 54, to allow any dirt or fluid which might otherwise collect on such shoulders to be discharged from the female member, thus to eliminate any possibility of fluid locks in the tool. The spacing sleeve 87 is provided with a plurality of ports 101 in the lower end thereof to permit flow of fluid and dirt from within the bore of the female member out through the ports 100.

For a description of the mode of operation of the illustrated embodiment of my invention, I refer to Figs. 18 to 24 inclusive, which illustrate a sequence of steps for performing a jarring operation. Throughout these figures similar reference lines are employed to indicate the relative positions of the male member in the female member. Thus a horizontal line above each figure represents the annular and downwardly facing shoulder 105 on enlargement 23 of the male member, and a horizontal line with cross-hatches depending therefrom represents the upwardly facing annular face 106 which defines the upper end of the female member. In these schematic figures the anvil elements 45 and 46 and the screw threads 37 of the female member are represented as cross-hatched members in association with the channel 58 of the male member.

For drilling purposes the drill string will be rotated in the well in a clockwise direction (as indicated by arrow 108 in Fig. 18) by means of a rotary power source (not shown) and located at the top of the well. Now let it be assumed that the drill string has become stuck in the well at a place below the well tool and that the upper limit of torque or rotary strain of the power source (conventionally about 20,000 ft. lbs.) is insufficient to overcome the resistance developed at the stuck point, whereby a jarring operation will be required in order to release the drill string.

To proceed with a jarring operation, the operator ap-

plies a back strain on the upper end of the drill string, i.e. in a counter clockwise direction as indicated by arrow 109 in Fig. 19, of about 7,000 ft. lbs to unscrew the female threads 37 from the male threads 41, thus to position the parts as shown in Fig. 19 with the anvils 45 and 46 located in the leg 63 of channel 58 and with the column of screw threads 37 located in the space between adjacent column of screw threads 41. As explained above, disconnection of these screw threads will occur rather than at any other screw thread connection in the drill string because of the abutment of the ends of threads 37 against the stops 43 on the male member which occurs when a torque of about 7,000 ft. lbs. is applied to the drill string, whereas the section joints throughout the drill string are tightened to about 15,000 to 20,000 ft. lbs. torque.

With the anvils located in the channels 58 at the position represented in Fig. 19, the shoulder 94 of the collar 91 on the male member is adjacent the upper end of the catches 85 on the spring cage 81. For a down-jar operation from this position it is preferred to lift the male member to a position where the shoulder 95 of the collar 92 engages the lower edge of the catches 85 on the spring cage 81. A downward force is then exerted on the drill string. As the male member is free to move downwardly into the female member until the shoulder 94 of collar 91 strikes the catches of the spring cage, considerable kinetic energy is developed in the free falling drill string above the joint. Such kinetic energy coupled with the downward force exerted at the top of the well is sufficient to cause the spring strips of the spring cage to bow outwardly into the recess 86 when the shoulder 94 strikes against the catches on the spring cage. The male member and the drill string above the joint are then free to move downwardly, as indicated by arrow 110 in Fig. 20, until the hammer surface 66 strikes against anvil 45 to impart a severe down-jar to the drill string. A downward force applied to the male member when the shoulder 94 is resting on the catches 85 of the spring cage results in a down-jar of still greater severity because the force needed to expand the spring cage becomes built up in the drill string and is then released instantaneously upon release of the shoulder 94 as is explained more fully in my copending application, Serial No. 431,066, filed May 20, 1954. It is seen therefore that down-jars of varying degrees of severity may be had depending on the relative positions of the shoulder 94 and the catches 85 when a downward force is applied to the male member.

Repeated down-jars may be imparted to the tool, or preferably each such down-jar may be followed by an up-jar. To perform an up-jar operation, the male member is lifted to a position where the shoulder 94 of the collar 91 is adjacent the upper edge shoulder of the catches 85 on the spring cage. An upward tension is then exerted on the drill string whereby kinetic energy is developed in the drill string and when the shoulder 95 of collar 92 strikes against the catches 85, the spring strips of the spring cage will bow outwardly and cause the male member to be jerked upwardly in the direction of arrow 111 of Fig. 21, whereupon the hammer surfaces 67 strike against the anvils 46 to impart a severe up-jar to the drill string. The abutment shoulders 94 and 95 on the collars 91 and 92 respectively and those on the catches 85 of the spring cage are slightly bevelled to provide for outward expansion of the spring cage upon impact of these shoulders. An up-jar of maximum severity is obtained by causing interengagement of the shoulder 95 against the catches 85 and then exerting an upward pull on the drill string to stretch the drill string and develop an upward tension of sufficient strength to cause expansion of the spring cage and instantaneous release of the shoulder 95 as is more fully explained in my said copending application, Serial No. 431,066.

Usually such jarring operation will loosen the drill string its stuck point and the parts of the tool may

then be reengaged in the position shown in Fig. 18 for continuing the drilling operation. Should the jarring operations fail to release the stuck drill string the male member may then be recovered by removing it from the female member. Such removal of the male member requires that that member be lowered by a predetermined short distance from the position illustrated in Fig. 21 to the position illustrated in Fig. 22 at which position the recesses 47 of the anvils 45 and 46 are aligned with the lugs 65 and 76 respectively on the male member. The male member is then rotated in a counter-clockwise direction (arrow 113 in Fig. 23) to locate the anvils in the outlet leg 60 of the channel from where the anvils may become disengaged from the channels by lifting the male member (arrow 114 in Fig. 24) thereby to withdraw the male member from the female member.

It is understood that the form of my invention herein shown and described is a practical and preferred embodiment of the same, and that changes may be resorted to within the scope of my invention which is not limited to the details disclosed but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures.

What I claim is:

1. A jar tool for well operations comprising a male member provided with screw threads, a female member provided with screw threads, said threads being interrupted along longitudinally extending spaces to define thread columns whereby the thread columns on each member are registerable with the thread spaces on the other member to permit relative axial movement of the members without screw thread interengagement, one of the members having a longitudinally extending channel formed therein to provide hammer surfaces in each end thereof, an anvil on the other member registerable in said channel for impacting against said hammer surfaces, spring means on one of the members, releasable spring engaging means on the other of said members, said means being disposed on said members respectively in a position such that the spring means and spring engaging means are interengaged when the anvil is disposed at a position between said hammer surfaces.

2. A jar tool for well operations comprising an elongate male member and an elongate female member, the male member having an outside wall and the female member having an inside wall, the male member being telescopically receivable in the female member, one of said members having a longitudinally extending channel formed in the said wall thereof with the opposite ends of the channel defining hammer shoulders, an anvil integral with the wall of the other of said members, the anvil being relatively movable in the channel for striking against said hammer shoulders, a spring cage assembly extending around the male member, a catch on said cage assembly, an annular groove formed around one of said members for receiving said catch, said groove being defined between two annular shoulders facing toward each other, said annular shoulders being spaced apart by a distance substantially greater than the axial dimension of said catch, the catch, the groove, the anvil and the channel being disposed on their respective members in a position such that the catch is positioned in the groove when the anvil is disposed at a position between said hammer shoulders, whereby free axial movement of the members and movement of the anvil in the channel are interrupted upon engagement of the catch with either of said annular shoulders.

3. A jar tool for well operations comprising an elongate male member and an elongate female member, the male member having an outside wall and the female member having an inside wall, the male member being telescopically receivable in the female member, one of said members having a longitudinally extending channel formed in the said wall thereof, an anvil integral with the said wall of the other member, the anvil being rela-

tively moveable longitudinally in the channel, the channel comprising two longitudinally extending legs parallel to each other and spaced apart and a circumferentially extending leg interconnecting said two longitudinally extending legs, the circumferentially extending leg being defined by opposite sides and a bottom extending between said sides, said one member having axially spaced apart hammer shoulders defining the ends respectively of one of said longitudinally extending legs for impact against the anvil, and a lug projecting radially outward from said bottom, the lug being spaced between said sides, the anvil having a circumferentially extending passage formed therein for accommodating the lug to allow relative movement of the anvil through the circumferentially extending leg when the members are in position with the anvil passage in alignment with the lug, the anvil being abutable against the lug when out of lug-anvil alignment, and the abutment surfaces of the lug and the anvil being complementally inclined so that when the anvil is brought into abutment against the lug, the anvil will tend to ride on the incline of the lug thereby to expend the force of abutment and prevent shearing off of the lug.

4. A jar tool for well operations comprising an elongate male member and an elongate female member, the male member having an outside wall and the female member having an inside wall, the male member being telescopically receivable in the female member, one of said members having a longitudinally extending channel formed in the said wall thereof, with the opposite ends of the channel defining hammer shoulders, an anvil integral with the wall of the other of said members, the anvil being relatively moveable longitudinally in the channel and being of a predetermined extent measured axially of said members, the anvil being of substantially lesser axial extent than the space between said hammer shoulders, the difference in the axial extents of the anvil and the channel being a first slack dimension, a spring cage extending around the male member, a catch on the cage extending radially from the cage, one of the members having a circumferentially extending groove formed therein for receiving the catch, that member other than said groove-containing

member being a cage-retaining member, the cage-retaining member having stop means engageable with the cage for limiting axial movement of the cage with respect to the cage-retaining member, said groove being defined between two circumferentially extending shoulders facing toward each other, said groove shoulders being spaced apart by an axial dimension of substantially greater extent than the axial extent of the catch, the difference in the axial extents of the catch and the groove being a second slack dimension, said first slack dimension being substantially greater than said second slack dimension, the catch extending into the groove when the anvil is disposed at a position between said hammer shoulders, the cage being expandable radially outward to release the catch from within the groove axially beyond said shoulders for allowing the anvil to strike against said hammer shoulders.

5. A jar tool according to claim 4 in which said groove is defined between two axially spaced apart collars extending around the male member, said circumferentially extending shoulders being the mutually facing shoulders of the collars, the remote sides of the collars which are opposite said circumferentially extending shoulders respectively being inclined to permit gradual expansion of the cage with the catch riding on the inclined shoulders toward positioning in said groove.

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