

June 14, 1960

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2,940,730

HYDRAULIC RELEASE, SAFETY TOOL JOINT

Filed March 25, 1957

3 Sheets-Sheet 1

Fig. 1A.

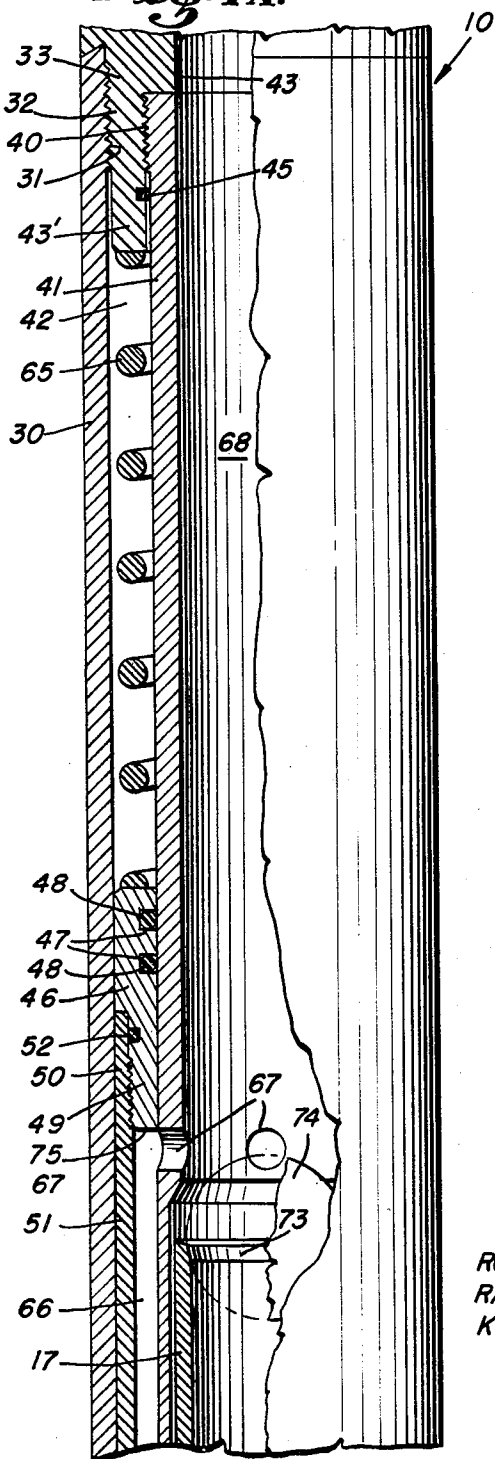
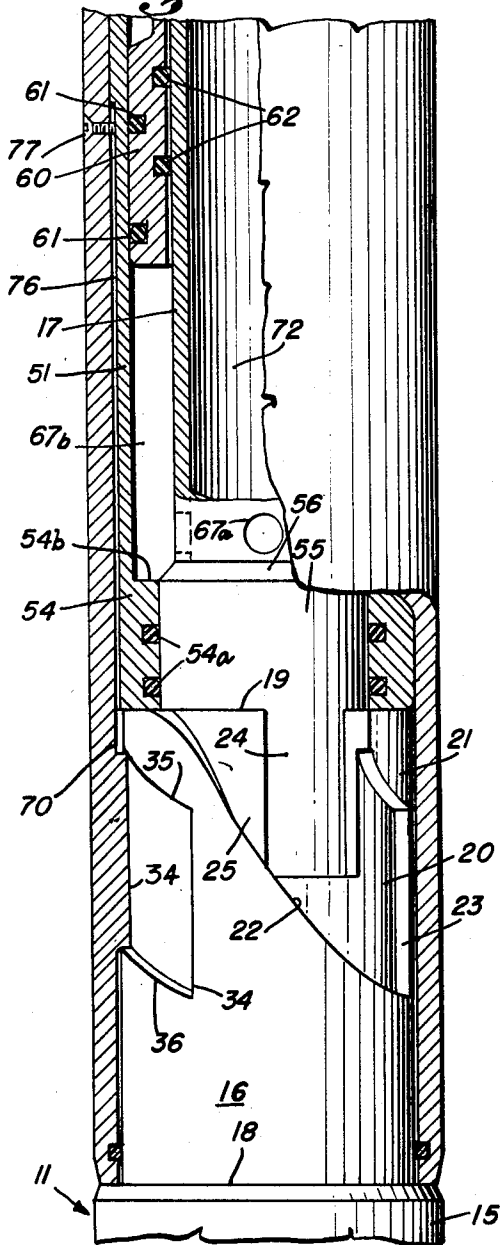


Fig. 1B.



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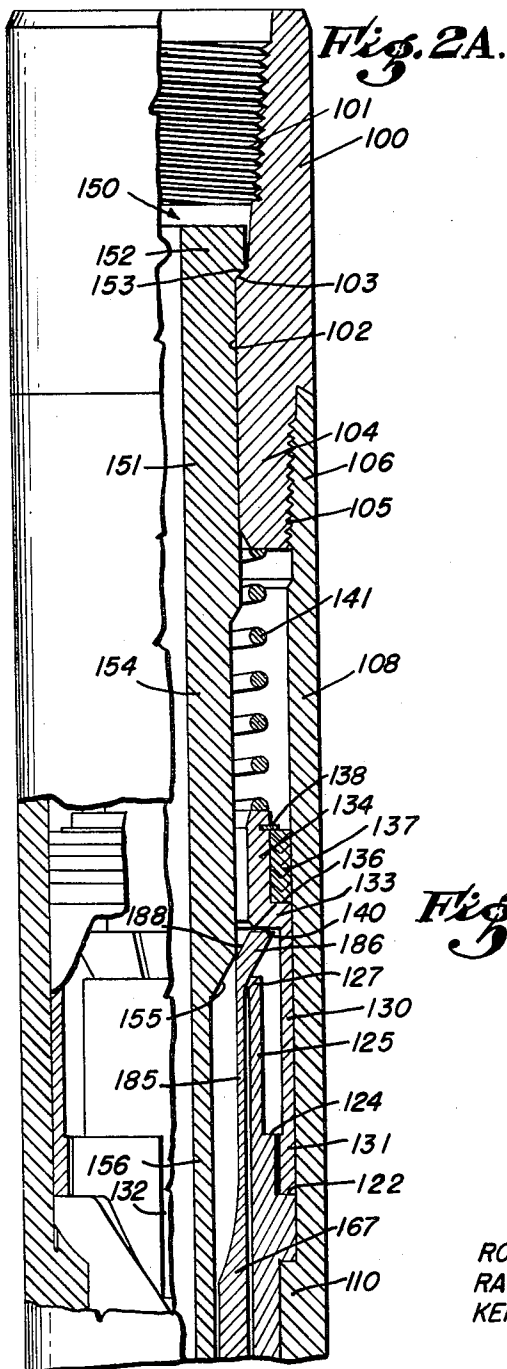
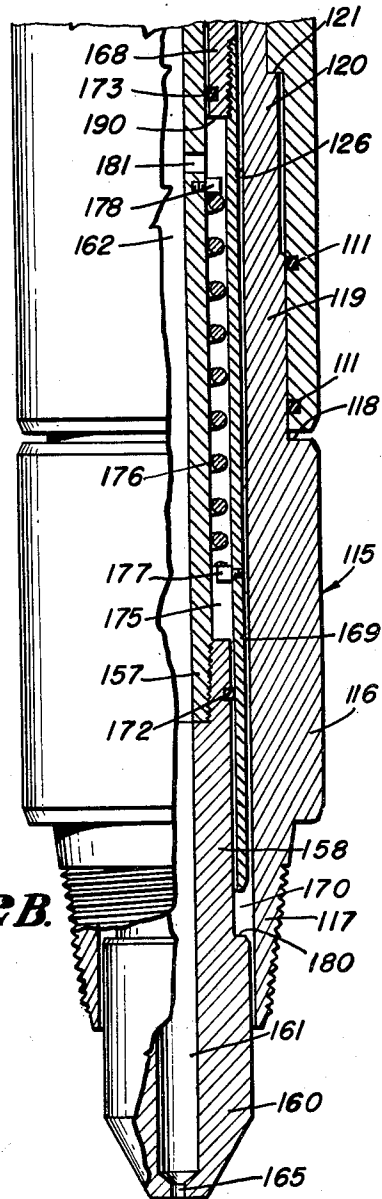
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3 Sheets-Sheet 2



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HYDRAULIC RELEASE, SAFETY TOOL JOINT

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3 Sheets-Sheet 3

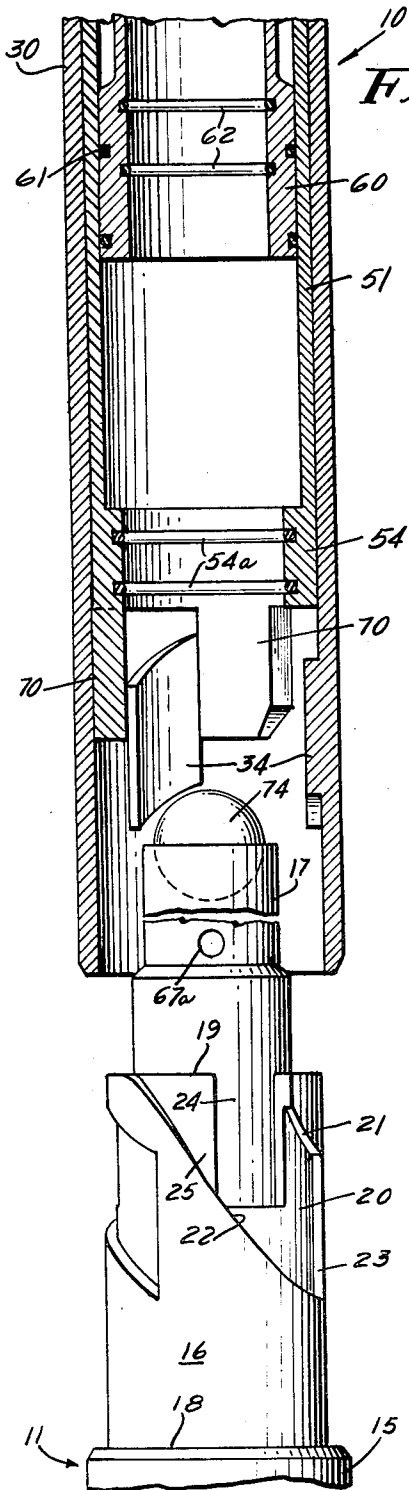


Fig. 3.

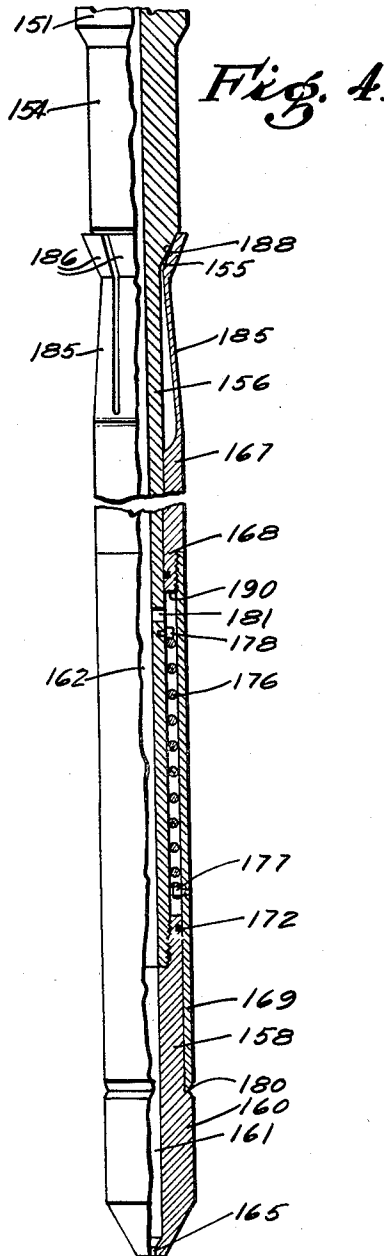


Fig. 4.

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HYDRAULIC RELEASE, SAFETY TOOL JOINT

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13 Claims. (Cl. 255—28)

This invention relates generally to well drilling equipment or apparatus and relates more particularly to improvements in releasable, safety joints for well strings and the like.

While the invention has particular utility in connection with oil well drilling equipment, and is herein shown and described in connection therewith, it is to be understood that its utility is not confined thereto.

In the drilling of oil wells, strings of different types are operated and there are occasions when it is desired to detach and/or reattach portions of the strings to other portions thereof. For example, the lower portion of a string may become jammed or stuck so that it cannot readily be pulled or raised. Under such circumstances, it is desirable to detach the unfrozen or upper part of the string and to withdraw the recoverable portion.

Also, in at least one type of offshore drilling operation it is essential to disconnect and to reconnect certain portions of the string at different stages of said operation, and under some circumstances it is highly desirable to detach the upper portion of the string very quickly, as, for example, under emergency conditions such as a sudden storm.

It is therefore an object of the present invention to provide a safety joint that will meet the various requirements of the conditions set forth above.

It is another object of the invention to provide a device of this character having a barrel unit and a mandrel to which the barrel unit may be attached automatically.

Still another object of the invention is to provide apparatus of this character having latch means which, when the barrel unit is seated on the mandrel, automatically locks or latches said unit in said seated position.

A further object of the invention is to provide apparatus of this character having simple and effective latch releasing means.

A still further object of the invention is to provide apparatus of this character having means for hydraulically effecting relief of the latch.

It is another object of the invention to provide apparatus of this character having means insertable into the string and seating within the safety joint for causing the hydraulic pressure to effect relief of said barrel unit from the mandrel.

Still another object of the invention is to provide apparatus of this character wherein the last mentioned means may be drilled out.

A further object of the invention is to provide a device of this character that is relatively simple and sturdy in construction, and effective and reliable in operation.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings which represent certain embodiments. After considering these examples, skilled persons will understand that variations may be made without departing from the principles disclosed, and we contemplate the employment

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of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings:

5 Fig. 1A is a longitudinal section of the upper portion of a releasable, safety joint embodying the present invention;

Fig. 1B is a longitudinal section of the lower portion of said joint;

10 Fig. 2A is a side elevation with portions broken away of the upper end of a releasable safety joint of an alternative arrangement;

Fig. 2B is a side elevation, with portions broken away of the lower end of such joint having the alternative arrangement;

15 Fig. 3 is a view similar to Fig. 1B but showing the barrel unit separated from the mandrel; and

Fig. 4 is a side view, partially in section, of the releasing tool of the arrangement disclosed in Figs. 2A and 2B.

20 Referring more particularly to Figs. 1A and 1B, there is shown a safety joint having a barrel unit, indicated generally at 10, and a mandrel, indicated generally at 11. The mandrel 11 has an externally threaded pin, not shown, of the usual character for attachment in the usual manner to the adjacent end of a drill string part, also not shown.

It is to be understood, of course, that there may be other means for connecting the parts of the device to adjacent drill string parts, in which case, the approximate respective connector parts will be provided on the mandrel and barrel unit hereinafter described in place of the threaded pin and socket connector herein shown.

25 Mandrel 11 includes a tubular body 15 from the upper end of which extends a reduced diameter body portion 16. From the upper end of the body portion 16 a tubular shank 17 of reduced diameter with respect to the body portion 16 extends upwardly. There is an annular external shoulder 18 at the junction of the body portion 15 and the body portion 16, and a second shoulder, 30 19, at the junction of the body portion 16 and the tubular shank 17. From the shoulder 19 a suitable number of downwardly inclined spiral or helical recesses 20 are provided, there being three of said recesses in the present disclosure although some other suitable number may be used.

35 The top and bottom walls 21 and 22 respectively of each recess 20 are helically shaped and generally parallel to each other, while the closed end wall 23 extends longitudinally with respect to the mandrel.

40 The upper end of each recess 20 is open and at the open end of each of the recesses, there is a key sleeve locking slot 24 formed in the bottom wall 25 of the recess, said locking slot 24 being open at the upper end and extending longitudinally downwardly from the shoulder 19.

45 The barrel unit 10 comprises a tubular barrel 30 having internal threads 31 at the upper ends thereof for threadable reception of the externally threaded lower portion 32 of a top sub 33 which is connected to a drill string or the like in the usual, well-known manner.

50 Within the barrel 30 of the barrel unit 10, there are a plurality of interior lugs 34 adjacent the lower end of said barrel but spaced inwardly or upwardly thereof, said lugs having their top and bottom ends 35 and 36 respectively inclined at substantially the same angle as the upper and lower walls 21 and 22 respectively of the recesses 20, there being a lug 34 for each recess or slot 20 and said lugs are slidably receivable in said recesses.

55 The lower end portion of the top sub has an enlarged diameter, internally threaded part 40 for threadable reception of the externally threaded upper end

portion of a fixed sleeve or sleeve guard 41 having an external diameter substantially less than the internal diameter of the barrel 30 so as to provide a longitudinally extending annular chamber 42, the interior diameter of said sleeve being substantially the same as the interior diameter of the bore 43 of the top sub. There is a depending annular flange 43' at the lower end of the top sub and the interior and exterior walls of said flange are spaced from the adjacent exterior wall of the sleeve 41 and the adjacent interior wall of the barrel 30 respectively. The inner side of the flange 43' is provided with an annular groove to which is disposed a sealing ring 45 of any suitable material for effecting a seal between said flange and the sleeve 41.

Slidable within the barrel 30 is a key sleeve ring 46, of such thickness as to be slidable in the chamber 42. Adjacent the upper end of the key sleeve ring 46 are a pair of annular grooves 47 which are longitudinally spaced apart and in which are received respective sealing rings 48 to provide a seal between said key sleeve ring and said sleeve 41. The key sleeve ring has a lower end portion 49 of reduced external diameter and externally threaded for threadable reception of an internally threaded upper end portion 50 of the key sleeve 51. An external annular groove is provided adjacent the upper end of the portion 49 of the key sleeve ring for a sealing ring 52. As the key sleeve and the key sleeve ring are secured together these parts are slidable together within the barrel 30. However, the internal diameter of the key sleeve is substantially greater than the external diameter of the fixed sleeve 41 so that there is an annular chamber between said key sleeve 51 and fixed sleeve 41. At the lower end, the key sleeve 51 is provided with an inwardly extending annular portion 54, the inner diameter of which is such as to receive a part 55 of the mandrel which extends upwardly of the shoulder 19 between the part 16 of the mandrel and the shank 17, the portion 55 being of smaller diameter than the body portion 16 and of greater diameter than said shank 17, there being a tapered portion 56 between said portion 55 and shank 17.

Annular portion 54 is provided with a plurality of annular grooves spaced apart longitudinally of said sleeve 41, said grooves having annular sealing rings 54a disposed therein for sealing engagement with said part 55 of the mandrel.

The lower end of the sleeve 41 is internally enlarged for slidable reception of the shank 17. Sleeve 41 also has an outwardly extending annular portion 60, the external diameter of the portion 60 being slightly smaller than the internal diameter of the key sleeve so that said key sleeve may slide on said portion 60. A pair of longitudinally spaced annular grooves are provided in the outer side of said portion 60 for reception of respective sealing rings 61 to provide a sliding seal between said portion 60 and said key sleeve 51. The fixed sleeve 41 is also provided with a pair of annular internal grooves which are longitudinally spaced apart and located adjacent the lower end of said fixed sleeve, there being respective annular seals 62 disposed in said grooves. The portion 60 with the respective seals 61 and 62 may be termed the mid-seal as it is located substantially midway between the lower end of the key sleeve and the key sleeve ring when the key sleeve is in its lowermost position whereas the lower end thereof rests on the shoulder 19 of the mandrel. There is means, for yieldingly urging said key sleeve to said lowermost position, said yielding means comprising a spring 65 in the chamber 42 between the lower end of the part 43 of the top sub and the upper end of the key sleeve ring 46. Between the fixed sleeve 41 and the upper part of the key sleeve is an annular chamber 66 having communication by means of ports 67 in the fixed sleeve 41 with the interior bore 68 of said fixed sleeve. When the lower end of the key sleeve rests on the shoulder 19 of the mandrel, the

ports 67 are positioned just below the lower end of the key sleeve ring. Also, when the lower end of the key sleeve 51 rests on said shoulder 19 keys 70 carried by the key sleeve at the lower end thereof are disposed in the key slots 24 and prevent the lugs 34 from moving out of the recesses 20 thereby locking the barrel unit and the mandrel together so that they will rotate together in either direction.

The mandrel has an internal bore 72 the diameter of which is somewhat less than the diameter of the bore 68 of the barrel unit. At the upper end of the shank 17 of the mandrel, the bore 72 flares outwardly to provide a seat 73 for a ball 74 which is adapted to be inserted into the string at the upper end thereof. The ball is adapted to pass downwardly with the liquid in the string until said ball reaches the seat 73 and seats thereon, whereupon the fluid pressure above the ball is transmitted through the ports 67 into the chamber 66. This pressure in chamber 66 acts on the lower end 75 of the key sleeve ring 46 and forces same upwardly against the resistance of spring 65. The key sleeve 51 is carried upwardly with the upward movement of the key sleeve ring and draws the keys 70 upwardly out of their slots 24 to thereby permit the lugs 34 to move spirally upwardly out of the recesses 20. There is means provided for permitting the key sleeve to move longitudinally but to prevent rotation of said sleeve relative to the barrel. This means comprises a groove 76 which extends longitudinally of the key sleeve 51 and a screw 77 which is screwed into a tapped opening provided therefor in the barrel, the inner end of said screw being disposed in said groove 76. Pressure equalizing ports 67a are provided in the mandrel shank 17, said ports connecting the interior of the mandrel with space 67b between the lower end of the sleeve guard and an interior shoulder 54b of key sleeve 51.

Ball 74 may be of metal or it may be of some material that may be readily drilled such as, for example, a plastic material. When the ball has been removed so that the hydraulic pressure on the lower end 75 of the key sleeve ring is relieved, spring 65 will move the key sleeve downwardly. When the barrel unit is separated from the mandrel the lower end of said key sleeve will engage the upper sides of the lugs 34. However, when the barrel unit is attached to the mandrel the lower end of the key sleeve engages said shoulder 19, as hereinabove described.

More specifically, the barrel unit is automatically connected to the mandrel as said barrel unit is lowered onto the mandrel by means of the pipe string to the lower end of which the barrel unit is connected. The weight of the string and barrel unit is sufficient to easily compress the spring 65 and move the key sleeve upwardly when the lower ends of the keys 70 engage the shoulder 19 of the mandrel as the lugs 34 move into the helical recesses 20. As these recesses have a relatively sharp inclination or pitch, the lugs readily slide into same and when they reach the end walls 23 of the recesses, the keys slip into the key slots 24.

When releasing the barrel unit from the mandrel, after the ball 74 has been dropped and the pressure above described has raised the key sleeve to the release position, a straight upward pull will effect separation of the barrel unit from the mandrel due to the inclination of the helical recesses 20.

Referring to Figs. 2A and 2B the device comprises a top sub 100 having the usual tapered, internally threaded socket 101 for connection to the pin of an adjacent portion of a well string, not shown. A bore 102 extends downwardly from said socket and there is an annular shoulder 103 at the junction of said bore 102 and socket 101. At the end of the top sub opposite the socket 101 there is a reduced diameter portion 104 which is externally threaded at 105 for threadable connection to the internally threaded upper end portion 106 of a tubular barrel 108. Within the barrel 108 are a plurality of internal

lugs 110 which are annularly spaced apart. The lugs 110 are similar to the lugs 34 of the arrangement shown in Figs. 1A and 1B, the upper and lower ends of said lugs being spirally inclined. The lugs 110 are spaced upwardly of the lower end of the barrel 108 and adjacent said lower end are a pair of internal, annular grooves which are longitudinally spaced apart and in which are disposed annular sealing rings 111.

A mandrel, indicated generally at 115, includes a body 116 from the lower end of which depends an externally threaded pin 117 whereby the mandrel may be threadably connected to an adjacent portion of the string. At the opposite end of the body 116 there is a shoulder 118 from which there extends axially upwardly a reduced diameter portion 119. From the latter there extends upwardly a slightly reduced diameter portion 120 adjacent the upper end of which are a plurality of annularly spaced helical or spiral recesses 121 for reception of the lugs 110. It is to be noted that the lug and slot arrangement in the mechanism of Figs. 2A and 2B is similar to the lug and slot arrangement of the mechanism shown in Figs. 1A and 1B, the slots being open at their upper ends and extending downwardly from a shoulder 122. Above the shoulder 122 there is a reduced diameter portion 123 which extends axially upwardly from a shoulder 124 and the interior bore 126 of the mandrel flares outwardly at 127 at the upper free end of the portion 123. Slidable within the barrel 108 is a key sleeve 130 having a plurality of annularly spaced depending keys 131 adapted to be received in key slots 132 at the entrance of the recesses 121. The arrangement is similar to that shown in Fig. 1B, the key 131 preventing removal of the lug 110 from the recesses 121 when the key sleeve is in the lowermost position and the keys disposed in said slots 132. At the upper end, the key sleeve has an inwardly extending annular portion 133 from the inner edge of which there is an upwardly extending annular collar 134. The upper side of the annular portion 133 forms a shoulder 136 on which is seated an annular packing element 137 which encircles the major portion of the collar 134 and is held in position by a snap ring 138 received in a groove provided therefor in the collar adjacent the upper end thereof. The underside of the annular portion 133 comprises a shoulder 140, the purpose of which will be described hereinafter. A coil spring 141 reacts between the upper end of the collar 134 and the portion 104 of the top sub 100 to urge the key sleeve downwardly into the locking position. The downward movement of the key sleeve is limited by engagement with the lugs 110.

Means for raising the key sleeve 130 so as to move the keys 131 out of the key slots 132 comprises a releasing tool, indicated generally at 150. The releasing tool is inserted into the upper end of the drill string in the well-known manner and drops down through said string and into the safety release joint. The releasing tool comprises a body portion 151 having an enlarged head 152 with an external shoulder 153 between said body and head, said shoulder 153 being received on the shoulder 103 of the top sub 100. The body 151 has a depending somewhat reduced diameter portion 154 with an inwardly and downwardly inclined annular cam face 155 from the lower end of which extends a tubular sleeve 156. At the lower end of the sleeve 156 there is an externally threaded portion 157 for threadable reception in an internally threaded socket at the upper end of the reduced diameter portion 158 of a member 160 having an axially extending bore 161 of substantially the same diameter as the bore 162 of the sleeve 156, part 154, body 151 and head 152 of the releasing tool. Bore 161 has a downward opening, one of restricted size, which comprises a restricted orifice 165.

Slidable on the sleeve 156, and adjacent the upper end thereof, is an annular piston 167 having a depending reduced diameter portion 168 that is externally threaded for threadable reception of the internally threaded upper

end portion of a tubular skirt 169 slidable in the bore 126 of the mandrel and extending downwardly into an annular chamber 170 between the reduced diameter portion 158 of the member 160 and the wall of the bore 126 of the mandrel when the releasing tool is disposed within the barrel unit and mandrel as shown in Figs. 2A and 2B. An annular seal 172 is disposed in an external annular groove adjacent the upper end of the portion 158 to provide a seal between said portion and the sleeve 169. An annular sealing ring 173 is disposed in an internal annular groove in the piston 167 to provide a seal between said piston and sleeve portion 156 of the releasing tool.

As the internal diameter of the sleeve 169 is substantially greater than the external diameter of the sleeve portion 156 an elongated annular chamber 175 is provided between these parts for reception of a coil spring 176 having one end reacting against a plurality of annularly spaced set screws 177 provided in tapped openings in sleeve 169. The opposite end of the spring 176 reacts against a plurality of annularly spaced set screws 178 received in tapped openings provided therefor in the sleeve 156, the outer ends of said set screws 178 extending into the chamber 175 adjacent the upper end thereof. With this arrangement the spring 176 urges the sleeve 169 and piston 167 downwardly. Downward movement of the sleeve and piston is limited by a shoulder 180 at the upper end of the member 160, the lower end of said sleeve 169 engaging said shoulder when the sleeve and piston 167 are at their lowermost position. One or more ports 181 in the sleeve 156 provide means for the transmission of fluid pressure from the bore 162 of the releasing tool to the chamber 175.

Piston 167 is provided with a plurality of resilient fingers 185 which extend longitudinally upwardly from the upper end of said piston. At the upper ends of the fingers 185 are outwardly and upwardly inclined end portions 186. Normally the free ends of the fingers 185 are resting against the outer side of the sleeve 156 with the inner sides 188 of said end portions 186 lying against the cam surface 155 of the releasing tool.

When the pressure in the chamber 175 increases in value sufficiently to overcome the resistance of spring 176, the piston 167 moves upwardly thereby causing the finger tips 186 to move upwardly and outwardly into engagement with the shoulder 140 of the key sleeve. As shown in Figs. 2A and 2B the piston 167 of the release tool has been raised by fluid pressure to a point where the upper ends of the portions 186 of the fingers 185 are just about to engage the shoulder 140 of the key sleeve. As the piston continues to move upwardly, the key sleeve is correspondingly moved upwardly to a position whereat the keys 131 are out of the key slots in the mandrel so that the barrel unit may be removed from the mandrel by an upward pull on said barrel unit effected through the string to which said barrel unit is attached.

The purpose of having the orifice 165 is to permit continued circulation of fluid as long as the barrel unit is connected to the mandrel.

It is believed that the invention and many of the attendant advantages thereof will be understood from the foregoing description and it is believed that it will be apparent that various changes may be made in the form, construction and arrangements of the parts of the invention without departing from the spirit and scope thereof or sacrificing all of its material advantages, the forms hereinbefore described being by way of example.

We claim:

1. A hydraulic release, safety tool joint for incorporation into a pipe string, comprising: a tubular mandrel having a body portion with a reduced diameter part, at the upper end of which is a base portion of a shank which extends upwardly from said base, said base portion being of reduced diameter with respect to said body part and the portion of the shank extending upwardly from the base thereof being of reduced diameter with respect to

said base, the body part being provided with a plurality of annularly spaced, external, helical recesses each of which is open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over the reduced diameter part of the mandrel and having a plurality of internal lugs having helical upper and lower ends, said lugs being adapted to be removably received in the respective helical recesses of the mandrel; a sleeve guard within the barrel and secured at the upper end, said sleeve guard having an external diameter substantially less than the internal diameter of the barrel; a tubular key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots to lock the lugs in said recesses, said key sleeve being slidable upwardly into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; and means, including means insertable into said string, for raising the normal fluid pressure within the string and barrel unit and causing said increased pressure to be exerted on a part operably connected with the key sleeve for urging said key sleeve to a position whereat the keys thereof are moved out of said key slots.

2. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a body portion with a reduced diameter part, and a shank at the upper end of said reduced diameter part, said shank having a base portion of reduced diameter with respect to said body part and located adjacent same, the portion of the shank extending upwardly from said base being of reduced diameter with respect to said base, the body part being provided with a plurality of annularly spaced, external, helical recesses each of which is open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over the reduced diameter part of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective helical recesses of the mandrel; a sleeve guard within the barrel and secured at the upper end, said sleeve guard having an external diameter substantially less than the internal diameter of the barrel; a tubular key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots for locking said lugs in said recesses, said key sleeve being slidable upwardly into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; and means, including means insertable into the barrel unit for raising the normal fluid pressure within the barrel unit and causing said increased pressure to be exerted on a part operably connected with the key sleeve for urging said key sleeve to a position whereat the keys thereof are moved out of said key slots.

3. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a body portion with a reduced diameter part, at the upper end of which is a shank base from which a shank extends, said base portion being of reduced diameter with respect to said body part and the portion of the shank extending upwardly from the base thereof being of reduced diameter with respect to said base, the body part being provided with a plurality of annularly spaced, external, recesses each of which is open at the upper end, and an upwardly opening key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a sleeve guard within the barrel and secured at the upper end, said sleeve guard having an external diameter substantially less than the internal diameter of the barrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots, said key sleeve being slidable upwardly

into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; and means, including means insertable into the string to which the barrel unit is attached, for raising the normal fluid pressure within said barrel; and a pressure responsive part operable upon said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots.

4. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a body portion with a reduced diameter part, at the upper end of which is a shank base from which a shank extends, said base portion being of reduced diameter with respect to said body part and the portion of the shank extending upwardly from the base thereof being of reduced diameter with respect to said base, the body part being provided with a plurality of annularly spaced, external, recesses each of which is open at the upper end, and an upwardly opening key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a sleeve guard within the barrel and secured at the upper end, said sleeve guard having an external diameter substantially less than the internal diameter of the barrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots, said key sleeve being slidable upwardly into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; and means, including means insertable into the string to which the barrel unit is attached, for raising the normal fluid pressure within said barrel; a pressure responsive part operable upon said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots; and passageway means for maintaining a reduced circulation of fluid through the string.

5. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external, recesses each of which is open at the upper end, and an upwardly opening key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over a portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots; yielding means urging said key sleeve downwardly; means, including means insertable into the barrel unit for raising fluid pressure within said barrel; and a pressure receiving part operable by said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots.

6. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external recesses each of which is open at the upper end, and an upwardly opening key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over a portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots; yielding means urging said key sleeve downwardly; means, including means insertable into the barrel unit for raising the fluid pressure within said barrel; a pressure receiving part operable by said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots; and passageway means for maintaining a reduced circulation of fluid through the string.

7. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external recesses each of which is open at the upper end,

and an upwardly opening longitudinally extending key slot at the open end of each of said recesses, said mandrel having an internal seat at the upper free end thereof; and a barrel unit including a tubular barrel adapted to slide over an upper end portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots; a part on said key sleeve against which fluid pressure in the joint is exerted; yielding means urging said key sleeve downwardly with a predetermined force; and a ball insertable into the barrel unit and seatable on the mandrel seat for raising the fluid pressure within the joint and causing said increased pressure to act on said part of the key sleeve for urging said key sleeve to a position whereat the keys thereof are moved out of said key slots.

8. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external recesses each of which is open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses, said mandrel having an internal seat at the upper free end thereof; and a barrel unit including a tubular barrel adapted to slide over an upper end portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots; a part on said key sleeve against which fluid pressure in the joint is exerted; yielding means urging said key sleeve downwardly with a predetermined force; and a ball of material that may be drilled by a drill bit insertable into the barrel unit and seatable on the mandrel seat for raising the fluid pressure within the joint and causing said increased pressure to act on said part of the key sleeve for urging said key sleeve to a position whereat the keys thereof are moved out of said key slots.

9. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external recesses each of which is open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over an upper end portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel, said barrel unit having a shoulder in the upper end portion; a sleeve guard within the barrel and secured at the upper end, said sleeve guard having an external diameter substantially less than the internal diameter of said barrel; a key sleeve slidable in the barrel and having depending keys at the lower end for reception in the key slots, said key sleeve being slidable upwardly into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; and means insertable into the barrel unit for raising the normal fluid pressure within the barrel, said means having a pressure responsive part engageable with the key sleeve and actuated by said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots.

10. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a plurality of annularly spaced, external, recesses each of which is open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over an upper end portion of the mandrel and having a plurality of internal lugs adapted to be removably received in the respective recesses of the mandrel, said barrel unit having a shoulder in the upper end portion; a sleeve guard secured within the barrel, said sleeve guard having an external diameter substantially less than the internal diameter of said barrel; a key sleeve slidable in the barrel and

having depending keys at the lower end for reception in the key slots, said key sleeve being slidable upwardly into the space between said barrel and sleeve guard; yielding means urging said key sleeve downwardly; means insertable into the barrel unit for raising the normal fluid pressure within the barrel, said means having a pressure responsive part engageable with the key sleeve and actuated by said increased pressure to urge said key sleeve to a position whereat the keys thereof are moved out of said key slots; and passageway means for maintaining a reduced circulation of fluid through the string.

11. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a body portion with a reduced diameter part, from which extends a shank having a base adjacent to said body portion, said base portion being of reduced diameter with respect to said body part and the portion of the shank extending upwardly from the base thereof being of reduced diameter with respect to said base, the body part being provided with a plurality of annularly spaced, external recesses inclined from the vertical and open at the upper end and an upwardly opening longitudinally extending key slot at the open end of each of said recesses, said shank having a plurality of openings therein adjacent the base, and an internal seat at the upper free end thereof; and a barrel unit including a tubular barrel adapted to slide over the reduced diameter body part and having a plurality of internal lugs adapted to be received in the respective recesses of the mandrel; a top sub threadably attached to the upper end of the barrel; a sleeve guard having an external diameter substantially less than the internal diameter of the barrel and having the upper end thereof threadably secured to the top sub, said sleeve guard depending within the barrel and having an enlarged lower end portion slidable over the shank and provided with openings therethrough adjacent the enlarged portion, said sleeve guard also having a lower end portion of enlarged external diameter, the latter being somewhat less than the internal diameter of the barrel; a tubular key sleeve slidable in the barrel and received slidably between the interior wall of the barrel and the exterior surface of the enlarged lower end portion of the sleeve guard, the lower end of said key sleeve having an enlarged internal portion slidable on to the shank base and from which depend a plurality of keys slidably receivable in the key slots of the reduced diameter body part; a key sleeve ring threadably connected to the upper end of the key sleeve, said key sleeve ring being slidable within the space between the sleeve guard and the barrel, the key sleeve ring having a lower end portion disposed within the key sleeve and located just above the openings in the sleeve guard when the barrel unit is operably attached to the mandrel; and a ball receivable within the bore of the sleeve guard and adapted to seat on the internal seat at the free end of the mandrel shank.

12. A hydraulic release, safety tool joint, comprising: a tubular mandrel having a body portion with a reduced diameter part, at the upper end of which is a shank, the body part being provided with a plurality of annularly spaced, external recesses inclined from the vertical and open at the upper end, and an upwardly opening longitudinally extending key slot at the open end of each of said recesses; and a barrel unit including a tubular barrel adapted to slide over the shank and reduced diameter body part and having a plurality of internal lugs adapted to be received in the respective recesses of the mandrel; a top sub threadably received within the upper end of the barrel and having an internal shoulder; a tubular key sleeve slidable in the barrel and having an internal shoulder, the lower end of said key sleeve having a plurality of keys slidably receivable in the key slots of the body part; yielding means urging the key sleeve downwardly; and a releasing tool comprising a tubular body having a shoulder adjacent the upper end engageable with the shoulder of the top sub and having a reduced diam-

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eter lower end portion with an upwardly and outwardly inclined annular shoulder at the upper end of said reduced diameter portion, an annular piston slidable on said reduced diameter portion, a plurality of longitudinally extending annularly spaced fingers on the upper end of said piston, each of said fingers terminating at the upper free end in an enlarged tip having an inclined surface engageable with the inclined shoulder whereby said finger ends will be forced outwardly into engagement with the shoulder of the key sleeve when the piston is moved upwardly, a tubular skirt on said piston, said skirt having a larger internal diameter than the external diameter of the reduced diameter part of the releasing tool body so as to provide a pressure chamber therebetween, an end member attached to the lower end of the reduced diameter part of the tubular body of the releasing tool, and yielding means urging the skirt and key sleeve downwardly, the reduced diameter portion of the tubular body of the releasing tool having ports therein connecting

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the interior of said tool with said pressure chamber below the lower end of said piston.

13. The invention defined by claim 12, wherein the lower end member of the releasing tool is provided with a restricted passage longitudinally therethrough.

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