

Feb. 22, 1949.

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2,462,477

SAFETY JOINT

Original Filed May 13, 1940

3 Sheets-Sheet 1

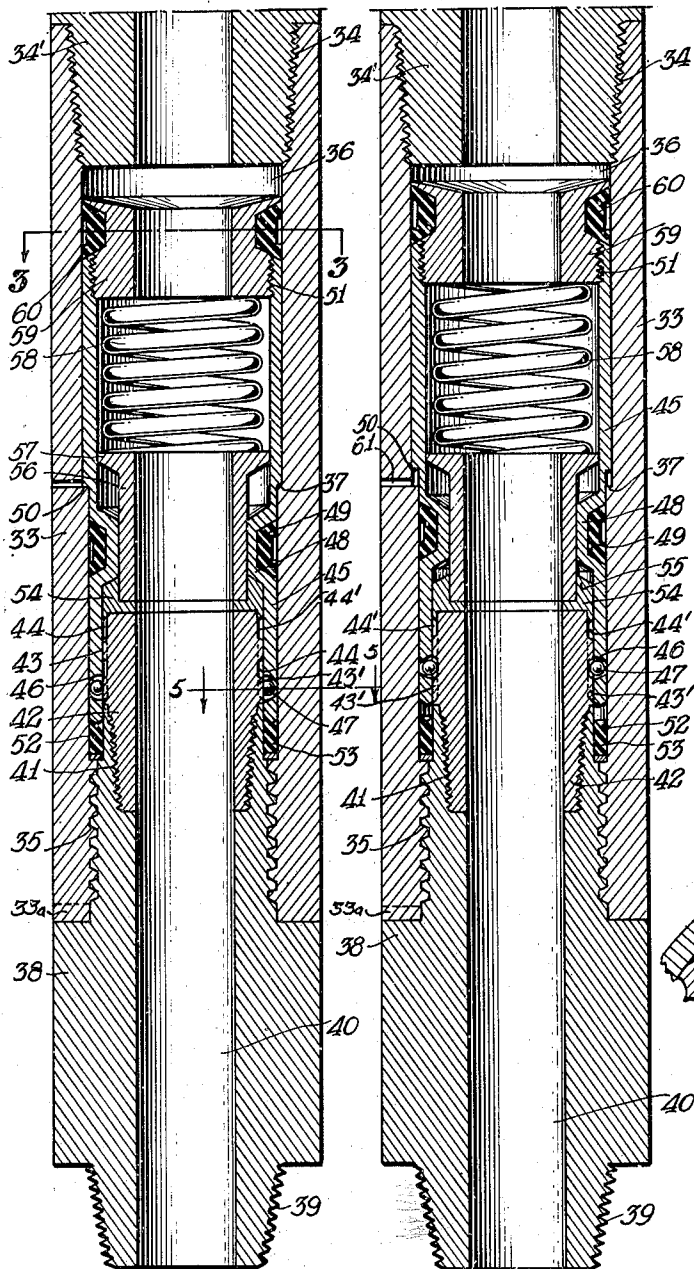
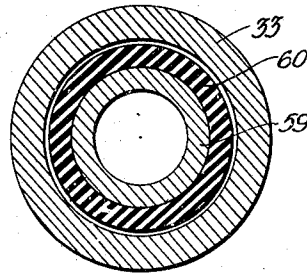


Fig. 3.

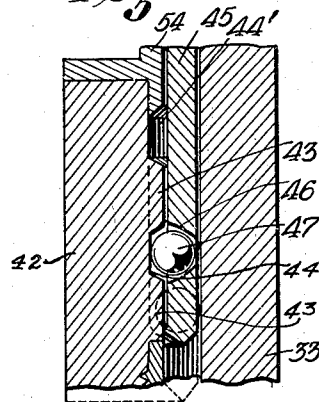


Fig. 4.

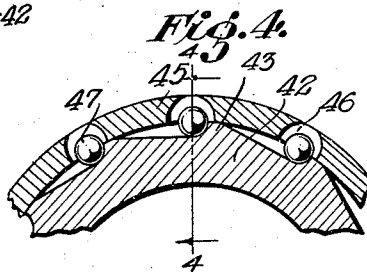


Fig. 5.

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3 Sheets-Sheet 2

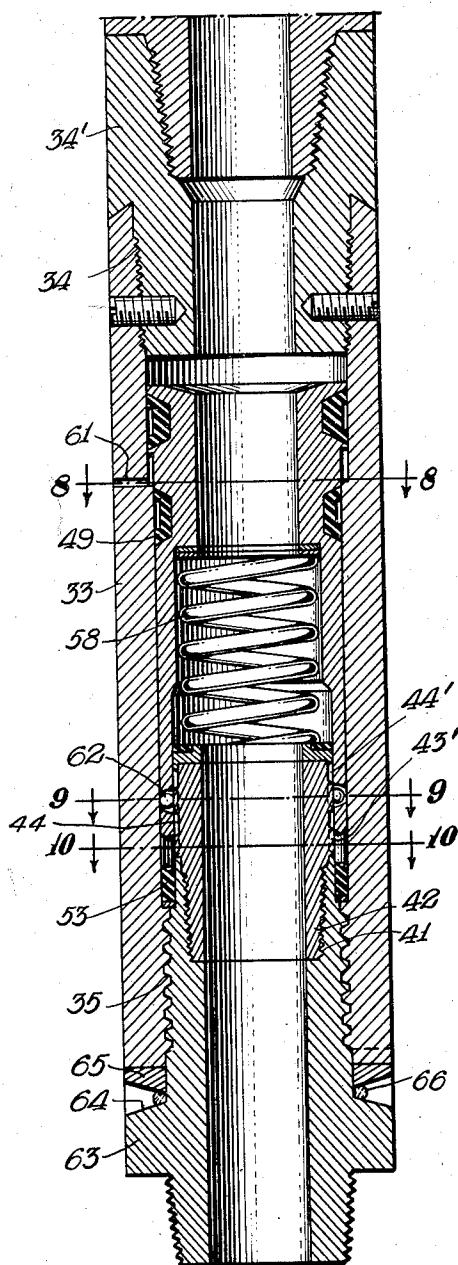


Fig. 6.

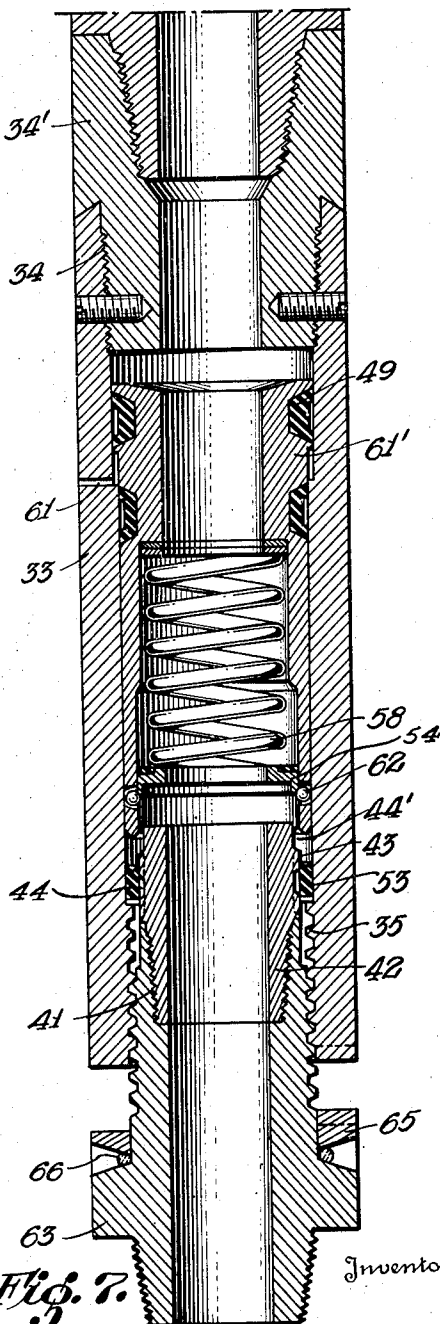


Fig. 7.

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3 Sheets-Sheet 3

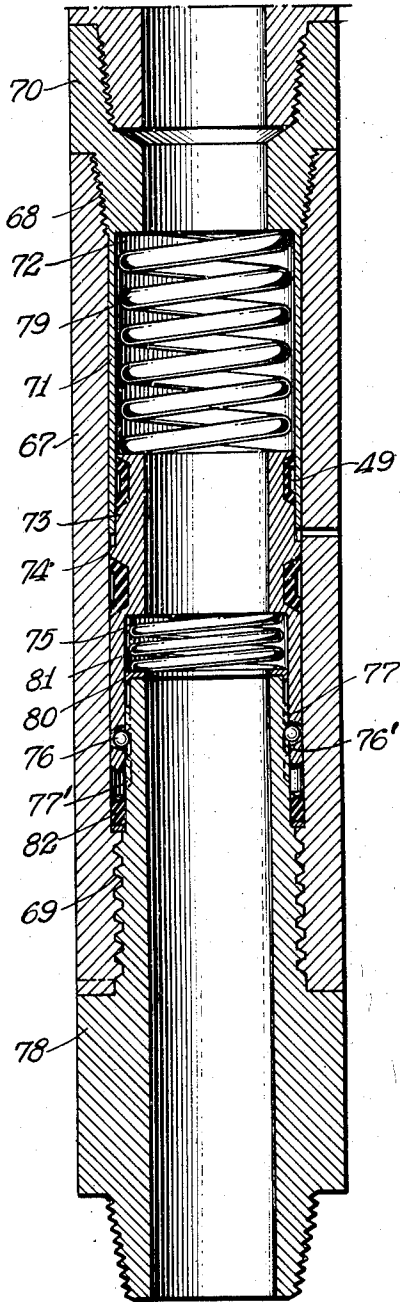


Fig. 11.

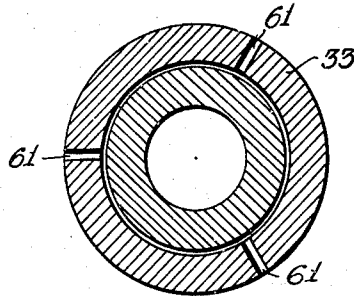


Fig. 8.

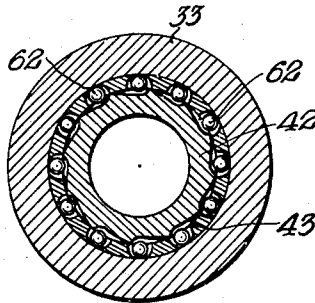


Fig. 9.

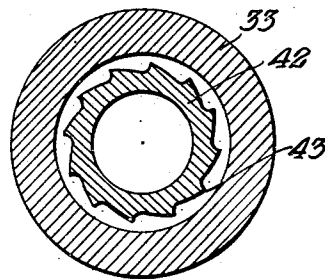


Fig. 10.

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UNITED STATES PATENT OFFICE

2,462,477

SAFETY JOINT

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Original application May 13, 1940, Serial No.
334,947. Divided and this application April 26,
1945, Serial No. 590,327

10 Claims. (Cl. 255—28)

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This invention relates to new and useful improvements in means for recovering elements from well bores.

In the well art, it is well known that in the drilling and completion of wells, pipe, in one form or another, is substantially at all times extending into the well bore. During the actual drilling, the drill stem or pipe, which is made up of sections connected by coupling collars, has the drill bit mounted on its lower end and is rotatable so as to rotate the bit and perform the drilling operation. After the well is drilled in, well tubing and casing are disposed within the well bore and, of course, remain therein so long as the well is producing. The pipe extending into the well bore may separate, collapse or for other reasons, may fall downwardly in the bore to the bottom thereof; or the wall of the bore may cave in and firmly lodge the pipe, or a portion thereof, within the bore. When any of the foregoing occurs, it is necessary that the pipe be removed or "fished out" from the bore before the well operations may continue and manifestly, such removal, particularly where the pipe is firmly lodged or stuck within the bore, creates quite a problem.

An important object of the invention is to provide a positively locked safety joint that can be operated to be unlocked or to be partly or wholly released, and which can then be rejoined and relocked in the well.

Another object of the invention is to provide a plurality of positively locked safety joints connected into a well string, each joint being capable of selective actuation by pressure fluid, whereby any one of said joints may be disconnected when desired.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Fig. 1 is an enlarged, vertical, sectional view of one form of the safety joint in its locked position,

Fig. 2 is a view similar to Fig. 1, wherein the combination for unlocking the device is being worked,

Fig. 3 is a horizontal cross-sectional view taken on the line 3—3 of Fig. 1,

Fig. 4 is an enlarged, vertical, sectional view of a portion of the ball lock employed in the form

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shown in Figs. 1 and 2, showing the balls in a raceway and taken substantially on the line 4—4 of Fig. 5,

Fig. 5 is a large, fragmentary, cross-sectional view, showing the engagement of the balls with the cam mechanism, taken along the line 5—5 of Fig. 1,

Fig. 6 is an enlarged vertical, sectional view, showing another form of the safety joint,

Fig. 7 is a view similar to Fig. 6, showing the safety joint of Fig. 6 in its unlocked position.

Fig. 8 is a horizontal cross-sectional view taken on the line 8—8 of Fig. 6,

Fig. 9 is a horizontal cross-sectional view taken on the line 9—9 of Fig. 6,

Fig. 10 is a horizontal cross-sectional view taken on the line 10—10 of Fig. 6,

Fig. 11 is an enlarged, vertical, sectional view, showing another form of the safety joint.

In the drawings, Figs. 1—11 show various means and combinations whereby a stuck pipe may be removed from the bore of a well. There has been shown selectively operated safety joints which may be operated from the surface of the well. These safety joints are placed at intervals in the string of drill pipe and the lock on each safety joint may be selectively unlocked. For example, the lowermost lock could be operated from the surface to unlock, and if it would not rotate so as to disconnect the stuck pipe, then the next higher selective safety joint could be unlocked so as to operate the next safety joint; and so on up the string of tubes until a safety joint was reached which could be both unlocked and released.

There is shown in the drawings, Figs. 1 to 11, several forms of safety joints.

In Figs. 1 to 5, there is shown an example of one form of safety joint. The numeral 33 designates a housing or an elongated hollow sleeve, which is internally screw-threaded at its upper end 34 to receive a pipe or a tool joint pin 34' on a pipe section. The lower end of 33 is internally screw-threaded with a square or acme type thread 35 of coarse pitch and steep lead. Also the housing 33, below the lower end, is provided with a cylindrical cam-shaped ratchet stop 33a on its lower annular face, as is indicated in Figs. 1 and 2. The object of this is to prevent further forward rotation of the safety thread 35 after the abutting stop face of the complementary cam face 33a on the upstanding shoulder of the hollow pin 34 has contacted the coacting stop face of the ratchet on the housing 33. The housing 33 is provided with an axial bore 36, and the cen-

tral portion of said bore is slightly reduced so as to provide a shoulder 37 therein. Attached to the lower end of the housing 33 is a pin 38 which has its upper end externally screw-threaded so as to correspond to and coact with the screw threads 35. Its lower end 39 is externally screw-threaded so as to receive a tool joint (not shown). The pin 38 is provided with an axial bore 40, and the upper end of said bore is screw-threaded at 41 so as to receive and firmly secure the clutch nipple 42. The outer surface of said clutch nipple is provided with two rows of wedge cams 43 and 43', and in the space between the rows of wedge cams 43 and 43' is a ball raceway 44 (Figs. 4 and 5); and in the space above the row of wedge cams 43 is a ball raceway 44'. Surrounding the clutch nipple 42, and extending upwardly, is a slidable sleeve 45 which snugly engages the inner surface of the member 33, and is movable within the bore 36. The lower end of said sleeve 45 is provided with a plurality of openings 46, and confined within said openings are locking balls 47. The hollow sleeve 45 is bent circumferentially inwardly at 48 so as to receive a packing ring 49. The sleeve 45 movably engages the upper surface of the enlarged part of the bore 36, and is provided with a shoulder 50 which corresponds to and coacts with the shoulder 37 of the member 33. The upper end 51 of the sleeve 45 is internally screw-threaded to receive the spring retainer 59 and this also retains the packing 60. Spring retainer 59 additionally functions as a piston to move sleeve 45. A recess 52 is provided above the threads 35 to receive a packing ring 53 which is insertable therein. A stop ring 54 overlies the top of the clutch nipple 42, and has an upstanding top collar 55 which abuts the shoulder portion 48 when the sleeve 45 is moved downwardly against the collar 55, which acts as a stop.

The lower beveled edge of the ring 54 acts as a ball retainer for the balls 47 whenever the lock is removed from the housing 33 and when the safety threads 35 are released. Resting on the ring 54 and slidable within the inside reduced diameter part 48, is a sleeve spring seat 56 which has its upper end 57 flanged outwardly to receive the coil spring 58. The coil spring 58 is confined above by a retainer 59 which is attached to the upper screw-threaded portion 51 of the sleeve 45, normally resiliently holding the sleeve 45 elevated. The retainer 59 is provided with a packing ring 60. A bleed hole 61 is provided in the body 33 adjacent to the shoulder 37 so as to equalize the fluid pressure.

One or more, preferably several, of these safety joints may be inserted, as indicated above, at short intervals in that part of a string of pipe or of tubes that later in use may become lodged or stuck in a bore. A suitable number of these joints are assembled with variously tensioned springs in each of the joints, and the joints may be made up into a string of pipe in such a manner that the joint at the bottom will have the weakest spring 58, and the next joint above in the string will be the next weakest and will increase the tension so that the top joint will have the strongest spring 58.

When the first joint is made up in a string and before the fluid pressure has become so great as to compress the spring 58 by forcing the sleeve 45 downwardly, then the spring 58 will urge the sleeve 45 upwardly until the top of the spring seat 59 will bear upwardly against the lower end of the pin 34'. In this elevated position of the sleeve 45, the locking balls 47 will also be elevated, and

will be engaged in the upper row of clutch cams 43 so as to prevent reverse rotation which would cause parting of the safety threads 35. When the pump is running so as to remove the cuttings from the bit, as in drilling, then the pressures within the joint will be so great as to compress the springs 58 in all the safety joints, and then the sleeve 45 will be forced down until the shoulder 50 of said sleeve is resting on the shoulder 37 (Fig. 1) of the housing 33; said locking balls 47 will also be lowered and will be in engagement with the lower row of clutch cams 43', and in this position, the joint will be locked so as to prevent reverse rotation to unscrew the safety threads 35 while drilling.

The locking of the joint between the sleeve 33 and pin 38 takes place as follows: It has been pointed out above that the sleeve 45 snugly engages the inner surface of the member 33, and also two packing rings 49 and 60 are disposed between the member 33 and sleeve 45. Thus there is a frictional engagement between the sleeve 45 and the member 33 and upon reverse rotation of the member 33 with the locking balls 47 in engagement with either of the rows of clutch cams 43 or 43', the sleeve 45 is also reversely rotated to carry the balls 47 up the incline of the cams 43 or 43' until the balls contact the inside of the member 33. Upon slightly further reverse rotation, the balls 47 are rotated and thus forced into tight locking position; there being no need for the sleeve 45 to press the balls 47 with any great force up the inclines of the cams to tightly lock the member 33 and nipple 42 together, and thus also lock the member 33 and pin 38 together, since, as described above, nipple 42 is firmly secured to pin 38.

When it is desired to unlock any particular safety joint, preparatory to unscrewing the safety threads 35, and to release this particular safety joint, an intermediate fluid pressure is built up with the pumps until the inside pressure acting on the upper part of the sleeve 45, i. e., the piston 59, is sufficiently greater than the outside pressure acting upon the shoulder 50 of the sleeve 45, that this differential in pressure at this particular joint is sufficiently great to partially move the sleeve 45 downwardly until the sleeve 45 and the locking balls are in the position of the parts as indicated in Figs. 2 and 4, which will move the locking balls into the ball raceway 44. The strength of each spring being known, the approximate intermediate differential of pressure acting upon the upper part of the sleeve, i. e., the piston 59, and the shoulder 50, or a relatively narrow such differential pressure range for each joint is also known, and hence the range of such differential pressure for any joint may be worked through in small increments, reverse rotation being attempted after each incremental increase in such differential pressure. In general, such differential pressure range for the lowermost joint is worked through first and if reverse rotation is not obtained, the pressure is increased to the next highest such differential pressure range corresponding to the next highest joint and this differential pressure range worked through as before. This process is continued until a joint is reached at which reverse rotation is obtained. With the parts in the raceway 44 as shown in Figs. 2 and 4 at a joint at which rotation is obtainable, the safety joint can be slightly rotated in a reverse and counterclockwise direction, and will be partially unlocked to such an extent that now the upper part of the joint can be turned

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in a reverse direction until the locking balls 47, along with the sleeve 45 and the upper part of the joint, have been relatively elevated up far enough so that the locking balls will be forced up into the upper row of clutch cams and will prevent, for the time, any further reverse rotation. The pump is stopped or the fluid pressure within the joint is released, which will then permit the spring 58 to expand upwardly to lift the sleeve 45 and move the locking balls 47 to the raceway 44' above the upper row of clutch cams 43 due to the fact that the member 33 and sleeve 45 have been elevated upwardly relative to the nipple 42, at which time the upper part of the joint may be further rotated in a counterclockwise direction until the threads 35 are completely unscrewed, and at such time the joint will have been released so that it can then be withdrawn from the well. However, if for any reason it was found desirable to reconnect the joint, it could be done without coming out of the well to reset any of the parts thereof. Also, it will be seen that all three of the packings and all parts of the control except the nipple 42 were removed from the lower portion of the joint. It is pointed out that only the lower portion 38 of the joint and the nipple 42 are left in the well. It will be observed that because it is necessary not only to have an intermediate fluid pressure to operate the locking means, but that it is necessary to operate a number of variations, it might be said that the lock is a foolproof one and substantially all possibilities of the joint becoming unlocked and released during normal operations in a bore hole are eliminated. Also, it will be seen that such a safety joint is very strong, and that it is no longer necessary, to lose any substantial parts of the lock or packings at any time.

In Figs. 6 to 10, inclusive, there is shown another form of a safety joint which is somewhat similar to the type shown in Figs. 1 and 2. In said Figs. 6 to 10, a pump pressure is applied to the movable, hollow, piston head or block 61' which has its lower end retaining the balls 62. The lower end 63 of the joint has its outer surface cut inwardly to form an annular shoulder 64. An annular metal ring 65, having a ratchet clutch, may be placed upon said shoulder and welded at 66 so that said member 63 is capable of receiving varying lengths of the upper structure. The object of this construction is to reduce the cost of manufacture and to permit easy and exact matching of the two opposing coacting halves of this clutch without requiring extra time and special shop equipment to form the clutch faces. The structure shown in Figs. 6 and 7 operates very similar to that shown in Figs. 1 and 2, and in place of the packing ring 49 being below the spring, it is above the spring in Figs. 6 and 7; thus showing another form for operating a safety joint in the same manner. Fig. 7 illustrates the manner in which the spring 54' functions as a ball retainer for the ball 62 when the safety threads 35 are released. The ring 54 functions in a similar manner as described previously.

In Fig. 11 there is shown an example of still another form of the safety joint, having a tubular body 67 with its upper end 68 internally screw-threaded and its lower end 69 provided with an internal-safety joint thread. The thread 69 may be right-handed or left-handed. An adaptor 70 is provided, and is attached to the upper end 68 of the member 67. The adaptor 70 has a depending, elongated sleeve 71 which snugly engages the inner surface of the member 67,

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and has an enlarged axial bore 72 therein. Slidable within the member 67, is a tubular member 73 which has its upper outer portion reduced so as to form a shoulder 74 which will abut the lower end of the sleeve 71. The member 73 has an axial bore therethrough, and said bore is enlarged at the lower portion of the member 73 thereby forming a shoulder 75. The lower portion of the member 73 holds the balls 76, which are identical to the balls described in the previous figures, and they operate with rows of cams 77 and 77' which are integral with the upstanding portion of the pin 78. Confined between the upper end of the member 73 and the adapter 70, is a coil spring 79. At the upper end of the pin 78 is a ball retaining ring 80, and confined between the bearing ring and shoulder 75 of the member 73, is a coil spring 81. When the joint is assembled, the heavy spring 79 will act downwardly, thereby moving the balls 76 so that said balls will become engaged within the lower row of the cams 77', and thereby locking the members 67 and 73 together. Fluid pressure passes through the joint, but ordinary drilling pump pressure on the fluid will act upon the member 73, and the joint is still locked together, but now in the upper row of cams 77. However, when it becomes desirable to disengage the joint, the pump pressure is lowered so as to only partially compress the spring 79, and act on the lower shoulder 75 of the member 73 to move said member upwardly against the tension of the spring 79. The spring 81 will also help to move the member 73 upwardly. This movement will move the balls 76 upwardly into the raceway 76', and the joint 69 may at that time be broken until the balls 76 contact the next cam 77; pump pressure is increased so as to again move the member 73 upwardly. It is pointed out that the movement of the member 73 upwardly is limited by the sleeve 71 of the adapter 70. When the balls 76 snap through the upper row of cams, they are then free to be moved so that the joint 69 may be completely disconnected. It is pointed out that below the cams is a packing ring 82 which is engaged by the lower end of the member 73 so as to pack off against escaping pressures. Also, it is an object to seal and pack off the threads 68 as well as the threads 69.

It is believed that the advantages of each of the foregoing constructions are obvious, but these may be partially summarized as follows:

All three embodiments comprise locking means which may be operated from without the well; that is, by increasing or decreasing the pump pressure, a safety joint may be locked or unlocked. Furthermore, all parts of the safety joint are removed when it is unlocked, except for the extreme lower pin and nipple; thus saving considerable expense and avoiding waste. In addition, it is to be emphasized that the safety joint in each embodiment comprises hollow members so that there is no interference whatever with the passage of the tools, core barrels and the like, through the pipe string.

This application is a division of my co-pending application, Serial No. 334,947, filed May 13, 1940, for Methods of and means for recovering elements from well bores now Patent No. 2,394,759 issued Feb. 12, 1946.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means

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stated by any of the following claims or the equivalent of such stated means be employed.

Therefore, particularly point out and distinctly claim as my invention:

1. In a string of pipe for a well bore, a safety joint comprising a housing, a slidable sleeve in said housing having locking and unlocking positions, a clutch nipple mounted within said sleeve, rollable elements carried by openings in said sleeve and a row of circumferentially arranged cam wedge faces carried by said nipple adapted to cooperate with said elements to lock said housing and nipple together, a raceway on said nipple adjacent said row of cam wedge faces, and a spring in the housing yieldingly urging the sleeve toward one of said positions.

2. The structure set forth in claim 1 wherein said sleeve has an internal shoulder and said sleeve has an annular spring seat on its upper end, said spring engaging said shoulder and seat.

3. The structure set forth in claim 1 wherein said sleeve includes an annular spring retainer, and a ring member slidable within said sleeve above said rollable elements and normally seated on the upper end of said nipple, said spring engaging said retainer and ring member, said ring member engaging said rollable elements upon separation of said nipple and sleeve to retain the same in said openings.

4. The structure set forth in claim 1 including an adapter interposed between the upper end of said housing and the upper end of said sleeve, and an annular shoulder on said adapter, said spring being mounted between said shoulder and said sleeve.

5. The structure set forth in claim 1 including an adapter interposed between the upper end of said housing and the upper end of said sleeve, an annular shoulder on said adapter, said spring being mounted between said shoulder and the upper end of said sleeve, an annular spring seat on the interior of said sleeve, and a second spring mounted between said annular spring seat and the upper end of said nipple, said second spring being of smaller magnitude than said first named spring.

6. In a string of pipe for a well bore, a safety joint comprising a housing, a slidable sleeve in said housing, said sleeve having an annular spring retainer secured to its upper end, a clutch nipple mounted within said sleeve and having an annular spring seat on its upper end, a spring mounted between said retainer and seat, rollable elements carried by openings through said sleeve and spaced circumferential rows of cam wedge faces carried by said nipple adapted to cooperate with said rollable elements to lock said housing and nipple together, and a raceway on said nipple between said rows of cam wedge faces.

7. In a string of pipe for a well bore, a series of safety joints, said joints each comprising a housing, a slidable sleeve in said housing having

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locking and unlocking positions, a clutch nipple mounted within said sleeve, rollable elements carried by openings through said sleeve and a row of circumferentially arranged cam wedge faces carried by said nipple adapted to cooperate with said elements to lock said housing and nipple together, a raceway on said nipple adjacent said row of cam wedge faces, and a spring in the housing yieldingly urging the sleeve toward one of said positions, said springs in said joints being progressively stronger upwardly of said series of joints to retain the rollable elements in locking position at correspondingly increasing fluid pressures.

8. In a string of pipe for a well bore, a series of safety joints, said joints each comprising a housing, a slidable sleeve in said housing, said sleeve having an annular spring retainer secured to its upper end, a clutch nipple mounted within said sleeve and having an annular spring seat on its upper end, a spring mounted between said retainer and seat, rollable elements carried by openings through said sleeve and spaced circumferential rows of cam wedge faces carried by said nipple adapted to cooperate with said rollable elements to lock said housing and nipple together, and a raceway on said nipple between said rows of cam wedge faces, said springs in said joints being progressively stronger upwardly of said series of joints to retain the rollable elements in locking position at correspondingly increasing fluid pressures.

9. For use in a safety joint in a well pipe including housing and pin elements and rollable elements shiftable to locking and unlocking positions with the first elements; a tubular nipple having spaced circumferential series of cam wedge faces extending therearound and a raceway for receiving said rollable elements between said wedge faces, and means for rigidly connecting the nipple with said pin element.

10. For use in a safety joint in a well pipe including housing and pin elements and rollable elements shiftable to locking and unlocking positions with the first elements; a tubular nipple integral with said pin element having spaced circumferential series of cam wedge faces extending therearound and a raceway for receiving said rollable elements between said wedge faces.

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