June 21, 1960 D. E. DAFFIN 2,941,599

COLLAR STOP FOR WELL TOOLS

Filed Nov. 25, 1957 3 Sheets-Sheet 1

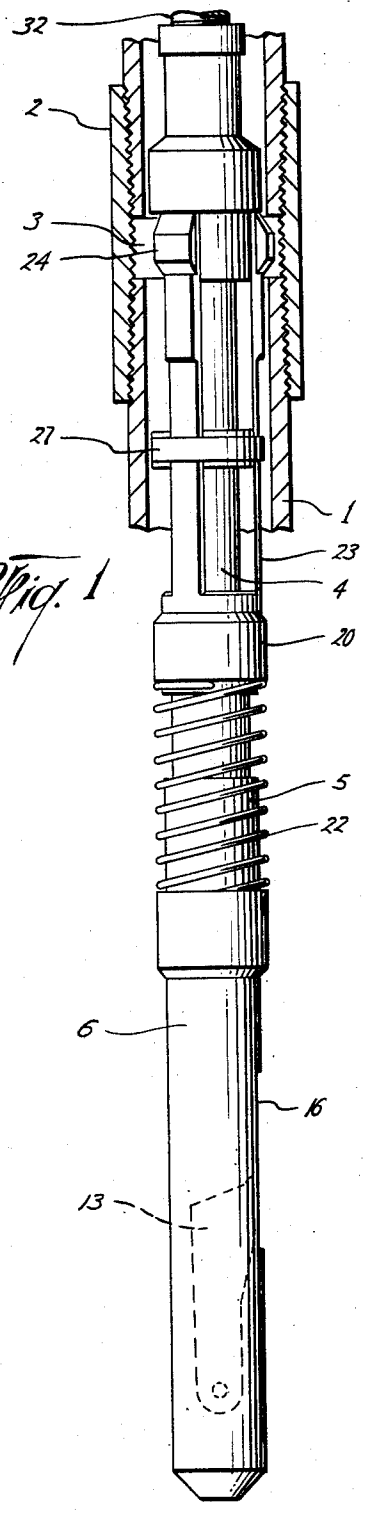


Fig. 1

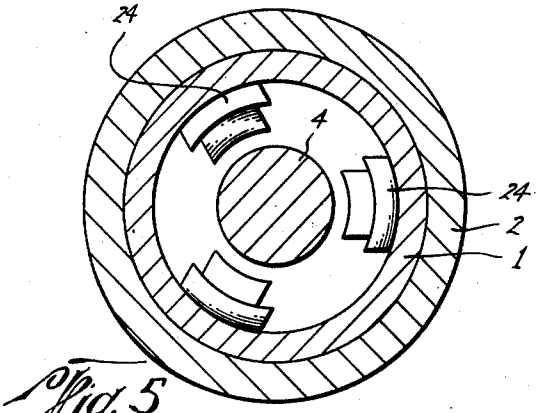


Fig. 5

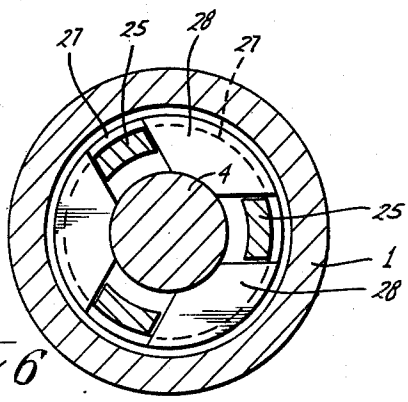


Fig. 6

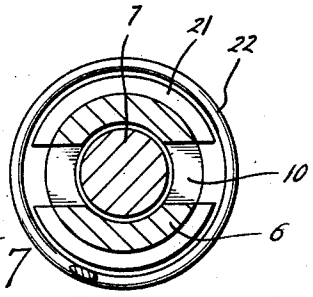


Fig. 7

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COLLAR STOP FOR WELL TOOLS

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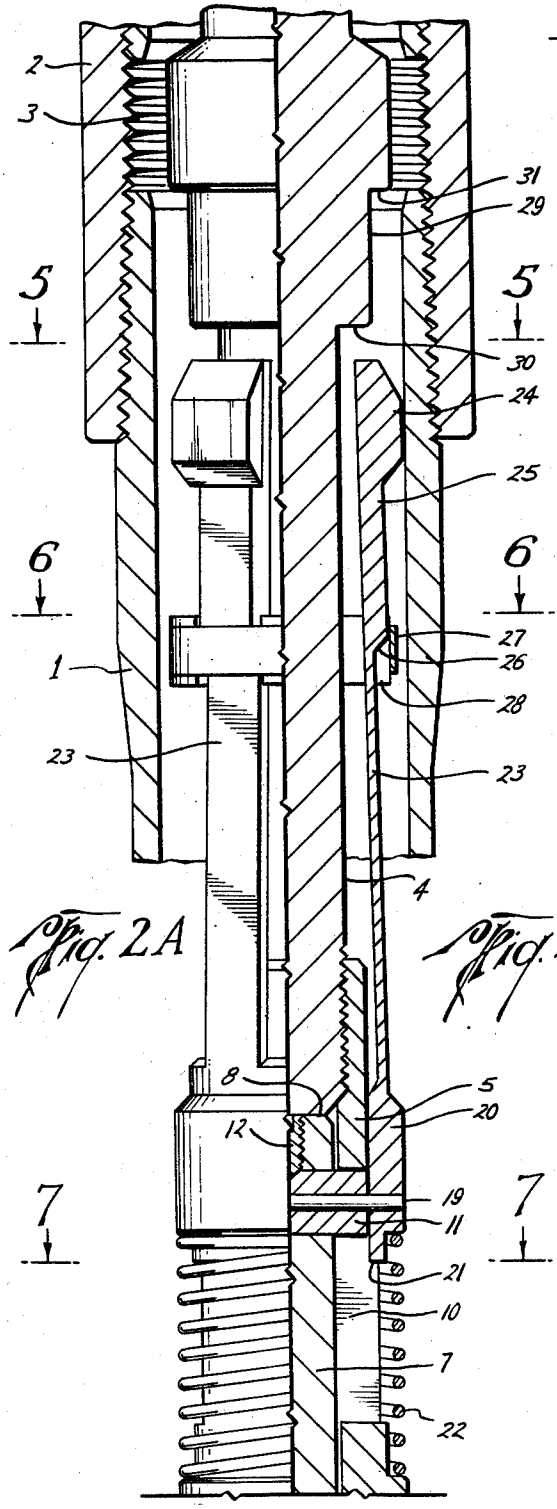


Fig. 2A

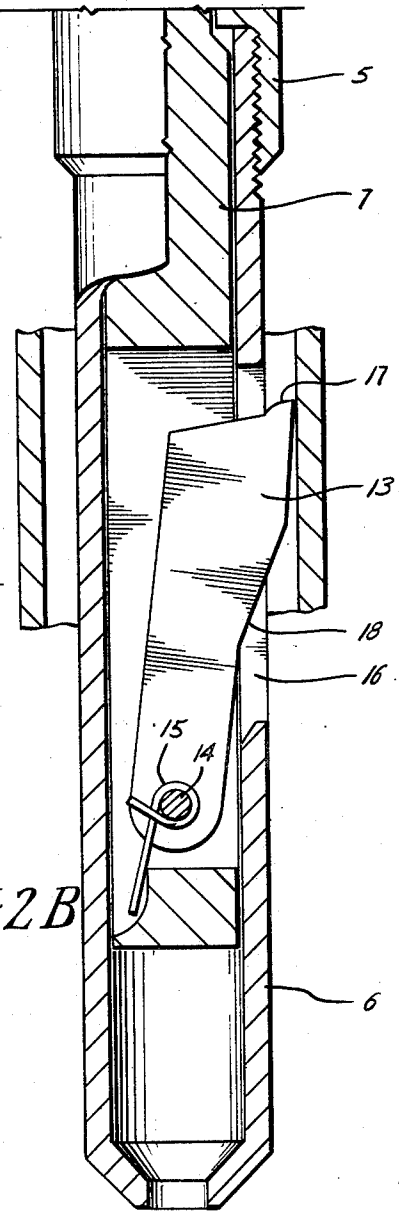


Fig. 2B

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COLLAR STOP FOR WELL TOOLS

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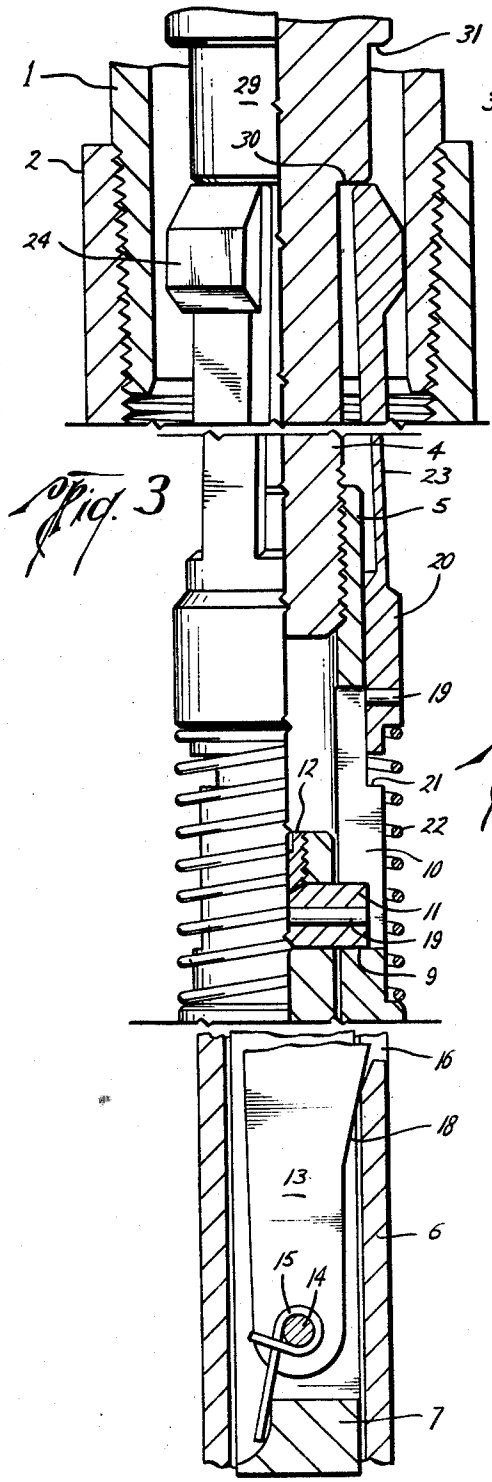


Fig. 3

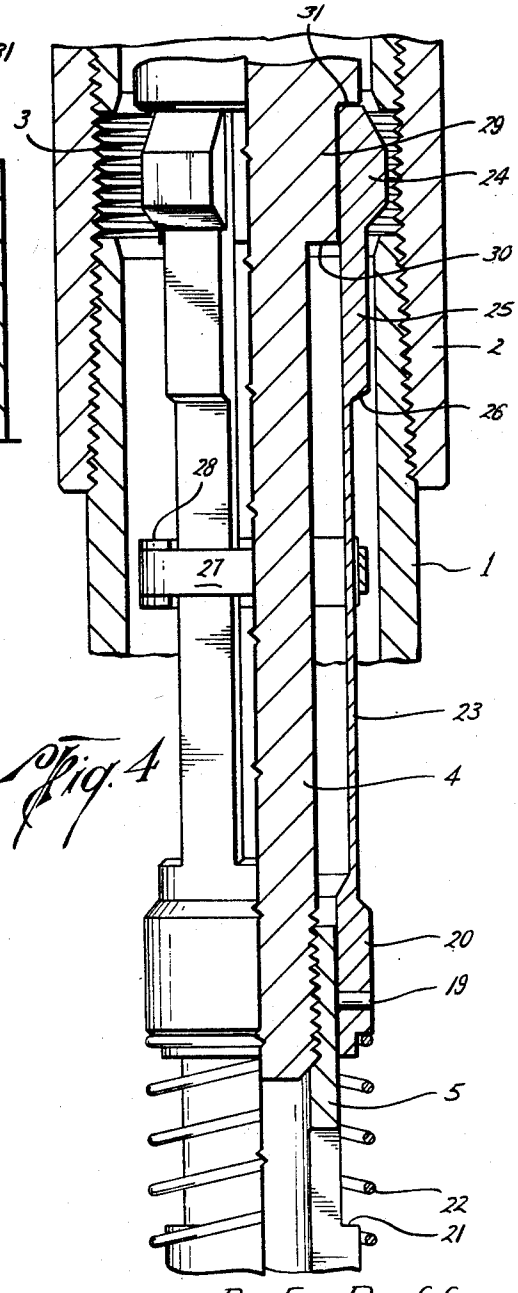


Fig. 4

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COLLAR STOP FOR WELL TOOLS

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10 Claims. (Cl. 166—219)

This invention relates to a retrievable well tool and more particularly to an improved device especially adapted for suspension and manipulation by a wire line within a well tubing string for descent to and positive securement at any selected depth and for later release and removal as need dictates. Various types of well control and working mechanisms are used at below-surface levels and they commonly are provided with latches by which they can be located in place but such latch mechanisms as heretofore employed have been complex in nature, difficult to handle, subject to easy breakage and often require special landing nipples for incorporation in the tubing string in a manner which is expensive and limits the position at which a tool can be set.

It is an object of the present invention to provide an improved latching-in device constructed of a few sturdy parts that can be easily and inexpensively manufactured and quickly assembled into a simple co-operative relationship for affording a landing unit which is reliably responsive, foolproof and positive in action without the exercise of great manipulative skill for positioning at any desired level and which unit is unlikely to get out of order or be damaged by shock and abnormal wear in its contemplated usage.

A further object of the invention is to provide an improved device having a tube engageable stop projection initially held retracted in inoperative protected position and so maintained during descent and until the previously selected level is reached whereupon a triggering action will free the retracted stop for atuomatic snapout into latching relation with an adjoining keeper formation such as is afforded at any coupling joint between tubing lengths and, following further manipulation, will be securely retained against retraction until such time as retrievement is desired.

Other objects and advantages will become apparent during the course of the following specification having reference to the accompanying drawings wherein Fig. 1 is a side elevation of the improved collar stop assembly with the parts in position of secure attachment at a collar joint location in the tubing string shown in vertical section; Figs. 2A and 2B are companion views on a larger scale of upper and lower halves of the collar stop device partly in vertical section and partly in elevation, with the parts in their initial relationship for descent in the well tubing; Fig. 3 is an elevation in part vertical section of the improved device after the frangible connection has been broken and with the slide elements spread apart and with the upper slide element in an intermediate axial position in which the latch dog is conditioned for final expansion as soon as it comes into alignment with the next adjoining tubular collar; Fig. 4 is a part section, part elevation, showing the latch mechanism in locked relationship with the tubing; and Figs. 5, 6, and 7 are transverse sectional views on lines 5—5, 6—6, and 7—7 respectively, of Fig. 2A.

The usual well tubing string consists of an end to end succession of pipe lengths, fragments of which are indicated at 1 in the drawings, with external coupling collars 2 threaded on adjacent tube ends so that the adjoining edges of each pair of tubes are spaced apart and

form between them an annular space or notch 3 terminating upwardly in a downwardly facing shoulder or seat constituted by the bottom edge of the uppermost tube and terminating downwardly in an upwardly facing seat or shoulder constituted by the upper edge of the lower of the tubes. By way of example, if the tube sections are on the order of thirty feet long, a tubing joint collar or annular notch occurs every thirty feet throughout the length of the pipe string. It is here proposed to latch the tool at any selected one of the many tubing collars. Thus the mechanism can be used with any conventional tubing string without need for first pulling the string and replacing it after inserting a special landing nipple.

The main body of the improved tool here involved is free of moving parts and may be considered as one integral piece but for convenience and manufacturing practicability it is formed of three separately machined pieces 4, 5, and 6 threaded together in end to end succession. The uppermost piece 4 is a solid central pin threaded at its lower end into the upper end of an intermediate piece 5, which is a hollow tube exteriorly shouldered and slotted and has its lower end interiorly threadably receiving the upper end of the low tubular piece 6, which constitutes a dependent skirt portion.

Slidably mounted within the hollow skirt 6 is a slide plunger 7 whose weight tends to bias it downwardly from the upper position indicated in Fig. 2B to a lower position shown in Fig. 3. Its uppermost slide limit is defined by seating abutment of its uppermost end face with the lower end face of the pin 4, as is indicated at 8 in Fig. 2A. A lowermost limit for downward slide travel of the plunger 7 is provided at 9 in Fig. 3 between an upwardly facing marginal seat at the bottom of each of a pair of transversely aligned and axially elongated slots 10 in the tubular skirt element 5, and which seat is engaged by outwardly projected end portions of a transverse hollow stud 11 contained within a through opening at the upper end of the slide plunger 7. An axially extending set screw 12 in the upper end of the plunger 7 bears against the hollow stud 11 to center the same and hold it in place.

As best seen in Fig. 2B, the bottom portion of the plunger 7 contains an axially elongated slot in which is pocketed a laterally shiftable ratchet tooth or pawl 13 swingably mounted at its lower end on a transverse pivot pin 14 carried by the plunger 7. Surrounding the pin 14 is the loop of a coiled spring wire 15 having one end bearing against a fixed seat in the plunger 7 and having the opposite end terminally bent as an angular toe which is fitted within a small notch in the edge of the pivoted pawl 13 to bias the pivoted pawl laterally and cause its upper free end to swing outwardly from the plunger. A window or side opening 16 in the wall of the skirt 6 is aligned with the upper end of the pawl 13 when the plunger 7 is at its upper limit of slide travel and accommodates lateral projection of the pawl through the skirt 6 for pawl contact with the inside face of the tubing during descent of the tool. During such descent, the pawl 13 ratchets freely pass the several internal notches 3 in the coupling string but upon reverse or upward travel the upper and outer toothed formation 17 of the pawl will flip out into the notch 3 next above the start of upward travel and will then engage with the downwardly facing shoulder at the upper limit of the notch and block the plunger against further upward travel. With the pawl so stopped, any additional upward travel of the skirt 6 will bring the bottom edge of the window 16 into engagement with the ratchet pawl 13 at the upwardly and outwardly inclined slide surface shown at 18 and these interengaging abutment surfaces cam the pawl backwardly against the force of the spring 15 and through the window 16 to an inactive retracted position within the hollow skirt 6, as seen in Figs. 1 and 3.

Initially the slide plunger or pawl carrier 7 is held at its top limit defined by the abutment faces at 8 and with the retractable ratchet pawl 13 projected through the window 16 by means of a frangible connection such as a shear pin 19 fitted through the hollow stud 11 and diametrically opposed openings at the lower end of a slide collar 20 surrounding a reduced diameter upper portion of the tubular skirt 5 and the lower portion of the pin 4 and having its lower marginal edge in seating contact with an upwardly facing shoulder 21 on the sleeve 5 as a limit to downward travel of the sleeve 20. A coiled compression spring 22 surrounds the skirt portion 5 and bears at opposite ends on seating shoulders on the skirt 5 and slide collar 20 and exerts an upward biasing force on the collar, but such force is rendered inactive when the two slide members are joined by the frangible shear pin, as illustrated in Fig. 2A.

Preferably the slide collar or sleeve 20 is formed of spring steel and has integral with it a group of three circularly spaced upwardly extended spring detent fingers or arms 23 which in normal unstressed relation have their free ends expanded in relation to one another and projected outwardly to positions as illustrated in Fig. 4. Each spring finger terminates on its outer face in a laterally enlarged double tapered lug or dog 24 whose top and bottom surfaces form latching shoulders or stops for co-operation with the opposed shoulders of the keeper notch 3. Below the detent lug 24 is a thickened spring finger portion 25 which terminates in a downwardly and inwardly inclined camming shoulder 26. The camming shoulder 26 and the thickened finger portion 25 are so proportioned and dimensioned that when the collar is anchored at its lower limit of travel each spring finger will be drawn or deflected inwardly and held contracted within a clearance pocket surrounding the pin 4 and by retaining abutment within the interior bearing surface of a detent positioning means afforded by a circular band 27 fitted within peripheral grooves in a set of circularly spaced lugs 28 formed integrally with or welded on the pin 4.

The pin 4 is of staged or stepped external diameter and its lowermost portion is of smaller diameter to afford working clearance for inward contraction of the spring fingers 23. Connecting the smaller diameter portion of the pin with an adjoining enlarged pin portion 29 is a bearing shoulder 30 which provides a slide bearing abutment for the terminal tip of each spring finger 23 under a condition wherein the shear pin 19 has been broken and the latching detent dogs 24 are out of alignment with a locating keeper notch 3. Under such condition, the widened portion 25 of the spring finger and the camming shoulder 26 will have moved upwardly above the retaining band 27 under the force of the coil spring 22 until the abutment shoulder 30 is contacted.

Each spring finger when in slide bearing contact with the shoulder 30 is free to contract and expand as the outer detent face slides along and over irregularities in the inner face of the tubing string. To facilitate such free lateral movement at the finger tip, the bearing abutment shoulder 30 as well as the mating contact face on the tip of the finger 23 are formed for flat engagement in a transverse plane normal to the axis of the pin 4. Should axial travel of the tool assembly move the projectable spring fingers out of lateral confinement by the relatively smaller internal diameter of the tubing and into latch dog alignment with a large diameter annular keeper notch 3, the spring fingers by their own elasticity will snap outwardly beyond the radial limits of the shoulders 30 and under the upward expansion force of the coil spring 22 on the slide collar 20 the terminal parts of the spring fingers will slide to overlapping relation with the peripheral face of the enlargement 29 to the upper limit afforded by the downwardly facing shoulder 31 on the under side of a still larger diametrical portion of the pin 4. Because the outside diameter of the enlargement 29 corresponds to the inside diameter of the several spring fingers when unstressed, a snug backing fit is had to solidly resist finger retraction. This will be the condition of the parts illustrated in Figs. 1 and 4 and the latch dogs 24 will be locked in projected relation between the upwardly and downwardly facing seats at the keeper notch 3. The weight of the tool assembly will be transmitted through the shoulder 31 and the dog 24 into the upwardly facing seat of the notch in the tubing string. The tool will be so held securely against displacement because the external diameter of the backing section 29 in relation to internal tube diameter maintains the latch dogs in expanded relationship.

When the parts are so positioned they can be readily released by imparting to the main supporting body or pin 4 an upward movement relative to the fixed latches until the stop abutment 30 rises above the upper terminals of the spring fingers and thus provides inwardly of the fingers the annular clearance space about the reduced diameter portion of the pin 4. Upward body travel will be transmitted into the slide collar 20 through the yieldable spring 22 until the bottom of the collar seats on the shoulder 21 when the upward force is directly transmitted into the collar. In any further relative upward travel after the fingers are contracted, the band 27 quickly comes into contact with each cam surface 26 and forces the spring fingers farther inwardly and the band 26 slides over the exterior faces of the widened portions 25 and retains the fingers in contracted position. During continued upward travel of the released tool and as each successive annular keeper notch is passed, there may be a tendency for the spring finger momentarily to snap outwardly toward the groove, depending on whether the speed of wire line withdrawal is faster than recovery of the spring 22, but the continued upward movement of the pin 4 will cause the latch dog 24 to cam itself out of each notch and back into retracted position.

The use and securement of the device alone as shown in the drawings, will serve as a block to prevent lost articles dropping downwardly below the device. It can be installed or removed by the usual wire line tools, in which case a suitable fishing head will be directly fastened to the screw threaded stud 32, shown at the top of the body in Fig. 1. When the stop device is to locate a control valve or other working mechanism, such mechanism can be suspended from the bottom of the tool or fastened in tandem relation at the top through the screw threaded stud 32, and a suitable fishing head then forms a part of the well control device. In any event, the parts as assembled at the surface will be brought into the relationship illustrated in Figs. 2A and 2B and so held by the insertion of the shearable pin 19.

During tool descent with the spring detent carrier or slide collar 20 held at its lower limit, the spring fingers will be contracted with the latch ineffectual and the ratchet pawl 13 will drag on and ride down the inner wall of the tubing string, dropping into and out of keeper notches passed on the way. By gauging the length of wire line let out, the level selected for location of the tool can be met and when it is reached the wire line can be reeled back slowly for enabling the ratchet pawl 13 to drop out into the first tubing notch encountered on the upward travel. Since further upward travel of the slide plunger 7 is stopped upon engagement of the upwardly facing abutment surface of the pawl tooth 17 with the downwardly facing shoulder of the notch, an upward tug or jerk transferred through the wire line, the tool body and the stop shoulder 21 to the collar 20, will shear the pin 19 between the upwardly pulled collar 20 and the stopped plunger stud 11. As soon as the connection is broken, the ratchet stop no longer is effective and will be pushed back to its inoperative position. At the same time the expansive force of the spring 22 will raise the spring finger terminals above confinement under the band 27 and travel of the tool either upwardly or

downwardly to the next adjoining keeper notch 3 will accommodate full outward spread of the dogs 24 into an aligned notch and beyond the stop abutments 30 for reception downwardly of the backing head 29 in expansion maintaining relation with the latches. Accidental displacement of the parts will not occur but should removal become desirable, a wire line connection with the main body or upper end of the pin 4 and elevation of the pin will first raise the backing cylinder 29 above the latches to permit their inwardly cammed contraction into the annular clearance space below the shoulder 30 and the device can be brought back to the surface.

From the foregoing, it will be seen that there has been provided a tubing collar engageable and retrievable stop comprised essentially of a supporting or main body and two sliders, one of which is reciprocably guided on an upper pin portion of the body and the other of which is slidably guided within a lower hollow skirted portion of the body and both of which are subject to biasing forces tending to spread them apart but which biasing forces initially are resisted by a frangible interconnection joining the sliders against relative travel away from one another whereby a latch dog carrying spring finger extension constituting a part of the upper slider is ineffective and retractable within a lateral clearance space around the pin and a pawl constituting a part of the other slider projects laterally through a window in the skirted body portion for a one-way clutch sliding or ratcheting action on the tubing string wall during tool descent and which pawl, after the selected depth is reached and a raising force is applied to the tool, makes brake stop abutment with a downwardly facing shoulder of the tubing wall, whereupon an upward thrust on the tool effects breakage of the frangible interconnection to allow the sliders to be biased apart, In relation to its enclosing skirt, the bottom slider assembly drops and carries its ratchet pawl downwardly out of projection through the skirt window and inwardly of the skirt wall for pawl contraction and retention in inoperative position. Breakage of the interconnection serves primarily for freeing the spring finger carrying collar for upwardly biased travel and shifts the inwardly retracted spring finger beyond lateral constraint of a bearing abutment whereby the spring finger being no longer under restraining stress of the abutment and in response to its inherent elasticity can snap outwardly to expanded unstressed position as it comes into alignment with a keeper notch in the tubing string. Concurrently with full expansion of the finger, its radially inner face slidably overlaps the peripheral face of an enlarged backing formation on the pin above the previously mentioned clearance space and is thus positively maintained against retraction from projected latching relation until such time as the body is shifted upwardly relative to the keeper notch anchored latch a sufficient distance to raise the backing formation out of finger abutment and again present the clearance space behind and for reception and contraction of the spring finger out of latching relation to the keeper notch. Thus the assembly, comprising only a few parts free of complexity, can be lowered to any depth with the latch mechanism inactive but easily brought into operative relation at a predetermined level for tool securement against displacement and later can be manipulated at any desired time for assembly release and removal from the well.

While the foregoing deals with a preferred embodiment, various modifications can be made without departing from the invention as defined by the attached claims.

What is claimed is:

1. A well tool for use with a string of tubing having upwardly and downwardly facing seats for co-operation with laterally projectable-retractable parts of the well tool, said well tool including a laterally outwardly biased retractable ratchet pawl having an upwardly facing stop abutment seat, a laterally outwardly projectable latch detent having a downwardly facing stop abutment seat, a pair of abutments, one engageable with the ratchet pawl to retain the same retracted and the other abutment being engageable with the latch detent to retain the same projected, a support body carrying both abutments, a pair of carriers reciprocably mounted by the support body and biased for travel away from one another, said carriers supporting the ratchet pawl and the latch detent for reciprocatory travel with said carriers into and out of engagement with their respective retaining abutments, relieved portions on said support body spaced from said abutments in the direction of reciprocatory travel of the pawl and the detent and affording pawl and detent receiving lateral clearances in the reciprocatory paths of the pawl and the detent beyond their seating engagement with said abutments for pawl projection and detent retraction and frangible connection means joining said carriers against travel away from one another and thereby holding said pawl and said detent against relative reciprocatory travel of said pawl from its position of projection and of said detent from its position of retraction.

2. In a well tool of the character described, a supporting body, a pair of carriers slidably mounted on the supporting body and biased for travel away from one another, a frangible connection joining said carriers against such travel, a retractable ratchet pawl mounted for travel with one of said carriers and projected laterally outwardly therefrom when said frangible connection is effective, a latching detent means carried by the other of said carriers for travel therewith and arranged for projection laterally outwardly upon carrier travel when said frangible connection is broken, bearing means located on the body to be engageable with the detent means to hold the same retracted while said carriers are joined and a pair of body mounted abutments which upon travel of said carriers away from one another are operatively engageable with said pawl and said detent means to retract the pawl and hold the detent means projected.

3. In a retrievable well tool, a body adapted for connection with a suspension line, a pair of slide members reciprocably mounted on the body each for travel away from the other, a frangible interconnection joining said slide members to one another and immobilizing them with said body against relative travel away from one another, a ratchet pawl carried by one of the slide members and biased laterally outwardly therefrom as a stop against upward body movement so long as said slide members are immobilized, an abutment on the body engageable by the pawl to retract the same to an inoperative stop position upon breakage of said frangible interconnection and slide movement of said one of the slide members away from connection with the other slide member, a laterally projectable latch detent carried by said other slide member, detent positioning means carried by the body in co-operative relation with the detent to control detent retraction while said other slide member is immobilized and detent projection by slide travel of said other slide member upon breakage of said frangible interconnection and yieldable spring means interposed between the body and the detent carrying member and active to bias member travel toward detent projected position and to yield upon upward body movement relative to the detent carrying member to accommodate member return travel to the detent retracted position.

4. A tool as in claim 3 wherein the detent positioning means includes two detent abutments spaced apart in the direction of slide travel of said other slide member and one of which abutments has slide bearing with the exterior face of the detent for retaining the same inwardly retracted at the immobilized limit of sliding travel of said other slide member and the other of which abutments has slide bearing with the interior face of the detent for retaining the same outwardly projected near the opposite limit of slide travel of said other slide member.

5. The tool as in claim 3 wherein said body includes limit stop formations engageable by the frangibly interconnected slide members for the transmission of downward body travel to the member carrying the pawl and for the transmission of upward body travel to the member carrying the detent.

6. The tool as in claim 3 wherein the direction of slide travel of the pawl carrying member from immobilized position is downward and the direction of slide travel of the detent carrying member from immobilized position is upward and wherein said body includes a downwardly facing seat which bears on and transmits downward body travel to the immobilized pawl carrying member and an upwardly facing seat which bears on and transmits upward body travel to the immobilized detent carrying member.

7. In a retrievable well tool, a body adapted for connection with a suspension line, a pair of slide members reciprocably mounted on the body each for travel away from the other, a frangible interconnection joining said slide members to one another and immobilizing them with said body against relative travel away from one another, a ratchet pawl carried by one of the slide members and biased laterally outwardly therefrom as a stop against upward body movement so long as said slide members are immobilized, an abutment on the body engageable by the pawl to retract the same to an inoperative stop position upon breakage of said frangible interconnection and slide movement of said one of the slide members away from connection with the other slide member, a laterally projectable latch detent carried by said other slide member, detent positioning means carried by the body in co-operative relation with the detent to control detent retraction while said other slide member is immobilized and detent projection by slide travel of said other slide member upon breakage of said frangible interconnection, the direction of slide travel of the pawl carrying member from immobilized position being downward and the direction of slide travel of the detent carrying member from immobilized position being upward, a downwardly facing seat on the body which bears on and transmits downward body travel to the immobilized pawl carrying member, an upwardly facing seat on the body which bears on and transmits upward body travel to the immobilized detent carrying member and a spring bearing in compression between the body and said detent carrying member to yieldably bias the latter upwardly when the frangible interconnection is broken.

8. In a well tool to be retrievably located in a string of tubing, a body for connection with a suspension line, a pair of slide members mounted on the body, a frangible interconnection initially joining said slide members against movement away from one another, one of said slide members including a ratchet pawl engageable with a portion of the tubing to stop upward travel with the body and the other member and thereby effect breakage of said frangible interconnection, said other member including a collar surrounding and slidably bearing on said body and having a spring detent finger extended axially therefrom with a tubing engaging detent dog carried thereby, said spring finger being elastically retractable radially of the axis of the body to position said detent dog away from a projected finger unstressed relation in which said detent dog is in tubing contact position to stop downward travel of the body, said collar being slidable on the body between axially spaced opposite limits in one of which said frangible interconnection is effective and to the other of which the collar is free to slide after the interconnection has been broken, said body in the region of detent dog slide travel having stepped peripheral surfaces one of which is of greater radial dimension than the other and is axially disposed at the detent dog position of the collar free slide limit and is radially dimensioned to form a solid backing for the innermost face of the spring finger in its unstressed projection relation as a stop against finger retraction and the other of which affords spring finger retraction clearance, a shoulder separating said stepped peripheral surfaces and constituting a flat abutment face in a radial plane normal to the axis of the body, an abutment face on the spring finger mating with the shoulder abutment face for radial slide bearing thereon when the slide collar is at a given point intermediate its opposite limits and a retainer device fixed on the body and engageable with the outer face of the spring finger to retain the same retracted when the slide collar is held at its one limit by said frangible interconnection.

9. In a retrievable well tool, a body having a lower hollow skirt and an upper pin adapted for connection with a suspension line, a collar slidably fitted on the body and provided with a radially retractable spring finger extended axially upwardly beside the pin and terminated laterally in a latching dog, a collar engaging spring carried by the body to bias the collar for upward sliding action between lower and upper limits, a plunger slidable within the skirt between upper and lower limits and provided with an outwardly biased pawl projectable at the upper plunger limit through a window in the skirt to resist upward body travel and retractable by engagement with the skirt below said window at the lower plunger slide limit, a frangible connection between the slidable plunger and the slidable collar retaining the plunger at its upper limit and the collar at its lower limit and being adapted to be broken upon ratchet pawl resistance to upward body travel and thereby free the plunger and the collar for travel respectively to the plunger lower limit and the collar upper limit and axially spaced apart pin portions of stepped diameters, the upper of which is in the axial region occupied by the terminal dog of the upwardly extended spring finger when the collar is at its upper slide limit and is of a radial dimension approximating the radial dimension from the collar axis to the inner face of the spring finger when the latter is substantially free of elastic stress and the lower of which portions is in the axial region occupied by the finger dog when the collar is at its lower slide limit and is of a radial dimension smaller than that of the upper pin portion to afford radial clearance into which the spring finger can be retracted to inoperative latching relation.

10. In a retrievable well tool, a retractable latching detent, means active to yieldably bias said detent to a projected latching position, a support body on which the detent is mounted slidably between upper and lower limits, a backing abutment on the body engageable behind the projected detent at its upper slide limit to preclude retraction thereof, a detent receiving pocket on the body below said backing abutment providing clearance into which said detent may be retracted when it is away from said upper limit, an abutment surface on the body engageable by the detent at its lower limit to compel detent retraction, a retractable ratchet pawl, means mounting said pawl for slide travel relative to the body between upper and lower limits, a frangible interconnection joining said detent at its lower limit with the retractable ratchet pawl at its upper limit in which it is active as a stop against upward tool travel for causing breakage of said frangible interconnection and means on the body engageable by said ratchet pawl at its lower limit to compel pawl retraction to an inactive position.

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