

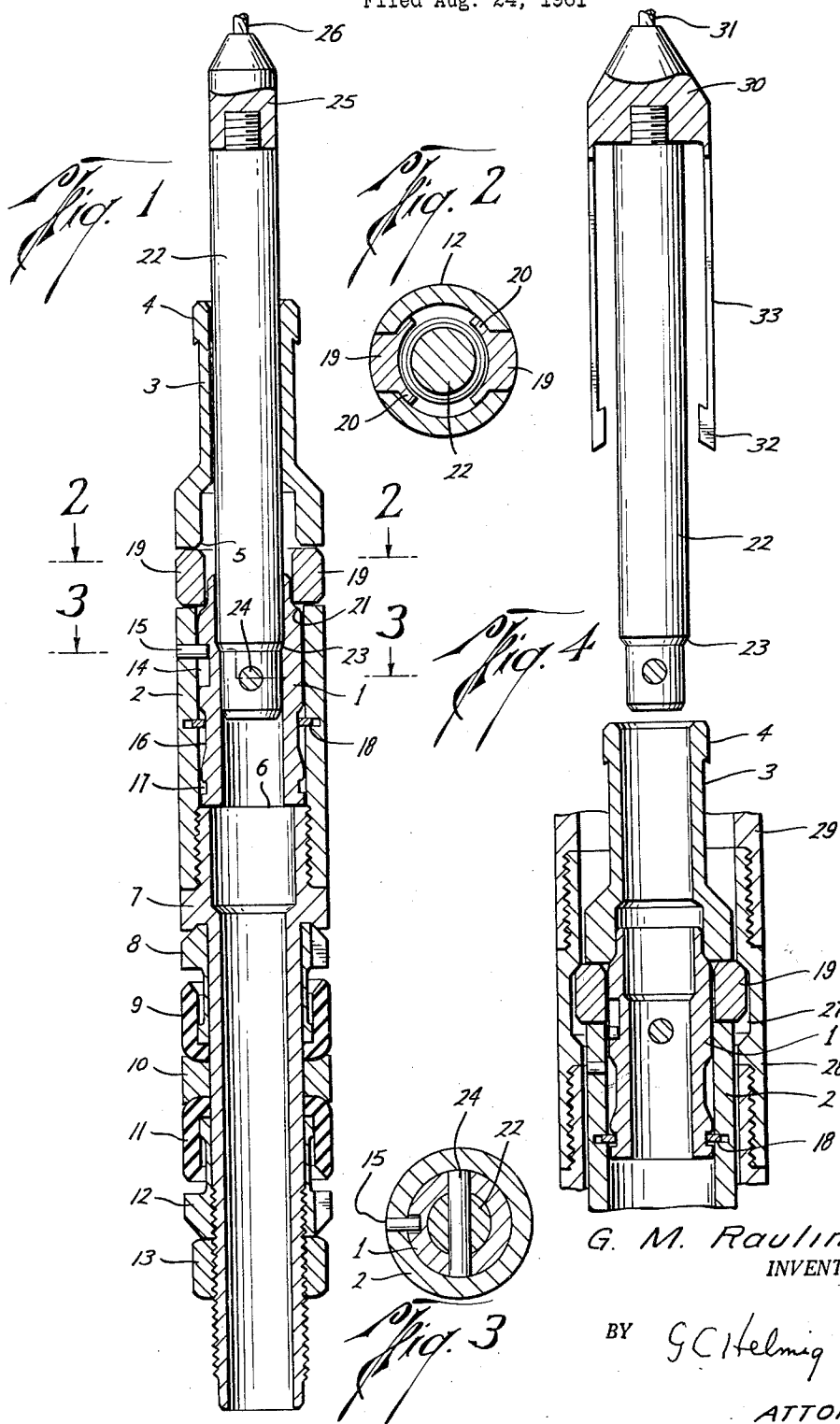
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PIPE RECESS LOCKING DEVICE

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3,071,192

PIPE RECESS LOCKING DEVICE

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This invention relates to well tools and more particularly to a device to be lowered into or removed from a tubing string with the use of conventional wire line suspension systems and to be latched and unlatched at a desired location of a tubing wall recess such as occurs at connecting collars or is formed in a special nipple, mandrel or other unit of a tubing string assembly. A latchable device serves various purposes, including that of a locator stop and of a hanger for any number of subsurface controls, and if desired can carry peripheral sealing elements for co-operation with a tubing string interior surface.

Subsurface latching tools have sometimes utilized friction slips or wedges and have also incorporated projectable dogs and peripheral stop shoulders to seat against landing abutments at given depths in the tubing string. An object of the present invention is to avoid dependency on holding resiliency and friction and the limitations of integral stop protuberances and to provide a latching dog laterally shiftably mounted in a tubing body and controlled by an expander which is longitudinally slidably housed by the body for relative longitudinal movement between several positions in one of which the dog is retracted with its outer face spaced radially from the body center line a distance slightly less than the inside radius of the tubing string; in another of which the dog is projected and positively blocked against retraction and in still another and intermediate position the dog is temporarily projected into a tubing string recess and gives a signal of recess location but is not blocked against retraction and is insecure.

A further object of the invention is to provide a well tool to be run into a well by suspending the inner expander through a releasable connection with a lowering line while the outer body and dog assembly is supported by downward bearing of the retracted dog on an upwardly facing tapered seat of the expander so that body weight is transmitted through dog contact with the tapered seat and affords an outward camming action on the dog, which on slow traverse in either vertical direction of any tubing string recess tends to push into an aligned recess but without becoming hung up should the expander be then lowered for relieving the temporary outward bias on the dog and, on the other hand, with a positive blocking of the projected dog should the expander be raised to an upper limit in which a detent interlock is active between the expander and the body for anchoring the parts and whereupon the expander connection with the running tool can be broken and permit removal of the running tool.

Another object is to provide such well tool having an initially effective but releasable interconnection between the body and the expander for accommodating lost motion adjustment for effecting dog projection and retraction without lockup and permitting relative movement within a fraction of the entire range with resistance to relative member movement beyond the given fractional portion whereby to resist unintentional action of the locking detent prior to the time it is desired to establish the final dog blocking relationship.

Additional objects and advantages will appear from the following specification having reference to the accompanying drawing illustrating a preferred embodiment of the invention and wherein FIG. 1 is a vertical sectional view of the improved latching tool with the parts in in-

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tial release relationship and connection with a wire line suspension system preparatory to a lowering operation; FIGS. 2 and 3 respectively are transverse sections on lines 2-2 and 3-3 of FIG. 1 and FIG. 4 is a vertical section of the improved latch with the parts in secure anchorage within a part of a tubing string and also illustrating a pulling tool and latch releasing prong in position immediately in advance of prong entry into the tool assembly for effecting a pull-out operation.

The improved tool as seen in the drawing includes a pair of relatively movable inner and outer members 1 and 2 longitudinally slidably nested one within the other. The outer member 2 is a tubular body or barrel whose outside diameter throughout the major portion of its length is slightly less than the inside diameter of the well tubing string for which its use is intended. At its upper end, the body 2 has a fishing neck 3 which terminates upwardly in a pickup head 4. In the region below the reduced diameter fishing neck 3, there is an internal shoulder 5 formed in the wall of the body 2, which provides a stop abutment for seating co-operation with the upper end of the inner member 1 at one limit of relative longitudinal slide movement of the members. A bottom limit stop shoulder 6 is afforded by an adapter 7 detachably threaded interiorly of the lower end of the body 2. The adapter 7 is representative of various well working instrumentalities including flow valving and abutment stop inserts which are to be positioned within and latched or anchored in a well tubing string. In the drawing, the adapter has a dependent hollow tubular portion on which is sleeved a peripheral sealing assembly inclusive of an upper spacer ring 8, a cupped seal 9, an intermediate spacer ring 10, a cup seal 11, a bottom spacer 12 adjustably threaded on the adapter and held by a lock nut 13. Below the bottom lock nut 13, the extended portion of the adapter tube may be utilized for the attachment of a subsurface tool of any desired type.

In length, the inner member 1 is less than the longitudinal distance between the upper and lower stop abutments 5 and 6 on the outer body 2 to establish the over-all effective range of relative movement and the opposite limits of such movement by reason of the seating engagement with the stop shoulders 5 and 6 of the opposite ends of the inner member 1. Intermediate its length, the member 1 has a longitudinally elongated slot 14 in its periphery whose length is only a fraction of the effective range of relative longitudinal movement of the members. The top and bottom terminal shoulders of the slot 14 afford stop abutments for engagement with an inwardly projecting end of a shearable pin 15 fixed and carried by the body 2 and providing a short range of relative member movement. In the initial tool assembly, the pin 15 is arranged as seen in FIG. 1 and is of a suitable frangible material such as brass in relation to the harder material such as steel, of which the members 1 and 2 are formed. The shearable pin retains the parts for a small range of movement upwardly and downwardly within the lower portion of the over-all range of relative movement and it can be broken and rendered ineffective at a time when the outer body 2 is forcibly held against movement upwardly in a tubing string and an upward jarring or other force is purposefully imposed on the inner member 1.

Peripherally, the member 1 in the region containing the lost motion slot 14 is of a diameter only slightly less than the internal diameter of the body 2 in the region between the stop shoulders 5 and 6 and in this peripheral region below the slot 14 is an axially elongated annular groove or recess 16 of a width approximating the length of the slot 14. At the lowermost portion of the annular groove 16, the inner member 1 is inclined downwardly and outwardly and spaced a short distance below the

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annular groove 16, the inner member 1 has peripherally formed therein an annular relatively narrow groove 17 whose upper side face is slightly tapered downwardly and inwardly and whose lower side face is in a radial plane and provides an abrupt stop shoulder. These grooves 16 and 17 are for co-operation with and constitute recesses for the reception of an inwardly biased spring detent or snap ring 18 fitted within an annular retaining groove in the interior face of the body 2. The co-operation of the parts is such that during relative member movement within the limited range of the lost motion slot 14 the snap ring 18 remains in the longitudinally elongated groove 16 and offers no resistance to relative movement in either direction. However, should the shearable pin 15 be broken and free the members for movement, then such movement, which brings the top of the inner member 1 toward and into seating abutment with the stop shoulder 5, also causes the ring 18 to be expanded as it is traversed by the downwardly and outwardly inclined lower side portion of the groove 16 for snap-in reception within the lower groove 17 upon alignment therewith. This position of the parts is then maintained in the absence of a downwardly applied force on the inner member 1.

Such relative longitudinal movement between the inner and outer members of the tool controls the projection and retraction of one or more latching dogs. As here shown, there are a pair of oppositely disposed latching dogs 19 laterally shiftably mounted within windows in the side wall of the body 2. As best seen in FIG. 2, each dog at its opposite lateral portions at the inner face carries a pair of retainer lips 20 for co-operation with the inner face of the body 2 to prevent fall-out of the radially shiftable dog. Top and bottom ends of the dog have slide bearing on the body 2 at the top and bottom of the receiving window for the transmission of vertical force between the body and the dog. Each of the four corners of the dog is broken and has an inclined surface for co-operation with other inclined surfaces with which the dog is to co-operate. In transverse dimension, as seen in FIG. 1, the dog is somewhat wider than is the wall of the body 2 at and below the dog receiving window. In retracted relation, the outer face of the dog 19 is in substantial alignment with the periphery of the body 2 or is spaced from the body center line a distance corresponding with the radius of the peripheral surface of the body. In this retracted position, the inner face of the dog 19 is inwardly offset from the interior surface of the body at the window and therebelow and the bottom internal and downwardly and outwardly inclined corner of the dog 19, as seen in FIG. 1, is in co-operating seating engagement with a downwardly and outwardly inclined shoulder 21 at the upper end of the inner member 1. The load or weight of the outer hollow body 2 and any appurtenances secured thereto is imposed on the dogs 19 and transmitted therefrom on the downwardly inclined shoulder 21 and into the inner tubular member 1 when the latter is the suspending agency of the tool. For the purpose of such suspension, a suitable running tool is releasably secured to the inner member 1 prior to final tool assembly.

As shown in FIG. 1, the running tool involves a rod or prong 22 of a diameter slightly less than the reduced diameter of the fishing neck 3 and terminating downwardly in a short length pin portion immediately below a downwardly tapered shoulder 23. The bottom of the prong 22 is arranged for the fit of its reduced diameter pin within an upwardly counterbored portion of the opening through the hollow inner tube 1 with the shoulder 23 seated on a mating internal tube shoulder. The releasable connection referred to consists of a shearable pin 24 projected transversely through aligned openings in the wall of the inner tube member 1 and in the bottom pin portion of the prong 22. This shearable pin 24 is less frangible than the shearable pin 15, or is the stronger of the two pins. At its upper end, the prong 22 has a

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screw threaded pin for detachable connection with a socket 25 on the lower end of wire suspension line 26.

With the parts arranged as described and in their running relationship shown in FIG. 1, the tool is ready to be lowered into a tubing string. In the absence of restraint to outward dog projection, the weight of the tool body 2 transmitted into the wire line suspended inner mandrel 1 and through the shiftable dogs 6 in contact with the tapered shoulder 23 will result in an outward camming action on the dogs and they will tend to ride downwardly on the inclined shoulder 21 and be biased outwardly until they clear the shoulder and slide on downwardly in front of the peripheral surface of the inner member or expander mandrel 1. Such relative movement can occur within the limit of the lost motion pin and slot connection 15—14. Upon insertion of the tool into a tubing string, the initially contracted dogs will bear outwardly on the interior of the tubing string and tend to push out into and hang at any tubing string recess traversed by the tool. Such action may be ineffective on fast run-in but if wire line pay-out is slowed to a creep, dog projection and drop below the shoulder 23 may momentarily stop descent of the hollow tubular body 2 and transfer its weight into the tubing string. Continued pay-out of the wire line will lower the inner member 1 relative to the temporarily stopped body 2 so the camming shoulder 21 again drops below the lower internal corner of the dogs 19 and allows dog retraction to initial running relation. Should it be desirable, however, to maintain the dogs in projected position after relative movement has placed the light shear pin 15 at or adjacent the bottom shoulder of the lost motion slot 14, then a sharp upward pull or jarring action on the wire suspension line can be exerted for shearing the pin connection 15 and for accommodating elevation of the inner member 1 toward the end of its effective upper limit of relative movement established by engagement of the expander shoulder 21 with the limit abutment stop 5. In such final movement, the spring detent or snap ring 18 will ride out of its receiving groove 16 and snap into the retaining groove 17 upon alignment coincidently with the upper limit being reached. Thereafter, the detent locates the members against longitudinal displacement relative to one another in the relationship which blocks dog retraction. A further and heavier jar will serve to break the stronger shear pin 24 for removal of the prong 22 on windup of the suspension wire line.

The relationship of the parts will then be as shown in FIG. 4, wherein the dogs are illustrated as being blocked by the inner expander in contact peripherally with the rear faces of the dogs while they are projected into an annular keeper groove 27 formed interiorly of a connecting nipple 28 joining adjacent ends of tubing elements 29 forming parts of a tubing string.

When a tubing string incorporates a number of locating nipples 28 at various depths in the well, the temporary projection and retraction of the dogs during the running-in operation with the inner member or hollow expander 1 serving as the means by which the tool is suspended from a wire line, will signal the traverse of the descending tool of each keeper groove or surface recess of the tubing string. Thus, if the number of such recesses are known, the signals transmitted through the wire line will indicate the passage of the tool beyond each such recess. Additionally, if the number of recesses are unknown and it is desired to anchor the tool in a recess closest to a given depth, then the amount of wire line payed out will be gauged for determining tool depth, whereupon the next signal received will indicate the location of a latch keeper groove. Upon passage beyond that groove, the wire line can be slowly rereeled until the dogs are realigned with the keeper groove and are projected into the groove by the partial elevation of the expander or inner member 1 within the limit afforded by the relatively light shear pin within the groove 14. Successive shearing, first of the pin 15 and then of the heavier pin

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24, will establish the positive latched-in relation of the projected dogs and the displacement resisting action of the snap ring 18, along with removal of the prong and running-in tool.

For latch removal, the prong 22 is attached to a pulling tool 30 having suitable pickup formations for co-operation with the fishing neck. As seen in FIG. 4, the pulling tool 30 suspended by the wire line 31 has been positioned so that the bottom of the prong 22 is about to enter the center bore through the latch tool. As the lowering operation proceeds, the bottom shoulder 23 of the prong will finally come into engagement with the upwardly facing shoulder between the stepped diameter internal bore of the shiftable expander or inner member 1 and at the same time the internal lugs 32 at the bottom of the dependent spring blades 33 of the pulling tool will have passed downwardly of the head 4 on the fishing neck 3 and will have been expanded during such movement and snapped back under the bottom of the head 4. These lugs 32 can now slide downwardly on the fishing neck 3 with further prong descent in response to the imposition through the suspension line of a down jar which will be transmitted into and drop the inner member or expander 1 relative to the latched hollow body 2 and break the releasable lock afforded by the snap ring 18. The snap ring expands out of retaining groove 17 and springs back into the groove 16 as the expander member slides downwardly into supported abutment with the stop shoulder 6 and out of dog blocking relation. Immediately the relative positioning of the tool members 1 and 2 is re-established to that shown in FIG. 1, the previously expanded dogs 19 are free to be retracted from latching reception within the keeper groove 27 and the tool body 1 is now suspended by the wire line through its pulling tool engagement with the bottom of the fishing neck head 4. Line elevation raises the latch assembly for upward passage through and removal from the tubing string.

Following removal of the tool from the well, it can be taken apart by the removal of the adapter 7 from the lower end of the body and then re-assembled with new shear pins 15 and 24 for re-use.

It will be understood that the foregoing disclosure of but one embodiment of the improved subsurface well tool is free of limitation on the inventive concept other than defined in the attached claims.

What is claimed is:

1. A well tool adapted for passage through a tubing string having a latch keeper containing portion with which the tool is to co-operate, said tool including a tubular body member having a dog locating window in the side thereof, a dog shiftable fitted within the window and provided with upwardly and downwardly facing abutment surfaces having load transmitting and slide bearing engagement with the body member for dog movement laterally to and from an outwardly projected position and reception within a tubing string keeper upon radial alignment therewith, an expander member slidably enclosed by the tubular member for relative longitudinal movement of the members within a given range and adapted for releasable connection with a suspension line for running the well tool through a tubing string, a dog engaging formation on the expander member having an upwardly facing camming shoulder engageable with an underside of the dog for supporting the body member at one limit of the said given range of relative movement and for biasing the dog outwardly under the weight of the body member, retainer means on said members having releasable latching engagement with one another at the opposite limit of said range but being ineffective until relative member movement reaches said opposite limit and a releasable interconnection initially joining the members and confining their free relative longitudinal movement within a fraction of said range adjacent said one limit and to and from a dog projecting position intermediate said range and against relative movement to said opposite limit.

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2. A well tool adapted for passage through a tubing string having a latch keeper containing portion with which the tool is to co-operate, said tool including a latch expander member adapted for suspension by a running tool and provided with an upwardly facing shoulder, a running tool, a shearable connection between the member and the running tool, a tubular body member slidably housing said expander member for their relative longitudinal movement, a lost motion connection between the members comprising a pair of longitudinally spaced apart and oppositely facing stop abutments carried by one of the members and a shear pin of lesser shear resistance than said shearable connection carried by the other member and projected therefrom into and movable within the space between said stop abutments, initially inactive means to interconnect said members upon their relative movement beyond the range of said lost motion connection following a shearing of the shear pin and comprising a spring detent and a co-operating keeper therefor carried one by one member and the other by the other member and a laterally shiftable dog having bearing support on the body member and being adapted for co-operation with the tubing string portion for retraction relative to the body member into seating engagement with said shoulder and to be projected upon alignment with the latch keeper through dog seating engagement with said shoulder and under the weight of said body member.

3. A well tool adapted for passage through a tubing string having a latch keeper containing portion with which the tool is to co-operate, said tool including an inner member and an outer member slidably interfitted to one another for relative longitudinal movement, a latch dog laterally shiftable carried by the outer member for displacement from a retracted position to a projected latching position, a longitudinally extended dog engageable surface on the inner member located below and out of contact with the dog in dog retracted position and shiftable upon relative member movement into engagement with the inner face of the dog to hold the same in projected position, an upwardly and inwardly inclined camming shoulder at the top of said longitudinally extended surface for upward bearing engagement with the retracted dog and the support there-through of the outer member from the inner member when said members are positioned adjacent one limit of their effective range of relative movement, such bearing engagement between the dog and the inclined camming shoulder being active under the supported weight of the outer member to bias the dog toward projected position, shearable means initially movably interconnecting said members and confining their relative longitudinal movement within a fractional portion of said range and adjacent said one limit and sufficient to accommodate dog projection and retraction and a detent on one member and a detent receiving keeper on the other member adapted for interlocking relation upon relative member movement to the opposite limit of said range and which keeper and detent, while member movement is confined by said shearable means, being spaced apart a longitudinal distance greater than the length of said fractional portion of the effective range of movement.

4. A well tool adapted for passage through a tubing string having a latch keeper containing portion with which the tool is to co-operate, said tool including a tubular body member, a latch dog laterally shiftable mounted by the body member for relative projection and retraction, an expander member slidably housed within the body member for relative longitudinal movement between top and bottom limits and provided with a longitudinally extended surface to be positioned in retraction blocking engagement with the inner side of the dog at one limit of relative member movement and to be positioned below and out of retraction blocking relation with the dog at the opposite limit of relative movement, a tapered camming shoulder at the top of said surface for bearing engagement with the underside of the dog, a tool suspension

running element having a shearable connection with the expander member, a shear pin of lesser shear resistance than said shearable connection carried by one member and projected therefrom, the other member having a longitudinally elongated slot aligned with and shiftably receiving the projected pin while the body member is at the upward limit of relative member movement and the expander member is at the lower limit of relative movement and which pin and slot accommodate movement through a fraction of the effective range of relative longitudinal member movement, a snap ring carried by one of said members and the other of said members having an upper snap ring receiving groove receiving the snap ring prior to a shearing of the shear pin and being of a longitudinal length approximating the length of said elongated slot and the last mentioned other of said members also having a lower snap ring receiving groove spaced below the first mentioned snap ring receiving groove and of a longitudinal size approximating the width of said snap ring for retention engagement of the ring upon relative member movement to said opposite limit.

5. In a well tool adapted for detachable connection with a latch keeper in a tubing string, a tubular body member having a window through the side wall thereof, a keeper engageable dog laterally shiftable in the window to and from projected relation with the body member, a dog engageable expander member having a dog engaging formation controlling lateral shift action of the dog and axially slidably mounted in the body member to and from dog projecting position, a detent bearing surface provided on one member and terminated at one end in a retainer groove and a snap detent carried by the other member in slidable engagement with said bearing surface and receivable by said retainer groove for retention of the expander

member upon its slide movement to given dog projecting position, and a lost motion and frangible interconnection between the members initially effective for limiting the range of expander member movement to another dog projecting position which is short of the aforesaid given dog projecting position.

6. In a subsurface well tool latch assembly for releasable attachment within a keeper recess of a tubing string, a latch dog expander member adapted for suspension connection with a running tool, a tubular body member slidably enclosing the expander member and providing longitudinally spaced apart limit abutments therefor at the bottom and top limits of the effective range of relative member longitudinal movement, a latch dog laterally shiftably mounted by the body member and engageable by said expander member to control dog retraction and projection in response to relative member movement, a shoulder on the expander member having outward camming engagement with the latch dog under body weight transmitted thereto adjacent the bottom limit of relative member longitudinal movement, a frangible lost motion connection between the members initially restricting their relative longitudinal movement to and from said bottom limit and within a fraction of said range and initially inactive retainer elements positioned by the members and engageable with one another in response to expander member movement beyond the confines of said lost motion connection to thereby hold the members in dog projecting relation.

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