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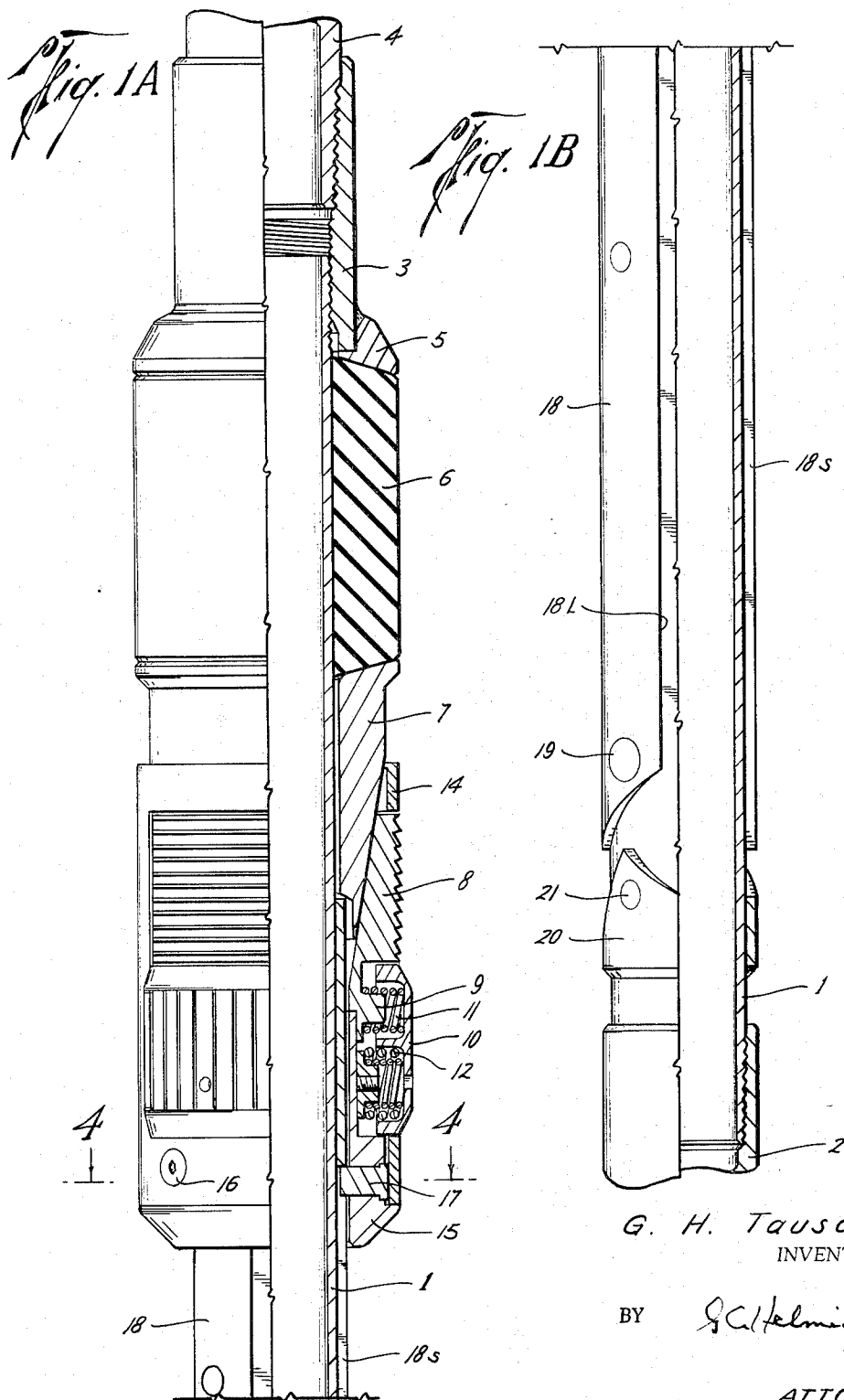
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3,209,832

WELL PACKER RESPONSIVE TO TUBING RECIPROCATON

Filed Nov. 6, 1963

2 Sheets-Sheet 1



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Fig. 2

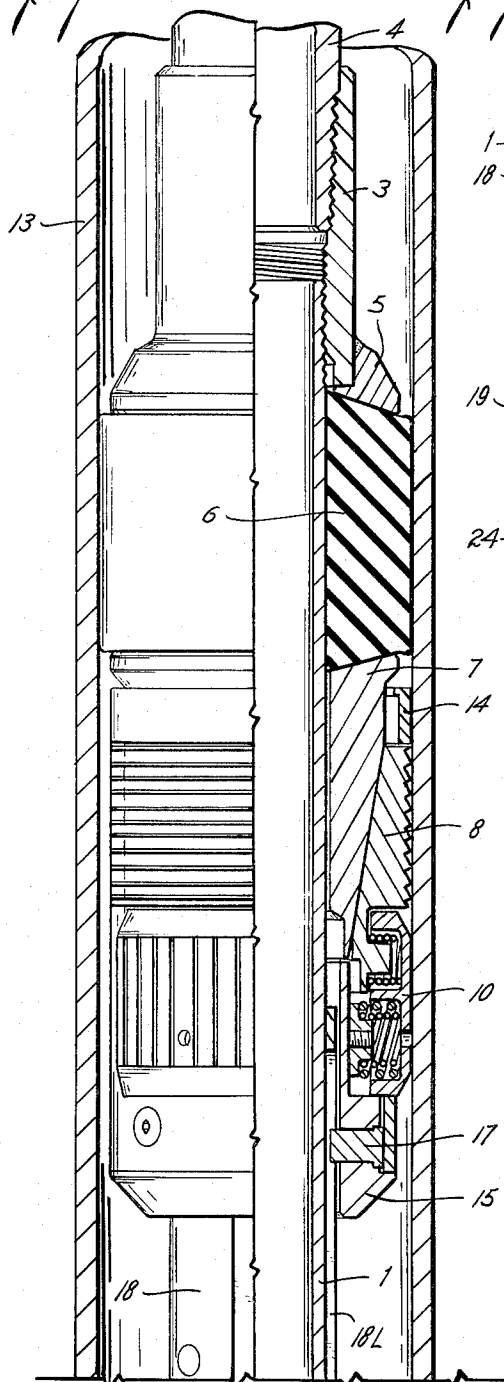


Fig. 3

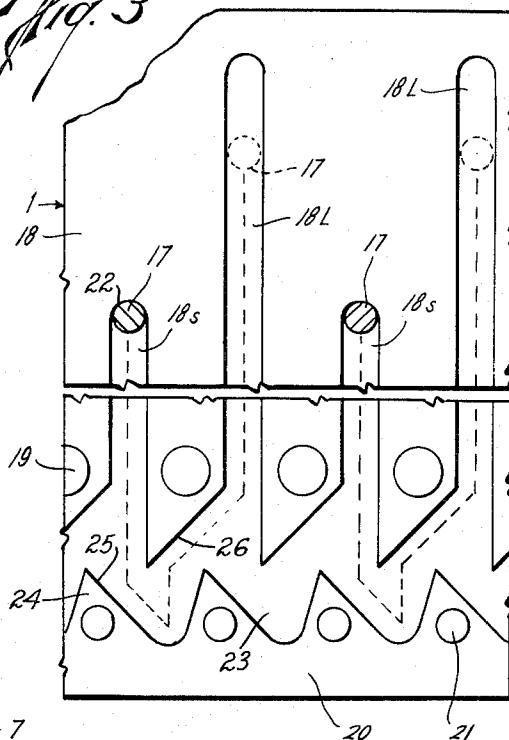
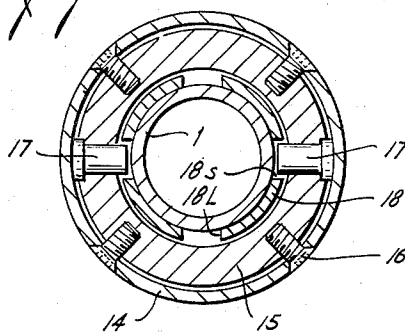


Fig. 4



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WELL PACKER RESPONSIVE TO TUBING RECIPROCATION

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This invention relates to sub-surface well tools and more particularly to an improved weight set packer to be lowered in a well bore as part of a tubing string assembly and to be set at a desired depth for sealing the annulus space around the tubing string.

An object of the invention is to provide a tubular mandrel and packer unit whose parts are positively maintained in release position while being run down a well bore and which parts can be conditioned for and operated to radially expanded packer setting position solely in response to controlled longitudinal reciprocation of the tubing string by the ordinary suspension mechanism without tubing string rotation and need for special equipment at the surface for application of torque to and resultant undesirable twisting within a long tubing string.

A further object of the invention is to provide for release of a previously set packer and its maintenance in unseated position for retrieving or for resetting without removal from the well and in either case by mere tubing string reciprocation and wholly free from the imposition of turning forces applied at the surface.

Additional objects and advantages will become apparent from the following specifications having reference to the accompanying drawings wherein:

FIGS. 1A and 1B are companion, half elevation and half sectional views of the improved tubing string packer assembly showing the parts in released relationship; FIG. 2 is a part vertical section and part elevation showing the packer element extended into set relation within a well casing; FIG. 3 is an elevational development of the pin guide and groove formations on the periphery of the packer mandrel and with which co-operate the clutch pins or keys of the packer assembly, and; FIG. 4 is a transverse section as on line 4-4 of FIG. 1A.

In the preferred embodiment illustrated in the drawing, there is shown a long tubular mandrel 1 which is screw threaded at opposite ends for its connection as an assembly in a tubing string. Its lower end as shown in FIG. 1B is coupled to the upper end of a tubing section or a tool and its upper end is preferably coupled by a nipple 3 to an adjoining tubing section 4. Conveniently, a downwardly facing bearing abutment is provided by a ring 5 fixedly secured relative to the mandrel 1 as by a welded connection with the nipple 3. Embracing the mandrel below the abutment ring 5 is a packer collar 6 of rubber or other similar elastic deformable material which upon the application of an axial squeezing force will be deformed radially so as to grow in wall thickness. At its lower end face the packing collar 6 has bearing abutment on the upwardly facing seat of a slip expander ring 7 loosely sleeved on the mandrel 1 and terminating downwardly in a conical or tapered outer wedging face for engagement with complementary faces of a set of segmental slips 8. Lower heel portions 9 on the slips extend below co-operating friction drag blocks or shoes 10 which are resiliently biased outwardly as by means of coil springs 11 interposed radially between the slip heel portions 9 and the blocks 10. One or more additional coil springs as shown at 12 may be disposed beneath each block and when the packer is placed within a tubular well casing shown at 13, the several blocks will slide on the interior of the casing and provide a desired degree of resistance to slide movement of the slip and expander assembly. As

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is customary, the several slips and the friction blocks are retained as a sub-assembly with a tubular cage 14 and have radial movement within windows in the cage. As part of the cage 14 and as an internal backing for the encased parts, there is inserted a tubular retainer 15 within the lower portion of the cage and secured as by fastening studs 16.

The structure thus far described is similar to a conventional weight set packer assembly. In the absence of securement to the mandrel of the slideably sleeved parts below the packing collar 6, then downward movement of the tubing string within the casing 13 as transmitted through the packer, will be resisted by the frictional engagement of the drag shoes or blocks 10 on the casing. Such relative downward movement of the expander 7 first wedges outwardly the several slips 8 and causes their teeth or wickers to bite into the casing to resist further downward movement of the expander for a resultant deformation of the packer collar 6 into surface sealing relation with the casing 13.

In the present instance, control of packer setting operation is provided by a simplified coupling clutch arrangement comprising slotted or grooved portions on the lower periphery of the mandrel and into which is fitted an internal key or tip portion of a radial pin 17 carried by the cage sub-assembly. Preferably, a pair of diametrically opposite pins 17 project through counterbored openings in the retainer sleeve 15 and have headed portions fitted within the counterbore and held in place by being overlapped by the lower portion of the cage 14. Co-operating with each pin 17 are a pair of longitudinal grooves 18L and 18S and the grooves of the two sets are equally circularly spaced apart and at 90° intervals around the mandrel circumference. Conveniently, these grooves are provided by longitudinal slotting from one end, a separately formed tubular mandrel portion 18 which is sleeved on the main portion of the mandrel 1 and secured thereto as by rivets 19. In width, the keying grooves 18L and 18S are slightly in excess of the diameter of the pin 17 and the side surfaces of the grooves provide guides on which the pins are slideable. In each case, the shorter groove provides a limit stop 22 at its upper end for the inwardly projected pin 17 and is located at a distance below the uppermost packer abutment 5 sufficient to hold the cage assembly so spaced therefrom as to maintain the packer collar in released position and free from compressive stress. This is the relationship of the parts as seen in FIG. 1A and downward movement of the tubing string is transmitted through the pin 17 to pull in unison with the tubing string the entire cage assembly with the friction blocks 10 sliding on the well casing. When, however, the pin is received within the longer grooves 18L then the upper end of the long groove is spaced from the upper packer abutment ring 5 a distance less than that which limits relative longitudinal movement between the pin 17 and the mandrel so that the friction bearing between the casing and the drag block 12 can set the slip and provide solid abutment for the lower end of the packing collar 6 on relative downward movement of the tubing string.

Transfer of the pin 17 from one to the other of the grooves 18L and 18S occurs when the pin is within a cross-over channel 23 below the lower ends of and communicating the grooves with one another. Such a cross-over channel is provided by toothed ring 20 secured as by rivets 21 to the mandrel in downwardly spaced relation to the lower end of the grooved mandrel sleeve 18. The upper edge of the ring 20 is cut to sawtooth shape and provides a series of circularly spaced and upwardly projecting teeth 24, one for co-operation with each longitudinal groove and are so arranged so that each tooth provides a downwardly and annularly inclined guide or

cam surface 25 for the cage carried pin as relative mandrel movement presents the pin below a longitudinal groove. Thus when tubing string is elevated with the pin braked against vertical travel, the cam surface 25 of the ring 20 will contact and shift the pin 17 in a counter-clockwise direction as seen in the drawings and toward the bottom of the inclined tooth 24 and into vertical alignment with an upwardly and annularly inclined camming surface 26 on the under side of the sleeve 18 between adjoining grooves 18s and 18L. Thereupon reverse and downward travel of the tubing string will push the mandrel sleeve bottom edge surface 26 against the pin 17 and further cam and turn the pin and cage in the counter-clockwise direction until the pin reaches longitudinal alignment with the next groove. Thereupon descent of the mandrel brings the groove portion on downward without affecting the pin 17. If the pin is then in the shorter groove 18s, the upper end of the groove on abutment with the pin limits further relative travel and retains the packer in released condition. On the other hand, if the pin is in the long groove 18L, the pin eventually comes into the upper reach of the groove without interference to action of the friction blocks 10 for setting the slips 8 and stopping the lower packer abutment 7 and for longitudinally squeezing the packer collar 6 with further descent of the mandrel mounted abutment ring 5.

With the pins or keys 17 located in the long grooves 18L and the packer in set position as shown in FIG. 2, the packer unit can be released at any subsequent time by pulling the tubing string upwardly and thereby moving the abutment ring 5 away from the packer 6. Continued mandrel elevation will bring the key pins 17 against the bottom ring 20 of the crossover groove 23 and cam the pins and associated cage assembly through a part turn. The ring 20 will then support and elevate the pins and cage assembly during further upward travel of the tubing string. With release of the packer, the mandrel unit can be raised entirely out of the well or optionally it can be moved either upwardly or downwardly to a new packer setting position. On downward mandrel movement, the downwardly facing inclined cage faces of the tubular element 18 will cam the pins into alignment with and reception by the shorter grooves 18s whose top ends restrict the range of relative pin movement and restrain reduction in the spaced relation between the abutment 5 and 7 for precluding expansion of the packer collar. At the desired depth at which the packer is to be set, the packer setting operation as previously described can take place.

Throughout the operation of setting and releasing the packer assembly, the only application of force to shift the tubing string is in the axial direction by back and forth reciprocation of the string. Torque for rotation is not imposed on the string at any time. While one specific embodiment of the novel structure has been referred to in detail, it is to be understood that various modifications and adaptations can be made without de-

parting from the invention as set out in the attached claims.

What is claimed is:

1. In a weight set packer having a deformable packing ring surrounding a mandrel unit between a downwardly facing seat fixed on the mandrel unit and an upwardly facing seat on a tubular assembly slidably surrounding the mandrel unit and including at least one inwardly projecting pin and drag block arranged to bear on the wall of a well in which the packer is to be set, said mandrel unit comprising a central conduit adapted for connection in a tubing string and a pair of pin positioning tubular members sleeved on the outside of the conduit in inwardly spaced concentric relation to said tubular assembly and fixed to the conduit in axially spaced apart relation at adjacent end portions of the members to provide a pin guiding annular channel surrounding the conduit between said end portions, the lowermost of said tubular members having its upper end portion of sawtooth formation arranged to present one side edge of each tooth inclined downwardly and annularly for pin camming engagement, the uppermost of said tubular members having a series of circularly spaced apart longitudinal pin locator slots, each opening downwardly into said annular channel in longitudinal alignment with a downwardly inclined side edge of a tooth therebelow, each of said circularly spaced apart slots in relation to a next adjacent slot of the series differing in length projection above the bottom edges of the lower end portion of the uppermost member and said bottom edges being inclined upwardly and annularly in divergent relation to said downwardly inclined side edges of the sawtooth upper end portion of the lowermost member, whereby the downwardly inclined and upwardly inclined edges cooperate in guiding the pin from below any given slot toward longitudinal alignment with the next adjacent slot in response to conduit reciprocation.

2. In a weight set packer as in claim 1, said longitudinal slots of differing lengths being arranged with the longer of the slots in alternate circular succession to the shorter of the slots and said annular channel being common to all slots whereby the guided direction of pin transfer toward each of the series of slots is in every instance of the same circular hand of revolution about the axis of the annular channel.

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