April 2, 1963 S. L. VILLALON, JR., ET AL 3,083,770

TENSION PACKER

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FIG. 1.

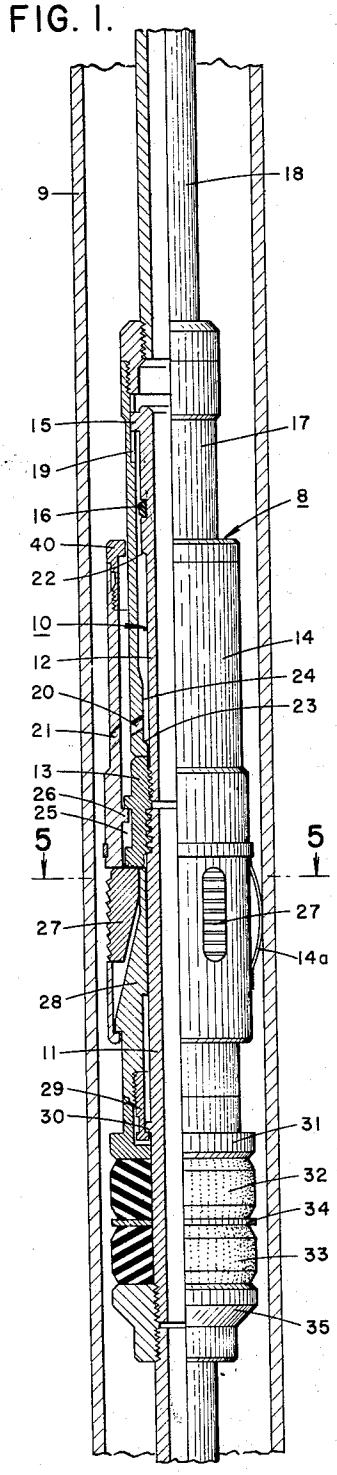
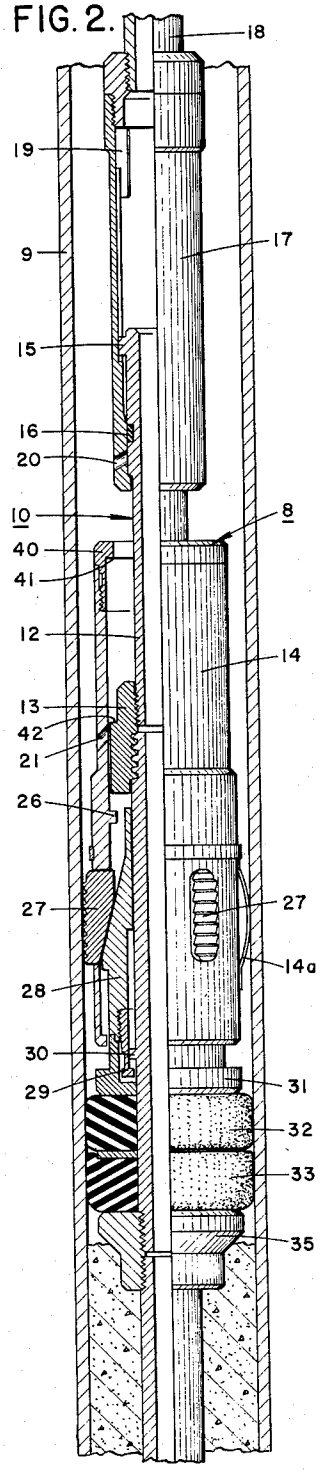


FIG. 2.



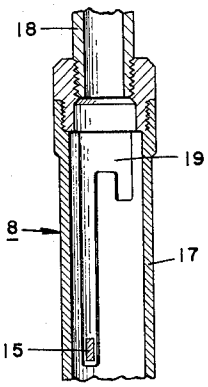


FIG. 3.

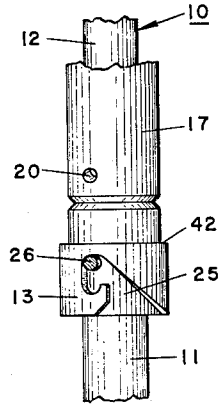


FIG. 4.

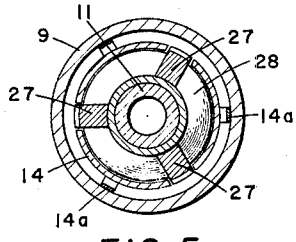


FIG. 5.

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FIG. 6.

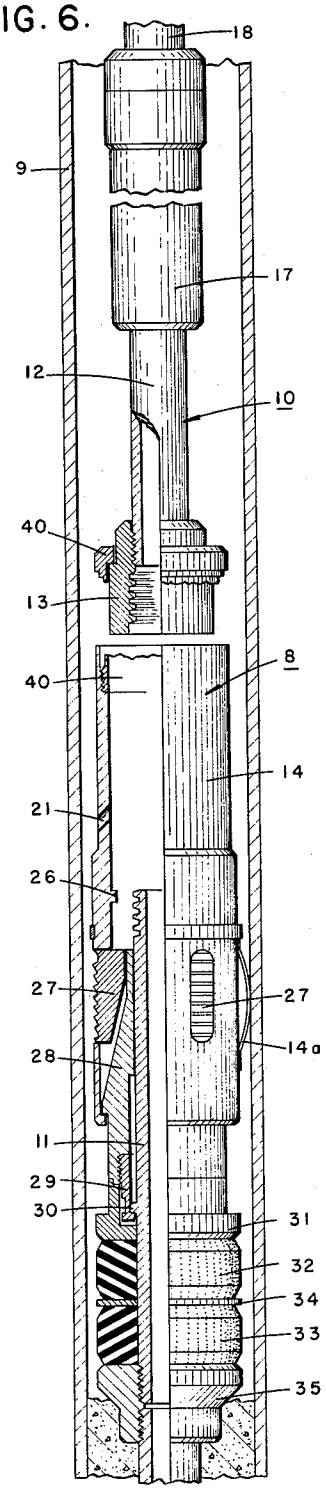


FIG. 7.

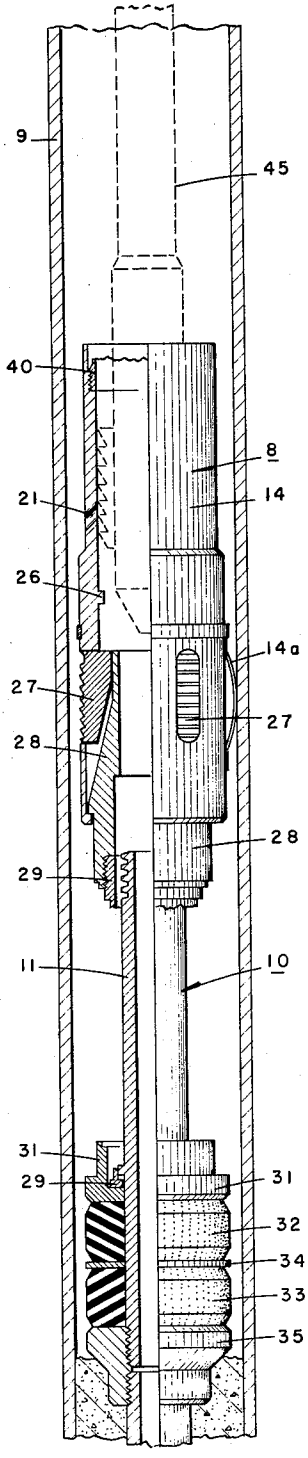
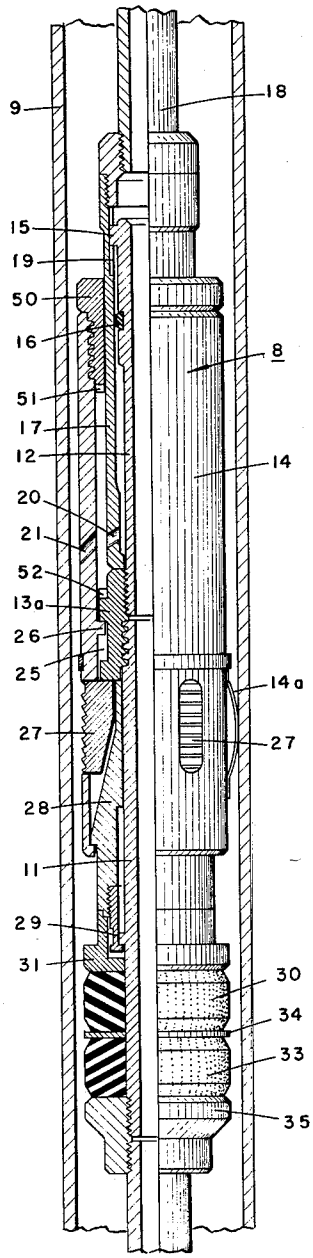


FIG. 8.



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TENSION PACKER

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12 Claims. (Cl. 166—124)

The present invention is directed to a packer assembly for use in oil wells and the like and more particularly to a packer of the retrievable type. Such a packer can be employed in various well operations such as squeeze cementing, acidizing or repressuring of oil wells, etc.

During such operations it is necessary to provide a packer between the tubing or operating string and the well casing so that treating liquids such as, for example, cement, may be pumped down the tubing and pressurized without being allowed to flow up the annulus between the pipe string or tubing and the casing wall.

Most conventional packer assemblies of this nature are set by moving the operating string down once the packer is positioned at the desired depth, the packer assembly being held in place by drag springs and the like so that the operating string can be moved relative to the packer housing. Such packers require considerable weight (which can only be afforded by the operating string) to perform the setting operation. The weight is needed to expand the packing element and squeezes it against the casing wall tight enough to provide a satisfactory seal in the tubing casing annulus.

However, at times it is necessary to set such packer assemblies at more shallow depths wherein the operating string or tubing is not of sufficient length to provide the necessary weight required to perform the setting operations.

When such conditions prevail, it is necessary to provide a packer that can be set in tension, that is, instead of applying the pipe weight to set the packer, an upward strain or pull on the operating string or tubing performs the setting operations. It is obvious that such a packer being set by upward movement of the pipe string must be released by downward movement of the string.

Releasing tension packers of this nature is quite simple if the operation being performed does not place obstacles in the casing below the packer which prevents the operating string from being moved downwardly when it is desired to remove the packer assembly. Such a condition sometimes exists after squeeze cementing operations. The lower end or lower shoe of the packer may be entirely "cemented in" whereby the normal releasing operation cannot be performed due to the assembly being stuck.

It is the primary object of the present invention to provide a packer assembly which can be set by tension and at the same time provide means whereby the tool can be removed in case it becomes stuck or "cemented in."

Briefly described, the present tool is provided with upper and lower frangible means hereinafter referred to as "tension sleeves." The upper tension sleeve is designed to rupture or shear at a predetermined pull or strain and the lower tension sleeve shears at a greater predetermined pull or strain applied to it. The tool is so designed that each time a tension sleeve is sheared a portion of the assembly can be removed from the casing and the remaining portion provides an extending neck or sleeve which can be easily engaged by a "fishing" or pulling tool.

The structure, operation, and advantages of the tool of the present invention will be more clearly understood by the following description taken in conjunction with the drawings in which:

FIG. 1 is a view partly in section of the present device and the position assumed when the tool is being lowered into a well casing;

FIG. 2 is a similar view showing the assembly set in the casing with cement having been pumped through and in place below the assembly;

FIG. 3 is a fragmentary view of a portion of the device showing the "J slot and lug" arrangement for controlling and circulating valve of the assembly;

FIG. 4 is a fragmentary view showing another "slot and lug" arrangement for controlling the pipe slips of the device;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 1;

FIG. 6 is a view showing the parting of the upper tension sleeve and the lower end of the tool cemented in the casing;

FIG. 7 illustrates the shearing of the lower tension sleeve and the removal of the major portion of the assembly; and

FIG. 8 illustrates a modification of the present invention.

Referring now to the drawings and particularly FIGS. 1 through 5, the device generally designated by the numeral 8 is lowered in a casing 9 on the lower end of an operating string 18 with the parts in the position shown in FIG. 1. A mandrel generally designated 10 composed of an upper section 12 and a lower section 11 joined together by a safety joint or collar 13 has arranged about it a slip housing 14.

The upper, outer periphery of mandrel section 12 is provided with a lug 15 and a sealing means such as a packing ring 16.

A valve sleeve 17 is slidably arranged about the upper mandrel section 12 and is as shown threadedly connected to a tubing or operating string 18 which extends to the earth's surface and connects to a hoisting means not shown. The inner wall of valve sleeve 17 is provided with a J slot 19 (see FIG. 3) which operably engages with the lug 15 on mandrel section 12.

Valve sleeve 17 is provided with at least one port 20 and the slip housing is provided with ports 21. Ports 20 and 21, sleeve 17, and packing 16 together serve as a circulating valve for controlling fluid flow between the interior of mandrel 10 and the annulus between the housing 14 and the casing 9. This circulating valve is open in its lowermost position as shown in FIG. 1 with the lower end of the sleeve 17 abutting the top of safety collar 13. Flow of fluid may occur upward through the mandrel 10 around the upper end of the upper mandrel section 12, down through the annular space between the upper mandrel section 12 and the interior of the sleeve valve 17 and out through lateral ports 20 and 21. When the sleeve is in its uppermost position as shown in FIG. 2, the valve is closed as the packing ring sealingly engages the surface 24 of sleeve 17 above port 20 and shoulder 23 contacts shoulder 22 of the mandrel section 12.

Safety collar 13 is provided with an open bottom J slot 25 which operably engages a lug 26 formed on the inner wall of housing 14. Housing 14 is also provided with drag springs 14a which engage the wall of casing 9. Lug 26 and slot 25 control the operation of slips 27 which are mounted in housing 14. The slips 27 are moved in and out of the housing by a wedge member 28 which is mounted about mandrel section 11 with its lower end extending out the lower end of housing 14.

A frangible sleeve 29 referred to as the lower tension sleeve is threadedly connected into the lower end of the wedge member 28 and has an internally projecting shoulder which engages an annular shoulder 30 of mandrel section 11. As can be seen, the shoulder 30 prevents upward movement of slip wedge 28 with respect to the mandrel section 11. As shown in FIG. 1, the thin upper wall section of wedge 28 abuts against the bottom of safety collar 13.

An upper packer shoe **31** is mounted about mandrel **11** and the tension sleeve **29** and is retained against the lower end of wedge **28** by a pair of packer sleeves **32** and **33** which are separated by a metal ring **34**. The sleeves **32** and **33** are held in place by shoe **31** and a lower shoe **35** which is threadedly connected to mandrel section **11** as shown.

Upper packer sleeve **32** is formed of a somewhat firm resilient material such as **95** durometer rubber while the lower sleeve **33** is formed of a softer material such as **75** durometer rubber. This arrangement affords a more efficient seal when the sleeves are compressed and squeezed against the casing wall. The more firm sleeve **32** acts as a back-up for the softer sleeve **33**.

As can be seen, the upper end of housing **14** is provided with a second tension sleeve **40** which forms a shoulder **41** and which is adapted to be engaged by a shoulder **42** of collar **13**.

The upper tension sleeve **40** is designed to part or shear at approximately 30,000 pounds pull and the lower tension sleeve **29** at 100,000 pounds pull.

Operation

The assembly is lowered into the casing **9** by means of the tubing **18** to the desired depth at which the packer assembly is to be set. The various parts will assume the position as shown in FIG. 1. The drag springs **14***a* contact the wall of casing **9** with a force sufficient to support the housing **14** and prevent its rotation and vertical movement while the mandrel **10** is manipulated within it.

The tool is run in with the circulation valve assembly in the open position, but the valve is not necessarily locked open. The sleeve **17** being connected to the operating string **18** pushes against the upper end of the safely collar **13**. The shoulder **30** and the collar **13** prevent the wedge **28** from pushing out on the slips **27**. The lug **26** is in the locked position as shown in FIG. 4.

The tubing **18** is now rotated to the right, unlocking the circulating valve and the J lug **26**. The pipe is picked up and the circulating valve is closed as the packing ring **16** engages the surface **24** of valve sleeve **17**. Shoulder **23** is now contacting shoulder **22** and lug **15** is positioned in the long portion of the slot **19**.

Continued upward pull on tubing **18** moves the mandrel **10** upwardly and the wedge **28** forces the slips **27** into gripping contact with the wall of casing **9** as shown in FIG. 2. When the slips **27** are set to the extent that they prevent further upward movement of the wedge **28**, the packer sleeves **32** and **33** then begin to compress and further pull on tubing **18** causes them to be squeezed against the casing wall between the shoes **31** and **35** until they afford an effective seal between the mandrel and the casing.

The assembly is now in position whereby a treating fluid can be pumped down the tubing **18**, through the mandrel **10** and into the casing **9** below the packer assembly. As the pressure of the cement being pumped in increases, a greater force is applied to the wedge **28** causing the slips **27** to bite deeper into the pipe wall.

When it is desired to retrieve the assembly **8**, the tubing **18** is lowered, opening the circulating valve and the valve sleeve **17** abuts against the top of safety collar **13**. The tubing is rotated to the left which places the lugs in the locked position in their respective slots. The safety collar and shoulder **30** has forced the wedge **28** down out of contact with the slips **27** so that they can retract into the housing **14**. The assembly is now in position to be removed from the well casing.

Now, if the treating fluid pumped through the assembly were in the form of a cement slurry and allowed to set in the casing as shown in FIG. 2, the lower end of the assembly may be cemented in so that it is stuck. The hardened cement also affords an obstacle against downward movement of the mandrel when it is desired to release the tool.

It is not possible to now retrieve the assembly in the normal manner as previously described, as the mandrel **10** cannot be moved down with respect to the slip housing **14**. This is the sort of situation for which the upper and lower tension sleeves are provided.

The tubing is rotated to the right until the safety joint is disconnected from the lower mandrel section **11**. The lug may or may not be in the locked position in slot **19**. After the safety joint **13** has been backed off, the pipe is picked up until the shoulder **42** of collar **13** comes up against the shoulder **41** of the upper tension sleeve **40**. This raises the housing **14** and therefore raises the slips **27** out of contact with the wedge **28** allowing the slips to be retracted.

A pull is then applied to the tubing which is transmitted to the shoulder **41** of upper tension sleeve **40**. If the tool is not too tightly cemented in the entire assembly can now be retrieved. A jarring action may be attained by reciprocating the tubing **18** causing shoulder **42** to move upwardly, striking shoulder **41**. Should the tool be firmly cemented in and the force applied exceed 30,000 pounds, the upper tension sleeve will part or shear and the mandrel section **12**, circulating valve sleeve **17**, and the safety sleeve can be removed with the tubing **18**.

Should the tension sleeve **40** part and the upper portion of the tool be removed, the inner wall of the extended housing **14** provides a neck which can now be engaged by a fishing and pulling tool schematically shown as **45** in FIG. 7. An upward pull is then again applied to the tubing **18** which is connected to the pulling tool **45**.

The pull now applied can be anywhere in the range of 30,000 pounds to 100,000 pounds. During this pulling operation, the remainder of the assembly previously left in the casing may then be pulled loose and removed.

However, should the pulling force exceed 100,000 pounds, the lower tension sleeve **29** will then part or shear and the housing **14**, along with the slips and wedge, can then be removed, leaving the lower portion **11** of mandrel **10** and the packer sleeves **32** and **33** in the casing. The upwardly extending section **11** of the mandrel **10** now affords a neck that can be easily engaged by another fishing tool. The portion left in the casing as shown in FIG. 7 may be fished out or may be drilled up or may, if desired, be left in the casing.

Referring now to FIG. 8, the tool illustrated has been somewhat modified with respect to the other FIGS. 1 through 7. The upper tension sleeve **40** is here replaced by an upper safety sleeve **50** which is threaded into the upper end of the housing **14** as shown. The lower end of the sleeve is provided with spaced apart clutch teeth **51**. The upper end of safety collar **13***a* is also provided with clutch teeth **52**. The remainder of the tool is identical to that of the previous tool and like parts are identified with like numerals.

If the tool is not stuck or cemented in, the normal releasing procedure is the same as in the other modification. Should the tool, however, be stuck, the safety collar **13***a* is backed off and the teeth **52** raised by the tubing **18** into contact with the teeth **51** of the sleeve **50**. A predetermined pulling force is then applied against the sleeve **50** to try and pull the assembly **8** loose.

Should this not be sufficient to pull the tool loose, the tubing **18** may be reciprocated so as to use the collar **13***a* as a hammer against the bottom of the sleeve **50** to jar the assembly loose. If this still does not loosen the assembly, the tubing is pulled up and rotated so that the teeth **52** operably engage the teeth **51** and the upper safety sleeve **50** is backed off out of the housing **14**. The same parts as shown in FIG. 6, along with the safety sleeve **50**, can now be removed. The remainder of the assembly is then removed in the same manner as previously described with respect to the FIGS. 1 through 7.

It can be seen by the foregoing description and the drawings that the present invention affords a tension packer that can be set by upward movement of the oper-

ating string or tubing and be released by downward movement of the operating string.

The tool also provides means whereby the tool may be released by upward movement of the operating string, as well as downward movement.

The upper and lower tension sleeves provide means for removing the assembly a portion at a time, should the tool become stuck or cemented in during well treating operations.

The present invention also provides an assembly to which a reciprocating hammer action can be applied by the tubing in an effort to release the tool by jarring, should it become stuck or cemented in.

Having fully described and illustrated the advantages and operation of the device of the present invention, what is claimed is:

1. A packer assembly adapted to be suspended on the lower end of a pipe string and positioned in a well casing, comprising in combination: an elongated cylindrical housing provided with means for frictionally engaging the wall of said casing, spaced apart slips extending through windows in the wall of said housing, a hollow mandrel coaxially aligned with and extending through said housing, said mandrel comprised of an upper section and a lower section releasably connected together by a safety collar fixed to the lower end of said upper section above said slips, a releasable locking means releasably connecting said safety collar to the wall of said housing, a valve sleeve having a lateral port therein, said valve sleeve being slidably arranged about said upper mandrel section and operably engaging therewith for limited vertical movement thereon, the upper end of said valve sleeve adapted to be connected into the lower end of said pipe string, said upper mandrel section closing said port in its uppermost position and opening said port in its lowermost position, a slip operating member slidably arranged on said lower mandrel section and formed to bias said slips outwardly upon upward movement of said member relative to said slips, the lower end of said member extending out the lower end of said housing, a frangible tension sleeve connected to the lower end of said member and operably engaging said lower section whereby upward movement of said member relative to said mandrel is prevented while upward movement of said mandrel relative to said member is allowed, a deformable packer sleeve positioned about said lower mandrel section and extending from the lower end of said member to an annular plate fixed to the lower end of said mandrel, said packer sleeve being expandable radially into contact with said well casing upon upward movement of said mandrel relative to said member, a removable sleeve member threaded into the upper end of said housing for limiting the upward movement of said upper mandrel section when said mandrel sections are disconnected, said assembly providing an axial bore therethrough.

2. An assembly as in claim 1 in which said means for frictionally engaging the wall of said casing are drag springs.

3. An assembly as in claim 1 in which said releasable locking means comprises in combination an open bottom J slot formed on the outer wall of said collar operably engaging a J lug on the inner wall of said housing.

4. An assembly as in claim 1 in which said removable sleeve member is a frangible tension sleeve formed to part when a predetermined upward pull is exerted against it by the said safety collar.

5. A packer assembly adapted to be suspended on the lower end of a pipe string and positioned in a well casing comprising in combination: a hollow mandrel comprised of an upper section and a lower section releasably connected together by a safety collar fixed to said upper section, a valve sleeve having a circulating port therein, said valve sleeve being slidably arranged about and extending above said upper mandrel section and operably engaging said upper mandrel section for limited vertical movement thereon, said upper mandrel section closing said circulating port in said sleeve in its upper position and opening said port in its lower position, said valve sleeve adapted to connect by its upper end to said pipe string, a cylindrical housing arranged about said mandrel and provided with friction means for engaging the wall of said casing, a plurality of pipe gripping slips arranged in windows in said housing, a releasable locking means connected between said safety collar and the inner wall of said housing, a wedge shaped sleeve positioned in said housing below said slips and slidably arranged on said lower mandrel section, the lower end of said wedge shaped sleeve extending below said housing, the wedge surface of said sleeve facing so as to bias said slips outwardly upon upward movement of said wedge shaped sleeve in said housing, a frangible sleeve arranged about said lower mandrel section and connected to the lower end of said wedge shaped sleeve, the lower end of said frangible sleeve providing an internally projecting annular shoulder adapted to engage the underside of an annular shoulder on said lower mandrel section, an upper annular shoe member arranged about said lower mandrel section and abutting against the lower end of said wedge shaped sleeve, a lower annular plate fixed to the lower end of said lower mandrel section, a deformable packer means arranged about said lower section and extending between said plate members, said packer means being expandable into contact with said well casing upon upward movement of said lower mandrel section relative to said wedge shaped sleeve, a removable means connected into the upper end of said housing for limiting the upward movement of said upper mandrel section when said sections are disconnected, said removable means adapted to operably engage the said safety collar.

6. An assembly as in claim 5 in which said safety collar is provided with spaced apart clutch teeth on an annular upward facing shoulder thereon and said removable means is a sleeve threadedly connected into the upper end of said housing and provided with spaced apart clutch teeth about the lower end thereof, said teeth of said collar and said sleeve operably engaging when said sections are disconnected whereby rotation of said collar by said pipe string will unscrew said sleeve from said housing.

7. An assembly as in claim 5 in which said deformable packing means is comprised of an upper sleeve and a lower sleeve separated by an annular ring, said lower sleeve formed of a deformable material of lesser durometer than said upper sleeve.

8. An assembly in accordance with claim 5 in which said friction means are drag springs.

9. An assembly as in claim 5 in which said removable means is a tension sleeve adapted to limit the upward movement of said upper mandrel section when said mandrel sections are disconnected, said tension sleeve formed to part when a predetermined upward pull less than that required to part said frangible sleeve is exerted against it by said safety collar and said pipe string.

10. A tension packer assembly adapted to be carried on a pipe string and positioned within a well casing, comprising in combination: a housing having friction drag means adapted to engage the casing, wedge slips carried on said housing and movable into engagement with the casing, deformable packer means below said housing expandable into contact with the casing, a tubular mandrel extending through said housing and said packer means and having an upper section and a lower section, a safety collar fixed on said upper section and threadedly connected to said lower mandrel section, shoulder means on the lower mandrel section supporting said deformable packer means, a slip expander cone slidably on said lower mandrel section and between said deformable packer means and said wedge slips, whereby upward movement of said mandrel relative to said housing is effective to

expand said wedge slips into engagement with the casing, means whereby said upper mandrel section may be carried by a pipe string, and frangible means including a sleeve element on said housing engageable by said safety collar following threaded disconnection thereof from said lower mandrel section and subsequent lifting of said upper mandrel section by said pipe string.

11. A tension packer assembly adapted to be carried on a pipe string and positioned within a well casing, comprising in combination: a housing having lateral windows and having friction drag means adapted to engage the casing, wedge slips in said windows movable into engagement with the casing, deformable packer means below said housing expandable into contact with the casing, a tubular mandrel extending through said housing and said packer means and having an upper section and a lower section, a safety collar fixed on said upper section and threadedly connected to said lower mandrel section, shoulder means on the lower mandrel section supporting said deformable packer means, releasable control means on the housing and safety collar for limiting relative axial movement therebetween, a slip expander cone slidably on said lower mandrel section and between said deformable packer means and said wedge slips, whereby upon release of said control means upward movement of said mandrel relative to said housing is effective to expand said wedge slips into engagement with the casing, means whereby said upper mandrel section may be carried by a pipe string, and frangible means including a sleeve element on said housing engageable by said safety collar following threaded disconnection thereof from said lower mandrel section and subsequent lifting of said upper mandrel section by said pipe string.

12. A tension packer assembly adapted to be carried on a pipe string and positioned within a well casing, comprising in combination: a housing having friction

drag means adapted to engage the casing, wedge slips carried on said housing and movable into engagement with the casing, deformable packer means below said housing expandable into contact with the casing, a tubular mandrel extending through said housing and said packer means and having an upper section and a lower section, a safety collar fixed on said upper section and threadedly connected to said lower mandrel section, shoulder means on the lower mandrel section supporting said deformable packer means, a slip expander cone slidable on said lower mandrel section and between said deformable packer means and said wedge slips, whereby upward movement of said mandrel relative to said housing is effective to expand said wedge slips into engagement with the casing, means whereby said upper mandrel section may be carried by a pipe string, a frangible sleeve element on said housing engageable by said safety collar following threaded disconnection thereof from said lower mandrel section and subsequent lifting of said upper mandrel section by said pipe string, an abutment on the lower mandrel section, a frangible sleeve connected to said slip expander cone and having a portion thereof underlying said abutment, and cooperating means on the housing and expander cone whereby the housing may lift the expander cone to apply a tension force to the latter said frangible sleeve.

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