Feb. 27, 1962 J. W. HODGES 3,022,828

PACKER ASSEMBLY FOR MULTIPLE COMPLETION WELLS

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Fig. 1

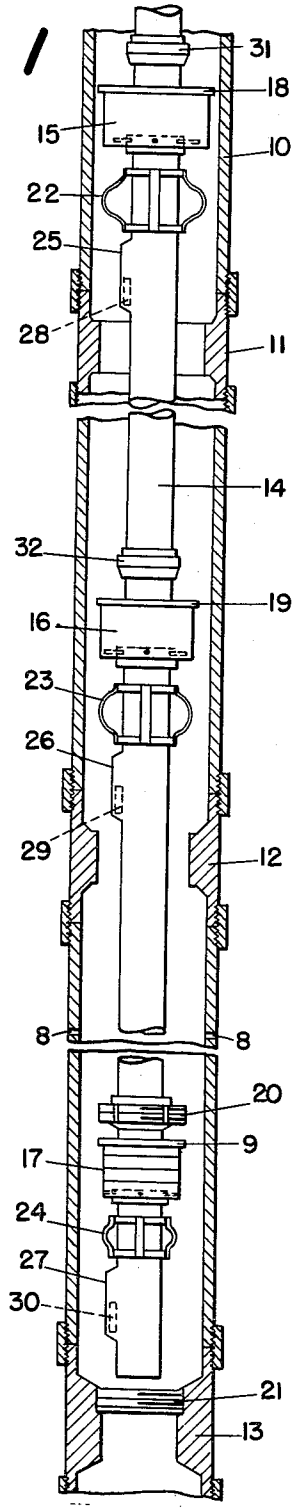
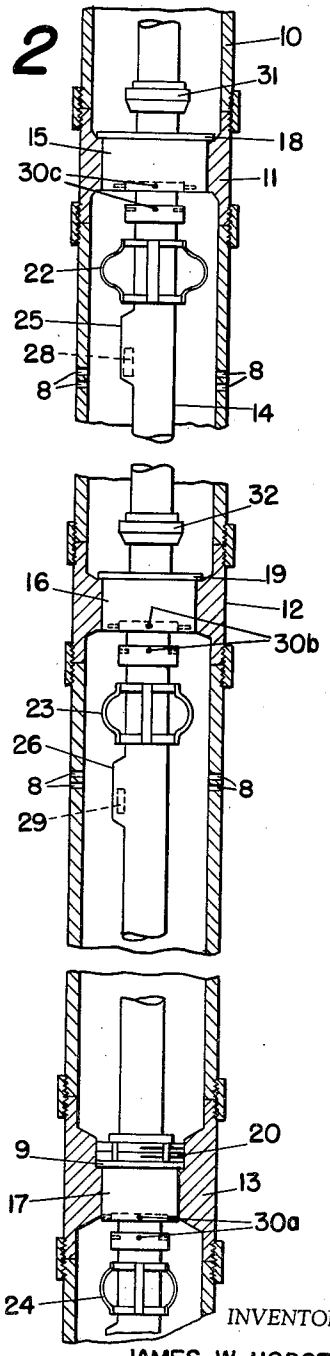


Fig. 2



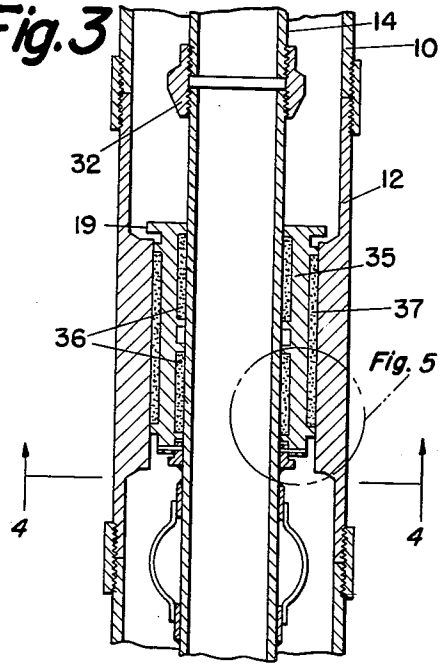
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Fig. 3



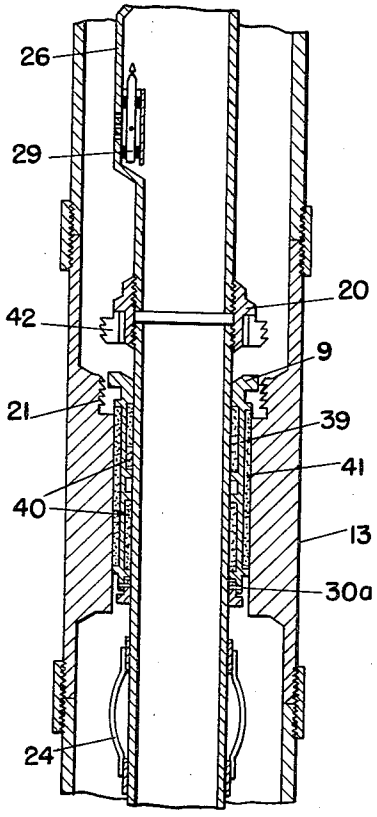


Fig. 4

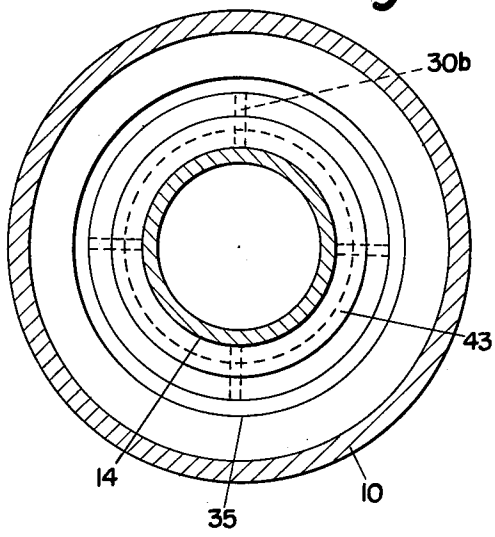
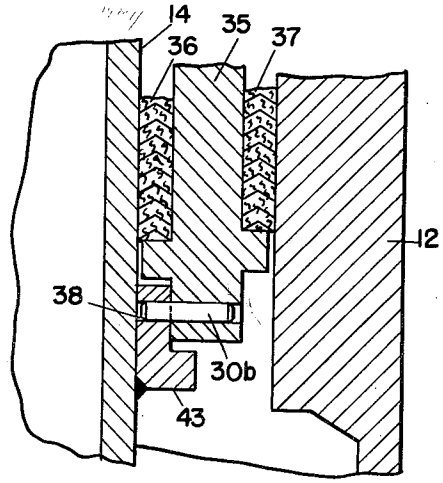


Fig. 5



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PACKER ASSEMBLY FOR MULTIPLE COMPLETION WELLS

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9 Claims. (Cl. 166—191)

This invention relates to means for completing oil or gas wells for simultaneous production from a plurality of formations through the well tubing. The invention more particularly is directed to a well packer assembly providing means for packing between the well tubing and casing at a plurality of depths in the well.

Many wells traverse a plurality of oil and/or gas formations, and it is often desirable to produce from more than one formation at a time. In my copending but now abandoned patent application Serial No. 741,925, filed June 13, 1958, flow control means are disclosed for use in cases where it is desired to produce simultaneously from a plurality of formations through the well tubing. Such means include a flow control tool adapted for positioning in a side pocket mandrel in the tubing string adjacent each productive formation for controlling the flow of fluid from the formation into the well tubing. In producing a well from two or more formations simultaneously in this manner, it is necessary to provide means for packing off the casing annulus between adjacent formations so as to prevent fluid from flowing from one formation to another.

Numerous forms of well packers are known most of which have expandible resilient means which, after the packer has been placed at the proper location in the well, are caused to expand to effect a seal between the well tubing and the casing. Use of conventional packers of this kind in a multiple completion well necessitates setting the several packers one by one. This operation sometimes presents difficulties due to premature setting of a packer before it has been properly located in the well and in any event is time consuming.

The present invention is directed to improved packing means for simultaneously packing off the casing annulus at two or more locations in a well. The packer assembly provided by the invention does not depend upon expandible elements for setting the packers, and it permits setting of all packers in a single operation. Difficulties due to premature setting of a packer are eliminated.

According to the invention a well packing assembly is provided which comprises a plurality of spaced coupling members in the casing each having an internal diameter less than the normal internal diameter of the casing and with such diameters being progressively smaller from the uppermost to the lowermost coupling member. The well tubing carries a plurality of annular packing elements positioned thereon to correspond approximately to the spacing of the coupling members located in the casing. These packing elements have progressively smaller external diameters from the uppermost to the lowermost element and are adapted to seat within the corresponding coupling members in fluid sealing relationship. An important feature of the assembly comprises means, such as shear pins, for holding each packing element in place relative to the tubing until such packing element has reached its fluid sealing position in the corresponding coupling member and for thereafter permitting the tubing to move downwardly relative to such packing element. This arrangement allows for discrepancies in the spacing of the packing elements along the well tubing and insures that each element will properly seat in its fluid sealing position. The assembly also includes means for preventing

each packing element after seating from being forced by well pressure upwardly out of its fluid sealing position.

The invention is more specifically described with reference to the accompanying drawings in which:

FIG. 1 is a generally diagrammatic elevational view, partly in section, illustrating a well packing assembly including three packers and showing the position of the packing elements before they have reached their seating positions.

FIG. 2 is an elevational view similar to FIG. 1 but showing the packing elements after reaching their seating positions.

FIG. 3 is a sectional elevational view illustrating in more detail the intermediate and lower packing means.

FIG. 4 is a cross-sectional view taken on the line 4—4 of FIG. 3.

FIG. 5 is an expanded sectional elevational view of a portion of the assembly of FIG. 3 including the means for securing the packing element to the well tubing and subsequently permitting the well tubing to slide downwardly after the packing element has seated.

With reference now to FIG. 1, 10 illustrates a well casing which contains upper, intermediate and lower coupling members 11, 12 and 13. Each coupling member has an internal diameter less than that of casing 10 and the diameters progressively decrease from the uppermost to the lowermost coupling member. Well tubing 14 carries three annular packing elements 15, 16 and 17 which are positioned thereon by means of shear pins in the manner shown in detail in FIG. 5. The spacing between the packing elements on tubing 14 is such as to correspond approximately to the spacing of coupling members 11, 12 and 13, although substantial discrepancies in the initial spacing can be tolerated without affecting the performance of the assembly. Each packing element comprises a retainer and resilient packing means as shown in more detail in FIG. 3. The retainers for the packing elements are provided at their top with shoulders or abutment means 18, 19 and 9 which function as stops when these packing elements reach their respective seating positions in coupling members 11, 12 and 13.

Adjacent the top of the lower packing element 17, tubing 14 is provided with a threaded collar member 20 which is adapted to engage threads 21 in coupling 13 when the tubing has reached its lowermost position, as shown in FIG. 2, and to secure the well tubing in place. Preferably member 20 is constructed so that its threads will spring into threads 21 by merely lowering the drill pipe without rotation, and also it is preferable that the resulting threaded connection be left-handed. This will permit the well tubing subsequently to be removed from the well by appropriate rotation without causing the tubing to become unscrewed at any of its other joints.

Beneath the three packing elements, tubing 14 carries spring guide members 22, 23 and 24. These are appropriately sized to guide the packing elements 15, 16 and 17 into couplings 11, 12 and 13 respectively and prevent premature shearing of the shear pins which hold the packing elements on tubing 14. Also carried by the tubing are stop members 31 and 32 which are positioned a short distance above packing elements 15 and 16 respectively. These serve the purpose of preventing the upper and intermediate packing elements from being pushed out of sealing relationship with the coupling members by pressure beneath the packers after they have been seated.

The well tubing is also provided with side pocket mandrels, illustrated schematically as 25, 26 and 27, which are positioned for location adjacent the several productive formations. The mandrels contain flow control devices, illustrated schematically as 28, 29 and 30, which contain means serving to regulate flow from the formation. These flow control devices preferably are of the

type disclosed in my aforesaid patent application Serial No. 741,925. These devices contain chokes for regulating flow rates from the formations into the tubing and also resilient check valve means which prevent any backflow to the formations. In accordance with conventional practice, separate sets of perforations **8** (see FIGS. 1 and 2) are provided in the casing **10**, positioned intermediate each respective adjacent pair of coupling members, for admitting formation fluids to the annulus between the casing and the tubing. The respective flow control devices **28–30** then regulate flow from the annulus into the tubing **14**. It may be seen that the control devices such as **28** and **29** each provide a separate controlled fluid flow passage positioned intermediate each respective adjacent pair of packing elements. The passage associated with device **28** is positioned intermediate packing elements **15** and **16**, while the passage associated with device **29** is positioned intermediate packing elements **16** and **17**. Each of such passages extends between the casing-tubing annulus and the interior of the tubing **14**.

As illustrated by FIG. 1 the well tubing has been lowered within the casing to a depth at which the packing elements **15**, **16** and **17** are approaching their seating positions in coupling member **11**, **12** and **13** but none of them has yet contacted its corresponding coupling member. FIG. 2, in which identical numerals are used for the parts described in connection with FIG. 1, shows the assembly after the well tubing has been lowered farther and all of the packing elements have reached their seating positions. As shown by FIG. 2 the upper packing element **15** has seated with its shoulder **18** abutting against coupling member **11**, the intermediate packing element **16** has reached its final seating position with shoulder **19** abutting against coupling member **12**, and the lower packing element **17** is in seated position with the threaded collar member **20** engaging threads **21** in coupling member **13**.

As illustrated by FIG. 2 the well tubing **14** has been lowered slightly further than necessary for seating the three packing elements in their respective coupling members. The pins **30***a*, **30***b* and **30***c* have all sheared, thus permitting the tubing **14** to slide through the packing elements until the threaded collar **20** has engaged threads **21** in coupling member **13**. The weight of tubing **14** is then supported by coupling member **13**. With the tubing in its lowermost position, stop members **31** and **32** should be located sufficiently close to packing elements **15** and **16** so that neither of the packers could be pushed upwardly enough to break the sealing engagement with coupling members **11** and **12**. However, a small upward movement of the packing elements after seating is not detrimental and hence the stop members **31** and **32** do not need to rest actually against the top of the packing elements when the packers have beeen placed in position.

FIGS. 3–5 illustrate in more detail the lowermost packer and any one of the packers located thereabove, for example, the intermediate packer **16**, when the well tubing **14** has been lowered to its position just prior to shearing of the shear pins **30**. The higher positioned packing element shown in FIG. 3 comprises a retainer **35** carrying inner and outer packing rings **36** and **37** made of a resilient packing material such as neoprene. A collar **43** secured to tubing **14** has one or more ports **38** for positioning the shear pin **30***b* which projects into an opening in retainer **35**, as best seen in FIG. 5. Likewise, the lowermost packing element **17** comprises a retainer **39** having a smaller diameter than retainer **35**, and inner and outer packing rings **40** and **41** constructed of resilient material. The packing rings for each packing element are designed to fit snugly in the respective coupling members to form fluid tight seals. The collar member **20**, shown in FIG. 3 just above the lowermost packer, has threaded spring fingers **42** which permit engagement with threads **21** in coupling member **13** when the tubing has been lowered sufficiently without necessity for rotating the tubing. When the tubing **14** is lowered farther than shown in FIG. 3, shoulders **9** and **19** abut against coupling members **13** and **12** respectively, and this causes pins **30***a* and **30***b* to be sheared so as to permit the tubing to slide downwardly through the packing elements until it reaches the position shown in FIG. 2. It should be noted that shearing of the pins need not occur simultaneously and that they normally will shear at different instants due to small discrepancies in spacing of the packing elements along the tubing.

In preparing a well for production utilizing the above described packer assembly, the casing is set in the well and cemented in place with appropriately spaced coupling members positioned therein between the various hydrocarbon bearing formations. The bores of the several coupling members preferably have been coated with a plastic material such as "Teflon" and greased heavily in order to prevent adherence of mud and cement to the surfaces. The formations are then perforated and drill stem tested in sequence from the upper to the lower sands. The well tubing carrying the packer assemblies as above described is then run into the well and lowered until all packers are seated. Flow control tools can then be positioned in the several side pocket mandrels by means of a wire line and a conventional kick-over device, so that flow from one or more of the productive formations into the well tubing can be secured. While FIGS. 1 and 2 illustrate assemblies adapted for production from three formations, it is to be understood that the invention can be utilized for producing from any plural number of hydrocarbon bearing formations traversed by the borehole.

A major advantage in employing packer assemblies according to the invention results from the relatively large bores which the coupling members can have for seating the packing elements. This permits the well tubing to contain side pocket mandrels for flow control tools, which mandrels can readily pass through the coupling members as the tubing is lowered in the well. Conventional packers heretofore available have not allowed this to be done. Other advantages include the elimination of expandible packing means and anchoring devices such as slips. Since the invention permits setting of all packers in a single operation, it provides substantial savings in rig time expense as compared to the conventional method of setting packers one by one.

I claim:

1. A well packing assembly for multiple completion wells comprising a well casing, a plurality of spaced coupling members in the casing each having an internal diameter less than the internal diameter of the casing and with said diameters being progressively smaller from the uppermost to the lowermost coupling member, a well tubing within the casing, a plurality of spaced annular packing elements positioned on the tubing to correspond approximately to the spacing of said coupling members, said packing elements having progressively smaller external diameters from the uppermost to the lowermost element with each being adapted to be positioned within the corresponding coupling member in fluid sealing relationship, and said packing elements and said tubing being relatively movable; abutment means associated with each packing element and engaging its respective coupling member to halt the downward movement of each packing element after such element reaches its fluid sealing position within its corresponding coupling member, and releasable means securing each packing element to the tubing, each of said last-mentioned means releasing in response to the halting of the downward movement of its corresponding packing element to permit the tubing to move downwardly relative to such packing element.

2. An assembly according to claim 1, including a separate controlled fluid flow passage positioned intermedi-

ate each respective adjacent pair of packing elements, each such passage extending between the casing-tubing annulus and the interior of the tubing.

3. An assembly according to claim 1 including members carried by the tubing for preventing each packing element from being forced upwardly out of fluid sealing relationship with its corresponding coupling member by fluid pressure beneath such packing element.

4. An assembly according to claim 1 including means for securing the tubing to the lowermost coupling member when the lowermost packing element is positioned therein.

5. A well packing assembly for multiple completion wells comprising a well casing, a plurality of spaced coupling members in the casing each having an internal diameter less than the internal diameter of the casing and with said diameters being progressively smaller from the uppermost to the lowermost coupling member, each of said coupling members providing a shoulder adjacent its upper end; a well tubing within the casing, a plurality of annular packing elements positioned on the tubing to correspond approximately to the spacing of said coupling members, said packing elements having progressively smaller external diameters from the uppermost to the lowermost element with each being adapted to be positioned within the corresponding coupling member in fluid sealing relationship, said packing elements being slidable on said tubing, each of said packing elements having means adjacent its upper end adapted to abut against the corresponding coupling member shoulder after such element reaches its fluid sealing position to halt further downward movement of the packing element relative to the coupling member; and a shear pin for releasably holding each packing element in place relative to the tubing until said abutment against the corresponding coupling member shoulder has occurred, the shear pins then being sheared to release the tubing for movement downwardly relative to such packing element.

6. An assembly according to claim 5 including members carried by the tubing for preventing each packing element from being forced upwardly out of fluid sealing relationship with its corresponding coupling member by fluid pressure beneath such packing element.

7. An assembly according to claim 5 including means for securing the tubing to the lowermost coupling member when the lowermost packing element is positioned therein.

8. An assembly according to claim 7 including members carried by the tubing for preventing each packing element from being forced upwardly out of fluid sealing relationship with its corresponding coupling member by fluid pressure beneath such packing element.

9. A well packing assembly according to claim 5 including guide means carried by the tubing adjacent each packing element for preventing premature shearing of the shear pins as the packing elements enter the coupling members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,506,680	Otis	May 9, 1950
2,703,144	Clifford	Mar. 1, 1955
2,839,144	Ault	June 17, 1958
2,869,645	Chamberlain et al.	Jan. 20, 1959
2,870,843	Rodgers	Jan. 27, 1959