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2,595,563

JAR TYPE WELL PACKER

Filed Sept. 2, 1947

2 SHEETS—SHEET 1

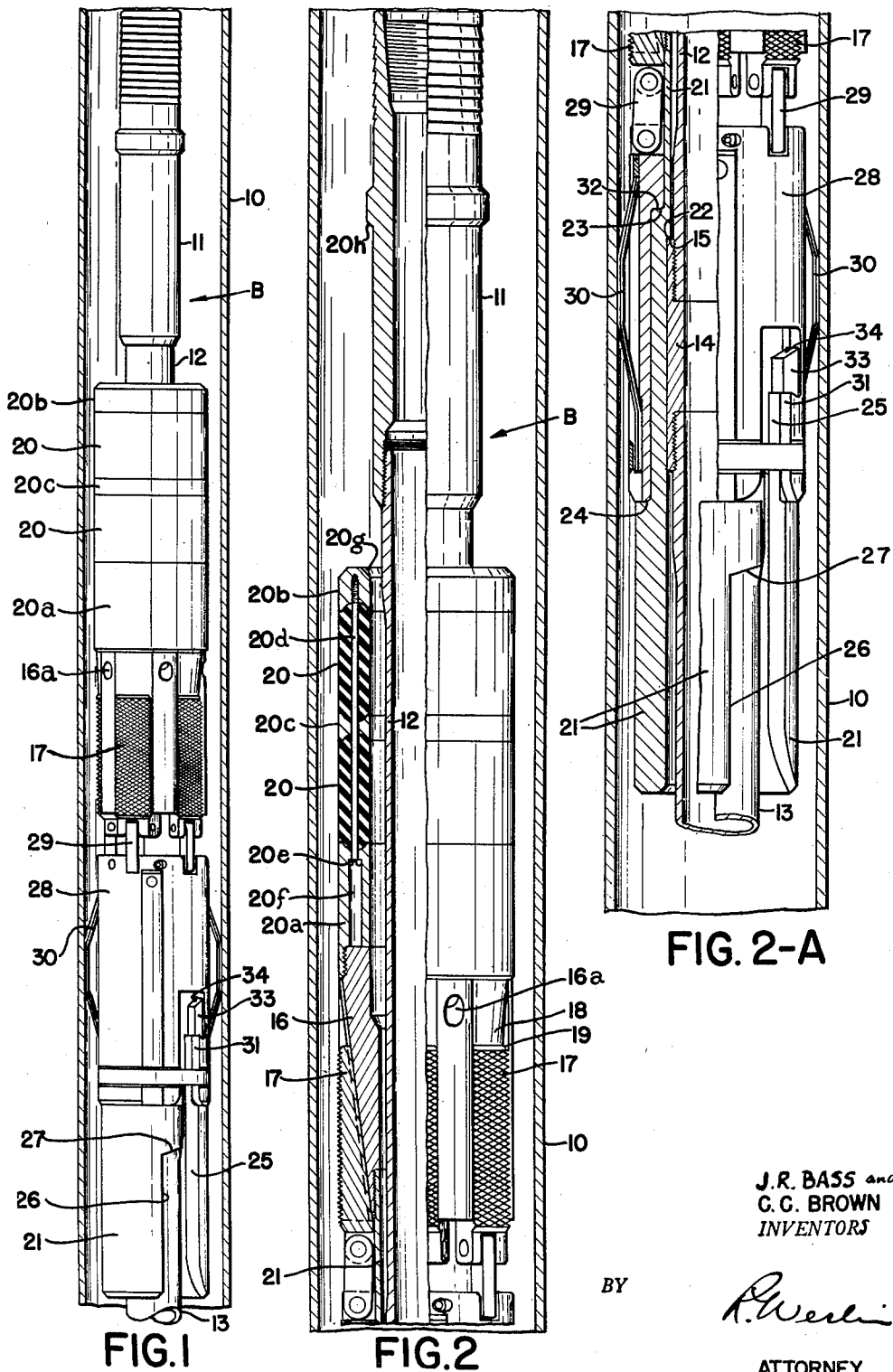


FIG. 2-A

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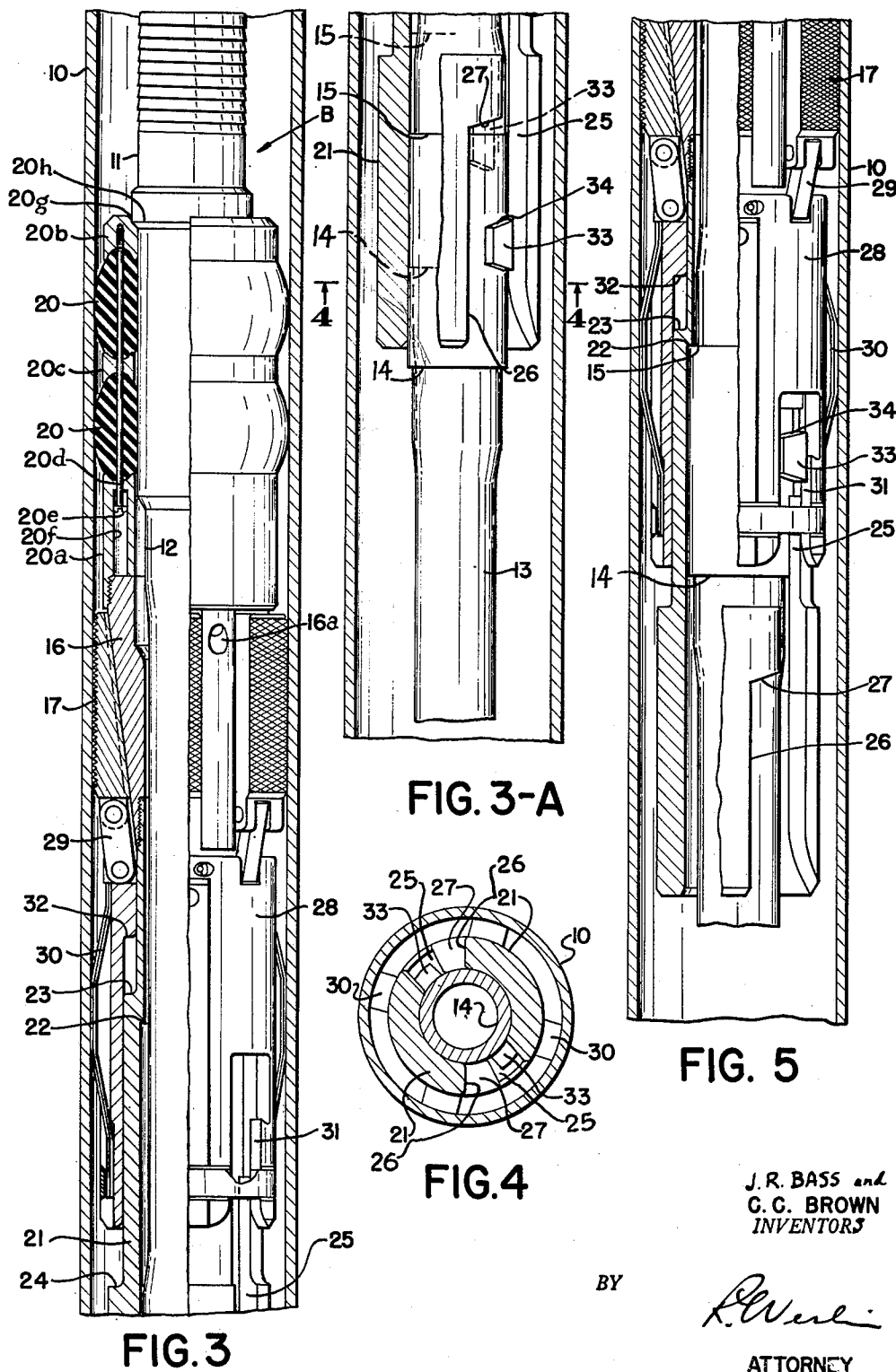
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JAR TYPE WELL PACKER

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2 SHEETS—SHEET 2



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2,595,563

JAR TYPE WELL PACKER

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10 Claims. (Cl. 166—12)

1

This invention relates to well packers and particularly to packers of the hook-wall type adapted for use in deep wells.

At the great depths currently being attained in the drilling of oil and gas wells, the problems attendant upon the use of packers both for testing purposes and for production purposes have been increased greatly, due primarily to the extremely high loads impressed upon the packers in such deep wells, both by the great weight of the long strings of pipe and by the hydrostatic pressure of the fluid columns normally present in such deep wells.

When hook-wall packers of the more conventional type are set in a well under such heavy loads, the toothed slips, which conventionally engage the wall of the well casing, are driven so tightly into the metal of the well casing that their subsequent release, when it is desired to remove the tubing or production string and packer from the well, is frequently very difficult to accomplish. The packing element may likewise become so tightly compressed against the wall of the casing as to become almost bonded to the metal of the casing, with the result that great difficulty is also frequently experienced in effecting its release. The difficulty is frequently accentuated by settling and deposit of sand and silt carried by the well fluids on and around the packing and slip elements.

The problem of efficient setting and release of packers in such deep wells is particularly important in connection with the use of such packers as test packers, wherein repeated setting and release of the same packer must be effected at several different depths in a well for the purposes of testing various portions of the casing for leaks and for testing various elevations in the well for producing horizons. In such operations it becomes especially important that no great difficulty should be experienced in the repeated setting and release of the packer, since otherwise great delay and severe damage or destruction of the packer and damage to the well itself may result in many cases.

The packer in accordance with this invention combines the functions of a more or less conventional hook-wall packer, and a cooperating jarring mechanism of novel form and construction which is adapted to effect the ready release of the packer under extreme load conditions at which release of the packer cannot be effected with more conventional structures and methods without damage or destruction to the packer elements. The novel jarring mechanism is of a form

2

which is adapted to employ the high energy available in long pipe strings when under tension to release the packer structure.

Accordingly, a primary object of this invention is the provision of an improved packer structure for a use in deep wells which is readily releasable under heavy load conditions.

An important object of this invention is the provision of a hook-wall type packer which combines the functions of a packer and a novel jar mechanism for efficient and ready release of the packer.

A further object is the provision of a packer which is releasable by jarring action effected through relative rotary and longitudinal movement of the pipe string on which the packer is mounted.

A more specific object is the provision of a hook-wall packer having a release element for normally releasing the packer by relative vertical movement of the supporting pipe string and which, by appropriate application of relative rotary movement, may be caused to produce a sharp jarring action upon the packer elements so as to effect release of the casing engaging elements which do not release in response solely to the normal vertical movements.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate one useful embodiment in accordance with this invention.

Fig. 1 is an elevational view of the packer structure in accordance with this invention showing the position of the parts thereof, while the packer is being inserted in a well casing;

Figs. 2 and 2a comprise an enlarged quarter-sectional elevation of the packer structure shown in Fig. 1, which illustrates the positions of the several packer elements in a well casing prior to the setting of the packer;

Figs. 3 and 3a comprise a view similar to Figs. 2 and 2a showing the position of the packer elements when the packer is set in a well casing, and showing in broken lines the positions of some of the packer elements at the instant of release;

Fig. 4 is a cross-sectional view along line 4—4 of Fig. 3a, looking upwardly toward the upper end of the packer structure; and

Fig. 5 is a quarter-sectional elevation of a portion of the packer structure showing intermediate positions of some of the packer elements during the release movements thereof.

Generally speaking, and in accordance with an

3

illustrative embodiment of this invention, the foregoing objects are accomplished by providing a novel inter-engaging means between the packer supporting body and the slip expanding mandrel by which torsional and tensional forces may be developed in the supporting pipe which are automatically releasable to produce sharp jarring impacts for transmission to both the slips and the conventional resilient sealing elements in a manner which will effect their release substantially simultaneously.

Referring to the drawings and particularly to Figs. 1, 2 and 2a, there is shown a well casing 10 in which has been inserted a packer structure in accordance with this invention, which is conventionally connected into a tubing or other pipe string (not shown), which is employed in the conventional manner to lower the packer structure into the well and provides support for the same. The packer structure comprises a tubular body, indicated generally by the letter B, composed of sections 11, 12 and 13 which are connected to form a part of the pipe string supporting the packer structure. Sections 12 and 13 of the body are joined together by means of a threaded collar 14, the external diameter of which is greater than that of the connected sections 12 and 13, thereby forming an annular external shoulder 15 about the lower end portion of body section 12. Concentrically disposed about body section 12 is a downwardly tapering conical mandrel 16 which supports a plurality of angularly spaced wickered slips 17 of generally conventional shape, which are slidable on the surface of mandrel 16 in slots 18 and are held therein by a conventional dove-tail tongue-and-groove arrangement indicated at 19. Passageways 16a extend through the body of mandrel 16 and provide communication between the interior and exterior thereof. The upper end of mandrel 16 carries a vertically aligned group of annular compressible sealing elements 20—20, constructed of rubber or rubber-like resilient materials, which are adapted to be expanded under compression to seal the annular space between casing 10 and the tubular body B. These sealing elements are of generally conventional construction and are supported between a pair of metal end rings 20a and 20b and an annular spacer 20c interposed between sealing elements 20—20, end ring 20a being screwed on the upper end of mandrel 16. A number of angularly spaced elongated tie rods 20d (only one shown) extend vertically upwardly through the sealing elements and the supporting end rings and spacers, and are provided with heads 20e at their lower ends which are slidably engaged in an annular slot 20f in end ring 20a and having their opposite ends screwed into end ring 20b, thereby tying the sealing elements together into a unitary structure with mandrel 16. The upper edge of end ring 20b is ground to form an annular seat 20g, which cooperates with an annular valve member 20h carried by body section 11 to close the annular space between the interior of the packer structure and supporting body B when relative longitudinal movement between the body B and the packer structure in setting the packer brings annular valve 20h into contact with seat 20g. The lower end of mandrel 16 is threaded internally for rigid connection thereto of an elongated sleeve member 21 which concentrically surrounds body sections 12 and 13 as well as coupling 14. Sleeve member 21 is counterbored from its lower end to provide an internal an-

4

nular shoulder 22, which is adapted for cooperation with shoulder 15 on coupling 14. The external diameter of sleeve member 21 is successively enlarged toward its lower end to form vertically spaced external annular shoulders 23 and 24. Sleeve member 21 is provided with J-slots 25 on diametrically opposite sides thereof (see Fig. 4), the longitudinal legs of the J-slots extending downwardly to the lower end of sleeve member 21. The hook portions of the J-slots are arranged so that they will be opposite substantially the mid-section of coupling 14 when the packer structure is in the unreleased position.

A longitudinal recess 26 is cut into the left hand wall of the longitudinal portion of each of the J-slots 25 and extends upwardly to a point spaced below shoulder 24 of the sleeve member. The upper ends of recesses 26 are arranged to form upwardly sloping shoulders 27, the outer ends of which terminate at the adjacent edges of the related J-slots.

Concentrically surrounding sleeve member 21 is a generally tubular slip cage 28, of generally conventional construction, to the upper end of which slips 17 are pivotally connected by means of links 29. The outer surface of slip cage 28 carries conventional bow springs 30 for frictionally engaging the inner wall of casing 10 in the conventional manner. The lower portion of slip cage 28 is provided with a pair of diametrically opposed J-slots 31 which register with J-slots 25 of sleeve member 21. However, the length of slip cage 28 is less than that of sleeve member 21 so that its lower end terminates just above shoulder 24 of the sleeve member. Slip cage 28 is provided internally thereof, adjacent its upper end, with an annular shoulder 32 which is adapted for cooperation with shoulder 23 on sleeve member 21, for purposes to be described hereinafter. A pair of J-pins 33 extend laterally from diametrically opposite points on collar 14 and are arranged for cooperation with J-slots 25 and 31 in the setting and release of the packer structure, as will be more fully described hereinafter. The upper faces of each of J-pins 33 are machined to form surfaces 34, sloping upwardly at angles complementing shoulders 27.

The above-described packer structure is operated in the following manner: Body B of the structure is connected into a tubing or other pipe string (not shown) in the conventional manner and lowered into casing 10. During this operation, the several elements of the packer structure will be maintained in the positions shown particularly in Figs. 1, 2 and 2a, through the locking engagement of J-pins 33 in the hook portions of J-slots 25 and 31, thus allowing the packer structure to move freely down the casing except for the frictional resistance resulting from the contact of bow springs 30 with the inner wall of casing 10, this resistance being, of course, overcome by the weight of the packer structure and supporting pipe string in effecting the lowering of the packer structure through the casing. At this stage annular valve member 20h will be spaced from end-ring 20b, thus leaving open the annular space between the packer structure and the supporting body B and permitting the free passage through the structure of well fluids entering through passageway 16a, to thereby further reduce the resistance to the downward movement of the packer structure in the casing and to permit circulation of well fluids through

the well in the conventional manner, when desired.

It will be noted that when the packer structure is in the locked or unreleased position, as illustrated in Figs. 1, 2 and 2a, shoulder 15 on collar 14 is in engagement with internal shoulder 22 of sleeve member 21 and forms means for supporting sleeve member 21 and its connected mandrel and packer elements on body B of the structure. At the same time, external shoulder 23 on sleeve member 21 is in engagement with internal shoulder 32 of cage 28.

When the locked structure has been lowered to the point in the casing at which it is to be set, the pipe string carrying the structure is rotated at the top of the well in the clockwise or right-hand direction, which will, of course, rotate body B in like manner, while the frictional contact of bow spring 30 with the wall of casing 10 will hold the packer structure stationary to thereby permit this relative rotational movement. J-pins 33, being an integral part of body B, will move out of the hook portion of J-slots 25 and 31 in response to this relative rotational movement and will enter the vertical legs of the J-slots. Thereupon, the pipe string will be lowered at the top of the well, lowering body B relative to the surrounding packer structure and allowing J-pins 33 to descend through the vertical legs of the J-slots. As the supporting body B is thus lowered, sleeve member 21 carrying mandrel 16 and the sealing elements carried thereby, being supported on collar 14, will also move downwardly. The downward movement of the mandrel relative to slips 17 and slip cage 28 will expand the slips into engagement with the casing wall. The engagement of the slips with the casing wall will stop the further downward movement of mandrel 16, sleeve member 21 and the sealing elements 20, but the lowering of the pipe string will be continued until annular valve 20h contacts seat 20g, closing the annular space between the packer structure and body B and transferring the weight of the string upon sealing elements 20—20. Under the pressure exerted by the weight of the pipe string, the sealing elements will expand and seal the annular space between the exterior of the packer structure and casing 10. At the same time, pressure will also be exerted against the upper end of mandrel 16 causing the latter to drive slips 17 into very tight gripping engagement with the wall of casing 10 and thereby completing the setting of the packer structure. The continued downward movement of body B in completing the setting of the packer will bring J-pins 33 to a position in the J-slots 25 opposite recesses 26 and below sloping shoulders 27. The position of the several elements of the packer structure, when the packer has been set, is shown in full lines in Figs. 3 and 3a. It will be noted that shoulder 23 is now spaced somewhat below shoulder 32 while shoulder 15 has moved a considerably greater distance below shoulder 22.

With the packer structure thus set, the desired testing on other operations may be now conducted in the conventional manner, the packer structure remaining as described until the completion of such operations.

To release the packer for withdrawal from the well, under conditions where no unusual sticking of the slips and sealing elements has occurred, an upward pull is taken at the top of the well on the pipe string supporting body B. This will first lift valve 20h off of end ring 20b, relieving

the packer structure of the weight of the pipe string. Continued upward movement of the pipe string will bring shoulder 15 into contact with shoulder 22 and this engagement will force sleeve member 21 and mandrel 16 upwardly relative to slips 17 which, by their sliding engagement with mandrel 16 will be retracted thereby, thus pulling them out of engagement with casing 10. At the same time, the release of pressure upon sealing elements 20—20 will permit them to return to their contracted form while the upward force exerted against the mandrel through the engagement of shoulder 15 with shoulder 22 will aid in releasing the sealing elements from their engagement with the casing wall. Finally, continued upward movement of the supporting pipe string will pull the entire packer structure upwardly out of the casing. It will be noted that under conditions where no special difficulty is encountered in releasing the packer structure, no rotational movements or any movements other than direct upward pull on the supporting pipe string are required in order to effectively release the packer.

Where sticking of the slips and sealing elements is not excessive but sufficient to resist release solely through the upward pull on the supporting pipe string as described, some degree of jarring may be accomplished by merely lowering the pipe string and bringing it up quickly. The relatively quick sequential impacts of shoulder 15 upon shoulder 22 and of shoulder 23 upon shoulder 32 may be sufficient to effect release of the packing elements and the slips, although the force available for producing the desired degree of shock is necessarily limited because of the inertia of the pipe string which is inherent in a direct upward pull on the usually very long pipe strings.

However, packers of the general type described frequently become so tightly stuck in the casing that the relatively simple release movements previously described will be ineffective to release the packer and permit its withdrawal from the well. Under such circumstances, the packer structure in accordance with the present invention possesses certain novel features of construction by which high energy jarring impacts may be applied to the packer structure during release movements, which will effect relatively quick and efficient release of the packer structure in a manner to be described hereinafter.

When such difficult release conditions are encountered, the packer structure being set and the parts thereof in the relative positions shown in full lines in Figs. 3 and 3a, the supporting pipe string will be rotated at the top of the well in the clockwise or right-hand directions which will cause J-pins 33 to enter recesses 26 until the forward faces of the J-pins engage the inner walls of the recesses. While the actual degree of rotation required to effect this engagement is relatively small at the point of engagement, the natural flexibility of the long string of pipe to which the packer is normally connected will necessarily require that several turns of the pipe string be made at the top of the well to produce the small rotary movement required for moving J-pin 33 into recess 26. For example, in a string of pipe several thousand feet long, about two full turns will be required at the top of the well. This twisting of the long pipe string will introduce a considerable degree of torque into the pipe string which will cause the pipe string to unwind or rotate in the op-

posite direction when the torque-creating force is released at the top of the well. With the pipe string thus placed under a torque load, an upward pull will be applied to the pipe string at the top of the well sufficient to bring the sloping surfaces 34 of J-pins 33 up against the complementarily faced shoulders 27, as illustrated in broken lines in Fig. 3, and to develop tension in the pipe string while it is in torque. The application of this tension or stretching force to the pipe string against the resistance created through the engagement of J-pins 33 with shoulders 27 will produce a reaction of forces at these contacting faces, the resultant of which will be generally rearwardly in the plane of the contacting faces and will produce a camming action between the faces so as to force J-pins 33 to slide rearwardly off of shoulders 27 and into the vertical legs of J-slots 25. This action will produce a quick release of the tension in the pipe string which, due to its resiliency, will cause body B to jump sharply upwardly relative to sleeve member 21 and by virtue of this sudden release of the large amount of energy available in the stretched pipe string, will drive shoulder 15 up against shoulder 22 (see Fig. 5) with a sharp, high-energy impact which will be transmitted through sleeve member 21 to mandrel 16 and sealing elements 20-20 and will jar these elements sharply in the upward direction as is required to effect their release. This impact will be followed almost instantaneously by a similar sharp impact of shoulder 23 striking shoulder 32 which will similarly sharply jar slip cage 28 and slips 17 to aid in effecting their release from the casing. These inter-engaging parts are so dimensioned that the impacts between shoulder 15 and sleeve member 21 and between sleeve member 21 and slip cage 28 follow in very close succession such that the force of the original impact is transmitted almost instantaneously both to mandrel 16, slip cage 28 and slips 17, whereby all of these elements will be caused to move in a releasing direction practically simultaneously. Since mandrel 16 will be moving upwardly under the force of the initial impact, it will place a retractive pull upon slips 17 and the closely following second impact directly upon the slip cage will cause the latter and the slips to move upwardly substantially in unison with the mandrel whereby both sets of elements which were in engagement with the casing will thus be released and driven upwardly substantially together.

If the first jar fails to release the packer, the jarring operation may be repeated as many times as may be found necessary to free the packer. Each repetition of the jarring action is simply accomplished by lowering the supporting pipe string at the top of the well, rotating it to the right, and taking an upward strain again thereon in the manner described.

By means of the described apparatus, the great amount of energy available in a twisted and stretched supporting pipe string, particularly in deep wells requiring long strings of pipe, is caused to be released quickly and transmitted with full effect in the sharp impacts which will be applied substantially simultaneously against the portions of the packer structure which are engaged with the casing to effect their release.

In the ordinary case, only a very few turns of the upper end of the pipe string at the top of the well, followed by a relatively small upward strain is all that is necessary to produce

the jarring movements described and thus release of the packer structure may be effected quickly and effectively with a minimum of effort even in cases of severe sticking of the structure.

Various alterations and modifications may be made in the details of this invention within the scope of the appended claims but without departing from the spirit of this invention.

What we claim and desire to secure by Letters Patent is:

1. A well packer including a tubular body member supporting for relative movement thereon a sealing element, a slip cage, slips hingedly connected to said cage, a slip-expanding member connected to said sealing element movable into and out of expansive relation with said slips in response to relative longitudinal movement between said members, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, and opposed abutment elements carried by said members longitudinally spaced from said shoulders and positioned to be engaged in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, said abutment elements having cam-shaped engaging surfaces shaped to slide past each other to effect sudden release therebetween upon application to one of said members of an axially directed engaging force exceeding the resistance of the engaged abutment elements to such release.

2. A well packer including a tubular body member supporting for relative movement thereon a sealing element, a slip cage, slips hingedly connected to said cage, a slip-expanding member connected to said sealing element movable into and out of expansive relation with said slips in response to relative longitudinal movement between said members, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, and opposed abutment elements carried by said members longitudinally spaced from said shoulders and positioned to be engaged in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, said abutment elements having engaging surfaces inclined at an angle to the longitudinal axis of said members.

3. A well packer including a tubular body member supporting for relative movement thereon a sealing element, a slip cage, slips hingedly connected to said cage, a slip-expanding member connected to said sealing element movable into and out of expansive relation with said slips in response to relative longitudinal movement between said members, an extension sleeve rigidly connected to said slip-expanding member concentrically interposed between said slip cage and said body member, opposed jarring shoulders mounted on said sleeve and said body member engageable upon relative longitudinal movement between said sleeve and said body member, and opposed abutment elements mounted on said sleeve and said body member longitudinally spaced from said shoulder and positioned to be engaged in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation between said sleeve and said body member, said abutment elements having engaging surfaces upwardly inclined at

an angle to the longitudinal axis of said sleeve and body member.

4. A well packer including a tubular body member supporting for relative movement thereon a sealing element, a slip cage, slips hingedly connected to said cage, a slip-expanding member connected to said sealing element movable into and out of expansive relation with said slips in response to relative longitudinal movement between said members, an extension sleeve rigidly connected to said slip-expanding member concentrically interposed between said slip cage and said body member, a first pair of opposed jarring shoulders mounted on said body member and said sleeve, a second pair of jarring shoulders mounted on said sleeve and said slip cage and axially spaced from said first pair, said pairs being positioned for sequential engagement in response to upward movement of said body member relative to said sleeve member and said slip cage, and opposed abutment elements mounted on said sleeve and said body member longitudinally spaced from both said pairs of shoulders and positioned to be engaged in advance of engagement of both said pairs of shoulders upon relative longitudinal movement and upon limited relative rotation between said sleeve and said body member, said abutment elements having engaging surfaces upwardly inclined at an angle to the longitudinal axis of said sleeve and body member.

5. A well packer including a tubular body member supporting for relative movement thereon a sealing element, a slip cage, slips hingedly connected to said cage, a slip-expanding member connected to said sealing element movable into and out of expansive relation with said slips in response to relative longitudinal movement between said members, an extension sleeve rigidly connected to said slip-expanding member concentrically interposed between said slip cage and said body member, opposed jarring shoulders mounted on said sleeve and said body member engageable upon relative longitudinal movement between said sleeve and said body member, a longitudinal slot in said sleeve, a pin on said body member extending into said slot, and an abutment at one side of said slot longitudinally spaced from said shoulders and positioned to be engaged by said pin in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, the pin-engaging surface of said abutment inclining upwardly into said slot.

6. In a well packer including a tubular body member supporting for relative movement thereon a tubular packer member carrying expandable elements for engaging a well wall, a jarring mechanism for effecting release of said packer member from said well wall comprising, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, and opposed abutment elements carried by said members longitudinally spaced from said shoulders and in position to be engaged in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, said abutment elements having relatively slidable cam-shaped engaging surfaces shaped to cause said abutment elements to be forced past each other longitudinally to effect sudden release therebetween when the axially directed force applied to one of said members in effective engagement of said abutment elements exceeds the re-

sistance of the engaged abutment elements to such release.

7. In a well packer including a tubular body member supporting for relative movement thereon a tubular packer member carrying expandable elements for engaging a well wall, a jarring mechanism for effecting release of said packer member from said well wall comprising, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, and opposed abutment elements carried by said members longitudinally spaced from said shoulders and in position to be engaged in advance of engagement of said shoulders upon relative longitudinal movement and upon limited rotation of said members, said abutment elements having relatively slidable engaging surfaces inclined at an angle to the longitudinal axis of said members.

8. In a well packer including a tubular body member supporting for relative movement thereon a tubular packer member carrying expandable elements for engaging a well wall, a jarring mechanism for effecting release of said packing member from said well wall comprising, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, a longitudinal slot on one of said members, a pin on the other of said members extending into said slot, and an abutment at one side of said slot longitudinally spaced from said shoulders and positioned to be engaged by said pin in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, the pin-engaging surface of said abutment inclining upwardly into said slot.

9. In a well packer including a tubular body member supporting for relative movement thereon a tubular packer member carrying expandable elements for engaging a well wall, a jarring mechanism for effecting release of said packer member from said well wall, comprising, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, a longitudinal slot on one of said members, a pin on the other of said members extending into said slot, an abutment at one side of said slot longitudinally spaced from said shoulders and positioned to be engaged by said pin in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, the pin-engaging surface of said abutment inclining upwardly into said slot, and a pin-receiving recess in the side of said slot opposite said abutment.

10. In a well packer including a tubular body member supporting for relative movement thereon a tubular packer member carrying expandable elements for engaging a well wall, a jarring mechanism for effecting release of said packer member from said well wall comprising, opposed jarring shoulders carried by said members engageable upon relative longitudinal movement between said members, a longitudinal slot in one of said members, a pin on the other of said members extending into said slot, an abutment at one side of said slot longitudinally spaced from said shoulders and positioned to be engaged by said pin in advance of engagement of said shoulders upon relative longitudinal movement and upon limited relative rotation of said members, said abutment and said pin having relatively slidable

11

engaging surfaces inclining upwardly toward said slot.

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