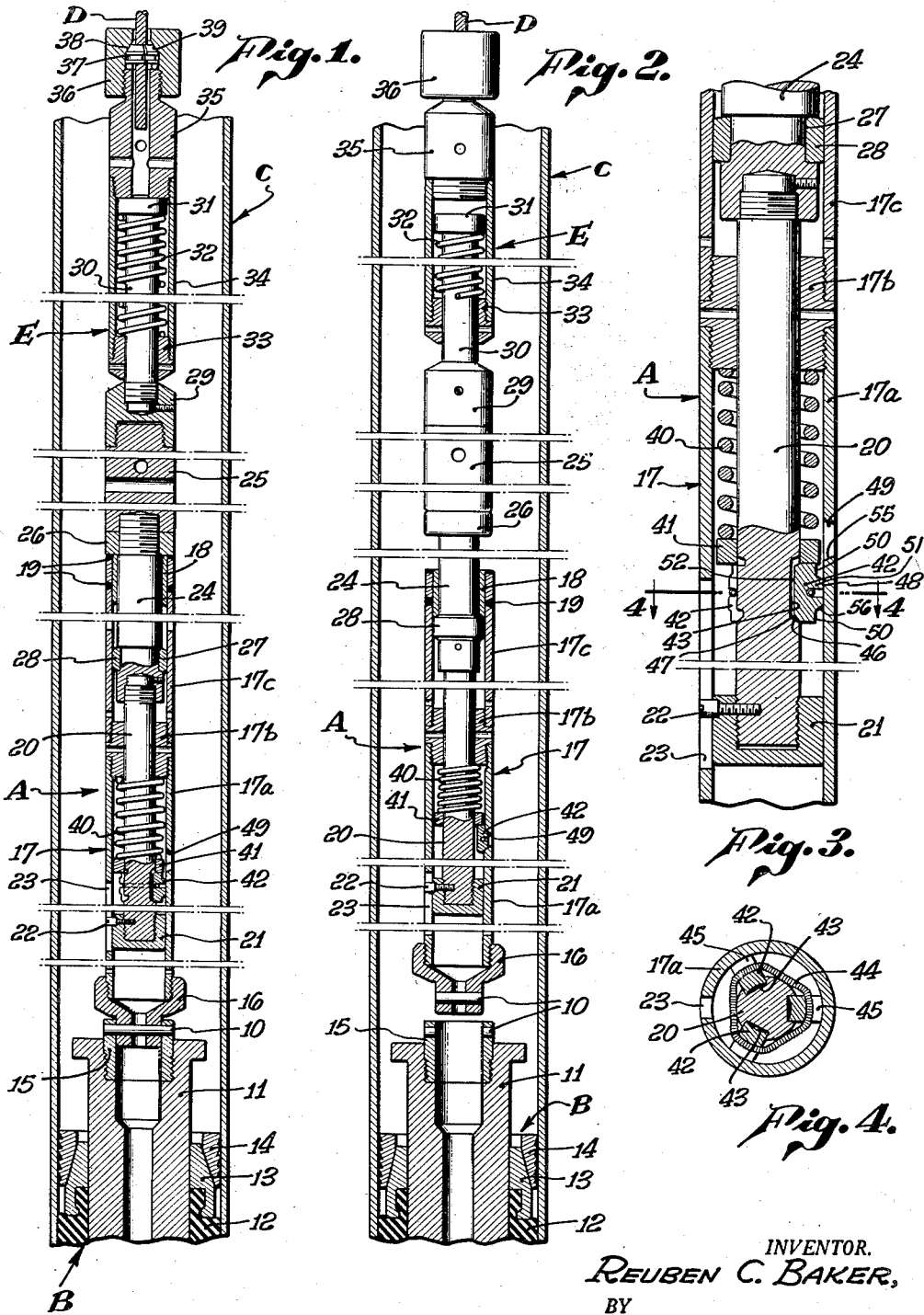


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WELL JARRING APPARATUS

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WELL JARRING APPARATUS

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The present invention relates to sub-surface well tools, and more particularly to tools for producing a jarring or hammering action on devices in a well bore.

An object of the present invention is to provide well jarring apparatus capable of striking one or more substantial blows, with relatively small strains imposed on the running-in string to which the apparatus is secured.

Another object of the invention is to provide well jarring apparatus capable of being run in a well bore on a wire or similar flexible line, and of imparting a comparatively severe shock or blow with only a minor extent of tensioning of the wire line, thereby safeguarding the latter.

A further object of the invention is provide well jarring apparatus adapted to be run in a well bore on a wire line, for the purpose of imparting a severe blow, in which the apparatus can be reset with ease while in the well bore, in order to strike repeated blows whenever necessary in the accomplishment of the desired result.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through a well apparatus disposed in a well casing or similar conduit;

Fig. 2 is a view similar to Fig. 1, with the parts in another operating condition;

Fig. 3 is an enlarged longitudinal section through part of the jarring apparatus; and

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 3.

The well jarring apparatus A is disclosed in the drawings as forming part of a mechanism for setting a bridge plug B in a well casing C, or similar conduit string, the entire device being adapted for running-in the well casing on a wire or other flexible line D. It is to be understood, however, that the jarring device may be employed generally in performing jarring operations on devices or tools other than on well packers, such as bridge plugs, and that it may be run in the well bore on a string of tubing or drill pipe, instead of a wire line.

As shown in the drawings, the upper end of the jarring device A is attached to an accelerator or energy storing device E. Its lower end is con-

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nected directly or indirectly to the well packer B by means of a shear pin 10, which it is desired to disrupt after the well packer has been anchored in packed-off condition within the well casing C.

Only a portion of the well packer B is disclosed in the drawings, since it forms no part of the present invention. Details regarding its construction may be found in United States Patent No. 2,373,006, to which attention is invited. Part of the well packer includes a tubular body 11 around which a rubber packing sleeve 12 is disposed for sealing against the body and the wall of the well casing C. The upper end of the packing sleeve is attached to a frusto-conical expander 13, which cooperates with a plurality of segmental slips 14 for anchoring the well packer to the casing against upward movement.

It is desired to release the wire line D and the apparatus A, E connected thereto from the bridge plug B after the latter has been anchored in packed-off condition within the well casing C. To perform this releasing function the aforementioned shear pin 10 is disrupted. This pin interconnects an adapter 15 threaded into the upper end of the body 11 and a sub 16 secured directly, or indirectly, to the housing portion 17 of the jarring device A. The exertion of an upward force on the housing 17 and sub 16 of sufficient magnitude will shear the pin 10 and effect disconnection between the apparatus and the bridge plug.

The jarring mechanism includes the outer housing 17, which is made of several parts. The lower housing portion 17a is secured to the sub 16 directly, or may be secured thereto indirectly through a mechanism for setting the bridge plug B (not disclosed), which is shown and described in the above patent and also in the application of Reuben C. Baker et al., Serial No. 1845, now Patent No. 2,640,547, filed January 12, 1948, for "Gas Operated Well Apparatus." The upper end of the lower housing portion 17a is threaded onto an intermediate sub 17b, which is threaded into an upper housing portion 17c, having a jarring head, hammer member or sleeve 18 secured thereto within its upper end, as by the use of welding material 19.

Disposed within the housing 17 is an operating or spring restrained mandrel 20 having a cap 21 threaded on its lower end. This mandrel is slidable within the housing 17 and carries a set screw 22 extending within a longitudinal slot 23 in the lower housing portion 17a. The spring restrained mandrel 20 extends through the sub 17b into the upper housing portion 17c, where it is threadedly secured to a jar mandrel 24, whose upper end is threaded into the lower end of a sinker bar 25, of suitable length and weight, to which it is locked by a nut 26.

The jar mandrel 24 has a peripheral groove 27 containing a ring or hammer member 28, whose exterior is adapted to ride along the inner wall of the upper housing portion 17c. In order to assemble the ring 28 in the groove 27, it may be composed of two halves, or any other number of parts. The ring 28 is adapted to strike a blow against the housing head 18, which will be transmitted to the shear pin 10, in producing failure or disruption of the latter when desired.

The upper end of the sinker bar 25 is threaded into a sub 29 that is threadedly secured onto the mandrel 30 of the accelerator or energy storing device E. This device includes a head 31 integral with or otherwise attached to the upper end of the mandrel 30, and forming a seat for a helical compression spring 32 surrounding the mandrel, with its lower end bearing upon a lower head or seat 33, slidable along the mandrel 30 and threaded into an outer barrel or housing 34 threadedly attached to an upper sub 35. This latter part is threaded into a rope socket 36, in which the lower end of the wire line D is attached in any suitable manner, as by the use of Babbitt metal (not shown), or by the use of segmental internally wickered slips 37 adapted to grip the wire line. These slips 37 are urged firmly against the line D by engagement of their tapered surfaces 38 with companion tapered surfaces 39 in the rope socket 36.

The jarring ring 28 on the jar mandrel is spaced initially below the jarring head 18 on the outer housing or barrel 17 by a spring and latch or dog device disposed within the lower housing portion 17a. A helical compression spring 40 surrounds the spring mandrel 20, with its upper end bearing against the sub 17b, and its lower end bearing against a ring or spring seat 41 adapted to rest upon a plurality of latches or dogs 42, preferably uniformly spaced around the mandrel 20. These dogs 42 couple the spring 40 to the mandrel 20 when the dogs are received within longitudinally extending grooves 43 in the mandrel. A coil spring 44 is disposed around all of the dogs 42 and fits within external grooves 45 therein, tending to urge the dogs inwardly.

The helical compression spring 40 is tending to urge the latches or dogs 42 out of their grooves 43, since the lower inner ends 46 of the dogs are tapered in a downward and outward direction for cooperation with companion surfaces 47 forming the lower ends of the grooves 43. However, the force of the helical compression spring 40 is prevented from shifting the dogs out of the grooves by virtue of engagement of the outer surfaces 48 of the dogs with the inner wall of the lower housing portion 17a. It is only when the dogs have been elevated into alignment with holes or slots 49 in the lower housing portion that the helical compression spring 40 can be effective to shift the dogs slightly downwardly along the tapered grooved surfaces 47 and outwardly of the grooves 43. The extent of outward movement of the dogs is determined by engagement of upper and lower dog shoulders 50 with the housing material on opposite sides of each slot 49.

When the outer portions 51 of the dogs are disposed within the slots 49 with the shoulders 50 engaging the lower housing wall, the inner portions 52 of the dogs are removed radially from the mandrel grooves 43, thereby freeing the mandrel 20 from the influence of the compression spring 40, and allowing the mandrel 20 to move upwardly. The set screw 22 and longitudinal slot 23 maintain the dogs 42 in longitudinal alignment

with their companion slots 49 in the lower jar housing portion 17a.

The apparatus is run in the well casing with the shear pin 10 intact and with the bridge plug slips 14 and packing 12 disposed in retracted positions. The dogs or latch elements 42 are disposed in the mandrel grooves 43 with the dogs below the housing slots 49 and bearing upon the inner wall of the housing 17. When in this position, the jar ring 28 is disposed in spaced relation below the head 18 on the housing. When the location in the well casing has been reached at which the bridge plug B is to be anchored in packed-off condition, the mechanism is actuated to produce outward engagement of the slips 14 and packing 12 with the casing, as described in the patent and application above referred to. The setting mechanism (not shown) may exert a sufficient force to shear the pin 10 and disconnect the entire mechanism from the well packer B. If, however, such disconnection does not take place, the wire line D is suitably manipulated to bring the jar mechanism A into operation.

It is to be noted that the bridge plug B is anchored to the casing C and will not move upwardly. Since the shear pin 10 is intact, the jar housing 17, connected to the packer, also will not move upwardly. Upward movement of the spring restrained mandrel 20 and jar mandrel 24 connected thereto are resisted by the helical compression spring 40 in the lower housing portion 17, since this spring exerts a downward force on the mandrel 20 through the dogs 42 disposed within the mandrel grooves 43. The sinker bar 25, attached to the jar mandrel 24, also has its upward movement resisted by the helical compression spring 40, which is also true of the sub 29 attached thereto and the mandrel portion 30 of the accelerator device E.

The taking of an upward pull or strain on the wire line D will move the rope socket 36, sub 35, accelerator housing 34 and head 33 upwardly, in order to compress the accelerator spring 32. This force of compression is transmitted to the accelerator mandrel 30, and through the sub 29, sinker bar 25, jar mandrel 24, spring restrained mandrel 20, dogs 42 and ring 41 to the helical compression spring 40 in the jar housing 17.

As the compression force on the upper spring 32 increases, the same force is transmitted to the lower spring 40, the latter being compressed as the result of upward movement of the spring restrained mandrel 20 and jar mandrel 24, and parts thereabove, under the influence of the upper spring 32. The upward movement of the mandrel 20 continues until the dogs 42 are disposed opposite the housing slots 49. Such alignment of the dogs 42 with the slots 49 allows the lower spring 40 to force the dogs 42 downwardly slightly along the inclined ends 47 of the grooves 43 and radially outward into the slots (Fig. 2). When the dogs are shifted completely out of the grooves 43, the spring restrained mandrel 20 is uncoupled from the spring 40 and has substantially all restraint removed from it, which then allows the upper spring 32 to expand suddenly and move the mandrel 30, sub 29, sinker bar 25, and jar mandrel 24 rapidly upward with it. Such rapid upward movement causes the jar ring or hammer 28 to strike a severe blow on the jar head or hammer 18, which is transmitted through the housing 17 and sub 16 to the shear pin 10, shearing the latter and disconnecting the apparatus above the bridge plug B from the bridge plug.

As an example, let it be assumed that the lower

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spring is compressed with a force of about 1000 lbs. when the lower mandrel 20 is shifted to align the dogs 42 with the slots 49. Substantially the same compressive force has been imparted to the upper spring 32; so that when the dogs 42 are released from the mandrel 20, the jar mandrel 24 is moved upwardly and accelerated very rapidly until its ring 28 strikes a blow against the jar head 18. The kinetic energy that is transmitted to the jar head is quite substantial, since the rapid velocity that has been acquired by the jar ring under the impetus of the upper compression spring 32 is arrested almost instantly, in the manner of a hammer blow, and will impart a force of many thousand pounds on the shear pin, sufficient to effect its complete disruption. As an example, it may require 30,000 lbs. total force to shear the pin 10. It has been found that the compression of the springs 32, 40 to about 1,000 lbs. is sufficient to cause a hammer blow of sufficient intensity to effect a clean, double shear of the pin 10, and the full withdrawal of the sub 16 from the adapter 15. The force of the blow can be varied readily by changing the force of the springs and the weight of the sinker bar 25.

In the event that a single blow has not produced shearing of the pin 10, the mechanism can easily be reset for the purpose of striking another blow. All that is required is to lower the wire line D, which causes the jar mandrel 24 and spring restrained mandrel 20 to lower, until the mandrel grooves 43 are in alignment with the dogs 42 that have been disposed within the housing slots 49. The lower ends 55 of the housing slots and the companion lower surface 56 on the outer portion 51 of each dog are tapered in a downward and inward direction. Alignment of the mandrel grooves 43 with the dogs 42 allows the lower compression spring 40, which has been previously compressed by a substantial force (about 1,000 lbs. in the above example), to force the dogs 42 downwardly and radially into the grooves 43, until they are free of the housing slots 49. Thereafter, the lowering of the mandrels 20, 24 may continue to the extent desired, as assisted by the expansion of the compression spring 40. In effect, the mandrel mechanism has been reset or recocked for another trigger-like hammer blow operation.

The above-noted cycle of operation is repeated through recompressing the upper spring 32 and the lower spring 40, by the taking of an upward pull on the wire line D until the dogs 42 are again aligned with the housing slots 49, which releases the dogs from the mandrel 20 and allows the upper spring 32 to rapidly shift the jar mandrel 24 upwardly and move its ring 28 to strike another blow on the housing head 18, which blow is transmitted to the shear pin 10. If necessary, the mandrel 20 may be lowered and then elevated repeatedly, in order to strike a multiplicity of blows on the housing head 18, which is transmitted to the device to be jarred or released.

The apparatus has been disclosed and described in connection with an accelerator or energy storage device E including the upper spring 32. In the event that the wire line D is sufficiently long, the accelerator may be dispensed with and the wire line connected directly to the sinker bar 25. The taking of an upward pull on the wire line D will store sufficient energy in the line itself, due to its elasticity and the stretch imparted to it, to cause rapid acceleration of the jar mandrel 24 and the ring 28 against the housing head 18 after the dogs 42 have been released from the spring restrained mandrel 20.

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It is, accordingly, apparent that a jarring device has been provided which is capable of imparting a severe blow or jarring effect with substantially little strain imposed on a wire line, or other running-in string that may be employed in lowering the apparatus through the well casing. The mechanism is reset very simply, merely by lowering the wire line, in the event that additional or repeated blows are required.

10 The inventor claims:

1. In apparatus of the character described adapted to be lowered in a well bore on a running-in string; a spring; means for stressing said spring; inner and outer telescopically arranged members, one of said members being connected to said stressing means; spring means for resisting relative longitudinal movement between said members in one direction; latch means releasably connectible to one of said members and operatively engaged by said spring means for transmitting the force of said resisting spring means to said one member in response to stressing of said spring; said spring means operatively engaging the other of said members; and means on said other member enabling said latch means to be released from said one member when said spring has been stressed to a predetermined degree to permit said one member to be moved by said spring without restraint from said spring means.

2. In apparatus of the character described: inner and outer telescopically arranged upper members adapted to be lowered in a well bore on a running-in string; a compression spring adapted to bear upon said members and adapted to be compressed upon longitudinal movement of one of said members relative to the other of said members; inner and outer telescopically arranged lower jarring members, one of said jarring members being connected to one of said upper members; coengageable hammer means on said jarring members spaced initially from each other; spring means for resisting engagement of said hammer means; latch means releasably connectible to one of said lower members and operatively engaged by said spring means for transmitting the force of said spring means to said one of said lower members; said spring means operatively engaging the other of said lower members; and means on said other lower member for effecting release of said latch means from said one of said lower members to allow said compression spring to engage said coengageable hammer means with each other.

3. In apparatus of the character described: inner and outer telescopically arranged upper members adapted to be lowered in a well bore on a running-in string; a compression spring confined between said members and adapted to be compressed upon longitudinal movement of one of said members relative to the other of said members; inner and outer telescopically arranged lower jarring members, one of said jarring members being connected to one of said upper members; coengageable hammer means on said jarring members spaced initially from each other; latches on said inner jarring member releasably connectible to said inner jarring member; a compression spring confined between and engaging said outer member and said latches; said outer member having openings therein into which said latches can enter in order to free said latches from said inner member.

4. In apparatus of the character described: inner and outer telescopically arranged upper members adapted to be lowered in a well bore on

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a running-in string; an upper compression spring confined between said members and adapted to be compressed upon longitudinal movement of one of said members relative to the other of said members; inner and outer telescopically arranged lower jarring members, one of said jarring members being connected to one of said upper members; coengageable hammer means on said jarring members spaced initially from each other; latches adapted to be received within grooves in said inner jarring member to couple said latches to said inner jarring member; a lower compression spring confined between and engaging said outer jarring member and latches to exert a resisting force on said inner jarring member; said outer jarring member having openings into which said latches are movable to disconnect said latches from said inner jarring member, to release said lower compression spring from said inner jarring member and allow said upper compression spring to effect engagement of said hammer means; said grooves and latches having companion tapered surfaces for enabling said lower compression spring to shift said latches outwardly into said openings, and said latches and outer jarring member having coengageable tapered surfaces for enabling said lower compression spring to shift said latches inwardly out of said openings and into said grooves.

5. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; laterally movable latch means adapted to be coupled to said inner member for longitudinal movement with said inner member relative to said outer member; spring means between and bearing upon said latch means and said outer member; coengaging cam means on said inner member and latch means tending to shift said latch means laterally to uncouple said latch means from said inner member; the inner wall of said outer member engaging said latch means to prevent lateral movement of said latch means and hold said latch means coupled to said inner member while said latch means moves longitudinally with said inner member along said outer member; and means on said outer member enabling said latch means to be released from said inner member upon longitudinal movement of said inner member and latch means relative to said outer member.

6. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; laterally movable latch means adapted to be coupled to said inner member for longitudinal movement with said inner member relative to said outer member; spring means between and bearing upon said latch means and said outer member; coengaging cam means on said inner member and latch means tending to shift said latch means laterally to uncouple said latch means from said inner member; said outer member engaging said latch means to prevent lateral movement of said latch means and hold said latch means coupled to said inner member while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein into which said latch means can enter, to free said latch means from said inner member upon longitudinal movement of said inner member and latch means relative to said outer member.

7. In apparatus of the character described:

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inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; coengageable hammer means on said members spaced initially from each other; spring means for resisting engagement of said hammer means; laterally movable latch means on and coupled to said inner member to move longitudinally with said inner member relative to said outer member, said latch means engaging said spring means to transmit the force of said spring means to said inner member; coengaging cam means on said inner member and latch means tending to shift said latch means laterally out of coupling engagement with said inner member under the force of said spring means; said outer member engaging said latch means to prevent lateral movement of said latch means and hold said latch means coupled to said inner member while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein for receiving said latch means upon longitudinal movement of said inner member and latch means relative to said outer member, in order to enable said latch means to move laterally and be released from said inner member and allow said hammer means to engage.

8. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; laterally movable latch means adapted to be coupled to said inner member for longitudinal movement with said inner member relative to said outer member; spring means between and bearing upon said latch means and said outer member to resist relative longitudinal movement between said inner and outer members; coengaging cam means on said inner member and latch means tending to shift said latch means laterally to uncouple said latch means from said inner member; said outer member engaging said latch means to prevent lateral movement of said latch means and hold said latch means coupled to said inner member while said latch means moves longitudinally with said inner member along said outer member; and means on said outer member enabling said latch means to be released from said inner member upon longitudinal movement of said inner member and latch means relative to said outer member.

9. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; laterally movable latch means adapted to be coupled to said inner member to move longitudinally therewith relative to said outer member; spring means between and bearing upon said latch means and said outer member to resist relative longitudinal movement between said inner and outer members; means engaging said latch means to shift said latch means laterally and uncouple said latch means from said inner member; said outer member engaging said latch means to prevent such lateral shifting of said latch means to uncoupled position while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein into which said latch means can enter upon longitudinal movement of said latch means with said inner member relative to said outer member, to free said latch means from said inner member and allow said inner member to move longitudinally relative to said outer member free from the resistance of said spring means.

10. In apparatus of the character described:

inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; coengageable hammer means on said members spaced initially from each other; spring means for resisting engagement of said hammer means; laterally movable latch means on and coupled to said inner member to move longitudinally with said inner member relative to said outer member, said latch means engaging said spring means to transmit the force of said spring means to said inner member; said outer member engaging said latch means to hold said latch means coupled to said inner member; said outer member while said latch means moves longitudinally with said inner member along said outer member having openings therein for receiving said latch means upon longitudinal movement of said latch means with said inner member relative to said outer member, in order to enable said latch means to be uncoupled from said inner member and allow said hammer means to engage.

11. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; coengageable hammer means on said members spaced initially from each other; laterally movable latch means receivable in grooves in said inner member to be coupled to said inner member for longitudinal movement therewith relative to said outer member; a spring surrounding said inner member and bearing against said outer member and latch means to resist relative longitudinal movement between said inner and outer members; said grooves having tapered surfaces engageable with companion tapered surfaces on said latch means to enable said spring to urge said latch means outwardly; said outer member engaging said latch means to prevent lateral movement of said latch means from said grooves while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein into which said latch means may enter upon their alignment therewith upon their longitudinal movement with the inner member relative to said outer member, in order to free said inner member from said latch means and allow said hammer means to engage.

12. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; coengageable hammer means on said members spaced initially from each other; laterally movable latch means receivable in grooves in said inner member to be coupled to said inner member for longitudinal movement therewith relative to said outer member; a spring surrounding said inner member and bearing against said outer member and latch means to resist relative longitudinal movement between said inner and outer members; said grooves having tapered surfaces engageable with companion tapered surfaces on said latch means to enable said spring to urge said latch means outwardly; said outer member engaging said latch means to prevent lateral movement of said latch means from said grooves while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein into which said latch means may enter upon their alignment therewith upon their longitudinal movement with said inner member relative to said outer member, in order

to free said inner member from said latch means and allow said hammer means to engage; said outer member and latch means having coengageable inclined surfaces for enabling said spring to shift said latch means inwardly into said grooves upon alignment of said grooves with said latch means.

13. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; coengageable hammer means on said members spaced initially from each other; a plurality of laterally movable latches receivable within grooves in said inner member to be coupled to said inner member for longitudinal movement therewith relative to said outer member, the lower ends of said grooves and latches having coengaging tapered surfaces inclined in an outward and downward direction; a compression spring confined between and engaging said outer member and latches to resist relative longitudinal movement between said inner and outer members; said outer member engaging said latches to prevent lateral movement of said latches from said grooves while said latch means moves longitudinally with said inner member along said outer member; said outer member having openings therein into which said latches may enter when said latches are moved upwardly with said inner member within said outer member, in order to remove said latches from said grooves and free said hammer means for engagement with each other; the portion of said outer member defining the lower ends of said openings having inwardly and downwardly tapering surfaces engageable with companion surfaces on said latches.

14. In apparatus of the character described: inner and outer telescopically arranged members adapted to be lowered in a well bore on a running-in string; laterally movable latch means adapted to be coupled to said inner member to move longitudinally therewith relative to said outer member; coengaging cam means on said inner member and latch means; spring means between and bearing upon said latch means and said outer member and acting through said coengaging cam means to shift said latch means laterally to uncouple said latch means from said inner member; said outer member engaging said latch means to prevent lateral movement of said latch means out of coupling relation to said inner member while said latch means moves longitudinally with said inner member along said outer member; and means on said outer member enabling said latch means to be shifted laterally by said cam means and uncoupled from said inner member upon longitudinal movement of said inner member and latch means relative to said outer member.

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