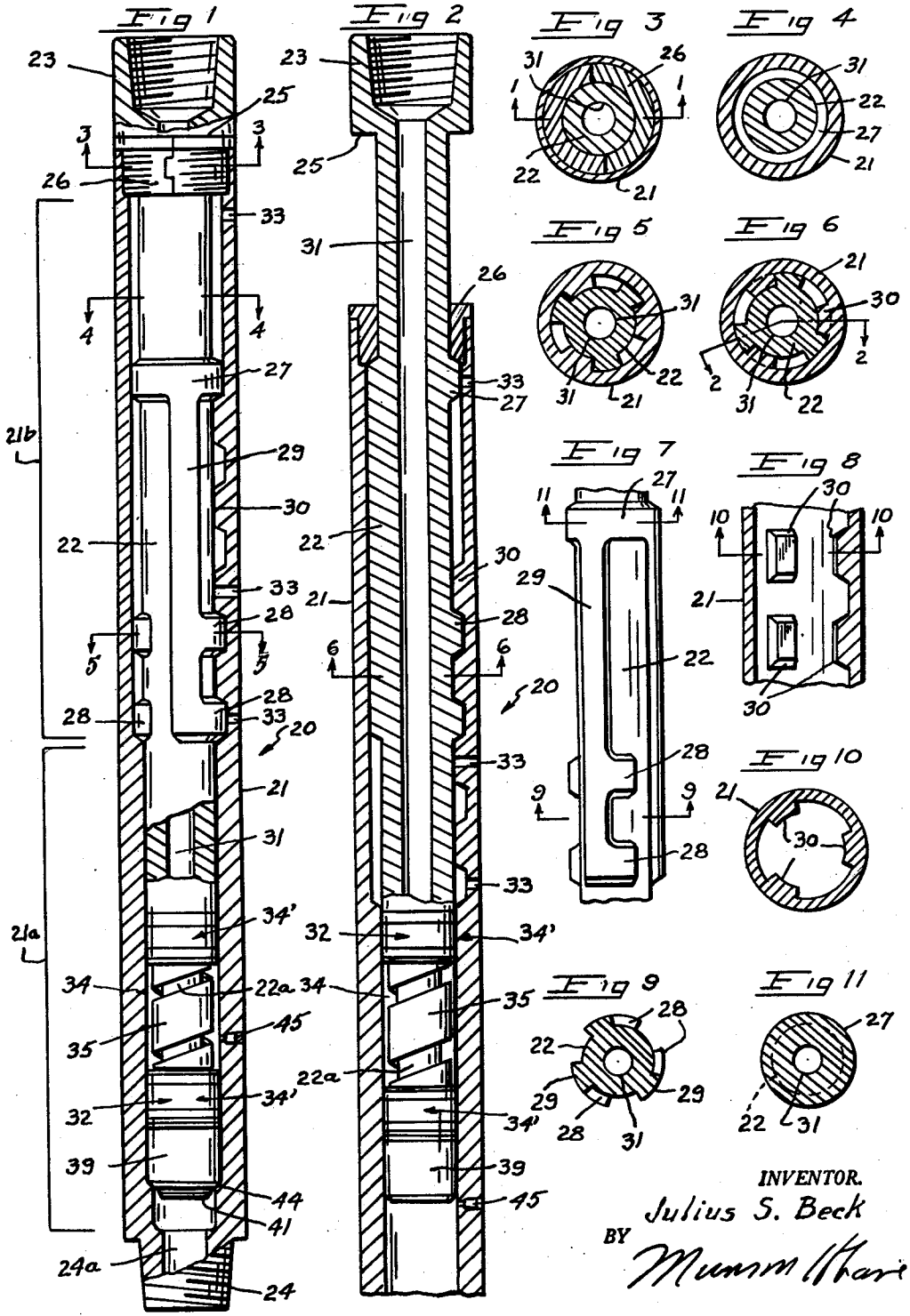
April 7, 1964 J. S. BECK 3,128,102

SEAL FOR A SUSPENSION DRILLING DEVICE

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SEAL FOR A SUSPENSION DRILLING DEVICE

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Fig 12

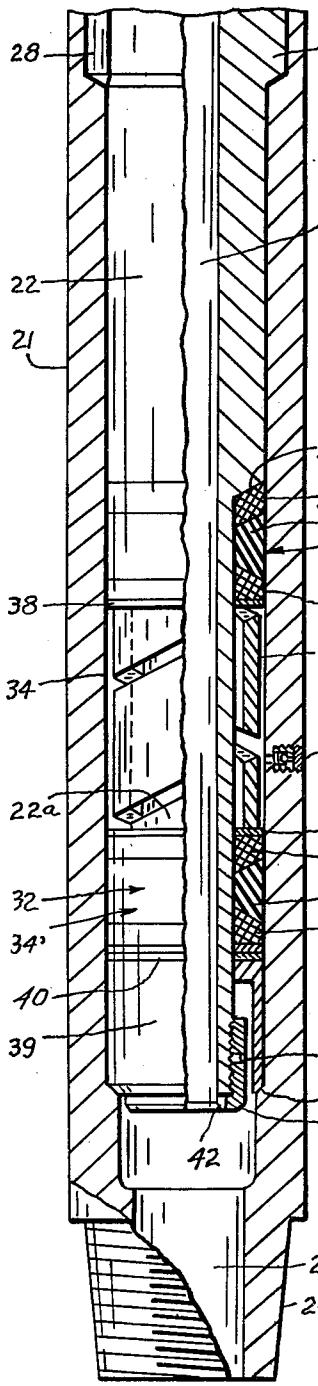


Fig 13

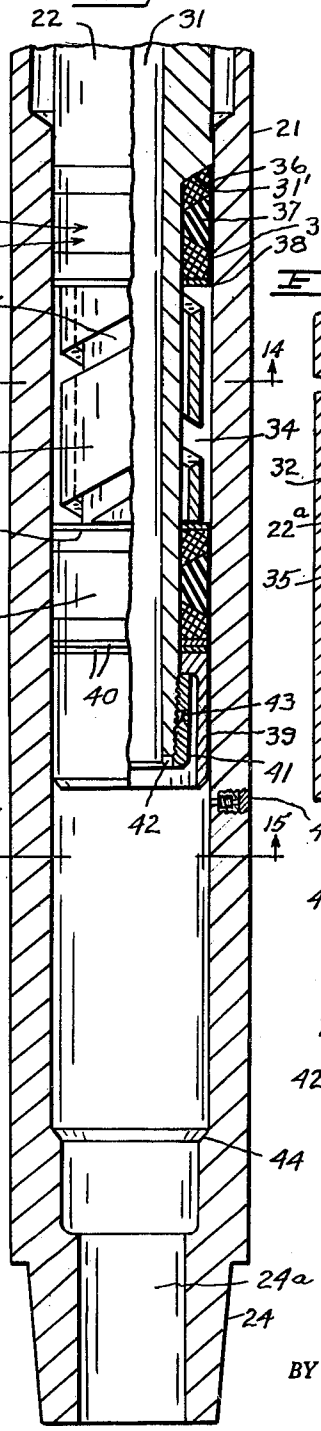


Fig 14

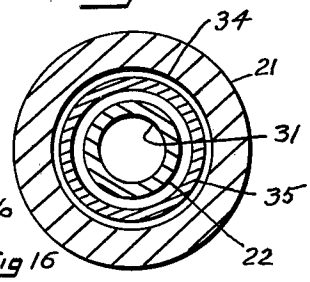


Fig 16

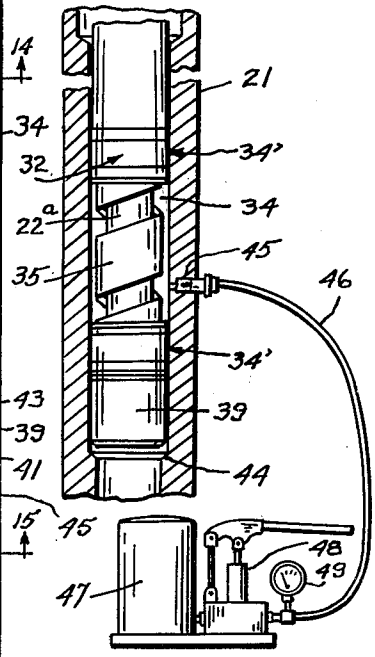
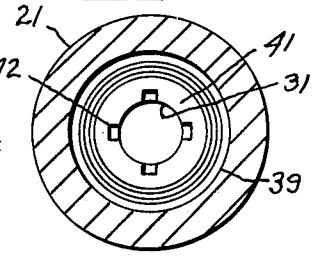


Fig 15



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3,128,102

SEAL FOR A SUSPENSION DRILLING DEVICE

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10 Claims. (Cl. 277—17)

This invention relates to new and useful improvements in the art of oil well drilling, and in particular the invention concerns itself with a suspension drilling device and jar of the general type disclosed in my prior Patents Nos. 2,819,878 and 2,819,879, both dated January 14, 1958.

In the operation of devices of this type, it is important to take cognizance of hydrostatic, hydraulic and rock pressures, and of the direction in which these pressures act to cause circulation or reverse circulation of fluid in the well and in the drill pipe. Movement of the fluid in the well through the drill is undesirable, particularly under the relatively high pressures often encountered, since the abrasive properties of the fluid tend to cause scoring and eventual washouts. Thus, sealing means are usually provided in such devices to prevent the undesirable fluid movement, and the principal object of this invention is to provide sealing means of novel construction and operation, which are more effective and dependable than sealing means of conventional types.

With the foregoing object in view and such other objects and features as will become apparent as this specification proceeds, the invention will be understood from the following description taken in conjunction with the accompanying drawings, wherein like characters of reference are used to designate like parts, and wherein:

FIGURE 1 is a view of the device or tool, partly in vertical section and partly in elevation, showing the same in a collapsed or retracted position;

FIGURE 2 is a view similar to that shown in FIGURE 1 but illustrating the tool in its extended position;

FIGURE 3 is a cross-sectional view, taken substantially in the plane of the line 3—3 in FIGURE 1;

FIGURE 4 is a cross-sectional view, taken substantially in the plane of the line 4—4 in FIGURE 1;

FIGURE 5 is a cross-sectional view, taken substantially in the plane of the line 5—5 in FIGURE 1;

FIGURE 6 is a cross-sectional view, taken substantially in the plane of the line 6—6 in FIGURE 2;

FIGURE 7 is a fragmentary elevational view of the mandrel;

FIGURE 8 is a fragmentary vertical sectional view of the body or barrel;

FIGURE 9 is a cross-sectional view, taken substantially in the plane of the line 9—9 in FIGURE 7;

FIGURE 10 is a cross-sectional view, taken substantially in the plane of the line 10—10 in FIGURE 8;

FIGURE 11 is a cross-sectional view, taken substantially in the plane of the line 11—11 in FIGURE 7;

FIGURE 12 is an enlarged, fragmentary view, partly in vertical section and partly in elevation, showing the lower end portion of FIGURE 1 in greater detail;

FIGURE 13 is a view, similar to that shown in FIGURE 12 and illustrating the lower end portion of FIGURE 2 in greater detail;

FIGURE 14 is a cross-sectional view, taken substantially in the plane of the line 14—14 in FIGURE 13;

FIGURE 15 is a cross-sectional view, taken substantially in the plane of the line 15—15 in FIGURE 13; and

FIGURE 16 is a fragmentary view, partly in vertical section and partly in elevation, of the lower end portion of FIGURE 1 and showing in elevation apparatus used for pressure loading the compensating chamber of the tool.

For purposes of orientation it may be noted that FIGURES 1 and 2 are taken substantially in the planes of the lines 1—1 and 2—2, respectively, in the respective FIGURES 3 and 6.

Referring now to the accompanying drawings in detail, the suspension drilling device and jar of the invention is designated generally by the reference numeral **20** and embodies in its construction a tubular body or barrel **21** accommodating therein a slidable tubular mandrel **22**. The upper end of the mandrel **22** is provided with an enlarged, internally screw-threaded box **23**, while the lower end of the barrel **21** is provided with a reduced, externally screw-threaded sub or pin **24**, whereby the entire device may be connected to the drill pipe in the usual manner. The underside of the enlarged box **23** affords an annular shoulder **25** which is engageable with the top of a split nut **26** provided in the upper end of the barrel **21**, so that when the tool is contracted as shown in FIGURE 1, the abutment of the shoulder **25** with the nut **26** serves as a stop for downward sliding movement of the mandrel in the barrel, thus creating an impact for jarring the barrel and the drill string therebelow. The mandrel **22**, of course, passes slidably through the nut **26** and the split formation of the latter facilitates its installation or removal without pulling the mandrel out of the barrel.

The intermediate portion of the mandrel **22** is provided with an integral ring **27** which is engageable with the underside of the nut **26** to limit the extent of upward sliding of the mandrel in the barrel and also to create an impact or jarring action on the up stroke. Moreover, the mandrel is provided below the ring **27** with vertically spaced, integral keys **28** and with vertical ribs **29** disposed at one side of the keys in the respective sets, the sets of keys and ribs being shown as spaced circumferentially of the mandrel for coaction with vertically and circumferentially spaced lugs or bosses **30** which are provided within the intermediate portion of the barrel **21**, whereby the mandrel may be releasably locked in a selected position longitudinally of the barrel and whereby torque may be transmitted from the mandrel to the barrel in substantially the same manner as in my aforementioned Patents No. 2,819,878 and 2,819,879.

The entire length of the mandrel **22** is provided with an axial bore or passage **31** for drilling fluid and the lower end portion of the mandrel, indicated at **22***a*, is diametrically reduced so as to accommodate the seal assembly which is designated generally by the numeral **32**. This seal assembly is located within the lower region of the barrel designated as **21***a* in FIG. 1, while the upper region **21***b* accommodates the jarring means **27, 28, 29, 30**. The axial mandrel passage **31** is of sufficient diameter to permit survey or other instruments to be lowered therethrough, and it will be also noted that the upper end of the barrel **21** which accommodates the nut **26** is large enough to allow passage of the largest diameter of the mandrel during assembly and disassembly of the tool when the nut **26** is removed.

Relief holes **33** may be provided in the barrel **21** for fluid entrapped between the ring **27**, keys **28**, ribs **29** and the bosses **30** in the barrel, and the lower end portion **21***a* of the barrel which accommodates the seal assembly **32** constitutes a pressure compensating chamber or cylinder **34**, as will presently become apparent.

The seal assembly **32**, located on the diametrically reduced portion **22***a* of the mandrel, consists of two or more vertically spaced sealing units **34'** and a resiliently compressible spacer or spring **35** therebetween. Each of the units **34'** comprises a pair of bevelled sealing rings **36** of lead, or the like, and a ring **37** of rubber, or the like, interposed therebetween, the ring **37** having bevelled surfaces in engagement with the bevelled rings **36** so that when the unit **34'** is subjected to axial pressure, the rings **36** urge the ring **37** radially outwardly into sealing engagement with the wall of the chamber **34** in the barrel

portion 21*a*, such sealing engagement becoming greater with increasing of the axial pressure applied to the unit, as will be clearly understood.

The assembly 32 also includes spacers or washers 38 interposed between the sealing units 34' and the spacer 35; a slidably mounted sleeve 39, additional spacers or washers 40 between the sleeve 39 and the lower unit 34'; and a retaining nut 41. These various components of the seal assembly 32 are positioned on the mandrel portion 22*a* prior to the installation of the mandrel in the barrel, the nut 41 being threaded on the lower end of the mandrel only to a sufficient extent to retain the parts assembled during installation of the mandrel in the barrel, but insufficient to expand the rings 37 to a point or extent which would render installation of the mandrel in the barrel difficult. The mandrel is installed in the barrel in the contracted position of the device as shown in FIGURES 1 and 12 so that the nut 41 is readily accessible through the hole or passage 24*a* in the pin 24, whereupon a spanner type wrench is inserted through the passage 24*a* to to engage kerfs 42 formed in the outer or lower end of the nut, whereby full tightening of the nut on the mandrel may be effected. The nut 41 is equipped at one side thereof with an insert 43 of Teflon, or the like, which is engaged and cut by the threads on the mandrel during the nut tightening operation and thus serves to lock the nut against backing off.

The upper sealing unit 34' abuts an annular shoulder 31' existing on the mandrel 22 at the upper end of the diametrically reduced mandrel portion 22*a*, and when the nut 41 is tightened as shown in FIGURE 13, the resilient spacer or spring 35 becomes somewhat compressed so that the rings 37, urged outwardly by the rings 36, are brought into good sealing contact with the wall of the chamber 34 in the barrel 21, thus forming an effective seal in both upward and downward directions. It will be observed that the lower portion of the barrel 21 is provided with an internal shoulder 44 which is engaged by the lower end of the sleeve 39 when the device is fully contracted, as shown in FIGURE 12. In this position the sleeve 38 slides the lower sealing unit 34' upwardly on the mandrel portion 22*a*, thus causing compression of the sealing means 32 in the axial direction to a full extent, and providing a full sealing effect. It will be noted that the compression of the sealing means caused by engagement of the sleeve 39 with the shoulder 44 takes place independently of the tightening of the nut 41, the latter having become separated from its abutment with the sleeve 39 when the mandrel is slid downwardly to the full extent relative to the barrel, as shown in FIGURE 12.

When it is desired to pressurize the sealing means by force other than and in addition to the pressurizing effect created by the tightening of the nut 41, the mandrel is moved to a position where the lower end of the sleeve 39 is out of contact with and above the shoulder 44 as shown in FIGURE 16, and grease or some other fluid is admitted under pressure into the chamber 34 between the units 34' of the seal assembly, this being effected through a check valve 45, or the like, provided in the side of the barrel portion 21*a* in communication with the chamber portion between the units 34'. For such purpose, the grease or other fluid is conveyed to the valve 45 by a suitable hose 46 from a supply tank 47 by a suitable pump 48, a pressure gauge 49 being provided on the hose or line 46 so that the pressure loading of the chamber of the seal assembly may be carried out to the extent required by the hydrostatic, hydraulic and rock pressures of a particular well.

Such pressures in or at the well bore may attempt to cause reverse circulation of fluid upwardly through the drill stem, but the invention compensates for such pressures so as to prevent leakage of the fluid upwardly between the mandrel and the barrel where the abrasive nature of the fluid would cause premature wear of parts. For this purpose the invention utilizes the radially expansible sealing means between the mandrel and the barrel, so that with such sealing means in the expanded position, upward leakage of fluid between the mandrel and the barrel cannot take place. In the one and same embodiment of the invention the sealing effect may be accomplished in a variety of different ways. For example, the seal units 34' may be radially expanded by tightening of the nut 41. Alternatively, they may be expanded by inward or downward sliding of the mandrel in the barrel so that the sleeve 39 abuts the shoulder 44, in which event the force-exerting effect of the nut 41 is not necessary. Or, the seal units may be expanded by introduction of fluid under pressure through the valve 45 into the chamber 34 between the seal units, such pressurized fluid serving to exert an axial force on the seal units to radially expand them, regardless of whether the lower seal unit 34' is prevented from downward sliding by the nut 41 or by engagement of the sleeve 39 with the shoulder 44. Or, the seal units may be expanded by pressure of fluid existing in the barrel below the mandrel, that is, within the hollow sleeve 39, in which event the sleeve will be forced upwardly by such fluid pressure and, by exerting an axial force on the seal units, will radially expand the same. In the last mentioned instance the sealing action is truly automatic and responsive to fluid pressure within the well bore and, as such, it is quite independent of the nut adjusting means 41 as well as of the abutment means 39, 44. In the event that the fluid pressure in the well bore becomes too great, it may be compensated for or minimized by introduction of fluid under pressure into the seal chamber 34 through the valve 45, so as to prevent over-compression of the spring 35, it being noted that introduction of fluid under pressure into the chamber 34 assists the action of the spring 35 to keep the seal units 34' apart.

Over-compression of the spring 35 is to be avoided if the spring is to perform a useful function in absorbing or dampening shocks incident to jarring of the tool. While the shocks and jars are desirable for loosening an article or object stuck in the well, nevertheless, the dampening action afforded by the spring takes the initial shock impact and thereby prevents cracking or other damage of the parts, while still delivering a major portion of the impact to the stuck object. Again, in this instance it will be noted that introduction of fluid under pressure into the chamber 34 assists the action of the spring 35, so that the unit may be "pre-loaded" as desired, not only for shock dampening purposes, but also for counteraction of excessive bore pressures as already mentioned.

It will be apparent from the foregoing that the portion of the chamber 34 between the units 34' of the seal assembly 32 provides what may be referred to as a loading zone of the tool, which may be pressure loaded with grease or other suitable fluid so as to compensate for hydrostatic, hydraulic and rock pressures of the well. The arrangement of this loading zone is such that it moves with the seal assembly during movement of the mandrel in the barrel without loss of pressure or leakage of the seal units. The seal assembly thus prevents undesired movement of well fluid through the tool, and the pressure-loaded compensating chamber of the seal assembly affords a shock absorbing and dampening effect in the balancing of pressures in the tool. It will be also observed that the seal assembly functions effectively without depending upon the mechanical movement of the mandrel in the barrel and without being affected by the jarring action of the tool.

While in the foregoing there has been described and shown the preferred embodiment of the invention, various modifications may become apparent to those skilled in the art to which the invention relates. Accordingly, it is not desired to limit the invention to this disclosure and various modifications and equivalents may be resorted to, falling within the spirit and scope of the invention as claimed.

What is claimed as new is:

1. In combination with a drill string, a tubular body connected at one end thereof to a section of said drill string, a tubular mandrel slidably mounted in said body and extensible therefrom, the extending end of said mandrel being connected to another section of the drill string, means limiting longitudinal sliding movement of said mandrel and means limiting rotational movement of the mandrel in said body, the end portion of said mandrel in said body being diametrically reduced and providing an abutment shoulder, a first radially expansible seal unit positioned on said reduced portion of the mandrel in abutment with said shoulder, a second radially expansible seal unit positioned on said reduced mandrel portion in spaced relation from said first seal unit, resiliently compressible means interposed between the first and second seal units for spacing the same apart, and a screw-threaded element positioned on said reduced mandrel portion in abutment with said second seal unit, whereby upon tightening of said screw-threaded element said seal units may be radially expanded into engagement with the inside surface of said tubular body.

2. The combination as defined in claim 1 wherein the interior of said tubular body between said spaced seal units constitutes a pressure compensating chamber, a valve provided in said tubular body in communication with said chamber, and means disposed exteriorly of said body and connected to said valve for introducing fluid under pressure into said chamber.

3. The combination as defined in claim 1 wherein said resiliently compressible means comprise a compression spring surrounding said reduced mandrel portion and having its ends in abutment with the respective seal units.

4. In a suspension drilling device and jar, the combination of a tubular barrel adapted at one end thereof for connection to a drill string section, a tubular mandrel slidable in said barrel and projecting through the other end thereof for connection to another drill string section, means for limiting longitudinal sliding and rotational movements of said mandrel relative to said barrel, the end portion of said mandrel in said barrel being diametrically reduced and providing an abutment shoulder, and sealing means between the mandrel and the barrel, said sealing means comprising a first radially expansible seal unit positioned on said reduced mandrel portion in abutment with said shoulder, a second radially expansible seal unit positioned on said reduced mandrel portion in spaced relation from said first seal unit, a compression spring surrounding said reduced mandrel portion and having its ends in abutment with the respective seal units for spacing the same apart, the extremity of said reduced mandrel portion being screw-threaded, and a nut provided on said screw-threaded extremity in abutment with said second seal unit, said nut being accessible through the adjacent end of said barrel and tightening of the nut causing said seal units to be radially expanded into engagement with the inside surface of the barrel, and coacting means provided in said barrel and on said reduced mandrel portion in engagement with said second seal unit for moving the second seal unit toward the first seal unit against the action of said spring and independently of the tightening of said nut when the mandrel is slid fully into said barrel.

5. In a suspension drilling device and jar, the combination of a tubular barrel adapted at one end thereof for connection to a drill string section, a tubular mandrel slidable in said barrel and projecting through the other end thereof for connection to another drill string section, means for limiting longitudinal sliding and rotational movements of said mandrel relative to said barrel, the end portion of said mandrel in said barrel being diametrically reduced and providing an abutment shoulder, and sealing means between the mandrel and the barrel, said sealing means comprising a first radially expansible seal unit positioned on said reduced mandrel portion in

abutment with said shoulder, a second radially expansible seal unit positioned on said reduced mandrel portion in spaced relation from said first seal unit, a compression spring surrounding said reduced mandrel portion and having its ends in abutment with the respective seal units for spacing the same apart, the extremity of said reduced mandrel portion being screw-threaded, and a nut provided on said screw-threaded extremity in abutment with said second seal unit, said nut being accessible through the adjacent end of said barrel and tightening of the nut causing said seal units to be radially expanded into engagement with the inside surface of the barrel, and a sleeve slidably positioned on said reduced mandrel portion between said nut and said second seal unit, and abutment means provided in said barrel and engageable by said sleeve when said mandrel is slid fully into the barrel, whereby to move the second seal unit toward the first seal unit against the action of said spring and independently of the tightening of said nut.

6. In a suspension drilling device and jar, the combination of a tubular barrel adapted at one end thereof for connection to a drill string section, a tubular mandrel slidable in said barrel and projecting through the other end thereof for connection to another drill string section, means for limiting longitudinal sliding and rotational movements of said mandrel relative to said barrel, the end portion of said mandrel in said barrel being diametrically reduced and providing an abutment shoulder, and sealing means between the mandrel and the barrel, said sealing means comprising a first radially expansible seal unit positioned on said reduced mandrel portion in abutment with said shoulder, a second radially expansible seal unit positioned on said reduced mandrel portion in spaced relation from said first seal unit, a compression spring surrounding said reduced mandrel portion and having its ends in abutment with the respective seal units for spacing the same apart, the extremity of said reduced mandrel portion being screw-threaded, and a nut provided on said screw-threaded extremity in abutment with said second seal unit, said nut being accessible through the adjacent end of said barrel and tightening of the nut causing said seal units to be radially expanded into engagement with the inside surface of the barrel, each of said seal units comprising a pair of bevelled rings slidable on said reduced mandrel portion, and an intermediate ring of resiliently compressible material interposed between said pair of rings, said intermediate ring having bevelled surfaces complemental to and in engagement with the bevelled rings, whereby the bevelled rings may radially expand the intermediate ring under pressure imparted axially to the seal unit.

7. In a drilling device, the combination of a tubular barrel, a tubular mandrel slidable in said barrel, said mandrel having a diametrically reduced end portion terminating in a screw-threaded extremity and providing an abutment shoulder in spaced relation from said extremity, and sealing means between said mandrel and said barrel, said sealing means comprising a first radially expansible seal unit positioned on said reduced mandrel portion in abutment with said shoulder, a second radially expansible seal unit positioned on the reduced mandrel portion adjacent said screw-threaded extremity, a resiliently compressible spacer interposed between and abutting said seal units, a nut provided on said screw-threaded extremity in abutment with said second seal unit whereby upon tightening of said nut said seal units may be radially expanded into engagement with the inside surface of said barrel, the interior of said barrel between said seal units constituting a pressure compensating chamber, a valve provided in said barrel in communication with said chamber, and means disposed exteriorly of said barrel and separably connected to said valve for introducing fluid under pressure into said chamber.

8. The device as defined in claim 7 together with co-

acting means provided in said barrel and on said reduced mandrel portion in engagement with said second seal unit for moving the second seal unit toward the first seal unit against the action of said resiliently compressible spacer and independently of the tightening of said nut when said mandrel is slid in one direction in said barrel.

9. The device as defined in claim 7 together with a sleeve slidably positioned on said reduced mandrel portion between said nut and said second seal unit, and abutment means provided in said barrel and engageable by said sleeve when said mandrel is slid in one direction in the barrel, whereby to move the second seal unit toward the first seal unit against the action of said resiliently compressible spacer and independently of the tightening of said nut.

10. The device as defined in claim 9 wherein said abutment means comprise an internal shoulder formed in said barrel and engageable by said sleeve, said sleeve being hollow and accommodating said screw-threaded extremity of the mandrel and said nut therein.

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