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 well 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 5—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 a 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 21 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 thereof. The lower end 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 23 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 22a, 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 21a in FIG. 1, while the upper region 21b 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 also be 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 22a 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 22a 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 21a, 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 slidable 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 22a 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 the 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 24a in the pin 24, whereupon a spanner type wrench is inserted through the passage 24a 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 end 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 22a, and when the nut 41 is tightened as shown in FIGURE 3, 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 24 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 22a, 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 causing the sealing effect 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 21, 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 21a in communication with the chamber portion 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 without being affected by the abrasive nature of the fluid would cause premature wear of parts. For this purpose the invention utilizes the radially ex-
What is claimed as new is:

1. In combination with a drill string, a tubular body connected 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, 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 abutment shoulder, a second radially expansible seal unit positioned on said reduced mandrel portión 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 said resiliently compressible means comprise a compression spring surrounding said reduced mandrel portion and having its ends in abutment with the respective seal units.

3. 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 slidably 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 consisting of a first 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 abutment 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 slideable 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 complemenal 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.

4. In a drilling device, the combination of a tubular barrel, a tubular mandrel slideable 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 abutment 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.

5. 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.

**References Cited in the file of this patent**

**UNITED STATES PATENTS**

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor(s)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,031,312</td>
<td>Gates</td>
<td>Mar. 30, 1937</td>
</tr>
<tr>
<td>1,566,462</td>
<td>Bashline</td>
<td>Dec. 22, 1925</td>
</tr>
<tr>
<td>1,977,110</td>
<td>Burn et al.</td>
<td>Oct. 16, 1934</td>
</tr>
</tbody>
</table>