United States Patent

Wallace

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[54] WELL BORE SEAL APPARATUS FOR CLOSED FLUID CIRCULATION ASSEMBLY

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[51] Int. Cl. E21b 17/10, E21c 9/00

[58] Field of Search 175/325, 60, 215, 206

[56] References Cited

UNITED STATES PATENTS

462,392	11/1891	Bullock	175/325 X
2,419,738	4/1947	Smith	175/325
2,663,545	12/1953	Grable	175/325 X
3,109,501	11/1963	Pugh	175/325
3,151,690	10/1964	Grable	175/325 X
3,155,179	11/1964	Hunt et al.	175/215
3,283,835	11/1966	Kellner	175/215 X
3,376,942	4/1968	Van Winkle	175/215 X

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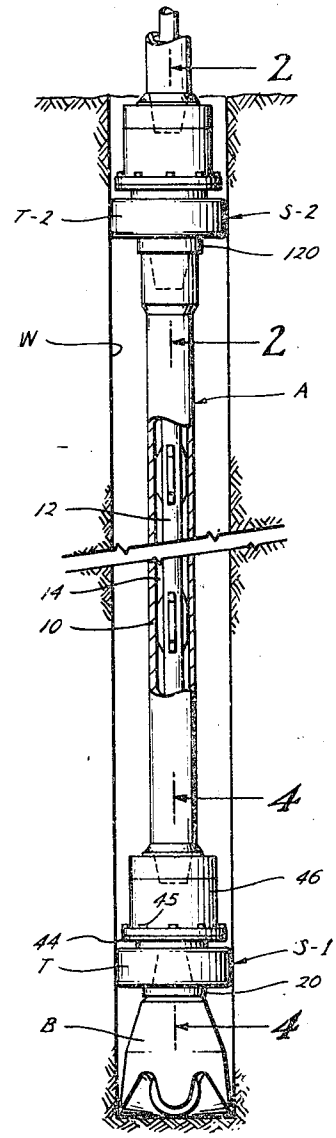
[57] ABSTRACT

A well bore seal apparatus for a closed fluid circulation assembly, wherein one or more seal means are disposed to engage a well bore for sealing off the annulus externally of the closed fluid circulation assembly so that air, drilling mud, water and other fluids are sealed off from the annulus during drilling operations. This invention is especially suitable for drilling in permafrost, solid frozen ground and other solid formations which might be adversely affected by the presence of fluid in the annulus during drilling. The seal apparatus may also serve as a stabilizer during drilling, particularly when seal means are disposed at longitudinally spaced points on the assembly.

7 Claims, 4 Drawing Figures



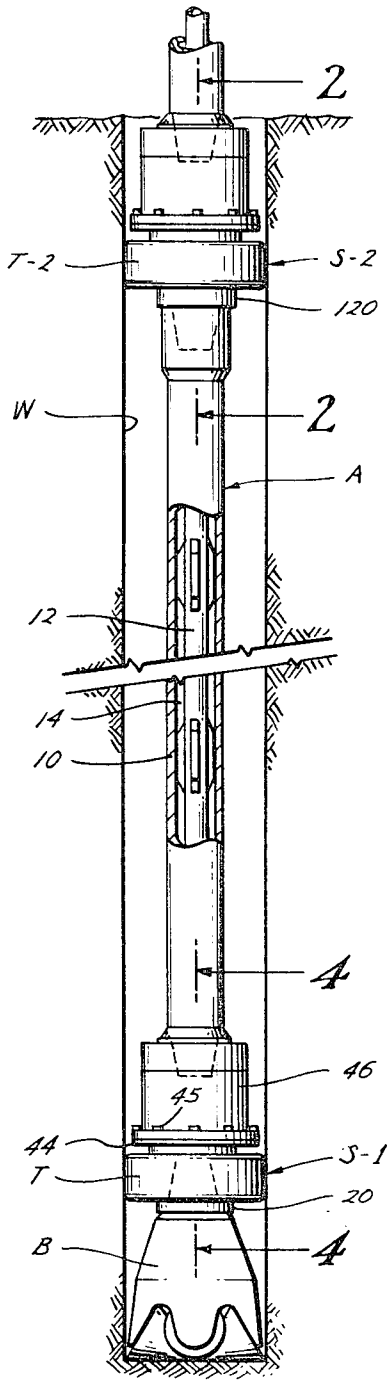


Fig. 1

Fig. 3

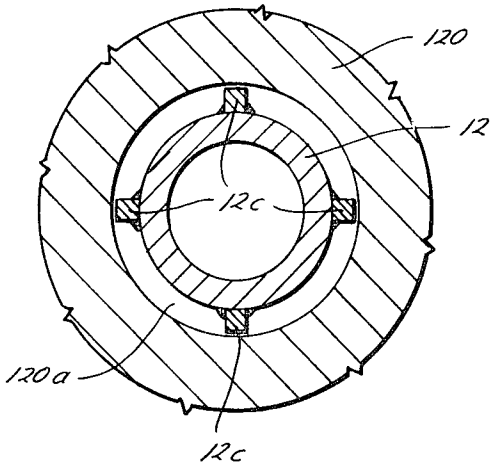


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Fig. 2

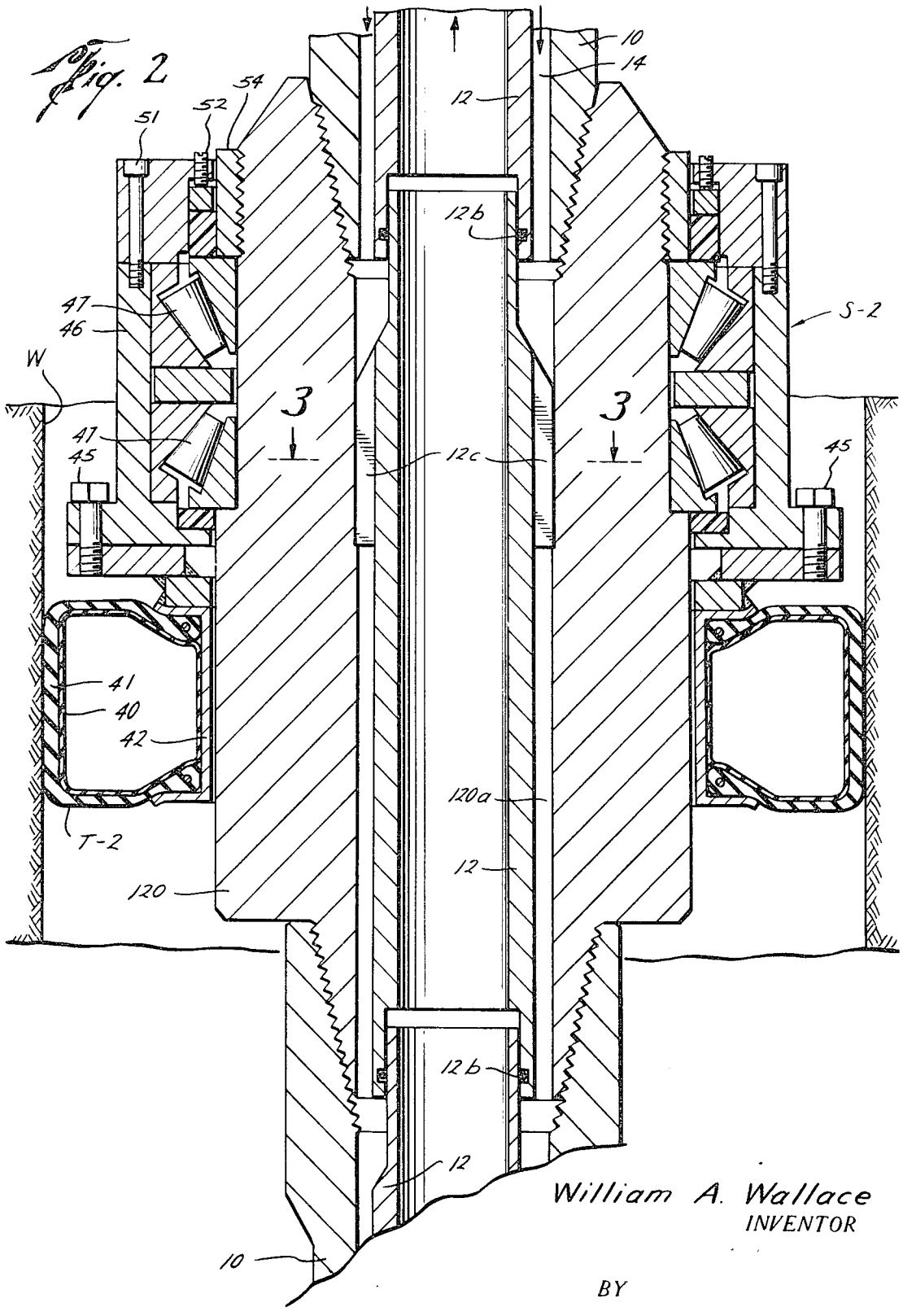

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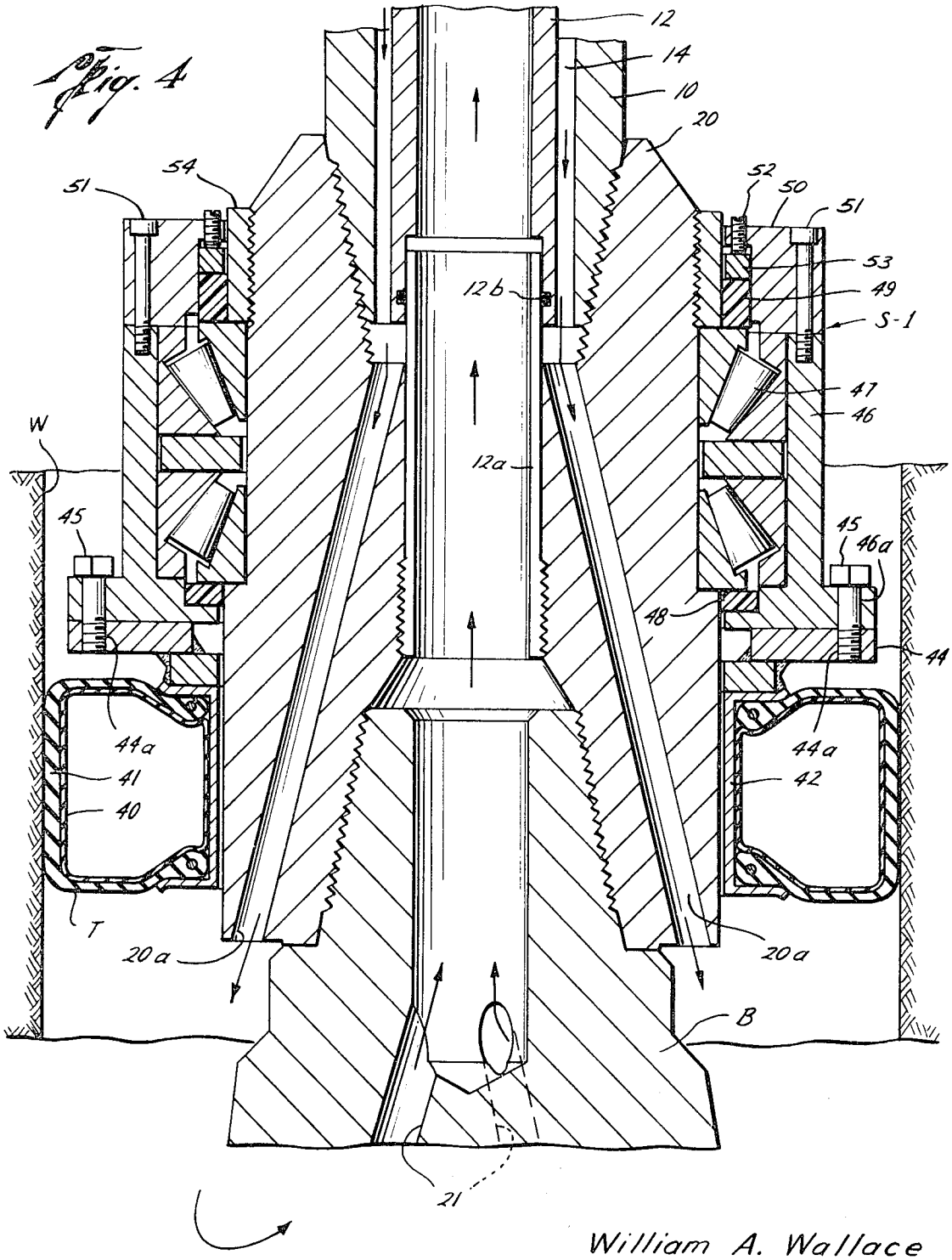
Fig. 4



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WELL BORE SEAL APPARATUS FOR CLOSED FLUID CIRCULATION ASSEMBLY

BACKGROUND OF THE INVENTION

The field of this invention is well apparatus for closed fluid circulation.

In drilling in Alaska, and other areas where there is a permafrost, solid frozen ground, or similar soil condition, conventional drilling techniques and apparatus are difficult, and sometimes impossible, to use. For example, because of the subfreezing temperatures, drilling mud employing water as a constituent is unsatisfactory since the water freezes. Cool air has been used, but when it circulates, it creates friction heat which thaws the permafrost or frozen ground, causing it to slid off and fall into the well bore.

Prior closed fluid circulation apparatus, such as disclosed in U.S. Pat. No. 3,208,539, has also been unsatisfactory because it requires static fluid such as drilling mud in the annulus between the open hole or well bore and the apparatus, and such static fluid is likewise subject to freezing.

SUMMARY OF THE INVENTION

The present invention relates to a seal apparatus for sealing off a well bore during drilling so as permit closed fluid circulation without introducing or circulating drilling mud, air or other fluid in the annulus between the wall of the well bore and the closed fluid circulation apparatus, whereby drilling may be satisfactorily accomplished in permafrost, solid frozen ground, or other solid formations which are not normally subject to collapse or cave-ins.

In its specific form, the invention includes a flexible ring, such as an air inflated automobile or vehicle tire, which is adapted to flexibly engage the wall of the well bore to form a seal therewith. Such seal is located near the lower end of a closed fluid circulation assembly and above the drill bit to confine the circulation fluid below such seal. One or more additional seal means are located on the assembly to stabilize the assembly as it is lowered during drilling and to provide supplementary seals should the lowermost seal leak or fail.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevation, partly in section, of the preferred form of the apparatus of this invention, shown in a well bore;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1 and illustrates the seal means of this invention disposed at the upper or intermediate elevation with respect to the closed fluid circulation assembly;

FIG. 3 is a cross-sectional view taken on line 3—3 to illustrate more in detail the structure of FIG. 2; and

FIG. 4 is a sectional view taken on line 4—4 of FIG. 1 to illustrate the details of the lower means which is disposed in proximity to the drill bit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, the letter A designates generally the closed fluid circulation assembly which includes an outer drill pipe **10**, and an inner tube **12**. A first seal means S–1 is mounted on the assembly A above, and preferably in close proximity to, a drill bit B which is secured to the lower end of the assembly A. A second seal means S–2 is disposed on the assembly A at a point longitudinally spaced above the seal means S–1. Such second seal means S–2 is representative of one or more seal means disposed above the lower seal means S–1, which additional seal means may be spaced longitudinally throughout the length of the assembly A from the upper end of the well bore W downwardly along the assembly A. The upper seal means, above the seal means S–1, serve to stabilize and centralize the assembly A, and to also provide a second or supplementary seal in the event the first seal means S–1 fails or leaks to some extent.

Considering the invention more in detail, the assembly A is of the type illustrated in U.S. Pat. No. 3,208,539, or any other suitable construction wherein the inner pipe **12** is mounted concentrically within the outer pipe **10** so that a fluid passage **14**, preferably annular, is disposed between the inner pipe **12** and the outer pipe **10**. As best seen in FIG. **4**, the lowermost part of the outer pipe **10** is threaded or is otherwise secured to an adapter sub **20** which preferably has a plurality of fluid passages or ports **20***a* for the flow of fluid to or from the annular passage **14**. As illustrated in FIG. **4**, the arrows show the normal direction of fluid flow, which is downwardly through the annular passage **14** from the surface to the discharge at the ends of the ports or passages **20***a* into the vicinity of the drill bit B. The bit B is of any conventional construction and it is threaded or is otherwise secured to the lower end of the adapter sub **20** (FIG. **4**). Suitable bit holes **21** permit a fluid return or circulation from the area of the bit B in the well bore W upwardly into the interior of the inner pipe or tube **12**. Thus, the fluid is circulated downwardly through the outer passage **14** and is returned upwardly through the bore of the inner tubes **12** to the upper end thereof at the surface of the well.

Although various ways of mounting the inner tube **12** may be utilized, one manner of mounting same is illustrated in FIG. **4**, wherein a fixed inner tube **12***a* is threaded into the bore of the sub **20** above the bit B. A plurality of pipes or sections are interfitted with each other to form the complete inner tube **12** for the full length of the assembly A as best seen by a comparison of FIGS. **1**, **2** and **4**. At each interfitting joint between sections of the inner tube **12**, an O-ring seal **12***b* or other suitable sealing means is provided. Longitudinally extending ribs or spacers **12***c* (FIGS. **2** and **3**) are provided on the sections of the inner tube **12** to maintain same spaced from the wall of the bore of the outer pipe **10**, and from the wall of the bore of any additional adapter subs such as the sub **120** (FIG. **2**).

The seal means S–1 (FIG. **4**) includes a resilient ring such as a vehicle tire T for an automobile or other vehicle. An inner-tube **40** is shown as disposed within the casing **41** of the tire T in the known manner, and such tire T is suitably mounted upon a hub **42** which is circular and which has a substantially U-shaped cross section. The tire T is inflated with air or other suitable inflating medium so as to be yieldable and to provide sealing and gripping engagement by the tire tread with the interior wall of the well bore W, while also permitting the tire T to slide longitudinally downwardly as the drilling progresses with the drill bit B. As will be explained, the tire T is mounted so that it does not rotate during the rotation of the drill bit B and the adapter sub **20** therewith.

An annular support ring **44** is welded to the hub **42** with an intermediate spacer ring **43** therebetween. The support ring **44** has a plurality of bolt holes **44***a* for receiving a plurality of bolts **45** which extend downwardly through suitable bolt holes **46***a* in a housing **46**. A pair of bearings **47** are disposed inwardly of the housing **46** to permit relative rotation of the mounting body or sub **20** relative to the housing **46** and the tire T. Suitable resilient seals **48** and **49** are disposed below and above the bearings **47**, and they are suitably retained in sealing position by a retainer cap **50** having a plurality of retaining bolts **51** therewith. A setscrew **52** engages an annular metal ring **53** in the cap **50** so as to adjust the sealing action of the sealing element **49** as desired. The seal rings **48** and **49** may be made of Teflon or any other suitable plastic or sealing material. A lock ring **54** is disposed on the sub **20** and it engages the upper part of the uppermost bearing **47** for holding the bearings **47** in position on the sub **20**.

To accommodate well bores of different diameters, the tire T may be made of different external diameters, and the different diameters of tires T may be mounted upon the same apparatus illustrated in FIG. **4**. Such changes in diameters of the tire T may be readily effected by providing an increased diameter hub **42** which is then welded outwardly to support plate **44** with a suitably spaced spacer ring **43**. It will thus be appreciated that the spacer ring **43** can be positioned at the outer extremity of the support plate **44** so that the increase in the diameter of the tire T may be similarly increased. Also,

some variation may be provided by the amount of inflation of the tire T.

Referring now to FIG. 2, wherein the upper seal means S–2 is illustrated, it can be seen that the seal means S–2 is essentially a duplicate of the seal means S–1, and therefore like parts bear the same numeral and/or letter designations in both FIGS. 2 and 4. The mounting sub 120 is modified in FIG. 2 as compared to the sub 20 since the flow of circulating drilling fluid occurs through an annular passage 120*a* provided externally of the inner tube 12 (FIG. 2). The tire in FIG. 2 has been designated T–2 to distinguish same from the tire T in FIG. 4, but they are preferably of the same construction.

As previously explained, the seal means S–2 is representative of one or more of the upper and intermediate seal means provided with the assembly A throughout the length thereof.

In the operation or use of the apparatus of this invention, the seal means S–1 is disposed at the lower end of the closed fluid circulation assembly A as shown in FIG. 1, and it is lowered into the well bore W so as to seal off the portion of the well bore W thereabove. The tire T engages the wall of the well bore W and slides downwardly along same as the drill bit B rotates and drills downwardly. The tire T does not itself rotate because its annular tread frictionally engages the well bore wall to prevent rotation of the structure upon which the tire T is mounted, as heretofore described. Since the fluid which is used for drilling is confined within the circulation assembly A, except in the vicinity of the drill bit B, there is no breakdown in the wall of the well bore W, even though the drilling is through permafrost, hard frozen ground or other similar soils and formations.

At suitably spaced intervals, the second and other seal means such as represented by the second seal means S–2 is positioned so as to serve to centralize and stabilize the assembly A during the drilling. As each additional seal means is added to the assembly A, it moves downwardly and becomes an intermediate seal means so that the additional seal means are spaced longitudinally throughout the length of the assembly A. Should a leak develop at the lowermost seal means S–1, the next seal means thereabove will prevent the fluid from moving upwardly and will thus assist in maintaining the well bore W stabilized and free from the effects of heated air or drilling fluid which might freeze or otherwise harden.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

I claim:

1. Seal apparatus for a closed fluid circulation assembly, comprising:

an outer drill pipe having a first tubular sub therewith;

an inner pipe disposed substantially concentrically within said outer pipe to provide a longitudinal flow passage between said inner pipe and said outer pipe;

a first inflated vehicle tire having an annular external tire tread mounted on said first tubular sub; and

a rotatable mounting means for mounting said tire on said tubular sub for rotation of said sub relative to said tire when said tire is prevented from rotating due to its frictional engagement with the wall of the well bore.

2. The apparatus set forth in claim 1, wherein:

said first tubular sub is disposed above and in close proximity to the bottom of the well bore; and

said sub has a fluid passage for circulating fluid relative to the bottom of the well bore.

3. The apparatus set forth in claim 1, including:

a second inflated vehicle tire disposed above said first inflated vehicle tire and longitudinally spaced therefrom;

a second tubular sub connected in said outer drill pipe; and

mounting means for mounting said second tire on said second tubular sub for rotation of said second sub relative to said second tire when said second tire is prevented from rotating due to its engagement with the wall of the well bore.

4. The structure set forth in claim 1, wherein:

said mounting means has a removable tire hub therewith for substituting tire hubs of different diameters for thereby accommodating tires of different diameters for use in well bores of different diameters.

5. The structure set forth in claim 4, wherein:

said mounting means prevents substantial longitudinal movement of said tire relative to said sub to thereby cause said tire to move downwardly in the well while maintaining the seal with the wall of the well bore as drilling progresses.

6. The structure set forth in claim 4, wherein:

said mounting means includes means for removably mounting said removable tire hub on said tubular sub.

7. Seal apparatus for a closed fluid circulation assembly, comprising:

an outer drill pipe having a plurality of longitudinally spaced tubular subs therewith;

an inner pipe disposed substantially concentrically within said outer pipe to provide a longitudinal flow passage between said inner pipe and said outer pipe;

a plurality of inflated vehicle tires, each having an annular external tire tread mounted on said plurality of tubular subs; and

rotatable mounting means for mounting one of said tires on each of said tubular subs for rotation of said subs relative to said tires when said tires are prevented from rotating due to their frictional engagement with the wall of the well bore.

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