

Sept. 3, 1957

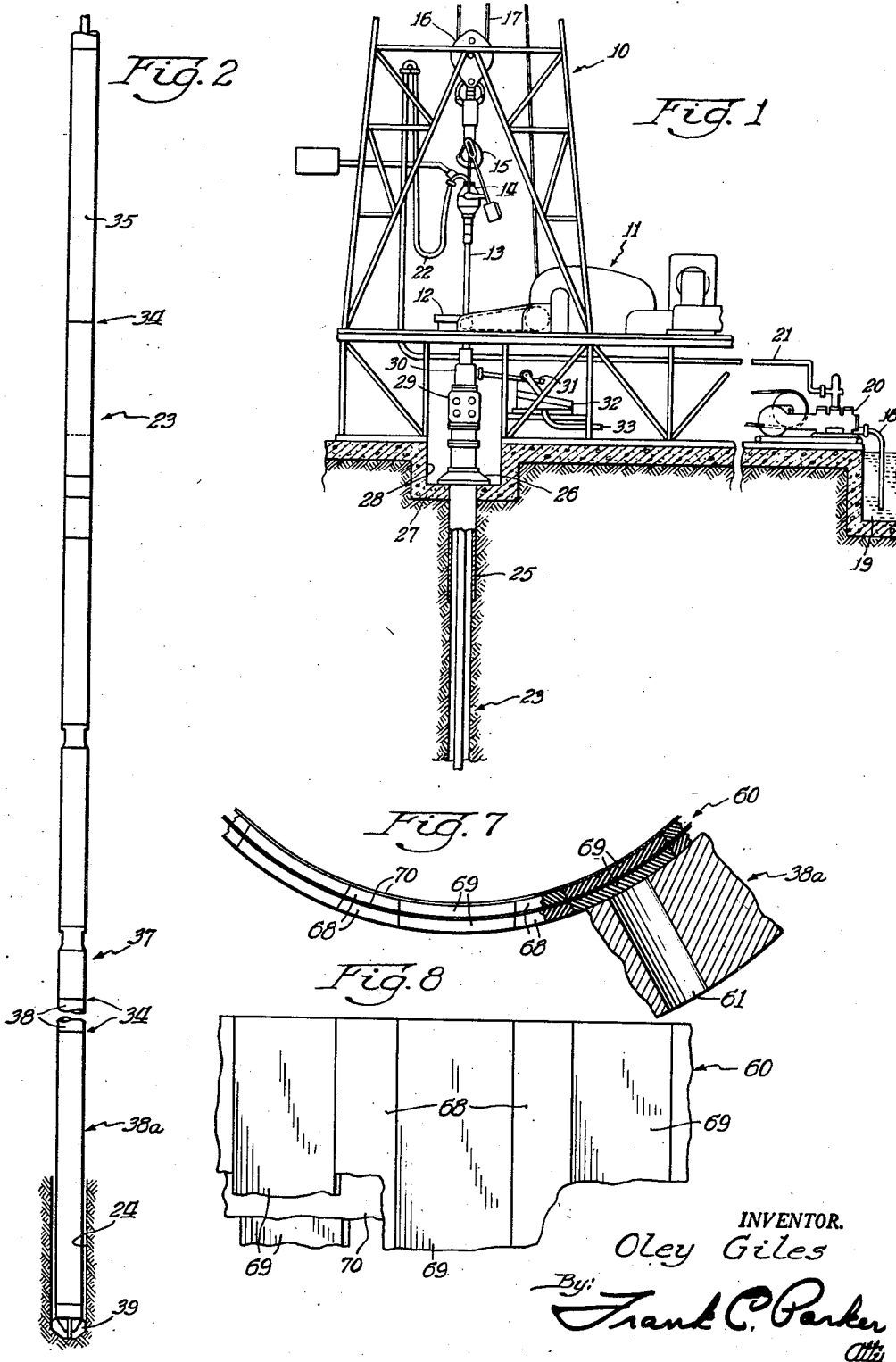
O. GILES

2,805,044

EARTH BORING APPARATUS

Filed Nov. 22, 1954

3 Sheets-Sheet 1



Sept. 3, 1957

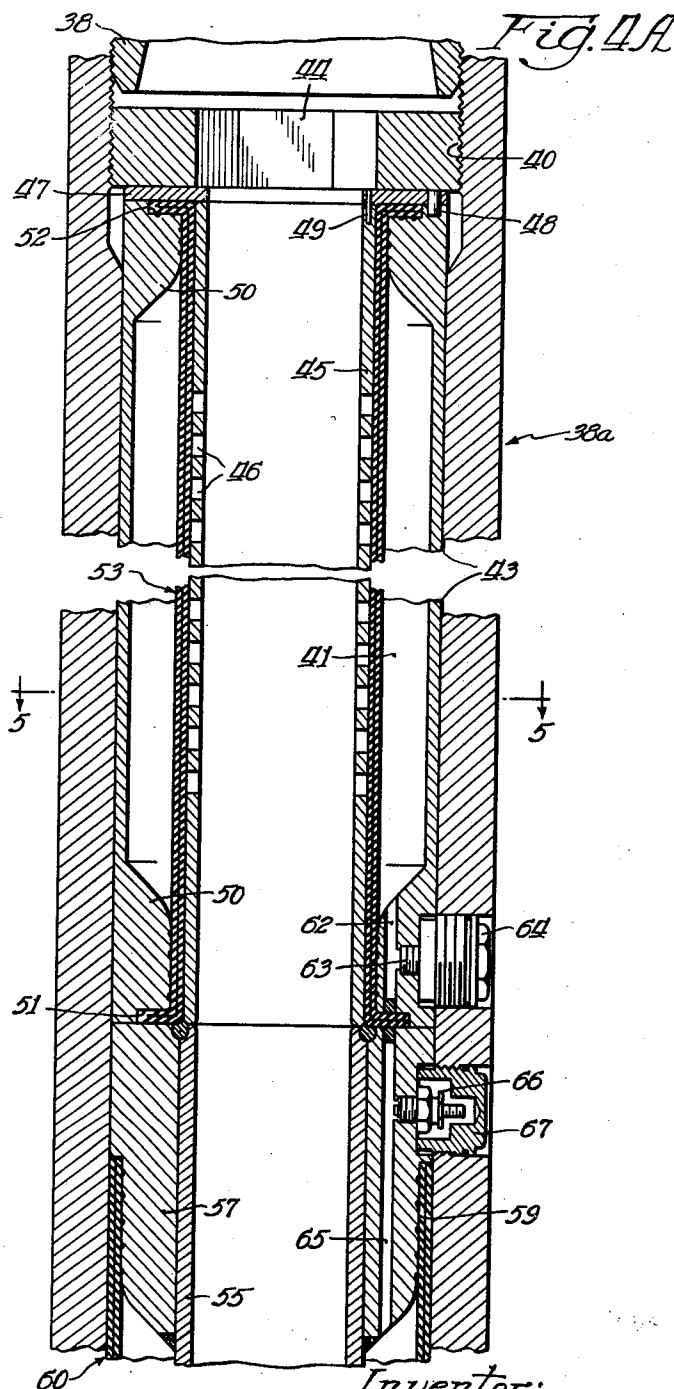
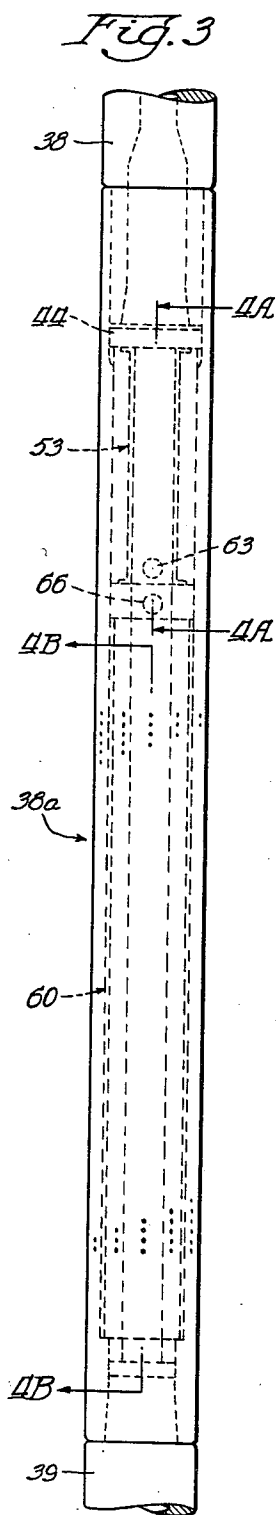
O. GILES

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Inventor:
Oley Giles
By: *Frank C. Parker*
Att.

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O. GILES

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Fig. 5

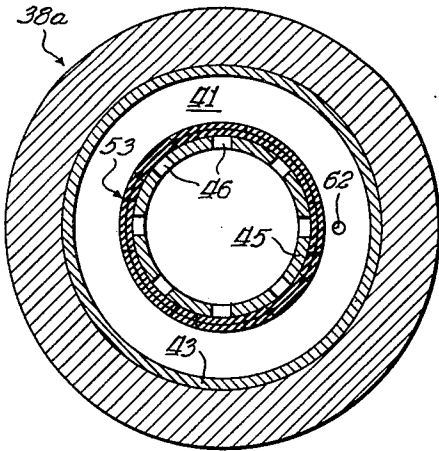


Fig. 6

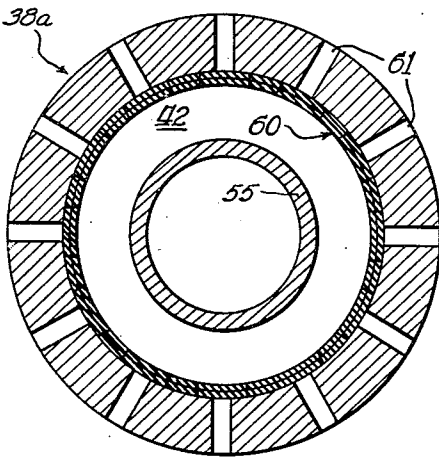
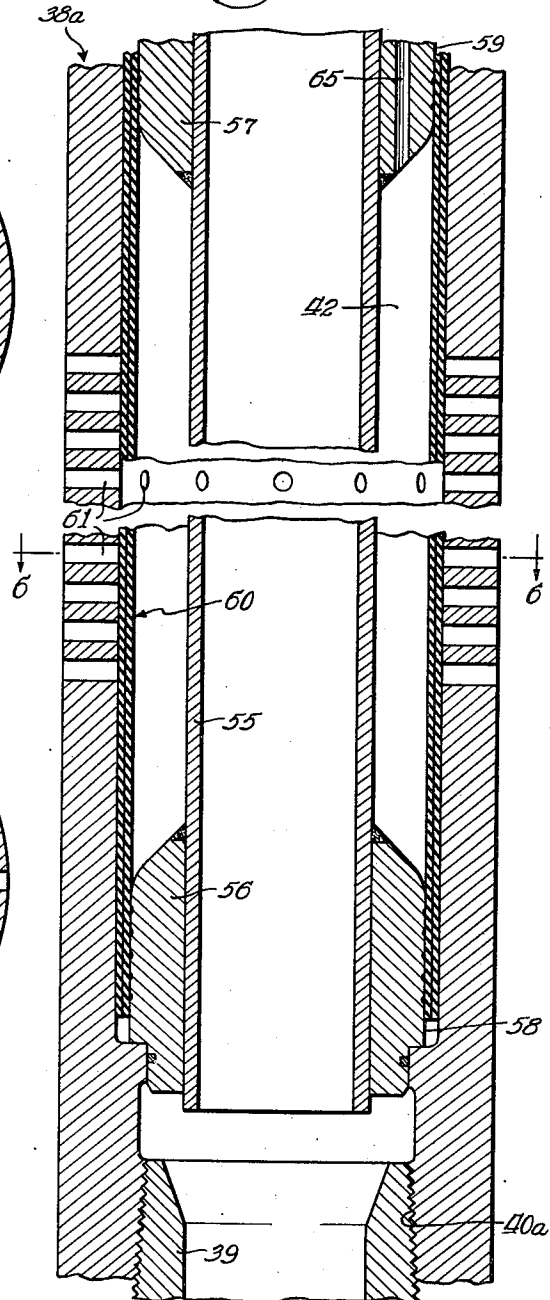


Fig. 4B



Inventor:
Oley Giles
By: *Frank C. Parker*
Att.

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2,805,044

EARTH BORING APPARATUS

Oley Giles, Glendale, Calif., assignor to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

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3 Claims. (Cl. 255—28)

The present invention relates in general to earth bore drilling apparatus and more particularly to an earth boring drill of the type employing a vertically reciprocating drill rod and bit which vibrates at a frequency substantially equal to the resonant vibration frequency of the rod and bit.

More particularly, the present invention is intended to provide an auxiliary device adapted to be utilized in conjunction with earth bore drilling apparatus of the general type disclosed in the patent to A. G. Bodine, 2,554,005.

In earth boring apparatus of the type disclosed in the aforementioned Bodine patent, suitable vibration generating mechanism is utilized for generating sonic vibrations in the drill rod and bit in order to provide the necessary force to effect the drilling operation. In such drilling devices, the vibrating bit is maintained in engagement with the bottom of the well hole and the formation immediately adjacent to the bit is shattered either due to vibrations imparted thereto by the bit itself or due to the percussive action of the bit on the formation. In a drill of this type the bit reciprocates or vibrates vertically at very nearly the resonant frequency of the massive drill rod and bit and the amplitude of the vibrating bit is of the order of three sixteenths to approximately one-half inch.

As is customary in oil well drilling operations, a suitable mud fluid is pumped into the well hole downwardly through the drill string and drill rod, with the mud fluid emerging from the bottom of the drill rod being forced out of the well hole upwardly around the drill rod and drill string inside of the well hole. As the mud fluid rises in the well hole in this manner it takes with it the formation fragments which have been broken up by the bit. When the well hole reaches a depth of several thousand feet, the hydrostatic pressure existing at the bottom of the well hole, due to the long column of mud fluid, is considerable and is of the order of several thousand pounds per square inch. Further, the mud fluid is substantially incompressible. Due to this fact, without some means being provided for acoustically disconnecting or decoupling the mud fluid from the drill rod and bit, substantially all of the energy which is put into the drill rod and bit by the vibratory mechanism is consumed by the pressure surges of the mud fluid in the well hole resulting from sound waves generated in the mud fluid at the bottom of the well hole by the vibrating drill rod and bit.

The present invention has for its principal object to provide an effective means for acoustically disconnecting or decoupling a sonically or an acoustically vibrating drill rod and bit, disposed in a well hole with the bit in substantial engagement with the bottom of the well hole, from the column of mud fluid in the well hole utilized for the purpose of flushing or washing out the chips and fragments of the formation at the bottom of the well hole which are loosened or broken up by the vibrating bit.

More specifically, the principal object of the present invention is to provide an improved form of acoustic or sonic decoupler cell of the general type disclosed in the

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copending application of J. P. Selberg and G. D. Currie, Ser. No. 360,706, filed June 10, 1953, which issued as Patent No. 2,771,270 on November 20, 1956.

A more particular object of the present invention is to provide a decoupler cell of the type mentioned in the immediately preceding paragraph wherein the compressible chamber comprises a flexible membrane disposed within an apertured enclosing casing in order to admit the mud fluid against the flexible membrane so as to permit the compressible chamber to absorb the pressure surges of mud fluid resulting from sound waves generated therein by the vibratory drill rod and bit. In further particularity the flexible membrane comprises a flexible rubber member having hard rubber inserts therein disposed opposite the apertures in the enclosing casing for preventing extrusion of the membrane through the casing apertures when the pressure within the chamber exceeds the pressure outside the chamber.

Numerous other objects and advantages of the present invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings wherein:

Fig. 1 is a view showing an earth bore drilling derrick for supporting the drilling apparatus of the present invention within a well bore;

Fig. 2 is a view showing the lower end of a drilling string supported by the derrick of Fig. 1 and having a decoupler cell of the type disclosed herein included as an integral part of the drill string;

Fig. 3 is a view showing the general features of the decoupler cell comprising the subject matter of the present invention;

Figs. 4A and 4B comprise detailed sectional views showing the decoupler cell of Fig. 3 on an enlarged scale;

Fig. 5 is a detailed sectional view taken substantially along the line 5—5 in Fig. 4A and looking in the direction of the arrows;

Fig. 6 is a sectional view taken substantially along the line 6—6 in Fig. 4B and looking in the direction of the arrows;

Fig. 7 is an enlarged fragmentary sectional view showing the flexible decoupler sleeve in greater detail; and

Fig. 8 is a fragmentary plan view illustrating the decoupler cell flexible sleeve shown in Fig. 7.

Referring now to the drawings, wherein like reference numerals in the different views identify identical parts, and with particular reference to Figs. 1 and 2, the equipment disposed on the surface above the well hole will first be described. This equipment is conventional and includes a derrick 10, draw works 11, driving rotary table 12, kelly 13 extending through table 12, swivel 14 coupled to the upper end of the fluid passage through kelly 13, and hook 15 supporting the bail of swivel 14. The hook 15 is suspended through a travelling block 16 and cable 17 from the top of the derrick 10, and the cable 17 is wound on the usual hoisting drum of the draw works 11. Mud fluid, such as is conventionally employed in rotary oil well drilling operations, is pumped through a supply pipe 18 from a supply tank or sump 19 and is delivered under pressure by a pump 20 through a pipe 21 and hose 22 to the goose neck of swivel 14, and from this point the mud fluid flows down through the kelly 13 and through a drill pipe string 23 coupled to the lower end of the kelly 13.

The kelly 13 and the drill string 23 extend into a bore hole 24 which extends downwardly into the earth. The bore hole 24 is lined for a suitable distance down from the ground surface by surface casing 25 which is supported by a landing flange 26 resting on a concrete footing 27 in the bottom of a pit 28. A blow-out preventer 29 is mounted at the head of the casing 25 and a riser 30 above the blow-out preventer 29 is provided with a

mud flow line 31. The mud flow line or delivery pipe 31 is shown as discharging to a conventional vibratory mud screen 32, and the mud is led from the latter back to the sump 19 by means of a pipe line 33.

The drill pipe string 23 coupled at the lower end of the kelly 13 comprises a conventional drill pipe string and it will be understood that this pipe string is made up of a number of usual drill pipe lengths 35 coupled together by the usual tool joints as indicated at 34.

The drill pipe string 23 also includes suitable driving motor means and a vibration generator assembly (not shown) of the type disclosed in the aforementioned patent to Bodine 2,554,005. It will suffice to state herein that the motor and vibrator are capable of vibrating the drill rod and bit below at a frequency approximately equal to the resonant vibration frequency of the drill rod and bit. For further description of the motor and vibrator, reference should be had to the aforementioned Bodine patent.

At some point below the motor and vibrator assembly, the drill pipe string 23 includes a massive elongated elastic longitudinally vibratory drill rod 37. The longitudinally vibratory drill rod 37 is of substantial mass and length and it is contemplated that it will be made up of a plurality of steel drill collars 38, which are connected together by means of conventional tool joints 34. It is contemplated that one of the drill collars 38a will be provided with an acoustic or sonic decoupler cell comprising the subject matter of the present invention and described in detail in connection with Figs. 3-6. At the bottom of the drill rod 37, a bit 39 is provided, which may be of any well-known type. The bit 39 is of conventional construction and detailed description thereof in the present case is not deemed necessary in order to understand the present invention.

The decoupler cell disposed in the drill collar 38a and comprising the subject matter of the present invention shown in Figs. 3-6 will be described.

The drill collar 38a is internally threaded, as indicated at 40, for the purpose of engaging corresponding external threads on the next drill collar section 38 above. It will be noted that the drill collar 38a is also provided with internal threads 40a at its lower end for providing means for connecting the next lower drill collar 38 thereto.

The decoupler cell mounted within the drill collar 38a comprises an upper chamber 41 and a lower chamber 42. The upper chamber 41 is formed within a cylindrical sleeve 43 which fits snugly within the drill collar 38a and which is prevented from moving upwardly within the drill collar 38a by means of an internal nut 44 threaded into the upper threaded region 40 on the drill collar 38a. Mounted concentrically within the sleeve 43 is an internal sleeve 45 formed with a plurality of perforations or apertures 46 therein. Both of the sleeves 43 and 45 abut a disc 47 disposed against the nut 44 and suitable pins 48 and 49 hold the sleeves 43 and 45 from rotation. The external sleeve 43 is formed at each end with a radially inwardly projecting shoulder 50, with the shoulders respectively being cut away, as indicated at 51 and 52. A flexible rubber membrane 53 is positioned between the shoulders 50 on the external sleeve 43 and the inner sleeve 45, the rubber membrane 53 being adapted to fit snugly between the two sleeves so as to effect a seal between the external sleeve 43 and the rubber membrane 53.

The lower chamber 42 of the decoupler cell is formed by an internal sleeve 55 having annular members 56 and 57 welded thereto. The annular members 56 and 57 are cut away, as indicated at 58 and 59 respectively, in order to receive a flexible rubber membrane 60 between the annular members 57 and 58 and the drill collar 38a. The membrane 60 fits snugly between the annular members 57 and 58 and the drill collar 38a so as to provide the sealed chamber 42. A plurality of perforations or apertures 61 are formed in the drill collar 38a adjacent the flexible membrane 60.

Suitable means are provided for filling each of the decoupler cell chambers 41 or 42 with any desired gas under pressure. This means will now be described. The shoulder 50 is drilled as indicated at 62 to provide a passageway for admitting the gas into the chamber 41 and the passageway 62 communicates with a valve 63 having a fluid-tight closure cap 64 threaded into a suitable opening in the drill collar 38a for insuring that the chamber 41 will be sealed.

The annular member 57 is drilled as indicated at 65 to provide a passageway for admitting gas into the chamber 42 by means of a valve 66 adapted to be closed by a cap 67 threaded into an opening in the drill collar 38a.

In the operation of the decoupler comprising the subject matter of the present invention, the drill collar section 38a is lowered into earth bore 24 and, as will be apparent, the pressure of the mud fluid pumped into the earth bore 24 through the drill string 23 increases with increasing depths of the bore 24. Therefore, the chambers 41 and 42 are filled with a gas under a pressure substantially equal to or slightly greater than the pressure of the mud fluid at the depth at which the decoupler cell is to operate. Thus, when pressure surges are created in the mud fluid due to the vibratory drill rod 37, the surging mud fluid may communicate with the rubber membranes 53 and 55 through the apertures 46 and 61 respectively. The flexible chambers 41 and 42 are therefore effective to dampen the pressure surges which are created in the mud fluid at the bottom of the well hole.

It will be apparent that as the decoupler cell is withdrawn from the earth bore hole or while it is being inserted therein, there is a substantially greater pressure existing within the chambers 41 and 42 than exists in the area around the chambers. As a result, there is a tendency for the increased pressure of the gas within the chambers 41 and 42 to urge the flexible membranes against the apertured sleeves respectively and this tends to cause extrusion of the flexible membrane through the apertures 46 and 61. The present invention discloses means for minimizing this tendency for the flexible membranes to be extruded through the decoupler cell apertured sleeves.

Referring to Figs. 7 and 8, the rubber membrane 60 is disclosed in greater detail. This membrane comprises alternate strips of relatively soft flexible material indicated by reference numeral 68 and relatively hard strips of rubber 69 designed to be disposed opposite the apertures in the enclosing casing for the decoupler cell. The hard rubber strips 69 are more resistant to extrusion through the openings in the enclosing casing for the decoupler cell while the relatively soft rubber strips 68 provide the necessary flexibility for the membrane 60. In the specific form disclosed, very thin bonding sleeves 70 are provided with the strips 68 and 69 alternately disposed between two of the bonding sleeves 70 and with a second group of the strips 68 and 69 being bonded on the other side of one of the bonding sleeves 70. This merely represents one manner in which the sleeve 60 could be formed. In one specific application it has been found that the bonding sleeves 70 may be made of a strong flexible material, known commercially as butyl while the soft flexible strips 68 may be made up of a rubber known commercially as Buna-N and the hard strips 69 may be made of a relatively harder rubber known commercially as SGO.

The important feature of the present invention is that the sleeves 60 be provided with alternate longitudinally extending strips of relatively soft and hard flexible material so that the hard strips may be disposed opposite the openings in the decoupler cell sleeve so as to prevent extrusion of the sleeve through the openings when the pressure within the cavity or chambers exceed the external pressure.

It will be understood that both flexible sleeves 53 and 60 will be constructed in the manner shown in Figs. 7 and

8 so that the desirable features disclosed herein will be present in each of the flexible sleeves.

It is contemplated that numerous changes and modification may be made in the present invention without departing from the spirit or scope thereof.

What is claimed is:

1. Sonic decoupling means adapted to absorb energy consuming pressure surges of mud fluid in a well hole in the earth caused by sound waves generated by a longitudinally vibrating drill rod and bit, wherein the bit is disposed in contact with the bottom of the well hole and is vibrating at a frequency approximating the resonant vibration frequency of the rod and bit, and comprising a decoupler cell adapted to be securely mounted in concentric relation to said drill rod in a region thereof which is subject to said energy consuming pressure surges in the mud fluid, said decoupler cell including means defining a resilient compressible chamber adapted to be cyclically compressed at the vibration frequency of the rod and bit for thereby absorbing said pressure surges of the mud fluid caused by the sound waves generated by the vibrating rod and bit, an enclosing casing disposed around said compressible chamber and being formed with a plurality of apertures therein for admitting the mud fluid to the compressible chamber, and said compressible chamber comprising a flexible membrane having hard inserts therein disposed opposite said casing apertures for preventing extrusion of the membrane through said apertures when the pressure within the chamber exceeds that outside the chamber.

2. Sonic decoupling means adapted to absorb energy consuming pressure surges of mud fluid in a well hole in the earth caused by sound waves generated by a longitudinally vibrating drill rod and bit, wherein the bit is disposed in contact with the bottom of the well hole and is vibrating at a frequency approximating the resonant vibration frequency of the rod and bit, and comprising a decoupler cell adapted to be securely mounted in concentric relation to said drill rod in a region thereof which is subject to said energy consuming pressure surges in the mud fluid, said decoupler cell including means defining a resilient compressible chamber adapted to be cyclically compressed at the vibration frequency of the rod and bit for thereby absorbing said pressure surges of the mud fluid caused by the sound waves generated by the vibrating rod

and bit, an enclosing casing disposed around said compressible chamber and being formed with a plurality of rows of apertures therein for admitting the mud fluid to the compressible chamber, and said compressible chamber comprising a flexible membrane having elongated hard insert strips therein disposed opposite said rows of casing apertures for preventing extrusion of the membrane through said apertures when the pressure within the chamber exceeds that outside the chamber.

3. Sonic decoupling means adapted to absorb energy consuming pressure surges of mud fluid in a well hole in the earth caused by sound waves generated by a longitudinally vibrating drill rod and bit, wherein the bit is disposed in contact with the bottom of the well hole and is vibrating at a frequency approximating the resonant vibration frequency of the rod and bit, and comprising a decoupler cell adapted to be securely mounted in concentric relation to said drill rod in a region thereof which is subject to said energy consuming pressure surges in the mud fluid, said decoupler cell including means defining a resilient compressible chamber adapted to be cyclically compressed at the vibration frequency of the rod and bit for thereby absorbing said pressure surges of the mud fluid caused by the sound waves generated by the vibrating rod and bit, an enclosing casing disposed around said compressible chamber and being formed with a plurality of rows of apertures therein for admitting the mud fluid to the compressible chamber, and said compressible chamber comprising a flexible rubber membrane having relatively hard rubber insert strips therein disposed opposite said rows of casing apertures for preventing extrusion of the membrane through said apertures when the pressure within the chamber exceeds that outside the chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,345,475	Herman et al.	Mar. 28, 1944
2,359,147	Merten	Sept. 26, 1944
2,604,118	Greer	July 22, 1952
2,664,049	Coberly	Dec. 29, 1953

FOREIGN PATENTS

699,265	Great Britain	Nov. 4, 1953
707,812	Great Britain	Apr. 21, 1954