Nov. 20, 1956 J. P. SELBERG ET AL 2,771,270

EARTH BORING APPARATUS

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Fig. 1

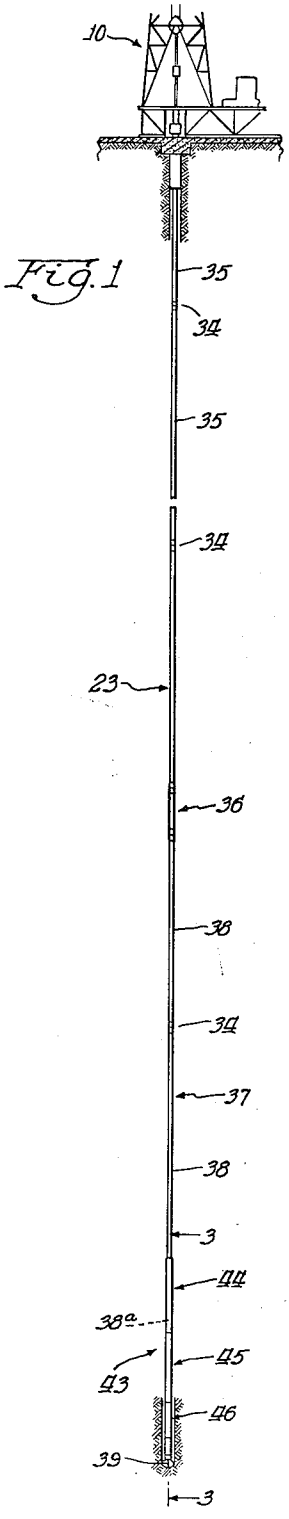
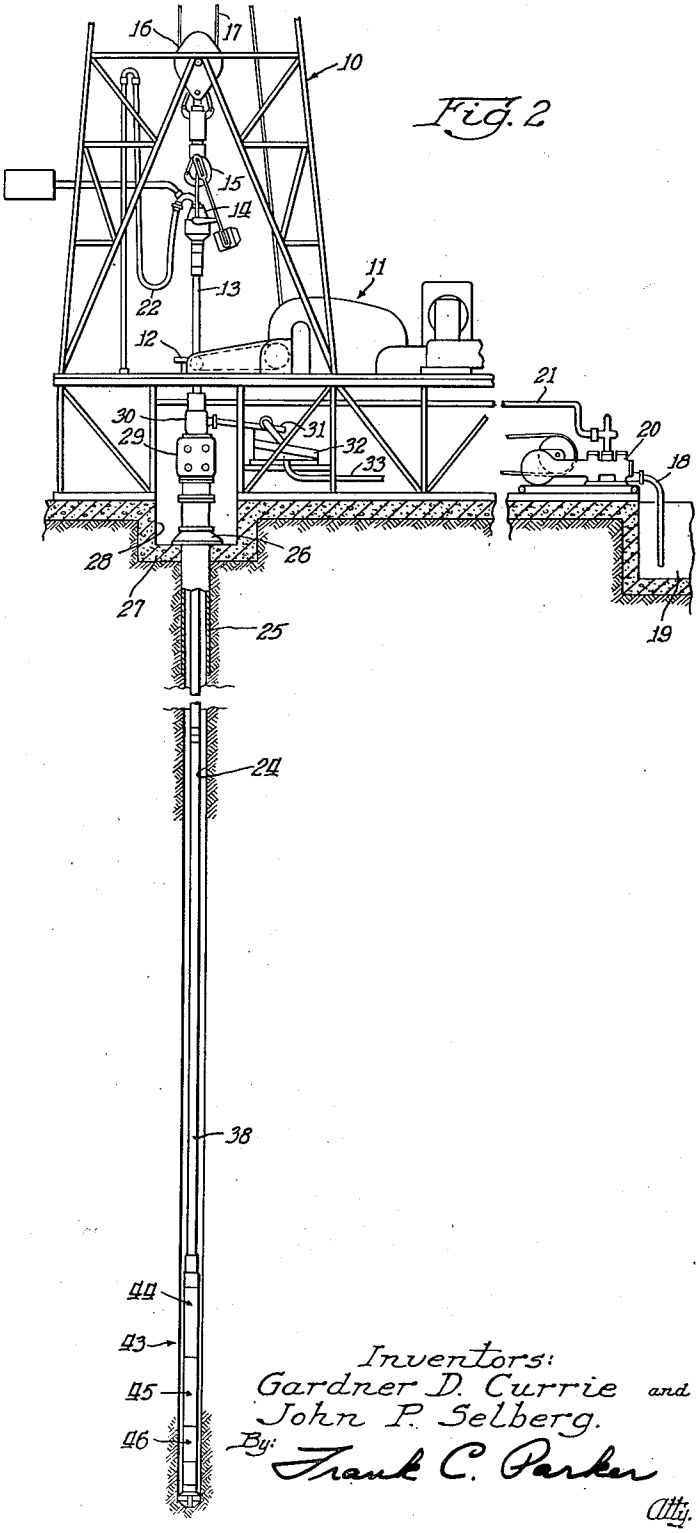


Fig. 2



Inventors:
Gardner D. Currie and
John P. Selberg.
By: Frank C. Parker
Atty.

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Fig. 3

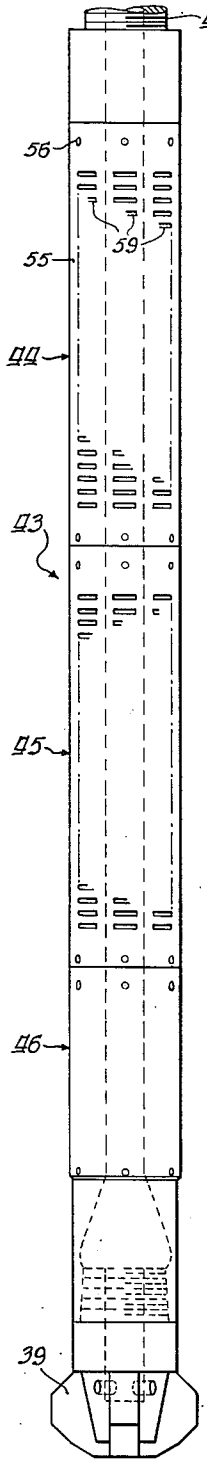


Fig. 4

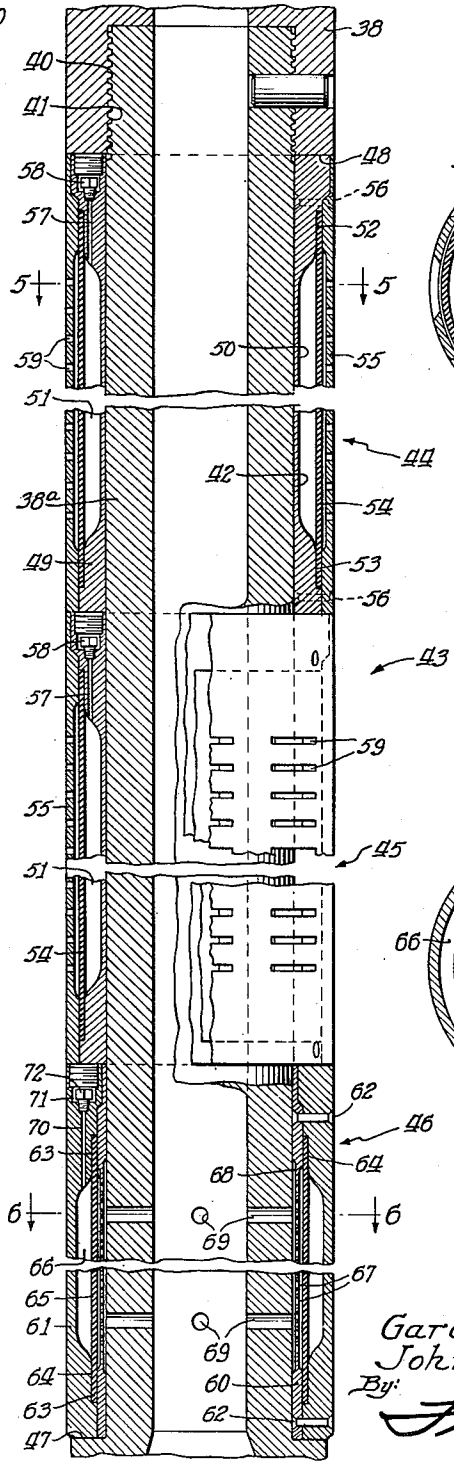


Fig. 5

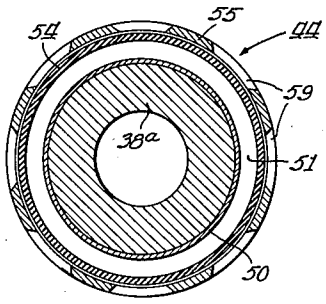
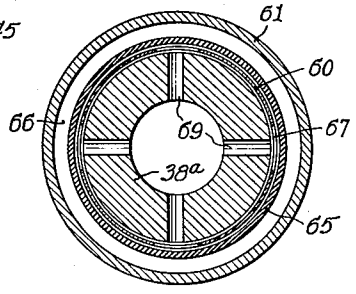


Fig. 6



Inventors:
Gardner D. Currie and
John P. Selberg.
By:
Frank C. Parker
Atty.

Nov. 20, 1956 J. P. SELBERG ET AL 2,771,270

EARTH BORING APPARATUS

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Fig. 7

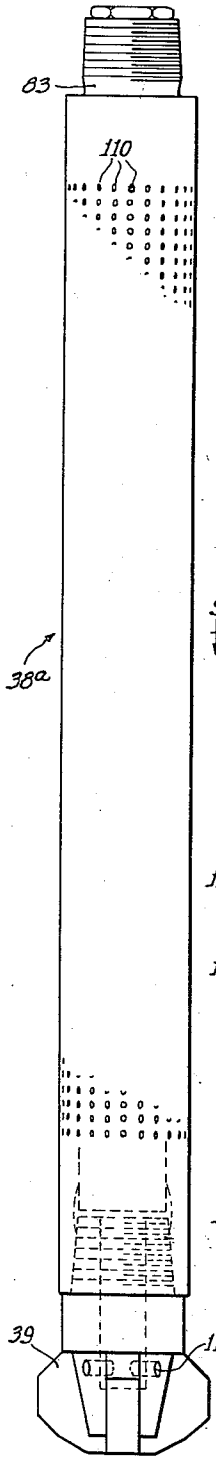


Fig. 8

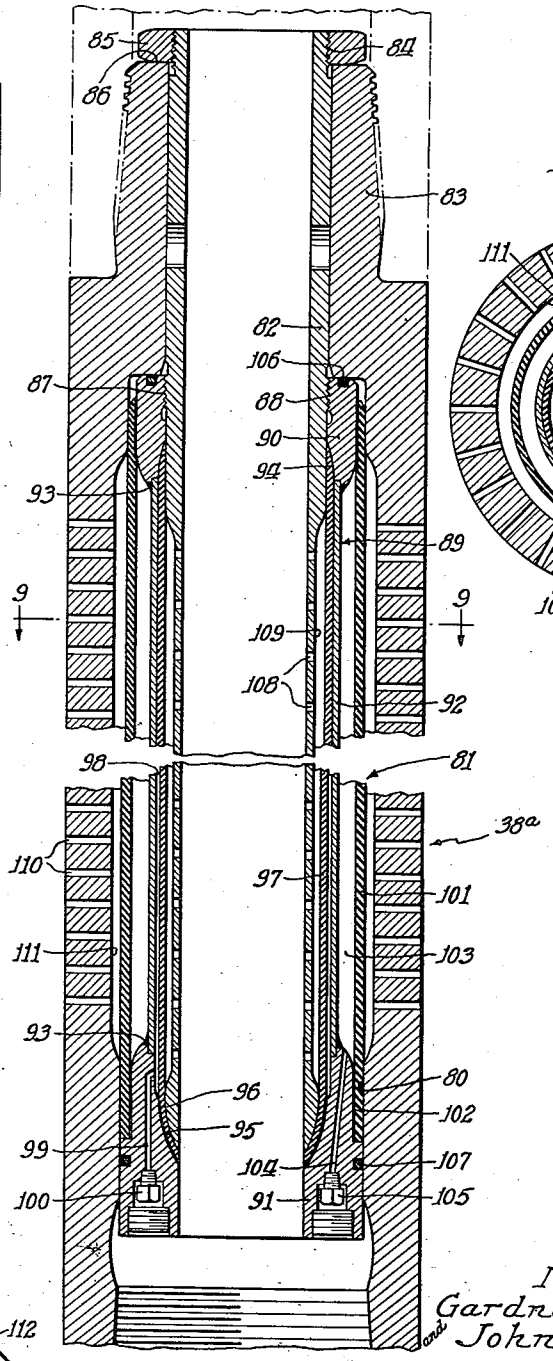
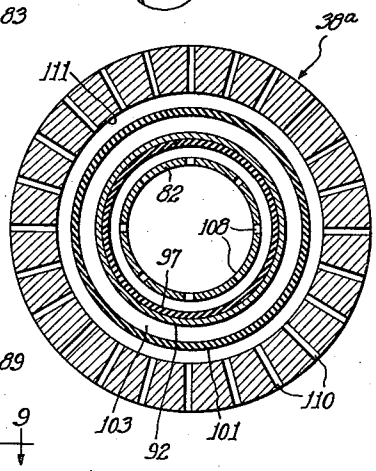


Fig. 9



Inventors:
Gardner D. Currie
and John P. Selberg
By: Frank C. Parker
Atty.

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2,771,270

EARTH BORING APPARATUS

John P. Selberg, Los Angeles, and Gardner D. Currie, Altadena, Calif., assignors to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

Application June 10, 1953, Serial No. 360,706

12 Claims. (Cl. 255—23)

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, an object of the present invention is to provide a compressible means adapted to be disposed in the well hole in the region where the mud fluid tends to cyclically surge as a result of sound waves generated in the mud fluid by the vibrating drill rod and bit.

A further object of the invention is to provide an acoustic or sonic decoupler cell adapted to be mounted concentrically with respect to a section of drill rod disposed near the bottom of the well hole for providing a compressible chamber capable of absorbing energy consuming pressure surges of mud fluid caused by sound waves generated in the mud fluid by the longitudinally vibrating drill rod and bit.

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 is disposed between two concentric walls, one of which together with a flexible membrane forms the compressible chamber and the other of which is apertured 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.

A further object of the invention is to provide a compact mud fluid decoupler cell adapted for use with sonic earth bore drilling apparatus, which decoupler cell is capable of being inserted in a cut-away portion of the drill rod in a region thereof which is subject to the pressure surges of the mud fluid.

In one embodiment of the present invention, the drill rod section disposed immediately above the drill bit is turned down on its outer periphery for receiving the decoupler cell therearound. In this embodiment of the invention, the decoupler cell is divided into a plurality of sections, some of which are acted upon by mud fluid from outside the drill rod and others of which are acted upon by mud fluid from within the drill rod.

In a second embodiment of the present invention, a pair of compressible chambers, each of which is filled with an inert gas, are disposed concentrically with respect to each other, the inner chamber being adapted to have the mud fluid from within the drill rod act thereon and the outer chamber being adapted to have the mud fluid from outside of the drill rod act thereon.

In each embodiment of the present invention, it is contemplated that the drill rod will be apertured in order to permit the mud fluid to be received against at least one of the compressible chambers so as to allow the chamber to absorb the pressure surges of mud fluid generated by sound waves in the mud fluid caused by the longitudinally vibrating drill rod and bit.

One of the advantages of the present invention lies in the fact that the decoupler cells disclosed herein are compact and each of the different forms thereof is designed to be received in a cut-away portion of the drill rod immediately above the vibrating bit. The decoupler cells themselves are substantially self-contained units which facilitates handling and assembly thereof in the drill rod.

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 the drilling apparatus of the present invention suspended in a well bore;

Fig. 2 is a view similar to Fig. 1 but drawn on an enlarged scale, showing a typical installation of the surface equipment and showing the drilling string down to and including the bit, with that portion of the drill rod including the decoupler cell also shown;

Fig. 3 is a view showing a drill rod section and bit at-

tached thereto having one form of the decoupler cell, which comprises the subject matter of the present invention, mounted therein;

Fig. 4 is a detailed sectional view showing the decoupler cell and drill rod section of Fig. 3 on an enlarged scale;

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

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

Fig. 7 is an elevational view of a second embodiment of the present invention;

Fig. 8 is an enlarged elevational sectional view of the drill rod section and decoupler cell disclosed in Fig. 7; and

Fig. 9 is a detailed sectional view taken substantially along the line 9—9 in Fig. 8 and looking in the direction of the arrows.

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 indicated generally by reference number **36**. The motor means and vibrator assembly **36** are of the type disclosed in the aforementioned patent to Bodine 2,554,005 and the details of operation and construction of the motor and vibrator will not be described in the present case. It will suffice to state herein that the motor and vibrator **36** 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 **36**, reference should be had to the aforementioned Bodine patent.

Immediately beneath the motor and vibrator assembly **36**, 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 the lowermost drill collar **38***a* 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. 3–9. Immediately beneath the lowermost drill collar **38***a*, which is provided with the decoupler cell, the drill string **23** is provided with any well-known type of bit **39**. 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 on the lower drill collar **38***a* and comprising the first embodiment of the present invention shown in Figs. 3–6 will first be described.

The lowermost drill collar **38***a*, as is clearly shown in Fig. 4, is externally threaded, as indicated at **40**, for the purpose of engaging internal threads **41** on the next drill collar section **38** above. It will be noted that the lowermost drill collar **38***a* may also be provided with internal threads at its lower end for providing means for connecting the bit **39** thereto.

In order to provide mounting means for the decoupler cell, the drill collar **38***a* is turned down on its outer diameter, as indicated at **42**, for the purpose of receiving the decoupler cell or sleeve **43**. The decoupler cell **43** is composed of three sections **44**, **45** and **46** which either may be integrally formed with each other or may comprise separate sections. In any event, the entire decoupler cell **43**, comprising the three sections **44**, **45** and **46**, is held against longitudinal displacement by means of an abutment shoulder **47** disposed at the lower end of the lower drill collar **38***a* and by means of the radially extending face **48** on the lower end of the next adjacent drill collar section **38**.

The decoupler cell section **44** comprises an inner sleeve portion **49** firmly seated on the turned down portion **42** of the drill collar **38***a*. The sleeve portion **49** is cut away, as indicated at **50**, to provide a generally cylindrically shaped opening designated by reference numeral **51**. The sleeve portion **49** is cut away as indicated at **52** and **53** and a flexible membrane **54** of substantially cylindrical shape is disposed with its longitudinally spaced peripheral portions disposed in the cut away portions **52** and **53** of the sleeve **49**. The membrane **54** may be made of rubber or it may be made of other suitable material having similar properties.

The decoupler cell section **44** also includes an outer sleeve portion **55** having an outer diameter substantially equal to the outer diameter of the drill collar section **38** immediately above the decoupler section **44**. It is contemplated that at the longitudinal extremities of the sleeve portion **55**, it will fit snugly around the internal sleeve portion **49** and that as a result of this snug fit between the end portions of the sleeves **49** and **55**, the cylindrical flexible membrane **54** will be securely sealed at its longitudinally spaced peripheral regions between the two sleeve portions **49** and **55** in order to provide a substantially sealed compressible chamber **51**.

Means are provided for maintaining the sleeves **49** and **55** in fixed relation to each other and such means comprise rivets **56** which extend through both sleeves. The drill collar **38***a*, internal sleeve **49**, external sleeve **55** and flexible membrane **54** are all substantially cylindrical and are each mounted substantially concentrically with respect to each other, as is clearly illustrated in the sectional view shown in Fig. 5 of the drawings.

It is contemplated that the cylindrical opening **51** defined by the inner sleeve **49** and the flexible membrane **54** will be filled with an inert gas under a pressure substantially equal to the pressure of the mud fluid at the depth to which the decoupler cell is lowered. For the purpose of filling the chamber **51** with said inert gas under pressure, a suitable passage **57** is provided with a suitable valve **58** also being provided for maintaining said passage **57** closed to retain the desired pressure of the inert gas in the chamber **51**.

The external sleeve 55 is provided with a plurality of apertures 59, each of which is adapted to admit mud fluid from between the drill collar 38*a* and the vertical walls of the well against the flexible membrane 54. The flexible chamber 51 is thereby capable of absorbing any pressure surges generated in the mud fluid by the vibrating drill rod 37 and the bit 39.

The middle decoupler cell section 45 is substantially identical with the upper decoupler cell section 44 and therefore an additional description of the middle decoupler section 45 will not be given as it is deemed unnecessary.

The lower section 46 of the decoupler cell 43 comprises an inner sleeve portion 60 which fits snugly on the drill collar 38 and is disposed concentrically therearound. The lower section 46 also includes an outer sleeve portion 61 disposed concentrically around the inner sleeve portion 60 and rigidly secured thereto by means of a plurality of rivets 62. Disposed between the two sleeve portions 60 and 61 and having its peripheral end portions 63 mounted in the offset portions 64 of the outer sleeve 61, is a flexible membrane 65. The flexible membrane 65 is sealed to the outer sleeve portion 61 at its peripheral extremities and together with the outer sleeve portion 61 forms a substantially cylindrical compressible chamber 66.

The inner sleeve portion 60 is provided with a plurality of radially extending perforations 67 and the inner sleeve portion is cut away slightly, as indicated at 68, to provide a cylindrical opening between the sleeve 60 and the drill collar 38*a*. The drill collar 38*a* is provided with a plurality of radially extending perforations 69 for establishing mud fluid communication between the inside of the drill collar 38*a* and the compressible chamber 66 through the perforations 69 and 67. An opening 70 communicating with the chamber 66 and leading to a valve chamber 71 is provided for admitting an inert gas under substantial pressure into the chamber 66. When the chamber 66 is filled or substantially filled with the inert gas, a conventional valve plug 72 is closed in order to maintain the gas under the proper pressure in the chamber.

The constructional details of the second embodiment of the present invention shown in Figs. 7–9 will now be described. In this form of the invention, the lowermost drill collar 38*a* is turned down, as indicated at 80, on its inner diameter in order to provide for the reception of a decoupler cell 81.

The decoupler cell 81 comprises an internal sleeve 82 which fits snugly within sleeve portion 83 of the lowermost drill collar 38*a*. The innermost sleeve 82 has external threads 84 adapted to receive a threaded nut 85 which may be screwed down to abut against shoulder 86 on the upper end of the drill collar 38*a*. The inner sleeve 82 is also externally threaded, as indicated at 87, and internal threads, as indicated at 88, formed on a second sleeve portion 89 cooperate therewith in order to hold the two sleeves 82 and 89 in longitudinally adjusted position. The sleeve 89 comprises two end portions 90 and 91 and a central, substantially cylindrical, portion 92 which is welded to the end portions 90 and 91, as indicated at 93.

The end portion 90 of the sleeve 89 is turned down on its internal diameter as indicated at 94 and the end portion 91 of the sleeve 89 is turned down as indicated at 95 to provide a concave annular surface. The inner sleeve 82 is provided on its lower end with a convex annular surface 96 substantially complementary to a concave annular surface 95 on the lower portion 91 of the sleeve 89.

A substantially cylindrical flexible membrane, which may be formed of rubber or any other suitable material, indicated generally by reference numeral 97, is disposed between the inner sleeve 82 and the sleeve 89. The flexible membrane 97 is sealed between the two sleeves 82 and 89 at its upper end between the turned down portion 94 of the upper section 90 of the sleeve 89 and the complementary external surface of the inner sleeve 82. The membrane 97 is sealed between the sleeves 82 and 89 at its lower peripheral end between the surfaces 95 and 96. That space indicated by reference numeral 98, which is disposed between the central portion 92 of the sleeve 89 and the flexible membrane 97 comprises a chamber, which when filled with an inert gas forms a resilient chamber or cushion for absorbing energy dissipating or consuming sound waves generated by the vibrating drill rod 37 and bit 39. The lower portion 91 of the sleeve 89 is provided with a suitable conduit 99 for filling the chamber 98 with an inert gas and a suitable valve plug 100 is provided for closing the chamber 98 once it has been filled with the inert gas.

A second, substantially cylindrical flexible membrane, which may be made of rubber or any other suitable material, is designated by reference numeral 101 and is positioned between the sleeve 89 and the turned down portion 80 of the drill collar 38. The lower section 91 of the sleeve 89 is cut away, as indicated at 102, for receiving the lower peripheral end of the cylindrical membrane 101, the outer surface of the membrane 101 being disposed against the inner surface 80 of the drill collar 38*a*. The upper peripheral end of the membrane 101 is positioned between the upper section 90 of the sleeve 89 and the inner surface of the drill collar 38*a*. It is contemplated that each peripheral end portion of the membrane 101 will be sealed with respect to the sleeve 89 so that the space between the membrane 101 and the central sleeve portion 92, as indicated by reference numeral 103, will form a suitable chamber for the reception of an inert gas under substantial pressure. The inert gas is admitted into the chamber 103 through the conduit 104 formed in the lower section 91 of the sleeve 89 and the valve plug 105 is provided for closing the chamber 103 once the desired pressure of the inert gas has been obtained within the chamber 103. Suitable sealing rings 106 and 107, disposed respectively in peripheral openings in the upper section 90 and the lower section 91 of the sleeve 89 are provided for respectively sealing either end of the sleeve 89 with respect to the inner surface of the drill collar 38*a*.

The inner sleeve 82 is provided with a plurality of radially extending perforations 108 and the outer surface of the inner sleeve 82 is turned down, as indicated at 109. Mud fluid from within the drill collar 38*a* is adapted to be admitted through the perforations 108 in the sleeve 82 into the space defined by the internal sleeve 82 and the flexible membrane 97. The drill collar 38*a* is provided with a plurality of radially extending perforations 110 and the drill collar 38 is turned down further, as indicated at 111, to provide a suitable space between the flexible membrane 101 and the inside surface of the drill collar 38*a* so that mud fluid from outside of the drill collar 38*a* may be admitted against the flexible membrane 101 through the perforations 110.

In the operation of the drilling rig disclosed in Figs. 1 and 2, mud fluid, pumped from the sump 19 by the pump 20, is forced downwardly through the inside of the kelly 13 and drill string 23. This mud fluid drives the mud turbine motor and vibratory mechanism 36 in order to effect sonic vibration of the vibratory drill rod 37 and bit 39. It is contemplated, that the drill rod 37 and bit 39 will be of a length equal to substantially one-half wave length of the normal resonant vibration frequency of the drill rod and bit or of the order of 100 to 125 feet.

When the drill rod 37 and bit 39 are caused to vibrate at a frequency substantially equal to the resonant frequency thereof, the bit 39 may remain in substantial engagement with the earth formation at the bottom of the well hole so that the formation at the bottom of the well hole is fractured as a result of stresses imparted

thereto by the vibrating bit and the bit may also break up the formation at the bottom of the well hole as a result of percussive action of the bit on the formation. In any event the broken up particles of the formation at the bottom of the well hole, or cuttings, as they are known in the oil drilling industry, must be removed from the well hole. For accomplishing this purpose, the mud fluid which is pumped into the well hole through the drill string **23** proceeds downwardly through the inside of the vibratory drill rod **37** and upon reaching the bottom of the drill rod **37** emerges through suitable openings **112** in the bit **39**. The mud fluid emerging through the openings **112** moves at a sufficiently fast rate to wash away the cuttings at the bottom of the well hole. The mud fluid is of the proper consistency to maintain the cuttings in suspension therein while the mud fluid passes upwardly between the drill string **23** and the sides of the well hole. In this manner, the cuttings are withdrawn from the well hole between the inside of the hole and the outside of the drill string **23**. It is therefore apparent, that the mud fluid supplied by the mud pump **20** is utilized not only as a source of power for driving the drill itself but is also used as a means for removing the cuttings.

When the well hole reaches a substantial depth, i. e. of the order of a few thousand feet or more, the pressure of the mud fluid approaches a substantial value. As a result, each vertical reciprocation of the drill rod **37** and bit **39** tends also to vibrate the mud in the well hole. In other words, each time that the bit **39** and drill rod **37** elongate, additional pressure is imposed on the mud fluid at the bottom of the well hole and each time that the bit **39** and drill rod **37** contact, the pressure on the mud fluid is decreased and it tends to drop in the well hole. It will therefore be apparent that as a result of the high pressure of the mud fluid at the bottom of the well hole, there is a tendency for the mud fluid to become sonically or acoustically coupled to the drill rod and bit. When this occurs, it may be said that sound waves are generated in the mud fluid. These sound waves generated in the mud fluid serve only to cause pressure surges in the mud fluid which dissipate the energy from the drill rod and bit and make it practically impossible to operate the bit so as to effect disintegration of the formation at the bottom of the well hole.

In order to prevent this dissipation of the energy from the drill rod **37** and bit **39**, it is desirable to acoustically decouple or disconnect the column of mud fluid in the well hole from the drill rod **37** and bit **39**. The present invention, by providing the compressible chambers filled with inert gas, effectively decouples the vibrating drill rod and bit from the column of mud fluid in the bottom of the well hole.

As was stated previously, when the rod and bit elongate, the pressure of the mud fluid is increased thereby forming a pressure surge in the mud fluid and by enabling the mud fluid to act against the compressible chambers formed by the flexible membranes in each of the embodiments of the invention, the pressure surges in the mud fluid both within the drill rod **37** and outside of the drill rod **37** may displace the compressible chambers sufficiently to allow them to absorb the sound waves generated in the mud fluid by the vibrating bit.

It will be noted that the decoupler cells of each embodiment of the present invention are located immediately above the drill bit **39**. This location of the decoupler cell is important as the decoupler cell, to perform its function must be located in a region where the waves induced in the mud fluid actually cause pressure surges of the mud fluid.

In order to stop the generation of the sound waves in the mud fluid, the acoustic decoupler cells are disposed a substantial distance less than a quarter wave length, measured in the mud fluid, from the bit. If the decoupler cell is disposed as much as a quarter wave length away from the bit, from which the wave generation in the mud fluid is started, the wave can be started and then even if it is later stopped, some of the energy has been lost. By disposing the acoustic decoupler cell very near to the bit, the bit is prevented from being an actual source of wave generation in the mud fluid.

In the present invention, the bit **39** disposed at the lower end of the drill rod **37** is the source of the sound wave disturbance in the mud fluid. In order to substantially prevent the generation of the sound waves in the mud fluid, the decoupler cell is mounted within one-quarter wave length, measured in the mud fluid, from the bit, and preferably is disposed a distance from the bit equal to substantially one-eighth of the wave length measured in the mud fluid. Since the speed of sound in the mud fluid is only about one-fourth of that in the drill rod, a quarter wave length in the mud fluid is approximately one-quarter of a quarter wave length measured along the drill rod. With half wave operation, that is, with a drill rod and bit of the order of one hundred to one hundred and twenty-five feet in length, a quarter wave length in the mud fluid becomes a distance of the order of fifteen feet. In accordance with the present invention, it therefore is necessary to locate the decoupler cell within fifteen feet from the bit **39**. In each embodiment of the present invention, the decoupler cells are disposed immediately above the bit **39** and accordingly are well within the fifteen feet limit on the distance they may be displaced from the bit **39**. As a result, any pressure surges in the mud fluid caused as a result of the waves induced in the mud fluid by the vibrating drill rod and bit, are immediately absorbed by the compressible decoupler cell so as to prevent the dissipation of energy imparted to the drill rod and bit by the vibratory meshanism **36**.

It is therefore apparent that the present invention provides an effective decoupler cell for use with oil well drilling apparatus of the type disclosed in the aforementioned Bodine Patent No. 2,554,005. The decoupler cells disclosed herein are of particular utility since the compressible chambers provide the greatest possible area which can be acted upon by the mud fluid per unit length of the chambers. Further, it is possible to form the decoupler cells as individual units which may be either formed as part of the drill collar section when the section comprises original equipment or the decoupler cells may be easily replaced within or around the drill collar sections in the field during actual drilling operations.

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

What is claimed is:

1. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portion of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means formed on said drill rod defining annular resilient compressible chamber means disposed around said rod and located on said rod substantially less than one-quarter wave length distance in the mud fluid from said bit, said chamber means being cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

2. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portion of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially

the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means formed in said drill rod defining annular longitudinally extending cavities therein and disposed in said drill rod substantially less than one-quarter wave length distance in the mud fluid from said bit, each of said cavities being filled with gas under substantial pressure and each being covered with a flexible membrane for providing a sealed resilient compressible chamber, each of the chambers being cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

3. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portion of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means forming an annular portion of said drill rod disposed at substantially less than one-quarter wave length distance in the mud fluid from said bit, said annular portion of said drill rod being formed with a plurality of longitudinally extending cavities therein, flexible membranes covering each of said cavities and sealed to the drill rod at the junctures of said cavities for providing sealed compressible chambers, each of the compressible chambers being filled with an inert gas under pressure and the outside of each of said flexible membranes being in communication with the mud fluid for providing means cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

4. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portions of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means on a portion of said drill rod disposed substantially less than one-quarter wave length distance in the mud fluid from said bit and forming a pair of radially spaced cylindrical walls defining a generally cylindrically shaped opening therebetween, a generally cylindrically shaped flexible membrane disposed between said walls and having longitudinally spaced end regions peripherally sealed between said walls, said membrane and one of said walls together forming a generally cylindrically shaped sealed cavity adapted to be filled with a gas under substantial pressure, and the other of said walls being perforated for admitting the mud fluid against the membrane, said membrane being cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

5. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portion of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means on a portion of said drill rod disposed at substantially less than one-quarter wave length distance in the mud fluid from said bit and forming a plurality of pairs of radially spaced cylindrical walls defining generally cylindrically shaped openings respectively formed between each pair of walls, a generally cylindrically shaped flexible membrane disposed between each pair of said walls and having longitudinally spaced end regions peripherally sealed between the walls, each of said membranes and one of said walls of the pair between which it is disposed together forming a generally cylindrically shaped sealed cavity adapted to be filled with gas under substantial pressure, and the other of the walls of each pair being perforated for admitting the mud fluid against the respective membranes, each of said membranes being cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

6. Acoustic mud fluid decoupling means for acoustically isolating mud fluid in the bottom portion of a well hole from a longitudinally vibrating drill rod and bit disposed in the well hole, wherein the bit is disposed in engagement with the bottom of the well hole and the drill rod and bit are adapted to vibrate at substantially the resonant vibration frequency of the drill rod and bit and the bit tends to generate energy consuming sound waves in said mud fluid, and comprising means on a portion of said drill rod disposed at substantially less than one-quarter wave length distance in the mud fluid from said bit and forming three radially spaced substantially concentric cylindrical walls defining a pair of radially spaced generally cylindrically shaped openings, a pair of generally cylindrically shaped flexible membranes disposed between the central cylindrical wall and the inner and outer walls respectively, each of said membranes having longitudinally spaced end regions peripherally sealed with respect to said central wall and said membranes together with said central wall respectively forming a pair of generally cylindrically shaped cavities each adapted to be filled with an inert gas under pressure, and said inner and outer walls each being perforated for admitting the mud fluid respectively from within and without said drill rod against said membranes, each of said membranes being cyclically compressible at the vibration frequency of said rod and bit in response to pressure surges in the mud fluid generated by the vibrating rod and bit and thereby being effective to absorb cyclic displacement of the mud fluid.

7. 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 generally cylindrically shaped resilient compressible chamber adapted to be cyclically compressible 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.

8. 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

of mud fluid, said decoupler cell including means defining a generally cylindrically shaped resilient compressible chamber portion, said chamber portion comprising a flexible rubber sleeve sealed at its end regions with respect to a concentric wall of said cell and adapted to be filled with an inert gas under a pressure of the order of the pressure of the mud fluid at the bottom of the well hole, said chamber portion thereby being cyclically compressible at the vibration frequency of the rod and bit for absorbing said pressure surges of the mud fluid caused by the sound waves generated by the vibrating rod and bit.

9. 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 drill 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 of mud fluid, said decoupler cell including means defining a generally cylindrically shaped resilient compressible chamber, and said drill rod including means defining radially outwardly extending perforations formed in a portion thereof disposed concentrically with respect to said chamber for admitting the mud fluid against said chamber, said chamber thereby being cyclically compressible 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.

10. 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 of said mud fluid, said decoupler cell including means defining a generally cylindrically shaped resilient compressible chamber, and said drill rod including means defining radially inwardly extending perforations formed in a portion thereof disposed concentrically with respect to said chamber for admitting the mud fluid from within said drill rod against said chamber, said chamber thereby being cyclically compressible 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.

11. 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 concentrically mounted within said drill rod in a region thereof which is subject to said energy consuming pressure surges of mud fluid, said decoupler cell comprising a first sleeve forming a solid cylindrical wall and a second sleeve having perforations therein disposed radially inwardly with respect to said first sleeve, and said drill rod including means forming a perforated cylindrical wall disposed radially outwardly with respect to said first sleeve, a pair of flexible cylindrical membranes respectively disposed between said first and second sleeves and between said first sleeve and said perforated cylindrical wall portion of said drill rod, each of said membranes having its longitudinally spaced end regions sealed with respect to said first sleeve to respectively define therewith a pair of compressible chambers adapted to be filled with an inert gas, said perforated sleeve and wall portion of said drill rod respectively admitting the mud fluid from within and without said drill rod against said membranes for thereby absorbing said energy consuming pressure surges of mud fluid caused by said sound waves.

12. 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 mounted in a cutaway portion of the drill rod formed in a region thereof which is subject to said energy consuming pressure surges of mud fluid caused by said sound waves, said decoupler cell including means defining a pair of axially aligned generally cylindrically shaped resilient compressible chambers, each of said compressible chambers being filled with an inert gas under a pressure of the order of the pressure of the mud fluid at the bottom of the well hole, and said chambers being respectively adapted to receive and absorb said pressure surges of mud fluid from within and without said drill rod.

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