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[54] **PLENUM CHAMBER**

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[52] **U.S. Cl.** ..... **181/33 K,** 175/209

[51] **Int. Cl.** **E21b 41/00**

[58] **Field of Search** .... 181/33 K, 33 R, 33 C, 36 A, 181/36 D; 175/209–211

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[57] **ABSTRACT**

A plenum chamber for covering and sealing a bore hole opening at the surface of the ground and for reducing the noise produced during a drilling operation is provided. The plenum chamber has a housing means comprising an open bottom and a closed top having a port therein which is adapted to receive a drill shaft. A vibration damping and sound absorbing means is disposed between and contacts a substantial portion of the external and internal walls of the housing means. Sealing means are connected to the housing means for maintaining the top and the bottom thereof in sealing engagement with the drill shaft and the surface of the ground, respectively. Drilling cuttings and dust particles carried up the bore hole by a compressed air stream are trapped by the plenum chamber in a highly efficient manner. Mechanical vibrational energy imparted to the housing means by impact of the drilling cuttings thereagainst is dissipated by the vibration damping and sound absorbing means. The external wall operates as a reflective barrier means to confine noise within the plenum chamber until it is eventually absorbed. As a result, the noise produced during operation of rotary drilling machines is substantially reduced.

14 Claims, 2 Drawing Figures

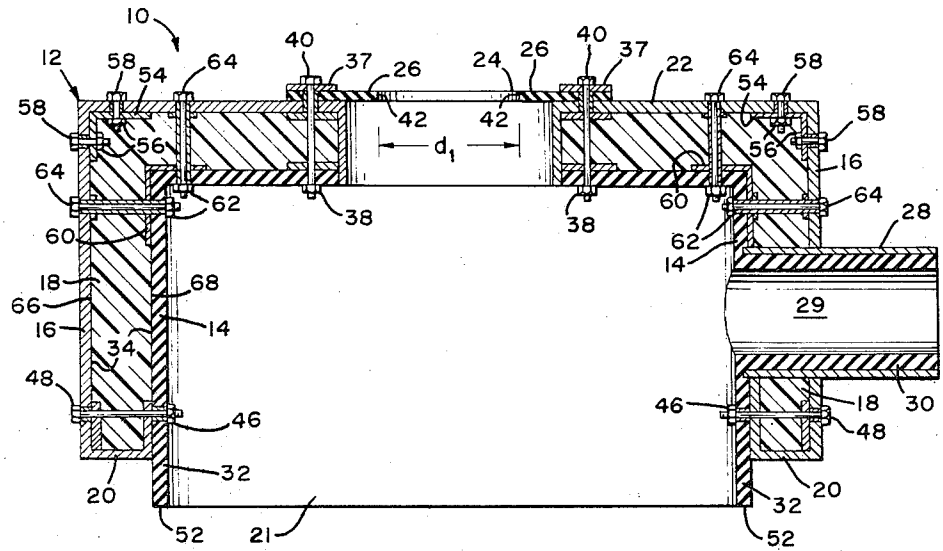

FIG. 1

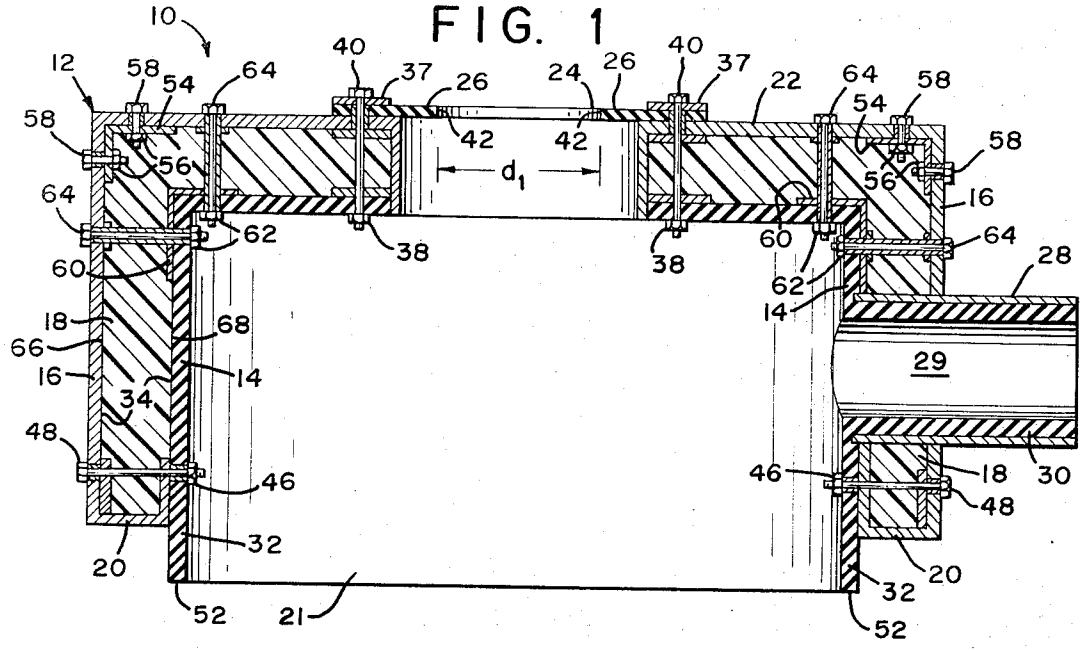
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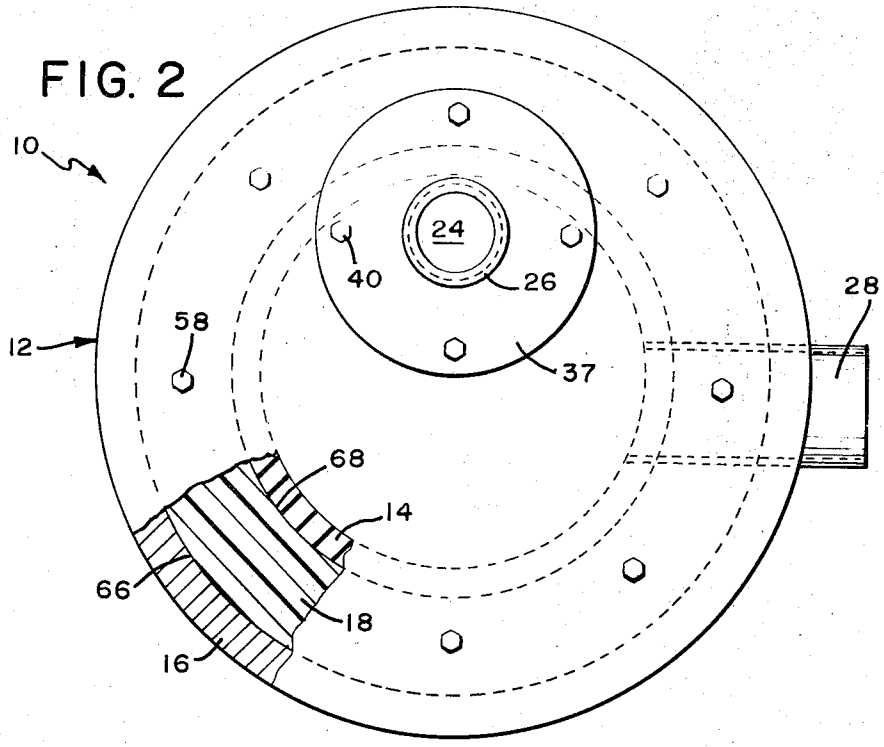
FIG. 2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PLENUM CHAMBER

BACKGROUND OF THE INVENTION

This invention relates to the drilling of blast holes, wells and the like by the rotary method, and more particularly to a plenum chamber which reduces noise and dust pollution produced during the drilling operation and concomitantly shields workmen at the drill site from drilling cuttings carried up a bore hole by a compressed air stream.

DESCRIPTION OF THE PRIOR ART

In the drilling of wells, blast holes and the like by the rotary method, compressed air is passed in a stream down through a hollow drill shaft, across the face of a drill bit connected thereto and upwardly through an annular space between the drill shaft and the walls of a bore hole to a suction nozzle at the surface of the ground. The suction nozzle covers a portion of the annular space and serves to entrap drilling cuttings such as gravel, sand and stones, which are carried up the bore-hole by the air stream. From the suction nozzle the drilling cuttings are directed through a conduit to a dust collector.

One of the problems associated with drilling operations of the type described is the difficulty of reducing the noise produced thereby. Due to the high resonance factor of the suction nozzle, the impact of the drilling cuttings thereagainst produces a ringing noise which, under normal operations, often reaches a level as high as 115 decibels (dbA) or more. This level of noise interferes with the drill operator's ability to converse and can gradually impair his hearing. Moreover, such noise is annoying to nearby housing residents, and zoning ordinances have been enacted which impose stringent regulations governing the amount of noise emanating from drilling operations.

Another problem associated with the above described drilling operations is related to safety. The pressure of the compressed air stream is sufficiently high that a considerable amount of drilling cuttings and dust particles are not trapped by the suction nozzle. Untrapped drilling cuttings are ejected from the bore hole at a velocity high enough to injure nearby workmen. Moreover, prolonged exposure to escaping dust particles can adversely affect the health of such workmen. Apparatus which shields workmen at the drill site from drilling cuttings carried up the bore hole by the compressed air stream and which reduces noise and dust pollution produced during the drilling operation would have significant advantages over the suction nozzles heretofore employed.

SUMMARY OF THE INVENTION

The present invention provides a plenum chamber for covering and sealing a bore hole opening at the surface of the ground and for reducing the noise produced during a drilling operation. Such plenum chamber comprises a housing means having an external wall composed of a reflective barrier means, an internal wall composed of an abrasion resistant means and a vibration damping and sound absorbing means disposed between and contacting a substantial portion of each of said external and internal walls. The housing means has an open bottom and a closed top having a port therein adapted to receive a drill shaft. A first sealing means is

connected to the top of the housing means adjacent the port for maintaining the port in sealing engagement with the drill shaft. A conduit (pipe) is provided which extends through the housing means so as to provide an outlet therein for removal of drilling cuttings and dust particles from the plenum chamber, said conduit having an internal surface composed of an abrasion resistant means. A second sealing means is connected to the bottom of the housing means for maintaining the bottom in sealing engagement with the surface of the ground.

It has been found that significant advantages result from covering and sealing a bore hole opening with a plenum chamber of the type described above. The first and second sealing means maintain the housing means in sealing engagement with the drill shaft and the surface of the ground. Hence, drilling cuttings and dust particles carried up the bore hole by an air stream are trapped by the plenum chamber in a highly efficient manner. Due to the particular structure of the housing means, the noise produced by the impact of the drilling cuttings thereagainst is reduced to a level far below that expected for rotary drilling operations. The reflective barrier means confines such noise within the plenum chamber until it becomes absorbed by the vibration damping and sound absorbing means, which additionally serves to dissipate the mechanical vibrational energy of the housing means. As a result, the noise produced during operation of rotary drilling machines can be reduced by as much as 25 dbA or more.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood and further advantages will become apparent when reference is made to the following detailed description and the accompanying drawings in which:

FIG. 1 is a side elevational view of a plenum chamber incorporating the elements of the present invention; and

FIG. 2 is a plan view of the plenum chamber of FIG. 1, partially cut away to expose an interior portion thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The plenum chamber of the present invention comprises a housing means having an open bottom and a closed top. Such housing means may be fabricated in a number of diverse sizes and configurations. For illustrative purposes, the invention is described in connection with a housing means having a substantially cylindrical configuration. It will be readily appreciated, however, that the configuration of such housing means can be polygonal. Likewise it is intended that plenum chambers comprising housing means which are bell-shaped cap-shaped, dome-shaped or otherwise shaped so as to form a hollow chamber having an open bottom and a closed top have configurations falling within the scope of the present invention.

Referring to FIG. 1 of the drawings, the plenum chamber, shown generally at **10,** comprises a housing means, generally indicated at **12.** The housing means **12** has an external wall **16** composed of a reflective barrier means, an internal wall **14** composed of an abrasion resistant means and a vibration damping and sound absorbing means **18** disposed between and contacting a substantial portion of each of the internal wall

14 and the external wall 16. Housing means 12 is open at the bottom, the opening 21 being defined by a base 20, and closed at the top 22. The top 22 of the housing means 12 has a port 24 therein which is adapted to receive a drill shaft (not shown). A first sealing means 26 is connected to the top 22 of the housing means adjacent the port 24 for maintaining the port 24 in sealing engagement with the drill shaft. A conduit (pipe) 28 is provided which extends through the housing means 12 so as to provide an outlet 29 therein. Drilling cuttings and dust particles entrapped by the plenum chamber 10 during a drilling operation are passed through the outlet 29 to a dust collector (not shown). The conduit 28 has an internal surface 30 composed of an abrasion resistant means. A second sealing means 32 is connected to the base 20 of the housing means 12 for maintaining the base 20 in sealing engagement with the surface of the ground.

The abrasion resistant means of which the internal wall 14 and the internal surface 30 are composed can be any abrasion resistant material which is resilient and which has sufficient toughness to withstand erosion upon subjection for prolonged periods to the impact of drilling cuttings carried up the bore hole by a compressed air stream. A typical abrasion resistant material suitable for use as the abrasion resistant means comprises an elastomeric material, such as natural or synthetic rubber, having a hardness of about 35 to 75 durometer Shore A. The thickness of the abrasion resistant means employed depends upon the size, shape and hardness of the drilling cuttings and their force of impact against the internal wall 14 and internal surface 30. Generally, the abrasion resistant means has a uniform thickness ranging from about ⅛ to 3 inches.

The reflective barrier means which forms external wall 16 can be any material which has sufficient strength and rigidity to provide support for the plenum chamber 10 and which is capable of confining therewithin the noise produced by impact of the drilling cuttings. Materials which are suitable for use as the reflective barrier means comprise lead; aluminum; plywood; reinforced plastics, including polyester resins such as isothalic polyesters and polyvinyl resins such as polyvinyl chloride, which are reinforced with asbestos fibers, glass fibers, nylon fibers or wire mesh; and reinforced elastomers, including natural and synthetic rubbers, which are reinforced with asbestos fibers, glass fibers, jute fibers, nylon fibers or wire mesh. The thickness of the reflective barrier means employed depends upon the size of the bore hole opening and the impact force of drilling cuttings produced during the drilling operation. Generally, the reflective barrier means has a uniform thickness ranging from about ⅛ to 2 inches.

The vibration damping and sound absorbing means 18 can be made of any durable vibration damping and sound absorbing material which will not disintegrate upon subjection for prolonged periods to the vibration of the housing means 12. Such vibration damping and sound absorbing material may be either foamable or non-foamable. Typical vibration damping and sound absorbing materials suitable for use as the vibration damping and sound absorbing means include fibrous material such as asbestos fibers, glass fibers, cellulosic fibers or mineral wood fibers; urethane rubbers; silicone rubbers; saw dust; wood chips; granulated plastic materials such as granulated polypropylene, polyethylene or polyvinyl chloride; honeycombed structures composed of paper and cardboard; and sand. Preferably the vibration damping and sound absorbing means is made of a damping material which comprises asbestos fibers, silicone rubbers or urethane rubbers. Generally, the vibration damping and sound absorbing means 18 has a vibration decay rate ranging from about 4 to 400 dbA per second, and a sound absorption coefficient of about 0.04 to 1. Preferably, the vibration damping and sound absorbing means has a vibration damping capacity sufficient to substantially reduce the vibrational energy of each of the internal wall 14 and the external wall 16 within a relatively short period of time. Thus the vibration damping capacity of the vibration damping and sound absorbing means is preferably sufficient to reduce the vibrational energy of the internal and external walls 14 and 16 by 40 to 80 dbA per second during a time period ranging from about 1/100 to 2 seconds. The amount of the vibration damping and sound absorbing means 18 employed depends upon the size of the bore hole opening and the impact force of drilling cuttings against the internal wall 14. Generally, the vibration damping and sound absorbing means 18 should contact a substantial portion of the internal wall 14 and the external wall 16 of the housing means 12, as in the order of about 30 to 100 percent, preferably at least about 85 percent of the cavity defining surface 34 collectively provided thereby, and should have an average thickness of at least about 30 percent of the average combined thickness of the internal wall 14 and the external wall 16.

The first sealing means 26 comprises a resilient, readily deformable elastomeric material such as natural or synthetic rubber, or any other suitable resilient elastomeric and readily deformable plastic material formed to a substantially annular (ring-shaped) configuration such as that of a gasket. The first sealing means 26 is connected to the top 22 of the housing means 12 by a suitable fastening means such as a fastening plate 37, through which bolts 40 extend. The bolts 40 are secured to the housing means 12 by attaching nuts 38. The central portion of sealing means 26 defines port 24, which is adapted to receive and engage a portion on the exterior surface of a drill shaft (not shown). Inside diameter d_1 of the first sealing means 26, in its relaxed or undeformed state, preferably is slightly smaller than the outside diameter of the drill shaft, so that it is stretched to some extent in a radial direction and deformed outwardly upon insertion of the drill shaft therethrough. Due to the elastomeric and readily deformable properties of the first sealing means 26, the inner surface 42 thereof assumes substantially the same configuration as that of the engaged portion of the drill shaft and is held thereagainst with sufficient force to substantially prevent the passage of drilling cuttings and dust particles therebetween. Thus, during such time as the drill shaft extends through the port 24, the first sealing means maintains the port 24 in sealing engagement therewith.

The second sealing means 32 is formed in a substantially annular configuration from material of the type used to make the first sealing means 26. The upper portion of the second sealing means 32 is connected to the housing means 12 adjacent the base 20 by suitable fastening means such as nuts 46 and bolts 48 or the like. The lower portion of the second sealing means 32 projects downwardly from base 20. The length of the projection in its relaxed or undeformed state preferably

is slightly larger than the difference in height between the "peak" and "valley" portions of the textural surface of the ground located adjacent the bore hole opening. Generally, the length of the projection ranges from about ½ to 6 inches. When the base **20** of the plenum chamber **10** is positioned on the surface of the ground adjacent the bore hole opening so that the top **22** covers the opening, the lower portion of the second sealing means **32** is stretched to some extent and deformed axially upwardly. The end **52** of the lower portion assumes substantially the same configuration as the surface of the ground engaged thereby and is held thereagainst with sufficient force to substantially prevent the passage of drilling cuttings and dust particles therebetween. Hence, during such time as the plenum chamber **10** covers the bore hole opening, the second sealing means **32** maintains the base **20** in sealing engagement with the surface of the ground.

In assembling the housing means **12,** a rigid structure is formed from the external wall **16.** This may be done by molding the external wall **16** to form a substantially unitary structure or by fastening together the respectively separate components of the external wall **16** by means of attaching plates **54,** through which bolts **58** extend. The bolts **58** are secured to the housing means **12** by attaching nuts **56.** A suitable amount of the vibration damping and sound absorbing means **18** is placed against the portion of surface **34** provided by the external wall **16.** The internal wall **14** is then placed against the vibration damping and sound absorbing means **18** and is connected to the external wall **16** by suitable fastening means such as attachment plates **60,** nuts **62** and bolts **64** or the like. Upon completion of the latter assembly step, the vibration damping and sound absorbing means becomes disposed between and contacts a substantial portion of each of the internal wall **14** and the external wall **16.** This structural condition of the housing means **12** can alternatively be obtained by forming the vibration damping and sound absorbing material in situ between the internal wall **14** and the external wall **16.** After connecting the internal wall **14** to the external wall **16,** the latter is provided with one or more tapped holes (not shown) which communicate with the cavity formed by inner surface **34** of the external wall **16** and the internal wall **14.** The cavity is then filled with the vibration damping and sound absorbing material in a conventional manner. If the vibration damping and sound absorbing material is of the foamable variety, the cavity can be filled therewith by injecting a melted charge of foamable vibration damping and sound absorbing material into the cavity at a pressure sufficiently high to prevent foaming and then relieving the pressure from the vibration damping and sound absorbing material within the cavity so as to allow the foaming thereof. The various methods and types of apparatus employed to dispose the vibration damping and sound absorbing means **18** within the cavity will be well understood by those skilled in the art.

In FIG. **2** there is illustrated a top plan view of the plenum chamber **10.** When disposed between the internal wall **14** and the external wall **16,** the vibration damping and sound absorbing means **18** preferably has a substantially annular configuration in which each of the outer surface portion **66** and the inner surface portion **68** thereof has a substantially circular shape. Such substantially annular configuration of the vibration damping and sound absorbing means **18** (1) reduces the vibrational energy of the housing means **12** and (2) absorbs sound waves within the plenum chamber **10** in a highly efficient manner and is, for this reason preferred. Other configurations of the vibration damping and sound absorbing means, including a ring-shaped structure wherein outer and inner surface portions **66** and **68** are polygonal, or a structure wherein the ring is unclosed, such as one having either a U-shaped or an arcuate form, can also be used. The form of the vibration damping and sound absorbing means **18** shown in FIG. **2** is intended to be illustrative and should not be interpreted to limit the scope of the invention to the particular structure disclosed. Accordingly, the term "substantially annular configuration" as used in the specification and claims with reference to the vibration damping and sound absorbing means **18** is intended to include, as well, configurations of the type discussed in this paragraph. So long as the vibration damping and sound absorbing means **18** is disposed between and contacts a substantial portion of each of the internal wall **14** and the external wall **16,** the noise produced during drilling operations can be substantially reduced.

In operation, compressed air passes in a stream down through the hollow drill shaft of a drilling machine (not shown) across the face of a drill bit connected thereto and upward through an annular space between the drill shaft and the walls of a bore hole to an opening at the surface of the ground. Base **20** of the plenum chamber **10** is positioned on the surface of the ground adjacent the bore hole opening so that the top **22** covers the opening. Sealing means connected to the top **22** and the base **20** of the housing means **12** maintain the top **22** and the base **20** in sealing engagement with the drill shaft and the surface of the ground, respectively, whereby drilling cuttings and dust particles carried up the bore hole by the compressed air stream are trapped by the plenum chamber **10** in a highly efficient manner. The drilling cuttings pass through an opening provided in housing means **12** by the conduit **28** to a dust collector (not shown). Mechanical vibrational energy imparted to housing means **12** by impact of drilling cuttings against the internal wall **14** is dissipated by the vibration damping and sound absorbing means **18.** The external wall **16** operates as a reflective barrier means to confine noise within the plenum chamber **10** until it is eventually absorbed. As a result, the noise produced during operation of rotary drilling machines is substantially reduced.

Having thus described the invention in rather full detail, it will be understood that these details need not be strictly adhered to but that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

We claim:

1. A plenum chamber for covering and sealing a bore hole opening at the surface of the ground and for concomitantly reducing the noise produced during a drilling operation, comprising:

a. a housing means having an external wall composed of a reflective barrier means, an internal wall composed of an abrasion resistant means and a vibration damping and sound absorbing means disposed between and contacting a substantial portion of each of said external and internal walls;

b. said housing means having an open bottom and a closed top defined by said internal and external

walls and having a port therein adapted to receive a drill shaft;

c. a first sealing means connected to said top of said housing means adjacent said port for maintaining said port in sealing engagement with said drill shaft;

d. a conduit extending through said housing means so as to provide an outlet therein for removal of drilling cuttings and dust particles from the plenum chamber, said conduit having an internal surface composed of an abrasion resistant means; and

e. a second sealing means connected to the bottom of said housing means for maintaining said bottom in sealing engagement with the surface of the ground.

2. A plenum chamber as recited in claim **1** wherein said vibration damping and sound absorbing means has a vibration decay rate ranging from about 4 to 400 dbA per second and a sound absorption coefficient of about 0.04 to 1.0.

3. A plenum chamber as recited in claim **2** wherein said vibration damping and sound absorbing means contacts from about 30 to 100 percent of the inner surface of said internal and external walls.

4. A plenum chamber as recited in claim **3** wherein said vibration damping and sound absorbing means has a vibration damping capacity sufficient to substantially reduce the vibrational energy of each of said internal and external walls of said housing means by about 40 to 80 dbA per second during a time period ranging from about 1/100 to 2 seconds.

5. A plenum chamber as recited in claim **1** wherein said vibration damping and sound absorbing means is selected from the group consisting of asbestos fibers, silicone rubbers and urethane rubbers.

6. A plenum chamber as recited in claim **1** wherein said internal wall comprises an elastomeric material having a hardness of about 35 to 75 durometer Shore A (ASTM).

7. A plenum chamber as recited in claim **1** wherein said reflective barrier means is selected from the group consisting of lead, aluminum and reinforced elastomers.

8. A plenum chamber as recited in claim **1** wherein said first sealing means comprises a resilient, readily deformable elastomeric material having a substantially annular configuration and being connected to said top of said housing means, said first sealing means having a central portion which defines said port and an inside diameter which, in its undeformed state, is slightly smaller than the outside diameter of said drill shaft.

9. A plenum chamber as recited in claim **1** wherein said housing means is substantially bell-shaped.

10. A plenum chamber as recited in claim **9** wherein each of the internal wall of said housing means and the internal surface of said conduit has a uniform thickness ranging from about ⅛ to 3 inches.

11. A plenum chamber as recited in claim **10** wherein the external wall of said housing means has a thickness ranging from about ⅛ to 2 inches.

12. A plenum chamber as recited in claim **11** wherein said vibration damping and sound absorbing means has a thickness of at least about 30 percent of the average combined thicknesses of said internal wall and said external wall.

13. A plenum chamber as recited in claim **1** wherein said vibration damping and sound absorbing means has a substantially annular configuration.

14. A plenum chamber as recited in claim **1** wherein said second sealing means comprises a resilient readily deformable elastomeric material having a substantially annular configuration, the upper portion of said second sealing means being connected to said base and the lower portion of said second sealing means projecting downwardly from said base.

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