Aug. 27, 1963 B. E. GREENFIELD 3,101,499

PIPE CLEANER

Filed May 27, 1959 2 Sheets-Sheet 1

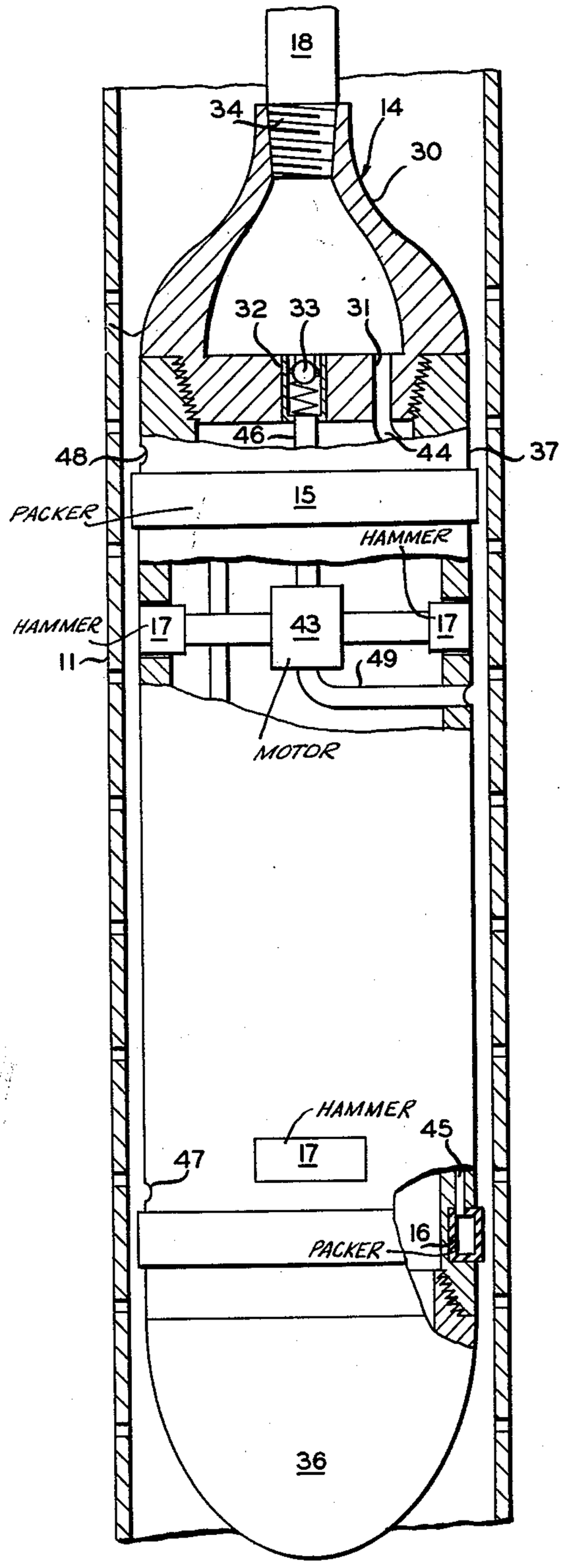
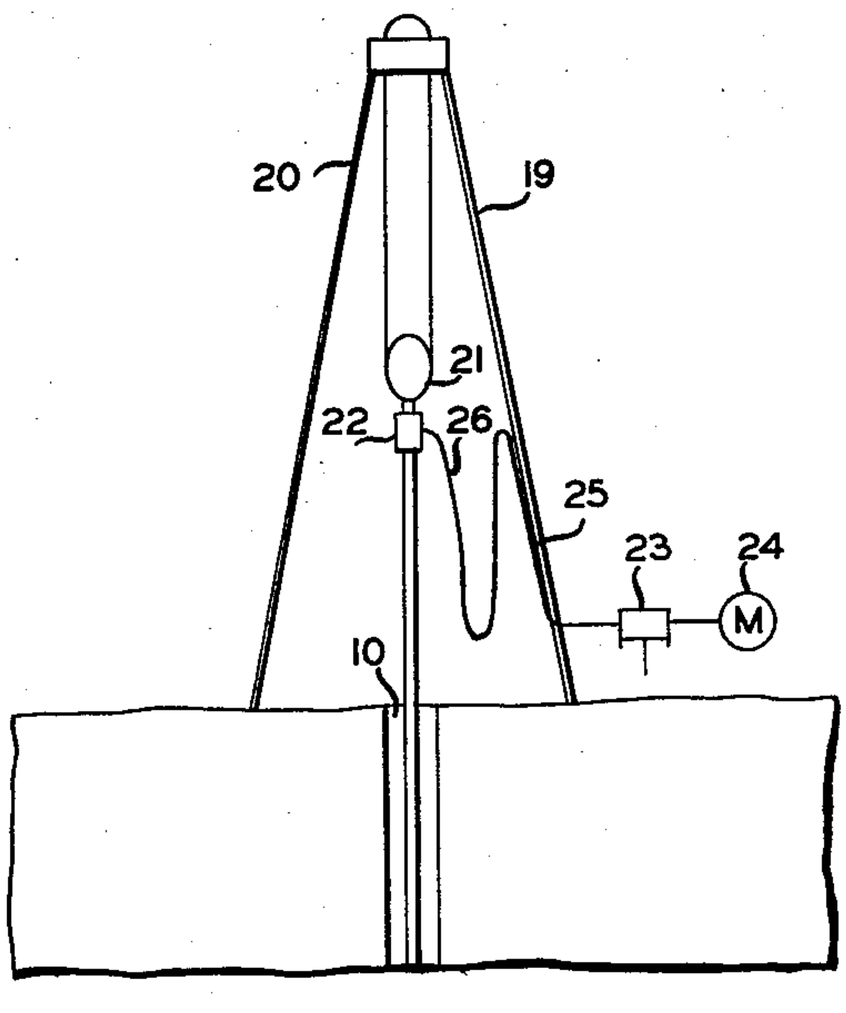


FIG. 2



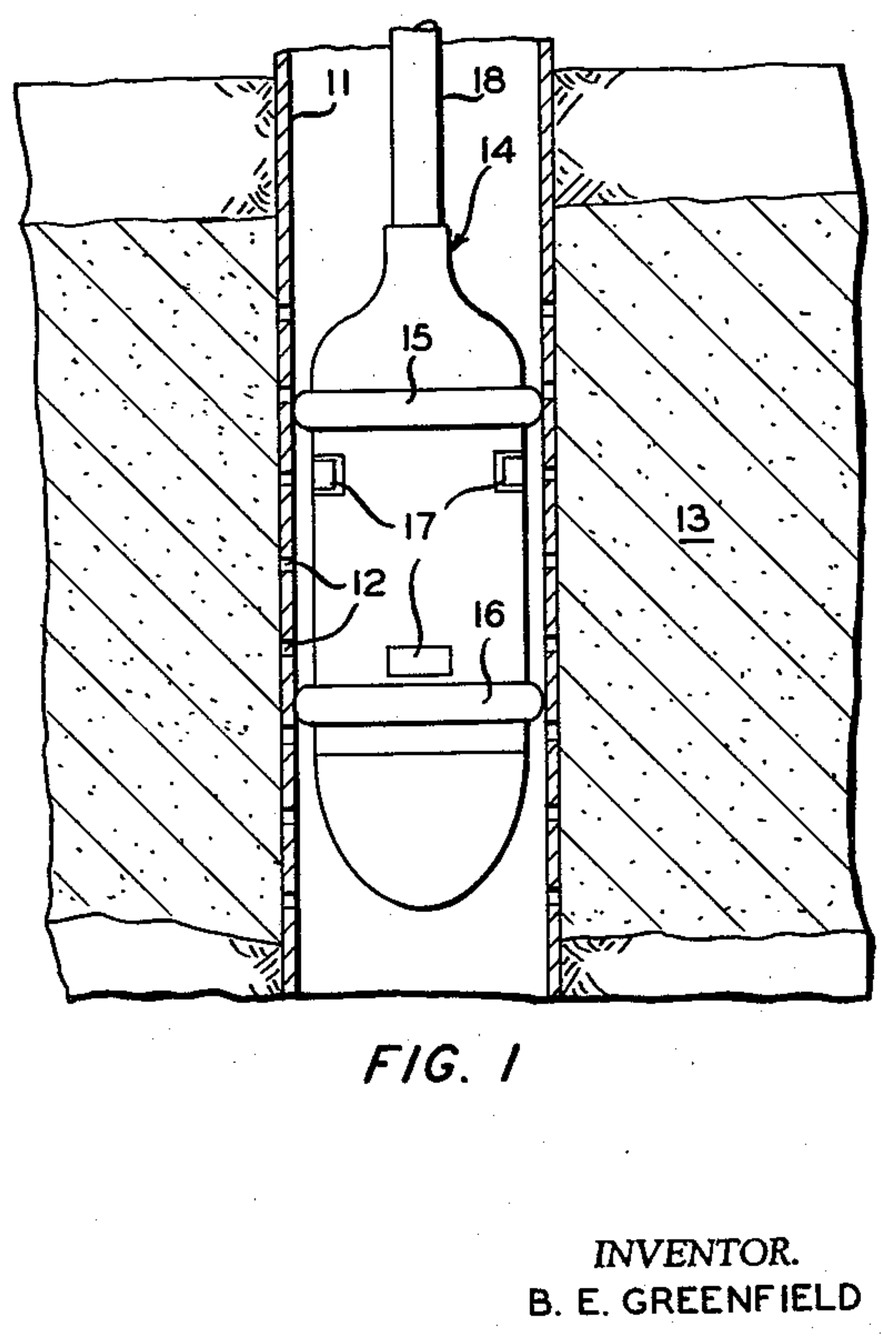


FIG. 1

INVENTOR.
B. E. GREENFIELD

BY Hudson & Young

ATTORNEYS

Aug. 27, 1963 B. E. GREENFIELD 3,101,499

PIPE CLEANER

Filed May 27, 1959 2 Sheets-Sheet 2

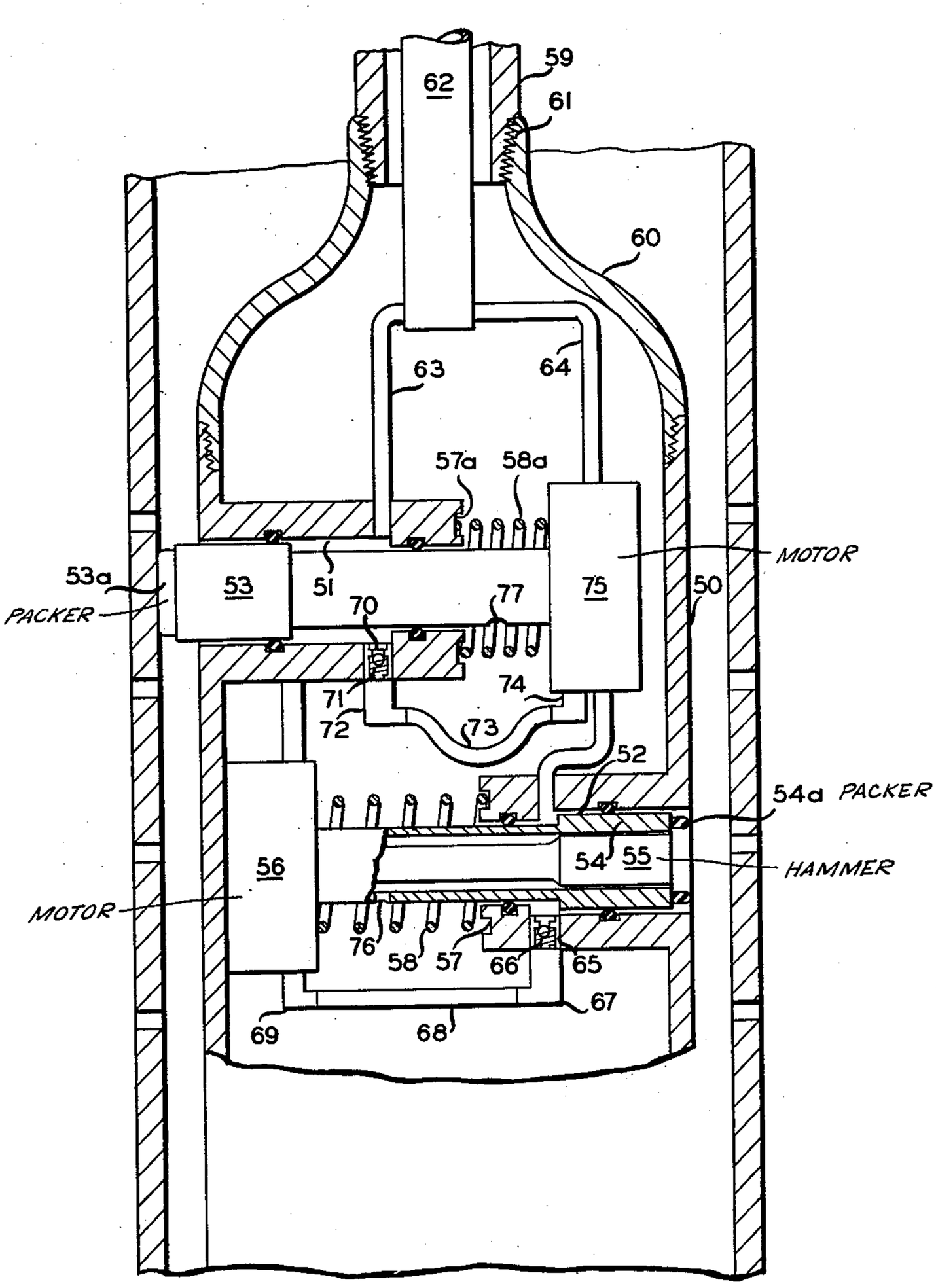


FIG. 3

INVENTOR.
B. E. GREENFIELD
BY Hudson & Young
ATTORNEYS

United States Patent Office

3,101,499

Patented Aug. 27, 1963

3,101,499

PIPE CLEANER

Bill E. Greenfield, Odessa, Tex., assignor to Phillips Petroleum Company, a corporation of Delaware

Filed May 27, 1959, Ser. No. 816,129
4 Claims. (Cl. 15—104.07)

This invention relates to a method and apparatus for cleaning scale and other material from the walls or perforations of a pipe, well screen, or similar structures. In one of its aspects, the invention relates to a method for cleaning a hollow structure by providing a substantially liquid-free space within said structure and causing a power driven hammer to operate in the liquid-free space and contact the structure thereby freeing the structure of undesired accumulated material. In another aspect, the invention relates to a pipe cleaner comprising hammering means, means to position and means to anchor the hammering means in a pipe. In another aspect, the invention relates to a pipe cleaner comprising hammering means, means to position the hammering means in a pipe and means to isolate a space within the pipe in the vicinity of the hammering means, and means to maintain this space substantially liquid-free. In another aspect, this invention relates to pneumatic powered pipe cleaning means in which a single source of pneumatic power fluid actuates both the driving means for the cleaner and the means which maintains the substantially liquid-free space.

There are many instances in which it is desirable to clean accumulated material from the walls of pipe, from pipe perforations, or from tubular screens and similar structures. For example, it is necessary at times to clean scale from boiler tubes, accumulations of particles of sand, gravel, wax, etc., from oil well casings or tubing or from perforations in such pipes, or accumulations from well screens in oil or water wells. One method which has been proposed to perform such cleaning operations is the use of means to hammer the structure to be cleaned, thus loosening the undesired accumulations to be washed or blown away or otherwise removed from the structure.

Previously known cleaning devices have not been provided with suitable anchoring means thereby making efficient operation impossible unless the device is positioned on a relatively short and stiff supporting member, a procedure which is impossible in a long pipe. Also, where appreciable amounts of liquid are present in the structure to be cleaned, the operation has been inefficient due to the damping action of the liquid on the moving parts of the device.

It is an object of the present invention to provide an improved cleaning device for pipes, and a method for cleaning pipes, pipe perforations, tubular screens, etc. Another object of the invention is to improve the operation of a pipe cleaning device by preventing movement of the device relative to the object being cleaned during its operation therein. Another object is to improve the efficiency of a pipe cleaning device by preventing liquid damping of the working parts of the device.

Other aspects, objects and the several advantages of the invention are apparent from a study of the disclosure, drawing, and the appended claims.

According to the present invention there are provided improved pipe cleaning means having suitable anchoring means. Also according to this invention there are provided improved pipe cleaning means which provide substantially liquid-free working space for the cleaning means.

In a more specific embodiment, pipe cleaning means are provided with means to isolate a portion of the space within the pipe, thus providing a substantially liquid-free space for the operation of the device.

In one embodiment, the means comprises first and second packers spaced along the body of the cleaning device, thus providing the liquid-free space between them. In another embodiment, the means comprises a separate encircling packer for each hammering means, thus providing separate substantially liquid-free spaces for each of the hammering implements. In a still more specific embodiment, the hammering means and the packer means are both actuated by the same source of pressure fluid. In some of the embodiments, the space provided by the packer means is substantially evacuated of liquid by the exhaust from pneumatic means used to actuate the hammering means.

Although the present invention is applicable to pipe cleaning in general, in several specific embodiments it is particularly well suited for use in deep wells, for example, oil, gas, or water wells. In the specification and claims, the word pipe is used in a broad sense to include various types of hollow structures to which the present invention is applicable, for example, oil well casings and tubings, perforated or solid, well screens and other similar structures, but the word is not considered to be limited either to conduits or to objects having circular cross section, but might be applied to other hollow structures, including those which are not circular in cross section.

In the drawings, FIGURE 1 is a schematic vertical cross section of an embodiment of the invention being used in a well to clean the well casing in the perforated section. FIGURE 2 is a schematic view, partly in cross section, of a portion of the apparatus of FIGURE 1, partly in cross section, an embodiment of the invention having a pair of spaced apart packers providing a space between, in which the hammering means can operate substantially free of damping liquid. Figure 3 is a schematic vertical cross section of a portion of an embodiment in which each separate hammering device is provided with separate packer means to provide separate liquid-free operating spaces for each separate hammering implement.

Referring to FIGURE 1, well bore **10** is provided with a casing **11**, which has perforations **12** in the vicinity of an underground formation **13** which may, for example, be a fresh water bearing or oil and gas bearing zone from which production is desired. The pipe cleaner **14** is provided with packers **15** and **16** between which hammers **17** operate. Cleaner **14** is supported in well **10** by a string of pipe **18** which, in turn, is supported from derrick **19** by cable **20**, traveling block **21** and swivel **22**. Means for providing pressure fluid include compressor **23**, driven by motor **24**, which may be, for example, an electric motor provided with electric power in a conventional manner from a source not shown, standpipe **25** and hose **26**.

The embodiment of the pipe cleaner illustrated in FIGURE 2 is substantially identical with cleaner **14** of FIGURE 1. This cleaner includes an upper end piece **30**, containing port **31** and opening **32** in which pressure regulating valve **33** is supported, upper end piece **30** being further provided with threaded opening **34** to which pipe **18** is attached.

The cleaner of FIGURE 2 is further provided with nose guide **36** and body **37** which serves to connect upper end piece **30** and nose guide **36** and also provides supporting structure for the remaining parts of the cleaner. These parts include upper packer **15**, lower packer **16**, and hammers **17**. Each hammer is provided with power from a pneumatic motor, the power for the upper hammers being represented by box **43**, which is intended to represent either a single motor adapted to drive both hammers or separate driving motors, one for each hammer. Upper packer **15** comprises a hollow circular tube which communicates with port **31** through conduit **44**. Lower packer **16** comprises a similar hollow tube which also communicates with conduit **44** through a conduit **45**

in body 37. The driving motors for all hammers are connected with opening 32 and conduit 46. Exhaust ports 47 and 48 are connected by means of a conduit (not shown) in body 37. Each of the hammer actuating motors is provided with a conduit 49 to carry the exhaust pressure fluid to the outside of body 37. If desired, a pressure regulating valve can be provided in exhaust port 47 to maintain a positive pressure in the space between packers 15 and 16. It will be understood, of course, that the drawing of FIGURE 2 is largely schematic and that mechanical details of structure within the ordinary skill of the art and not necessary to a clear understanding of the invention have not been shown. For example, details of structural provisions for assembly and disassembly as well as details of the driving motors, etc., have been omitted. A preferred form of pneumatic motor is that manufactured by Ingersoll-Rand and used in the J–50 Jackhammer. Any suitable driving motor can be utilized. For example, a motor such as disclosed in U.S. Patent No. 834,306, issued October 30, 1906, to Krause can be utilized to provide the motor to drive hammers 17, being a single motor adapted to drive both hammers. Motors such as the ones disclosed in U.S. Patent No. 1,714,282, issued May 21, 1929, to Stevens and in U.S. Patent No. 640,822, issued January 9, 1900, to Smith also can be used. When the motor of Stevens is used, two motors are utilized to drive the two hammers 17. The motor of Stevens also is suitable for use as the motor 75 and the motor 56 in FIGURE 3. Smith shows motors suitable for both single and double action. It is noted also that various modifications can be made within the scope of the invention such as changing the number and location of the hammer, the number of packers and their method of actuation, the type of body member, its configuration and structure, etc.

In operation, the pipe cleaner of FIGURE 2 is supported in a well by surface equipment similar to that illustrated in FIGURE 1. When the cleaner has been positioned at the desired depth, motor 24 is started to drive compressor 23 thereby supplying pressure fluid, air, for example, through standpipe 25 and hose 26 and swivel 22 to pipe 18. The pressure fluid flows through port 31 and conduit 44 into packers 15 and 16, thereby expanding the packers into contact with the wall of the well casing 11. During the time that packers 15 and 16 are being expanded, pressure regulating valve 33 prevents the flow of pressure fluid to the motors, as represented by 43, which drive the hammers 17. When the packers 15 and 16 have been expanded, and at a predetermined pressure above that necessary to actuate these packers, valve 33 opens, allowing the pressure fluid to flow to the motors thus actuating the hammers. Exhaust fluid from the motors flows through conduits such as the conduit 49 to the space between packers 15 and 16 and then through exhaust ports 47 and 48 to the annular space within the well casing surrounding pipe 18. Any liquid trapped between packers 15 and 16 will also flow through ports 47 and 48 to the space above the well cleaner, thus providing a substantially liquid-free space for the operation of the hammers and preventing the damping action which liquid would have. In some instances, where there may be substantial flow through the perforations or well screens in which the cleaner is positioned, it may be desirable to provide a back pressure valve in port 47 to maintain a positive pressure in the space between packers 15 and 16 to prevent the major portion of this inflow of liquid. It is noted that the packers 15 and 16 serve the dual function of anchoring the cleaner in the pipe and isolating the space in which the hammers operate.

In the embodiment illustrated in FIGURE 3, body 50 is provided with cylinders 51 and 52 in which are positioned packer pistons 53 and 54. Of course, it will be recognized that any desired number of cylinders and corresponding pistons may be provided. Packer pistons 53 and 54 are provided with packer rings 53*a* and 54*a* respectively. Each piston is hollow and thus provides working space for a hammer such as the one illustrated at 55. Each hammer is, in turn, driven by a power fluid motor such as 56, and 75. Recesses such as 57 and 57*a* are provided in the body 50, as shown, to position springs 58 and 58*a*. Spring 58 is under compression and normally holds motor 56 and hammer 55 in the retracted position shown in the lower illustrated unit. Spring 58*a* serves the same function in the upper unit. A supporting pipe 59 is connected to end piece 60 by threads 61. An inner pipe 62 provides a passageway for pressure fluid while supporting pipe 59 serves as the exhaust conduit. Conduits 63 and 64 connect with the interior of cylinders 51 and 52, respectively. The cylinders are provided with outlet ports 65 and 70 in which there are provided pressure regulating valves 66 and 71. Outlet port 65 communicates with elbow 67, flexible conduit 68, elbow 69, and thus with motor 56. Similarly, port 70, valve 71, elbow 72, flexible conduit 73, and elbow 74 connect motor 75 with cylinder 51. The power fluid motors, such as those illustrated as 56 and 75, exhaust to the space within pistons 53 and 54 and discharge ports 76 and 77 are provided to the interior of body 50.

In operation, the cleaner of FIGURE 3 is lowered into position in a manner and with equipment similar to that described for use with the embodiments of FIGURES 1 and 2 with the exception that the two concentric pipes 59 and 62 are provided.

It will be recognized by those skilled in the art that it is not essential that pipes 59 and 62 be concentric but may even be desirable, in some instances, to have these pipes run as parallel strings. In either case, the pipe 62 is connected with a suitable source of power fluid while pipe 59 exhausts to the atmosphere. Power fluid flowing through pipe 62 continues through conduits 63 and 64 to cylinders 51 and 52. The resulting pressure increase within the cylinders pushes the respective pistons toward the outside of body 50 against the force of spring 58 or 58*a*. The movement of the pistons continues until the packer elements 53*a* and 54*a* contact the wall of the pipe to be cleaned. These members serve the dual function of anchoring the cleaner in the pipe and isolating the space in which the hammers operate. At this point, the pressure within the system is allowed to increase slightly to a value sufficient to overcome the valves 66 and 71, thus permitting pressure fluid to enter motors 56 and 75 to drive their respective hammers. In the drawing, it will be seen that piston 53 is illustrated in the operative pressure applied position while piston 54 is in the retracted, low pressure position. When the respective pistons have been positioned with packer elements contacting the wall of the pipe to be cleaned, and pressure fluid is flowing to the driving motors, these motors will exhaust to the space within the packer pistons and discharge to the interior of body 50 as, for example, through ports 76 and 77 and thence through pipe 59 to the surface. It will be seen that, since the discharge ports 76 and 77 are at the lower portion of the respective hollow pistons, any liquid in these pistons will be discharged along with the exhaust pressure fluid, thus providing a substantially liquid-free space around each of the operating hammers.

It will be recognized that different motor power and packer actuating systems can be used. For example, the hammer motors may, if desired, be driven electrically, in which case they may, for example, comprise solenoid motors to reciprocate the hammers. Similarly, the packers may be actuated in other ways as, for example, by mechanical manipulation of the pipe string, pressure supplying combustible material, etc. However, it is further noted that there are specific advantages through the use of pressure fluid actuated components. For example, in both the embodiments described in relation to FIGURES 2 and 3, a single source of pressure fluid performs the three functions of driving the power means for the hammer, actuating the packer means, and evacuating the

space in which the hammers operate. Although in the preferred embodiments of the invention, a packer means serves the dual function of anchoring the cleaner and sealing a space in which the cleaner operates, separate packer means for each of these functions can be provided.

It is also possible to use the single pipe system of FIGURE 1 with an apparatus similar to that of FIGURE 3, by providing an exhaust opening in body **50**, for example, or to use the two pipe system of FIGURE 3 with the type of apparatus illustrated in FIGURES 1 and 2, by connecting port **47** with the discharge pipe. Exhaust ports **76** and **77** may or may not be provided with pressure regulating valves, as desired.

The operating pressure of the various parts of the system will depend to some extent upon the environment in which the cleaner operates. When operated in a well, the pressure existing at the bottom of the well bore determines the pressure necessary to set the packer. The exhaust pressure will also be a function of the well bore pressure where the single pipe system of FIGURE 1 is used, and in most instances, also in the two pipe system of FIGURE 3, since the exhaust fluid serves the additional function of forcing liquid from the zone in which the hammers operate. In some instances, it may be desirable to omit pressure regulating valve **33** of FIGURE 2 or the similar valves **66** and **71** of FIGURE 3. Since the exhaust pressure usually will be controlled by the well bore pressure, the operating pressure of the fluid motor usually will be above the pressure necessary to actuate the packers. However, it is sometimes desirable and may be essential in some instances to use the pressure regulating valve means to make certain the packer means are properly in position thus anchoring the cleaner before starting the fluid motors.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, the drawing, and the appended claims to the invention the essence of which is that there are provided a method and apparatus for cleaning hollow structures, said method comprising providing a substantially liquid-free space in which the cleaner operates and, in some embodiments, maintaining said space substantially liquid-free and operating power means for said cleaner by the use of pressure fluid from the same source; said apparatus comprising a pipe cleaner, a packer means to anchor said cleaner, a packer means to isolate a space in which said pipe cleaner operates and means to keep said space substantially liquid-free, a preferred embodiment comprising packer means serving a dual function by anchoring the cleaner and isolating a working space.

I claim:

1. A pipe cleaner comprising a body, a hammer carried by said body, pneumatic power means carried by said body to operate said hammer, means to position said cleaner in a pipe comprising means for supporting said body and supplying pressure fluid thereto to actuate said power means comprising a supporting tube attached to said body, packer means attached to said body actuated by pneumatic pressure to close the annular space between said body and the pipe surrounding said hammer, first conduit means for supplying pressure fluid to said packer means, second conduit means for supplying pressure fluid to said power means, means in said body to discharge exhaust fluid from said power means to the space surrounding said hammer closed by said packer means, and means in said body to discharge fluid from said space.

2. A pipe cleaner comprising a body, a hammer carried by said body, pneumatic power means carried by said body to operate said hammer, means to position said cleaner in a pipe comprising means for supporting said body and supplying pressure fluid thereto to actuate said power means comprising a supporting tube attached to said body, packer means attached to said body actuated by pneumatic pressure to close the annular space between said body and the pipe surrounding said hammer, first conduit means for supplying pressure fluid to said packer means, second conduit means for supplying pressure fluid to said power means and closure means in said second means adapted to open upon the application of pressure above that required for actuation of said packer, thereby delaying the actuation of said power means until after said packer means is actuated, means in said body for discharging exhaust fluid from said power means to said space surrounding said hammer closed by said packer means, and means in said body to discharge fluid from said space.

3. A pipe cleaner comprising a body, a hammer carried by said body, pneumatic power means carried by said body to operate said hammer, means to position said cleaner in a pipe comprising means for supporting said body and supplying pressure fluid thereto to actuate said power means comprising a supporting tube attached to said body, first and second packers attached to said body, spaced apart thereon, actuated by pneumatic pressure to close the annular space between said body and said pipe surrounding said hammer, first conduit means in said body for supplying pressure fluid to said packer means, second conduit means for supplying pressure fluid to said power means, means in said body to discharge exhaust fluid from said power means to the space surrounding said hammer closed by said packer means, and means in said body to discharge fluid from said space.

4. A pipe cleaner comprising a body, a hammer carried by said body, pneumatic power means carried by said body to operate said hammer, means to position said cleaner in a pipe comprising means for supporting said body and supplying pressure fluid thereto to actuate said power means comprising a supporting tube attached to said body, first and second packers attached to said body spaced apart thereon, actuated by pneumatic pressure to close the annular space between said body and said pipe surrounding said hammer, first conduit means for supplying pressure fluid to said packer means, second conduit means for supplying pressure fluid to said power means, closure means in said second conduit means adapted to open upon application of pressure above that required for actuation of said packer, thereby delaying the actuation of said power means until after said packers are actuated, exhaust means from said power means to the space between said packers, and means in said body to discharge fluid from said space.

References Cited in the file of this patent

UNITED STATES PATENTS

640,822	Smith	Jan. 9, 1900
834,306	Krause	Oct. 30, 1906
1,714,282	Stevens	May 21, 1929
2,148,722	Baily	Feb. 28, 1939
2,340,959	Harth	Feb. 8, 1944
2,617,134	Barton	Nov. 11, 1952
2,641,927	Grable et al.	June 16, 1953
2,851,111	Jones	Sept. 9, 1958
2,874,783	Haines	Feb. 24, 1959
2,918,973	Ozinga	Dec. 29, 1959