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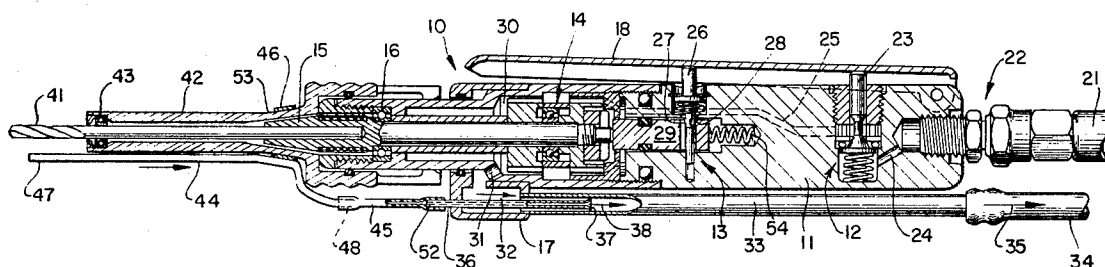
[56] **References Cited**
UNITED STATES PATENTS
 3,128,079 4/1964 DeGroff 128/305 X
FOREIGN PATENTS
 1,113,555 5/1968 Great Britain 15/409
 1,252,562 12/1960 France 32/28

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[54] **POWER DRIVEN SURGICAL INSTRUMENT
 HAVING ASPIRATOR**
3 Claims, 6 Drawing Figs.

[52] U.S. Cl. **128/305,**
 14/409, 415/503
 [51] Int. Cl. **A61b 17/16,**
 A61c 1/02, F03b 13/04
 [50] Field of Search **32/28;**
 15/3.53, 339, 387, 409; 128/305; 415/503

ABSTRACT: A high speed compressed gas-powered surgical instrument having a self-contained aspirator to assure a clear surgical field. The spent gases from the instrument motor are directed away from the surgical field and are used to create a partial vacuum in the aspirator conduit terminating adjacent the working end of the cutting tool.



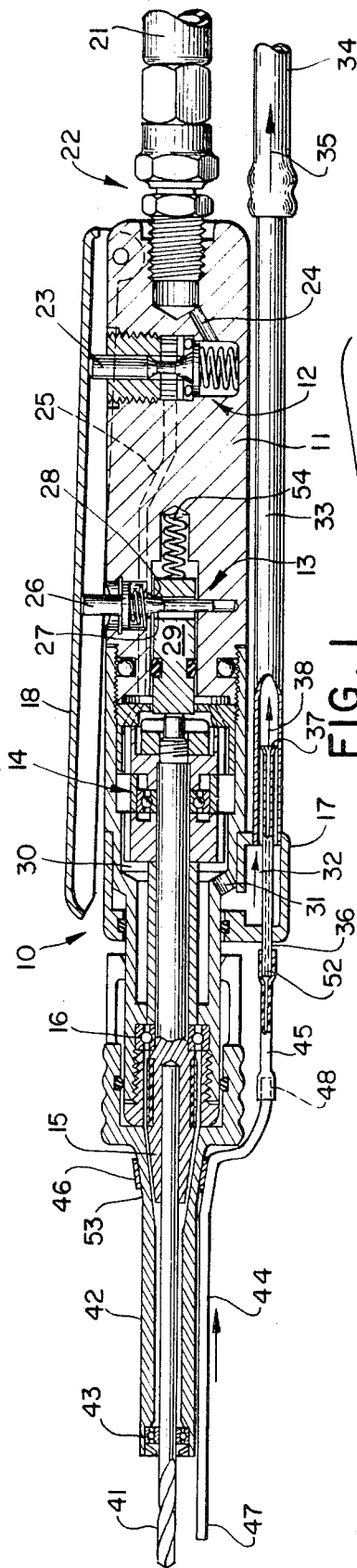


FIG. 1

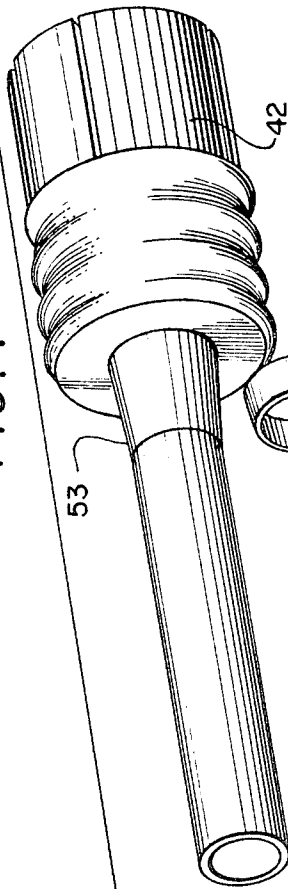


FIG. 2

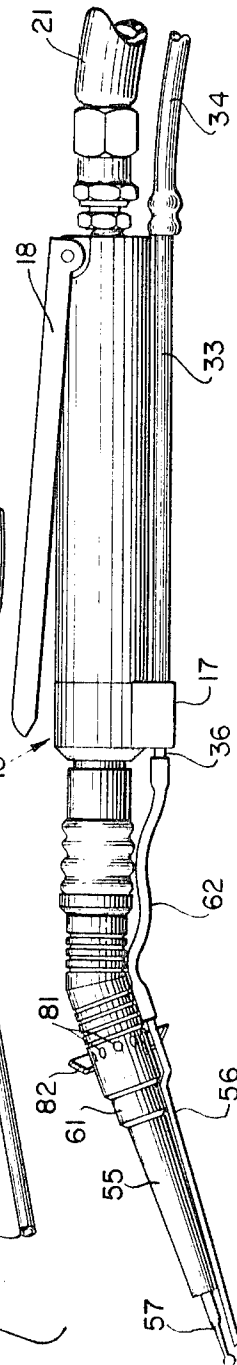


FIG. 3

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POWER DRIVEN SURGICAL INSTRUMENT HAVING ASPIRATOR

FIELD OF THE INVENTION

This invention relates generally to power driven surgical instruments and more particularly concerns a high speed surgical air drill having a self-contained aspirator system and means for directing exhaust gases away from the surgical field.

DISCUSSION OF THE PRIOR ART

High speed air drills were first used for medical purposes in the fields of dentistry and dental surgery. Although the dental tools are generally inadequate for use in surgery, the basic principles of the compressed gas-powered drill mechanisms are broadly applicable to the medical profession for surgical procedures involving cutting, drilling and shaping of solid materials such as bone.

Several developments have been made which enable the use of high speed instruments for many different surgical procedures. Due to the general nature of the surgical environment in which such instruments are used, a surgeon often finds himself operating with the tip of the cutting tool submerged in fluid material which must be aspirated in some manner. This is normally done by a separate suction device operated by an assistant who attempts to keep the surgical field as dry as possible while allowing the operation to proceed with a minimum of interference. Such added equipment and procedures tend to interfere somewhat with the operating surgeon and thereby increase the time necessary to complete an operation. When the surgical field is severely restricted in size, the use of separate aspirating equipment is a serious disadvantage and significantly increases the time and complexity of the operation. It has been medically proven that patient recovery time, and chances of survival in serious cases, can be substantially improved by decreasing the time required for an operation. Thus, an objective of the present invention is to provide means for performing many types of surgery more quickly and efficiently.

Another disadvantage of some of the prior art devices is that the spent gases from the instrument motor are exhausted in uncontrolled fashion in the vicinity of the surgical field. The existence of a stream of air or gas anywhere in the operating area and especially between the surgeon's eyes and the surgical field is a definite handicap in performing the operation. Furthermore, such a stream of gas could blow portions of clothing or other foreign material about the area, causing distraction or possibly contamination. Accordingly, it is another object of this invention to remove gases which are exhausted from the rotating motor completely away from the operating area.

SUMMARY OF THE INVENTION

Broadly speaking, this invention comprises a controllable motor and a connected chuck disposed within a housing, interchangeable cutting tools mounted in the chuck and an aspirator system attached to the housing and extending to the vicinity of the working end of the cutting tool. The motor is powered by compressed air or an inert compressed gas such as nitrogen. The basic instrument, including the housing, motor and chuck, comprise what will herein be termed an "air drill." The air drill, together with the cutting tool and an interchangeable cutting tool extension and support, is disclosed in U.S. Letters Pat. No. 3,384,085 issued on May 21, 1968 to Robert M. Hall, and this invention is an improvement thereon. The patent to Hall is cited herein for reliance as disclosure and in the specification which follows herebelow, the basic instrument disclosed in the above patent will be described only as may be necessary to the explanation of the construction and operation of this invention.

The aspirator system of this invention comprises a conduit extending from adjacent the forward tip of the cutting tool into an exhaust tube. The rearward end in the aspirator conduit in the exhaust tube is flared so that a venturi effect is created by the flow of exhaust gases past that end of the aspirator conduit. The exhaust tube thus performs the functions of directing exhaust gases away from the operating area as well as creating a partial vacuum in the conduit for aspirating the surgical field.

The advantages of the prior air drill are well enumerated in the above-mentioned patent. The improvement disclosed herein provides even greater flexibility for such a surgical instrument, allowing it to be conveniently used in an even wider range of surgical procedures, while materially simplifying such procedures. When the air drill of this invention is used in an operation where fluid material is present in the surgical field, the need for a separate aspirator is eliminated with the necessary aspiration being accomplished simultaneously with the cutting, drilling and shaping done by the surgeon. The intensity of the high pitched sound of the air drill is greatly diminished through the use of the exhaust gas directing means disclosed herein. This result is beneficial to both the patient and operating room personnel for both psychological and physical reasons. Also, prior art air drills which were smoothly cylindrical presented certain control difficulties for surgeons with wet, slippery gloves. Such control problems arise from the fact that the rotation of the instrument motor creates an element of torque on the air drill, which torque is sharply increased when the cutting tool initially makes contact with bone or other body material. The exhaust tube and aspirator of this invention provide radial projections which effectively prevent any rotation from occurring when the instrument is normally gripped for use. Furthermore, by preventing exhaust gas from blasting forward in an uncontrolled manner, any tendency of the instrument to react by jumping rearward when first energized is removed.

An alternative embodiment discloses means for reversing the direction of flow in the aspirator conduit to free it of materials which have caused obstructions therein. This reversing means generally comprises a valve in the exhaust tube downstream from the venturi, which valve can be closed to reverse the fluid flow through the aspirator conduit under the pressure of the exhaust gas.

BRIEF DESCRIPTION OF THE DRAWING

A complete understanding of the invention and its features and advantages will become apparent from the following detailed description taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a sectional view of a surgical instrument constructed in accordance with the principles of this invention;

FIG. 2 is an enlarged separated view of the normally interconnected interchangeable cutting tool extension and support member and aspirator conduit shown in FIG. 1;

FIG. 3 is an elevational view of the surgical instrument of FIG. 1 having a modified cutting tool extension and support member;

FIG. 4 is the surgical instrument of FIG. 1 with an alternative arrangement for controlling the supply of compressed gas to the instrument together with a vacuum pump connected in the exhaust line;

FIG. 5 is an enlarged sectional view taken through the cutting plane 5-5 of FIG. 4; and

FIG. 6 is a partial elevational view of the drill of FIG. 1, showing in section a direction reversing valve in the exhaust line.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the drawing, the details of the motor and the path of compressed gas flow through the surgical instrument are clearly shown in FIG. 1. The operation of the motor is fully set forth in U.S. Pat. No. 3,384,085 referred to

above and will be described only very basically herein. The basic surgical instrument, referred to generally by the reference numeral 10, includes housing 11 which essentially encloses control valve 12, motor braking mechanism 13, motor 14, chuck 15, bearings 16, exhaust manifold 17 and throttle lever 18.

The motor is normally powered by compressed air or an inert compressed gas such as nitrogen. The compressed gas enters handle 11 from supply tube 21 through a conventional coupling 22. When throttle lever 18, which is pivoted at the rear of instrument 10 near coupling 22, is pressed downward, stem 23 is forced downward opening valve 12 to thereby permit the compressed gas to flow through it from passageway 24 into passageway 25 and then to motor 14. Also when throttle lever 18 moves downward, stem 26 of braking means 13, which is in contact with the throttle lever, is forced downward causing tapered surface 27 thereon to press against shoulder 28 of brake member 29, forcing the brake member in a rearward direction away from motor 14. The compressed gas then powers motor 14 as it passes through the motor in a forward direction. Upon leaving the motor, the spent gas enters chamber 30 forward of the motor and passes into manifold 17 through opening 31 in housing 11. This reduced pressure gas then proceeds rearwardly in the direction of arrow 32 through rigid exhaust tubing 33 and on through flexible exhaust tubing 34 in the direction of arrow 35. It is evident from the drawing that tubing 34 is removably secured to tubing 33 in a conventional manner. The aspirator system includes venturi tube 36 which is securely mounted in manifold 17 and extends rearwardly into exhaust tubing 33. The rearward end 37 of venturi tube 36 in exhaust tubing 33 is flared as shown in FIG. 1. When the exhaust gas flows past end 37 of tube 36, a partial vacuum is created within tube 36 because of the venturi structure in tubing 33. The purpose of this will be explained below.

Chuck 15 is connected to motor 14 and rotates therewith. Interchangeable tools, such as drill 41, may be inserted as desired into chuck 15 where they are firmly grasped for rotation with the motor. FIG. 1 shows interchangeable cutting tool extension and support member 42 mounted on the forward end of housing 11. This element is not necessary to the construction and operation of the present invention but is often used and will therefore generally be included as part of the combination described herein. Extension 42 is interchangeable with other extensions having different sizes and configurations for different surgical procedures, an example of which is shown in FIG. 3. The primary purpose of extension 42 is to provide a bearing 43 as close as possible to the operating tip of drill 41 to prevent a "whipping" action of the drill tip. The specific construction and advantages of extension 42 are fully described in the above-mentioned U.S. Pat. No. 3,384,085.

The aspirator system, which is mounted on and combined with the air drill generally described above, may be generally termed a conduit, which includes substantially rigid tube 44, flexible tube 45, venturi tube 36 and exhaust tubing 33 and 34. Rigid tube 44 is shown removably mounted on extension and support 42 by means of ring mount 46 which encircles tapered portion 53 of the extension, as is clearly shown in the enlarged separated view of FIG. 2. Of course, tube 44 may be mounted directly on the forward end of housing 11 if extension 42 is not used. Alternately, tube 44 and extension 42 may be permanently secured together by any suitable means and the combination attached to air drill 10 as a unit. Forward end 47 of tube 44 extends to a point forward of the forward end of extension 42 and adjacent the tip of cutting tool 41 when the latter is mounted in chuck 15, while the rearward end 48 of tube 44 roughly aligns longitudinally with forward end 52 of venturi tube 36. A short length of flexible tubing 45 connects rearward end 48 of tube 44 to forward end 52 of venturi tube 36. It is thus evident that when throttle lever 18 is pressed downward causing cutting tool 41 to rotate at high speed, a partial vacuum exists at forward end 47 of rigid tube 44 as a result of the venturi effect created by exhaust gases flowing rearwardly past end 37 of venturi tube 36, thereby causing

fluids surrounding the forward end of tube 44 to flow through the aspirator system in the direction of arrow 38.

There are several advantages of the invention disclosed herein, an example of which is described above and shown in FIG. 1. One is that with the manifold construction and exhaust tubing shown, the exhaust gases are prevented from in any way obstructing the surgical field or distracting the surgeon's attention therefrom. Another is that with a relatively simple apparatus, the need for a separate aspirator system is removed and the immediate area around the field of operation is continuously aspirated as the air drill is being used. Other advantages include greatly reduced noise level by directing the exhaust gas away from the operating area, and enhanced handling and manipulation control of the instrument.

It is evident from FIG. 1 that when throttle lever 18 is released it is forced upward by the springs in valve 12 braking mechanism 13. As lever 18 rises valve 12 closes and the compressed gas is prevented from reaching motor 14 through passageway 25. At the same time stem 26 of braking mechanism 13 moves upward allowing brake member 29 to move forward under the urging of spring 54 and make frictional contact with motor 14, thus stopping the rotation of motor almost immediately after the power is removed therefrom.

The air drill shown in FIG. 3 is equipped with a different cutting tool extension and support member 55 and aspirator tube 56. Extension member 55 is provided with a suitable universal joint and chuck to transmit the rotation of the motor to cutting tool 57. Aspirator tube 56, while shaped to conform to the configuration of extension member 55 is connected to the extension by means of ring mount 61, in a manner similar to the connection shown in FIG. 2. Venturi tube 36 is mounted as before in exhaust manifold 17 and is connected to the rearward end of aspirator tube 56 by means of flexible tubing 62. It is thus evident that the aspirator system shown in FIGS. 1 and 2 may be easily modified for any size, shape or length of cutting tool extension and support, as indicated by FIG. 3.

With further reference to FIG. 3, air exhaust holes 81 may be seen approximately midway along extension 55. A certain amount of the spent gas, after powering motor 14, tends to seep into extension 55 and travel forward therein. To prevent this exhaust gas from passing out of the extension through its forward end in the vicinity of the surgical field, holes 81 are provided at an intermediate location and are directed away from the operating area by means of dish-shaped baffle 82. This baffle is disposed rearwardly of ring mount 61 and surrounds extension 55. It is provided with a slot through which aspirator tube 56 passes. This slot also allows the aspirator tube to be removed from the extension if desired, without the necessity of removing baffle 82.

Another embodiment of the surgical instrument disclosed herein is shown in FIGS. 4 and 5. Alternatives for both the aspirator system and the means for controlling the operation of the air drill are shown in FIG. 4. A clamp ring 63 having an arm 64 is rotatably mounted on housing 11 rearward of exhaust manifold 17. This device enables the operating surgeon to lock the air drill with the motor rotating in order to free his fingers from the controls so that he may enjoy greater dexterity and consequently greater operating precision during delicate surgical procedures. Another and related advantage of clamp ring 63 is that the air drill operation may then be controlled by foot valve 65 which is a conventional device shown schematically in FIG. 4. This also enables the surgeon to have full use of his hands as may be required, but at the same time provides him direct control over the air drill motor with his foot. Some surgeons prefer foot control because fingertip manipulation of throttle lever 18 often produces a certain amount of wavering of the tip of the cutting tool, while others like the flexibility of being able to use either method of control.

FIG. 5 shows the air drill in cross section through the exhaust manifold, with clamp ring 63 in locking position. It is

evident from this figure that arm 64 locks throttle lever 18 in the open, or power-on, position when clamp ring 63 is rotated clockwise. Thus, with clamp ring 63 mounted on housing 11, air drill 10 may be operated by finger control of throttle lever 18, locked in a full operating condition, or controlled by operation of foot control valve 65.

The aspirator system alternative shown in FIG. 4 includes a vacuum pump 66 connected in the exhaust line 34 of the air drill. By thus creating a partial vacuum in exhaust tube 33, the partial vacuum in the aspirator system will be increased, thereby increasing the capacity of the system, while simultaneously increasing the operating efficiency of the air drill motor.

Another modified embodiment of the instrument disclosed herein is shown in FIG. 6 wherein a "trumpet" valve 67 has been inserted into exhaust tube 33 downstream from venturi 37 to thereby enable the flow of the aspirated fluid to be easily reversed. Trumpet valve 67 comprises a plunger 71 having a tapered valve member 72, a stem 73 and a flat head 74. Spring 75 urges valve 67 to an open position by maintaining pressure on disc 76 which is secured to stem 73. Should an obstruction become lodged at some point in the aspirator system forward of venturi 37, valve 67 may be closed by simply pressing in on flat head 74, thereby closing exhaust tube 33. The exhaust gas then will be directed down venturi tube 36 in the direction opposite to that indicated by arrow 38 in FIG. 1. This reverse pressure will normally be sufficient to blow any obstruction out of the aspirator system through forward end 47 of tube 44. When the obstruction has been removed, valve 67 is released and the exhaust and aspirator systems are returned to normal operation.

Since exhaust tubing 33, 34 are also part of the aspirator system, tubing 34 will normally terminate in some type of reservoir or sump for collecting the fluid material picked up by the aspirator. Vacuum pump 66, which is shown schematically, may include such a reservoir.

It should be noted that this air drill is an extremely light weight, easily operated instrument. Its total length is slightly over five inches and it weighs in the vicinity of six ounces. The motor rotates at approximately one hundred thousand revolutions per minute with compressed gas having pressure in the range of ninety to one hundred ten pounds per square inch. All parts of this instrument are autoclavable while the instrument itself is fully spark-free for operating room safety. The flexible tubing may be made of such materials as neoprene and the rigid tubing can be made of such noncorrosive materials as titanium. The power source is normally an inert gas such as compressed dry nitrogen or pure grade compressed dry air.

Although one basic embodiment and several modifications have been shown and described herein, many other improvements and modifications will likely occur to those skilled in this art which are within the inventive concepts disclosed herein.

What I claim is:

1. A high speed compressed gas-powered surgical instrument for retaining and rotating a cutting tool connected thereto, comprising:

a housing having a compressed gas-powered motor therein, means for connecting said motor to a source of compressed gas and valve means for selectively applying compressed gas to said motor for rotation thereof;

a chuck at the forward end of said surgical instrument, said chuck being driven by said motor and being capable of removably retaining a cutting tool for rotation therewith;

an interchangeable cutting tool extension and support member mounted on the forward end of said housing, said extension and support member being formed with a plurality of side openings therein to allow seepage exhaust gas to escape therefrom;

baffle means secured to said support member for directing said seepage exhaust gas away from said forward end of said extension and support member;

means for directing primary motor exhausting gas away from said forward end of said surgical instrument, said

means including a manifold and a tube coupled to said manifold; and

conduit means extending from a point forward of said forward end of said surgical instrument rearwardly into said tube, the rearward end of said conduit means within said tube being flared so as to reduce the cross-sectional area in one portion of said tube through which said primary exhausting gas flows, thereby providing a partial vacuum in said conduit means in response to flow of said primary exhausting gas through said tube and past said flared end of said conduit;

said conduit means being removably secured to said extension and support member and extending forward of the forward end of said extension and support member;

said conduit means comprising a substantially rigid forward portion secured to said extension and support member, a substantially rigid rearward portion secured to and extending into said tube and including said flared portion, and a flexible portion removably interconnecting said forward portion and said rearward portion.

2. A high speed compressed gas-powered surgical instrument for retaining and rotating a cutting tool connected thereto, comprising:

a housing having a compressed gas-powered motor therein, means for connecting said motor to a source of compressed gas and valve means for selectively applying compressed gas to said motor for rotation thereof;

a chuck at the forward end of said surgical instrument, said chuck being driven by said motor and being capable of removably retaining a cutting tool for rotation therewith;

means for directing motor exhausting gas away from said forward end of said surgical instrument, said means including a manifold and a tube coupled to said manifold;

conduit means extending from a point forward of said forward end of said surgical instrument rearwardly into said tube, the rearward end of said conduit means within said tube being flared so as to reduce the cross-sectional area in one portion of said tube through which said exhausting gas flows, thereby providing a partial vacuum in said conduit means in response to flow of said exhausting gas through said tube and past said flared end of said conduit; and

a clamp ring mounted on said housing for rotation between first and second positions;

wherein said means for selectively applying compressed gas to said motor includes a throttle lever operable between an open position permitting compressed gas to flow to said motor and a closed position for inhibiting the flow of compressed gas to said motor;

said clamp ring, when in said first position, locking said throttle lever in said open position and, when in said second position, permitting said throttle lever to be moved freely between said open and closed positions.

3. A high speed compressed gas-power surgical instrument for retaining and rotating a cutting tool connected thereto, comprising:

a housing having a motor therein, means for connecting said motor to a source of compressed gas and valve means for selectively applying compressed gas to said motor for rotation thereof;

a chuck at the forward end of said surgical instrument, said chuck being driven by said motor and being capable of removably retaining a cutting tool for rotation therewith;

means for directing motor exhausting gas away from said forward end of said surgical instrument, said means including a manifold and tube coupled to said manifold;

conduit means extending from a point forward of said forward end of said surgical instrument rearwardly into said tube, the rearward end of said conduit means within said tube being flared so as to reduce the cross-sectional area in one portion of said tube through which said exhausting gas flows, thereby providing a partial vacuum in said conduit means in response to flow of said exhausting gas

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through said tube and past said flared end of said conduit;
and
valve means in said tube for selectively reversing the

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direction of flow of said exhausting gas to a forward
direction through said conduit means.

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