July 1, 1969 G. K. AUSTIN, JR 3,452,751

AIR OPERATED EVACUATION SYSTEM

Filed Nov. 12, 1965 Sheet 1 of 2

FIG. 1

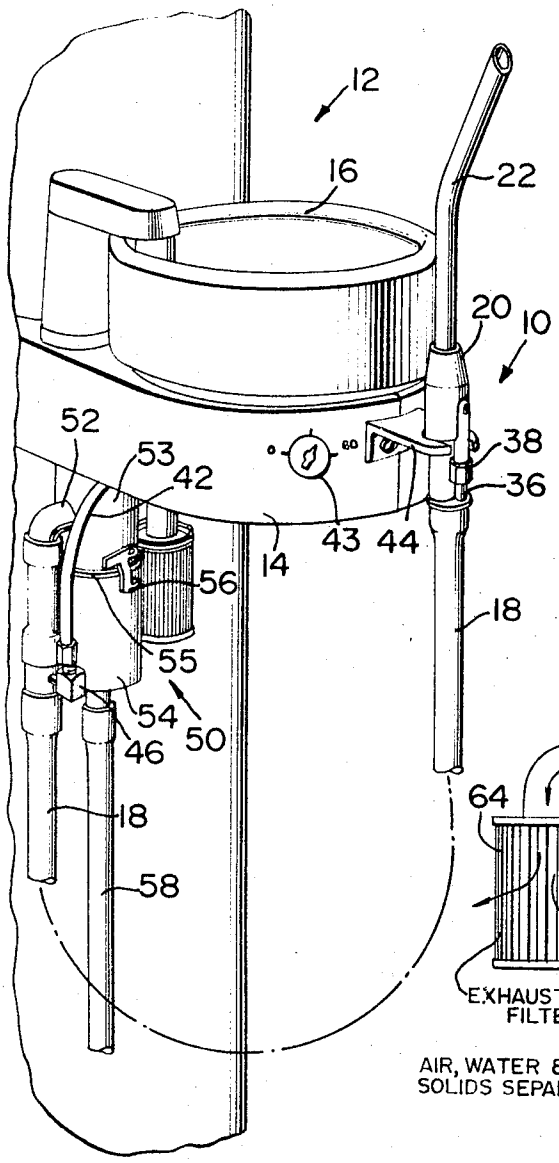
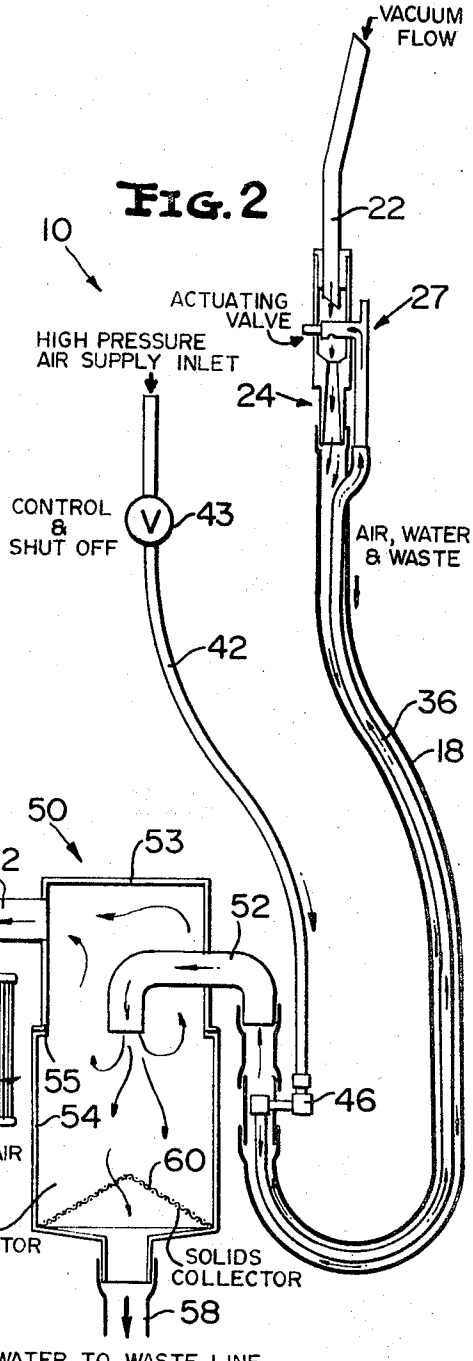


FIG. 2



INVENTOR

GEORGE K. AUSTIN Jr.

BY Mason, Porter, Adler & Backer

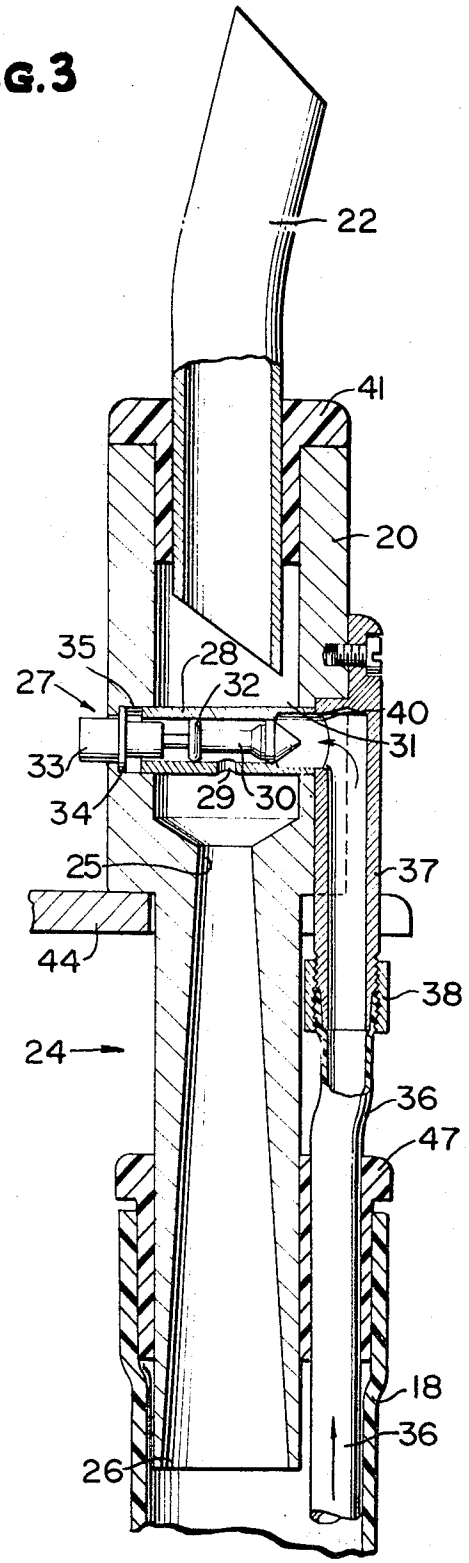
ATTORNEYS

July 1, 1969 G. K. AUSTIN, JR 3,452,751

AIR OPERATED EVACUATION SYSTEM

Filed Nov. 12, 1965 Sheet 2 of 2

FIG. 3



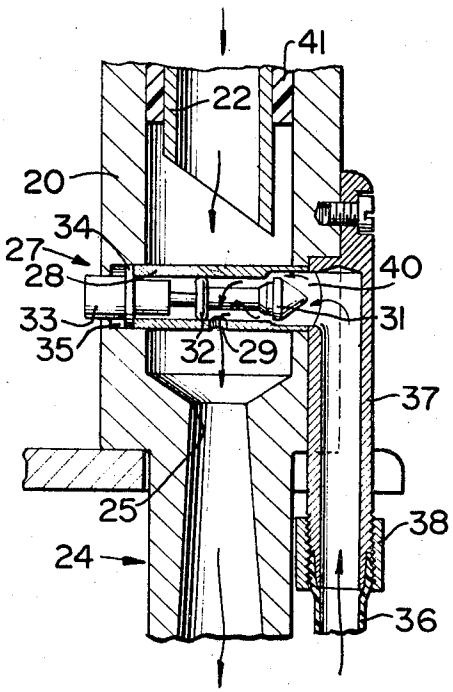


FIG. 4

INVENTOR
GEORGE K. AUSTIN Jr.

BY Mason, Porter, Diller & Brown
ATTORNEYS

United States Patent Office 3,452,751
Patented July 1, 1969

3,452,751

AIR OPERATED EVACUATION SYSTEM

George K. Austin, Jr., P.O. Box 111,
Newberg, Oreg. 97132

Filed Nov. 12, 1965, Ser. No. 507,324
Int. Cl. A61m *1/00*; F04f *5/48, 5/00*
U.S. Cl. 128—277 5 Claims

ABSTRACT OF THE DISCLOSURE

An air operated aspirating apparatus wherein a Venturi is located adjacent an intake end of a fluid conducting line and fluid pressure means are provided for directing a flow of gas through the Venturi toward the downstream end of said line. The fluid conducting line carries entrained matter, under the influence of positive pressure, to a fluids and solids separator located in said line downstream from said Venturi.

This invention relates to an air operated evacuation system and more particularly to improved apparatus for evacuating water and debris which accumulates in the mouth of a dental patient during the practice of high-speed dentistry using the washed-field technique.

Previously known types of apparatus useful for practicing this dental technique include the use of a motor-fan air evacuation unit similar to a conventional household vacuum cleaner. Such units are utilized to draw a suction, or produce a negative pressure, in a fluid conducting line which has an intake end adaptable for being held in the mouth of a dental patient. Such previously known apparatus relies upon the motor-fan air evacuation unit to cause wash water and debris to be entrained in a large volume flow of air and be moved through the fluid conducting line to waste by the action of negative pressure created by the motor-fan evacuation unit.

It is a primary objective of this invention to provide a novel type of evacuation apparatus wherein a Venturi is located closely adjacent the intake end of the fluid conducting line and the flow of actuating air to the Venturi produces a low positive pressure from the Venturi to the outlet end of the fluid conducting line thereby substantially reducing the amount of air intake at the intake end of the fluid conducting line. Accordingly, the present invention reduces the amount of atmospheric air which is drawn into the patient's mouth thereby reducing the amount of atmospheric dust deposited upon the moist tissues of the patient's mouth and also reducing dehydration of such moist tissues.

Another object of this invention is to reduce the length of travel, under a negative pressure, for the material which is being evacuated.

Another object of this invention is to provide regulating means for varying the inflow of air at the nozzle of the fluid conducting line.

Another object of this invention is to eliminate the vacuum line pulsations commonly found in prior art devices.

Another object of this invention is to provide an improved evacuation apparatus in combination with a conventional dental unit wherein the pressure control valve is conveniently mounted upon the dental unit and the downstream end of the fluid conducting line is conected to the detal unit drainage system.

Another object of this invention is to provide evacuation apparatus which includes an actuating valve having a novel construction and being located closely adjacent to the intake end of the fluid conducting line.

A further object of this invention is to provide a novel combination of a high pressure gas line and a low pressure fluid conducting line wherein the high pressure gas line is disposed within the low pressure fluid conducting line whereby inadvertent rupture of the high pressure gas line would create no hazard to persons or related equipment.

It is to be understood that while the present invention is described with particular reference to dental or surgical procedures, the invention is not limited to use in such fields, since other related uses will become readily apparent to those skilled in the art.

With the above and other objects in view which will hereinafter appear, the nature of the invention will be clearly understood by reference to the following and detailed description, the appended claimed subject matter and the several views illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a fragmentary perspective view illustrating the major components of the present invention mounted upon the cuspidor arm of a conventional dental unit.

FIGURE 2 is a diagrammatic view, partly in section, illustrating the evacuation apparatus contemplated by the present invention.

FIGURE 3 is an enlarged cross-section of a novel hand piece illustrating the finger tip valve in the non-operating position.

FIGURE 4 is a fragmentary section showing the finger tip valve in the depressed or operating position.

Referring to the drawings in detail, the invention relates to a novel evacuation apparatus, generally indicated by the numeral **10**, which is shown for illustrative purposes as being usable in combination with a conventional dental unit, generally indicated by the numeral **12**. The dental unit **12** is preferably of the type provided with a cuspidor arm **14** and a cuspidor **16**.

A fluid conducting line **18** includes a hand piece **20** at the intake end thereof and is provided with an intake nozzle **22**. The intake nozzle **22** is small enough in size to be insertable within the mouth of a dental patient at the same time that a dentist is performing a drilling or surgical operation.

Incorporated within the hand piece **20** is a Venturi, genally indicated by the numeral **24** and clearly shown in FIGURES 2–4. The Venturi **24** includes a small diameter open portion **25** located at the upstream end thereof and an enlarged diameter open portion **26** located at the downstream end thereof. An actuating valve, generally indicated by the numeral **27**, is located in the hand piece **20** and is disposed intermediate the intake nobble **22** and the Venturi **24**. The actuating valve **27** includes a tubular housing **28** transversely disposed within the hand piece **20** and having a jet opening **29** on a side thereof directed toward the Venturi **24**. A plunger **30** is slidably mounted within the housing **28** and is provided with a pair of O-rings **31** and **32**. The plunger **30** is provided with a push button **33** having a collar **34** disposed within a recess **35** in the hand piece **20**. A high pressure gas line **36** has one end thereof attached to the tubular housing **28** by a hollow stem **37** and a suitable screw-threaded coupling **38**. A flow of high pressure gas through the line **36** will, as is best shown in FIGURE 3, force the plunger **30** to the left so as to cause O-ring **31** to be seated within the tubular housing **28**. As is shown in FIGURE 4, when the push button **33** is depressed the O-ring **31** is moved into a cavity **40** and becomes unseated from the tubular housing **28** so that high pressure gas flowing through the line **36** and housing **28** exits through jet opening **29** and is directed through Venturi **24** downstream from the intake nozzle **22**. Accordingly, a partial vacuum or negative pressure, i.e., pressure below atmospheric pressure, is created in the intake nozzle **22** upstream from the actuat-

ing valve **27**. The intake nozzle **22** is attached to the hand piece **20** by a suitable plastic fitment **41** and a sealing fit is established between the nozzle **22** and the fitment **41** so that atmospheric air, liquids and small solids are sucked into the nozzle **22** and are drawn downstream past the actuating valve **27** by the action of the partial vacuum. After the air, liquids and solids pass the actuating valve **27** they are forced downstream through the Venturi **24** and line **18** by a positive pressure, i.e., above atmospheric pressure, which is produced by the air or other gases which enter the Venturi through the high pressure gas line **36** and jet opening **29**. Thus, the matter drawn into the apparatus gets an added push by low positive pressure from the jet opening **29** completely through the fluid conducting line **18**.

The evacuation apparatus **10** is preferably operated by high pressure air but other compressed gases, such as carbon dioxide, can also be used. In the preferred form of the invention, the high pressure gas line **36** has a first line portion **42** connected to a high pressure air supply (not shown) such as a suitable air compressor. A control and shut-off valve **43** is located in the line portion **42** and is preferably mounted upon the cuspidor arm **14** so as to be conveniently located adjacent a mounting bracket **44** for hand piece **20**.

A fitting **46**, as is shown in FIGURE 2, is provided for connecting line portion **42** to the high pressure gas line **36**. As is clearly apparent from FIGURES 2 and 3, the apparatus **10** is provided with a safety feature wherein the high pressure gas line **36** is contained within the fluid conducting line **18** from the fitting **46** to a fitment **47** located adjacent the upstream end of the line **18**. The fitment **47** has a pair of openings formed therein and provides a seal-fit with the Venturi portion **24** of the hand piece **20** and with the high pressure gas line **36**.

An air, water and solids separator, generally indicated by the numeral **50**, is connected to the downstream end of fluid conducting line **18** by a drain tube **52**. The separator **50** includes an upper portion **53** and a lower portion **54** which are detachably connected together, at **55**, by a conventional screw-coupling or bayonet joint or may be clamped together by a gravity-actuated latch member **56**.

The discharge portion of drain tube **52**, located within the separator **50**, is directed downwardly toward a drain and waste line **58**. It is desirable that a screen member or solids collector **60** is disposed within the lower portion **54** in order to trap large solid particles, such as gold inlays, which may inadvertently be drawn into the intake nozzle **22** during a dental operation.

The upper portion **53**, of the separator **50**, is equipped with an outlet tube **62** so as to be placed in fluid communication with an exhaust air filter **64**. Thus, air entering the apparatus at the intake nozzle **22** and at the actuating valve **27** is exhausted at the filter **64**, while liquids and small solids are passed to waste through line **58**.

The evacuation apparatus **10** is operated by high pressure air, or other gas, entering at the supply inlet such that the pressure may be regulated at the control and shut-off valve **43** so that air at a constant pressure is delivered by line portion **42** and line **36** to the actuating valve **27**. The high pressure air cannot pass O-ring **31** until the plunger **30** is depressed by a force upon push button **33**. When the push button **33** is depressed the O-ring **32** prevents the air from escaping through the recess **35** and around the collar **34**. Thus, the high pressure air is directed outwardly through jet opening **29** and passes downstream through the Venturi **24** so as to create a partial vacuum or negative pressure in the intake nozzle **22**. Atmospheric air rushes into intake nozzle **22** and will entrain therein liquids and solids which are to be disposed of. As such material passes the actuating valve **27** it is introduced to a positive pressure as a result of the expansion of the high pressure air fed into the system through the line **36**. The air, liquids and solids pass through the fluid conducting line **18** and drain tube **52** and are separated at the separator **50** such that the air is exhausted through filter **64** and the liquids and small solids pass through the screen **60** and into the drain and waste line **58**. Large solid materials are separated from smaller solid material and liquids by the screen **60**. The large solids may be removed from the lower portion **54** by disconnecting the lower portion from the upper portion **53** at the connection **55**.

A typical set of operating data for a commercial embodiment is set forth in the following table:

Static vacuum in. Hg	Air line pressure, p.s.i.g.	Water ejected, cc. per second	Vac. air flow at nozzle, c.f.m.	Input, c.f.m.	Vortex, in.
0.5	10	0.9	1.6	.07	
1.1	20	5	2.9	1.1	5/32
1.8	30	11	3.9	1.5	7/32
2.3	40	18	5.2	1.8	1/4
3.0	50	25	6.1	2.1	9/32
3.7	60	30	6.7	2.4	5/16
4.6	70	35	7.0	2.6	

The above data were compiled while using an intake nozzle **22** which had an internal diameter of 25/64 inch. Air pressure in the high pressure gas line **36** was varied in increments of 10 p.s.i. from zero to 70 p.s.i.g. A desirable operating pressure, both from the standpoint of efficiency and the use of relatively low pressures for safety purposes is 40 p.s.i.g. At this recommended pressure the apparatus develops a static vacuum of 2.3 inches of mercury, which value is well below that which would cause pain to a patient if the intake nozzle **22** were to come in contact with tissue.

Using the washed field technique of dentistry, a stream of cleansing liquid is projected upon the operative field in order to control temperature at the drilling bit and to wash away debris. It has been established that the capacity of a patient's mouth is approximately 150 cubic centimeters per minute. As is indicated by the above table the apparatus of the present invention is capable of ejecting 18 cubic centimeters of cleansing liquid per second when operating at the recommended air pressure of 40 p.s.i.g. It is readily apparent that the present apparatus is capable of ejecting over 1,000 cubic centimeters of cleansing liquid per minute while vacuum air flow at the nozzle **22** is held at a relatively small flow of 5.2 cubic feet per minute as compared to known types of apparatus which require an air flow in excess of a 8.0 cubic feet per minute.

What is claimed is:

1. Evacuation apparatus comprising a fluid conducting line having an intake end and a downstream end, a Venturi disposed within said fluid conducting line adjacent the intake end, means for directing a flow of gas through said Venturi away from said intake end toward said downstream end to produce a negative pressure upstream from said Venturi, said downstream of said fluid conducting line being provided with a separator device for separating air from liquids and solids, said separator device including means for connecting said device to a waste line and a solids collector screen disposed for preventing passage of large solids into said waste line, and an exhaust air filter mounted adjacent a top portion of said separator device for filtering air received from said fluid conducting line and precluding discharge of liquids and solids therethrough.

2. Apparatus as defined in claim **1** wherein said separator device includes means for detachably coupling the top portion of said device to the bottom portion of said device.

3. Evacuation apparatus comprising a fluid conducting line having an intake end and a downstream end, a Venturi disposed within said fluid conducting line adjacent the intake end, and means for directing a flow of gas through the Venturi away from said intake end toward said downstream end to produce a negative pressure upstream from said Venturi, the improvement comprising said evacuation apparatus in combination with a

dental unit and a source of compressed gas, a gas pressure control valve mounted on said dental unit and connected to said source of compressed gas, and a high pressure gas line having a first portion leading from said gas control valve to said fluid conducting line adjacent the downstream end thereof and a second portion disposed within said fluid conducting line and extending from adjacent said downstream end to adjacent said intake end, and valve means connected to said second portion of said gas line at the upstream side of said Venturi.

4. Evacuation apparatus comprising a fluid conducting line having an intake end and a downstream end, a Venturi disposed within said fluid conducting line adjacent the intake end, and means for directing a flow of gas through said Venturi away from said intake end toward said downstream end to produce a negative pressure upstream from said Venturi, the improvement comprising said evacuation apparatus in combination with a dental unit having a waste line; a separator device, means on a lower portion of said separator device connecting it to said waste line, means on an upper portion of said separator device connecting it to the downstream end of said fluid conducting line, an exhaust air filter mounted on the upper portion of said separator device, a solids collector screen disposed in said lower portion of said separator device, and means for detachably connecting said lower portion to said upper portion of said separator device.

5. Evacuation apparatus comprising a fluid conducting line having an intake end and a downstream end, a Venturi disposed within said fluid conducting line adjacent the intake end, and means for directing a flow of gas through said Venturi away from said intake end toward said downstream end to produce a negative pressure upstream from said Venturi; said means for directing a flow of gas through said Venturi comprising an actuating valve having a jet disposed in fluid communication with said fluid conducting line at the upstream end of said

Venturi, and a gas supply line connected to said actuating valve; an intake nozzle detachably mounted at the intake end of said fluid conducting line and having an orifice open to the atmosphere, and means for producing a static suction at said orifice of no more than five inches of mercury and being capable of drawing an inflow stream of air of less than eight cubic feet per minute at atmospheric pressure through said orifice when said gas supply line discharges 2.6 cubic feet of gas per minute at 70 pounds per square inch gage through said actuating valve.

References Cited

UNITED STATES PATENTS

988,345	4/1911	Irgens	128—277
1,345,606	7/1920	Leonard	128—277 X
2,253,143	8/1941	Siegel	32—33
2,575,513	11/1951	Fox	128—277
2,900,978	8/1959	Johannisson	128—276
3,017,886	1/1962	Thompson	128—276
3,164,153	1/1965	Zorzi	32—33
2,191,717	2/1940	Jeffery	230—95
2,605,043	7/1952	Stetser	230—95
2,846,710	8/1958	Haka	230—95
2,851,213	9/1958	Swallert	230—95
2,902,992	9/1959	Renvall	128—145.7
3,143,109	8/1964	Gewertz	128—276
3,335,727	8/1967	Spoto	128—276

FOREIGN PATENTS

942,189	2/1949	France.
1,008,125	5/1952	France.

CHARLES F. ROSENBAUM, *Primary Examiner.*

U.S. Cl. X.R.

15—409; 103—258; 230—11