United States Patent

Beguiristain

[15] **3,636,974**

[45] **Jan. 25, 1972**

[54] EVACUATOR SYSTEM WITH SHUTOFF VALVE

[72] Inventor: **Luis Beguiristain**, St. Paul, Minn.

[73] Assignee: **The Torit Corporation**, St. Paul, Minn.

[22] Filed: **Mar. 4, 1970**

[21] Appl. No.: **16,381**

[52] **U.S. Cl.** **137/565**, 137/606, 32/33

[51] **Int. Cl.** **A61c 17/04**, F16k 31/02

[58] **Field of Search** 137/565, 606; 32/33

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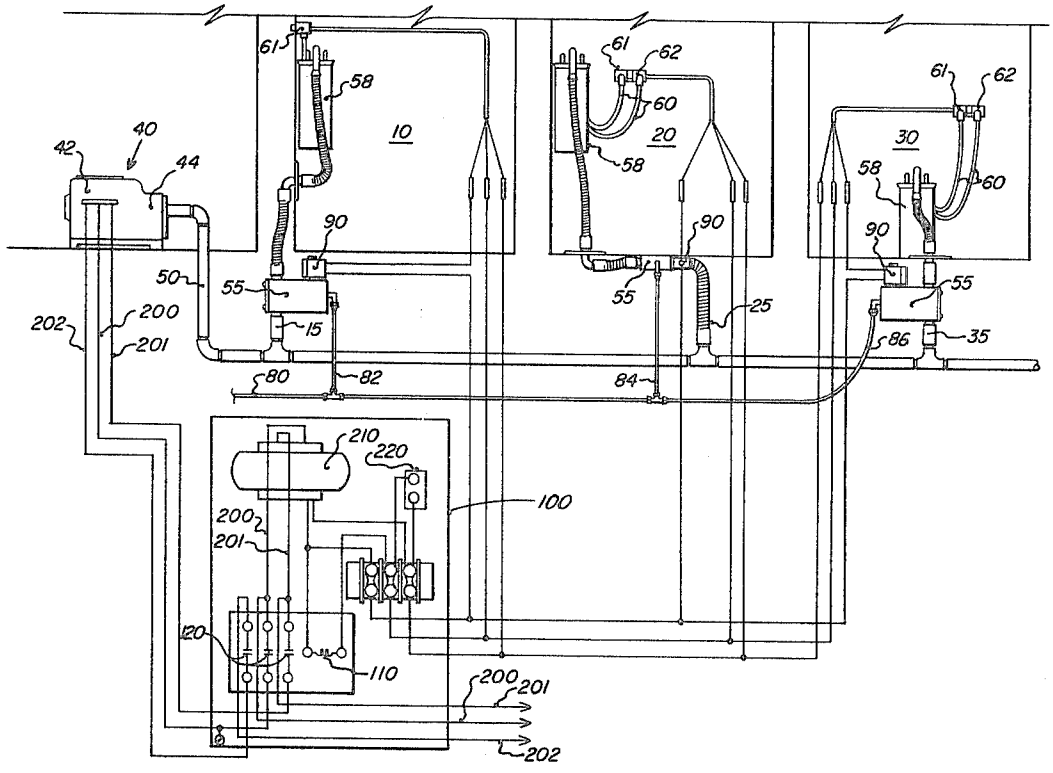
Primary Examiner—William R. Cline

Attorney—Schroeder, Siegfried, Ryan & Vidas

[57] **ABSTRACT**

An improved evacuation system with shutoff valve in which a plurality of stations having evacuator units therein may be operated from a single vacuum source, such as a motor-driven vacuum pump. The individual stations are connected from a main flow line of the vacuum pump through branch lines which include an improved shutoff valve which is piloted and electrically controlled by hanger switches at the individual stations. The improved circuit includes an arrangement by means of which operation of any of the hanger switches will energize and operate the respective valve and also energize the operation of the vacuum pump simultaneously therewith.

13 Claims, 4 Drawing Figures



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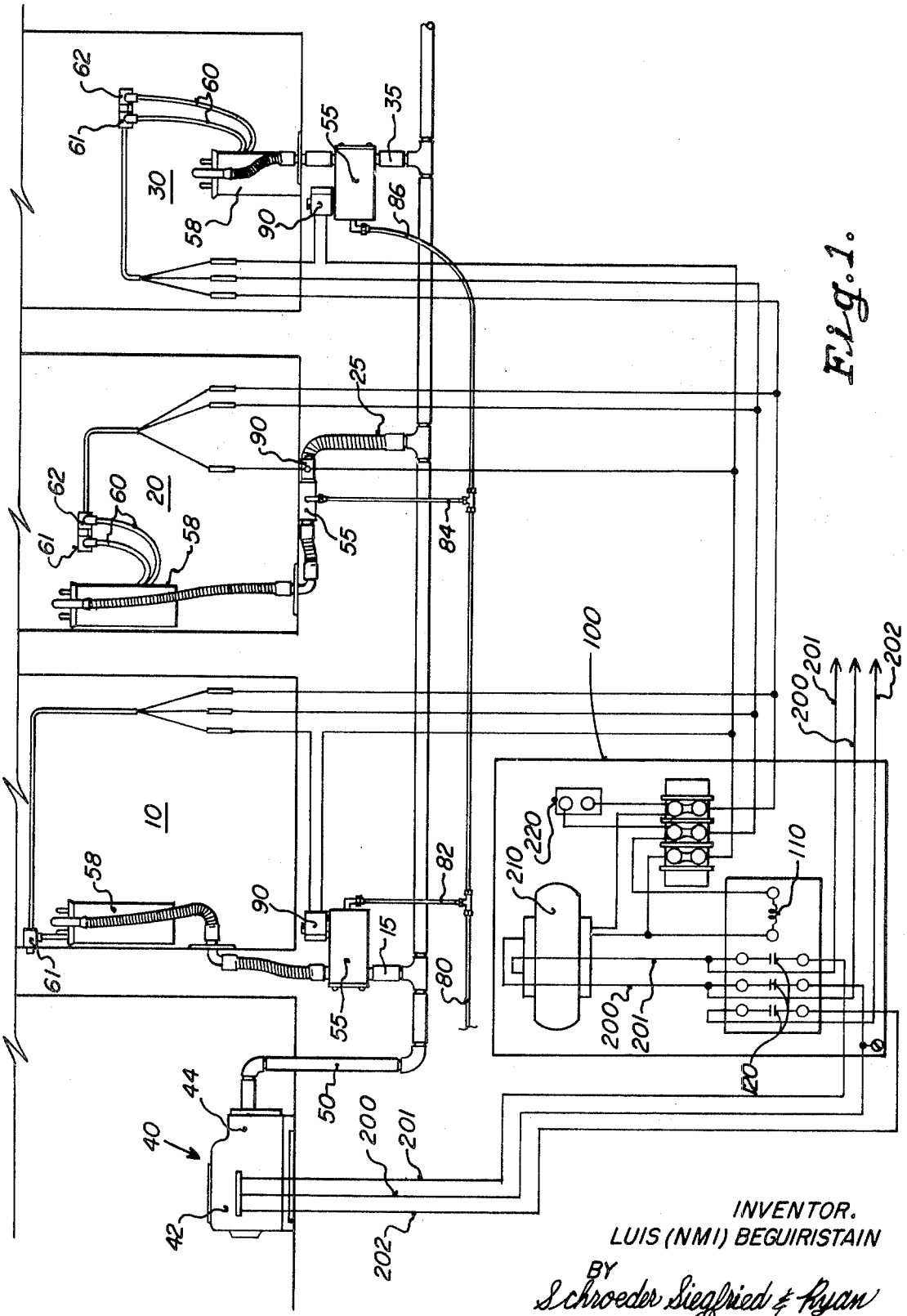


Fig. 1.

INVENTOR.
LUIS (NMI) BEGUIRISTAIN

BY
Schroeder Siegfried & Ryan
ATTORNEYS

Fig. 2.

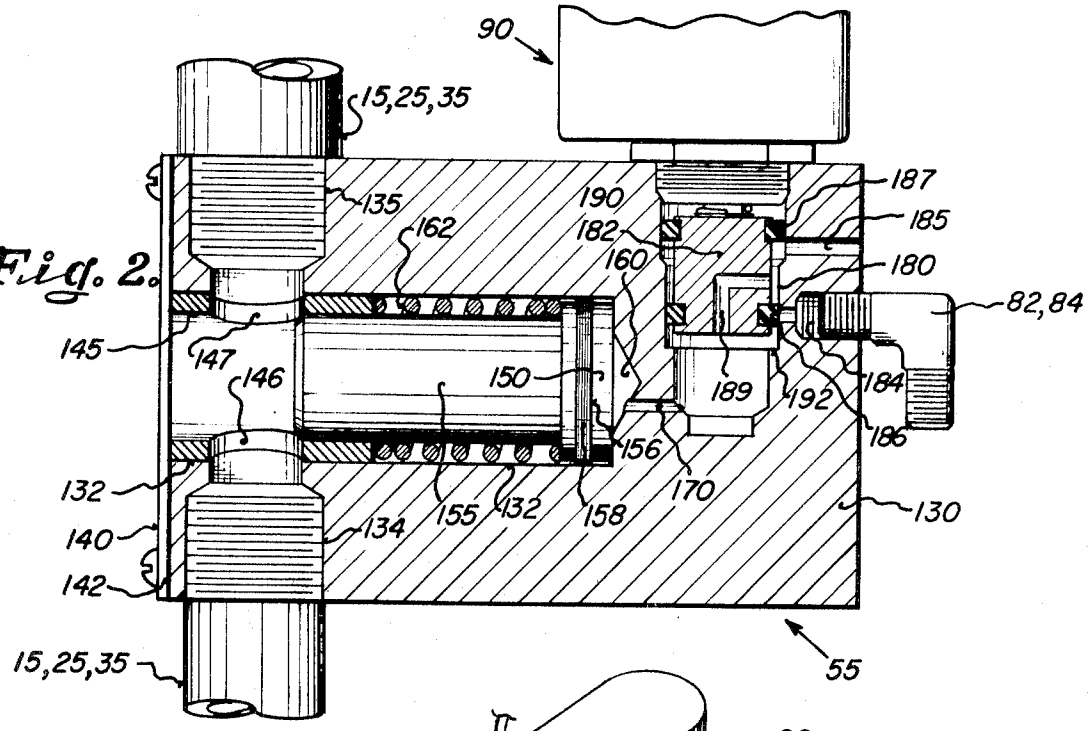
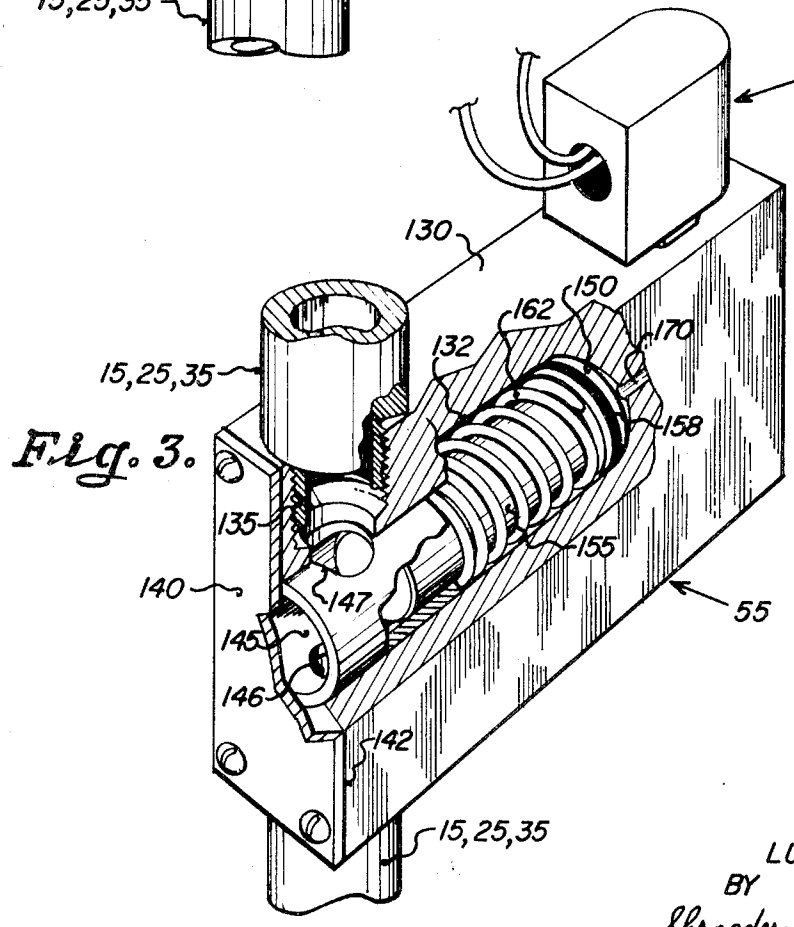


Fig. 3.



INVENTOR.
LUIS (NMI) BEGUIRISTAIN
BY
Shroeder Siegfried & Ryan
ATTORNEYS

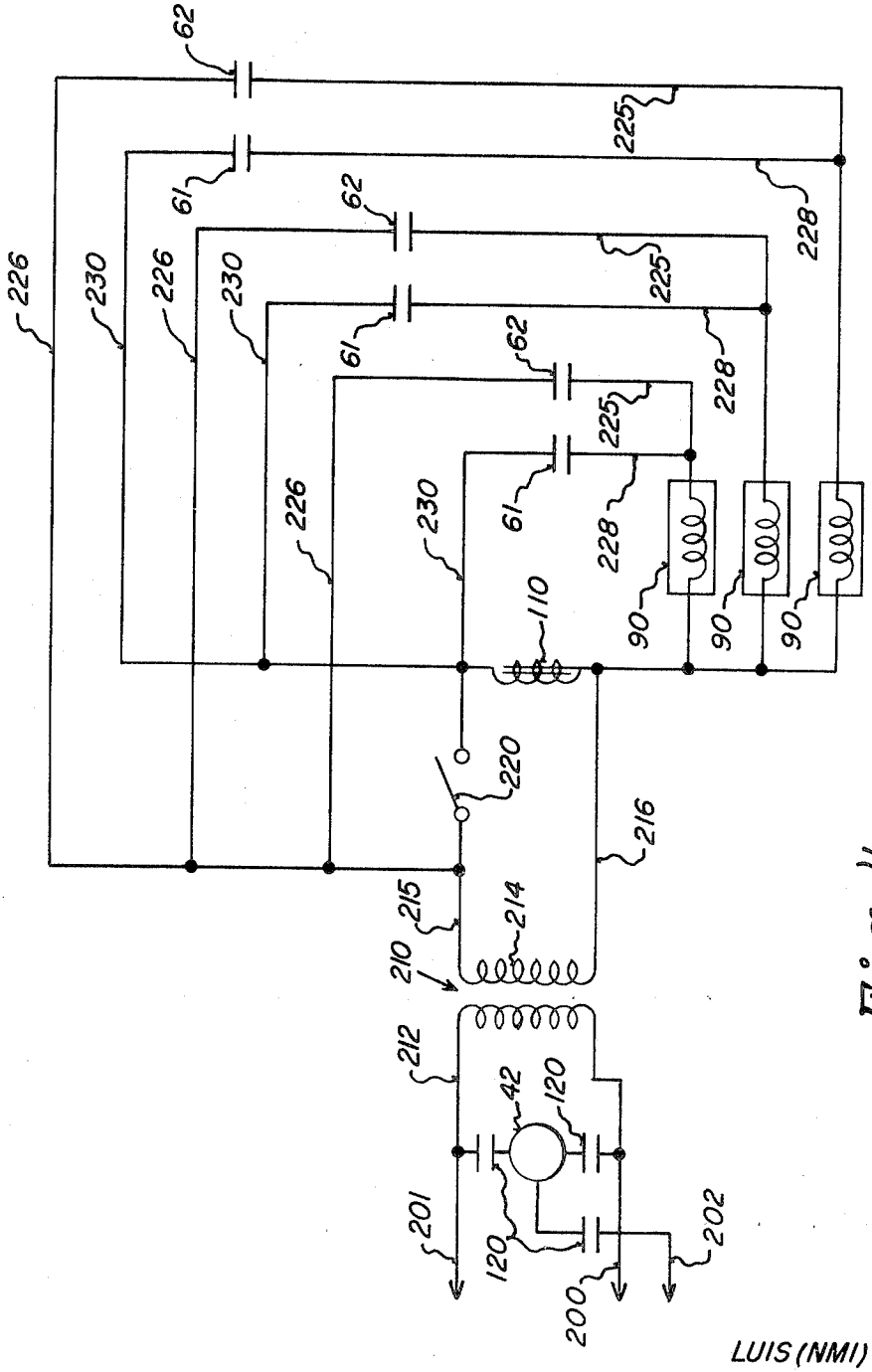


Fig. 4.

INVENTOR.
LUIS (NMI) BEGUIRISTAIN
BY
Schroeder Siegfried & Ryan
ATTORNEYS

EVACUATOR SYSTEM WITH SHUTOFF VALVE

My invention relates to improvements in evacuator systems and more particularly to an improved evacuator system in which a plurality of evacuator stations may be connected to a single vacuum source and isolated therefrom except when in use by a simplified piloted shutoff valve.

Evacuator systems are broadly old and take a variety of forms. In the area of dentistry, such systems or oral evacuators or saliva ejectors normally require a separate source for each station with manually operated control switches for energizing and operating the same. In certain systems, the evacuator hose with the tip thereon is sometimes associated with a hanger switch which when the hose is raised will operate an electric circuit to energize the motor-driven vacuum pump of the system. Under other systems, more than one station or evacuator unit may be serviced from the same motor-driven pump with similar control apparatus at each station. Such units have the disadvantage of having each evacuator hose connected to the vacuum source such that whenever the vacuum pump is running, the hoses not in use will similarly be open to the vacuum line allowing an undesirable noise and unnecessary leakage with a resultant restriction in the number of stations serviced by the source and an increase in the size of the source. In other systems, manually operated valves are included in the hose lines and these must be operated by the dentist to open the same when usage of the evacuator hose is required. The type of system is time consuming on the operator and quite often the valves are not closed when not in use, thereby restricting the efficiency of the system and increasing the load thereon, as well as introducing undesirable noise at varying stations.

Similar evacuator systems are employed in barber shops where hose lines with nozzle-type heads are utilized for removing hair clippings from a person having a hair cut. Normally, such evacuator systems are restricted either by requiring a single hose for several stations, or where several separate hose vacuum lines are available, all are open to the vacuum source when the source is operating to restrict the efficiency of the same and increase the size of the equipment required to properly operate the evacuator system. Thus prior systems have been restricted by limited capacity and inefficiency in operation as well as a relatively high cost in terms of the size of the motor-driven vacuum pump.

In the present evacuator system with shut off valve, an improved and simplified system is provided which will enable servicing from a single vacuum source of a plurality of evacuator stations which permits hose lines at individual stations to be isolated from the vacuum source except when they are in use. Manually operated closure valves for such hose lines are eliminated and the apparatus at any station may be readily put into use by lifting the hose from the hanger switch to connect the line to the vacuum source and to isolate the line from the vacuum source when the hose is retained. This permits the user to devote more time and effort to other aspects of his work and eliminates the undesirable leakage noise at any particular station. More particularly, it permits a plurality of stations to be connected to the same vacuum source and serviced thereby without increasing the cost of the source equipment and resulting in an overall reduction in cost of the entire system. Normally with a plurality of stations, only one or possibly two stations may be in operation at any one time and the capacity of the source will be sufficient to handle such units satisfactorily without any increase in size of the equipment and vacuum pump. Thus a plurality of stations, any one or more of, which may be operated simultaneously, may be connected to the main evacuating line and to the evacuator or vacuum source selectively through piloted shutoff valves which isolate stations not in use. The same application is applicable in barber shops and other environments where individual evacuator units or stations are required. Thus in the improved system and with a simplified shutoff valve at each station, a single source in the form of a motor-driven vacuum pump can service a plurality of stations considerably in excess of those previously serviced through an arrangement where only stations in use represent load on the system. This significantly reduces source costs and eliminates noise and the problems in manual valve operation. It leaves the users of the equipment free to continue their work without having to look after the evacuator system. The improved system provides for operation of the motor-driven vacuum pump only to maintain the desired vacuum pressure on a main line resulting with a significant decrease in operating costs and installation costs. The improved system utilizes a simplified piloted shutoff valve which seals the branch lines to each station and are controlled by the hanger switches or the equivalent type of control at the station. The pilot operator is controlled through a solenoid and air supply to operate a piston in a shutoff valve for the purpose of closing the same. The overall structure is simple in that the valve body employs a simplified bore in which the piston is mounted and with a simplified valve and bias spring arrangement to provide an improved shutoff valve design which is low in cost and easy to maintain.

Therefore it is the principal object of this invention to provide an improved evacuator system with shutoff valve.

Another object of this invention is to provide in an improved evacuator system a simplified and improved piloted shutoff valve.

Another object of this invention is to provide an evacuator system having plural stations and serviced from a single source without increasing the cost or size of the source.

A further object of this invention is to provide an improved evacuator system which is fully automatic in operation.

A still further object of this invention is to provide an evacuator system particularly adapted for use as a plural station evacuator system.

Another object of this invention is to provide in an evacuator system, a simplified solenoid operated air-piloted shutoff valve.

Still another object of this invention is to provide a system of this type which is relatively low in cost and in cost of installation and easy to maintain.

These and other objects of this invention will become apparent from reading of the attached description together with the drawings wherein:

FIG. 1 is a schematic diagram of a plural station oral evacuation system embodying my present invention,

FIG. 2 is a sectional view of the piloted shutoff valve of the oral evacuator system shown in FIG. 1,

FIG. 3 is a perspective view of the shutoff valve shown in FIG. 2 with parts broken away to show the shape and relationship of parts, and

FIG. 4 is a schematic electric circuit diagram of the oral evacuation system of FIG. 1.

The improved evacuator system with shutoff valve is shown schematically in FIG. 1 as an oral evacuation system comprising of a plurality of stations indicated at **10**, **20** and **30** respectively. Such stations would be individual dental chairs or rooms in a large office or individual or separate sites where evacuation equipment would be utilized. Although three are shown, it will be understood that any number within the capacity of the equipment may be employed and depending on the likelihood of only a given number of stations being operated simultaneously. The vacuum source as shown herein schematically is shown generally as a motor-driven pump **40** comprising a motor section **42** and a pump section **44**. Connecting the vacuum source with the individual stations is a main flow pipe **50** which leads to all of the stations and is connected to the evacuation equipment from the main flow pipe by a plurality of branch lines indicated at **15**, **25** and **35**. Included in each branch line or pipe is the improved piloted shutoff valve **55** which connects the individual station to the vacuum line. The individual piloted shutoff valve is insensitive to the influence of gravity and hence may be mounted in varying angular positions with respect to the space and mounting structure which supports the same for ease in installation. Also included at each station is a conventional evacuator or separator unit **58** having attached thereto the conventional evacua-

tor hoses **60**. The details of the evacuator hoses and the evacuator are omitted for simplicity and the evacuator hoses will normally be mounted when not in use on conventional hanger switches indicated at **61** and **62** which will operate between open and closed position when an individual evacuator hose is removed from its hanger position. Where such a system is other than a dental or oral evacuator system, a different type of evacuator or separator may be employed and the location of the same may be changed.

The piloted shutoff valve which controls communication between the evacuator hoses and the main flow line through the branch pipes is an air-operated unit and the pressure source, indicated by the pipes **80**, would normally be connected to a compressor and a storage tank (not shown) which would normally maintain a predetermined pressure available in the source line **80**. Individual branch conduits **82, 84** and **86** supply air under pressure to the individual piloted shutoff valves for the purpose of operating the same, as will be hereinafter noted. Similarly each piloted shutoff valve includes an electric controller or solenoid, indicated generally at **90**, which operates a small three-way control valve, to be hereinafter identified, for the purpose of piloting air pressure to the shutoff valve. This portion of the shutoff valve is controlled by the normally open hanger switches **61, 62** at the individual station which switches close operate whenever an evacuator hose is lifted from its retaining stand or hook. As will be hereinafter identified, all of the hanger switches and solenoid coils are connected in an electrical network through a main control panel **100** in which they operate a relay coil indicated by the terminals **110** of a contactor whose contacts indicated by the terminals **120** will control the energization of the motor-driven vacuum pump **40** to initiate a movement of air through the main pipe **50**.

The improved piloted shutoff valve will best be seen in FIGS. **2** and **3** wherein the valve body is designated at **130**. It is generally rectangular in cross section having a low profile and is a metallic block having a bore **132** extending from one edge of the same and centrally therein part way through the body. This bore is of uniform diametrical dimension and milled into the block and extending transversely thereto near the open end of the same are ports **134, 135** on either side of the body which communicate with this central bore **132**. These ports connect to the branch line conduits **15, 25** or **35** as indicated in the drawings. A cover **140** and including a gasket **142** is positioned over the end of the body to close and seal the same which is readily removable for inspection and maintenance in the valve. Positioned within the bore is a cylindrical sleeve member **145** which also includes ports **146** and **147** therein of the same diametrical dimension and adapted to mate with the ports **134, 135** in the body. Cooperating with this sleeve is the piston of the shutoff valve which includes in a cylindrical head portion **150** having a diametrical dimension substantially equal to that of the bore **132** and being lapped or machined so that it would freely slide therein. The remaining portion of the piston or reduced body portion **155** has a diametrical dimension substantially equal to the interior dimension of the sleeve **145** and these portions are lapped to provide a smooth substantially airtight fit. The head portion includes an additional grooved area **156** with a suitable sealing ring **158** therein and a portion of the bore above the piston indicated generally at **160** defines a pilot pressure chamber for the shutoff valve. A helical compression spring **162** is positioned between the sleeve **145** and the head portion **150** of the piston to urge the piston into the bore and in the direction of the pilot pressure chamber. Air under pressure in this chamber will overcome the bias of the spring and cause the body portion **155** of the piston to slidably move down across the ports **146, 147** of the sleeve member to close off the same and hence the passage through the valve body. The pilot pressure chamber has connected thereto a small port **170** leading to a second bore **180** in the valve body which extends generally transversely to the main bore **132** and above the same in the valve body. A solenoid actuator **90** attaches to this bore and carries a spool valve **182** for the purpose of valving air from the air pressure line through a passage **184** communicating with the bore **180** and a vent passage **185** extending to the surface of the valve. The spool valve has lands **186, 187** thereon which cooperate with the passages **185** and **184** in the body to control flow of air under pressure to and from the bore **180** and the pilot chamber **160** through the passage **170**. An interval passage **189** in the spool valve will provide an air passage from the end of the bore **180** through the spool valve to the area between the lands **186, 187** so that airflow may be directed into and out of the passages **185, 184**. A compression spring **190** included with the solenoid urges the spool into the bore and against a shoulder **192** therein. Energization of the electric solenoid will overcome the bias of the spring and move the spool in the opposite direction and against the compression of the spring. This movement will cover and uncover the passages **184, 185** for the purpose of valving air into and out of the second bore and communicating through the passage **170** to the pilot chamber **160** above the head portion **150** of the piston. The valve is operated to a shutoff position by introducing the air under pressure from the air source or line **80** and through the branch passages connected thereto to the valve body. With deenergization of the solenoid, the spring **190** moves the spool to a position where the land **187** covers the vent passage **185** and uncovers the passage **184** permitting flow of air under pressure to the area between the lands and through the passage **189** in the spool to the interior of the bore **180** wherein it will be directed through the passage **170** and into the pilot pressure chamber. This air under pressure on the head **150** of the piston will overcome the tension of the compression spring **162** which bears against the head and between the head and the sleeve to move the piston down so that the valve closure portion or reduced body portion **155** of the piston will move and cover the ports **146, 147** in the sleeve closing the passage through the valve body for the vacuum line.

By release of this pressure through energization and operation of the solenoid **90** to overcome the bias of spring **190**, the fluid above the enlarged head portion **150** of the piston is evacuated through the vent passage **185** since energization of the solenoid will move the spool to block the passage **184** and open the passage **185**. Under these conditions the compression spring acting on the piston will move the same against the vented air in the pilot pressure chamber to move the reduced portion of the piston **155** upwardly uncovering the ports **146, 147** in the valve body. The lapped fitting between the latter parts minimizes leakage in the valve body. Further, the pilot fluid is sealed from this portion of the valve body by the dynamic seal **158** on the piston head which isolates air under pressure from the pilot chamber into the area of the shutoff valve.

The shutoff valve is a simplified structure having a low-profile smooth exterior which permits mounting the same in various positions and because it is a piloted actuator with a spring return, with an electric solenoid for operating the same the valve body may be mounted in varying angular positions since it will not be effected in its operation by the force of gravity. Thus as will be seen in FIG. **1**, the shutoff valve may be mounted in varying angular positions.

The improved evacuator system provides for an automatic operation of an evacuator from any one of a plurality of station which are serviced by single evacuator pump and further provides that when one station is operating air will not be drawn from any of the others. Each station has its own isolating piloted shutoff valve which is operated by the movement of the evacuator hose from the hanger switch or the equivalent type of control to operate the valve and at the same time through the control panel **100** energizes the contactor for placing the motor-driven pump in operation.

The schematic wiring diagram of FIG. **4** discloses a simplified operating electrical circuit for the system. The alternating current power source indicated by the conductors **200, 201** and **202** will represent a single-phase grounded neutral

wire conventional 230 volts power source capable of energizing an electric motor for driving the vacuum pump. Conductors **200, 201, 202** are connected to the motor, indicated schematically in the diagram at **42**, through the power contacts **120**, such that motor and pump operation will be controlled by opening and closing of the contacts **120**. The conductors **200, 201** are also connected through a transformer **210** whose primary winding **212** is connected directly to the conductors **200, 201**. The secondary winding **214** of this transformer which is energized by one-half of the power source or conventional 110-volt AC current, will step down the control voltage to a level, for example, 24 volts, to supply the hanger switches and the solenoids for the respective shutoff valves as well as the operating coil **110** of the contactor. In the schematic control circuit the secondary winding **210** is connected through conductors **215, 216** to the operating coil **110** with a test switch **220** being positioned in this circuit. The hanger switches **61** and **62** control the energization of the solenoid coil **90** in the low voltage circuit. Thus as will be seen in the schematic diagram, the conductor **216** is connected to the solenoid coil and through a conductor **225** to the switch **62** leading through a conductor **226** to the conductor **215**. A second circuit leading from the conductor **225** through a conductor **228** and the hanger switch **61** leads to the conductor **230** and the contactor coil **110** connecting the same with the conductor **216**. This circuit will control the energization of the contactor to energize the motor driven vacuum pump whenever the hanger switches are operated by removal of an evacuator hose at any station. The individual evacuator hanger switches for the various stations are all connected in a parallel circuit, such that operation of any one of these stations will be effective to energize the control circuit for operation of the respective solenoid as indicated schematically in the drawings. Thus in operation of the evacuator system, a test may be made of the operation of the evacuator pump by closing the switch **220** which bypasses the hanger switches and directly energizes the contactor coil **110** to close the contacts **120** and energize the electric motor **42** of the same. Under normal operation the pump motor will be deenergized until such time as a station is operated by removal of a vacuum hose from a hanger switch where it is stored. Movement of the hose will operate both of the contacts **61, 62** at any one of the stations. The closure of the contact **62** will provide an energization circuit for the respective solenoid of the shutoff valve at that station through a circuit leading from the secondary winding of the transformer to conductor **215**, conductor **226**, contacts **62**, conductor **225**, solenoid winding **90** and conductor **216**. Simultaneously with this operation, a circuit would also be made from the conductor **225** and conductor **228** through the hanger switch **61**, conductor **230**, coil **62** and conductor **216** to similarly energize the operating coil of the power contactor for the motor driven vacuum pump. Whenever the hose is returned to its position this energizing and control circuit would be broken by opening of the switches **61** and **62**. Thus any single station may initiate operation of the vacuum pump to draw air through the main pipe **50** and the associated branch pipe by operation of the respective shutoff valve associated with the station. When more than one station is operating or whenever a second station begins to operate while the system is in operation, closure of these particular hanger switches will not effect the operation of the circuit under energization but will set up the circuit so that continued energization will be maintained when the first operating station ceases operation. In a system in which a plurality of stations are employed, it is normally the condition that only a few of the stations will be operating at any one particular time. Thus the motor-driven vacuum pump may have the capacity to handle the stations in operating and be capable of servicing a large number of stations with reduced capacity equipment. Whenever, of course, too large number of stations are connected to the main flow line at any one time, the equipment would be unable to satisfactorily provide evacuation flow from all of the stations and it would be necessary for some of the stations to shut down for efficient operation. This may delay for a short period of time operation at any particular station but does provide an evacuation system in which efficient operation will be maintained under normal operating conditions.

This overall evacuation system is shown herein for disclosure purposes as an oral evacuation system. It may be applied to other types of evacuation systems such as in multichair barber shops, where a plurality of individual vacuums are located with respect to each of the chairs. A difference in the system would arise as to the filtration of the air to eliminate the hair and dust from the system. This would normally be taken care of by a special filtration at the vacuum pump or in the main flow line. The same efficiency in simplicity of installation in the automatic system would be maintained.

In considering this invention therefore it should be remembered that the present disclosure is illustrative only and the scope of the invention should be determined by the appendant claims.

What is claimed is:

1. An evacuator system comprising, a vacuum source, a plurality of stations each having a manually operated evacuator hose and tip located therein, a main flow pipe connecting the vacuum source with each of the stations, a branch line flow pipe connected to the main flow pipe for each of the stations and connected to the evacuator hose lines therein, a piloted shutoff valve positioned in each branch line and controlling flow therethrough from the evacuator hoses to the main flow pipe and vacuum source, said piloted shutoff valve being an electric solenoid air-operated valve and including a source of air under pressure connected to each of the shutoff valves at each of the stations to operate the same and being controlled by the operation of the solenoid, control means at each station responsive to a condition of operation of the evacuator hoses for operating the piloted shutoff valve to open the valve and provide communication between the evacuator hoses and the main flow pipe, and means responsive to the operation of a control means at any station for providing vacuum pressure in the main flow pipe.

2. The evacuator system of claim 1 in which the piloted shutoff valve includes a valve body with a cylindrical bore therein in which is positioned a piston means to define between the end of the bore and the piston means a pilot pressure chamber, an air inlet passage connected to the source of air under pressure and leading to the pilot pressure chamber, spring means positioned in the bore behind the piston and urging the piston in the direction of the pilot pressure chamber, a vent passage in the body and communicating with the pilot pressure chamber, the electric solenoid including a three way valve positioned in the inlet air passage and the vent passage in the body and selectively connecting the inlet air passage and the vent passage to the pilot pressure chamber.

3. The evacuator system of claim 2 in which the vacuum source includes a motor-driven vacuum pump and in which the means responsive to the operation of any control means include a controller energized thereby to control the operation of the motor-driven pump.

4. The evacuator system of claim 2 in which the piloted shutoff valve includes a cylindrical sleeve member positioned in the bore in the valve body and having ports therein aligned with ports in the valve body and connected to the branch line flow pipe to control airflow therethrough, said sleeve member mounting a portion of the piston means which is adapted to move therein to cover and uncover the ports under the influence of pressure in the pilot pressure chamber and under the action of the bias means.

5. The evacuator system of claim 4 in which the solenoid-operated valve is a three way valve.

6. The evacuator system of claim 5 in which the piston means of the piloted shutoff valve has a cylindrical head portion and a reduced cylindrical body portion with the head portion slidably mounted in the cylindrical bore in the body and the body portion slidably mounted in the sleeve member.

7. An evacuator system comprising, a vacuum source including a motor-driven vacuum pump, a plurality of stations each having a manually operated evacuator hose and tip located therein, a main flow pipe for connecting the vacuum pump with all of the stations, branch line flow pipes for each of said stations connecting the evacuator hoses therein to the main flow pipe, a piloted shutoff valve positioned in each branch line flow pipe and controlling flow therethrough from the evacuator hoses to the main flow pipe and the vacuum pump, control means at each station and responsive to movement of the evacuator hoses from a position of storage to a position of usage for operating the piloted shutoff valve to open said valve and provide communication between the evacuator hoses and the main flow pipe, and additional control means responsive to operation of the first named control means in the main flow pipe for controlling for energizing the motor-driven vacuum pump, said piloted shutoff valve being an electric solenoid air-operated valve and including a source of air under pressure connected to each of the shutoff valves at each of the stations to operate the same and being controlled by operation of the solenoid.

8. The evacuator system of claim 7 and including means positioned between the evacuator hose lines for the plurality of stations and the vacuum source for separating solids and liquids in airflow from the evacuator hoses.

9. The evacuator system of claim 8 in which the means for separating solids and liquids from the airflow to the vacuum source includes an oral evacuator unit positioned at the extremity of the branch line flow pipes remote from the main flow pipe.

10. The evacuator system of claim 7 in which the control means at each station responsive to movement of the evacuator hose includes hanger switches and including an electric circuit means connected through the hanger switches and to the solenoids of the shutoff valve for operation of the same.

11. The evacuation system of claim 10 in which the motor-driven vacuum pump includes an electric motor driving a vacuum pump and in which the additional control means includes an electric contactor and including an electric control circuit for connecting a source of power to the electric motor with operation of any one of the first named control means.

12. The evacuation system of claim 11 in which the system is an oral evacuation system and including an oral-evacuator unit connected to the branch line flow pipe at each station and having connected thereto the manually operated evacuator hoses for communication therethrough to separate liquids and solids from the air flowing through the hoses to the vacuum source.

13. The evacuator system of claim 7 in which the piloted shutoff valve includes a valve body with a bore positioned therethrough and a pair of ports in the valve body communicating with the bore and connected to the branch line flow pipes, piston means positioned in the body and defining a pilot pressure chamber between the end of the piston and the end of the bore, a control air inlet passage in the body and connected to the pilot pressure chamber, bias means positioned in the bore and applying a force to the piston means in a direction of the pilot pressure chamber, a vent passage in the body, said piloted shutoff valve including an electrically operated control valve means positioned in the inlet air passage to the body and the vent passage in the body and selectively connecting the inlet air passage and the vent passage to the pilot pressure chamber to operate said valve in response to operation at the control means at the station with movement of the evacuator hoses from a position of storage to the position of usage.

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