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FLUID SAMPLING APPARATUS

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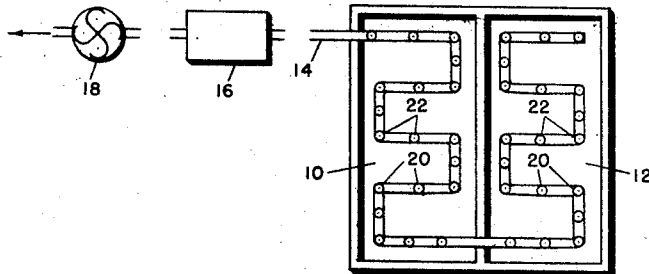


FIG. 1

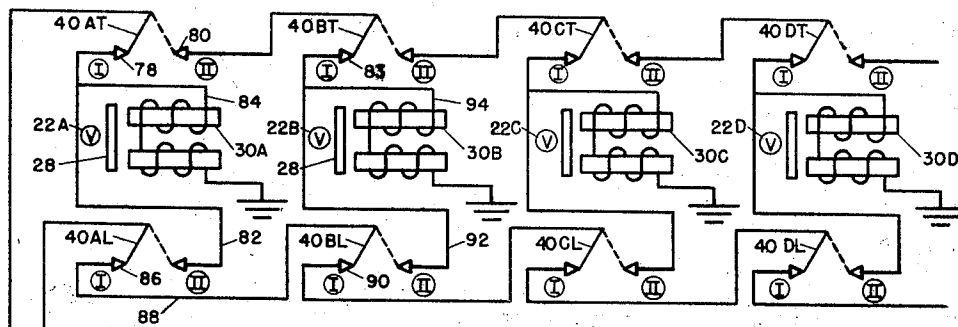


FIG. 2

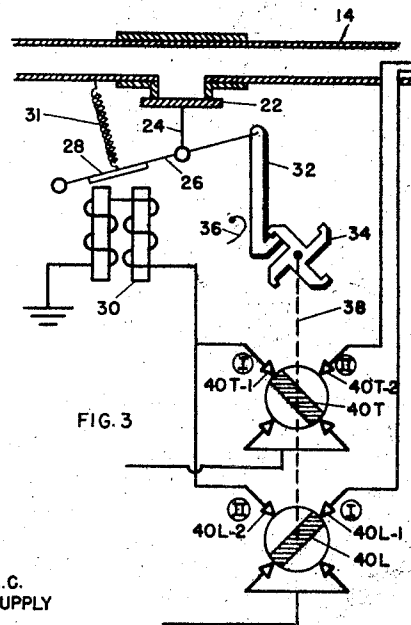
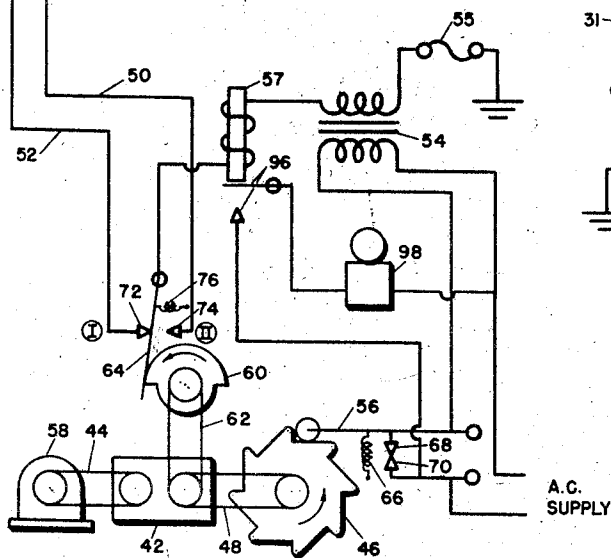


FIG. 3

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FLUID SAMPLING APPARATUS

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This invention relates to improvements in apparatus for sampling liquid or gaseous fluids, and is particularly directed to apparatus for selecting samples of such fluids to be tested for various purposes.

More specifically, the present invention relates to means for selecting a sample of any desired liquid or gaseous fluid and conveying the sample to a testing station, where the quality of the fluid is examined or tested, whereby to determine or detect the presence of foreign matter therein, such as suspended matter in a liquid, smoke in air, explosive or inflammable constituents in a gas, or any other impurities or foreign matter in the liquid or gaseous fluid selected for examination.

While the present invention has manifold applications in various types of apparatus and systems, it is particularly adapted for detecting the presence of smoke or products of combustion in air, and accordingly, for convenience of description, the invention will be described herein as applied to smoke detecting systems, without, however, limiting the scope of the invention to any particular application.

In smoke detecting systems of the character to which the present invention is adaptable, air is continuously drawn through detector conduits from one or more compartments or spaces to be supervised to a central observation station or smoke detector, whereby when a fire occurs in any of the compartments or spaces, the air drawn therefrom will have smoke or products of combustion from the fire commingled therewith, which, when illuminated by passing through a beam of light or through instruments at the observation station or in the smoke detector, is readily detected, either visually, thermoelectrically or photoelectrically.

In such systems the intake ends of the detector conduits, which are usually provided with so-called smoke accumulators, are generally located adjacent the ceiling of the compartment or space, as shown, for example, in United States Reissue Patent No. 22,047; but such arrangement, while generally satisfactory, nevertheless requires the smoke to move to a point adjacent the ceiling, or other point at which air can enter the conduit, before being drawn into the detector conduits.

One of the disadvantages of smoke detectors of the type referred to resides in the difficulty in instantaneously conveying the smoke-laden air to the detector at the outbreak of fire in sufficient density to be readily observed or to

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actuate the photoelectric detecting equipment, unless that equipment is made so sensitive as to be susceptible to false alarms due to the inherent instability of the detecting system and extraneous causes such as dust, stray electric currents, or physical shock or vibration.

One of the objects of the present invention resides in the provision of a system of the character indicated which overcomes the difficulties and disadvantages of prior systems, as hereinbefore mentioned.

Another object resides in the provision of sampling apparatus which operates efficiently regardless of localization or stratification of the suspended matter or other foreign matter to be detected in the fluid to be sampled.

Another object resides in rapid detection of foreign matter in fluids and in overcoming delay incident to the necessity of accumulating the foreign matter at one point.

A further object resides in the provision of a system of the character indicated, which permits of simple interconnecting electric wiring, and which also permits of inexpensive electrical operating means.

A still further object resides in the provision of supervisory means, whereby any derangement in the system is automatically detected.

Other and further objects and features of the present invention will be apparent as the invention is described in greater detail hereinafter.

A preferred embodiment of the invention, as applied to the detection of smoke, has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming part of the specification, wherein:

Fig. 1 is a diagrammatic view of the sampling means or system of the invention.

Fig. 2 is a wiring diagram showing schematically suitable electrical apparatus and connections for carrying out the invention; and

Fig. 3 is a diagrammatic view of a valve and valve operating means employed in the system of the invention.

Referring to the drawing in detail, and first to the illustration in Fig. 1, the reference numerals 10 and 12 represent a pair of adjacent compartments, which may be any type of compartment or enclosure, such as a ship's hold, a ventilator, a ventilating duct, a fur storage vault, a room, a tank or container, or any other space which is to be supervised, or which is adapted to contain a fluid to be sampled. While two such compartments or spaces are shown, it is to be understood that the present invention contemplates the sam-

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pling of fluid in a single enclosure, compartment or space, as well as in any number of such enclosures, compartments or spaces.

A conduit or pipe line 14 extends within the compartment in a horizontal, vertical or any desired plane, and may follow a zig-zag or any other desired course along the floor, ceiling, side walls of the compartment or in any other predetermined location in the compartment. One end of this pipe line extends out of the compartment and leads to a testing station 16, which in smoke detecting apparatus may be a conventional smoke detector, having associated therewith a conventional suction device 13. The suction device 13 is adapted to be in continuous operation when the apparatus is installed, whereby to draw air from the protected space or spaces through the pipe line 14 and the detecting device 13. When more than one compartment is to be protected, the pipe line may extend into adjacent or remotely located compartments; or if desired each compartment may have its own pipe line connected directly to the detector, which in such systems may include conventional means for determining the source or compartment from which smoke-laden air is withdrawn. Also, if desired, a selector, such as disclosed in United States Patents Nos. 2,032,746 and 2,034,281, may be employed for each compartment or for a plurality of compartments.

The pipe line 14 is provided with a plurality of openings or fluid inlets 20 serving as smoke pick-up points, suitably spaced throughout the length of the pipe. As will be seen from Fig. 1, these openings are located so as to pick up samples of fluid, such as air or smoke-laden air, at various points throughout the supervised space.

Each of the fluid inlets or openings 20 is provided with a valve 22 for controlling the admission of fluid into the pipe line. The various valves are operated in a predetermined sequence, preferably with one valve only being open at one time, whereby to prevent dilution of the fluid; each valve being automatically and sequentially actuated in the manner about to be described.

One of the valves 22 with its actuating means is diagrammatically illustrated in Fig. 3; and, as shown in this figure, the valve may be a simple flap valve having a connection 24 to an arm 26, carried by a pivotally mounted armature 28 of a solenoid 30, which arm is held in valve closing position by a spring 31. The free end of the arm 26 is pivotally connected to a pawl 32, which is held in engagement with a ratchet 34 by means of a spring 36. The ratchet 34 is mounted on a shaft 38, on which there are also mounted two switching commutators 40T and 40L, each having associated therewith a pair of fixed contacts 40T-1 and 40T-2 and 40L-1 and 40L-2, respectively.

When the solenoid 30 is energized, the armature 28 moves downwardly. This movement of the armature opens the valve 22, places the spring 31 under tension, and moves the pawl 32 downwardly. When the pawl reaches its lowermost position, it is moved by the spring 36 into engagement with a tooth on the ratchet 34. When the solenoid 30 is deenergized, the armature 28 is moved upwardly under the action of the spring 31, causing the valve 22 to be seated, whereby to close the inlet 20, and at the same time causing the pawl 32 to move upwardly, thereby rotating the ratchet 34 through 90°, and at the same time causing the ratchet shaft 38 and the switching commutators 40T and 40L to rotate through 90°; the switching commutators 40T and 40L and their

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associated fixed contacts being diagrammatically illustrated in Fig. 2.

In the description of the diagram illustrated in Fig. 2, which follows, solenoids similar to the solenoid 30, and their respective switching commutators, are shown; the commutators being referred to as solenoid switches, inasmuch as they control the operation of the solenoids, and inasmuch as any type of switching arrangement other than switching commutators may be employed in the system of this invention.

As will be seen from Fig. 2, circuits are provided which include the solenoids and solenoid switches for the sequential operation of four of the valves 22, which solenoids and switches are adapted to be connected through conductors 50 and 52 to the secondary of a transformer 54, which is in turn connected to a source of alternating current. Current is supplied to the solenoids through the transformer at a reduced voltage, whereby low voltage wire and simple, inexpensive solenoids may be employed. The wiring for the circuits illustrated may be run through the pipe line 14, thereby avoiding the need for a separate wiring conduit.

While alternating current is preferred, it is to be understood that the present invention is not to be limited in scope to the use of alternating current, as obviously direct current may be employed, in which event the transformer may be eliminated.

A main switch 56 for the transformer circuit is caused to open periodically, to break the circuit to the transformer, by means of a continuously operating motor 58, which is operatively connected to the main switch 56 by any suitable means, such as are diagrammatically illustrated in Fig. 2. The main switch 56 is closed, for example, in the order of three seconds and open for one-half second. This same motor 58, by means of the diagrammatically illustrated arrangement shown in Fig. 2, also operates a switch 64. The operation of the switch 64 by the motor 58 is so timed relative to the operation of the main switch 56, that following a predetermined number of operations of the switch 56, the switch 64 will move from position I to position II. Upon repetition of the same number of operations of the switch 56, the switch 64 returns to position I. The number of operations controlling the movement of the main switch 56 is equal to, and therefore determined by, the number of valves 22 employed in the pipe line 14.

The switch operating mechanism shown diagrammatically in Fig. 2 is merely illustrative and is not intended to limit the scope of the present invention, as it is but one of several mechanisms that may be employed for operating the switches 56 and 64 in timed relation. The mechanism shown comprises the motor 58, which is operatively connected by a belt 44 to a gear reduction device 42, which device in turn is operatively connected by a sprocket chain 48 to a sprocket on the shaft of a toothed wheel 46 for operating the switch 56, and by a sprocket chain 62 to a sprocket on the shaft of a cam 60 for operating the switch 64. The chains 48 and 62 are driven from a common sprocket driven by the gear reduction device, and definitely connect the wheel 46 and the cam 60 in phase so that there is no possibility of slippage.

The switch 56 carries a roller adapted to be held in engagement with the periphery of the toothed wheel 46 by a spring 66, so that as the toothed wheel rotates in a counterclockwise di-

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rection the roller will move inwardly and outwardly on the teeth to effect closing and opening of the contacts 68 and 70, whereby to make and break the circuit to the transformer 54.

The number of teeth on the toothed wheel is equal to the number of solenoid switches to be operated, and there being two switches, 40AT and 40AL, 40BT and 40BL, etc., for each of the four solenoids, 30A, 30B, 30C and 30D, diagrammatically illustrated in Figure 2, the toothed wheel illustrated has eight teeth, so that for each complete revolution of the toothed wheel there will be one complete cycle of operation of the solenoid operated valves. It is to be understood that in systems having a greater number of valves, the number of the teeth on the toothed wheel will be increased accordingly.

The cam 60 for operating the switch 64 will, during one-half of each revolution, hold the switch 64 in position I in engagement with the contact 72, to maintain the circuit closed through the conductor 52 and the respective solenoid switches 40AT, 40BT, etc. During the other half of the revolution of the cam, the switch 64 will be moved by the spring 76 into position II in engagement with the contact 74, to maintain the circuit closed through the conductor 50 and the respective solenoid switches 40AL, 40BL, etc. Inasmuch as the cam 60 rotates at the same speed as the toothed wheel, the switch 64 will remain in position I for one half of the revolution of the cam and of the toothed wheel, and in position II for the other half of revolution. In other words, during one complete revolution of the toothed wheel, it will open and close the switch 56 four times while the switch 64 is in position I and four times while the switch 64 is in position II.

A fuse 55 is provided in the grounded secondary circuit of the transformer 54, which, in the event of grounding or short circuiting of the wires of the system, will blow to open the circuit; while a relay 57 is interposed in the line leading from the secondary of the transformer to the switch 64. This relay is in a supervisory circuit, which will be described in detail hereinafter.

When the main switch 56 and the switch 64 are both closed, as shown in Fig. 2, current will flow from the source of power (the secondary of the transformer) through relay 57, the contact 72 of the switch 64, line 52, solenoid switch 40AT, contact 78, and solenoid 30A to ground, thereby energizing the solenoid 30A and causing the corresponding valve 22A to open.

By reason of the continuously operating motor 58 and the toothed wheel 46, the main switch 56 will then be opened, breaking the current supply circuit, in the manner previously described, thereby causing the solenoid 30A to be de-energized. When the solenoid is de-energized, the switching commutators 40T and 40L will be actuated by the pawl 32 and ratchet 34, in the manner previously described, resulting in the movement of each of the switches 40AT and 40AL from position I to position II, as shown in dot and dash lines in Fig. 2.

Immediately following the change-over of the switches 40AT and 40AL, as just described, the main switch 56, through operation of the toothed wheel 46, will again be moved to circuit closing position, whereby current will again flow from the secondary of the transformer 54 through switch 64, relay 57, contact 72, line 52, switch 40AT, which is now in position II, contact 80, switch 40BT, contact 83, and solenoid 30B to

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ground, thereby energizing the solenoid 30B and causing the valve 22B, controlled by that solenoid, to open, in the same manner as previously described in connection with the solenoid 30A. The cycle of operation just described continues, whereby solenoids 30C and 30D will similarly be energized to open their respective valves 22C and 22D; and each solenoid for each of the other valves employed in the pipe line 14 is similarly individually and sequentially operated. It is to be understood that, while only four solenoids are shown in Fig. 2, and while the operation of only two of these has been described in detail, the number of solenoids will correspond to the number of valves 22 employed in any pipe line or system, and that any desired number of valve-controlled inlets 20 may be employed.

After the last valve in the pipe line has been operated, through operation of the switches 40T, as just described, the cam 60, which will then have completed one-half a revolution, will permit the switch 64 to switch over to position II and engage contact 74. The switch 56 is then again closed, through the operation of the toothed wheel 46, whereby current will flow from the secondary of the transformer 54 through the switch 64, contact 74, line 50, switch 40AL, which, as previously described, is now in position II, lines 82 and 84, and solenoid 30A to ground. The energization of the solenoid will again cause its associated valve 22A to open, and when the circuit is again broken upon the opening of the main switch 56 by the toothed wheel 46, the solenoid 30A will be de-energized, the valve 22A closed, and the switching commutators actuated, resulting in the movement of both the switches 40AT and 40AL back to their number I positions.

The main switch 56 will now again be closed, whereby current will again flow through switch 64, contact 74, line 50, switch 40AL, which is now in position I, contact 86, line 88, switch 40BL, which is still in position II, contact 90, lines 92 and 94, and solenoid 30B to ground, causing the operation of the solenoid 30B and the opening of its associated valve 22B.

The sequence of operation, just described, continues until each valve in the pipe line is again operated. When the last valve in the line has been operated, the toothed wheel 46 and the cam 60 each will have completed one revolution, resulting in the completion of one cycle of operation of the system, at which time all of the solenoid switches will be in the full line positions, or positions number I, as illustrated in Fig. 2, ready for another cycle of operation.

It is to be understood that initial operation of the system can be effected with the solenoid switches 40T and 40L in either position I or position II, i. e. the full line or the dotted line positions, respectively, as shown in Fig. 2, and it therefore is not necessary to preset the solenoid switches for proper operation. It is also to be understood that if the switches for one solenoid should be in a different position from the other switches, at the beginning of the operation of the system, the system, nevertheless, will operate, at least until the supervisory system, later to be described, comes into operation. For example, if all the switches, except 40BT and 40BL, are in position I, as shown in Fig. 2, and the latter switches are in position II, at the beginning of the operation, the solenoid 30A would, nevertheless, operate in the normal manner, and upon operation of the switching commutators, the switches 40AT and 40AL would be moved to their

number II positions. Closure of the main switch 56 would then cause current to flow through switch 64, contact 72, line 52, switch 40AT, contact 80, switch 40BT, which is in position II, switch 40CT and solenoid 30C to ground. With current flowing in the manner just described, the solenoid 30B, the switch of which is in position II, is by-passed, while all the remaining solenoids will operate normally, until the last valve in the line has been operated. When the last valve has been operated, the main switch 56 will have operated once for each valve operated, but will not have operated for the by-passed valve, so that the valve will be out of phase with the switch operating mechanism. This out of phase condition results in the operation of the supervisory system about to be described.

The supervisory circuit included in the system of the present invention is for the detection of any derangement, such as the failure of a solenoid to exert sufficient force to cause its valve to open; failure of a switch to move from its position I to its position II or vice versa; failure of contacts, such as contact 80, for example, to close; or a broken, grounded or short-circuited interconnecting wire, the blowing of the fuse 55, or other derangements.

When the system of the present invention is operating normally, in the manner previously described, current flows through the secondary of the transformer 54 to the switch 64 each time the main switch 56 is closed. In the event of any derangement, such as previously mentioned, however, there will be a time during one complete revolution of the wheel 46 when no current will flow when it should be flowing. This situation will result in the valves getting out of step with the wheel 46, as for example, when one valve is by-passed as hereinbefore described, and therefore fails to operate on either half of the cycle of operation. When such derangement occurs, the last valve in the line will have operated at the time when the main switch operated for the previous valve, so that when the main switch operates for the last valve the circuit will be thrown open and therefore connects to nothing and no current will flow. It is when current fails to flow, due to any derangement, that the supervisory system will give a warning signal, as will be understood from the following description.

The supervisory circuit includes the relay 57, which is of the slow release type and which serves as a time delay relay, as will be described presently. The secondary voltage of the transformer 54 is increased sufficiently to compensate for the voltage drop across the relay.

When the main switch 56 is closed the current flow will operate the relay 57, and when the switch 56 is opened the current flow will momentarily be interrupted, but due to the slow release of the relay, contacts 96 of the supervisory system will not close immediately, so that normally the system will operate as though no relay was present. If, however, one of the solenoids is not connected in the circuit, because of some derangement, as previously mentioned, the current flow will be stopped for a short duration, substantially equal to the time required for the operation of a solenoid valve, which is sufficient to permit the wheel 46 to rotate one eighth of a complete rotation, whereby the roller on the switch arm 56 will engage the next tooth. The stopping of the current flow for this short duration will permit the contacts 96 to close, thereby closing the circuit to the alarm 98 to attract the attention

of the attendant to the derangement, whereby the fault may be corrected.

It is to be understood that the supervisory system just described is illustrative, as obviously the operating relay may be located at any desired point other than that illustrated; the relay may be of self locking type; and various other changes and modifications may be made without departing from the spirit and scope of the invention.

Inasmuch as air flowing through a pipe line has inertia, a small opening may, if desired, be provided at the extreme end of the pipe line 14, so as to permit a continuous flow of air through the entire length of the pipe line. While this opening may produce a slight diluting effect on smoke-laden air drawn into the pipe line at the inlets, the provision of such an opening would permit operation of the individual valves for shorter intervals so that a complete circuit of the supervised space or spaces is made in a shorter period, since it would not be necessary to wait for air to start flowing in a "dead" section of the pipe line.

Reference herein to the operation of the valves in sequence is not intended as limiting the invention to the operation of the valves in the order of their consecutive alignment in the pipe line, but is intended to include any order wherein any valve is operated following the operation of another valve. In some installations it may be desired to first operate the valve at one end of the pipe line, or a selected valve intermediate the ends of the line and then operate the valve at the other end of the pipe line or some other selected valve, following which other of the valves may be operated in any desired order. The selection of order of the valves for sequential operation is, however, predetermined for each installation of the system.

It is to be understood that the present invention is not limited to the operation of a single valve at a time, as obviously two or more valves may be operated simultaneously, if so desired.

It is to be understood also that the nature or type of detecting or testing means at the testing station 16 associated with the system of the present invention will depend upon the field in which the system is employed. When the system is employed in the detection of smoke, as previously described, the testing station may include any conventional smoke detecting device; when employed in the detection of toxic, explosive or inflammable constituents in a gas, such as the detection of carbon monoxide gas, for example, any conventional gas analyzer may be provided at the testing station; and when employed in the detection, examination, sampling or testing of any other liquid or gaseous fluid any suitable conventional device for such purposes may be provided at the said station. It is to be understood that the term "testing station" as employed in the claims is intended to include appropriate testing means at the said station, and the term "fluid" as employed in the claims is intended to comprise liquid and/or gaseous fluids.

From the foregoing description it will be seen that the present invention provides sampling means wherein a single pipe line is employed having a plurality of inlets so located that the medium to be sampled can be picked up at different points, whereby it is unnecessary to await the accumulation of the medium at a single point; wherein inlets are automatically controlled for sequential operation; wherein the solenoid valves are automatically set in normal position

upon initial operation of the apparatus; wherein simple and inexpensive interconnecting wiring and electrical equipment may be employed; and wherein any derangement in the system is automatically detected.

It will further be seen that the present invention accomplishes the various objects pointed out at the beginning of this specification.

While a preferred embodiment of the invention has been illustrated and described herein, it is to be understood that my invention is not to be limited to that precise embodiment, structure or arrangement of elements, as obviously various changes and modifications may be made therein without departing from the spirit and scope of the invention.

I claim:

1. In apparatus for sampling fluid medium in an enclosure, the combination of a conduit in the enclosure for the fluid medium to be sampled having a plurality of inlets in the wall thereof arranged in predetermined spaced relation and communicating directly with the fluid in the enclosure, an electrically controlled valve for each of said inlets, a source of electric current, an electric circuit including electric conductors within said conduit for carrying current from said source to said electrically controlled valves, and means for opening and closing said circuit to effect operation of said electrically controlled valves in a predetermined sequence.

2. In apparatus for sampling fluid medium in an enclosure, the combination of a conduit in the enclosure having a plurality of inlets in the wall thereof arranged in predetermined spaced relation and communicating directly with the fluid in the enclosure, a valve for each inlet, electrically controlled means for opening the valves, a spring conditioned upon the opening of the valves for closing the valves, and means for energizing and de-energizing said electrically controlled means arranged for operation in a predetermined sequence to permit a sample of the medium to be tested to enter the conduit through each inlet when opened.

3. In a system for detecting the presence of smoke in a supervised space, the combination of a conduit having a portion extending into said space, the portion of said conduit within said space being provided with a plurality of inlets in predetermined spaced relation, means for causing air to enter said inlets and to flow into said conduit through said inlets from the space, an electrically controlled valve for each of said inlets, a source of electric current, an electric circuit including electric conductors within said conduit for carrying current from said source to said electrically controlled valves, and means for opening and closing said circuit to effect operation of said electrically controlled valves in a predetermined sequence.

4. In apparatus for sampling fluid medium in an enclosure, the combination of a conduit having a plurality of inlets in the enclosure, a valve for each inlet, electrically controlled means for opening the valves, and spring means conditioned upon the opening of the valves for closing the valves when said electrically controlled means have been de-energized, the opening and closing means operating in a predetermined sequence to permit a sample of the medium to be tested to enter the conduit through each inlet when opened.

5. In apparatus for sampling fluid medium in an enclosure, the combination of conduit means

for the medium to be sampled having a plurality of inlets in communication with the enclosure, a valve for each inlet, electromagnet means for each valve for opening the valves, spring means conditioned upon the opening of the valves for closing the valves, an electric circuit including switch means associated with each electromagnetic means for sequentially connecting the same into said circuit to effect opening of its valve and including a current interrupter for de-energizing said circuit to render said electromagnetic means ineffective to permit said spring means to close said valves, and means associated with and operable by each of said electromagnetic means for effecting stepwise operation of said switch means upon closing of a valve.

6. In apparatus for sampling fluid media, the combination of sampling means having a plurality of inlets, a normally closed valve for each inlet, a solenoid for opening each valve, two electric circuits each for energizing said solenoids, switch means in each circuit, each of said switch means associated with said solenoids for sequentially connecting said solenoids in its circuit whereby to energize said solenoids to effect opening of their respective valves, and means for alternately connecting each circuit to a source of current supply until the switch means of said circuits have been energized thereby.

7. Apparatus according to claim 6, wherein said last mentioned means includes means for interrupting the current supply upon operation of each solenoid.

8. In apparatus for sampling fluid in an enclosure and testing the fluid to detect suspended matter therein, the combination of a testing station located remotely of the enclosure and including means for detecting suspended matter in the fluid, a single continuous conduit extending through the enclosure and communicating directly with said detecting means, said conduit having a series of lengthwise spaced apart openings in the wall thereof each serving as a direct inlet for fluid to be sampled at a given zone within the enclosure, and means for opening and closing said inlet openings in a predetermined sequence whereby fluid from the enclosure is admitted to said conduit through at least one pre-selected inlet opening at a time, said last mentioned means including a valve seat and a valve member therefor substantially at each inlet opening.

9. Apparatus according to claim 8, wherein said last mentioned means include a solenoid for opening each valve, an electric circuit in which said solenoids are connected, means associated with each valve for electrically connecting each solenoid sequentially into said circuit whereby to energize the solenoids to effect opening of their respective valves, and means for interrupting said circuit to effect de-energization of said solenoids and the closing of their respective valves.

10. In apparatus for sampling fluid media, the combination of sampling means having a plurality of inlets, a normally closed valve for each inlet adjacent thereto, a solenoid for opening each valve, two electric circuits, switch means in each of said circuits, said switch means being arranged for sequentially connecting said solenoids in the respective circuits and being arranged for synchronized movement, means operatively connected to each valve for effecting stepwise operation of said switch means in each of said circuits, and means for alternately con-

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necting each circuit to a source of current supply after the operation of a predetermined number of the valves.

11. In apparatus for sampling fluid media, the combination of sampling means having a plurality of inlets, a normally closed valve for each inlet, a solenoid for opening each valve, two electric circuits, switch means in each of said circuits, said switch means being arranged for sequentially connecting said solenoids in the respective circuits and being arranged for synchronized movement, pawl and ratchet means associated with each valve for effecting stepwise operation of said switch means in each of said circuits, and means operatively connecting each of said pawl and ratchet means to its respective valve for operation thereby.

12. In apparatus for sampling fluid media, the combination of sampling means having a plurality of inlets for fluid medium to be sampled, a normally closed valve for each inlet, electric means for opening each valve, a pair of electric circuits, switch means in each circuit, said switch means being arranged for sequentially connecting said electric valve opening means in the respective circuits, means operatively connecting said switch means for synchronized movement, means associated with each valve for effecting operation of said last mentioned means of said switch means upon each operation of a valve, and means for alternately connecting each circuit to a source of current supply following the oper-

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ation of a predetermined number of the valves.

13. In apparatus for sampling fluid media, the combination of sampling means having a plurality of fluid medium inlets, a normally closed valve for each inlet, a solenoid for opening each valve, a pair of electric circuits each for the same group of said solenoids, a current supply for said circuits, switch means in each circuit associated with said group of solenoids for sequentially connecting said solenoids in its circuit whereby to energize said solenoids to effect opening of their respective valves, and means for interrupting said current supply after each solenoid has been energized, whereby to de-energize the same and permit its respective valve to close, said last named means including means for alternately connecting said circuits to said current supply following the operation of a predetermined number of valves.

HARRY C. GRANT, JR.

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