March 30, 1971 C. A. ANDERSON 3,573,223

SMOKE GENERATOR WITH AUTOMATIC CONTROL SYSTEM THEREFOR

Filed Oct. 14, 1968 2 Sheets-Sheet 1

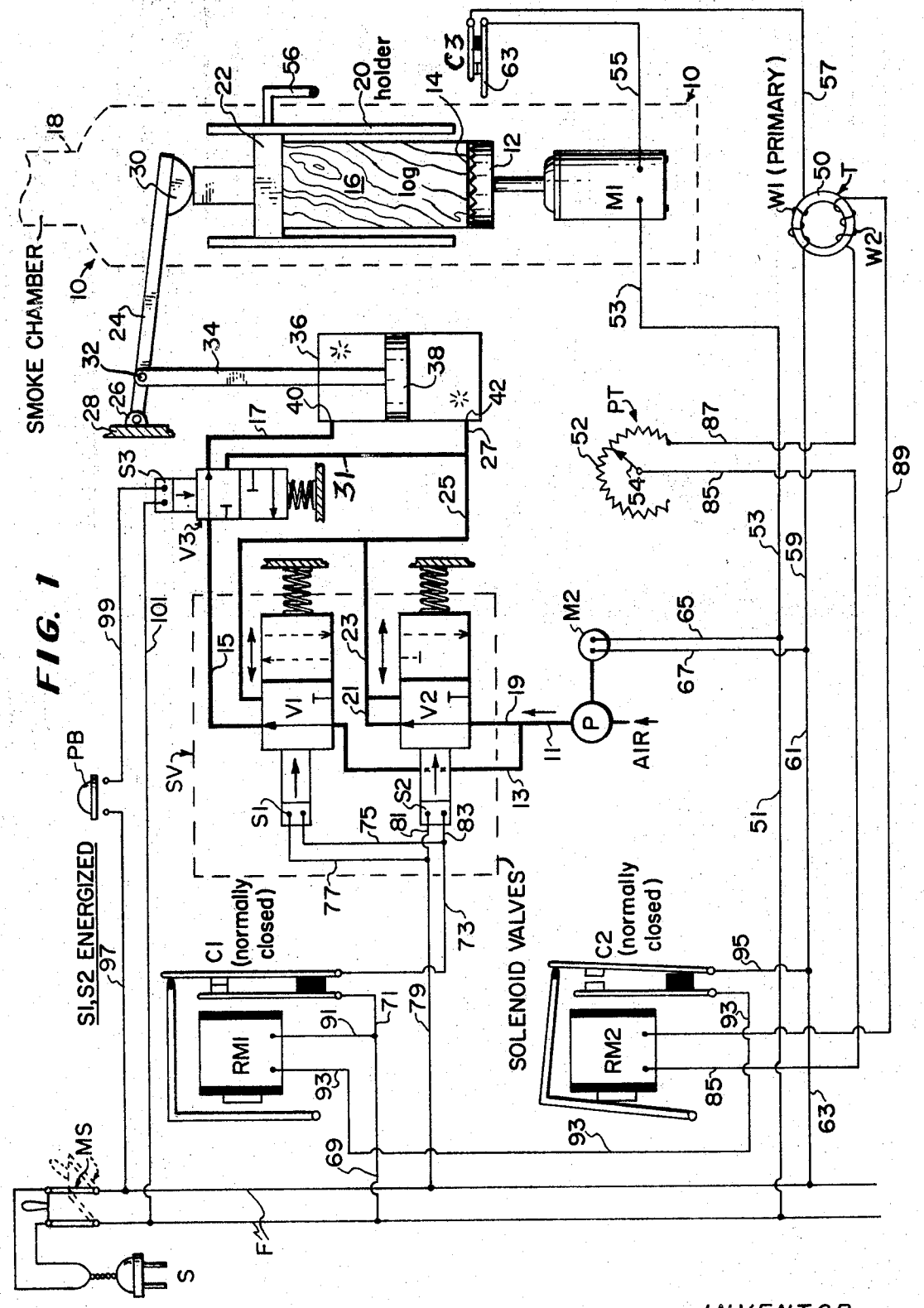


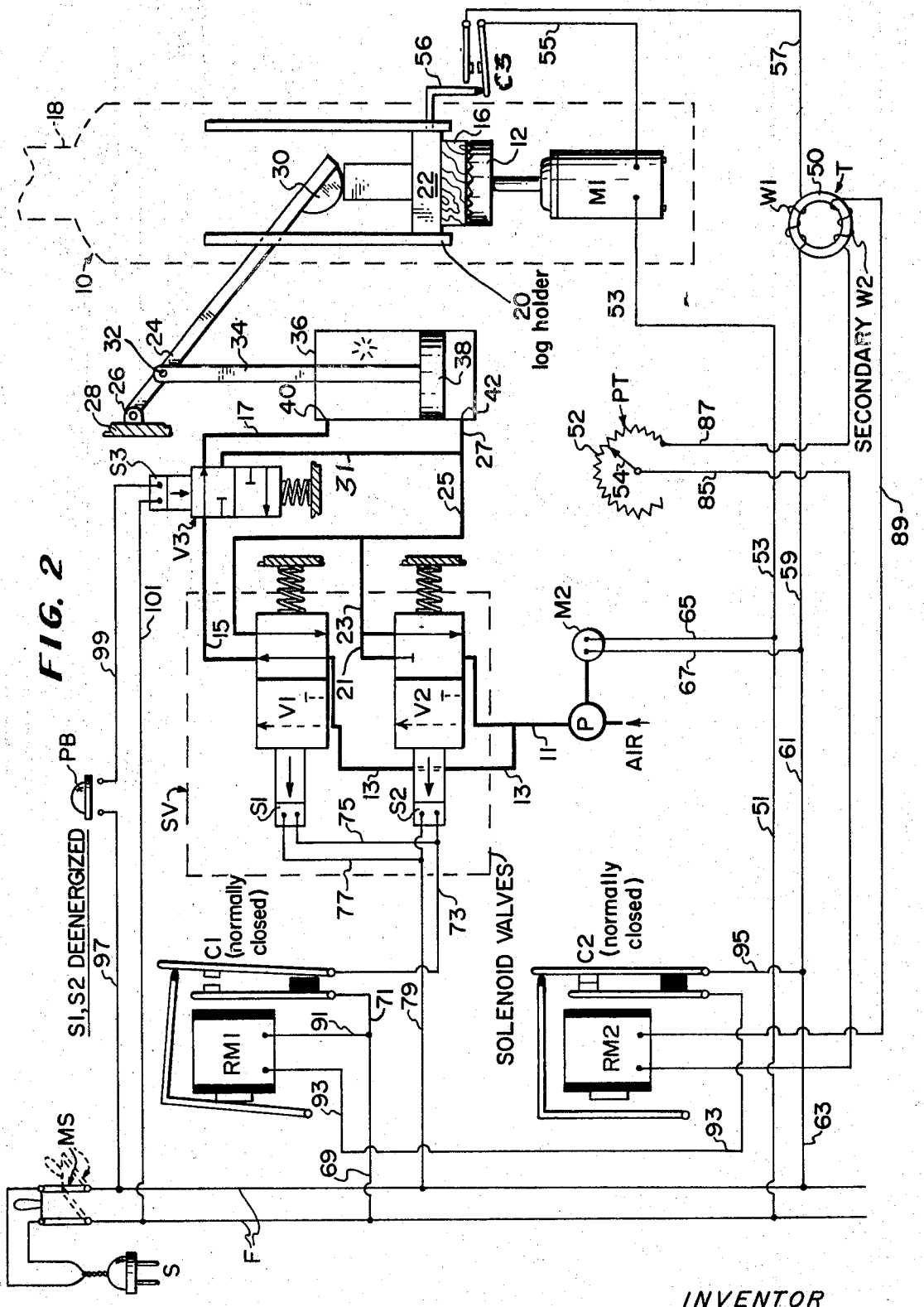
FIG. 1

INVENTOR
CHESTER A. ANDERSON
By Norman Berback
Attorney

March 30, 1971 C. A. ANDERSON 3,573,223

SMOKE GENERATOR WITH AUTOMATIC CONTROL SYSTEM THEREFOR

Filed Oct. 14, 1968 2 Sheets-Sheet 2



INVENTOR
CHESTER A. ANDERSON
By Norman Peterson
Attorney

United States Patent Office 3,573,223 Patented Mar. 30, 1971

3,573,223

SMOKE GENERATOR WITH AUTOMATIC CONTROL SYSTEM THEREFOR

Chester A. Anderson, McHenry, Ill., assignor to Speco, Inc., Schiller Park, Ill.

Filed Oct. 14, 1968, Ser. No. 767,267
Int. Cl. B01d; B01f; B01j 13/00
U.S. Cl. 252—359 8 Claims

ABSTRACT OF THE DISCLOSURE

A control system for a friction-type smoke generator wherein the pressure which is exerted by the wooden smoke-producing block against the usual rotating friction wheel is regulated according to the electrical current which is supplied to the motor for driving the friction wheel.

The present invention relates generally to a friction-type smoke generator which is designed primarily to supply smoke to a smokehouse and is of the type wherein the friction that is applied by a rotating abrasive wheel against a relatively fixed wooden log generates sufficient heat to effect smouldering combustion to the log, thus, creating dense smoke which is conducted through a stack to the associated smokehouse or other smoke enclosure for the curing of meat or other comestibles. More specifically, the invention is concerned with a novel automatic control system whereby a substantially constant coefficient of friction may be maintained between the abrasive wheel and the log undergoing abrasion thereby, to the end that uniform smoke generation may be maintained from the time of initial abrasion of the log until the log has been substantially consumed by the rotating grinding wheel.

Heretofore, where smoke generation has been effected by the voluntary smothering of burning materials, the problem of attaining uniform smoke density in a smokehouse or other enclosure has presented almost unsurmountable operational problems. With the advent of smoke generation by friction, the problems have been of a lesser nature, but nevertheless, it has been necessary for the operator of the friction-type smoke generator to observe and pay careful attention to the involved equipment and to make repeated adjustment of the pressure-applying means which progressively feeds the log against the rotating abrasive wheel. Where spring pressure has been employed for forcing or feeding the log against the wheel, small increments of adjustment are assimilated in the spring and are not effective against the wheel, while large increments of adjustment soon dissipate themselves so that frequent adjustments are necessary. For example, when the abrasive wheel encounters in the log a hard spot such as a knot, the coefficient of friction against the abrasive wheel drops sharply, thus requiring a large increase in the pressure of the log against the wheel. When such increase has been effected and the hard spot has become dissipated, the excess pressure then becomes applied to the softer remaining portion of the log and substantially smokeless combustion takes place when the log ignites. This calls for an immediate relief of pressure. The same phenomenon takes place when substantially constant hydraulic or pneumatic pressure is applied to the log for feeding purposes. These conditions also obtain when weights are applied to the log for the maintenance of pressure against the abrasive wheel. The repeated and frequent addition and subtraction of weights is a time-consuming procedure and not altogether satisfactory since it is difficult to ascertain how much weight should be added or withdrawn at any given time.

The present invention is designed to overcome the above-noted limitations that are attendant upon the construction and operation of conventional or standard friction-type smoke generators, and toward this end, the invention contemplates the provision in a friction-type smoke generator of a novel control system by means of which automatic friction control commensurate with the demand for friction in the attainment of substantially uniform smoke density may be attained, thus relieving the operator of the necessity of being in constant attendance during the entire generator cycle, i.e., during the abrasion of any given log.

In carrying out the invention, it is contemplated that either hydraulic or pneumatic pressure, preferably the latter, be employed for feeding the log against the rotating abrasive wheel and that regulation of such pressure be effected in accordance with the flow of energizing electric current through the electric motor which drives the wheel. Since the flow of energizing current through the motor circuit is a function of the work performed by the motor, i.e., the load, in the case of an electrically driven abrasive wheel variations in frictional resistance to rotation of the wheel will be proportional to the current flow in the motor windings. Thus, a sudden decrease in the amount of the friction that is developed between the log and the rotating abrasive wheel will result in a speeding up of the motor due to the reduced load, while at the same time the current demand by the motor will be reduced and the current flow through the motor windings will be automatically decreased. Conversely, a sudden increase in the friction between the log and the wheel will result in an increased current demand and an automatic increase in current flow through the motor windings.

According to the present invention, the control system for the friction-type smoke generator includes means for sensing the amperage in the electric circuit for the motor which drives the smoke-generating abrasive wheel and when this amperage remains above a predetermined level, a substantially constant predetermined pneumatic pressure is applied to the log to maintain it in contact with the rotating wheel. However, at such time as the amperage in the motor circuit falls below such predetermined level, certain relay mechanism is operated automatically with the net result that the fluid pressure that is applied to the log is increased, the increase in pressure being maintained until such time as the amperage in the motor circuit again attains or exceeds the predetermined level. The provision in a friction-type smoke generator of an automatic control system which operates upon the principles briefly outlined above constitutes the principal object of the present invention.

In carrying out the invention, a pneumatic cylinder and plunger arrangement is operatively connected to the log so that application of air under pressure to one end of the cylinder will apply down-pressure to the log to force it against the rotating abrasive wheel, while application of pressurized air to the other end of the cylinder will apply up-pressure to the log to reduce the amount of friction against the wheel. In addition to the cylinder and plunger arrangement, there is provided a solenoid valve arrangement which normally directs air to both ends of the cylinder so that the log is stabilized in a predetermined position of pressure application to the friction wheel. A current-sensing device is associated with the motor circuit for the abrasive wheel motor, such device being disposed in a local sensing circuit the resistance of which is controlled by a potentiometer. Normally, the setting of the potentiometer is such that the induced current in the local sensing circuit has no effect on the relay mechanism which continues to maintain the solenoid valve arrangement in its normal condition for application

of air to both ends of the cylinder. However, as soon as a decrease in the current flowing in the local sensing circuit takes place indicating a decrease in friction between the log and the abrasive wheel, the relay mechanism is actuated automatically to cause, in turn, operation of the solenoid valve arrangement whereby air pressure at one end of the cylinder is relieved so as to effect down-pressure on the log to thus increase its frictional contact with the abrasive wheel. When the frictional drag on the log again increases to such an extent that the desired normal frictional contact between the log and wheel is restored, the relay mechanism is again automatically operated to effect normal operation of the solenoid valve arrangement so that air is supplied to both ends of the cylinder, thus stabilizing the log at the new level of pressure application against the rotating abrasive wheel.

The local sensing circuit, the relay mechanism and the solenoid valve arrangement are effective in the manner indicated above, not only for the accommodation of sudden decreases or increases in the demand for friction between the log and the abrasive wheel, but also to accommodate gradual consumption or wear of the log. Thus, during normal log feeding operations as the log becomes worn and the coefficient of friction between the log and the wheel gradually decreases, the various pneumatic and electrical instrumentalities become effective repeatedly to sense the flow of current in the motor circuit, the frequency of operation being dependent upon various factors such as the amount of moisture in the log and the density of the log.

Other objects and advantages of the invention not at this time enumerated will become readily apparent as the specific nature of the invention is better understood.

The invention consists in the several novel features which are hereinafter set forth and more particularly defined by the claims at the conclusion thereof.

In the accompanying two sheets of drawings forming a part of this specification, one illustrative embodiment of the invention is shown, the disclosure being largely schematic in its representation.

In these drawings:

FIG. 1 is a combined hydraulic and electric diagram illustrating the present invention operatively applied to a friction-type smoke generator, the details of which are schematically illustrated, the various instrumentalities being disclosed in the condition which they assume at the commencement of a given log-consuming operation and at such time as a predetermined normal condition of frictional application to the log remains prevalent; and

FIG. 2 is a diagram similar to FIG. 1 but showing the instrumentalities in the condition which they assume when the coefficient of friction between the log and its cooperating abrasive wheel drops below a predetermined minimum.

THE SMOKE GENERATOR

Referring now to the drawings in detail, the smoke generator to which the present automatic friction control system is applied is of the general type which is manufactured and sold by Meat Products Equipment Company of Oakland, Calif. under the trade name "MET-PACO." A generator of this general type or character is schematically illustrated in the drawings and it embodies a smoke enclosure which is shown in broken lines and designated by the reference numeral **10**, the enclosure serving to retain a rotary abrasive wheel **12** having an upper tungsten carbide friction surface **14** against which there is adapted to be forcibly pressed or fed the lower end of a wooden log **16**. When the abrasive wheel **12** is rotated at high speed, the friction which is generated between the upper friction surface **14** and lower end of the log creates sufficient heat to produce a smouldering condition and this results in the generation of a large amount of smoke which fills the enclosure **10** and escapes through an upstanding stack **18** under the influence of a motor-driven

fan (not shown) from whence it is conducted through a conduit to a smokehouse or other meat-curing enclosure.

The abrasive wheel **14** has means (not shown) for supporting it for rotation about a vertical axis and is driven from an electric motor **M1** while the log **16** is vertically slidable in a cage-like log holder **20** under the downward impelling influence of a follower **22**. In addition to the gravitational weight of the log and its follower, a positive downward feeding of the log is effected under the control of a pneumatically actuated lever **24** which is pivoted at its proximal end to a bracket **26** on a fixed support **28** and carries at its distal end a pressure pad **30**. These medial region of the lever **24** is pivoted as at **32** to the upper end of an upstanding piston rod **34** which extends slidably through an opening in the top wall of a vertical cylinder **36**. The lower end of the piston rod is connected to a piston **38** which is vertically reciprocable within the cylinder **36**. Such cylinder is provided with an upper port **40** above the piston **38** and a lower port **42** below the piston. From the above description, it will be readily apparent that when air underpressure is admitted to the cylinder **36** through the upper port **40** with the lower port being vented to the atmosphere, the piston **38** will be shifted downwardly in the cylinder **36**, thus rocking the lever **24** in a clockwise direction as viewed in FIGS. 1 and 2 and causing the pad **30** to apply downward pressure to the follower **22** and, consequently, the log **16**, so as to increase the pressure of the log on the abrasive wheel **12**. Conversely, when air under pressure is admitted to the cylinder **36** through the lower port **42** with the upper port **40** being vented to the atmosphere, the pressure of the log **16** against the abrasive wheel **12** will be relieved. When air pressure is simultaneously applied to both the upper port **40** and the lower port **42**, the piston **38** will become stabilized, such stabilization being reflected through the plunger **34**, the lever **24**, the pad **30**, and the follower **22** to the log **16**.

The arrangement of parts thus far described is purely conventional and no claim is made to any novelty associated therewith, the novelty of the present invention residing rather in a certain or particular pneumatic and electrical automatic control system whereby substantially uniform frictional characteristics between the log **16** and the abrasive wheel **12** may be maintained for smoke-generating purposes during the progressive feeding of the log to and against the wheel throughout the entire log feeding operation of the generator from the time a given log is installed in the cage-like log holder **20** to the time when the log has been effectively consumed. An important feature of the invention resides in the manner in which log-stabilization takes place by the simultaneous application of air to both ports **40** and **42** of the cylinder **36** after each increment of pressure adjustment has been effected.

THE AUTOMATIC CONTROL SYSTEM

The pneumatic instrumentalities

The automatic control system of the present invention involves in its general organization a dual solenoid valve mechanism which is represented by the broken line rectangle **SV**. This mechanism includes a first valve **V1** which is operable under the control of a solenoid **S1** and a second valve **V2** which is operable under the control of a solenoid **S2**. Each of the two valves is a two-position valve which is biased by a tension spring.

In the energized condition of the solenoid **S1**, as shown in FIG. 1 of the drawings, air under pressure is supplied to the upper end of the cylinder **36** from a pump **P**, through lines **11**, **13**, the valve **V1**, a line **15**, a pressure release valve **V3** the function of which will be described presently, a line **17** and the upper port **40**. In the energized condition of the solenoid **S2**, air flows to the lower end of the cylinder **36** through the line **11**, a line **19**, the valve **V2**, lines **21**, **23**, **25**, **27**, and the lower port **42**.

The aforesaid pump P is dirven by an electric motor M2.

In the deenergized condition of the solenoid S1, as shown in FIG. 2 of the drawings, air under pressure remains applied to the upper end of the cylinder 36 through the fluid circuit previously described. In the deenergized condition of the solenoid S2, the supply of pressurized air to the lower end of the cylinder is discontinued while this end of the cylinder is vented to the atmosphere from the port 42, through the lines 27, 25, 23, 21 and the valve V2.

The previously mentioned pressure release valve V3 is a two-position valve which is biased by a compression spring and is operable under the control of a solenoid S3 which, when deenergized, so controls the valve V3 that the latter maintains the upper end of the cylinder 36 operatively connected to the valve V1 throughout the entire operative smoke-generating cycle of the generator. The solenoid S3 is adapted to be energized only at the end of the cycle when the log 16 has been consumed and it is desired to replace the same with a fresh log. Upon such energization of the solenoid C3, the admission of air under pressure to the upper end of the cylinder 36 is blocked so that there is no communication between the lines 15 and 17, while at the same time pressurized air from the bottom of the cylinder 36 will be discharged to the atmosphere through the lower port 42, and line 27, a line 31, and the valve V3.

The electrical instrumentalities

The two solenoid-actuated valves V1 and V2 are adapted to be energized and deenergized in unison under the control of a relay magnet RM1 having associated therewith a pair of normally closed contacts C1. The term "normally open" as employed therein in connection with these contacts, and the term "normally closed" as will be employed in connection with certain other contacts subsequently to be described, refers to the positions of the contacts in their free state as unaffected by any control relay magnet which may be associated therewith.

The relay magnet RM1, when energized, serves to open the normally closed contacts C1. A second relay magnet RM2 having a pair of normally closed contacts C2 is effective when energized to open the contacts C2. The relay magnet RM1 is adapted to become energized and deenergized under the control of the closing and opening movements of the contacts C2 while the two solenoids S1 and S2 are adapted to become energized and deenergized in unison under the control of the closing and opening movements of the contacts C1, all in a manner and for a purpose that will become clear when the operation of the smoke-generator is set forth.

The relay magnet RM2 depends for its energization and deenergization on the rate of current flow in a local sensing circuit which includes a series arrangement of the magnet RM2 itself, the secondary winding W2 of a current sensing transformer in the form of a toroid T, and a variable resistance in the form of a potentiometer PT. The sensing toroid T further embodies a laminated core 50 and a primary winding W1, the latter being disposed in series in the electrical circuit for the motor M1. The potentiometer PT includes the usual resistance element 52 and a sweep or wiper arm 54.

A third pair of contacts C3 is positioned in the path of movement of an actuating finger 56 which is carried by the log follower 22. These latter contacts are normally closed contacts (see FIG. 1) and are adapted to become open when engaged by the finger 56 near the end of the cycle when the log 16 has become substantially consumed.

Additional devices employed in connection with the electrical circuitry of the automatic control system constituting the present invention include a master switch MS which, when closed, supplies current from a suitable source S (which may be a commercial power line) for automatic operation of the smoke generator and a push button switch PB which, when closed, establishes a circuit through the solenoid S_3 for controlling the pressure relief valve V3.

OPERATION OF THE APPARATUS

In the operation of the smoke-generator, closure of the master switch MS supplies current to the feed line F from the curent source S. Energization of or current flow through the feed line F causes immediate energization of the motors M1 and M2. The circuit for the motor M1 extends from the line F, through leads 51, 53, the motor M1, a lead 55, the contacts C3, a lead 57, the winding W1 of the sensing toroid T, and leads 59, 61, 63, back to the line F. The circuit for the motor M2 extends from the line F, through the leads 51, a lead 65, the motor M2, a lead 67, and leads 61, 63 back to the line F.

Energization of the line F also causes immediate energization of both solenoids S1 and S2, the circuit for the solenoid S1 extending from the line F, through leads 69, 71, the normally closed contacts C1, leads 73, 75, the solenoid S1, and leads 77, 79 back to the line F. A similar parallel circuit exists for the solenoid S2 involving leads 81 and 83 in place of the leads 75 and 77.

Upon energization of the solenoids S1 and S2 as described above as viewed in FIG. 1, the aforementioned pneumatic circuits leading from the pump P to both ends of the cylinder 36 become effective to supply air under pressure through the ports 40 and 42 to the interior of the cylinder on opposite sides of the piston 38, thus stabilizing the piston and, consequently, the log 16 which rests upon the rotating abrasive wheel 12 and is prevented from itself rotating by the confining action of the cage-like log holder 20.

Assuming now that the predetermined optimum degree of friction between the log 16 and the abrasive wheel 12 is in excess of that which is afforded solely by the weight of the log and its follower 22, the potentiometer PT may be adjusted by rotating the sweep or wiper arm 54 in one direction or the other to establish an ohmic resistance in the local series circuit, which includes the relay magnet RM2, the potentiometer PT, and the secondary winding of the toroid T, commensurate with the desired degree of friction. This local circuit extends from the relay magnet RM2, through the lead 85, the wiper arm 54, a portion of the resistance 52, the lead 87, the secondary winding W2 and a lead 89 back to the relay magnet RM2. Adjustment of the potentiometer PT in the manner indicated above will reduce the ohmic resistance of the local circuit to such an etxent that the amount of curent flowing in the circuit for the motor M1 will induce a flow of current in the secondary winding W2, and consequently, in the local circuit, the amperage involved being insufficient to energize the relay magnet RM2. Deenergization of this magnet closes the contacts C2, whereupon a circuit will be completed from the line F, through the lead 69, a lead 91, the magnet RM1, a lead 93, the contacts C2 of the magnet RM2 (now closed), a lead 95, and the lead 63 back to the line F.

Energization of the magnet RM1 will cause opening of its contacts C1, whereupon the parallel circuits through the windings of the solenoids S1 and S2 will become deenergized, thus shifting the positions of the two valves V1 and V2 so that, as shown in FIG. 2, the air under pressure will continue to be supplied to the upper end of the cylinder 36 under the influence of the valve V1, but will be discontinued to the lower end of the cylinder by the valve V2, while at the same time pressurized air will be vented from the lower end of the cylinder 36 in the manner previously described at the time the pneumatic circuitry for these two valves, V1 and V2, was set forth. Under these circumstances, a positive downward pressure will be exerted upon the piston 38, thus swinging the lever 24 in a clockwise direction as viewed in FIGS. 1 and 2 and causing the pressure pad 30 to bear downwardly

against the follower **22** so as to increase the friction between the log **16** and the rotating abrasive wheel **12**. This condition of the two valves V1 and V2 will remain effective until the amperage in the motor circuit again decreases to the point where the induced current in the local circuit including the secondary winding W2 of the toroid T is insufficient to maintain energization of the relay magnet RM2. At this time, deenergization of the magnet RM2 causes reclosing of its contacts C2 and a consequent energization of the magnet RM1, thus restoring the relay mechanism and the valves V1 and V2 to their condition of piston balance or stabilization as previously described. Thereafter, consumption of the log **16** reduces the friction between the log and the abrasive wheel to a point where the operation just described is repeated in order to bring the pressure of the pad **30** back to the desired degree where proper friction between the log and the abrasive wheel again is attained. The smoke generator "cycles" in this manner repeatedly during consumption of the log, the frequency of the cycling operation being dependent upon various physical conditions such as those or moisture content of the log, its hardness and other factors which may affect the flood of current in the primary circuit of the motor M1.

It is to be noted that where the density of a given log **16** is fairly uniform throughout the longitudinal extent of the log, such cycling of the apparatus may have a frequency on the order of from five to fifteen seconds with the log being substantially consumed in a matter of from one hour to one and one-half hours. During this time, the operator is relieved of the responsibility of being in continual attendance at the generator, the same functioning smoothly and without manual attention during this time. In the event that a particular hard spot or region within the log is encountered by the abrasive wheel **12**, as for example, the presence of a knot, a sudden decrease in the coefficient of friction between the log and the abrasive wheel will immediately reduce the amperage of the primary circuit for the motor and cause tripping of the relay magnet RM2, thus opening its contacts C2 so as to deenergize the relay magnet RM1 and open its contacts C1 to reverse the positions of the two solenoid actuated valves V1 and V2 and vent the lower end of the cylinder **36** to the atmosphere, thereby applying increased pressure to the log by the pressure pad **30**, all in the manner previously described. The presence of such a knot, therefore, induces a special generator cycle for the purpose of disposing of the knot, and after it has been disposed of, the generator resumes its normal uniform cycling operation.

At such time as the log **16** becomes substantially consumed, the follower **22** will have moved downwardly into the vicinity of the contacts C3 where the actuating finger **56** will engage and open such contacts, thus opening the circuit for the motor M1 and terminating the rotation of the abrasive wheel **12**. Deenergigation of the motor circuit completely deenergizes the local circuit including the toroid T and the relay magnet RM2 so that the contacts C2 will open or remain open if they happen to be closed at this time. Opening of the contacts C2 deenergizes the relay magnet RM1 and closes the contacts C1 so that piston and log stabilization takes place.

In order to raise the pressure pad **30** from the log remnant, the pushbutton of the switch PB is depressed, thus energizing the solenoid S3 through a circuit extending from the line F, through a lead **97**, the pushbutton switch PB, a lead **99**, the solenoid S3, and a lead **101**, back to the line F. As previously described, energization of the solenoid S3 reverses the position of the valve V3 so that the upper end of the cylinder **36** is vented to the atmosphere while air under pressure continues to be supplied to the lower end of the cylinder **36** so as to raise the piston **38** and, consequently, the pressure pad **30**. With the pad **30** thus raised, a fresh log **16** may be inserted in the cage-like log holder **20**. Prior to such replacement of the log **16**, the master switch MS may be opened in order completely to disable the generator during log installation.

The invention is not to be understood as restricted to the details set forth since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. In a smoke geenrator of the type wherein smoke generation is effected by frictionally induced heat resulting from the abrasion of a combustible material, in combination, a rotatable abrasive wheel, an electric motor operatively connected to said wheel in driving relationship, an electric circuit for said motor, a log holder for maintaining a log in coaxial juxtaposed relationship and contact with respect to said abrasive wheel, a fixed cylinder, a piston slidable in said cylinder and effective when pressure fluid is supplied solely to one end of the cylinder to apply pressure to the remote end of the log in a direction to force the same against the abrasive wheel, and when fluid is supplied solely to the other end of the cylinder to relieve such pressure, and valve and relay means responsive to fluctuation in the current supply to the motor due to the variable friction developed between the log and its abrasive wheel for selectively supplying pressure fiuid to the opposite ends of said cylinder, said valve and relay means being automatically effective when a predetermined degree of pressure is applied to the log to supply fluid to both ends of the cylinder to stabilize the piston and consequently the log, and when pressure applied to the log and abrasive wheel falls below said predetermined degree resulting in current to drop in the motor to maintain the application of fluid to said one end of the cylinder while simultaneously venting said other end of the cylinder to the atmosphere to restore the pressure applied to the log to said predetermined degree, said valve and relay means including a first solenoid-actuated valve effective when deenergized to supply pressurized fluid to said one end of the cylinder while blocking the escape of fluid from the other end of the cylinder, and effective when energized to supply fluid to said one end of the cylinder while venting the other end of the cylinder to the atmosphere, and a second solenoid-actuated valve effective when deenergized to supply fluid to said one end of the cylinder while venting the other end of the cylinder to the atmosphere, and a second solenoid-actuated valve effective when deenergized to supply fluid to said one end of the cylinder while blocking the escape of fluid from the other end of the cylinder, and effective when energized to discontinue the application of fluid to said one end of the cylinder while venting the other end of the cylinder to the atmosphere, and electrical relay means effective when said predetermined degree of pressure is applied to the log to maintain said valves deenergized, and effective when the pressure applied to said log falls below said predetermined pressure to simultaneously energize both of said valves.

2. In a smoke generator, the combination set forth in claim **1** and wherein said electrical relay means is responsive to the flow of electrical current in said motor circuit to maintain the valves deenergized when the flow of current in said circuit is less than a predetermined maximum, and to maintain the valves energized when the flow of current in the circuit is in excess of said predetemined maximum.

3. In a smoke generator, the combination set forth in claim **2** and wherein said relay means includes relay magnet means effective when deenergized to maintain said valves deenergized and when energized to maintain the valves energized, and a transformer having a primary winding in said motor circuit and a secondary winding disposed in series relationship in a local circuit including said relay magnet means.

4. In a smoke generator, the combination set forth in claim 2 and wherein said relay means includes a first relay magnet effective when deenergized to maintain said valves energized and when energized to maintain the valves deenrgized, a second relay magnet effective when energized to maintain said first relay magnet deenergized and when deenergized to maintain said first relay magnet energized, and a transformer having a primary winding disposed in series relationship in a local circuit including said second relay magnet.

5. In a smoke generator, the combination set forth in claim 2 and wherein said relay means includes a first relay magnet having a pair of normally closed contacts and adapted, when energized, to open said contacts, an electric circuit common to said pair of contacts and said solenoid-actuated valves, a second relay magnet having a pair of normally closed contacts and adapted, when energized, to open said contacts, an electric circuit for said first relay magnet and including the contacts of the second relay magnet, and a local electric circuit for the second relay magnet and including a current sensing device associated with the motor circuit and effective to induce a flow of current in said local circuit, said device being effective when the flow of current in the motor circuit remains above a predetermined maximum to maintain the second relay magnet energized and when such flow of current falls below said predetermined maximum to deenergize said second relay magnet.

6. In a smoke generator, the combination set forth in claim 5 and wherein said current sensing device comprises a transformer having a primary winding disposed

in the motor circuit and a secondary winding disposed in said local circuit.

7. In a smoke generator, the combination set forth in claim 6 and including, additionally, a variable resistance disposed in said local circuit and effective to vary the response of said second relay magnet to the flow of current in said motor circuit.

8. In a smoke generator, the combination set forth in claim 6 and including, additionally, a third solenoid-actuated valve effective when deenergized to admit fluid from said first solenoid-actuated valve to the upper end of said cylinder and when energized to block the flow of fluid from said first solenoid-actuated valve to the upper end of the cylinder and simultaneously to vent said upper end of the cylinder to the atmosphere.

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WILBUR L. BASCOMB, JR., Primary Examiner

J. SOFER, Assistant Examiner

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