Jan. 17, 1950 K. W. MacKENZIE 2,494,822

ELECTRICAL PRECIPITATORS

Filed March 18, 1947 2 Sheets-Sheet 1

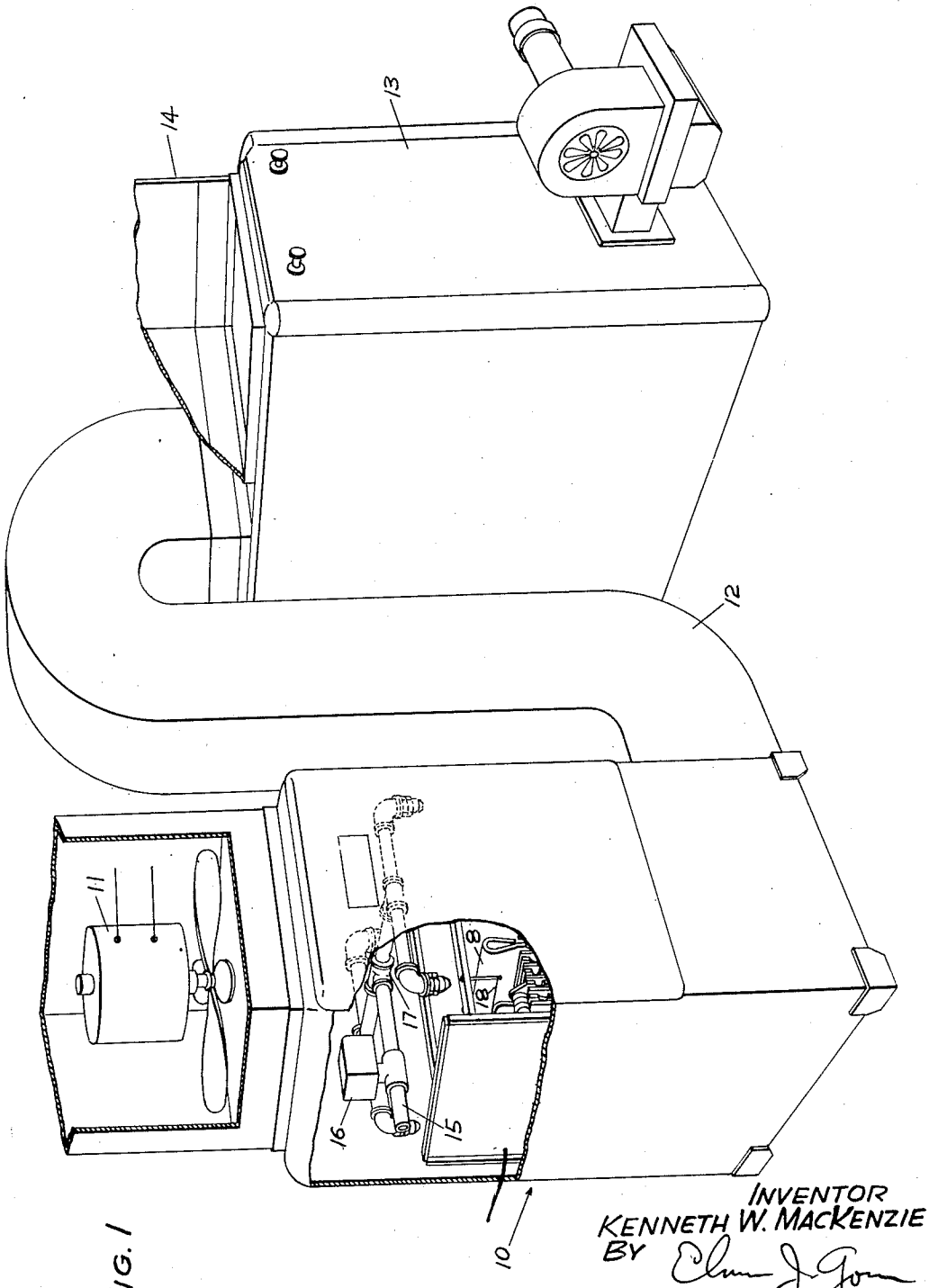


FIG. 1

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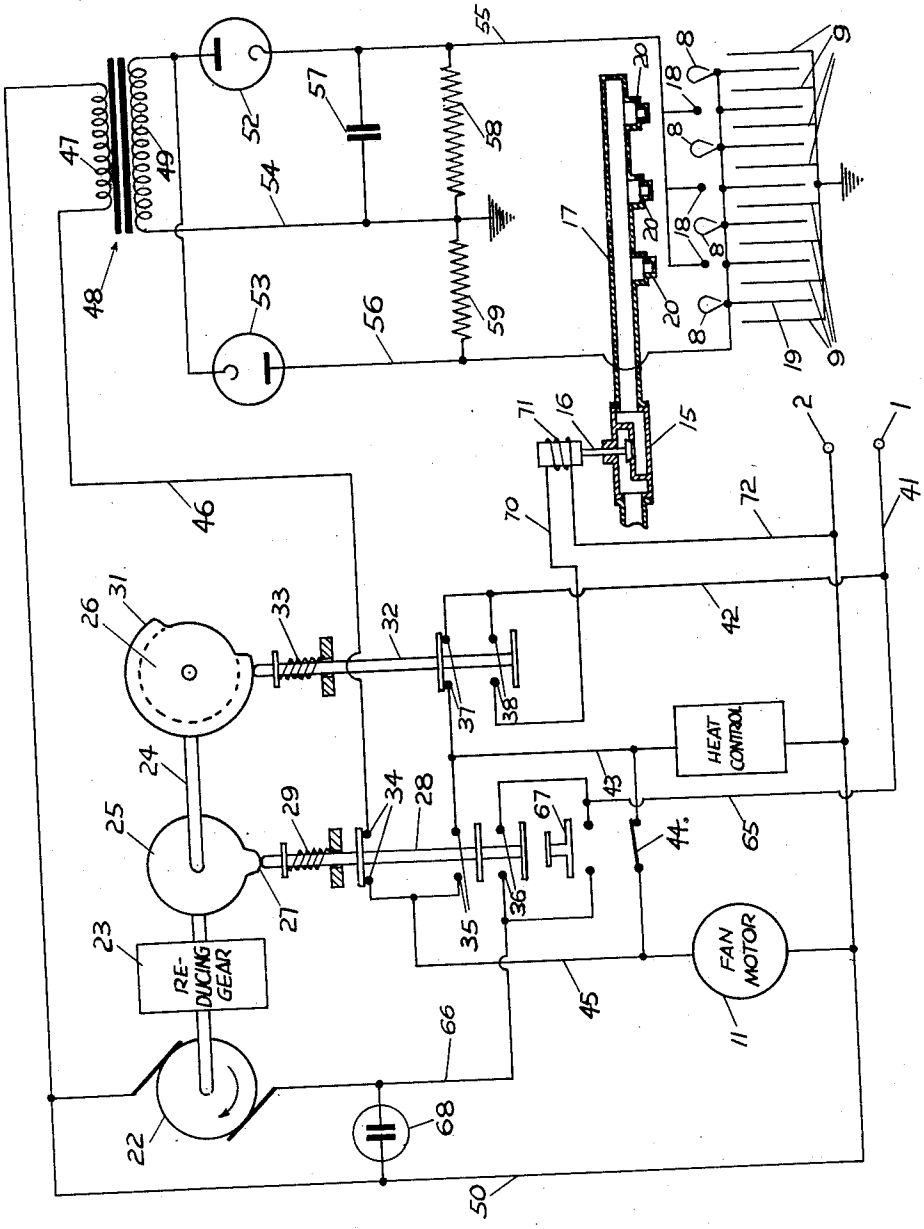


FIG. 2

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UNITED STATES PATENT OFFICE

2,494,822

ELECTRICAL PRECIPITATOR

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Application March 18, 1947, Serial No. 735,403

7 Claims. (Cl. 183—7)

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This invention relates to electrical precipitators for separating particulate matter from atmospheric air, and more particularly to a system for controlling the operation of such precipitators.

Electrical dust precipitators, of the type in which the air to be cleaned is first ionized in an ionizing zone, where the dust particles receive an electrical charge, and is then passed to a collecting zone where the charged particles are deposited upon suitable collecting electrodes, must be cleaned at intervals; otherwise the accumulated desposits will interfere with the operation of the system. Where the precipitator is intended for use in a home or other place where it would be impractical to employ a skilled attendant for maintaining the system, it is desirable to limit the operations required of the user and to so simplify these that the possibility of mistakes and misuse will be minimized. In my copending application, Serial No. 713,221, filed November 30, 1946, now Patent No. 2,476,248, dated July 12, 1949, there is shown an electrical dust precipitator suitable for home use in which the collecting electrodes may be washed in situ by a fluid spraying means associated with the system.

The present invention contemplates the provision of a control system which will effect the washing operation at the will of the operator without requiring material attention or time on the part of the operator.

To these ends it is an object of this invention to provide a control system for precipitators of the type described, which may be set in operation to effect the cleaning process by the actuation of a switch, and which will then effect the required operations in the desired sequence and with the proper timing.

It is a further object of the invention to provide a control system of the type described which will insure that the power supply to the ionizing and collecting electrodes will be discontinued prior to the initiation of the supply of cleaning fluid to the electrodes.

It is a further object of the invention to provide a control system of the type described which will permit the static charge on the precipitator electrodes to be dissipated prior to the spraying of such electrodes with cleaning fluid.

It is a further object of the invention to provide a construction in which the power supply to the motor of the fan or equivalent means for forcing air through the precipitator is discontinued during the period cleaning fluid is sprayed on the precipitator electrodes, and in which, upon the termination of the supply of cleaning fluid, the fan will force air through the precipitator for a predetermined period prior to the energization of the precipitator electrodes to entirely dry said electrodes before the appearance of high voltages therebetween.

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In some domestic systems it is desired to provide a construction in which the dust precipitating means is associated with the furnace, to the end that the air to be purified is first forced through the precipitating means and thence passed in heat absorbing relation to the furnace, thus providing a combined air purifying and heating system.

It is a further object of the present invention to provide, in such a combined system, a control circuit in which the fuel supply to the furnace and the control means capable of effecting such fuel supply are deenergized during the period in which the electrodes of the precipitator are being sprayed with cleaning fluid.

It is a further object of the invention to provide a control system of the type described in which the entire cleaning operation becomes automatic upon the actuation of a switch by the operator, and in which the washing and drying process will proceed, be accurately timed, and the precipitator returned to its normal operation upon completion of the process without further attention on the part of the operator.

The foregoing and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view, with parts broken away to show internal construction, of a combined air cleaning and heating system; and

Fig. 2 is a schematic view showing an electrical control system for combined air cleaning and heating systems in accordance with the invention.

Referring to the drawings, reference numeral 10 indicates generally a precipitator which may, for example, be of the type disclosed in my copending application previously mentioned. The air to be purified is forced through the precipitator 10 by means of a fan 11 and the air is then passed through a conduit 12 into heat absorbing relation to a furnace 13 from which the air passes through a hot air supply duct 14 to the air distributing system.

The precipitator 10 is of the type in which the collecting electrodes may be washed in situ. In this instance the cleaning fluid, which may be water, with or without soap or other detergents,

is supplied by way of a supply pipe 15 controlled by a solenoid valve 16. Upon the opening of the solenoid valve 16, the water is supplied under pressure to a manifold 17 positioned above the ionizing electrodes 8 and 18 and collecting electrodes 9 and 19. Manifold 17 is provided with a plurality of spray nozzles 20 directed toward the electrodes 8, 18 and 9, 19 in a manner to cause the cleaning fluid to impinge upon all parts of said electrodes.

In such a system, if the washing operation is left to the discretion of the operator, it is possible that the power supply for the energization of the electrodes will be left on at the time the solenoid valve 16 is energized to the detriment of the system. Also the operator might fail to cut off the power supply to the fan 11 prior to the initiation of the cleaning operation. In this event much of the spray from the nozzles 20 would be blown into the conduits of the heating and ventilating system, or be discharged from this system into the living quarters of the house, instead of falling to the collecting sump at the bottom of the precipitator. Other errors could be made such as failing to let the electrodes 8, 18 and 9, 19 dry after the spraying operation, before turning on the power supply to energize the electrodes. Also it would be undesirable to continue the fuel supply to the oil burner 21 of the furnace when the fan 11 is not in operation. Such errors are avoided and the operation made completely automatic by the control system shown in Fig. 2.

Referring to Fig. 2, a motor 22 has its shaft connected to the driving shaft of a speed reduction gear 23 having a driven shaft 24. A pair of cams 25 and 26 are mounted upon the shaft 24 to be driven at a very low speed through the reduction gear 23. For example, one revolution of the shaft 24 may require approximately twenty minutes. Cam 25 has an active portion 27, which active portion extends for only a few degrees of the angular movement of the cam, for example about four degrees. The active portion 27 actuates a rod 28 against the action of a spring 29. The cam 26 has an active portion 31, which active portion extends over substantially 270 degrees of the circumference cam. The active portion 31 of the cam 26 is adapted to actuate a rod 32 against the action of a spring 33. The rod 28 controls a pair of normally closed contacts 34 and two pairs of normally open contacts 35 and 36. By the term "normally" I refer to the position of the mechanism as shown in Fig. 2, which is the state of the system when the precipitator and the furnace are performing their normal functions of cleaning and heating the air forced therethrough by the fan 11, rather than to the condition in which these functions are discontinued to permit the cleaning of the collecting electrodes of the precipitator. The rod 32 controls a pair of normally closed contacts 37 and a pair of normally open contacts 38. In the position shown, a circuit is provided across the terminals 1 and 2 of a source of power supply, which circuit comprises the conductors 41 and 42, the closed contacts 37, conductor 43, fan switch 44, conductor 45, closed contacts 34, conductor 46, the primary winding 47 of a transformer 48, and conductor 50 leading to terminal 2. The secondary winding 49 of the transformer 48 is connected across the energizing circuit of the electrodes 18 and 19. The fan motor 11 is connected across the conductors 45 and 50. Thus, assuming that the fan switch 44, which

is actuated by a thermostat in the bonnet or hot air reservoir of the furnace, is closed, the precipitator electrodes 8, 18 and 9, 19 will be energized, the heat control system of the furnace will be in operation, and a circuit will be closed thorugh the fan motor 11 to force air through the system.

The power supply circuit for energizing the electrodes is more fully set forth in my copending application, Serial No. 692,893, filed August 24, 1946, now Patent No. 2,476,247, dated July 12, 1949. As shown, the system comprises a pair of rectifier tubes 52 and 53 connected in inverse relation to one terminal of the secondary winding 49. The other terminal of the secondary winding 49 is connected through a conductor 54 to ground. The tube 52 has its cathode connected by way of a conductor 55 to the fine wire electrodes 18 of the ionizing means. The tube 53 has its anode connected by a conductor 56 to the surface electrodes 8 of the ionizing means and to the charge electrodes 19 of the collecting system. The charge electrodes 19 are alternate plates of the collecting system, the intervening plates 9 of which are connected to ground. A condenser 57 and a resistor 58 are connected between the conductor 54 and the conductor 55. A resistor 59 is connected between the conductor 54 and the conductor 56.

The operation of the power supply system described in the foregoing is more fully set forth in my copending application, Serial No. 692,893, filed August 24, 1946. It is sufficient for the present purpose to note that the line 55 will be maintained at a predetermined positive potential of the order of 6 kv. Line 56 will be maintained at a negative potential of 6 kv and accordingly the potential difference between the fine wire electrodes 18 and the surface electrodes 8 which are connected to the line 56 will be of the order of 12 kv. The difference in potential between the collecting plates 19 which are connected to line 56 and intervening plates 9 which are connected to ground will be 6 kv.

When the parts are in the position shown, the circuit through the timing motor 22 is open and accordingly the cams 25 and 26 are at rest. The circuit for the motor 22 from the terminal 1 of the source of supply includes the conductor 41, a conductor 65, the contacts 36, and a conductor 66 connected to one terminal of the motor 22, the opposite terminal of which motor is connected to the conductor 50 and accordingly to the terminal 2. This circuit is normally open at the contacts 36. A push button switch 67 between the conductors 65 and 66 may be actuated by the operator to close a circuit by-passing the open contacts 36. When the push button switch 67 is closed, the motor 22 then drives the cams 25 and 26 very slowly in a clockwise direction through the speed reducing gear 23. Within a few seconds after the closure of the switch 67, for example for about ten seconds, the active portion 27 of the cam 25 will disengage the rod 28, permitting the rod to move upwardly, opening the contacts 34 and closing the contacts 35 and 36. The closure of the contacts 36 permits the operator to release the push button switch 67 and the circuit through the motor 22 will remain closed through said contacts 36. Preferably a neon lamp 68, connected across the motor 22, is provided to visually indicate to the operator that the circuit through the motor 22 is closed. If the operator releases the push button 67 before the contacts 36 have been closed, the lamp 68 will be

extinguished. The operator will again depress the push button 67 for a few seconds until the lamp 68 continues to glow upon the release of the push button, indicating that the circuit through the contacts 36 is closed. At the instant the contacts 36 are closed to maintain a circuit through the motor 22, contacts 34 are opened cutting off the power supply to the ionizing and collecting electrodes of the precipitator. Simultaneously the contacts 35 are closed. These contacts 35 close a circuit by-passing the switch 44 of the fan motor 11. Thus at this instant the fan is driven to force air through the precipitator regardless of the position of the fan switch 44 and while the power supply to the precipitator is cut off.

The contour of the active portion 31 of the cam 26 is such that the rod 32 is held in the position shown for about twenty seconds after the contacts 34 have been opened and the contacts 35 and 36 closed by the upward movement of the rod 28. This period of approximately twenty seconds allows sufficient time for any energy stored in the power supply circuit of the precipitator, as for example in the condenser 57 or in the capacitance provided by the collector plates 19, to leak off or be dissipated through the resistors 58 and 59 before the introduction of cleaning fluid into the precipitator. By the end of this period of twenty seconds the cam 26 has rotated through a sufficient angle in a clockwise direction so that the active portion 31 of the cam no longer holds the rod 32 in the position shown but permits the rod to move upwardly, breaking the contacts 37 and closing the contacts 38. The opening of the contacts 37 opens the circuit which during the previous twenty seconds permitted the flow of energy to the fan motor 11 through the conductor 42, the contacts 37, the contacts 35, and the conductor 45. Thus the fan can no longer force air through the precipitator. The circuit through the heat control system is also broken. It will be understood that the heat control system will include the means for controlling the supply of fuel to the oil burner and any limit switches or thermostatic devices capable of normally controlling the supply of fuel to the burner.

The closure of the contacts 38 closes a circuit from the conductor 42 through a conductor 70 leading to the energizing coil 71 of the solenoid valve 16 and thence by way of conductor 72 and conductor 50 to the terminal 2 of the supply source. The energization of the coil 71 opens the valve 16, permitting cleaning fluid from the pipe 15 to be sprayed upon the ionizing and collecting electrodes of the precipitator.

The cleaning fluid will continue to be sprayed upon the electrodes for a period of approximately five minutes, while the cam 26 rotates through an angle of approximately 90 degrees. At the end of this five-minute period, the active portion 31 of the cam 26 again engages the rod 32 to actuate this rod downwardly, breaking the contacts 38 and again closing the contacts 37. The circuit through the coil 71 being broken, the valve 16 closes, and cleaning fluid is no longer sprayed upon the collecting electrodes. The closure of the contacts 37 now closes a circuit through the fan motor 11 by way of the contacts 35 which are closed at this time so that the circuit through the fan is closed regardless of the position of the fan motor switch 44. A circuit also exists at this time from the terminal 1 through the conductor 42, the contacts 37 and

conductor 43 through the heat control system permitting the oil burner of the furnace to again be placed in operation under the control of the usual thermostatic devices. The fan motor thus forces air through the precipitator while the power supply to the ionizing and collecting electrodes remains broken at the contacts 34. This condition continues while the cams 25 and 26 rotate through an angle of approximately 265 degrees, and requiring approximately fifteen minutes. At the end of this fifteen-minute period, the active portion 27 of the cam 25 again contacts the rod 28 to effect the closure of the contacts 34 and the opening of the contacts 35 and 36. The parts are thus back in the position shown in Fig 2 of the drawings. The circuit through the motor 22 being broken, the cams 25 and 26 come to rest. Thus the system is again in its normal operative state, power being supplied to the transformer 48 of the precipitator power supply provided the fan switch 44 is closed.

From the foregoing it will be apparent that the invention provides a control system in which the entire cleaning operation is conducted automatically in a manner to assure that the sequence of operations will occur in the desired order.

While there has been herein described a preferred embodiment of the invention, other embodiments within the scope of the appended claims will be apparent to those skilled in the art from a consideration of the form shown and the teachings hereof.

What is claimed is:

1. An air cleaning and heating system comprising an electrical dust precipitator, a furnace, a heat control system for said furnace, a fan for forcing air through said precipitator for separating particulate matter therefrom, means conducting said air from said precipitator in heat absorbing relation to said furnace, washing means to clean deposits of particulate matter from said precipitator, and means effective upon the operation of said washing means to stop the operation of said fan and render said heat control means inoperative to effect the supply of fuel to said furnace, and a motor-driven timing system for deenergizing said electrical dust precipitator a short fixed time prior to the initiation of operation of the washing means.

2. A control system for electrical dust precipitators of the type including a plurality of ionizing and collecting electrodes, a power supply circuit for energizing said electrodes, and means for washing said electrodes in situ, comprising a timing motor, a manually controlled switch for initiating the operation of said motor, a normally open circuit by-passing said manually controlled switch, a first switching mechanism operated by said timing motor for opening said power supply circuit and simultaneously closing said normally open circuit to maintain said motor in operation regardless of the position of said manually controlled switch, a second switching mechanism operated by said timing motor after a predetermined time delay from the opening of said power supply circuit for supplying cleaning fluid to said washing means for a predetermined time, said first switching mechanism being effective to again close said power supply circuit and stop said motor after a predetermined interval from the termination of said supply of cleaning fluid.

3. In an air heating and cleaning system com-

prising a dust precipitator, a furnace, a heat control system for said furnace, a fan for blowing air through said precipitator for separating particulate matter therefrom, and into heat-absorbing relation with said furnace, a heat control switch for controlling said fan, washing means to clean deposits of particulate matter from said precipitator, a motor-driven timing system for controlling the operation of said washing means, a switch operated by said timing system for deenergizing said fan and said heat control during the operation of said washing means, and a switch operated by said timing system for positively energizing said fan, regardless of the position of said heat controlled fan switch, for a predetermined time immediately following cessation of operation of said washing means.

4. In an air heating and cleaning system comprising a dust precipitator, a furnace, a heat control system for said furnace, a fan for blowing air through said precipitator for separating particulate matter therefrom, and into heat-absorbing relation with said furnace, a heat control switch for controlling said fan, washing means to clean deposits of particulate matter from said precipitator, a motor-driven timing system for controlling the operation of said washing means, a switch operated by said timing system for deenergizing said fan and said heat control during the operation of said washing means, and a switch operated by said timing system for positively energizing said fan, regardless of the position of said heat controlled fan switch, for a predetermined time immediately following cessation of operation of said washing means, and a power supply for application of voltage to the plates of said precipitator, and a switch controlled by said timing system for deenergizing said power supply a short fixed time previous to the initiation of said washing operation to allow the precipitator plates to discharge to a low value.

5. In an air heating and cleaning system comprising a dust precipitator, a furnace, a heat control system for said furnace, a fan for blowing air through said precipitator for separating particulate matter therefrom, and into heat-absorbing relation with said furnace, a heat control switch for controlling said fan, washing means to clean deposits of particulate matter from said precipitator, a motor-driven timing system for controlling the operation of said washing means, a switch operated by said timing system for deenergizing said fan and said heat control during the operation of said washing means, and a switch operated by said timing system for positively energizing said fan, regardless of the position of said heat controlled fan switch, for a predetermined time immediately following cessation of operation of said washing means, and a power supply for application of voltage to the plates of said precipitator, and a switch controlled by said timing system for deenergizing said power supply a short fixed time previous to the initiation of said washing operation to allow the precipitator plates to discharge to a low value, and said fan being energized during the period when said source of voltage is being deenergized.

6. In an air heating and cleaning system comprising a dust precipitator, a furnace, a heat control system for said furnace, a fan for blowing air through said precipitator for separating particulate matter therefrom, and into heat-absorbing relation with said furnace, a heat control switch for controlling said fan, washing means to clean deposits of particulate matter from said precipitator, a motor-driven timing system for controlling the operation of said washing means, a switch operated by said timing system for deenergizing said fan and said heat control during the operation of said washing means, and a switch operated by said timing system for positively energizing said fan, regardless of the position of said heat controlled fan switch, for a predetermined time immediately following cessation of operation of said washing means, and a power supply for application of voltage to the plates of said precipitator, and a switch controlled by said timing system for deenergizing said power supply a short fixed time previous to the initiation of said washing operation to allow the precipitator plates to discharge to a low value, and said fan being energized during the period when said source of voltage is being deenergized, and a manually operated "push button" switch for initiating the automatic sequencing of the entire cleaning operation by the timing system.

7. In an air heating and cleaning system comprising a dust precipitator, a furnace, a heat control system for said furnace, a fan for blowing air through said precipitator for separating particulate matter therefrom, and into heat-absorbing relation with said furnace, a heat control switch for controlling said fan, washing means to clean deposits of particulate matter from said precipitator, a motor-driven timing system for controlling the operation of said washing means, a switch operated by said timing system for deenergizing said fan and said heat control during the operation of said washing means, and a switch operated by said timing system for positively energizing said fan, regardless of the position of said heat controlled fan switch, for a predetermined time immediately following cessation of operation of said washing means, and a power supply for application of voltage to the plates of said precipitator, and a switch controlled by said timing system for deenergizing said power supply a short fixed time previous to the initiation of said washing operation to allow the precipitator plates to discharge to a low value, and said fan being energized during the period when said source of voltage is being deenergized, and a manually operated "push button" switch for initiating the automatic sequencing of the entire cleaning operation by the timing system, and an indicating device associated with said timing system for indicating when said timing system is in operation.

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The following references are of record in the file of this patent:

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