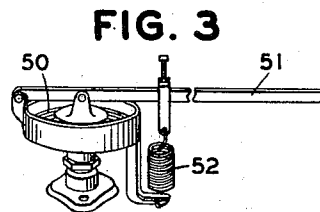
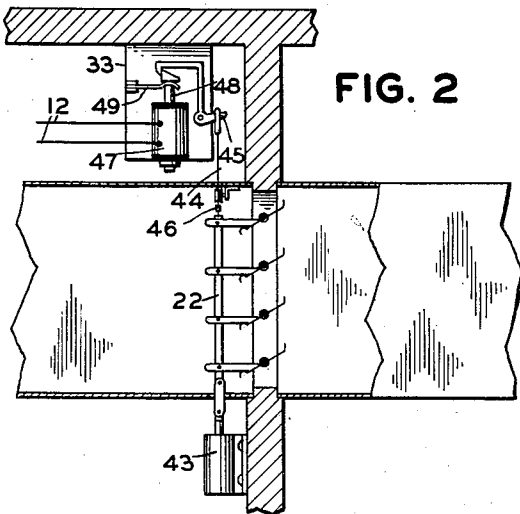
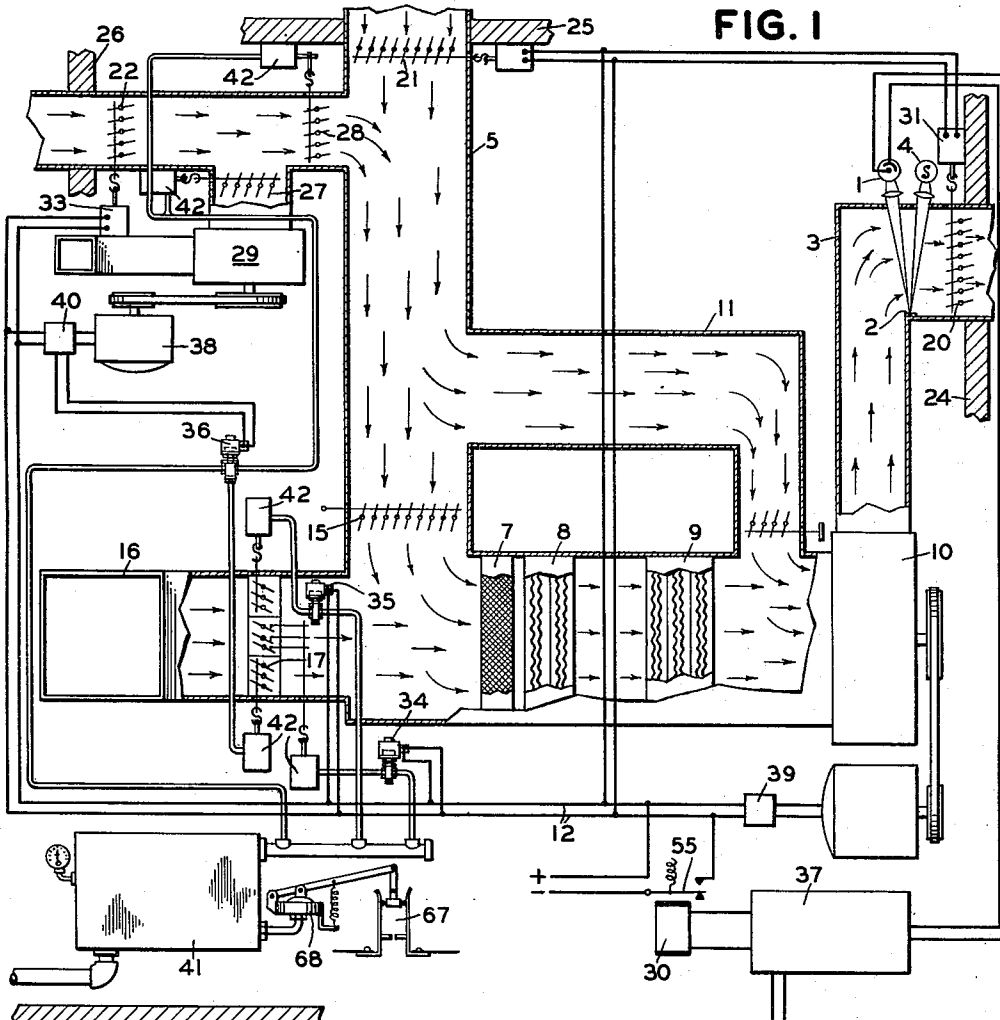


Feb. 16, 1943.

P. M. FARMER ET AL  
AUTOMATIC FIRE CONTROL SYSTEM FOR VENTILATING  
OR AIR CONDITIONING SYSTEMS  
Filed Nov. 1, 1938

2,311,374

2 Sheets-Sheet 1



INVENTORS  
P. M. FARMER  
F. C. EVANS  
R. F. SPAMER  
BY *A. H. Smith*  
ATTORNEY

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FIG. 4

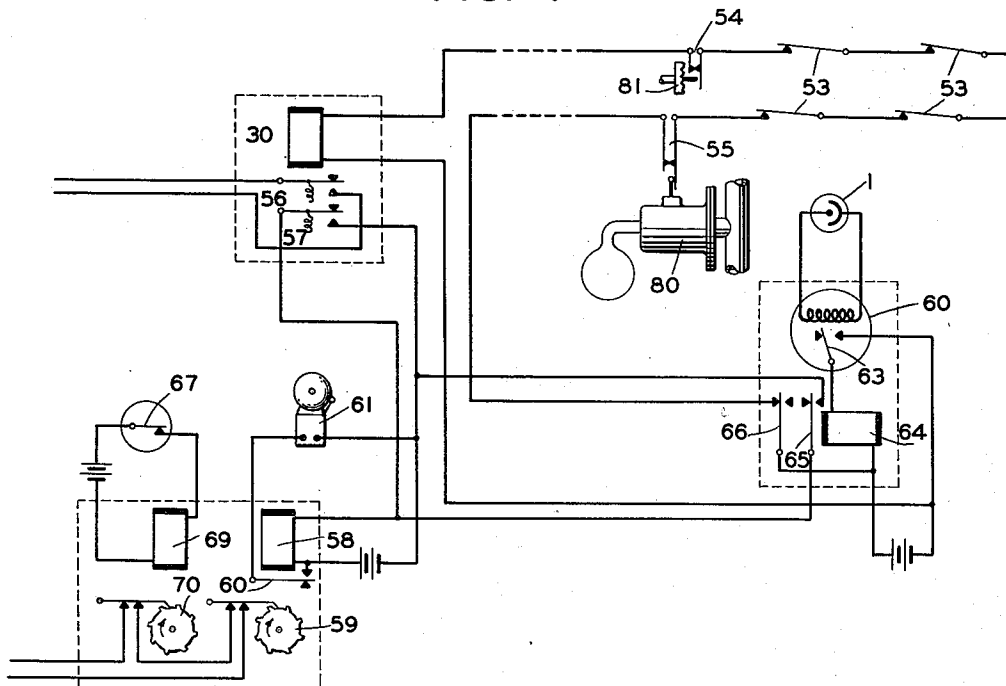


FIG. 5

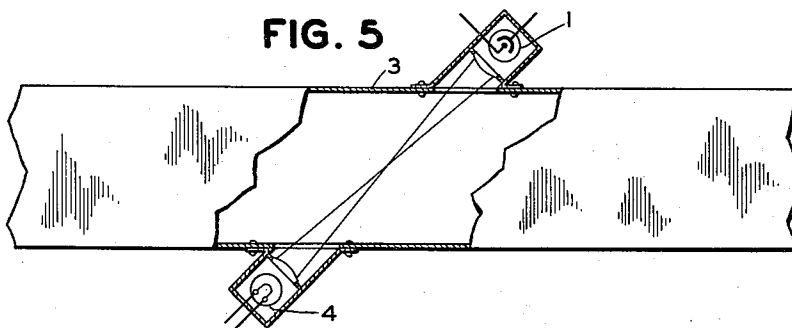
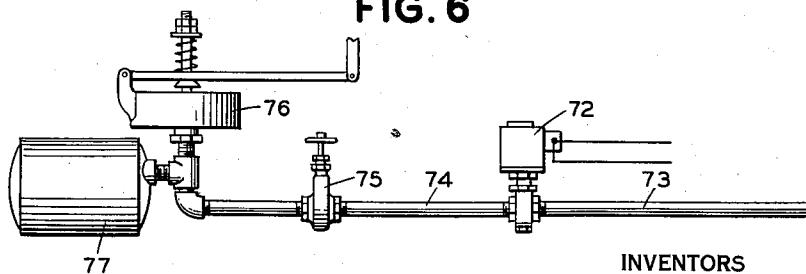


FIG. 6



INVENTORS  
P. M. FARMER  
F. C. EVANS  
R. F. SPAMER  
BY *A. R. Smith*  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,311,374

AUTOMATIC FIRE CONTROL SYSTEM FOR  
VENTILATING OR AIR CONDITIONING  
SYSTEMS

Paul M. Farmer, Maplewood, N. J., and Francis  
C. Evans, Dongan Hills, Staten Island, and  
Richard F. Spamer, Lynbrook, N. Y., assignors  
to The American District Telegraph Company,  
New York, N. Y., a corporation of New Jersey

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9 Claims. (Cl. 169—2)

This invention pertains generally to systems for conditioning air, for ventilating enclosures, and for warm air heating. Reference hereafter is made to such systems by the expression "air conditioning system," which should be taken to mean any system for the positive circulation of air in or to an enclosure, for the purpose of ventilation and/or heating, cooling or otherwise treating the air in the enclosure. The invention pertains more particularly to fire protection devices and systems for protecting air conditioned premises against fire, for enabling more positive and reliable operation of the usual fire protection devices by controlling circulation of air through an air conditioning system, and to limit the spread of fires.

Air conditioning has created new problems in fire protection in that air impelled into an enclosure at the high velocities necessary in air conditioning systems, especially air that is cooler than existing ambient temperature will prevent the proper operation of automatic sprinkler systems, of thermostatic fire detecting systems, particularly those of the fixed operating-temperature type, and of fire detecting or control apparatus. For instance, a sprinkler head located near the outlet of a cold air duct is prevented from operating when a fire occurs directly underneath it owing to the high velocity circulation of cold air which may blow the heat and flame away from the proper sprinkler, while on the other hand sprinkler heads remote from the fire may become heated to the operating temperature and open to discharge the extinguishing fluid where it will fail to extinguish the fire. Thermostatic and certain other automatic fire protection systems also fail to operate owing to the fact that the cold air circulating at high velocity prevents the usual rise in temperature due to fire conditions and therefore prevents operation of the fire protection systems.

Air conditioning systems also cause extensive damage by circulating smoke from the fire, thereby causing extensive smoke damage throughout the ventilated enclosure even though the fire itself is confined to a small portion thereof. Air conditioning systems may also under certain conditions draw in smoke from an outside fire and cause extensive smoke damage within the ventilated enclosure even though the fire does not occur therein. Furthermore, the duct system of a ventilating or air conditioning system will spread fire directly to various parts of the building unless some extinguishing means is located within the ducts. Ducts with combustible lin-

ings, or containing accumulations of combustible lint and small scraps of paper may also become involved in fires.

The principal object of this invention is to provide an air conditioning system with a means for automatically disabling the air conditioning system under predetermined conditions, as, for example, upon the occurrence of fire or smoke within the enclosure or within the air conditioning system itself, to prevent smoke damage and also allow the proper operation of the usual fire protection system.

A further object of this invention is to provide a fire detecting means within an air conditioning system for disabling said system and thereby allowing the proper operation of a sprinkler system.

Another object of this invention is to provide in an air conditioning system a smoke detector for detecting the passage of smoke within the duct system for the purpose of controlling dampers and fans within the system to prevent circulation of air therein.

Another object of the invention is to detect fire or smoke being drawn into an air conditioning system through the fresh or outside air intake of the system, such outside fires being known as "exposure" fires, and to control dampers and fans to prevent the drawing in of such fire or smoke.

Another object of the invention is to close the dampers in such sequence and with such timing that air conditioning system ducts are not damaged or collapsed, and so that the dampers themselves are not damaged.

Another object of the invention is to detect fires occurring in the combustible oil or other type air filters that are used in air conditioning systems, and to control fans and dampers upon such detection, and in cases where automatic extinguishers are provided to control filter fires, particularly where these extinguishers are of the gaseous (CO<sub>2</sub>) or dry powder types, to so control the air conditioning system that the extinguishing gas or powder will be confined to an automatically isolated section, limited in volume, surrounding the filter, thus permitting the use of less of the extinguishing medium than would otherwise be required, and so that the extinguishing medium, which may be harmful in nature either to humans or to certain property such as delicate fabrics, will not be introduced into the supply duct of an air conditioning system.

Another object of the invention is to provide a smoke detector, which also functions as a haze detector, which will detect any colored or partly opaque gas other than smoke which may be in-

troduced into an air conditioning system. Such a gas would be introduced upon accidental leakage of certain refrigerating gases from the cooling coils into the air stream.

Another object of the invention is to provide a means of disabling an air conditioning system which can be controlled from a conventional waterflow detector or a sprinkler system within an enclosure, so that if a sprinkler should operate, even though that sprinkler may not be the proper one to control a fire, it would disable the air conditioning system, thus causing the circulation of air to cease, and permitting the proper sprinkler to come into action with a minimum of delay.

Still another object of this invention is to provide a means for disabling an air conditioning system which can be controlled by the conventional manual or automatic fire alarm system which is adapted to supervise fire conditions within an enclosure, automatic fire alarms of the pneumatic, rate-of-rise type known as Aero-tube systems being particularly applicable because they take advantage of the dispersion of the slightly heated air from a fire, the dispersed air being spread along more and more of the protective tubing as the air spreads, this accumulating partial pressures in the Aero-tube system, so that it functions in spite of the high air velocities.

Further objects and advantages will appear from consideration of the following description of the drawings wherein:

Fig. 1 is a diagrammatic view of an air conditioning system and a fire protection system for controlling the same.

Fig. 2 is a detailed view of a damper and an electromagnetic release for opening and closing the damper.

Fig. 3 is a detailed view of a pneumatic operating unit for controlling dampers.

Fig. 4 is a circuit diagram showing the relation between a manual fire alarm system, a smoke detector and the control circuit for operating dampers in the system shown in Fig. 1.

Fig. 5 is a diagrammatic view of an alternative arrangement of the smoke detecting unit with respect to a duct in the air conditioning system.

Fig. 6 is a detailed view of the pneumatic control shown in Fig. 3 and the electromagnetic valving arrangement for operating the control unit.

Fig. 1 of the drawings shows a fire protecting system for use in air conditioning systems wherein a smoke detecting unit 1 is arranged with respect to the main supply duct 3 for detecting the passage of smoke and controlling the dampers in the duct system to prevent the circulation of smoke within the air conditioned enclosure. The air conditioning system comprises a return air duct 5 which feeds the returned air to a filter unit 7, and to a conditioning unit containing cooling coils 8 and heating coils 9, from which the air is impelled by the main supply fan 10 through the main supply duct 3 to the feed ducts of the system, not shown. Air may be recirculated without filtering or further conditioning through the by-pass 11 to the fan 10 depending upon the position of the automatic regulating damper 15. Fresh air enters the system through the fresh air intake 16 and passes through the sectionalized damper 17 to the filters and conditioning coils. Damper 17 may be automatically controlled in accordance with sea-

sonal changes in temperature from an automatic temperature responsive device.

In order to control the circulation through the system, a plurality of dampers are situated in the various ducts for the purpose of fire protection as well as for automatically regulating the supply of air to the enclosure which is to be air conditioned. Fire dampers 20 and 21 are situated at the fire walls 24 and 25 in the main supply duct and the return air duct. Another fire damper 22 is situated at the fire wall 26 for the purpose of controlling the air flow through return air duct 5. The automatic regulating dampers 17, 27 and 28 are also controlled in the event of a fire to aid in stopping the circulation of air through the system. These dampers are normally controlled from a pneumatic pipe system which will be described later.

The preferred smoke detecting arrangement is of the light-sensitive type and comprises a light-sensitive cell 1, a mirror 2 and light source 4, which combination directs a light beam across the path of air flow in the main supply duct whereby passage of smoke through said duct will decrease the amount of light passing to the light-sensitive cell and cause said cell to decrease its output. The cell output is fed into a control unit, shown in detail in Fig. 4, which operates the relay 30 and energizes an electric circuit 12 from a source of potential. The fire dampers 20, 21 and 22 are controlled by electromagnetic release mechanisms 31, 32 and 33, respectively, while the automatic regulating dampers 17, 27 and 28 are controlled from the pneumatic control system by means of the electromagnetic valves 34, 35 and 36, respectively, which are connected to the electrical circuit 12. The fan motors 37 and 38 are also under the control of the smoke detector circuit through their starting boxes 39 and 40, respectively, so that during the passage of smoke through the main supply duct the fan motors 37 and 38 are stopped to prevent the circulation of air or smoke through the duct system. Fan 29 driven by motor 38 serves to exhaust air from the system as conditions require.

The pneumatic control system comprises a storage pressure tank 41 which maintains a given pressure in the pipe system, the branches of which extend to pneumatic damper motors 42 which operate the automatic regulating dampers. Temperature and humidity sensitive apparatus, not shown, automatically controls the regulating dampers 15, 17, 27 and 28 through the same pneumatic pipe system, thereby maintaining the desired temperature and humidity conditions.

Fig. 2 shows the details of the electromagnetic release which is used for closing the dampers 20, 21 and 22 in the event a fire occurs. When smoke passes through the main supply duct 3, the smoke detector equipment operates to energize the solenoid 47, plunger 48, and the link member 45. The link 45 drops to release the connection 44 and the damper 22. Damper 22 closes under the restraint of the dashpot 43 which acts as a timing element for preventing sudden closure of the damper and the consequent evacuation of the duct connected to the main supply fan. Thus it is possible to close the dampers 20, 21 and 22 in any desired order and over any desired period of time after the smoke detector operates. The link 44 includes a fusible element 46 inside the duct which serves the purpose of detecting dangerous rises in temperature which might not be detected by the smoke detector. If a smokeless fire condition

arises, the fusible elements such as 46 become melted at certain given temperatures and allow the dampers to close, thus preventing the spread of smoke or fire through the duct system. The dampers may be restored to their normal condition by manually restoring the link member 45 and the connection 44 to their normal positions. It is evident that the release mechanism operates in the same manner in response to actuation of all the equipment shown in Fig. 4.

Fig. 3 is a diagrammatic showing of the pneumatic damper motor which comprises a diaphragm member 50 adapted to be operated from a pneumatic pipe line by an increase or decrease of pressure within said line. When the pressure is released, the movement of the diaphragm 50 is transmitted to the damper through the arm 51 under the influence of spring 52. Such pneumatic damper operating devices are shown in Fig. 1 in connection with the automatic regulating dampers 17, 27 and 28.

Fig. 4 shows, in detail, the electrical control circuit shown in Fig. 1 for controlling the fire protection dampers and the automatic regulating dampers comprising a manual fire alarm system, an automatic fire alarm system, the light-sensitive smoke detecting system and also contacts operated by water flow in an automatic sprinkler system. This circuit acts as a fire protective system and is so claimed in the appended claims. The manual fire alarm system comprises manually operated boxes, each containing a set of contacts such as those indicated by 53, the contacts being connected in a series circuit. This circuit is normally closed and maintains the relay 30, also shown in Fig. 1, normally energized. Relay 30 controls the transmitting relay 58, which in turn operates the central office transmitter 59. Relay 30, through its contacts 56, controls energization of the motor and damper operating circuit 12 shown in Fig. 1. Light-sensitive cell 1 also controls relay 30 through its associated relays 62 and 64, whereby a smoke condition will also cause closure of the dampers and the stopping of the fan motors in the air conditioning system shown in Fig. 1. The normally closed contacts 67 which are adapted to be operated by a pressure supervisory motor 68 shown in Fig. 1 control relay 69, which in turn controls a transmitter 70 for transmitting trouble signals to the central office for the purpose of notifying the central office operator of an abnormal pressure condition within the pneumatic valve system shown in Fig. 1. Thus the pneumatic system is under constant supervision.

It is also necessary to control the air conditioning system by means of water-flow detectors and automatic fire detecting systems so that in the event of a sprinkler head operating or in the event of fire within the enclosure, the air conditioning system will be disabled. It is further necessary to detect the fire conditions existing within the duct system and within the air filters, which are located within the duct system.

In order to conveniently control the air conditioning system from the above mentioned protective devices, additional contacts are provided in the manual fire alarm system. Contact 55 is adapted to be operated by a water-flow detector 80 within the sprinkler system while contacts 54 are adapted to be operated thermostatically by heat responsive elements located within the duct system within the oil filter unit 7 or by an automatic fire detecting system in the

air conditioned enclosure. The automatic fire detecting system may be of the pneumatic type in which case the detector 81 may operate the contacts 54. Thus, in the event of sprinkler head operation, or operation of the automatic fire detecting system, or fire within the air conditioning system itself, relay 30 will be deenergized to cause disablement of the air conditioning system or complete stoppage of the flow of air.

The operation of the electrical circuit described above may start either by manual operation of one or more of the contacts 53 in the manual fire alarm system or from the smoke detector located within the duct system. If one of the contacts 53, 54 or 55 are opened, relay 30 becomes deenergized thereby closing contacts 56 and 57. Contacts 56 close to energize circuit 12 which operates the electromagnetic releases 31, 32 and 33 thereby closing the fire dampers. Valves 34, 35 and 36 are also operated to close the automatic regulating dampers 17, 27 and 28. Closure of contact 57 energizes relay 58 to start the central office transmitter 59 which transmits a fire alarm. The local alarm 61 is also energized at this time by closure of contacts 60 of relay 58.

When smoke circulates through the duct system, light-sensitive cell 1 energizes the relay 62 which closes its contact 63 to energize relay 64. Relay 64 closes contacts 65 which energizes the transmitter relay 58 and the alarm 61 so that a fire alarm is also transmitted when a smoke condition arises. Light-sensitive cell 1 also causes the contact 66 to open, which is in the manual fire alarm circuit, and operates relay 30 as above described in connection with manual fire alarm operation.

Fig. 5 shows an alternative arrangement of the smoke detecting apparatus with respect to the main supply duct 3. In air conditioning systems or ventilating systems with extremely high air velocities, it is found that the smoke particles become so well diffused in the circulating air that smoke detection is very difficult and therefore it is sometimes necessary to use a long light beam which may be intercepted by a comparatively long air path whereby a greater amount of air and smoke can traverse the protective light beam. To accomplish this result, the light-sensitive cell 1 and the source 4 are supported in angular relation to duct 3 whereby the light emitted by source 4 traverses an angular path with respect to the duct 3.

The air conditioning system employs large heavy supply fans for impelling air through the system, and the fans have such great momentum that they continue to rotate for an appreciable period after the motor is cut off by the fire protection circuit. The result of this large momentum is that sudden closure of all dampers would cause great reduction of pressure within the duct system when the main supply fan is shut down and collapse of the ducts will occur unless some means of slowly closing the dampers is provided. Fig. 6 shows a means for delaying closure of the pneumatically operated dampers with respect to operation of the electrical control circuit. Electromagnetic releases may be similarly delayed by interposing time delay elements in their circuits. The electromagnetic valve 72 is operated from the control circuit 12, shown in Figs. 1 and 4, at the time that the fan motors are shut down. Valve 72 admits air from the supply pipe 73 to pipe 74. Increase of pressure in pipe 74 would normally operate the con-

trol unit 76 immediately and close the regulating dampers. However, as mentioned above, it is necessary to delay closure of the dampers and operation of control unit 76, for which purpose the gate valve 75 is provided. Gate valve 75 allows a slow increase of pressure within control unit 76 to thereby delay its operation for a period of several seconds. Another means for obtaining the same result is the expansion tank 77, which may be used either separately or in combination with gate valve 75. The expansion tank 77 operates to cause the pressure within the control unit 76 to increase slowly over a period of several seconds thereby delaying operation of the dampers.

From the above description of the protection system for air conditioning systems, it is evident that either an occurrence of smoke within the duct system or operation of one or more contacts in the fire alarm system will energize the electrical control circuit 12, which in turn operates the electromagnetic release devices 31, 32 and 33 to control the fire dampers 20, 21 and 22, respectively. Energization of the circuit 12 also operates the pneumatic valves 34, 35 and 36 to in turn operate the control units 42 for closing the automatic regulating dampers 17, 27 and 28. The fan motors 37 and 38 are also stopped when the circuit 12 energizes the stopping devices 39 and 40. The result of operation of the fire control and fire protection system is to completely disable the air conditioning system, thereby stopping circulation of air and smoke or the spread of fire through the duct system itself. However, the dashpots, such as 43 in Fig. 2, and the gate valves, such as 75 in Fig. 6, are so adjusted that the dampers close in the proper sequence and at such a speed that collapse or bursting of ducts is avoided.

It is evident from the above description that applicants provide a protection system for air conditioning systems which effectively disables the air conditioning system to prevent the circulation of smoke through a building or other enclosure and also prevents the circulation of other gases such as refrigerants which might be dangerous to humans or destructive of materials stored within the enclosure. The protective system further provides a means for disabling the air conditioning system for the purpose of preventing circulation of air at high velocities which would prevent the proper and efficient operation of sprinkler systems. If the air conditioning system were to continue high velocity circulation of air after a fire condition arose, the sprinkler system would be completely disabled and would allow spread of fire.

This invention also provides a means whereby the manual and automatic fire alarm systems which are ordinarily installed in all buildings of large size can control the air conditioning system to disable it upon the occurrence of fire conditions. The invention further causes duct fires to be confined to the particular part of a duct system in which they may have started. The fire dampers and the automatic regulating dampers under the control of the fire protective system will always confine the fire to the duct system. If extinguishing material or substances are discharged within the duct system the fire dampers also prevent the circulating fans from circulating the fluids or gases used for extinguishing purposes.

It is not intended that the term "air conditioning system" shall be limited to mean a system

for controlling the temperature, humidity and motion of air as it obviously may refer to any system which controls either the temperature, humidity or motion, or all three conditions of the air within an enclosure.

It will be obvious to those skilled in the art that various modifications are possible within the scope of the appended claims and we desire that this invention shall only be limited by the prior art and the appended claims.

We claim:

1. In an air conditioning system, an enclosure to be supplied with conditioned air, means for conditioning air, a duct system communicating with said enclosure for supplying air to and from said conditioning means, a fan for impelling air through said conditioning means and duct system to said enclosure, a plurality of dampers in said duct system for controlling the flow of air therethrough and a smoke detecting apparatus in the duct system to detect the passage of smoke through said duct system and means operatively connected to said smoke detecting apparatus for electrically closing said dampers during fire conditions within said enclosure or said air conditioning system.

2. In an air conditioning system, an enclosure to be supplied with conditioned air, means for conditioning air, a duct system communicating with said enclosure for distributing air from said conditioning means to said enclosure, means for impelling an air stream through said duct system and smoke detecting means for scanning the air stream to detect the passage of smoke through said duct system and means operatively connected to said smoke detecting means for stopping circulation of air through the duct system.

3. In an air conditioning system, an enclosure to be supplied with conditioned air, means for conditioning air, a duct system arranged to distribute air from said conditioning means to said enclosure, a supply fan for impelling air through said duct system, fire detecting means including a smoke detector arranged to be affected directly by the presence of smoke in the air impelled by the fan through said duct system and means operatively connected to said fire detecting means for controlling the flow of air through the duct system.

4. In combination, an enclosure, an air conditioning system comprising means for conditioning air, a duct system communicating with said enclosure for supplying air from said air conditioning system to said enclosure, a supply fan for impelling air through said duct system and a plurality of dampers in said duct system for controlling the flow of air therethrough, a fire protection system including smoke detecting apparatus for detecting the passage of smoke in said duct system and a sprinkler system in said enclosure for extinguishing fires and means operatively connected to the fire protection system for disabling said air conditioning system when either said smoke detecting apparatus or sprinkler operates whereby circulation of air and smoke is stopped and effective operation of the sprinkler system is enhanced.

5. In combination, an enclosure, an air conditioning system therein comprising means for cooling air, a fan for circulating air through said cooling means and said enclosure, smoke detecting means arranged to be affected by presence of smoke in the circulating air and means operatively connected to said smoke de-

protecting means for disabling said air conditioning system.

6. In combination, an enclosure, an air conditioning system comprising means for conditioning air, a duct system for supplying air to said enclosure from said means, a main supply fan for impelling air through said duct system, a plurality of automatically operated dampers for controlling the flow of air through said duct system, a pneumatic system for operating said dampers and a plurality of fire dampers for stopping the flow of air during fire conditions, a fire protection system within said enclosure for protecting it against fire, means operated by said fire protection system for closing all dampers and stopping the fan in said air conditioning system during fire conditions and means for controlling the speed of closure of said dampers to thereby prevent abnormal pressure and collapse of the ducts.

7. In combination, an enclosure, an air conditioning system comprising means for conditioning air, a duct system for supplying air from said means to said enclosure, a main supply fan for impelling air through said duct system, a plurality of dampers for controlling the flow of air through said duct system, a fire protection system within said enclosure for protecting it against fire, means operatively connected to be operated by said fire protection system for closing all dampers and stopping the fan in said air conditioning system during fire conditions and means for delaying the closure of said dampers to allow said fan to stop its rotation and thereby prevent collapse of ducts.

8. In combination, an enclosure, an air conditioning system therein comprising means for conditioning air, a duct system for supplying air to said enclosure from said means, a main supply fan for impelling air through said duct system, a plurality of dampers for controlling the flow of air through said duct system, a fire protection system within said enclosure for supervising fire conditions therein, means responsive to said fire protection system for closing all dampers and stopping the fan in said air conditioning system and means for controlling the speed of closure of said dampers while said fan stops its rotation to thereby prevent the abnormal pressure and collapse of the ducts.

9. In combination, an enclosure, an air conditioning system therein comprising means for conditioning air, a duct system for supplying air to said enclosure from said means, a fan for impelling air through said duct system, a plurality of dampers for controlling the flow of air through said duct system, smoke detector apparatus for detecting smoke in the air circulated by the fan, means responsive to said smoke detector apparatus for closing all dampers and stopping the fan in said air conditioning system and means for delaying the closure of said dampers while rotation of said fan is stopping to thereby prevent abnormal pressure and the collapse of ducts.

PAUL M. FARMER.  
FRANCIS C. EVANS.  
RICHARD F. SPAMER.