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Feeney

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[54] **GAS BURNER PROTECTIVE APPARATUS**

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[73] Assignee: **American Standard Inc.,** New York, N.Y.

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Related U.S. Application Data

[63] Continuation of Ser. No. 15,535, March 2, 1970, abandoned.

[52] **U.S. Cl.** **431/90**

[51] **Int. Cl.** **F23n 1/02**

[58] **Field of Search** 431/90, 12; 137/101.21; 237/61

[56] **References Cited**

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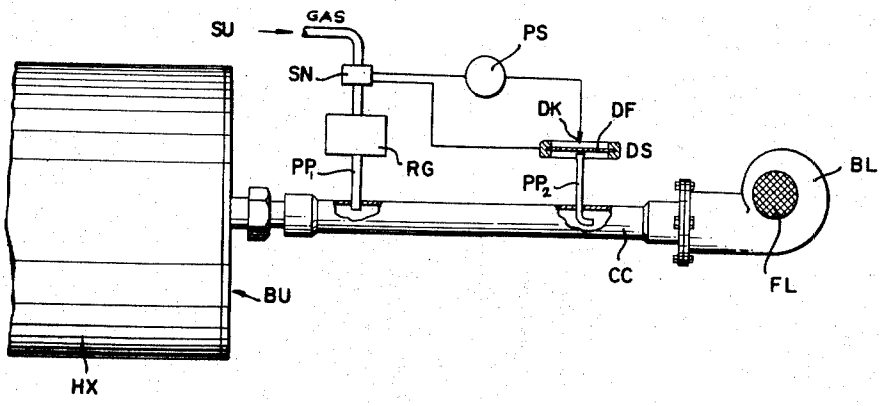
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Attorney—Jefferson Ehrlich et al.

[57] **ABSTRACT**

Covers a power gas burner supply system embodying apparatus for detecting and responding to any predetermined reduction in the volume of air supplied with the gas to the burner system. The detecting apparatus may include a hollow pipe one end of which senses the air flow which is transmitted to the burner system, and a pressure-actuated diaphragm swtich is coupled to the other end of the hollow pipe. The diaphragm, which is normally deflected when the air supply is adequate, is subjected to a change in deflection as the volume of air falls off. The switch may be used to trigger the removal of the gas furnish to the burner system as the deflection changes sufficiently. By maintaining the supply of air above a predetermined level, the burner system is continuously maintained in a satisfactory operating condition and the production of carbon monoxide by the burner system is virtually eliminated.

16 Claims, 3 Drawing Figures



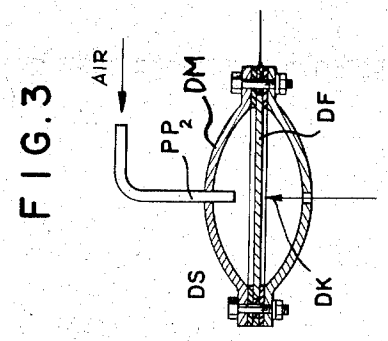


FIG. 3

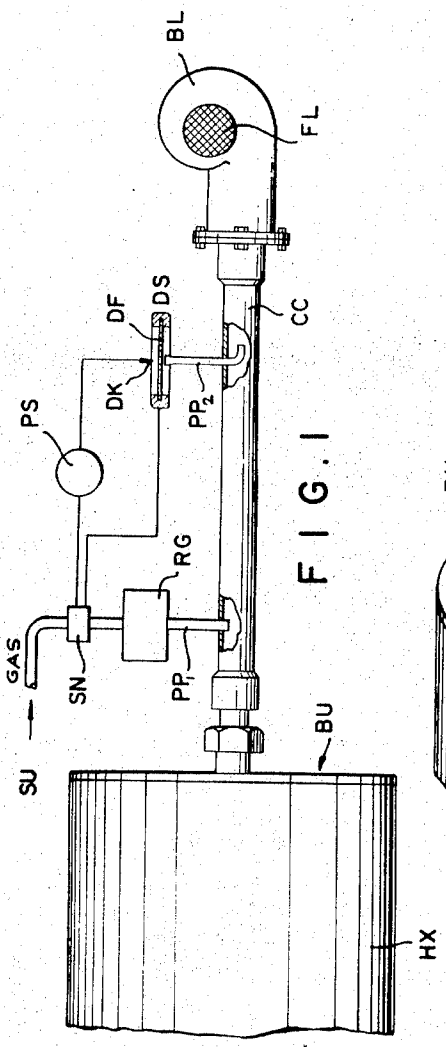


FIG. 1

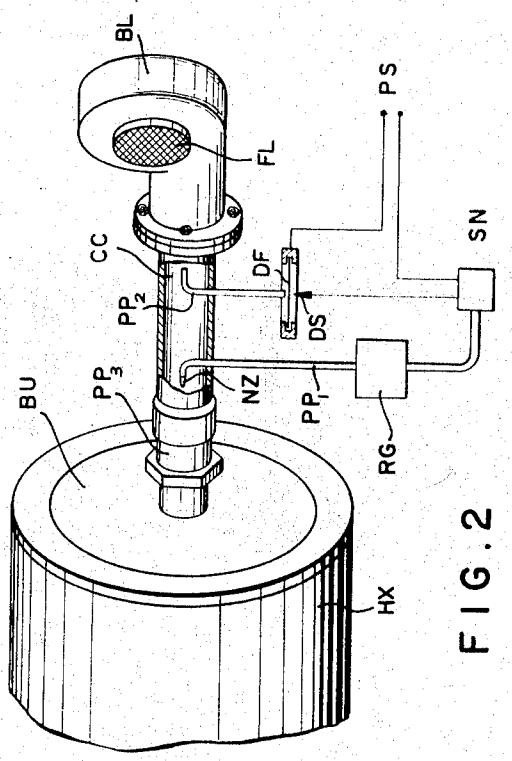


FIG. 2

GAS BURNER PROTECTIVE APPARATUS

This application is a continuation of application Ser. No. 15,535, now abandoned.

This invention relates to gas burner systems and apparatus and to protection arrangements for power gas burner systems and apparatus. More particularly, this invention relates to arrangements for safe operation of power gas burner systems and, more especially, for the substantial prevention of carbon monoxide production by the power gas burner systems and apparatus.

It is well established that carbon monoxide may be an ingredient of a poorly operating gas burner of a gas burner system. Carbon monoxide may be produced, and often is produced, by an insufficient supply of air to the burning gas. The very presence of carbon monoxide, a noxious gas, can be hazardous to the lives of people within the vicinity of the faulty operating gas burner. Hence, it is important to prevent faulty operation of the burner and this, in turn, may be achieved by protective means which will interrupt the gas supply when the air component falls below a predetermined level.

Various arrangements have heretofore been proposed for the fool-proof and fail-safe operation of gas burner systems. For example, paddle wheels and sail switches are well known forms of protective equipment for observing and assuring an adequate supply of air to the system. However, such equipments are expensive and inherently troublesome. Moreover, those structures that employ the pressure drop or head-loss principle, such as venturi devices, are also impracticable due to the additional power demands superimposed on the blower. So-called "static pressure taps" may be tried, but those would embody an extremely sensitive diaphragm switch and they are difficult, if not impossible, to start without supplementary equipment. A so-called velocity pressure probe may also be tried as the protective equipment, but if anything happened to one of the required two tubes embraced by such a probe without affecting the other tube, it would be extremely likely that the arrangement would fail in an unsafe mode or condition. Thus, simple, easy and inexpensive equipment requiring little or no maintenance to perform the protective functions are not believed to be currently available and this imposes a serious handicap to the development and adoption of a power burner system which is low in cost and easy to maintain and operate, and is especially suitable for homes or apartments of buildings.

One of the principal objectives of the presnet invention is to provide a simple arrangement suitable for detecting a developing insufficiency in the air supplied to the system which may lead to the improper operation of the burner system and thereby prevent yeilding any appreciable amount of carbon monoxide. According to the standards of regulatory public utility commissions, a carbon monoxide content exceeding about 0.04 percent is deemed unsatisfactory especially because even so small a percentage is a threat to the health and life of people in the vicinity of the gas burner. In order to overcome this potentiality, it is important that the amount of air supplied to the burner system be sufficient to provide a predetermined ratio to the gas fed to the burner system. If an amount of air, such as 110 percent of the stochiometric mixture, is required to obtain good and complete combustion in a burner system, any reduction in the ratio of the air to the gas will necessarily lead to faulty operation, resulting in the production of noxious carbon monoxide. Hence, to overcome that possibility, it becomes important to feed an excess of air and thereby maintain the supply well above the minimum required for good combustion.

A practical system, such as the one involved in this invention, can be readily developed using more than the minimum requirement of air of good combustion, Thus, an excess of air of some 20 to 50 percent would provide a margin of safety against the formation of carbon monoxide regardless of the age or condition of the burner. The excess air does somewhat diminish the thermal efficiency of the burner system and, therefore, increases the cost of operating the system, but Commissions have indicated a willingness to accept any such surplus for the protection it would provide against carbon monoxide formation.

A deficiency of air may arise for many possible reasons. For example, the filter through which air is supplied may become clogged by foreign matter or, if a blower is employed, the blower may become defective because its rotor does not rotate at the proper speed, or a leak may develop in a housing or conduit, or the exhaust port may become blocked (flue blockage). Hence, protection must be observed and maintained immediately upstream of the burner, especially when the burner is located in homes and apartments.

In accordance with this invention, a simple structure is contrived and it is interposed between the source of air for the burner and the burner itself for detecting promptly whether or not sufficient air, or a sufficient surplus of air, is being furnished to the burner. The arrangement may consist essentially of a tube, pipe or probe which is inserted in the path of airflow, the probe being positioned so that it senses or responds to the total pressure of the air as it moves through the conduit toward the burner, while at the other end of the probe, there is a switch in the form of a movable diaphragm or disk which is made responsive to the pressure of the air flowing through the conduit. When no air is in motion through the conduit, an electrical contact operated by the diaphragm will control a solenoid so as to block the flow of gas to the burner. On the other hand, as soon as a sufficient air velocity is attained through the conduit, the diaphragm will be deflected by the increased pressure against the diaphragm so as to close the associated contact, thereby operating the solenoid valve and opening the path of the gas to the burner system. This structure can be adjusted so that, as soon as the air pressure in the conduit is reduced to a predetermined level corresponding to an insufficient influx of air, the contact will be opened to release the solenoid valve and prevent any further flow of gas into the system. Thus, it is virtually impossible for incomplete combustion to take place at the burner system because, as the air supply falls, it can never fall below a predetermined or danger level because the gas will be shut off when this air volume level is reached.

The probe — which in its simplest form may be a pipe — is used in the testing process of this invention and it is connected or coupled to the diaphragm so that the sensitive end of the probe may be pointed upstream toward the source of air supply so as to respond to the total pressure in the conduit. The probe will relay the pressure of the moving air to the diaphragm for the effective control of the solenoid valve. It is, therefore, one of the main objectives of this invention to employ

a hollow probe, for example, a curved hollow probe, as already suggested, so that the sufficient deflection of the diaphragm and the operation of the related solenoid will depend upon, and occur only upon, a predetermined pressure due to the static and velocity factors in the path leading to the burner.

This invention and its various objects and features will be better and more clearly understood from the more detailed description and explanation hereinafter given, when read in connection with the accompanying drawing in which

FIG. 1 schematically illustrates one form of the invention given for the purpose of illustration;

FIG. 2 illustrates a somewhat more complete arrangement, shown partly in cross section, illustrating a somewhat different embodiment of this invention, and

FIG. 3 shows a form of diaphragm switch that may be employed in this invention.

The same reference characters will be employed throughout the drawing to refer to the same or similar parts.

Referring to FIG. 1 of the drawing, an arrangement is schematically illustrated for the power gas burner intake system of this invention. This arrangement includes a blower BL which usually embodies an appropriate built-in fan structure for supplying air at a predetermined pressure to a common conduit CC. The blower BL may include a filter FL through which air is received by the blower. This filter may be of any well-known type, but it is preferably an air filter suitable for the removal of dirt, dust and other extraneous materials which may be collected as the air to be utilized is delivered to the blower BL through the filter. A suitable air filter for this purpose may include a pleated paper air filter (similar to the air filter used on automobiles), but any other filter may be used.

The blower BL is connected to the burner BU by means of the common conduit CC. A source of gas SU, which may be natural gas, is fed through a conventional solenoid valve SN and then through a conventional regulator or other control apparatus RG. The regulator RG is connected by meanS of a conduit PP1 to the common conduit CC. The regulator RG may be combined with the solenoid SN and other control equipment and is commonly known as a "main gas control". Its principal function is to reduce the pressure of the gas arriving from source SU to a predetermined level which may be metered through an orifice. Assuming that the solenoid valve SN, which is shown schematically in the drawing, is open, then the regulator R1 will transmit gas through the conduit PPi at the desired or predetermined pressure level.

Thus, the blower BL will deliver air to the common conduit CC and the conduit PP1 will deliver gas to the same common conduit CC, so that both of these fluids may be combined and fed to the burner BU for combustion. The burner BU may be of any well known type. For example, it may be a surface combustion burner of the type shown and described in a Patent of W. J. Witten, No. 3,269,449, issued Aug. 30, 1966, entitled "Burner Apparatus" and assigned to the assignee of the present application.

If the volume of air supplied by the blower BL and the volume of gas supplied through the conduit PP1 are in the correct or optimal ratio, the burner BU will operate properly and will produce very little, if any, carbon monoxide. If the volume of air supplied by the blower BL increases above the optimal value, the burner BU will continue to operate without producing any carbon monoxide. But the efficiency of the burner will be somewhat reduced by the excess of the air supplied. The greater the ratio between the volume of air and the volume of gas, the greater will be the inefficiency of the burner BU.

However, as the volume of air supplied by blower BL recedes below an assigned value while the volume of gas to the conduit PP1 continues unchanged, the burner BU will operate unsatisfactorily. Due to the absence of sufficient air in the mixture supplied to the burner, carbon monoxide will be produced as already explained. The percentage of carbon monoxide will depend upon the percentage deficiency of the air in the mixture delivered to the burner. Any percentage of carbon monoxide above about 0.4 percent is beyond the limits permitted by regulatory commissions. A higher carbon monoxide percentage may well become hazardous to people in the vicinity of the burner, especially if there should be leakage of the exhaust products into the room where the burner is locatd.

In accordance with this invention, two additional elements are added to the minimal structure required to operate the gas injection system. These two elements are the hollow pipe, tube or probe PP2, sometimes called a total pressure probe, and the diaphragm switch DS. One end of the probe PP2, which is preferably a bent conduit as shown, is pointed towards the blower BL so that it will sence the total pressure in the conduit CC. The other end of the probe PP2 is connected or coupled to diaphragm DF which is peripherally supported and held between the apertures of the housing DM of the switch DS. Thus, the diaphragm DG, which may normally be flat or undeflected in the absence of pressure supplied through the probe PP2, will be deflected upwardly in FIG. 1 as the pressure through the probe PP2 increases. If the probe pressure is sufficient, the cOntact BK of the switch DS will be closed, whereupon power will be supplied from the source PS through the electromagnetic structure of the solenoid SN, the connection being established by the contact DK upon the deflection of the diaphragm DS. When so deflected, the solenoid valve SN will be opened and gas will be introduced from the source SU through the regulator RG and through the conduit PP1 to the common conduit CC, so that gas may be mixed with the air arriving from blower BL and travelling toward the burner BU.

According to this invention, the switch DS may be adjusted so that its contact DK will be closed only when a surplus of air is supplied by the blower BL through the common conduit CC. Thus, if the normal volume of air for complete combustion is 17cfm, for example, then the contact DK may be set to close as soon as the volume reaches, for example, 21cfm, or about 25 percent more air is supplied than is required for, let us say, 100 percent combustion at the burner BU. If the air volume continues above the selected level (21cfm), then the contact DK will remain closed and gas will be continually supplied to the burner through the conduit PP1. As soon as the volume of air falls below the predetermined volume (21cfm), then the contact DK will be opened, thereby releasing the solenoid valve SN and shutting off the flow of gas through the conduit PP1.

Thus, the arrangement of FIG. 1 will be continuously operated satisfactorily so long as the supply of air is at

its predetermined value which, in the example given, my be some 25 percent above the stochiometric value. There will, therefore, be some sacrifice in the efficiency of combustion to provide the range of protection deemed desirable against the development and production of a dangerous carbon monoxide content.

The probe PP2 may be curved so that the lower leg of the probe may be substantially parallel to the common conduit CC and perhaps also coaxial therewith, while the other leg of the probe may be, but need not be, perpendicular to the conduit CC. If the probe PP2 were straight or linear throughout and perpendicular to the conduit CC, only the static pressure in the conduit CC would be applied to the diaphragm DF of the switch DS. This would be insufficient to operate the solenoid to allow gas to enter. However, the curved structure shown in FIG. 1 of the drawing develops a pressure corresponding to the velocity of the fluent air in the conduit CC in addition to the static pressure normally present therein. The combination of the two pressures are additive and effective in deflecting the diaphragm DF. Both pressures must be applied if the burner is to operate. The static pressure itself would ordinarily be much too low to achieve the desired results.

Although a probe PP2 is shown as bent at a 90° angle, any other angle may be employed, after appropriate adjustments, to achieve the results desired, but the adjustment of switch DS would have to be correlated to the parameters developed under the conditions of other angulations.

The arrangement shown in FIG. 1 is fail-safe. If the tube connecting the probe PP2 is ruptured or disconnected after the equipment has been properly adjusted, the diaphragm DF will be returned to its original position so that the solenoid valve SN will be released. Hence, the supply of gas will be cut off. However, after years of operation, should the diaphragm DF fail, the failure will occur in a safe mode and prevent further gas flow.

FIG. 2 illustrates a modification of the arrangement of FIG. 1. Here the conduit PP1 may be bent as shown into a right angular shape so that the nozzle NZ will feed gas into the burner BU. The burner BU is located in the axial cylindrical space of a heat exchanger HX which may be of the type shown and described in a copending application of P. N. Renzi, filed on even date, and assigned to the same assignee. Reference may be made to that application for further explanation of the deSired operating features of the heat exchanger HX.

As in FIG. 1, the FIG. 2 arrangement will employ a probe PP2 for sensing the pressure of the air fed by the blower BL to the common conduit CC. This probe PP2 is located upstream of nozzle NZ, that is, between the blower BL and the nozzle NZ which feeds gas to burner BU. This is a preferred general location of the probe PP2, but obviously other positions along conduit CC may be employed for locating this probe PP2.

As in FIG. 1, any insufficiency of air through the common conduit CC will cause the diaphragm DF to break the contact DK and release the solenoid SN, thereby syarply interrupting the flow of gas through the conduit PP1. On the other hand, any increase in the flow of air through the conduit CC, no matter how great (within appropriate limits), will merely affect the efficiency of burner BU without introducing any significant amount of carbon monoxide.

The nozzle NZ of FIG. 2 may be positioned, for example, along the axis of the conduit CC and pointed toward the burner BU. Air supplied by the blower BL will mix with the gas discharged by nozzle NZ and the mixture will be burned by the burner. The nozzle NZ is usually adjusted so that the volume of air and the volume of gas provide a good ratio for complete combustion without producing carbon monoxide. The area of the nozzle NZ and the cross-sectional area of conduit CC adjacent nozzle NZ are so chosen that, as the vOlume of air changes, the volume of gas through nozzle NZ will change in the same ratio. This is more fully disclosed in an application, filed of even data, by T. P. Koen and assigned to the assignee of the present application.

FIG. 3 shows a simplified diagram of the diaphragm switch DS which may be employed in this invention. The contact DK may be positioned on either side of diaphragm DF depending upon the preferred operation of the switch relative to the solenoid valve SN.

As dust, dirt or other materials accumulate on the filter FL, the supply of air from the blower BL to the common conduit CC will be reduced and, if the blockage is sufficient, the volume of air fed to common conduit CC will be insufficient to maintain the contact DK closed. Hence the solenoid valve SN will be released and the gas supply stopped. Likewise, if the rotary mechanism of the blower BL fails to operate properly, that is, if it does not rotate at the requisite speed, then an insufficient amount of air will travel through the common conduit CC and again the flow of gas through the conduit PP1 will be interrupted. This arrangement, therefore provides real and prompt protection against the development of faulty operation that is so important to personnel in buildings equipped with power gas burners.

It will be noted that the arrangement of this invention, which includes the probe PP2 and the switch DS, is relatively simple and easy to install. The cost of the equipment is small and will not importantly affect the total cost of the burner mechanism for a miniature boiler installation. Any material may be used in the production of the probe PP2 as, for example, steel, copper, plastic, etc. The probe PP2 may have any cross-sectional shape, whether circular, elliptical, rectangular, etc., and its cross-section need not be uniform. It's only requirement is that it respond to the total pressure, or some part thereof, in conduit CC, that is, the pressure due to air velocity and the static pressure. Moreover, many types of diaphragm switches are readily available in the market at relatively low cost and any of them may be used in the practice of this invention. The free end of probe PP2 will be stationary and may be spaced from diaphragm DF and connected thereto by a flexible conduit, as desired, as will be readily understood.

Although the diaphragm DF has been shown and described in an arrangement in which it is undeflected when the solenoid valve is to be closed, it will be understood that, by reversing the connections, diaphragm DF may be deflected when the solenoid valve is to be closed and will become substantially undeflected when the solenoid valve is to be opened.

Although this invention applies equally well to power burners for generating steam, hot water, hot gases or other fluids, the invention has been shown and de-

scribed in relation to a surface combustion burner merely for illustration.

Previously, power burners were essentially employed in commercial and industrial establishments. Extensive electronic control equpments were necessarily part of the installation. However, this invention utilizes simple and inexpensive structure which is equally suitable for all installations whether large or small.

During the unfired condition of the system, no air is furnished to the conduit CC and hence the pressure due to the velocity of the air is zero. Upon operation of the blower (initiated by a call for heat), very little static pressure is developed due to the absence of downstream resistance. However, the higher flow rate provides sufficient velocity pressure so that the total pressure is sufficient to operate the diaphragm switch. The expansion of the gases upon combustion results in an increase in flow resistance which reduces the flow rate and hence velocity pressure. However, the flow characteristics are such that a sufficient increase in static pressure maintains the diaphragm switch operated.

The term "total pressure probe", as used herein, means any device which may be positioned in a flowing fluid so as to sense any combination of static and velocity pressures.

While this invention has been shown and described in certain arrangements merely for illustration and explanation, it will be apparent that this invention may be embodied in many and varied forms and organizations all within the scope of this invention.

What is claimed is:

1. Protective aPparatus for a power burner system having a conduit into which air and gaseous fuel are separately fed to the conduit at two points spaced from each other, the apparatus including a hollow tube having a single passage responding solely to static and velocity pressures of the air fed into the conduit, one end of which is pointed toward the source of air so that it senses the pressure changes corresponding to the velocity changes of the air moving in said conduit in the direction of the burner system, the pressurized air to be mixed with the gaseous fuel for the burner system, and switch mechanism means having a diaphragm which is coupled to the other end of the hollow tube so that only the incoming pressurized air may be applied to the diaphragm so that it may be deflected solely in accordance with the pressure of the air against the diaphragm, thereby to maintain at least a predetermined volume of air flowing in said conduit and to interrupt the supply of gaseous fuel when the volume of air supplied recedes below said predetermined volume rate.

2. Protective apparatus for a burner system according to claim **1**, such apparatus being connected to a blower for supplying air to the conduit in a predetermined volume rate and at a predetermined pressure.

3. Protective apparatus for a burner system according to claim **1**, in which the hollow tube is bent at substantially a 90° angle so that its sensing end is essentially pointed directly toward the air supply source to receive only the incoming air.

4. Apparatus for preventing the formation of a substantial amount of carbon monoxide in a burner system supplied by a mixture of air and gaseous fuel, comprising a conduit to which the air and gaseous fuel are supplied at different points along the conduit, a hollow pipe having a single fluid passage therein, one end of which is inserted in said conduit and transmits only the pressure changes corresponding principally to the changes of velocity of the air which flows in said conduit in the direction of the burner system for mixture with the gaseous fuel, and means responsive to the air pressure within the pipe receding below a predetermined value for interrupting the flow of gaseous fuel to the burner system, said means including a diaphragm against which said air pressure alone is directed and responds solely to the pressure of the air within said pipe and a solenoid for controlling the gaseous fuel flow to the burner system.

5. Apparatus for preventing the formation of a substantial amount of carbon monoxide in a burner system according to claim **4**, including a blower for feeding air to the burner system at a predetermined pressure above atmospheric pressure so that the pressure within the pipe will be equal to or above the value at which the diaphragm responds to interrupt the flow of gaseous fuel to the burner system.

6. Apparatus for preventing the formation of a substantial amount of carbon monoxide in a burner system according to claim **5**, in which the hollow pipe is bent at substantially a 90° angle so that one end thereof is pointed toward the blower so as to respond essentially exclusively to the pressure of the air fed by the blower to the burner system and its other end is coupled to the diaphragm to deflect the diaphragm.

7. Apparatus for preventing the formation of a substantial amount of carbon monoxide in a burner system according to claim **6**, including a valve for the control of the flow of gaseous fuel to the burner system, and means for coupling the diaphragm to the valve to operate the valve to cut off the flow of gaseous fuel to the burner system when the diaphragm is deflected by a predetermined amount.

8. A gas and air supply system for a power burner comprising, in addition to the burner, a conduit through which the gaseous fuel and air may be fed to the burner at different points along the conduit, a solenoid valve for controlling the flow of gaseous fuel to the conduit a bent hollow pipe having a single passage, one end of which is inserted into the conduit for responding principally to the air pressure changes corresponding to the velocity of the air flowing through the conduit to the burner, and a diaphragm switch coupled between the other end of said pipe and said valve for closing the valve to stop the flow of gaseous fuel therethrough when the pressure of the air supplied to the pipe falls below a predetermined value regardless of the presence or absence of gaseous fuel.

9. A gas and air supply system for a burner according to claim **8**, in which the hollow pipe is bent at substantially a 90° angle so that the end thereof which is inserted into the conduit is upstream of the point in the conduit at which gaseous fuel is supplied to the conduit and is pointed in the general direction of the flow of air through the conduit.

10. A gas and air supply system for a burner according to claim **8**, in which gaseous fuel is fed to the burner through a nozzle pointed toward the burner, the dimensions of the nozzle and the conduit being so related that the ratio of the volume of air to the volume of gaseous fuel supplied to the burner will be substantially constant during wide changes in the air volume.

11. A protective system to protect a power gaseous fuel burner against the production of carbon monoxide beyond a predetermined safe level, comprising a con-

duit coupled to the gaseous fuel burner, a bent pipe having a single passage which has one end within the conduit and pointed toward the direction from which air is fed into the conduit to develop air pressure changes corresponding principally and substantially solely to the air velocity changes in the cOnduit, a solenoid valve for controlling the flow of gaseous fuel into the conduit to be mixed with the air fed into the conduit, the mixture of air and gaseous fuel being supplied through the conduit to the burner, and a diaphragm switch coupling the solenoid valve to the end of the pipe which is outside the onduit to control the operation of the solenoid valve.

12. A protective system according to claim **11** in which a gaseous fuel regulator controls the pressure of the gaseous fuel supplied through the solenoid valve to the conduit.

13. A protective system according to claim **12,** in which a nozzle is positioned within the conduit for feeding gaseous fuel to the burner, the area of the opening of the nozzle and the area of the transmission section of the conduit bearing a predetermined ratio so that the volume of the gaseous fuel will be proportioned to the volume of the air without change, notwithstanding changes in the volume of the air.

14. A protective system according to claim **13,** including a blower for pressurizing the air supplied to the conduit.

15. Apparatus for substantially preventing the formation of carbon monoxide in a power burner system, comprising a gaseous fuel valve control mechanism coupled to a conduit through which air and gaseous fuel are fed to the burner system, said mechanism including a single tubular bent path which is simultaneously affected only by the velocity and static air pressures within the conduit, and means to operate said mechanism when the total air pressure in the conduit exceeds a predetermined value and to release said mechanism and to stop the flow of gaseous fuel when the total air pressure within the conduit recedes below said predetermined value.

16. Apparatus according to claim **15** in which the means to operate the mechanism includes a diaphragm which responds to the total air pressure.

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