June 24, 1930. R. THURM 1,765,549

GAS FIRING SYSTEM

Filed May 7, 1926 4 Sheets-Sheet 1

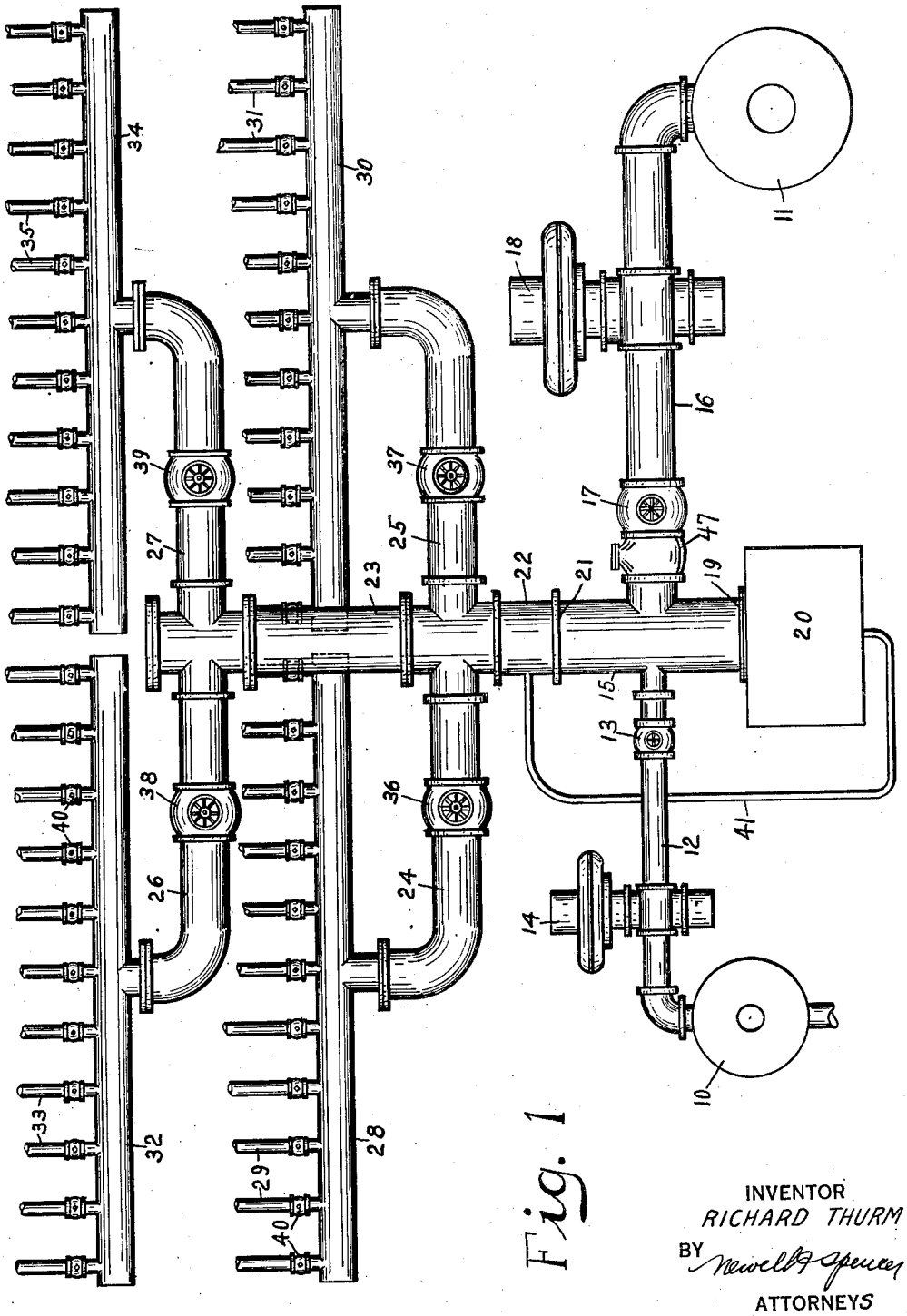


Fig. 1

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GAS FIRING SYSTEM

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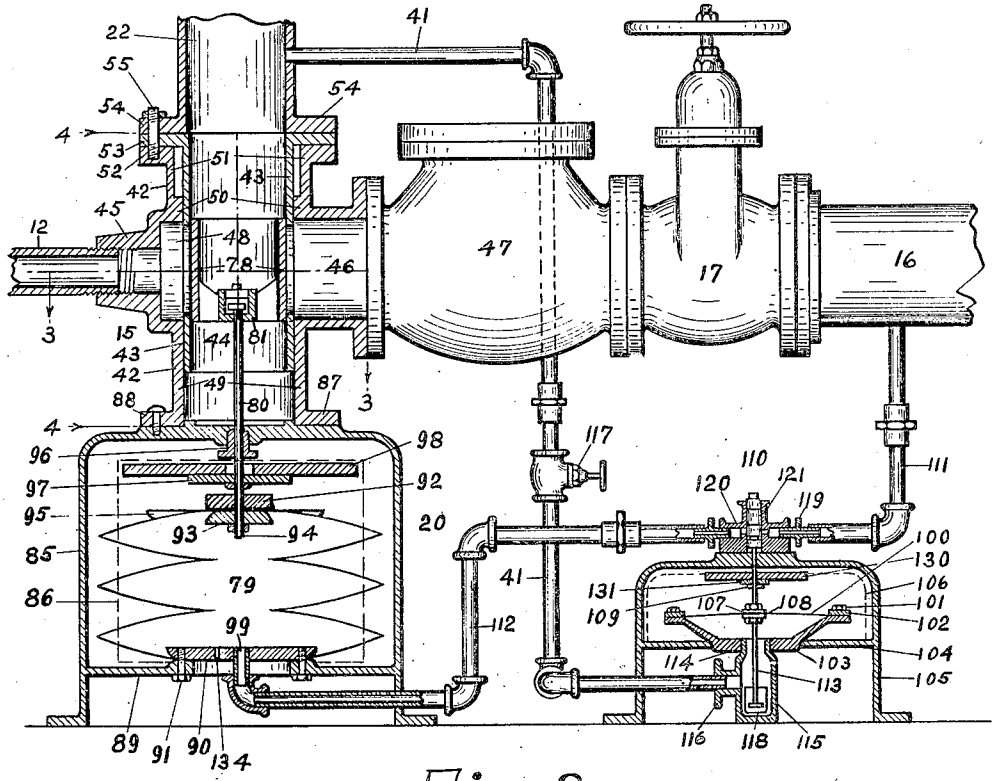


Fig. 2

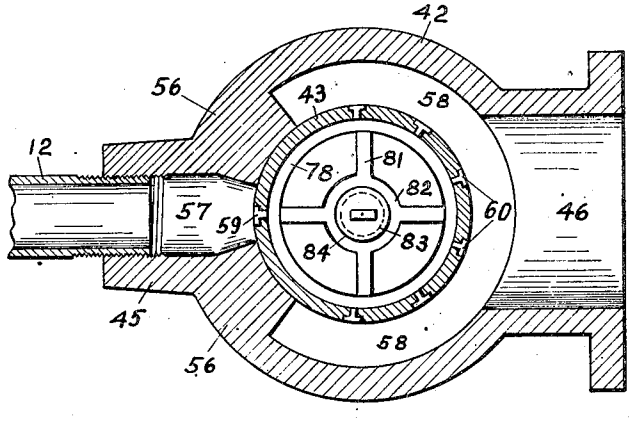


Fig. 3

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GAS FIRING SYSTEM

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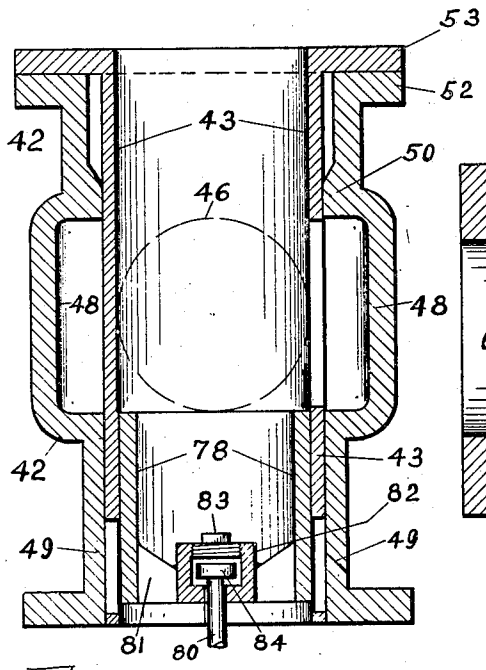


Fig. 4

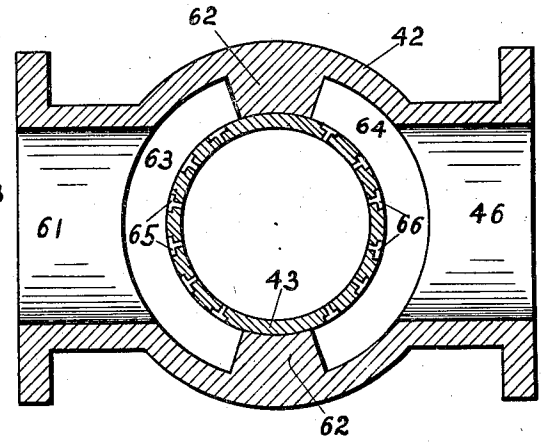


Fig. 5

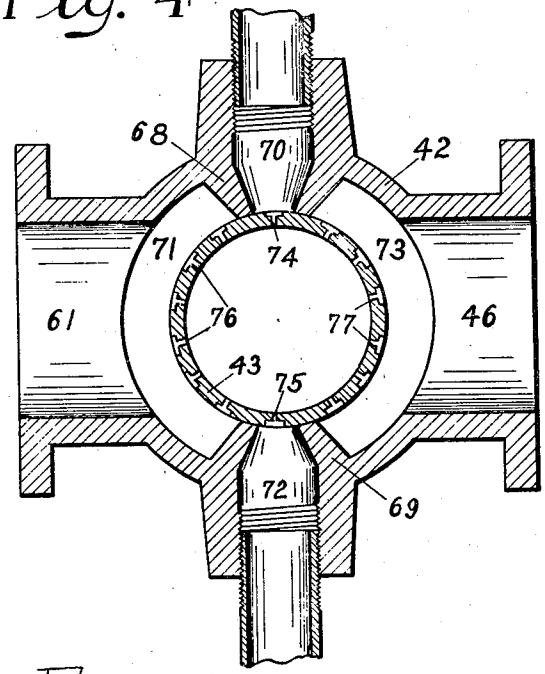


Fig. 6

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GAS FIRING SYSTEM

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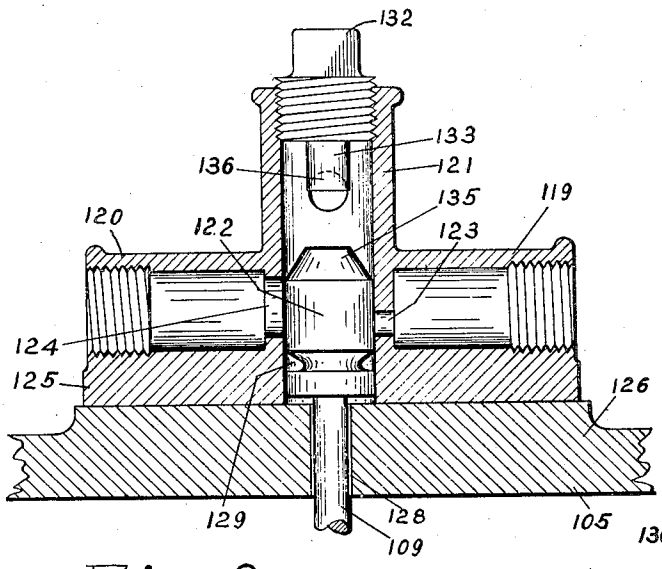


Fig. 8

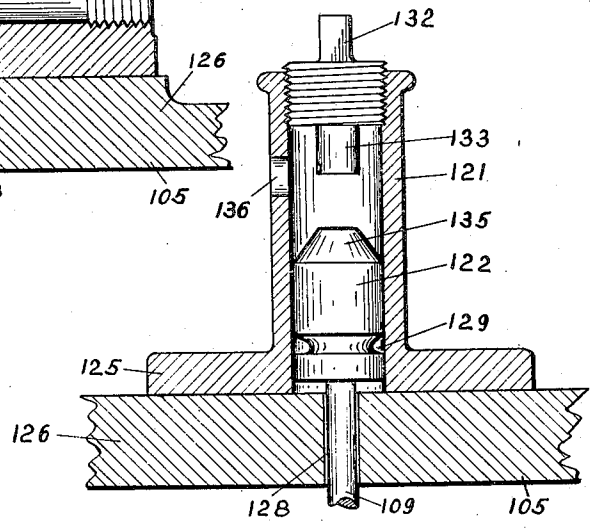


Fig. 9

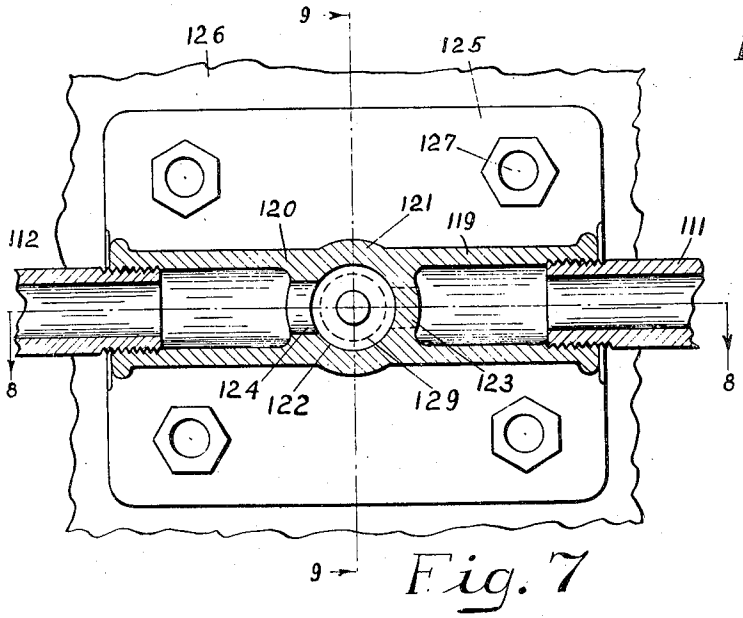


Fig. 7

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UNITED STATES PATENT OFFICE

RICHARD THURM, OF SAGINAW, MICHIGAN, ASSIGNOR TO BAKER PERKINS COMPANY, OF SAGINAW, MICHIGAN, A CORPORATION OF NEW YORK

GAS FIRING SYSTEM

Application filed May 7, 1926. Serial No. 107,345.

This invention relates to gas firing systems and particularly to those systems wherein it is necessary to mix the fuel gas with oxygen before supplying it to the burners.

In heating baking ovens, drying rooms and the like, and especially in ovens of the traveling tray type, in which articles are baked by being carried continuously through the heated chamber on an endless conveyor, a large number of long tubular burners are provided in the chamber. It is evident that since the fuel gas is burned inside the chamber to be heated, the atmosphere in such an oven consists of the products of combustion of the gas, steam and vapors from the articles being baked and is practically free of oxygen. For this reason, a sufficient quantity of oxygen, or oxygen-containing gas such as air, must be mixed with the fuel before combustion will take place.

It is, therefore, one object of this invention to provide gas firing systems of this class with an improved mixing and proportioning chamber, whereby the proportion of fuel gas and oxygen may be accurately predetermined.

It is a further object to provide such systems with means for maintaining the proportion of the gases at a predetermined value irrespective of the rate of flow of the mixture.

It is often desirable to vary the intensity of heat in the oven at times, either in different sections or in the entire oven. This is accomplished by merely turning off or on certain of the individual burners, or by adjusting the flow of gas through the same. It is well known, however, that when any of the outlets of a fluid system are closed, the pressure at the other outlets increases, and when any of the closed outlets are opened, the pressure at the other outlet diminishes, provided the supply pressure is steadily continued. Therefore, when certain of the gas burners are turned off, or are adjusted to diminish the flow of gas, the pressure at the other burners is increased, and when certain of the burners are turned on or are adjusted to increase the flow of gas, the pressure at the other burners is diminished. The variations in pressure thus produced at the burners causes the flame of the burners to be irregular and flicker and to go out easily, and backfiring and explosions in the burners and mains will frequently occur. Dangerous explosions in the baking chamber may even be caused by these variations in the pressure of the mains.

A more specific object of this invention is to provide an arrangement whereby the amount of gas supply and, therefore, the pressure in the mains may be so regulated that when the pressure in the mains increases, the supply will be reduced and when the pressure decreases, the supply will be increased.

These and other objects of the invention will become more apparent upon consideration of the following description, taken in conjunction with the accompanying drawings, illustrating the invention in its preferred form.

In the drawings—

Figure 1 is a diagrammatic representation of a system for use in an oven built in accordance with this invention;

Figure 2 is a view partly in elevation and partly in section, of the gas mixing valve and controlling mechanism therefor;

Figure 3 is a section taken on the line 3—3 of Figure 2;

Figure 4 is a section taken on the line 4—4 of Figure 2;

Figures 5 and 6 are views similar to Figure 3, illustrating modifications of the gas mixing valve shown in Figure 3;

Figure 7 is a plan view of a relay controlled valve;

Figure 8 is a section taken on the line 8—8 of Figure 7; and

Figure 9 is a section taken on the line 9—9 of Figure 7.

Referring to Figure 1, fuel gas (for example, ordinary illuminating gas) is compressed in a compressor 10, and is fed through pipe 12, of suitable cross sectional area, and containing a well known form of pressure regulator 14 and a control valve 13, into a gas mixing valve or chamber 15. A second compressor 11 feeds an oxidizing gas such as air at substantially the same pressure as the fuel gas (preferably 16–20″ water column pressure), through pipe 16, having a

control valve 17 and a pressure regulator 18, into the opposite side of valve 15, so that a mixture may be effected. A check valve 47 is interposed between the valve 15 and the control valve 17 so that, in case backfiring occurs in the burner tubes, the gases in the tube system or the burner side of valve 17, being under high pressure, will be prevented from penetrating into the tube 16 and thus into the compressor 11 and regulator 18.

A coupling section 22 leads from the upper side 21 of valve 15 to a main supply line 23, from which branch lines 24, 25, 26 and 27 extend, each one supplying a plurality of tubular burners 29, 31, 33 and 35 through manifolds 28, 30, 32 and 34 respectively. Suitable control valves 36, 37, 38 and 39 are located in the branch lines, and each burner is provided with an individual regulating valve 40. With the gas mixing valve 15 supplying its maximum capacity, and all of the valves 40 of the burners fully open, as are also valves 36 to 39, inclusive, it is intended that the pressure in section 22 and main 23 remain constant and preferably equal to 4–6″ water column pressure.

The amount of mixture supplied to main 23 is controlled automatically in accordance with the pressure existing in section 22 by means of mechanism represented diagrammatically at 20 and shown more in detail in Figure 2, a pipe 41 providing the proper connection. Therefore, whenever the pressure falls below 4–6″ the amount of gas supplied is increased, and when the pressure increases above 4–6″, the supply is decreased.

There is also combined in mixing valve 15 (Fig. 2) both a proportioning apparatus and a quantity regulator. This mechanism comprises a main housing 42, whose inner surface is circular in cross section, and made up of cylindrical sections of varying interior diameters, the widest section 48, thereof, being at the middle where the pipe 12 and valve 47 join parts 45 and 46 respectively, section 48 being equal in length to the diameter of the opening in part 46 (Fig. 4). Lower section 49 and short upper section 50 are co-axial, and their inner surfaces form part of the same cylindrical surface. Section 50, for convenience in assembling, has a slightly larger outer diameter than section 49 and is arranged to support on its flange 52, the flange 53 of proportioning tube 43. The flange 54 of coupling section 22 rests upon the flange 53, the three flanges being rigidly secured together by means of bolts 55.

The proportioning tube 43, preferably cylindrical in form and of uniform cross section, is arranged within the valve 15, so that it fits tightly in the sections 49 and 50. Between this tube 43 and enlarged section 48 is a space which is divided by means of partitions 56 into two compartments or chambers, one 57 connecting with the fuel gas inlet 45 and the other 58, connecting with the air inlet 46. The tube 43 is provided with a series of vertical slots 59, 60, which are preferably of equal length but may be of different width, the number of slots and their widths depending upon the amounts of the gases to be passed therethrough, in order to attain desired composition of the mixed gas. If it is desired to mix two gases, for example, in the ratio of two to one, the port opening to the conduit containing the gas to be supplied in the greater amounts is twice the width of the port opening to the conduit containing the gas to be supplied in the lesser amount. As an example, if one volume of the illuminating gas used required 5.4 volumes of air for its complete combustion, one slot 59 may be provided for the gas and 6 slots 60 for air, as shown in Figure 3, the proportion of the width of the slot for gas to that of each slot for air being as 1 is to 0.9.

Figure 5 shows a cross section of a mixing valve employed when using producer gas, which requires an equal amount of air for combustion, the inlet 61 for the gas and the inlet 46 for air having equal bores. In this case, an equal number of slots 65, 66 of the same width are provided in tube 43 between the mixing valve and chambers 63 and 64 formed by partitions 62.

Figure 6 discloses an arrangement wherein there is provided, in addition to the two oppositely disposed inlets for producer gas and air as in Figure 5, two additional inlets, one 72, for natural gas, and another, 70, for illuminating gas. Partitions 68 and 69 serve to form the proper number of chambers and there are provided a sufficient number of slots 74 to 77, inclusive, in the tube 43. In this case, if one volume of illuminating gas requires 5.4 volumes of air for combustion, one volume of producer gas requires one volume of air and one volume of natural gas requires eight volumes of air. Then the proportion of the widths of the slots for illuminating gas, producer gas, natural gas and air is as follows:

1 : 0.9 : 0.675 : 0.9

Within the slotted cylinder 43 is a piston 78, which is preferably cylindrical in form, and which is adapted to be moved longitudinally within the cylinder 43 by means of a piston rod 80, whereby the various slots or openings are covered to a greater or less extent, depending upon the pressure in the delivery end of the valve, as will be more fully hereafter explained. The rod 80 is fixed in the center of piston 78 to a star-shaped bracket 81. The middle part of the latter is preferably constructed as a cup 82, the bottom of which contains an opening for the rod 80 to pass through, a screw plug 83 (Figures 1, 3 and 4) closing the top. The top end

of rod 80 is provided with a reinforced member 84, and the rod is connected with a pressure bag 79 so that when the bag is deflated, the extending member rests upon the bottom of cup 82, and, when the bag is inflated, a certain amount of play is permitted between member 84 and plug 83.

The rod 80 extends downwardly into the interior of housing 85, through a suitable stuffing box 96 and may be securely fastened to a top piece 92. The top piece 92 rests on a thin circular plate of resilient metal 95 mounted on the uppermost leaf of the pressure bag 79. This arrangement acts to prevent the top leaf from rising too high when the bag is fully inflated. For this purpose, the plate 95 is concave on its under side, the plate having a spherical surface adapted to fit the upper leaf of the bag when the bag is fully inflated. The plates 92 and 95 are secured in place on the rod 80 preferably by means of supporting plate 93 and a nut 94 threaded on the rod.

A circular plate 97 adapted to hold weights 98 for adjusting the action of bag 79 is suitably fixed on rod 80, between stuffing box 96 and the top piece 92. The lowest leaf of bag 79 is tightly secured by means of bolts 91 between the reinforced rim of the annular bracket 89, extending from the sides of housing 85 and a circular plate 90. An opening 99 in plate 90 admits fluid under pressure into the bag 79 from pipe 112, which is connected through pipe 111 to the air pipe 16.

Interposed between the pipe lines 111 and 112 is a relay valve 110 (Figures 7, 8 and 9) comprising two horizontal tube sections 119 and 120 of equal length and size arranged coaxially at opposite sides of a vertical tube 121, in which a piston 122 slides easily up and down. Openings 124 and 123 in the walls of the vertical tube 121 connect respectively to the sections 120 and 119 and are covered and uncovered by piston 122. The latter is cylindrical in form and is provided with an annular recess 129, which is wider at the bottom and tapers upwardly. This recess 129 is located at such a distance from the bottom of the piston that with the latter in its uppermost position, the recess is in alignment with the openings 123 and 124.

In order to prevent piston 122 from being raised higher than necessary, tube 121 is closed by plug 132, provided with a projection 133, against which the tapering piston 122 may abut.

Relay valve 110 rests with its base 125 upon the reinforced part 126 of the top of a housing 105, bolts 127 being provided to secure it in place. Valve rod 109 integral with piston valve 122 extends down through an opening 128 into housing 105 and is secured to the center of a diaphragm 100 and is movable therewith. The diaphragm is tightly stretched across the broad rim of cup 103 by means of an annular ring 102 and screws 101, an annular bracket 104 extending from the walls of the housing and serving as a support for said cup. To the center of the diaphragm are fixed two disks, one 107, on its upper side carrying valve rod 109 and the other, 108, on its lower side, to which is secured a piston rod 113, projecting into a dashpot 118, located in a vessel 115 whose upper open end is screw-threaded into an opening 114 in the lower part of the cup 103. Vessel 115 is provided at its left side (Figure 2) with a flanged inlet 116, connected to which is a pipe line 41 having a control valve 117 and leading to tube section 22. Variations in pressure in section 22 are thereby conveyed to diaphragm 100 which, in responding thereto, causes the opening or closing of valve 110, thereby controlling the admission of compressed air into bag 79.

It should be noted that tube 22 might be connected directly to pressure bag 79 as shown in Figure 1, but for practical reasons it has been found more satisfactory to employ compressed air to inflate bag 79, the variations of pressure existing in tube 22, to which valve 44 must necessarily respond being very small, often less than $\frac{1}{10}$ of an inch water column pressure.

The operation of this mechanism is as follows:

The pressure desired to be maintained under normal conditions in tube 22 is predetermined at any value by means of removable weights 130 which rest on support 131 secured to rod 109. The number and size of these weights depend upon the pressure desired to be maintained on the underside of diaphragm 100, which pressure in turn depends upon the pressure in tube 22. Enough weight 130 must be supplied to hold diaphragm 100 against the normal pressure and in such a position that valve 110 is normally in its fully closed position.

As long as the pressure in the mains and, therefore, in tube 22 and on the diaphragm 100 remains normal, valve 110 will continue in its fully closed position.

As soon, however, as the pressure in the mains rises because of the shutting down of some of the burners or for any other reasons, the pressure in tube 22 will also increase. This increase in pressure will be transmitted through pipe 41 into vessel 115 and thence into cup 103. Diaphragm 100 will respond to the increase of pressure on its under side and will move upwardly. Upward movement of diaphragm 100 will cause upward movement of rod 109 and, consequently, of piston 122. Recess 129 will move into position to admit air from pipe 111 into pipe 112 and thus into pressure bag 79, through opening 99. The pressure bag will therefore gradually expand upwardly, carrying with it rod 80 and valve 78, thereby partially closing ports 59 and

60 to an extent depending upon the distance the valve is raised. The quantity of gases admitted to chamber 15 will be diminished and as a result the supply of mixture to the mains and to the burners will decrease. The pressure in tube 22 and on the under side of diaphragm 100 will thereupon drop to its normal a predetermined value whereupon valve piston 122 will close ports 123 and 124, cutting off the supply of air to bag 79. The latter will then gradually exhaust either through pinhole 134 in the bottom thereof or back through pipe 112 through the upper part of port 124 and out through atmospheric vent 136 in tube 121.

The top of piston 122 is tapered, so that when the piston is in its lowermost position, the rim of the cylindrical part of the piston is slightly lower than the top of port 124. The bottom of the latter port is level with that of port 123, while the top port 124 is considerably higher than that of part 123, which preferably is as high as recess 129 when the piston is in its fully raised position.

As bag 79 exhausts, valve 78 moves downwardly to open to a greater extent ports 59 and 60. As soon as the supply of gases to the mixing chamber is thus increased, the pressure in tube 22 again rises slightly and valve 110 will open slightly, admitting enough compressed air into bag 79 to raise valve 78 once more. This cycle of operation is repeated, the movements of valves 110 and 78 becoming less and less, until the point is reached at which an amount of compressed air enters pressure bag 79 just sufficient to maintain the valve 78 in such a position that the supply of fuel gas and air to the mixing chamber is equal to that consumed by the burners, while the pressure in the main 22 remains substantially normal. In a corresponding manner, if one or more of the burners which was turned off is again turned on, thereby temporarily diminishing the pressure in the tube section 22, the valve 78 will be automatically adjusted to increase the supply of gas and air to the mixing chamber, thereby restoring the pressure in said chamber to normal. Thus the valve 78 is automatically adjusted in accordance with the pressure in the tube section 22 to supply just the amount of gas and air required by the burners.

It is to be understood that various changes and modifications may be made in details and general arrangement of the apparatus without departing from the spirit or scope of the invention as defined in the claims.

What is claimed as new is:

1. In a gaseous fuel burner system, a gas supply line, an air supply line, a chamber wherein said gas and air are mixed to form a combustible fuel mixture, and a pressure-operated valve arranged to control the admission of gas and air to said mixing chamber, means actuated by the pressure in one of the supply lines for operating the valve, and means actuated by the pressure of the fuel mixture for controlling the valve.

2. In a gas burner system, in combination, a mixing chamber, a fuel supply main leading therefrom to a plurality of consuming units, separate pipes to admit fuel gas and air under pressure to said mixing chamber, means having communication with, and operated by the pressure in one of said pipes for regulating the volume of fuel gas and air admitted to the mixing chamber, and means having communication with and operated by the pressure in the fuel supply main for controlling the operation of the last mentioned means.

3. In a gas burner system, in combination, a mixing chamber, a fuel supply main leading therefrom to a plurality of consuming units, separate pipes to admit fuel gas and air into said chamber under pressure, the mixture being led from the chamber into the fuel supply main, and means for continuously varying the volume of fuel gas and air admitted into said chamber in proportion to the rate of consumption of said consuming units, said means being operated by the pressure present in one of the separate pipes leading to the mixing chamber, and controlled by the pressure in the fuel supply main leading to the consuming units.

4. In a gas burner system, a mixing chamber, means for supplying fuel gas under pressure to said mixing chamber, means for supplying air under pressure to said mixing chamber, a fuel mixture main leading from said mixing chamber, a valve for controlling the passage of fuel gas and air to the mixing chamber, means having communication with the air supplying means and operated by the pressure therein for operating said valve, and means having communication with the fuel mixture main and operated by the pressure therein for controlling the operation of the valve operating means.

5. In a gas firing system for ovens, in combination a plurality of burners located within the oven and adapted to burn a mixture of fuel gas and air in their correct proportion for a complete combustion of the fuel gas, pipes supplying the said mixture under pressure to the said burners, a mixing chamber connected with the said supply pipes and having two separate inlets, one for the fuel gas and one for the air, a proportioning tube fixed in the said mixing chamber and so arranged that the fuel gas and air enter the latter in the correct proportion, a tube valve slidably mounted in said proportioning tube for varying continuously, during its movement, the quantities of fuel gas and air admitted through the latter, and means adapted to operate automatically said tube valve under control of the pressure prevailing in

said supply pipes to maintain this pressure substantially constant during the operation of the oven.

6. In a gas firing system for ovens, in combination a plurality of burners located within the oven and adapted to burn a mixture of fuel gas and air in their correct proportion for the complete combustion of the fuel gas, a mixing chamber for these gases, two separate inlets provided in said mixing chamber, one for the fuel gas and one for the air, means for supplying gas and air to said chamber under substantially equal and constant pressures, proportioning means arranged in said mixing chamber and so constructed that the fuel gas and air enter the latter in the correct proportion, pipes connected to the said mixing chamber and supplying the said burners with the mixture of fuel gas and air, and means automatically regulating the quantities of fuel gas and air admitted to said mixing chamber under control of the pressure of their mixture in the said pipes supplying the said burners to maintain this pressure substantially constant during the operation of the oven.

7. In a gas firing system for ovens, in combination a plurality of burners adapted to burn a mixture of fuel gas and air in their correct proportion for the complete combustion of the fuel gas, pipes supplying this mixture to the said burners, a mixing chamber, from which these supply pipes are fed, an inlet to said mixing chamber for air, a number of inlets for fuel gas corresponding to the different kinds of fuel gas at disposal, means for delivering the fuel gas and air at substantially equal constant pressures, four chambers formed by projections extending from the inner surface of said mixing chamber and surrounding each inlet, a cylindrical tube rigidly mounted in said mixing chamber with the side walls of said four chambers fitting tightly thereto and having openings corresponding to said inlets and leading from said four chambers to said mixing chamber, the areas of the openings for the admission of air having the same ratios to the several areas of the openings for the admission of the respective gases as the ratios of air to said gases required for complete combustion, and means provided in said cylindrical tube for adjusting the quantities of air and fuel gas admitted to the said mixing chamber without altering their ratio to each other.

8. In a gas firing system, the combination with a supply main for leading a mixture of fuel gas and air in proper proportion under pressure to the burners, an upright mixing chamber having an open top connected with the said supply main and closed at its bottom, two separate inlets provided for the said mixing chamber, a gas main connected to one of said inlets and an air main connected to the second of said inlets respectively for the delivery of gas and air under substantially equal pressure to said chamber, a cylindrical proportioning tube fixed in the said mixing chamber, separate sets of slots provided in the said proportioning tube respectively opposite each of the said inlets, all the slots being of substantially equal lengths, their upper and lower ends being substantially horizontally aligned, and the relative dimensions of the sets being such that gas and air are admitted in the required proportion, a tube valve slidingly mounted in the said proportioning tube, an upright rod attached to said tube valve, a stuffing box in the base of said mixing chamber through which said rod passes, a pressure bag located below said chamber and connected at its upper end to the said rod, a pipe connecting the said pressure bag with the said air main, a piston valve intersecting said pipe, a diaphragm connected with said piston valve, a chamber over which the said diaphragm is stretched, a pipe connecting the said chamber with the said supply main, and an exhaust passage for said bag, the said parts being constructed and arranged so that, when the pressure in the said supply main rises above that normally required, the piston valve is opened, and the said pressure bag inflated by compressed air, and, when the pressure in the said supply main drops, the piston valve is closed, and the said pressure bag is deflated, the air contained therein escaping gradually through the said exhaust passage.

Signed at Saginaw, county of Saginaw, Michigan this 3rd day of May, 1926.

RICHARD THURM.