

June 30, 1931.

E. O. ENGELS

1,812,089

GAS MIXING APPARATUS

Filed Oct. 27, 1926 7 Sheets-Sheet 1

FIG. 1.

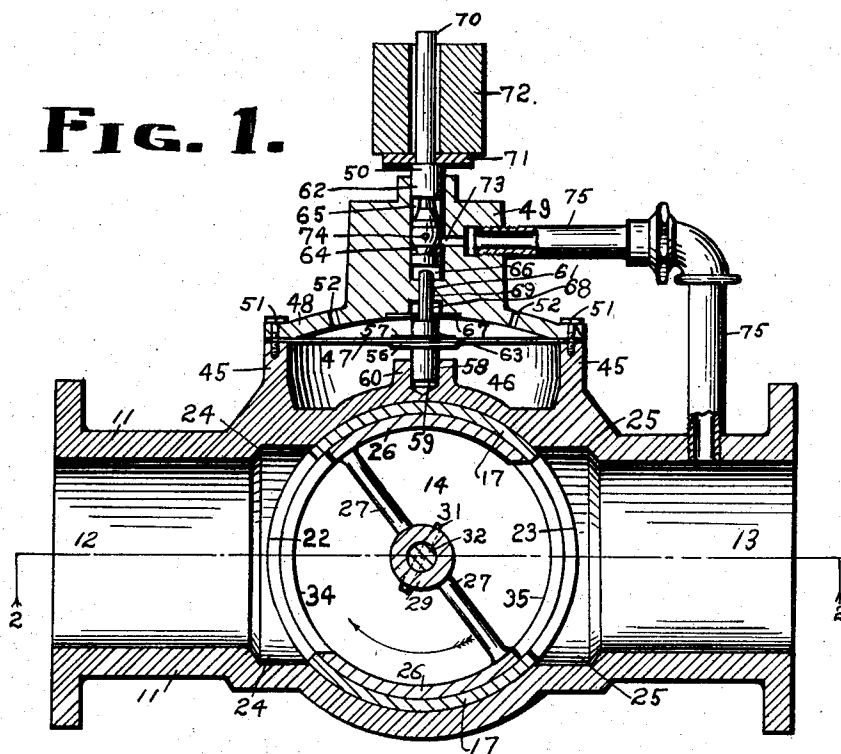


FIG. 4.

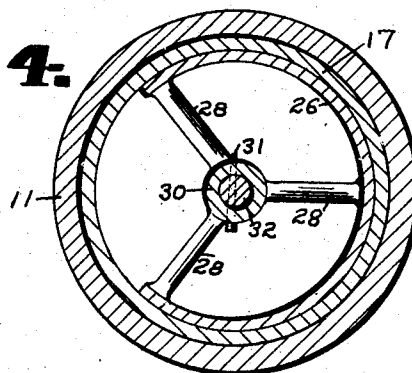
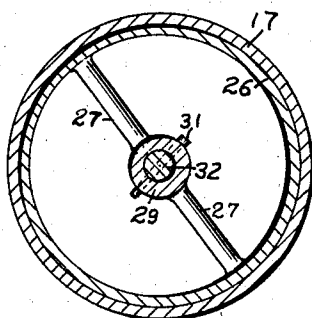


FIG. 3.



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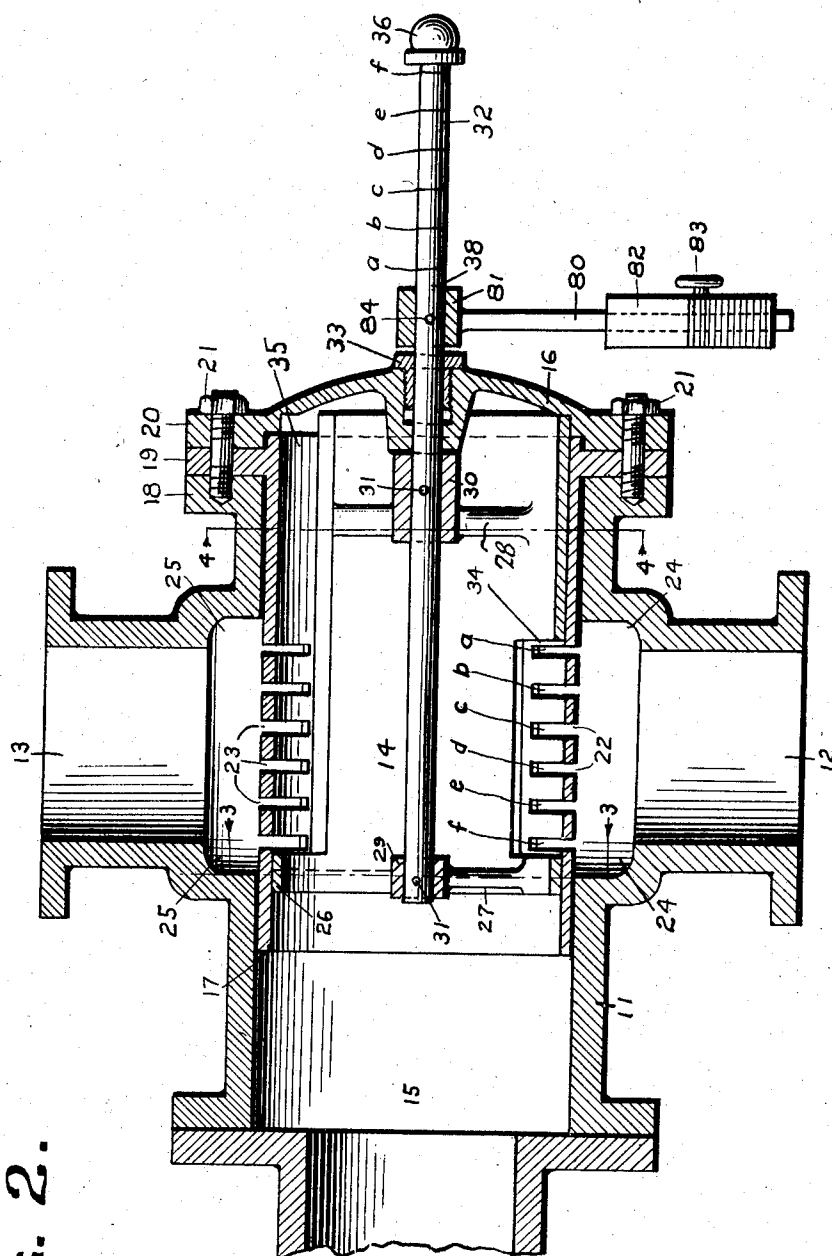


FIG. 2.

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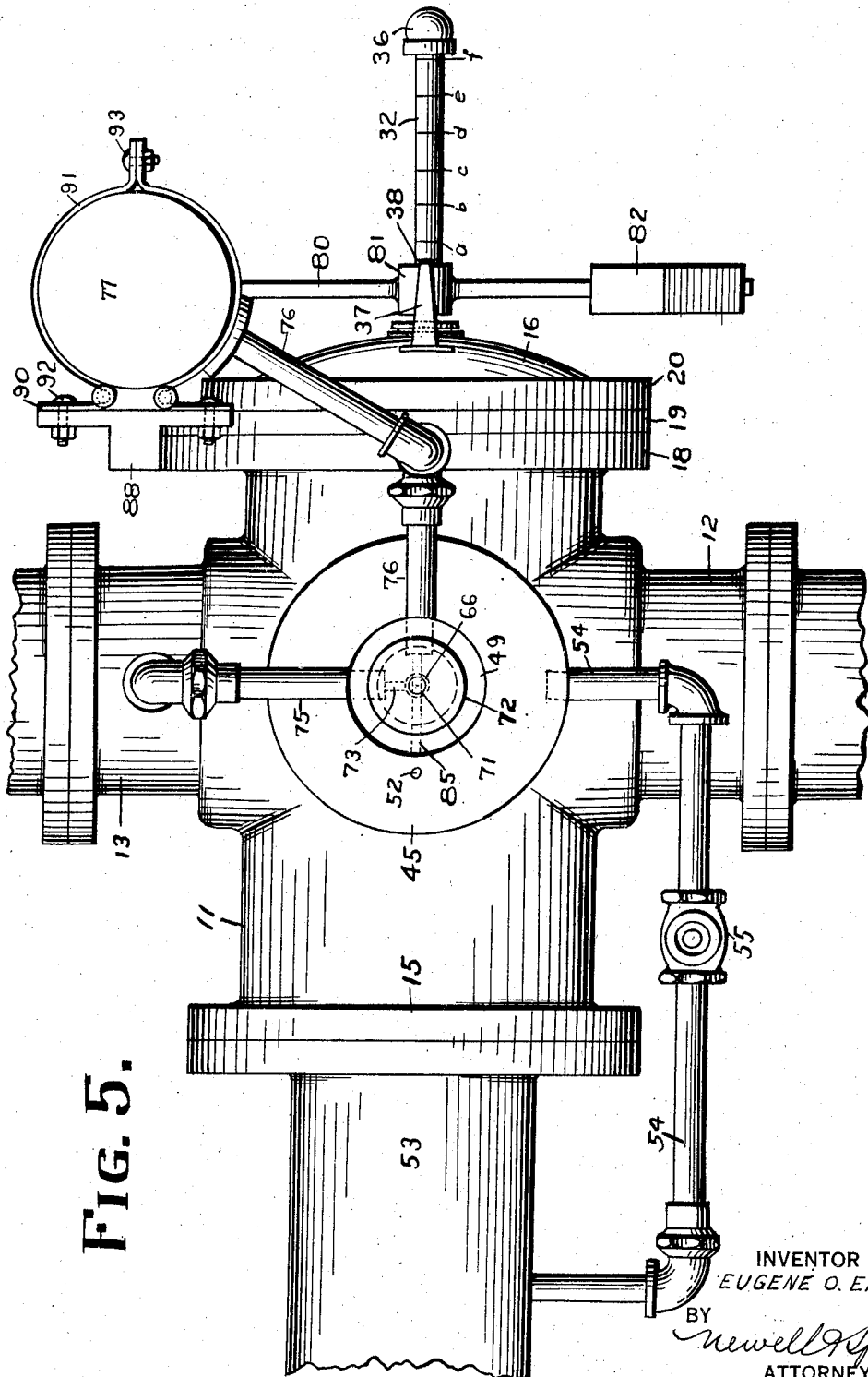
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GAS MIXING APPARATUS

Filed Oct. 27, 1926 7 Sheets-Sheet 3



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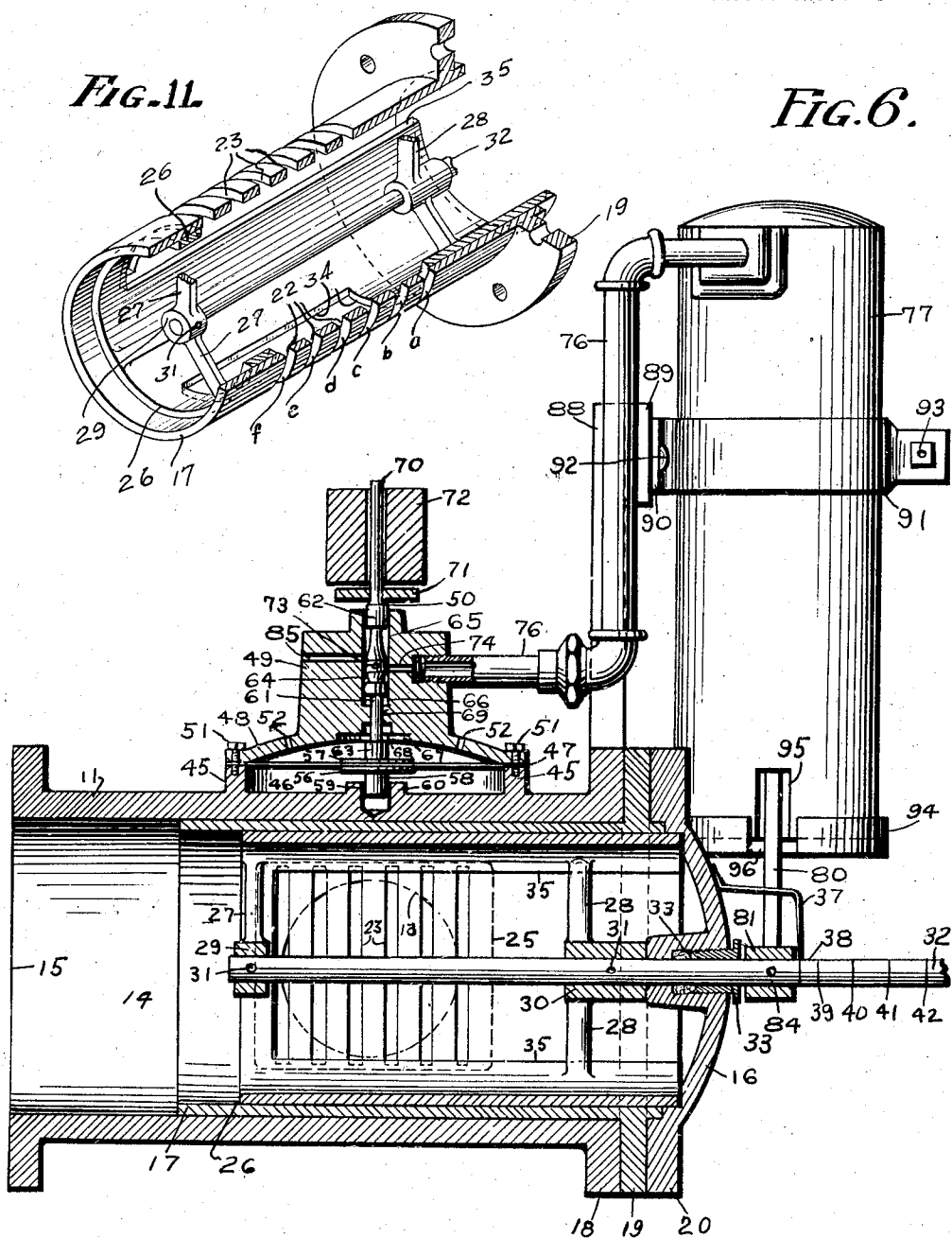
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GAS MIXING APPARATUS

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FIG. 11.

FIG. 6.



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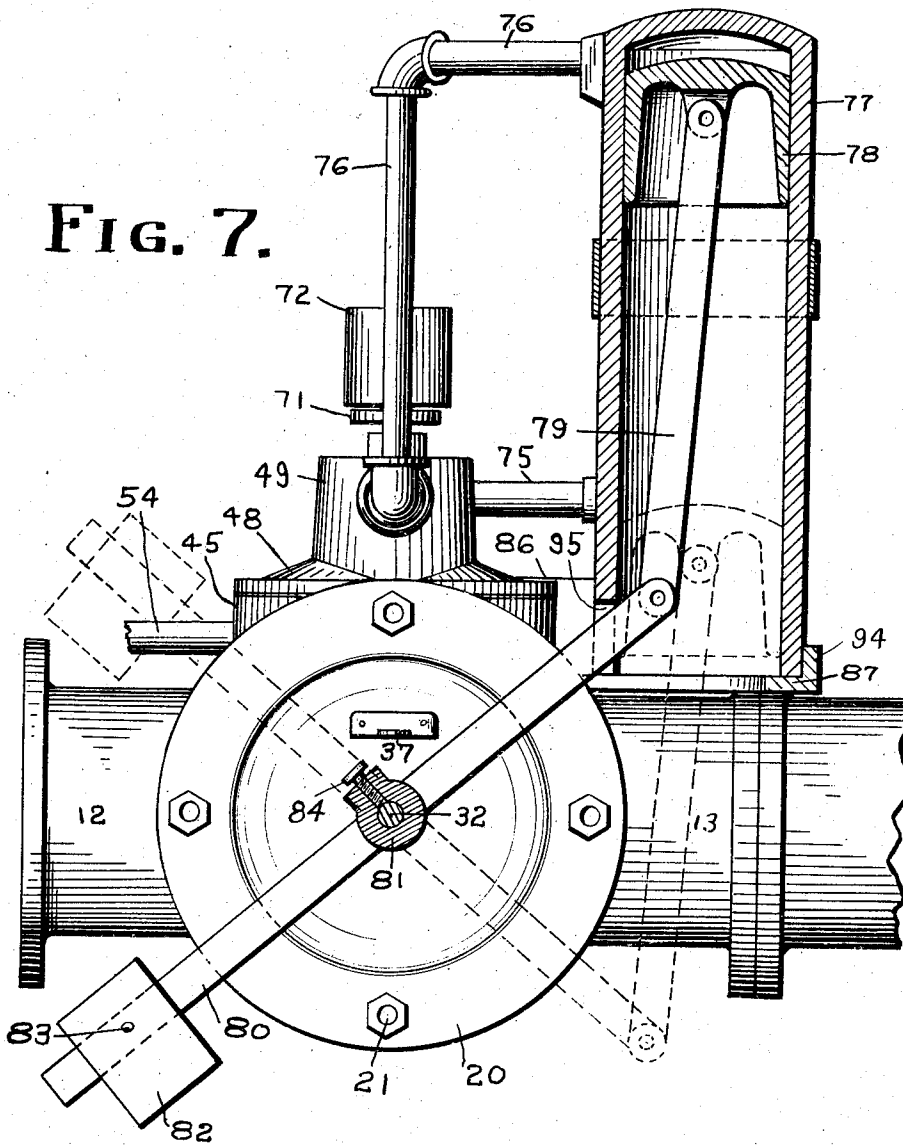
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GAS MIXING APPARATUS

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FIG. 7.



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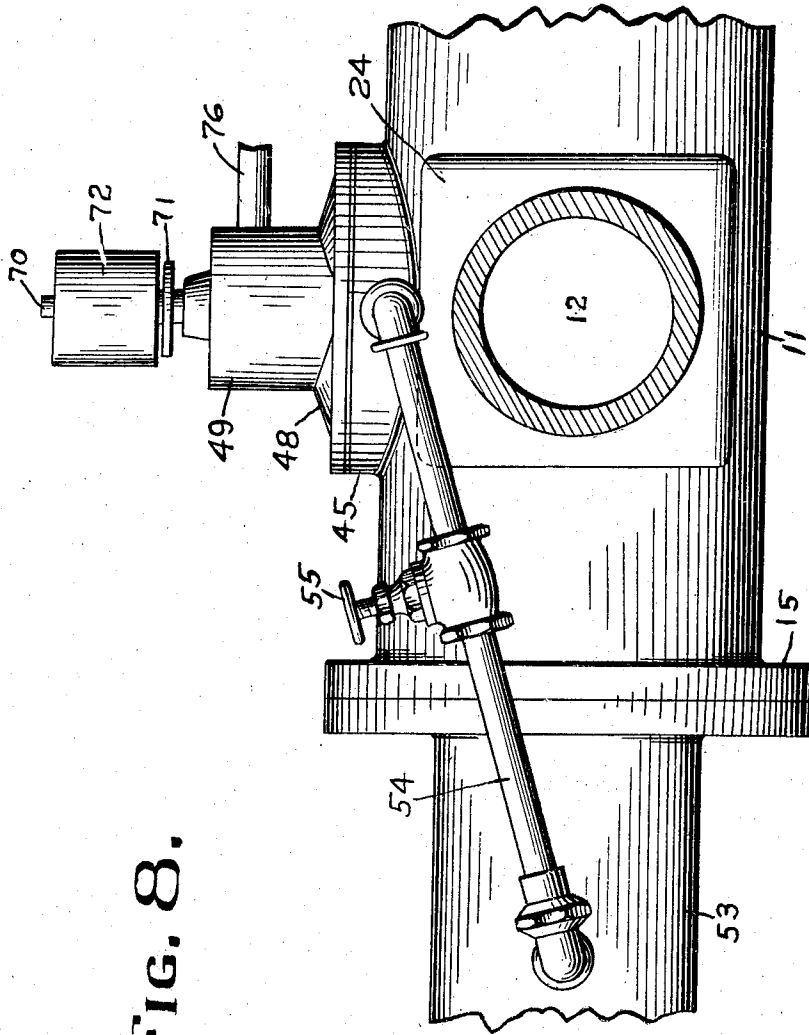
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GAS MIXING APPARATUS

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GAS MIXING APPARATUS

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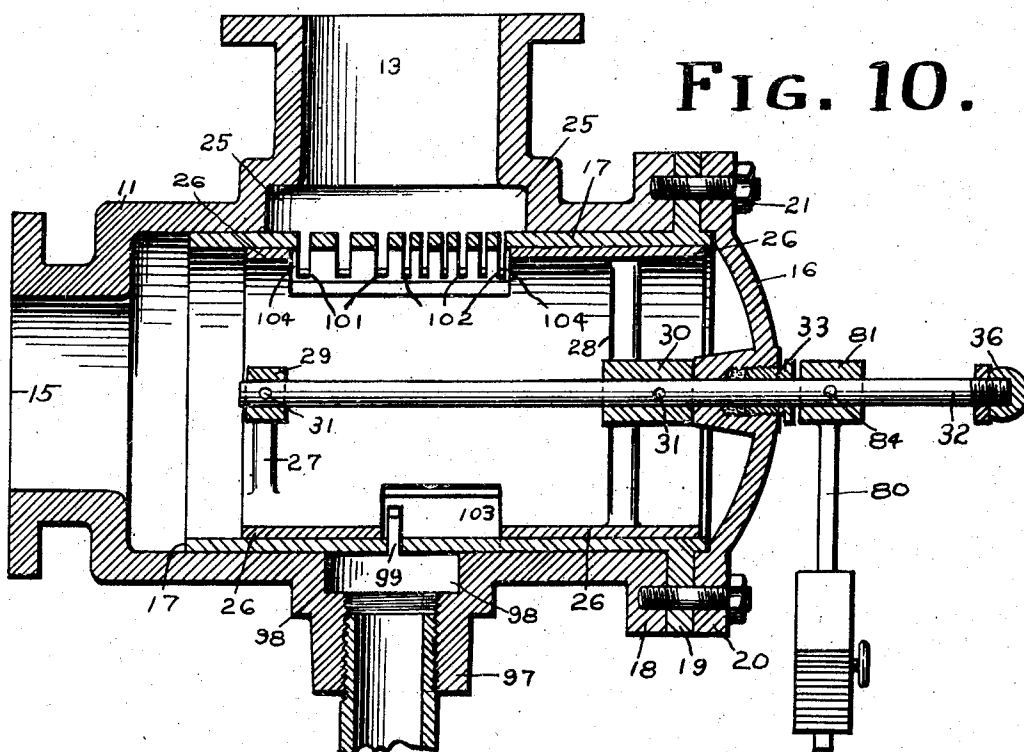


FIG. 10.

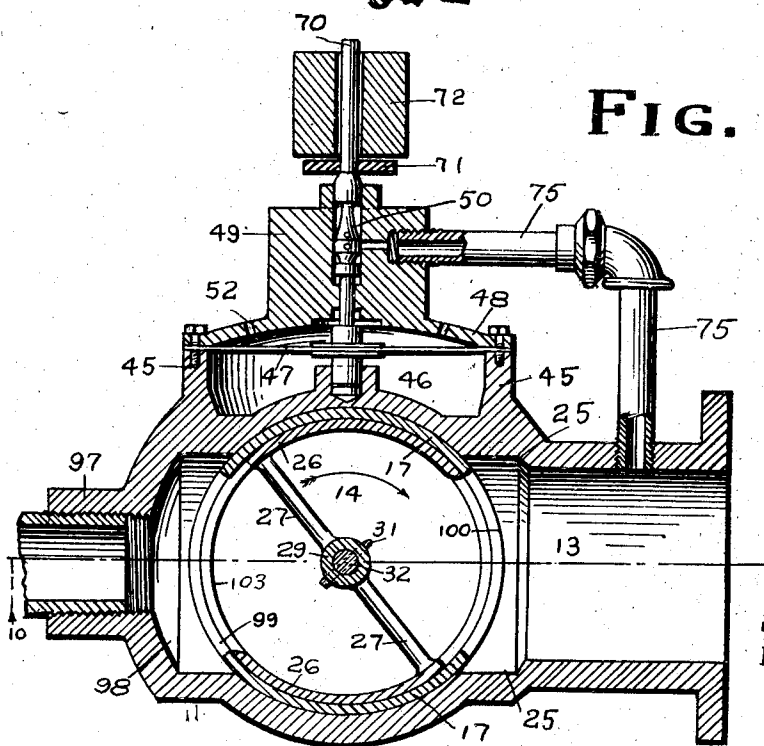


FIG. 9.

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UNITED STATES PATENT OFFICE

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GAS MIXING APPARATUS

Application filed October 27, 1926. Serial No. 144,535.

This invention relates to gas mixing apparatus for gas firing systems.

Certain features of the invention relate particularly to gas firing systems including a gas mixing apparatus in which the quantity of the gases entering the mixing apparatus is controlled by the pressure prevailing in the produced gas mixture, the quantity of the gases supplied being decreased when this pressure rises and increased when said pressure falls.

This invention is particularly applicable to gas firing systems for heating baking ovens, drying rooms and the like in which a gaseous mixture is burned in the oven chambers by means of open flame burners. It is evident that the atmosphere in such ovens contains little or no oxygen so that the fuel gas must be mixed with a sufficient quantity of oxygen or air for proper combustion before being fed to the burners. It is important in such systems that the proportion of fuel gas and air be maintained at a value such that at all times the gaseous mixture may be burned at a maximum efficiency.

In gas firing plants, it is frequently necessary or desirable to change the fuel gas being used in the mixture for another gas requiring a different quantity of air or oxygen for its efficient combustion, and it is therefore highly important in gas firing systems that the mixing apparatus shall be capable of use with various kinds of fuel gas. Producer gas requires substantially an equal volume of air to produce a mixture which will burn with maximum efficiency while other fuel gases such as water gas, town gas, natural gas, oil gas and the like require a considerably larger proportion of air to produce the most efficient gaseous mixture. Also certain gases which are commonly used in systems of this kind fluctuate slightly in composition and consequently require a slightly varying amount of air in the mixture for the most efficient combustion.

One of the principal objects of the present invention is to provide a gas mixing apparatus of the character above described in which the apparatus may be quickly and easily regulated to produce mixtures of dif-

ferent proportions of gases required for efficient combustion.

Another object of the invention is to provide a gas mixing apparatus constructed and arranged to mix gases for the formation of a combustible mixture in certain definite proportions in which the proportion of the gases in the mixture may be readily varied as desired during the operation of the apparatus.

Another object of the invention is to provide a gas mixing apparatus having provision for controlling the quantity of the gases entering the mixing apparatus in accordance with the pressure existing in the produced gas mixture, in which the proportion of the gases in the mixture formed may be varied as desired to produce the most efficient combustible mixture.

With these and other objects in view the invention comprises certain novel and improved features, constructions and combinations of parts hereinafter described and particularly pointed out in the claims, the advantages of which will be readily understood and appreciated by those skilled in the art.

The invention will be clearly understood from the accompanying drawings illustrating the invention in its preferred form and the following detailed description of the construction therein shown. In the drawings—

Fig. 1 is a vertical section through the center of a mixing apparatus built in accordance with this invention;

Fig. 2 is a horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 2;

Fig. 5 is a plan view of the apparatus showing the control mechanism and external connections;

Fig. 6 is a vertical section taken longitudinally through the center of the mixing apparatus and at right angles to the section of Fig. 1;

Fig. 7 is a front elevation of the apparatus showing in section a pressure cylinder

for automatically controlling the supply of gases;

Fig. 8 is a side elevation of a portion of the mechanism shown in Fig. 7;

Fig. 9 is a sectional view showing a modified form of the invention;

Fig. 10 is a section taken on the line 10—10 of Fig. 9; and

Fig. 11 is a perspective view showing the internal construction of the form of apparatus shown in Figs. 1 to 9 inclusive.

For the most efficient operation of gas firing plants, it is desirable to maintain the pressure of the gaseous mixture at the burners as nearly constant as possible, and to this end the flow of gases into the mixing apparatus is suitably controlled in the present construction. In actual practice, the total consumption of gas by the burners is always varying because individual burners are turned on and off and up and down constantly during the operation of the system. Variation in consumption, of course, varies the pressure in the lines supplying the burners and unless the supply of gas to the lines is controlled in accordance with this pressure, the burner flames flicker and become irregular. For this reason, in the present construction the pressure in the supply lines is employed to control automatically the quantity of gases admitted to the mixing chamber as the pressure varies, the quantity of these gases being increased when the pressure in the main supply line diminishes and the quantity of the gases being diminished when this pressure increases.

In order to mix fuel gas and air in the proportions desirable for forming a combustible mixture in the present form of the invention, the apparatus is provided with a main housing 11, preferably cylindrical in cross-section, having one end closed, as by a cover 16, and the other end opening, by means of outlet 15, into a main 53, which supplies the burners with the combustible mixture. Fuel gas and air preferably are led into the housing 11 through inlets 12 and 13 arranged in the cylindrical wall of the housing diametrically opposite to each other.

Fitting tightly to the inner walls of housing 11 and extending longitudinally from its closed end, well past the inlets 12 and 13, is a cylindrical proportioning tube 17 having a flange 19 which is rigidly secured between flange 18 of housing 11 and flange 20 of cover 16 by means of bolts 21. Gas and air are admitted into the mixing chamber 14 only through sets of preferably equal sized and parallel slot-like ports referred to collectively as 22 and 23 cut in the opposite walls of the cylindrical tube 17. Ports 22 are arranged in the tube 17 so that the fuel gas which enters through inlet 12 passes through forechamber 24 formed in

the side of housing 11 and then through the ports 22 into the mixing chamber. Ports 23 similarly are located so that air entering forechamber 25 from inlet 13 passes through ports 23 into the mixing chamber.

In order to regulate the amount of gas admitted into the mixing chamber 14, a cylindrical valve tube 26 is mounted for axial sliding movement and for rotative movement within the proportioning tube 17. The valve 26 is provided at one end with radial arms 27, connected to a central sleeve 29, and at its opposite end with radial arms 28, connected with a central sleeve 30 and a valve actuating rod 32 is secured by means of pins 31 within the sleeves 29 and 30. The rod 32 passes through a stuffing box 33 in the cover 16 and terminates in a knob or handle 36 by which the rod and valve tube may be actuated manually.

The valve tube 26 in the preferred construction is provided with two openings, one indicated at 34, preferably having its length and width at least equal to the corresponding dimensions of that portion of tube 17 in which the slots 22 are formed. The other opening in the valve tube indicated at 35 has a width preferably at least equal to the length of the slots 23 and extends nearly the full length of the valve tube, as clearly shown in Figure 2. When the valve tube is slid inwardly from the position shown in Figure 2 by an actuation of the adjusting rod 32, the ports 22 will be closed successively by the solid portion on the tube 26 to the right of the opening 34. The ports 23 however, will continuously remain open. Thus by the axial adjustment of the valve tube, the proportion of fuel gas admitted through the ports 22 to the air admitted through the ports 23 will be altered. By a rotation of the valve tube from the position shown in Fig. 1 in the direction of the arrow, the ports 22 and 23 will be closed to an equal degree but the proportion of fuel gas and air entering the valve chamber through the respective ports 22 and 23 will remain unchanged. The quantities of these gases entering the mixing chamber will, however, be diminished in accordance with the extent to which the valve tube is rotated. It is evident that both of these adjustments may be made simultaneously if desired.

The extension of rod 32 outside the valve casing has been calibrated in such a manner that it is possible to ascertain by merely glancing at the location of an indicator 37 what fuel gas ports 22 have been closed. For this purpose, marks *a* to *f* are cut or stenciled in rod 32 in such relation that when indicator 37 points to mark *a*, port *a* is closed and when it points to *b*, ports *a* and *b* are closed, and so on until when mark *f* is reached all of the ports are closed and no gas is being supplied. If desired, the cali-

brations on rod 32 may be made directly to indicate the adjustment of the valve tube for the type of fuel gas employed, such as "producer," "town," "natural" or "oil" gas. Thus by a simple longitudinal movement of rod 32, the operator may easily and quickly set the mixing device for supplying various kinds of gases requiring different amounts of air for the most efficient combustion of the mixture.

As above stated, when the pressure of the gaseous mixture in the supply mains is at a predetermined value, the pressure on the underside of the diaphragm, which is the same as the pressure in the supply main, and the downward force of the weight 72 balance each other. This weight, therefore, determines the normal pressure in the supply main and this normal pressure may be varied by the substitution of different weights.

It is desirable to maintain as nearly a uniform flow of the gaseous mixture to the burners as possible and it is therefore desirable to prevent violent fluctuations in the pressure of the gaseous mixture in the main by which the burners are supplied. This is best accomplished by automatically regulating the quantity of gas and air admitted into the mixing chamber in accordance with fluctuations in the supply line pressure.

For this purpose, preferably a branch pipe line 54 having a regulating valve 55, connects the supply main 53 with the lower portion of a chamber 46 formed by an annular projection 45 on housing 11. The pressure of the gaseous mixture in chamber 46 which is the same as that in the supply main, acts upon a diaphragm 47 stretched by means of set screws 51 across the top of chamber 46 between the annular projection 45 and a vaulted cover 48. Atmospheric pressure is maintained on the upper side of diaphragm 47 through vents 52 in cover 48. This diaphragm 47 is free to move up and down at its centre. Whenever the pressure in the chamber 46 rises sufficiently to overcome the atmospheric pressure and the weight of the parts supported by the diaphragm 47, said diaphragm is moved upwardly.

A disc 57 is rigidly fixed to the central part of the diaphragm 47 and carries a slide rod 61 arranged to slide in a suitable guideway 69 formed in a boss 49 projecting centrally from the vaulted cover 48. This slide rod 61 is arranged to actuate the plunger 62 of a valve 50 slidably mounted in a suitable housing formed by the boss 49. Upward movement of the rod 61 in the guideway 69 is limited by the engagement of the upper end of an enlargement 63 on the rod with the upper face of a recess 68 in the boss 49 in which said enlargement engages. The boss 49 is formed also with a recess 67 to receive the disc 57.

A central disc 56 is secured to the lower side of the diaphragm and to this disc is attached a short guide rod 58 engaging in a guideway 59, passing centrally through a projection 60 on the frame below the diaphragm. The downward movement of the diaphragm is limited by the engagement of the disc 56 with the upper end of the projection 60.

The valve 50 in the preferred construction is provided with a peripheral groove 64, which when the valve is in a certain position in its housing connects the passageways 73 and 74 formed in the boss 49. The passageway 73 communicates with a pipe line 75 leading from the air inlet 13. The passageway 74 is connected by a pipe line 76 with an air pressure cylinder 77, in which is slidably mounted a piston 78, the pipe line communicating with the cylinder at a point above the piston in all positions of the piston (see Figure 7). When the valve 50 is in position to establish communication between the passageways 73 and 74, air under pressure is led from the inlet 13 through said passageways and pipe line 76 into pressure cylinder 77. This cylinder is mounted at its base upon a bracket 87 having an upturned rim 94 and attached to the frame of the apparatus, and the cylinder is held in position on said bracket by means of a hinged clasp 91 surrounding the cylinder, and securely held thereon by bolt 93. The members of hinged clasp 91 are secured by bolts 92 to an arm 88 on a bracket 86 attached to the frame of the apparatus. Instead of taking for the above purpose air under pressure from the inlet 13, any suitable gaseous fluid under suitable pressure may be employed.

The piston 78 will move downwardly under the pressure of the air entering on its upper side and will carry with it link rod 79, which is hingedly connected to piston 78 at one end, and at the other end is pivotally connected to one arm of a two-armed lever 80 which is rigidly secured at its middle part by means of sleeve 81 and set screw 84 to rod 32 of valve tube 26. Valve tube 26 is thus rotated in a direction to close partially or to close to a further degree the air and gas ports 22 and 23. An adjustable weight 82 on the other arm of lever 80 may be secured thereto at any point by means of thumb-screw 83 for the purpose of balancing the weight of the piston 78 and rod 79 and also to serve as a counterweight for the pressure on piston 78 to steady its action. The cylinder 77 is formed at its lower end with a slot 95 and the bracket 87 is formed with a slot 96 in which the lever 80 and link bar 79 operate. As soon as the quantity of gases admitted through ports 22 and 23 is reduced as a result of their partial closing, the pressure existing in main 53 will be re-

duced, whereupon the pressure on the under side of diaphragm 47 is diminished. The latter then moves downward under the pressure of weight 72, carrying with it the
 5 plunger 62 of valve 50.

The valve 50 is also formed with a peripheral groove 65, somewhat wider than the groove 64 and so arranged that, when the valve is in a certain position in its housing, the groove connects the passageway 74
 10 with a passageway 85 in the boss 49, leading from the valve housing to the outside atmosphere. It will be noted from an inspection of Figures 1 and 6 that the passageway
 15 85 is in a plane somewhat higher than the passageways 73 and 74. The valve 50 is acted upon by the weight 72 mounted on an extension 70 on the valve plunger and engaging at its base a supporting disc 71 on
 20 the plunger, which weight tends to hold the valve in its lowermost position in the housing.

When the gaseous mixture in the supply main 53 is under a predetermined normal
 25 pressure, the gaseous pressure on the underside of the diaphragm 47 balances the force of the weight 72 and the valve 50 is maintained in a position in the valve housing to cut off communication between the passageways 73 and 74 and also to cut off communication between passageway 74 and passageway 85. The valve tube 26 under ordinary
 30 conditions when the normal predetermined pressure exists in the supply main will occupy a position about its axis of rotation to close partially both the ports 23 through which the air enters the mixing chamber and the ports 22 through which the fuel gas enters said chamber, in accordance with the
 35 amount of gas mixture consumed by the burners.

When the pressure in the supply main falls below this predetermined pressure, on account of the turning on or the turning up
 45 of one or more burners, or for any other reason, diaphragm 47 is depressed and the valve 50 is moved downwardly by the weight 72. The downward movement of the valve brings the groove 65 into position to connect the passageway 74 with the passageway 85,
 50 thereby allowing the cylinder 77 to exhaust gradually into the atmosphere and the piston 78 is slowly moved upwardly in the cylinder 77 by the action of the weight 82. Thus, the valve tube 26 is adjusted to open
 55 further the ports 22 and 23, allowing an increased supply of air and fuel gas to enter the mixing chamber. This will increase the pressure of the gaseous mixture in the supply main and the diaphragm will rise, carrying the valve 50 upwardly until, when substantially the normal pressure is reached in the supply main, groove 65 is carried out of registration with passageway 74, thereby
 60 cutting off communication between passage-

way 74 and passageway 85. When the pressure of the gas in the supply main is increased above the normal predetermined pressure on account of the turning out or the turning down of one or more burners,
 70 the diaphragm 47 is raised and the valve 50 is moved upwardly against the force of weight 72, thereby bringing groove 64 into registration with passageways 74 and 73. When this occurs, compressed air from the inlet 13 will enter the upward part of the cylinder 77, thereby moving the piston 78
 75 downwardly in the cylinder. This downward movement of the piston will actuate the valve tube 26 to close further the ports 22 and 23, thereby diminishing the supply of air and fuel gas entering the mixing chamber. This will diminish the pressure of the gaseous mixture in the supply main and the diaphragm 47 will fall and the valve 50
 80 will move downwardly under the force of the weight 72 until, when substantially the normal pressure is reached in the supply main, groove 64 is carried out of registration with passageways 73 and 74 and communication between these passageways is cut off by the valve.

Thus the valve tube 26 is automatically adjusted in accordance with the pressure in supply main 53 to supply just the amount of gas and air required for the burners. The grooves 64 and 65 are preferably made substantially in the form in the drawings; that is, the groove 64 is made somewhat shorter than the groove 65 and tapers toward its upper end, while groove 65 tapers toward its lower end. In actual practice it has been found that these forms of grooves are most efficient in the operation of the valve mechanism.

The present construction enables a change to be made from one kind of fuel gas to another quickly and easily during the operation of the system. If, during the operation of the present apparatus, a supply of one kind of fuel gas is exhausted and it is desired to substitute another kind of fuel gas available for use, which requires a different proportion of air for its complete and efficient combustion, it is only necessary to
 115 loosen the screw 84 and then to slide the rod 32 either inwardly or outwardly to the proper setting for the gas to be used, as indicated by pointer 37. Screw 84 may then be tightened in the desired position and the substituted gas admitted through the same inlet as the former gas.

Producer gas requires for its complete combustion about an equal volume of air. For other gases ordinarily employed in gas firing systems, such as town gas, natural gas or oil gas, five or six volumes of air are ordinarily required for one volume of fuel gas to produce complete and efficient combustion. The proportioning and mixing valve dis-

closed in Figures 1 to 8, inclusive, and Figure 11 is intended particularly for use with producer gas in a system in which, when the producer gas is exhausted, a change is made to town gas, natural gas or oil gas. In the construction shown in these figures, the proportion of fuel gas to air in the mixture is produced by varying only the quantity of fuel gas. Whenever the types of fuel gas available for use in a gas firing system are such that the variations in their air requirements is small as, for instance, town gas, natural gas and oil gas, it may be advisable to vary the proportions of air and fuel gas in the mixture for the particular fuel gas used by varying the quantity of air admitted, while keeping the amount of gas a substantially constant factor of the proportion. Figures 9 and 10 on the drawings disclose a construction especially adapted for the use interchangeably with town gas, natural gas or oil gas. In the construction shown in these figures, the gas inlet 97 is made considerably smaller and with a correspondingly smaller forechamber 98 than in the construction shown in Figures 1 to 8 inclusive and Figure 11. The proportioning tube 17 contains only one port 99 for the admission of gas, while the ports for the admission of air are divided into groups of different sizes. One group of ports 101 are wider than any of the other ports and are never closed by longitudinal movement of the valve tube 26. These wide ports 101 are of a size to admit the smallest relative quantity of air required for the complete and efficient combustion of the quantity of fuel gas entering the mixing chamber through the port 99 by any of the fuel gases employed. The proportioning tube 17 is also formed with a second set or group of ports 102, preferably greater in number than the ports 101 and smaller in size. In the construction shown, the ports 102 are of substantially the same length as the ports 101 but are considerably narrower than the latter ports.

The valve tube 26 in the construction shown in Figures 9 and 10 is mounted within the proportioning tube in substantially the same manner as in the construction shown in Figures 1 to 8 inclusive and Figure 11 and has a similar construction. This valve tube, however, is provided with an elongated opening 103 through which the fuel gas passing through slot 99 enters the mixing chamber. The opening 103 is of such a length that the port 99 is not closed by the valve tube during the movement of said tube longitudinally between its limiting positions. The valve tube 26 is also provided with an opening 104 through which the air passing through the ports 101 and 102 enters the mixing chamber. This opening is so arranged and is of such a size that the ports

102 will be closed successively by the longitudinal movement of the valve tube 26 toward the left from the position in which it is shown in Figure 10 but that the ports 101 remain open at all times.

When the air ports are all open, the greatest relative quantity of air required in the proportion for any one of the types of fuel gas used, is admitted through these ports. By adjusting the valve tube, it is possible to close any number of the ports 102 to vary the quantity of air admitted relatively to the quantity of gas during the operation of the device. On account of the relatively large number and narrowness of the ports 102, a relatively fine adjustment of the relative quantity of air may be secured.

As the above described construction of my new gas mixer shows, its working parts and especially also those contained within the mixer housing can be easily and efficiently lubricated and taken apart for cleaning purposes, which constitutes a great advantage.

It is to be understood that the invention is not limited to the particular construction and arrangement of parts of the illustrated embodiment of the invention, but that the invention may be embodied in other forms within the scope of the claims.

What I claim as new is:

1. A gas mixing apparatus, comprising in combination a gas receiving chamber, means for supplying two or more gases in predetermined proportions to the chamber, a valve for adjusting the quality of at least one of said gases admitted to the chamber, and means for adjusting the valve in accordance with the pressure of the gaseous mixture, comprising a cylinder, a piston mounted in the cylinder, a connection between the piston and valve for adjusting the valve, a pipe leading into the said cylinder, fluid under pressure for operating the piston therein, and a valve adapted to control the flow of the fluid under pressure into and out of the said cylinder and actuated by the pressure of the produced gaseous mixture.

2. A gas mixing apparatus comprising in combination a gas mixing chamber, means for supplying two or more gases in predetermined proportions to the chamber, said chamber having a cylindrical interior wall, ports in said wall, a cylindrical tubular valve mounted within the cylindrical wall of said chamber for axial and rotative movement to adjust the area of said ports, means for automatically adjusting the valve rotatively in accordance with the pressure of the gaseous mixture, comprising a cylinder, a piston mounted in the cylinder, a connection between the piston and the valve for adjusting the valve, a pipe leading into the said cylinder fluid under pressure for operating the piston therein, and a valve adapted to control the flow of the fluid under

pressure into and out of the said cylinder and actuated by the pressure of the produced gaseous mixture, and means for axially adjusting the valve.

5 3. In a gas firing system; a gas mixing apparatus comprising a mixing chamber provided with separate ports through which the respective gases to be mixed may be
10 passed into said chamber, and a single cylindrical valve member movable longitudinally of said chamber independently of rotation to vary the effective area of one of said
15 ports and thereby to vary the proportions of the gases admitted to said chamber and rotatable independently of its longitudinal movement to vary the effective area of the openings for each of said gases admitted to said chamber while maintaining the proportions thereof constant.

20 4. In a gas firing system a gas-mixing apparatus comprising gas-mixing chamber having a cylindrical wall, separate ports located circumferentially around said cylindrical wall for the entrance of the gases to
25 be mixed, a cylindrical tube mounted in said chamber for axial and rotative movement, said tube being provided with apertures, one of which is of substantially the same size as one of said ports and another of which
30 is of substantially the same circumferential width as another of said ports but exceeding that port in length, and means for moving said cylindrical tube parallel to its axis independent of its rotation so as to vary the
35 effective area of one of said ports without varying the effective area of the other of said ports, and means for rotating said cylindrical tube about its axis independent of its longitudinal movement so as to vary the
40 effective area of each of said ports proportionately.

5 5. In a gas firing system a gas-mixing apparatus comprising a gas-mixing chamber having a cylindrical wall provided with
45 circumferential slots arranged in longitudinal rows along said cylindrical wall for admitting gases to said chamber, a cylindrical tube mounted in said chamber for axial and rotative movement, said tube being provided with apertures, one of which is of
50 substantially the same size as the slotted area through which one of said gases is admitted to such chamber and another of said apertures being of a size such that two sides thereof substantially correspond with and
55 are of substantially equal length with two sides of the slotted area for admitting another of said gases and the other two sides thereof substantially correspond with the other two sides of the slotted area except
60 that they are greater in length than those of said slotted area, means for moving said cylindrical tube in a direction along said longer sides so as to vary the width of a
65 slot or the number of slots through which

gas is admitted to said chamber from one of said slotted areas, and means responsive to consumption of the mixture of gases for automatically moving said tube in a direction along the equal sides so as to vary the quantity of the gases admitted to said chamber through said slots without substantially changing the proportion of their effective openings.

6. In a gas firing system a gas mixing device comprising a chamber provided with inlet ports through which respectively the gases to be mixed are admitted to said chamber and a single valve member for controlling the passage of one or more of the gases into said chamber, said member being movable in one direction to vary the effective area of one or more of said ports while maintaining the effective area of one or more of the remaining ports constant so as to vary the proportions of the gases admitted to said chamber and being independently movable in another direction to vary the effective area of each of said ports proportionately so as to vary the quantity of gases admitted to said chamber while maintaining the proportions thereof constant.

Signed at Saginaw, Michigan, this 20th day of October, 1926.

EUGENE OSCAR ENGELS.