

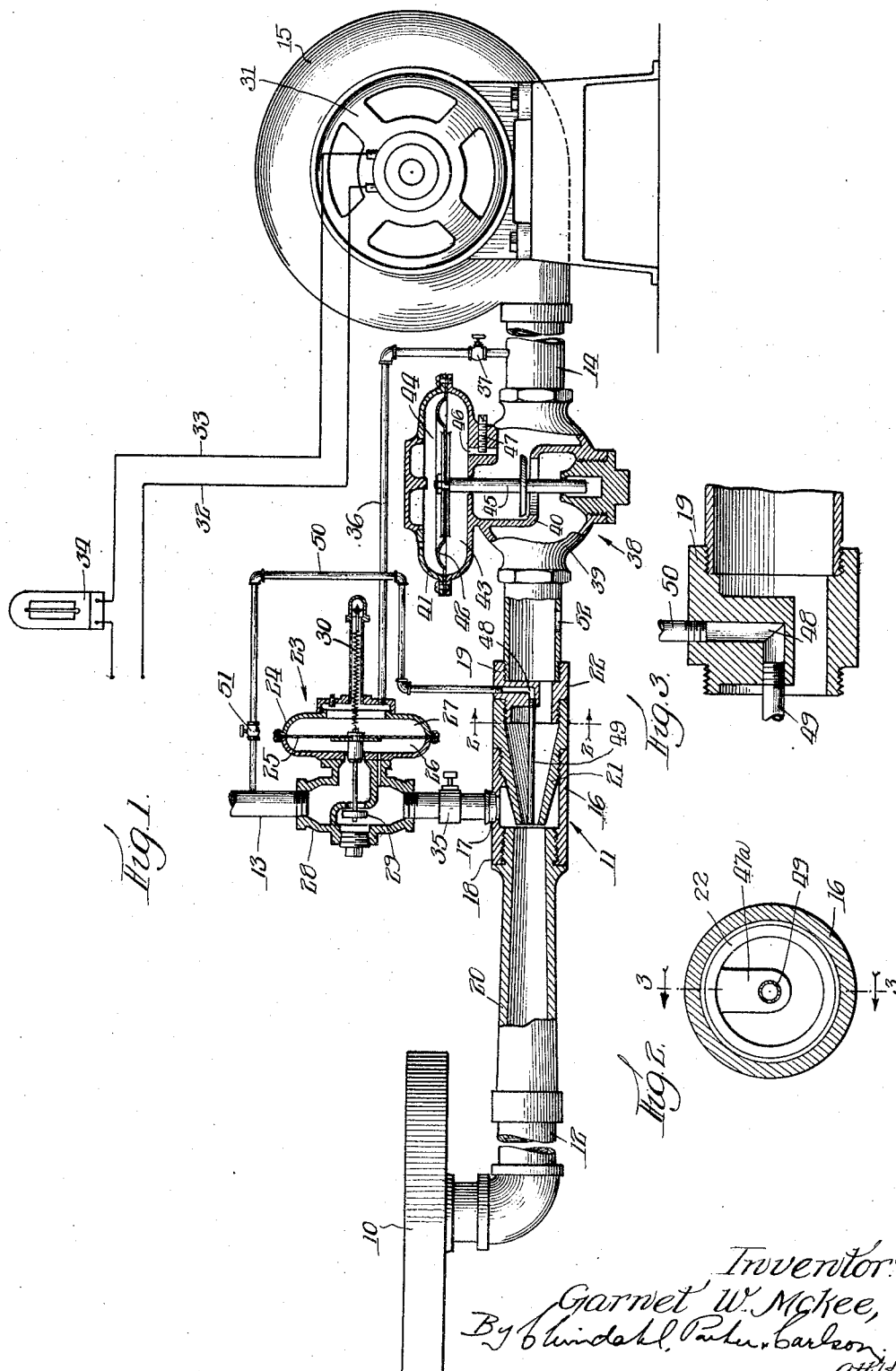
Dec. 27, 1932.

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1,892,115

COMBUSTION SYSTEM

Filed Aug. 24, 1929



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UNITED STATES PATENT OFFICE

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COMBUSTION SYSTEM

Application filed August 24, 1929. Serial No. 388,117.

The present invention relates to improvements in gas combustion systems, and has particular reference to combustion systems which are adapted to operate under varying loads.

Heretofore, considerable difficulty has been encountered in adjusting the supply of fuel mixture to the burner over a substantial range. This has been true in particular in systems which are intended to be adjustable from a full capacity during operative periods to a small minimum capacity during inoperative periods. In so varying the supply of fuel mixture, back-firing tends to occur.

A general object of the present invention therefore resides in the provision of a novel combustion system in which the supply of fuel mixture can be turned down over a wide range and to a very small minimum without resulting in back-firing.

Another object resides in the provision of a new and improved combustion system which is adapted to be operated at a substantial capacity and to be turned down to a minimum capacity, and which under the first condition will mix gas with air under pressure, and under the second condition will mix gas with atmospheric air to provide the desired fuel mixture.

Still another object is to provide a combustion system of the foregoing character which is simple and inexpensive in construction, and which comprises simple automatic means for changing from air under pressure to atmospheric air and vice versa as the full load is respectively cut out and in.

A further object resides in the provision in the foregoing system of novel means for automatically slowing down the initial inrush of air under pressure when the system is turned up to operate under full load, so that gas will reach the burner first and before the proportion of gas and air is stabilized, thereby preventing back-firing.

Other objects and advantages will become apparent as the description proceeds.

In the accompanying drawing, Fig. 1 is a fragmentary view partially in section of a combustion system embodying the features of my invention.

Fig. 2 is a fragmentary sectional view on an enlarged scale taken along line 2-2 of Fig. 1.

Fig. 3 is a sectional view taken along line 3-3 of Fig. 2.

While the invention is susceptible of various modifications and alternative constructions I have shown in the drawing and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawing, the system constituting the exemplary embodiment of the invention comprises generally a burner 10 of suitable construction, a fuel mixing device 11 for supplying fuel to the burner through a connecting pipe 12, a gas line or main 13 opening to the mixing device and adapted to be connected to any suitable source of gas (not shown), and an air line or main 14 opening to the mixing device and adapted to be connected to any suitable source of air under pressure, such as a blower 15.

The mixing device may be of any suitable form, and in the present instance comprises a hollow cylindrical casing 16 having a screw threaded gas inlet fitting 17 intermediate its ends, and screw threaded fittings 18 and 19 at opposite ends. A Venturi tube 20 is secured in the fitting 18 and is connected at its large end to the pipe 12 leading to the burner. The gas line 13 is connected to the fitting 17. Secured in the fitting 19 is a suitable air inlet nozzle 21 which extends substantially across the gas inlet and terminates in front of the inlet throat of the Venturi tube 20, and which is connected through an intermediate fitting or coupling 22 with the air line 14.

Interposed in the gas line 13 is a suitable zero governor 23. In the present instance, the governor is of well known construction, comprising a casing 24, a pressure responsive member such as a diaphragm 25 in said casing and defining therein two chambers 26 and

27, a valve fitting 28 in the line 13 and vented at its discharge end to the chamber 26, a valve member 29 in the fitting 28 and operatively connected to the diaphragm 25, and a tension spring 30 connected to the diaphragm and tending to flex the latter into the chamber 27 to close the valve.

The blower 15 may be driven by any suitable means, such as a motor 31 connected to current supply means 32 and 33. Interposed in the main 33 is a thermostatic switch 34 for making and breaking the circuit for the motor 31.

It will be evident that when the blower 15 is in operation, air under pressure will be discharged from the nozzle 21 into the throat of the Venturi tube 20, and will induce a proportionate flow of gas from the line 13. To provide means for adjusting the air-gas ratio, a suitable valve 35 is interposed in the line 13 between the mixing device 11 and the zero governor 23.

Means is provided for automatically cutting off the supply of gas through the governor 23 when the blower 15 is inoperative, and for automatically supplying gas when the blower is put into operation. To this end, the spring 30 is given a slight tension sufficient to close the valve 29 when no air under pressure is being discharged from the nozzle 21. A restricted pipe line 36 having an adjustable bleed valve 37 is provided to connect the spring chamber 27 to the air line 14 at the outlet of the blower 15. It will be evident that when the blower 15 is put into operation to supply air under pressure for blast operation of the system, pressure will be transmitted through the line 36 and the chamber 27 to the top of the diaphragm 25 to open the governor valve 29.

Suitable means is provided for slowing up the initial flow of air under pressure so as to permit the gas to reach the mixing device 11 at the same time as or a little ahead of the air so that there will be no possibility of back-firing. Preferably this means comprises a regulator 38 interposed in the air line 14 between the mixing device 11 and the line 36. In the present instance, the regulator 38 comprises a valve casing 39 defining a valve seat 40, a diaphragm casing 41 rigid with the casing 39, a diaphragm 42 in the casing 41 and defining two chambers 43 and 44 therein, and a valve member 45 for the seat 40 and operatively connected to the diaphragm. The chamber 43 communicates through a bleed passage 46 with the inlet end of the valve casing 39. The chamber 44 is vented to the atmosphere. The weight of the diaphragm 42 and connected parts tends to hold the valve 45 in closed position. However, when the blower is put into operation, air pressure is transmitted through the passage 46 against the lower side of the diaphragm to gradually open the valve 45. The speed at which the

valve 45 opens may be varied by adjusting a screw 47 threaded into the passage 46.

Suitable means is provided for supplying a small amount of fuel mixture to the burner when the blast is inoperative, representing the minimum turn-down condition. To this end, the fitting 22 is formed with a central internal lug 47^a having a passage 48 opening from the outer periphery of the fitting to the end face of the lug adjacent the nozzle 21. A small gas jet tube 49 is secured in the inner end of the passage 48, and extends axially through the nozzle 21 substantially to the end of the latter. A restricted pipe line 50 is secured in the outer end of the passage 48, and serves to connect the latter with the gas line 13 at a point in front of the governor 23. Interposed in the line 50 is a suitable adjusting valve 51. Thus, a small amount of gas is by-passed at all times around the governor valve 29. The air line 14 is formed with an air inlet aperture 52 at a point between the fitting 22 and the regulator 38 through which a flow of air from the atmosphere is induced by the jet of gas from the tube 49.

It will be evident that I have provided a highly advantageous combination blast and atmospheric gas combustion system which can operate at full capacity or a wide range of turn down without back-firing. When the blower 15 is rendered inoperative, the valves 29 and 45 will be closed automatically, and the system will operate at atmospheric conditions. A small stream of fuel mixture will be supplied to the burner. When the blower 15 is put into operation, pressure will be transmitted to the governor 23 to open the valve 29 thereby supplying gas to the mixer 11. The flow of air under pressure to the mixer however is retarded by the regulator 38 which opens the valve 45 gradually. Hence, at the start of the blast, a relatively rich fuel mixture will first be supplied to the burner 10, and after the valve 45 is open, the normal air-gas ratio will be maintained. The initial inrush of air is thereby prevented from causing back-firing regardless of the wide change in the amount of fuel mixture supplied under the two general conditions.

I claim as my invention:

1. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a line for supplying gas to said device, a line for supplying air to said device, a regulator interposed in said air line and comprising a valve and means tending to close said valve, said means being responsive to the pressure in said air line at the inlet side of said valve to effect a gradual opening of said valve when air under pressure is admitted to said air line.

2. A combustion system comprising, in combination with a burner, a mixing device

for supplying a fuel mixture to said burner, a line for supplying gas to said device, a line for supplying air under pressure to said device, means for turning on and off the supply of air to said air line, and a regulator interposed in said air line, said regulator comprising a valve, a pressure responsive member operatively connected to said valve and normally tending to close the latter, a restricted bleed passage for transmitting the pressure in said air line at the inlet side of said valve to said pressure responsive device to gradually open said valve when the supply of air to said air line is turned on, and means for adjusting the effective transverse area of said passage.

3. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a line for supplying gas to said device, a line for supplying air to said device, and a regulator interposed in said air line and comprising a valve and yieldable means tending to close said valve, said regulator having a bleed vent exposing said means to the pressure at the inlet side of said valve, whereby the admission of air to said air line will initially effect a gradual opening of said valve and will then maintain said valve in open position.

4. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a line for supplying gas to said device, a line for supplying air under pressure to said device, a means for turning on and off the supply of air under pressure to said air line, and a regulator interposed in said air line, said regulator comprising a valve having a full closed position and an open position, a pressure responsive member operatively connected to said valve for holding said valve in its closed position when the supply of air is turned off, and a bleed passage for transmitting the pressure in said air line at the inlet side of said valve to said pressure responsive device for causing the latter to open said valve gradually when the supply of air is turned on.

5. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a line for supplying gas to said device, a line for supplying air under pressure to said device, means for turning on and off the supply of air to said air line, and means in said air line responsive to the pressure of the air in said line for automatically retarding with a gradually diminishing effect the initial flow of air through said air line to said device.

6. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a gas line for supplying gas to said device, a

governor interposed in said gas line and comprising pressure responsive means normally tending to close said gas line, an air line for supplying air under pressure to said device, means interposed in said air line, said means tending to close said air line when no air is supplied to said air line and being automatically operable with a gradually diminishing effect to retard the initial inflow of air to said device when air under pressure is supplied to said air line, and a line connecting said governor and said air line at a point in front of said last mentioned means for transmitting the pressure in said air line to said pressure responsive means to open said gas line when air under pressure is supplied to said air line.

7. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a gas line for supplying gas to said device, a governor interposed in said gas line and comprising pressure responsive means normally tending to close said gas line, an air line for supplying air under pressure to said device, means interposed in said air line, said means tending to close said air line and being automatically operable with a diminishing effect to retard the initial flow of air to said device when air under pressure is supplied to said air line, and means for transmitting the pressure in said air line at a point in front of said last mentioned means to said pressure responsive means to effect opening of said gas line when air under pressure is supplied to said air line.

8. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a gas line for supplying gas to said device, an air line for supplying air under pressure to said device, means for opening and closing said air line, means for admitting a limited amount of air from the atmosphere to said device when said air line is closed, means for opening and closing said gas line, and by-pass means for supplying a limited amount of gas from a point in said gas line in front of said last mentioned means to said device.

9. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, said device having an air injector nozzle and a gas induction inlet, a gas line for supplying gas to said inlet, an air line for supplying air under pressure to said nozzle, means for cutting off and on the supply of air under pressure to said air line, a restricted aperture in said air line opening to the atmosphere, governor means for opening and closing said gas line, and a by-pass line leading from said gas line at a point in front of said governor means to said nozzle for supplying a small stream of gas to said device when said gas line is closed at said governor means.

10. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a gas line opening to said mixing device, a governor interposed in said gas line for opening and closing the latter, said governor comprising a pressure responsive member normally tending to close said gas line, an adjusting valve interposed in said gas line between said governor and said device, a bypass line from said gas line around said governor for supplying a small jet of gas to said device at all times, an air line for supplying air under pressure to said device, means for supplying air under pressure to said air line, a regulator interposed in said air line, said regulator comprising a valve and a pressure responsive member normally tending to close said valve and responsive to the pressure at the inlet side of said valve to open said valve with a gradual effect when air is supplied to said air line, a line connecting said governor and said air line at a point in front of said regulator for actuating said first mentioned member to open said gas line when air is supplied to said air line, and means for supplying atmospheric air to said device at all times.

11. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to said burner, a gas line opening to said mixing device, a gas valve interposed in said gas line for opening and closing the latter, pressure responsive means normally tending to close said valve, means for supplying a small jet of gas to said device at all times, an air line for supplying air under pressure to said device, an air valve for opening and closing said air line, pressure responsive means normally tending to close said last mentioned valve, means for supplying low pressure air to said device at all times, and means for transmitting the inlet pressure in said air line to both pressure responsive means to open said gas and air valves in sequence in the order named when air under pressure is admitted to said air line.

12. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to the burner, a gas line for supplying gas to said device, a control valve in said gas line, an air line for supplying air under pressure to said device, a control valve in said air line, means for supplying air to said air line, and means responsive to the pressure in said air line for automatically opening said valves in sequence in the order named when said first mentioned means is rendered operative and for closing said valves when said first mentioned means is inoperative.

13. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to the burner, a gas line for supplying gas to said device,

a control valve in said gas line, an air line for supplying air under pressure to said device, a control valve in said air line, means for supplying air to said air line, means responsive to the pressure in said air line for automatically opening said valves in sequence in the order named when said first mentioned means is rendered operative and for closing said valves when said first mentioned means is inoperative, and supplemental means for supplying secondary gas and air to said device when said valves are closed.

14. A combustion system comprising, in combination with a burner, a mixing device for supplying a fuel mixture to the burner, a gas line for supplying gas to said device, a control valve in said gas line, an air line for supplying air under pressure to said device, a control valve in said air line, means for supplying air to said air line, and means responsive to the pressure in said air line for automatically opening said valves in sequence in the order named when said first mentioned means is rendered operative and for closing said valves when said first mentioned means is in operative, said last mentioned means being adjustable to vary the time element separating the opening of said valves.

In testimony whereof, I have hereunto affixed my signature.

GARNET W. McKEE.