July 9, 1929. R. S. McNEIL 1,719,898

METHOD OF AND APPARATUS FOR PRODUCING A FUEL MIXTURE OF PREDETERMINED CALORIFIC VALUE

Filed Oct. 6, 1925

Fig. 1.

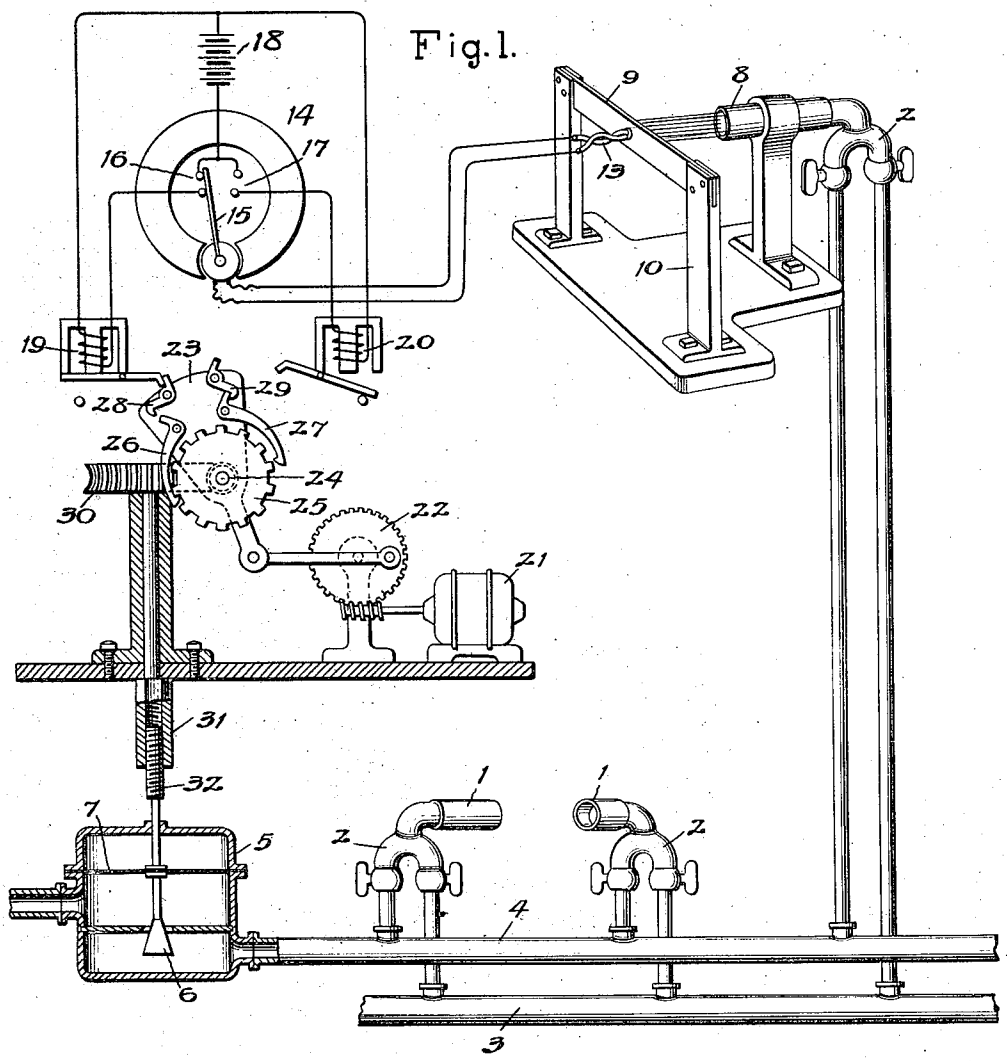


Fig. 2.

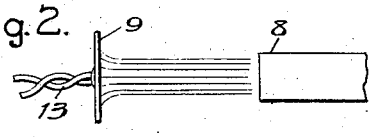


Fig. 3.

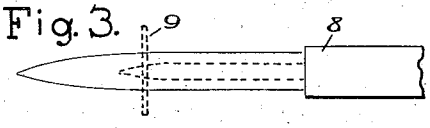
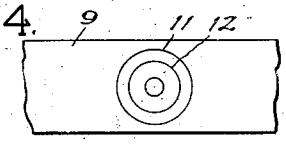


Fig. 4.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR PRODUCING A FUEL MIXTURE OF PREDETERMINED CALORIFIC VALUE.

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My invention relates to automatically maintaining the calorific or heat producing value of the fuel mixture for a gas burner substantially constant without adjusting or varying the gas and air inlets of the burner to compensate for variations in the density and heating quality of the gas.

In many manufacturing operations gas and air are mixed in a gas and air mixing chamber under pressure to produce a fuel mixture for a burner which produces a conical blue flame like a Bunsen burner. In incandescent lamp making, for example, where automatic machinery is used the temperature of the flame of these burners should be kept as nearly constant as possible. In many cases the illuminating gas commonly used as the gas for the fuel mixture for these burners is a mixture of coal gas and water gas. Although the ratio of the coal gas to the water gas may vary considerably during the day with variations in conditions at the gas plant, the gas mixture or illuminating gas delivered by the gas plant is usually proportioned to produce a gas of substantially uniform calorific or heating value. However coal gas is lighter than water gas, hence as the ratio of one gas to the other changes the density of the illuminating gas changes. Since a light gas flows through an orifice more easily than a heavy gas, a gas and air mixer adjusted to give a fuel mixture of a predetermined calorific value with coal gas will not give a mixture of the same calorific value with water gas even though the calorific or heat producing value and the pressure of the water gas and of the coal gas are the same. In order to maintain the heat constant the burners on the machines were heretofore adjusted from time to time by hand when the composition of the illuminating gas varied enough to produce noticeable variations in the heat of the flames.

The object of my invention is to provide a method of automatically maintaining the calorific or heat producing value of the fuel mixture for the flame substantially constant without adjusting the burners and regardless of variations in density of the gas. A further object is to provide simple and reliable apparatus for automatically controlling or regulating the composition of the fuel mixture supplied to the burner to maintain the desired uniformity of calorific value and hence of the temperature of the flames.

In accordance with my invention a conical test flame like that of a Bunsen burner, and fed from the same gas and compressed air mains as the working flame, is directed against a thin ribbon of metal such as nichrome positioned between the hottest part of the flame and the burner, so as to produce on the ribbon a red hot ring with a dark center spot. The size of this dark center spot and its temperature varies with the size and heat of the test flame. Any change in density or in composition of the gas which alters the calorific valve of the fuel mixture and therefor makes the flame longer or shorter correspondingly changes the size of this dark spot on the metal ribbon. For example, as the flame lengthens the dark spot increases in size and the temperature of its center falls. A thermo-couple is placed in contact with the metal ribbon on the opposite side from the burner and at the center of the dark spot to respond to these changes in temperature due to variations in the temperature of the test flame, and controls through suitable automatic mechanism the composition of the fuel mixture supplied to the working flame in such a way that the calorific value of the mixture and hence the temperature of that flame remains constant. For example, by varying the pressure at which the gas is supplied to the gas and air mixing chambers of the burner variations in the heating value of the fuel mixture and in the temperature of the flame can be obtained without touching or adjusting the burner.

A variation in temperature which affects the thermo-couple causes a variation in the electromotive force generated by the thermo-couple, thereby actuating a voltage responsive device, such as a contact making volt meter, which in turn through suitable apparatus controls a pressure reducing valve in the gas mains and thereby varies the pressure of the gas supplied to the mixing chamber for the working burner. In this manner the gas regulator or heat control mechanism is moved automatically in response to any variation in the temperature of the test flame, and quickly varies the gas pressure to bring the calorific value of the fuel mixture for the flame back to normal.

My invention will best be understood in

connection with the accompanying drawing, illustrating diagrammatically one of the many forms of apparatus which may be used to practice my invention, and in which Fig. 1 is a diagram of the gas and air connections to the working burner, with a control mechanism constructed in accordance with my invention; Fig. 2 is a view partly in section showing the relation of the metal ribbon and thermo-couple to the test burner, Fig. 3 is a side view showing the relation of the metal ribbon to the flame produced by the test burner, and Fig. 4 a plan view of the ribbon showing the relative size and location of the thermo-couple, the dark spot on the ribbon and the annular zone of higher temperature produced by the test flame.

In the particular arrangement shown in Fig. 1, working burners 1 are supplied with a combustible fuel mixture obtained by combining in mixing chambers 2 air from a compressed air main 3 with gas from a gas main 4. These working burners are of a type generally used and produce a blue conical flame similar to that obtained from a Bunsen burner. The gas main 4 is fed with gas through a regulator or reducing valve 5 consisting of a control valve 6, which is moved by a pressure responsive diaphragm 7 to prevent very wide variations in pressure in the gas main 4.

A continuous indication of temperature of the flames produced by the gas being used in the working burners is obtained by means of a test burner 8 supplied from the air and gas mains 3 and 4 and mounted to direct its blue conical flame against a refractory target, such as a thin metal ribbon 9, of nichrome or similar heat resisting alloy, carried in a yoke 10.

The ribbon 9 is positioned, as shown in Figs. 2 and 3, so that the tip of the inner blue cone of the Bunsen flame from the burner touches the ribbon. The hot spot on the ribbon is in the form, as best shown in Fig. 4, of a red hot ring 11 with a dark center spot 12 at a temperature of about 320°. As the density of the gas and its calorific or heat producing qualities vary the flame from the test burner 8 lengthens and shortens, causing the dark spot 12 to vary in size and in temperature. A thermo-couple 13 secured to the ribbon opposite the test burner at the center of the dark spot on the ribbon responds to variations in the temperature of the dark spot by corresponding variations in the electromotive force produced by the couple. A suitable couple for this purpose consists of iron and constantan, which is an alloy consisting of about 40% nickel and 60% copper.

The variations in temperature of the spot 12 on the test ribbon 9 automatically varies the pressure of the gas in the gas main 4 to the extent necessary to maintain the calorific value of the fuel mixture for the test and working flames substantially constant without adjustment of the burners. Since light gas flows through an orifice easier than heavy gas, a mixing chamber correctly adjusted for coal gas will not produce a fuel mixture which gives heat enough with water gas at the same pressure. More gas is needed and raising the pressure accomplishes the desired result.

A convenient form of gas pressure control apparatus is illustrated diagrammatically in Fig. 1, in which the thermo-couple 13 is connected to a voltage responsive device, such as a contact making volt-meter 14, having a movable arm 15 cooperating with two sets of contacts 16 and 17 connected to a battery or similar source of current 18 to energize solenoids 19 and 20. A sensitive volt-meter such as that shown in U. S. Patent No. 1,033,816, July 30, 1912, may be used as a relay responsive to minute voltage variations of the thermo-couple.

The control valve 6 of the gas regulator is positively moved by the thermo-couple and the volt meter 14 through some apparatus such as that illustrated diagrammatically in which a constantly running motor 21 drives a worm gear 22 and thereby oscillates a rocking arm 23 about the shaft 24 of a ratchet wheel 25. Pawls 26 and 27 mounted on the arm 23 are controlled by latches 28 and 29 which in turn are controlled by the armatures of the solenoids 19 and 20. In Fig. 1 the solenoid 19 is energized, and its armature is in position to engage and lift the latch 28 as the arm 23 reaches the limit of its counter-clockwise movement, thereby permitting the pawl 26 to drop into place between the teeth of the ratchet wheel 25. As the arm 23 moves clockwise the pawl turns the wheel 25 in a clockwise direction. As the arm reverses its direction of swing the pawl 26 rides upon a tooth of the wheel and is caught by the latch 28 which holds it inoperative until again released by the armature of solenoid 19. As long as solenoid 19 is energized the ratchet wheel 25 is turned clockwise step by step by pawl 26, and as long as solenoid 20 is energized the ratchet wheel is turned step by step in a counter-clockwise direction by pawl 27. When the arm 15 of the voltmeter does not touch either set of contacts 16 and 17, and neither solenoid is energized neither pawl is released, and the arm 23 swings back and forth without effect on the ratchet wheel, which remains stationary.

The shaft 24 controls the regulating valve 6 through any suitable mechanism, such as a worm wheel 30, which rotates a tubular nut 31 threaded on a bolt 32 connected to the valve 6. Rotation of the nut 31 in one direction or the other raises and lowers the bolt 32 and valve 6, whereby the pressure of the gas in the gas main 4 is varied.

In the operation of the device the flame of the test burner 8 is adjusted to produce on the ribbon 9 a red hot circle 11 with a dark cen-

ter spot 12 at a temperature of about 320° C. As the density of the gas varies the flame from the test burner lengthens and shortens and the temperature of the dark spot 12 varies. These variations are converted by the volt meter 14 and the valve actuating mechanism into movements of the regulator valve 6 of such a character and extent that the pressure of the gas in the gas main 4 is varied sufficiently to bring the calorific value of the fuel mixture back to normal and hence the temperature of the flames from the working burner 1 and from the test burner 8 back to normal without any change or adjustment of the burners. Elimination of manual adjustment of the burners is of very great advantage in a large factory where a larger number of working burners 1 are in use.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The method of producing a fuel mixture of gas and air of substantially constant and predetermined heat producing value from a gas variable in its heat producing properties which consists in maintaining a Bunsen test flame fed by said gas, producing on a target in said flame a circular hot spot with a center which varies in temperature with variations in said test flame, and automatically varying the pressure of the gas fed to said fuel mixture in response to variations in the temperature of the center of the hot spot produced by said test flame to counteract the temperature change produced by a variation in said gas.

2. The method of producing a fuel mixture of predetermined calorific value from air and a gas variable in its heat producing value which consists in maintaining a Bunsen test flame fed by said gas, producing with said flame on a target a ring of high temperature varying in size with the length of said test flame and automatically varying the pressure of the gas fed to said fuel mixture in response to said variations in temperature of said target within said ring of high temperature.

3. The method of mixing air with gas variable in density to produce a fuel supply of constant heating value which consists in maintaining a test flame fed from said fuel supply and having the form of a Bunsen flame, directing the test flame against a target so that the inner blue cone, of the Bunsen flame impinges upon it to produce a ring of high temperature with a cooler center spot, and varying the pressure of said gas in response to variations in temperature of said center spot on the target.

4. In a device of the character described, the combination with a source of fuel supply, of a test burner connected to said source of supply and constructed to produce a blue Bunsen flame having an inner blue cone, a metal target mounted in front of said burner to be inpinged upon by the inner blue cone of the Bunsen flame, a thermal responsive device secured to said target in alignment with the axis of the inner blue cone of the flame, and control mechanism responsive to said thermal responsive device for varying the pressure of the fuel in said source of supply.

5. In a device of the character described, the combination with a working burner and a gas main for supplying said burner, of a test burner supplied from said gas main and constructed to produce a blue Bunsen flame having an inner cone, a thin metal ribbon mounted in alignment with said burner to be transverse to said test flame and to be impinged upon by the inner cone of said flame, a thermo-couple mounted on said ribbon on the side opposite said test burner and in alignment with the inner blue cone of said test flame, and pressure control means responsive to said thermo-couple for varying the pressure of the gas in said gas main.

6. In a device of the character described, a combination of a test burner supplied from a gas main and constructed to produce a blue Bunsen flame with an inner cone, a metal sheet mounted in front of said burner to extend transversely of said flame and to have produced upon it a ring of high temperature having a center of lower temperature, a thermo-couple secured to said metal sheet on the side opposite said burner and inside said ring of high temperature, a voltage responsive device connected to said thermo-couple, pressure regulating means for varying the pressure of the gas in said gas main, and actuating mechanism controlled by said voltage responsive device for actuating said pressure regulating means in response to variation in the temperature of said thermo-couple.

7. In a device of the character described, a test burner connected to a gas main, a thin metal ribbon mounted in front of said burner to be transverse to and to be impinged upon by the flame from said burner, a thermo-couple secured to said ribbon on the side opposite said burner and in alignment with the flame from said burner, a pressure regulating valve for varying the pressure of the gas in said gas main, and valve actuating mechanism comprising a continuously moving motor driven member, a valve actuating member connected to said regulating valve, and means responsive to voltage variations of said thermo-couple for intermittently connecting said motor driven member and said valve actuating member to move said regulating valve in one direction or the other in response to voltage variations of said thermo-couple.

In witness whereof, I have hereunto set my hand this 30th day of September 1925.

RONALD S. McNEIL.