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METHOD AND APPARATUS FOR THE CONTROL OF COMBUSTION

Filed May 17, 1924

Fig. 1.

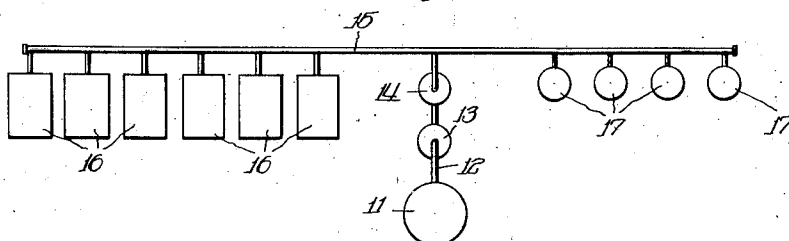


Fig. 2.

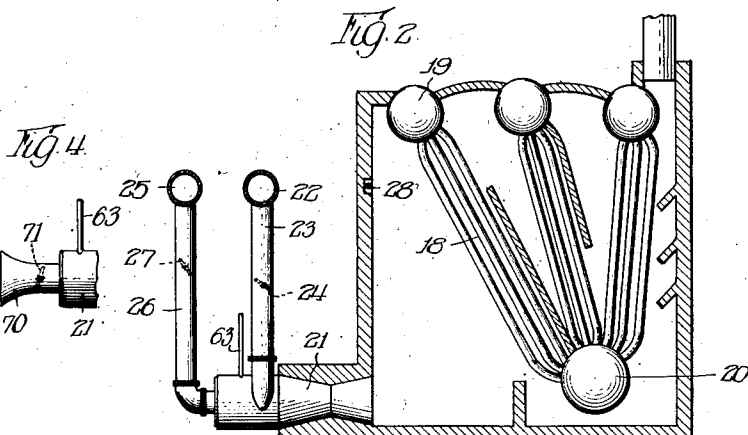


Fig. 4.

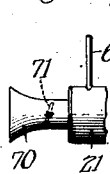
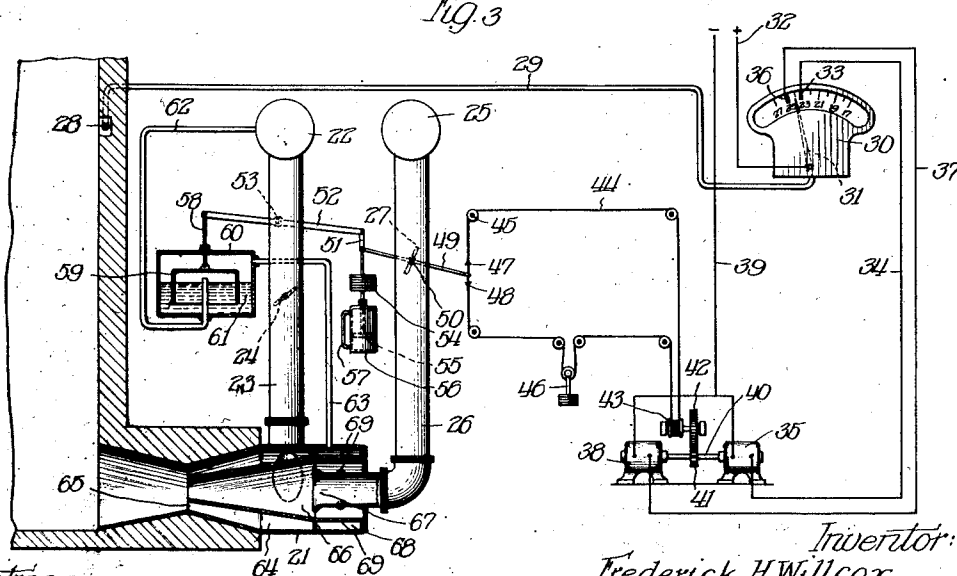


Fig. 3



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR THE CONTROL OF COMBUSTION.

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This invention relates to a new and improved method for the control of combustion and to an apparatus for carrying out said method.

5 Blast furnace, coke oven, producer and similar gases are largely used, for firing hot blast stoves, coke ovens, furnaces and boilers, particularly in metallurgical plants. A difficulty in securing complete combustion
10 of such gases, and consequent efficient operation lies in the facts that blast furnaces, coke ovens and producers in normal operation do not produce a continuously uniform quantity of gas, and that the heating or
15 power load is rarely constant, but is usually fluctuating. The amount of air supplied to cause complete combustion of the gas must therefore be varied to correspond to the amount of gas supplied.

20 It is an object of the present invention to provide a means and method for controlling the combustion in stoves, furnaces, ovens and boilers or the like.

It is a further object to provide a means
25 and method of this character controlled both by the content of the products of combustion and by the pressures of the air and gas supply.

Other and further objects will appear as
30 the description proceeds.

I have illustrated a preferred form of apparatus for carrying out my invention in the accompanying drawings, in which—

35 Figure 1 is a schematic layout of an installation adapted for the use of the present invention;

Figure 2 is a section through a typical boiler construction with which the present invention is adapted for use;

40 Figure 3 is a somewhat schematic drawing illustrating the application of the present invention to control the burner associated with the boiler; and

Figure 4 is a fragmentary view illustrating a modified form of air intake.

In Figure 1 a blast furnace is indicated
45 at 11, the furnace top being connected by downcomer 12 with the dust catcher 13. From the dust catcher 13 the blast furnace gas passes on to the washer 14 and thence
50 to the gas header 15. This header is connected to a plurality of boilers 16 and also to a battery of hot blast stoves 17.

As shown in Figure 2 the boiler is of the
55 water tube type having tubes 18, steam

drums 19 and water drum 20. The boiler is heated by means of the burner 21, this burner being supplied with the gas from header 22 by means of passage 23 controlled by valve 24. The burner is supplied with
60 air from header 25 by means of passage 26 controlled by valve 27, or from the atmosphere through the flared opening 70 controlled by valve 71.

The sampling tube 28, suitably located
65 in the boiler setting, leads to an indicator or gauge located to indicate the carbon dioxide content of the products of combustion at that point. The CO₂ indicator may be one of the several appliances now used and
70 in itself forms no part of the present invention. Referring now to Figure 3, the sampling tube 28 is shown connected by pipe 29 with the indicator 30. The indicator 30 is provided with the indicating pointer 31
75 which is connected by wire 32 with the positive side of an electrical circuit. The indicator 30 is provided with a contact 33 connected by wire 34 with one side of a motor 35. It is also provided with a contact 36
80 connected by wire 37 with one side of a second motor 38. Contacts 33 and 36 are adjustable and may be set to any desirable and practical content of CO₂ in the gases of combustion. The opposite side of both
85 motors are connected to the negative side of the electrical circuit by means of wire 39.

The two motors are faced in opposite directions and are connected to a common shaft 40 carrying a gear 41 meshing with a gear 42 adapted to drive a drum 43. The
90 endless cable 44 has a loop passing about this drum 43. The cable 44 is supported upon a plurality of pulleys and is provided with the weight 46 hung thereon to take up
95 any slack which may develop. Cable 44 is provided with a pair of spaced contacts 47 and 48, these contacts being adapted to engage the end of the lever arm 49. This arm 49 is fixedly connected to the pivot shaft 50
100 which carries the butterfly valve 27 which valve controls the flow through air passage 26.

The opposite end of the lever 49 is connected by link 51 to the rock lever 52 which
105 latter is pivotally supported at 53. Suspended from link 51 is the weight 54 and the piston 55. The piston 55 fits into the dash pot cylinder 56 which latter is provided with the restricted by-pass 57.

The opposite end of lever 52 is connected by link 58 with the bell 59 which latter is located in a closed chamber 60, the edges of the bell being below the level of the liquid 61 contained in the chamber. The passage 62 connects the gas space under the bell 59 with the gas header 22. The pipe 63 connects the upper portion of the chamber 60 with the burner nozzle 21.

10 This burner nozzle 21 comprises an outer chamber 64 into which the gas passage 23 discharges tangentially. The nozzle is provided with a Venturi throat 65 into which the chamber 64 discharges. The conical air
15 chamber 66 also discharges into the Venturi throat. The air passage 26 discharges into the rear of chamber 66 through the bell mouth section 67. The chamber 68 surrounds the rear portion of the chamber 66
20 and communicates therewith by openings 69. The passage 63 enters the chamber 68 of the burner, as clearly shown in Figure 3. It will be noted that the bell 59 is balanced between the air pressure within the chamber
25 68 of the burner nozzle 21 on the one hand and the gas pressure within the main 22 on the other hand. In the event of gas pressure change in main 22, a movement of bell 59, causing a change in position of damper
30 27, immediately changes pressure in chamber 68, tending to counteract the effect on bell 59 of the gas pressure in main 22, thereby acting as a stabilizing element in the control system.

35 In the operation of the burner to heat the boiler, gas from the blast furnace or producer and air are fed to the burner. The air is led from the header 25 through passage 26 and is introduced axially of the
40 burner through the flaring section 67 into the chamber 66. The flow of air through the passage 26 is controlled by the valve 27. The gas is led from the gas header 22 through passage 23 to enter the burner chamber 64 tangentially. The flow of gas is hand
45 controlled by the valve 24 located in passage 23.

The air and gas mingle in the Venturi throat 65 and burn under the first pass of the boiler. Combustion is substantially completed by the time the gases reach the point
50 where the sampling tube 28 to the carbon dioxide indicating apparatus is located. A sample of the products of combustion at this point consequently correctly represents the
55 percentage of carbon dioxide which is an indication of the completeness of combustion, as well as of excess or deficiency of air supply.

60 If the carbon dioxide content is high, it is an indication that the combustion is incomplete and consequently the burner is not operating efficiently. It is therefore necessary to open the air control valve and supply
65 additional air.

This air is automatically supplied by the

apparatus herein described. The pointer 31 of the indicator 30 moves in accordance with the carbon dioxide content of the gas. When the carbon dioxide content is too high the pointer 31 engages the contact 36, thus closing the circuit to operate motor 38. This motor then operates to wind the cable 44 to cause the contact 47 to engage the valve lever 49 and to move it to open the air valve 27 to permit the passage of more air. When the carbon dioxide content falls the contact is broken and the motor ceases operating.

If the carbon dioxide is low, indicating excess air, the pointer 31 engages contact 33 thus operating motor 35 and closing the air valve 27. Consequently the carbon dioxide content may be automatically maintained between desired close upper and lower limits.

The carbon dioxide indicator of this type is not instantaneous in its action and consequently the operation of the valve is somewhat retarded. It is, however, sufficiently rapid in operation to take care of the air supply when there are variations in gas supply or steam or heating load extending over the usually encountered periods.

I have, however, provided additional control means adapted to take care of relatively sudden fluctuations in gas flow and pressure due to fuel supply, or to heating, or to load conditions. The bell 59 is balanced between the air pressure in the upper portion of the chamber 60 and the gas pressure under the bell. The gas pressure is substantially that of the gas header, to which the connecting pipe 62 directly leads. The air pressure above the bell is the static air pressure in the outer nozzle chamber 68 and not the velocity pressure in the nozzle. A sudden increase in gas flow and consequently gas pressure will raise the bell against the air pressure and this raising of the bell will rock the lever 52 to swing the air control valve wider open. This movement continues until the air and gas pressures in the chamber and under the bell are stabilized. Similarly a drop in gas pressure will permit the bell to drop and the air will be partly closed down.

The balanced bell construction will operate more quickly than the valve operating means controlled by the carbon dioxide indicator and will approximately take care of sudden changes in gas pressures and flow. The bell means can vary the valve opening in an amount controlled by the spacing between the stops 47 and 48 on the cable 44 without affecting the positioning of the cable.

These two controls together control the air flow approximately in accordance with the gas pressure and also closely in accordance with the combustion as evidenced by the carbon dioxide content at the end of the first pass in the boiler.

While I have shown somewhat diagrammatically one form of installation adapted to carry out my method of control, I contemplate such changes in both method and apparatus as come within the scope of the appended claims. It is understood that while shown as applied to a steam boiler, I contemplate its application to other furnaces, such as hot blast stoves, coke ovens, heating furnaces, and open hearth furnaces where gaseous fuels are used as heating agencies or means, said fuels requiring an air supply, and forming gases of combustion containing carbon dioxide among other products of combustion.

I claim:

1. Apparatus for the control of gaseous combustion comprising a burner, gas and air passages leading to the burner, a valve

controlling the air passage, automatic valve control means responsive to unbalanced gas and air pressures, and additional automatic valve control means responsive to variations in the carbon dioxide content of the products of combustion from the burner.

2. The method of multiple combustion control which comprises controlling the flow of air for combustion by relatively quickly acting means responsive to the relative pressure between the air and fuel as supplied for the combustion and by relatively slowly acting means responsive to the carbon dioxide content of the products of combustion.

Signed at Chicago, Illinois, this 14th day of May, 1924.

FREDERICK H. WILLCOX.