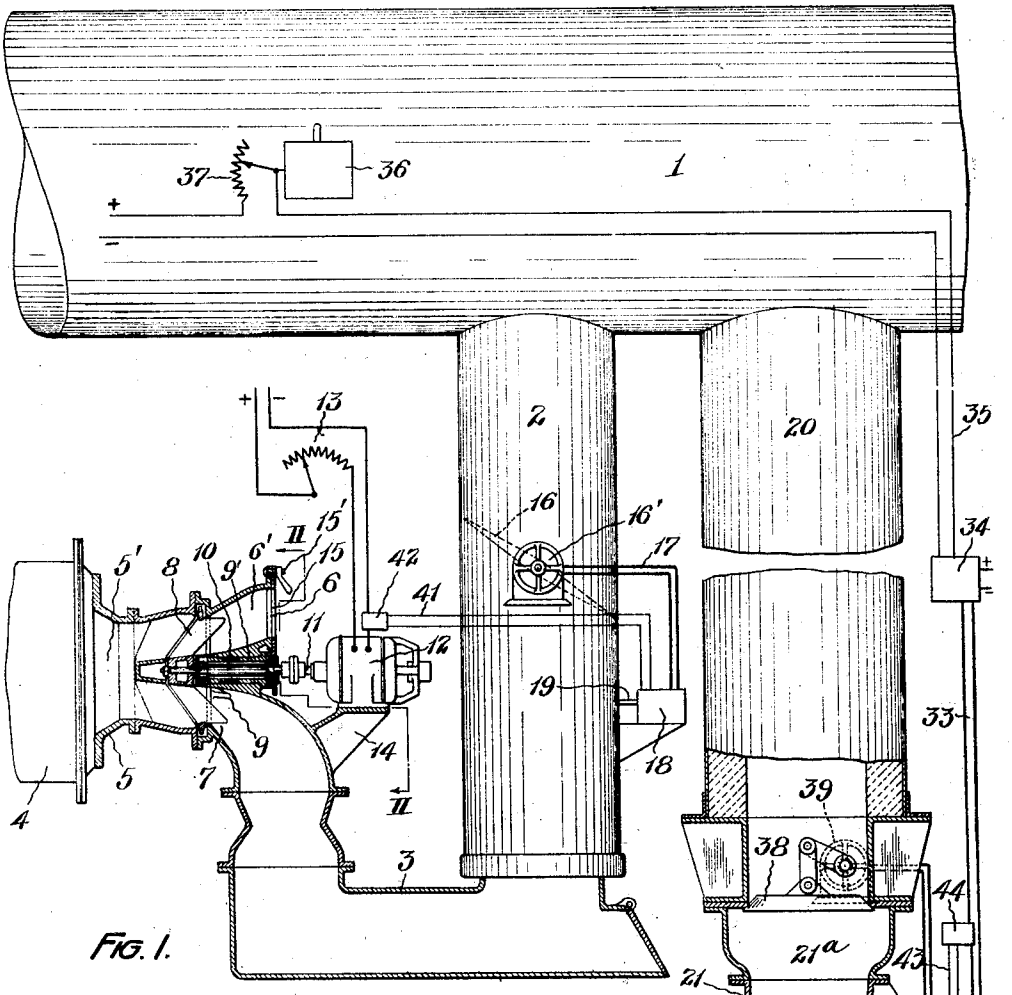
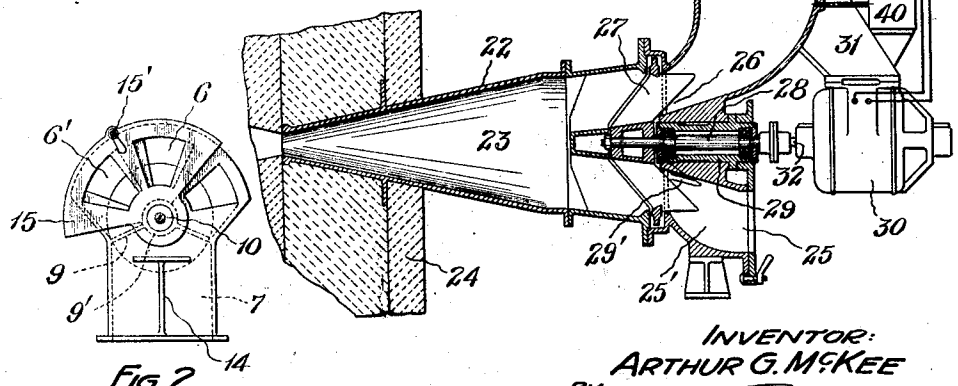
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METHOD OF UTILIZING FUEL GAS PRODUCED UNDER CONDITIONS OF VARYING PRESSURE

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METHOD OF UTILIZING FUEL GAS PRODUCED UNDER CONDITIONS OF VARYING PRESSURE

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My invention relates to methods of burning the fuel gas obtained from any suitable source generating such gas under conditions of varying pressure as for example a blast-furnace, coke oven, or the like, particularly where it is desirable or feasible to apply the heat derived from such combustion to the production of steam or for applying the heat to stoves, regenerators, or the like for use in the process carried out in a particular plant, or both. In the case of a blast furnace, I find it particularly adaptable for use in either making steam in one or more boilers, or in heating the stoves which are used to impart heat to the air-blast, or both simultaneously.

The object of this invention is to apply such heat to any one of different purposes such as are above referred to, for example, and also make such application to purposes involving different conditions, and all in an economical and efficient manner and simultaneously if required.

In blast furnace practice, for example, it is desirable, for the purposes of economy, to consume practically all of the gases from the furnace. The two principal spheres of consumption are the blast furnace stoves and the steam boilers.

It is the practice to cause or attempt to cause the stoves to consume part of the varying volume of by-product gas at a fairly constant rate, so as to maintain as nearly as possible a predetermined fixed temperature thereof, and to effect the consumption of the remaining varying quantity of gas under the boilers.

My invention therefore in the particular form illustrated consists of a process which is designed to provide a flow of gas mixed with air for heating the stoves and of a predetermined volume and ratio of air and gas mixture, constant for a given set condition; and also a process combined or associated therewith, which will provide a gas and air mixture of a given ratio of mixture but the volume of which will vary directly as the pressure of the gas at the source (that is in the blast furnace or gas main leading therefrom), and which may be applied to heating the boilers.

To these several ends, therefore, my invention consists of a method whose operation is exemplified by the accompanying drawing and hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail certain steps illustrating my improved process for burning blast furnace gases, such described steps indicating, however, but one of the various series of steps by which the improved process may be carried out.

Figure 1 represents, more or less diagrammatically, an elevation partly in section of an apparatus by means of which my invention may be carried out in connection with a blast-furnace.

Fig. 2 represents a detail section taken upon the plane indicated by line II—II, Fig. 1.

The illustrated disclosure of the apparatus exemplifying the operation of my invention comprises the gas main 1 which is connected directly with a blast furnace (not shown). Connected with this main is one end of a branch pipe 2, the other end of which is connected with one end of a casing 3. The other end of the casing communicates with the combustion chamber of the blast furnace stove (not shown) by means of any suitable means such as a duct 4, Fig. 1. This casing is provided with a nozzle 5 having a mixing chamber 5′, and air-inlet opening 6 and a gas-inlet opening 7 for such chamber. Intermediately of the outlet end of the mixing chamber and the air and gas inlet openings is a suction blower 8. A wall 9 separates the air inlet duct 6′ and gas inlet duct back of the blower, as shown in Fig. 1. The blower is so arranged that it completely intercepts the air and gas communication with said mixing chamber, as shown in Fig. 1.

The blower shaft 10 is mounted in a suitable bearing 9′ forming part of said wall 9, projects backwardly out of the casing 3 and is connected with the shaft 11 of a variable speed electric motor 12. This motor is controlled by a rheostat 13 by means of which its speed may be varied manually, and may be conveniently mounted upon a stand 14

formed integral with the casing 3 as shown.

The area of the air in opening 6 may be varied by shutter 15, Fig. 2, pivotally mounted upon the shaft 10 and provided with a locking device 15′ by means of which it may be fixed in any desired position.

Located in the pipe 2 is a valve 16 operated by a suitable electric device 16′ such as an armature, whose field is controlled by a circuit 17 itself controlled by a regulator 18 of which the pressure of the gas intermediate of the valve 16 and the blower 8 is a function. Any suitable regulator of known construction may be used for this purpose, as will be readily understood. This regulator, of course, is connected with the interior of the pipe by a small tube 19, Fig. 1, by means of which the pressure may be communicated to the regulator.

The construction of the regulator and its connection with said valve is such that when the pressure of the body of gas below the valve increases, the said valve is moved to decrease the area of the valve opening, and vice versa, thus maintaining substantially constant pressure in the space intermediate of the valve and blower.

The operation of the device as thus far described is as follows:

It is first determined what volume of mixture of gas and air and also what proportion of gas and air in the mixture are required to produce by their combustion the desired temperature in the stove.

The atmospheric pressure may for the purpose in hand be considered constant.

The valve 16 and regulator 18 are set to produce a given predetermined pressure below said valve, having no necessary definite pressure relation to the atmospheric pressure of the air.

Assuming now that the blower is running at a given speed, the gas will be drawn from pipe 2, air through the opening 6, into mixing chamber 5′, thence discharged into and burned in the stove. The gas and air are also initially mixed by the vanes of the blower 8 when passing through the latter.

The area of the gas inlet opening 7 is constant. The volume of gas passing through said opening therefore depends upon the pressure of the gas in the space back of said opening, that is prior to the passage of the gas through the latter. If the pressure be kept constant, the volume of gas passing through said opening will remain constant.

Should the pressure of gas in the main 1, and hence below valve 16, rise, regulator 18 will cause said valve to operate to decrease the area of valve opening, reduce the pressure below the valve and thus restore it to its constant and predetermined pressure.

The regulator 18 and valve 16 maintain this constancy of pressure. As a result, a mixture is produced having a constant proportion of gas and air.

By running the motor at constant speed, a constant volume of such mixture is introduced into the stove.

Now by adjusting the shutter 15 an area of air inlet opening may be secured to provide the required proportion of gas and air in the mixture, and by running the motor at the required constant speed, the desired volume of such mixture may be burned in the stove, and a uniform temperature of the latter thus secured.

It will therefore be seen that I obtain a mixture of air from a source of constant pressure (the atmosphere) with gas from a source of varying pressure (the blast furnace) by reducing to, and maintaining at, a constant pressure the varying pressure of the gas, this maintained constant gas pressure having no necessary definite pressure relation to the constant pressure of the air at its source; and then by means of a suitable device (the blower), apply the same pressure to both the air and the gas to force them into the combustion chamber.

Now should it be desired to increase the temperature of the stove, the motor would simply be speeded up a degree necessary to provide a flow of the required increased volume of the mixture.

Also having one end connected with the main 1, is a pipe 20 whose other end is connected with a casing 21 formed with a burner nozzle 22 whose interior forms a mixing chamber 23. This nozzle communicates with the combustion chamber of a boiler furnace 24 as shown in Fig. 1.

This casing is also provided with an air-inlet opening 25 and a gas-inlet opening 26, communication therethrough being controlled by a suction-blower 27. The latter is mounted upon a shaft 28 supported by a bearing 29 forming a part of a wall 29′ separating the opening 26 from the inlet duct 25′. A variable speed motor 30 mounted upon a bracket 31 integral with the casing 21, has its shaft 32 connected with the blower shaft 28. The speed of the motor is controlled by a circuit 33, including a rheostat 34 of any well-known construction. Said circuit is connected with a secondary circuit 35 which contains a regulator 36 controlled by the pressure in the main 1 and which operates a rheostat 37 automatically. As the pressure increases in the main the rheostat 37 is moved to operate the rheostat 34 so as to increase the current in circuit 33 to increase the speed of the motor and increase the volume of the mixture of air and gas injected into the mixing chamber 23 and discharged into the combustion chamber by the nozzle 22.

It is, however, for the purpose of economical combustion, desirable to maintain the previously determined proportions of air and

gas, as will be understood, and independently of the change of pressure of the gas at the source and hence change of volume of the mixture.

This I accomplish in the manner similar to that described in connection with the stove burner and which I shall now describe.

The pipe 20 is provided with a valve 38 which is hooked up with the armature of an electrical device 39 (of any well-known construction) whose field is controlled by a circuit including a regulator 40 itself controlled by the pressure in the space between the valve 38 and the blower 27.

As the pressure in this space 21^a increases or decreases, it causes the regulator 40 operating through motor 39 to close or open the valve 38 thus maintaining the pressure in space 21^a at a substantially constant pressure within the limits of delicacy of the regulator.

In case of any variation of the pressure of gas in the main 1 (indicating a greater or less quantity of gas available for use) then regulator 36 is actuated by this change of pressure to increase or decrease the speed of motor 30 thus increasing or decreasing the quantity of gas and air delivered to combustion chamber and maintaining during such change the same relation in volume between the gas and air.

It will be understood that as the blower 27 takes more or less gas from the chamber 21^a the regulator 40 will operate to maintain the pressure in said chamber constant as described above.

It will thus be seen that as the pressure in the gas main 1 decreases the speed of the motor 30 driving the blower 27 decreases at the same time that the regulator 40 acts to open the valve 38; likewise as the pressure in the gas main 1 increases the motor 30 and the blower 27 also increase in speed, whereas at the same time the regulator 40 tends to close the valve 38, and the net result produces a condition of constant pressure in the chamber 21^a at varying volumes or rates of flow.

As the volume of air and gas forced into the mixing chamber 23 is proportional to the openings on the inlet side of the fan and the speed of the fan, it will thus be seen that with the varying volumes a constant ratio of gas and air in the mixing chamber can be maintained. As explained before, the single device (the blower 27) applies the same force to both the air and gas for sending it through the nozzle.

In case the pressure of the gas falls below a predetermined minimum, I have provided means for automatically shutting off either of the motors 12 or 30.

To this end a circuit 41 is connected with the regulator 18 and includes a limit switch 42. When the pressure of the gas below valve 16 falls below the minimum, a switch is actuated to break the motor circuit 13 as will be understood.

Similarly a circuit 43 is connected with regulator 40 and actuates a limit switch 44 to break the motor circuit 33.

It will be understood from the above that this arrangement of simultaneously providing a constant flow of gas and air for the stoves and a varying flow of gas and air for the boilers is in most cases desirable, but also that it is not necessary to use both simultaneously as herein set forth. Either may be used to the exclusion of the other, although I have claimed in this application only the processes, either by which a varying volume of gas and air, mixed at a constant ratio, is forced to the boilers; or in which a constant volume of gas and air is fed to the stove and a varying volume to the boilers, the respective ratios in both cases being maintained constant and the gas in both cases being withdrawn from the source of varying pressure at respectively constant pressures.

What I claim is:

1. The method of utilizing the fuel gas produced in a blast furnace or similar source wherein such gas is generated under varying pressure, which consists in withdrawing a part of said gas at a maintained constant predetermined pressure, applying thereto a predetermined forcing pressure and thus conducting the same into a mixing chamber, positively conducting into said mixing chamber, by the same predetermined forcing pressure, a predetermined proportion of air derived from a source at atmospheric pressure, the constantly maintained predetermined pressure of the withdrawn gas having no definite necessary pressure relation to the atmospheric pressure of the air, and burning the gas and air, simultaneously withdrawing the varying balance of the generated gas, maintaining said balance at a constant predetermined pressure, applying to this balance of the gas a predetermined forcing pressure and thus conducting the same into a second mixing chamber, positively conducting into said second mixing chamber, by the same predetermined forcing pressure applied to said balance of the gas, a predetermined proportion of air derived from a source at atmospheric pressure, the constantly maintained predetermined pressure of the withdrawn balance of gas having no definite necessary pressure relation to the atmospheric pressure of the air, changing said last-mentioned forcing pressure in proportion to the varying pressure of the gas at its source without changing the proportions of the gas and air, and burning said last-mentioned gas and air.

2. The method of utilizing fuel gas produced under conditions of varying pressure, which consists in withdrawing the produced gas at an automatically-maintained constant

predetermined pressure, applying to the gas so withdrawn a predetermined forcing pressure and thus positively conducting the same into a mixing chamber, positively conducting into said mixing chamber, by the same predetermined forcing pressure, a predetermined proportion of air derived from a source at atmospheric pressure, and automatically changing the pressure by which the gas and air are forced into the mixing chamber in proportion to the varying pressure of the gas at its source without changing the proportions of the gas and air.

3. The method of utilizing the fuel gas produced in a blast furnace or similar source wherein such gas is generated under varying pressure, which consists in withdrawing a part of said gas at a maintained constant predetermined pressure, applying thereto a predetermined forcing pressure and thus conducting the same into a mixing chamber, positively conducting into said mixing chamber, by the same predetermined forcing pressure, a predetermined proportion of air derived from a source at atmospheric pressure, and burning the gas and air; simultaneously withdrawing the varying balance of the generated gas, maintaining said balance at a constant predetermined pressure, applying to this balance of the gas a predetermined forcing pressure and thus conducting the same into a second mixing chamber, positively conducting into said second mixing chamber, by the same predetermined forcing pressure applied to said balance of the gas, a predetermined proportion of air derived from a source at atmospheric pressure, changing said last-mentioned forcing pressure in proportion to the varying pressure of the gas at its source without changing the proportions of the gas and air, and burning said last-mentioned gas and air.

Signed by me this 1st day of August, 1925.

ARTHUR G. McKEE.