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(54) Gas fuelled heating unit for household and similar appliances

(57) The invention refers to a gas fuelled heating unit for a household appliance, such as for instance a cooking or similar appliance. The unit comprises a burner (2), wherein the fuel-gas supply and/or mixing conduit (1), the air conduit (8) and the flue-gas conduit (14) are flexible hoses in view of enabling the unit to be transported and used in any appliance of the above cited kind. In a preferred manner, the unit also comprises first processor means (7) connected to sensor means (5) to process out and monitor the weighed flow rate of the gas and, as a result, to accordingly drive second processor means (12) connected to respective sensor means (10) to process out and monitor the most appropriate weighed air flow rate.

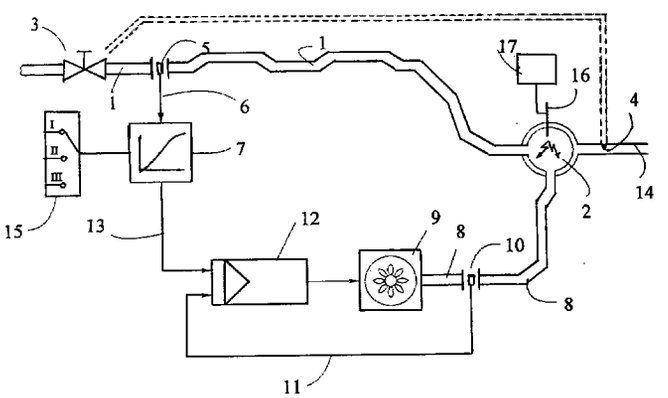

Fig. 1

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Description

The invention relates to a gas fuelled heating unit for a household or similar appliance, which comprises the means which are substantially defined in the introductory part of the appended claim 1.

Household appliances intended for food cooking and preparation applications, as well as for sanitary water heating applications, are commonly known, which utilize the heat produced by the combustion of fuel gases (the latter being grouped into three main families, ie. manufactured gas, natural gas and liquid petroleum gas, according to the chemical composition and heat value thereof).

So-called "atmospheric" combustion systems are generally used in such appliances, ie. systems in which it is the fuel gas itself which, while supplied under pressure from a gas supply mains or a gas bottle, "sucks in" directly from the surrounding atmosphere a part of the combustion air, ie. the so-called primary air, upon flowing out of a calibrated injector and expanding in a Venturi pipe. The amount of air which is "sucked in" in this manner is proportional to the fuel gas input rate, so that the use of different injectors for the various gas families becomes manadtory in view of keeping the heat output of the burner unaltered.

The remaining part of the combustion air, ie. the so-called secondary air, is taken in directly from the zone surrounding the flame and is considerably in excess with respect to the stoichiometric ratio. These systems are very simple in their construction and highly reliable, but have two main drawbacks. First of all, they have in fact a relatively low efficiency, which can reach 60% at most, also due to the effect above cited air excess condition under which they normally operate. Furthermore, they imply the use of different injectors for the various families of fuel gas utilized, which practically means a lot of obvious complications for the manufacturer, the installer and, finally, also the end user.

Household appliances are also known in which a heat exchanger is provided between the burner flame and the food to be cooked and/or the liquid to be heated up, as this is for instance disclosed in IT-A-1143809 (glass-ceramic cooking surface with "covered" IR burners), IT-A-533545 (boiler with burner arranged outside the water reservoir and a double-flowpath flue conduit submerged in the reservoir), and IT-B-30764/78 (cooking oven with heat exchanger exchanging heat from the flue products to the forced hot-air flow circulated for cooking the food). Also in these cases the combustion system, although less exposed to the influence of the surrounding atmosphere, is required to be capable of operating in an equally satisfactory manner when supplied with gases of anyone of the three afore mentioned families, and this clearly imposes a considerable excess of combustion air which, as this has been already stated before, lowers the efficiency of the system. Again, the above mentioned complications derivinf from the necessity for different injectors to be used in connection with the various gas families remain unaltered.

Finally, fully pre-mixed combustion systems, ie. combustion systems in which the air needed for combustion is totally pre-mixed", are also known in the art. These are based on the use of forced-draught burners operating solely with primary air, in which fuel gas under pressure and combustion air are supplied at any desired pressure and in a relation which is substantially equal to the stoichiometric one. Combustion systems of this kind have hitherto been used almost exclusively in industrial plants (ovens for brick-making factories, glassmaking shops, cement factories, steam generators for steam power plants and the like) owing to an inherent complexity of their construction that would certainly not allow them to be used in home appliance or similar applications. Furthermore, they are designed and made to operate with a single family of fuel gases, ie. the one which is concretely available in the area in which the industrial plat is sited.

It therefore is a main purpose of the present invention to provide a low-cost, constructionally simple heating unit which, apart from featuring a high efficiency, is capable of being used universally in household appliances for cooking food and/or heating up working fluids (in practice, hot sanitary water and air), regardless of the actual family of fuel gases being used.

The characteristics of such a heating unit for household and similar appliances are substantially as recited in the appended claims.

The invention will anyway be more clearly and readily understood from the detailed description which is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematic view of the block diagram of a first embodiment of the present invention, and

- Figure 2 is a schematic view of the block diagram of a second embodiment of the present invention.

According to the invention, a first embodiment (see Figure 1) of the heating unit comprises a first flexible hose 1 for the supply of fuel gas under pressure (coming from a traditional gas supply mains or bottle, which for reasons of greater clarity are not shown in the Figure) to a combustion chamber 2 which occupies a confined space under heat-exchange conditions with the means that utilizes the heat thereof, as this will be explained more clearly further on.

At the beginning of such a flexible hose 1 there is arranged a manually operated cock which may most appropriately, but not necessarily, be of the type with associated safety valve function, ie. provided with an internal shutting member (not shown) which is functionally associated with a solenoid that is crossed by the flow of the current generated by the Peltier effect in a thermocouple 4 which is heated by the flame produced in a combustion chamber 2.

By turning the cock 3 open to a greater or smaller

extent, the user actually determines the flow rate of the fuel gas in the flexible hose 1, ie. the heat input rate into the combustion chamber 2. Inside the gas-supply flexible hose 1 there is arranged a speed sensor 5 which is associated, through appropriate and generally well-known circuit means 6, with a first processor means 7. The latter is in turn associated with a selector means 15 (which is duly pre-set at the factory and/or during installation) for the fuel-gas family which is actually used, and it therefore is capable of computing on a real-time basis the weighed flow rate of the gas and, as a result, the amount of primary air needed in the combustion chamber 2.

According to the invention, the primary air, too, is supplied to the combustion chamber 2 through a second flexible hose 8 by means of a motor-driven fan 9, or similar means, which takes it in from the surrounding atmosphere and sets it under pressure. The instant value of the weighed air flow rate is processed and monitored by a second processor means 12 which is connected, through further and again generally well-known circuit means 11, to an air speed sensor 10 arranged in the flexible hose 8.

A logic connection line or bus 13 connects said first processor means 7 to said second processor means 12 which, according to the weighed flow rate of fuel gas in the flexible hose 1 calculated by the first processor means 7, provides for the set point (pressure-weighed flow rate) of the motor-driven fan 9 to be adjusted automatically so as to ensure that fuel gas and combustion air in the combustion chamber 2 are constantly in a relation which is substantially equal to the stoichiometric one. Again, according to the present invention the flue gases are exhausted from the combustion chamber 2 through a third flexible hose 14. The possible configurations of the combustion chamber 2 (which comprises an output electrode 16 of a generator 17 of high-voltage electric discharges to ignite the fuel gas/air mixture), the gas and air supply flexible hoses 1 and 8, respectively, and the flue exhaust flexible hose 14 can be freely selected by the designer provided that they are capable of ensuring:

- an as simple and convenient as possible transport and use of the heating unit in a confined space of any household appliance (ie. cooktop, cooking oven, boiler and the like),

- the highest possible efficiency in the heat-exchange process between the food to be cooked (and/or working fluid to be heated up) in said household appliance and the combustion products inside the combustion chamber 2 and the flexible flue-exhaust hose 14, the latter being obviously made of any suitable heat-conductive material, eg. copper.

By way of mere orientation, the use is suggested of sensors of the series AWM5000 made and marketed by Honeywell as the sensors 5 and 10 for the fuel gas and the combustion air flow, respectively, as well as microprocessors of the Motorola 6805 family, duly programmed and set for processing the weighed flow rates of the fuel gas and the combustion air, as the first processor means 7 and the second processor means 12, respectively.

The advantages offered by the above described embodiment of the present invention may be summarized as follows:

- the heating unit does not require the use of special injectors for each family of fuel gas, since the fuel gas/combustion air mixture is formed automatically in the due stoichiometric relation, without any addition of secondary air;

- the flow speed sensors provided for the fuel gas and the combustion air in the respective flexible supply hoses have extremely short response times, so that it practically not necessary for special, electronically modulated (and, therefore, very delicate and expensive) valves to be used to adjust the input rate of the fuel gas;

- the fact that, along with said flow speed sensors in the flexible supply hoses, two processor means are used to process out and monitor weighed (and not volumetric) input rates, does away with the necessity for means to be provided, either in the heating unit or in the household appliance associated therewith, to compensate for variations in the temperature and the pressure of the fuel gas and the air;

- the overall component costs are therefore limited and fully compatible with those that are generally acceptable in household appliance applications.

Considering now a second embodiment of the present invention, as illustrated in Figure 2, it can be noticed that some component parts are the same as those used in the first embodiment, so that they do not need any further explanation and are referred to with the same numerals in the drawing. A feature of this second embodiment of the invention is the presence, in the flexible flue-exhaust hose 14, of an oxygen (O_2) sensor 20, which may alternatively be a carbon monoxide-to-carbon dioxide ratio (CO/CO_2) sensor, to monitor, by means of a third processor means 21 connected via a line or bus 22 to said sensor 20, the "soundness" of the combustion.

By mere way of example, the use is suggested of a component of the series AWM5000 made and marketed by Honeywell as the oxygen or carbon monoxide-to-carbon dioxide ratio sensor 20, as well as a microprocessor of the Motorola 6805 family, duly programmed and set, as said third processor means 21.

The third processor means 21 is also connected, via further buses 23 and 24, to the afore mentioned first processor means 7 and second processor means 12. In

this manner, should the sensor 20 detect a deterioration in the soundness, or quality, of the combustion, the third processor means is able to inform the second processor means 12 of the necessity for the input rate of the fuel gas in the flexible supply hose 1 to be reduced and/or the input rate and/or pressure of the combustion air in the flexible supply hose 8 to be increased through a corresponding adjustment of the set point of the motor-driven fan 9, since the fuel gas-to-combustion air ratio must constantly lie close to the stoichiometric value, without any addition of secondary air (ie. without any excess air).

The advantages offered by this second embodiment of the present invention are substantially the same as listed in connection with the afore described first embodiment, except for the overall component costs which in this case are obviously higher due to the addition of the oxygen sensor 20, the third processor means 21 and the connection buses 22, 23 and 24.

It will of course be appreciated that, based on the teachings of the present invention, those skilled in the art may derive a number of further embodiments and variants thereof, without departing from the scope of the present invention.

In particular, in the case of a heating unit intended for application in a cooking appliance, the manually operated cock 3 may be replaced by an electromagnetic valve operatively linked with, apart from a traditional electronic cooking programme control device, a sensor of the temperature in the interior of the combustion chamber 2. In this manner, the unit is able to perform its duty by automatically taking into account the actual heat demand according to the time schedule or programme that will have been pre-set by the user.

Claims

1. Heating unit comprising means (1, 8) for supplying and mixing fuel gas and combustion air in predetermined proportions into a confined space (2) in which the combustion thereof takes place, means (16, 17) to ignite the fuel gas-air mixture, means (14) to exhaust in a controlled manner the flue gases from said confined space (2), **characterized in that** it is arranged as a transportable unit for use in any household appliance to the purpose of cooking food and/or heating up working fluids, said means (1, 8) for supplying and mixing fuel gas and combustion air, as well as said means (14) for exhausting in a controlled manner the flue gases, being substantially formed by flexible hoses.

2. Heating unit according to claim 1, **characterized in that**, when such a unit is mounted in said household appliance, said confined space (2) in which the combustion process takes place and at least a substantial portion of the means (14) for exhausting the flue gases in a controlled manner are arranged in a heat-exchange relation with the food to be cooked and/or the working fluid to be heated up.

3. Heating unit according to claim 1 or 2, **characterized in that** it comprises means (15) to select the family and/or type of fuel gas to be supplied, said selection means being adapted to be pre-set at the factory and/or upon of said appliance.

4. Heating unit according to any of the claims 1 to 3, **characterized in that** it comprises first processor means (7), connected to sensor means (5) of the fuel-gas flow rate through the flexible supply hose (1) thereof, adapted to process out and monitor the weighed input rate of the fuel gas and to drive associated second processor means (12), connected to sensor means (10) of the forced combustion-air flow rate through the flexible supply hose (8) thereof, adapted to process out and monitor the weighed input rate of the combustion air, as well as adapted to control the operation of operational means (9) that are capable of altering the physical parameters of the air flow.

5. Heating unit according to any of the claims 1 to 4, **characterized in that** it comprises third processor means (21) connected to sensor means (20) arranged in the flexible flue-exhaust hose (14), said third processor means (21) being in turn connected to said first processor means (7) and said second processor means (12) to restore optimum fuel gas and combustion air mixing conditions whenever a deterioration in the quality of combustion is detected.

6. Heating unit according to any of the claims 1 to 6, **characterized in that** it comprises at least a sensor of the temperature in the space where the combustion process takes place and/or in the flexible flue exhaust hose so as to give rise, through the corresponding operation of said first and said second processor means, to such weighed fuel gas and combustion air input rates, through their respective flexible supply hoses, as to produce the desired heat output.

7. Heating unit according to claim 6, **characterized in that** it is operatively linked with a per se known electronic cooking programme control switch.

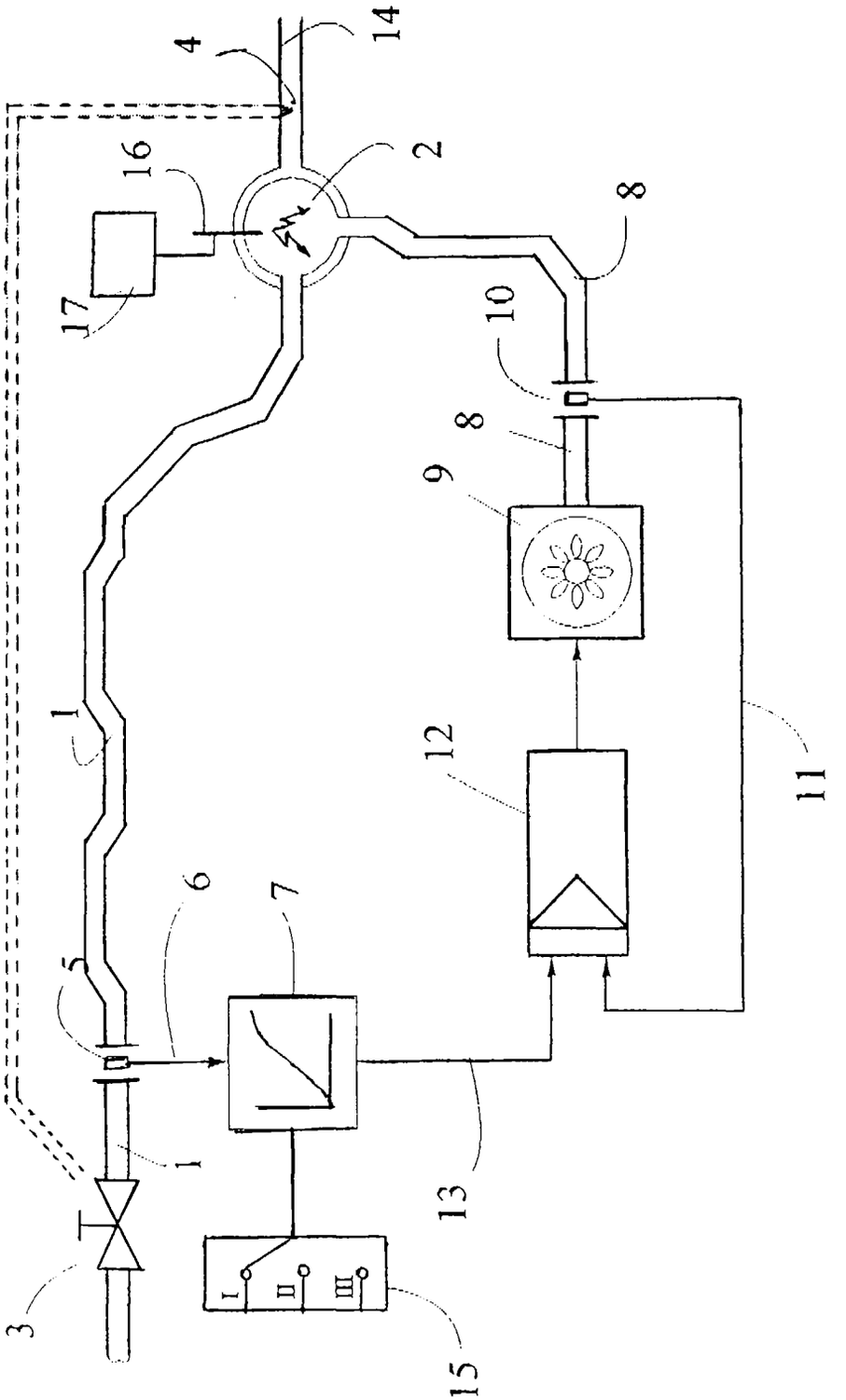

Fig. 1

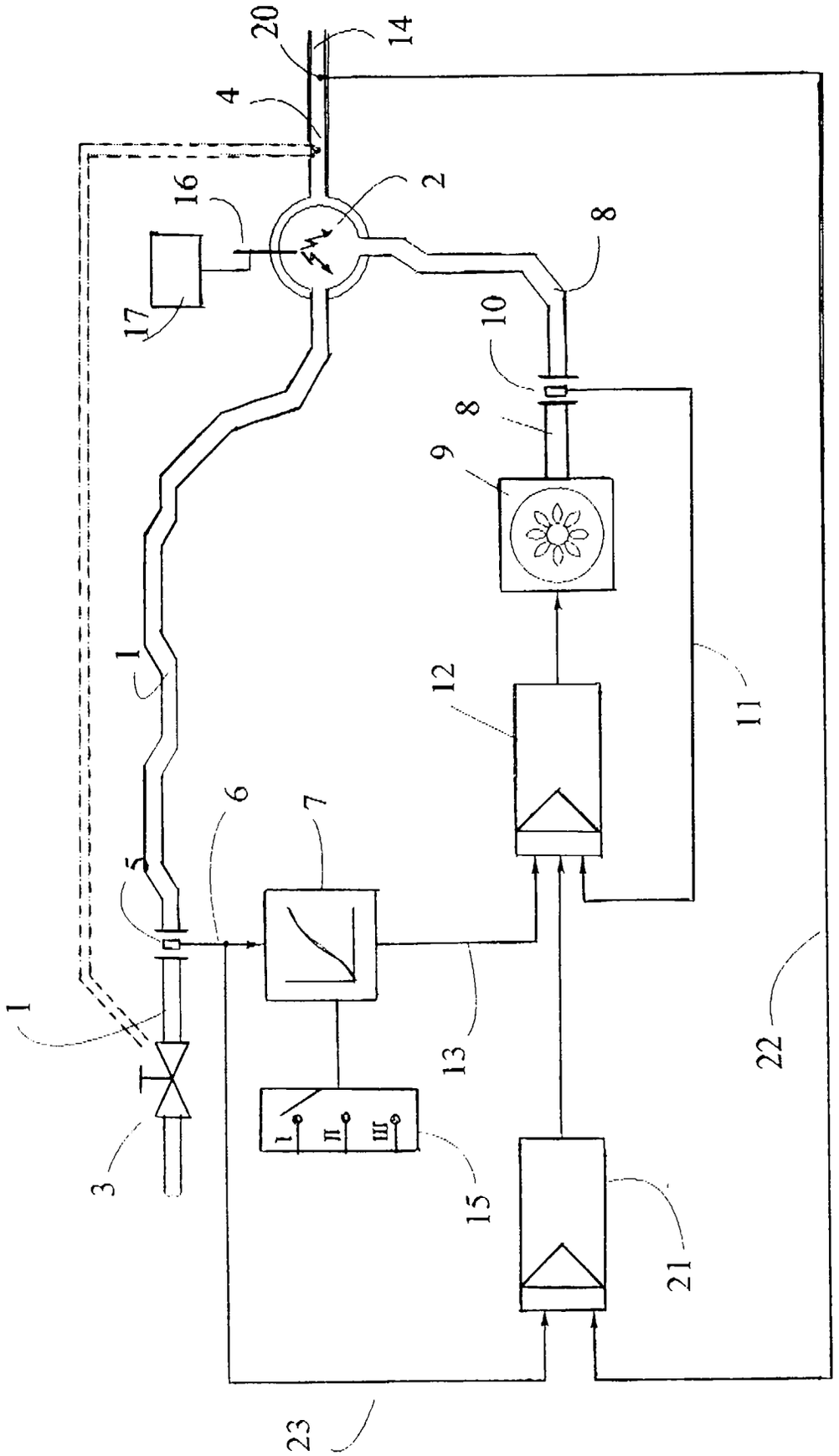

Fig. 2