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HEATING APPARATUS FOR BURNING GASES OR LIQUID
FUELS, ESPECIALLY FUEL OIL
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3,190,340

METALLIC OR NON-
METALLIC MATERIAL

FIG. 1

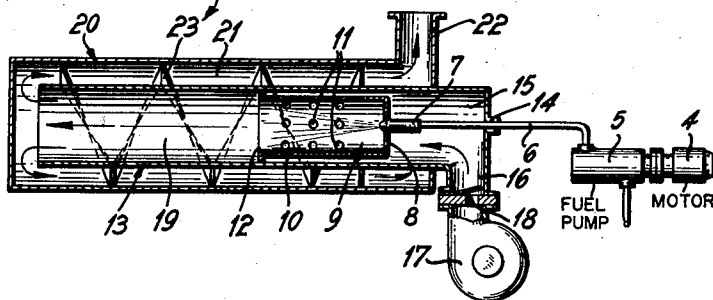


FIG. 2

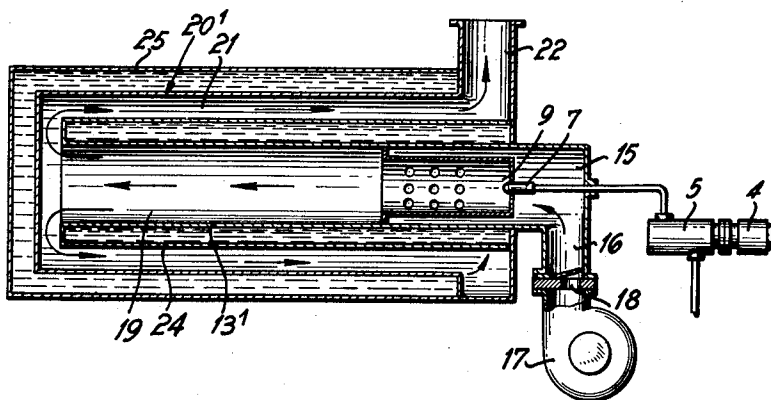
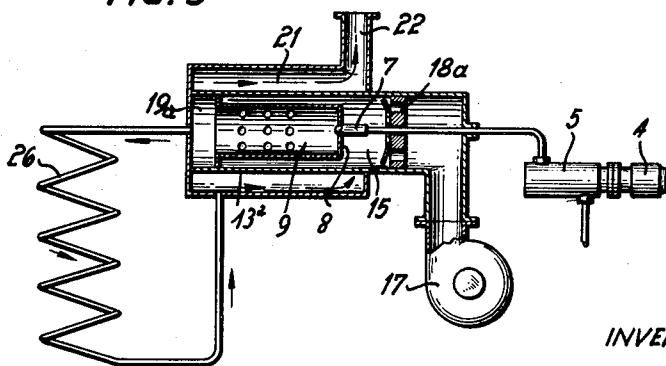


FIG. 3



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HEATING APPARATUS FOR BURNING GASES OR LIQUID FUELS, ESPECIALLY FUEL OIL

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This invention relates to a heating apparatus for gaseous or liquid fuels, especially fuel oil, in which compressional vibrations produced by oscillating combustion are present in the combustion chamber and in combustion gas flues series-connected with said combustion chamber.

The combustion chamber and the combustion gas flues of the known heating apparatus for improving the heat transmission and combustion are of such dimensions that they act as resonators and the fuel gas burner vibrates with the natural frequency of the vibration system created by the impulse-like combustion. The use of such heating apparatus very often requires very accurate control which can be easily carried out by connecting and disconnecting the supply of fuel as a function of temperature or pressure of the medium to be heated. However, such automatic control cannot be attained with the necessary accuracy and reliability, especially not with respect to the connecting action of the heating apparatus operating as self-excited oscillators or resonators with regard to the natural frequency, because in case of low heat requirement the temperature or the pressure has to be maintained so precisely that the heating apparatus has to deliver numerous short bursts of fire within one minute, which can only be guaranteed by an automatic disconnection, but especially connection, which is responsive to small pressure or temperature differences.

It is, therefore, the object of the invention to sensitively control by connection and disconnection in a reliable manner a heating apparatus operating with oil or gas.

This object is achieved according to the invention by providing a heating apparatus for gaseous or liquid fuels, especially combustion oil, in which compressional vibrations produced by oscillating combustion are present in the combustion chamber and in combustion gas flues series-connected with said combustion chamber, the compressional vibrations in the combustion gas burner being positively excitable and independent of the natural frequency of the heating apparatus.

Advantageously, a blower is provided which serves for the air feed and a check valve is associated with the blower for impulse-like air supply, which check valve is controllable by gas pressure vibrations produced by impulse-like mechanical fuel supply and combustion. In this connection it is suggested to place, by appropriately dimensioning the heating apparatus, the natural frequency of the heating apparatus near the frequency of the fuel supply which can be determined by the stroke of supply pumps, in order to obtain a high pressure amplitude in the fuel gas burner which is particularly effective for the heat transmission.

The air and the fuel are expediently mixed in the combustion chamber which is substantially cup-shaped and has a bottom through which the fuel is axially supplied and a cylindrical jacket, and radial air inlet openings are provided in the cylindrical jacket.

These air inlet openings act as chokes for the air supply and can, in connection with an air chamber connected in series with the check valve, effect a phase displacement between the fuel and air current whereby in any case and absolutely safe ignition is guaranteed in the positively controlled vibration system. Optimum dimensioning of the air inlets will not only result in safe ignition of each individual fuel impulse but also in the possibility to operate practically with a theoretical air requirement without unburnt matter in the waste gases.

Moreover, the vibration system or the oscillator can be kept reliably in service down to very low fuel supply frequencies so that failure of the ignition will be avoided. It will also be possible to infinitely vary the oscillator by changing the fuel supply frequency, as can easily be effected by varying the stroke of the fuel pumps.

With regard to the development of the gas pressure vibrations required for the transfer of heat it is suggested to series-connect the combustion chamber with a system of gas conduits of adequate lengths which guarantee sufficiently high speed. To this end the combustion chamber may be surrounded by a jacket at some distance, one end of which is in connection with the blower via the check valve and the other end of which is closely joined to the open end of the combustion chamber and opens either directly or indirectly by means of coiled tubes into an annular chamber formed by a second jacket which may be provided with an incorporated coiled sheet of metal or ceramic material for elongating the flow passage of the flue gases.

It is further suggested regarding the supply of fuel in impulses, to use for liquid a single-cylinder plunger pump with a series-connected pivot nozzle, and for gaseous fuel a diaphragm pump with a series-connected gas jet containing an outlet valve responsive to preliminary pressure of gas.

Several embodiments of the invention will now be described by way of example and with reference to the accompanying drawing, in which:

FIG. 1 is a longitudinal section through a heating apparatus according to the invention;

FIG. 2 is a longitudinal section through another embodiment of the heating apparatus, and

FIG. 3 is a longitudinal section through a further embodiment of the heating apparatus.

Referring to the drawing, a pump 5 serving for the fuel supply is driven by a motor 4, said pump being designed as a single-cylinder plunger pump for liquid fuel, particularly fuel oil, and as a diaphragm pump for gaseous fuel and in any case determining by its number of strokes the exciting frequency of the vibration system of the heating apparatus. A pump pressure line 6 opens into a burner unit 7 which is arranged at the bottom 8 of cup-shaped combustion chamber 9 and provided with an injection nozzle having a member which in the intervals between the injection impulses locks the nozzle opening towards the combustion chamber. For liquid fuels it is suitable to use pivot nozzles which free the fuel passage only at a desired adjustable injection pressure so that the liquid fuel is vaporized under the action of this opening pressure. The combustion chamber 9 is provided with a cylindrical jacket 10 having radial openings 11 as inlets for the combustion air and is supported at its inside open end 12 in a flange-like manner against a tube-like casing 13 which surrounds the combustion chamber at some distance. Into the rear part 15 of the casing 13, which is closed at its ends and provided with a sealed opening 14 for the pump pressure line 6, there opens a compressed-air line 16 of a blower 17. In the embodiments of FIGS. 1 and 2 a check valve 18 which can be opened in the direction of the rear part 15 is incorporated in the compressed-air line 16. The open front part 19 of the casing 13 forms a combustion gas channel which communicates with an annular chamber 21 formed by a second casing 20 surrounding in a jacket-like manner said casing 13. The annular chamber 21 serves for further conduction of the combustion gases and opens into outlet 22. According to the embodiment of FIG. 1 the

gases are helically conducted by a coiled sheet 23 in the annular chamber 21 for the purpose of extending the flow passage indicated by arrows. The annular chamber 21 by means of its portion extending beside the combustion chamber 9 acts as a recuperator for heating the combustion air flowing between the cylindrical jacket 10 and the casing 13. Despite the relatively small heating areas of the recuperator there exists, owing to the gas pressure vibrations, a good heating efficiency because the coefficient of heat transmission is considerably increased in comparison with that in the case of a uniform gas flow.

The coiled sheet consists of metal or a ceramic material 23 and is so dimensioned that the natural frequency of the vibration system produced by the combustion chamber and the gas channel approaches the proximity of the injection frequency. Thus, a high pressure amplitude can be obtained which is desirable for the intended improvement of the heat transmission.

In the heating apparatus according to FIG. 1 the heat produced is carried off from the outer casing 20 of the annular chamber 21. The heating apparatus can, therefore, operate as a heat radiator, e.g. as an oil- or gas-burning radiating tube for industrial equipment such as a drying plant. If air is blown against the tube from outside, in which case additional ribbed heating surfaces may be provided externally for improving the heat transmission, the tube will act as an air heater.

In the embodiment according to FIG. 2 the heat produced is used for heating or vaporizing a liquid. For this purpose a casing 13¹ and a casing 20¹ have been equipped with a double casing 24 and 25, respectively, for receiving the liquid.

In the embodiment according to FIG. 3 a single or several parallel-connected coiled tubes 26 are connected to the front part 19a of a casing 13², through which tubes the combustion gases stream. The coiled tubes 26 may serve to heat working or drying rooms but may also be used as radiation heating area or for heating liquid baths. The cooled waste gases are returned to the annular chamber 21, which coaxially surrounds the combustion chamber 9, and then leave through the outlet 22. The annular chamber 21 serves again as a recuperator for pre-heating the combustion air. The embodiment according to FIG. 3 also shows another design and arrangement of the check valve 18 of the embodiments of FIGS. 1 and 2. In this case a check valve 18a is mounted behind the combustion chamber 9 parallel to its bottom 3.

In some cases it may be advisable to use return flow chokes without moving parts instead of the check valves mentioned above.

I claim:

1. A heating apparatus for burning gaseous or liquid fuels, especially fuel oil, comprising, in combination, a cup-shaped combustion chamber having a closed end and an open end; combustion gas guide means communicating with said open end of said combustion chamber and forming therewith a resonance system; air passage means communicating at one end thereof with said combustion chamber intermediate the ends of the latter; air blower means connected to the other end of said air passage means for producing a continuous pressure on the air in said air passage means so that said air permanently tends to enter said combustion chamber, and fuel supply means communicating with said combustion chamber through said closed end thereof and including mechanical means for cyclically feeding fuel at a predetermined frequency into said combustion chamber to produce during combustion thereof compressional vibrations having timely spaced compression periods in said combustion chamber substantially preventing entrance of air from said blower during said compression periods whereby air is intermittently supplied through said air passage means to said combustion chamber at said predetermined frequency at times between said compression periods.

2. A heating apparatus for burning gaseous or liquid fuels, especially fuel oil, comprising, in combination, a cup-shaped combustion chamber having a closed end and an open end; combustion gas guide means communicating with said open end of said combustion chamber and forming therewith a resonance system having a natural frequency; air passage means communicating at one end thereof, with said combustion chamber intermediate the ends of the latter; air blower means connected to the other end of said air passage means for producing a continuous pressure on the air in said air passage means so that said air permanently tends to enter said combustion chamber and fuel supply means communicating with said combustion chamber through said closed end thereof and including mechanical means for cyclically feeding fuel at a predetermined frequency in the proximity of said natural frequency of said resonance system into said combustion chamber to produce during combustion thereof compressional vibrations having timely spaced compression periods in said combustion chamber substantially preventing entrance of air from said blower during said compression periods whereby air is intermittently supplied through said air passage means to said combustion chamber at said predetermined frequency at times between said compression periods.

3. A heating apparatus for burning gaseous or liquid fuels, especially fuel oil, comprising, in combination, a cup-shaped combustion chamber having a closed end and an open end; combustion gas guide means communicating with said open end of said combustion chamber and forming therewith a resonance system having a natural frequency; air passage means communicating at one end thereof with said combustion chamber intermediate the ends of the latter; air blower means connected to the other end of said air passage means for producing continuous pressure on the air in said air passage means so that said air permanently tends to enter said combustion chamber, one-way valve means in said air passage means movable between an open position permitting flow of air in said direction and a closed position; and fuel supply means communicating with said combustion chamber through said closed end thereof and including mechanical means for cyclically feeding fuel at a predetermined frequency into said combustion chamber to produce during combustion thereof compressional vibrations having timely spaced compression periods in said combustion chamber whereby said valve means is moved to said closed position thereof by said compressional vibrations during said compression periods so that air is intermittently supplied through said air passage means to said combustion chamber at said predetermined frequency at times between said compression periods.

4. A heating apparatus for burning gaseous or liquid fuels, especially fuel oil, comprising, in combination, a cup-shaped combustion chamber having a closed end, an open end and a substantially cylindrical wall between said ends; combustion gas guide means communicating with said open end of said combustion chamber and forming therewith a resonance system having a natural frequency; air passage means communicating at one end thereof with said combustion chamber intermediate the ends of the latter, said air passage means being in part formed by a jacket surrounding said cup-shaped combustion chamber and a plurality of radial air inlet openings formed in said cylindrical wall of said combustion chamber and communicating with the interior of said jacket; air blower means connected to the other end of said air passage means for producing a continuous pressure on the air in said air passage means so that said air permanently tends to enter said combustion chamber; one-way valve means in said air passage means movable between an open position permitting flow of air in said direction and a closed position; and fuel supply means communicating with said combustion chamber through said closed end thereof and including mechanical means for cyclically feeding fuel at a

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predetermined frequency in the proximity of said natural frequency of said resonance system into said combustion chamber to produce during combustion thereof compressional vibrations having timely spaced compression periods in said combustion chamber whereby said valve means is moved to said closed position thereof by said compressional vibrations during said compression periods so that air is intermittently supplied through said air passage means to said combustion chamber at said predetermined frequency at times between said compression periods.

5. A heating apparatus for burning gaseous or liquid fuels, especially fuel oil, comprising, in combination, a cup-shaped combustion chamber having a closed end, an open end and a substantially cylindrical wall extending between said ends; combustion gas guide means communicating with said open end of said combustion chamber and forming therewith a resonance system, said combustion gas guide means including a tubular member of a diameter greater than that of said cylindrical wall projecting coaxially with the latter forwardly from said open end of said combustion chamber fluidly tightly connected thereto and having opposite the connected end a free open end, a casing surrounding said tubular member and forming therewith an annular passage communicating with the interior of said tubular member through said free open end thereof, and a flue communicating with said annular passage at a portion thereof distant from said open free end; air passage means communicating with said combustion chamber intermediate the ends of the latter, said air passage means being in part formed by an extension of said tubular member extending rearwardly from said open end of said combustion chamber and surrounding the latter and a plurality of radial air inlet openings formed in said cylindrical wall of said combustion chamber and communicating with the interior of said extension of said tubular member; air blower means communicating with the interior of said extension of said tubular member rearwardly of said closed end of said combustion chamber for producing a stream of air in a direction from said air blower means toward said combustion chamber permanently tending to enter the latter; one-way valve means in said air passage means movable between an open position permitting flow of air in said direction and a closed position; and fuel supply means communicating with said combustion chamber through said closed end thereof and

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including mechanical means for cyclically feeding fuel at a predetermined frequency into said combustion chamber to produce during combustion thereof compressional vibrations having timely spaced compression periods in said combustion chamber whereby said one-way valve means is moved to said closed position thereof by said compressional vibrations during said compression periods so that air is intermittently supplied through said air passage means to said combustion chamber at said predetermined frequency at times between said compression periods.

6. A heating apparatus as set forth in claim 5 and including a sheet member extending along a helix through said annular passage formed between said tubular member and said casing and being connected along longitudinal edges thereof to said tubular member and said casing, respectively.

7. A heating apparatus as set forth in claim 6 in which said sheet member consists of metal.

8. A heating apparatus as set forth in claim 6 in which said sheet member consists of non-metallic material.

9. A heating apparatus as set forth in claim 8 in which said sheet member consists of ceramic material.

10. A heating apparatus as set forth in claim 5 in which said tubular member and said casing are respectively surrounded by a jacket adapted to pass a medium to be heated therethrough.

11. A heating apparatus as set forth in claim 5 wherein said combustion gas guide means include at least one coiled tube in series with said combustion chamber.

References Cited by the Examiner

UNITED STATES PATENTS

1,923,614	8/33	Clarkson	158—28
2,448,595	9/48	Holbrook	158—28
2,707,515	5/55	Lafferentz et al.	158—4
2,708,926	5/55	Huber et al.	158—4
2,844,195	7/58	Wein	158—28
2,907,382	10/59	McIlvaine.	
2,982,530	5/61	Drakengren.	

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