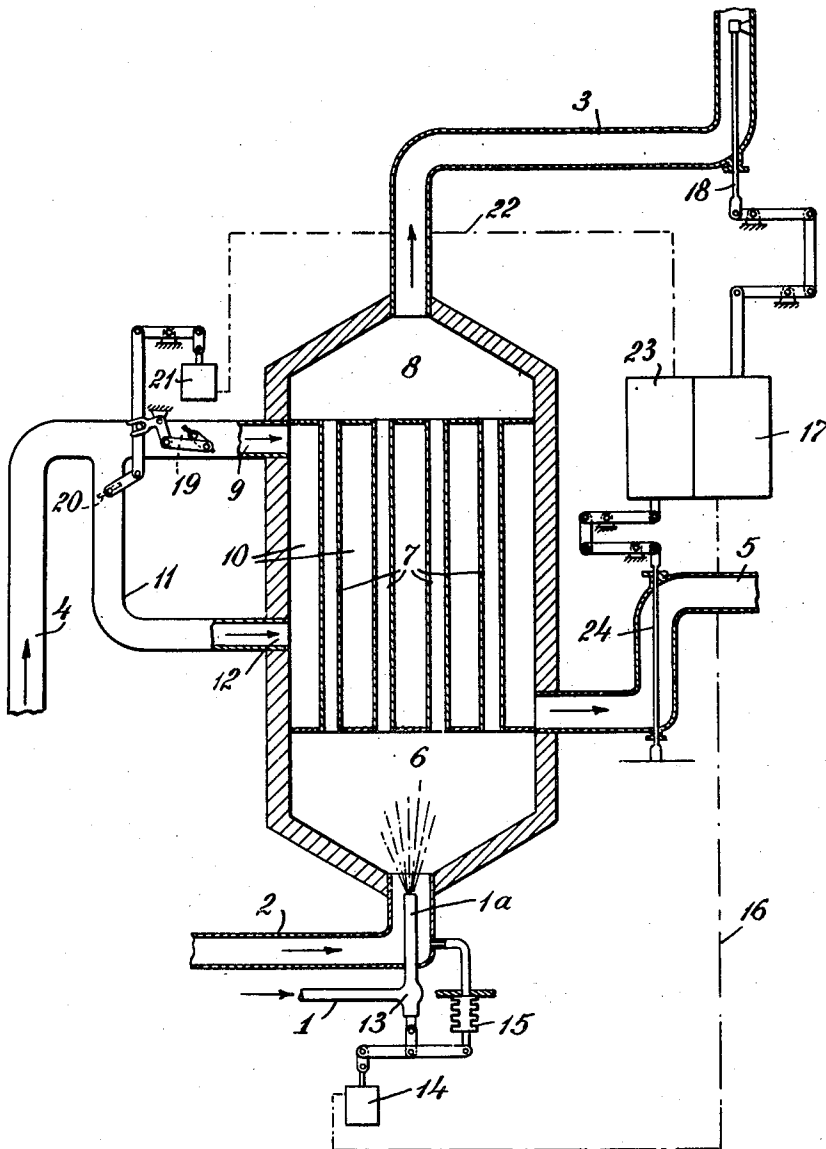


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GAS HEATER REGULATION

2 Sheets-Sheet 1

Fig. 1.



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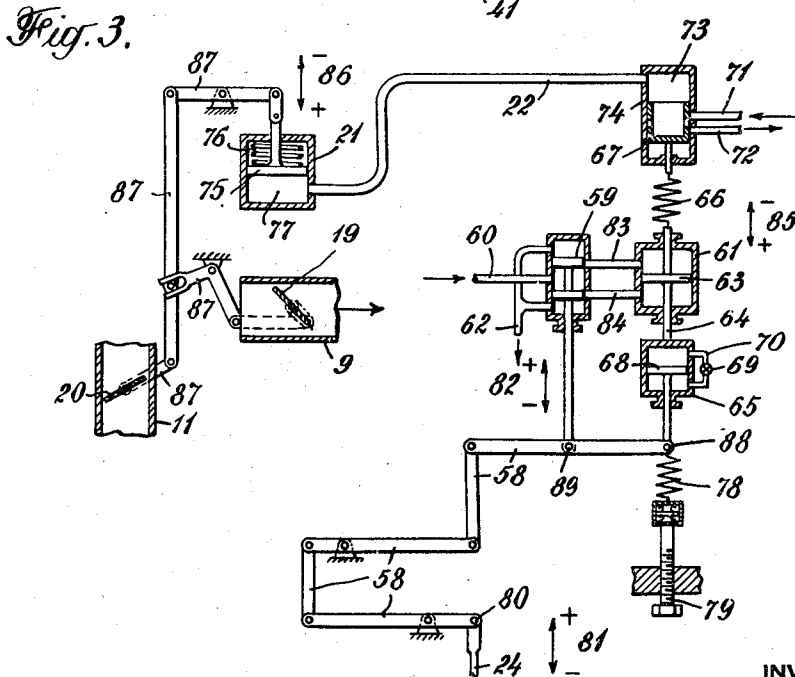
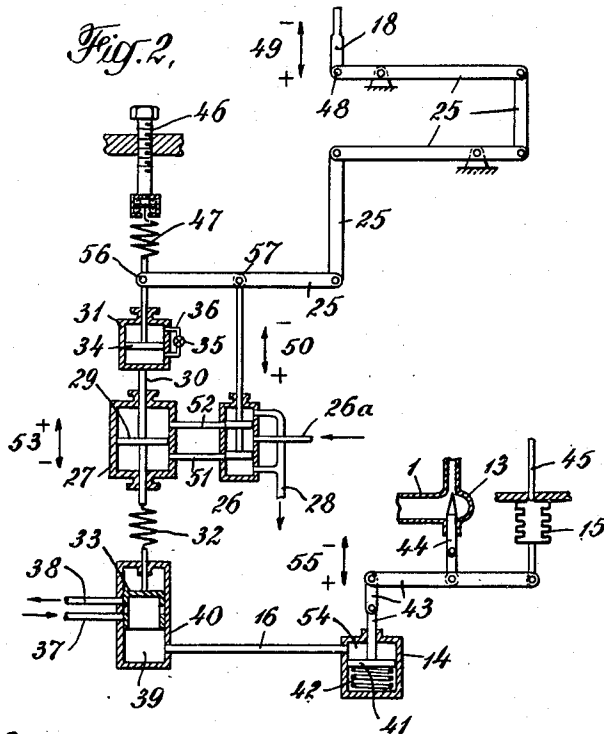
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GAS HEATER REGULATION

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2 Sheets-Sheet 2



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GAS HEATER REGULATION

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The invention relates to a method of regulating independently the temperature of the heated gas and the temperature of the combustion gas of gas heaters and to a gas heater for applying this method.

The method proposed by the invention is characterised in that, apart from the regulation of the heat supply from the fuel in accordance with the temperature of the combustion gases, a quantity of the gas to be heated which is regulated in accordance with the temperature of the heated gas is made to bypass at least a part of the heat-exchange surface. The gas heater proposed by the invention is characterised in having a temperature measuring device which is influenced by the combustion gases and through which the fuel quantity is regulated, and a temperature impulse transmitter which is influenced by the heated gas and which regulates a quantity of the gas to be heated that bypasses the heating surface.

It is expedient for the regulating devices for setting the fuel and for setting the bypass quantity to be equipped with a yielding return device which adjusts the normal value of the temperature to be regulated without lasting irregularity. By means of an additional impulse transmitting device the member regulating the fuel quantity can be influenced in addition in accordance with the pressure of the combustion air.

The invention is explained in more detail below with the aid of the drawings.

Fig. 1 shows the gas heater for carrying out the method of the invention.

Fig. 2 shows the fuel regulating arrangement, and

Fig. 3 the regulating arrangement for the quantity of gas bypassed.

To the gas heater shown in Fig. 1 fuel is supplied through the pipe 1 and combustion air through the pipe 2, the combustion gas flows through the pipe 3 to points of consumption not shown in the drawing. The gas to be heated is supplied to the gas heater through a pipe 4, while the heated gas passes through the pipe 5 to points of consumption not shown in the drawing.

The fuel is atomized through the burner 1a and is introduced, mixed with the combustion air, into the combustion chamber 6, in which combustion takes place. The combustion gas flows out of the combustion chamber through the heat-exchange tubes 7 into the collecting chamber 8 and is led off from this into the pipe 3.

The major part of the gas to be heated is supplied from the pipe 4 through the pipe 9 to the

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one end of the space 10 surrounding the heat-exchange tubes 7, and another regulable part is introduced into the space 10 through the bypass pipe 11 at a point 12 at which the major quantity supplied through the pipe 9 is already partly heated. The heated gas is extracted at the other end of the space 10 and led off into the pipe 5.

For regulating the fuel quantity a regulating member 13 is provided in the fuel pipe, and this is controlled by the servomotor 14 and in addition by the pressure registering box 15. The servomotor 14 is under the influence of the temperature measuring implement 18 through the medium of the impulse pipe 16 and the impulse transmitter 17.

In the pipes 9 and 11 branching off from the pipe 4 are arranged the regulating members 19 and 20 respectively, which are controlled by the servomotor 21. This servomotor is influenced through the impulse pipe 22 and the impulse transmitter 23 by the temperature measuring implement 24. Through the regulating device described, not only is the heat supply to the gas heater from the fuel regulated in accordance with the temperature of the combustion gas, but the bypassed quantity of the gas to be heated is also regulated in accordance with the temperature of the heated gas.

The regulating device for the quantity of fuel (Fig. 2) has as its temperature measuring implement 18 a metal rod which undergoes measurable changes of length under the influence of temperature changes. These changes of length are transmitted through the lever mechanism 25 to the control valve 26 of the impulse transmitter. This valve controls the supply of pressure medium from the pipe 26a to the auxiliary servomotor 27 and the discharge of fluid from this servomotor to the discharge pipe 28.

The piston 29 of the servomotor 27 is connected on the one hand through the rod 30 to the drag device 31 and on the other hand through the spring 32 to the control valve 33. The piston 34 of the drag device separated two cylinder spaces from each other which are connected through a pipe 35 provided with a throttling point 35. The valve 33 controls the supply of a pressure medium from the pipe 37 into the control space 39 of the valve casing 40 and the discharge from this control space to the pipe 38. The control impulses of the impulse transmitter described are transmitted to the servomotor 14 through the control pipe 16.

The servomotor 14 has a piston 41 upon which the force of the spring 42 acts from below and

the force of the control medium in the space 54 from above. Through the lever mechanism 43 the piston 41 influences the valve 44 of the regulating member 13 in the fuel pipe 1. An additional influencing of the valve 44 is effected through the pressure registering box 15, which is connected through the pipe 45 to the pipe which conducts the combustion air.

For setting the normal value for the temperature of the combustion gas which is to be regulated, a setting device 46 is provided with which the position of the spring 47 and the joint 56 can be altered.

If the temperature of the combustion gas rises above the normal value, the joint 48 of the temperature measuring implement is displaced in the + direction of the arrow 49. The control valve 26 is then displaced in the + direction of the arrow 50. Thus pressure fluid passes from the pipe 26a through the pipe 51 into the cylinder space situated below the piston 29. The fluid compressed on the upper side of this piston flows through the pipe 52 into the discharge pipe 28. The piston 29 is now displaced in the + direction of the arrow 53.

Through the displacement of the servomotor piston 29 the existing compression stress of the spring 32 is reduced, whereupon the control valve 33 is forced by the control fluid present in the space 39 in the + direction of the arrow 53. Communication is established between the discharge pipe 38 and the control space 39, so that the control pressure in the space 39 is reduced by the discharge of fluid until the decreased pressure loading on the valve 33 again balances the reduced compression stress of the spring 32 in the middle position of the valve, in which the control openings of the pipes 37 and 38 are closed.

The reduced control pressure in the space 39, in the pipe 16 and in the control space 54 of the servomotor 14 causes a displacement of the piston 41 in the - direction of the arrow 55 through the spring 42. The cross-section of flow of the regulating member 13 freed by the valve 44 is then diminished, and a smaller quantity of fuel flows to the burner. The deviation of the temperature from the normal value which originally started the regulating movement is thus again equalised.

Overregulation and oscillation are prevented with the aid of the drag coupling 31, which takes effect as a yielding return means and at the very beginning of the regulating adjustment initiates a return movement. During the displacement of the servomotor piston 29 the drag piston 34 is also displaced in the + direction of the arrow 53 while loading the spring 47. The joints 56 and 57 are thus displaced in the direction opposite to the original direction of displacement, so that the control valve 26 is again drawn back towards its middle position.

The regulating device only comes to rest when the spring 47 is unloaded and the valve 26 in its middle position closes the control openings of the pipes 51 and 52. This position of rest, however, can only present itself when the measuring implement 18 is influenced by a temperature which corresponds exactly to the normal value set by the setting device 46. In the process the piston 34 of the drag device in the cylinder 31 will be displaced. This speed of displacement and thus the speed of the return motion depend on the magnitude of the cross-section of throttling of the throttling member 35. The yielding return means works accordingly in such a way that no lasting deviation from the normal

value and thus no lasting irregularity presents itself.

A similar regulating process, but with regulating motions in the opposite direction, sets in when the temperature falls below the normal value. In this case the cross-section of flow of the valve 44 in the regulating member 13 is increased. The thereby increased fuel quantity is able to equalise once more the reduction of temperature which originally started the regulating motion.

By means of the setting device 46 the normal value to be maintained by the regulating device can be set to correspond to service conditions. A displacement of the setting device 46 in the + direction of the arrow 53 gives an increase of the normal temperature value. The joint 56 will then hold the spring 47 free from load only in a higher position. This position of the joint 56 corresponds to a lower position of the joint 48, which is allocated to the increased normal temperature value. A displacement of the setting device 46 in the - direction of the arrow 53 gives a reduction of the normal temperature value.

An additional influence on the valve 44 is exerted through the pressure of the combustion air. At higher pressure the membrane box 15 expands and frees the flow passage for a larger fuel quantity than when the pressure of the combustion air is low.

The regulating device for the bypassing of a part of the gas to be heated (Fig. 3) has the regulating members 19 and 20 in the pipes 9 and 11, which are influenced by the temperature measuring implement 24 designed as a rod sensitive to temperature. The alterations in the length of this measuring rod are transmitted through the lever mechanism 58 to the control valve 59 of the impulse transmitter. Through this valve the supply of a pressure medium from the pipe 60 to the auxiliary servomotor 61 and the discharge from the servomotor into the discharge pipe 62 are controlled.

The piston 63 of the servomotor is connected on the one hand through the rod 64 to the drag device 65 and on the other through the spring 66 to the control valve 67. The piston 68 of the drag device separates two cylinder spaces which are connected through a pipe 70 provided with a throttle point 69. The control valve 67 controls the supply of a pressure medium from the pipe 71 or its discharge into the pipe 72.

The control space 73 of the valve casing 74 is connected through the control pipe 22 to the servomotor 21. The servomotor 21 has a piston 75 which is held in equilibrium by the force of the spring 76 acting from above and the pressure of the control space 77 acting from below. Through the lever mechanism 87 the piston 75 controls the regulating members 19 and 20 in the main pipe 9 and in the bypass pipe 11.

For setting the normal value for the temperature of the heated gas to be regulated the setting device 79 is used, by means of which the load on the spring 78 can be changed.

When the temperature of the heated gas rises above the normal value, the rod 24 is increased in length, so that the joint 80 is displaced in the + direction of the arrow 81. In this way the control valve 59 is displaced in the + direction of the arrow 82. A communication is established between the pipes 60 and 83, so that pressure fluid can flow into the cylinder space situated above the piston 63. The piston 63 is displaced in the + direction of the arrow 85 and the fluid

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thereby compressed in the lower cylinder space is led off through the pipe 84 to the discharge pipe 62.

Through the displacement of the servomotor piston 63 the existing compressive stress of the spring 66 is reduced and the valve 67 is thus displaced in the + direction of the arrow 85. Communication is then established between the discharge pipe 72 and the control space 73. By the discharge of control fluid the control pressure in the space 73 is reduced, until the pressure loading on the valve 67, hereby diminished, balances the reduced compressive stress of the spring 66 in the middle position of the valve, the control openings of the pipes 71 and 72 then being closed.

The reduced control pressure in the space 73 is transmitted through the pipe 22 into the control space 77 of the servomotor 21. The piston 75 is displaced by the spring 76 in the + direction of the arrow 86. The regulating members 20 and 19 are thereby so displaced that an increased cross-section of flow is available for the bypass quantity flowing through the pipe 11 and a diminished cross-section of flow for the major quantity flowing through the pipe 9. A greater quantity of the gas to be heated bypasses the heat-exchange surface of the gas heater, so that lower heating results and thus the increase of temperature which initiated the regulating motion is again evened out.

Overregulation and oscillation is prevented with the aid of the drag coupling 65, which takes effect as a yielding return means and at the very beginning of the regulating displacement begins a return motion. During the displacement of the servomotor piston 63 the drag piston 68 is also displaced in the + direction of the arrow 85 while loading the spring 78. The joint 89 is therefore displaced in the direction opposed to the original direction of displacement, so that the control valve 59 is drawn back towards its middle position.

The regulating device comes to rest only when the spring 78 is unloaded and the valve 59 in its middle position closes the control openings of the pipes 83 and 84. This position of rest, however, can only present itself when the measuring implement 24 is influenced by a temperature which corresponds exactly to the normal value set. The yielding return means works accordingly in such a way that no lasting deviation from the normal value and thus no lasting irregularities present themselves.

A similar regulating process, but with the opposite direction of regulation sets in if the temperature which influences the measuring device 24 falls below the normal value. The bar 24 is shortened so that the regulating member 20 frees a smaller cross-section of flow, but the regulating member 19 a larger cross-section. In this way an increased quantity of the gas to be heated is conducted over the heating surfaces of the gas heater, so that the final temperature is correspondingly raised until the normal value is re-established.

By means of the setting device 79 the normal value to be maintained by the regulating device can be adapted to correspond to the prevailing conditions. A displacement of the setting device 79, designed as a screw, in the + direction of the arrow 85 causes an increase of the normal value of the temperature. The joint 88 will then transmit the unloaded condition of the spring 78 only in a lower position. To this position of the joint

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88 corresponds a position of the joint 80 which, in the + direction of the arrow 81, corresponds to the desired higher normal temperature value. A displacement of the setting device 79 in the - direction of the arrow 85 reduces the normal value for the temperature.

With the aid of the regulating arrangement described, the temperatures of the combustion gas led off from the gas heater and of the heated gas are regulated separately from each other, each in the light of special conditions. Delays of regulation as a result of the heat stored in the walls of the heat-exchange surfaces are obviated. If, for instance, the temperature of the combustion gas leaving the heat-exchanger rises above the normal value, the regulating device brings about a reduction of the fuel supply, whereby the outlet temperature of the combustion gases is immediately reduced. By the diminution of the fuel supply the temperature in the combustion chamber is diminished, and through this there follows at once a drop of the temperature of the combustion gas, this happening before the temperature of the heat-exchange surfaces has altered.

Likewise when the temperature of the gas to be heated exceeds the normal value, an increased quantity is at once led through the bypass pipe so as to bypass the heat-exchange surfaces. In this way the heat absorption of the whole quantity of gas is reduced, in spite of the fact that the temperature of the heat-exchange surfaces has not yet altered.

Instead of setting the normal values by hand, they may also be set automatically in accordance with the service magnitude of a plant of which the gas heater forms part. If the permissible fluctuations of temperature in a particular use of the gas heater are broad enough not to require the extreme evenness of regulation assured by yielding return devices, the basic advantages of the invention may be obtained and fluctuations held within permissible limits while employing rigid return devices.

Gas heaters of the type described are particularly suitable for heating the air in gas turbine plants. Compressed air can then be supplied to the burner 1a through the pipe 2 and to the space 10 through the pipe 4 from a common pipe. The heated air serves, for instance, for operating the turbine which drives the compressors, while the combustion gas drives the useful output turbine. The temperature of the heated air and the temperature of the combustion gas can then be maintained in accordance with the conditions required by the service independently of each other. The additional influencing of the fuel regulating member 13 by the pressure registering box 15 is effected in an expedient manner in accordance with the pressure of the combustion air.

I claim:

1. A method for the regulated heating of gases in separate streams which includes supporting a combustion in one of the streams, passing the stream containing the combustion gases through a zone of heat exchange contact with another of the streams, regulating the fuel supplied to the combustion in dependence on the temperature of the combustion gas stream leaving the heat exchange zone, and independently regulating the length of passage through the heat exchange zone of a portion of the heated stream in dependence on the temperature of that heated stream on leaving said zone.

2. A gas heater including, in combination, a burner, a heat exchanger heated by the combus-

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tion gases from said burner, a first entrance conduit for delivering a stream of gas to be heated to said heat exchanger, an exit conduit for taking off heated gas from said heat exchanger, a bypass entrance conduit for delivering a portion of the stream of gas to be heated to said heat exchanger near said exit conduit than said first entrance conduit, a flue for taking off the combustion gases from said heat exchanger, a flow regulator controlling the distribution of gas to be heated between said first entrance conduit and said bypass entrance conduit in response to the temperature in said exit conduit to decrease or increase the quantity of gas bypassed as said exit conduit temperature falls below or rises above a set value, respectively, and a fuel regulator controlling the quantity of fuel delivered to the burner in response to the temperature in said flue to decrease or increase the quantity of fuel as said flue temperature rises above or falls below a set value, respectively.

3. The combination of claim 2 in which a temperature responsive device located in the flue in combination with a yielding return device actuates the control member of a servomotor and said servomotor actuates a fuel regulating valve.

4. The combination of claim 2 in which a temperature responsive device in the exit conduit in combination with a yielding return device ac-

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tuates the control member of a servomotor and the servomotor actuates coordinated flow regulating valves in said first and bypass entrance conduits.

5. The combination of claim 2 in which the quantity of fuel delivered to the burner is additionally controlled by the fuel regulator in response to the pressure of the combustion supporting atmosphere to decrease or increase the quantity of fuel as said combustion supporting atmosphere pressure falls below or rises above a set value, respectively.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,038,402	MacPhee	Sept. 10, 1912
1,585,170	Roucka	May 18, 1926
1,748,091	Summers	Feb. 25, 1930
1,850,466	Martin	Mar. 22, 1932
2,016,317	Dahl	Oct. 8, 1935

FOREIGN PATENTS

Number	Country	Date
850,923	France	Sept. 25, 1939