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GENERATION AND SUPERHEATING OF VAPOR
BY BURNING COMBUSTIBLE GAS
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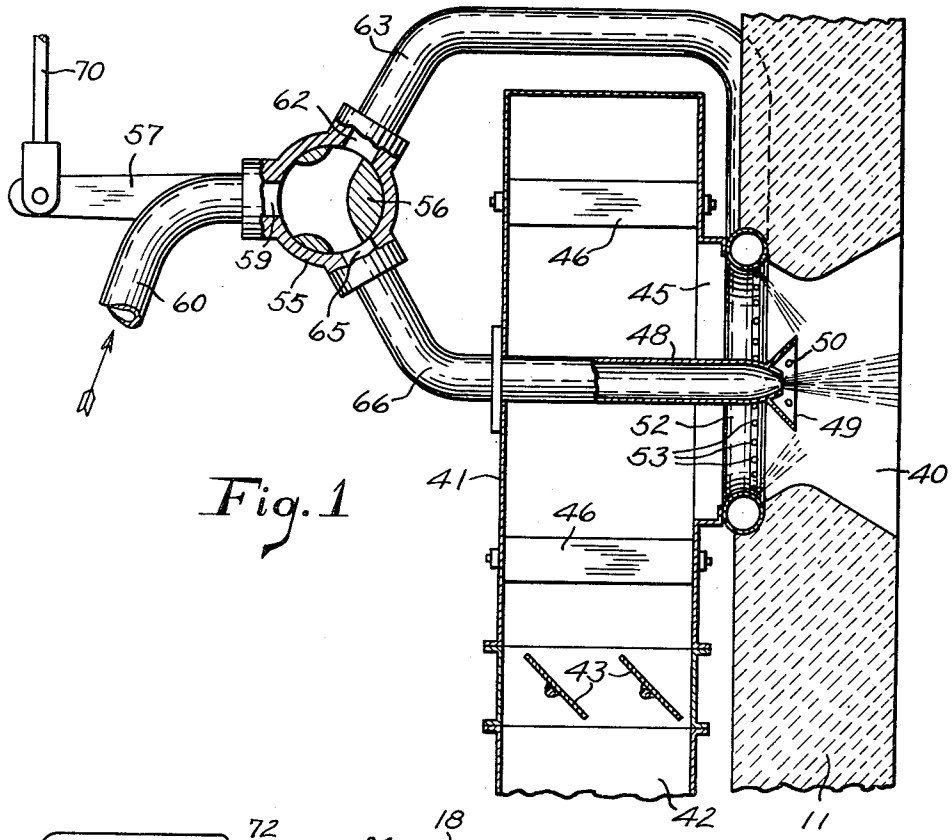

Fig. 1

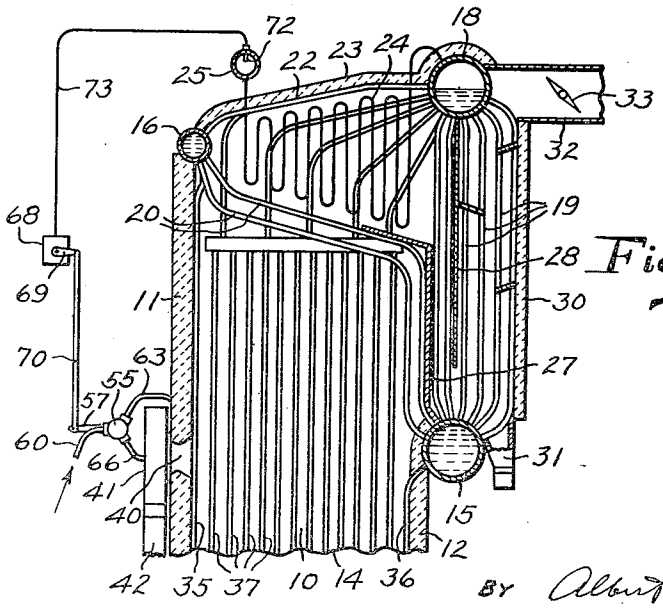

Fig. 2

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GENERATION AND SUPERHEATING OF VAPOR BY BURNING COMBUSTIBLE GAS

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This invention relates to the generation and superheating of vapor by burning combustible gas, and more particularly to an apparatus whereby the temperature of superheated vapor may be accurately controlled despite wide variations in the rate of vapor generation.

When steam is to be used for power purposes, it is the common practice to employ a steam boiler and an associated steam superheater, these parts being constructed and arranged to utilize the heat derived from the combustion of fuel. In many such installations the superheater receives all or a very substantial part of its heat by convection from the combustion gases after they have left the furnace, the furnace itself usually having water cooled walls to absorb radiant heat. When a steam generating unit of this type is in operation, it is found that the temperature of the steam leaving the superheater will vary with changes in the steam output. This is undesirable, and many attempts have been made to maintain a substantially constant steam temperature, but the prior arrangements have been subject to various disadvantages. In some cases dampers are required to control the flow of hot gases, but it is difficult to provide dampers which will close tightly when necessary and which will withstand the severe operating conditions. Injection of water into the steam is a known practice, but unless the water is distilled it will contaminate the steam. Desuperheaters of the indirect contact type are expensive and often require complicated piping.

It is accordingly one object of the invention to provide a comparatively simple, inexpensive, and dependable apparatus for generating and superheating vapor to a predetermined temperature by burning combustible gas.

It is a further object of the invention to provide a novel apparatus for controlling the temperature of superheated vapor, such as to avoid the disadvantages of the prior art.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawings illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a vertical section through a gas burner and a portion of an associated furnace wall; and

Fig. 2 is a vertical longitudinal section through a steam generating and superheating unit, with the burner of Fig. 1 mounted in operative position thereon.

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The embodiment illustrated comprises a furnace or combustion chamber 10 having a front wall 11, a rear wall 12, and two opposed side walls 14 (one only being shown). A horizontal water drum 15 is located adjacent the top of the rear wall 12, and a small horizontal water drum or header 16 is located adjacent the top of the front wall 11. A horizontal steam-and-water drum 18 is mounted above the rear water drum 15 and is connected thereto by a bank of upright water tubes 19. Two rows of water tubes 20 extend upwardly from the front portion of the water drum 15 and then forwardly to the drum 16. A row of water tubes 22 leads upwardly and rearwardly from the drum 16 to the drum 18 and serves to support a roof 23. A superheater 24 is mounted above the water tubes 20 and beneath the roof 23, the rear ends of the superheater tubes being connected to the drum 18 to receive steam therefrom, and their front ends being connected to a steam outlet header 25. A baffle 27 extends upwardly from the drum 15 behind the upright portions of the water tubes 20, and a baffle 28 extends downwardly from the drum 18 behind the two front rows of water tubes 19. A wall 30 is located behind the rearmost row of water tubes 19. A soot hopper 31 is provided between the bottom of the wall 30 and the water drum 15, and a gas outlet duct 32 is provided at the top of the wall 30, this duct having a damper 33 therein. Rows of water wall tubes 35 and 36 are associated with the front and rear walls 11 and 12 respectively, and a row of water wall tubes 37 is associated with each of the side walls 14. As so far described the steam generating and superheating apparatus is of a well-known construction.

In order to obtain the heat necessary for operation of the apparatus, combustible gas and air are introduced into the furnace as two elements for combustion to mix with one another, thereby producing a flame and hot gaseous products of combustion. Steam is generated in the various water tubes, particularly in the tubes which are in position to receive and absorb heat radiated by the flame, and this lowers the temperature of the combustion gases. The steam travels through the superheater 24, which is in a position to receive heat from the hot gases mainly by convection.

For the purpose of controlling the temperature of the superheated steam, we vary the luminosity of the flame and thereby vary the rate at which heat is radiated therefrom to the surrounding water tubes. In this manner we are able to alter the temperature of the gases reaching the super-

heater and thus obtain control of the superheated steam temperature. In order to make possible the required variation in flame luminosity, we preferably direct portions of one of the combustion elements in two separate paths. One of these paths is such as to bring about a comparatively slow mixing of the elements and a luminous flame. The other path is such as to bring about a comparatively rapid mixing of the elements and a non-luminous flame. The flame luminosity is controlled by varying the relative rates of flow in the respective paths.

Referring now particularly to Fig. 1, it will be seen that the front wall 11 of the furnace is provided with an opening 40 for the admission of the fuel and air. In front of this opening there is mounted a burner box 41 forming a plenum chamber to which air is supplied under pressure from a suitable source through a duct 42 equipped with the usual dampers 43. Air flows rearwardly from the box 41 through an opening 45 in the rear wall thereof and thence through the furnace wall opening 46. This air stream is preferably caused to spin about the axis of the opening 40, in known manner, by means of angularly positioned vanes or louvers 46 located within the box 41. A fuel nozzle 48 is axially aligned with the furnace wall opening 40 in position to discharge a comparatively large jet of combustible gas rearwardly therethrough. This gas will mix with the surrounding air rather slowly, producing a highly luminous flame within the furnace. A conical baffle 49 may be mounted on the rear end of the nozzle to deflect the air stream away from the fuel jet and thus still further delay the mixing. If desired, a few small openings 50 may be provided through this baffle. Between the burner box 41 and the wall 11, and surrounding the wall opening 40, there is mounted a gas ring 52 in the form of a hollow torus having a series of orifices 53 from which comparatively small jets of combustible gas are directed inwardly toward the axis of the ring and at a slight angle rearwardly toward the furnace. Since these gas jets travel inwardly across the air stream which flows through the opening 40, the gas and air will mix very rapidly, producing a substantially non-luminous flame within the furnace.

By controlling the relative proportions of fuel gas delivered to the central nozzle 48 and to the ring 52 we are able to vary the luminosity of the flame and thereby control the temperature of the superheated steam. Various forms of apparatus may be employed for this purpose. In the particular embodiment illustrating there is provided a three-way valve 55 having a valve member 56 controlled by an operating lever 57. This valve has an inlet 59 which is supplied with fuel gas by a pipe 60, an outlet 62 which is connected to the gas ring 52 by a pipe 63, and an outlet 65 which is connected to the central nozzle 48 by a pipe 66. In order to provide automatic control for the valve 56 there is shown a power relay 68 of a suitable and well-known type having an arm 69 connected to the valve lever 57 by a link 70. A temperature responsive bulb 72 is mounted within the superheater outlet header 25 and connected to the relay 68 by a small tube 73. This bulb may be of a known type containing a volatile liquid which will vary the fluid pressure at the relay 68 if any variation occurs in the steam temperature.

The operation of the invention will now be apparent from the above disclosure. A suitable combustible gas, such as natural gas, will be delivered through the pipe 60 to the three-way valve 55 at a rate required by the current demand for steam. Some of this gas will flow through the pipe 63 to the gas ring 52 and be discharged from the orifices 53. The remainder of the gas will flow through the pipe 66 and be discharged from the nozzle 48. Air from the duct 42 will flow past the dampers 43 and the louvers 46 to the opening 45 and thence through the wall opening 40, mixing with the gas to produce a flame and hot gaseous products of combustion in the furnace 10. These hot gases will travel upwardly past the tubes 20 into contact with the superheater 24, downwardly behind the baffle 27, and upwardly behind the baffle 28 to the outlet duct 32. Steam will be generated in the various heat-exposed water tubes and released in the drum 18, whence it will travel through the superheater 24 to the header 25. If the temperature of the steam in this header increases above a desired value, the bulb 72 will increase the fluid pressure transmitted through the tube 73 to the relay 68, which will respond by lowering the arm 69 and the valve lever 57. This will turn the valve member 56 in a counter-clockwise direction to cause a greater proportion of the fuel gas to flow through the central nozzle 48, thereby increasing the luminosity of the flame. This will increase the radiation of heat from the flame to the water tubes surrounding the furnace and thus reduce the temperature of the hot gases reaching the superheater, so that less heat will be transmitted by convection to the steam and its temperature will be lowered. Similarly, if the steam temperature drops appreciably below the desired value, the bulb 72 will decrease the fluid pressure transmitted through the tube 73 to the relay 68. Consequently the relay arm 69 will move upwardly, lifting the valve lever 57 and turning the valve member 56 in a clockwise direction. This will increase the proportion of the fuel gas flowing through the gas ring 52, and decrease the luminosity of the flame. Hence less heat will be radiated from the flame to the surrounding water tubes, the temperature of the hot gases reaching the superheater will be increased, more heat will be transmitted by convection to the steam, and the temperature of the steam will be raised. In this manner, the steam temperature may be accurately controlled.

It will be recognized that the invention provides a highly advantageous apparatus for controlling the temperature of superheated vapor in vapor generators fired by gas. The apparatus is comparatively simple and inexpensive. If desired, the relay 68 may be omitted, and the valve lever 57 may then be controlled manually. Any movement of this lever, whether produced automatically or manually, will effect a very prompt adjustment of the vapor temperature.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. Apparatus for generating and superheating vapor comprising walls forming a furnace, a burner to introduce a combustible gas and air as two elements of combustion into the furnace to produce a flame and gaseous products of combuston, the burner providing two separate conduits for portions of one of said elements, one conduit being such that the portion of the element discharged therefrom will mix rather slowly with the other element to produce a comparatively luminous flame and the other conduit being such that the portion of the element dis-

charged therefrom will mix rather rapidly with the other element to produce a comparatively non-luminous flame, means to control the relative rates of flow in the two conduits and the resultant flame luminosity, vapor generating elements in position to absorb heat radiated by the flame, and a vapor superheater in position out of the presence of the vapor generating elements to receive heat mainly by convection from the said gaseous products.

2. Apparatus for generating and superheating vapor comprising walls forming a furnace, a burner to introduce a combustible gas and air into the furnace to produce a flame and gaseous products of combustion, the burner providing two separate conduits for portions of the gas, one conduit being such that the portion of the gas discharged therefrom will mix rather slowly with the air to produce a comparatively luminous flame and the other conduit being such that the portion of the gas discharged therefrom will mix rather rapidly with the air to produce a comparatively non-luminous flame, means to control the relative rates of gas flow in the two conduits and the resultant flame luminosity, vapor generating elements in position to absorb heat radiated by the flame, and a vapor superheater in position out of the presence of the superheater to receive heat mainly by convection from the said gaseous products.

3. Apparatus as set forth in claim 2, in which a three-way valve is provided to control the relative rates of gas flow in the said two conduits.

4. Apparatus as set forth in claim 3, in which means is provided to control the three-way valve

automatically in response to variations in the temperature of the vapor leaving the superheater to cause more gas to flow through the said one conduit when it is desired to lower the superheat.

5. Apparatus for generating and superheating vapor comprising walls forming a furnace, a burner to introduce combustible gas and air into the furnace to produce a flame and gaseous products of combustion, the burner including a nozzle arranged to discharge a large jet of gas free from air and a hollow gas ring surrounding said nozzle having a series of orifices arranged to discharge small jets of gas free from air transversely of the gas from said nozzle into an air stream flowing through the gas ring, means to direct gas in controlled relative proportions to the central nozzle and to the gas ring, vapor generating elements in position to absorb heat radiated by the flame, and a vapor superheater in position out of the presence of the vapor generating elements to receive heat mainly by convection from the said gaseous products.

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