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METHOD AND INSTALLATION FOR THE PRODUCTION OF STEAM, PARTICULARLY THROUGH THE COMBUSTION OF REFUSE AND OTHER LOW QUALITY FUELS

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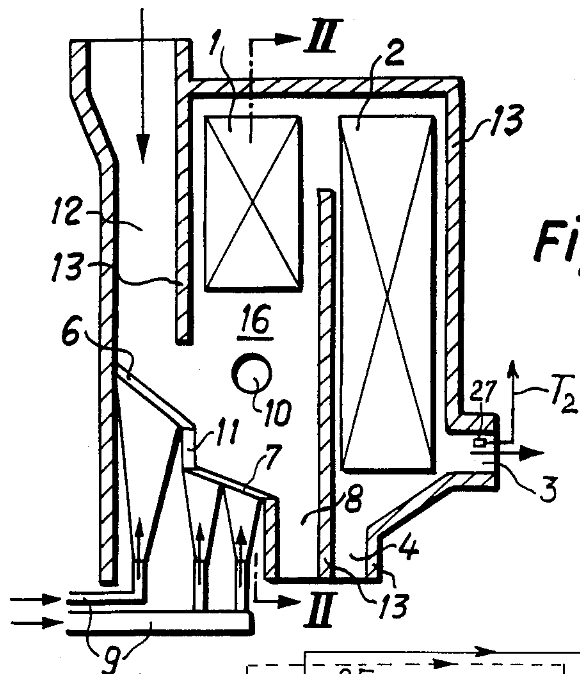

Fig. 1

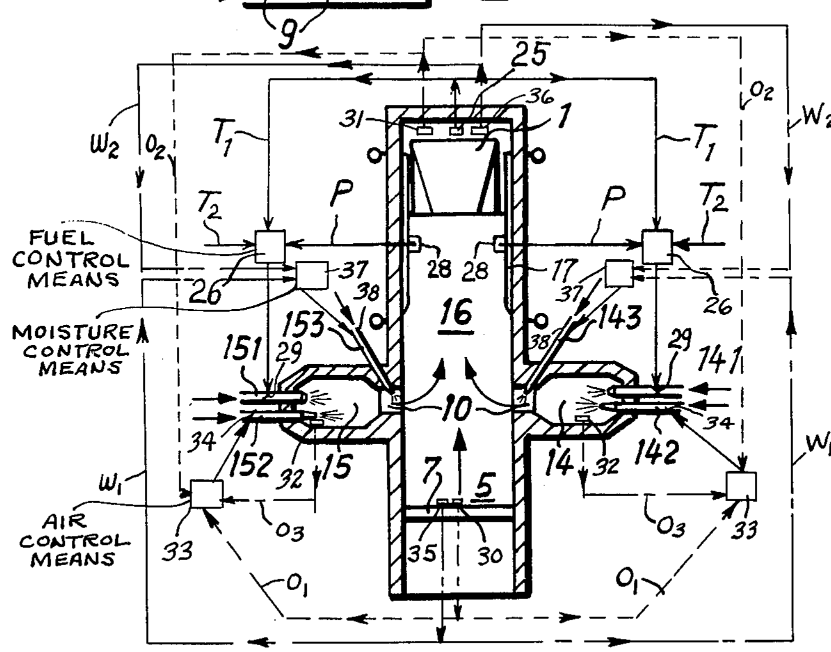

Fig. 2

INVENTOR
Richard Tanner
BY Werner W. Kleeman
His Attorney

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METHOD AND INSTALLATION FOR THE PRODUCTION OF STEAM, PARTICULARLY THROUGH THE COMBUSTION OF REFUSE AND OTHER LOW QUALITY FUELS

Richard Tanner, Zurich, Switzerland, assignor to Von Roll AG., Gerlafingen, Switzerland, a corporation of Switzerland

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The present invention broadly has reference to an improved method and installation for producing steam, especially by burning low quality fuels of varying heating values such as domestic refuse for example.

It is known that with an installation which includes a steam boiler and is provided for burning domestic refuse or another low quality fuel, difficulties are encountered since these fuels are of varying quality and therefore have varying combustion properties. Since, as has been found in practice, the quantity of fuel introduced cannot be adapted to variations in quality, this means that the steam boiler cannot be operated continuously at a load corresponding to its rated capacity. Particularly in the case of fairly large plants designed for high steam parameters, this may result in poor utilization of the rated capacity and therefore of the capital invested.

It is known to use a so-called supporting fire for compensating for these fluctuations in combustion properties, this fire being arranged at a specific point in the refuse combustion chamber. This fire is fed with a high-quality fuel, such as fuel oil, gas or pulverised coal. However, this supporting fire has the disadvantage that it has a much higher combustion temperature than the refuse combustion temperature. As a result, there are irregularities in the heat regime of the furnace, and non-uniform heat transfer to the boiler. It has already been attempted to eliminate this disadvantage by varying the arrangement of the supporting fire and by regulating the supporting fire from the outside in dependence of the steam load. Nevertheless, no uniform heat regime and therefore no uniform transfer of heat has so far been obtained.

Accordingly, it is a primary object of the present invention to provide an improved method and apparatus which effectively and reliably eliminates the aforementioned disadvantages.

A further important object of the present invention is the provision of an improved method of and installation for the production of steam, especially through the combustion of low quality fuels, such as domestic refuse and the like, and affording good utilization of the rated capacity of the steam boiler as well as uniform heat transfer to such steam boiler.

According to one aspect of the invention there is provided an improved method of producing steam, comprising burning high-quality fuel in a first combustion space, burning low-quality fuel in a separate second combustion space shielded against heat radiation from said first combustion space, leading gases produced in said second space to a location spaced from the first and second spaces, leading hot gases produced in the first space to said location at which they are continuously mixed with said gases produced in said second space, leading the mixed gases from said location into contact with a heat-transfer surface of a steam boiler to produce steam, and controlling the combustion process in said first space to control thermal properties of said mixed gases and thus to obtain a desired thermal action at said heat-transfer surface.

According to another aspect of the present invention, there is provided an improved installation for producing

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steam, comprising a first combustion space for receiving high quality fuel, a second combustion space for receiving low quality fuel, separating and shielding means between said first combustion space and said second combustion space for shielding the second space against heat radiation from the first space, duct means so arranged that when the installation is in use, gases produced in said second space and hot gases produced in said first space are led to a location, which is spaced from the first and second spaces and at which said gases produced in said second space are continuously mixed with said gases produced in said first space, at least one heat-transfer surface of a steam boiler which is disposed downstream of said location, another duct means serving to lead the mixed gases from said location into contact with said surface, and means serving to regulate the combustion process in said first space. The first combustion space can advantageously be the interior of at least one muffle, in other words, a relatively small combustion chamber.

Still further objects and the entire scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and a specific example, while indicating a preferred embodiment of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

FIGURE 1 is a vertical sectional view through an installation for producing steam; and

FIGURE 2 shows a cross-sectional view taken along lines II—II in FIGURE 1.

Referring now to the drawing, the inventive installation includes a steam boiler of which only the heating surfaces **1**, **2** of the aforesaid boiler are illustrated in FIGURE 1. The heating surface **1** operates as a radiant heating surface and is located downstream of a refuse combustion space **5** and apertures or openings **10**. The heating surface **2** is arranged in a downward flue for the gases of combustion. An outlet **3** for these gases leads into a suitable chimney not shown in the drawing. Fly ash is removed continuously or periodically at location **4**. In the refuse combustion space **5** a preliminary drying or predrying grate **6** and a refuse combustion grate **7** are arranged. Between the two grates there is situated a steep descending wall **11**. At location **8**, cinders and unburned portions of the refuse are removed in a manner well known to those versed in the art. A device **9** which may be of standard construction and hence is not illustrated in detail, supplies the drying and combustion air to the grates **6** and **7** in known manner. Situated above the combustion grate **7** and in respective opposite side walls are apertures or openings **10** which establish communication between the interiors of muffles or combustion compartments **14** and **15**, on the one hand, and a mixing location **16**, on the other hand. The refuse for burning is poured into an inlet shaft **12**. The installation includes supporting brickwork or masonry **13**, as shown in FIGURE 1. Such brickwork is advantageously arranged such as to provide duct means for conducting the gases from the combustion space **5** as well as from the combustion chambers or compartments **14**, **15** to the location **16**, and from there to the heating surfaces **1** and **2**.

The two combustion chambers **14** and **15** are advantageously arranged above and laterally of the refuse combustion space **5**. The radiant heating surface **1** and its associated boiler pipes **17** are seen above the combustion chambers 14, 15 in FIGURE 2. Suitable burners **141, 151**, air feed means **142, 152** and water injection nozzles **143, 153** are arranged in the combustion chambers **14** and **15**. The fuel burners **141, 151** can be designed optionally for oil burning, for pulverized coal burning, or for gas burning. Since details of the aforesaid burners, air feed means and injection nozzles are unimportant for the understanding of the invention, and further, insofar as such units may be conventional and of any construction suitable for the purposes of the invention, the same have for simplicity in illustration only been schematically represented in the drawing.

It is expedient to give the combustion chambers **14, 15** a particular length in order to ensure that the flame burns completely within the corresponding combustion chamber and also to give them constructions leading to the apertures **10**. This constructional arrangement of the combustion chambers **14, 15** shields and separates the refuse combustion space **5** against heat radiation from the aforesaid combustion chambers.

The installation described hereinabove operates as follows:

From the refuse inlet shaft **12** shown in FIGURE 1, the refuse reaches the preliminary drying grate **6** and is pre-dried by means of hot air supplied by the device **9**. Re-cycled hot flue gases can also be used by the device **9** to pre-dry the refuse. The dried refuse drops over the wall **11** onto the actual combustion grate **7**. The combustion air in introduced below the grate **7** by the device **9**, it also being possible in known manner (not shown) to introduce secondary air at some suitable point in the refuse combustion space **5**. The course of the gases which are produced by the combustion process in the refuse combustion space **5** is indicated by the lowest arrow in FIGURE 2. The hotter gases produced by the combustion process in the combustion chambers **14** and **15** pass through the openings **10** as indicated by the curved arrows in FIGURE 2, the two gas-streams being thereupon mixed in a continuous and uniform manner at a space or location **16**, which is spaced from the combustion chambers **14** and **15** and the refuse combustion space **5**, in the manner best shown in FIGURE 2.

The shielding of the aforesaid space **5** against radiation from the interiors of the combustion chambers **14, 15** affords a further advantage that the refuse burning on the combustion grate **7** is not detrimentally influenced by such radiation, for example crust formation is avoided. This is also prevented by the fact that the apertures **10** are located some distance above the grate **7**, so that the hot gases flowing out of the apertures **10** do not contact the refuse on the grate **7**. Moreover, in the extreme case when no refuse is present, the hot gases from the openings or apertures **10** cannot reach the combustion grate **7** to subject such grate to excessive temperatures. This gives the grate **7** a long working life.

In the combustion chambers **14** and **15**, control of the production of hot gases is effected by controlling the admission of fuel at the burners **141, 151**, the admission of air at the means **142, 152**, and the introduction of water at the water injection nozzles **143, 153**. Control is effected in dependence on the characteristics of the refuse combustion, e.g. on temperature, oxygen content, and moisture content. Due to this control and the mixing of the gases, a predetermined and uniform action of heat on the heating surfaces **1, 2** of the steam boiler is maintained.

A short explanation will now be given of the manner in which this control is carried out. The control means and measuring means for this purpose are known to the art and are therefore only schematically shown in FIGURES 1 and 2.

The temperature measured at the uppermost part of the upward flue, which we shall refer to briefly as above the heating surface **1**, and at the flue gas outlet **3**, and the boiler pressure act as control variables on the rate of supply of fuel at the burners **141, 151**. The value of these variables is continuously monitored as T_1, T_2 and P by conventional temperature and pressure feelers or measuring means shown in the drawings as elements **25, 27** and **28** respectively. These values are fed into a pair of conventional control means **26** which operate to open or close the valves **29** in the fuel injection nozzles **141, 151**. With increase in temperature above predetermined maximum values, the rate of introduction of fuel is decreased. When there is an increasing temperature difference between that above the surface **1**, T_1, and that at the outlet **3**, T_2, i.e. a greater consumption of steam, the rate of introduction of fuel is increased. The rate of introduction of fuel is decreased when the pressure, P, exceeds a predetermined maximum value.

The oxygen content, measured in a conventional manner above the combustion grate **7** for refuse by measuring means **30**, above the heating surface **1** by measuring means **31** and in the combustion chambers **14** and **15** by measuring means **32**, act as a control variable on the rate of air admission at air feed means **142, 152**, the respective values O_1, O_2 and O_3 being fed to oxygen control means **33** for actuating valves **34** in the air feed means **142, 152**. When there is an increasing or decreasing excess air factor above the heating surface **1**, the introduction of air at air feed means **142** and **152** is reduced or increased, as the case may be. Combustion in the combustion chambers **14** and **15** is adapted to the combustion in the refuse combustion space **5** by ascertaining the oxygen content differences between the measurement points above the heating surface **1**, O_2 and above the combustion grate **7**, O_1 and between the interior of the combustion chambers, O_3 on the one hand, and above the grate, O_1, on the other hand. The introductions of air at air feed means **142, 152** is throttled or increased depending on the values of the differences obtained. The rate of water injection at **143, 153** is regulated by the moisture content, W_1, measured by conventional means **35** above the grate **7** and, W_2, measured by conventional means **36** above the heating surface **1**. When there is an increase in moisture content above the heating surface **1**, the rate of injection of water is decreased. When the difference between the moisture content above the grate **7**, W_1, and the moisture content above the surface **1**, W_2, has a positive value, the introduction of water is increased. Variation in introduction of moisture input is regulated by conventional control means **37** actuating valves **38** in water injection nozzles **143, 153**. This control outline merely represents one possible example. Other control arrangements may also be used.

While there is shown and described a present preferred embodiment of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practised within the scope of the following claims.

Having thus described the present invention what is desired to be secured by United States Letters Patent is:

1. A method of producing steam comprising the steps of: supplying high quality fuel, air and water into a first combustion space, burning said high quality fuel in said first combustion space, supplying low quality fuel and air into a separate second combustion space shielded against heat radiation from said first combustion space, burning said low quality fuel in said second combustion space, leading gases produced in said second combustion space to a location spaced from the first and second combustion spaces, leading hot gases produced in said first combustion space to said location at which they are continuously mixed with said gases produced in said second combustion space, leading the mixed gases from said location into contact with a heat-transfer surface of a steam boiler to produce steam, and controlling the combustion process in said first combustion space to control thermal properties of said mixed gases and thus to obtain a desired thermal action at said heat-transfer surface, the step of controlling the combustion process in said first combustion space being effected by adjusting the supply of said high quality fuel, air, and water, to said first combustion space.

2. An installation for producing steam comprising means providing a first combustion space for receiving high quality fuel, means providing a second combustion space for receiving low quality fuel, separating and shielding means provided between said first combustion space and said second combustion space for shielding the second space against heat radiation from the first space, means so arranged that when the installation is in use, gases produced in said second space and hot gases produced in said first space are led to a location which is spaced from the first and second spaces and at which said gases produced in said second space are continuously mixed with said gases produced in said first space, at least one heat-transfer surface of a steam boiler disposed downstream of said location, means serving to lead the mixed gases from said location into contact with said heat-transfer surface, and means serving to regulate the combustion in said first space, said means providing said second space incorporating wall means, said means providing said first space defining at least one combustion chamber arranged laterally of said wall means and opening into a region disposed downstream of said second space.

3. An installation for producing steam according to claim 2 wherein said regulating means includes means for supplying high quality fuel, air and water to said first space.

4. An installation for producing steam, particularly by the combustion of inferior fuels such as domestic refuse and the like comprising means providing a first combustion space for receiving high quality fuel, means providing a second combustion space for receiving low quality fuel, separating and shielding means provided for shielding the second space against heat radiation from the first space, means providing a location spaced downstream from said second space and at which said gases produced in said second space are continuously mixed with said gases produced in said first space, means for conducting gases produced in said second space and hot gases produced in said first space to said location, said first combustion space being arranged downstream of said second combustion space with respect to the direction of gas flow of gases emanating from said second combustion space, and opening into said location, at least one heat-transfer surface of a steam boiler disposed downstream of said location and in the zone of movement of the mixed gases, and means serving to regulate the combustion process in said first space.

5. A method of producing steam comprising the steps of: burning high quality fuel in a first combustion space, burning low quality fuel in a separate second combustion space shielded against heat radiation from said first combustion space, leading gases produced in said second combustion space to a location spaced from the first and second combustion spaces, leading hot gases produced in the first combustion space to said location at which they are continuously mixed with said gases produced in said second combustion space, leading the mixed gases from said location into contact with a heat-transfer surface of a steam boiler to produce steam, measuring the temperature of said mixed gases at a location downstream of said heat-transfer surface, and controlling the combustion process in said first combustion space as a function of said measured temperature to control thermal properties of said mixed gases and thus to obtain a desired thermal action at said heat-transfer surface.

6. A method of producing steam according to claim 5, further including the step of controlling the combustion process in said first combustion space as a function of the pressure prevailing at the steam boiler.

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FREDERICK L. MATTESON, Jr., *Primary Examiner.*

JOHN J. CAMBY, CHARLES SUKALO, *Examiners.*