

[54] SELF-RECUPERATIVE BURNERS

[72] Inventors: **Brian Oeppen; John Edmondson; Stanley Sourbutts**, all of Warwickshire, England

[73] Assignee: **The Gas Council**, London, England

[22] Filed: **Oct. 30, 1970**

[21] Appl. No.: **85,619**

[30] Foreign Application Priority Data

Nov. 1, 1969 Great Britain.....53,674/69

[52] U.S. Cl.....431/166, 431/215

[51] Int. Cl.....F23c 7/06

[58] Field of Search.....431/215, 161, 166

[56] References Cited

UNITED STATES PATENTS

3,101,773 8/1963 Buaha.....431/166

FOREIGN PATENTS OR APPLICATIONS

114,844 7/1926 Switzerland.....166

Primary Examiner—Edward G. Favors

Attorney—Kemon, Palmer & Estabrook

[57] ABSTRACT

A furnace has a self-recuperative burner mounted in a port in a wall of the furnace so as to form a products passage to conduct products of combustion from the furnace chamber to outside the furnace. The burner includes an air passage which leads to a nozzle mounted in the inlet of a combustion chamber and which is in heat-exchange relationship with the products passage. The air passage extends at first forwards beyond the inlet of the combustion chamber and then rearwards to the nozzle so that the air-heating surface area is more effective and metal in the hot-test part of the products passage is cooled.

5 Claims, 3 Drawing Figures

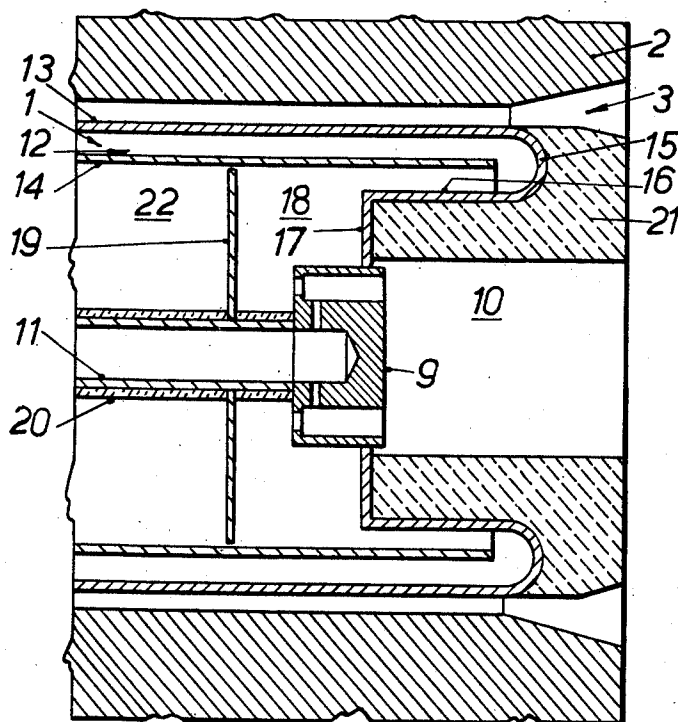


FIG - 1 -

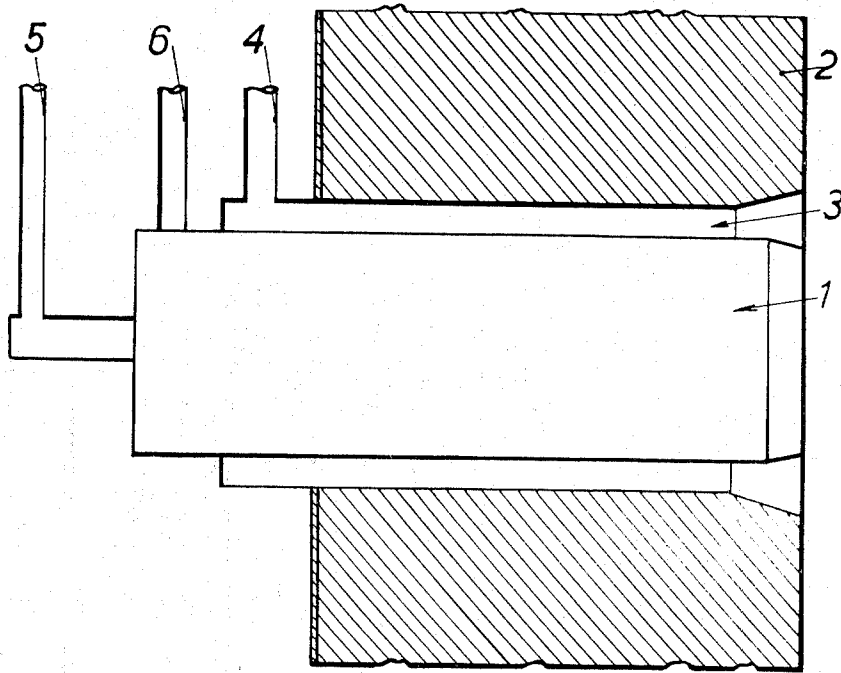


FIG-2-

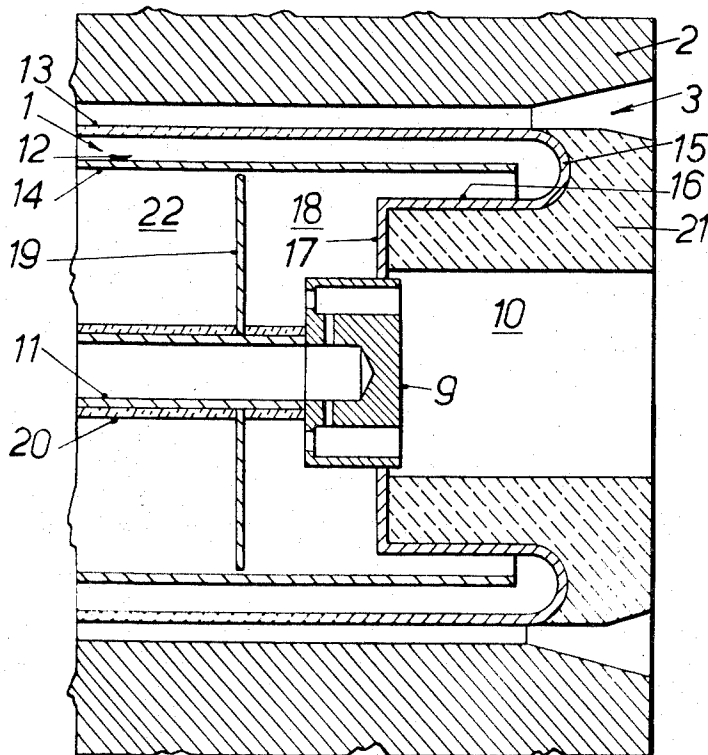
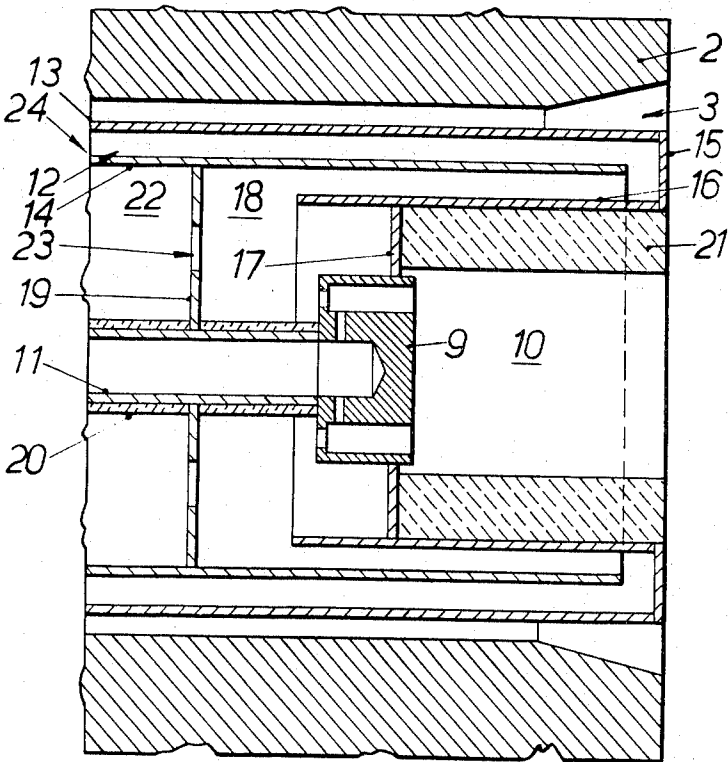


FIG. 3 -



SELF-RECUPERATIVE BURNERS

This invention relates to self-recuperative burners for use in fuel-fired industrial furnaces, heat treatment furnaces and the like and of the kind wherein, in use, fuel and combustion air are delivered separately by way of passages to a mixing nozzle or respective nozzles directed into a combustion chamber where the fuel and air are ignited and which is arranged in use to open into a space for products of combustion, the space including a products passage for conducting products of combustion to the exterior of the furnace, and the combustion air passage of the burner being arranged to be disposed in use in heat-exchange relationship with the space to constitute a recuperator in which products of combustion preheat the combustion air passing along the air passage. Such self-recuperative burners are hereinafter referred to as being "of the kind described."

Such a burner may be arranged to fire directly into a furnace chamber, in which case the furnace chamber together with the products passage constitute the space. Alternatively a burner may heat the furnace chamber indirectly by being arranged to fire into a radiant tube in which case it is the interior of the radiant tube which together with the products passage constitute the space.

For direct firing a burner is normally arranged in use to project into a hole provided in a wall of the furnace, the products passage being formed by a gap between the burner and the internal surface of the hole. In the case of a burner firing into a radiant tube the burner is normally enclosed in a tube between which tube and the burner a products passage is defined.

Hitherto in self-recuperative burners of the kind described the combustion air passage does not extend beyond the inlet end of the combustion chamber, thus what may be a relatively large proportion of the length of a burner is not used for heat transfer. In such burners metal parts, such as members supporting refractory components, for example, the combustion chamber, extend or are disposed beyond the inlet end of the combustion chamber and are exposed to temperatures at or approaching those in the furnace chamber. Hitherto to avoid rapid deterioration of such metal parts burners have been confined to use in applications where the products of combustion have temperatures less than about 1,100° C.

Normally, in use, burners are disposed so that their combustion chambers are disposed within the thickness of the furnace wall with their outlets at the inner surface of the wall for direct firing or in a corresponding position in the case of indirect firing. The products of combustion during their flow along a products passage lose heat to the furnace wall. Therefore, where known burners are in use, as there is no recuperator beyond the inlet end of the combustion chamber and the products of combustion have already lost heat to the furnace wall before reaching the recuperator, the recuperator is relatively inefficient.

The present invention consists in a self-recuperative burner of the kind described wherein the combustion air passage extends, in heat-exchange relationship with the space, forwards, with respect to the direction of flow in the combustion chamber, beyond the inlet end of the combustion chamber before turning back to the nozzle.

The combustion chamber of such a burner may be of circular cross-section in which case tubes may be mounted one within another to define annular cross-section air passages and the burner may be mounted in a cylindrical port in a furnace wall to define an annular cross-section products passage so that a recuperator so formed surrounds the burner. However, in the case of a burner with a narrow rectangular cross-sectional combustion chamber two recuperators may be provided one adjacent each of the longer sides of the combustion chamber.

Where the normal layout of such burners is followed, that is to say, with the combustion chamber within the thickness of the furnace wall and with the outlet of the combustion chamber at the inner surface of the furnace wall, the air passage may extend to or nearly to the inlet end of the products passage before turning back to the nozzle. By suitable design and with appropriate dimensions metal parts beyond the inlet end of the combustion chamber can now be cooled by the recuperator so that they can be kept below a temperature of 1,100° C. even though the products of combustion are greatly above that temperature. This extends the range of applications for self-recuperative burners into higher-temperature heat treatment processes, with the advantage that it is in such applications that a degree of air preheating which contributes markedly to thermal efficiency is most readily obtained.

If, in a high-temperature application, a self-recuperative burner is designed so that at maximum throughput, the maximum temperature of the metal recuperator is, say 1,000°C, a problem can arise when the burner is turned to low-fire. The recuperator (as with most heat exchangers) is more efficient at low through-puts, and the combustion air and metal temperatures will increase compared with their values at high-fire. The metal temperature could therefore exceed the maximum allowable for an acceptable life. One way of overcoming this is to design a less efficient recuperator. The combustion air pre-heat temperature is less, and the maximum metal temperature, even at low flows, can be held below 1,000°C. This method, however, is obviously wasteful, in that the combustion air pre-heat becomes less at high-fire than that which could safely be obtained.

A better way of overcoming this problem according to a further feature of the present invention is to design the recuperator optimally to meet the operating conditions at high-fire and to provide means for bleeding from the air passage just before the nozzle air in excess of combustion requirements at low-fire. In this way sufficient flow of air can be maintained through the recuperator to prevent an excessive rise in metal temperature.

In addition to such high-temperature applications, the invention has advantages in the field or lower-temperature heating, since with it a self-recuperative burner becomes more economical, in view of the increased heat transfer area made available by the provision of the extended air passage.

Throughout the range of temperatures, the extended air passage reduces the flow of heat from the combustion chamber, and from the hot gases flowing outwards along the products passage, to the furnace wall. This is because some heat is transferred from the combustion chamber and from the products passage to the

ingoing combustion air flowing in the extended air passage, instead of to the furnace wall.

The invention is advantageous when it is a question of replacing a town gas burner by a burner for use with natural gas. The latter needs to have a longer combustion chamber, provision of which in known self-recuperative burners of the kind described would result in either a reduction in the heat exchanger length or an increase in the overall length of the burner. As the full thickness of the furnace wall can be used for heat recovery with the present invention, this disadvantage of burning natural gas is avoided.

Embodiments of the invention will now be described by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic longitudinal sectional view of a burner according to the invention shown as mounted in use in part of a furnace wall,

FIG. 2 is a fragmentary longitudinal view of the burner shown in FIG. 1, and

FIG. 3 is a view similar to FIG. 2 of a different burner according to the invention.

The burner 1 shown in FIGS. 1 and 2 is mounted in a cylindrical port formed in a wall 2 of a furnace. An annular cross-section products passage is formed between the burner 1 and the wall of the port, and has an outlet 4. Fuel in the form of gas is supplied to the burner 1 through an inlet 5 and air is supplied to the burner through an inlet 6.

In FIG. 2 a nozzle 9 closes the inlet end of a combustion chamber 10 and is supplied with gas through a central tube 11. A combustion air passage 12 is formed by the annular space between concentric tubes 13 and 14. The forward end of the outer tube 13 is joined by an end wall 15 (curved in the present instance) to an inner concentric tube 16 inside the tube 14. The rear end of the tube 16 is joined to an annular plate 17 surrounding the nozzle 9. The forward end of the tube 14 is spaced from the end wall 15 to allow air to flow round it and then back along the annular space between the tube 14 and the tube 16 into an air box 18 the rear wall of which is an annular plate 19 which is welded to the central tube 11 and extends radially outwards to the tube 14. The central tube 11 is covered with insulation 20. Refractory material 21 surrounds the combustion chamber 10 and extends radially at the front to the outer diameter of the tube 13.

The tube 13 being the outermost tube forms with the wall of the port the annular products passage 3. The front of the refractory material 21 is coincident with the inside surface of the furnace wall 2. The burner 1 having the end wall 15 spaced somewhat from the inside surface of the furnace wall 2 by the refractory material 21, is particularly suitable for operation when the products of combustion reach very high temperatures. For operation at lower temperatures this spacing is not so necessary and the end wall 15 could be flush with the inner surface of the furnace wall.

When the burner 1 is in operation products of combustion leave the furnace along the products passage 3. Heat is radiated by the outer tube 13 to the tube 14 and from the tube 14 to the tube 16. In this way, in the region of the combustion chamber 10, combustion air will gain heat by convection from the inner surface of the outer tube 13, both surfaces of the tube 14 and the outer surface of the tube 16.

As the central gas tube 11 is not only covered by insulation 20 but separated from the tube 14 by an annular air space 22 between the insulation 20 and the inner surface of the tube 14, heat transfer to gas in the tube 11 is minimal and there is little risk of cracking of the gas with its attendant troubles.

FIG. 3 of the drawings shows a burner 24 which is generally similar in construction to that of the burner 1 of FIGS. 1 and 2 and corresponding parts are indicated by similar reference numerals. The essential difference is that a hole 23, or more than one hole, opens through the annular plate 19 into the annular space 22. At the rear end of the burner 24, external to the furnace, is a connection controlled by a valve (not shown), which leads from the annular space 22 to the outside of the burner 1.

Under low-fire conditions an adequate flow of air can be maintained through the air passage 12 to keep the temperature of the metal exposed to combustion products down to an acceptable level. Air entering the air box 18 in excess of burner combustion requirements can then be bled off by suitably setting the external valve, through the hole 23, or holes 23, the annular space 22, the external valve and the connection.

Under high-fire conditions the rate of flow of air through the air passage 12 is normally determined by the combustion conditions required, for instance, to provide for stoichiometric combustion. Under high-fire conditions, therefore, the volume of air through the air passage 12 would normally be that required for combustion alone but the construction of burner 24 as described may be used to enable the end wall 15 to be flush with the inner surface of the furnace wall 2 (as shown in FIG. 3), as the metal temperature there can be moderated, if necessary, by increasing the air flow and bleeding off through the holes 23 the excess above combustion air requirements by opening the external valve.

However, this burner 24 having a metal end wall 15, unprotected by refractory and flush with the inner surface of the furnace wall (as shown in FIG. 3), can be used for operation at higher temperatures than would otherwise be possible; whether the burner 24 is operating at high-fire or at low-fire, excess air can be caused to flow through the air passages so as to moderate the temperature of the end wall 15, the excess over combustion requirements being bled off through the holes 23 and the external valve.

We claim:

1. A furnace including a self-recuperative burner mounted in a wall of said furnace and comprising a combustion chamber defining an inlet, a nozzle disposed at said inlet of said combustion chamber, said burner defining a combustion air passage leading to said nozzle from an air inlet, a fuel passage leading to said combustion chamber and an air bleed connection including communication means leading from a point adjacent said nozzle to outside said furnace whereby air can be bled from said burner before it enters said nozzle, said furnace defining a space for products of combustion into which an outlet of said combustion chamber opens and said furnace including a products passage for conducting products of combustion to the exterior of said furnace, said air passage being disposed adjacent the exterior of said burner whereby it is in heat-exchange relationship with said space and con-

5

stitutes a recuperator in which said products of combustion preheat combustion air passing along said air passage.

2. A furnace according to claim 1 wherein said combustion air passage extends at first forwards to an inlet end of said products passage and then rearwards to said nozzle which is disposed within said wall of said furnace.

3. A furnace according to claim 2 wherein said combustion chamber of said burner is disposed within said wall of said furnace, said outlet of said combustion chamber being at an interior surface of said wall of said furnace.

4. A furnace defining a space for products of combustion and including an opening through a wall of said furnace leading from said space to the exterior of said furnace, said furnace including a self-recuperative burner mounted in said opening in said furnace wall and comprising a combustion chamber of circular cross-section defining an inlet and an outlet which opens into said space, a nozzle disposed at said inlet of said combustion chamber, means including three tubes disposed one within another, each said tube being concentrically arranged with respect to an axis of symmetry of said combustion chamber, said three tubes

6

thus defining inner and outer portions of a combustion air passage, an annular front wall portion connected to an inner one and an outer one of said three tubes at their forward ends and disposed forwards of said inlet of said combustion chamber, an intermediate one of said three tubes having its forward end spaced from said front wall portion to define a passage portion connecting said inner and outer portions of said combustion air passage, said inner portion of said combustion air passage being connected to said nozzle and said outer portion of said combustion air passage being connected to an air inlet and disposed adjacent the exterior of said burner, said outer one of said tubes defining with said opening in said furnace wall a products passage for conducting products of combustion to the exterior of said furnace, said combustion air passage being in heat-exchange relationship with said space and said products passage and constituting therewith a recuperator in which such products of combustion preheat combustion air passing along said air passage.

5. A furnace according to claim 4 wherein said annular front wall portion is disposed at an interior surface of said furnace wall.

* * * * *

30

35

40

45

50

55

60

65