BURNER WITH AIR-PREHEATED RECOVERY

Filed Aug. 15, 1968 2 Sheets-Sheet 1

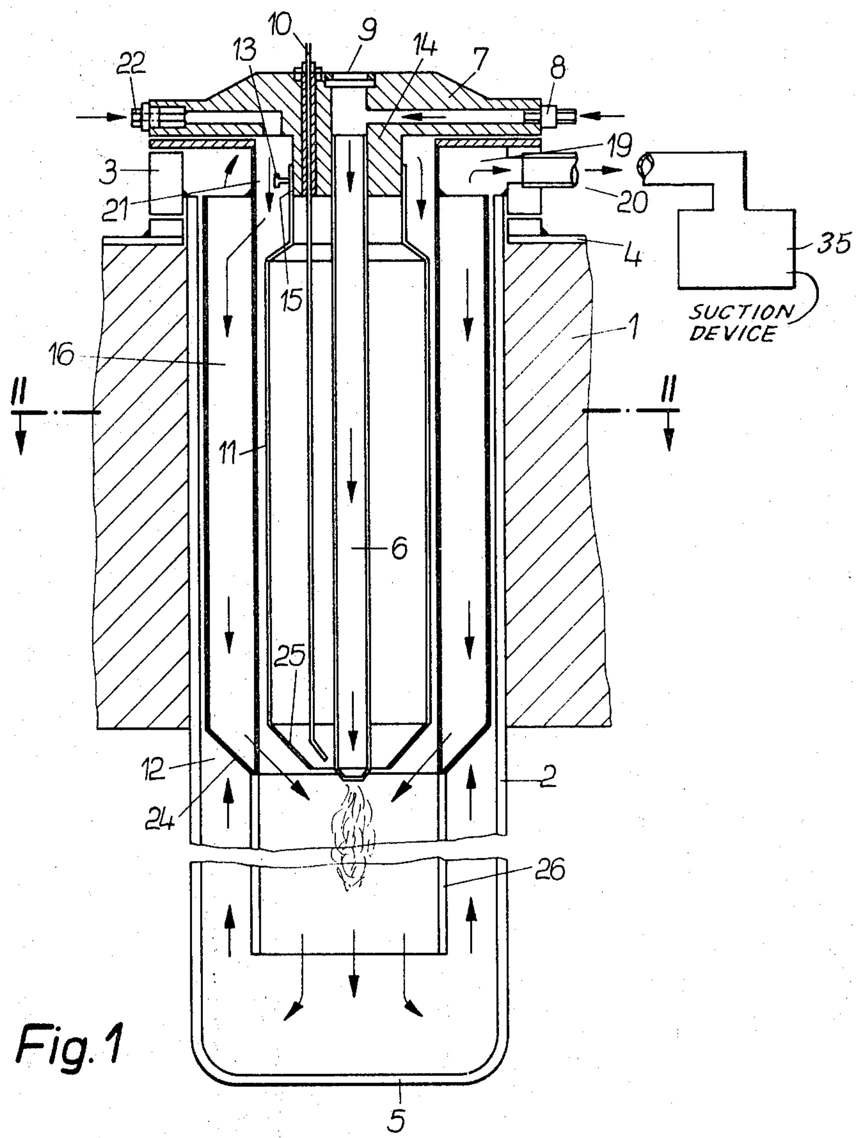

Fig. 1

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Sept. 22, 1970 J. WUNNING 3,529,812

BURNER WITH AIR-PREHEATED RECOVERY

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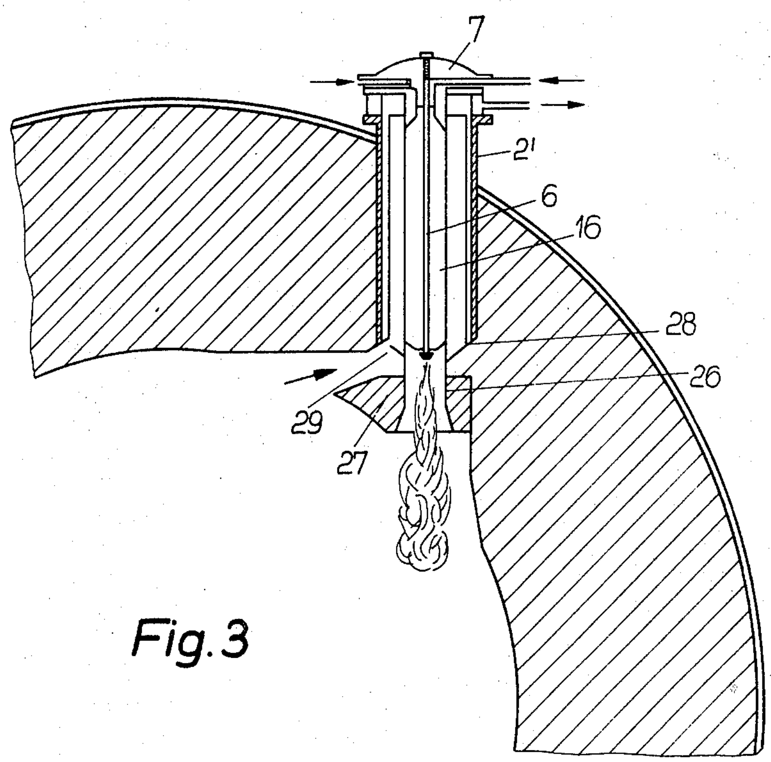

Fig. 3

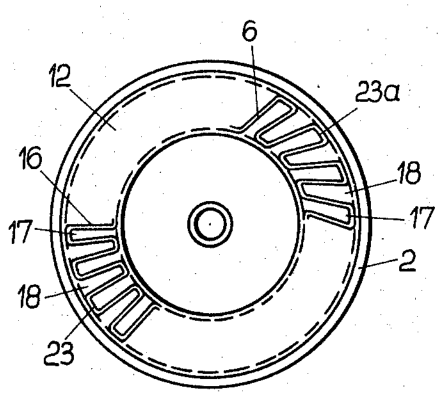

Fig. 2

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BURNER WITH AIR-PREHEATED RECOVERY

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Int. Cl. F231 9/00
U.S. Cl. 263—19 13 Claims

ABSTRACT OF THE DISCLOSURE

An industrial burner having a recuperative air preheating device including an air duct cylinder mounted around the burner and forming an annular gap between the air duct cylinder and a jacket tube. Means, such as an accordion-type folded body, is mounted in the annular gap to provide a plurality of radially extending partitions which form a plurality of axial canals in said annular gap. Air flowing in alternate canals is preheated by heat transferred thereto from the hot flue gases flowing in the remaining alternate canals.

The invention relates to industrial-type burners, preferably for gaseous fuels, and more particularly to burners having heat exchange surfaces for preheating of air.

In prior art industrial burners using jet heating tubes and more particularly burners having jacket jet heating tubes, incoming air flowing in a direction opposite to the waste gases, is preheated on its way to the mouth of the burner nozzle. For this purpose a rib recuperator is generally provided which consists mainly of radially positioned heat exchange sheets which extend in an axial direction in the air supply canal over which flows the air to be heated. These sheets have additional portions which project into a waste gas discharge canal in which the hot waste gases flowing over the additional portions of the sheets transfer heat to said sheets. A heat transfer efficiency rate of about 70% can be achieved with such known rib recuperators at furnace temperature of around 900° C. While this efficiency is acceptable in many industrial furnaces, there was a need for further improvement of the degree of efficiency of the burners. There was also a need for such a more efficient burner which also reduces the temperature of the waste gases.

Therefore, the main object of this invention is to provide a burner which is more efficient than the above-described known burners, which does not require increased space, which is economical to manufacture and operate, and which emits exhaust gases having reduced temperatures.

SUMMARY OF THE INVENTION

According to this invention, a burner comprises a central fuel nozzle and an air duct cylinder surrounding the nozzle. A jacket tube surrounds and is spaced from the air duct cylinder to form an annular gap therebetween. Also provided is an air inlet and a flue gas outlet. Further provided is means forming a plurality of axial canals within the annular gap, alternate ones of the axial canals being connected as air supply canals for the fuel nozzle and the remaining alternate canals being connected as flue gas canals for conducting flue gas from the nozzle. Heat contained in the flue gases is conducted to the supply air through the walls of the radially extending canals.

The above described type of burner according to this invention provides relatively large heat exchange surfaces between the gas discharge and air supply canals. Also, due to the multiple subdivision of the air canals, a very favorable flame formation develops in the burner. Moreover, the heat exchange canals are relatively small so that a good heat exchange is ensured while still providing a relatively large free space within the air duct cylinder which can be used for ignition devices, air cooling ducts with oil nozzles, or the like.

The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional view of a jacket jet heating tube having a burner according to the invention;

FIG. 2 is a sectional view of the jet heating tube of FIG. 1 taken along line II—II; and

FIG. 3 is a sectional view of another industrial burner according to the invention.

Referring now to FIGS. 1 and 2, a jacket jet heating tube is mounted into a furnace wall **1**. The heating tube comprises a jacket tube **2** of heat resistant material which is fastened on one end to furnace sheet **4** via members **3**. Tube **2** is terminated at its other end by an end portion **5** made of the same material as **2**. Within jacket tube **2** is a centrally arranged tubular-shaped fuel nozzle **6**. Nozzle **6** is mounted in a lid **7** and fuel, such as oil or gas for example, is fed thereto via duct **8**. An inspection hole **9** is provided and an ignition electrode **10** is mounted to lid **7**.

Fuel nozzle **6** is surrounded by a concentric air duct cylinder **11** which cooperates with jacket tube **2** to form an annular gap **12** therebetween. Cylinder **11** is necked down at its upper end and is fastened to a cylindrical member **14** of lid **7** by means of screw **15**. This mounting arrangement allows adjustment of the position of cylinder **11**. In the annular gap **12** between air duct cylinder **11** and jacket tube **2**, axially extending canals **17** and **18** are formed by means of axially extending partition walls **16**. Alternate canals **17** and **18** are designated as air canals **17** and as flue gas canals **18**. Flue gas canals **18** are connected to a waste gas collecting duct **19** which ends in a waste gas discharge connection **20** connected to a suction draft device **35**. The air supply canals **17** are connected with an annular space **21** through which air enters from an air supply duct **22**.

The subdivision of the annular gap **12** into axial canals **17, 18** (that is, the formation of partition walls **16**) is accomplished by inserting a molded sheet body **23** into the annular gap **12**. The molded body **23**, as can be seen from FIG. 2 (left side), is folded in accordionlike manner. The folds on one side of body **23** cooperate with jacket tube **2** to define the axial flue gas canals **18**, and the folds on the other side of body **23** cooperate with cylinder **11** to define the air supply canals **17**. The molded sheet body **23** consists of a heat resistant material. The molded sheet body **23** can also be formed from a number of sheet strips of different materials, because a higher temperature is present substantially in the area of the mouth of burner nozzle **6**.

Air supply duct canals **17** are terminated at their lower ends by walls **24** at the front side facing the mouth of burner nozzle **6**. The walls **24** are arranged in an oblique manner inclined toward the axis of the burner tube **6** to permit all air in canals **17** to escape towards the burner. In the lower portions thereof, the partition walls **16**, as can be seen from FIG. 1, can also be cut in a corresponding oblique manner. Air duct cylinder **11**, in the area of the burner nozzle mouth, has a conical ring-shaped front wall **25**, which, as indicated by air flow arrows in FIG. 1, conducts the air escaping from air canals **17** substantially laterally into the flame of burner **6**.

Further provided is an interior tube **26** which is secured to the molded sheet body **23** in the vicinity of the extended lower part of air duct cylinder **11**. Interior tube **26**, which surrounds the flame and is normally provided in well known jacket jet heating tubes, conducts the flue gases developed during the combustion, in the direction indicated by arrows in FIG. 1, into the annular gap **12**. The flue gases then enter flue gas canals **18** and are prevented from entering the air supply canals **17** by front walls **24** which close off canals **17**.

The molded sheet body **23** shown in FIG. 2 on the left side, has partition walls **16** which are substantially radial, the edges of the folds of sheet **23** extending parallel to the burner axis. In a variation of the invention, a molded sheet body **23***a* (indicated on the right side in FIG. 2) is shaped in such a manner that the folds thereof run tangentially with respect to the burner axis so that the escaping air, at the mouth of the burner nozzle **6** is provided with a twist. This results in a twist flame being produced. The folds of sheet **23***a* can run in spiral-like manner; the characteristics of the twist can be adjusted to the specific requirements to provide the desired air flow.

Referring to FIG. 3, a burner similar to that of FIGS. 1 and 2 is shown wherein the same elements are given the same reference numerals. In this embodiment, however, interior tube **26** is inserted into a perforated burner stone **27** and jacket tube **2'** is open at its lower end **28** which is located toward the interior space of the furnace. Thus the flue gases coming from burner stone **27** enter the interior furnace space. From there they can enter through an annular space **29**, located between burner stone **27** and the front wall of jacket tube **2'** (at **28**) into flue gas canals **18**, which canals are not shown in detail since the arrangement of FIG. 3 is the same as the arrangement of FIGS. 1 and 2.

The molded body **23** of FIGS. 1 and 2 may be made by means of any well known method. One such method consists of shaping a sheet metal strip of suitable heat resistant material between two rollers into a corrugated sheet-type form. The corrugated metal strip is then gathered together to form the accordionlike folds shown in FIG. 2. The corrugated strip is then provided with front walls **24** on alternate channels thereof which are welded on and directed such that the supply air is blown into the flame of the burner **6** in substantially a lateral direction. The sheet-molded body **23** is then bent around and inserted into the annular gap **12**, as shown in FIGS. 1 and 2.

It should be clear that the accordionlike sheet-molded body **23** can be replaced by a plurality of individual partition walls which are placed within the annular region **12**. Suitable means will then be provided for securing the partition walls in place. In order to produce a twist flame with this type of construction, the longitudinal edges of the individual partition walls must be directed in a tangential manner or in a spiral-like manner with respect to the axis of the burner **6**. The particular design of such a configuration should be clear to those ordinarily skilled in the art within the spirit of this invention.

In order to vary the exit speed of the supply air from the individual air supply canals in the area of the mouth of the burner nozzle **6**, the air duct cylinder **11** is arranged in such a manner that it can be axially shifted. This is accomplished by means of loosening the set screw **13** and axially adjusting the position of cylinder **11**. The set screw **13** is re-tightened when the desired position is reached. This effectively varies the dimensions of the opening between slanted walls **24** and **25**, which in turn varies the exit speed of the supply air.

In order to improve the heat transfer from the gas in the flue gas canals to the air in the air supply canals, bodies which increase the turbulence of the air or flue gas flowing in the canals may be provided. For example, wire nets or screens may be provided in the canals.

A burner was built according to the invention and was examined and tested in detail to confirm the above-mentioned clear advantages over conventional types of burners. The "fold recuperator" which, according to the invention, is accommodated in the relatively small annular gap **12** is small enough so that there is sufficient space for the accommodation of auxiliary devices, such as ignition devices and the like, while using a burner having the same length and the same outer diameter as the known prior art burners. The improved burner according to this invention provides a kF value (k=heat transfer number, F=heat exchange surface) several times higher than comparable conventional designs. The kF value is a well known characteristic which is used for expressing the efficiency of such a recuperator. The actual burner which was built featured a jacket tube **2** having an outer diameter of 150 mm. The length of the recuperator, that is of the folded-molded-sheet part **23** was about 400 mm., which corresponds to a normal industrial furnace so that the recupreator does not project to the outside.

At a furnace temperature of 950° C. and a jet tube load of 15,000 kcal./hr., a flue gas temperature of 350° C. was obtained at the burner outlet. This corresponds to a furnace efficiency rate of more than 85%. A very favorable flame formation was achieved, which is due, at least in part, to the multiple subdivision of the current of supply air. The supply air was preheated to about 750° C. at the mouth of the burner nozzle **6**—up to a point above the ignition temperature of the fuel. This further enhanced the performance of the burner under test.

Due to the high degree of efficiency, a gas-air mixture control is not necessary with the new burner according to this invention since even at 100% air excess, the degree of efficiency was still found to be above 70%. In addition, due to the low flue gas temperature at the burner outlet, the attending personnel is much less inconvenienced by the effect of the heat in the vicinity of the furnace. This is of importance in view of present requirements with regard to industrial hygiene.

Another advantage of the low flue gas temperature at the burner outlet is that it is now possible to connect the flue gas canals on one side to a suction draft device. With flue gas temperatures below 400° C., no important design problems are present with regard to suction draft blowers and throttle valves. Also, air quantity controls, such as nozzles, may be provided in the area of the air entry into the air supply canals. In this case the air distribution duct required in pressure operation and the mixture control are not necessary. Fuel is then brought to the various jet tubes of the furnace at substantially zero pressure. The actual quantity control of fuel can be effected with a throttle unit in the flue gas duct by a burner or a group of burners. Also, the use of suction with jet tubes equipped with the above-described burners is desirable for the reason that when the steel tubes are slightly permeable no flue gas can penetrate into the furnace and impair any protective gas atmosphere possibly present there.

It should be clear that this invention is not confined to application in only burners having jacket jet heating tubes. All furnaces which remain closed during operation or must be opened only temporarily, can be equipped with burners according to this invention to provide improved performance.

What is claimed is:

1. A burner comprising:
a central fuel nozzle (**6**);
a jacket tube (**2**) surrounding and spaced from said nozzle (**6**);
an air inlet (**22**);
a flue gas outlet (**20**); and
recuperative air preheating means including:
an air duct cylinder (**11**) mounted within the space between said nozzle (**6**) and said jacket tube (**2**);
an annular gap (**12**) being formed between said cylinder (**11**) and said jacket tube (**2**);
and means (**23**) forming a plurality of axially extending canals (**17, 18**) within said annular gap (**12**) comprising a plurality of axially directed par-

tition walls extending transverse to the axis of the cylinder, alternate ones of said canals (17) being coupling to said air inlet to supply air to said nozzle (6), the remaining alternate axial canals (18) being coupled to said flue gas outlet (20) for conducting flue gases from said nozzle (6), heat from said flue gases being transferred to said supply air via said canal forming means.

2. A burner according to claim **1**, wherein said partition walls (16) extend substantially radially within said annular gap (12).

3. A burner according to claim **1**, wherein said partition walls are formed by a corrugated folded molded sheet (23), the folds on one side thereof cooperating with said jacket tube (2) to define exhaust gas canals (18) and the folds on the other side thereof cooperating with said cylinder (11) to define air supply canals (17).

4. A burner according to claim **1**, further comprising means (24) for terminating said air supply canals (17) on the front sides thereof which face the mouth of said fuel nozzle (6).

5. A burner according to claim **4**, wherein said terminating means (24) includes front walls (24) positioned such that all of said walls (24) form a conical segment, said walls being inclined toward the center axis of the burner.

6. A burner according to claim **5**, wherein said air duct cylinder (11) is terminated in a conical ring-disk type front wall (25) in the area of the mouth of said fuel nozzle (6), such that air leaving said air supply canals (17) is conducted into the flame of said burner along said conical wall (25).

7. A burner according to claim **1**, wherein the longitudinal edges of said partition walls (16) run tangentially in a spiral-type manner with respect to the axis of said burner (6).

8. A burner according to claim **3**, wherein the axis

of the folds of said molded sheet (23*a*) run tangentially in a spiral-type manner with respect to the axis of said burner.

9. A burner according to claim **1**, wherein said air duct cylinder (11) includes means (13) for enabling the position of said air duct cylinder (11) to be shifted in an axial direction.

10. A burner according to claim **3**, wherein said molded sheet body (23) is formed from a plurality of sheet strips of different materials.

11. A burner according to claim **1**, wherein said flue gas canals (18) are connected to a suction draft device on one side.

12. A burner according to claim **5**, wherein said partition walls (16) and the folds of the molded sheet part (23) respectively, are chamfered at the ends thereof which face the mouth of said fuel nozzle (6).

13. A burner according to claim **1**, further comprising:

a burner stone (27) having an opening therein; and

an interior tube (26) extending from the lower portion of said air duct cylinder (11), said interior tube (26) projecting into said opening in said burner stone (27), thereby defining a ring area (29) with said jacket tube through which the flue gas enters into said flue gas canals (18).

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JOHN T. CAMBY, Primary Examiner

U.S. Cl. X.R.

126—110; 263—20