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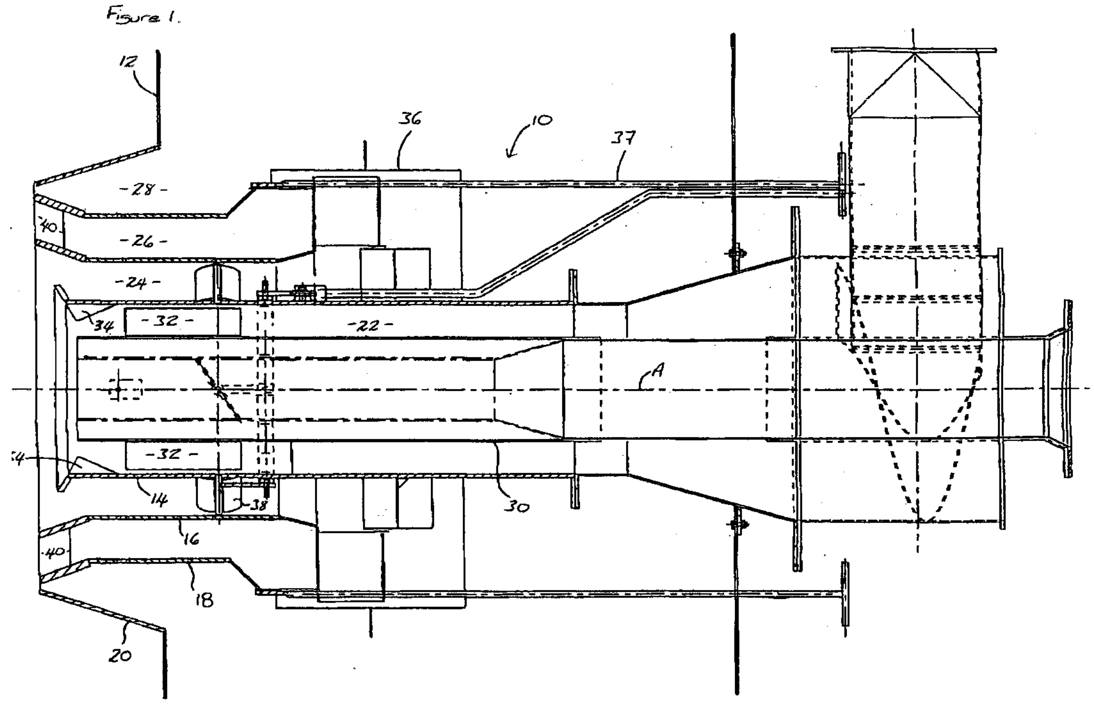
(54) **Burner for the combustion of fuel**

(57) A burner (10) for the combustion of fuel comprises a passage (22) through which in operation a mixed flow of fuel and air passes for primary combustion at its outlet. Two further annular passages (24 & 26), concentric with and radially outward of the passage (22) are provided through which supplementary flows of air pass to support primary combustion. The outlets of the two annular passages (24 & 26) diverge to discharge the supplementary flows of air at an angle to the mixed flow of fuel and air. An additional air passage (28) in provided radially outward of the passages (24 & 26). Air discharges from the air passage to adjust the effective angle of divergence of the supplementary flows or air which support combustion. The air discharged from the additional passage (28) controls the overall flame geometry to prevent interaction between flames from adjacent burners (10). The flame shape is optimised to meet the furnace geometry leading to a reduction of pollutant emissions.

Figure 1.



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Description

The present invention relates to burners and in particular to burners which yield low levels of nitrogen oxide in their combustion products.

The emission of pollutants in combustion products are legislatively controlled due to environmental concerns.

Burners are therefore designed to reduce the amount of pollutants, especially nitrogen oxides, that they produce in operation. The amount of nitrogen oxide emitted in combustion products depends upon the flame temperature, the amount of oxygen available during combustion and the nitrogen content of the fuel.

Conventional low NOx coal burner designs limit NOx formation by minimising the oxygen available in the region of maximum coal volatile release rate within the flame and by controlling the mixing of the fuel and combustion air to minimise peak flame temperature. Examples of burners designed to reduce nitrogen oxide emissions can be found in European patent number 0343767 and European patent application 0667488, which are owned by the applicant.

In EP0343767 a mixed flow of fuel and air passes for primary combustion at the outlet of the burner. Supplementary flows of air pass through further annular passages, concentric with and radially outward of the fuel/air mixture, to support primary combustion. Deflecting elements are arranged in the primary combustion air/fuel flow to produce regions of high fuel concentration. Flow disturbing members assist in stabilising the flame at the burner outlet to promote conditions that reduce the nitrogen oxide emissions. In EP0667488 circumferential staging is achieved by dividing the supplementary air into discrete jets. Bluff bodies obstruct the discharge of the supplementary flow of air and furnace gases circulate in the region downstream of the bluff bodies. The furnace gases are low in oxygen and at a higher temperature and are induced into the primary air/fuel stream. The furnace gases delay mixing of the fuel and air mixture with the supplementary air flows to reduce the nitrogen oxides produced.

In both these burner designs the annular passages through which the supplementary flows of air pass are divergent. The outlets of the annular passages diverge to discharge the supplementary flows of air at an angle to the mixed flow of fuel and air. The divergent passages cause interaction between the flames from adjacent burners. The interaction between the flames from adjacent burners causes the generation of additional NOx.

The present invention seeks to provide an improved burner which controls the flame shape to reduce the interaction between flames from adjacent burners in the combustion chamber. The flame can be optimised to meet the furnace geometry leading to an overall reduction of pollutant emissions.

According to the present invention a burner for the combustion of fuel comprises at least one passage through which in operation a mixed flow of fuel and air passes for primary combustion at an outlet from said passage and an at least one further annular passage, concentric with and radially outward of the first passage, through which a supplementary flow of air passes for discharge at an outlet for combustion with the products of said primary combustion, an additional air passage being provided adjacent the at least one further annular passage through which the flow of supplementary air passes to control the shape of the flame, characterised in that the at least one further annular passage is divergent at its outlet.

In the preferred embodiment of the present invention the additional air passage is radially outward of the at least one annular passage through which the supplementary flow of air passes.

The additional air passage may inject air parallel to the central axis of the burner or the additional air passage may inject air inwardly towards the central axis of the burner. In one embodiment of the present invention the air is injected radially inwardly by an angle of the order of 40° relative to the central axis of the burner. This may be important in controlling the rear burner flame reactions and hence overall NOx emissions.

The at least one further annular passage may be provided with a plurality of members which obstruct the discharge of the supplementary flow of air. Preferably the obstruction members are wedge shaped. The obstruction members may extend across the additional air passage or separate obstruction members may be provided in the additional air passage. Different numbers of obstruction members may be provided in the at least one further passage through which the supplementary flow of air passes and in the additional air passage.

The at least one further passage is convergent and has guide vanes located therein. The amount of air passing through the inlet to the at least one further passage is controlled by an annular baffle plate.

Preferably two further annular passages are provided both of which are concentric with the at least one first passage and which provide supplementary air flows for combustion with the products of primary combustion.

Vanes are provided in the radially inner annular passage which swirl the supplementary flow of air passing therethrough. The vanes may be axially moveable to vary the degree of swirl in the supplementary air passing therethrough.

The at least one further passage may be provided with elements which produce fuel rich areas in the air and fuel mixture passing therethrough and with flow disturbing means which modify the flow pattern of the air and fuel mixture at the outlet of the at least one first passage.

The flow disturbing members are located in the wake of the flow from the elements.

For a better understanding of the present invention and to show how it may be carried into effect, reference shall now be made by way of example to the accompanying drawings, in which:

FIGURE 1 is a longitudinal cross-section through a burner constructed in accordance with one embodiment of the present invention.

FIGURE 2 is a longitudinal cross-section through a burner constructed in accordance with a second embodiment of the present invention.

FIGURE 3 is a longitudinal cross-section through a burner in accordance with a third embodiment of the present invention.

Referring to Figure 1 a burner 10 is mounted in the wall 12 of a furnace. The burner 10 may be one of several mounted in the wall 12, each burner injects ignited fuel into the furnace. Each burner 10 extends along a central axis A and comprises coaxial tubes 14, 16, 18 and 20 which define a series of concentric passages 22, 24, 26 and 28.

Located in the central passage 22 is a burner gun 30 which injects ignited fuel into the furnace. A mixed flow of fuel and air passes through the central passage 22 for primary combustion at the outlet of the burner 10. Fuel is suspended in the primary flow of combustion air which passes through the central passage 22 in a spiralling stream. A series of deflecting elements 32 are mounted at equiangular spacings about the central axis of the passage 22. The deflecting elements 32 are blade-like members which have curved cross section and which extend parallel to the central axis of the passage 22. The fuel suspended in the primary combustion air flow impinges upon the curved faces of the deflecting elements 32 to produce a series of regions with a high fuel-air ratio downstream of the elements 32. Flow disturbing members 34 are located at the outlet end of the passage 22 downstream of the deflecting elements 32. The members 34 are wedge shaped with bluff downstream edges and are located in the wake of the flow from the deflecting elements 32.

In operation the flow of fuel and primary air from the passage 22 produces a flame which attaches to the wedges 34. Supplementary flows of air pass through the further annular passages 24 and 26 to support primary combustion. The flow of secondary combustion air through the passage 24 provides an additional source of oxygen to support the flame and prevent ash deposition. The tertiary flow of combustion air through the passage 26 provides oxygen for combustion later in the flame.

The amount of secondary and tertiary air supplied to the annular passages 24 and 26 is controlled by an annular sleeve damper 36. The sleeve damper is actuated by control rods 37.

A set of blades 38 is provided in the annular passage 24. The blades 38 swirl the secondary air before it passes to the outlet of the annular passage 24 which is divergent. In the embodiments shown in Figures 1-3 the blades 38 are mounted so they can be rotated but are fixed axially. It will however be appreciated by one skilled in the art that in other burner configurations it may be beneficial to be able to move the blades 38 axially to vary the degree of swirl in the secondary air passing to the divergent outlet of the passage 24.

A tertiary flow of combustion air is supplied to the annular passage 26. The outlet of the annular passage 26 is divergent and is partially blocked by wedge shaped plates 40. The tertiary combustion air flow is directed radially outward and discharges into the furnace through four quadrant apertures. Spaces are created in the tertiary combustion flow as it discharges into the furnace. The spaces are filled by an inward flow of hot inert furnace gases which penetrate between the secondary and tertiary air flows. By this means mixing of the tertiary air and the primary fuel/air mixture is delayed and the concentration of the air is reduced, which results in considerable reduction in the nitrogen oxides produced.

An additional air passage 28 is provided radially outward of the annular passage 26 through which the tertiary air is supplied. Air passes through the passage 28 and is injected into the furnace to deflect the tertiary air and hence control the shape of the flame. The shape of the flame is controlled to prevent interaction between the flames from adjacent burners and reduce the generation of additional NOx.

In Figure 1 the additional air passage 28 is angled inwardly towards the central axis of the burner 10. The additional air passage 28 injects air inwardly to control the angle of the tertiary combustion air. The best flame control was attained with the additional air passage 28 inclined by an angle of 40° to the central axis of the burner 10.

Figure 2 shows an alternative embodiment of the present invention in which the additional air passage 28 is horizontal to the central axis of the burner 10. The air is injected horizontally into the furnace to control the tertiary air.

Figure 3 shows a further embodiment of the present invention in which the additional air passage 28 is horizontal to the central axis of the burner 10 however the sloping outer wall of the tertiary passage 26 is cut back.

It will be appreciated by one skilled in the art that the additional air register 28 could be an either radially inward or radially outward of the passages 24 and 26 through which the supplementary air flows.

The wedge shaped plates 40 in the passage 26 through which the tertiary combustion air passes may also extend across the outlet of the additional air passage 28. Alternatively separate wedge shaped plates 40 could be provided at the outlet of the additional air passage 28. Different numbers of wedge shaped plates may be provided in the outlet to the tertiary passage 26 and the additional air register 28 and the wedge shaped plates may be at different locations.

Claims

1. A burner for the combustion of fuel comprises at

least one passage through which in operation a mixed flow of fuel and air passes for primary combustion at an outlet from said passage and an at least one further annular passage, concentric with and radially outward of the first passage, through which a supplementary flow of air passes for discharge at an outlet for combustion with the products of said primary combustion, an additional air passage being provided adjacent the at least one further annular passage through which the flow of supplementary air passes to control the shape of the flame, characterised in that the at least one further annular passage is divergent at its outlet.

2. A burner as claimed in claim 1, wherein the additional air passage is radially outward of the at least one annular passage through which the supplementary flow of air passes.

3. A burner as claimed in claim 1 or 2, wherein the additional air passage injects air parallel to a central axis of the burner.

4. A burner as claimed in claim 1 or 2, wherein the additional air passage injects air inwards towards a central axis of the burner.

5. A burner as claimed in claim 4, wherein the additional air passage injects air inwardly by an angle of the order of 40° to the central axis of the burner.

6. A burner as claimed in any preceding claim, wherein the at least one further annular passage may be provided with a plurality of members which obstruct the discharge of the supplementary flow of air.

7. A burner as claimed in claim 6, wherein the obstruction members are wedge shaped.

8. A burner as claimed in claim 6 or 7, wherein the obstruction members extend across the additional air passage.

9. A burner as claimed in claim 6 or 7, wherein separate obstruction members are provided in the additional air passage.

10. A burner as claimed in claim 9, wherein the additional air passage is provided with a different number of obstruction members than the at least one further passage.

11. A burner as claimed in any preceding claim, wherein the at least one further passage is convergent and has guide vanes located therein.

12. A burner as claimed in any preceding claim, wherein the amount of air passing through the inlet to the at least one further passage is controlled by an annular baffle plate.

13. A burner as claimed in any preceding claim, wherein two further annular passages are provided both of which are concentric with the at least one first passage and provide supplementary air flows for combustion with the products of primary combustion.

14. A burner as claimed in claim 13, wherein vanes are provided in the radially inner annular passage which swirl the supplementary flow of air passing therethrough.

15. A burner as claimed in claim 14, wherein the vanes are axially moveable to vary the degree of swirl in the supplementary air passing therethrough.

16. A burner as claimed in any preceding claim, wherein the at least one further passage may be provided with elements which produce fuel rich areas in the air and fuel mixture passing therethrough and with flow disturbing means which modify the flow pattern of the air and fuel mixture at the outlet of the at least one first passage.

17. A burner as claimed in claim 16, wherein the flow disturbing members are located in the wake of the flow from the elements.

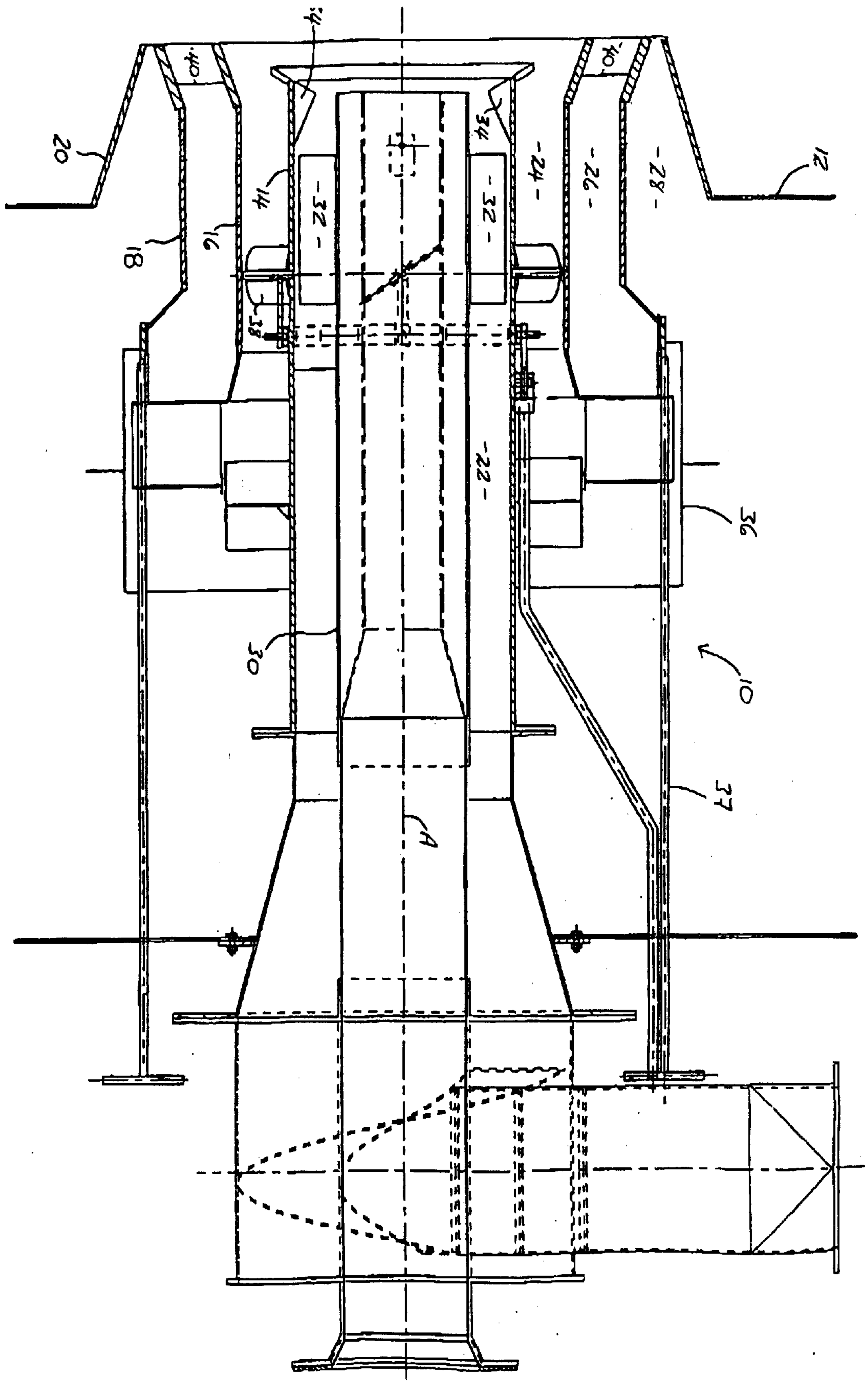

Figure 1

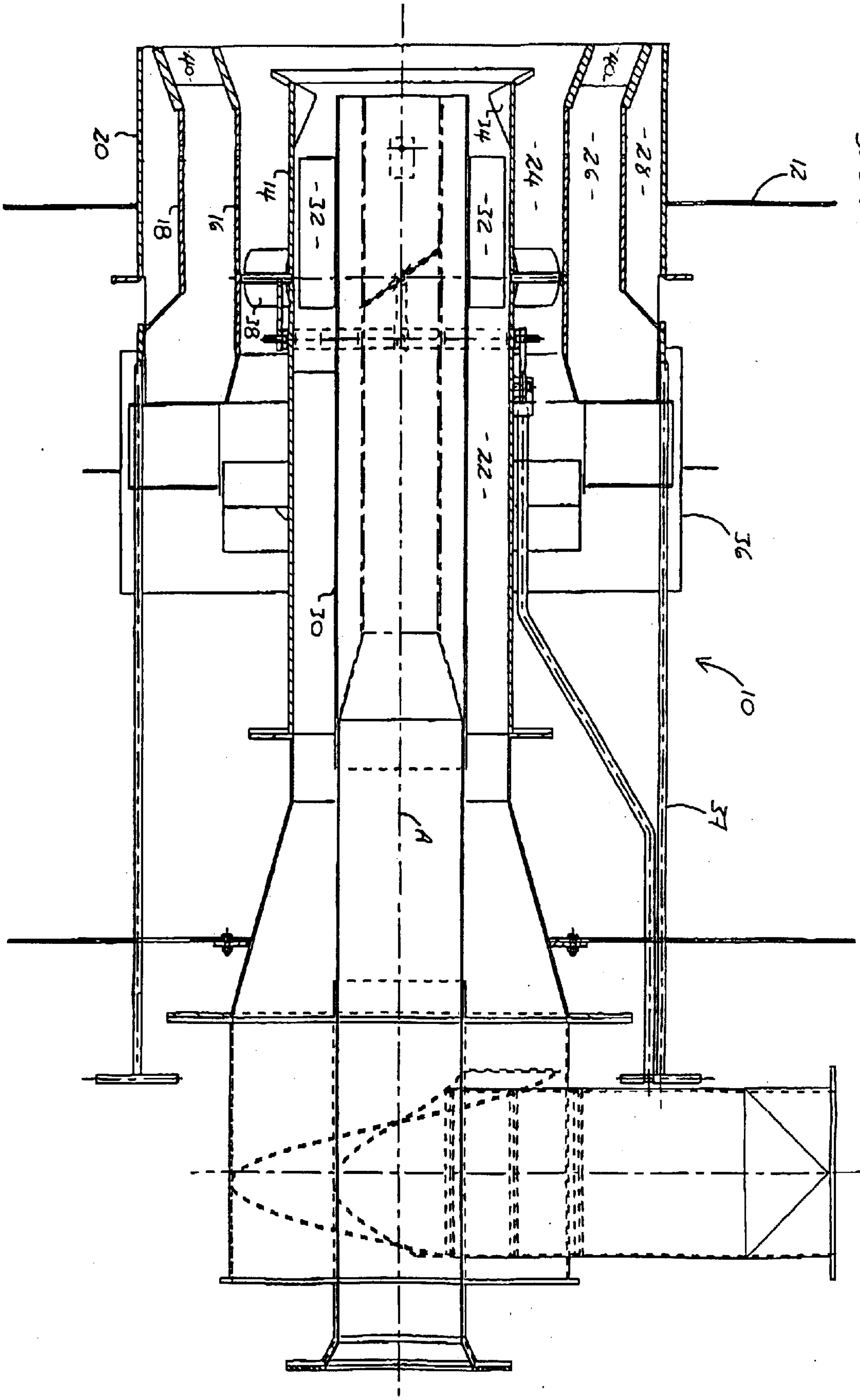

Figure 2

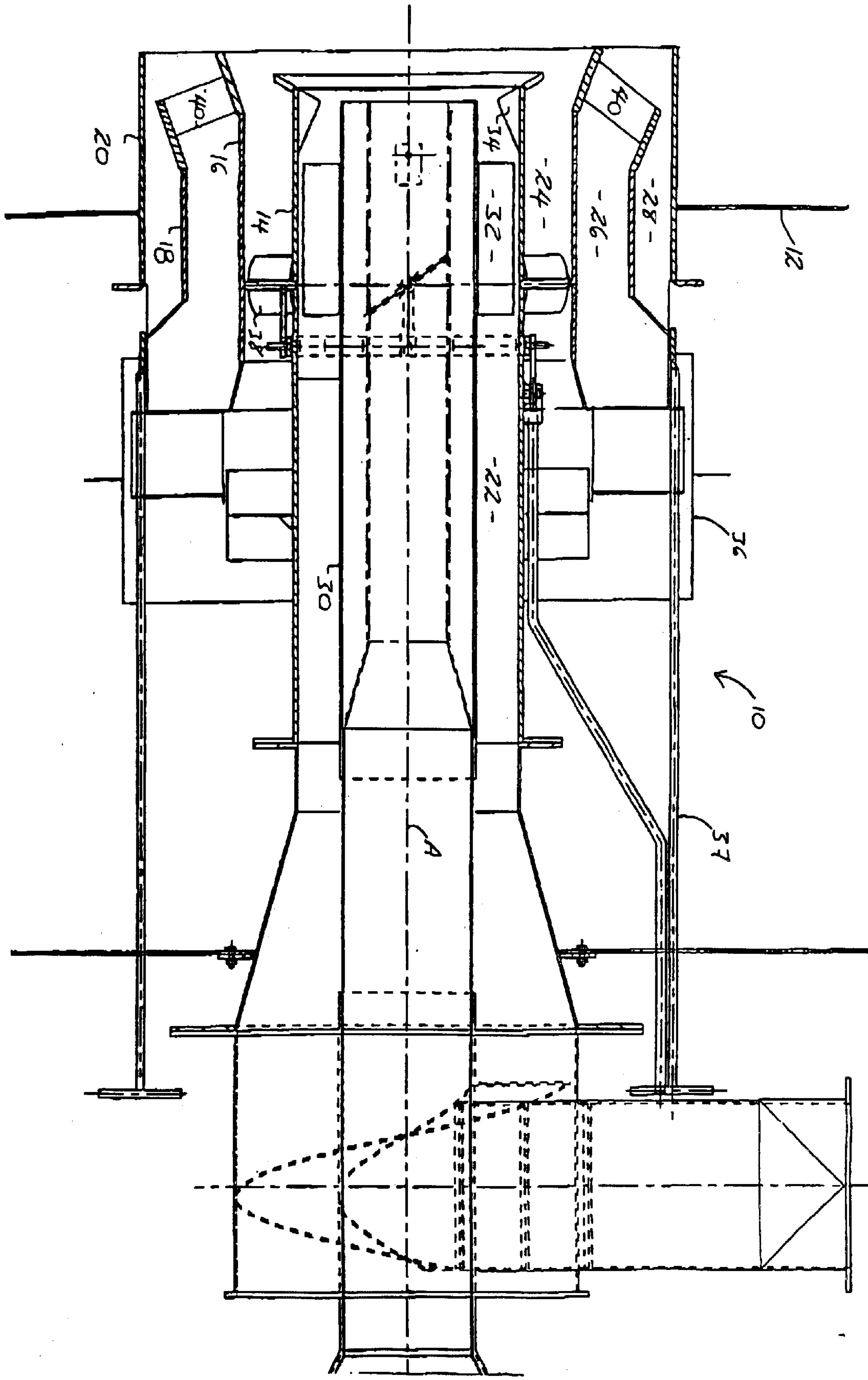

Figure 3