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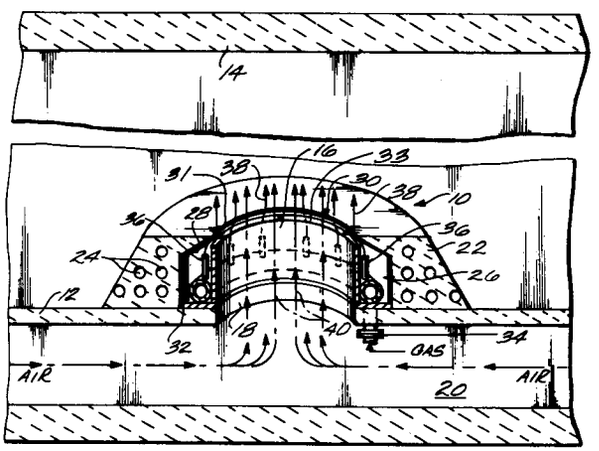
(54) Burners for soaking pit furnaces.

(57) A burner (10) for soaking pit furnaces produces essentially complete combustion of the gas and air mixed in the burner. The burner includes a tubular inner wall structure (16) and an outer housing (22) spaced from the inner wall to form a hollow interior (26) between the inner wall and the housing. The inner wall terminates adjacent a surrounding portion (31) of the housing to form a narrow opening (30) from the hollow interior which extends around the periphery of the inner wall structure. A gas supply pipe (32) located in the hollow interior surrounds the inner wall structure (16) and directs the flow of gas under pressure toward the narrow peripheral opening (30). The inner wall (16) forms an air supply pipe and air is forced under pressure through the air supply pipe and past the narrow opening.



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BURNERS FOR SOAKING PIT FURNACES

Background

This invention relates to burners for soaking pit furnaces for steel mills and the like. More particularly, the invention relates to an improvement in a bottom-fired soaking pit furnace in which one centrally located burner extends through the floor of the soaking pit and directs the flame upwardly into the interior of the soaking pit furnace.

Steel ingots produced in steel mills are placed in a soaking pit furnace for heating the ingots to a temperature of about 2400°F. The heated ingots soak at that temperature to uniformly heat them throughout until they are malleable enough to be rolled. In a commonly used soaking pit having a prior art burner, it presently takes from about 3 to 4 hours to heat a steel ingot to a temperature of about 2400°F and another 4 hours or so to soak the ingot to its malleable condition. Such a prior art burner is used in a bottom-fired soaking pit. The burner includes an upright gas pipe disposed centrally in a relatively wide air flow channel which surrounds the gas pipe. Air flows upwardly through the channel and

mixes with gas flowing from the pipe. The burner produces a yellow flame, indicating incomplete combustion of the gas and air. The incomplete combustion results in excessive oxide scale buildup on the surface of the steel ingots. The scale acts as an insulator which increases the time and energy required to heat up and soak the steel ingots. Moreover, the scale buildup on the ingots reduces the weight of high grade steel production per ingot. The layer of oxide scale is removed from the ingots after they are soaked and is used in less profitable lower grade steel.

The present invention provides a burner for soaking pits which produces a continuous clean burning blue flame during use. By avoiding incomplete combustion, the burner of this invention reduces scale buildup on the ingots. This results in greater production of more profitable higher grade steel per ingot. The flame produced by the burner of this invention also burns hotter, which reduces the amount of time required for the ingots to reach their soaking temperature, as well as reducing the soaking time of the ingots. The hotter flame also provides a corresponding energy saving because the amount of gas consumption required to heat each ingot is reduced. Inasmuch as scale buildup is reduced, and the scale can act an an insulator, the amount of heat transferred to the ingots by the burner of this invention is increased, which provides an additional saving in heating and soaking time. By reducing soaking time, production can be increased without additional increase in fuel cost. Further, by avoiding incomplete combustion, air pollution is reduced, and the useful life of the soaking pit burner and furnace structure is extended.

Summary of the Invention

According to one embodiment of this invention, a burner for a soaking pit furnace comprises a housing, an air supply pipe extending through the housing and terminating at an end spaced closely apart from an adjacent portion of the housing to form a narrow elongated opening surrounding the periphery of the air supply pipe and located between the end of the air supply pipe and the adjacent portion of the housing. The air supply pipe causes air flowing through it to flow away from the pipe and past the narrow peripheral opening. Gas supply means force gas to flow under pressure through the narrow opening in a direction away from the end of the gas supply pipe so that the gas mixes with air flowing past the narrow opening. This forms a combustible gas/air mixture in which the gas is mixed so well with the air that the mixture, when ignited, produces a continuous clean-burning blue flame.

In another embodiment of the burner, a mixing chamber includes a tubular inner wall structure spaced inwardly from a surrounding outer housing to form a hollow interior space between the inner wall and the outer housing. The inner wall has an end which is spaced closely apart from an adjacent portion of the outer housing to form a narrow elongated annular opening surrounding the periphery of the inner wall. Gas supply means force gas under pressure to flow through the hollow interior of the mixing chamber toward the narrow opening. An air supply means also forces air under pressure through the hollow interior of the mixing chamber where it mixes with the gas flow therein to produce a combustible gas/air mixture which flows out through the narrow opening. The gas and air mix so well within the chamber that the mixture flowing from the narrow opening produces complete combustion,

when ignited, resulting in a continuous, clean-burning, blue flame.

These and other aspects of the invention will be more fully understood by referring to the following detailed description and the accompanying drawings.

Drawings

FIG. 1 is a semi-schematic, cross-sectional perspective view showing a soaking pit burner according to one embodiment of this invention, the cross-sectional view being taken on a section line through the center of the burner;

FIG. 2 is a semi-schematic, cross-sectional view showing an alternate form of the burner according to this invention, the cross-sectional view being taken on a section line through the center of the burner; and

FIG. 3 is a semi-schematic, cross-sectional view showing an alternate form of the burner shown in FIG. 2 and taken on a section line through the center of the burner.

Detailed Description

FIG. 1 shows a bottom-fired soaking pit furnace having a single burner 10 extending through a floor 12 of the furnace. The furnace also includes upright side walls (not shown) extending above the floor, and a soaking pit cover 14 above the side walls for forming an enclosure which is fired by a flame produced by the burner 10.

The burner includes an upright tubular, cylindrical air supply pipe 16 extending around a circular opening 18 in the floor 12 of the soaking pit furnace. The air supply pipe 16 is connected to a source of air under pressure flowing through an air tunnel 20 below the soaking pit floor 12. Air flowing in the air tunnel 20 is forced to flow upwardly through the air supply pipe 16.

A ring-shaped housing 22 extends above the floor of the soaking pit and surrounds the exterior portion of the air supply pipe 16 which projects above the opening in the soaking pit floor 12. The housing 22 is made from a heat-resistant material such as steel, or a refractory material such as ceramic or brick. The housing can have embedded water cooling pipes illustrated schematically at 24. A major upright portion of the housing interior surface is spaced apart from the exterior wall of the air supply pipe 16 to provide a substantially enclosed annular hollow interior space or chamber 26 surrounding the exterior wall of the air supply pipe 16 above the opening 18.

An upper interior wall portion of the housing tapers inwardly toward the end of the air supply pipe 16 to form an annular baffle 28 located above the chamber 26 and surrounding the upper end portion of the air supply pipe 16. The inside edge 31 of the baffle 28 is spaced apart from the exterior of the air supply pipe 16 to form

narrow annular opening 30 at the top of the housing 22. The narrow opening 30 is located immediately adjacent the exterior upper end portion of the air supply pipe and extends entirely around the periphery of the air supply pipe. The narrow opening 30 is located immediately adjacent the outer surface of the air supply pipe, the opening being separated from the inside surface of the air supply pipe 16 solely by the wall thickness of the pipe, which in one embodiment is less than about one inch. The peripheral opening 30 is narrow in relation to the diameter of the air supply pipe. Preferably, the width of the opening is less than about 20% of the diameter of the air supply pipe. In one embodiment, the air supply pipe 16 has an inside diameter of 24 inches, and the width of the narrow opening 30 is in the range of about 1/2 to about 2 inches.

The baffle portion of the housing 22 covers the top of the hollow chamber 26, and the inside annular edge 31 of the baffle 28 extends above the top edge 33 of the air supply pipe 16 so that the narrow opening 30 is actually formed above the top edge 33 of the air supply pipe. Thus, the narrow opening 30 above the interior of the chamber 26 faces radially inwardly toward the centerline of the air supply pipe 16.

An annular gas supply pipe 32 disposed within the chamber 26 surrounds the exterior wall of the air supply pipe 16. The annular gas supply pipe 32 is connected to a gas line 34 for supplying a source of gas under pressure to the interior of the gas supply pipe 32. The gas supply pipe is located in the bottom portion of the chamber 26, and a plurality of circumferentially spaced apart upright standpipes 36 extend around the top of the gas pipe and are directed generally upwardly toward the narrow opening 30 above the gas supply pipe. In one embodiment, the gas supply pipe 32 has a ring

diameter of about 32 inches and an inside diameter of about 4 inches.

In using the burner 10, a fuel such as natural gas or coke oven gas under pressure, preferably about 15 to 20 psi line pressure, is introduced to the gas supply pipe through the gas line 34. The gas flows upwardly through the spaced apart standpipes 36 toward the narrow annular opening 30. The gas flows through a major portion of the chamber 26 prior to flowing out through the opening 30. This produces a laminar, generally uniform cross-sectional flow of gas through the narrow opening 30 generally in the direction of the arrows 38 shown in FIG. 1. Simultaneously, combustion air is forced under pressure, say 15 to 20 psi line pressure, through the air supply pipe 16 in the direction of the arrows 40 shown in FIG. 1. The air flows in an upward laminar stream past the annular narrow opening 30. The baffle 28 reduces the cross-section of gas flow prior to the gas flowing out through the narrow opening 30 and produces a low pressure region of gas flow which aids in continuously and uniformly drawing gas flow through the narrow opening into the air stream flowing past the narrow opening 30, which intimately mixes the gas with the air stream. The gas stream is contiguous with and surrounds the air stream which tends to draw the surrounding flow of gas into it, producing a mixing effect resulting in a combustible gas/air mixture which produces a continuous, clean-burning blue flame when ignited. By generating a low pressure region in the stream of flow above the burner, the flame is constantly self-sustaining. The narrow size of the opening 30 and the gas pressure setting allow the gas to flow out so that the flame produced by the fas flutters, rather than producing more of a gas jet stream which has a tendency to blow out. Moreover, the narrow opening 30 inhibits any tendency for

pre-ignition to occur within the chamber 26, and the portion of the baffle 28 which covers the chamber keeps scale and soot from building up in the interior of the chamber or clogging the gas supply pipe. I have learned that by interchanging the gas and air supply, i.e., so that the gas flows through the pipe 16 and air flows through the narrow opening 30, a yellow flame is produced, indicating incomplete combustion.

FIG. 2 illustrates an alternate burner according to this invention in which a ring-shaped outer housing 122, similar to housing 22, surrounds an upright tubular inner wall structure 116 similar to air supply pipe 16. An interior chamber 126 similar to the chamber 16 is formed between the inside of the housing 122 and the exterior surface of the inner wall structure 116. The top of the housing 122 has an inwardly tapering annular baffle 128 similar to the baffle 28, and a narrow annular opening 130 is formed around the periphery of the wall structure 116 similar to the narrow annular opening 30 of the burner shown in FIG. 1.

An air tunnel 120 similar to the air tunnel 20 provides a source of air under pressure; but in the burner of FIG. 2, the air is introduced to the interior of the chamber 126 through a plurality of circumferentially spaced apart air inlet openings 119 which extend from the air tunnel 120 into the lower portion of the chamber 126. The air inlet openings 119 are formed in a plate 121 which rests on top of the floor 112 of the soaking pit. The plate 121, or similar wall structure, closes off the bottom interior portion of the inner wall structure 116 so that air flowing in the air tunnel flows only through the air inlet openings 119 and into the chamber 126. A rotatable plate (not shown) can be superimposed on the plate 121 and rotate registering openings adjacent the openings 119 to provide a means

for regulating the pressure of air flowing into the chamber 126. An annular gas supply pipe 132 similar to gas supply pipe 32 is located in chamber 126 above the air inlet openings 119.

The gas supply pipe 132 includes a plurality of circumferentially spaced apart upright standpipes 136 directed generally toward the narrow opening 130. A gas line 134 introduces gas under pressure to the interior of the gas supply pipe 132, and gas is directed from the standpipes 136 through a major portion of the interior chamber 126 and toward the narrow opening 130. Air under pressure forced through the air inlet openings 119 passes around the gas pipe, and mixes with gas flowing through the chamber 126 toward the narrow opening 130. The interior chamber 126 provides a mixing chamber in which the gas and air are mixed, and the narrow opening produces a restriction in the cross-sectional area through which the gas/air mixture flows, resulting in an intimately mixed combustible gas/air mixture flowing through the narrow opening 130. This intimately mixed combustible mixture, when ignited, produces a clean-burning blue flame at the top of the burner.

FIG. 3 shows an alternate form of the burner shown in FIG. 2 in which a clean-burning blue flame also is produced. The perforated plate 121 of FIG. 2 is replaced with a plate 221 in FIG. 3 having a central opening 218 for receiving the supply of air from the air tunnel 220. In this instance, the opening through the tubular wall structure 216 has a plug 223 for directing the flow of air through a plurality of circumferentially spaced apart air inlet openings 219 located below the plug and around the lower portion of the wall structure 216. Thus, the flow of air from the air tunnel 220 is directed through the openings 219 and into the chamber 226 where the air mixes with the gas from the gas pipe 232 prior to the gas/air mixture flowing through the opening 230.

WHAT IS CLAIMED IS:

1. A burner for a soaking pit furnace comprising a housing 22; and air supply pipe 16 extending through the housing and terminating at an end 33 which is spaced closely apart from an adjacent portion 31 of the housing to form a narrow elongated opening 30 surrounding the periphery of the air supply pipe and located between the end of the air supply pipe and said adjacent portion of the housing, the air supply pipe causing air flowing through it to flow away from the end of the pipe and past the narrow peripheral opening; and gas supply means 34 forcing gas to flow under pressure through said narrow opening and away from the gas supply pipe so that the gas mixes with air flowing past said narrow opening to form a combustible gas/air mixture in the vicinity of said narrow opening.

2. Apparatus according to claim 1 in which the narrow opening extends substantially entirely around the periphery of the air supply pipe.

3. Apparatus according to claims 1 or 2 in which the housing surrounds the air supply pipe and forms a hollow interior space extending continuously around an exterior portion of the air supply pipe; and in which the gas supply means are located in the hollow interior of the housing.

4. Apparatus according to claim 3 in which the gas supply means comprises a gas supply pipe 32 surrounding an exterior portion of the air supply pipe; and the gas supply pipe includes means 36 for directing the flow of gas from within the hollow interior of the housing out through the narrow opening adjacent the end of the air supply pipe.

5. Apparatus according to claim 4 in which the gas directing means includes spaced apart openings around said gas supply pipe, and the spaced apart openings are at the ends of upright standpipes 36 directed toward the narrow opening.

6. Apparatus according to any of claims 1 to 3 in which the gas supply means includes means spaced from the narrow opening to direct the flow of gas through the hollow interior of the housing prior to the gas flowing through the narrow opening so as to produce a substantially uniform flow of gas through the narrow opening.

7. Apparatus according to any preceding claim in which the housing includes baffle means 28 adjacent the periphery of the air supply pipe for reducing the cross-sectional area through which the gas flows prior to flowing through said narrow opening.

8. Apparatus according to any preceding claim including a supply of air under pressure connected to the air supply pipe; and a supply of gas under pressure connected to the gas supply means.

9. A soaking pit furnace for heating ingots and having a burner according to claim 8 extending into the furnace.

10. Apparatus according to any preceding claim in which the narrow opening has a width of less than about 20% of the diameter of the air supply pipe.

11. Apparatus according to any preceding claim in which the narrow opening is between about 1/2 to 2 inches in width.

12. Apparatus according to any preceding claim in which the housing surrounds the air supply pipe and forms a hollow interior space extending around an elongated exterior portion of the air supply pipe; and in which the gas supply means forces gas to flow through the housing and along the elongated exterior portion of the air supply pipe so that gas flows out through the narrow opening substantially contiguous with and surrounding the flow of air from the air supply pipe, and in which the gas flow through the narrow opening is separated from air flowing in the air supply pipe essentially only by the wall thickness of the air supply pipe.

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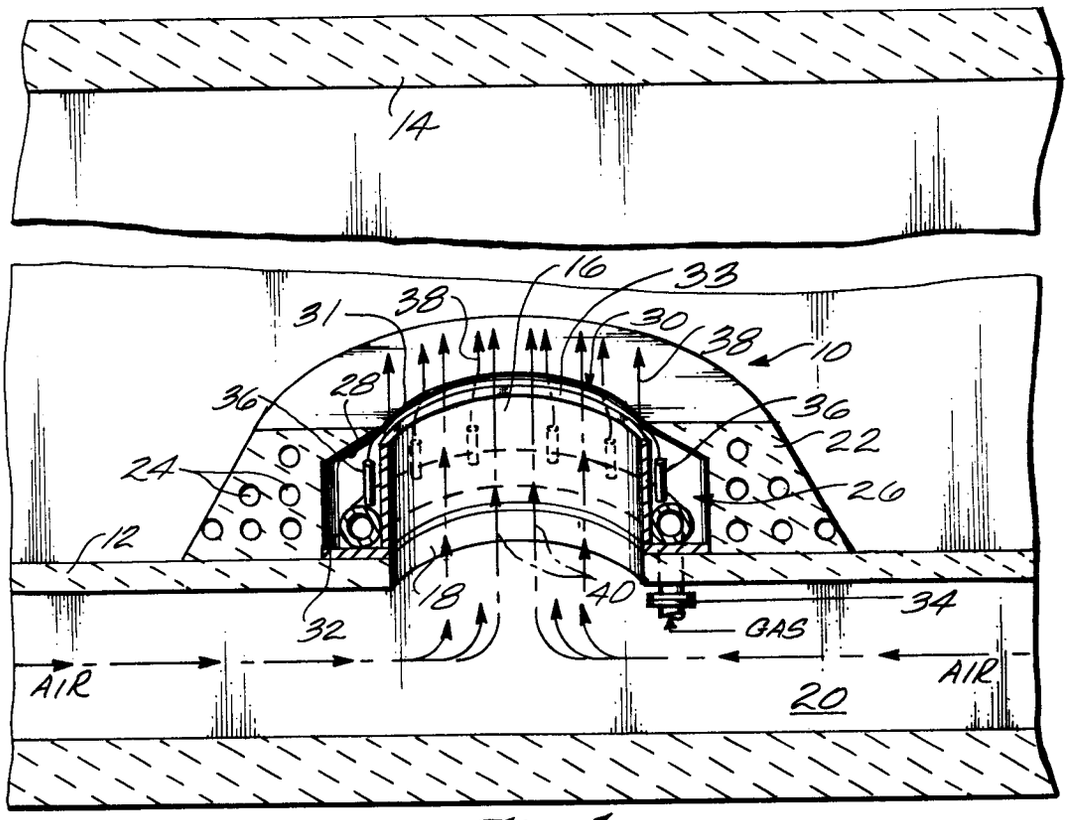

Fig. 1

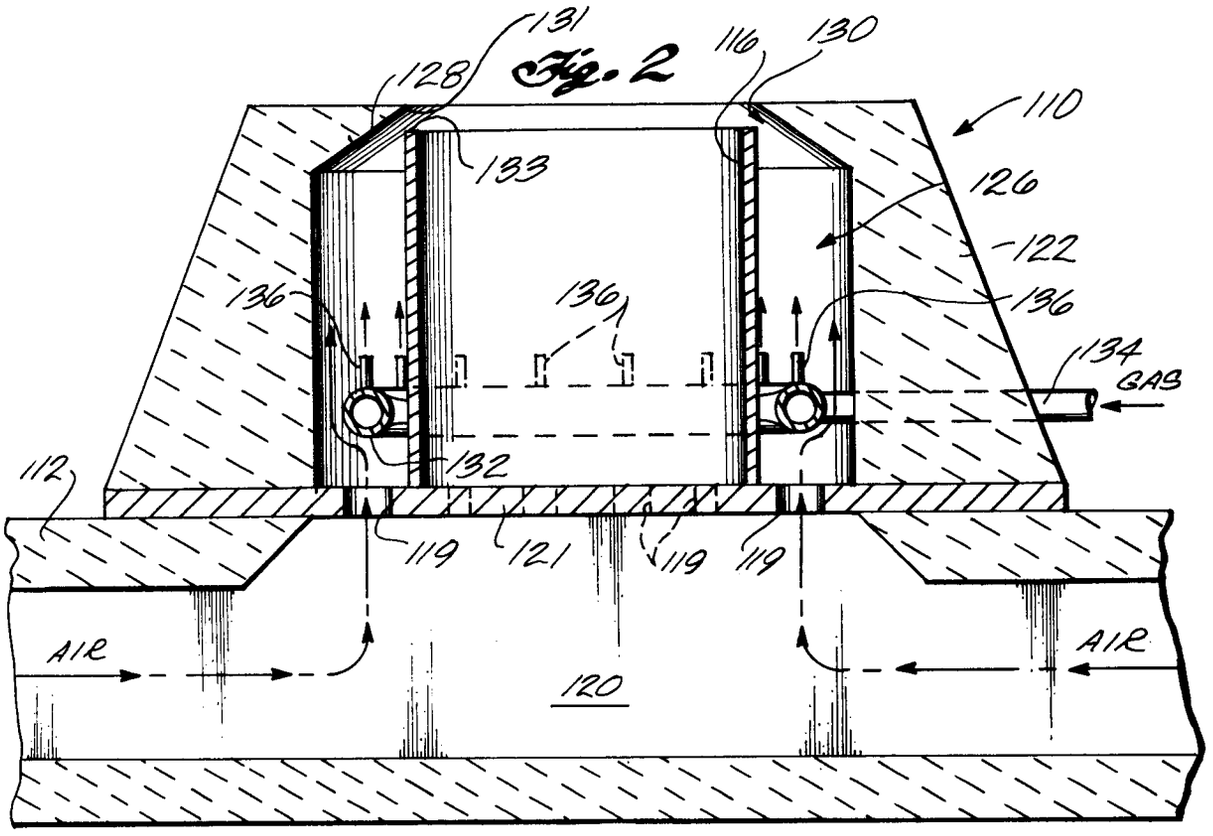

Fig. 2

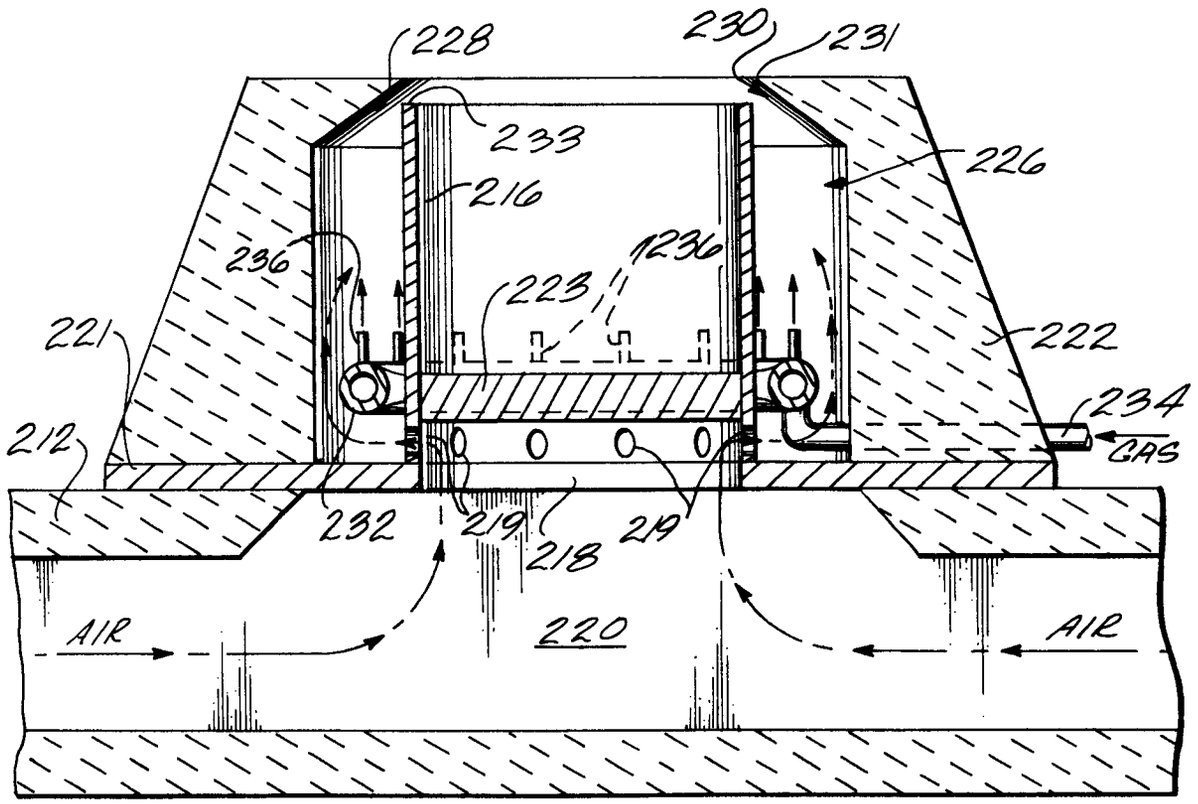
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Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

0002036
Application number
EP 78 10 1340

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 1 328 225 (BOYLE) * Entire patent *	1-3,7, 8,12
	GB - A - 973 278 (DIDIER-WERKE AG) * Page 1, lines 64-88; page 2, lines1-55; figures 1,2,3 *	1-3,7, 12
	US - A - 3 411 761 (GMELL) * Column 1, lines 11-27; column 2, lines 14-41; column 3, lines 24-75; column 4, lines 1-67; figures 1-4 *	3,8,9
A	DE - C - 494 492 (PEABODY)	1
A	US - A - 4 033 714 (LONGWORTH)	1
A	US - A - 2 628 088 (AUSTIN)	1
A	US - A - 2 563 683 (LEWIS)	1
A	US - A - 2 480 255 (MORTSON)	1
A	US - A - 2 389 027 (CORBIN)	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

F 23 D 15/00
C 21 D 9/70
F 23 D 13/00

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

F 23 D
C 21 D

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12-02-1979	PHOA

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