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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number:
F22B 37/10	A1	WO 86/ 02140
		(43) International Publication Date: 10 April 1986 (10.04.86)

(21) International Application Number: PCT/US85/01692

(22) International Filing Date: 29 August 1985 (29.08.85)

(31) Priority Application Number: 656,098

(32) Priority Date: 28 September 1984 (28.09.84)

(33) Priority Country: US

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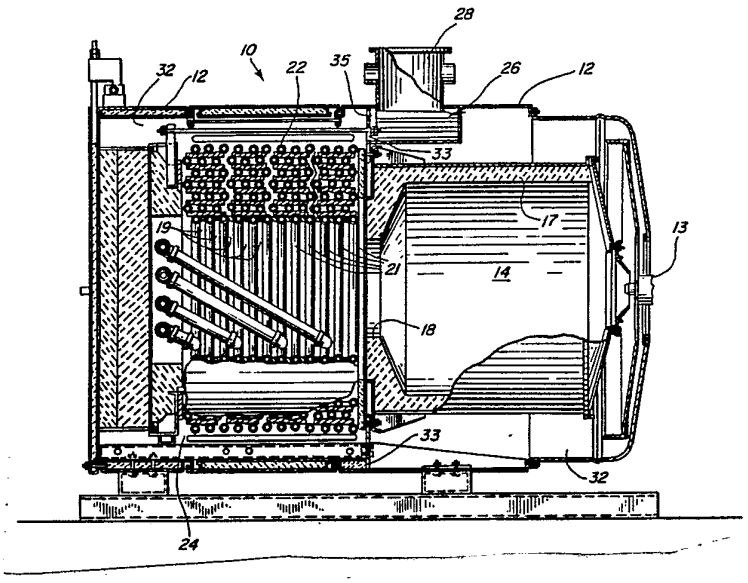
(81) Designated States: DE (European patent), FI, FR (European patent), GB (European patent), JP, NL (European patent), NO, SE (European patent).

Published
With international search report.

(54) Title: AIR PREHEATER FOR A COMPACT BOILER



(57) Abstract

A coil boiler (10) includes an air preheater (26) for recovering energy from exhaust gases to heat secondary combustion air. The air preheater is defined by a compact heat exchange structure. The heat exchange structure provides lateral flow interrupters (36) on a combustion gas side, and transverse flow (35) interruption on the flow resistance to exhaust combination gases is minimized while heat transfer to inlet air is substantially increased through flow interruption. A transverse hair-pin heat exchange coil (100) is also provided. The heat exchange coil is located in plenum space (40) in the boiler surrounding the coil bank (22) of the boiler. The heat exchange coil is connected to an external water supply. Water circulating through the heat exchange coil is heated and delivered to the coil bank as preheated feedwater or is delivered to an end use location.

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"AIR PREHEATER FOR A COMPACT BOILER"

BACKGROUND OF THE INVENTION

This invention relates to combustion gas heat recovery for heating inlet air and improving overall boiler efficiency. In particular, a heat exchange unit is disclosed that provides highly efficient secondary air heating in a compact boiler such as disclosed in U.S. Patent 3,282,257, hereby incorporated by reference.

Known approaches to combustion air preheating such as disclosed in U.S. Patent 3,838,666 have been in existence for some time; however, these structures are expensive and complicated additions to compact boilers. Further, the disclosed techniques require rerouting of exhaust gases with increases in pressure drop over the exhaust gas path. The effectiveness of this approach is, generally speaking, not cost effective.

Applicant has discovered that use of a novel air preheating heat exchange structure located within the existing boiler housing can provide substantial increases in overall boiler efficiency. These efficiencies are attained without substantial increase in pressure drop, particularly along the exhaust gas discharge path. The novel heat exchange structure disclosed provides a cost-effective means for increasing boiler efficiency and does not require complicated and expensive ancillary structures or appurtenances to the boiler.

It has also been discovered that further boiler efficiency can be obtained by the inclusion of a transverse hairpin type heat exchange coil. The heat exchange coil is positioned in a plenum space surrounding the coil bank of the boiler and is connected to an external cold water supply. Water is circulated through the heat exchange coil and preheated water is delivered to an end use or to the coil bank as preheated feed water.

Accordingly, it is an object of this invention to provide increased efficiency of a compact coil boiler

through utilization of a novel heat exchange structure and coil placed within the existing boiler housing.

It is a further object of this invention to provide a heat exchange unit for recovering heat from exhaust gases of a boiler wherein the existing gas flow is not appreciably affected.

It is an additional object of this invention to provide a heat exchange structure for heat recovery and/or air preheating in a compact boiler which utilizes readily available material in a simple structure.

It is an additional object of this invention to provide a heat exchanger design for using energy from exhaust gases for combustion air preheating in a compact boiler wherein exhaust gas or "hot side" pressure drops are minimized, and combustion air or "cold side" heat exchange is enhanced while utilizing identical heat transfer surface geometry.

It is yet another object of this invention to provide an air preheater and heat exchange coil for increasing efficiency of a compact coil boiler within original boiler envelopes utilizing low cost, easily manufactured, and readily available material in a simple structure.

SUMMARY OF THE INVENTION

In accordance with the invention disclosed, an air preheater for a compact coil boiler is provided wherein the heat exchange structure of the preheater is contained within an internal boiler plenum. The heat exchange surfaces include an essentially corrugated separator sheet having longitudinal flow interrupters mounted adjacent to the exhaust gas collector volume. Exhaust gas flow is channeled parallel to the hot side of the separator while traversing a path from a boiler coil outlet to exhaust stack. Combustion air is preheated through transverse flow along similar fins on the cold or

opposite side of the corrugated separator sheet. The flow separator acts to exchange heat at reduced pressure drop, and to increase effective heat exchange are for flow along the exhaust gas and combustion air sides, respectively.

Use of identical structure for high/low temperature gas flows provides substantial increase in heat transfer while remaining totally within the gas collecting portion of the boiler.

A transverse hairpin type heat exchange coil is also provided. The heat exchange coil is located in the plenum space surrounding the coil bank of the boiler. An external cold water supply is connected to the heat transfer coil and heated water from the coil may be delivered to an end use or to the boiler as preheated feed water.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

Figure 1 is a partial sectional view of a compact boiler including a preheater constructed in accordance with the principles of the present invention;

Figure 2 is a semi-pictorial, partially cut-away view of a typical compact coil boiler, particularly showing the location of the air preheater of the present invention;

Figure 3 is a partially pictorial view of a typical compact coil boiler, particularly showing the internal locations of boiler heat exchange coils, and air preheater with a source of combustion air;

Figure 4 is a detailed semi-pictorial view of the preheater of the present invention particularly showing combustion gas and preheated air flow passages with flow directions of the gases;

Figure 5 is a partial sectional view of the preheater structure of the present invention showing action of the air side flow interrupters.

Figure 6 is an additional partial sectional view of an alternate embodiment of the air preheater;

Figure 7 is a partial sectional view of a further alternate embodiment of the preheater;

Figure 8 is a perspective, partially cut away view of the boiler without the preheater illustrating the heat exchange coil;

Figure 9 is a perspective view of the coil bank of the boiler and the heat exchange coil;

Figure 10 is a view taken along line 10-10 in Figure 9;

Figure 11 is a schematic illustration of an external use circuit including the heat exchange coil; and

Figure 12 is a schematic illustration of a feed water circuit including the heat exchange coil.

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figures 1-5, a boiler assembly 10 is illustrated. Assembly 10 includes a burner 13 supplying predetermined fuel and air mixtures to a combustion chamber 14 where fuel and air mixtures generate high temperature combustion gases that exit through combustion chamber exit or choke 18. Combustion chamber 14 utilizes refractory material capable of withstanding high temperatures for the walls 17 and to define the chamber outlet or choke 18.

Burner combustion air is provided by a blower assembly 30 (FIG. 2) communicating with the interior of boiler outer shell 12 via a blower inlet 31. Blower inlet 31 communicates with an annular plenum chamber 32 and blower 30 pressurizes the plenum chamber 32 forcing air through burner 13 and into the combustion chamber 14.

Combustion gases exit choke 18, enter a coil inlet zone 20, and under pressure, flow through interstices 19 of coil turns 21. Exhaust gases exiting the coil turns 21 are collected in a combustion or flue gas collecting chamber 24. Flue gas collection chamber 24 is in fluid communication with an air preheater assembly 26, lying entirely within flue gas collection chamber 24, adjacent combustion chamber 14.

Combustion gases passing through coil turns 21 raise the temperature of liquid contained within the coils. Combustion gases then pass through air preheater 26 exiting to the atmosphere via stack or outlet 28.

With particular reference to Figure 4, air preheater 26 of the present invention is illustrated. Preheater 26 utilizes a separator or wall 34 having an essentially corrugated or fluted surface with flow interrupters 36 fixed to alternate convolutions of the surface. Wall 34 and interrupters 36 are mounted on the boiler bulkhead 33. The flow interrupters 36 and wall 34 define isolated flow areas 35 and 37 for the air and exhaust gas sides of the preheater 26, respectively. Exhaust gas and preheated air are prevented from mixing by separator 34, longitudinal seals or bulkheads 38, and a transverse or end seal or bulkhead 40.

In operation, air preheater 26 is in fluid communication with the flue gas collection chamber 24 at an open end 39 adjacent bulkhead 33. A lower edge 39A of open end 39 engages and extends slightly above separator 34, thereby providing a gas flow path via upper passages 37. Gases enter the air preheater 26 through open end 39, traverse the upper surfaces of passages 37 and exit in a vertical direction through stack outlet 28.

Similarly, combustion air entering plenum 32 via the blower inlet 31 flows below separator 34 in a path perpendicular to the flutes or corrugations of the surface 34 and interrupters 36 generating air side flow

patterns including turbulent vortices 41 (FIG. 5). It has been discovered that this combination of a corrugated surface 34 and interrupters 36 substantially increases the heat transfer effectiveness of the combination through destruction of the boundary layer along surface 34. It has also been discovered that the higher temperature gases flowing in a direction parallel to the flow interrupters 36 above surface 34, by virtue of their high temperature and higher viscosity, provide substantially increased heat transfer without a substantial increase in exhaust gas pressure drop. Excessive pressure drop in the exhaust gas path is highly undesirable.

Heat transferred to combustion air supplied by blower assembly 30 raises the air temperature substantially resulting in an increase in overall boiler combustion efficiency. This increase is achieved without appreciable combustion gas pressure drop along the exhaust path to the stack 28. Additionally, novel means has been provided for increasing boiler efficiency without substantially increasing combustion air blower requirements. Further, the heat exchanger of this invention provides increased efficiency entirely within the initial confines of existing compact boilers, allowing installment of the air preheater 26 in existing boilers without structure modifications.

With reference to Figure 6, for example, a separator 34A is bent or formed to define vertically extending interrupters 36A. Discontinuous separators 34B in Figure 4 are each formed at a right angle to define vertical separators 36B.

As best illustrated in Figs. 8-10, boiler 10 includes a heat transfer or economizer coil 100. Heat transfer coil 100 is mounted in the plenum chamber 32 and surrounds the coils or coil bank 21. In this position, coil 100 is heated by exhaust gas of a lower temperature

since the gas has passed through interstices 19 and over coils 21. Consequently, water flowing through heat transfer coil 100 is of a lower temperature than the fluid flowing through coils 21. This lower temperature fluid is useful as hot water for customer use or as feedwater for coils 21.

Heat transfer coil 100 is of a hairpin configuration and surrounds at least a portion of the coil bank defined by coils 21. In the preferred embodiment illustrated, approximately seventy percent of the coil bank is surrounded.

Coil 100 includes an inlet 102 that may be connected to external cold water supply. An outlet 104 is also provided. Outlet 104 may be connected to a tap or other device to allow customer usage. For example, referring to Fig. 11, cold water may be provided from a supply 106 to a pump 108. Pump 108 is connected to inlet 102 of coil 100. The water is then heated and flows through outlet 104 to a tap or similar device.

As illustrated in Fig. 12, a cold water supply 110 is connected to a condensate receiver tank 112. Water from tank 112 is pumped by pump 114 through heat exchanger coil 100. Heated water is passed into drum 116 for storage and pumped into boiler 10 and coils 21 by pump 118 as preheated feedwater thereby increasing the efficiency of boiler 10.

Thus, it is apparent that there has been provided in accordance with the invention, an air preheater for compact boilers that fully satisfies the objects, aims and advantages set forth. Although the air preheater has been disclosed utilizing a specific type and variety of a corrugated or fluted surface with continuous longitudinal flow interrupters, it is evident that many alternatives and/or modifications including but not limited to Figures 6 and 7, will be apparent to those skilled in the art in the light of the foregoing

description. It is therefore intended to embrace all alternatives, modifications, and variations as fall within the spirit and scope of the appended claims.

I claim:

1. In a compact fluid heater of the type including a shell, a combustion chamber in said shell, coils mounted in said shell, a plenum chamber surrounding said coils, an air blower communicating with said plenum and a source of air, an exhaust gas outlet in said shell, the improvement comprising:

an air preheater adjacent said coils and intermediate said chamber and plenum including impermeable heat conducting first and second surfaces for isolating exhaust gas and air flows, respectively;

said first surface extending in a first direction from said second surface to define a lateral flow channel along said first surface for directing said exhaust gas to said exhaust gas outlet;

said first surface extending in a second direction from said second surface to define a flow interrupter transverse to said lateral flow channel for interrupting said air flow.

2. The fluid heater of claim 1 wherein said second surface comprises a fluted surface having convolutions parallel to exhaust gas flow.

3. The fluid heater of claim 1 wherein said first surface extends above said second surface in said first direction and below said second surface in said second direction.

4. The fluid heater of claim 1 further comprising first means for directing said exhaust gas above said second surface and second means for directing said air below said second surface.

5. The fluid heater of claim 1 further comprising a heat exchange coil mounted in said plenum chamber surrounding said coils, said heat exchange coil

including an inlet for connection to an external supply of fluid and an outlet for connection to an end use.

6. In a compact boiler, comprising:

a generally cylindrical combustion chamber having a burner at one end and a distal outlet for delivering combustion gases;

a generally cylindrical coil bank concentric to and axially spaced from said combustion chamber having a central gas inlet and radial interstices for channelling combustion gases from the interior of said coil bank to an outer periphery;

a combustion air plenum for supplying air to said combustion chamber;

a flue gas collector adjacent said outer periphery of said coil bank;

a stack for discharging exhaust gases;

a passage extending from said flue gas collector to said plenum for communicating said collector and said stack;

a separator extending the length of said passage; first means communicating flue gas from said collector on a first side of said separator;

second means communicating air from an air source to a second side of said separator;

rectangular transverse extensions on and generally perpendicular to said separator, said extensions defining longitudinal flue gas flow channels on said first side of said separator, and air flow interrupters on said second side;

wherein flue gases exiting said collector flow through said channels, and air entering flows across said interrupters thereby raising the temperature of said air.

7. The compact boiler set forth in claim 6 wherein said extensions are transverse to the direction

of flow of said air and of a configuration to create eddy currents in said air flow.

8. The compact boiler set forth in claim 6 wherein said separators is of an undulating configuration.

9. The compact boiler set forth in claim 6 further comprising a heat exchange coil mounted in said plenum surrounding said coil bank, said heat exchange coil including an inlet for connection to an external fluid supply and an outlet.

10. The compact boiler set forth in claim 9 wherein said heat exchange coil is of a hairpin configuration.

11. A compact boiler, comprising;
a housing,
a coil bank mounted in said housing,
a combustion chamber in said shell, said coil bank surrounding said combustion chamber,
a plenum chamber surrounding said coil bank,
a heat exchange coil mounted in said plenum chamber surrounding said coil bank,
said heat exchange coil including an inlet for connection to a supply of fluid.

12. The compact boiler claimed in claim 11 wherein said heat exchange coil is of a hairpin configuration.

13. The compact boiler claimed in claim 11 further comprising an air preheater mounted in said plenum chamber, said preheater including first and second surfaces, said first surface in a first direction from

said second surface to define a lateral flow channel and extending in a second direction from said second surface to define a flow interrupter transverse to said lateral flow channel for interrupting said air flow.

14. The compact boiler, claimed in claim 11 wherein said second surface comprises a fluted surface having convolutions parallel to exhaust gas flow.

15. A compact boiler, comprising;

a shell,

a coil bank mounted in said shell,

a plenum chamber surrounding said coil bank,

a combustion chamber in said shell surrounded by said coil bank,

an air preheater in said plenum, said preheater including first and second surfaces for isolating exhaust gas and air flows, respectively,

said first surface extending in a first direction from said second surface to define a lateral flow channel along said first surface for directing said exhaust gas to said exhaust gas outlet,

said first surface extending in a second direction from said second surface to define a flow interrupter transverse to said lateral flow channel for interrupting said air flow,

a heat exchange coil mounted in said plenum chamber surrounding said coil bank,

said heat exchange coil including an inlet for connection to a supply of fluid and an outlet.

16. The boiler set forth in claim 15 wherein said heat exchange coil is of a hairpin configuration.

17. The boiler set forth in claim 15 wherein said second surface comprises a fluted surface including convolutions parallel to exhaust gas flow.

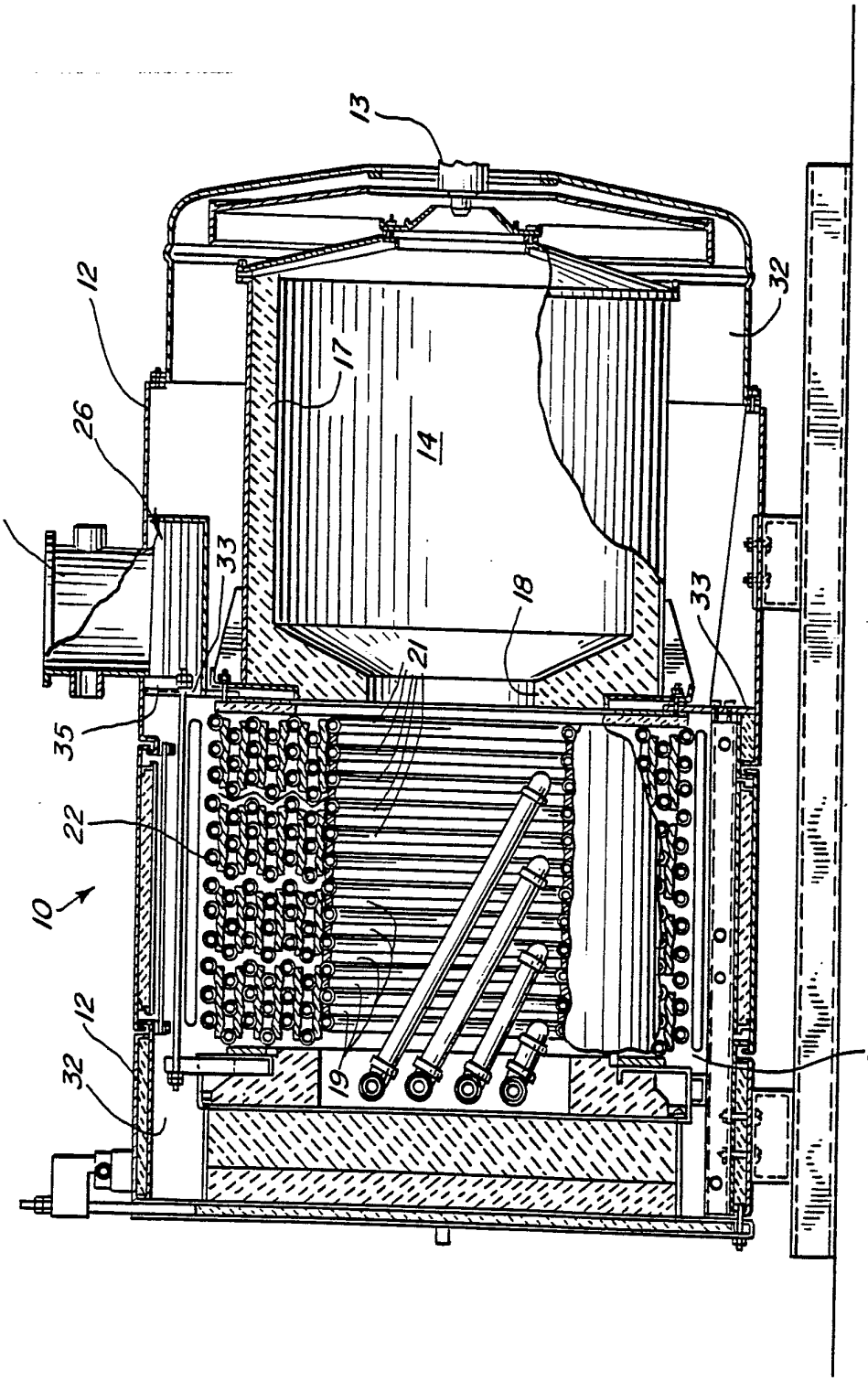


FIG. 1

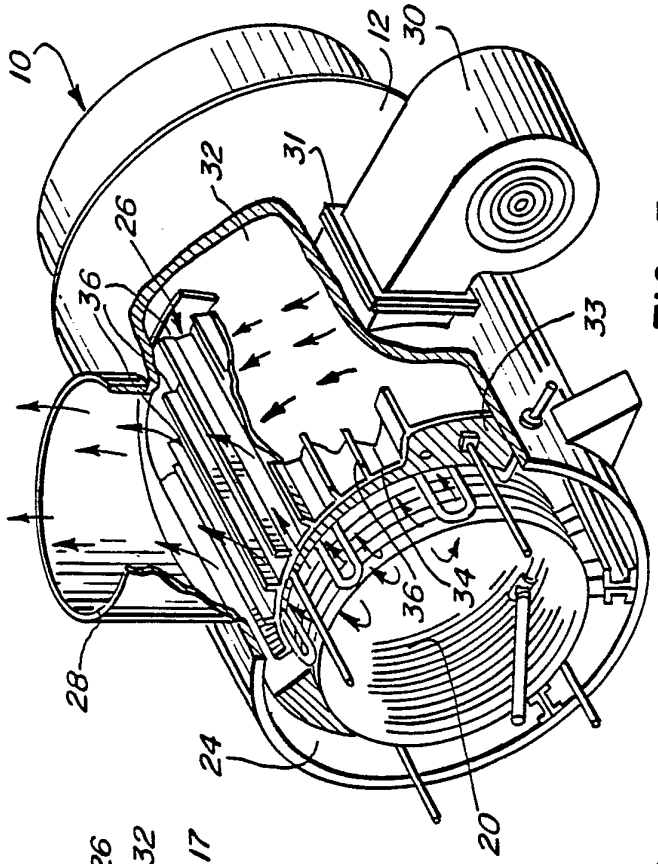


FIG. 3

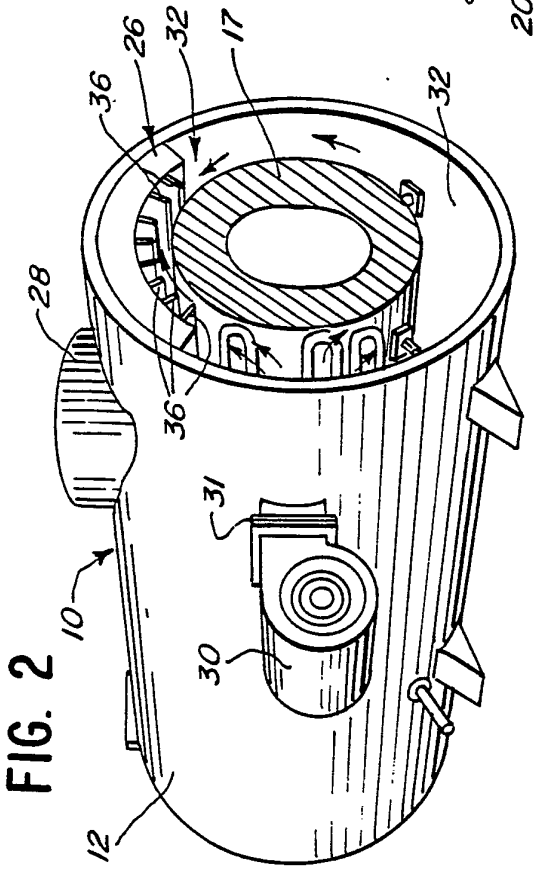


FIG. 2

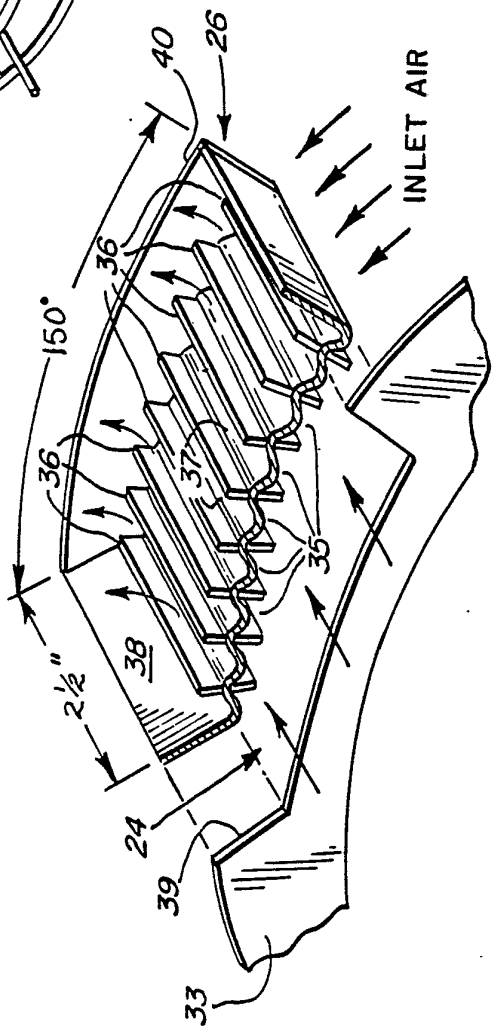
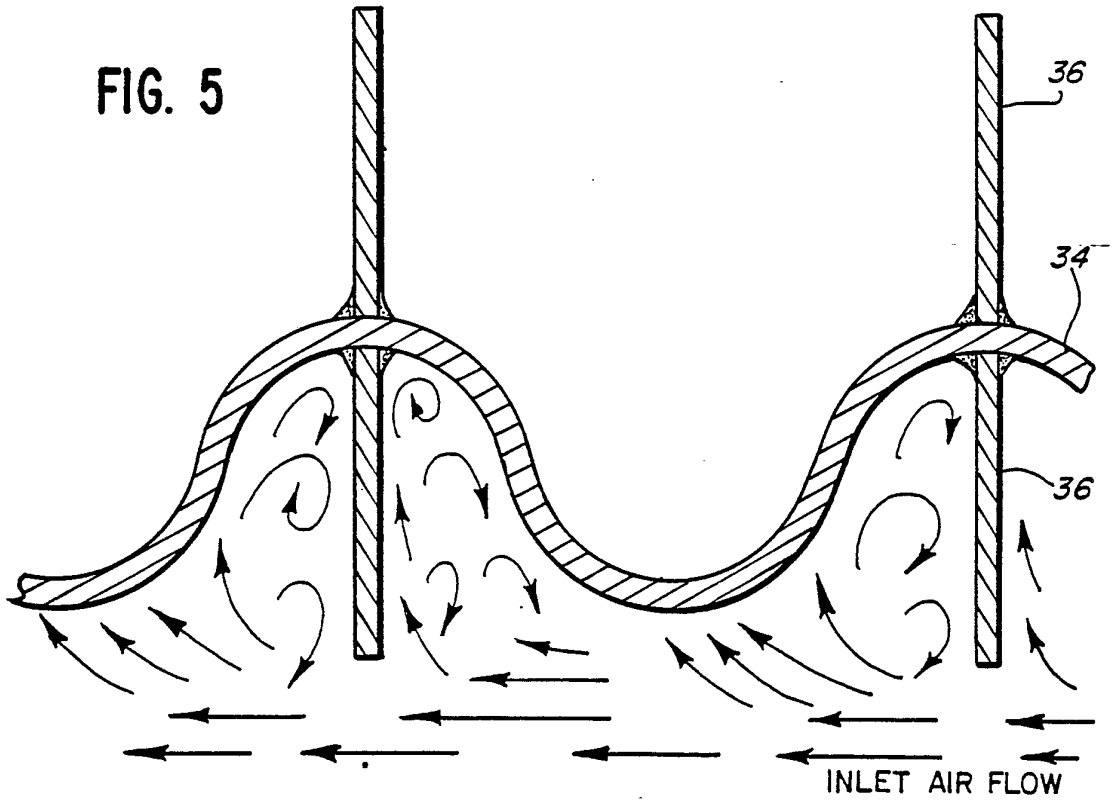


FIG. 4

FIG. 5



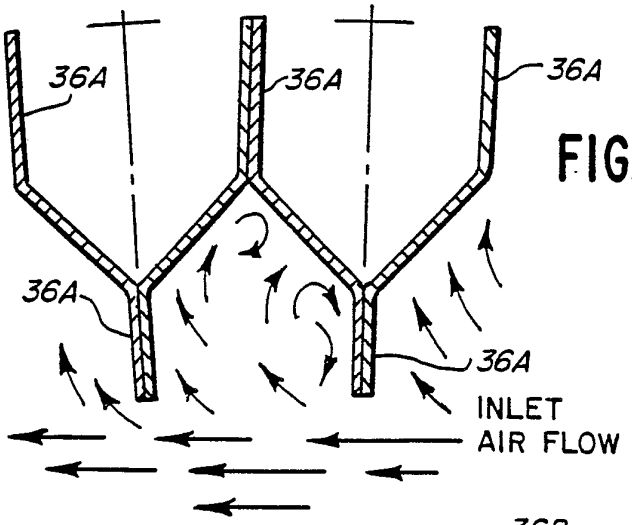


FIG. 6

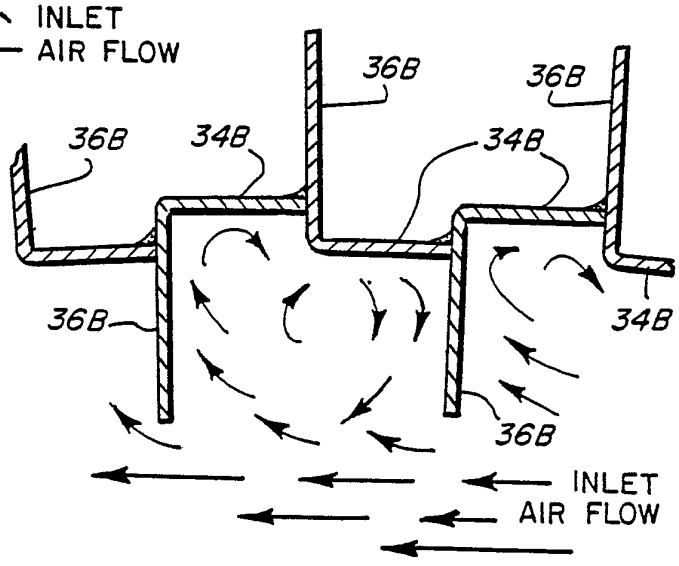


FIG. 7

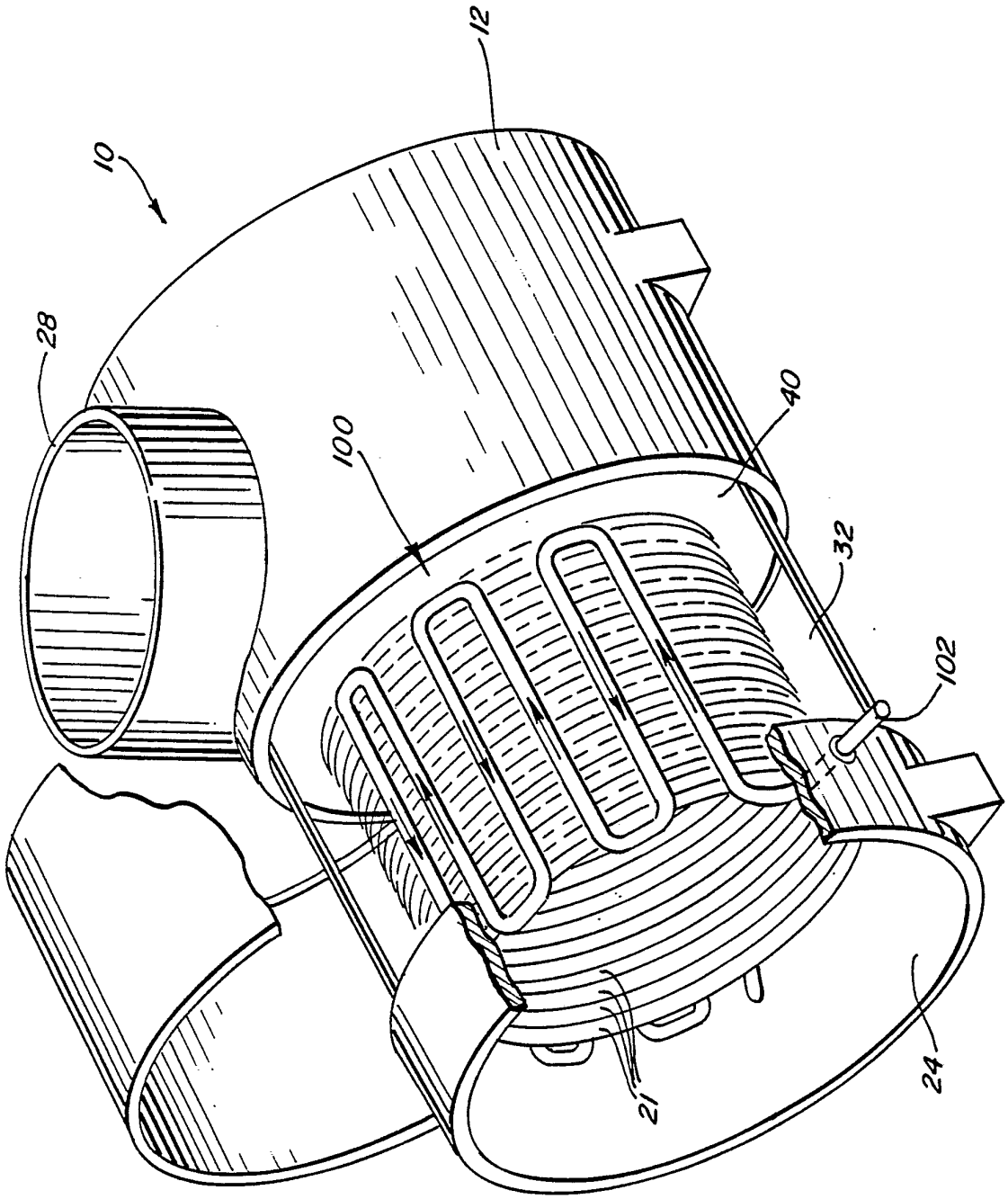


FIG. 8

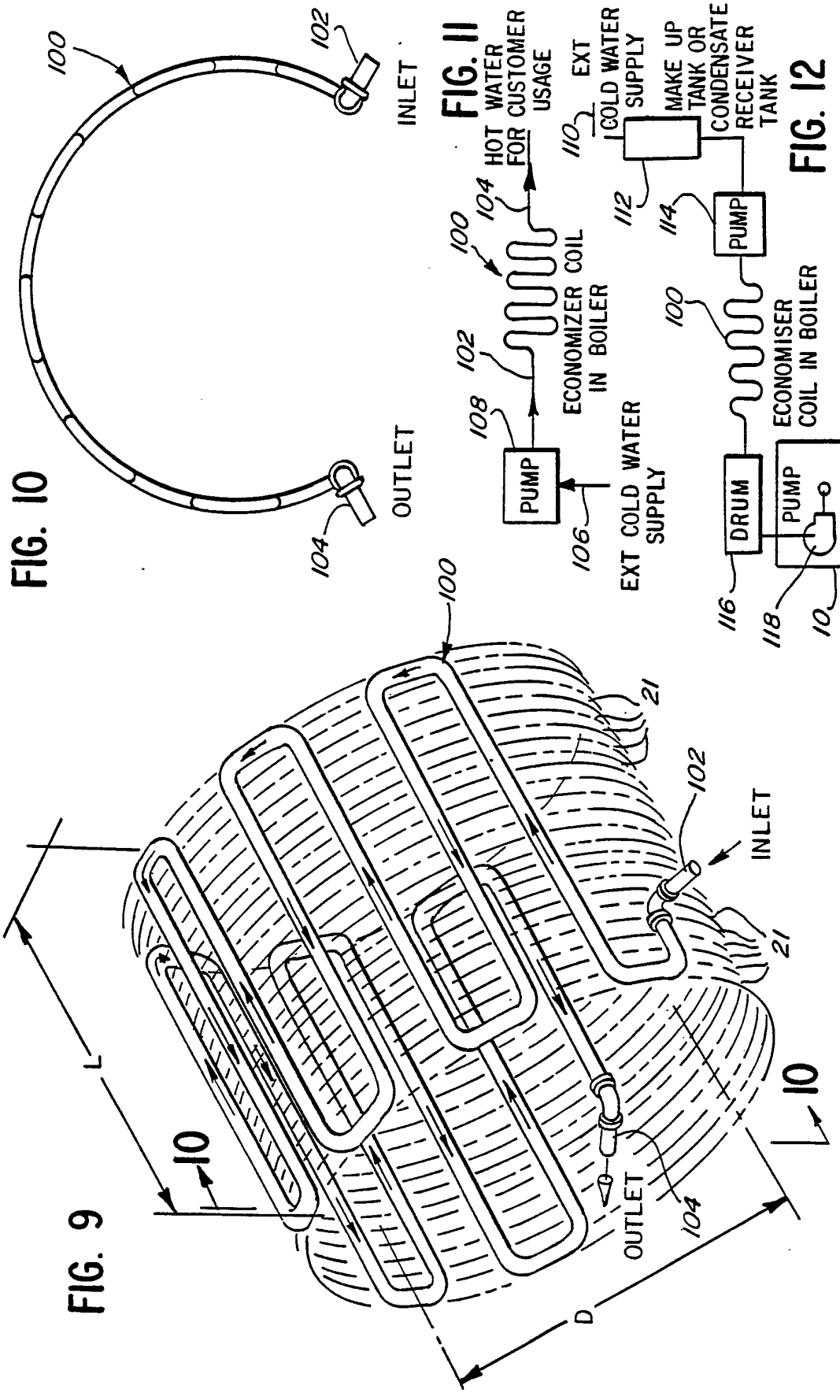


FIG. 9
FIG. 10
FIG. 11
FIG. 12
100
102
104
INLET
OUTLET
L
D
10
21
HOT WATER FOR CUSTOMER USAGE
ECONOMIZER COIL IN BOILER
EXT COLD WATER SUPPLY
PUMP
108
106
110
112
114
MAKE UP TANK OR CONDENSATE RECEIVER TANK
ECONOMISER COIL IN BOILER
DRUM
116
118

INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/01692

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL. [4] F22B 37/10 U.S. CL. 122/248

II. FIELDS SEARCHED

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Classification System	Classification Symbols
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X, P	US, A, 2,011,423, 13 August 1985 Sheldon	1, 5, 11, 12, 13, 15, 16
A	US, A, 3,398,722, 27 August 1968 Smykal, Jr. et al	
A	US, A, 3,351,041, 07 November 1967 Watson et al	
A	US, A, 4,357,910, 09 November 1982 Blockley et al	
A, P	US, A, 3,881,451, 06 May 1975 Smith	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
02 November 1985	14 NOV 1985
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