United States Patent [19]

Dow, Jr. et al.

[11] **3,907,210**

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[54] **APPARATUS TO IMPROVE COMBUSTION OF FUEL**

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[52] **U.S. Cl.** **239/553.3**; 239/567; 431/165

[51] **Int. Cl.**[2] **B05B 01/14**

[58] **Field of Search** 239/553.3, 553.5, 557, 239/566, 567; 431/165, 190

[56] **References Cited**

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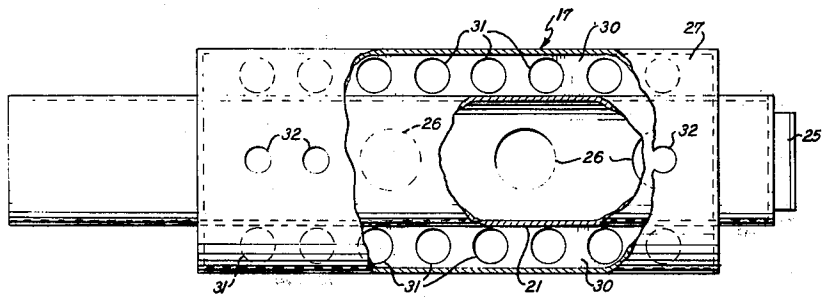
Primary Examiner—John J. Love

Attorney, Agent, or Firm—Marvin Reich

[57] **ABSTRACT**

Preheated secondary combustion air is delivered across the axis of the burner flame in an oil-fired boiler. By virtue of a secondary combustion air delivery apparatus, the secondary air is heated in three stages before delivery into the flame and is then delivered in a multiplicity of evenly pressurized air jets to control the size of the flame while increasing the heat thereof. A substantial savings of fuel is obtained and boiler efficiency is increased.

10 Claims, 8 Drawing Figures



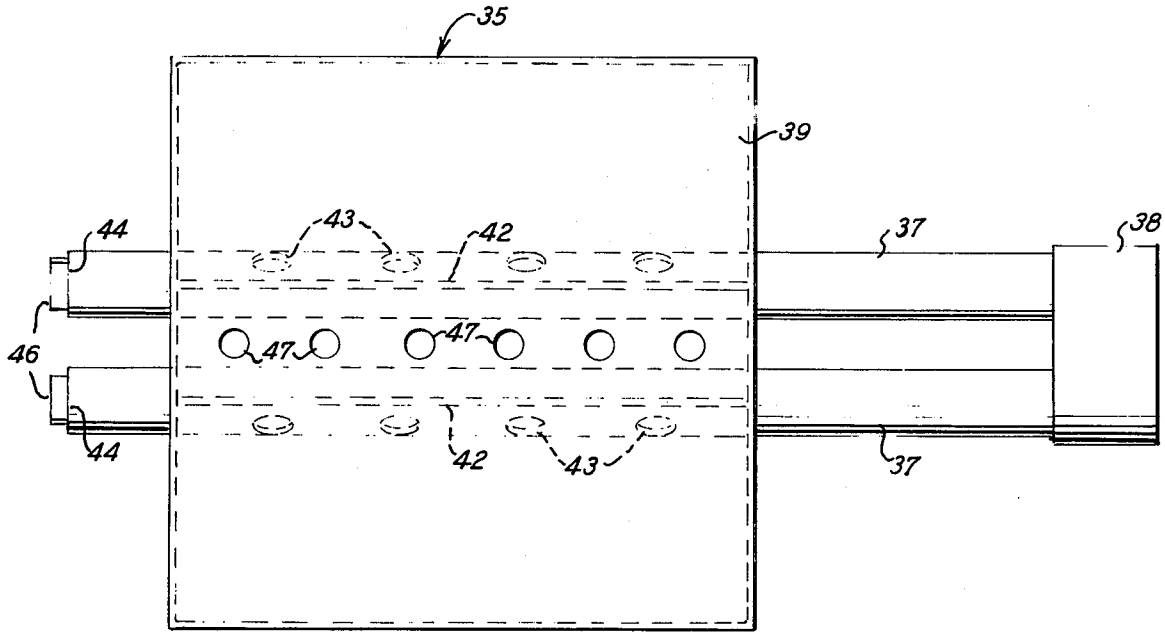

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Fig-7

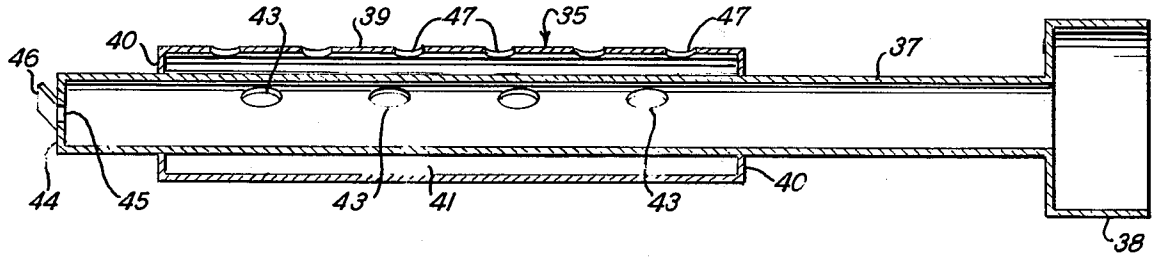
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Fig-8

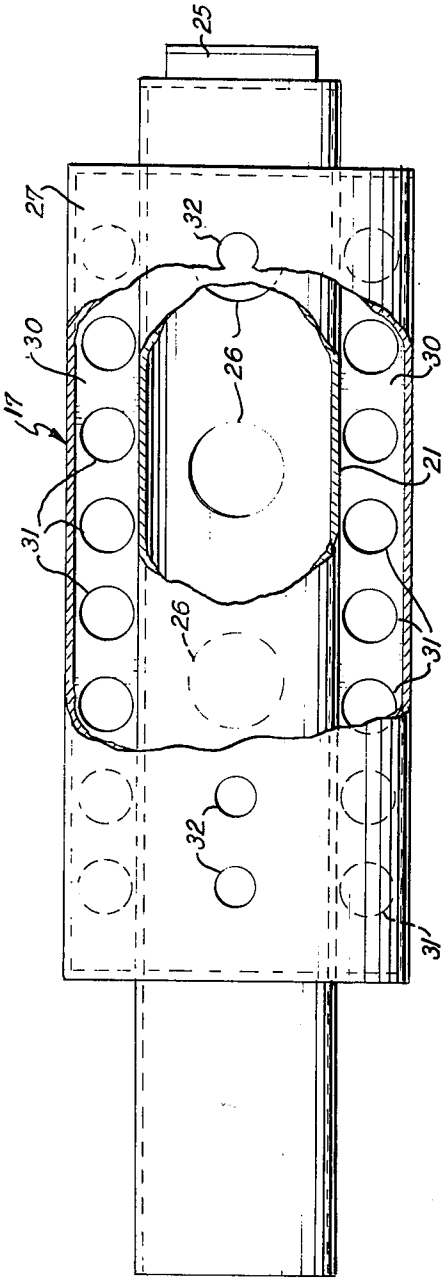

FIG-2

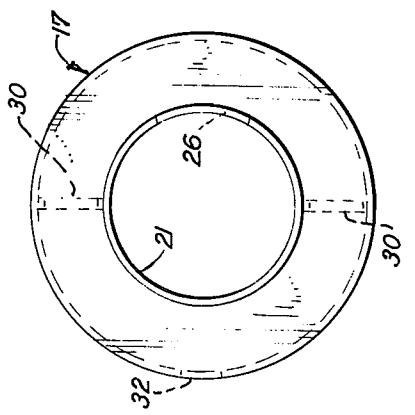

FIG-3

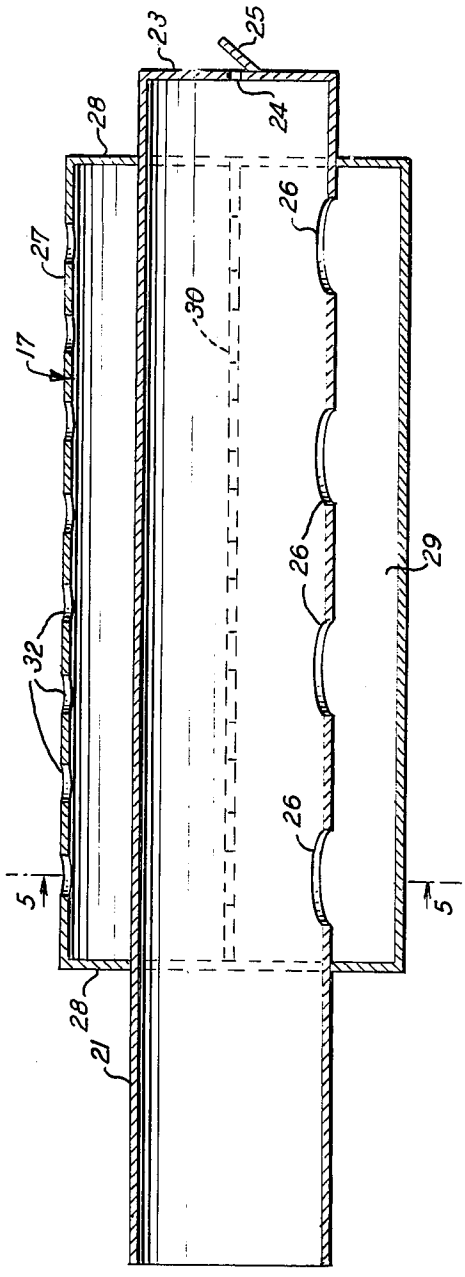

FIG-4

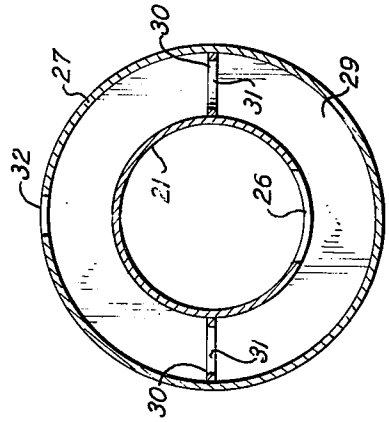

FIG-5

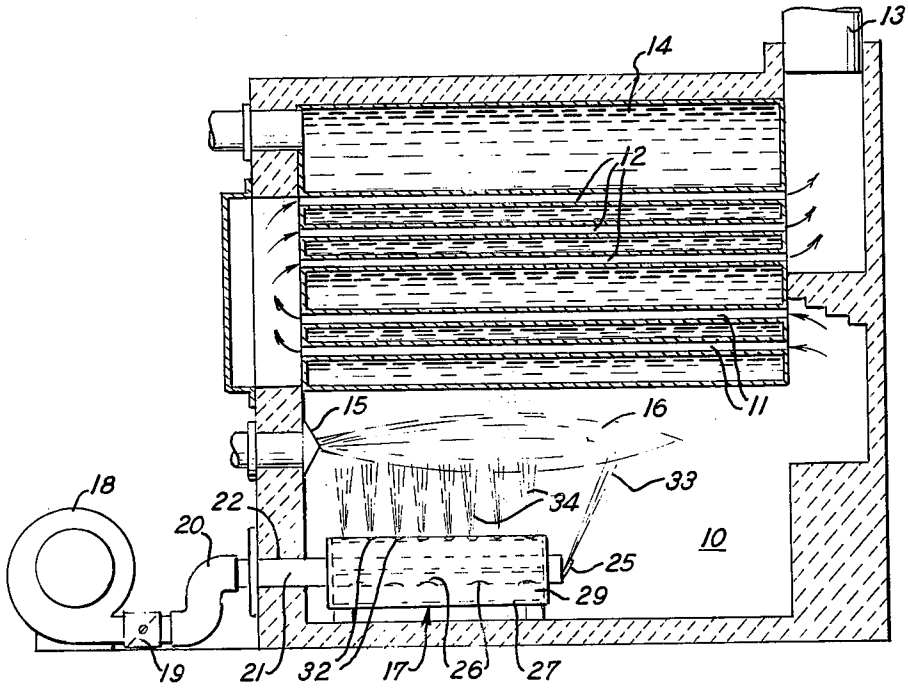
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FIG. 1

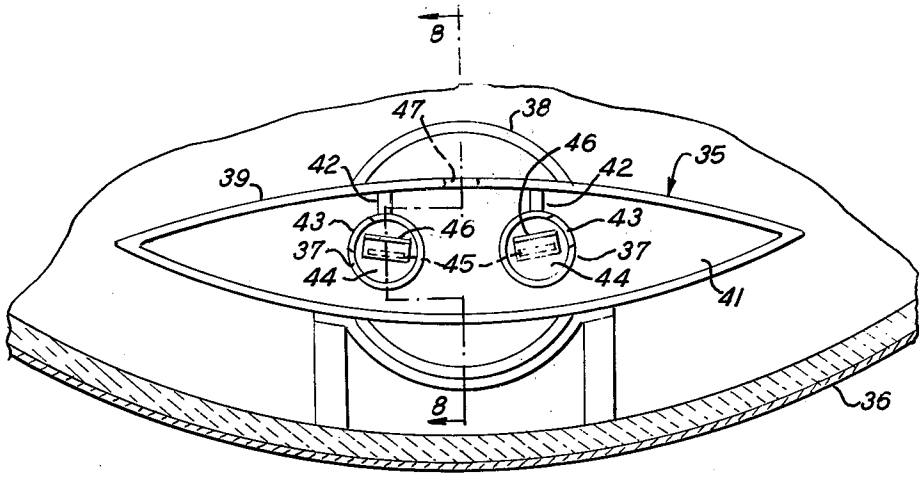
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FIG. 6

APPARATUS TO IMPROVE COMBUSTION OF FUEL

BACKGROUND OF THE INVENTION

In prior U.S. Pat. No. 3,291,182, issued to I. A. Dow, Jr. et al., the art has recognized the advantage of delivering preheated secondary air directly into an oil burner flame in a steam boiler, such air being delivered at right angles to the flame axis by spaced nozzle means forming a part of the air preheating and delivery structure.

The present invention has for its objective to improve upon the device of said prior patent by the provision of an apparatus which is capable of more evenly heating the secondary combustion air in a greater number of heating stages, followed by more even delivery of the secondary air into the flame at spaced intervals along its length. As a result an even hotter and more controlled flame is achieved with an even greater savings of fuel and a further increase in boiler efficiency. A correspondingly greater reduction in soot deposited on the surrounding walls of the furnace chamber is achieved, as well as an increased reduction in pollutants reaching the atmosphere. The smaller and more controlled flame is prevented from impinging directly on the surrounding surfaces of the furnace chamber and boiler.

By means of the invention, only the optimum volume of preheated secondary air at the highest possible temperature will be delivered into the burner flame so as to superheat the same. The secondary air will be highly uniform both as to its temperature and pressure at the several points along the flame where the air is delivered in distinct jets across the axis of the flame. It is this high degree of uniformity in the preheated secondary combustion air jets which constitutes a very distinct improvement over the prior art.

Other features and advantages of the invention will become apparent during the course of the following detailed description.

BRIEF DESCRIPTION OF DRAWING FIGURES

FIG. **1** is a vertical sectional view taken through an oil-fired boiler equipped with secondary combustion air delivery means embodying the invention.

FIG. **2** is a plan view of the secondary air delivery means, partly in section and partly broken away.

FIG. **3** is an end elevation of the same.

FIG. **4** is a central vertical longitudinal section through the air delivery means.

FIG. **5** is a transverse vertical section taken on line **5—5** of FIG. **4.**

FIG. **6** is an end elevation showing a modification of the invention.

FIG. **7** is a plan view of the apparatus of FIG. **6.**

FIG. **8** is a longitudinal vertical section taken on line **8—8** of FIG. **6.**

DETAILED DESCRIPTION

Referring to the drawings in detail wherein like numerals designate like parts, and attention being directed first to FIG. **1,** the numeral **10** designates the furnace chamber of a fire tube boiler having banks of fire tubes **11** and **12** above the furnace chamber, the upper bank of tubes delivering the combustion gases to a chimney **13.** The boiler vessel through which the boiler fire tubes extend is designated by the numeral **14.**

A conventional cone oil burner **15** produces a substantially horizontal flame **16** in the upper part of the furnace chamber **10** as shown approximately in FIG. **1.** The invention proper for delivering preheated secondary combustion air directly into the flame **16** in a controlled and uniform manner has the ability to produce a hotter flame and a smaller flame of more uniform heat than one which will require a minimum amount of fuel to maintain in comparison to a conventional arrangement where the invention is not employed.

Referring to FIGS. **1** through **5,** the invention comprises a secondary air preheating, distribution and delivery apparatus **17** which receives air at boiler room temperature from a fan **18** having an adjustable outlet valve **19.** From this point, the pressurized air is delivered through a suitable hose **20** to an interior sleeve **21** of the invention which extends through an opening **22** in the adjacent furnace wall and is suitably coupled to the hose **20.** The sleeve **21** extends forwardly of the burner **15** for a considerable distance in the furnace chamber **10** near and above the floor thereof. It has a forward end wall **23** provided with a small aperture **24** for directing a small longitudinal air jet against a fixed inclined baffle plate **25** carried by the end wall **23** immediately below the aperture **24.** The sleeve **21** is additionally provided in its bottom with preferably four equidistantly spaced relatively large discharge openings **26.**

Surrounding the sleeve **21** for the major portion of its length in the furnace chamber **10** is an outer cylindrical sleeve or envelope **27** having end walls **28** which are joined to the inner sleeve **21** in a gas-tight manner. The two sleeves **21** and **27** are concentrically arranged to form between them an annular chamber **29.** This chamber is divided into upper and lower sections by a pair of diametrically arranged internal baffle plates **30** rigidly connected between the two sleeves **21** and **27.** The baffle plates **30** each have a plurality of equidistantly spaced openings **31,** such as eight openings formed therethrough, the openings **31** being smaller than the openings **26.** The envelope or sleeve **27** is provided in its top with a longitudinal row of relatively smaller openings **32,** such as eight openings, and these are diametrically opposite to the openings **26** and are spaced 90° circumferentially from the two baffle plates **30.** When the apparatus **17** is installed in the furnace chamber **10,** the openings **32** face upwardly directly under the longitudinal axis of the flame **16.**

During operation air is delivered at boiler room temperature by the fan **18** to the interior of sleeve **21** where back pressure is created due to the closed end wall **23** which has only the small aperture **24.** The pressurized air in the sleeve **21** is distributed evenly through the relatively large openings **26** into the annular chamber **29** below the baffle plates **30.** The air receives a first stage of heating by conduction and convection while within the sleeve **21,** it being understood that the entire apparatus **17** is at an elevated temperature being disposed in the furnace chamber. The first stage of heating of the air within the sleeve **21** takes place as follows. Baffles **30** conduct heat inwardly from the exterior sleeve **27** which is directly exposed in the furnace chamber. Hot air in the annular chamber **29** also delivers heat from the envelope **27** to the interior sleeve **21,** which in turn elevates the temperature of the air passing through it.

The air thus heated in the first stage in sleeve 21 then exits downwardly through the openings 26, as described, and enters the lower portion of chamber 29 below baffle plates 30. A precalculated volume of air also exits through aperture 24 and is deflected upwardly by element 25 as a single angled jet 33, FIG. 1. This heated air jet is applied to the end or tail of the flame 16 to create turbulence in the flame and to atomize particles therein to assure complete combustion. Most of the air from interior sleeve 21 enters and fills the lower part of annular chamber 29 and is somewhat restricted therein by baffle plates 30 causing an evening of pressure in the lower chamber portion. The air in this lower chamber portion therefore lingers somewhat for a longer second stage of heating above the temperature of first stage heating. The temperature in the second stage is raised by contact of the air with envelope 27 which is a heat sink or radiator in reverse. It must be recognized that the air has exited downwardly from openings 26 and has its direction reversed by the bottom of envelope 27 before beginning to flow upwardly toward the openings 31. During this reversal and gradual upward flow, the air will bathe the very hot surface of the envelope 27 and absorb its heat. Beginning at the bottom of the envelope directly below the openings 26, the air circulates over every square inch of the heated surface of the outer envelope.

In its upward travel, the restriction of the air is relieved as it is vented through the openings 31 of baffle plates 30 to enter the upper portion of annular chamber 29. The air is now rising with even distribution from end-to-end of the envelope 27 due to the effect of the equidistantly spaced and equally sized openings 31. During the time that the air is ascending from the distribution openings 31 through the upper portion of chamber 29, it is subjected to a third stage of heating. The upper portion of the annular chamber 29 is the hottest, being closest to the flame 16. Thus, as the air approaches the discharge ports 32 in the top of the envelope 27 and directly below the flame 16, it will have reached its hottest temperature prior to delivery into the flame as a plurality of distinct and separate jets 34 directed at right angles to the flame axis.

Each equally sized opening 32 directs an equal volume of preheated air at a uniform elevated temperature and a uniform pressure toward the flame 16 causing essential turbulence along the length of the flame and injecting directly into the flame precisely the required amount of excess or secondary combustion air for maximum efficiency. Too much secondary air or too little is avoided by the invention and herein resides the chief feature of the invention which distinguishes it from the prior art. This chief feature can be described as the ability of the apparatus 17 to deliver evenly to all parts of the flame jets of preheated secondary air which are almost perfectly uniform as to temperature, volume and pressure or velocity. In contrast to this, prior devices lacked the ability to deliver the air evenly to the flame and also lacked the ability to preheat the air in three stages. In the prior art, the cooler air and the greatest volume of air was necessarily delivered toward the tail of the flame and the secondary air became progressively hotter but fell in volume and pressure toward the base of the flame. This lack of uniformity is completely avoided with the present invention. The advantages of the invention will be readily apparent to those skilled in the art.

FIGS. 6 through 8 depict a modification of the invention in the form of a low profile appartus 35 particularly suitable for a cylindrical boiler 36. In this form of the invention, twin sleeves or barrels 37 are joined by a coupling 38 to a common fan, not shown, similar to the fan 18. A low profile exterior envelope 39 surrounds the barrels 37 throughout most of their lengths inside of the furnace chamber. The envelope 39 has end walls 40 joined to the barrels 37 in a gas-tight manner to form a rigid construction. A relatively large internal chamber 41 is provided between the barrels 37 and the two walls of the low profile envelope 39. This chamber is interrupted at the tops of the barrels 37 by a pair of baffles 42 which interconnect the top wall of the envelope 39 with the barrels. The two baffles 42 are solid or unapertured throughout their lengths inside of the envelope 39.

Each barrel 37 has a plurality of spaced openings 43 whose axes are inclined and divergent above the horizontal, whereby air discharging through the openings 43 will bathe the top wall of envelope 39 and will flow outwardly away from baffles 42, following a downward course, and then returning toward the center of the envelope, FIG. 6, below the two barrels and then upwardly between the barrels and baffles 42. Additionally, each barrel 37 has a forward end wall 44 provided with a single port 45 in the form of a slot, see FIG. 6. Upturned deflector plates 46 secured to end walls 44 divert single jets of heated air upwardly into the tail of the flame 16 for the purposes served by the jet 33 of the previous embodiment. The slots 45 and deflector plates 46 are convergent upwardly, FIG. 6, so that the two air jets discharging at the ends of the barrels 37 will be directed toward the center of the flame.

The envelope 39 is provided in its top wall midway between the two barrels 37 and baffles 42 with a row of equidistantly spaced discharge openings 47 which correspond in purpose to the openings 32 of the previous embodiment. That is to say, the preheated secondary combustion air exiting from the openings 47 will be delivered into the flame 16, across the axis thereof with even elevated temperature, volume and intensity for the same purposes fully described above in connection with the air jets 34. In the modification of FIGS. 6 through 8, the secondary combustion air will be heated in only two stages rather than three, the first heating stage being within the barrels 37 and the second stage being within the envelope 39 while the air is traveling from the openings 43 toward the discharge openings 47. Nevertheless, the modified form of the invention results in the application to the burner flame 16 throughout its length of secondary air which is uniform or constant as to temperature, pressure and volume. The general mode of operation of the apparatus remains the same in both forms of the invention, in that the apparatus serves very efficiently to preheat, evenly distribute, and deliver the air to the flame.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or scope of the subjoined claims.

We claim:

1. An apparatus for delivering preheated secondary air into a burner flame comprising a sleeve adapted to receive air from a fan and having a plurality of longitu-

dinally spaced openings in its side wall, an envelope surrounding said sleeve and side wall openings and joined to the sleeve to form between the sleeve and the envelope a chamber for air, said envelope having a plurality of longitudinally spaced air discharge openings formed through its side wall remotely from the sleeve wall openings, and baffle means interposed between the sleeve and envelope side wall openings to regulate the passage of air from the former to the latter, said baffle means extending from the outer surface of said sleeve to the inner surface of said envelope, thereby defining a first and second cavity, means for forcing said air to contact said envelope in a lingering fashion for causing heat transfer from said envelope to said air comprising openings in said baffle means.

2. An appartus for delivering preheated secondary air into a burner flame comprising a sleeve adapted to receive air from a fan and having a plurality of longitudinally spaced openings in its side wall, an envelope surrounding said sleeve and side wall openings and joined to the sleeve to form between the sleeve and the envelope a chamber for air, said envelope having a plurality of longitudinally spaced air discharge openings formed through its side wall remotely from the sleeve side wall openings, and baffle means interposed between the sleeve and envelope side wall openings to regulate the passage of air from the former to the latter, said sleeve and envelope are concentric cylinders and said baffle means consists of a pair of baffle plates extending diametrically of the sleeve and envelope in the chamber formed therebetween, said baffle plates each having a plurality of longitudinally spaced equally sized openings.

3. The apparatus as defined by claim **2,** and an end wall closing one end of said sleeve exteriorly of said envelope, said end wall having a single aperture, and an inclined deflector element on said end wall to divert air discharging from said aperture into a jet having an inclined axis relative to the axis of said sleeve.

4. The apparatus as defined by claim **2,** and said sleeve side wall openings spaced substantially 180° from the envelope side wall openings, said baffle plates spaced midway between the openings of the sleeve and envelope and dividing said chamber, said chamber being annular.

5. The apparatus as defined by claim **4,** and the openings of said sleeve, baffle plates and envelope being successively smaller in size.

6. An apparatus for delivering preheated secondary air into a burner flame comprising a sleeve adapted to receive air from a fan and having a plurality of longitudinally spaced openings in its wall, an envelope surrounding said sleeve and side wall openings and joined to the sleeve to form between the sleeve and the envelope a chamber for air, said envelope having a plurality of longitudinally spaced air discharge openings formed through its side wall remotely from the sleeve side wall openings, and baffle means interposed between the sleeve and envelope side wall openings to regulate the passage of air from the former to the latter, and a pair of sleeves in spaced parallel relationship each having plural longitudinally spaced side wall openings, a coupling element common to said sleeves connected to corresponding ends thereof and adapted to receive air from a fan source, and said envelope being a low profile envelope surrounding the pair of sleeves and their openings and having plural spaced discharge openings in one side wall thereof between said sleeves, and said baffle means consisting of a pair of baffle plates extending between said sleeves and one side wall of the low profile envelope and disposed on opposite sides of the envelope openings and between the latter and the sleeve openings.

7. The apparatus as defined by claim **6,** wherein the side wall openings of the two sleeves diverge and have axes angled toward the wall of the envelope having the envelope openings and being angled away from corresponding sides of the pair of baffle plates.

8. The apparatus as defined by claim **7,** and end walls closing corresponding ends of said sleeves, said end walls having small apertures, and deflector elements on said end walls adjacent said apertures.

9. The apparatus as defined by claim **6,** and end walls on corresponding ends of said sleeves and having apertures, and deflector elements on the end walls adjacent to said apertures.

10. The apparatus as defined by claim **6,** and said low profile envelope comprising a pair of opposing arcuate side walls joined at corresponding edges substantially outwardly on opposite sides of said sleeves and being symmetrical about said sleeves, the curvature of said envelope side walls conforming substantially to the curvature of a circular boiler with which the apparatus is employed.

* * * * *