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HEAT EXCHANGE APPARATUS HAVING CENTRIFUGAL FAN

Filed Oct. 28, 1953

2 Sheets-Sheet 1

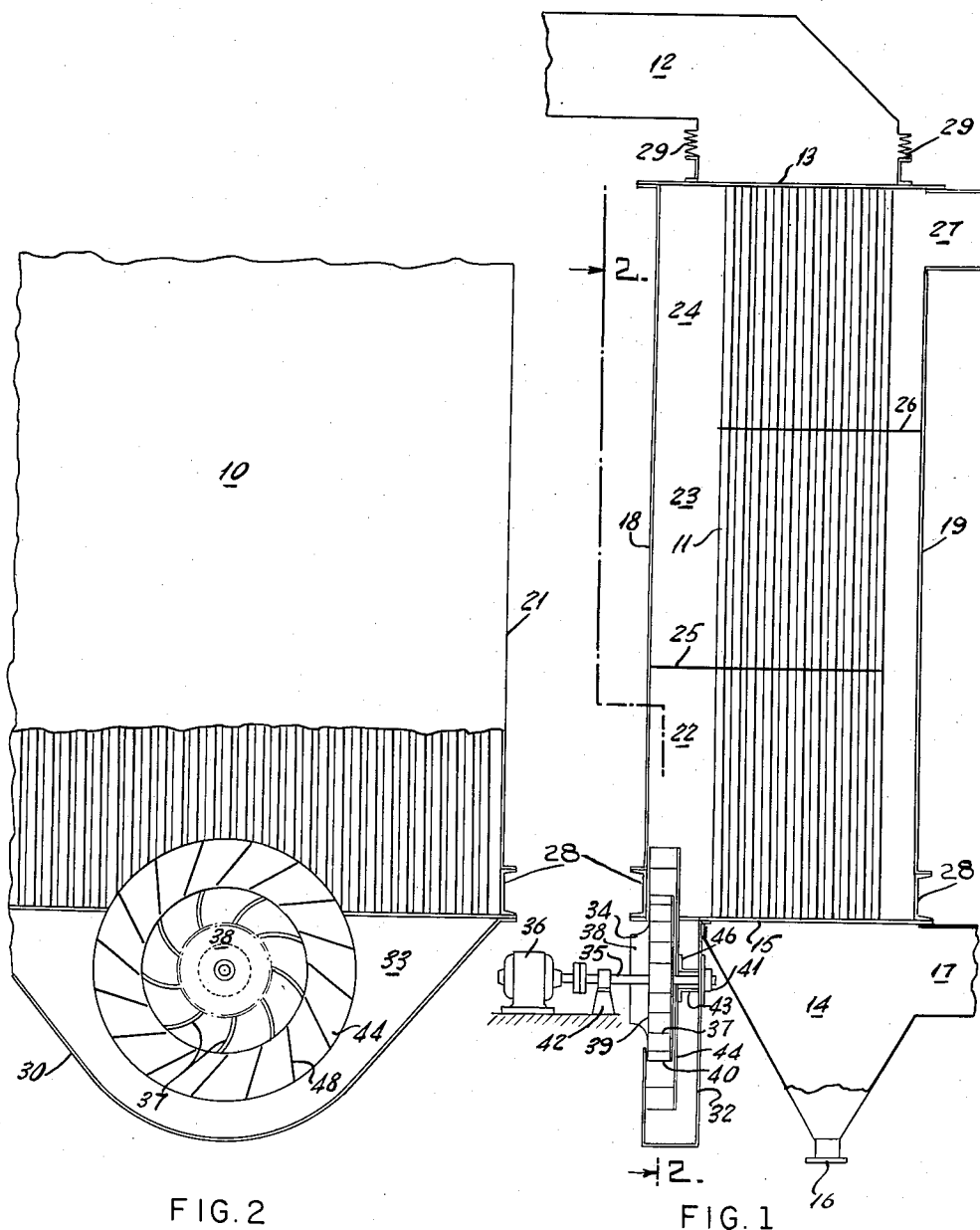


FIG. 2

FIG. 1

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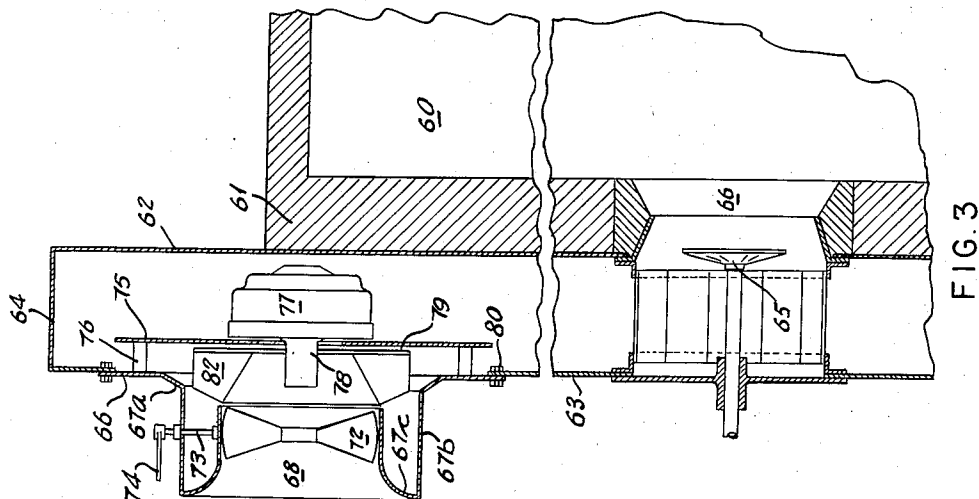


FIG. 3

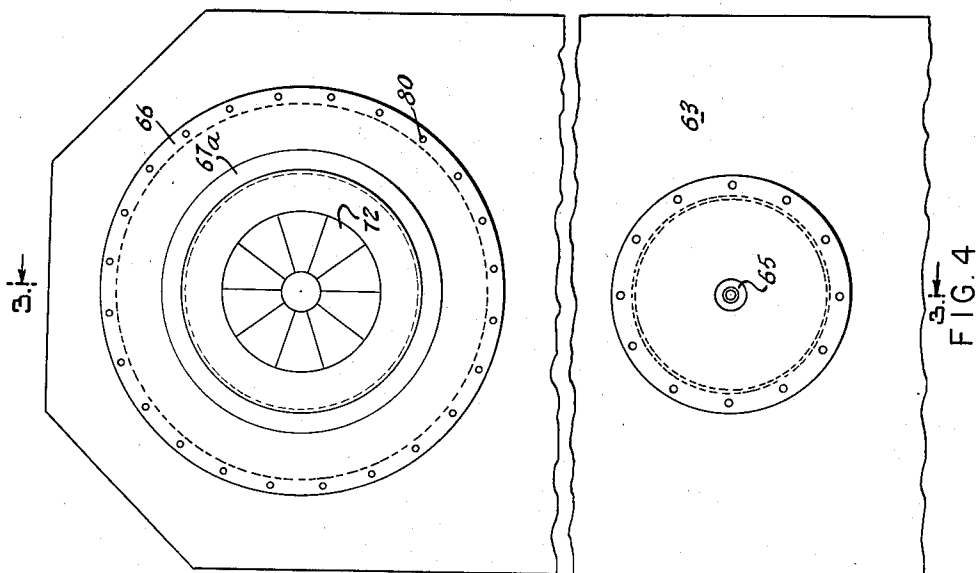


FIG. 4

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HEAT EXCHANGE APPARATUS HAVING CENTRIFUGAL FAN

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This invention relates in general to centrifugal fans and, more particularly, to an improved arrangement of forced-draft type centrifugal fan as an integrated part of the apparatus with which it is used.

Heretofore, fans of the forced draft centrifugal type have been constructed with a surrounding casing, or housing, which usually is in the form of a spiral or scroll. This spiral housing is shaped so as to provide an effective means of collecting the high velocity gases delivered at the periphery of the fan rotating member. At the air discharge end of the fan spiral housing, some transition ductwork has also been necessary to change the spiral gas flow in the fan housing to straight line flow and to convert a portion of the high gas velocity head into static pressure head. Even with the most efficient duct shapes for this transition, only 50 to 70 percent of the reduction of velocity pressure head leaving the fan housing is regained as static pressure head at the end of the ductwork. Both the fan housing and the transition ductwork of these fans are expensive and space consuming.

A primary object of my invention is to provide a centrifugal fan of the character described in which the fan housing and transition ductwork is integrated with the apparatus with which it is used, thereby eliminating the necessity for any separate housing or transitional ductwork.

It is a further object to provide a compact, efficient, relatively noiseless, and inexpensive forced-draft centrifugal fan in which the fan housing or casing forms part of an air heater, boiler furnace, or similar apparatus.

It is a still further object to provide a combination of a centrifugal fan, the casing of an apparatus and a diffuser, whereby the casing and the diffuser function efficiently to change a portion of the velocity energy of a gas discharged by such fan into static pressure head in the flow passage between said casing and said apparatus.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which is illustrated and described a preferred embodiment of the invention.

Of the drawings:

Fig. 1 is a part elevation and part sectional view of an air heater having the invention fan arrangement incorporated therewith;

Fig. 2 is a vertical partial sectional view taken on the line 2-2 of Fig. 1;

Fig. 3 is a sectional view of another embodiment of the invention used in conjunction with a boiler furnace taken on line 3-3 of Fig. 4; and

Fig. 4 is a front elevation view of the embodiment shown in Fig. 3.

Referring to Figs. 1 and 2, a tubular recuperative type air heater incorporating the invention is generally designated at 10 as comprising vertically elongated tubular

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heating gas conduits 11 through which are directed furnace gases which have previously been passed over fluid heating surfaces in a boiler (not shown). These furnace gases are directed through the air heater incoming gas passage 12 to the gas conduits 11 which are connected into communication with the passage 12 through an upper tube sheet 13. The conduits 11 are also connected at their opposite ends through a lower tube sheet 15 into communication with a gas exit chamber 14, through which the gases leaving the air heater are passed. The exit chamber 14 has a conical shaped hopper portion with an opening 16 at the bottom to discharge any solid materials in the gases, such as ash. The gases flow laterally from chamber 14 through a flue passage 17.

The air heater 10 includes a casing formed by a vertical front wall 18, a vertical rear wall 19, and vertical side walls (one of which designated 21 is shown) which enclose the space around the gas conduits 11 between the tube sheets 13 and 15. The space thus enclosed is divided into three horizontal air passes 22, 23 and 24 which are partially separated by horizontal plate baffles 25 and 26. An air outlet 27 is disposed in the rear wall 19. The air being heated flows in a general contra-flow direction to the heating gas. The entire air heater is supported from the bottom by structural members 28. Expansion joints 29 are provided above the top tube sheet 13 to allow for expansion and contraction.

In accordance with the invention, the front wall 18 of air heater 10 extends below the tube sheet 15 and it, together with lower curved side walls 30 and 31 and vertical wall 32, forms a fan rotor compartment 33 which is integral with the air heater 10. A centrifugal type fan is arranged in the compartment 33. It comprises a fan rotor 34 attached to a shaft 35 which, in turn, is connected to, and normally rotated by, a driving electric motor 36. The fan rotor 34 is comprised of a number of circumferentially spaced radial air impeller blades 37 which extend radially from a circular air inlet cone 38, and these blades are arranged to discharge air at their peripheries when rotated. Impeller blades 37 are mounted between a front rotor annulus 39 which is a continuation of the inlet cone 38 and a rear rotor annulus wall 40. Annulus 39 overlaps the front air heater wall 18 at its outer periphery adjacent the inlet. The motor 36 is bottom supported, and the shaft 35 is supported by an end bearing 41, in the wall 32 and a middle bearing 42. A tubular spacer 43 surrounds shaft 35 between walls 32 and a diffuser plate 44. With the fan rotor arranged in the casing as described, it is not necessary to have a seal between the impeller and the air heater casing. Any expansion or contraction of the air heater can be accommodated by the clearance between the vertical front portion of the impeller and the casing due to the fact that the front of the impeller seals the opening in the wall 18.

The invention fan arrangement is further characterized by the provision of the circular diffuser rear wall or plate 44 which is secured to tubular spacer 43 by member 46, and is slightly spaced from the rear wall of the rotor 34. It is rigidly connected to the tubular member 43 by back members 46 which are welded thereto. The diffuser wall 44 and the wall 18 form a passage for the circumferential discharge of air continuing the sweep of the impellers 37. This passage functions to convert velocity head into static pressure head by increasing the radius of the air spin and by increasing area of the air discharge passage. In the embodiment shown in Figs. 1 and 2, guide vanes 48 are provided as an additional means of diffusing the whirl velocity into static pressure.

Referring to Figs. 3 and 4, a boiler furnace incorporating another embodiment of the invention is generally designated 60. The boiler furnace has a refractory front

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wall and roof 61 to which a vertical front casing wall 62 is attached. This front casing wall extends above the top of the furnace 60, and spaced from this front wall is an outside casing wall 63 which extends parallel to the front wall and is connected thereto by top casing wall 64 to form a plenum or gas supply chamber therebetween. A burner 65 for the boiler furnace is positioned in the space between the casing and the front wall and extends into a port 66.

To supply air for combustion of the fuel discharged by the burner 65, a centrifugal fan constructed in accordance with the invention is disposed directly in a circular opening in the outside casing wall 63. The invention is characterized by a complete centrifugal fan assembly which may be attached to the outside casing wall 63 so that air may be taken in axially and discharged radially directly into the space between the front casing internal wall and the outside casing wall without any connecting ductwork or housing other than the boiler casing itself.

The fan unit comprises a circular mounting plate 66 which acts as an outer first diffuser plate and which is joined by a frustoconical section 67a to a cylindrical inlet section 67b. Inside the inlet section is a curved inwardly tapering portion 67c which evolves into a straight cylindrical inlet portion defining an air passage 68. A plurality of adjustable vanes 72 are radially disposed in this passage. These vanes are curved at their edges to fit the cylindrical configuration of the air passage and are attached to radial shafts 73 about which they may be rotated for opening and closing the air passage. A handle 74 connected by linkages to each of the shafts 73 is provided to regulate the amount of this opening.

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static pressure. It operates noiselessly and provides a very even distribution of air at the discharge.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In combination, a heat exchange apparatus having a casing forming an air plenum chamber constructed to equalize the velocity effects of received air, an air outlet from said chamber for supplying air to said heat exchange apparatus for further use therein, said chamber having a pair of laterally spaced opposite walls, one of said walls having a circular air inlet therein open to the atmosphere, and means for maintaining the air in said chamber at a superatmospheric static pressure comprising a centrifugal air impeller rotatably mounted in said chamber coaxially with said air inlet and adjacent said one wall, said impeller having radially arranged blades extending beyond the periphery of said air inlet, and a substantially circular stationary diffuser plate in said chamber of substantially larger diameter than the diameter of said impeller blades and arranged in a plane parallel to and intermediate said walls and adjacent to the inner side of said air impeller, said diffuser plate forming in conjunction with said laterally spaced walls, an annular air diffuser passageway of relatively narrow width and substantial radial extent between said diffuser plate and said one wall open throughout its periphery to said plenum chamber and a substantially unobstructed air passageway between said diffuser plate and the remaining wall for the passage of air from said diffuser passageway periph-

atmosphere, and means for maintaining the air in said chamber at a superatmospheric static pressure comprising a centrifugal air impeller rotatably mounted in said chamber coaxially with said air inlet and adjacent said one wall, said impeller having radially arranged blades extending beyond the periphery of said air inlet, a substantially circular stationary diffuser plate in said chamber of substantially larger diameter than the diameter of said impeller blades and arranged in a plane parallel to and intermediate said walls and adjacent to the inner side of said air impeller, said diffuser plate forming in conjunction with said laterally spaced walls, an annular air diffuser passageway of relatively narrow width and substantial radial extent between said diffuser plate and said one wall open throughout its periphery to said plenum chamber and a substantially unobstructed air passageway between said diffuser plate and the remaining wall for the passage of air from said diffuser passageway periphery to said air outlet, whereby the velocity head of the air discharged by said impeller blades is converted by the controlled expansion flow through said diffuser passageway to static pressure head in the plenum chamber, impeller driving means positioned in said chamber at the opposite side of said diffuser plate from said impeller,

and air flow regulation means mounted in said air inlet opening.

4. A combination according to claim 1 in which the heat exchange apparatus consists of a tubular indirect gas heated air heater wherein said air plenum chamber constitutes a portion of the inlet of said air heater.

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