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(54) ULTRA-LOW NOX BURNER

(57) A burner for use with an igniter for firing a flame into a heat-exchanger includes a body having a sidewall that defines an interior chamber. A first opening in the body receives a pre-mixed mixture of air and fuel. A second opening in the body is in fluid communication with the first opening. A distributor is connected to the body and closes the second opening. The distributor includes a first portion and at least one curved second portion provided on the first portion. Each second portion includes a plurality of first perforations in fluid communication with the first opening in the body. The first perforations of one second portion are positioned adjacent to the igniter such that ignition of the pre-mix mixture flowing through the first perforations results in a flame through the second portion. A flange extends around the first portion and includes second perforations.

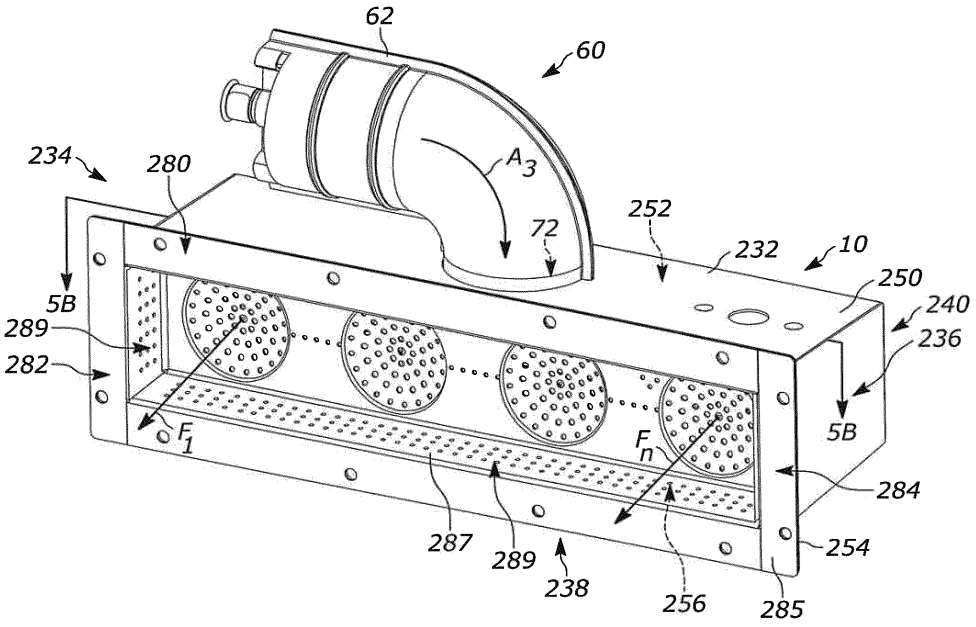

FIG. 5A

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Description

Related Applications

[0001] This applications claims priority to U.S. Provisional Application Serial No. 62/977,541, filed February 17, 2020, the entirety of which is incorporated herein by reference.

Technical Field

[0002] The invention relates to burners for appliances such as furnaces and, in particular, relates to an ultra-low oxides of nitrogen (NO_x) burner that provides flame carryover to accommodate multiple heat exchanger tubes in residential and commercial gas-fired furnaces.

Background

[0003] Recently, new NO_x emission requirements for residential gas-fired central furnaces have been implemented in an effort to reduce the environmental impact of their use. A few types of burners used on different types of gas-fired appliances are capable of meeting the specified NO_x level. None, however, have been successfully applied to a residential gas-fired furnace of the type to which this invention pertains, for several reasons. In particular, the current burners are designed to fire into a single heat exchange chamber. Current residential furnace designs, however, have heat exchangers made with multiple tubes, clamshell or drum sections with separate burners firing into each tube or section. The cost of applying current single ULN system burner technologies to multiple section heat exchangers would be prohibitively expensive due to the cost of requiring multiple ULN system burners.

Summary of the Invention

[0004] In one example, a burner for use with an igniter for firing a flame into a heat-exchanger includes a body having a sidewall that defines an interior chamber. A first opening in the body receives a pre-mixed mixture of air and fuel. A second opening in the body is in fluid communication with the first opening. A distributor is connected to the body and closes the second opening. The distributor includes a first portion and at least one curved second portion provided on the first portion. Each second portion includes a plurality of first perforations in fluid communication with the first opening in the body. The first perforations of one second portion are positioned adjacent to the igniter such that ignition of the pre-mix mixture flowing through the first perforations results in a flame through the second portion. A flange extends around the first portion and includes second perforations.

[0005] In another example, a device for mixing air and fuel for a burner includes a mixing wheel having circumferentially arranged openings for receiving air. A nozzle is connected to the mixing wheel and includes a longitudinal passage for receiving fuel. Radial openings extend from the longitudinal passage and upstream of the mixing wheel for delivering the fuel upstream of the mixing wheel. A restrictor plate is positioned upstream of the nozzle and includes circumferentially arranged openings for helping to mix the air and fuel for delivery to the burner.

[0006] Other objects and advantages and a fuller understanding of the invention will be had from the following detailed description of the preferred embodiments and the accompanying drawings.

Brief Description of the Drawings

[0007]

Fig. 1 is a schematic illustration of an appliance with an example burner and air/fuel mixer.
Fig. 2A is a section view of a gas supply tube connected to the mixer of Fig. 1.
Fig. 2B is a section view of another example gas supply tube for connection to the mixer of Fig. 1.
Fig. 2C is an enlarged view of a gas flow regulation device of Fig. 2B.
Fig. 3 is a section view of the mixer of Fig. 1.
Fig. 4 is a front view of the mixer of Fig. 3.
Fig. 5A is a front view of one example burner.
Fig. 5B is a section view of the burner of Fig. 5A-5A taken along line 5B-5B.
Fig. 6A is a front view of a distributor of the burner.
Fig. 6B is a rear view of the distributor.
Fig. 7 is a front view of a mesh burner surface for the distributor.
Fig. 8 is a schematic illustration of flames extending from the distributor into heat exchanger tubes.
Fig. 9A is an isometric view of an example furnace including the burner and mixer in accordance with the invention.
Fig. 9B is a side view of the furnace of Fig. 9A with the side panel removed.
Fig. 10 is an exploded view of the furnace of Fig. 9A.
Fig. 11 is an isometric view of cabinet portions of the furnace shown in Fig. 9A.

Detailed Description

[0008] The invention relates to burners for appliances and, in particular, relates to an ultra-low-NO_x burner that provides flame carryover to accommodate multiple heat exchanger sections in residential and commercial gas-fired furnaces. Alternative appliances in which the burner of the present invention may be used include, for example, water heaters and, ovens.

[0009] Fig. 1 illustrates an example burner 10 for an appliance 20 in accordance with the present invention. The appliance 20 can be any residential or commercial appliance, e.g., furnace, water heater, tankless water heater, oven, etc. The burner 10 can be a pre-mixed burn-

er in which a mixture of air and combustible fuel, *e.g.,* gas, is pre-mixed upstream of the burner or otherwise mixed prior to combustion so that no secondary air is needed. Alternatively, the burner 10 can be a non-premixed burner (not shown).

[0010] In Fig. 1, a mixer 60 is connected to an upstream side of the burner 10. An inducer blower 856 is provided downstream of the burner 10 draws air in the manner A_1 into the mixer 60. A controller 110 is electrically connected to the blower 856 for selectively turning the blower off and on at a single, fixed speed. The blower 856 can also be a variable speed type if additional control is desired.

[0011] A gas valve 40 and manifold or tube 42 cooperate to supply fuel to the burner 10. To this end, the gas valve 40 supplies fuel to the tube 42 in the manner A_2. The controller 110 is connected to the gas valve 40 for controlling operation thereof. The tube 42 is fluidly connected to an upstream side of the mixer 60. The mixer 60 mixes the incoming air (provided by the blower 856) and fuel (provided by the gas valve 40) and directs a premixed mixture to the burner 10 in the manner A_3.

[0012] As shown in Fig. 2A, the tube 42 extends from a first/upstream end 44 to a second/downstream end 46. An opening 52 is provided at the first end 44. An opening 54 is provided at the second end 46. A passage 50 extends the length of the tube between the openings 52, 54. Corrugations 53 are provided along the length of the tube 42 and extend radially outward from the passage 50. An adaptor 56 is connected to the first end 44 and configured for attachment to the gas valve 40. To this end, the adaptor 56 includes a passage 58 for receiving the first end 44 of the tube 42 and exterior threads 57 for securing to the gas valve 40. The adaptor 56 is tubular and slides over the first end 44 such that the adaptor does not obstruct the passage 50.

[0013] In another example shown in Figs. 2B-2C, the tube 42 is U-shaped and free of corrugations. The adapter 56 is connected to the first end 44 of the tube 42. Another adaptor/gas flow regulation device 56a is connected, e.g., threaded, to the adapter 56. The gas flow regulation device 56a extends from a first/upstream end 61 to a second/downstream end 63. The first end 61 is threaded and connected to the gas valve 40. A first passage 65 extends from the first end 61 towards the second end 63 and has opposing ends that are countersunk. A threaded second passage 67 extends from the second end 63 towards the first end 61. A frustoconical projection 69 extends longitudinally into the second passage 67. The first passage 65 extends through the projection 69 into fluid communication with the second passage 67.

[0014] The adaptor 52 is inserted into the second passage 67 such that the adaptor and gas flow regulation device 56a are threaded together. Consequently, the first end 44 of the tube 42, the adaptor 54, the gas flow regulation device 56a, and the gas valve 40 are connected together in a sealed, fluid-tight manner. The projection 69 and passages 65, 67 are sized and shaped to help control or regulate the flow of gas from the gas valve 40 to the tube 42.

[0015] Referring to Figs. 3-4, the mixer 60 includes a tube or elbow 62 extending about a centerline 63 from a first or inlet end 64 to a second or outlet end 66. An opening 70 is provided at the inlet end 64. An opening 72 is provided at the outlet end 66. A passage 68 extends from the opening 70 to the opening 72. Air from outside the mixer 60 is drawn in by the blower 856 and enters the passage 68 *via* the opening 70.

[0016] A support bracket 80 is connected to the second end 46 of the tube 42 and secured to the interior of the tube 62 for helping to stabilize and center the tube 42. To this end, the support bracket 80 includes a centrally located opening 82 for receiving the tube 42.

[0017] A mixing wheel 90 is provided in the passage 68 and has a lip 95 extending into a first recess 76 in the tube 62. The first recess 76 extends circumferentially about the centerline 64. The mixing wheel 90 includes openings 92 arranged in an annular pattern about the centerline 63. In one example, the openings 98 are wedge-shaped or triangular and advantageously allow for more airflow through the mixing wheel 90 compared to circular openings. The mixing wheel 90 includes a central opening 94 that receives the second end 46 of the gas tube 42.

[0018] A nozzle 84 extends into the second end 46 of the gas tube 42 and upstream of the mixing wheel 90. The nozzle 84 includes a longitudinal passage 86 for receiving the incoming gas A_2 from the tube 42. Openings 88 extend radially outward from the passage 86 to positions upstream of the mixing wheel 90.

[0019] A flow restrictor plate 96 is provided in the passage 68 downstream of both the mixing wheel 90 and the radial openings 88 in the nozzle 84. The flow restrictor plate 96 extends into a second recess 78 in the tube 62 that encircles the centerline 63. The flow restrictor plate 96 includes openings 98 symmetrically arranged in an annular pattern about the centerline 63. In one example, the openings 98 are circular. Regardless, the openings 98 improve fuel/air mixing and help eliminate combustor noise.

[0020] In operation, air A_1 is received through the opening 70 in the tube 62 (*see* Fig. 3) and travels through the openings 92 in the mixing wheel 90. The air A_1 is then mixed with gas A_2 discharged through the radial openings 88 of the nozzle 84. Once mixed, the air and gas mixture A_3 flows through the openings 98 in the flow restrictor plate 96 and into passage 68 to be discharged through the opening 72 to the burner 10.

[0021] Figs. 5A-5B illustrate one example burner 10 in accordance with an aspect of the present invention. The burner 10 has a generally rectangular shape and includes a body 232 extending from a first end 234 to a second end 236. The body 232 is formed from a durable material, such as metal, and has a first or front side 238 and a second or rear side 240 opposite the front side. The body 232 is formed by a sidewall 250 that has an elongated shape such as, for example, rectangular or trapezoidal.

The sidewall 250 defines an interior chamber 252 that receives the pre-mixed mixture of fuel and air A_3 from the mixer 60. To this end, an inlet opening (not shown) in the body 232 fluidly connects the interior chamber 252 to the mixer 60.

[0022] A flange 254 extends from the sidewall 250 along the front side 238 of the body 232. The flange 254 has a rectangular shape and includes an opening 256 in fluid communication with the interior chamber 252. The opening 256 in the flange 254 receives a distributor 280.

[0023] A baffle 253 is provided in the interior chamber 252 to direct the incoming pre-mix mixture A_3 to particular locations within the body 232, *e.g.*, outwards toward the first and second ends 234, 236. The baffle 253 includes a base 242 positioned generally at the center of the body 232 and a pair of tapered legs 244 extending outward from the base in opposite directions. The base 242 can be, for example, U-shaped. The baffle 253 can extend the entire width of the interior chamber 252 between the ends 234, 236.

[0024] One or more openings 255 can extend through the legs 244. Alternatively, the openings 255 can be omitted (not shown). The openings 255 can be the same size or different sizes from one another. The presence of the openings 255 and/or the positioning of the baffle 253 relative to the distributor 280 and incoming pre-mix mixture A_3 can help improve the operating range of the burner 10 and dampen noise during burner operation.

[0025] Referring to Figs. 6A-6B, the distributor 280 extends along a centerline 286 from a first end 282 to a second end 284 and closes the opening 256 in the flange 254 to substantially seal the front side 238 of the body 232. To this end, the distributor 280 includes a flange 285 secured to the flange 254 on the body 232. In one example, the flanges 254, 285 are welded to one another. A separate seal (not shown) may be provided between the flanges 254, 285 to ensure a fluid-tight seal therebetween.

[0026] The distributor 280 has an elongated shape, e.g., rectangular, that mimics the shape of the opening 256 in the flange 254. When the distributor 280 is secured to the flange 254 the first end 282 of the distributor is positioned at the first end 234 of the body 232 and the second end 284 of the flange is positioned at the second end 236 of the body. The distributor 280 and baffle 253 are separated by a gap 283 (*see* Fig. 5B) where the pre-mixed mixture helps to cool the distributor by flowing around and/or upstream of ignition. The gap 283 can extend around the distributor 280 to adjacent the ends 234, 236 of the body 232. The gap 283 can also help improve flame stability.

[0027] The distributor 280 is formed from a thin, durable, and heat-resistant material, such as metal, metal screen or expanded metal. The distributor 280 includes a first portion 288 and at least one dimple or second portion 290 formed or provided on the first portion. The number, size, and spacing of the second portions 290 coincides with the number, size, and spacing of downstream heat exchanger sections (not shown) used in the furnace in which the burner 10 is used. In particular, each second portion 290 is aligned with an open end of an associated heat exchanger section such that the end of each section is in fluid communication with each second portion. Each second portion 290 is configured to provide a desired flame characteristic or profile from the burner 10 to the respective heat exchanger section.

[0028] In one example, the first portion 288 has a planar configuration and each second portion 290 is curved or dimple-shaped, e.g., rounded, concave or convex. Every second portion 290 may have the same configuration or different configurations from one another. A concave second portion 290 will provide a narrow, long or elongated flame while a convex second portion will provide a wider, more dispersed flame. Each second portion 290 may exhibit any circular or polygonal shape such as triangular, square or the like.

[0029] As shown in Fig. 6A, four concave portions 290 are provided on a planar first portion 288 and each concave portion has the same generally circular or hemispherical shape. The planar portion 288 extends substantially along or parallel to the centerline 286. In other words, the planar portion 288 can be offset from the centerline 286. Each concave portion 290 extends transverse, e.g., generally perpendicular, to the centerline 286 of the planar portion 288 towards the rear side 240 of the body 232. The concave portions 290 may all extend in the same direction or may extend in different directions relative to one another and relative to the first portion 290.

[0030] A series of perforations 292 is formed in each concave portion 290 and extends entirely through the material of the distributor 280. The perforations 292 may exhibit any shape, e.g., circular, square, triangular, etc., and may be randomly spaced about the concave portion 290 or may have predetermined spacing. Each concave portion 90 can have substantially the same perforation 292 configuration. The perforations 292 cooperate with the concave portions 290 to produce an elongated flame for each concave portion that extends into the corresponding heat exchanger section (not shown) during use of the burner 10.

[0031] The perforations 292 and/or concave portions 290 may be individually or collectively tailored to provide a series of flames that have particular positions, sizes, and shapes. In one example, the perforations 292 can extend at angles through the concave portions 290 such that the pre-mixed mixture flow therethrough is directed to a common point downstream of the particular concave portion. This adds to flame stability and helps to focus the flame produced at each concave portion 290 towards the center of the respective heat exchanger section (not shown).

[0032] Alternatively or additionally, the first perforations 292 may have different sizes within the same concave portion 290. For example, the size of the first perforations 292 may increase in a direction extending towards the center of the concave portion 290 to maximize

the flow area through the middle of the concave portion. Accordingly, the largest first perforation 292 may be located near or at the center of the concave portion 290. Consequently, the flame provided by that concave portion 290 is substantially aligned with the center of the respective heat exchanger section. In other words, the flame is concentrated at the center of the concave portion 290 - where the largest flow area is located - and is minimized around the periphery of the concave portion - where the smallest flow area is located.

[0033] A series of carryover perforations 294 may also extend through the planar portion 288 of the distributor 280. The carryover perforations 294 may be similar, identical or different than the perforations 292 in the concave portions 290. As shown in Fig. 6A, the carryover perforations 294 constitute one row of five perforations connecting each of the four concave portions 290 in succession and extending substantially along and parallel to the centerline 286. The carryover perforations 294 cooperate with the perforations 292 to provide a flame path between adjacent concave portions 290. The path allows a flame initiated at one concave portion 290 to propagate to all the concave portions 290 in the distributor 280. It will be appreciated that the carryover perforations 294 may be omitted between some of the concave portions 290 or omitted entirely. The number of carryover perforations 294 between adjacent pairs of the concave portions 290 can be the same or different.

[0034] A portion 287 of the flange 285 extends substantially perpendicular to the first portion 288 and forms a perimeter around/surrounds the first portion. As shown, the portion 287 is rectangular. A series of openings 289 extend entirely through the portion 287 such that collectively the openings extends entirely around the first portion 289. The openings 289 are positioned downstream of the first and second portions 288, 290 and can vary in size and/or shape. The openings 289 help to achieve an intended burner surface pressure drop, which helps manage flame stability, prevent burner noise, and provide cooling for the distributor 280.

[0035] As shown in Fig. 7, a fiber mesh burner surface 300 overlies the distributor 280 and is formed from a material such as an iron-chromium-aluminum alloy, *e.g.*, FeCrAlM. The fiber mesh burner surface 300 is porous and may constitute a moldable metal fabric, foamed metal, formed perforated ceramic or the like. The material of the fiber mesh burner surface 300 can be selected to promote desired flame characteristics. The burner surface 300 can be formed by, for example, sintering, weaving and/or knitting techniques.

[0036] The burner surface 300 can be contoured to match the contour of the distributor 280. That said, the burner surface 300 can include a planar portion 302, dimples or rounded portion(s) 304 extending from the planar portion, and a flange portion 306 extending entirely around the planar portion. The burner surface 300 can alternatively be planar across its entire length and therefore be planar overlying the second portions 290 (not shown). A cover retainer (not shown) can be secured to the flange 283 of the distributor 280 to secure the fiber mesh burner surface 300 thereto.

[0037] In operation, and referring back to Fig. 5A, the pre-mix mixture of air and fuel A_3 exits the mixer 60 and passes into the interior chamber 252 of the body 232. The baffle 283 directs the flow towards the opening 256 in the flange 254, *i.e.,* from the rear side 240 to the front side 238, and outward towards the ends 234, 236. The pre-mix mixture A_3 then flows through the distributor 280 and, more specifically, flows through the perforations 292, 294 in both the concave portions 290 and the planar portion 288 of the distributor. The pre-mix mixture A_3 then flows though the burner surface 300. An igniter (not shown) positioned adjacent to the leftmost concave portion 290 (as viewed in Fig. 1) ignites the pre-mix mixture flowing through the leftmost concave portion 290.

[0038] Alternatively, the igniter could be positioned adjacent to any other concave portion 290. In any case, when the igniter is activated, the air and fuel mixture A_3 is ignited to produce a flame, indicated generally by arrow F_1 in Fig. 5A that extends from the surface of the fiber mesh burner surface 300 (omitted in Fig. 5A) outward away from the burner 10. The flame F_1 has a desired size and shape based on the configuration of the concave portion 290 and associated perforations 292.

[0039] Referring further to Fig. 8, the flame F_1 extends away from the concave portion 290 and an inlet 402 of an associated heat exchanger section/tube 400. The distributor 280 and/or flange 285 can be axially spaced a predetermined distance d from the inlet 402 configured to protect the inlet from the flame F_1 and/or direct heat into the inlet in the most efficient manner. In one instance, the predetermined distance d is under about 1".

[0040] The flame F_1 in the leftmost concave portion 290 carries over or propagates across the planar portion 282 *via* the carryover perforations 294 and ignites the pre-mix mixture A_3 flowing through the adjacent concave portion. The flame through this concave portion 290 likewise has a desired size and shape for the associated heat exchanger section (not shown). The flame propagation is repeated to each successive concave portion 290 *via* the corresponding carryover perforations 294 until a flame F_n is produced in the rightmost concave portion of the distributor 280 (as viewed in Fig. 5A), which directs the flame F_n into the corresponding heat exchanger section 400 in the furnace, water heater, etc. (not shown).

[0041] A flame sensor (not shown) may be positioned adjacent to the rightmost concave portion 290 that produces the flame F_n in order to provide proof of ignition and propagation. Due to the repeatability and simplicity of the carryover perforations 294, the distributor 280 can be configured to provide a low-NO_x flame to any number of similar or different heat exchanger sections in an efficient, reliable manner. Moreover, since all the concave portions 290 are fluidly connected *via* the carryover perforations 294, the igniter and flame sensor can be placed adjacent to any concave portion(s) and the low-NO_x

flame F_1 will reliably propagate to all other concave portions.

[0042] Figs. 9A-11 illustrate an example furnace 820 including the burner 10 and mixer 60. Although the mixer 60 is shown as being curved it will be appreciated that the mixer could be substantially straight such that the gas valve 40 is more directly aligned with the burner 10 (not shown). Referring to Fig. 10, the furnace 820 includes a furnace cabinet that houses and supports the burner assembly 10, along with peripheral components, including heat exchangers, blowers, etc.

[0043] In particular, the furnace 820 includes a furnace cabinet 822, a primary heat exchanger 824 that comprises a plurality of serpentine tubes 824a, a secondary, condensing heat exchanger 826, and a circulating air blower 828. Alternatively, the primary heat exchanger 824 may have a clamshell design (not shown) known in the art. Further detail about the construction of the furnace 820 is detailed in U.S. Appln. No. 14/763,362, the entirety of which is incorporated by reference herein.

[0044] Referring also to Fig. 11, the furnace cabinet includes a pair of vertical side panels 830 and a vertical rear panel 832. An intermediate plate assembly 834 is supported between the side panels 830 and the rear panel 832 and includes a blower deck plate 835 and an inverted L-shaped support plate 836. A vertical section 836a of the L-shaped support plate 836 forms a vest panel which, as will be explained, supports the burner 821 of the present invention. A horizontal segment 835a of the blower deck plate 835 and portions of the side panel 830 and rear panel 832 define a heat exchange chamber 838 (best shown in Fig. 9B). The furnace 820 also includes a base 837 that cooperates with the horizontal segment 835a and portions of the side panel 830 and rear panel 832 to define a blower chamber for receiving the blower 828.

[0045] The secondary heat exchanger 826 (Fig. 10) sits atop and is supported by the deck plate segment 835a and overlies a rectangular opening 840. The blower 828 is supported below the deck plate 835 and includes a rectangular exit (not shown) aligned with the deck plate opening 840. Air discharged by the blower 828 enters the heat exchange chamber 838 through the opening 840. A control panel 843 is attached to the blower 828 and/or the blower deck plate 835 and mounts conventional controls for the blower and burner assembly 10.

[0046] The burner assembly 10 is attached to the vest panel 836a and is received in a rectangular opening 842 (Fig. 11) defined in the vest panel 836a of the plate 836. In particular, the burner body 232 is shaped and sized to conform to the rectangular opening 842 in the vest panel 836a. The burner body 232 is suitably attached to the exterior side of the vest panel 836a.

[0047] The distributor 280 is clamped between the body 232 and the exterior of the vest panel 836a. A combustion chamber defining cover 844 (Fig. 9B) is attached to the interior side of the vest panel 836a in alignment with the burner body 232. The burner surface 300 is supported between the distributor 280 and the interior of the combustion chamber cover 844.

[0048] The combustion chamber cover 844 includes a plurality of openings (not shown) each aligned with one of the burner portions 90' defined in the distributor 80'. The openings each receive an associated inlet side 846 of an associated heat exchange section 824a (Fig. 10). This aligns the portions 290 on the distributor 280 with associated heat exchange sections 824a. The inlet sides 846 of the heat exchange sections 824a may be attached to the combustion chamber cover 844 by means of a known swaging process.

[0049] The flame of each portion 290 extends through the associated opening 844a of the cover 844 and into the inlet side 846 of the associated heat exchange section 824a. The flames are tailored such that the tip of each flame terminates at or adjacent to the inlet side 846 of each section 824a, *i.e.,* the flames may barely extend into the interior of each tube.

[0050] As best seen in Fig.9B, discharge ends 847 of each heat exchange section 824a are connected (as by swaging) to an intermediate collector box 850 having associated ports 850a. The intermediate collector box 850 receives the hot exhaust gasses from the heat exchange sections 824a and causes the exhaust gas to pass through the secondary heat exchanger 826. After passing through the secondary heat exchanger 826, the exhaust gasses are received and collected in a collector chamber 854 which communicates with an induced draft blower 856. The exhaust gasses are drawn out by the induced draft blower 856 and are discharged to an outlet conduit 858. The exhaust is then conventionally discharged to another outlet located outside the heated space or home.

[0051] Although the furnace 820 is shown and described as a condensing type furnace it should be noted that the burner 10 and/or mixer 60 shown and described herein can be used in a non-condensing type furnace. Typically, in this type of furnace, the secondary heat exchanger 826 would be eliminated. In addition, the burner assembly 10 would be mounted in alignment with a horizontal slot (not shown) that would be located in a lower section of the vest panel 836 nearer the horizontal segment 835a.

[0052] In this configuration, the sections 824a would have their inlet sides 846 join burner assembly 10 near the bottom of the vest panel 836. The upper or discharge ends 847 of the heat exchange sections 824a would be connected to a collection chamber located at the top of the vest panel 836 and in fluid communication with the induced draft blower 856.

[0053] The burner assembly 10 may advantageously be configured for use in high-efficiency residential furnaces. More specifically, by using both the first and secondary heat exchangers 824, 826 the condensing furnace 820 is capable of about 90% or greater efficiency. Using only the primary heat exchanger 824 produces a non-condensing furnace 820 capable of about 80-83%

efficiency.

[0054] The preferred embodiments of the invention have been illustrated and described in detail. However, the present invention is not to be considered limited to the precise construction disclosed. Various adaptations, modifications and uses of the invention may occur to those skilled in the art to which the invention relates and the intention is to cover hereby all such adaptations, modifications, and uses which fall within the spirit or scope of the appended claims.

Claims

1. A burner for use with an igniter for firing a flame into a heat-exchanger comprising:

   a body having a sidewall that defines an interior chamber;
   a first opening in the body for receiving a pre-mixed mixture of air and fuel;
   a second opening in the body in fluid communication with the first opening; and
   a distributor connected to the body and closing the second opening, the distributor comprising:

      a first portion;
      at least one curved second portion provided on the first portion, each second portion including a plurality of first perforations in fluid communication with the first opening in the body, wherein the first perforations of one second portion are positioned adjacent to the igniter such that ignition of the pre-mix mixture flowing through the first perforations results in a flame through the second portion; and
      a flange extending around the first portion and including second perforations.

2. The burner of claim 1 further comprising at least one baffle positioned within the interior chamber for directing the pre-mixed mixture to the at least one second portion, the baffle being tapered and including a base and legs extending outwardly from the base.

3. The burner of claim 2, wherein each leg of the baffle includes at least one opening for reducing noise during operation of the burner.

4. The burner of claim 2 or 3, wherein the baffle extends an entire width of the interior chamber.

5. The burner of any one of claims 1 to 4, wherein the second perforations extend entirely around the first portion.

6. The burner of any one of claims 1 to 5, wherein the second perforations are arranged in multiple rows.

7. The burner of any one of claims 1 to 6, wherein the flange is secured to a flange on the body for connecting the distributor to the body.

8. The burner of any one of claims 1 to 7, wherein the distributor and body are separated by a gap for receiving the pre-mixed mixture to cool the distributor.

9. The burner of any one of claims 1 to 8, further comprising a mesh burner surface including a planar portion, curved portions extending from the planar portion, and a flange portion extending around the planar portion.

10. A furnace including the heat exchanger and burner of any one of claims 1 to 9.

11. A device for mixing air and fuel for a burner, comprising:

    a mixing wheel including circumferentially arranged openings for receiving air;
    a nozzle connected to the mixing wheel and including a longitudinal passage for receiving fuel, radial openings extending from the longitudinal passage and upstream of the mixing wheel for delivering the fuel upstream of the mixing wheel; and
    a restrictor plate positioned upstream of the nozzle and including circumferentially arranged openings for helping to mix the air and fuel for delivery to the burner.

12. The mixing device of claim 11, wherein the openings in the mixing wheel are wedge-shaped.

13. The mixing device of claim 11 or 12, wherein the openings in the restrictor plate are circular.

14. A furnace including the mixing device of any one of claims 11 to 13.

15. The mixing device of any one of claims 11 to 13, further comprising:

    a gas valve;
    a tube extending from the gas valve to the mixing wheel;
    an adaptor connected to an end of the tube; and
    a gas flow regulation device threadably engaged with the adaptor and the gas valve to form a fluid-tight seal between the tube, the adaptor, the gas flow regulation device, and the gas valve.

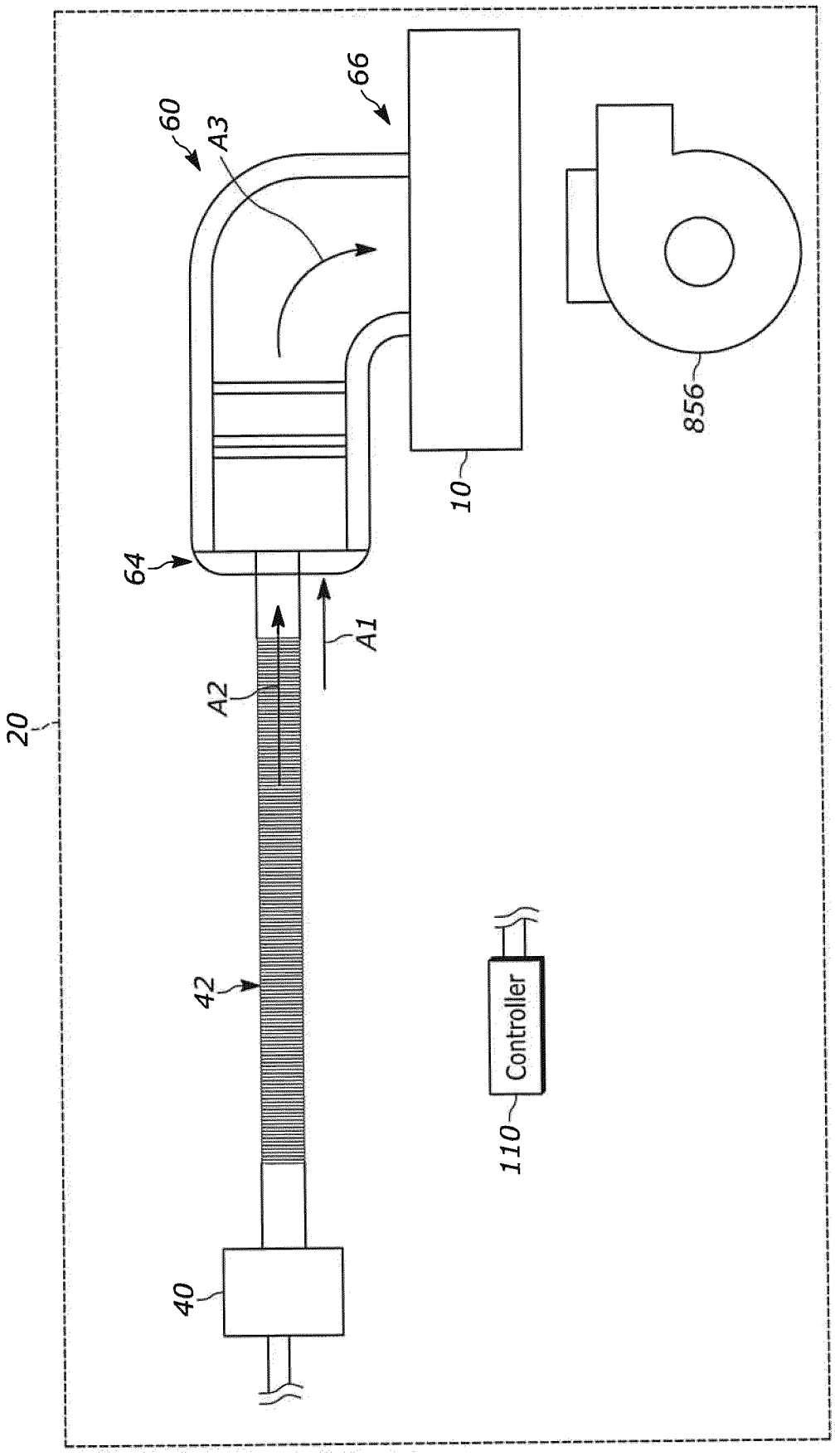


FIG. 1

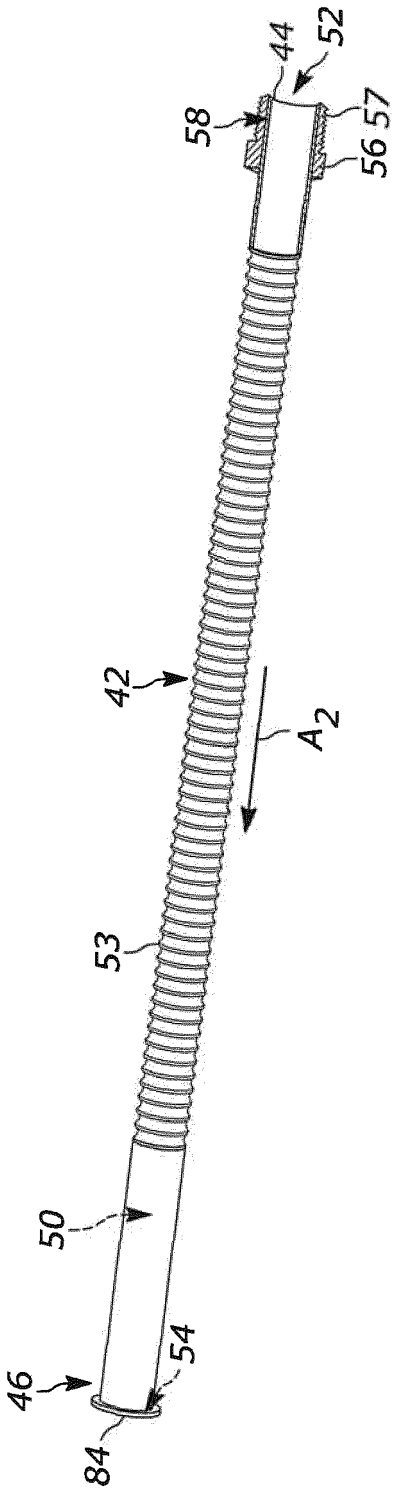


FIG. 2A

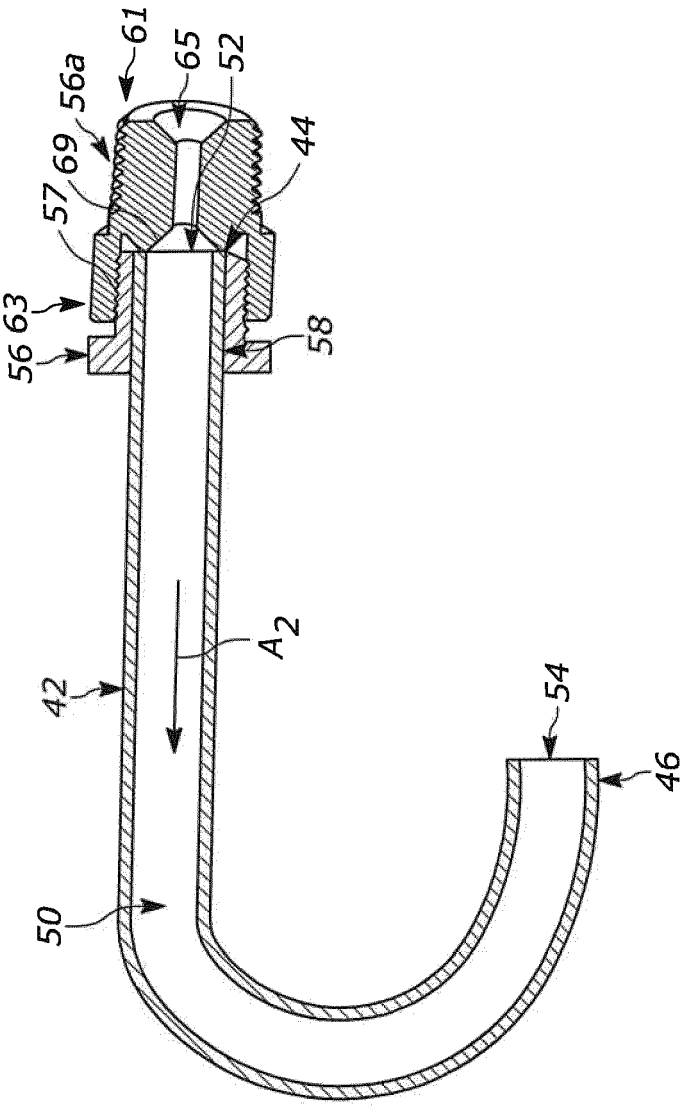


FIG. 2B

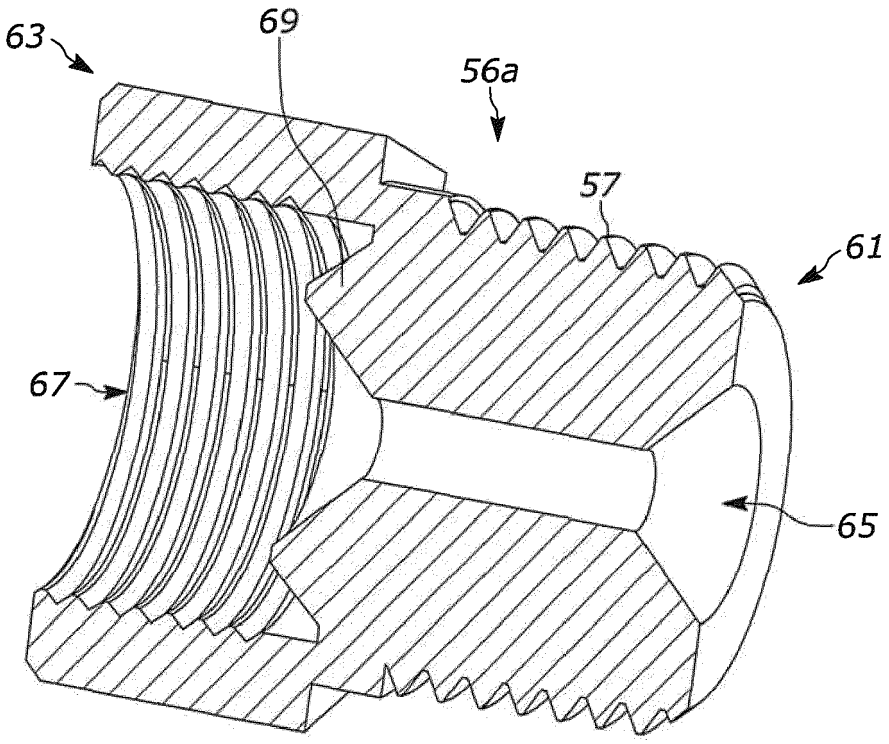
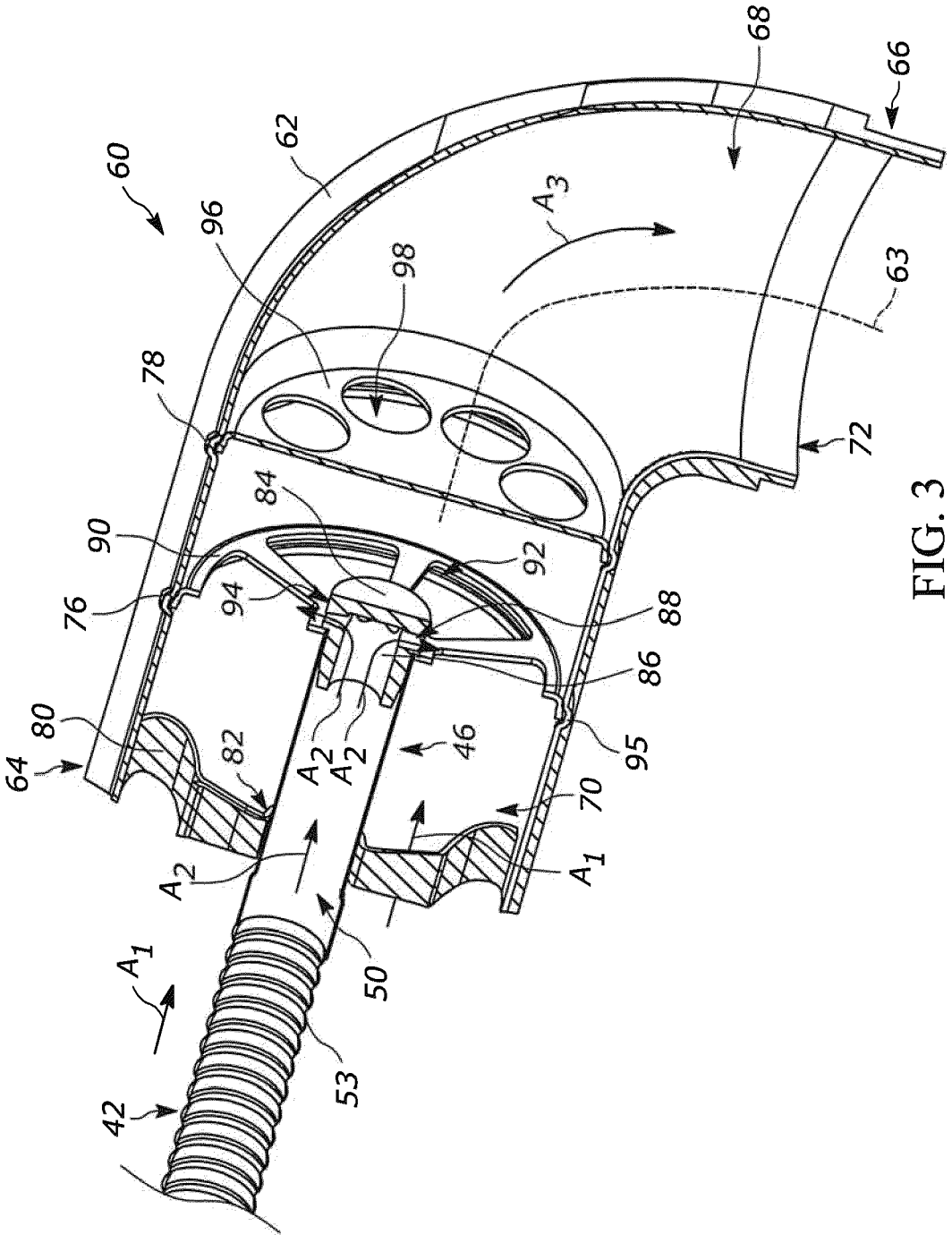


FIG. 2C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A_1
A_2
A_3

FIG. 3

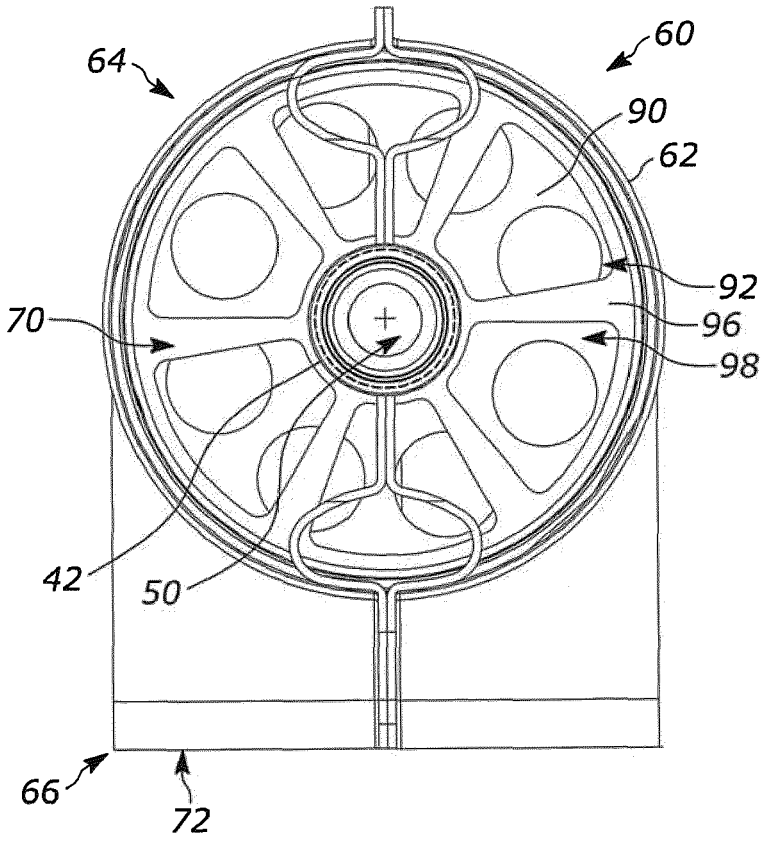
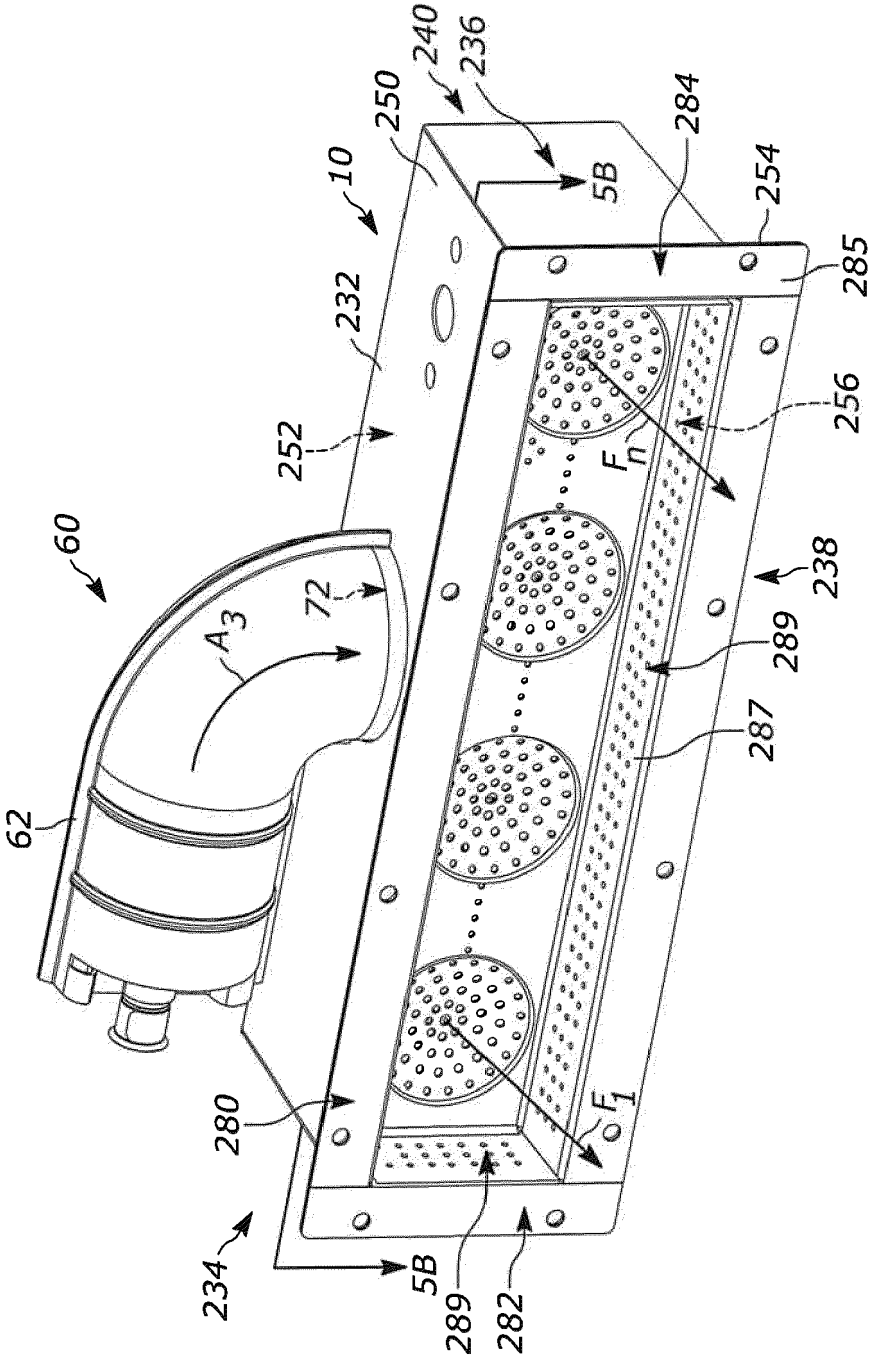


FIG. 4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5B
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285
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F_n
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72
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62
280
F_1
234
5B
289
282

FIG. 5A

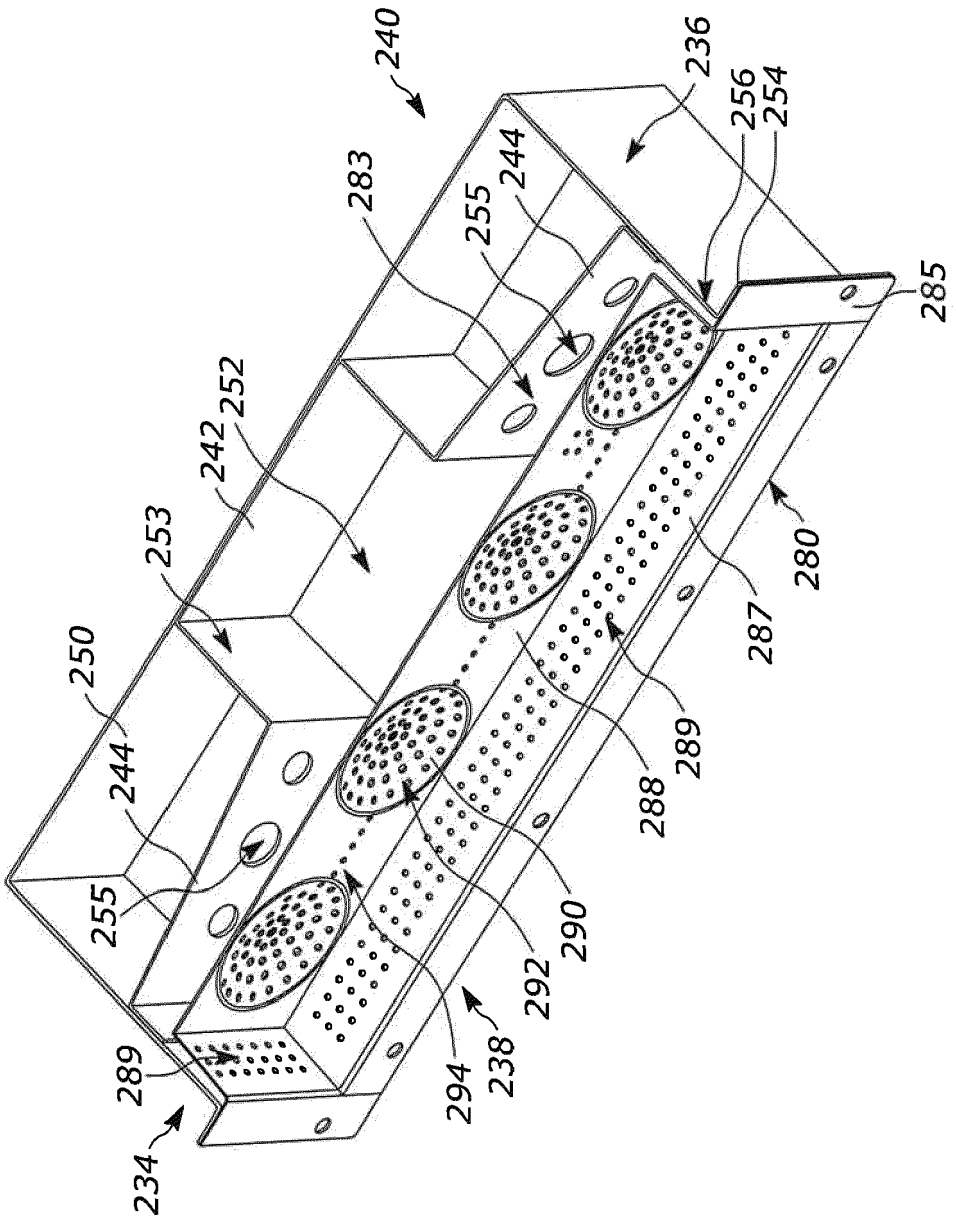
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FIG. 5B

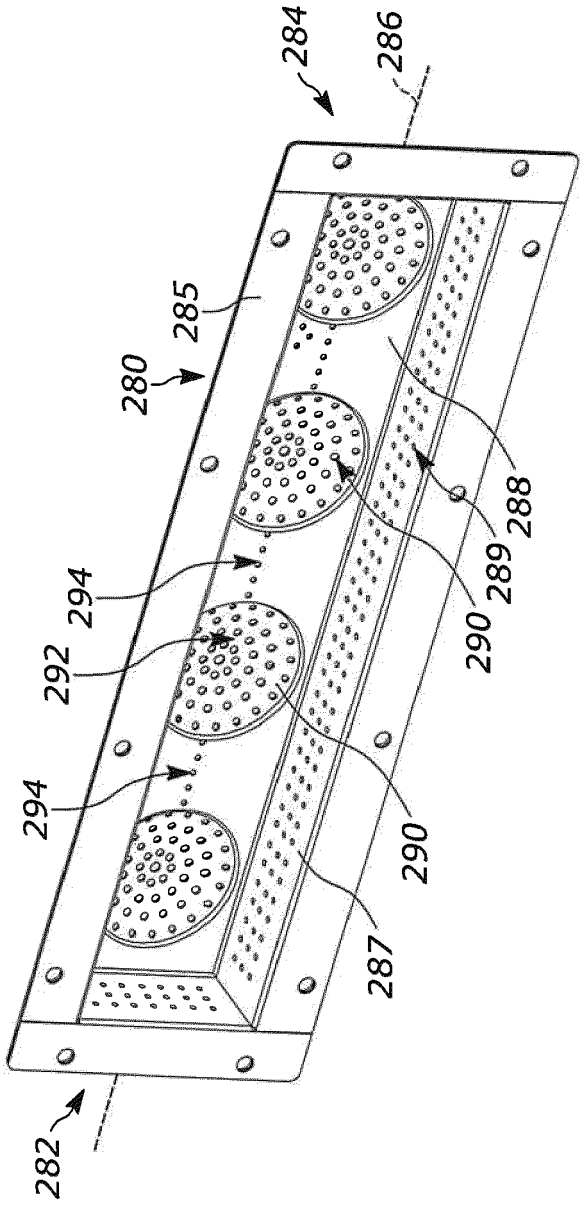

FIG. 6A

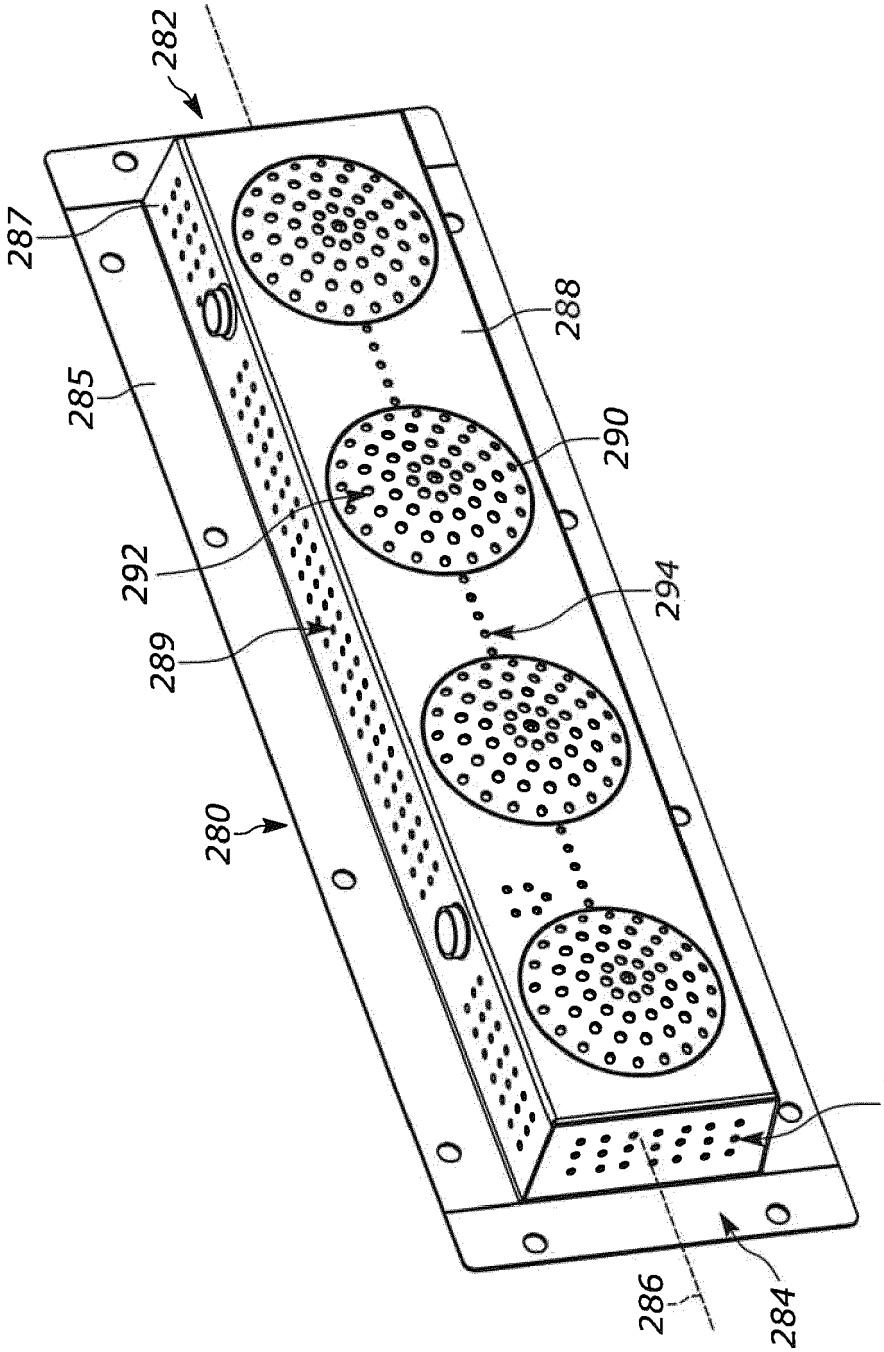

FIG. 6B

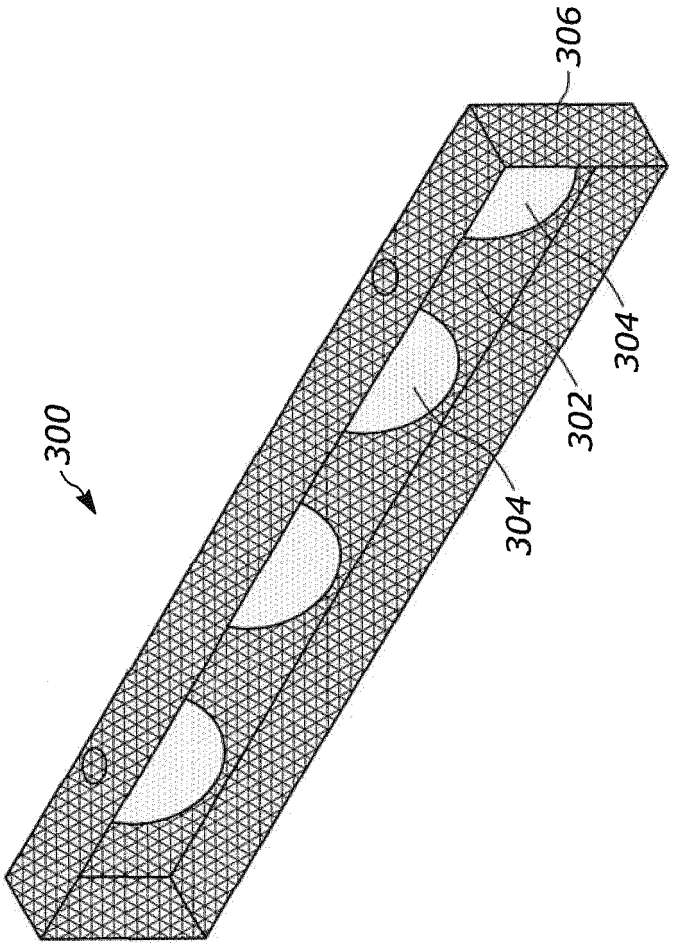

FIG. 7

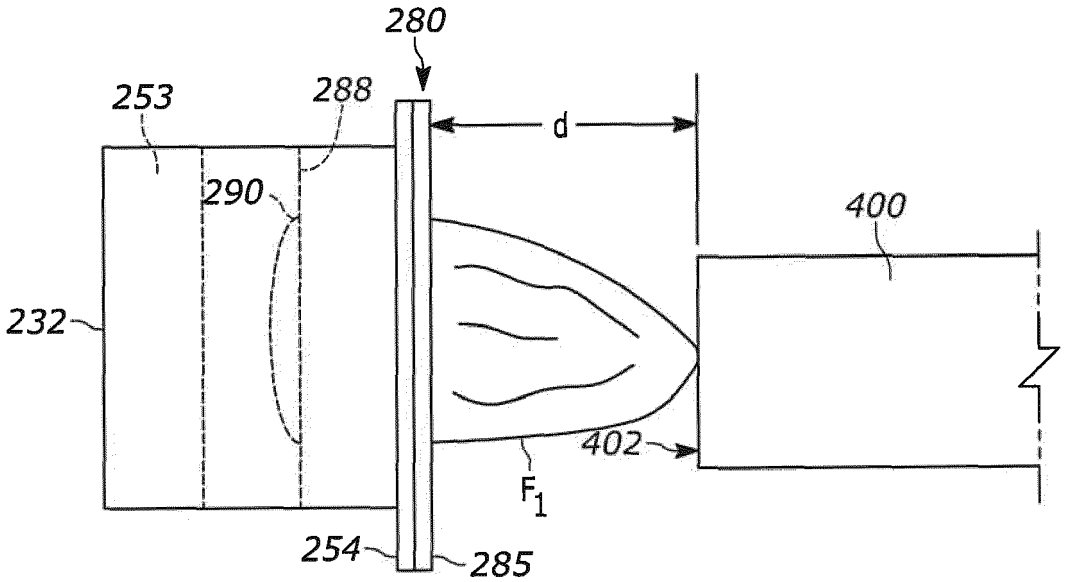

FIG. 8

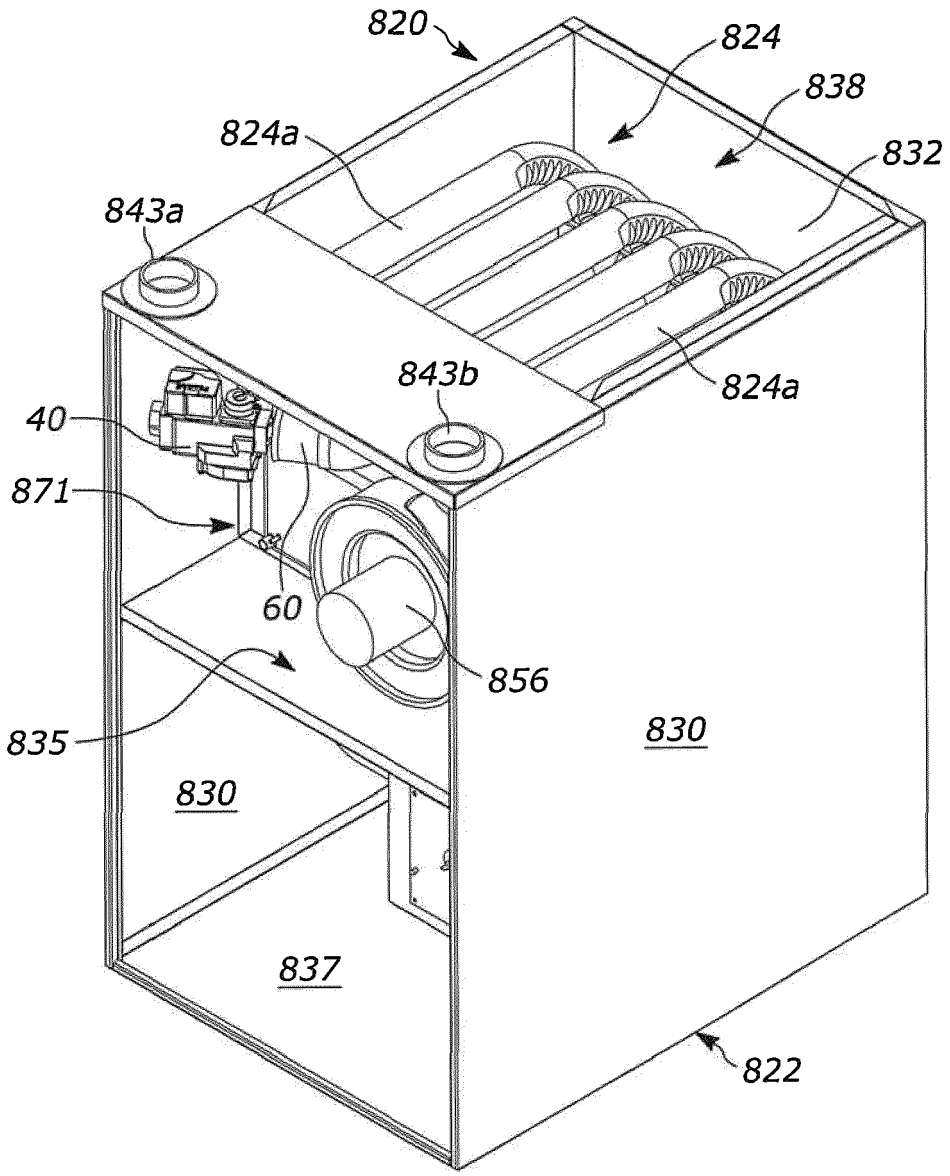
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FIG. 9A

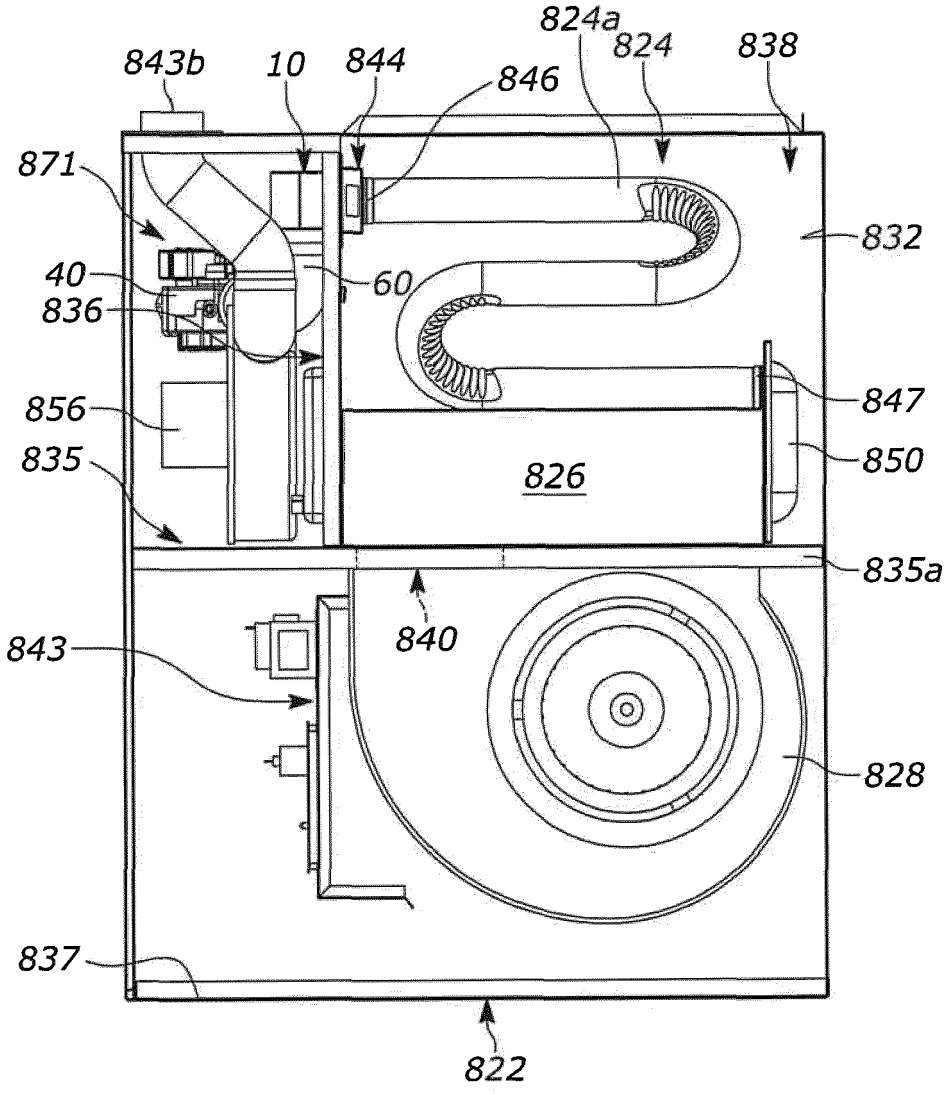
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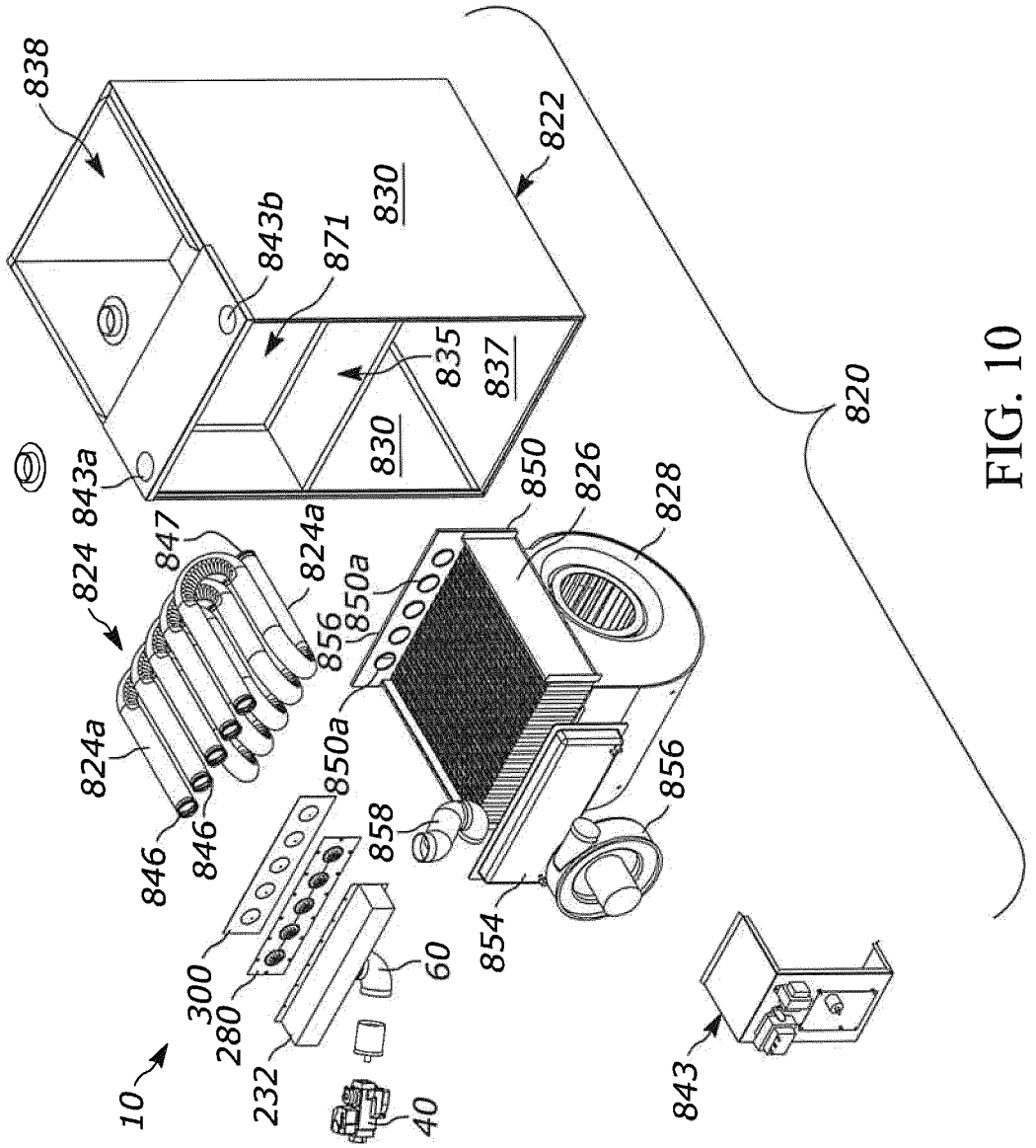
FIG. 9B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843

FIG. 10

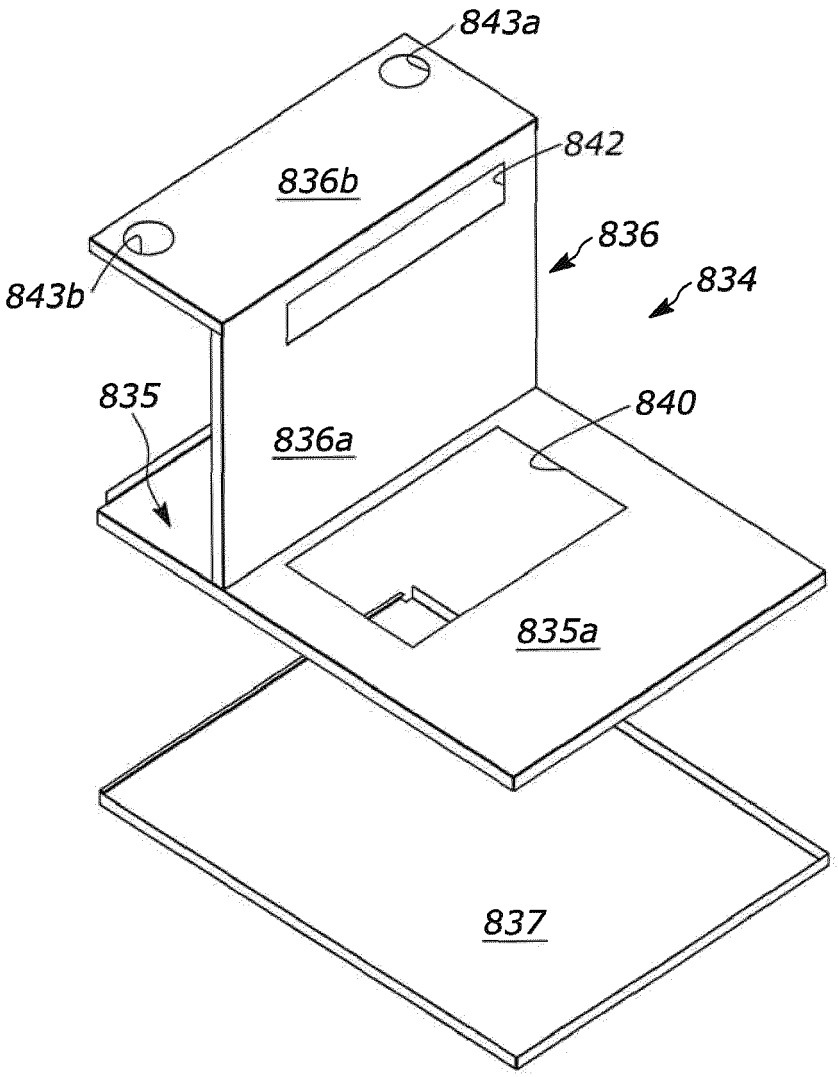

FIG. 11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 62977541 **[0001]**
- US 763362 **[0043]**