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(54) **Flame screen burner assembly**

Flammenschirmbrenneranordnung

Ensemble pare-flammes de brûleur

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Description

[0001] This invention relates to a flame screen arranged as a flame arresting burner assembly for use with the combustion of a gaseous fuel.

[0002] In a combustion process for a gaseous or liquid fuel, the leading edge of the flame is usually referred to as a flame front. It is often required to control the flame front in a combustion process, for example to prevent the flame igniting a combustible surrounding atmosphere, or to prevent a so-called "light-back" where the flame front moves in an uncontrolled way backwards into the fuel feed pipe. For example, it is known to use a simple gauze as in a traditional miner's lamp to isolate the flame front from a possibly hazardous gas laden surrounding atmosphere. Such a gauze is a simple and low cost solution both as a flame arrester and a flame trap, but also a gauze can serve as a burning surface for the actual combustion process itself. A simple gas ring has perforations for the exit of the combustible mixture of gas and air and these perforations act in essentially the same way as a fine gauze and so serve as a flame arresting screen.

[0003] The size and the depth of the openings in flame arresting screens have a significant effect upon the performance of such screens. The actual shape and physical arrangement of the openings are particularly important when considering burner design. Special characteristics such as flame shape, flame stability, turn-down ratio, ignitability, flame temperature and flame speed all may depend upon the flame screen design.

[0004] The requirements for a flame trap are generally less arduous than those needed for a flame screen. Flame traps are commonly fitted in a pipeline feeding a combustible fuel mixture to a process. The prime object of a flame trap is to prevent light-back which may occur when the flame moves in an uncontrolled way backwards into the feed pipe with the possible danger of travelling back to and igniting the bulk fuel storage system. The main requirements of a flame trap is to be capable of stopping a flame from passing in the reverse direction with the minimum possible impediment to the flow of fuel in the forward direction.

[0005] Modern requirements for burners adapted for use with hydrocarbon fuels include very high combustion efficiency, whilst maintaining a very low volumes of undesirable by-products such as carbon monoxide and oxides of nitrogen (NOx). Thorough pre-mixing of the fuel with the required amount of oxygen with little or no take up of oxygen from the combustion space is a good basis to burn hydrocarbons cleanly and completely. In order to control the flame front of such burners, an efficient flame screen is needed not only to maintain the performance but also for safety reasons. When burning pure hydrogen or gas mixtures containing high ratios of hydrogen, it has been found that particularly small apertures are needed for safe and consistent operation of such burners.

[0006] The use of very small apertures in a flame screen has several negative effects. Clearly there will be a greater pressure loss across the screen that will in most cases require a larger delivery system at a higher pressure, leading to increased cost. A further significant disadvantage is that the range of flame shapes and patterns that can be obtained may cause difficulties in some applications over the ability to control the undesirable production of CO and NOx.

[0007] Instead of having very small apertures or a woven wire gauze in a screen, it is known to use fine fibres in knitted, woven or randomly strewn or packed forms. The purpose of a fibrous flame screen of this kind can be as a cost reduction measure because such a screen requires less engineering exactitude to install and operate.

[0008] Compared to very fine drilled or woven wire screens, a fibrous screen makes it possible to have a large flow area of even smaller but more numerous openings. Also, because the fine fibres may easily glow when heated by a gas flame, a fibrous screen may serve as a simple infra red heat emitter to aid heat transfer.

[0009] A major disadvantage of a fibre based screen is that it tends to become blocked readily with small airborne particles such as dust and pollen, due not only to the fine openings but also the indirect pathways within such materials. Most applications using fibrous flame screens require fine filtration of the gas and air mixture leading to increased costs in materials and maintenance.

[0010] It is known that the flame screens described above function by causing a temperature loss in a flame attempting to return into the fuel and oxygen mixture; the reduced temperature and aperture will thus prevent the flame passing through the screen. The screen will be cooled by the action of the cold combustible gas mixture passing therethrough, when operated in the correct direction. It therefore follows that an alternative to reducing the size of the openings could be to increase the depth of each opening, by increasing the thickness of the screen, to allow a longer path for an effective heat exchange to take place. This has been achieved simply by laminating pressed metal strips by either stacking or winding them into a sandwich that allows gas passages to be created, for example between flat layers and corrugated layers. This technique can produce long narrow passages that form the basis of many flame arresters and traps manufactured today.

[0011] A design as just described is not so useful as a burner screen. Due to the need to press intricate shapes, often in difficult materials such as stainless steel, the layers need to be of thin material. In addition, this technique often also relies upon the component parts being sprung or friction fitted together and because pressed metal is particularly prone to changing shape with temperature, reliability in use can be low. The consequence is the arrangement has limited use as a burner flame screen, as the assembled components require a sturdy mount and also a very durable arrangement to contain the gas and air mixture prior to that mixture exiting the screen.

[0012] According to EP 2 573 463 A2 a multi-layer

flame screen burner assembly is known, which comprises first and second outer layers, at least one flame lyer having a plurality of fingers defined by slots provided in the flame layer, the slots opening along one edge of the flame layer, and at least one gas distribution layer overlying the flame layer and defining an aperture which overlies the slots between the fingers of the adjacent flame layer, the flame layer and overlying gas distribution layer together being disposed between the outer layers, and the burner assembly having at least one port for the admission of combustible gas to the aperture of the gas distribution layer, whereby gas supplied to the port is fed through the aperture to the slots between the fingers of the flame layer.

[0013] According to the invention there is disclosed a multi-layer flame screen burner according to claim 1. Further developments of the invention can be taken from the dependent claims.

[0014] Other features and advantages of flame screen burner assemblies of this invention will become apparent from the following description of preferred embodiments, referring to the drawings as necessary, and also from the appended claims.

[0015] By way of example only, certain specific embodiments of flame screen burner assemblies will now be described in detail, reference being made to the accompanying drawings, in which:

Figure 1 is an exploded view of a planar embodiment of flame arresting burner assembly ;

Figures 2A to 2D show alternative flame plates;

Figure 3 shows yet another flame plate for use in a further embodiment of a burner assembly;

Figures 4A to 4D show alternative gas distribution plates for use in embodiments of burner assembly, Figure 4D also showing two possible further edge profiles;

Figures 5A and 5B show two planar gas distribution plates and one planar flame plate assembled together for use with a pair of cover plates (not shown) to form an embodiment of burner assembly;

Figures 6A and 6B show two alternative planar gas distribution plates and one alternative planar flame plate assembled together for use with a pair of cover plates (not shown) to form another embodiment of burner assembly, similar to that of Figure 1;

Figure 7 shows the plates used in a further embodiment of burner assembly, having a circular form;

Figure 8 shows the plates used in yet another embodiment of burner assembly, having a generally rectangular form;

Figure 9 is an exploded view of a cylindrical embodiment of flame arresting burner assembly constructed and arranged in accordance with the invention;

Figure 10A is an end view on the assembled burner of Figure 9 and Figure 10B is a detailed view on an enlarged scale on a portion of the periphery of the burner as shown in Figure 10A; and

Figures 11A to 11C and 11D show two alternative gas supply arrangements for a burner.

[0016] Figure 1 shows the first embodiment of flame arresting burner assembly in the form of a plurality of planar plates assembled together, for the combustion of a gas. The burner assembly comprises a pair of cover plates 10,11 each of generally rectangular form of essentially identical external shape and size. Each plate has a rectangular extension 12,13 formed from a corresponding edge of each plate and cover plate 11 has a port 14 formed in the extension 13 for the admission of combustible gas to the burner assembly, as will be described below. Provided between those cover plates 10,11 are two flame plates 15 and also one gas distribution plate 16 disposed between the flame plates, the flame plates and gas distribution plates also being of the same external shape and size as the cover plates 10,11. Though shown in exploded in Figure 1, the completed burner assembly has the five plates assembled together in a multi-layer sandwich arrangement.

[0017] Each flame plate 15 has an opening 17 formed in a rectangular extension 18 to the plate, the opening and extension corresponding to those of cover plate 11. Each flame plate also defines four fingers 19 by way of slots 20 formed through the plate, the slots opening through edge 21 of the plate opposed to the edge of the plate having extension 18. The fingers 19 and slots 20 are both of generally rectangular shape such that the gaps between the fingers are of constant width.

[0018] The gas distribution plate 16 also has a rectangular extension 22 provided with an aperture 23 having a first part 24 corresponding to the opening 17 of the flame plate and the port 14 of cover plate 11, and a second part 25 of generally rectangular shape and extending across the gas distribution plate, the second part 25 communicating with the first part through a narrow channel 26. A gas supply pipe 27 is connected to the cover plate 11 in register with the port 14 such that when all of the plates are assembled together, the gas is supplied to the first part 24 of the aperture 23 in the gas distribution plate and from there is fed into the second part 25 of that aperture and thence into the slots 20 of the flame plates, all as shown by the arrows in Figure 1.

[0019] All of the plates described above are made of relatively thin sheet metal, such as stainless steel. The plates may be made for example by a stamping operation and are assembled together to form the complete burner. Appropriate fixings are provided to hold the plates clamped together. For example, the plates could be held together by way of rivets, spiral pins or other fasteners, or could be welded together. For some burners a combination of fasteners may be employed, such as spiral pins and welding at different locations around the burner.

[0020] Referring now to Figures 2A to 2D, there are shown four different configurations for flame plates suitable for use in a slightly different configuration of burner assembly from that described in Figure 1. Flame plate

30 shown in Figure 2A has four fingers 31 with simple rectilinear slots 32 between the fingers, the overall configuration of the plate being substantially quadrilateral but otherwise the arrangement of the fingers is essentially as shown in Figure 1. Each slot 32 opens along edge 33 of the plate 30 but is closed by the plate at the other end 34 of the slot. The dimensions of the fingers and of the slots may be selected to give the required flame pattern.

[0021] Flame plate 35 shown in Figure 2B has slots 36 the width of which increases in the direction towards edge 37 of the plate. This configuration of each slot reduces the gas velocity therein, to aid stability of the flame. Conversely flame plate 38 (Figure 2C) has slots which narrow towards edge 39. This configuration may be used to maintain gas velocity, when this is required. Flame plate 40 (Figure 2D) is similar to plate 30 but the free ends 41 of the fingers 42 are formed with teeth or serrations 43. These serve to extend the flame base and the particular shape and dimensions of these serve to create the required flame profile and effect. It has also been found that the teeth or serrations projecting from the finger ends 41 into the flame base increase the electrical conductivity of the flame to earth, thus greatly improving the reliability of a flame sensing system which may be used with the burner.

[0022] Figure 3 shows yet another flame plate 45 having an external shape and size similar to the flame plates 15 of the assembly of Figure 1. Thus, this flame plate 45 has an extension 18 provided with an opening 17 as with flame plate 15, as well as fingers 19 and slots 20. The flame plate of Figure 3 differs from that of Figure 1 in that the fingers 19 have side edges which are configured to provide slots having a labyrinthine path for the gas passing along the slots. This is achieved by providing each finger with projections 46 directed towards the corresponding edge of the adjacent finger. It is found that this configuration is particularly suitable for use with certain gases which require additional chilling by the flame screen to prevent light-back. This is especially so for hydrogen when fully pre-mixed with oxygen in stoichiometric proportions. By providing a labyrinthine path in this way, a greater chilling effect can be achieved. In addition, the projections 46 may serve as a baffle to prevent a loud exit noise when shutting down a gas burner that has failed to maintain the required gas/air ratio at turn-off.

[0023] Gas distribution plate 48 (Figure 4A) is of substantially quadrilateral shape, the overall dimensions of which correspond to those of the flame plates of Figures 2A to 2D. The distribution plate 48 has a rectangular aperture 49 extending partway across the plate and disposed such that when the distribution plate overlies flame plate 30 with the edges in alignment, the aperture 49 overlies the slots 32 adjacent the other ends 34 thereof. The size and shape of the aperture 49 may be selected in order to produce a required flame pattern.

[0024] Gas distribution plate 50 (Figure 4B) is similar to distribution plate 48 except that the plate has an extension 51 from one edge and a generally T-shaped aperture 52, including a part disposed in the extension 51. Thus, this plate is suitable for use in a burner generally as shown in Figure 1 and the aperture 52 allows the fuel gas to be fed to the slots of the flame plate at a location spaced from the other ends of the slots; this may give a more uniform distribution of gas. When a plurality of flame plates as shown in Figure 3 and gas distribution plates as shown in Figure 4B are assembled together the part of the aperture within the extension may form a common conduit to allow the supply of gas to each flame plate.

[0025] Gas distribution plate 53 (Figure 4C) is similar to plate 50 except that edge 54 of the aperture 55 is profiled to assist the chosen distribution of gas to the slots of the chosen flame plate, between the fingers thereof. The edge 54 selectively directs the combustible gas and air mixture towards the sides of the plate and reduces the gas flow to the central slot. Adjustment of the profile allows a wide choice of flame patterns.

[0026] Gas distribution plate 56 (Figure 4D) is similar to plate 53 but includes extra apertures 57,58 adjacent the free ends of the fingers of a chosen flame plate. Selection of appropriate shapes and dimensions for these extra apertures (which need not be as shown in Figure 4D) allows a precise flame pattern to be achieved. Also illustrated with plate 56 is a profiled edge 59 which will overlie the free ends of the fingers of the chosen flame plate. The profiled edge 59 is designed to extend the burning surface, thereby to create additional flame stability. Adjacent the profiled edge of plate 56 are shown two possible other profiled edges which could be used instead at the edge of plate 56. The profile of that edge 59 may be a combination of curves or angles selected to create the required effect. It has also been found that such a profiled edge increases the electrical conductivity to earth of the flame, greatly to improve the reliability of flame sensing systems.

[0027] Figures 5A and 5B show a stacking configuration for two gas distribution plates 48 and one flame plate 30, to be used in conjunction with two simple rectangular cover plates (not shown) one of which has a port for the introduction of combustible gas to the burner assembly.

[0028] Figures 6A and 6B show a stacking configuration similar to that of Figures 5A and 5B but using gas distribution plates similar to those of Figure 1 and two flame plates also similar to those of Figure 1. As compared to the burner of Figure 1, which has two flame plates 15 and one gas distribution plate 16, the assembly of Figures 6A and 6B has two gas distribution plates 16 and one flame plate 15.

[0029] The burners of Figures 5A, 5B and Figures 6A,6B are completed by two cover plates (not shown) arranged to overlie the gas distribution plates. At least one of those cover plates, but possibly both, includes a gas/air supply port in register with aperture 23 in the distribution plates. In the case of the assembly of Figures 6A and 6B, both the flame plate and the gas distribution plate have aligned extensions with openings therein, to

allow the flow of gas between the two distribution plates, through the opening in the extension of the flame plate. In other respects, and when assembled with two cover plates, the arrangement is essentially the same as Figures 5A and 5B.

[0030] The above-described embodiments are of planar configuration but may be arranged in circular, rectangular or similar formats. Figure 7 shows a configuration having two circular (in plan) cover plates 61,62, a circular flame plate 63 and at least one circular gas distribution plate 64 with a central opening 65. Cover plate 61 has a gas supply port 66 in communication with the central opening 65 of the gas distribution plate 64, in order that combustible gas may be supplied to the slots 67 between the plurality of generally radially extending fingers 68 of the flame plate 63.

[0031] Figure 8 shows a configuration similar to that of Figure 7 but having a generally rectangular overall shape. Thus, there is a pair of cover plates 70,71, cover plate 70 having a gas supply port 72. Flame plate 73 has a plurality of fingers 74 extending outwardly from a hollow central region with slots 75 between the fingers. A gas distribution plate 76 has an external profile matching that of the outer ends of the fingers 74 and a central aperture 77 for feeding combustible gas to the slots between the fingers.

[0032] The burner assemblies of Figures 7 and 8 are examples of possible burner assemblies but almost any configuration of flame shape may be achieved by providing flame and distribution plates with appropriate shapes. The flame pattern, length, depth and intensity may be determined by the shape of each cut-out slot and finger of the flame plate, as described above. The examples of Figures 7 and 8 will fire through a full 360 angular degrees. Other angles may be selected depending upon the slot and finger pattern.

[0033] With all of the above described burner assemblies, different numbers of flame plates and gas distribution plates may be employed. For example, one such burner assembly has two cover plates, five gas distribution plates and six flame plates arranged alternately, in an overlying manner and secured together to provide a high output burner.

[0034] Figures 9 and 10 show a cylindrical embodiment of burner assembly of this invention using the same principles as those of the previous embodiments which are of a planar configuration. This cylindrical burner assembly 79 has inner and outer cylindrical cover rings 80,81, the inner cover ring 80 having a port 82 for the supply of combustible gas to the assembly. The burner assembly also has two cylindrical gas distribution rings 83,84 and two cylindrical flame rings 85,86. The diameters of the rings 80 and 81, and 83 to 86 are such that all six rings interfit closely with ring 80 innermost and ring 81 outermost and the gas distribution rings and flame rings arranged alternately. Figure 10A is an isometric view of the overall assembly with the rings interfitted as described, and Figure 10B is an end view on the overall assembly.

[0035] The inner gas distribution ring 83 has a first circumferentially-extending aperture 87 which includes an offset region 88 in register with the port 82 when assembled with the inner cover ring, and two further aligned circumferentially-extending apertures 89,90. Outer gas distribution ring 84 also has a first circumferentially-extending aperture 91 with an offset region 92 corresponding to that of the ring 83, and further circumferentially-extending apertures 93. Each of the flame rings 85,86 has a plurality of fingers 94 extending parallel to the axis of the assembly, with slots 95 formed between those fingers.

[0036] A gas supply pipe (not shown) is connected internally of the inner cover plate 80 to the port 82, for feeding combustible gas to the apertures 87 to 93 of the two gas distribution rings, such that the gas is fed to the slots 95 between the fingers 94 of the flame rings, for combustion at the outer ends of the slots in the same manner as has been described above in relation to the planar embodiments of Figures 1 to 8.

[0037] Though the cylindrical inner cover plate 80 is shown as having a gas port 82 to which a gas supply pipe (not shown) may be connected, it would be possible to provide two circular end plates on the inner cover plate 80 thereby to form a chamber within the cylindrical inner cover plate, and to furnish a gas port in one of those circular end plates, for the connection thereto of a gas supply pipe. With such an arrangement, it may be possible to omit the cylindrical inner cover plate; in this case the end plates must be welded at least to the innermost cylindrical gas distribution ring 83. Further, as with the planar burners, different numbers of inter-fitting cylindrical flame and gas distribution plates may be arranged alternately between the cylindrical inner and outer cover plates, in order to achieve the required burning profile.

[0038] With all of the above described embodiments, combustible gas is supplied to the burner through a port in one of the cover plates, though for a burner having a large number of flame and gas distribution plates, it would be possible to have corresponding ports in the opposed cover plates and a pair of gas supply pipes connected to the two ports. Figures 11A to 11C and 11D show two alternative arrangements, where gas is supplied to the burner assembly other than through a port in at least one of the cover plates. In these Figures, parts having essentially the same function as those of the previous embodiments are given the same reference characters; these parts will not be described again here.

[0039] Figures 11A to 11C show a burner substantially as has been described above with reference to Figure 1, except that two similar planar cover plates are used neither of which is provided with a gas supply port. Instead, the extensions 12,13,18 and 22 of the plates are formed as slots opening on the edges of the extensions furthest from the major areas of the plates. Gas is supplied to the assembly through a gas supply pipe 97 of square cross-section and having a cut-out region 98 of such a shape and size that the slots of the extensions of the burner

plates will inter-fit snugly therewith, as shown in Figures 11B. Once fitted together (Figure 11C), the pipe is welded in position to provide a gas-tight seal around the cut-out region 98. It will be appreciated that in this assembly, gas is fed from the pipe 97 to the slots 20 between the fingers 19 of the flame plates 15 by entering the channel 26 and then the second part 25 of the aperture 23 in the gas distribution plate. In all other respects, the burner of Figures 11A to 11C performs as has been described above with reference to at least Figure 1.

[0040] Figure 11D shows an alternative gas supply arrangement for the burner of Figures 11A and 11B. Instead of the supply pipe 97, the burner is housed within a generally rectangular plenum chamber 100 defined by opposed side walls 101, opposed top and bottom walls 102 and a rear wall (not visible in Figure 11D). Combustible gas is supplied to the interior of the chamber 100 by a gas supply pipe 103 provided in a wall of the chamber; two alternative locations for the gas supply pipe are shown but in practice it is envisaged that only one such pipe need be provided. Once the burner has been installed in the chamber, it is secured in position by a bezel 104 which fits closely to the side, top and bottom walls of the chamber and also to the burner. Typically, the bezel will be welded to the burner and also to the plenum chamber walls, to give a gas-tight seal. In all other respects, the burner of Figure 11D performs as has been described above with reference Figures 11A to 11C.

[0041] Advantages which may be obtained with various embodiments of the flame screen burner assemblies of this invention, for the combustion of fuel gas may include the following:

1) Improved performance due to improved cooling of the gases. The gas passes through openings that are of a flat section in a thicker material which allows mostly laminar gas flow and also more surface contact with the screen. It is possible to extend the gas path in order to obtain several more benefits such as a compact design for use with difficult gases such as hydrogen and also control of exit noise which may occur on a failure of the gas/air ratio, on shutdown.

2) An opportunity for easily changing the opening area of the flame plates. This may be obtained by way of a continuous tapering or a stepped reduction in the width of each slot to maintain gas velocity or, when inverted, flame stability.

3) The gas distribution plates and flame plates may be suitably profiled at the flame front. This profiling can be a continuous zig-zag, scalloping or other pattern to change the size and shape of the plate at the base of the flame, thereby to change the ignition, ionisation and flame stability or other characteristics of the flame.

4) The design does not require the component parts to be bent in the course of manufacture or even to be flexible. The components may be produced in materials which cannot be used with other burner designs but which offer advantages due to heat, gas and chemical resistance. These materials may be metallic or non-metallic, coated or uncoated.

5) Burners may be designed and constructed in many different shapes such as linear, circular or rectangular. Moreover, combinations of these different shapes may be manufactured.

6) The tooling and set-up costs for these burners is economical and uncomplicated, for most of the possible variations in design.

7) The burners have lower maintenance requirements due to the strength of construction and the high resistance to blockage by foreign particles.

Claims

1. A multi-layer flame screen burner assembly comprising first and second outer layers (80, 81), at least one flame layer (85) having a plurality of fingers (94) defined by slots (95) provided in the flame layer, the slots (95) opening along one edge of the flame layer, and at least one gas distribution layer (83) overlying the flame layer (85) and defining an aperture (87) which overlies the slots (95) between the fingers (94) of the adjacent flame layer (85), the flame layer and overlying gas distribution layer together being disposed between the outer layers (80,81), and the burner assembly having at least one port (82) for the admission of combustible gas to the aperture (87) of the gas distribution layer (83), whereby gas supplied to the port is fed through the aperture to the slots between the fingers of the flame layer, and wherein the layers (80,81 and 83 to 86) are formed into a substantially cylindrical three-dimensional shape, **characterised in that** the outer layers (80,81), the or each flame layer (85,86) and the or each gas distribution layer (83,84) being in the form of inter-fitting cylinders, with the slots (95) in the or each flame layer (85,86) extending substantially parallel to the axis of the cylindrical shape.

2. A burner assembly as claimed in claim 1, wherein there are at least three alternately arranged layers (83 to 86) between the outer layers (80,81).

3. A burner assembly as claimed in claim 1 or claim 2, wherein the port (82) for the supply of gas to the burner is provided in an outer layer (80), the port being in communication with the aperture (87) in the or each gas distribution layer between the outer layers.

4. A burner assembly as claimed in claim 1 and in which there is a multiplicity of flame and gas distribution layers (83 to 86), wherein the layers between the outer layers (80,81) have openings (188,92) therein in register with each other, and for each gas distri-

bution layer (83,84) the aperture (87,91) therein has first and second parts (89,90,91,93) in communication with each other.

5. A burner assembly as claimed in any of the preceding claims, wherein the slots (95) in the or each flame layer (85) are substantially parallel-sided.

6. A burner assembly as claimed in any of claims 1 to 4, wherein the slots (95) in the or each flame layer (85) taper from one end to the other, either towards the inner ends of the slots or towards the outer ends of the slots.

7. A burner assembly as claimed in any of the preceding claims, wherein the fingers (94) to each side of a slot (95) are provided with projections directed towards the adjacent finger whereby a labyrinthine path for the gas flow is defined by the projections.

8. A burner assembly as claimed in any of the preceding claims, wherein the free ends of the fingers (94) have a non-linear profile in order to modify the flame front produced by the burner assembly.

9. A burner assembly as claimed in any of the preceding claims, wherein the edge of the or each gas distribution layer (83) adjacent the free ends of the fingers has a non-linear profile in order to modify the flame front produced by the burner assembly.

10. A burner assembly as claimed in any of the preceding claims, wherein the aperture (87) in the or each gas distribution layer (83) is generally rectangular and overlies the slots between the fingers of an adjacent flame layer, at or adjacent the inner ends of the slots.

11. A burner assembly as claimed in any of the preceding claims, wherein the or each gas distribution layer (83) has an edge opposed to the edges of the layers producing the flame front and the aperture (87) in the or each gas distribution layer opens through said opposed edge, and there is provided a gas supply pipe (97) fitted to the burner in communication with the or each aperture opening through said opposed edge thereby to supply gas to the slots between the fingers in the or each flame plate.

12. A burner assembly as claimed in any of the preceding claims, wherein the burner assembly is located in a plenum chamber (100) with the edges of the layers which produce the flame front exposed though a face of the chamber, and there being a gas supply pipe (103) in communication with the interior of the chamber thereby to supply gas to the burner.

Patentansprüche

1. Mehrschichtflammen-Bildschirmbrennbaugruppe, aufweisend eine erste und zweite Außenschicht (80, 81), wobei zumindest eine Flammenschicht (85) eine Mehrzahl an Fingern (94), die durch Schlitze (95) definiert sind, die sich in der Flammenschicht befinden, aufweist, wobei die Schlitze (95) sich entlang einer Kante der Flammenschicht öffnen, und zumindest eine Gasverteilungsschicht (83) aufweist, die auf der Flammenschicht (85) aufliegt und eine Öffnung (87) definiert, die auf den Schlitzen (95) zwischen den Fingern (94) der benachbarten Flammenschicht (85) aufliegt, wobei die Flammenschicht und die daraufliegende Gasverteilungsschicht zusammen zwischen den Außenschichten (80, 81) angeordnet sind, und die Brennbaugruppe zumindest einen Anschluss (82) für das Zuführen von Brenngas zu der Öffnung (87) der Gasverteilungsschicht (83) aufweist, wobei dem Anschluss zugeführtes Gas durch die Öffnung zu den Schlitzen zwischen den Fingern der Flammenschicht geleitet wird, und wobei die Schichten (80, 81 und 83 bis 86) in einer im Wesentlichen zylindrischen dreidimensionalen Form ausgebildet sind,
dadurch gekennzeichnet, dass
die Außenschichten (80, 81), die bzw. jede Flammenschicht (85, 86) und die bzw. jede Gasverteilungsschicht (83, 84) in Form dazwischenpassender Zylinder vorliegen, wobei die Schlitze (95) in der oder jeder Flammenschicht (85, 86) im Wesentlichen parallel zu der Achse der zylindrischen Form verlaufen.

2. Brennbaugruppe nach Anspruch 1, wobei es zumindest drei abwechselnd angeordnete Schichten (83 bis 86) zwischen den Außenschichten (80, 81) gibt.

3. Brennbaugruppe nach Anspruch 1 oder 2, wobei sich der Anschluss (82) für die Zufuhr des Gases zu dem Brenner in einer Außenschicht (80) befindet, wobei der Anschluss mit der Öffnung (87) in der oder jeder Gasverteilungsschicht zwischen den Außenschichten kommuniziert.

4. Brennbaugruppe nach Anspruch 1, in der es vielfache Flammen- und Gasverteilungsschichten (83 bis 86) gibt, wobei die Schichten zwischen den Außenschichten (80, 81) Öffnungen (118, 92) darin aufweisen, die miteinander registrieren, und wobei die Öffnung (87, 91) für jede Gasverteilungsschicht (83, 84) darin erste und zweite Teile (89, 90, 91, 93) aufweist, die miteinander kommunizieren.

5. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die Schlitze (95) in der oder jeder Flammenschicht (85) im Wesentlichen parallelseitig sind.

6. Brennbaugruppe nach einem der Ansprüche 1 bis 4, wobei sich die Schlitze (95) in der oder jeder Flammenschicht (85) von einem Ende zu dem anderen verjüngen, entweder in Richtung der inneren Enden der Schlitze oder in Richtung der äußeren Enden der Schlitze.

7. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die Finger (94) zu jeder Seite eines Schlitzes (95) mit Vorsprüngen versehen sind, die in Richtung des benachbarten Fingers ausgerichtet sind, wobei ein Labyrinthpfad für die Gasströmung durch die Vorsprünge definiert ist.

8. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die freien Enden der Finger (94) ein nichtlineares Profil aufweisen, um die Flammenfront zu modifizieren, die durch die Brennbaugruppe erzeugt wird.

9. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die Kante der oder jeder Gasverteilungsschicht (83), die zu den freien Enden der Finger benachbart ist, ein nichtlineares Profil aufweist, um die von der Brennbaugruppe erzeugte Flammenfront zu modifizieren.

10. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die Öffnung (87) in der oder jeder Gasverteilungsschicht (83) generell rechteckig ist und auf den Schlitzen zwischen den Fingern einer benachbarten Flammenschicht liegt, an oder neben den inneren Enden der Schlitze.

11. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei die oder jede Gasverteilungsschicht (83) eine Kante aufweist, die den Kanten der Schichten gegenüberliegt, die die Flammenfront erzeugen, und sich die Öffnung (87) in der oder jeder Gasverteilungsschicht durch die gegenüberliegende Kante öffnet, und eine Gaszuführleitung (97) vorhanden ist, die an dem Brenner in Kommunikation mit der oder jeder Öffnung angebracht ist, die sich durch die gegenüberliegenden Kante öffnet, wodurch Gas den Schlitzen zwischen den Fingern in der oder jeder Flammenplatte zugeführt wird.

12. Brennbaugruppe nach einem der vorgenannten Ansprüche, wobei sich die Brennbaugruppe in einer Trockenkammer (100) befindet, wo die Kanten der Schichten, die die Flammenfront erzeugen, durch eine Fläche der Kammer freiliegen, und wobei eine Gaszuführleitung (103) mit dem Inneren der Kammer kommuniziert, um dadurch dem Brenner Gas zuzuführen.

Revendications

1. Ensemble de brûleur à pare-flammes multicouche comprenant une première et une deuxième couche extérieure (80, 81), au moins une couche de flamme (85) comportant une pluralité de doigts (94) définis par des rainures (95) réalisées dans la couche de flamme, les rainures (95) s'ouvrant le long d'un bord de la couche de flamme, et au moins une couche de répartition de gaz (83) superposée à la couche de flamme (85) et définissant une ouverture (87) qui se superpose aux rainures (95) entre les doigts (94) de la couche de flamme (85) adjacente, la couche de flamme et la couche de répartition de gaz superposée étant, ensemble, disposées entre les couches extérieures (80, 81), et l'ensemble de brûleur ayant au moins un orifice (82) pour l'admission de gaz combustible vers l'ouverture (87) de la couche de répartition de gaz (83), de sorte que le gaz fourni à l'orifice est introduit via l'ouverture dans les rainures entre les doigts de la couche de flamme, les couches (80, 81 ; 83-86) étant réalisées selon une forme tridimensionnelle sensiblement cylindrique,
caractérisé en ce que les couches extérieures (80, 81), la ou chaque couche de flamme (85, 86) et la ou chaque couche de répartition de gaz (83, 84) ont la forme de cylindres inter-emboîtés, les rainures (95) dans la ou dans chaque couche de flamme (85, 86) s'étendant de manière sensiblement parallèle à l'axe de la forme cylindrique.

2. Ensemble de brûleur selon la revendication 1, **caractérisé en ce qu'**il comprend au moins trois couches (83-86) disposées en alternance entre les couches extérieures (80, 81).

3. Ensemble de brûleur selon la revendication 1 ou 2, **caractérisé en ce que** l'orifice (82) pour la fourniture de gaz au brûleur est réalisé dans une couche extérieure (80), l'orifice communiquant avec l'ouverture (87) de la ou de chaque couche de répartition de gaz entre les couches extérieures.

4. Ensemble de brûleur selon la revendication 1 et comprenant plusieurs couches (83-86) de répartition de gaz et de flamme, caractérisé en que les couches entre les couches extérieures (80, 81) ont des lumières (88, 92) en alignement mutuel, et en ce que, pour chaque couche de répartition de gaz (83, 84), l'ouverture (87, 91) a une première et une deuxième parties (89, 90, 91, 93) en communication l'une avec l'autre.

5. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les rainures (95) dans la ou dans chaque couche de flamme (85) sont sensiblement parallèles.

6. Ensemble de brûleur selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** les rainures (95) dans la ou dans chaque couche de flamme (85) se rétrécissent d'une extrémité à l'autre, soit en direction des extrémités internes des rainures soit en direction des extrémités externes des rainures.

7. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les doigts (94) de chaque côté d'une rainure (95) comprennent des saillies dirigées vers le doigt adjacent, de sorte que les saillies définissant un chemin de labyrinthe pour le flux de gaz.

8. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les extrémités libres des doigts (94) ont un profil non linéaire de manière à modifier le front de flamme produit par l'ensemble de brûleur.

9. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le bord de la ou de chaque couche de répartition de gaz (83) adjacent aux extrémités libres des doigts a un profil non linéaire de manière à modifier le front de flamme produit par l'ensemble de brûleur.

10. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'ouverture (87) dans la ou dans chaque couche de répartition de gaz (83) est généralement rectangulaire et est superposée aux rainures entre les doigts d'une couche de flamme adjacente, au niveau de ou de manière adjacente aux extrémités internes des rainures.

11. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la ou **en ce que** chaque couche de répartition de gaz (83) a un bord opposé aux bords des couches produisant le front de flamme et **en ce que** l'ouverture (87) dans la ou dans chaque couche de répartition de gaz s'ouvre à travers ledit bord opposé, et **en ce qu'**il est prévu un conduit d'alimentation en gaz (97) monté sur le brûleur en communication avec la ou avec chaque ouverture s'ouvrant à travers ledit bord opposé pour alimenter ainsi en gaz les rainures entre les doigts dans la ou dans chaque plaque de flamme.

12. Ensemble de brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'ensemble de brûleur est placé dans une chambre de plénum (100) avec les bords des couches produisant le front de flamme exposés à travers une face de la chambre, et **en ce qu'**un conduit d'admission de gaz (103) est en communication avec l'intérieur de la chambre pour fournir ainsi du gaz au brûleur.

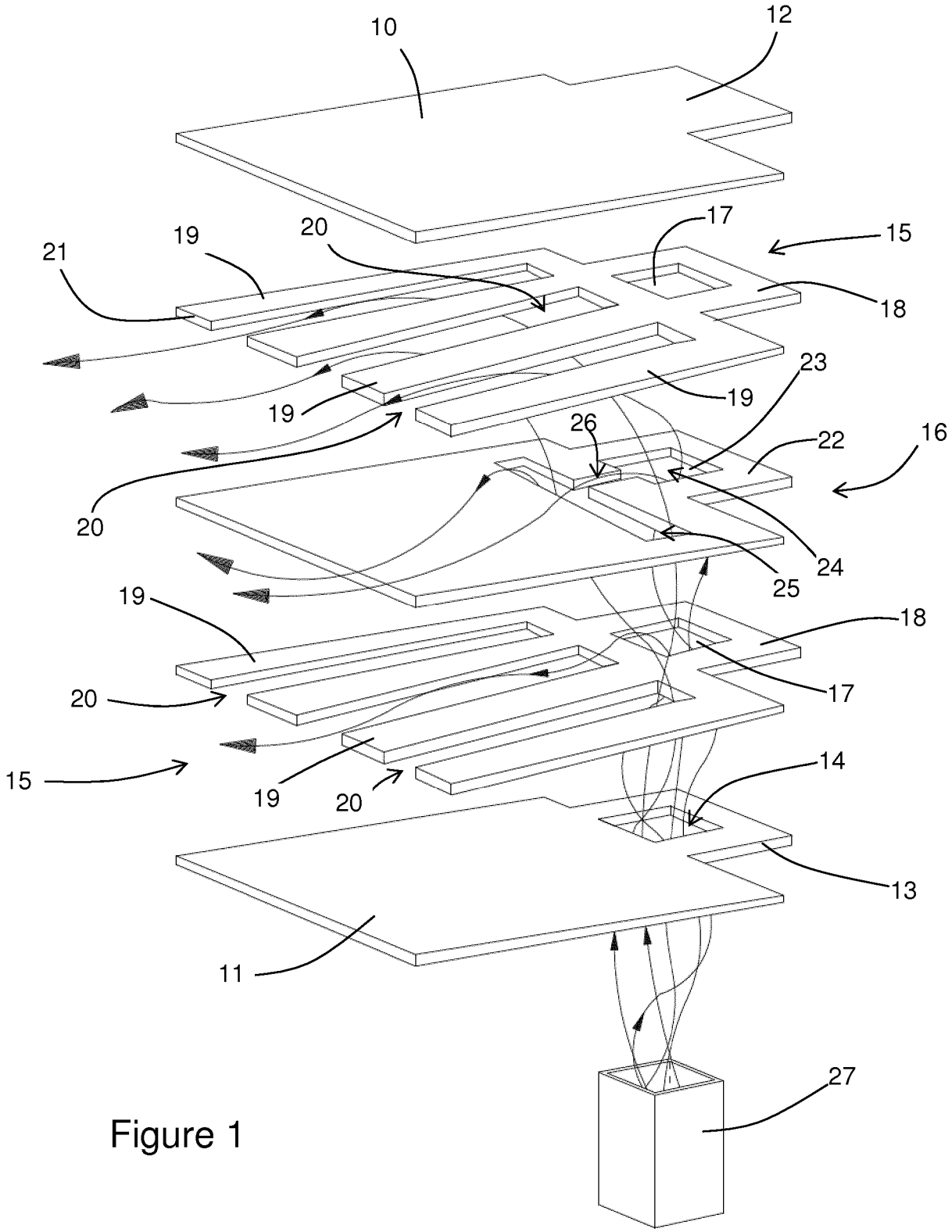
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Figure 1

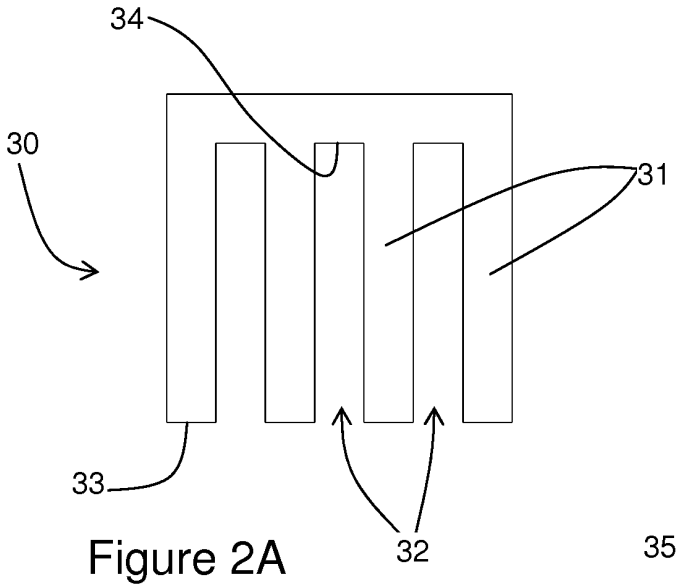


Figure 2A

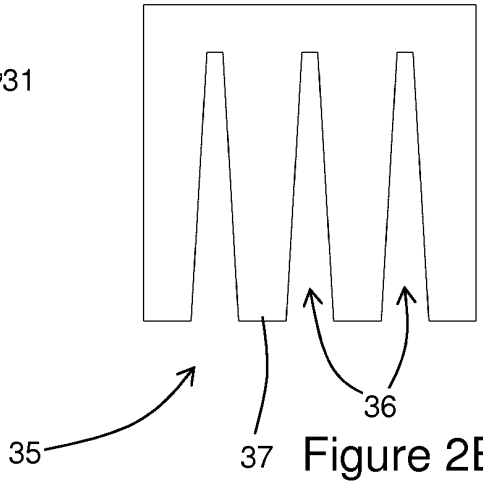


Figure 2B

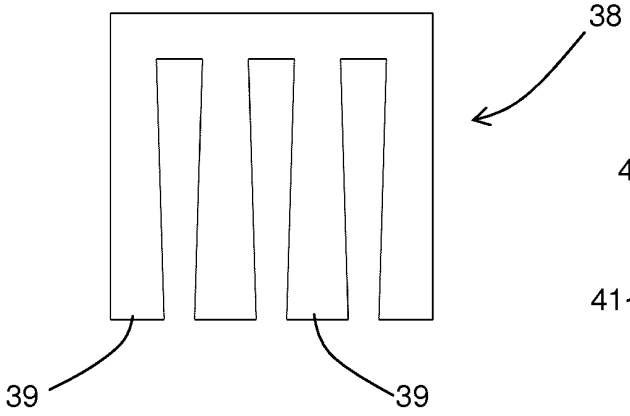


Figure 2C

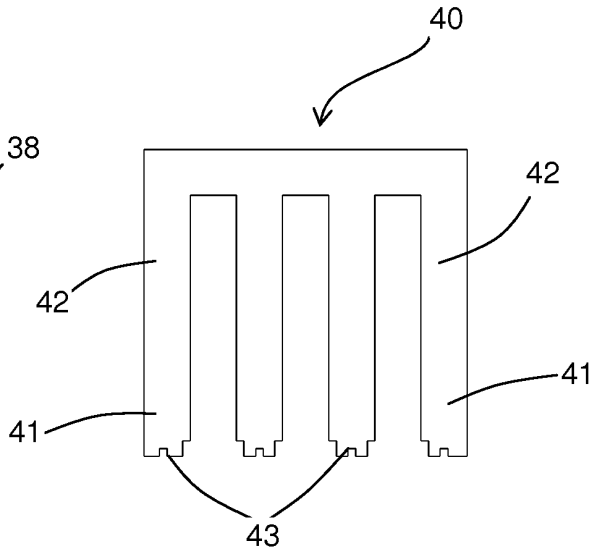
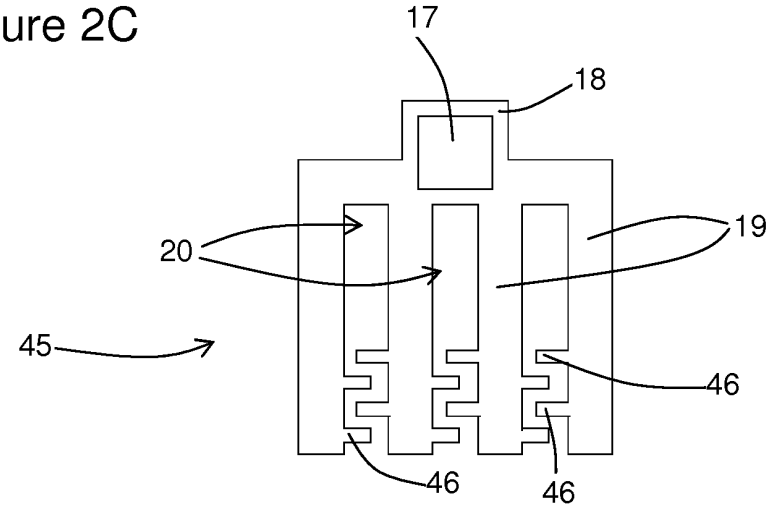


Figure 2D



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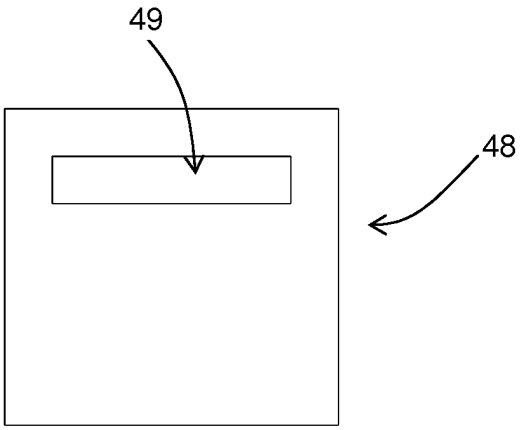


Figure 4A

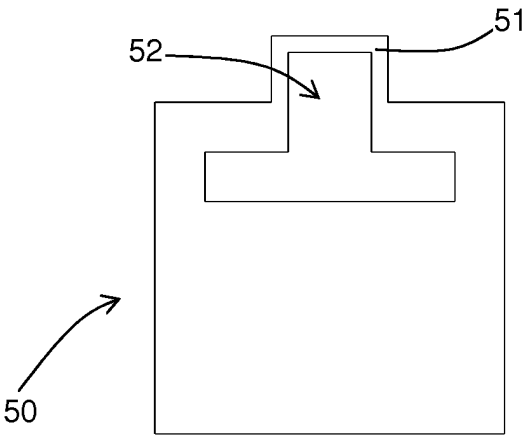
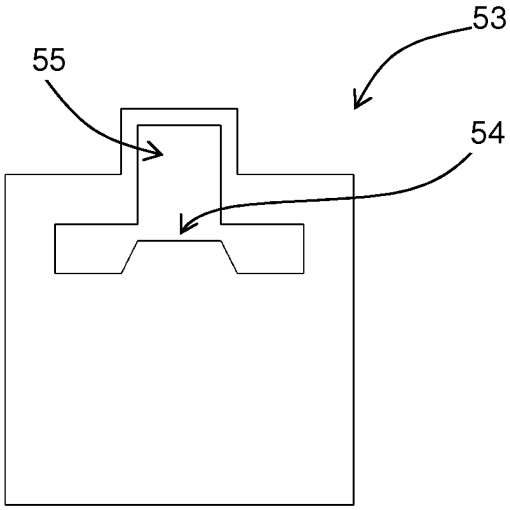


Figure 4B



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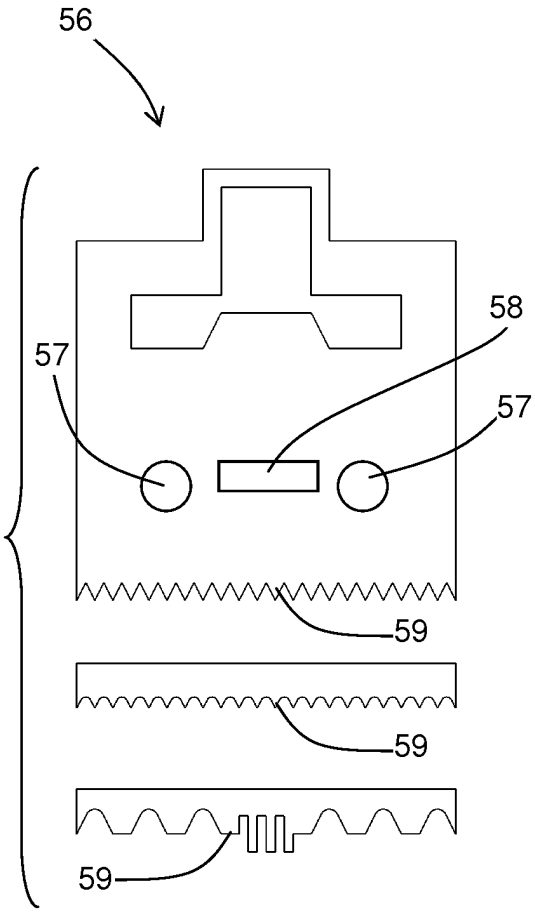


Figure 4D

Figure 6A

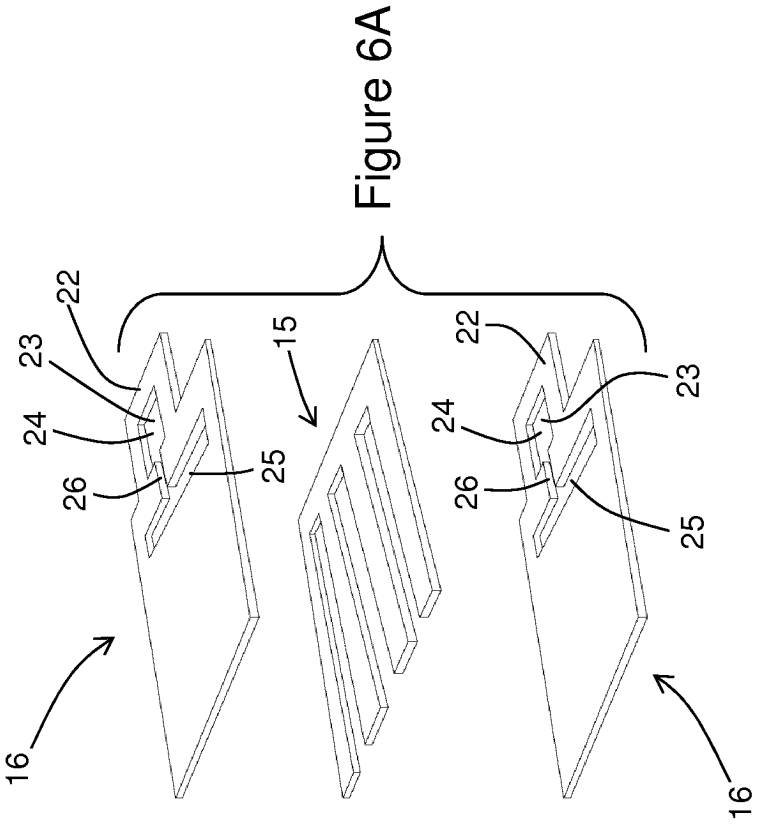


Figure 6B

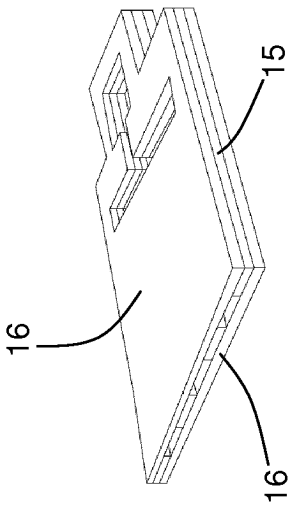


Figure 5A

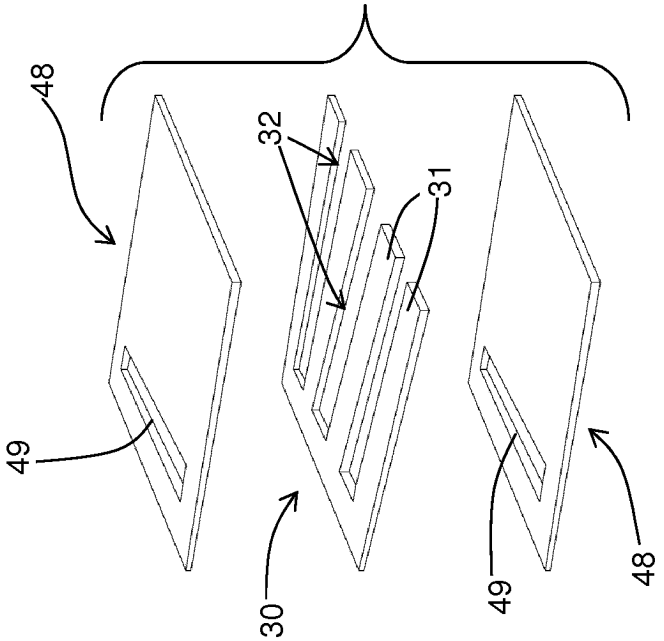


Figure 5B

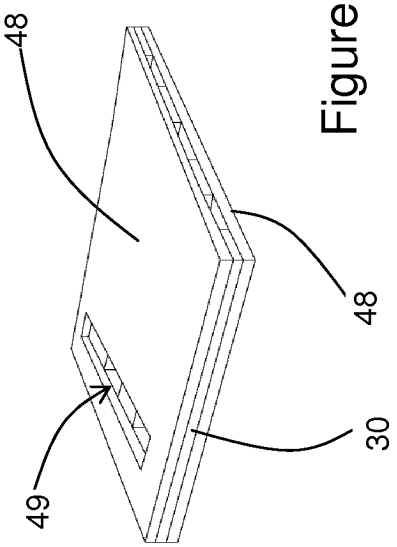


Figure 7

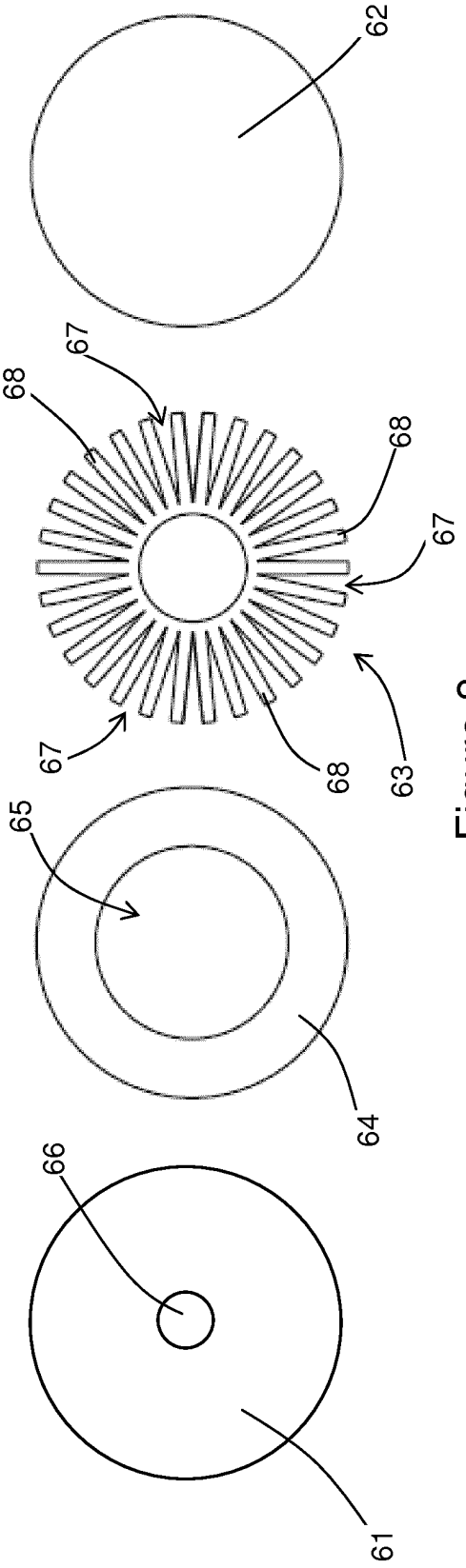
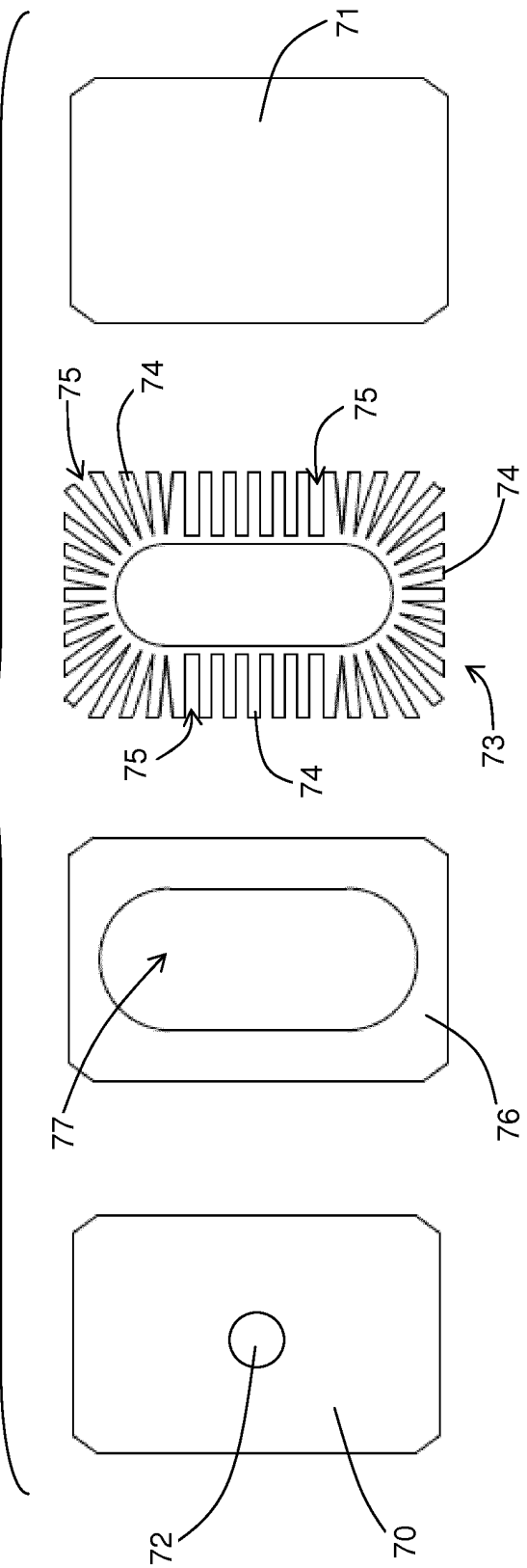


Figure 8



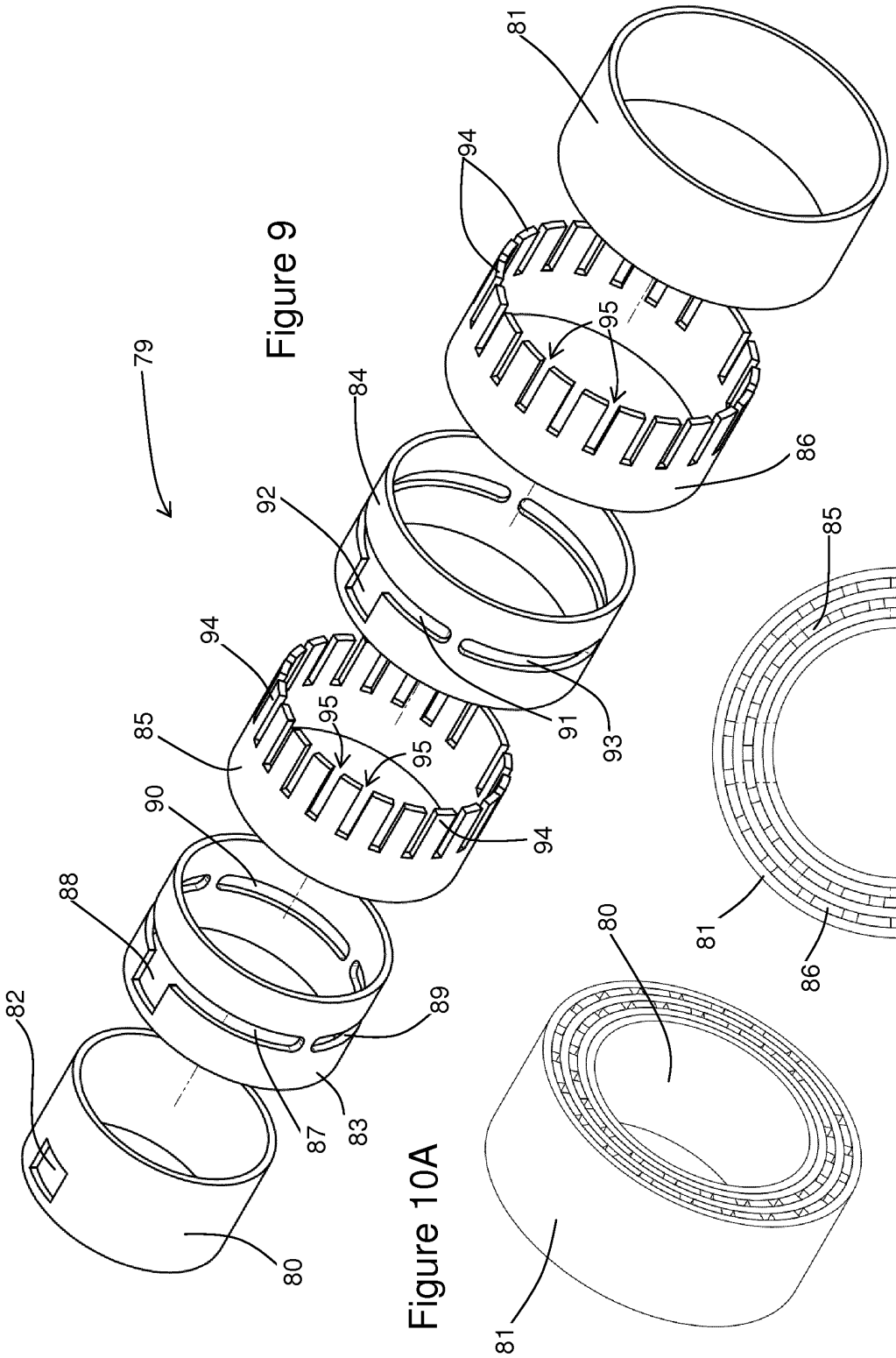


Figure 9

Figure 10B

Figure 10A

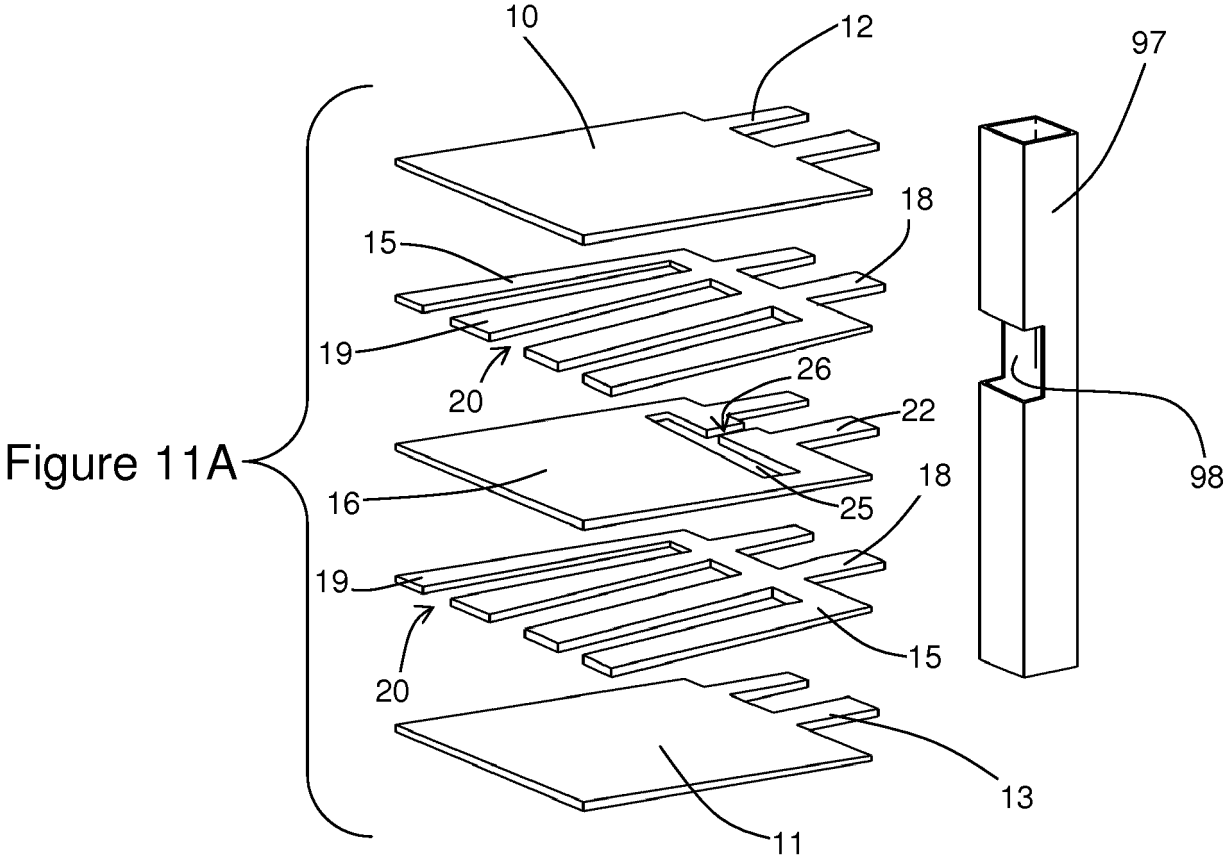


Figure 11A

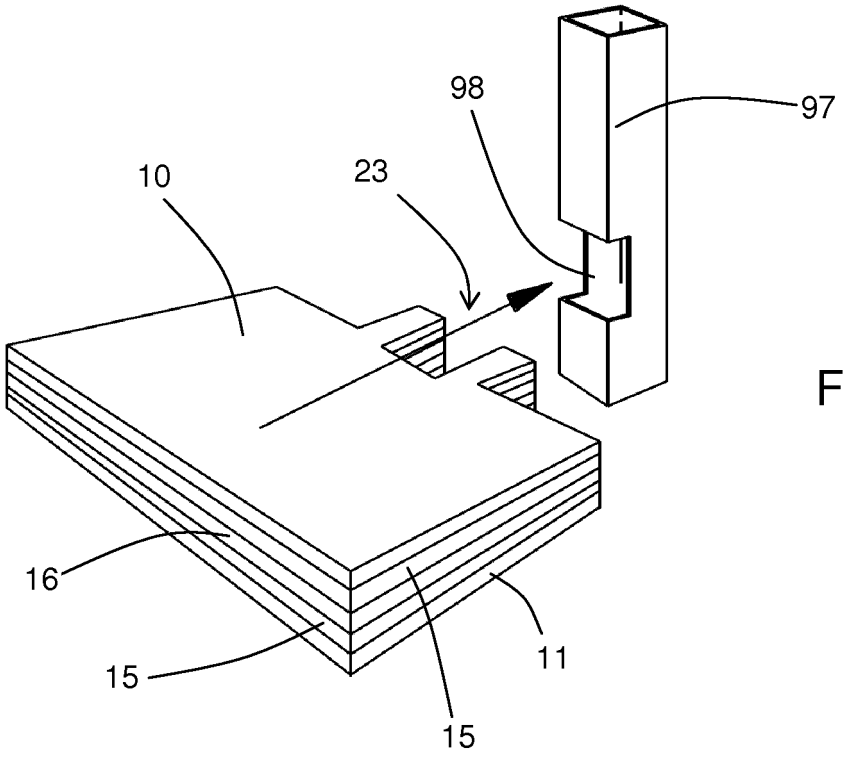


Figure 11B

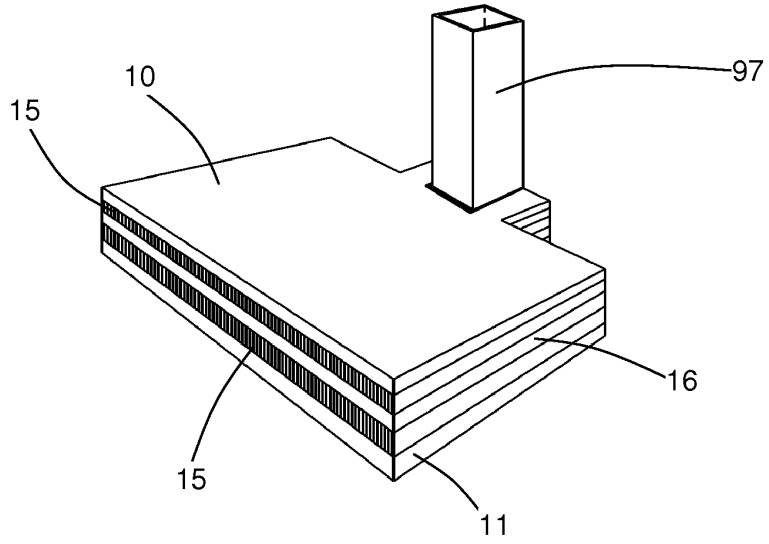
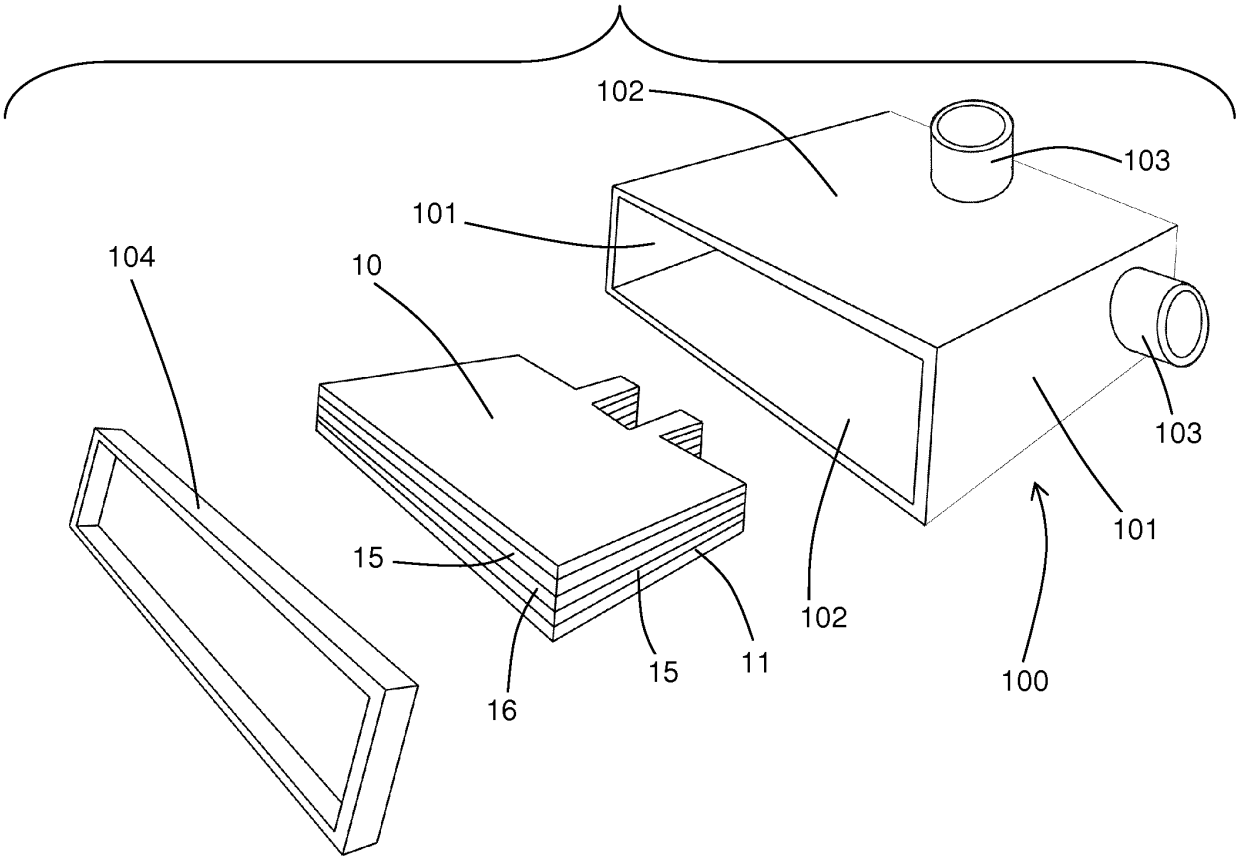


Figure 11C

Figure 11D



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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