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(54) **PORTED BURNER**

(57) A fuel burner includes a tube extending along a centerline from a first end to a second end and having an outer surface and an inner surface defining a central passage. The central passage is supplied at the first end with a mixture of air and combustible fuel pre-mixed upstream of the tube. The second end is closed by an end wall in a fluid-tight manner. The tube has fluid directing structure for directing the pre-mixed mixture radially outward from the central passage to an exterior of the tube such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

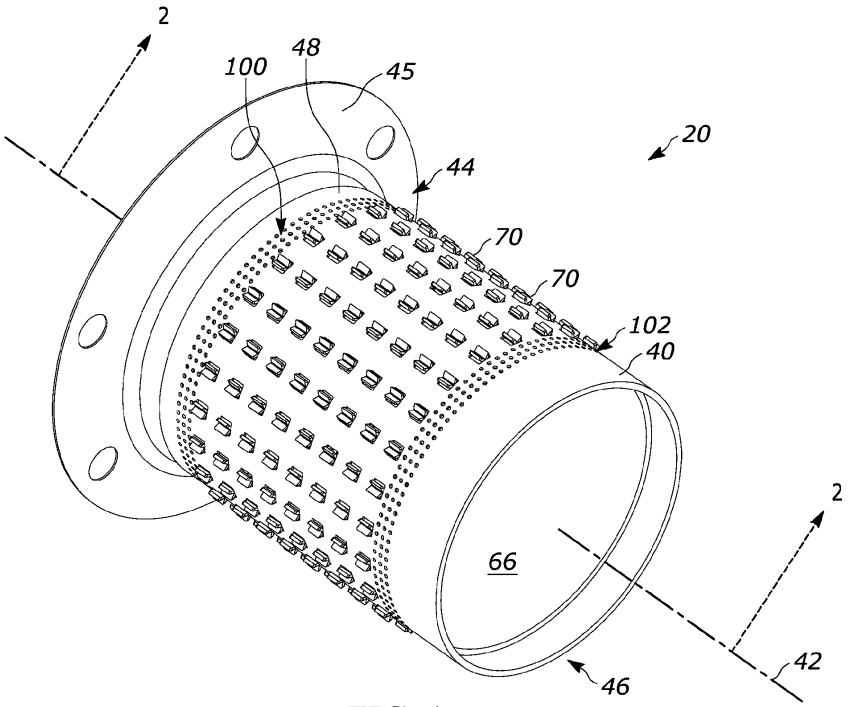

FIG. 1

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Description

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Appln. Serial No. 63/039,744, filed June 16, 2020, the entirety of which is incorporated by reference herein.

TECHNICAL FIELD

[0002] The invention relates to a fuel burner and, in particular, relates to a combustor for a heating appliance.

BACKGROUND

[0003] Power burners of various types have been in use for many years. "Nozzle mix" or "gun style" burners are those burners that inject fuel and air separately in some manner so as to provide a stable flame without a ported flame holder component. Other types of power burners use some method of pre-mixing the fuel and air and then delivering the fuel-air mixture to a ported burner "head". These "heads" or "cans" can be made of a variety of materials including perforated sheet metal, woven metal wire, woven ceramic fiber, etc. Flame stability, also referred to as flame retention, is key to making a burner that has a broad operating range and is capable of running at high primary aeration levels.

[0004] A broad operating range is desired for appliances that benefit from modulation, in which the heat output varies depending on demand. A burner having a flame that is lifted off the burner surface will remain cool, thereby prolonging its life. Lifting burners, however, can be unstable and can cause poor combustion (high CO) or loss of flame altogether.

SUMMARY

[0005] In one example, a fuel burner includes a tube extending along a centerline from a first end to a second end and having an outer surface and an inner surface defining a central passage. The central passage is supplied at the first end with a mixture of air and combustible fuel pre-mixed upstream of the tube. The second end is closed by an end wall in a fluid-tight manner. The tube has fluid directing structure for directing the pre-mixed mixture radially outward from the central passage to an exterior of the tube such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

[0006] In another example, a fuel burner includes a base extending along a centerline from a first end to a second end and having an upstream side and a downstream side. The upstream side is supplied with a mixture of air and combustible fuel pre-mixed upstream of the base. The base has fluid directing structure for directing the pre-mixed mixture from the upstream side to the downstream side such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

[0007] Other objects and advantages and a fuller understanding of the invention will be had from the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a schematic illustration of an example fuel burner.
Fig. 2 is a section view of Fig. 1 taken along line 2-2.
Fig. 3 is a section view of Fig. 2 taken along line 3-3.
Fig. 4 is a top view of Fig. 3.
Fig. 5 is an enlarged view of another example fluid directing structure.
Fig. 6 is a schematic illustration of another example fuel burner.

DETAILED DESCRIPTION

[0009] The invention relates to a fuel burner and, in particular, relates to a fuel burner for a heating appliance that includes ports and guides for directing fluid, *e.g.,* fuel or a combination of air and fuel, about the exterior of the burner in a manner that lifts flames produced from the ignited fluid above the burner surface. The burner surface can be planar or non-planar.

[0010] Figs. 1-4 illustrate one example fuel burner 20 in accordance with the present invention. The fuel burner 20 may be used in industrial, household, and commercial appliances such as, for example, a water heater, boiler, furnace, etc. In one instance, the fuel burner 20 can be a can-style burner. The fuel burner 20 includes a base or tube 40 that extends along a centerline 42 from a first end 44 to a second end 46. The first end 44 includes a flange 45 for securing the burner 20 to, for example, a portion of an appliance. Although the tube 40 is illustrated as having a circular shape, it will be appreciated that the tube may exhibit alternative shapes, such as triangular, square, oval or any polygonal shape.

[0011] The tube 40 has a constant cross-section. Alternatively, the tube 40 may have a cross-section that varies (not shown), *e.g*., is stepped, tapered, etc., along the centerline 42. In such a construction, the cross-section of the tube 40 may increase or decrease from the first end 44 to the second end 46 (not shown). In any case, the tube 40 is made from a durable, flame-resistant material, such as metal.

[0012] The tube 40 includes an outer surface 48 and an inner surface 50 that defines a central passage 60 extending through the tube from an opening 62 at the first end 44 to an opening 64 at the second end 46. The opening 64 at the second end 46 is sealed by an end wall 66 secured to the tube 40 in a fluid-tight manner.

[0013] As shown in Fig. 2, the central passage 60 is

configured to receive a pre-mixed mixture of combustible fuel and air from a duct or passageway in the appliance fluidly connected to a blower/gas valve premixing assembly (not shown). The combustible fuel can be a liquid, e.g., atomized or vaporized, or gas.

[0014] The periphery of the tube 40 includes fluid directing structure 70 for directing fluid radially outward from the central passage 60 to a position adjacent to and radially outward of the outer surface 48 and the fluid directing structure, *i.e.,* exterior to or outside of the tube.

[0015] The fluid directing structure 70 may include a series or openings with associated fins or guides for directing the fluid in the desired manner (Figs. 3-4). In one example, the fluid directing structure 70 includes a plurality of openings or ports 80 in the tube 40 for allowing the air/fuel mixture to pass from the central passage 60 to the exterior of the tube.

[0016] Each of the openings 80 extends entirely through the tube 40 from the outer surface 48 to the inner surface 50. Each opening 80 may have any shape, such as rectangular, square, circular, triangular, etc. The openings 80 may all have the same shape or different shapes. The openings 80 are aligned with one another along the periphery, *i.e.,* around the circumference, of the tube 40 and can, in one example, form an endless loop. One or more endless loops of openings 80 may be positioned adjacent to one another or spaced from one another along the length of the tube 40. Each loop may have any number of openings 80. The openings 80 in adjacent loops may be aligned with one another or may be circumferentially offset from one another.

[0017] Alternatively or additionally, the openings 80 can be symmetrically or asymmetrically arranged about the circumference of the tube 40, arranged diametrically opposed from one another, arranged at predetermined circumferential positions from one another, arranged or disproportionally concentrated on one half of the tube's length or circumference or any combination of the foregoing.

[0018] The size, shape, configuration, and alignment of the openings 80 in the tube 40 is dictated by desired flow and performance characteristics of the air/fuel mixture flowing through the openings. Although the openings 80 are illustrated as being arranged in a predetermined pattern along the tube 40, it will be appreciated that the openings may be randomly positioned along the tube (not shown).

[0019] Each opening 80 includes a corresponding fluid directing projection or guide 82 for directing the air/fuel mixture passing through the associated opening 80 radially outward and generally circumferentially about the periphery of the tube 40, *e.g.,* in a direction extending about the centerline 42. The guides 82 are formed in or integrally attached to the tube 40. In one example, the guides 82 are formed by lancing or louvering the tube 40. Other methods of forming the guides 82 are contemplated.

[0020] Each guide 80 can be substantially U- or V-shaped and includes a base 84 connected to the tube 40. A pair of legs 86 extends in opposite directions from the base 84 and generally circumferentially about the centerline 42 (as shown). Each leg 86 extends at an angle (not shown) relative to the outer surface 48 the tube 40. The legs 86 may extend at the same angle or at different angles relative to the outer surface 48. In any case, the legs 86 of adjacent guides 82 extend towards and thereby confront one another.

[0021] The openings 80 and corresponding guides 82 can be arranged such that the centerline 83 of each base 84 extends parallel to the centerline 42 of the tube 40 (*see* Fig. 2). Alternatively or additionally, the centerlines 83 can extend perpendicular to the centerline 42 (rotated 90° from the configuration shown) and/or at angle(s) from the centerline 42. In other words, the guides 82 can be arranged in any pattern along/about the tube 40 so long as legs 86 of adjacent guides 82 confront one another. That said, the guides 82 can direct fluid passing therethrough in upstream/downstream directions about and/or parallel to the centerline 42 and/or in directions that are neither upstream nor downstream but about the centerline 42.

[0022] It will also be appreciated that the openings 80 and associated guides 82 can be configured such that more than two guides confront one another. For example, one or more groups of three, four, five, etc. guides 82 can be arranged to direct fluid in a direction towards a common point at the center of the arrangement (not shown).

[0023] The tube 40 can include additional or secondary fluid directing structure 100, 102 constituting ports or openings at the respective ends 42, 44 extending through the tube on opposite longitudinal sides of the fluid directing structure 70. In other words, the fluid directing structure 70 is positioned longitudinally between the openings 100 in the first end 42 and the openings 102 in the second end 44. The openings 100 extend radially through the first end 42 and towards the centerline 42 to the central passage 60. The openings 102 extend radially through the second end 44 and towards the centerline 42 to the central passage 60. As shown in Fig. 3, neither the openings 100 nor the openings 102 includes associated fins or guides. The openings 100, 102 can be circular (as shown), round, rectangular, polygonal, etc. Either or both sets of openings 100, 102 can be omitted.

[0024] In an alternative configuration shown in Fig. 5, the openings 100, 102 are designated as 100a, 102a for clarity. At least a portion of the openings 100a can include an associated guide 110 extending from or secured to the tube 40 and configured to direct fluid towards the second end 44. Alternatively or additionally, at least a portion of the openings 102a can include an associated guide (not shown) extending from or secured to the tube 40 and configured to direct fluid towards the first end 42. In this manner, the guides can direct fluid generally towards one another on opposite sides of the fluid directing structure 70. The guides and openings 100a, 102a can

be formed from louvering or lancing the tube 40.

[0025] In this configuration, the openings 100a, 102a can have a generally rectangular shape. The associated guides can extend at the same angle relative to the outer surface 48 as the guides 82 or at a different angle. The openings 100a, 102a and associated guides can be circumferentially offset from the openings 60 and guides 82 (as shown) or aligned therewith.

[0026] In operation, the pre-mixed mixture M flows into the central passage 60 at the first end 44 of the tube 40 (*see* Fig. 2). The end wall 66 prevents the pre-mixed mixture M from exiting the second end 46 of the tube 40 except through the fluid directing structures 70, 100, 102. Consequently, the pre-mixed mixture M is directed radially outward through the fluid directing structures 70, 100, 102 in the respective manners R_1, R_2, R_3 to the tube exterior.

[0027] Since the circumferentially adjacent guides 82 confront one another, fluid exiting the guides flows in a direction towards the adjacent guide such that the resulting flames Fi impinge one another as shown in Fig. 3. This advantageously lifts the impinging flames Fi off the outer surface 48 of the burner and provides enhanced flame stability. At the same time, the pre-mixed mixture M also flows through the openings 100, 102 to the exterior of the tube 40 such that the resulting flames (not shown) extend substantially normal to the outer surface 48.

[0028] In the case of the openings 100a, 102a and any guides associated therewith (Fig. 5), the pre-mixed mixtures flowing through the openings 100a, 102a are directed towards one another such that the resulting flames F_2 extend towards one another and towards the flames Fi extending from the guides 82. Both configurations for the secondary fluid directing structure help to provide flame stability at the ends 42, 44 of the tube 40.

[0029] In any case, to produce the flames the pre-mixed mixture is ignited by an ignition device (not shown) of any number of types well known in the art and positioned in any number of suitable locations to light the burner 20. Flame proving means (not shown) can be positioned in any number of suitable locations to detect the presence of flame. The flames from the ignited air/fuel mixture is directed into, for example, the heat exchange tube of the heating appliance.

[0030] In another example shown in Fig. 6, the fuel burner 220 has a planar base 240. The base 240 extends along a centerline 242 from a first end 244 to a second end 246. The base 240 has a first surface or side 248 and a second surface or side 250. The pre-mixed mixture M is supplied from the second surface 250 side of the base 240 and, thus, the second surface is the upstream side or surface of the base.

[0031] The fluid directing structure 70 is identical to the fluid directing structure shown and described in Figs. 1-5 except the associated guides 82 and openings 80 in Fig. 6 are provided on planar surfaces 248, 250 instead of curved surfaces 48, 50. That said, the fluid directing structure 70 of the fuel burner 220 can direct fluid passing therethrough perpendicular to the centerline 242 (as shown), parallel to the centerline 242 and/or one or more angles relative to the centerline 242 (not shown). In all cases, the legs 82 of adjacent fluid directing structures 70 of the fuel burner 220 confront one another and, thus, the flames exiting therefrom impinge one another and are lifted off the surface 248.

[0032] Due to the exceptional flame retention/stability of the burner of the present invention, it is capable of running at very high combustion loadings. High loadings allow the burner to run in a stable "lifted flame" mode *i.e.,* the flame is spaced from the burner surfaces. Lifting of the flame in this manner is desirable in that the burner surfaces are not directly heated, thereby maintaining the surfaces at a lower temperature and lengthening the usable life of the combustor. A high combustion loading also allows the use of a smaller, space saving, and less costly burner for a given application. Furthermore, the burner of the present invention, due to the exceptional flame retention as discussed above, is also capable of operating cleanly (low CO) at very high levels of excess air, which produces NOx levels well below those achievable with conventional burner.

[0033] 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. For example, it will be understood that the burner described above can incorporate a "variable port area" by configuring the end wall 66 to be movable along the centerline 42 of the tube 40. The wall 66 can be movable to prevent fluid flow through, for example, the openings 102. Such a construction would allow for optimized combustion performance by matching the port area for combustion to the power output required.

[0034] What have been described above are examples of the present invention. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the present invention, but one of ordinary skill in the art will recognize that many further combinations and permutations of the present invention are possible. Accordingly, the present invention is intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims.

[0035] The following description pages 9 to 11 contain preferred embodiments.

Embodiment 1. A fuel burner comprising:

a tube extending along a centerline from a first end to a second end and having an outer surface and an inner surface defining a central passage, the central passage being supplied at the first end with a mixture of air and combustible fuel pre-mixed upstream of the tube, the second end being closed by an end wall in a fluid-tight manner, the tube having fluid directing structure for directing the pre-mixed mixture radially outward from the central passage to an ex-

terior of the tube such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

Embodiment 2. The fuel burner of embodiment 1, wherein the fluid directing structure includes a plurality of openings and a guide associated with each opening, each guide including a base connected to the tube and a pair of legs extending circumferentially in opposite directions from the base such that the legs of adjacent fluid directing structures confront one another.

Embodiment 3. The fuel burner of embodiment 2, wherein the guides are arranged in a series of rows that extend continuously around the periphery of the tube to encircle the centerline.

Embodiment 4. The fuel burner of embodiment 2, wherein the guides are substantially V-shaped.

Embodiment 5. The fuel burner of embodiment 1, further comprising secondary fluid directing structure positioned on opposite longitudinal sides of the fluid directing structure.

Embodiment 6. The fuel burner of embodiment 5, wherein the secondary fluid directing structure comprises ports extending through the tube to the central passage.

Embodiment 7. The fuel burner of embodiment 6, wherein a guide is associated with each port and extends towards the fluid directing structure.

Embodiment 8. A heating appliance including the fuel burner of embodiment 1.

Embodiment 9. A fuel burner comprising:
a base extending along a centerline from a first end to a second end and having an upstream side and a downstream side, the upstream side being supplied with a mixture of air and combustible fuel premixed upstream of the base, the base having fluid directing structure for directing the pre-mixed mixture from the upstream side to the downstream side such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

Embodiment 10. The fuel burner of embodiment 9, wherein the fluid directing structure includes a plurality of openings and a guide associated with each opening, each guide including a base connected to the tube and a pair of legs extending in opposite directions from the base such that the legs of adjacent fluid directing structures confront one another.

Embodiment 11. The fuel burner of embodiment 10, wherein the guides are substantially V-shaped.

Embodiment 12. The fuel burner of embodiment 9, further comprising secondary fluid directing structure positioned on opposite longitudinal sides of the fluid directing structure.

Embodiment 13. The fuel burner of embodiment 12, wherein the secondary fluid directing structure comprises ports extending through the base.

Embodiment 14. The fuel burner of embodiment 13, wherein a guide is associated with each port and extends towards the fluid directing structure.

Embodiment 15. A heating appliance including the fuel burner of embodiment 9.

Claims

1. A fuel burner comprising:
a base extending along a centerline from a first end to a second end and having an upstream side and a downstream side, the upstream side being supplied with a mixture of air and combustible fuel premixed upstream of the base, the base having fluid directing structure for directing the pre-mixed mixture from the upstream side to the downstream side such that flames exiting adjacent fluid directing structures extend towards and impinge one another.

2. The fuel burner of claim 1, wherein the fluid directing structure includes a plurality of openings and a guide associated with each opening, each guide including a base connected to the tube and a pair of legs extending in opposite directions from the base such that the legs of adjacent fluid directing structures confront one another.

3. The fuel burner of claim 2, wherein the guides are substantially V-shaped.

4. The fuel burner of claim 1, further comprising secondary fluid directing structure positioned on opposite longitudinal sides of the fluid directing structure.

5. The fuel burner of claim 4, wherein the secondary fluid directing structure comprises ports extending through the base.

6. The fuel burner of claim 5, wherein a guide is associated with each port and extends towards the fluid directing structure.

7. A heating appliance including the fuel burner of claim 1.

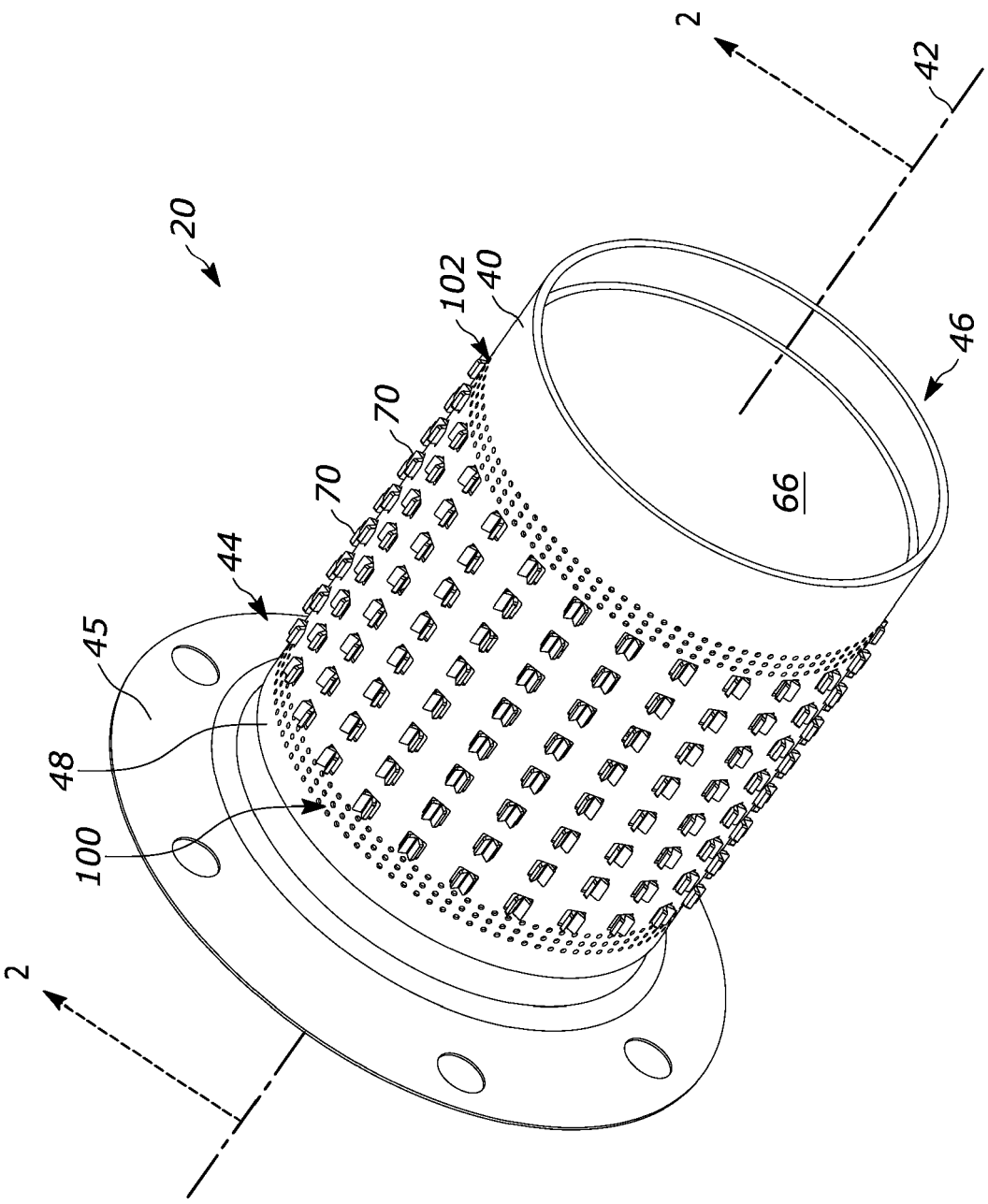
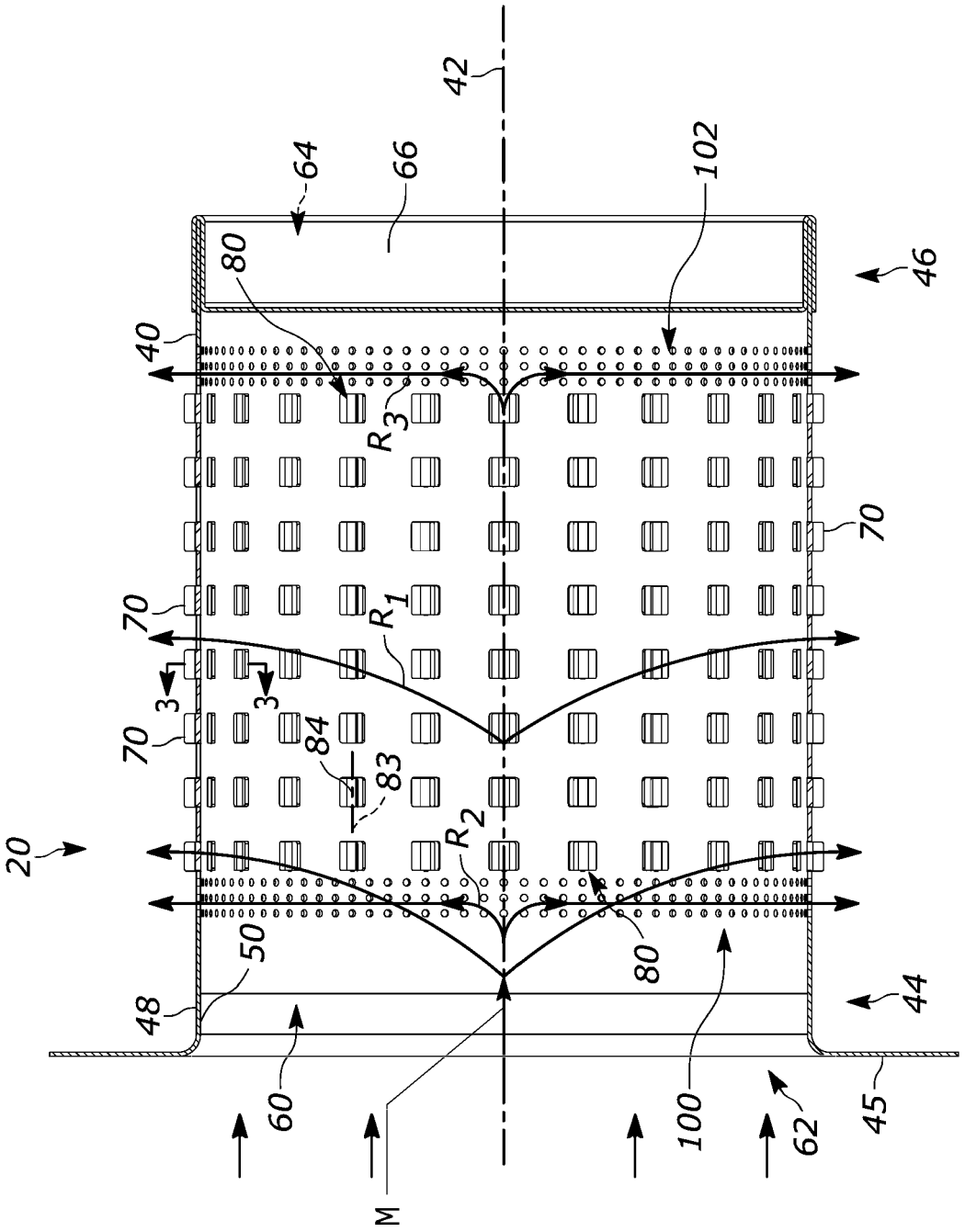


FIG. 1


42
64
66
102
46
80
40
R3
70
70
R1
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3
70
84
83
20
R2
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48
44
60
M
100
62
45

FIG. 2

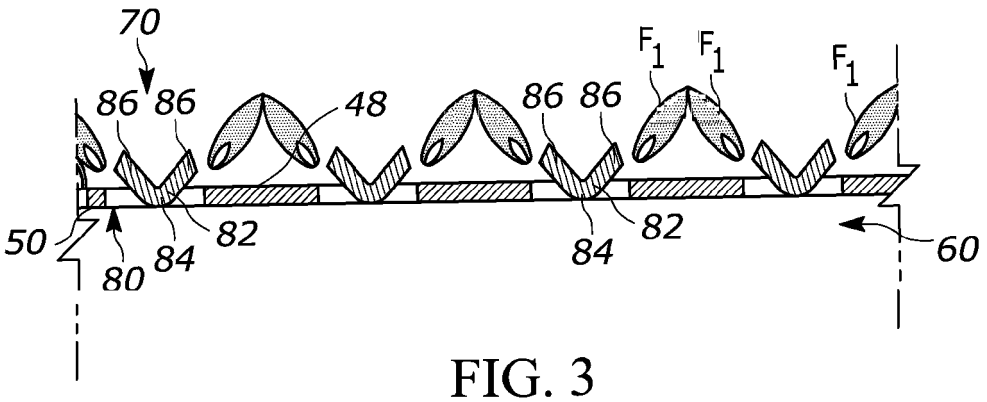

FIG. 3

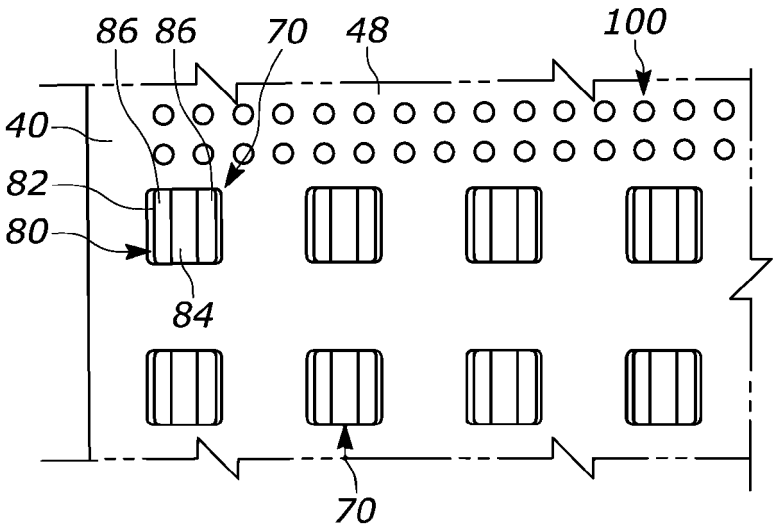

FIG. 4

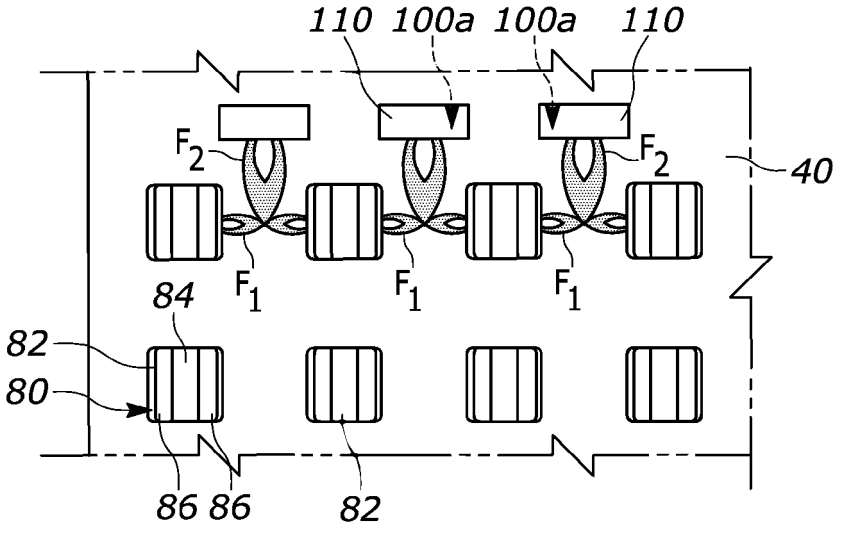

FIG. 5

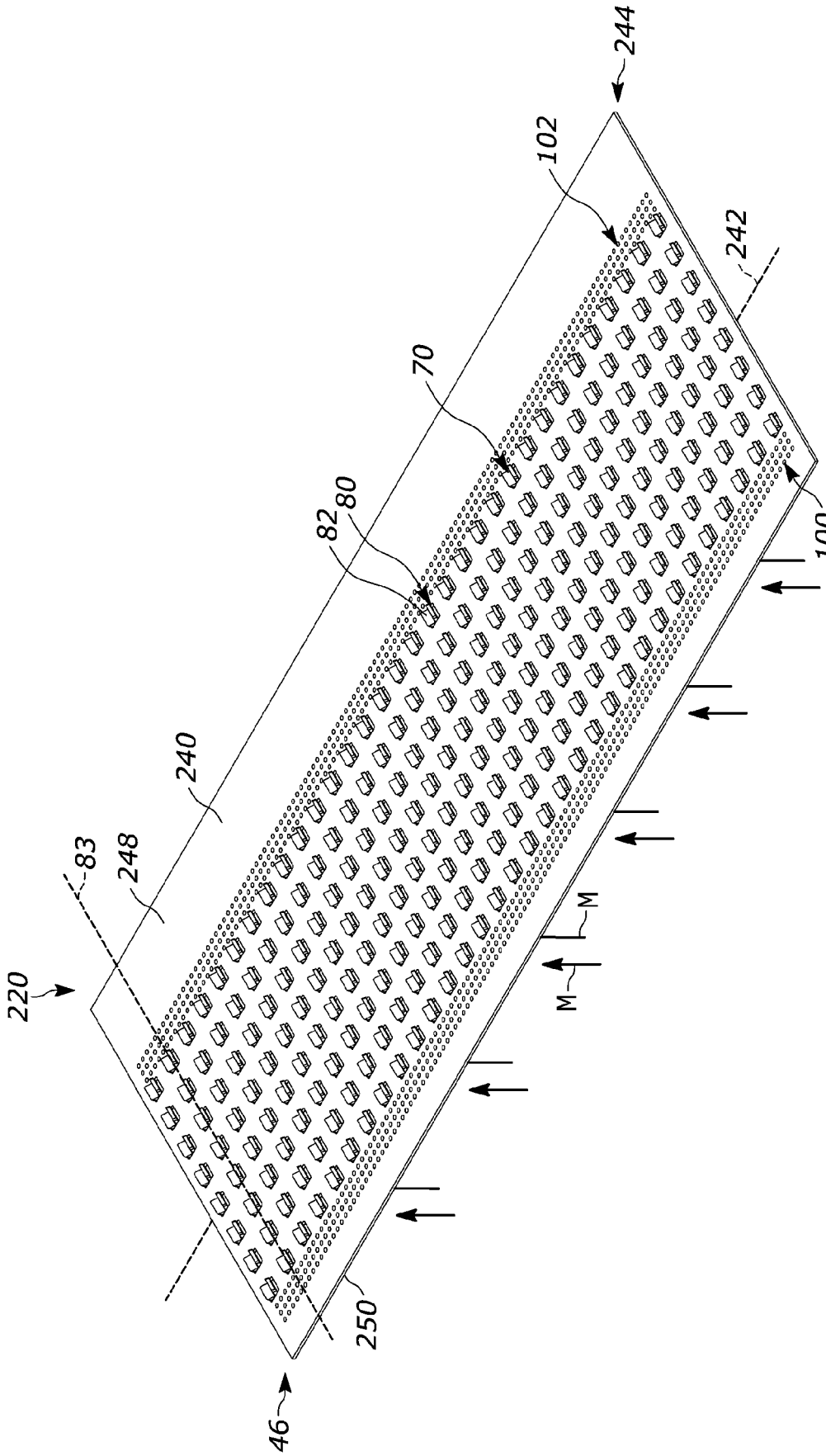

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 March 2022	Theis, Gilbert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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