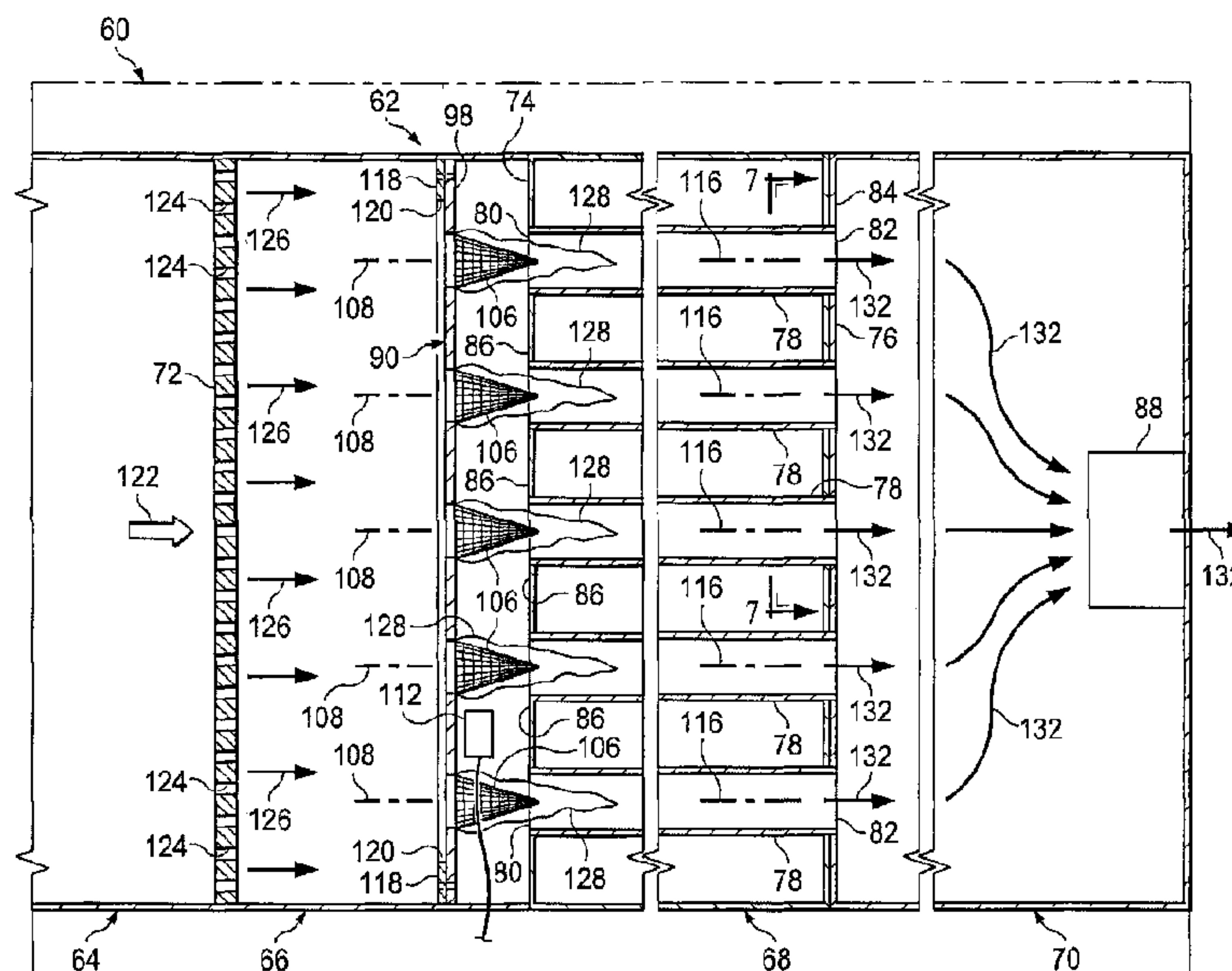




(86) Date de dépôt PCT/PCT Filing Date: 2015/01/06
(87) Date publication PCT/PCT Publication Date: 2015/07/09
(45) Date de délivrance/Issue Date: 2018/01/23
(85) Entrée phase nationale/National Entry: 2016/06/27
(86) N° demande PCT/PCT Application No.: US 2015/010227
(87) N° publication PCT/PCT Publication No.: 2015/103575
(30) Priorité/Priority: 2014/01/06 (US14/148,204)

(51) Cl.Int./Int.Cl. *F24H 3/08* (2006.01)
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(54) Titre : APPAREIL DE BRULEUR MULTICONE A COMBUSTIBLE POUR ECHANGEUR DE CHALEUR MULTITUBE
(54) Title: MULTI-CONE FUEL BURNER APPARATUS FOR MULTI-TUBE HEAT EXCHANGER



(57) Abrégé/Abstract:

Installed in a fuel-fired heating appliance is a specially designed burner assembly operative to receive and combust a pre-mixed flow of fuel and air to create therefrom a spaced apart plurality of flames which are aligned with and flow directly into the inlets of a corresponding spaced plurality of heat exchanger tubes. The flames create within the tubes hot combustion gases that transfer combustion heat to a supply fluid flowed externally across the tubes. The burners are of a hollow perforate metal construction, are mounted on and forwardly project from a support structure toward the tube inlets, and have rearwardly facing open inlet ends that receive the pre-mixed flow of fuel and air. Via a flame carryover structure, a single igniter is utilized to ignite all of the burners.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
9 July 2015 (09.07.2015)



(10) International Publication Number
WO 2015/103575 A1

(51) International Patent Classification:
F24H 3/08 (2006.01)

(21) International Application Number:
PCT/US2015/010227

(22) International Filing Date:
6 January 2015 (06.01.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14/148,204 6 January 2014 (06.01.2014) US

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

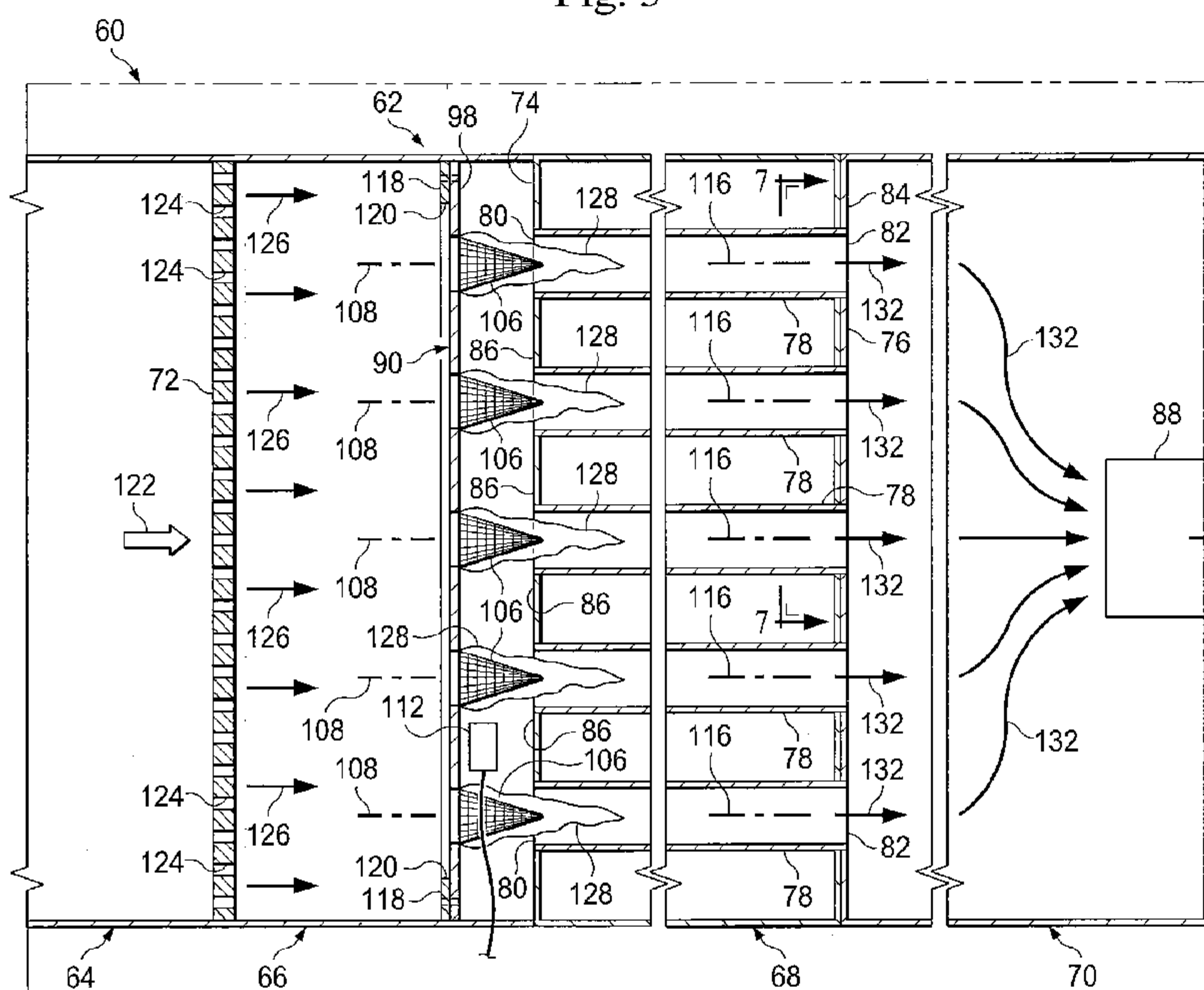
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: MULTI-CONE FUEL BURNER APPARATUS FOR MULTI-TUBE HEAT EXCHANGER

Fig. 3



(57) Abstract: Installed in a fuel-fired heating
appliance is a specially designed burner as-
sembly operative to receive and combust a
pre-mixed flow of fuel and air to create there-
from a spaced apart plurality of flames which
are aligned with and flow directly into the in-
lets of a corresponding spaced plurality of
heat exchanger tubes. The flames create with-
in the tubes hot combustion gases that transfer
combustion heat to a supply fluid flowed ex-
ternally across the tubes. The burners are of a
hollow perforate metal construction, are
mounted on and forwardly project from a sup-
port structure toward the tube inlets, and have
rearwardly facing open inlet ends that receive
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carryover structure, a single igniter is utilized
to ignite all of the burners.

MULTI-CONE FUEL BURNER APPARATUS FOR MULTI-TUBE HEAT EXCHANGER

BACKGROUND OF THE INVENTION

5 The present invention relates generally to fuel-fired heating appliances, such as air heating furnaces, and more particularly provides specially designed combustion apparatus for such fuel-fired heating appliances.

 In fuel-fired heating appliances such as, for example, air heating furnaces, a known firing method is to flow a fuel/air mixture into a burner box structure in which a burner
10 structure and an associated igniter structure are disposed and are operative to combust the fuel/air mixture and thereby create hot combustion gases used to heat air (or another fluid as the case may be) for delivery to a location served by the heating appliance. The hot combustion gases are flowed through a series of heat exchanger tubes, externally across which the fluid to be heated is flowed, and then discharged from the heating appliance into a
15 suitable flue structure.

 Typically, spaced apart open inlet portions of the heat exchanger tubes extend through openings in a wall of the burner box that faces the burner structure which, in a conventional form thereof, is an elongated flat or curved single mesh burner. FIG. 1 schematically depicts a conventional fuel-fired heating appliance combustion section 10 comprising, from left to
20 right in FIG. 1, a burner box 12, a heat exchange housing 14, and a collector box 16, joined together as indicated. The burner box 12 forwardly terminates at a rear wall 18 of the heat exchange housing 14, and the heat exchange housing 14 forwardly terminates at a rear wall 20 of the collector box 16.

 A spaced plurality of heat exchanger tubes 22 (representatively five in number)
25 extend through the interior of the heat exchange housing 14 and have open rear inlet ends 24 supported in corresponding openings in the rear wall 18 of the heat exchange housing 14, and open front outlet ends 26 supported in corresponding openings in the rear wall 20 of the collector box 16. As can be seen in FIG. 1, the open rear inlet ends 24 of the heat exchanger tubes 22 are interdigitated with imperforate sections 28 of the rear heat exchange housing
30 wall 18. A draft inducer fan 30 is operatively positioned as shown in the collector box 16.

 Referring now additionally to FIG. 2, a representative conventional elongated rectangular flat metal mesh burner 32 is positioned within the burner box 12 in a rearwardly spaced, facing relationship with the open inlet ends 24 of the heat exchanger tubes 22.

Burner 32 is carried within a suitable metal frame 34 (see FIG. 2) secured to an interior flange portion 36 of the burner box 12. A conventional igniter 38 is operatively associated with the flat burner 32.

During firing of the heating appliance with which the burner 32 is associated, a flow
5 40 of pre-mixed fuel and air is forwardly drawn through the burner box 12 to the burner 32 at which point the flow 40 is combusted by the igniter 38 to form along an elongated reaction flame pattern 42 emanating from the front side of the burner 32. As can be seen in FIG. 1, portions of the flame 42 are drawn into the heat exchanger tube inlets 24 and form therein hot combustion gases 44, while the balance of the flame 42 is directed against the imperforate
10 portions 28 of the rear wall 18 of the heat exchange housing 14.

During firing of the conventional combustion section 10, air 46 (or other fluid as the case may be) is suitably flowed externally across the heat exchanger tubes 22 to create heated air 48 for delivery to a conditioned space served by the heating appliance. Simultaneously, the draft inducer fan 30 draws cooled combustion gases 50 from the heat exchanger tube
15 outlet ends 26, through the interior of the collector box 16, and then exhausts the cooled combustion gases 50 to a suitable flue.

A variety of well known problems, limitations and disadvantages are present in this conventional design of a premixed fuel/air combustion system and are primarily created by the use of the flat burner 32. For example, in this application, the negative pressure created
20 by the draft inducer fan 30 tends to forwardly bow the heated burner 32 to its dashed line orientation shown in FIG. 1. This bowing can undesirably change the reacting flow pattern, and can also facilitate some undesired fuel/air mixture flow paths around the burner.

Additionally, the flat burner 32, by virtue of presenting a fairly large single combustion zone within the burner box 12, causes a large amount of the created combustion
25 products to exist within and heat up the burner box 12 prior to being drawn through the heat exchanger tubes 22 by the draft inducer fan 30. High temperatures inside the heating appliance cabinet is not desirable because it can cause problems for the other components and it also is a form of efficiency reducing heat loss. Moreover, the flat burner 32 has been found to often be a primary source of an undesirable source of operating noise, including ignition
30 noise, structural vibration noise and steady state high frequency noise. Replacing the flat burner 32 with a curved single burner has been found to at least somewhat alleviate the bowing problem of the flat burner, but still can create an unacceptably large level of operational noise when used in a premixed fuel/air combustion application.

As can be readily seen from the foregoing, a need exists for improved premixed fuel/air combustion apparatus for use in fuel-fired heating appliances. It is to this need that the present invention is primarily directed.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 FIG. 1 is a schematic cross-sectional view through a portion of a conventional flat burner-based combustion section of a fuel-fired heating appliance;
- FIG. 2 is a cross-sectional view through the combustion section taken along line 2-2 of FIG. 1;
- FIG. 3 is a schematic cross-sectional view through a portion of a specially designed
- 10 fuel-fired heating appliance combustion section embodying principles of the present invention;
- FIG. 4 is a front side perspective view of a unique multi-cone burner assembly portion of the FIG. 3 combustion section;
- FIG. 5 is an exploded perspective view of the FIG. 4 multi-cone burner assembly;
- 15 FIG. 6 is a rear side perspective view of the FIG. 4 multi-cone burner assembly;
- FIG. 7 is a schematic cross-sectional view through a heat exchanger tube portion of the FIG. 3 combustion section; and
- FIG. 8 is a schematic side edge elevational view of an alternate embodiment of the FIG. 4 multi-cone burner assembly.

20 DETAILED DESCRIPTION

Cross-sectionally depicted in schematic form in FIG. 3 is a portion of a fuel-fired heating appliance, representatively an air heating furnace 60, that incorporates therein a premixed fuel/air combustion section 62 embodying principles of the present invention. While the heating appliance 60 is representatively an air heating furnace, principles of the

25 present invention are not limited to furnaces, and could be employed to advantage in a variety of other types of fuel-fired heating appliances including, but not limited to, water heaters, boilers and pool heaters.

The combustion section 62 comprises, from left to right in FIG. 3, a mixing box 64, a burner box or combustion chamber 66, a heat exchange housing 68, and a collector box 70

30 joined together as indicated. At the juncture of the mixing box 64 and the burner box is a perforated diffuser plate 72 which may be similar in configuration and operation to the perforated diffuser plate 64 illustrated and described in copending U.S. application no.

14/084,095 owned by the assignee of the present application. The burner box 66 forwardly terminates at a rear wall 74 of the heat exchange housing 68, and the heat exchange housing 68 forwardly terminates at a rear wall 76 of the collector box 70.

A spaced plurality of heat exchanger tubes 78 (representatively five in number) extend through the interior of the heat exchange housing 68 and have open rear inlet ends 80 supported in corresponding openings in the rear wall 74 of the heat exchange housing 68, and open front outlet ends 82 supported in corresponding openings in the rear wall 84 of the collector box 70. The open rear inlet ends 80 of the heat exchanger tubes 78 are interdigitated with imperforate sections 86 of the rear heat exchange housing wall 74. A draft inducer fan 88 is operatively positioned as shown in the collector box 70.

With reference now to FIGS. 3-6, according to an aspect of the present invention, a specially designed burner assembly, illustratively a multi-cone burner assembly 90, is supported within the burner box 66 between the perforated diffuser plate 72 and the open inlet ends 80 of the heat exchanger tubes 78. As best illustrated in FIGS. 4-6, burner assembly 90 includes a support structure comprising an elongated rectangular metal support plate 92, an elongated rectangular metal mesh backing member 94, and an elongated rectangular metal mounting frame 96, the backing member 94 being sandwiched as shown between the support plate 92 and the mounting frame 96. The support plate 92 has front and rear sides 98 and 100, and five longitudinally spaced circular openings 102 extending therethrough and being joined by slots 104 formed through the support plate 92.

The burner assembly 90 further includes five hollow metal mesh cone-shaped burners 106 pressed, apexes first, forwardly through the circular openings 102, and projecting forwardly beyond the front support plate side 98 along cone axes 108. After the burners 106 are positioned in the circular support plate openings 102, they are retained therein by placing the backing member 94 on the rear side 100 of the support plate 92 and securing the mounting frame 96 to a peripheral portion of the support plate 92, as with suitable fasteners 110. As later described herein, the conical burners 106 are lit by a suitable igniter 112 illustratively positioned between the bottom two burners 106 as viewed in FIG. 3. A created flame on either of these two burners is passed to the other four burners via a metal mesh flame carryover structure 114 (see FIG. 4) disposed in the support plate slots 104 interconnecting the circular plate openings 102, and thus interconnecting the burner cones 106.

Turning now to FIG. 3, the plate-mounted burner cones 106 are operatively positioned within the burner box 66 with the burner cones 106 projecting forwardly, apexes-first, toward

the heat exchanger tube inlets 80, the burner cone axes 108 aligned with the tube axes 116, and the cone burner apexes projecting slightly into the heat exchanger tube inlet ends 80, by securing the support plate 92 to an interior burner box flange portion 118 over an opening 120 therein. While this illustrative positioning of the burner assembly 90 within the burner box 66 positions the burner cone apexes slightly within the heat exchanger tube inlets 80, the burner assembly could be alternatively positioned somewhat forwardly or rearwardly of its indicated FIG. position within the burner box 66 without departing from principles of the present invention.

During firing of the furnace 60, an initially pre-mixed flow 122 is forwardly drawn by the draft inducer fan 88 through the interior of the mixing box 64 and into the interior of the burner box 66 via the plate perforations 124 to form further mixed flows 126 of the fuel/air mixture that in turn are drawn forwardly into the interiors of the burner cones 106. The flows 126 of fuel/air mixture entering the burner cones 106 are combusted to create at the burner cones 106 a spaced series of individual flames 128 that are interdigitated with the imperforate sections 86 of the rear wall 74 of the heat exchanger housing 68 and enter the heat exchanger tube inlets 80.

Referring now to FIGS. 3 and 7, flames 128 are drawn forwardly through the heat exchanger tubes 78 while air 130 (or another type of fluid as the case may be) is suitably flowed externally across the heat exchanger tubes 78, receives combustion heat therefrom, and is discharged from the heating appliance 60 as heated air. This heat transfer from the heat exchanger tubes 78 to the air 130 cools the hot combustion gases created within the heat exchanger tubes 78, with the cooled combustion gases 132 entering the interior of the collector box 70 for discharge from the collector box 70 to a suitable flue (not shown) by the draft inducer fan 88.

The use of the specially designed multi-cone burner assembly 90 provides several advantages over the conventional single elongated flat burner 32 shown in FIG. 1, or a laterally curved version thereof. For example, as can be seen by comparing FIG. 3 to FIG. 1, the flame pattern generated by the multi-cone burner assembly 90 of the present invention is defined by a spaced series of individual flames 128 that directly enter the heat exchanger tubes 78 without appreciably extending across the imperforate portions 86 of the heat exchange housing wall 74, as compared to the blanketing of the corresponding imperforate wall areas 28 by the single extended flame pattern 42 generated by the conventional flat burner 32 shown in FIG. 1. This feature of the present invention reduces the inefficiency

caused in the FIG. 1 system by undesirably transferring a substantial portion of the generated combustion heat to the burner box 12 instead of to the heat exchanger tubes 22.

Moreover, the reduction of combustion heat transfer to the burner box 66 diminishes the potential damage to other components of the heating appliance 60 due to combustion heat transferred thereto. Additionally, the cone burners 106 of the present invention, due to their hollow, forwardly projecting configurations, are substantially more dimensionally stable when being fired than the conventional flat burner 32 shown in FIG. 1 which may tend to bow forwardly to its dotted line position during firing, thereby creating undesirable operational noise. This operational noise is substantially reduced, if not entirely eliminated, in the burner assembly 90 of the present invention.

The forward extension of the hollow burner cones 106 beyond their supporting structure increases the total active burner surface beyond that of a corresponding number of flat circular burners used in place of the cone burners 106. Accordingly the cone burners 106 may be sized to provide generally the same overall burner area of a corresponding single flat burner (such as the flat burner 32 in FIGS. 1 and 2), thereby providing the cone burners 106 with operational temperatures similar to that of the single flat burner 32.

While the burners 106 shown in FIGS. 3-6 are illustratively of hollow conical configurations, the present invention is not limited to conical configurations, and a variety of other hollow, forwardly projecting burner configurations may be utilized if desired without departing from principles of the present invention. By way of non-limiting example, an alternate embodiment 90a of the previously described burner assembly 90 is shown in FIG. 8. For ease in comparing the two burner assemblies, components in the burner assembly 90a similar to those in burner assembly 90 have been given identical reference numerals to which the subscripts "a" have been appended.

With reference now to FIG. 8, the burner assembly 90a representatively has five spaced apart hollow, generally dome-shaped metal mesh burners 106a extending through spaced apart circular openings (not visible in FIG. 8) in the metal support plate 92a and projecting forwardly from its front side 98a. The dome-shaped burners 106a are interconnected by metal mesh flame carryover sections 114a disposed in slots (not visible in FIG. 8) in the support plate 92a. The igniter 112a is representatively disposed between the two rightmost burners 106a and is operative to create the spaced apart individual burner flames 128a from the pre-mixed flows 126a of fuel and air sequentially passing forwardly through the mounting frame 96a, the perforate backing member 94a, the circular support plate holes (not visible in FIG. 8) and into the interiors of the burners 106a.

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The foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims.

WHAT IS CLAIMED IS:

1. Fuel-fired heating apparatus comprising:
 - a housing having an interior, a rear inlet end, and a front outlet end;
 - 5 a plurality of heat exchanger tubes having spaced apart inlets communicating with the interior of the housing at the front outlet end of the housing, and outlets;
 - a burner assembly supported within the housing and including:
 - a support structure disposed rearwardly of the heat exchanger tube inlets and having a spaced plurality of openings extending forwardly therethrough,
 - 10 a spaced plurality of hollow, perforate fuel burners carried by the support structure, the fuel burners projecting forwardly from the support structure in alignment with the heat exchanger tube inlets and having rear inlets respectively communicating with the plurality of support structure openings; and
 - combustion apparatus operative to sequentially (1) flow a fuel/air pre-mixture from a source thereof forwardly through the support structure openings into the interiors of the fuel burners, (2) combust the fuel/air pre-mixture received within the fuel burners to create separate, spaced apart, forwardly directed burner flames respectively aligned with and received within the heat exchanger tube inlets to create hot combustion gases within the heat exchanger tubes for heating a supply fluid flowed externally across the heat exchanger tubes,
 - 15 and then (3) flow cooled combustion gases outwardly from the outlets of the heat exchanger tubes.
2. The fuel-fired heating apparatus of Claim 1 wherein:
 - the fuel-fired heating apparatus is an air heating furnace.
- 25 3. The fuel-fired heating apparatus of Claim 1 wherein:
 - each of the fuel burners has a generally cone-shaped configuration with a forwardly directed apex portion.
- 30 4. The fuel-fired heating apparatus of Claim 1 wherein:
 - each of the fuel burners has a generally dome-shaped configuration.
5. The fuel-fired heating apparatus of Claim 1 wherein:
 - each of the fuel burners is of a metal mesh material.

6. The fuel-fired heating apparatus of Claim 1 wherein:
the housing has an interior flange portion, and
the support structure is secured to the interior flange portion.
- 5 7. The fuel-fired heating apparatus of Claim 1 wherein the support structure includes:
a support plate through which the openings forwardly extend, the openings receiving
rear inlet portions of the fuel burners, the support plate having front and rear sides,
a perforate backing member positioned against the rear side of the support plate, and
a mounting frame connected to a peripheral portion of the support plate and retaining
10 the perforated backing member on the support plate.
8. The fuel-fired heating apparatus of Claim 1 wherein the combustion apparatus
includes:
a draft inducer fan operative to draw the cooled combustion gases outwardly from the
15 outlets of the heat exchanger tubes.
9. The fuel-fired heating apparatus of Claim 1 wherein the combustion apparatus
includes:
an igniter operative to ignite one of the fuel burners, and
20 flame carryover apparatus operative to spread the flame from the ignited burner to at
least one unignited fuel burner.
10. The fuel-fired heating apparatus of Claim 9 wherein:
the support structure includes a support plate through which the openings forwardly
25 extend, the openings receiving rear inlet portions of the fuel burners, and
the flame carryover apparatus includes slots formed in the support plate and
interdigitated with the openings, and a mesh material disposed in the slots, interconnecting
the fuel burners, and operative to spread a flame from an ignited fuel burner to an unignited
fuel burner.
30
11. The fuel-fired heating apparatus of Claim 10 further comprising:
a perforated diffuser plate, positioned rearwardly of the burner assembly, through the
perforations of which the fuel/air pre-mixture flows before entering the support structure
openings.

12. A pre-mixed fuel/air burner assembly comprising:

a support structure having a spaced plurality of openings extending forwardly therethrough;

5 a spaced plurality of hollow, perforated fuel burners having open inlet ends carried by the support structure and respectively communicated with the plurality of support structure openings to receive within the fuel burner interiors fan-created flows of pre-mixed fuel and air, and outlet ends spaced forwardly apart from the support structure; and

10 combustion apparatus operative to ignite flows of pre-mixed fuel and air received within the interiors of the fuel burners to create spaced apart individual flames forwardly emanating from the fuel burners.

13. The pre-mixed fuel/air burner assembly of Claim 12 wherein:

the pre-mixed fuel/air burner assembly is configured for use in a fuel-fired air heating furnace.

15

14. The pre-mixed fuel/air burner assembly of Claim 12 wherein:

each of the fuel burners has a generally cone-shaped configuration with a forwardly directed apex portion.

20 15. The pre-mixed fuel/air burner assembly of claim 12 wherein:

each of the fuel burners has a generally dome-shaped configuration.

16. The pre-mixed fuel/air burner assembly of Claim 12 wherein:

each of the fuel burners is of a metal mesh material.

25

17. The pre-mixed fuel/air burner assembly of Claim 12 wherein the combustion apparatus includes:

an igniter operative to ignite one of the fuel burners, and

30 flame carryover apparatus operative to spread the flame from the ignited burner to at least one unignited fuel burner.

18. The pre-mixed fuel/air burner assembly of Claim 17 wherein:

the support structure includes a support plate through which the openings forwardly extend, the openings receiving rear inlet portions of the fuel burners, and

the flame carryover apparatus includes slots formed in the support plate and interdigitated with the openings, and a mesh material disposed in the slots, interconnecting the fuel burners, and operative to spread a flame from an ignited fuel burner to an unignited fuel burner.

5

19. A pre-mixed fuel/air burner assembly comprising:

a support plate having a spaced plurality of openings extending therethrough between front and rear sides thereof, the support plate further having slots formed therethrough, the slots being interdigitated with and intercommunicating the plurality of support plate

10 openings;

a spaced plurality of hollow, metal mesh fuel burners having open inlet ends respectively mounted within the plurality of support plate openings to receive fan-created flows of pre-mixed fuel and air, and outlet ends spaced forwardly apart from the support plate;

15 a perforated backing member positioned against the rear side of the support plate over the support plate openings;

a mounting frame secured to a peripheral portion of the rear side of the support plate and retaining the perforated backing member thereon;

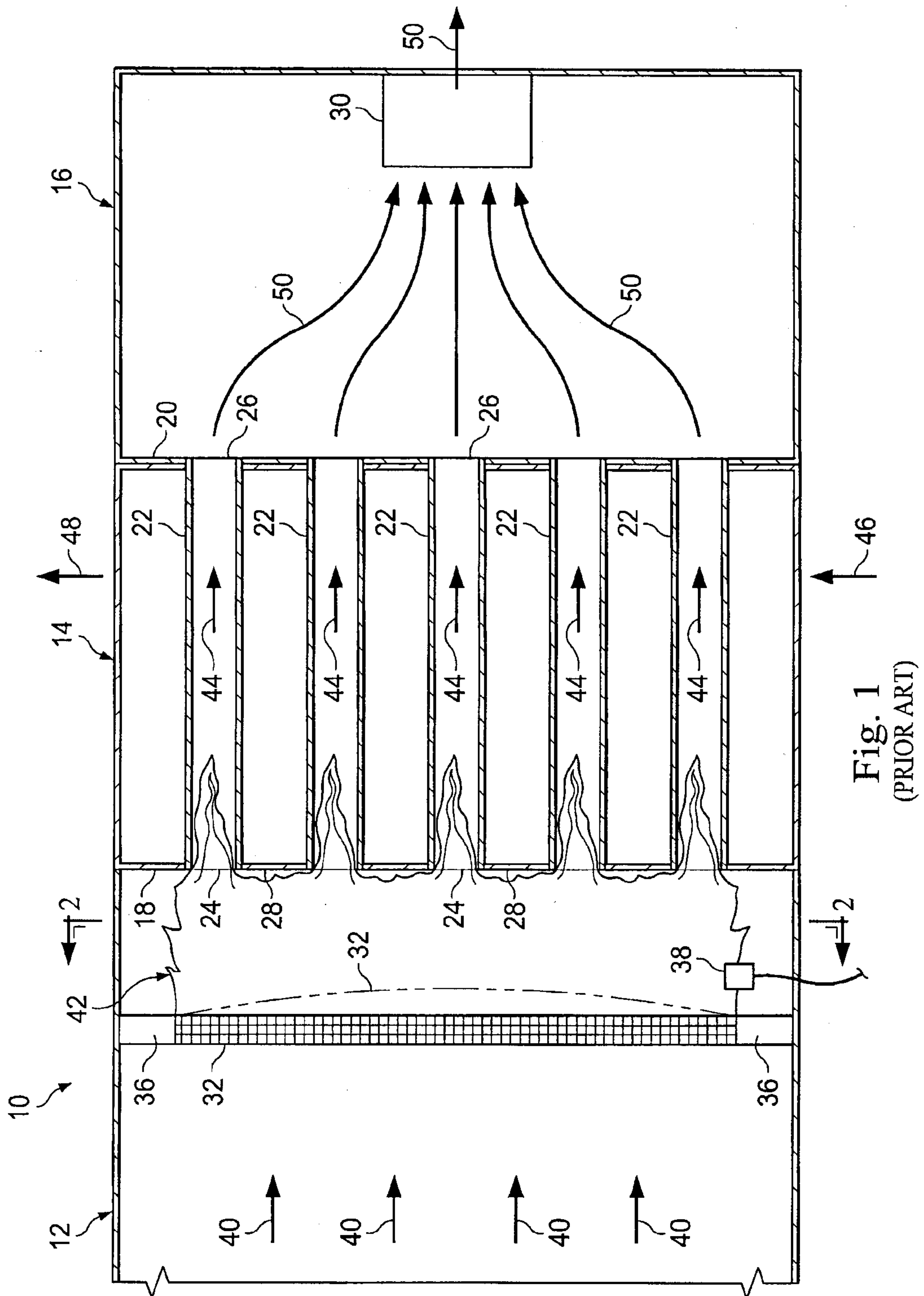
20 an igniter associated with the support plate and operative to ignite a pre-mixture of fuel and air within one of the fuel burners; and

a mesh material disposed within the slots and intercommunicating the fuel burners, the mesh material being operative to carry the flame from an ignited fuel burner to an unignited fuel burner.

25 20. The pre-mixed fuel/air burner assembly of Claim 19 wherein:
the fuel burners have generally conical configurations.

21. The pre-mixed fuel/air burner assembly of Claim 19 wherein:
the fuel burners have generally dome-shaped configurations.

30



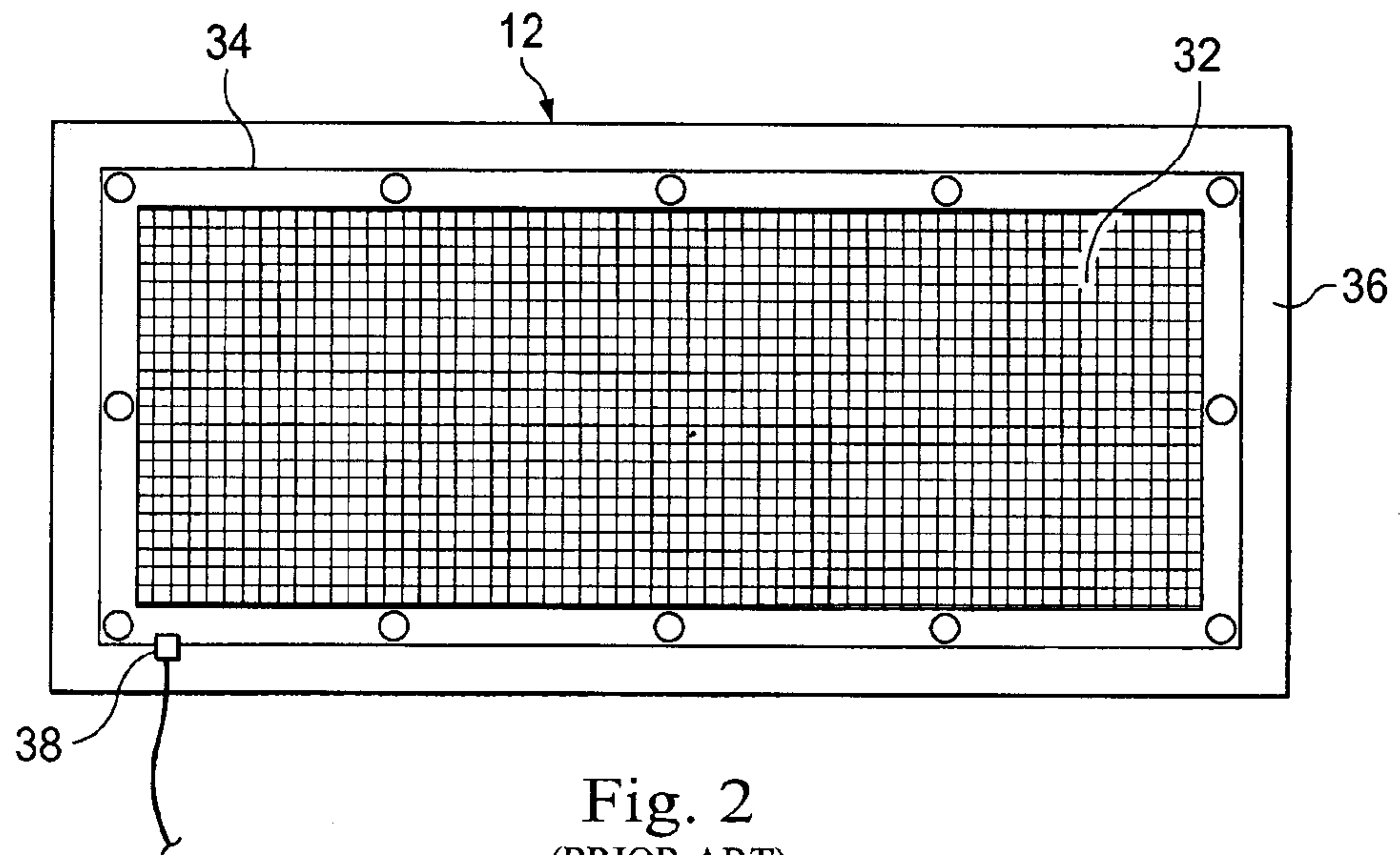


Fig. 2
(PRIOR ART)

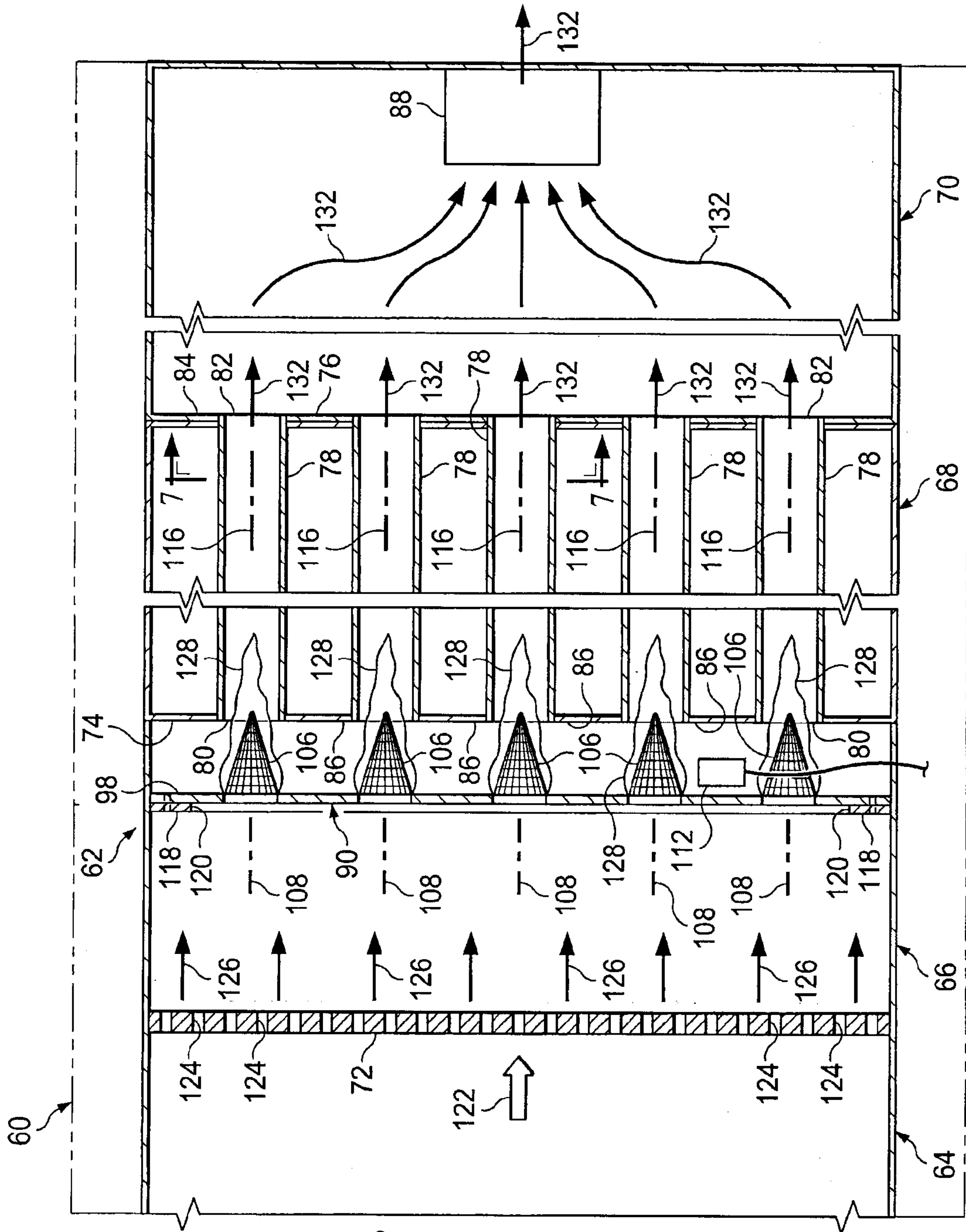


Fig. 3

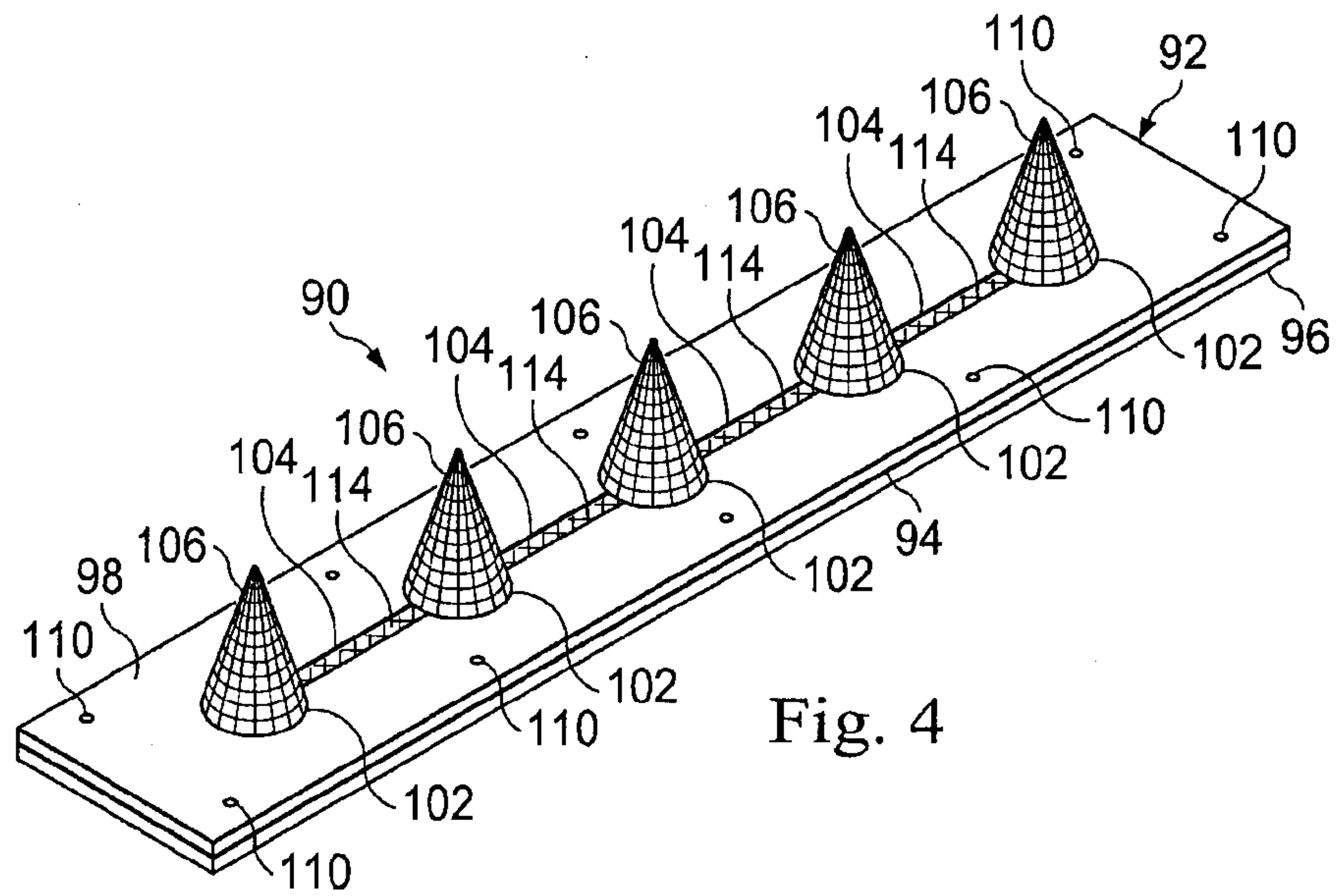


Fig. 4

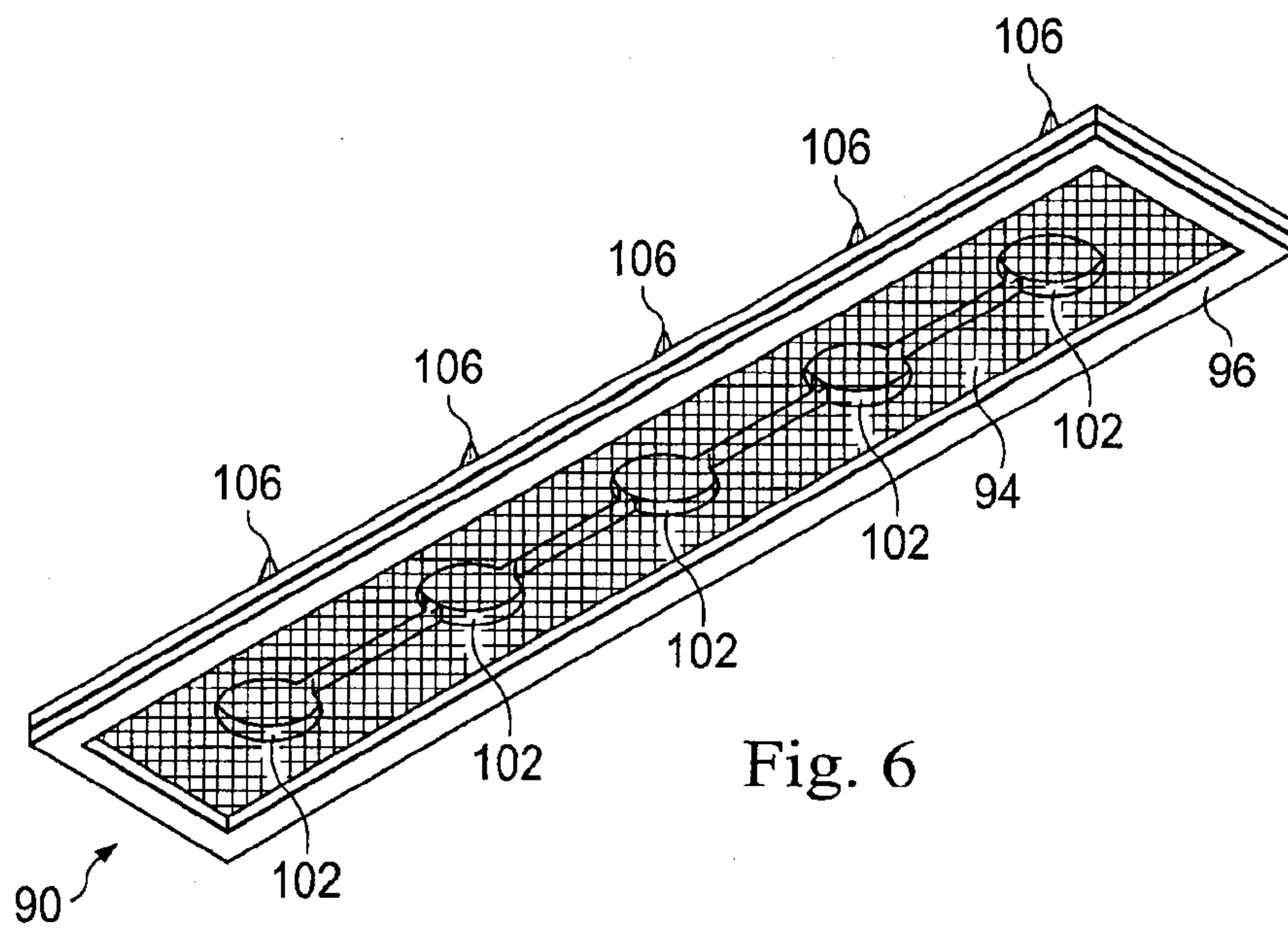


Fig. 6

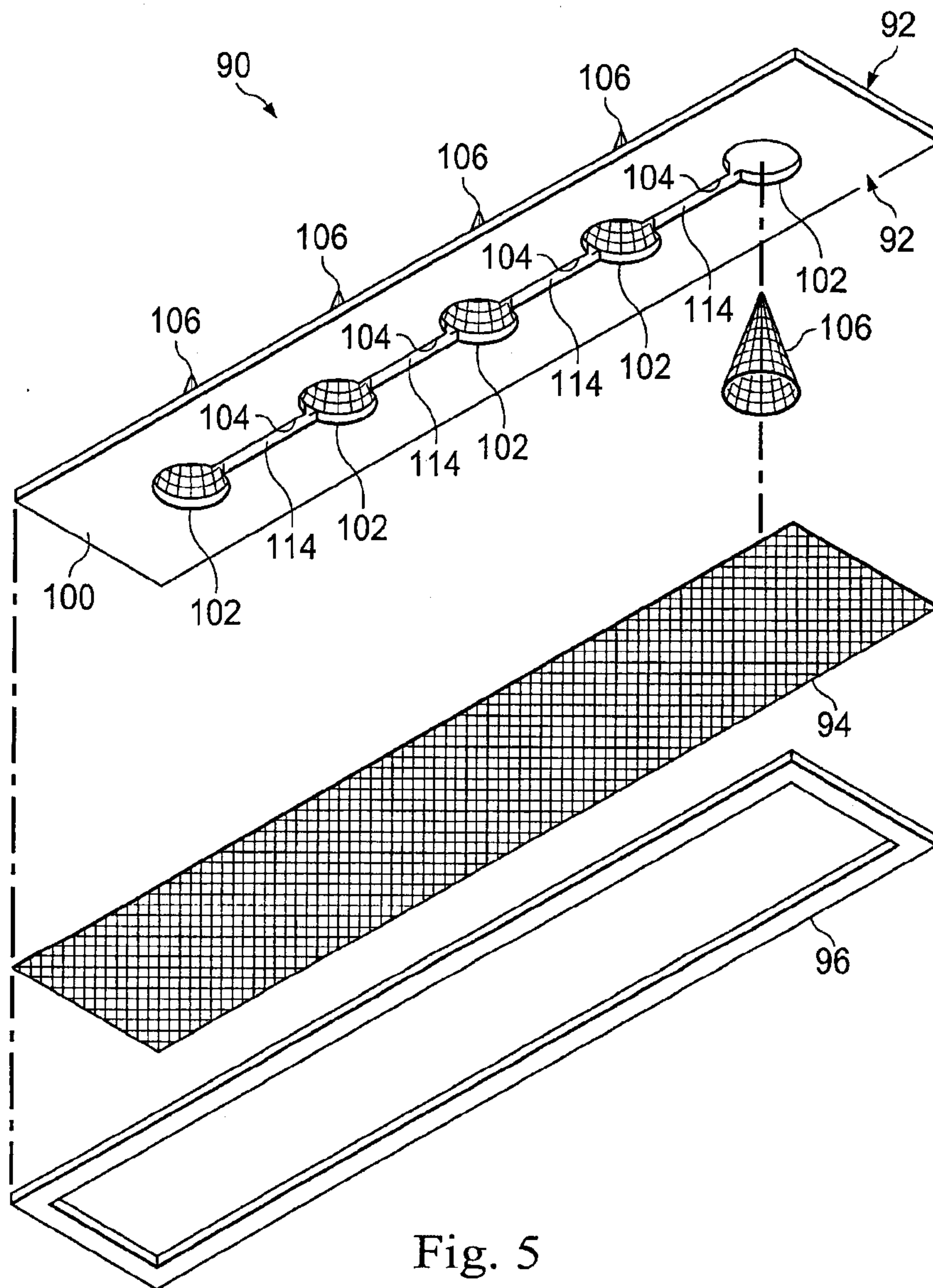


Fig. 5

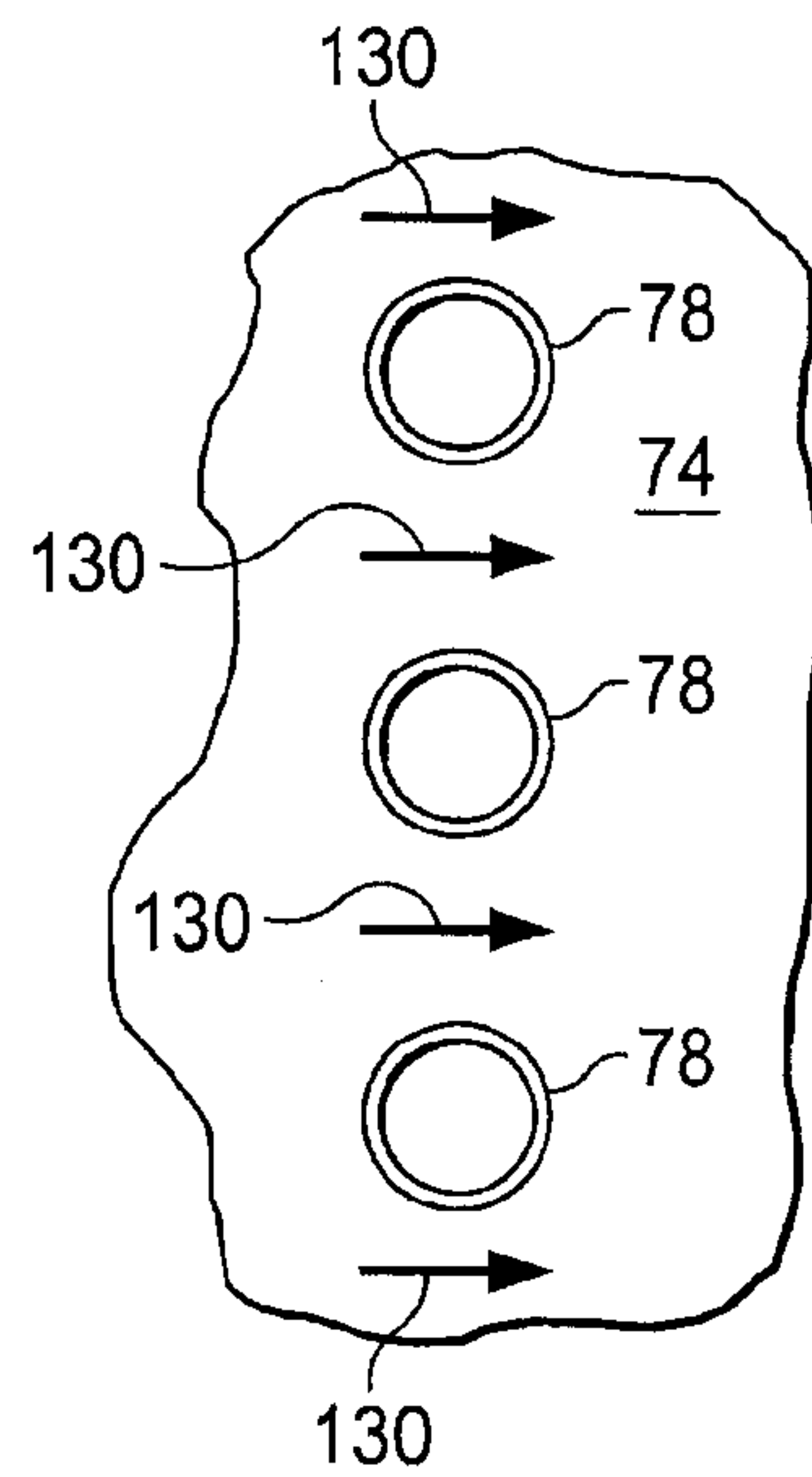


Fig. 7

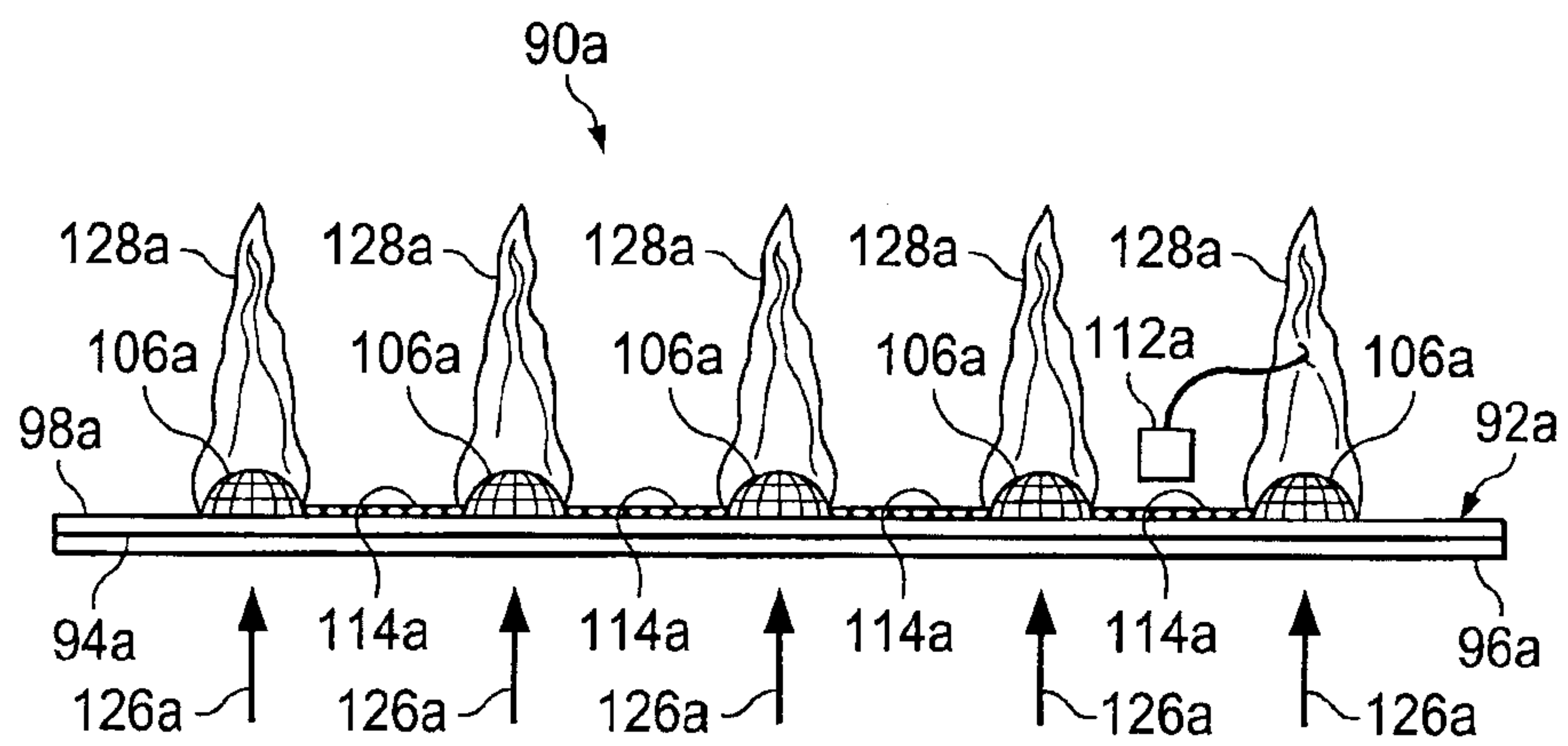


Fig. 8

