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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
07 March 2024 (07.03.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/049865 A1

(51) International Patent Classification:
F24C 1/12 (2021.01) *F24H 9/02* (2006.01)
F23D 14/12 (2006.01)

(21) International Application Number:
PCT/US2023/031479

(22) International Filing Date:
30 August 2023 (30.08.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/402,530 31 August 2022 (31.08.2022) US

(71) Applicant: **ZHEJIANG YOTRIO GROUP CO., LTD.** [CN/CN]; No. 1 Qianjiang South Road, Linhai, Zhejiang (CN).

(72) Inventor; and
(71) Applicant *(for MW only)*: **GARRISON, Scott Adam** [US/US]; 5708 Niagara Court, Fitchburg, Wisconsin 53575 (US).

(74) Agent: **DOUGLAS D. ZHANG**; Ziegler IP Law Group, LLC, 3135 Easton Turnpike, SHU i-Hub, W-256, Fairfield, Connecticut 06825 (US).

(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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, 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, ME, 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))*

WO 2024/049865 A1

(54) **Title:** HEAT SHIELD AND HEAT SHIELD KIT FOR A PATIO HEATER

(57) **Abstract:** A heat shield for a patio heater, includes a central hub having a main piece and connector engagement members on the main piece. The heat shield further includes reflector panels disposed side by side, and connectors. Each of the reflector panels has an inner peripheral edge, an outer peripheral edge, two spaced-apart lateral edges each extending from the inner peripheral edge to the outer peripheral edge, and a first engagement profile on each of the lateral edges. Each of the connectors has an inner end, an outer end, and a length, and defines a second engagement profile that extends along the length and is configured to engage respective first engagement profiles of two adjacent reflector panels of the reflector panels to join the two adjacent reflector panels together with the inner end engaging a respective connector engagement member on the main piece.

HEAT SHIELD AND HEAT SHIELD KIT FOR A PATIO HEATER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 63/402,530 filed on 31 August 2022, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates generally to outdoor heaters. More particularly, the present disclosure relates to a heat shield and a heat shield kit for a patio heater.

BACKGROUND

Patio heaters are popular and useful devices for outdoor settings. They have various designs and shapes and use various energy sources. For example, some patio heaters use electricity as an energy source. Other patio heaters use propone or natural gas as an energy source. FIG. 1 shows a conventional gas patio heater in a preassembled stage, the main components of which are known in the art and clearly illustrated in FIG. 1.

More specifically, as shown in FIG. 1, the conventional gas patio heater includes a base 30, a wheel assembly 31 to be mounted on the base 30, three post supports 32 to be mounted on the base 30, a lower post 33 to be mounted on the top of the post supports 32, an upper post 34 to be mounted on the top of the lower post 33, a tank housing 40 to be supported by the base 30 for covering a portable gas tank (not shown) sitting on the base 30, a head assembly 41 to be mounted on the top of the upper post 34, a heat shield 42 to be mounted on the top of the head assembly 41, and a gas hose 43 for supply gas from the gas tank to the head assembly 41. The

gas hose 43 has a regulator 44 at one end thereof for regulating the gas flow from the gas tank to the head assembly 41. As is known in the art, the heat shield 42, which is typically made of steel or aluminum, functions to reflect the heat generated by the head assembly 41 toward a user or users positioned near the gas patio heater. To accomplish this task, it is necessary for the edge of the heat shield 42 to extend well beyond the head assembly 41.

Conventional gas patio heaters are most commonly made with Ready to Assemble (RTA) or Knock Down (KD) construction in order to maximize the number of products that can fit on a shipping container. This necessity presents a problem in that the heat shield would be larger than the patio heater box if it were made as one piece. The common solution to this problem is to make the heat shield RTA/KD construction as well, as multiple smaller pieces allow the heat shield to fit into the same smaller box as the RTA/KD patio heater. RTA/KD heat shields are common in the market these days. Almost exclusively the most common method for RTA/KD heat shield construction uses a combination of a central hub, several reflector panels, and several screws and nuts for assembling.

Although making the heat shield in multiple smaller pieces is a solution for shipping purposes, it creates a new problem in that an end user has to assemble the multiple smaller pieces. This process takes time and can be quite frustrating for the end user. The reason this process is time-consuming and frustrating is due to the manner in which the RTA/KD heat shield assembles.

FIG. 2A illustrates the RTA/KD heat shield of FIG. 1 in a preassembled stage. More specifically, as shown in FIG. 2A, there are one central hub and four reflector panels. The central hub has six holes on its peripheral edge. Each reflector panel has five holes with two holes on each of its lateral edges. As shown in FIG. 2B, an end user needs to overlap one lateral

edge of a reflector panel with a respective lateral edge of another reflector panel, align the respective holes, and put a screw in the outer holes, and then loosely attach a nut to the screw. The end user needs to repeat these steps until all four reflector panels are loosely connected to each other. The end user then needs to put the central hub on top of the loosely connected four reflector panels, align the six holes on the central hub with respective six holes of the reflector panels, insert screws in these holes, and then attach nuts to these screws. Finally, the end user needs to fully tighten all screws and nuts. This process requires at least twelve screws and twelve nuts. In addition, this process is time consuming and can be quite frustrating for the end user.

SUMMARY

As described herein, the exemplary embodiments of the present disclosure overcome one or more of the above or other disadvantages known in the art.

One aspect of the exemplary embodiments relates to a heat shield for a patio heater. The heat shield comprises a central hub comprising a main piece and connector engagement members on the main piece; reflector panels disposed side by side, each of the reflector panels comprising an inner peripheral edge, an outer peripheral edge, two spaced-apart lateral edges each extending from the inner peripheral edge to the outer peripheral edge, and a first engagement profile on each of the lateral edges; and connectors each comprising an inner end, an outer end, and a length, and defining a second engagement profile that extends along the length and is configured to engage respective first engagement profiles of two adjacent reflector panels of the reflector panels to join the two adjacent reflector panels together with the inner end engaging a respective connector engagement member on the main piece.

Another aspect of the exemplary embodiments relates to a heat shield kit for a patio heater. The heat shield kit comprises a central hub comprising a main piece and a plurality of connector engagement members mounted on the main piece; a plurality of reflector panels, each of the reflector panels comprising an inner peripheral edge, an outer peripheral edge, two spaced-apart lateral edges each extending from the inner peripheral edge to the outer peripheral edge, and a first engagement profile on each of the lateral edges; and a plurality of connectors, each of the connectors comprising an inner end, an outer end, and a length, and defining a second engagement profile that extends along the length and is configured to engage respective first engagement profiles of two reflector panels of the plurality of reflector panels when the two reflector panels are disposed side by side to join the two reflector panels together with the inner end engaging a respective connector engagement member on the main piece.

These and other aspects and advantages of the exemplary embodiments will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for the purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. Moreover, the drawings are not necessarily drawn to scale and unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described therein. In addition, any suitable size, shape or type of elements or materials could be used.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows a conventional gas patio heater in a preassembled stage;

FIG. 2A show the conventional heat shield of FIG. 1 in assembling stage;

FIG. 2B shows how two reflector panels of FIG. 2A are connected to each other;

FIGs. 3 and 4 show an exemplary embodiment of the heat shield in accordance with the present disclosure; FIG. 3 is a top, perspective view and FIG. 4 is a bottom, perspective view;

FIG. 5 shows the main components of the exemplary embodiment of FIGs. 3 and 4 in a preassembled stage;

FIG. 6 is an enlarged cross-section view along line A-A in FIG. 3;

FIG. 7 shows another embodiment of the connector engagement member; and

FIG. 8 shows a patio heater kit that includes a heat shield kit in accordance with the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

FIGs. 3-5 show an exemplary embodiment of the heat shield in accordance with the present disclosure. In particular, the heat shield 52 includes a central hub 53, four reflector panels 70, and four connectors 90.

The central hub 53 includes a round main piece 54, which has a top surface 55, a bottom surface 56 opposite to the top surface 55, and a peripheral edge 60. The central hub 53 also includes a rim 61 that extends downward and optionally, slightly outward from the peripheral edge 60. Optionally a flange 61a is provided on the rim 61. In addition, the rim 61 (along with the flange 61a when one is provided) has four spaced apart openings 62 that are sized or configured to receive the respective connectors 90. In addition, the central hub 53 has four connector engagement members 63, which are evenly distributed on the bottom surface 56 of the main piece 54 and radially aligned with the respective openings 62 on the rim 61. In one

embodiment, each connector engagement member 63 includes a tab 63a that is attached to the bottom surface 56 of the main piece 54 by fasteners 64 such as two screws and two nuts. The tabs 63a could be attached to the main piece 54 by just one fastener or by other means such as adhesive or weld. Alternatively, the tabs 63 could be made a part of the main piece 54 as one-piece component.

As shown in FIG. 3, the main piece 54 has a flat center piece 54a and a slated side piece 54b that extends outward and downward from the center piece 54a. The side piece 54b has three apertures 57 for mounting the central hub 53 to a head assembly of a patio heater. In addition, the side piece 54b has four apertures that are disposed between and radially aligned with the respective openings 62 and the connector engagement members 63 for receive fasteners such as screws 100. Moreover, the side piece 54b has holes for receiving the screws for the tabs 63a.

Each reflector panel 70 includes an inner peripheral edge 71, an outer peripheral edge 72, two spaced-apart lateral edges 73 each extending from the inner peripheral edge 71 to the outer peripheral edge 72, and a first engagement profile 74 on each of the lateral edges 73. Each reflector panel 70 slants from its inner peripheral edge 71 toward its outer peripheral edge 72. And when connected to each other side by side, the reflector panels 70 form an annular ring. In this embodiment, each reflector panel 70 forms a quarter-annular ring of the same size, wherein the two lateral edges 73 of each reflector panel 70 define an angle of 90 degrees. In other embodiments, the two lateral edges of some of the reflector panels 70 define an angle of more than 90 degrees while the two lateral edges of the other reflector panels define an angle of less than 90 degrees, as long as the total of the angles of these reflector panels 70 is 360 degrees. Moreover, in some embodiments, the number of the reflector panels could be 2, 3, 5, for example, as long as they collectively form an annular ring when they are connected to each other

side by side. And the number of the connector engagement members 63/the connectors 90 corresponds to the number of the reflector panels. As shown in FIGs. 3 and 4, when the reflector panels 70 are connected to each other side by side, the flange 61a of the central hub 53 sits on and covers the inner peripheral edges 71 of the reflector panels 70.

As shown in FIG. 5, each first engagement profile 74 includes a generally L-shaped first engagement member 75. The first engagement member 75 includes a first section 75a extending upward from the respective lateral edge 73, a second section 75b extending outward from the upper edge of the first section 75a in a direction toward the other lateral edge 73 of the same reflector panel 70, and a curved tip section 75c that extends outward and downward from the outer edge of the second section 75b.

Moreover, optionally, each reflector panel 70 further includes a rim 76 that extends along the outer peripheral edge 72. The rim 76 stops at a distance from each curved tip section 75c of the first engagement member 75 so that the rim 76 will not negatively affect the operation of a respective connector 90. This rim 76 enhances the structural strength and stability of the rest of the reflector panel 70 and at the same time provides a smooth edge to protect the end user.

Each connector 90 is elongated and includes an inner end 91, an outer end 92, and a length LL. The inner end 91 is configured to engage a respective connector engagement member 63 on the main piece 54 of the central hub 53. In addition, each connector 90 defines a second engagement profile 93 that extends along the length LL and is configured to engage respective first engagement profiles 74 of two adjacent reflector panels 70. More specifically, as shown in FIG. 6, the second engagement profile 93 includes a generally T-shaped engagement channel 94, which is defined by a top section 95 and two side sections 96 of the second engagement profile 93. The two side sections 96 extend generally downward and then inward. The lower edges 96a

of the two side sections 96 are disposed spaced apart from each other to define a slit or opening 97 therebetween. The top section 95 of the reflector panel 70 has a slot (now shown) near the inner end 91 and the slot is aligned with the respective aperture on the side piece 54b to receive the screw 100, which together with a nut 101 can fixedly connect the reflector panel 70 to the central hub 53. Optionally, the slot is elongated in the direction of the length LL of the connector 90.

As should be apparent from a review of FIGs. 3-5, the slit 97 is sized to receive the first sections 75a of the respective first engagement members 75 of two adjacent reflector panels 70. And the generally T-shaped engagement channel 94 is sized and/or configured to receive the respective first engagement members 75 of the two adjacent reflector panels 70 therein to join the two adjacent reflector panels 70 together. In addition, the generally T-shaped engagement channel 94 is sized and/or configured to receive a respective tab 63a on the main piece 54 of the central hub 53.

A stop 98 is optionally provided at the outer end 92 of each connector 90 for engaging the outer peripheral edges 72 of two adjacent reflector panels 70.

Referring to FIG. 7, in other embodiments, each connector engagement member 63 includes a receiver 63b that is attached to the bottom surface 56 of the main piece 54 of the central hub 53 and configured to receive the inner end 91 of the respective connector 90. The receiver 63b includes an inner end 103, an outer end 104, and defines a receiving channel 105 that has a cross section that diminishes in a direction from the outer end 104 toward the inner end 103. Such a receiving channel 10 makes it easier to align and receive the inner end 91 of the respective connector 90.

When assembling a heat shield 52, in one example, a user puts two reflector panels 70 side by side, uses a connector 90 to engage the respective first engagement members 75 of the two reflector panels 70 and then slides the connector 90 toward the central hub 53 until its inner end 91 receives a respective tab 63a on the main piece 54 of the central hub 53 and its stop 98 engages the outer peripheral edges 72 of the two reflector panels 70. The user then uses a fastener such as a combination of a screw and a nut to fixedly connect the connector 90 to the central hub 53. The user repeats this process until all the reflector panels 70 and the central hub 53 are connected to each other to form a heat shield. At most, only four screws and four nuts are needed to assemble the heat shield 52, which greatly simplifies the assembling process and saves time compared with the prior art.

FIG. 8 shows an embodiment of a patio heater kit 110 that includes an assembled heat shield kit in accordance with the present disclosure.

Thus, while there have been shown, described, and pointed out fundamental novel features of the invention as applied to the exemplary embodiments thereof, it will be understood that various omissions and substitutions and changes in the form and details of devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, the engagement member 75 needs not to be continuous; it could include separated sections along the respective lateral edge 73. Similarly, the two side sections 96 of the connector 90 need not to be continuous; they could include separated sections along the length LL of the connector 90. Moreover, the central hub 53 could be in a different shape such as a square when viewed from the top, and the reflector panels can form a kind of pyramid frustum structure.

Furthermore, it is expressly intended that all combinations of those elements and/or method steps, which perform substantially the same function in substantially the same way to achieve the same results, are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiments as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

CLAIMS

What is claimed is:

1. A heat shield for a patio heater, comprising:

a central hub comprising a main piece and connector engagement members on the main piece;

reflector panels disposed side by side, each of the reflector panels comprising an inner peripheral edge, an outer peripheral edge, two spaced-apart lateral edges each extending from the inner peripheral edge to the outer peripheral edge, and a first engagement profile on each of the lateral edges; and

connectors each comprising an inner end, an outer end, and a length, and defining a second engagement profile that extends along the length and is configured to engage respective first engagement profiles of two adjacent reflector panels of the reflector panels to join the two adjacent reflector panels together with the inner end engaging a respective connector engagement member on the main piece.

2. The heat shield of claim 1, wherein each of the connectors further comprises a stop at the outer end to engage the outer peripheral edges of the two adjacent reflector panels.

3. The heat shield of any one of claims 1 and 2, wherein the first engagement profile comprises a generally L-shaped first engagement member comprising a first section extending outward from the lateral edge, and wherein the second engagement profile comprises a generally T-shaped engagement channel with a slit at a bottom of the engagement channel that extends

along the length, the slit be sized to receive the first sections of the respective first engagement members of the two adjacent reflector panels.

4. The heat shield of any one of claims 1-3, wherein the reflector panels form an annular ring.

5. The heat shield of claim 4, wherein each of the reflector panels forms a quarter-annular ring.

6. The heat shield of claim 4, wherein the main piece is round and comprises a top surface, a bottom surface and a peripheral edge, wherein the connector engagement members are on the bottom surface of the main piece, wherein the central hub further comprises a rim that extends downward from the peripheral edge of the main piece and covers the inner peripheral edges of the reflector panels, the rim having openings that are radially aligned with respective connector engagement members for receiving the inner ends of the respective connectors.

7. The heat shield of any one of claims 1-6, wherein each of the connector engagement members comprises a tab configured to be received by the inner end of a respective connector.

8. The heat shield of any one of claims 1-6, wherein each of the connector engagement members comprises a receiver configured to receive the inner end of a respective connector.

9. The heat shield of claim 8, wherein the receiver comprises a second inner end, a second outer end, and a receiving channel having a cross section that diminishes in a direction from the second outer end toward the second inner end.

10. The heat shield of any one of claims 1-9, wherein each of the connectors is fixedly connected to the main piece of the central hub by a fastener.

11. A heat shield kit for a patio heater, comprising:

a central hub comprising a main piece and a plurality of connector engagement members mounted on the main piece;

a plurality of reflector panels, each of the reflector panels comprising an inner peripheral edge, an outer peripheral edge, two spaced-apart lateral edges each extending from the inner peripheral edge to the outer peripheral edge, and a first engagement profile on each of the lateral edges; and

a plurality of connectors, each of the connectors comprising an inner end, an outer end, and a length, and defining a second engagement profile that extends along the length and is configured to engage respective first engagement profiles of two reflector panels of the plurality of reflector panels when the two reflector panels are disposed side by side to join the two reflector panels together with the inner end engaging a respective connector engagement member on the main piece.

12. The heat shield kit of claim 11, wherein each of the connectors further comprises a stop at the outer end to engage the outer peripheral edges of the two reflector panels.

13. The heat shield of any one of claims 11 and 12, wherein the first engagement profile comprises a generally L-shaped first engagement member comprising a first section extending outward from the lateral edge, and wherein the second engagement profile comprises a generally T-shaped engagement channel with a slit at a bottom of the engagement channel that extends along the length, the slit be sized to receive the first sections of the respective first engagement members of the two adjacent reflector panels.

14. The heat shield kit of any one of claims 11-13, wherein the reflector panels form an annular ring when connected to each other by the connectors in a side by side manner.

15. The heat shield kit of claim 14, wherein each of the reflector panels forms a quarter-annular ring.

16. The heat shield of claim 14, wherein the main piece is round and comprises a top surface, a bottom surface and a peripheral edge, wherein the connector engagement members are on the bottom surface of the main piece, and wherein the central hub further comprises a rim that extends downward from the peripheral edge of the main piece and covers the inner peripheral edges of the reflector panels, the rim having openings that are radially aligned with respective connector engagement members for receiving the inner ends of the respective connectors.

17. The heat shield kit of any one of claims 11-16, wherein each of the connector engagement members comprises a tab configured to be received by the inner end of a respective connector.

18. The heat shield kit of any one of claims 11-16, wherein each of the connector engagement members comprises a receiver configured to receive the inner end of a respective connector.

19. The heat shield kit of any one of claims 11-18, further comprising a plurality of fasteners for fixedly connecting the connectors to the main piece of the central hub.

20. A patio heater kit comprising a heat shield kit of any one of claims 11-19.

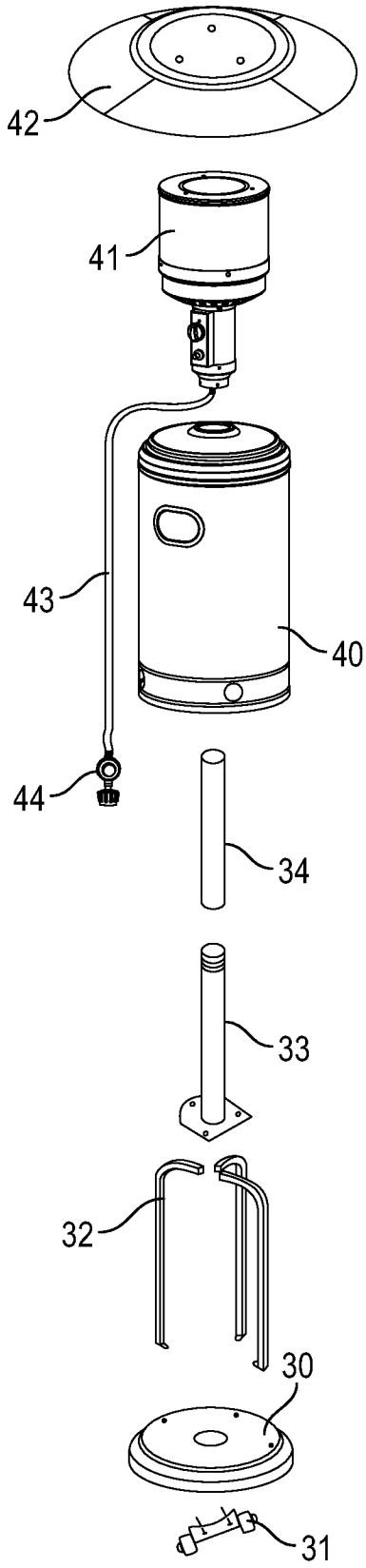

FIG. 1

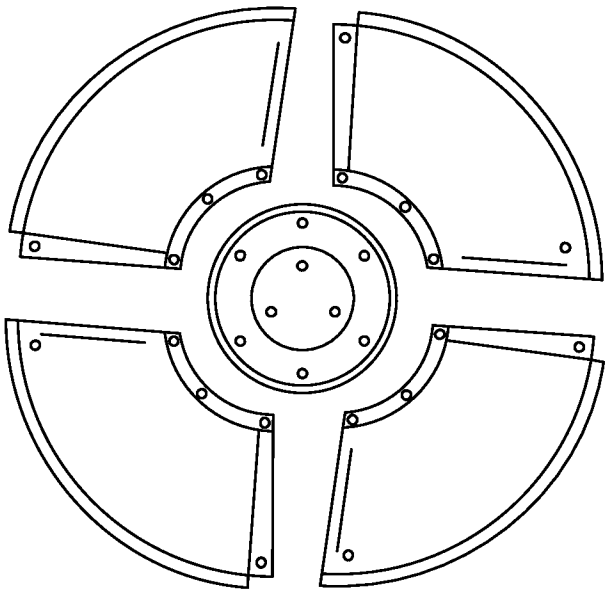

FIG. 2A

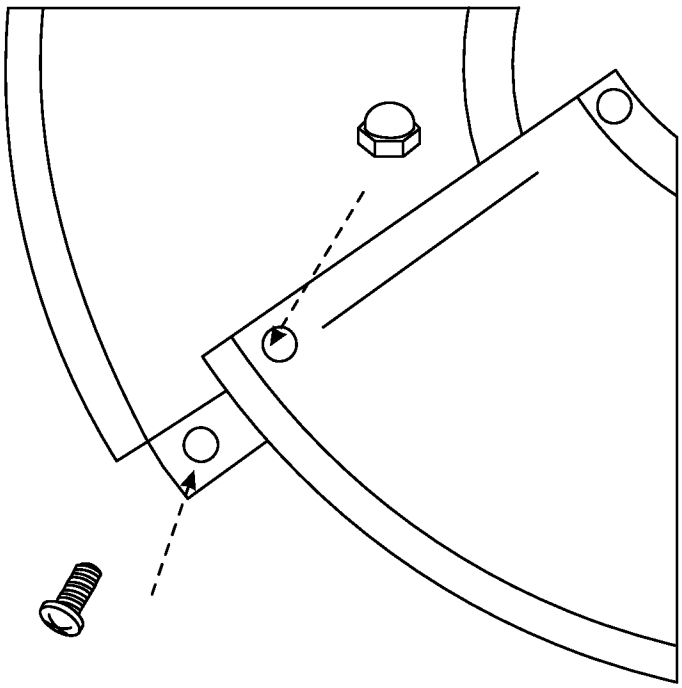

FIG. 2B

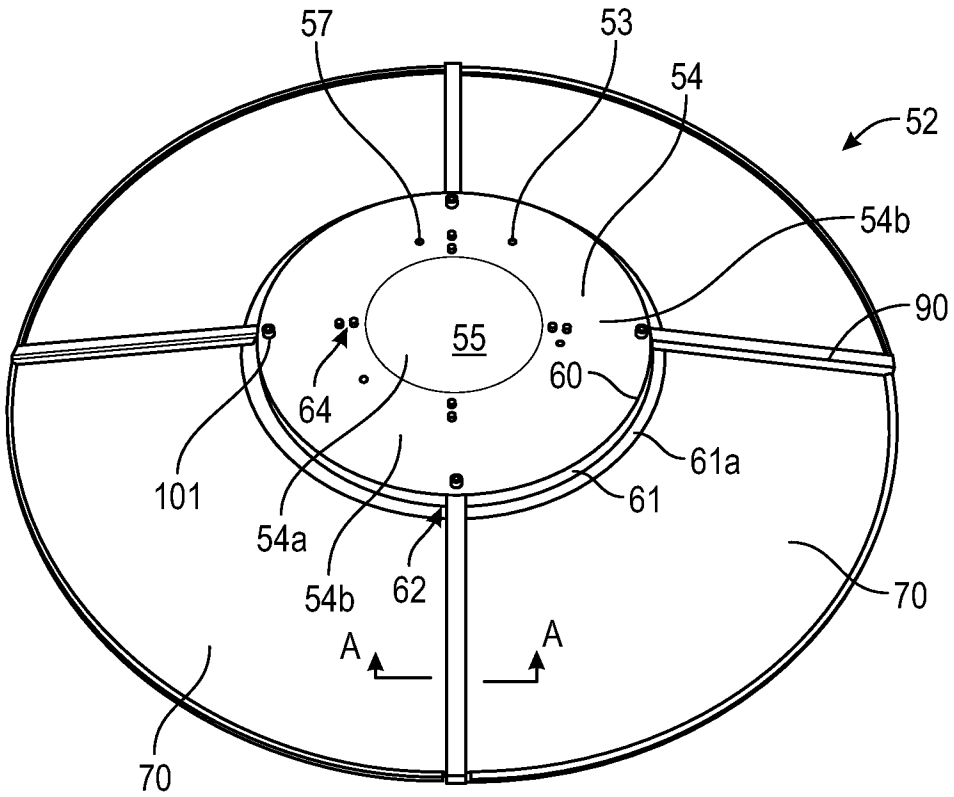

FIG. 3

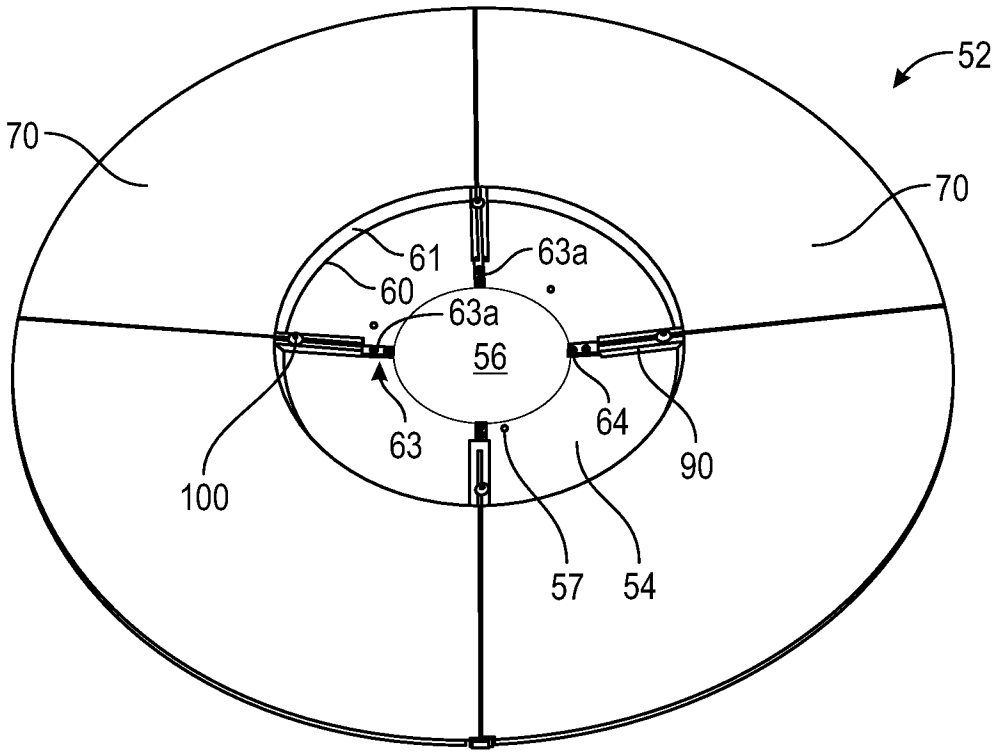

FIG. 4

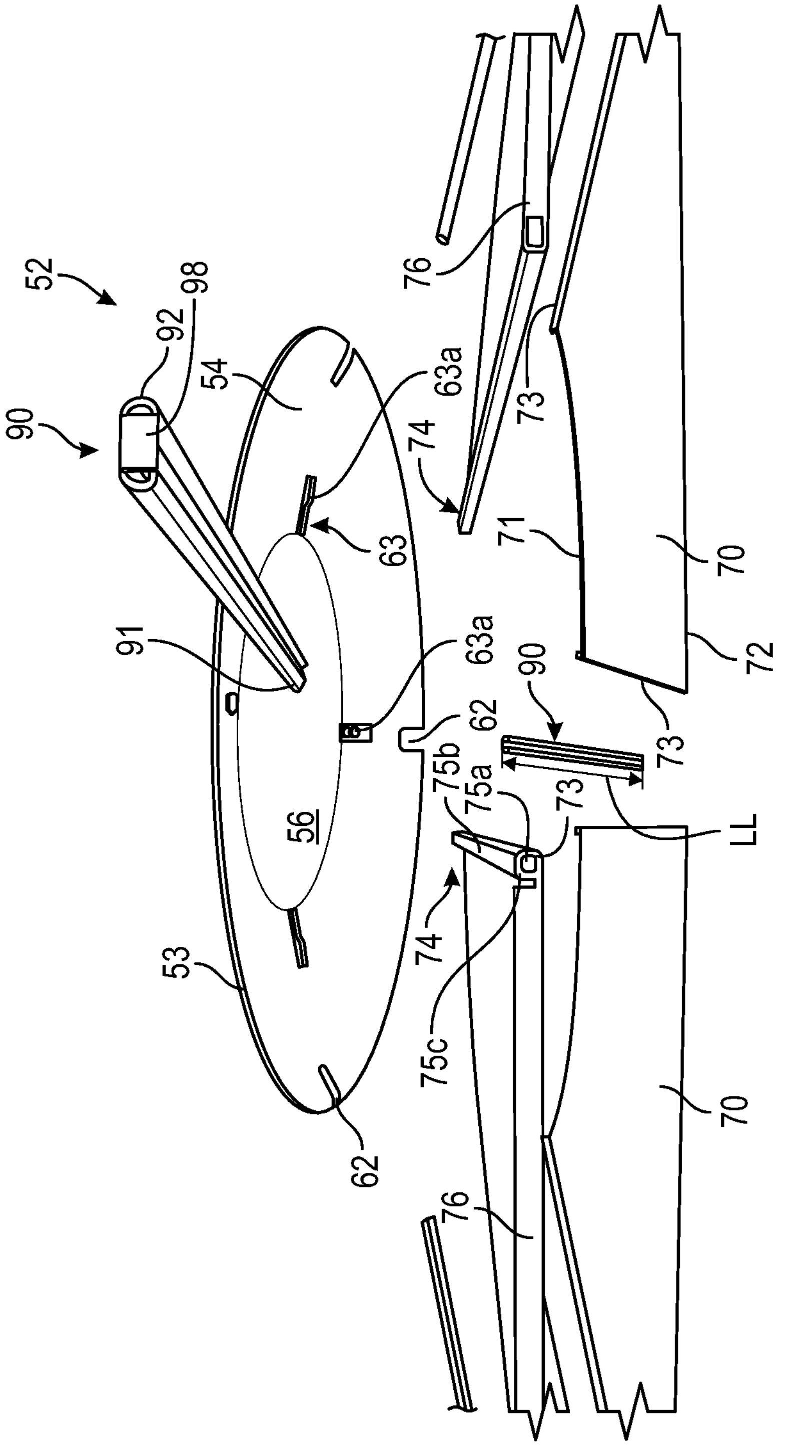
52
90
92
98
54
63a
76
73
74
63
71
70
91
63a
62
72
90
73
75b
75a
73
56
LL
53
74
75c
62
70
76

FIG. 5

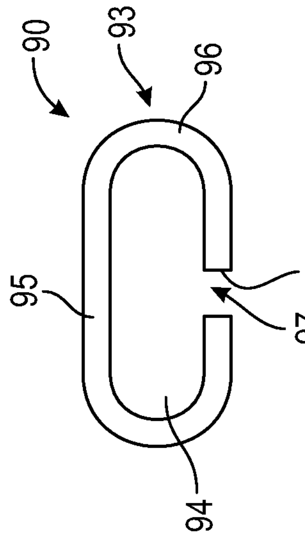
90
93
96
95
96a
97
94

FIG. 6

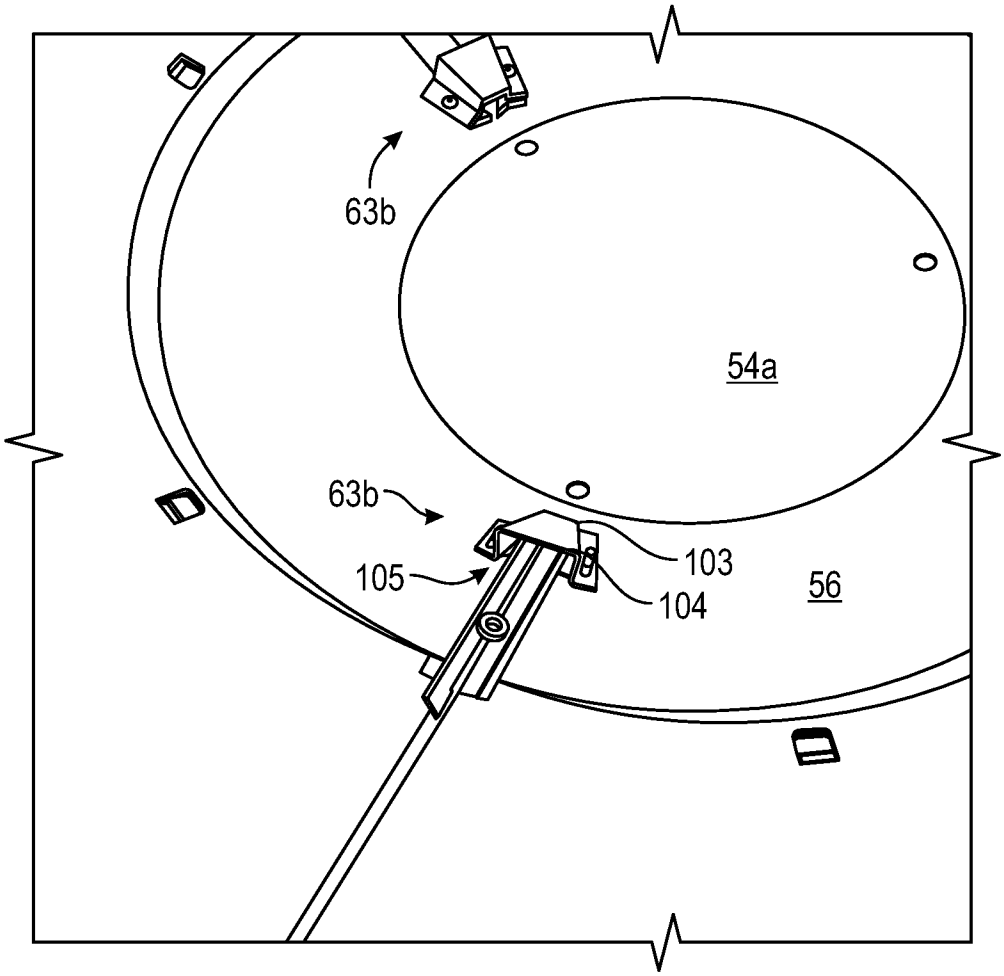

FIG. 7

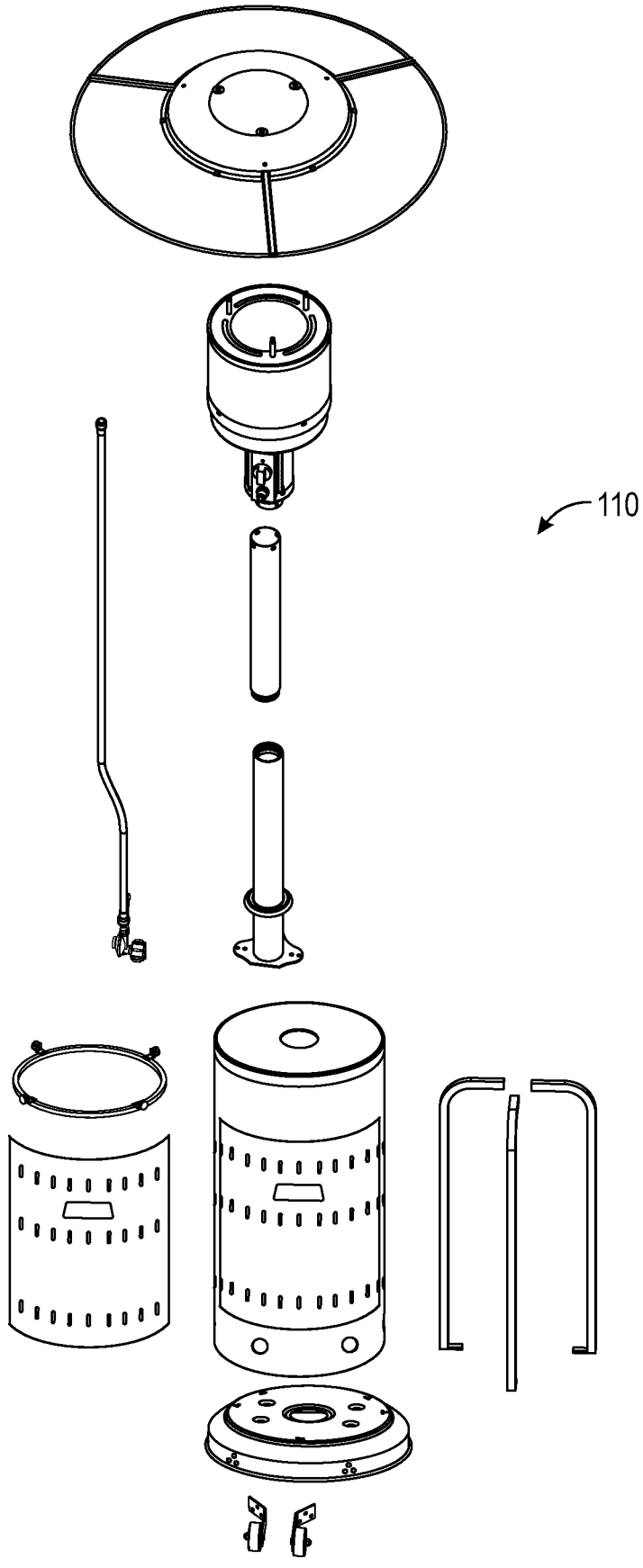

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 23/31479

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. F24C 1/12 (2023.01)
ADD. F23D 14/12, F24H 9/02 (2023.01)

CPC - INV. F24C 1/12

ADD. F23D 14/12, F24H 9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2003/0029438 A1 (BOSSLER) 13 February 2003 (13.02.2003) entire document, especially para [0030], [0026]	1, 3/(1), 11, 13/(11) --- 2, 3/(2), 12, 13/(12)
Y	US 2002/0023636 A1 (ASHTON ET AL.) 28 February 2002 (28.02.2002) entire document, especially para [0086], [0025]	2, 3/(2), 12, 13/(12)
A	US 2020/0386412 A1 (P.R.E. SALES INC.) 10 December 2020 (10.12.2020) entire document	1-3, 11-13
A	US 2011/0067694 A1 (BECHTOLD) 24 March 2011 (24.03.2011) entire document	1-3, 11-13

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2023 (28.11.2023)	JAN 26 2024
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 23/31479

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-10, 14-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.