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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
08 October 2020 (08.10.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/204979 A1

(51) International Patent Classification:
F04D 25/08 (2006.01) *F04D 29/34* (2006.01)

(21) International Application Number:
PCT/US2019/038203

(22) International Filing Date:
20 June 2019 (20.06.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
16/376,925 05 April 2019 (05.04.2019) US

(71) Applicant: **RITE-HITE HOLDING CORPORATION** [US/US]; 8900 North Arbon Drive, Milwaukee, Wisconsin 53223 (US).

(72) Inventors: **WIEGEL, Aaron J.**; 4835 Bennett Road, Benton, Wisconsin 53803 (US). **SWIFT, David**; 1777 Old Mill Road, Dubuque, Iowa 52003 (US). **DONDLINGER, Jason**; 33779 125th Street, Bellevue, Iowa 52031 (US). **PARUCH, Lucas I.**; 15183 Lore Oaks Ct, Dubuque, Iowa 52002 (US). **SNYDER, Ronald P.**; 13264 West Clay Drive, Dubuque, Iowa 52002 (US).

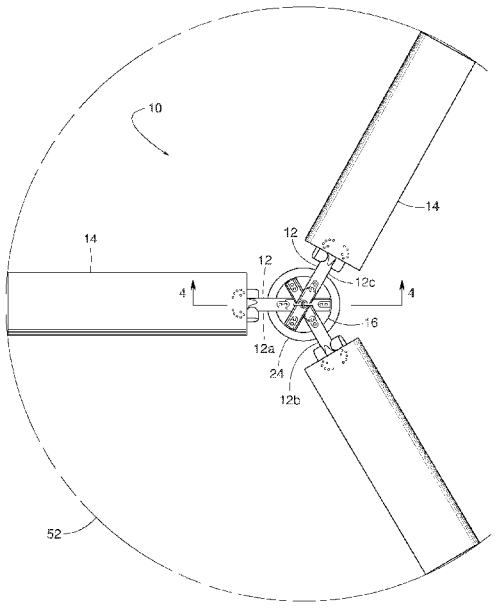
(74) Agent: **SALMON, Scott D.**; Hanley, Flight & Zimmerman, LLC, 150 S. Wacker Drive, Suite 2200, Chicago, Illinois 60606 (US).

(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, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, 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).

(54) Title: FAN BLADE MOUNTING STRUCTURES AND ARRANGEMENTS

FIG. 1



(57) Abstract: Example axial fans (10) (overhead fans) include a set of radially extending spokes (12a, 12b, 12c) that connect a set of fan blades (14) to a motor-driven hub (16). Each spoke has at least one notch (56, 68, 70), so the spokes can be assembled in interlocking relationship with each other, such that the spokes extend at different rotational angles from the rotational axis of the hub but lie in substantially the same horizontal plane. Such an arrangement enables the spokes to support the cantilevered weight and other vertical loads exerted by the fan blades while providing a compact assembly. In some examples, a retainer (88) extends through aligned bores of several components of the fan along the axis of rotation.

WO 2020/204979 A1

[Continued on next page]

Published:
— *with international search report (Art. 21(3))*

FAN BLADE MOUNTING STRUCTURES AND ARRANGEMENTS

FIELD OF THE DISCLOSURE

[0001] This disclosure relates generally to axial fans, and more particularly to the structure and arrangement of components connecting fan blades to a hub of the fan.

BACKGROUND

[0002] Axial fans rotate a series of fan blades around an axis to generate airflow in a direction generally parallel to the rotational axis. Some axial fans have a series of radially extending spokes connecting the fan blades to a hub driven by an electric motor.

[0003] To reduce stratification or circulate air within a space (e.g., a room), axial fans can be mounted to or suspended from an elevated structure, such as a ceiling, a roof joist, a truss, or an overhead beam. In such a mounting arrangement, an axial fan can be referred to as an overhead fan or a ceiling fan.

[0004] Overhead fans intended for use in large spaces typically have relatively long fan blades to cover a broad area of the space or room. With long fan blades (i.e., a larger diameter), an overhead fan can provide adequate air circulation while rotating slower than other fans with shorter blades (i.e., smaller diameter), and consequently may be generally referred to as high volume low speed (or HVLS) fans. Rotating slower can reduce fan-generated noise and avoid creating significant or isolated drafts within a room.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a bottom view of an example overhead fan constructed in accordance with the teachings disclosed herein.

[0006] FIG. 2 is a side view of FIG. 1.

[0007] FIG. 3 is close-up bottom view of a central portion of FIG. 1 with the outlines of two of the three fan blades shown in phantom lines.

[0008] FIG. 4 is a cross-sectional view taken along line 4-4 of FIG. 1, but with the fan blades omitted.

[0009] FIG. 5 is a partially exploded side view of the example overhead fan shown in FIGS. 1 – 4.

[0010] FIG. 6 is a top view of an example upper spoke constructed in accordance with the teachings disclosed herein.

[0011] FIG. 7 is a side view of FIG. 6.

[0012] FIG. 8 is a bottom view of FIG. 7.

[0013] FIG. 9 is a top view of an example middle spoke constructed in accordance with the teachings disclosed herein.

[0014] FIG. 10 is a side view of FIG. 9.

[0015] FIG. 11 is a bottom view of FIG. 10.

[0016] FIG. 12 is a top view of an example lower spoke constructed in accordance with the teachings disclosed herein.

[0017] FIG. 13 is a side view of FIG. 12.

[0018] FIG. 14 is a bottom view of FIG. 13.

[0019] FIG. 15 is a bottom view similar to FIG. 3 but showing another example overhead fan constructed in accordance with the teachings disclosed herein.

DETAILED DESCRIPTION

[0020] FIGS. 1 – 5 show various views of an example overhead fan 10 with one or more spokes 12 (e.g., upper spoke 12a, middle spoke 12b, lower spoke 12c, a first spoke, a second spoke, a third spoke, etc.) for connecting at least one fan blade 14 (e.g., a first fan blade, a second fan blade, etc.) to a rotatable hub 16. The term, "overhead fan" refers to an axial fan to be hung from an elevated structure 18 such as a ceiling, a roof joist, a truss, an overhead beam, etc., wherein the hub 16, spokes 12, and blades 14 rotate about a generally vertically-oriented rotational axis 20.

[0021] In the illustrated example of FIGS. 1 – 5, fan 10 includes an optional pole (or drop tube) 22 mounted to elevated structure (e.g., a building ceiling) 18, a motor housing 24 attached to pole 22, hub 16 rotatably coupled to housing 24, spokes 12a-c attached to hub 16, and a fan blade 14 attached to each of spokes 12a-c.

[0022] In some examples, fasteners (e.g., bolts and nuts) 26 and/or a friction fit securely couple fan blade 14 to spoke 12. As shown in the illustrated examples, the connection portion of each fan blade 14 and spoke 12 is configured such that when assembled and mounted, the spoke 12 remains connected to and bears the weight of the fan blade 14. Accordingly, in the event that fastener 26 fails, the blade 14 will not disconnect from the fan 10. In some examples of fan 10, fasteners (e.g., screws) 28 on opposite sides of rotational axis 20 securely couple spokes 12a-c to hub 16, fasteners (e.g., bolts and nuts) 30 securely couple housing 24 to pole 22, and fasteners (e.g., screws) 32 securely couple pole 22 to elevated structure 18. Fasteners 26, 28, 30, and 32 are schematically illustrated to represent any type of suitable fastener for securing the components together.

[0023] In the illustrated example, a bearing 34 couples hub 16 to housing 24 for rotational relative movement. A ring nut 36 and a stationary hollow shaft 38 couple an inner race 40 of bearing 34 to housing 24, while a clamp ring 42 couples an outer race 44 of bearing 34 to hub 16. In some examples, bearing 34 is a duplex tapered roller bearing providing hub 16 with axial and radial support and ensuring smooth rotation of hub 16 with respect to the stationary portion of fan 10 (e.g., housing 24) about axis 20.

[0024] In some examples, hub 16 is rotated by a permanent magnet brushless motor 45 to achieve desirable torque/speed characteristics without the need for a gearbox. Some gearboxes can be noisy, drip oil and require periodic servicing. Commutator brushes of brushed motors, can also be noisy and require occasional replacement. FIG. 4 shows brushless motor 45 comprising a stator 46 attached to housing 24 and a series of permanent magnets 48 attached to hub 16. An electronically timed electromagnetic field

between stator 46 and magnets 48 rotates hub 16, and thus also rotates spokes 12 and fan blades 14.

[0025] As shown in the illustrated example, when assembled and mounted, fan blades 14 are supported in a cantilevered manner and apply a significant vertical load and rotational moment on spokes 12. To ensure spokes 12 support the load of blades 14, some examples of spokes 12 are positioned such that they extend in a radial direction 50 across the fan's rotational axis 20 and are secured on both sides of the axis. Each spoke 12 can have at least one inboard fastener 28a and at least one outboard fastener 28b on opposite sides of rotational axis 20 for securing each spoke 12 to hub 16. In some examples, spoke 12 extends across the entire or most of the diameter of the hub 16, and is secured on either side (for example with inboard and outboard fasteners 28a, 28b) at or immediately adjacent to the periphery (bottom surface) of the hub 16.

[0026] To avoid irregular airflow patterns that could generate vibration and noise, fan blades 14 are mounted so as to share a common path of rotation 52, whereby one fan blade 14 follows in substantially the same path as every other fan blade 14. The term, "path of rotation" refers to the swept area in space through which fan blades 14 travel. Examples in which fan blades 14 extend straight out from hub 16 in a radial horizontal direction 54, the path of rotation 52 is generally a horizontal disc or cylindrical shape. In other examples, in which fan blades 14 are angled downward or upward, path of rotation 52 is generally a conical or frustoconical shape.

[0027] In order for a fan 10 to have fan blades 14 travel along the same path of rotation 52 while each spoke 12 extends across rotational axis 20, some examples of spokes 12 include notches (e.g., a first notch, a second notch, etc.) that allow spokes 12 to be mounted in an overlapping or nested relationship with each other. Upper spoke 12a, as shown in FIGS. 6 – 8, has a compound (bow-tie shape as viewed from below) notch 56 defined in the lower and side surfaces of the spoke 12a. FIG. 6 shows a top view of upper spoke 12a, FIG. 7 shows a side view of spoke 12a, and FIG. 8 shows a bottom view of it. Compound, downward-facing notch 56 provides space for middle

spoke 12b and lower spoke 12c to extend in different angular directions relative to upper spoke 12a across (perpendicular to) the rotational axis 20 (in a nested arrangement). In some examples, assembled (nested) spokes 12a-c also lie substantially in the same horizontal plane. In a nested arrangement, a combined height of the spokes 12a-c when assembled is less than the sum of the un-notched heights of all the spokes 12a, 12b, 12c. In some examples, fasteners 28 extend through holes 58 to connect and secure spoke 12a to hub 16 such that an upper surface 60 of spoke 12a is in contact with a lower face 62 of hub 16, and fastener 26 extends through hole 64 to secure fan blade 14 to spoke 12a.

[0028] In some examples, spokes 12a-c each have an individual shape (e.g., first shape, second shape, etc.) distinguishable from the others. Accordingly, spokes 12a-c must be assembled in one arrangement with all three spokes 12a-c interlocking as shown. In some examples, spokes 12a-c are substantially equal in length 66, which can provide balance and symmetry.

[0029] Middle spoke 12b, as shown in FIGS. 9 – 11, includes a first (diamond or parallelogram shape as viewed from above) notch 68 defined in its upper and side surfaces and a second (diamond or parallelogram shape as viewed from below) notch 70 defined in its lower and side surfaces, such that the notches (when viewed from above or below) lie at an angle (e.g., 60 degrees) from one another. FIG. 9 shows a top view of middle spoke 12b, FIG. 10 shows a side view of spoke 12b, and FIG. 11 shows a bottom view of it. Upward-facing, singular notch 68 provides space for overlapping upper spoke 12a to be nested, and downward-facing singular notch 70 provides space for overlapping lower spoke 12c to be nested, such that all three spokes lie in substantially the same horizontal plane. In some examples, fasteners 28 extend through holes 58 to connect and secure spoke 12b to hub 16 such that an upper surface 72 of spoke 12b is in contact with the lower face 62 of hub 16, and fastener 26 extends through hole 64 to secure fan blade 14 to spoke 12b.

[0030] Lower spoke 12c, as shown in FIGS. 12 – 14, has a compound (bow-tie shape as viewed from above) notch 74 defined in the upper and side

surfaces of the spoke 12c. FIG. 12 shows a top view of upper spoke 12c, FIG. 13 shows a side view of spoke 12c, and FIG. 14 shows a bottom view of it. Compound, upward-facing notch 74 provides space for middle spoke 12b and upper spoke 12a to extend in different angular directions relative to lower spoke 12c across (perpendicular to) the rotational axis 20 in a nested arrangement. In some examples, fasteners 28 extend through holes 58 to connect and secure spoke 12c to hub 16 such that an upper surface 76 of spoke 12c is in contact with the lower face 62 of hub 16, and fastener 26 extends through hole 64 to secure fan blade 14 to spoke 12c.

[0031] In some examples, when assembled, upper faces 60, 72, and 76 of spokes 12a, 12b and 12c; respectively, are substantially coplanar and in contact with the lower face 62 of the hub 16. The overlapping or nested arrangement of spokes 12 creates a plurality of overlapping interfaces 78, as shown in FIG. 4. In the illustrated example with three spokes 12, middle spoke 12b has a section 80 sandwiched between upper spoke 12a and lower spoke 12c at overlapping interfaces 78 intersected by rotational axis 20.

[0032] Also, as shown in the example of FIGS. 1 – 14, each spoke 12 may include a bore 82 (e.g., a first hole, a second hole, etc.) through its height which is aligned with rotational axis 20. In some examples, spoke bores 82 are also aligned with a central bore 84 of hollow shaft 38, and spoke bores and/or central bore 84 may also aligned with an inner bore 86 of pole 22. The alignment of spoke bores 82, central bore 84, and/or inner bore 86 allows one or more retainers 88 to be positioned through consecutively aligned bores to prevent one or more of spokes 12, hub 16, housing 24, and pole 22 from falling to the ground if fasteners 28, 30, 32, and/or ring nut 36 fail. Although the retainer 88 described below in reference to the illustrated embodiment extends through the entire height of the fan 10 (all components in the vertical assembly), fans 10 including one or more retainers 88 that connect or reinforce fewer than all of the vertically connected components of fan 10 fall within the scope of this disclosure.

[0033] Some examples of retainer 88 extend through the entire height of fan 10 and can include an anchor 90 fixed to elevated structure 18 or some

other structure, a vertically elongate member 92 (e.g., a cable, a chain, a rope, a strap, a wire, a rod, a bar, tube, etc.) with one end secured to anchor 90, and a fixture (e.g., bracket) 94 attached to an opposite end of elongate member 92 via a suitable fastener 96. In some examples, fixture 94 is also attached to the housing 24 and/or pole 22 (e.g., at an interface of the two components). In some examples, a catch member 98 attached to bracket 94 via a suitable fastener 100. Catch member 98 may be positioned at and/or is in contact with the lowermost portion (e.g., lowest spoke 12c) of the assembled and mounted fan. In some examples, catch member 98 has an outermost periphery (e.g., diameter) 102 that is greater than an innermost periphery (e.g., diameter) 104 of the bore 82 of the lowermost spoke 12c. In some examples, innermost periphery 104 is closer to rotational axis 20 than outermost periphery 102. In the illustrated example (FIGS. 3 and 4), catch member 98 includes a threaded rod extending radially through a hole in fixture 94 with nuts on either side securing it from movement.

[0034] Although the example fan 10 shown in FIGS. 1 – 14 has three fan blades 14, other examples of fan 10 have more fan blades 14, such as four or six. FIG. 15, for example, shows hub 16 driving six fan blades 14 connected to hub 16 with three spokes 12d, 12e, and 12f. Spokes 12d-f are similar to spokes 12a-c, except spokes 12d-f are longer and have a blade mounting hole 64 at each end of a spoke, so each spoke 12d-f supports two fan blades 14 (one on each end). A four-blade example of fan 10 could have two spokes similar to spokes 12d and 12 f but with corresponding notches shaped or configured such that the two spokes would be nested together at an angle (e.g., 90 degrees) from each other.

[0035] Fan blade mounting structures and arrangements are disclosed herein. Further examples and combinations thereof include the following:

[0036] Example 1 includes an overhead fan comprising a housing, a hub being rotatable relative to the housing about a rotational axis that is perpendicular to a radial direction, a first fan blade, a first spoke connecting the first fan blade to the hub, a second fan blade, and a second spoke connecting the second fan blade to the hub, the second spoke overlapping the

first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lying substantially perpendicular to the rotational axis, both the first spoke and the second spoke extending lengthwise in the radial direction across the rotational axis.

[0037] Example 2 includes the overhead fan of example 1, wherein the first spoke defines a first notch at the rotational axis, the second spoke defines a second notch at the rotational axis, and the overlapping interface is between the first notch and the second notch.

[0038] Example 3 includes the overhead fan of example 1, further comprising a first inboard screw fastening the first spoke to the hub, a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis, a second inboard screw fastening the second spoke to the hub, and a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

[0039] Example 4 includes the overhead fan of example 1, wherein the first spoke defines a first hole, the second spoke defines a second hole, and the rotational axis extends through both the first hole and the second hole.

[0040] Example 5 includes the overhead fan of example 4, further comprising a hollow shaft extending from the housing and being substantially fixed relative thereto, a bearing coupling the hub to the hollow shaft, and a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke, the retainer being in substantially fixed rotational relationship with the hollow shaft, the retainer including a catch member below both the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, the rotational axis being closer to the innermost periphery than to the outermost periphery.

[0041] Example 6 includes the overhead fan of example 1, further comprising a third fan blade, and a third spoke connecting the third fan blade to the hub, the third spoke having a section sandwiched between the first spoke and the second spoke at the overlapping interface.

[0042] Example 7 includes the overhead fan of example 1, further comprising a third fan blade connected to the first spoke.

[0043] Example 8 includes an overhead fan comprising a housing, a hollow shaft extending from the housing, a hub, a bearing coupling the hub to the hollow shaft such that the hub is rotatable relative to the housing about a rotational axis, a first fan blade, a first spoke connecting the first fan blade to the hub, the first spoke defining a first hole, a second fan blade, and a second spoke connecting the second fan blade to the hub, the second spoke defining a second hole, and a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke, the retainer being in substantially fixed rotational relationship with the housing, the retainer including a catch member below both the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, the rotational axis being closer to the innermost periphery than to the outermost periphery.

[0044] Example 9 includes the overhead fan of example 8, wherein the rotational axis is perpendicular to a radial direction, the second spoke overlaps the first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lies substantially perpendicular to the rotational axis, and both the first spoke and the second spoke extend in the radial direction across the rotational axis.

[0045] Example 10 includes the overhead fan of example 9, wherein the first spoke defines a first notch at the rotational axis, the second spoke defines a second notch at the rotational axis, and the overlapping interface is between the first notch and the second notch.

[0046] Example 11 includes the overhead fan of example 9, further comprising a third fan blade, and a third spoke connecting the third fan blade

to the hub, the third spoke having a section sandwiched between the first spoke and the second spoke at the overlapping interface.

[0047] Example 12 includes the overhead fan of example 8, further comprising a third fan blade connected to the first spoke.

[0048] Example 13 includes the overhead fan of example 8, further comprising a first inboard screw fastening the first spoke to the hub, a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis, a second inboard screw fastening the second spoke to the hub, and a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

[0049] Example 14 includes the overhead fan of example 8, wherein the rotational axis extends through the hollow shaft, through the first hole of the first spoke and through the second hole of the second spoke.

[0050] Example 15 includes an overhead fan comprising a housing, a hub being rotatable relative to the housing about a rotational axis, a first fan blade being rotatable to define a path of rotation, a first spoke connecting the first fan blade to the hub, the first spoke having a first shape, a second fan blade being rotatable along the path of rotation, and a second spoke connecting the second fan blade to the hub, the second spoke having a second shape that is distinguishable from the first shape.

[0051] Example 16 includes the overhead fan of example 15, wherein the first spoke and the second spoke are substantially equal in length.

[0052] Example 17 includes the overhead fan of example 15, wherein the second spoke overlaps the first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lying substantially perpendicular to the rotational axis, both the first spoke and the second spoke extending lengthwise in a radial direction across the rotational axis, wherein the radial direction is perpendicular to the rotational axis.

[0053] Example 18 includes the overhead fan of example 15, wherein the first spoke defines a first notch, the second spoke defines a second notch, and the first notch and the second notch overlap each other.

[0054] Example 19 includes the overhead fan of example 15, further comprising a first inboard screw fastening the first spoke to the hub, a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis, a second inboard screw fastening the second spoke to the hub, and a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

[0055] Example 20 includes the overhead fan of example 15, wherein the first spoke defines a first hole, the second spoke defines a second hole, the rotational axis extends through both the first hole and the second hole, and the overhead fan further comprising a hollow shaft extending from the housing, a bearing coupling the hub to the hollow shaft, and a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke, the retainer including a catch member below both the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, and the rotational axis being closer to the innermost periphery than to the outermost periphery.

[0056] Although certain example methods, apparatus, and articles of manufacture have been disclosed herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus, and articles of manufacture fairly falling within the scope of the claims of this patent.

CLAIMS

1. An overhead fan comprising:

a housing;

a hub being rotatable relative to the housing about a rotational axis that is perpendicular to a radial direction;

a first fan blade;

a first spoke connecting the first fan blade to the hub;

a second fan blade; and

a second spoke connecting the second fan blade to the hub, the second spoke overlapping the first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lying substantially perpendicular to the rotational axis, both the first spoke and the second spoke extending lengthwise in the radial direction across the rotational axis.

2. The overhead fan of claim 1, wherein the first spoke defines a first notch at the rotational axis, the second spoke defines a second notch at the rotational axis, and the overlapping interface is between the first notch and the second notch.

3. The overhead fan of claim 1, further comprising:

a first inboard screw fastening the first spoke to the hub;

a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis;

a second inboard screw fastening the second spoke to the hub; and

a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

4. The overhead fan of claim 1, wherein the first spoke defines a first hole, the second spoke defines a second hole, and the rotational axis extends through both the first hole and the second hole.

5. The overhead fan of claim 4, further comprising:

a hollow shaft extending from the housing and being substantially fixed relative thereto;

a bearing coupling the hub to the hollow shaft; and

a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke; the retainer being in substantially fixed rotational relationship with the hollow shaft, the retainer including a catch member below both the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, the rotational axis being closer to the innermost periphery than to the outermost periphery.

6. The overhead fan of claim 1, further comprising:

a third fan blade; and

a third spoke connecting the third fan blade to the hub, the third spoke having a section sandwiched between the first spoke and the second spoke at the overlapping interface.

7. The overhead fan of claim 1, further comprising a third fan blade connected to the first spoke.

8. An overhead fan comprising:

a housing;

a hollow shaft extending from the housing;

a hub;

a bearing coupling the hub to the hollow shaft such that the hub is rotatable relative to the housing about a rotational axis;

a first fan blade;

a first spoke connecting the first fan blade to the hub, the first spoke defining a first hole;

a second fan blade; and

a second spoke connecting the second fan blade to the hub, the second spoke defining a second hole; and

a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke; the retainer being in substantially fixed rotational relationship with the housing, the retainer including a catch member below both the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, the rotational axis being closer to the innermost periphery than to the outermost periphery.

9. The overhead fan of claim 8, wherein the rotational axis is perpendicular to a radial direction, the second spoke overlaps the first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lies substantially perpendicular to the rotational axis, and both the first spoke and the second spoke extend in the radial direction across the rotational axis.

10. The overhead fan of claim 9, wherein the first spoke defines a first notch at the rotational axis, the second spoke defines a second notch at the rotational axis, and the overlapping interface is between the first notch and the second notch.

11. The overhead fan of claim 9, further comprising:

a third fan blade; and

a third spoke connecting the third fan blade to the hub, the third spoke having a section sandwiched between the first spoke and the second spoke at the overlapping interface.

12. The overhead fan of claim 8, further comprising a third fan blade connected to the first spoke.

13. The overhead fan of claim 8, further comprising:

a first inboard screw fastening the first spoke to the hub;

a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis;

a second inboard screw fastening the second spoke to the hub; and

a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

14. The overhead fan of claim 8, wherein the rotational axis extends through the hollow shaft, through the first hole of the first spoke and through the second hole of the second spoke.

15. An overhead fan comprising:

a housing;

a hub being rotatable relative to the housing about a rotational axis;

a first fan blade being rotatable to define a path of rotation;

a first spoke connecting the first fan blade to the hub, the first spoke having a first shape;

a second fan blade being rotatable along the path of rotation; and

a second spoke connecting the second fan blade to the hub, the second spoke having a second shape that is distinguishable from the first shape.

16. The overhead fan of claim 15, wherein the first spoke and the second spoke are substantially equal in length.

17. The overhead fan of claim 15, wherein the second spoke overlaps the first spoke to define an overlapping interface between the first spoke and the second spoke, the overlapping interface lying substantially perpendicular to the rotational axis, both the first spoke and the second spoke extending lengthwise in a radial direction across the rotational axis, wherein the radial direction is perpendicular to the rotational axis.

18. The overhead fan of claim 15, wherein the first spoke defines a first notch, the second spoke defines a second notch, and the first notch and the second notch overlap each other.

19. The overhead fan of claim 15, further comprising:

a first inboard screw fastening the first spoke to the hub;

a first outboard screw fastening the first spoke to the hub, the first fan blade being closer to the first inboard screw than to the first outboard screw, the first inboard screw and the first outboard screw being at opposite sides of the rotational axis;

a second inboard screw fastening the second spoke to the hub; and

a second outboard screw fastening the second spoke to the hub, the second fan blade being closer to the second inboard screw than to the second outboard screw, the second inboard screw and the second outboard screw being at opposite sides of the rotational axis.

20. The overhead fan of claim 15, wherein the first spoke defines a first hole, the second spoke defines a second hole, the rotational axis extends through both the first hole and the second hole, and the overhead fan further comprising:

a hollow shaft extending from the housing;

a bearing coupling the hub to the hollow shaft; and

a retainer that is vertically elongate, the retainer extending through the hollow shaft, through the first hole in the first spoke, and through the second hole in the second spoke; the retainer including a catch member below both

the first hole and the second hole, the catch member have an outermost periphery, at least one of the first hole and the second hole having an innermost periphery, and the rotational axis being closer to the innermost periphery than to the outermost periphery.

FIG. 1

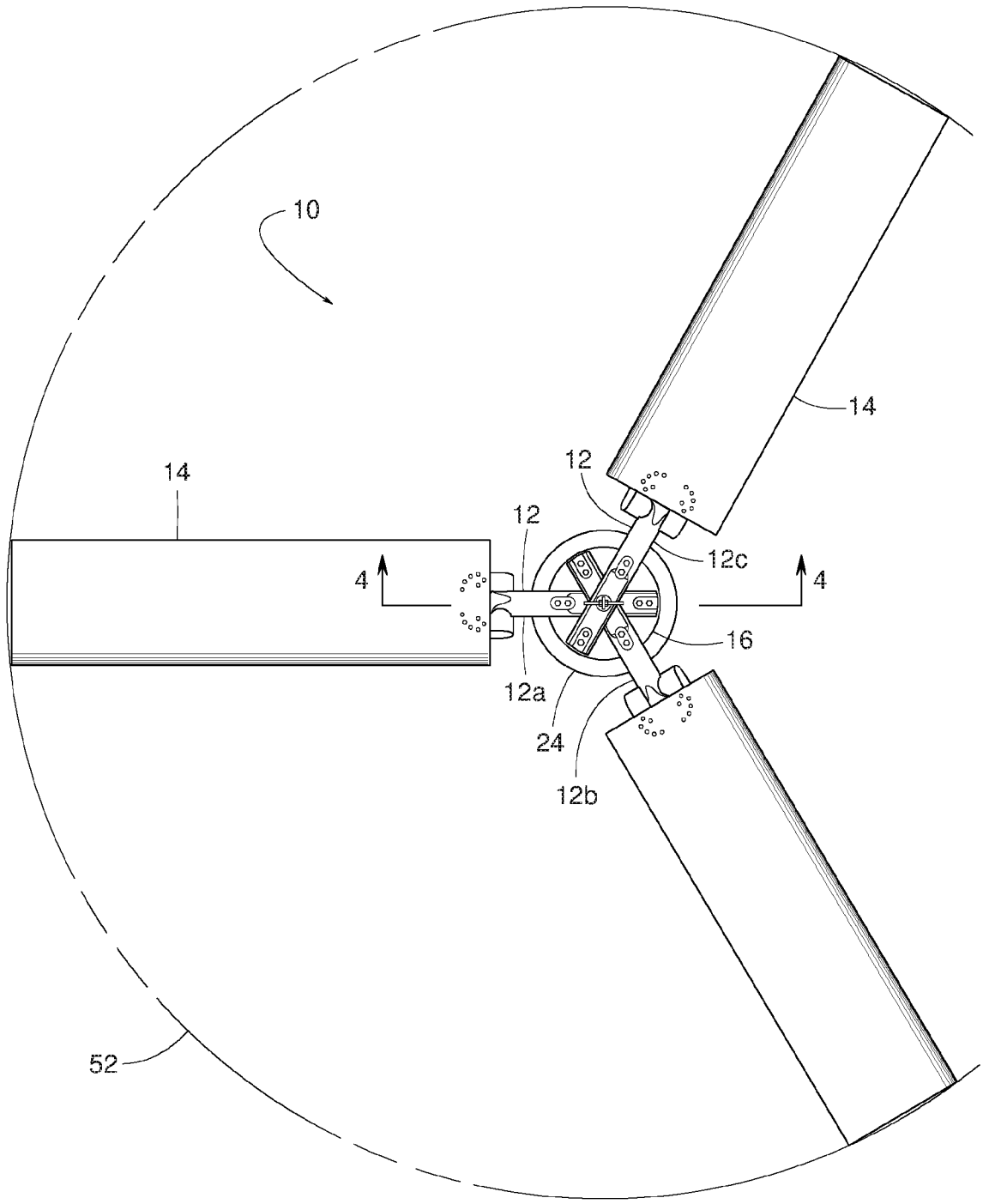


FIG. 2

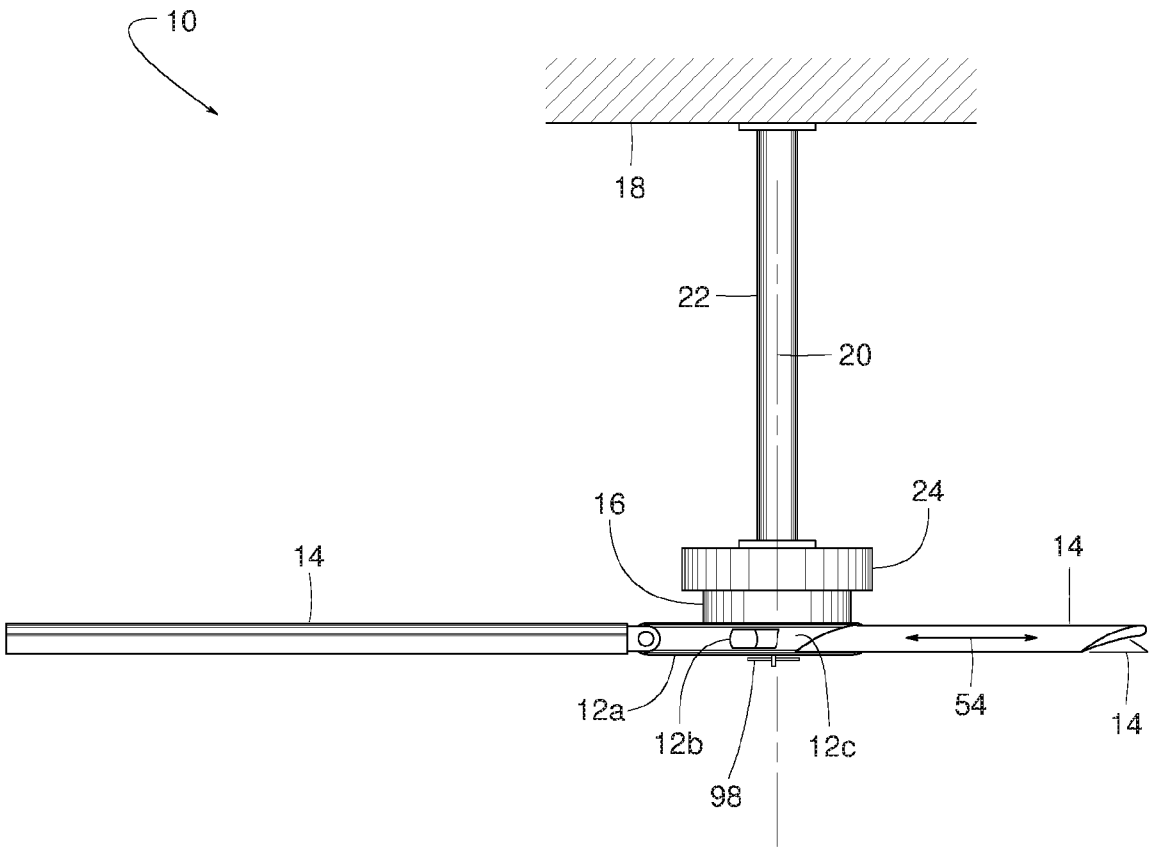


FIG. 3

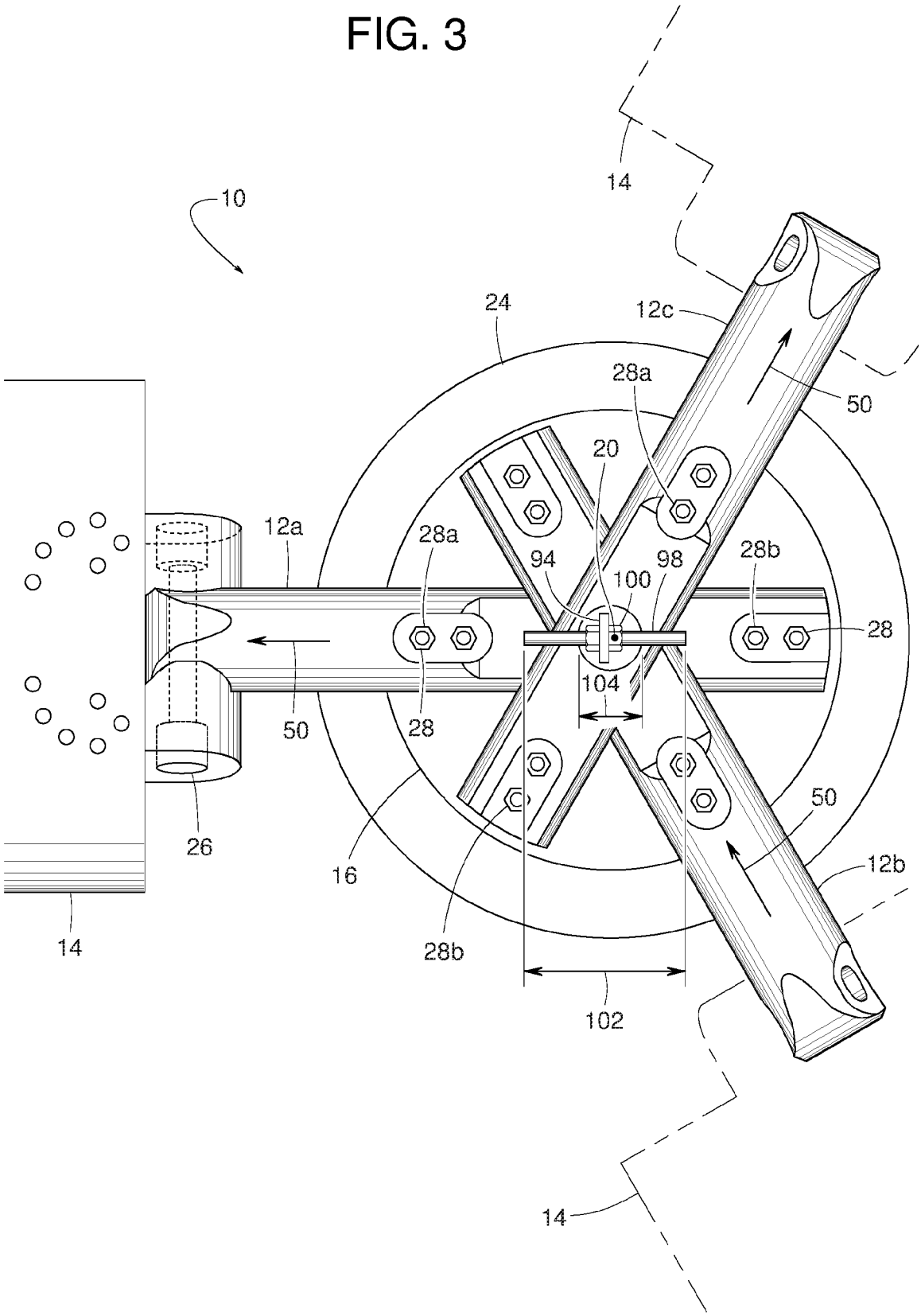

10
14
24
12c
28a
50
20
12a
28a
94
98
28b
100
28
104
50
28
26
16
50
12b
14
28b
102
14

FIG. 4

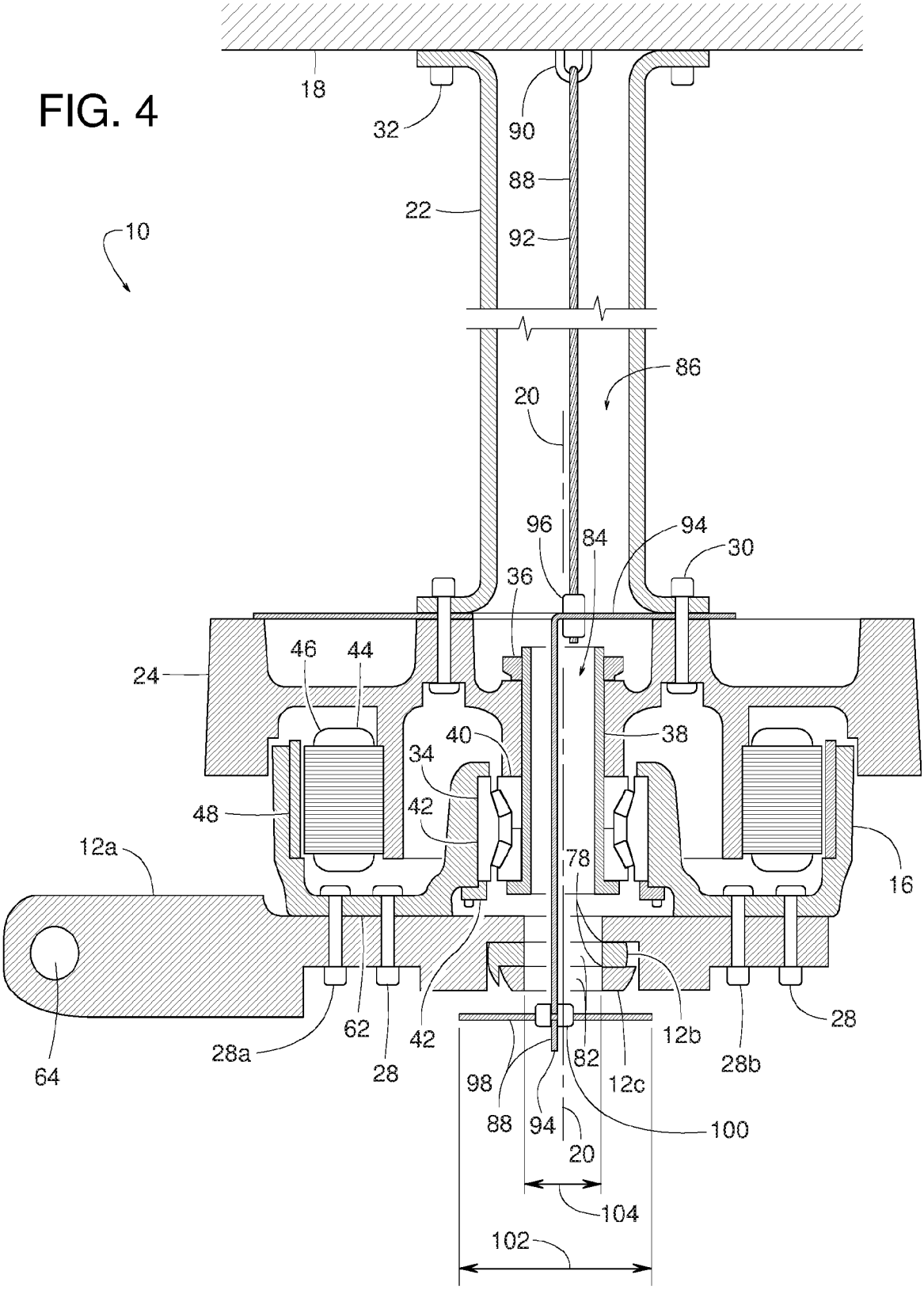

18
32
90
88
22
92
10
86
20
96
84
94
30
36
46
44
24
40
38
34
42
48
12a
78
16
64
28a
62
28
42
12b
28b
28
98
82
12c
88
94
100
20
104
102

FIG. 5

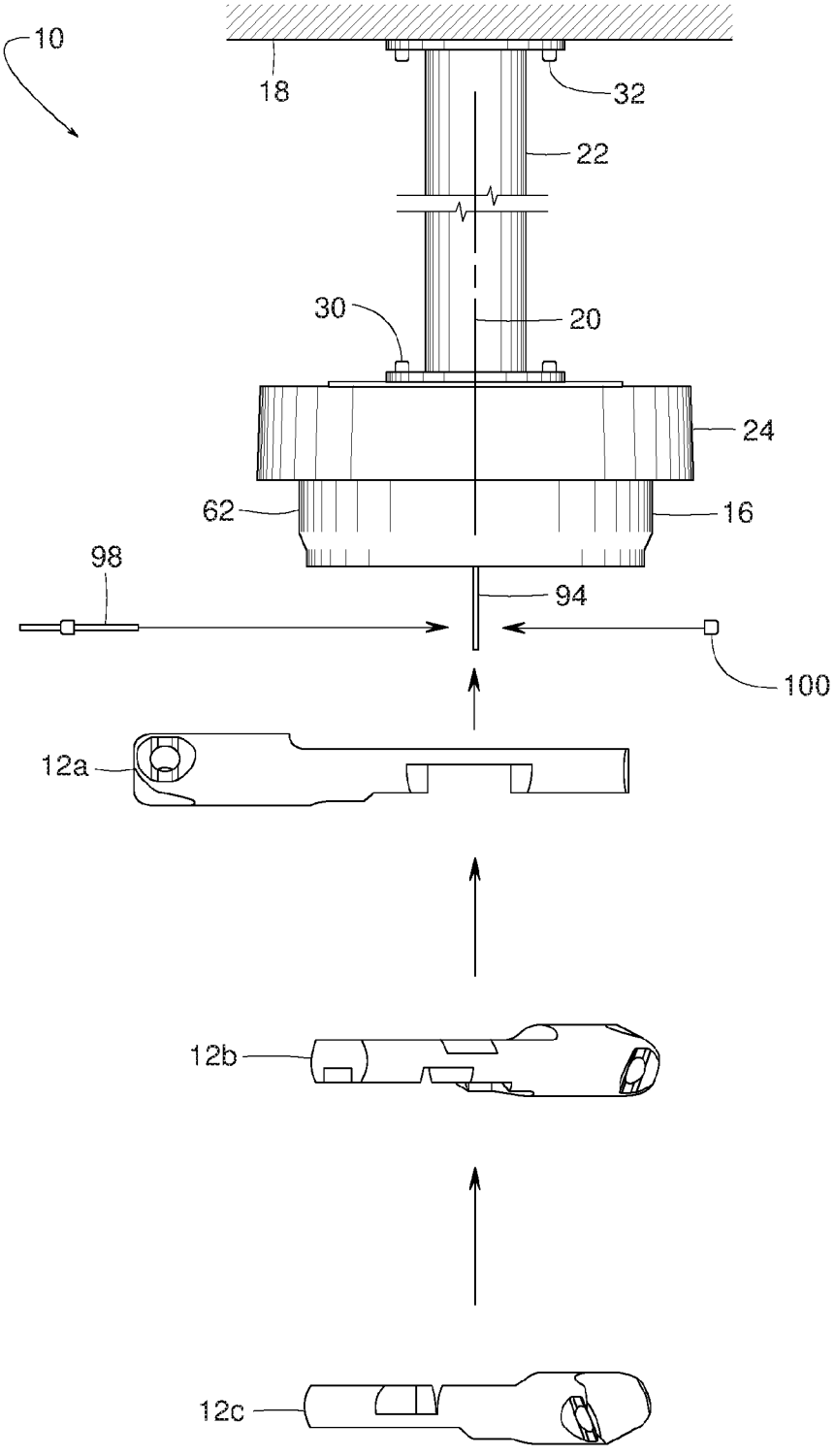


FIG. 6

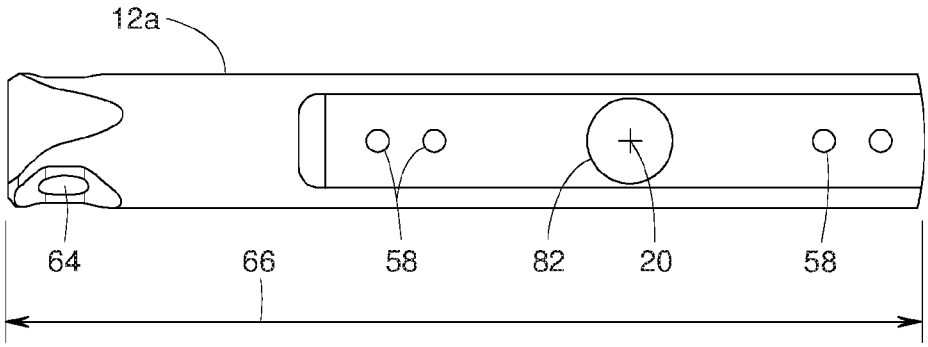


FIG. 7

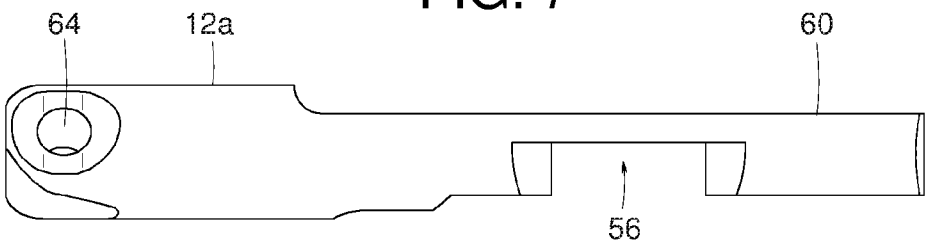


FIG. 8

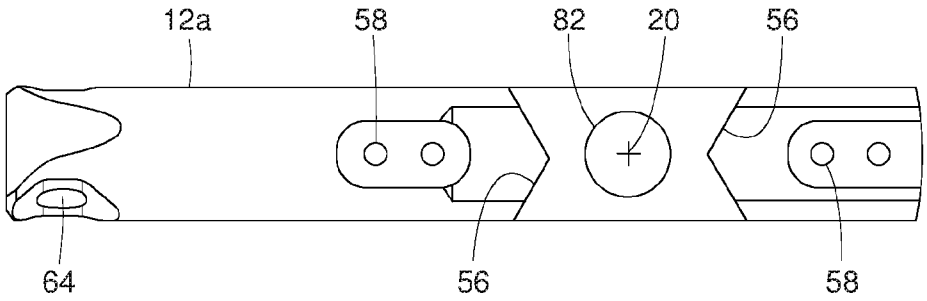


FIG. 9

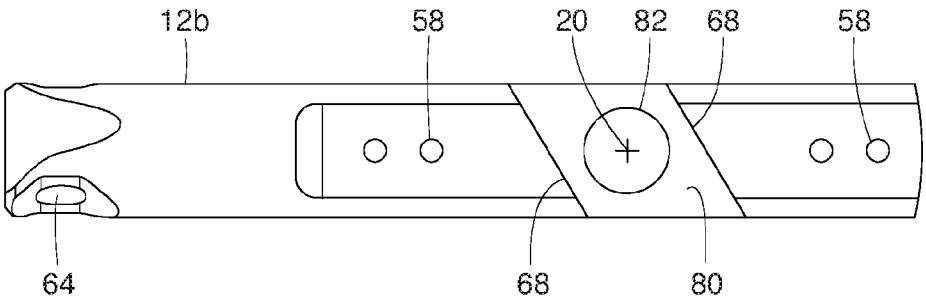


FIG. 10

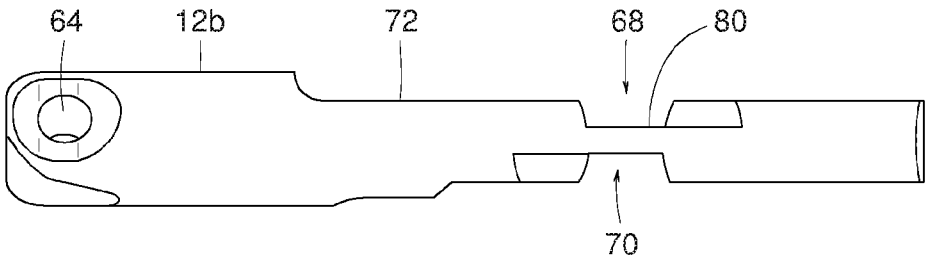


FIG. 11

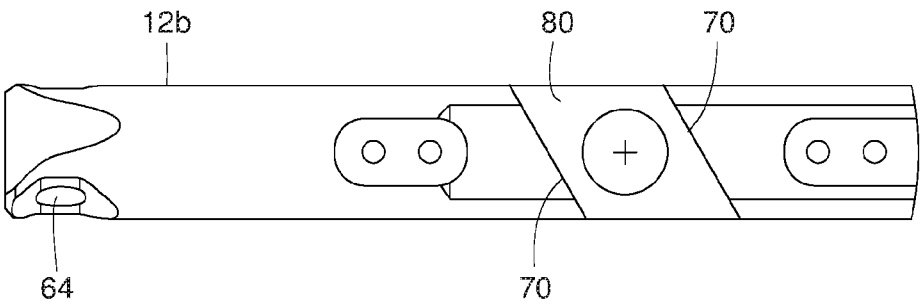


FIG. 12

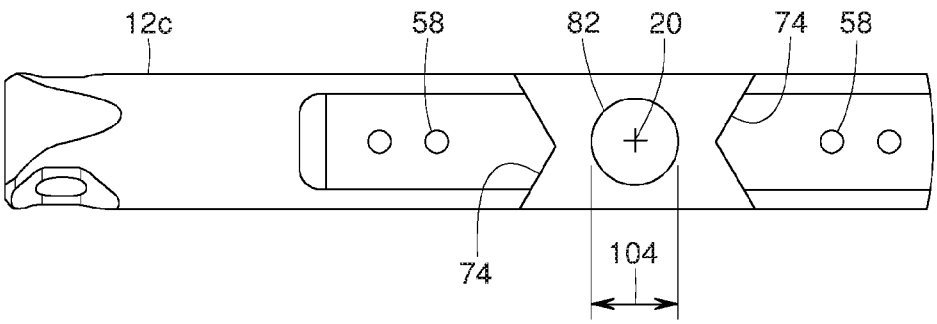


FIG. 13

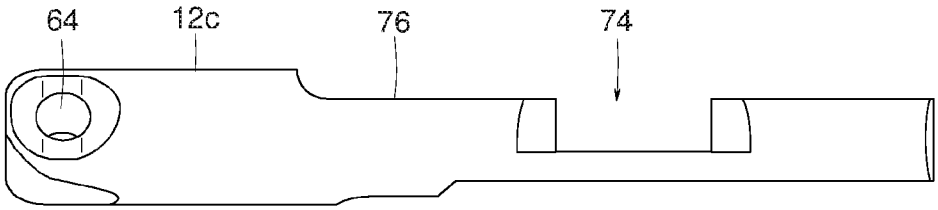


FIG. 14

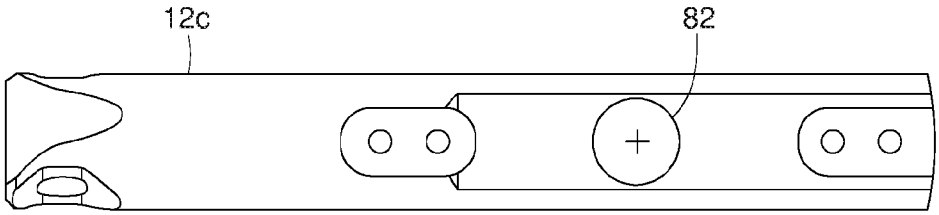
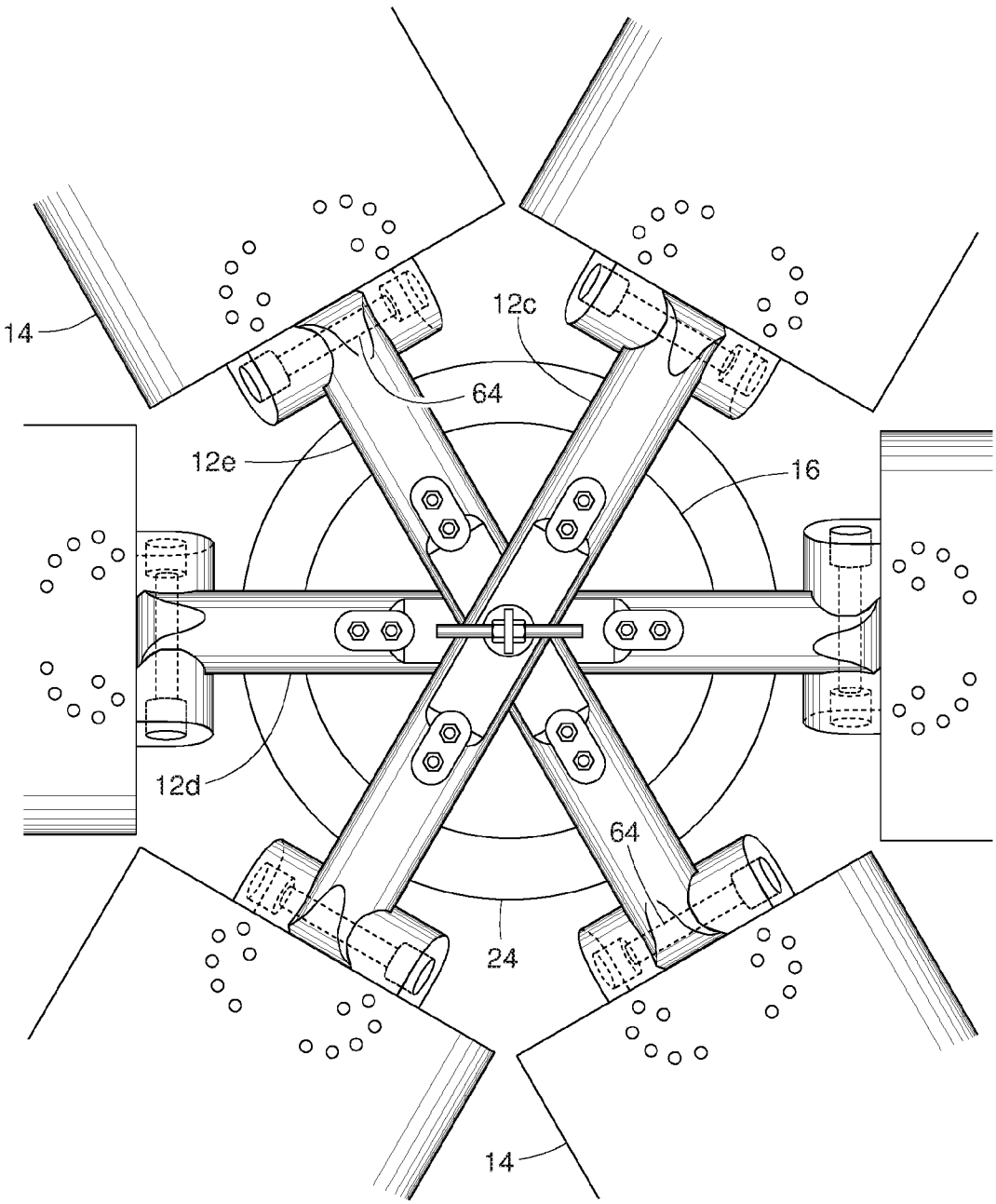


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/038203

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04D25/08 F04D29/34
ADD.

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)
F04D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 301 473 A (WENINGER FRANK L) 31 January 1967 (1967-01-31) column 4, lines 22-67; figures 6,7	15,16,18
A	EP 3 263 906 A2 (SUNONWEALTH ELECTRIC MACHINE IND CO LTD [TW]) 3 January 2018 (2018-01-03) paragraphs [0035] - [0062]; figures 2-12	1-20
A	EP 3 453 886 A1 (SUNONWEALTH ELECTRIC MACHINE IND CO LTD [TW]) 13 March 2019 (2019-03-13) paragraphs [0025] - [0039]; figures 1-9	1-20
A	US 2015/198175 A1 (LIN HSUN-YU [TW]) 16 July 2015 (2015-07-16) paragraphs [0017] - [0028]; figures 3-7	1-20

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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

"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
20 December 2019	13/01/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Nobre Correia, S

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/038203

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008/286101 A1 (GAJEWSKI MARK [US] ET AL) 20 November 2008 (2008-11-20) paragraphs [0077] - [0112]; figures 1-4 -----	5,8,20

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2019/038203

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3301473 A	31-01-1967	NONE	
EP 3263906 A2	03-01-2018	CN 107542684 A	05-01-2018
		EP 3263906 A2	03-01-2018
		US 2017370367 A1	28-12-2017
EP 3453886 A1	13-03-2019	CN 109469633 A	15-03-2019
		EP 3453886 A1	13-03-2019
		TW 201912945 A	01-04-2019
		US 2019072098 A1	07-03-2019
US 2015198175 A1	16-07-2015	TW M478749 U	21-05-2014
		US 2015198175 A1	16-07-2015
US 2008286101 A1	20-11-2008	US 2008286101 A1	20-11-2008
		US 2008286103 A1	20-11-2008
		US 2008286105 A1	20-11-2008