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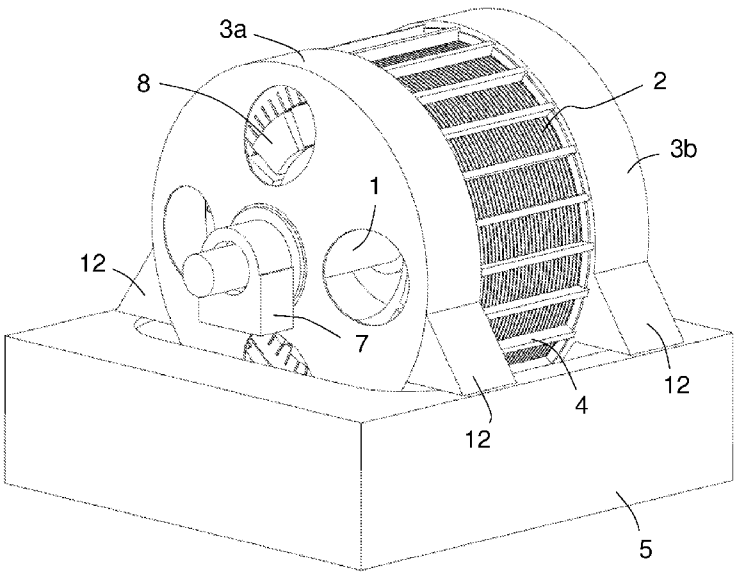


FIG. 1

(57) Abstract: The generator for producing electric energy comprises a rotatable rotor (1), a cylindrical stator (2) having a first end and a second end and surrounding the rotor (1), a first end housing (3a) arranged at the first end of the stator (2), a second end housing (3b) arranged at the second end of the stator (2), and a plurality of longitudinal support beams (4) arranged on the outer surface of the stator (2) and attached to the stator (2). The end housings (3a, 3b) are attached to the support beams (4) by means of bolts (6).

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[Continued on next page]

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Generator for producing electric energy

Technical field of the invention

The present invention relates to a generator for producing electric energy in accordance with claim 1.

Background of the invention

The main parts of a typical electric generator having a rated power of 10–15 MW include a cylindrical stator, a rotor arranged inside the stator and bearings supporting the rotor. The stator of a typical generator in the above mentioned power range is supported by a load carrying stator pipe, which surrounds the stator. Larger generators in the power range of 15–25 MW typically comprise several frame plates, which surround the outer perimeter of the stator. The bearings are supported by pedestals, which are separate from the frame plates. Both above mentioned constructions are complicated and expensive. Especially in the constructions using frame plates, a lot of welding is needed. Also the load path from the stator to the support structures of the generator is complicated, which can cause vibration and fatigue problems.

Summary of the invention

An object of the present invention is to provide an improved generator for producing electric energy. The characterizing features of the generator according to the invention are given in claim 1.

The generator according to the invention comprises a rotatable rotor, a cylindrical stator having a first end and a second end and surrounding the rotor, a first end housing arranged at the first end of the stator, a second end housing arranged at the second end of the stator, and a plurality of longitudinal support beams arranged on the outer surface of the stator and attached to the stator, wherein the end housings are attached to the support beams by means of bolts.

The construction of the generator is simple and requires less welding than many known constructions. The construction is also fatigue resistant and easy to manufacture and assemble.

According to an embodiment of the invention, the bolts protrude into the support beams in the longitudinal direction of the support beams.

According to an embodiment of the invention, the generator comprises a base frame and the rotor and the stator are supported against the base frame via the end housings. According to an embodiment of the invention, the stator is supported solely via the first end housing and the second end housing. According to an embodiment of the invention, bearings of the rotor are supported by the end housings. The generator has thus only a few load carrying parts, which makes the construction simple.

According to an embodiment of the invention, the support beams are attached to the stator by welds. According to another embodiment, the support beams are attached to the stator by means of bolts.

According to an embodiment of the invention, the number of the support beams is in the range of 15–35. The number of the support beams can be, for instance, in the range of 20–30.

According to an embodiment of the invention, each end housing comprises a section having the shape of a truncated cone tapering axially outwards from the stator. This stiffens the construction in the longitudinal direction and reduces vibrations.

According to an embodiment of the invention, each end housing is made as a one-piece cast.

According to an embodiment of the invention, each end housing is provided with air inlets for allowing cooling air flow through the end housing in the axial direction of the generator.

According to an embodiment of the invention, the rated power of the generator is at least 5 MW. The rated power can be for example in the range of 5–35 MW, or in the range of 8–27 MW.

Brief description of the drawings

Embodiments of the invention are described below in more detail with reference to the accompanying drawings, in which

Fig. 1 shows the main parts of a generator according to an embodiment of the invention,

Fig. 2 shows a stator of a generator according to an embodiment of the invention,

Fig. 3 shows the stator and end housings of a generator,

Fig. 4 shows an enlarged view of a joint between the stator and an end housing, and

Fig. 5 shows an end housing of a generator.

Description of embodiments of the invention

Figure 1 shows the main parts of a generator, which can be used for generating electric energy. The generator can be driven for example by a piston engine. The rated power of the generator is at least 5 MW, for instance in the range of 5 to 35 MW or in the range of 8 to 27 MW.

The generator comprises a rotatable rotor 1. The rotor 1 can be coupled by means of a coupling to the crankshaft of a piston engine or to some other power source that provides mechanical power for rotating the rotor 1 of the generator. The rotor 1 is provided with field winding (not shown) for generating a rotating magnetic field. Alternatively, the rotor 1 could comprise armature windings of the generator.

A cylindrical stator 2 surrounds the rotor 1. In case the rotor 1 is provided with the field winding, the armature windings of the generator are arranged in the stator 2. The rotating magnetic field generates in the armature windings electric current, which can be supplied to an external circuit. It would also be possible to arrange the field winding in the stator 2, in which case the rotor would be provided with the armature windings. The stator 2 has a first end and a second end. A first end housing 3a is arranged at the first end of the stator 2

and a second end housing is arranged at the second end of the stator 2. Via the end housings 3a, 3b, the stator 2 is supported against a base frame 5. In the embodiment of figure 1, each end housing 3a, 3b is provided with two support legs 12. The support legs 12 support the end housings 3a, 3b against the base frame 5. The stator 2 is supported against the base frame 5 solely via the two end housings 3a, 3b. Both the end housings 3a, 3b and the stator 2 are thus load carrying parts.

Each end of the rotor 1 is supported by means of a bearing 7. One of the bearings 7 is attached to the first end housing 3a and the other bearing is attached to the second end housing 3b. Also the rotor 1 is thus supported against the base frame 5 only via the end housings 3a, 3b. Each end housing 3a, 3b is provided with air inlets 8 for allowing cooling air flow through the end housing 3a, 3b in the axial direction of the generator. Cooling air can thus be introduced into the generator through the end housings 3a, 3b and exit through an upper part of the generator. Alternatively, one of the end housings 3a, 3b can function as a cooling air inlet and the other end housing 3a, 3b can function as a cooling air outlet.

The outer surface of the stator 2 is provided with a plurality of support beams 4. The support beams 4 run in the longitudinal direction, i.e. the axial direction of the stator 2 and extend from the first end of the stator 2 to the second end. The support beams 4 can be attached to the stator 2 by means of welds. Instead of welds, also bolts could be used. The use of bolts for attaching the support beams 4 to the stator 2 may reduce electrical losses of the generator. The number of the support beams 4 can be for example in the range of 15 to 35. The support beams 4 are preferably evenly distributed along the outer perimeter of the stator 2.

Figure 2 shows a stator 2 with the support beams 4. The stator 2 comprises a plurality of annular plates 11. The plates 11 are bundled together to form a pack. The support beams 4 extend at each end of the stator 2 over the pack formed by the stator plates 11. A pressure ring 9 is arranged at each end of the stator 2. The outer diameter of the pressure rings 9 is slightly larger than the outer diameter of the stator plates 11. At the ends of the stator 2, the support beams 4 extend over the pressure rings 9. The outer perimeter of the pressure ring 9 is provided with slots 16 for accommodating the support beams 4. The pressure ring 9 is attached to the support beams 4 by means of welds. By

means of the pressure rings 9, the stator plates 11 are kept pressed against each other. In addition to or instead of the pressure rings 9, for example threaded bars could be inserted through the stator plates 11 for keeping the plates 11 together.

Figure 3 shows end housings 3a, 3b that are attached to the stator 2. The end housings 3a, 3b are attached to the stator 2 via the support beams 4. Each end housing 3a, 3b is attached to each support beam 4 by means of a bolt 6, which protrudes into the support beam 4 in the longitudinal direction of the support beam 4. The end housing 3a, 3b is provided with a flange 10, through which the bolts 6 can be inserted. The flange 10 is parallel to the end surface of the stator 2. A joint between the end housing 3b and a support beam 4 can be best seen in the cross-sectional view of Fig. 4. The flange 10 of the end housing 3b is against the end surfaces of the support beams 4. In the embodiment of the figures, the flange 10 extends radially inwards from a cylindrical section 14 of the end housing 3a, 3b. The end surfaces of each support beam 4 are provided with threaded holes 13 for the bolt joints. Because of the bolt joints, less welding is needed for the assembly of the stator 2. Also, the load path between the support beam 4 and the end housing 3b is straight, which can help to reduce vibration and fatigue problems compared to more complex structures. The construction is also simpler to manufacture.

Figure 5 shows an end housing 3a, 3b according to an embodiment of the invention. The end housing 3a, 3b comprises a section 15 having the shape of a truncated cone. A cylindrical section 14 comprises the flange 10 that is attached to the stator 2. The conical section 15 extends outwards from the cylindrical section 14. When attached to a stator 2, the end housing 3a, 3b tapers axially outwards from the stator 2. The end housing 3a, 3b can be made as a one-piece cast. The end housings 3a, 3b can be made of cast iron.

It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims.

Claims

1. A generator for producing electric energy, the generator comprising
- a rotatable rotor (1),
- a cylindrical stator (2) having a first end and a second end and surrounding the rotor (1),
- a first end housing (3a) arranged at the first end of the stator (2),
- a second end housing (3b) arranged at the second end of the stator (2), and
- a plurality of longitudinal support beams (4) arranged on the outer surface of the stator (2) and attached to the stator (2),

wherein the end housings (3a, 3b) are attached to the support beams (4) by means of bolts (6).

2. A generator according to claim 1, wherein the bolts (6) protrude into the support beams (4) in the longitudinal direction of the support beams (4).

3. A generator according to claim 1 or 2, wherein the generator comprises a base frame (5) and the rotor (1) and the stator (2) are supported against the base frame (5) via the end housings (3a, 3b).

4. A generator according to any of claims 1 to 3, wherein the stator (2) is supported solely via the first end housing (3a) and the second end housing (3b).

5. A generator according to any of the preceding claims, wherein bearings (7) of the rotor (1) are supported by the end housings (3a, 3b).

6. A generator according to any of the preceding claims, wherein the support beams (4) are attached to the stator (2) by welds.

7. A generator according to any of the preceding claims, wherein the support beams (4) are attached to the stator (2) by means of bolts.

8. A generator according to any of the preceding claims, wherein the number of the support beams (4) is in the range of 15–35.

9. A generator according to claim 8, wherein the number of the support beams (4) is in the range of 20–30.

10. A generator according to any of the preceding claims, wherein each end housing (3a, 3b) comprises a section (15) having the shape of a truncated cone tapering axially outwards from the stator (2).

11. A generator according to any of the preceding claims, wherein each end housing (3a, 3b) is made as a one-piece cast.

12. A generator according to any of the preceding claims, wherein each end housing (3a, 3b) is provided with air inlets (8) for allowing cooling air flow through the end housing (3a, 3b) in the axial direction of the generator.

13. A generator according to any of the preceding claims, wherein the rated power of the generator is at least 5 MW.

14. A generator according to claim 13, wherein the rated power of the generator is in the range of 5–35 MW.

15. A generator according to claim 14, wherein the rated power of the generator is in the range of 8–27 MW.

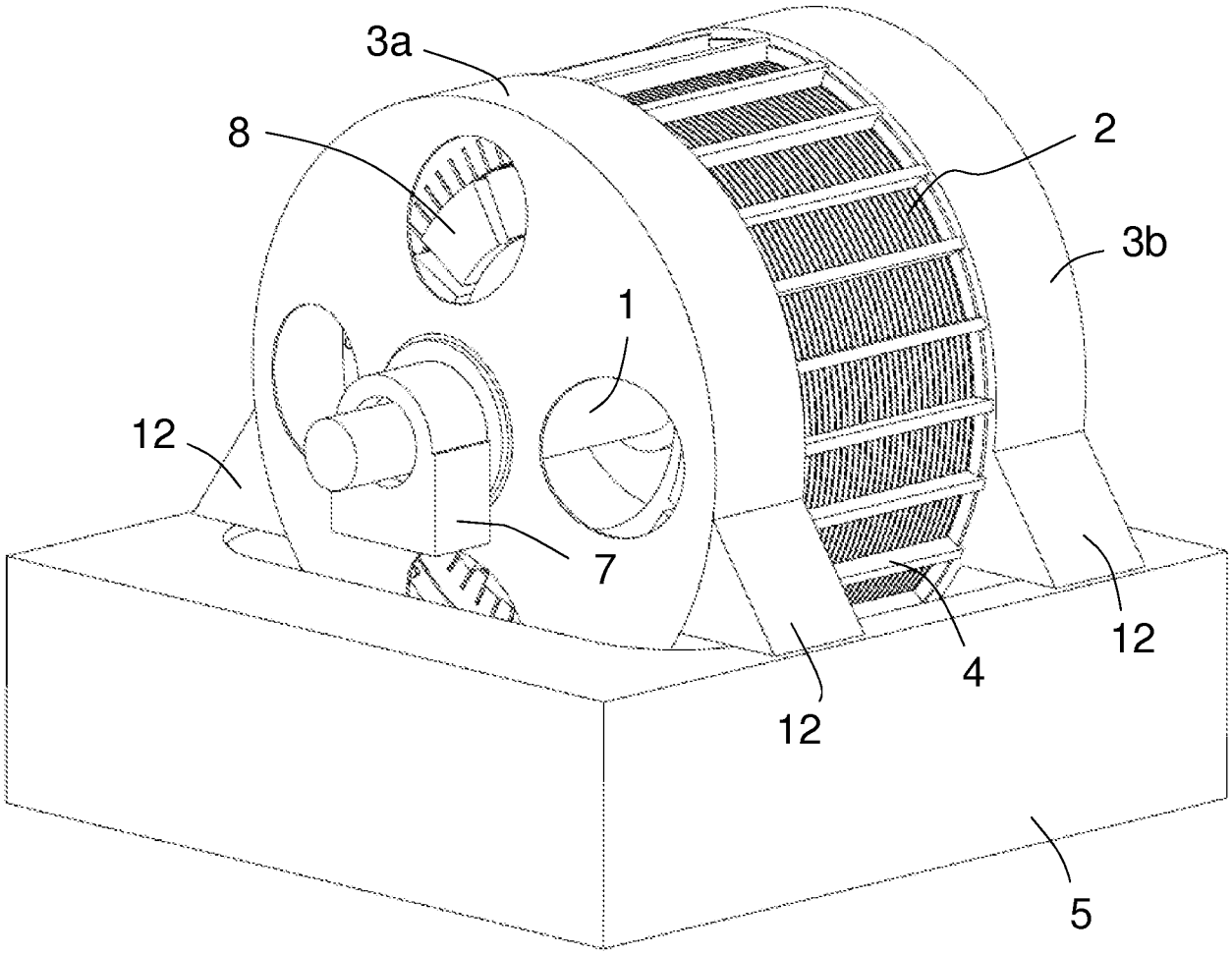


FIG. 1

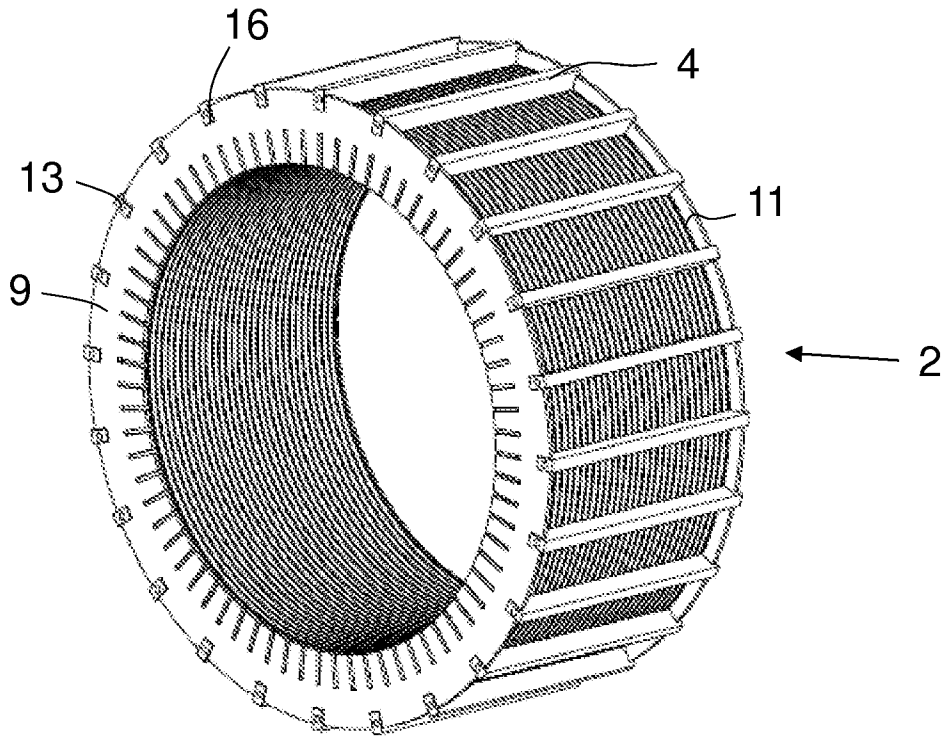


FIG. 2

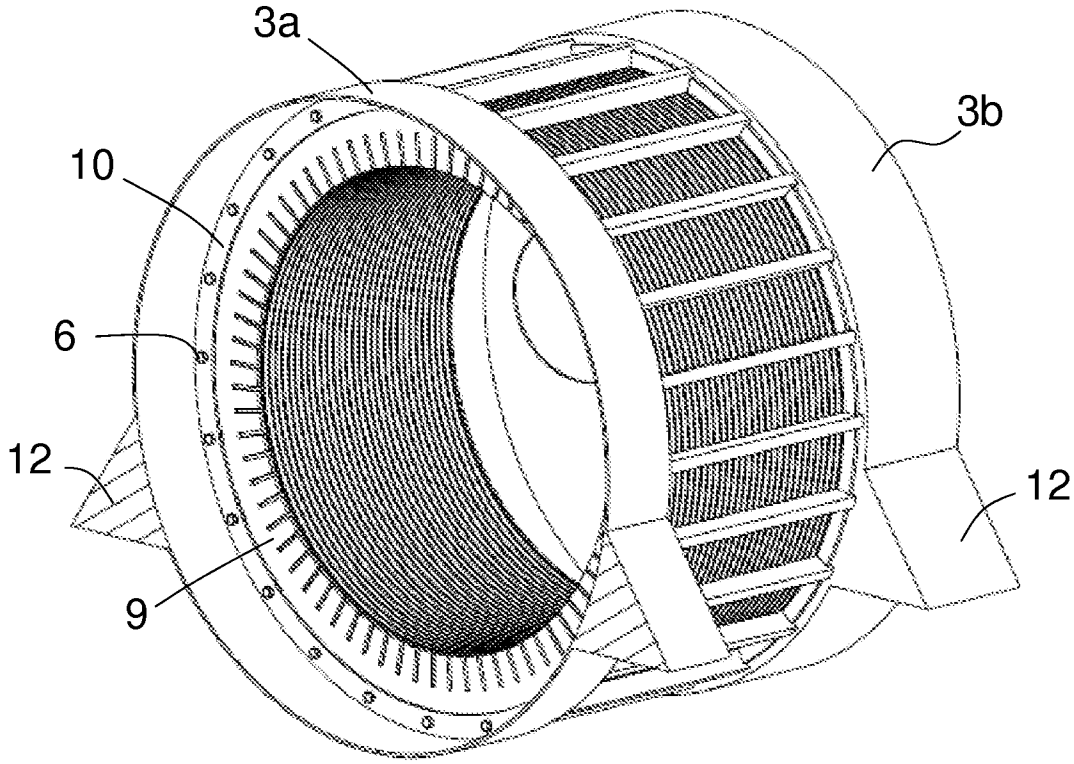


FIG. 3

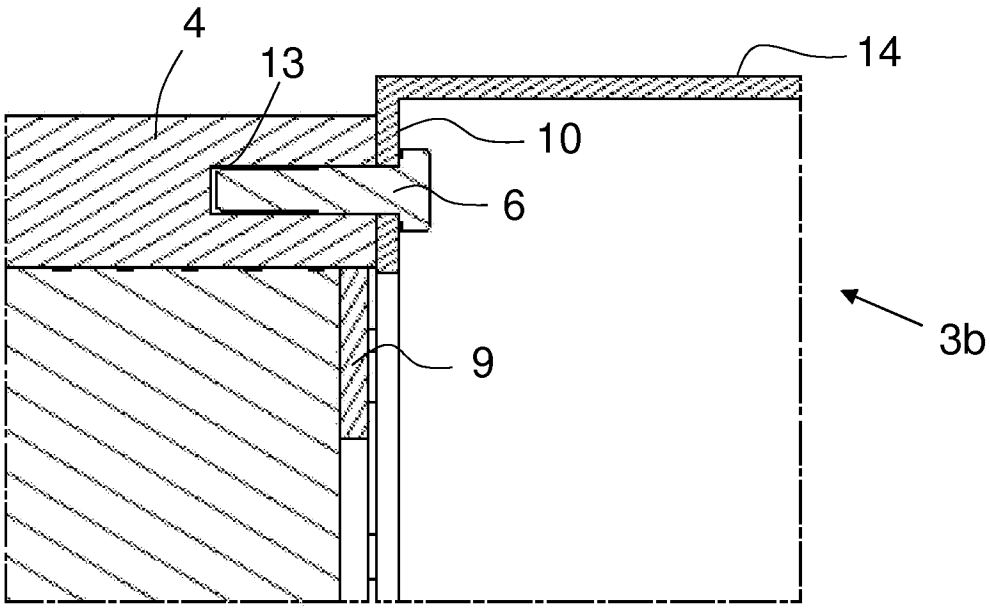


FIG. 4

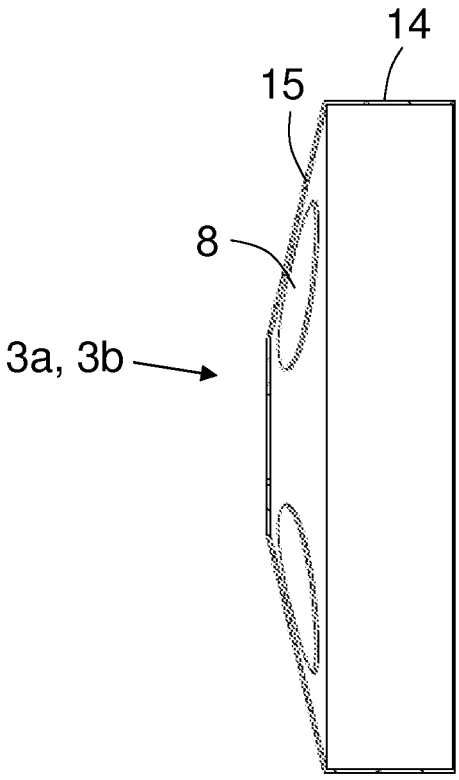


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2017/050957

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02K5/15 H02K5/16 H02K1/18
ADD. H02K5/06 H02K5/20

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)
H02K

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 1 771 475 A (WRIGHT EDWIN M) 29 July 1930 (1930-07-29) page 1, lines 6-24; figures 1-5 page 2, lines 9-11	1-15
X	GB 366 464 A (WILLIAM HARDING SCOTT; PAUL ALPHONSE HUBERT MOSSAY; GILBERT JAMES SCOT) 1 February 1932 (1932-02-01) page 5, lines 119-121; figures 1-12 page 1, lines 64-66	1,2,4-6, 12
X	US 2011/266913 A1 (ZIRIN ROBERT MICHAEL [US] ET AL) 3 November 2011 (2011-11-03) paragraphs [0002] - [0003], [0059] - [0060]; figures 1,11,21-22c,24	1,7-9, 13-15

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

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2018	17/08/2018

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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