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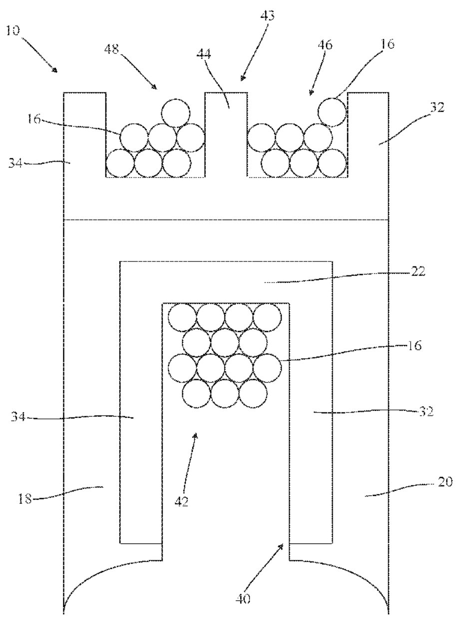

Fig. 9

(57) Abstract: A stator core assembly (10) for a permanent magnet motor (100) has a stator core (12), a bobbin (14) to which the stator core (12) is mounted, and a coil (16) wound around the bobbin (16). A first side (40) of the bobbin (14) has a primary channel (42) and a second side (43) of the bobbin (14) has first (46) and second (48) secondary channels. The coil (16) is wound around the bobbin (14) such that at least a portion of the coil (16) extends between the primary channel (42) and the first (10) secondary channel (46), and at least a portion of the coil (16) extends between the primary channel (42) and the second secondary channel (48).

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A STATOR CORE ASSEMBLY

FIELD OF THE INVENTION

The present invention relates to a stator core assembly, and more particularly, although not exclusively, to a stator core assembly for a permanent magnet motor.

BACKGROUND OF THE INVENTION

Permanent magnet motors typically comprise rotor assemblies, and one or more stator core assemblies for causing rotation of the rotor assembly in use.

There is a general desire to improve permanent magnet motors in a number of ways, including, for example, size, weight, manufacturing cost, efficiency, reliability, and noise.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a stator core assembly for a permanent magnet motor, the stator core assembly comprising a stator core, a bobbin to which the stator core is mounted, and a coil wound around the bobbin, wherein a first side of the bobbin comprises a primary channel and a second side of the bobbin comprises first and second secondary channels, and the coil is wound around the bobbin such that at least a portion of the coil extends between the primary channel and the first secondary channel, and at least a portion of the coil extends between the primary channel and the second secondary channel.

The stator core assembly according to the first aspect of the present invention may be advantageous principally as a first side of the bobbin comprises a primary channel and a second side of the bobbin comprises first and second secondary channels, and the coil is wound around the bobbin such that at least a portion of the coil extends between the primary channel and the first secondary channel, and at least a portion of the coil extends between the primary channel and the second secondary channel.

In particular, this may provide a reduction in temperature during use relative to a bobbin having only a single secondary channel of the same width as its primary channel, as a greater surface area of the coil may be exposed, and hence available for cooling airflow to pass over in use.

The stator core assembly according to the first aspect of the present invention may also allow for better alignment of the coil than, for example, an arrangement in which a single channel is present on each side of the bobbin, and extends across the entire width of the bobbin. By dividing the coil between the first and second secondary channels, each of the first and second secondary channels may contain less turns of the coil than an arrangement in which a single secondary channel extending across the entire width of the bobbin is used, thereby allowing for better alignment and closer control of the coil within the individual channels. Better alignment of the coil may enable greater consistency of winding, for example greater consistency during production of stator assemblies, which may lead to better tolerances.

The first side of the bobbin may comprise an opposite side of the bobbin to the second side of the bobbin. For example, the first and second sides may face in opposing directions.

The primary channel may comprise a channel which is closest to a permanent magnet of a permanent magnet motor when the stator core assembly is installed in the permanent magnet motor. A secondary channel may comprise a channel which is furthest from a permanent magnet of a permanent magnet motor when the stator core assembly is installed in the permanent magnet motor. The terms primary channel and secondary channel may refer to, for example, radially inner and outer channels relative to a permanent magnet of a permanent magnet motor when the stator core assembly is installed in the permanent magnet motor. The first side of the bobbin may be referred to as an inner side of the bobbin, and the second side of the bobbin may be referred to as an outer side of the bobbin.

The stator core may comprise first and second pole arms, and a coreback connecting the first and second pole arms. The stator core may be mounted to the bobbin such that the primary channel is located between the first and second pole arms, and the first and second secondary channels are located on the coreback of the stator core.

The bobbin may comprise first and second end walls, and an intermediate wall, which may define the first and/or second secondary channels. For example, the first end wall and the intermediate wall may define the first secondary channel and/or the intermediate wall and the second end wall may define the second secondary channel. The intermediate wall may have substantially the same depth as the first and/or second end walls. This may be beneficial as the first and/or second secondary channels may be defined over substantially the entire depth of the bobbin, thereby enabling better alignment of the coil over substantially the entire depth of the bobbin. The depth of the bobbin may comprise a dimension of the bobbin in a direction substantially parallel to a direction in which the pole arms of the stator core extend. The first and second end walls may be located on both the first and second sides of the bobbin and/or the intermediate wall may be located only on the second side of the bobbin.

Collectively the first and second end walls and the intermediate wall may give the second side of the bobbin a substantially E- or W- shaped cross-sectional shape. At least a portion of the bobbin may comprise a substantially E- or W-shaped cross-sectional shape. The primary channel may comprise a substantially c-shaped cross-sectional shape, for example a c-shaped cross-section defined by flat edges. The coil may be wound about the bobbin such that the coil has a substantially V-shaped profile when viewed in a direction along the length of the stator core assembly. For example, turns of the coil may define a V-shape when viewed in in a direction along the length of the stator core assembly. The stator core may comprise a substantially c-shaped cross-sectional shape, and may, for example, be referred to as a c-shaped stator core. Each of the secondary channels may comprise a substantially c-shaped cross-sectional shape, for example a c-shaped cross-sectional shape defined by flat edges. The cross-sectional shapes discussed above may comprise shapes viewed in a cross-section taken in a plane orthogonal to a longitudinal axis of the bobbin

The coil may be wound around the bobbin such that at least one turn of the coil extends along the primary channel and the first secondary channel, and at least one turn of the coil extends along the primary channel and the second secondary channel. A turn of the coil may comprise a substantially closed loop of the coil, for example a full revolution of the coil about the bobbin.

The primary and/or secondary channels may be substantially elongate in form, for example having a length greater than its width and/or depth. Each of the primary and secondary channels may extend beyond the stator core, for example beyond the stator core in a longitudinal direction.

The primary channel may comprise a single channel, for example a channel defined by two end walls and a base wall with substantially no intervening walls or protrusions therebetween. This may be beneficial as a high fill factor may be desired on the first side of the bobbin, for example between the pole arms of the stator core, and a single channel may enable a higher fill factor than, for example, multiple channels defined by walls within the space between the pole arms of the stator core. A single channel may comprise a channel defined by two end walls and a base wall with substantially no intervening walls or protrusions having a depth greater than a quarter of the depth of the wire forming the coil located therebetween.

The first and second secondary channels may extend over substantially the entirety of the second side of the bobbin, for example over substantially the entirety of the coreback of the stator core. This may be beneficial over, for example, an arrangement where channels are confined to only a region of the second side of the bobbin, ie only a region of the coreback of the stator core, as the overall depth of the coil when wound around the bobbin may be reduced. This may reduce the overall depth of the stator assembly. This may be beneficial when the stator assembly is installed in a permanent magnet motor in use, as it may reduce the amount of the stator assembly exposed to airflow through the motor in use, thereby providing improved aero efficiency and/or improved acoustics. By extending the first and second secondary channels over substantially the entirety of the second side of the bobbin an exposed surface area of the coil may be increased, and hence the stator assembly may benefit from a reduction in temperature in use.

A combined width of the first and second secondary channels may be greater than a width of the primary channel. Each of the first and second secondary channels may have substantially the same width as the width of the primary channel. Width may, for example, comprise a width in a direction substantially orthogonal to a direction in which the pole arms of the stator core extend.

The first and second end walls may be substantially aligned with edges of the first and second pole arms. For example, outermost edges of the first and second end walls may be substantially aligned with outermost edges of the first and second pole arms. The first and second end walls may define a substantially continuous surface with the respective first and second pole arms. This may be beneficial as it may remove corners and/or sharp edges from the stator assembly, and this may promote better aero efficiency when the stator assembly is installed in a motor in use.

The first and second secondary channels may comprise substantially the same dimensions, for example substantially the same width and/or height and/or depth. The intermediate wall may be located at a mid-point between the first and second end walls. The intermediate wall may be located at a mid-point of the coreback of the stator core. A portion of the coil contained within the first secondary channel may be substantially the same size as a portion of the coil contained within the second secondary channel. For example, the first secondary channel may house substantially the same number of turns of the coil as the second secondary channel. This may be beneficial as it may allow for even temperature distribution across the bobbin in use.

The bobbin may comprise a slot within which the stator core is received. The bobbin may comprise first and second bobbin portions, each having a slot for receiving a corresponding end of the stator core. The first and second bobbin portions may sandwich the stator core.

Each of the first and second bobbin portions may define a corresponding portion of the primary channel, a corresponding portion of the first secondary channel, and a corresponding portion of the second secondary channel.

The coil may comprise a single coil, for example a continuous coil defined by a single winding of wire.

The coil may comprise a single-phase winding or a three-phase winding.

The bobbin may comprise a third secondary channel, or indeed any number of further secondary channels. It will, however, be appreciated that a balance needs to be struck between the desired number of secondary channels, and available space to achieve a desired number of turns without increasing the size, for example depth, of the stator assembly.

According to a second aspect of the present invention there is provided a permanent magnet motor comprising a stator core assembly according to the first aspect of the present invention.

According to a third aspect of the present invention there is provided a vacuum cleaner comprising a permanent magnet motor according to the second aspect of the present invention.

According to a fourth aspect of the present invention there is provided a method of manufacturing a stator core assembly, the method comprising providing a stator core, and a bobbin having a first side comprising a primary channel and a second side comprising first and second secondary channels, the stator core being mounted to the bobbin, and winding a coil around the bobbin such that at least a portion of the coil extends between the primary channel and the first secondary channel, and at least a portion of the coil extends between the primary channel and the second secondary channel.

The stator core may comprise first and second pole arms connected by a coreback, and the stator core may be mounted to the bobbin such that the primary channel is located between the first and second pole arms of the stator core, and the first and second secondary channels are located on the coreback of the stator core.

The method may comprise winding a coil around the bobbin such that the coil is evenly split between the first and second secondary channels.

The method may comprise winding the coil about the bobbin such that the coil has a substantially V-shaped profile when viewed in a direction parallel to a longitudinal axis of the bobbin, for example in a cross-section taken in a plane orthogonal to a longitudinal axis of the bobbin.

The method may comprise alternately winding the coil between the primary and first secondary channel and between the primary and second secondary channel. For example, the method may comprise winding a first turn of the coil between the primary and first secondary channel, subsequently winding a second turn of the coil between the primary and second secondary channel, subsequently winding a third turn of the coil between the primary and first secondary channel, and so on until a desired number of turns have been completed, or the method may comprise winding a first row of turns of the coil between the primary and first secondary channel, subsequently winding a second row of turns of the coil between the primary and second secondary channel, subsequently winding a third row of turns of the coil between the primary and first secondary channel, and so on until a desired number of rows of turns have been completed

The method may comprise winding the coil between the primary and the first secondary channel until the first secondary channel is filled to a pre-determined level, and subsequently winding the coil between the primary and the second secondary channel until the second secondary channel is filled to a pre-determined level.

The method may comprise mounting the stator core to the bobbin such that the primary channel is located between the first and second pole arms of the stator core, and the first and second secondary channels are located on the coreback of the stator core.

Preferential features of aspects of the present invention may be equally applied to other aspects of the present invention, where appropriate.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the present invention, and to show more clearly how the invention may be put into effect, the invention will now be described, by way of example, with reference to the following drawings:

Figure 1 is a perspective view of a stator core assembly according to the present invention;

Figure 2 is a perspective view of a stator core of the stator core assembly of Figure 1;

Figure 3 is a schematic cross-sectional view of the stator core of Figure 2;

Figure 4 is an exploded perspective view of a bobbin of the stator core assembly of Figure 1;

Figure 5 is a first perspective view of the bobbin of Figure 4;

Figure 6 is a second perspective view of the bobbin of Figure 4;

Figure 7 is a first perspective view of the bobbin of Figure 4 in combination with the stator core of Figure 2;

Figure 8 is a second perspective view of the bobbin of Figure 4 in combination with the stator core of Figure 2;

Figure 9 is a schematic cross-sectional view of the stator assembly of Figure 1;

Figure 10 is a schematic cross-sectional view illustrating a first winding pattern of the stator assembly of Figure 1;

Figure 11 is a schematic cross-sectional view illustrating a second winding pattern of the stator assembly of Figure 1;

Figure 12 is an exploded perspective view of a permanent magnet motor including the stator assembly of Figure 1;

Figure 13 is a perspective view of a vacuum cleaner comprising the permanent magnet motor of Figure 12; and

Figure 14 is a flow chart schematically illustrating a method of manufacturing the stator assembly of Figure 1.

DETAILED DESCRIPTION

A stator core assembly according to a first aspect of the present invention, generally designated 10, is shown in Figure 1.

The stator core assembly 10 comprises a stator core 12, a bobbin 14, and a coil 16.

The stator core 12 is shown in isolation in Figures 2 and 3, and comprises first 18 and second 20 pole arms, and a coreback 22 connecting the first 18 and second 20 pole arms. The stator core 12 has a substantially c-shaped cross-sectional shape, for example when viewed in a cross-section taken in a direction substantially orthogonal to a longitudinal axis of the stator core 12, and hence the stator core 12 may be referred to as a c-shaped stator core. Although not shown in the Figures, the stator core 12 is formed of a plurality of laminations stacked one on top of the other. First 24 and second 26 locating projections extend outwardly from the stator core 12 near the interface between the respective first 18 and second 20 pole arms and the coreback 22, and are used to locate the stator core assembly 10 relative to a frame 102 of a permanent magnet motor 100.

The bobbin 14 is shown in isolation in Figures 4 to 6, and comprises first 28 and second 30 bobbin portions. Each bobbin portion 28,30 has respective first 32 and second 34 end walls, base walls 36, and stator core receiving slots 38. The base walls 36 extend between the first 32 and second 34 end walls, and act to space apart the first 32 and second 34 end walls. A first side 40 of each of the bobbin portions 28,30 thereby comprises a respective portion of a primary coil receiving channel 42 defined by the first 32 and second 34 end walls, and the base walls 36.

A second side 43 of each of the bobbin portions has an intermediate wall 44 extending from the base wall 36, and located approximately mid-way between the first 32 and second 34 end walls. The second side 43 of each of the bobbin portions 28,30 thereby comprises respective portions of first 46 and second 48 secondary coil receiving channels, defined by the first 32 and second 34 end walls, the base walls 36, and the intermediate walls 44.

The intermediate walls 44 have substantially the same height as the first 32 and second 34 end walls. The spacing of the first 32 and second 34 end walls varies about the perimeter of each bobbin portion 28,30, such that outer edges of the first 32 and second 34 end walls on the first side 40 of the bobbin portions 28,30 are spaced apart by a distance substantially corresponding to a spacing between inner edges of the first 18 and second 20 pole arms of the stator core 12, and outer edges of the first 32 and second 34 end walls on the second side 43 of the bobbin portions 28,30 are spaced apart by a distance substantially corresponding to a spacing between outer edges of the first 18 and second 20 pole arms of the stator core 12, ie corresponding to the width of the coreback 22 of the stator core 12. More simply put, the width of the base wall 36 increases between the first 40 and second 43 sides of the bobbin portions 28,30.

The stator core receiving slots 38 are substantially rectangular in form, and are shaped and dimensioned to receive a portion of the coreback 22 of the stator core 12. In particular, the height of each stator core receiving slot 38 substantially corresponds to the thickness of the coreback 22 of the stator core 12. The length of each slot 38 is such that collectively the first 28 and second 30 bobbin portions substantially enclose the coreback 22 of the stator core 12 when assembled, as seen in Figures 1 and 8. The first 28 and second 30 bobbin portions may not be of equal length, for example the first bobbin portion 28 may be longer than the second bobbin portion 30, and hence the respective slots 38 may also have different lengths.

As seen from Figure 7, the first 28 and second 30 bobbin portions effectively sandwich the stator core 12 when the slots 38 receive the coreback 22 of the stator core 12. The first 28 and second 30 bobbin portions are held in place about the stator core 12 via adhesive (not shown). The first side 40 of each bobbin portion 28,30 is received between the first 18 and second 20 pole arms of the stator core 12, such that the primary coil receiving channel 42 is located between the first 18 and second 20 pole arms. The second side 43 of each bobbin portion 28,30 is received on the coreback 22 of the stator core 12, such that the first 46 and second 48 secondary coil receiving channels are located on the coreback 22 of the stator core 12.

The coil 16 is a single-phase winding of the type commonly used in single-phase brushless permanent magnet motors. As can be seen from Figures 9 to 11, the coil 16 is wound around the bobbin 14 such that at least a portion of the coil 16 extends between the primary coil receiving channel 42 and the first secondary coil receiving channel 46, whilst the remainder of the coil 16 extends between the primary coil receiving channel 42 and the second secondary coil receiving channel 48. This gives the overall winding of the coil 16 a V-shape when viewed in cross-section, as seen in Figures 9 to 11.

The coil 16 may be wound about the bobbin 14 in different ways, as illustrated in Figures 10 and 11. In Figure 10, it can be seen that the coil 16 is wound about the bobbin 14 such that the first secondary coil receiving channel 46 is filled first, before subsequently filling the second secondary coil receiving channel 48. In Figure 11, it can be seen that the coil 16 is wound around the bobbin 14 such that a first row of turns is formed in the first secondary coil receiving channel 46, a first row of turns is then formed in the second secondary coil receiving channel 48, a second row of turns is then formed in the first secondary coil receiving channel 46, a second row of turns is then formed in the second secondary coil receiving channel 48, and so on until the first 46 and second 48 secondary coil receiving channels are filled. It will be recognised that other winding patterns may be possible, and a desired winding pattern may be chosen to simplify manufacturing if so desired.

The assembled stator core assembly 10 may allow for better alignment of the coil 16 than, for example, an arrangement in which a single channel is present on the coreback of a stator core, extending across the entire width of the coreback of the stator core. By dividing the coil 16 between the first 46 and second 48 secondary coil receiving channels, each of the first 46 and second 48 secondary channels may contain less turns of the coil 16 than an arrangement in which a single secondary channel is used, thereby allowing for better alignment and closer control of the coil 16 within the individual channels 46,48. Better alignment of the coil 16 may enable greater consistency of winding, for example greater consistency during production of stator assemblies 10, which may lead to better tolerances.

The stator core assembly 10 may also provide a reduction in temperature during use relative to a bobbin having only a single secondary channel of the same width as its primary channel, as a greater surface area of the coil 16 may be exposed, and hence available for cooling airflow to pass over in use. This reduction in temperature may be further enhanced by ensuring that the first 46 and second 48 secondary coil receiving channels extend over substantially the entirety of the coreback 22 of the stator core 10, as seen in Figures 9 to 11.

A permanent magnet motor 100 comprising four stator core assemblies 10 can be seen in Figure 12. The permanent magnet motor 100 is a single-phase brushless permanent magnet motor comprising a frame 102, a rotor assembly 104, and a diffuser 106. Control circuitry of the motor 100 is not shown here for clarity.

The frame 102 has four slots 107, each of which receives a corresponding stator assembly 10. The rotor assembly 104 comprises first 108 and second 110 bearings, an eight-pole permanent magnet 112, a shaft 114, and an impeller 116. The bearings 108,110, are attached to the shaft 114 either side of the eight-pole permanent magnet 112, with the impeller 116 attached to one end of the shaft. The rotor assembly 104 is held within the frame 102 by gluing the bearings 108,110 to corresponding bearing seats of the frame 102. The stator assemblies 10 are positioned in the slots 107 using their respective first 24 and second 26 locating projections, before being glued in place such that the pole arms 18,20 face the eight-pole permanent magnet 112.

A vacuum cleaner 200 comprising the permanent magnet motor 100 is shown in Figure 13.

A method 300 of manufacturing a stator core assembly 10 will be described with reference to Figure 14.

The method 300 comprises providing 302 a stator core 12 having first 18 and second 20 pole arms connected by a coreback 22, and a bobbin 14 having a primary coil receiving channel 42, and first 46 and second 48 secondary coil receiving channels. The method 300 comprises mounting 304 the stator core 12 to the bobbin 14 such that the primary coil receiving channel 42 is located between the first 18 and second 20 pole arms of the stator core 12, and the first 46 and second 48 secondary coil receiving channels are located on the coreback 22 of the stator core 12. The method 300 comprises winding 306 a coil 16 around the bobbin 14 such that at least a portion of the coil 16 extends between the primary coil receiving channel 42 and the first secondary coil receiving channel 46, and at least a portion of the coil 16 extends between the primary coil receiving channel 42 and the second secondary coil receiving channel 48.

It will be recognised that the stator core 12 and bobbin 14 may be provided as a subassembly, and in such a case that the step of mounting 304 the stator core 12 to the bobbin 14 may be omitted.

The winding 306 of the coil 16 may be carried out in the manner previously discussed above.

For example, the coil 16 may be wound 306 about the bobbin 14 such that the first secondary coil receiving channel 46 is filled first, before subsequently filling the second secondary coil receiving channel 48. Alternatively, the coil 16 may be wound 306 around the bobbin 14 such that a first row of turns is formed in the first secondary coil receiving channel 46, a first row of turns is then formed in the second secondary coil receiving channel 48, a second row of turns is then formed in the first secondary coil receiving channel 46, a second row of turns is then formed in the second secondary coil receiving channel 48, and so on until the first 46 and second 48 secondary coil receiving channels are filled. It will be recognised that other winding patterns may be possible, and a desired winding pattern may be chosen to simplify manufacturing if so desired.

CLAIMS

1. A stator core assembly for a permanent magnet motor, the stator core assembly comprising a stator core, a bobbin to which the stator core is mounted, and a coil wound around the bobbin, wherein a first side of the bobbin comprises a primary channel and a second side of the bobbin comprises first and second secondary channels, and the coil is wound around the bobbin such that at least a portion of the coil extends between the primary channel and the first secondary channel, and at least a portion of the coil extends between the primary channel and the second secondary channel.

2. A stator core assembly as claimed in Claim 1, wherein the stator core comprises first and second pole arms, and a coreback connecting the first and second pole arms, and the stator core is mounted to the bobbin such that the primary channel is located between the first and second pole arms, and the first and second secondary channels are located on the coreback of the stator core.

3. A stator core assembly as claimed in Claim 1 or Claim 2, wherein the bobbin comprises first and second end walls and an intermediate wall which define the first and/or second secondary channels.

4. A stator core assembly as claimed in any preceding claim, wherein each of the primary and secondary channels extends beyond the stator core.

5. A stator core assembly as claimed in any preceding claim, wherein the primary channel comprises a single channel.

6. A stator core assembly as claimed in any preceding claim, wherein the first and second secondary channels extend over the entirety of the second side of the bobbin.

7. A stator core assembly as claimed in any preceding claim, wherein a combined width of the first and second secondary channels is greater than a width of the primary channel.

8. A stator core assembly as claimed in any preceding claim, wherein the first and second secondary channels comprise the same dimensions.

9. A stator core assembly as claimed in any preceding claim, wherein a portion of the coil contained within the first secondary channel is the same size as a portion of the coil contained within the second secondary channel.

10. A permanent magnet motor comprising a stator core assembly as claimed in any preceding claim.

11. A vacuum cleaner comprising a permanent magnet motor as claimed in Claim 10.

12. A method of manufacturing a stator core assembly, the method comprising providing a stator core, and a bobbin having a first side comprising a primary channel and a second side comprising first and second secondary channels, the stator core being mounted to the bobbin, and winding a coil around the bobbin such that at least a portion of the coil extends between the primary channel and the first secondary channel, and at least a portion of the coil extends between the primary channel and the second secondary channel.

13. A method as claimed in Claim 12, wherein the method comprises alternately winding the coil between the primary and first secondary channel and between the primary and second secondary channel.

14. A method as claimed in Claim 12, wherein the method comprises winding the coil between the primary and the first secondary channel until the

first secondary channel is filled to a pre-determined level, and subsequently winding the coil between the primary and the second secondary channel until the second secondary channel is filled to a pre-determined level.

15. A method as claimed in any of Claims 12 to 14, wherein the method comprises mounting the stator core to the bobbin such that the primary channel is located between first and second pole arms of the stator core, and the first and second secondary channels are located on a coreback of the stator core.

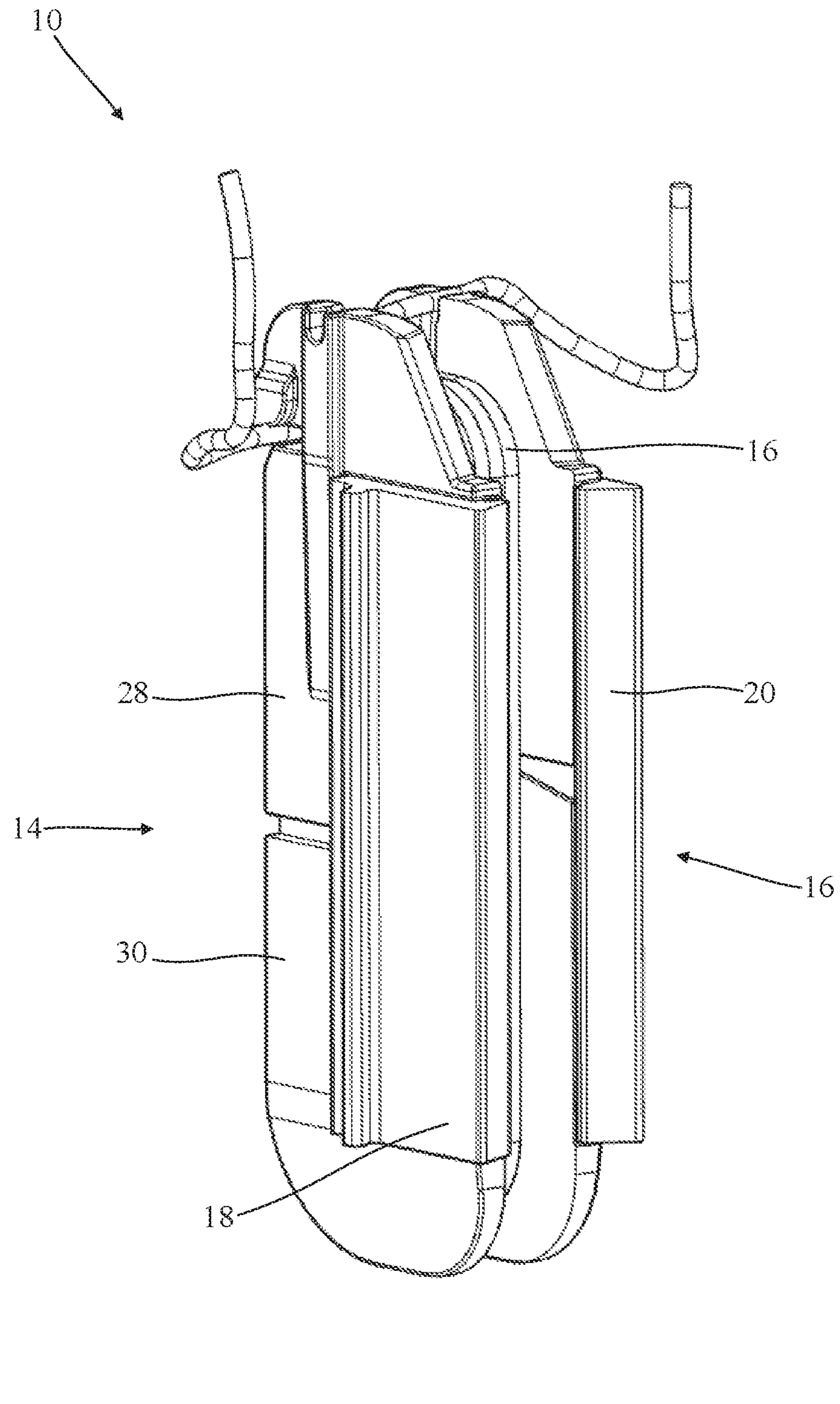

Fig. 1

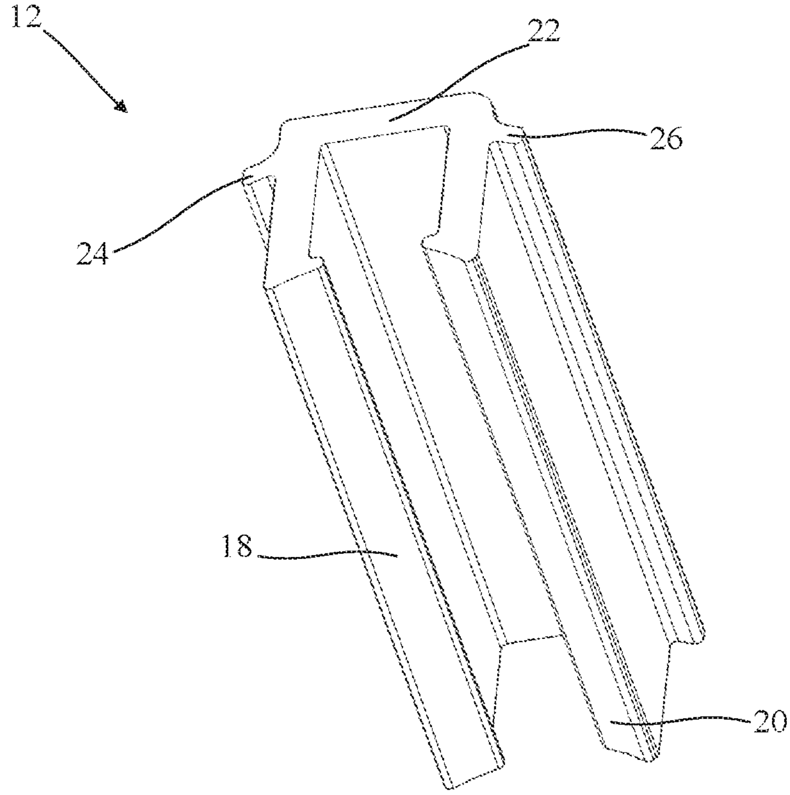

Fig. 2

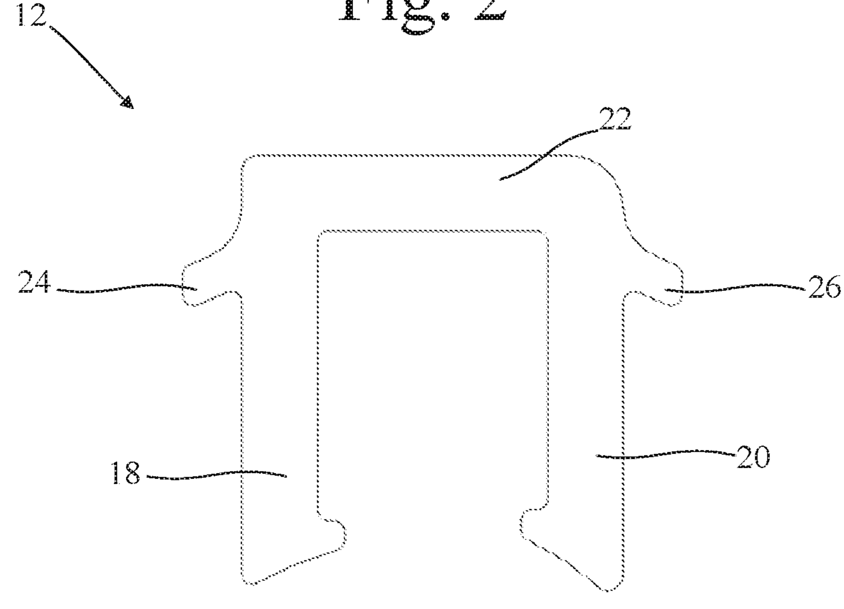

Fig. 3

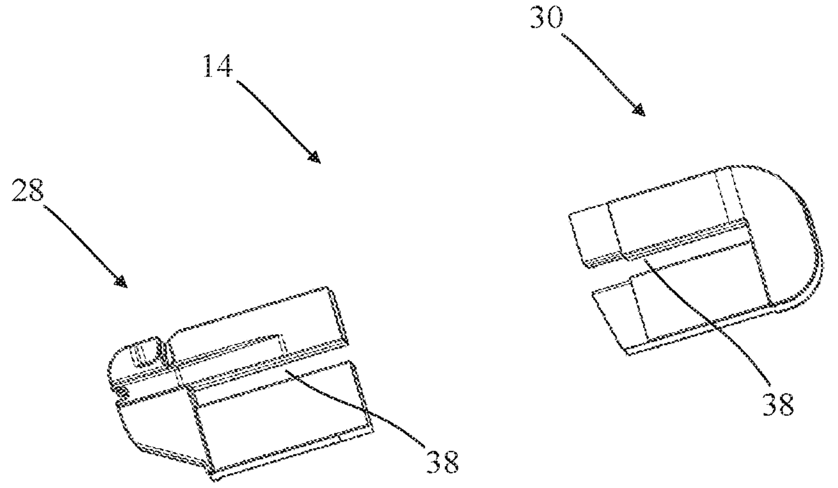

Fig. 4

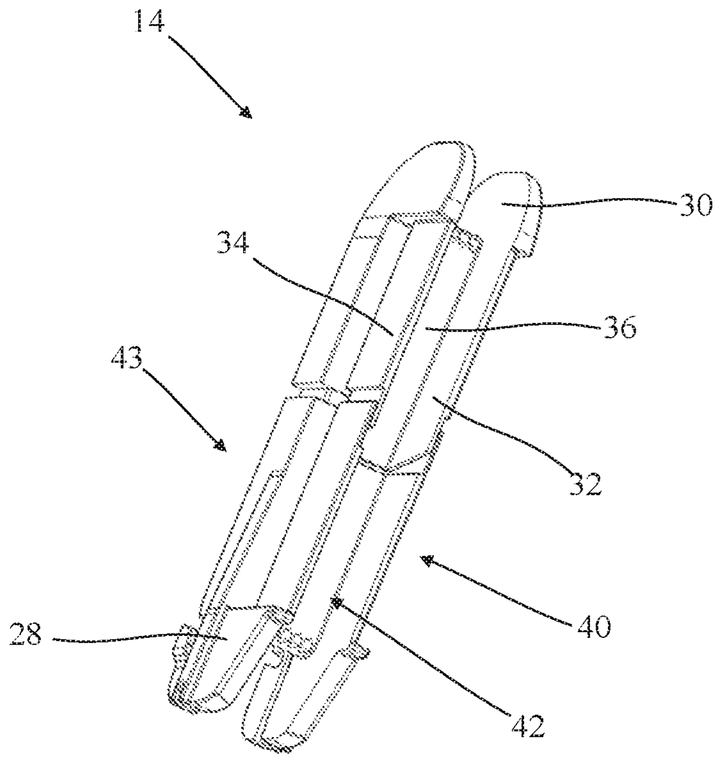

Fig. 5

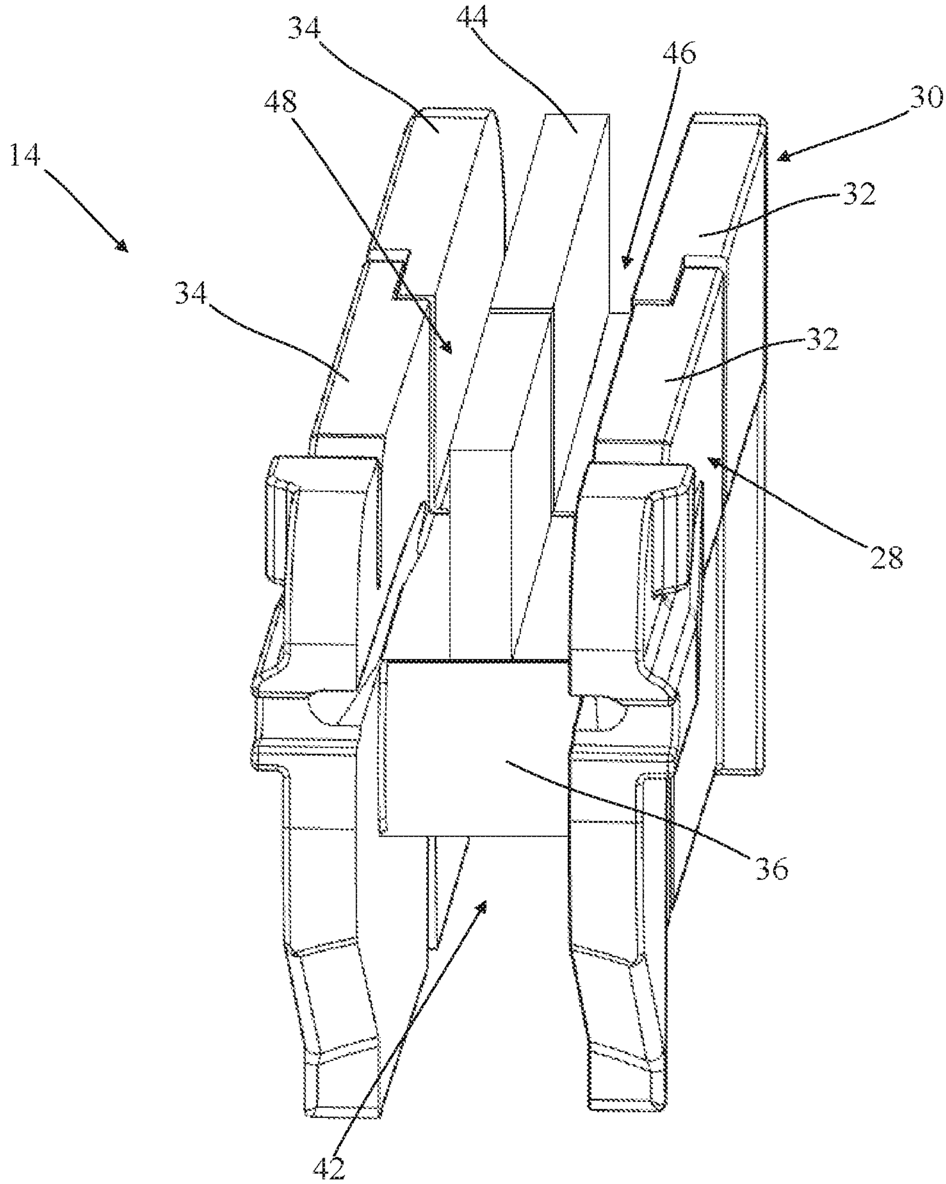

Fig. 6

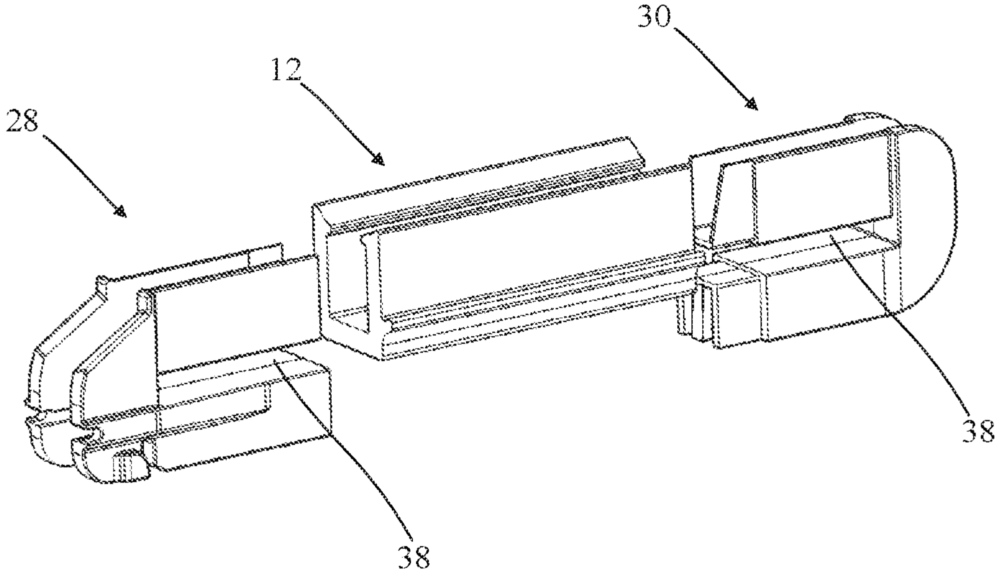

Fig. 7

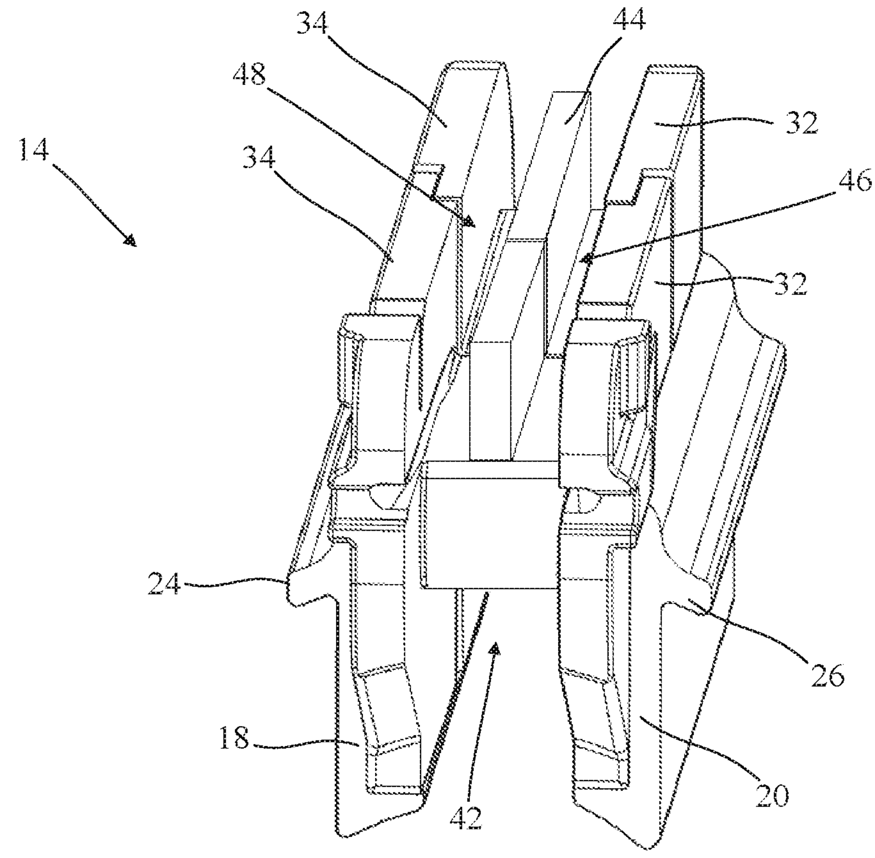

Fig. 8

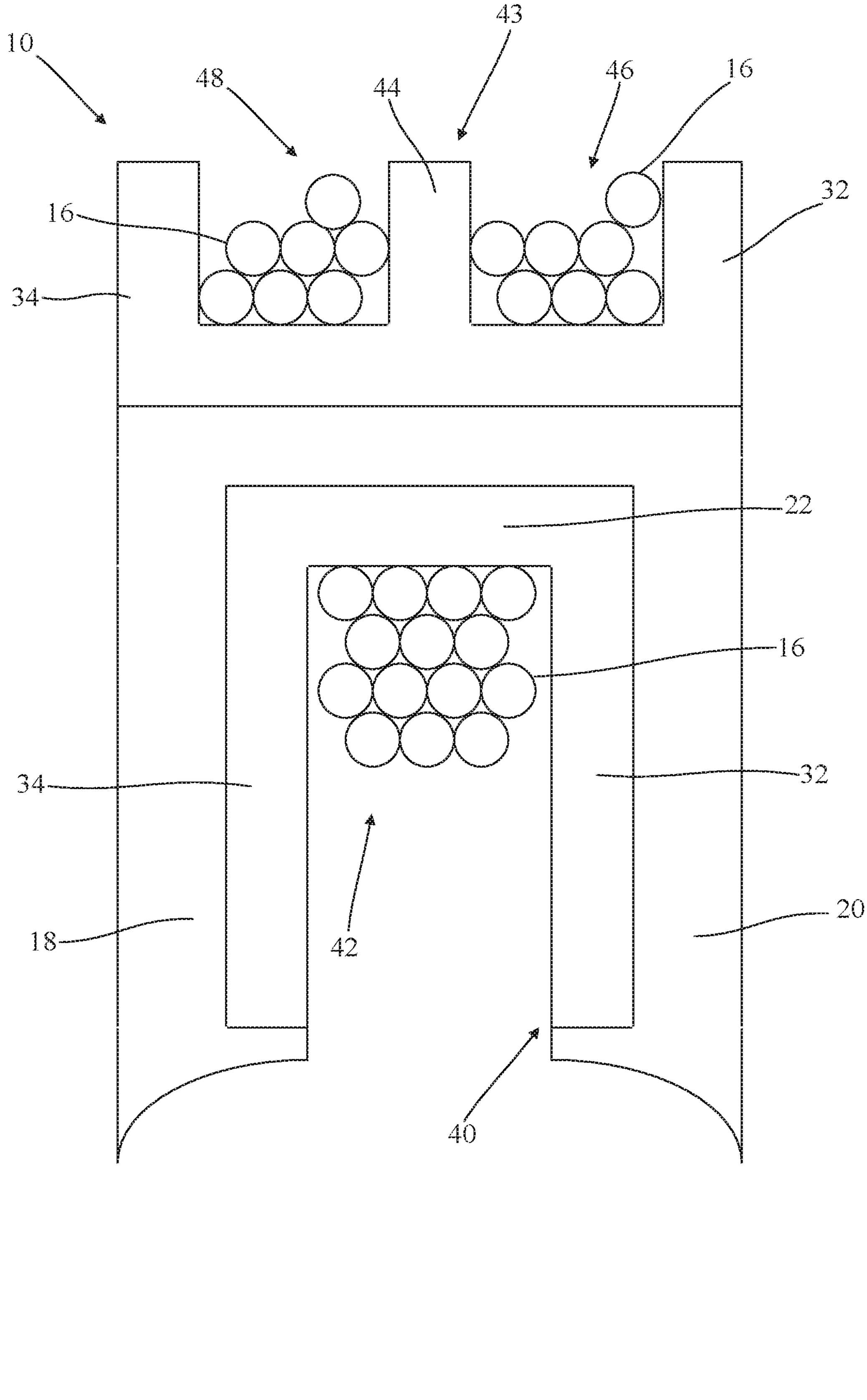

Fig. 9

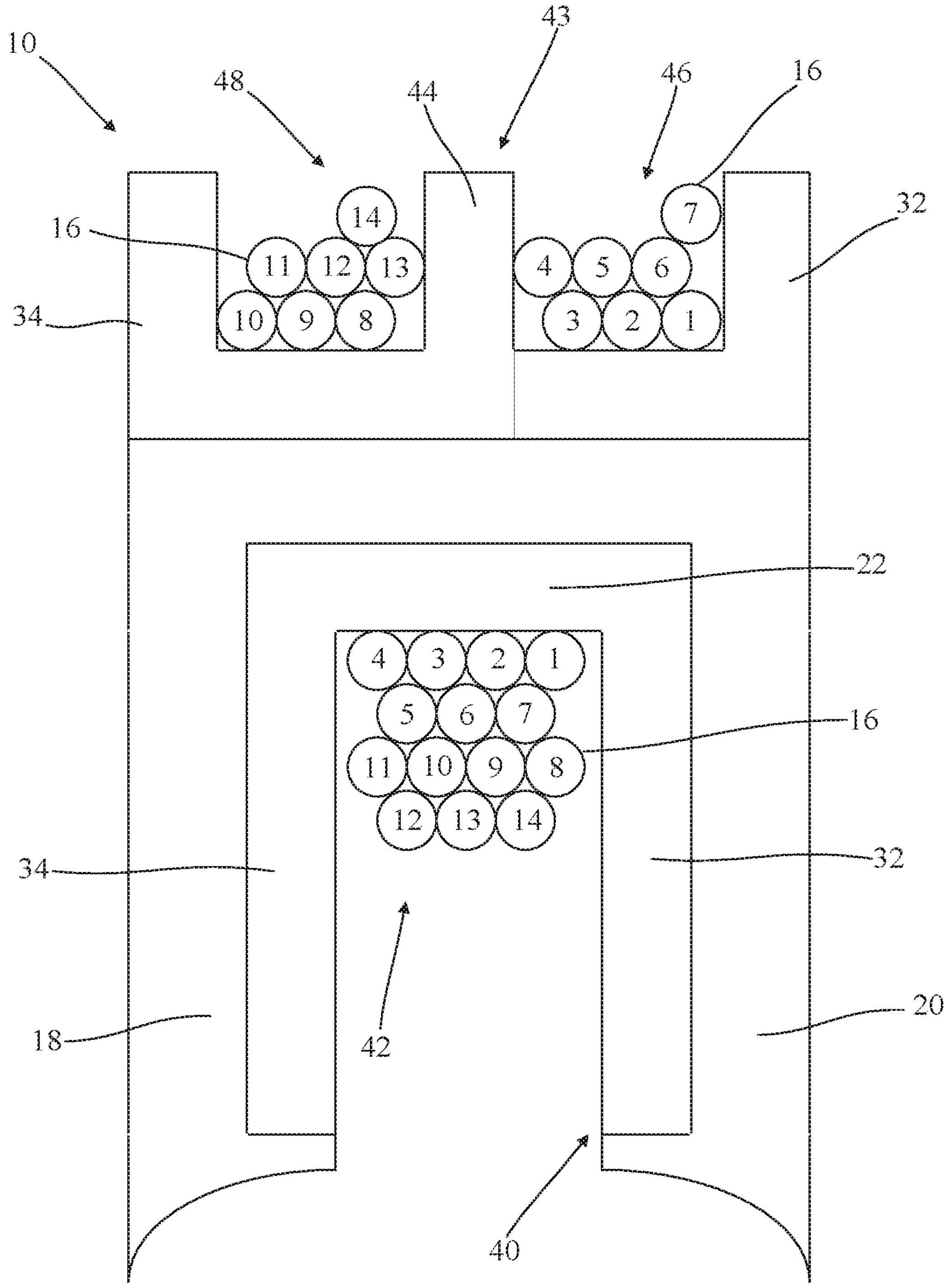
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Fig. 10

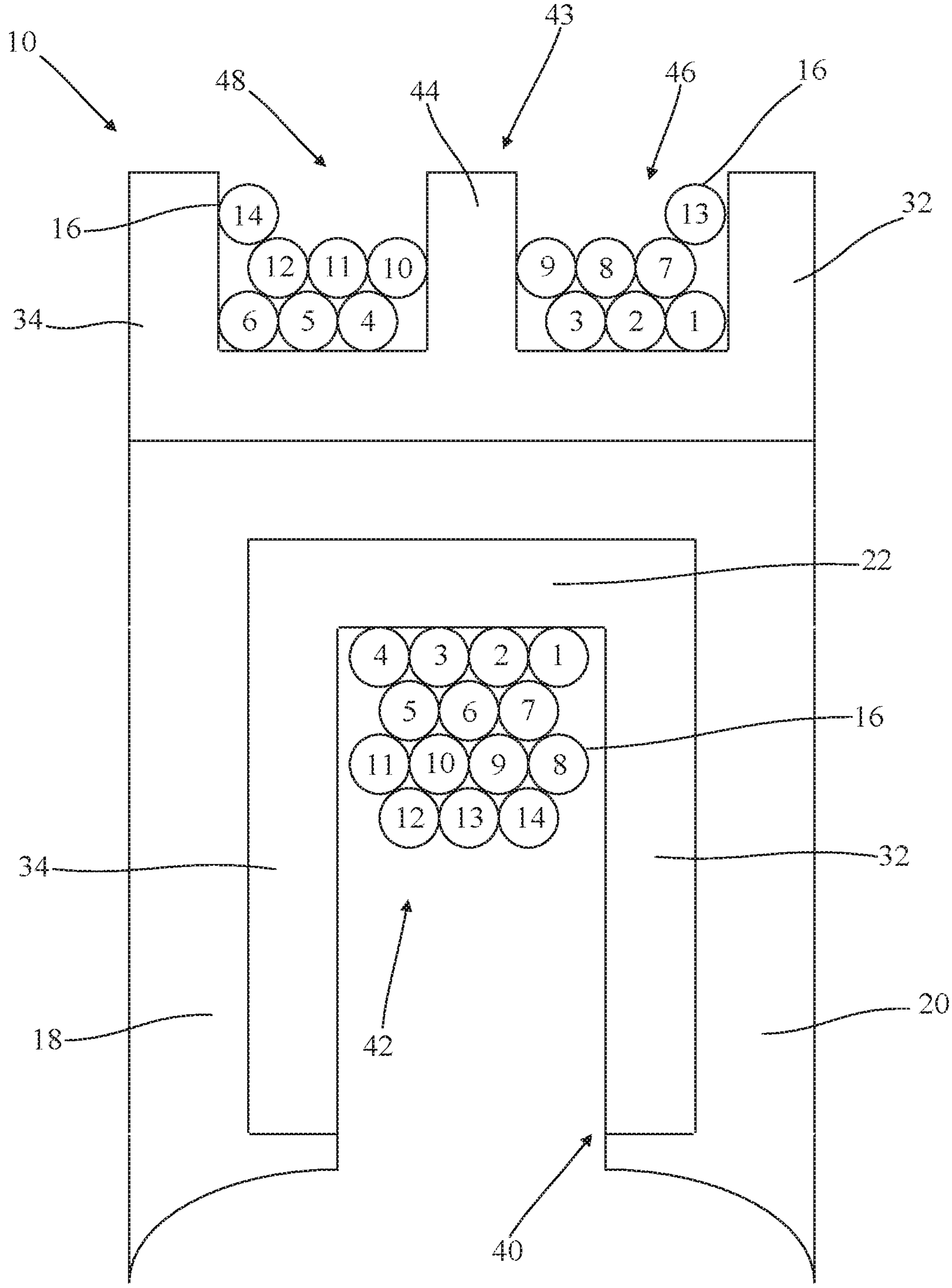
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Fig. 11

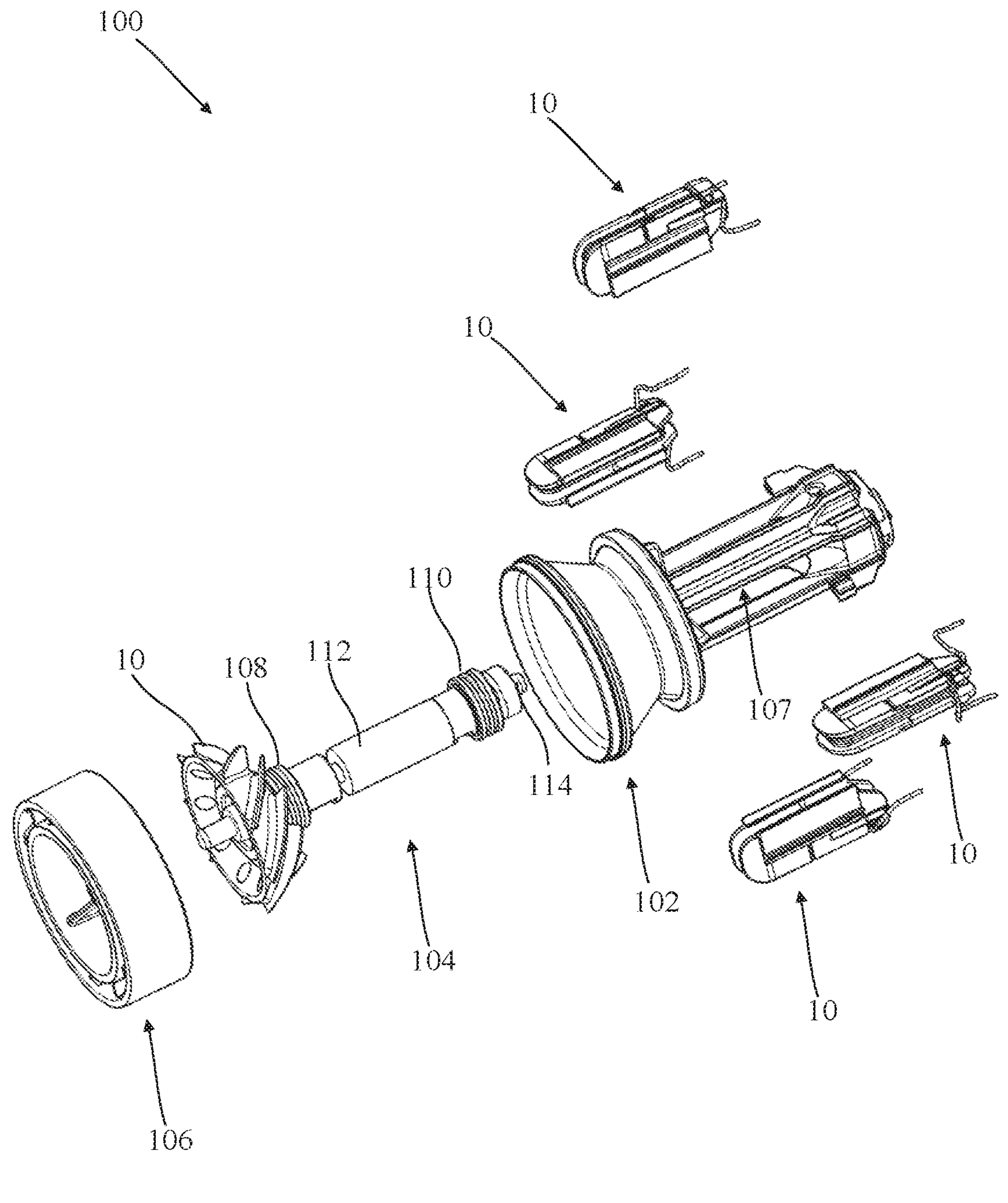

Fig. 12

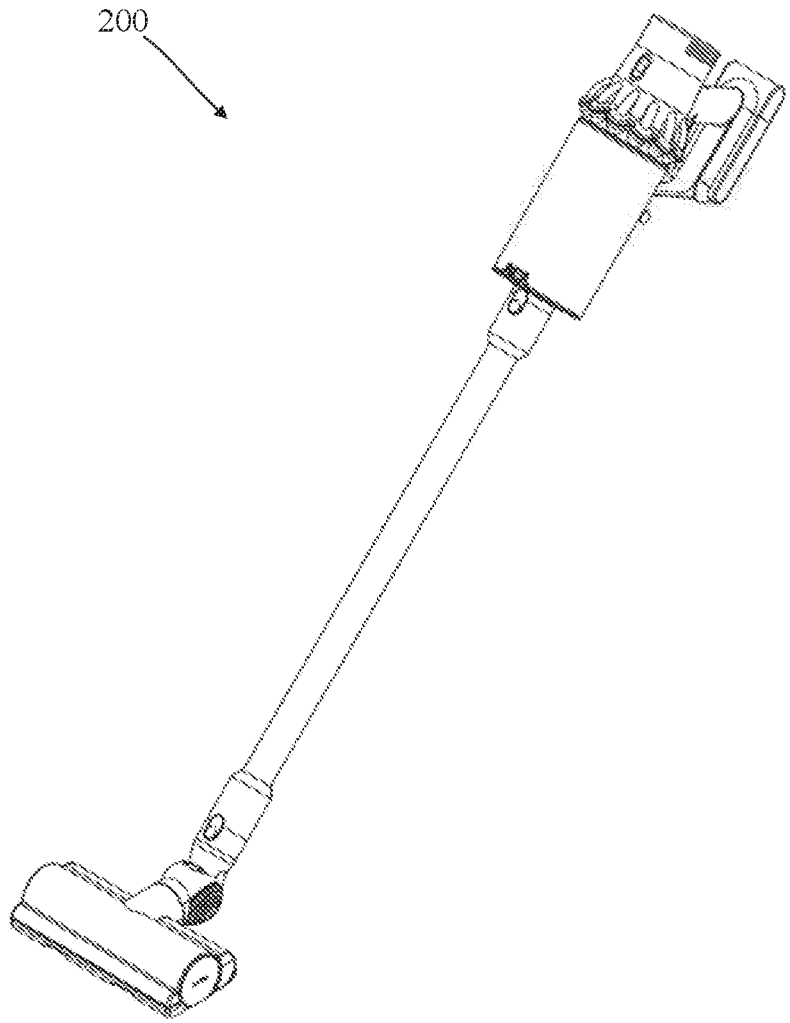

Fig. 13

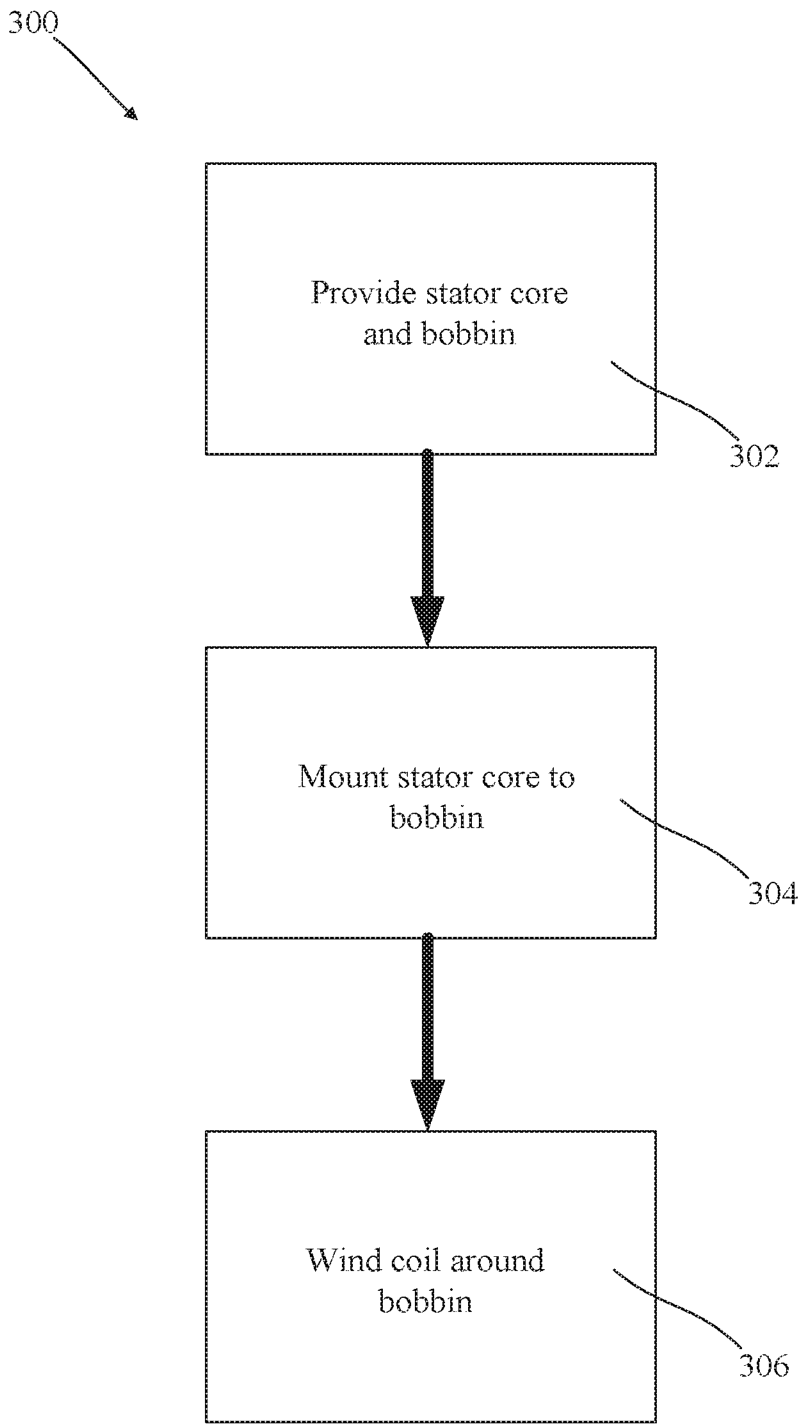
300
Provide stator core and bobbin
302
Mount stator core to bobbin
304
Wind coil around bobbin
306

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/052386

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02K1/14 H02K3/52 H02K15/095
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)
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 Y A	US 2010/264773 A1 (HINO TATSURO [JP] ET AL) 21 October 2010 (2010-10-21) paragraphs [0036], [0047] - paragraph [0052]; figures 11-17,24 -----	1,3,4,6, 10,12 11 13-15
X	EP 2 551 993 A1 (NISSAN MOTOR [JP]) 30 January 2013 (2013-01-30) paragraph [0010] - paragraph [0024]; figures 1-4 paragraph [0038] - paragraph [0043]; figures 6,7 -----	1,3,5
Y	EP 3 208 914 A1 (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORP [JP]) 23 August 2017 (2017-08-23) paragraph [0002]; figures 1,2,7 ----- -/--	11

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

[X] See patent family annex.

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"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
10 October 2019	18/10/2019

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	Sedlmeyer, Rafael

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/052386

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	GB 1 012 718 A (PHILIPS ELECTRONIC ASSOCIATED) 8 December 1965 (1965-12-08) page 2, line 3 - line 38; figure 1 -----	2,7-9

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2019/052386

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