(12) UK Patent Application (19) GB (11) 2 025 704 A

(21) Application No **7923234**
(22) Date of filing **4 Jul 1979**
(23) Claims filed **4 Jul 1979**
(30) Priority data
(31) **53479U**
(32) **5 Jul 1978**
(33) **Italy (IT)**
(43) Application published
23 Jan 1980
(51) **INT CL³**
H02K 7/18
(52) Domestic classification
H2A WK
(56) Documents cited
GB 1513871
GB 1395976
GB 1370655
GB 1349746
GB 1261725
GB 1233748
GB 1207046
GB 1167651
(58) Field of search
H2A
(71) Applicant
Whitehead Motofides S.p.A.
Via Salvatore Orlando, 10
57100 Livorno,
Italy
(72) Inventor
Giovanni Nardi
(74) Agents
Boult, Wade & Tennant

(54) **Alternator for an i.c. engine**

(57) An alternator for internal combustion engines comprises a rotor 14, 15 rotated by the engine and separated by a planar air gap from a stator 16, 17. The rotor comprises a permanent magnet annulus 14 located in a recess in the engine flywheel 12 and the stator comprises laminated cores fixed to a removable cover 6 of the i.c. engine.

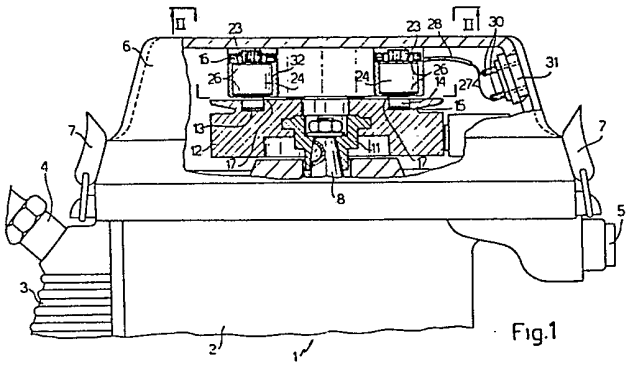

Fig.1

GB 2 025 704 A

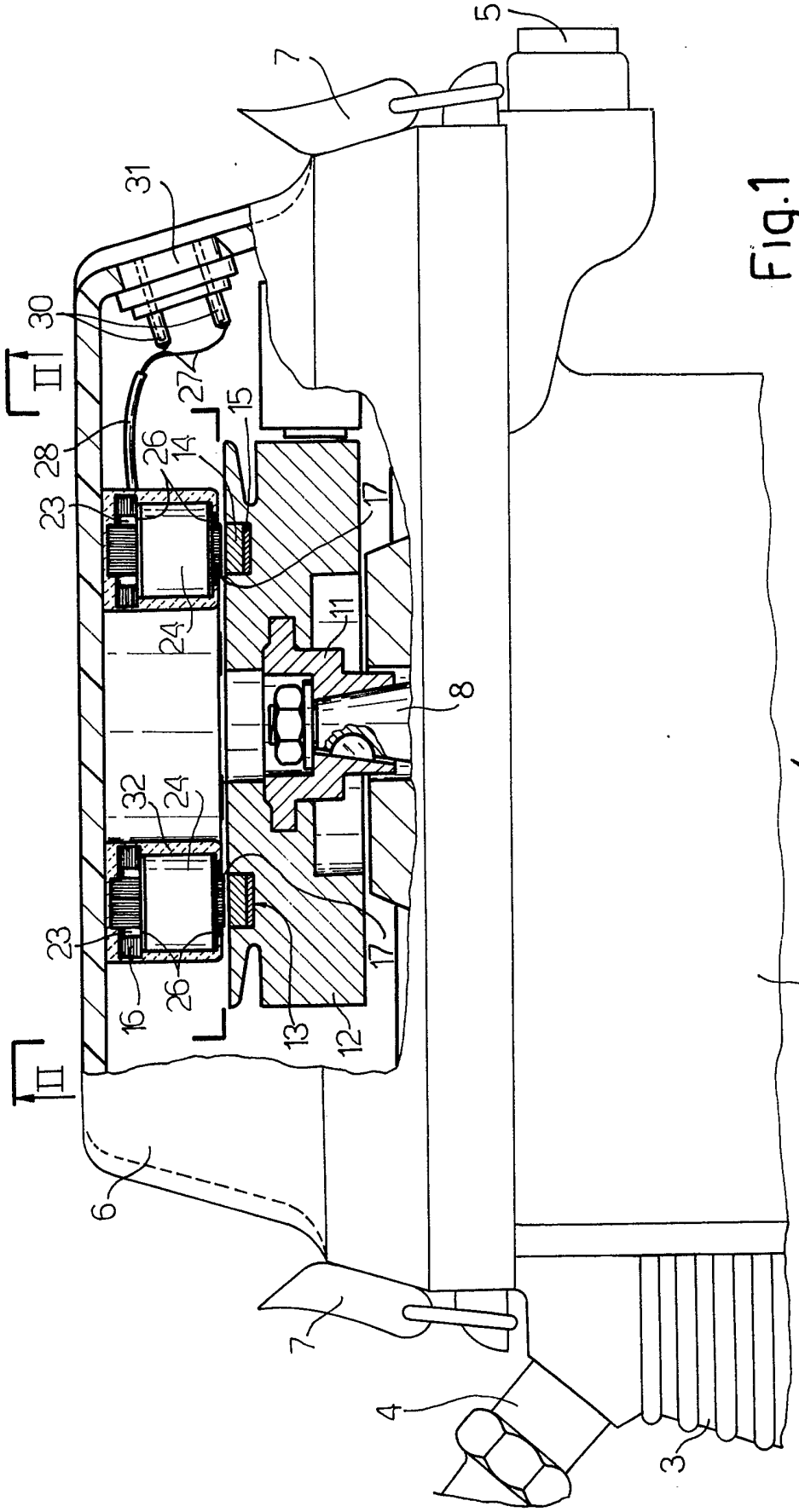
5
7
31
30
II
27
15
28
26
14
23
17
24
11
8
32
24
23
17
16
26
13
12
II
6
7
4
3
2
1'

Fig.1

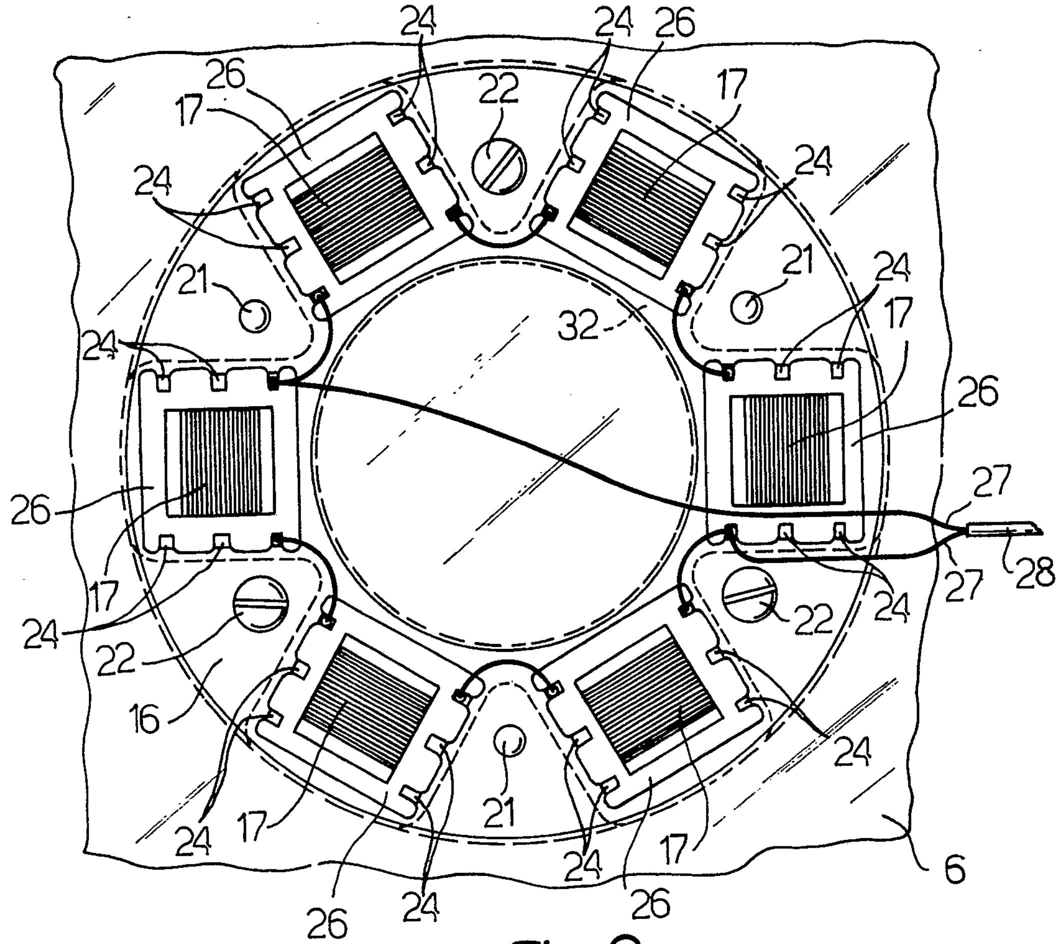
24
24
26
26
22
17
17
24
24
21
21
32
24
24
17
26
26
27
28
27
24
24
22
17
24
22
16
24
24
17
21
24
17
26
24
26
6

Fig.2

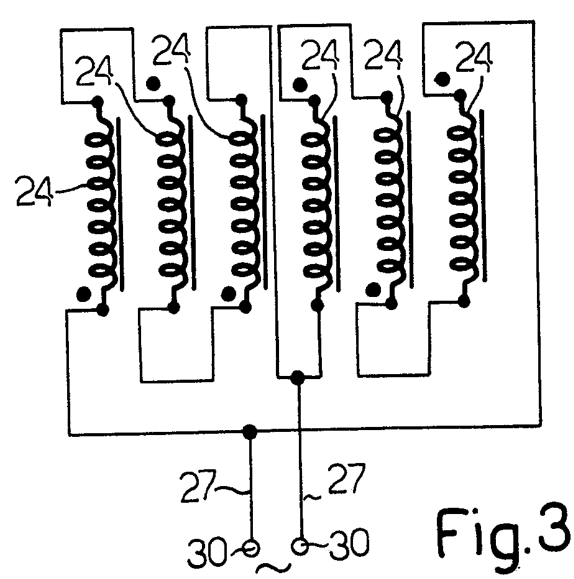
24
24
24
24
24
24
27
27
30
30

Fig.3

SPECIFICATION

Alternator for a marine engine

This invention relates to an alternator for internal combustion engines, in particular for outboard marine engines, and of the type comprising a rotor rotated by the engine, and a fixed stator, which faces the rotor and from which an alternating electrical voltage is taken.

In the various known embodiments, the rotor, which creates the magnetic field, is generally disposed such that the lines of flux in the air gap between the rotor and stator are substantially perpendicular to the axis of rotation of the rotor. However, such an arrangement of the rotor gives rise to substantial centrifugal stresses, and sometimes leads to constructional difficulties, especially where fitting to engines which are already constructed and therefore have their component members already prearranged.

The object of the present invention is to provide an alternator for internal combustion engines, in particular for marine engines, which does not comprise the aforesaid drawbacks, i.e. which does not give rise to additional stresses in the rotating members, nor gives rise to constructional or installation difficulties, and which is also particularly suitable for fitting to already constructed engines, for example as an accessory.

The invention provides an alternator for internal combustion engines, comprising a rotor rotated by said engine, and a fixed stator which faces the rotor and from which an alternating electrical voltage is taken, wherein in the air gap between the rotor and stator, the lines of flux of the magnetic field are substantially parallel to the axis of rotation of the rotor.

The present invention will be more apparent from the description of one embodiment given hereinafter by way of non-limiting example with reference to the accompanying drawings in which:

Figure 1 is a partly sectional side view of an outboard engine to which the alternator of the present invention is fitted;

Figure 2 is a section on the line II-II through the alternator of Figure 1; and

Figure 3 shows the basic electrical circuit diagram of the alternator of the present invention.

With reference to Figure 1, the alternator of the present invention is shown fitted to an outboard engine of known type, indicated overall by the reference numeral 1, of which the upper part is illustrated, showing an engine casing 2, a cylinder head 3, part of a sparking plug 4 and an extinguishing pushbutton 5. A cover 6 can be hooked on to the top of the engine by two hooks 7. The cone frustum end 8 of the drive shaft passes through the engine casing 2 and into the cover 6, and is fixed in known manner to a steel part 11 connected to a substantially cylindrical flywheel 12 of known type, advantageously of mazak, and comprising in its upper side region a groove in which a pull-starting cord is wound.

The upper face of the flywheel 12 is provided with an annular cavity 13, in which the rotor of the alternator according to the present invention is housed. This rotor is constituted by an annular plate 14 of permanent magnetic material, for example plastoferrite, disposed coaxially with the axis of rotation of the flywheel 12, and contained in a plane perpendicular to this axis, and disposed substantially in line with the upper surface of the flywheel 12. A relatively small thickness annular plate 15 of ferromagnetic material, advantageously soft iron, is disposed below said annular plate 14 in the cavity 13.

The rotor contained in the annular cavity 13 is faced by the stator, which is fixed to the cover 6 and is shown in Figure 2. The stator comprises a ferromagnetic core constituted by an annular base part 16 disposed coaxially to the axis of rotation of the flywheel 12, and contained in a plane perpendicular to this axis, and comprising a plurality of columns 17 (six in the example shown) which are disposed parallel to the axis of rotation of the flywheel 12 along the annular rim defined by said annular part 16. The columns 17 are fixed at one end to the annular part 16, and their other end faces the annular plate 14 at a short distance therefrom, to define a small air gap. Both the annular part 16 and columns 17 are constructed from a plurality of similar elements formed into a pack. The annular base part 16 is conveniently constructed by superposing ten single identical elements comprising three bores disposed at 120° apart, in which three rivets 21 are placed to lock the single elements into a pack and thus form the annular part 16 overall, and they also comprise a further three bores disposed at 120° apart through which three screws 22 pass for fixing the annular part 16 and consequently the stator to the inner surface of the cover 6. The annular part 16 also comprises six through apertures which house the six columns 17. Each column 17 is formed from a plurality of single elements (for example twentyfour) fitted together into a pack by means of a rivet 23 fixed towards the end housed in the aperture in the annular part 16. For this purpose, this aperture has a profile such that it can also house the rivet 23. Around each column 17 there is provided a relative winding 24 constituted by a pluraity of turns wound on a spool with a central cavity into which the column 17 is inserted, and an upper and lower base wall 26. The ends of the various windings 24 are connected together in accordance with the electrical circuit diagram shown in Figure 3, in which two groups, each consisting of three series-connected windings 24, are connected in parallel. The ends of these two groups are connected to two terminals 30 of a socket 31 fixed to the cover 6, by means of two wires 27 inside a single sheath 28.

The described alternator of the present invention is assembled as follows.

The annular cavity 13 is first formed in the flywheel 12, and the annular plate 14 and annular plate 15 are then fixed in this cavity by three screws 120° apart. The three permanent magnetic poles, of alternately opposite signs, are then formed in the annular plate 14 by a suitable apparatus constituted advantageously by columns disposed so that they

face the annular plate 14, and in which the magnetic fields of alternately opposite sign are created. In this manner, six magnetic poles (the same number as the columns 17) are formed in the annular plate 14, these being spaced equidistantly apart and of alternately opposite signs, their lines of flux being parallel to the axis of rotation of the flywheel 12. Between two consecutive magnetic poles (of opposite sign) there is a neutral zone, in three of which are disposed the screws for fixing the plates 14 and 15 to the flywheel 12. The stator is constructed by fixing together the pack for the annular base part 16 using the three rivets 21, then fixing together the pack for the six columns 17 using the rivets 23, then inserting the six columns 17 into the corresponding apertures in the annular base part 16, and then fixing the columns 17 to the part 16 by squeezing the upper projecting part of said columns 17 along two lateral grooves already formed in the elements making up the pack for the columns 17, then fixing each winding 24 on to its column 17 by inserting the columns 17 into the central cavity in the spool and bending the two side elements of the columns 17 on to the lower base wall 26 of the spool so as to fix it in position, then making the electrical connection between the terminals of the various windings 24 in accordance with the arrangement of Figure 3, and then impregnating the six windings 24 on the columns 17 with insulating material 32, advantageously epoxy resin. The stator constructed in this manner can then be fixed into the cover 6 by three screws 22, and the wires 27 can then be connected to the terminal 30. The cover 6 can then be fixed to the motor casing 2 by the hooks 7 such that the stator faces the rotor coaxially and at a short distance therefrom, as shown in Figure 1.

The operation of the described alternator according to the present invention is as follows. The cone frustum end 8 of the drive shaft rotates the flywheel 12 and consequently the annular plate 14 comprising the plurality of magnetic poles, which cause a variation in the flux linkage with the windings 24 of the stator, and an alternating induced electromotive force is therefore produced in these windings and is available at the socket 31. The value of this voltage and its frequency depend on the constructional characteristics of the alternator. The voltage can advantageously be 12 Volts and the frequency 50 Hz. The flux lines of the magnetic field created by the magnetic poles of the annular plate 14 pass through the air gap between the rotor and stator in a direction substantially parallel to the axis of rotation of the flywheel 12, then pass through the relative facing column 17, traverse the annular base part 16, then pass back through an adjacent column 17, again traverse the air gap and a pole of opposite sign in the annular plate 14, and then return to the previous pole through the annular plate 15.

With the described alternator of the present invention, there is consequently the advantage that because of the arrangement of the rotor such that lines of flux from the relative magnetic poles pass through the air gap in a direction parallel to the axis of rotation of the rotor, said rotor can be conveniently housed in the flywheel in a plane perpendicular to the axis of rotation of the flywheel, and is therefore involved in no centrifugal stress due to additional elements. The arrangement of the stator above the upper surface of the flywheel facilitates installation of the facing stator, which is easily fitted in the case of outboard engines, and in no way prevents removal of the cover, so that it is always possible to pull-start the engine by winding the cord around the groove in the flywheel 12. This arrangement of the stator and rotor also enables the alternator to be easily added as an accessory to already constructed engines.

Finally, it is apparent that modifications can be made to the alternator of the present invention which do not leave the scope of the inventive idea. Accessory elements can also be added, such as a rectifier block and/or voltage regulator for the alternating voltage produced by the alternator. The rectifier block can for example be contained inside the cover 6 and connected between the wires 27 and terminals 30.

CLAIMS

1. An alternator for internal combustion engines, comprising a rotor rotated by said engine, and a fixed stator which faces the rotor and from which an alternating electrical voltage is taken, wherein in the air gap between the rotor and stator, the lines of flux of the magnetic field are substantially parallel to the axis of rotation of the rotor.

2. An alternator as claimed in claim 1, wherein said rotor is rigid with a flywheel of said engine

3. An alternator as claimed in claim 2, wherein said rotor is embedded in an annular seat provided in said flywheel, so that it is coaxial to the axis of rotation of said flywheel and is contained in a plane perpendicular to said axis.

4. An alternator as claimed in claim 3, wherein said annular seat is provided in the upper surface of said flywheel.

5. An alternator as claimed in one of claims 2 to 4, wherein said rotor comprises a core of permanent magnetic material which creates a plurality of magnetic poles of alternately opposite signs, which are disposed facing said air gap along a circumference and of which the lines of flux are parallel to said axis of rotation of the rotor.

6. An alternator as claimed in claim 5, wherein said core of permanent magnetic material comprises an annular plate of permanent magnetic material, a plate of ferromagnetic material being disposed below said plate and opposite the air gap in order to close the circuit for the lines of flux of the magnetic field.

7. An alternator as claimed in claim 6, wherein said annular plate of permanent magnetic material is of plastoferrite.

8. An alternator as claimed in one of the preceding claims, wherein said stator is fixed to a removable cover of said engine.

9. An alternator as claimed in one of the preceding claims, wherein said stator comprises a core of ferromagnetic material for closing the circuit of the lines of flux of the magnetic field, said core compris-

ing a plurality of columns which at one end face said rotor and which are connected at their other end to an annular part.

10. An alternator as claimed in claim 9, wherein said columns are disposed parallel to the axis of rotation of the rotor, and said annular plate is coaxial to the axis of rotation of said rotor and is contained in a plane perpendicular to said axis.

11. An alternator as claimed in claim 9 or 10, wherein said columns and said annular part are constructed from a plurality of elements fixed together into a pack.

12. An alternator as claimed in one of claims 9 to 11, wherein said columns are disposed in apertures in said annular part, and are fixed by squeezing the end region of said columns.

13. An alternator as claimed in one of claims 9 to 12, wherein windings from which said alternating electrical voltage is taken are disposed around said columns.

14. An alternator as claimed in claim 13, wherein said windings are connected together so as to form two parallel groups of series-connected windings.

15. An alternator as claimed in claim 13 or 14, wherein said windings and said columns are impregnated with insulating material.

16. An alternator as claimed in one of claims 9 to 15 and dependent on claim 5, or one of claims 6 to 8 and dependent on claim 5, wherein the number of said columns is equal to the number of the magnetic poles in said rotor.

17. An alternator as claimed in one of the preceding claims, comprising a rectifier block for said alternating electrical voltage.

18. An alternator as claimed in one of the preceding claims, wherein said engine is a marine engine.

19. An outboard engine comprising an alternator as claimed in one of the preceding claims.

20. An alternator substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.