

The invention relates to a rotary electromotor to be fed with direct current, comprising:

- (a) a stator with stator poles and a rotor with rotor poles, permanent magnets being provided for the stator poles or for the rotor poles and electromagnets being provided for the respective other poles;
- (b) electronic switching means for switching electromagnets in accordance with the relative positions of the electromagnets and permanent magnets in each case;
- (c) and an arrangement of said permanent magnets and said electromagnets in such a manner that only some of the electromagnets of the electromotor can be switched simultaneously in each case.

Such an electromotor is known from EP-A-0 094 978.

Electronically controlled electromotors are becoming increasingly important in a number of fields of application. The electromotors involved are ones in which the necessary periodic switching of electromagnets is no longer carried out by a commutator but by electronic switching means. The electronic switching means include appropriate sensors which detect when the stator and the rotor are located in relative positions which are favourable for, or necessitate, the switching of the electromagnet or electromagnets to be

switched at the moment. The electronic switching means must of course also ensure that the current supply to the particular electromagnet(s) takes place in the current direction appropriate at the moment.

Electronically controlled electromotors are already known in which permanent magnets have been used either for the stator poles or for the rotor poles. Permanent magnets offer a number of advantages in this connection, among which in particular the lack of current consumption, the small dimensions and the simple production and assembly must be mentioned.

Furthermore, it has already been recognized that it is frequently unfavourable when all permanent magnets and electromagnets of the electromotor must be switched at the same time. Such a situation in which it is necessary to switch all electromagnets of the electromotor simultaneously, arises in particular when the mutual distance between the electromagnet poles and the mutual distance between the permanent magnet poles is equal everywhere. Consequences of the simultaneous switching of all electromagnets involved are that the motor runs relatively irregularly, the mains is loaded pulsatingly and there are difficulties in starting the motor. This may possibly be remedied by arranging the stator poles or the rotor poles not at right angles to the direction of relative movement of the stator poles and rotor poles but such that they diverge slightly from perpendicularity. However, this complicates the construction of the motor.

In a known rotary electromotor of the type mentioned at the outset (EP-A-0 094 978), the necessity of simultaneously switching all electromagnets is avoided by having the number of electromagnets differ from that of the permanent magnets. As a result, either the

electromagnets are all switched at different times or several electromagnets are switched simultaneously which are distributed symmetrically across the periphery of the electromotor and located in analogous relative positions to permanent magnet poles located opposite.

During the work on the present invention, however, it was observed that the switching of adjacent electromagnets at different times involves disadvantages. The switching of a certain electromagnet without simultaneously switching the two adjacent electromagnets leads to disturbing reactions in the two adjacent electromagnets because the switching of the electromagnet under consideration affects the respective adjacent electromagnet via the particular magnetic circuit. This phenomenon is to be referred to as the "transformer effect". Furthermore, there are also reactions in the electronic switching means associated with the adjacent electromagnets. The reactions of the above-mentioned type show themselves in reduced utilization of the electromotor, or reduced efficiency, and in possible overloading and thus destruction of components of the electronic switching means.

It is the object of the invention to make available an electromotor providing a reduction of disturbing reactions between adjacent electromagnets.

To meet this object, it is provided according to the invention

- (d) that several adjacent electromagnets form a group of electromagnets belonging to one phase each, this group cooperating with a number of permanent magnets located opposite;
- (e) that adjacent groups of electromagnets belong to different phases;

(f) and that, for forming a phase difference between adjacent groups of electromagnets,

- either the electromagnet pole distance differs from the - optionally averaged - permanent magnet pole distance at the transition point between adjacent groups of electromagnets;
- or the permanent magnets are arranged in groups of permanent magnets, the - optionally averaged - permanent magnet pole distance within the groups of permanent magnets corresponding to the - optionally averaged - electromagnet pole distance and the permanent magnet pole distance at the transition point between adjacent groups of permanent magnets differing from the - optionally averaged - electromagnet pole distance.

Thus, according to the invention, the adjacent electromagnets belonging to a common group of electromagnets are switched as belonging to one phase very close together in time, preferably simultaneously, and the electromagnets belonging to adjacent groups of electromagnets are switched as belonging to different phases at different times. One will realize that the teaching of the invention leads to the effect that those points of the electromotor at which electromagnets to be switched at different times are adjacent, are reduced in number because they are only present at the boundaries or transition points between the groups of electromagnets. Consequently, the disturbing reactions described above are reduced.

The document DE-A-2 416 695 discloses an electromotor having a permanent magnetic rotor and a winding-carrying stator, in which a plural number of a stator

poles each belongs to a group of stator poles connected to a common phase and in which a pole distance is present between adjacent groups of stator poles which is larger than the pole distance within a stator pole group. However, this electromotor is a synchronous motor operated by alternating current, in which the aim consisted in providing a possibility of increasing the stator pole width, whereas matching to an optimum electronic commutation was insignificant.

The term "pole distance" in the present patent is intended to refer to the distance between the centres of the electromagnet poles and the permanent magnet poles as measured in the direction of the relative movement of the corresponding poles. It is also evident that the electromagnets are switched on in each case by the associated electronic switching means with the current direction that is correct for the propulsive effect.

When the electromotor is composed with groups of permanent magnets, the design is preferably such that all electromagnets of the electromotor have the same mutual pole distance, whereas with respect to the permanent magnets only the pole distances within the groups of permanent magnets are equal to each other and to this electromagnet pole distance and a larger or smaller permanent magnet pole distance is provided at the transition point or boundary between adjacent groups of permanent magnets.

Preferably, the electromagnets within the groups of electromagnets are arranged with the same electromagnet pole distance. When this electromagnet pole distance corresponds to a permanent magnet pole distance which is equal everywhere, this results in the most complete utilization of the electromotor. On

the other hand, it may be advantageous with respect to further evening out the running of the motor and/or for favourably modifying the reverse voltage induced in the electromotor, to vary the electromagnet pole distance slightly within the groups of electromagnets so that the electromagnets, or at least some of them, are switched slightly earlier or slightly later than exactly corresponds to the geometrical relative position to permanent magnets located opposite. Such variation in the pole distances may also be carried out in the case of the permanent magnet poles. In case of such variations, a correspondence of average pole distance should be provided instead where pole distances corresponding to each other are referred to.

Due to the fact that the electromagnets belonging to a common group of electromagnets are preferably switched simultaneously, it is preferably possible to work with one common electronic switching means per group of electromagnets. However, it may also be favourable in the case of certain designs to divide the switching power up among several electronic subswitching means controlled, for example, by a common sensor means for detecting the relative position of the groups of electromagnets to the permanent magnets. As the switching power decreases, the price of the electronic subswitching means decreases superproportionally. Furthermore, this increases the protection against total failure of the electromotor.

In particular when the teaching of the invention is realized by reduced electromagnet pole distances between the groups of electromagnet poles, it is preferred as favourable to provide electromagnet poles with little or no winding on the ends of the groups of electromagnets. This does justice to the limited space conditions especially at these points.

The areas on the ends of the groups of electromagnets may quite generally be used in favourable manner for the attachment or the additional attachment of the electromagnets of each group to the stator or to the rotor. More room can be gained in a particularly favourable manner when the electromagnet pole distance is larger at the ends of the groups of electromagnets.

In a preferred development of the invention, the electromagnetic iron circuit is disconnected at the transition point between adjacent groups of electromagnets. In this way the disadvantageous reactions of adjacent electromagnets to be switched at different times, as described above, may also be prevented effectively at these points.

Further preferred features which may be realized in the electromotor according to the invention can be found in EP-A-0 094 974. The contents of this publication are made part of the disclosed contents of the present application by virtue of this explicit reference.

Not only electromotors but also electrogenerators may be constructed analogously according to the teaching of the invention, so that the claims and the description of the present invention relate analogously to generators as well.

The invention and developments of the invention shall be explained in more detail in the following by way of several embodiments which are shown schematically in part. The figures show:

Fig. 1 a cross-sectional view of a first electromotor;

Fig. 2 a diagram of the variation with time of the sensor signals for the individual groups of electromagnets;

Fig. 3 a developed view of part of a second electromotor;

Figs. 4 and 5 side views of several configurations of the transition point between groups of electromagnets.

The electromotor 2 shown in Fig. 1 has a substantially hollow cylindrical rotor 4 and a stator 6 arranged in the interior of said rotor. Permanent magnets 8 are attached around the inner periphery of rotor 4 in an annular arrangement with alternating polarity 28 and an equal permanent magnet pole distance 10 between them. Altogether 25 radially extending electromagnets 12 are attached to stator 6, the windings 14 present for all electromagnets 12 being shown at only two places. The radially outer surface of each electromagnet 12 constitutes an electromagnet pole 16, while the radially inner limiting surface of each permanent magnet 8 constitutes a permanent magnet pole face 18. Electromagnet pole faces 16 and permanent magnet pole faces have an air gap between them in the radial direction. Radially outside the circular row of permanent magnets 8 there is a cylindrical, magnetically

conductive part 20 as a magnetic return path for the backs of permanent magnets 8 located on the outside.

Five electromagnets 12 each are joined to form a group 22 of electromagnets, the electromagnet pole distances 24 within this group 22 being equal to each other and equal to permanent magnet pole distances 10. At the transition point between each group 22 of electromagnets and the adjacent group 22 of electromagnets, the electromagnet pole distance 26 at the group boundaries is 1.6 times the electromagnet pole distance 24 within the groups 22 of electromagnets. Permanent magnets 8 are directly adjacent each other in the peripheral direction.

In each group 22 of electromagnets, an electromagnet pole 16 is provided at the left-hand or right-hand end, in the peripheral direction, with a sensor 28 which is preferably designed as a Hall sensor. Each sensor 28 generates a signal, for example, when it is opposite a permanent magnet north pole, and generates no signal when it is opposite a permanent magnet south pole. The signal state of each sensor 28 is fed electrically to an electronic switching means 30, one switching means 30 being provided per group 22 of electromagnets and only two switching means 30 being shown in the figure for the sake of simplicity. When a signal of sensor 28 of a group 22 of electromagnets is present, switching means 30 of this group 22 ensures that all five electromagnets 12 of this group 22 are subjected to current, the electrical connection of the windings 14 to each other or to switching means 30 being such that adjacent electromagnets 12 of this group 22 carry current in opposite current directions. When sensor 28 of this group 22 does not provide a signal, switching means 30 ensures that all electromagnets 12 of this group 22 carry current in the

current direction opposite to the previous one. Thus, sensor 28 and switching means 30 ensure that all electromagnets 12 of group 22 under consideration have their current direction reversed when the five electromagnet poles 16 are just located centrally opposite five permanent magnet poles 18.

Due to the larger electromagnet pole distance 26 at the group boundaries, each group 22 of electromagnets which is adjacent is switched over subsequently so that all five groups 22 of electromagnets are switched over within the period the rotor 4 requires to rotate further past one permanent magnet pole distance 10. The switching over rhythm then begins again by switching over the first group 22 of electromagnets.

It is indicated in the lower part of Fig. 1 that switching means 30 may also be divided up into two subswitching means 30' and 30'', each subswitching means switching only some of electromagnets 12 of the particular group 22. A separate subswitching means may also be provided for each electromagnet 12. The various subswitching means are jointly controlled by sensor 28 of this group 22. Thus, the switching power of each subswitching means is smaller than the overall switching power of a common switching means 30 would have to be.

The individual electromagnets 12 have bases 32 on the radial inside which are enlarged in the peripheral direction. Within each group 22 of electromagnets these bases 32 abut in the peripheral direction, thereby closing the magnetic circuit at these points. Bases 32 do not abut at the boundary between each group 22 and the adjacent group 22, so that there is a disconnection of the magnetic circuit here.

Rotor 4 is of course mounted in front of and/or behind the plane of projection of Fig. 1, whereby the rotor may be guided closer to the centre of the rotational movement by face walls and mounted in an area with smaller diameter.

The radially outer part of electromotor 2 provided with permanent magnets 8 might also serve as a stationary stator and the part disposed inside and provided with the electromagnets could rotate. Electromagnets 12 might also be attached, protruding radially towards the inside, to the cylindrical outer part of electromotor 2, while permanent magnets 8 are attached on the outside to the radially inside part of electromotor 2.

Fig. 2 illustrates the timing of the signals of the sensors 28 of the particular groups 22 of electromagnets. The time is depicted in the horizontal direction. The rectangular boxes on the five horizontal lines refer to those time periods in which the particular sensor 28 provides a signal because it is located opposite a permanent magnet north pole. The sections between these boxes refer to the time periods in which the particular sensor 28 does not provide a signal because it is located opposite a permanent magnet south pole. At the beginning and at the end of each box all five electromagnets 12 of the group 22 of electromagnets controlled by the particular sensor 28 are switched over.

It can be seen especially clearly in Fig. 2 that after a time period t_1 corresponding to the continuing rotation of rotor 4 by 0.6 times one permanent magnet pole distance 10, the group 22 of electromagnets which is then adjacent is switched over.

Instead of providing an electromagnet 12 of each group 22 with one sensor 28, as described with reference to Fig. 1, one may also attach a first sensor to the left-hand edge of an electromagnet pole 16 in Fig. 1 and a second sensor to its right-hand edge in Fig. 1. The first sensor responds to magnetic north poles and the second sensor to magnetic south poles. When the first sensor is located opposite a magnetic north pole and the second sensor is located opposite a magnetic south pole, a signal is generated. When the first sensor is located opposite a magnetic south pole and the second sensor is located opposite a magnetic north pole, no signal is generated. The mode of operation of switching means 30 remains the same as described hereinbefore.

A further possibility consists in making electromagnet poles 16 somewhat shorter in the peripheral direction than permanent magnet poles 18 (as indicated in Fig. 1) and not only one switching over electromagnets 12 with respect to the direction of current flow, but switching them off for a short period following a time interval with a first direction of current flow, switching them on for the opposite second direction of current flow, then switching them off again for a short period, and so on. In this manner, current flow time intervals which contribute relatively little to the generated torque can be eliminated.

Fig. 3 shows the developed view of part of electro-motor 2 having a stator 6 and a rotor 4. Rotor 4 moves in a direction A of relative movement relative to stator 6. Permanent magnets 8 with permanent magnet pole faces 18 are attached to the top of stator 6 with their polarity alternating along the stator. The permanent magnets are arranged in groups 34 of permanent magnets each composed of six permanent magnets

8. Within groups 34 of permanent magnets, permanent magnet pole distances 10 are equal to each other; at the transition point or boundary between adjacent groups 34 the group boundary permanent magnet distance 27 is somewhat larger.

A row of electromagnets 12 with electromagnet pole faces 16 is arranged on the underside of rotor 4. An air gap 36 exists between permanent magnet pole faces 18 and electromagnet pole faces 16. Electromagnets 12 are arranged everywhere with the same electromagnet pole distance 24, which is equal to permanent magnet pole distance 10. Both permanent magnets 8 within groups 34 of permanent magnets and electromagnets 12 have small gaps 38 between them in the direction A of relative movement. Each electromagnet 12 is provided with a sensor, preferably designed as a Hall sensor, at its leading edge or its trailing edge, seen in direction A of relative movement. Furthermore, an electronic switching means 30 is provided for each electromagnet 12. Sensors 28 respond to the magnetic fields of permanent magnets 8 located opposite, as in the embodiment of Fig. 1. The electrical connection between the particular sensor 28 and the particular switching means 30 is indicated in the case of three electromagnets 12 but otherwise omitted. When, for example, sensor 28 of an electromagnet 12 reaches the first edge of a permanent magnet 8, seen in direction A of relative movement, the corresponding electromagnet 12 is switched over. This state is reached in Fig. 3 precisely for those six electromagnets 12 which are set off as group 22 of electromagnets. When this group of electromagnets moves on further by one permanent magnet pole distance 10, the leading electromagnet 12', seen in direction A of relative movement, is not switched over immediately because its sensor 28 is located above a group boundary gap 40. However, the

six electromagnets 12 following electromagnet 12' are switched over, these six electromagnets 12 being the remaining five of the group 22 of electromagnets under consideration hereinbefore and an electromagnet 12" following them. In this manner, a group 22' of electromagnets consisting of six electromagnets 12 is thus formed again, although it does not include the same electromagnets 12 as before. The six permanent magnets 12 located opposite a group 34 of permanent magnets in the same relative positions thus form a group 22 of electromagnets with constantly changing members which are all switched over at the same time. - In front of group 22 of electromagnets considered above and behind group 22 of electromagnets considered above there are also groups of electromagnets which are switched simultaneously when they assume a corresponding relative position to groups 34 of permanent magnets which are located in front of or behind group 34 of permanent magnets considered above. Due to the larger permanent magnet distance 26 at the group boundary these states are reached with time differences relative to the switching time considered above. Thus, a switching sequence results which is similar to that of the embodiment according to Fig. 1 except that the composition of the groups of electromagnets constantly changes and electromotor 2 runs even more smoothly than in the embodiment according to Fig. 1. Permanent magnet distance 26 at the group boundary is 1.33 times the permanent magnet distance 10 within groups 34 of permanent magnets, so that the picture of relative association between permanent magnets 8 and electromagnets 12 is repeated after three groups 34 of permanent magnets.

What was said on the embodiment of Fig. 1 with respect to further possibilities of arranging the sensors and

switching off electromagnets 12 for a short period applies analogously to the embodiment of Fig. 3.

Permanent magnets 8 may also be provided on rotor 4 and electromagnets 12 on stator 6.

Fig. 4 shows several possibilities of designing the configuration of electromagnets 12 at the boundary or transition point between two groups 22 of electromagnets, below a row of permanent magnets 8 arranged with alternating polarity and the same permanent magnet pole distance, this row of permanent magnets applying to all three Figs. 4a, 4b and 4c. In Fig. 4a, the right-hand group 22' of electromagnets is moved closer to the left-hand group 22 of electromagnets, resulting in an electromagnet pole distance 26 at the group boundary which is smaller than electromagnet pole distance 24 within groups 22. The electromagnets themselves all have the same design. Fig. 4b shows an analogous design, although electromagnet pole distance 26 at the group boundary is larger. Fig. 4c shows a possibility in which each group 22 or 22' of electromagnets comprises five electromagnet poles 16. One can imagine the creation of this configuration most easily as follows: starting with a thoroughly identical arrangement of electromagnets, one electromagnet pole 16 was cut up in its center at right angles to the direction in which the row of electromagnets 12 extends, and the resulting electromagnet pole halves 16' were moved apart at this cutting point, causing an electromagnet pole distance 26 at the group boundary which is smaller or larger than the "normal" electromagnet pole distance 24 to come about at this moving apart point. One can see the further peculiarity in this case that only the second and the fourth electromagnet poles - as seen progressing in the direction of the row of electromagnets - carry a winding 14,

while the first, third and fifth electromagnet poles are unwound. At the base of each wound electromagnet pole 16, the magnetic flux is divided toward the left and the right. Since the first and the last electromagnet poles are consequently each penetrated by only half the magnetic flux, they may be designed to have about half the cross-sectional size and about half the pole face of the others, which is why the term "pole half" 16' is justified. It may also be seen that the pole distance between each pole half 16' and the adjacent electromagnet pole 16, i.e. pole distance 24', is somewhat smaller than the "normal" electromagnet pole distance 24.

Reference is further made explicitly to the fact that groups 22 or 22' of electromagnets may be designed, instead with five electromagnet poles 16 or 16', also with three electromagnet poles, i.e. a central electromagnet pole 16 and two pole halves 16', as shown in Fig. 4c for a larger number of electromagnet poles. In such groups consisting of three electromagnet poles, only the middle electromagnet pole 16 carries a winding 14. This "triad configuration" is in fact particularly preferred in a development of the invention.

Fig. 5 shows several possibilities of designing the configuration of electromagnets 12 at the boundary or the transition point between two groups 22 and 22' of electromagnets, below a row of permanent magnets 8 arranged with alternating polarity and the same permanent magnet pole distance, this row of permanent magnets applying to both Fig. 5a and Fig. 5b. Fig. 5a shows a possibility having a smaller electromagnet pole distance 26 at the group boundary, although the two electromagnets 12a at the edge are each moved slightly closer to the adjacent complete electromagnet

of the same group 22, as has been described already with reference to Fig. 4c. Electromagnets 12a at the edge each carry a winding 14a having a smaller cross-section and have a smaller pole face, in order to do justice to the change in the available space. Fig. 5b shows a possibility in which electromagnet pole distance 26 at the group boundary is again smaller than the normal electromagnet pole distance 24. Here, too, one can see unwound pole halves 16' at the group boundary, although without pole heads enlarged at the top as were present in the embodiment according to Fig. 4c, and a somewhat smaller electromagnet pole distance 24' between electromagnet pole 16' at the edge and the adjacent electromagnet pole 16 of the group 22 concerned.

In the embodiment according to Fig. 4b, the bases of electromagnets 12 merge with each other at the group boundary. However, a magnetic disconnection could also be provided here, as shown in all other embodiments of Figs. 4 and 5. In all embodiments of Figs. 4 and 5, windings 14 are only shown for electromagnets 12 of the left-hand electromagnet group 22 in each case; in the right-hand group 22' they have been omitted for the sake of simplicity. The unwound legs provided in Figs. 4c and 5b improve the utilization of the magnetic flux in the area of the group boundary as well, with the design of the pole head being determined by the available space and optimum adaptation to the magnetic flux to be conducted.

The design of the electronic switching means 30 described did not have to be described in more detail since an expert is familiar with such switching means or can construct such switching means on the basis of his expert knowledge without difficulty. Four-quadrant inverters are preferred as switching means, and a

specific example of an appropriate four-quadrant inverter can be found in EP-A-0 094 978.

It is explicitly pointed out that permanent magnets with a relative permeability in the order of magnitude of the permeability of air ($\mu = 1$) are used in a preferred embodiment of the invention. When an electromotor is operated, the electromagnetic fields usually have weakening effects on the exciter part of the electromotor, the intensity of this effect depending on the magnetic resistance in the individual magnetic circuits between the stator and the rotor. In the embodiment of the invention described, however, the various magnetic circuits have high magnetic resistance even if the air gap is thin, due to the relative permeability of the permanent magnets which is lower than that of iron by several orders of magnitude. Consequently, the weakening effect described is crucially reduced. Furthermore, the inductance of the electromagnets to be switched is decreased substantially so that one can work at a high switching speed of the electromagnet poles. Particularly preferred are permanent magnets made of a material on a rare earth base with cobalt, in particular samarium-cobalt permanent magnets.



Patent Claims

1. A rotary electromotor (2) to be fed with direct current, comprising:

- (a) a stator (6) with stator poles (16) and a rotor (4) with rotor poles (18), permanent magnets (8) being provided for the stator poles (16) or for the rotor poles (18) and electromagnets (12) being provided for the respective other poles;
- (b) electronic switching means (30) for switching electromagnets (12) in accordance with the relative positions of the electromagnets and permanent magnets in each case;
- (c) and an arrangement of said permanent magnets (8) and said electromagnets (12) in such a manner that only some of the electromagnets (12) of the electromotor can be switched simultaneously in each case,

c h a r a c t e r i z e d i n

- (d) that several adjacent electromagnets (12) form a group (22) of electromagnets belonging to one phase each, this group cooperating with a number of permanent magnets located opposite;
- (e) that adjacent groups (22) of electromagnets belong to different phases;
- (f) and that, for forming a phase difference between adjacent groups (22) of electromagnets,
 - either the electromagnet pole distance (26) differs from the - optionally averaged- permanent magnet pole distance (10) at the



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transition point between adjacent groups (22) of electromagnets;

- or the permanent magnets (8) are arranged in groups (34) of permanent magnets, the - optionally averaged - permanent magnet pole distance (10) within the groups (34) of permanent magnets corresponding to the - optionally averaged - electromagnet pole distance (24) and the permanent magnet pole distance (27) at the transition point between adjacent groups (34) of permanent magnets differing from the - optionally averaged - electromagnet pole distance (24).

2. An electromotor according to claim 1, characterized in that the electromagnets (12) within the groups (22) of electromagnets are arranged to have the same electromagnet pole distance (24).

3. An electromotor according to claim 1, characterized in that the electromagnets (12) within the groups (22) of electromagnets are arranged to have slightly varying electromagnet pole distances (24).

4. An electromotor according to claim 1, characterized in that a somewhat reduced electromagnet pole distance (24') is present in a group (22) of electromagnets between an electromagnet pole (16') located at an edge and the adjacent electromagnet pole (16) of the group (22) of electromagnets.

5. An electromotor according to any one of claims 1 to 4, characterized in that a common electronic switching means (30) or several electronic subswitching means (30', 30'') are provided per group (22) of electromagnets, these subswitching means being preferably controlled by a common sensor means (28) for detecting



the relative position of the group (22) of electromagnets to the permanent magnets (8).

6. An electromotor according to any one of claims 1 to 5, characterized in that electromagnet poles (16') with less or no winding (14) are provided at the ends of the groups of electromagnets.

7. An electromotor according to any one of claims 1 to 6, characterized in that the electromagnetic iron circuit is disconnected at the transition point between adjacent groups (22) of electromagnets.

8. An electromotor according to any one of claims 1 to 7, characterized in that the portions at the ends of the groups of electromagnets are used for mounting or additionally mounting the electromagnets (12) of the respective group (22) of electromagnets to the stator (6) or to the rotor (4).

9. An electromotor according to any one of claims 1 to 8, characterized in that permanent magnets (8) are provided having a permeability in the order of magnitude of the permeability of air ($\mu = 1$).

10. An electromotor according to claim 9, characterized in that permanent magnets (8) are provided made of a material on a rare earth base and cobalt.