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(72) Inventeur/Inventor:
KRISTOFFERSEN, BJORN, NO

(73) Propriétaire/Owner:
SMART MOTOR AS, NO

(74) Agent: SIM & MCBURNEY

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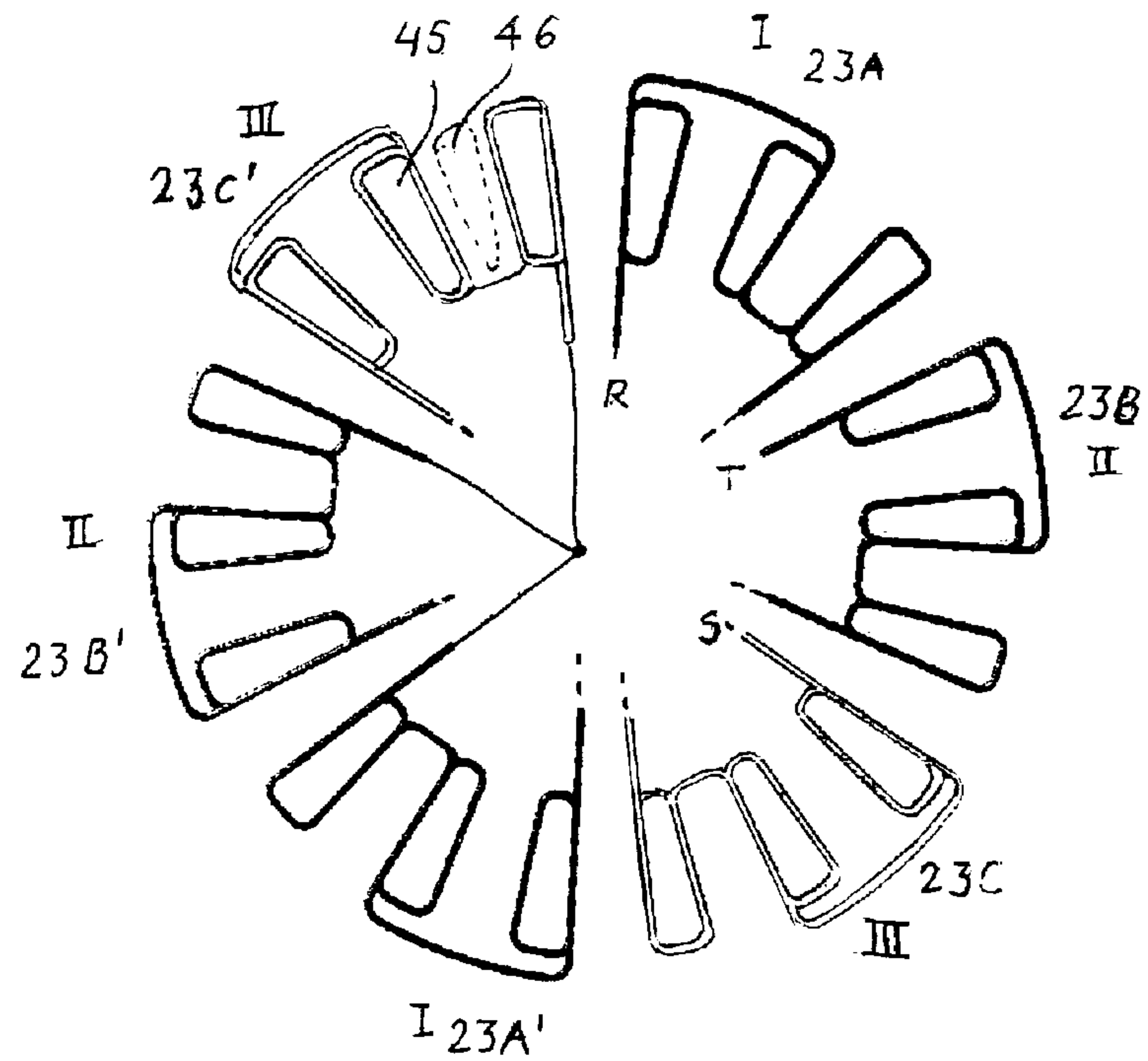
(54) Title: ELECTRICAL MACHINE



(57) Abrégé/Abstract:
Slow moving electrical machine, such as a motor or a generator or a combined motor-generator, comprising an annular set of windings (23) on irons cores (45) of laminated sheets or pressed iron powder, and a corresponding annular set of permanent magnets (369), particularly a permanently magnetized synchronous machine (PMSM) for sinus voltage. The windings are concentrated, not distributed in grooves and, winding cores (45) are arranged alternating with iron cores (46) without windings. Every second iron core is provided with a winding, the number of grooves or intervals between the cores and the number of poles being different, the number of grooves (s) and the number of poles (p) follow the equations |s-p!=2*m and s=12*n*m, wherein n and m are natural numbers. The electrical machine is built for three phase voltage, with serial connection of adjoining coils, to make 2*m such groups per phase, which can be connected in series or in parallel. This motor can be used as a wheel motor for a vehicle.

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(71) Applicant *(for all designated States except US)*: **SMART MOTOR AS** [NO/NO]; Boks 60 Pirsenteret, N-7462 Trondheim (NO).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **LODE, Jon** [NO/NO]; Granhaugan 8, N-7081 Trondheim (NO). **VIK, Einar** [NO/NO]; Gamle Oslovei 54, N-7020 Trondheim (NO). **SOLBAKKEN, Kjetil** [NO/NO]; Klaebuveien 138B, N-7031 Trondheim (NO). **KRISTOFFERSEN, Bjørn** [NO/NO]; Henrik Angellsgatan 11, N-7045 Trondheim (NO).

(74) Agent: **CURO AS**; Box 38, N-7231 Lundamo (NO).

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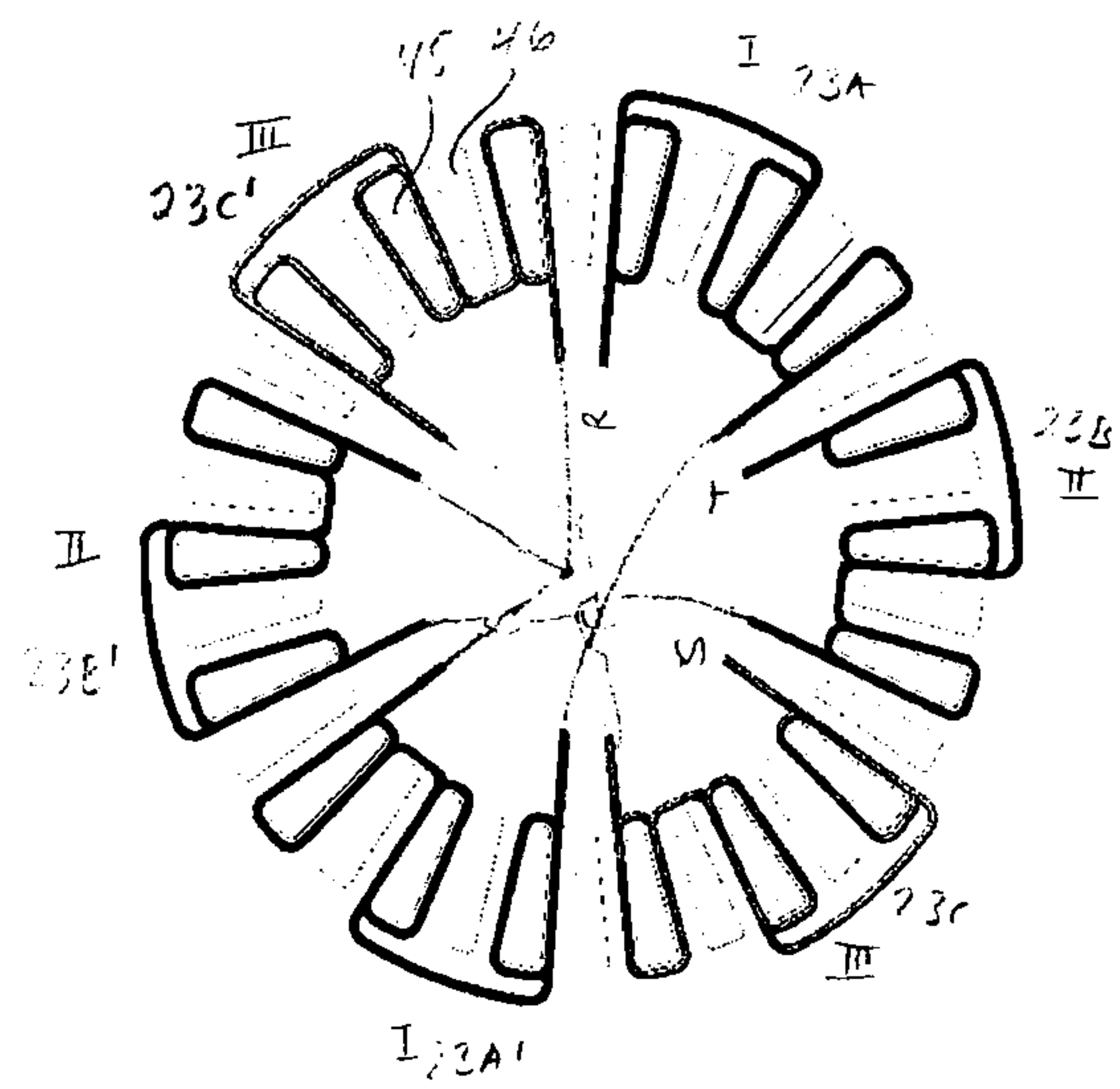

(57) Abstract: Slow moving electrical machine, such as a motor or a generator or a combined motor-generator, comprising an annular set of windings (23) on irons cores (45) of laminated sheets or pressed iron powder, and a corresponding annular set of permanent magnets (369), particularly a permanently magnetized synchronous machine (PMSM) for sinus voltage. The windings are concentrated, not distributed in grooves and, winding cores (45) are arranged alternating with iron cores (46) without windings. Every second iron core is provided with a winding, the number of grooves or intervals between the cores and the number of poles being different, the number of grooves (s) and the number of poles (p) follow the equations |s-p!=2*m and s=12*n*m, wherein n and m are natural numbers. The electrical machine is built for three phase voltage, with serial connection of adjoining coils, to make 2*m such groups per phase, which can be connected in series or in parallel. This motor can be used as a wheel motor for a vehicle.

WO 00/76054 A1

Electrical machine.

The invention relates to a slow moving electrical machine, such as a motor or generator or a combined motor-generator, as described herein.

Background

A slow moving electrical machine may be used for different purposes, e. g. for land or sea vehicles, for hoisting and lifting equipment and in some cases also for power generating. Such machines are known as "permanently magnetized synchronous machines" (PMSM). But some of these machines are not suitable for an intended, specific purpose, particularly depending on the conditions of efficiency and space demand.

A growing demand for energy economization, due to energy supply and energy costs, exists. This particularly applies to motors/generators intended for vehicles and other purposes being powered by batteries. To reduce the battery capacity required and extend the operational range or the power output of battery powered applications. The highest efficiency possible is necessary.

In some situations, the need for space economy is also a critical factor.

Objects

The main object of an aspect of the invention is to create an improved electrical machine, particularly a motor, which is more energy economical and space saving than prior art machines for similar purposes. Generally, it is an object of an aspect of the invention to create an energy efficient electrical machine, which can compete with existing synchronous machines for industrial purposes, but at the same time the machine should be suitable for being powered by a battery, to be used for operating vehicles and other equipment without continuous mains power.

It is particularly important to provide an electrical machine suitable for slow rotation, with electronic drive control, to avoid the need for gears. It is also desirable to be able to scale the machine within large limits according to the purpose and also be able to use identical components for different sizes.

Other objects of aspects of the invention linked to particular areas of use will appear from the description of embodiments to follow.

The invention

The invention is as described herein.

The invention provides a slow moving electrical machine comprising an annular set of windings on iron cores of laminated sheets or pressed iron powder, and a corresponding annular set of permanent magnets, wherein

the windings on iron cores are concentrated windings,

the windings on iron cores are arranged alternating with iron cores without windings, whereby every second iron core is provided with a winding,

the number of grooves between the cores and the number of poles being different, the number of grooves, s, and the number of poles, p, following the equations

$|s-p| = 2*m$ and $s = 12*n*m$

n and m being natural numbers, the machine being built for three phase voltage, with serial connection of adjoining windings to make 2*m such groups per phase, which are connected in series or in parallel.

This machine has proved suitable as a motor for e. g. vehicles, thrust propellers and winches. It can be manufactured in different sizes. Within one size range, identical elements can be used for different purposes, e. g. powder cores, magnets, iron yokes for magnets, coils and the plastic frames for the powder cores. This standardizing of elements will reduce the manufacturing costs.

It is possible to adapt an electrical machine according to the invention, particularly as a motor, to different purposes, e. g. for powering wheel chairs and other vehicles, for powering thrusters on ships, for winches and for process applications demanding slow rotation. The need for gears is eliminated, and the costs will be lower than for corresponding known power units. The rotational control and the conversion from motor to generator application in combined use can be achieved with electronic controls based on known principles, which in most cases can be incorporated into the housing of the machine.

For motor applications, the electrical machine according to the invention has several advantages.

-low vibrations under operation, and thus low noise,

-high starting torque
-high efficiency, particularly when using laminated cores,
-high flexibility in design, particularly with regard to the main dimensions
-it can easily be provided with double or multiple stator and can thus be easily scaled up
-based on standard components, particularly powder cores, magnets, iron yokes, coils and forms with coils.

The invention will bring the greatest advantage used in connection with an axial field, i. e. axially magnetizing. But it will also work with a radial field, when easy mounting and demounting is particularly important.

Further details of the invention will appear from the following description of embodiments.

Examples

The invention is described in more detail with reference to the accompanying drawings, wherein

Fig. 1 shows an axial section of an embodiment adapted for use as a slow rotating integrated wheel motor for a vehicle. This embodiment may be applicable to wheel chairs, cars or other transport purposes,

Fig. 2 shows a schematic section through the stator windings with cores of iron powder,

Fig. 3 shows a diagram for the winding of fig. 2.

The electrical machine of Fig. 1 is a motor suitable for powering a vehicle, such as a wheel chair, a car or another transport means with wheels. It may be provided for periodical use as generator, e.g. at braking. The motor includes a shaft 11 that, by an inner gradually reduced end 12 with a key groove 13 and a key 14 is held by a carrier arm 15 or corresponding bracket on the vehicle. The locking is provided with a nut 16 with a washer 17.

The shaft 11 carries a stator part 18 and a rotating part, both comprising multiple components. The stator part 18 includes a hub 19 shrunk on the shaft with a radial central flange 20 emerging into and carrying a cylindrical stator bushing 21 extending towards the carrier arm 15, but ending in an axial distance from this element. The stator bushing 21 has a moulded form 22 of plastic with inlaid windings 23 distributed around the circumference. In the illustrated embodiment, eighteen separated stator coils 23 are provided. The stator coils have, in radial section, a rectangular shape which will cooperate with a rotor part described below. Details of the stator windings will also be further described.

As carrier for the rotor and a wheel, an annular inner disk 24 and an annular outer disk 25 are provided, the outer disk being integrated with a generally cylindrical rim 26 carried also by the inner disk.

The inner disk 24 is carried by a bearing housing 27 with a bearing 28 mounted on the shaft 11 close to the carrier arm 15. At its circumference the inner disk 24 is connected to a flange 29 of the rim 26 by screws 30.

The outer disk 25 is mounted on the end of the hub 19 and is connected with screws 31 to a central enclosure 32 also providing housing for a bearing 33 on the end of the shaft 11.The outer end of the rim 26 has a second flange 34 which together with the inner flange 29 provides space for a tire (not shown) or another wheel track. For accommodating a tube valve, the rim 26 has an opening 35 adjoining the outer flange 34.

The disks 24 and 25 function as a motor housing and rotor carrier, each having a set of rotor segments or magnets 36. The magnets 36, thirty-eight on each side, of the illustrated embodiment, can be manufactured of a known permanent magnetic material. They are carried by an iron ring 37 mounted on the respective disks 24, 25 with screws 38 from the outside. It is important that the number of magnets are different from the number of grooves between the iron elements of the windings.

Between the magnets 36 and the stator form 22, an airgap A is present. The airgap is permanent, partly due to the outer arrangement of the bearing 33, which provides high stability.

For introducing a power cable (not shown) to the windings 23, the shaft 11 has an axial bore 39 which through an inclined bore 40 is communicating with the a space 41 inside the stator bushing. A continued bore through the shaft communicates with a space 42 at the end of the shaft , and provides for accommodating parts of the electronic power control circuits.

The space 41 within the stator bushing 21 can also accommodate components of the control circuit. A braking device can be arranged in the free space between the disks 24, 25, for certain purposes, e.g. for the use in vehicles.

In Fig. 2 the windings of the axial machine of Fig. 1 are shown schematically, with three double sets of stator windings 23A, 23B and 23C, respectively 23A', 23B' and 23C', which are mounted on iron cores 45, prepared from laminated sheets or iron powder. The coils are arranged distributed and not in grooves. Each set of windings encloses three iron cores with a free iron core 46 arranged interchangeably. Thus there are thirty-six iron cores 45.

Generally, the number of grooves s and the number of poles p follows the equations

$$|s-p|=2*m \text{ and } s=12*n*m$$

n and m being natural numbers, making 2*m such groups per phase, to be connected in series or parallel.

The set of windings can be connected in series as shown or in parallel, in both cases for 3 phase feeding (RST).

The embodiment with iron powder has a lower efficiency than corresponding elements prepared with sheet lamells, but this is not necessary for some equipment with a restricted time of use. On the other hand, it will lower the operating costs substantially.

The stator windings 23 on the iron cores 45 are molded into a plastic component or stator form 23 (Fig. 1).

In Fig. 3 a winding diagram for the winding of Fig. 2 is shown, with at set of windings for each phase and with the ends prepared for connection in series or parallel. On the drawing n=3 and m=1.

Modifications

Iron cores in the form of conventional laminates can be used. This provides a higher efficiency but at somewhat higher costs. The purpose and the utilization will determine which solution is optimal. The use and design can be modified according to various needs. In one embodiment, the disks 24, 25 with the outer rim 26, can be attached to a carrier, while the shaft 11 is connected to a unit to be rotated.

Claims

1. A slow moving electrical machine comprising an annular set of windings on iron cores of laminated sheets or pressed iron powder, and a corresponding annular set of permanent magnets, wherein

the windings on iron cores are concentrated windings,

the windings on iron cores are arranged alternating with iron cores without windings, whereby every second iron core is provided with a winding,

the number of grooves between the cores and the number of poles being different, the number of grooves, s, and the number of poles, p, following the equations

$|s-p| = 2*m$ and $s = 12*n*m$

n and m being natural numbers, the machine being built for three phase voltage, with serial connection of adjoining windings to make 2*m such groups per phase, which are connected in series or in parallel.

2. An electrical machine according to claim 1 wherein the machine is one of a motor, a generator or a combined motor-generator.

3. An electrical machine according to claim 1 or 2 wherein the set of permanent magnets is a permanently magnetized synchronous machine (PMSM).

4. An electrical machine according to any one of claims 1 to 3 with an axial field and wherein at least two rotors are arranged side by side to create multiple air gaps.

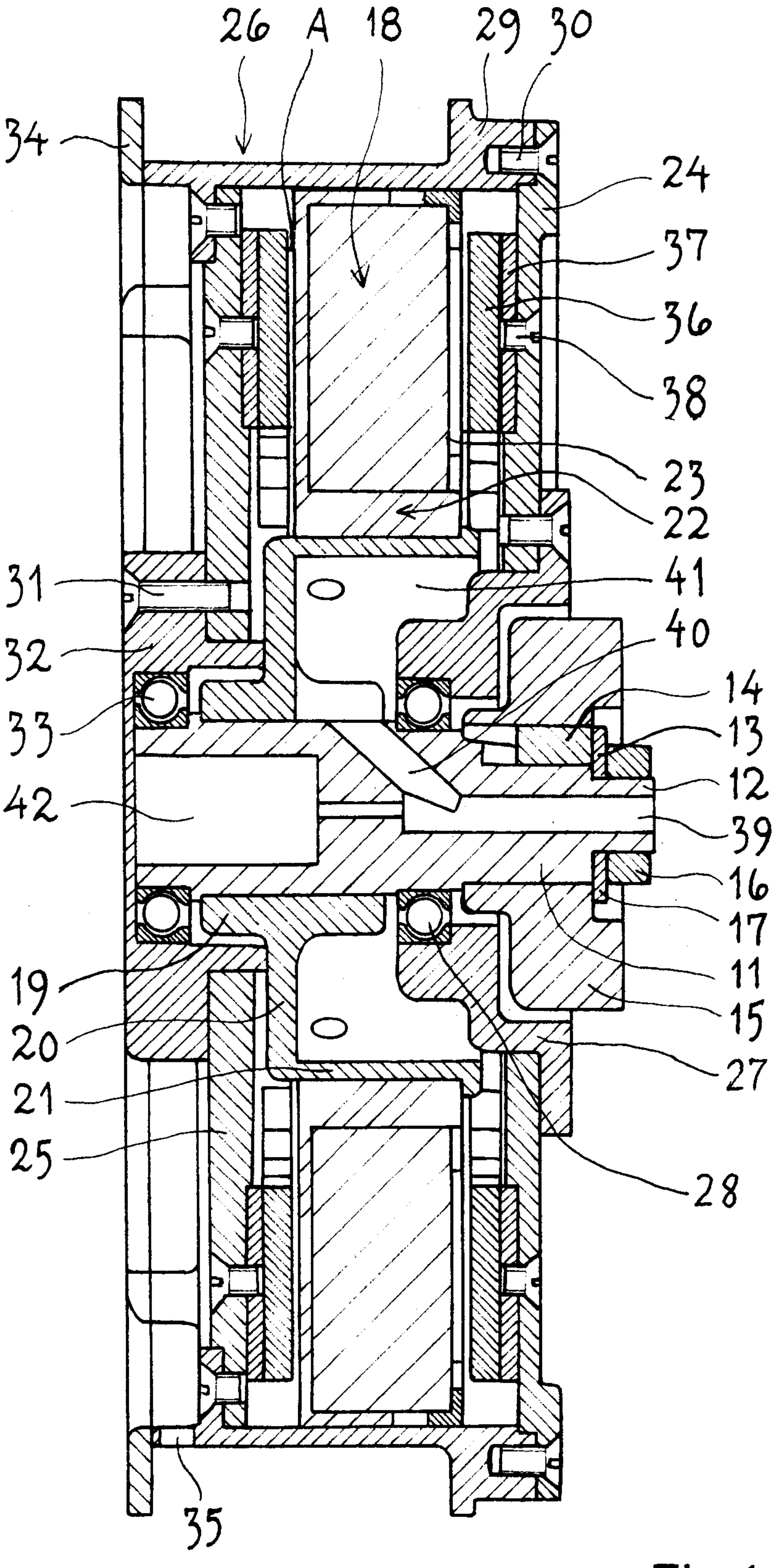
26
A
18
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Fig.1

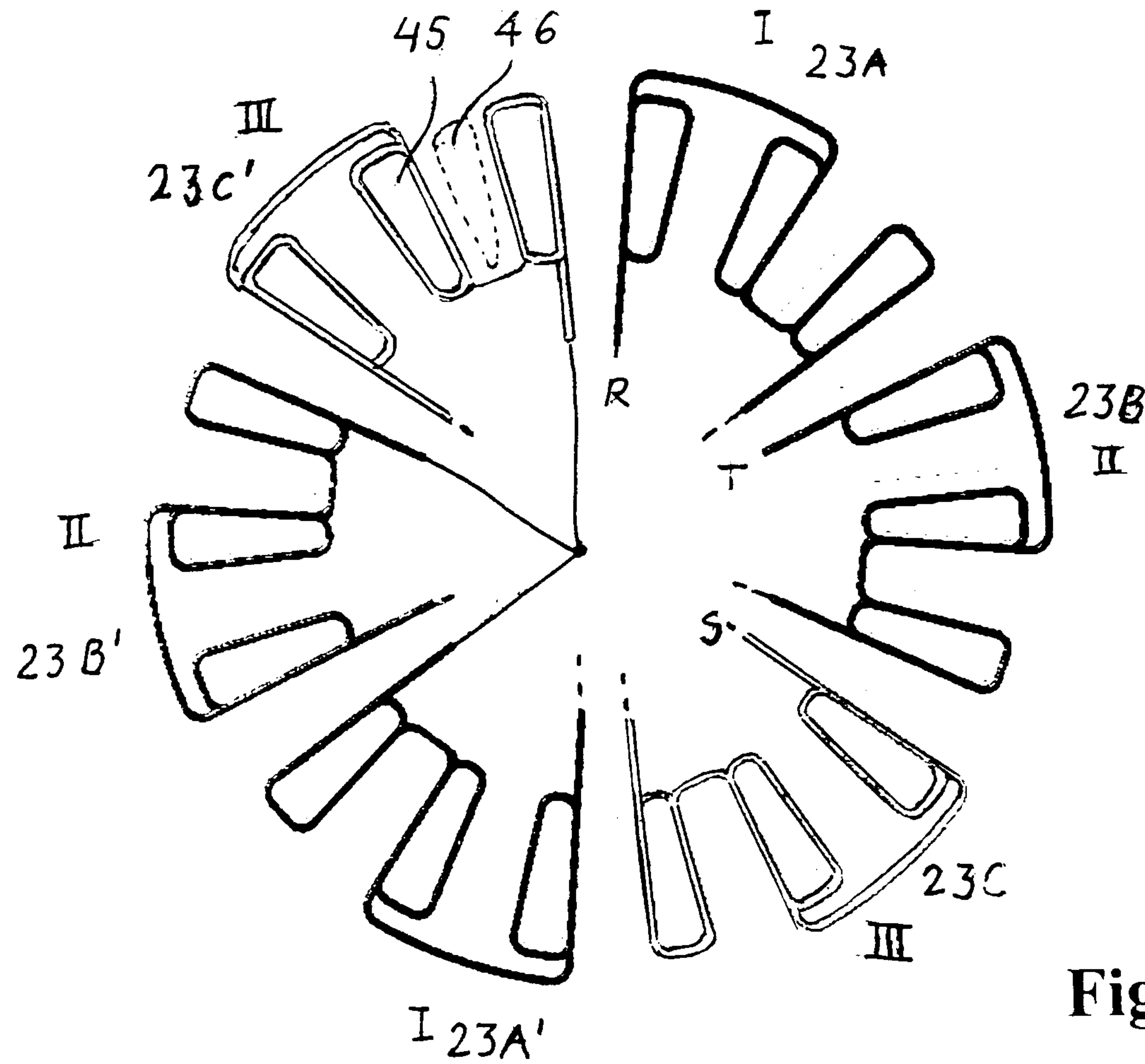

45
46
III
23c'
I
23A
R
23B
II
T
II
23 B'
S
23C
III
I
23A'

Fig.2

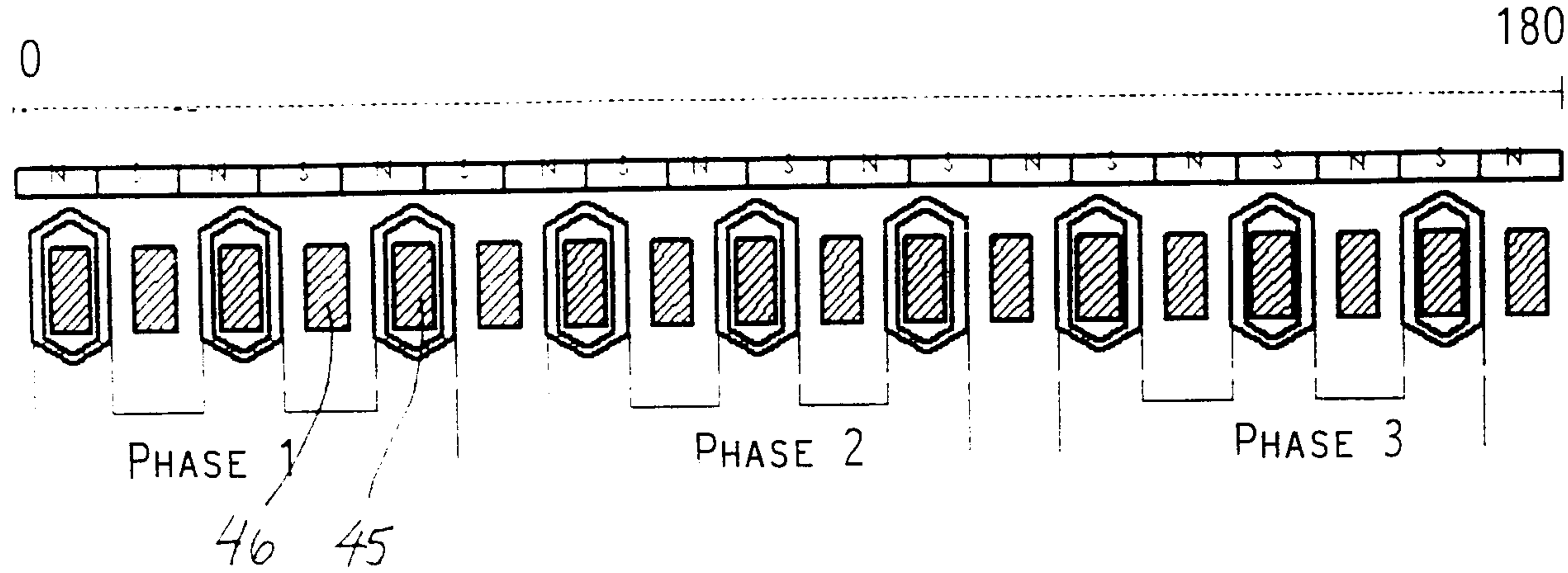
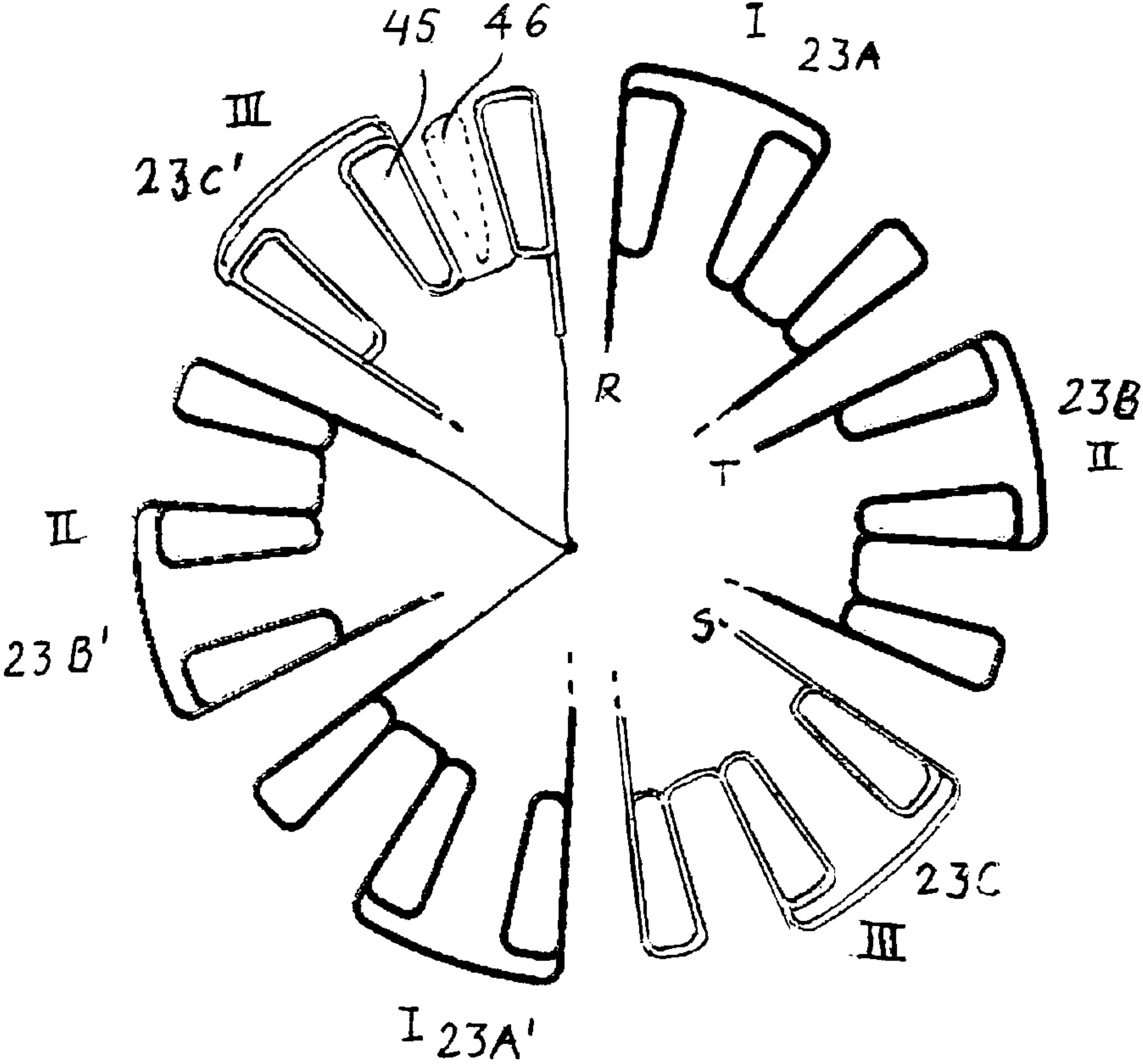

0
180
Phase 1
Phase 2
Phase 3
46
45

Fig.3


45
46
I
23A
III
23c'
R
23B
II
T
II
23 B'
S
23C
III
I
23A'