

PLANAR GEOMETRY COLLECTOR
DESCRIPTION

5 The present invention relates to a planar geometry collector and more particularly to a method of manufacturing the same.

Planar geometry collectors are used in direct current machines, for example, the direct current machine claimed in Application 83 21 457 (2 165 635) from which the present application was divided.

10 In accordance with the present invention, there is provided a method of manufacturing a planar-geometry collector having a circular succession of collector lamellas and at least one cross-connecting means which electrically connects together predetermined associated
15 ones of the collector lamellas to form a collector lamella group, the method comprising initially forming such a collector in which the cross-connecting means electrically connects together collector lamellas in addition to the predetermined associates ones, and then
20 destroying the electrical connection between the cross-connecting means and the collector lamellas other than the predetermined associated ones.

25 Preferably, the method comprises forming the at least one cross-connecting means and its associated collector lamellas as remaining portions of at least one larger conductive layer by removing superfluous

portions of the at least one larger conductive layer.

The invention will be more readily understood from the following illustrative description and the accompanying drawings, in which:

5 Fig. 1 schematically depicts a first machine, here with a flat air gap, an eight-pole stator magnet, a rotor comprised of six equiangularly arranged rotor coils, and a collector having twelve collector lamellas.

10 Fig. 2 schematically depicts the collector of Fig. 1 including three cross-connecting means and anti-interference capacitors;

15 Fig. 3 depicts the rotor winding of Fig. 1, strung out to show the manner in which the six rotor coils can be fabricated using only a single conductor which proceeds without break from one coil to the next;

20 Fig. 4 is a longitudinal section through a preferred embodiment of a motor having the rotor-coil and stator-magnet arrangement of Fig. 1, depicted at a greater than true scale;

Fig. 5 is a plan view of the collector of the motor of Fig. 1, seen from the brush side, at enlarged scale, with certain parts of the structure broken away to facilitate visualization;

25 Fig. 6 is a section, taken along line VI-VI of Fig. 7, through a spring element which serves to press an anti-interference circuit module into position against the _____

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1 collector, and which furthermore serves as a cross-connecting means interconnecting four collector lamellas;

Fig 7 is a plan view of the spring element of Fig 6, seen along line VII of Fig 6;

5 Fig 8 depicts a collector blank at an early stage of fabrication of the collector, seen from the brush side, with an orientation corresponding to that of Fig 5;

Fig 9 is a section through the collector blank of Fig 8, taken along line IX-IX of Fig 8, the orientation of the blank being upside-down in Fig 9 compared to Fig 8;

10 Fig 10 is a view of the collector blank as shown in Fig 9, in finished state, embedded in a molded body of insulating material, an anti-interference circuit module being shown in position in dash-dot lines;

15 Fig 11 is a longitudinal section like that of Fig 4 but of a second collector-type D.C. machine of symmetrical construction, a portion of the structure at the left side being removed to facilitate visualization, the depiction being at about four times
20 typical true scale;

Fig 12 is a partially sectioned side view of the carrier member of the motor construction of Fig 11;

Fig 13 depicts a molded rotation-transmitting member of the machine of Fig 11;

25 Fig 14 is an end view of the carrier member of Fig 12, additionally showing, in dash-dot lines, the position of a rotor coil, and furthermore showing the location of connecting wires;

Fig 15 depicts the carrier member of Figs 12 and 14 with the rotor coils and collector mounted in place;

Fig 16 is a view of the structure of Fig 15 seen from below;

Fig 17 is a longitudinal section, like that of Figs 4 or 11, through a third collector-type D.C. machine,
35 on a larger than true scale;

1 Fig 18 illustrates in plan view the arrangement of
stator magnets and brushes on the yoke plate of the
machine of Fig 17;

5 Fig 19 is a section through an element of the
rotor of the machine of Figs 17 and 18, such element
serving as a carrier member for the rotor coils and for
the flat collector;

10 Fig 20 is a plan view of that face of the element
of Fig 19 on which the rotor coils are to be mounted;

10 Fig 21 is a plan view of the flat collector of the
motor of Figs 17 - 21, in incompletely fabricated condition;

 Fig 22 is a plan view of the flat collector of Fig
21, in finished condition; and

15 Fig 23 is a plan view of the carrier member of
Fig 19 and, mounted thereon, six equiangularly spaced rotor
coils, as well as the connections of the rotor coils to the
collector and to an anti-interference circuit module.

20 In the various Figures, identical or corresponding
elements are denoted by identical reference numerals. Terms
such as "upper", "lower", "left", "right", etc., refer to
the orientation of a particular structure as depicted in
a particular Figure. To impart a notion of typical true
scale, a "1 cm" length designation appears in various
Figures, but the exact dimensions of particular depicted
25 structures can of course be larger or smaller.

 Fig 1 is a schematic plan view of a first embodiment
of a machine 20, in this instance a machine having a flat
air gap, and in particular is a view taken along a section
plane parallel to the air gap. Depicted are a collector 22
30 having twelve collector lamellas 1-12, six rotor coils A-F
and, behind the latter, a stator magnet 21 which has eight
poles and is axially magnetized. Typically, the stator
magnet may be a one-piece annular member polarized in the
illustrated manner and has a plot of induction versus
35 angular location, along the circumferential direction of the

1 stator magnet, with the shape of a trapezoid wave. However,
the stator magnet could alternatively comprise, for
example, an assembly of discrete magnet segments. The
radial extent of the stator magnet ring is such as to cover
5 the magnetically active sections of the rotor coils A-F
that is, the portions of the latter extending generally
in a radial direction. Fig 1 depicts the stator magnet ring
extending radially outwardly to an exaggerated degree,
beyond the radially outer periphery of the set of six rotor
10 coils, merely to facilitate visualisation of the angular
extents of the successive stator poles.

Fig 2 depicts, in a likewise very schematic manner,
the electrical interconnections amongst constituent elements
of the collector 22, in this instance depicted as a generally
15 planar collector. It will be appreciated, however, that
other collector geometries could be employed. Of the
twelve collector lamellas 1-12, lamellas 4, 8 and 12 are
each provided with a respective bent-up conductive tab 4A,
8A, 12A. As will be explained below, the bent-up conductive
20 tabs 4A, 8A, 12A serve as electrical contacts which form
conductive connections to an anti-interference circuit
module. The latter comprises three identically dimensioned
capacitors or condensers 23, 24, 25 as shown in Fig 2.
Capacitor 23 is connected between conductive tabs 4A and 8A,
25 capacitor 24 between tabs 8A and 12A and capacitor 25
between tabs 12A and 4A.

As shown in Fig 2, the twelve collector lamellas
1-12 are electrically interconnected by three cross-
connecting means, as follows:

30 A first cross-connecting means 26 electrically
connects together the four collector lamellas 2, 5, 8, 11 of a
first collector lamella group;

A second cross-connecting means 27 electrically
connects together the four collector lamellas 1, 4, 7, 10
35 of a second collector lamella group; and

1 A third cross-connecting means 28 electrically connects together the four collector lamellas 3,6,9,12 of a third collector lamella group.

5 In the instance depicted in Fig 2, the set of twelve collector lamellas is thus subdivided into three collector lamella groups, each constituted by a respective four collector lamellas, the four lamellas of one group being spaced from one another at intervals of 90 mechanical degrees.

10 Two brushes 30,31 are employed to transmit current to and from collector lamellas 1-12. The brushes 30,31 are not located diametrically opposite each other. Instead, one brush, namely, brush 30, is mounted on the stator beneath a north pole segment of the stator magnet 21, and the other brush, here brush 31, beneath a south pole segment, the
15 angular spacing between the two brushes being $45 + n \times 90$ mechanical degrees, wherein $n = 0, 1, 2$ or 3.

It is to be noted that, as an alternative to the rotor-mounted cross-connecting means 26,27, 28 equivalent cross-connections could be established by using, instead
20 of one brush 30 and one brush 31, two sets of brushes, each set of brushes being constituted by four brushes, with the four brushes of one set being angularly offset by about 45 mechanical degrees from the four brushes of the other set. In such a case, the four brushes of one set of brushes would
25 be electrically connected to one another, and the four brushes of the other set would be electrically connected to one another.

In this first embodiment, the set of six rotor coils A-F is provided with a total of only three external connection
30 points 32,33,34 and these are, as shown, electrically connected to respective ones of the three collector lamellas 1,5,9. In this respect, reference is made to Fig 3, which illustrates the manner in which the six coils A-F are fabricated as a continuous-conductor chain of coils. As can be
35 seen from a comparison of Figs 1 and 3, the six rotor coils

1 A-F are organized as three coil-pairs A,B; C,D; and E,F.
The two coils of each coil-pair A,B or C,D or E,f are
located diametrically opposite each other, relative to the
rotor rotation axis.

5 As shown in the embodiment of Fig 3, the six rotor
coils A-F may be wound from a single conductor which extends
without break from one coil to the next. The single
conductor, in addition to the portions thereof forming
the six coils per se, comprise transitional portions which
10 extend from one coil to the next. These transitional
portions are either inter-coil transitional portions, which
extend a distance L_1 from one coil of a coil-pair to the
other coil of the same coil-pair, or else are inter-coil-
pair transitional portions which extend a distance L_2 from
15 a coil of one coil-pair to a coil of a neighbouring
coil-pair. As shown, the inter-coil spans L_1 are greater
than the inter-coil pair spans L_2 . The ratio $L_1:L_2$ can
preferably be of the order of 3:2 or 4:3.

As shown in Fig 3, the inter-coil-pair transitional
20 portions of the constituent conductor each extend first
from a coil of one coil-pair to a respective connection
point, at 33 or 34 or 32, and then from such a connecting
point to a coil of an adjoining coil-pair. The connection
point 32A, 32F is electrically connected to the collector
25 lamella 1. The connecting point 33 is electrically
connected to the collector lamella 5. The connection point
34 is electrically connected to the collector lamella 9.
As will be appreciated from Fig 1, each of the six coils A-F
is symmetrical with regard to a respective symmetry plane
30 which passes through the rotor rotation axis, and the three
connection points 32,33, 34 are spatially located near
adjoining coils but angularly offset by a distance d , as
shown in Fig 3, relative to the symmetry plane of the
respective coil. As also indicated in Fig 3, all six coils
35 A-F have the same winding sense.

1 During assembly of the machine, the rotor coil A
may be secured at a location where its symmetry plane
coincides with the radial line of separation between
collector lamellas 10 and 11, as shown in Fig 1, with
5 coil B then being located diametrically opposite thereto.
Then, coil C of Fig 1 is secured adjoining coil B, with
the symmetry plane of coil C coinciding with the line of
separation between collector lamellas 2 and 3, with coil D
being then positioned diametrically opposite coil C. Then,
10 coil E is secured in place alongside coil D, with the
symmetry plane of coil E coinciding with the line of
separation between collector lamellas 6 and 7, as shown in
Fig 1, and coil F is then secured in place diametrically
opposite Coil E. Electrical connection of the connecting
15 points 32,33, 34 to respective collector lamellas has
already been described above.

Naturally, the connection point 32A, instead of
being connected to collector lamella 1, could equivalently
be connected to any of lamellas 4,7 or 10, since the four
20 collector lamellas 1,4,7,10 are anyway electrically
connected together by the second cross-connecting means
27. Thus, and expressed in another way, in the illustrated
embodiment the coil connecting point 32 is electrically
connected to the second cross-connecting means 27; the coil
25 connection point 33 to the first cross-connecting means
26; and the connection point 34 to the third cross-connect-
ing means 28. Expressed yet another way, the three series
circuits A-B, C-D, E-F are connected in delta configuration
between the three cross-connecting means 26,27, 28.

30 As will be apparent from the above description, the
fabrication of the six rotor coils A-F, by virtue of their
formation from a single, uninterrupted, continuously wound
conductor, is very simple, and likewise simple is their
assembly and their electrical connection to collector 22.
35 These are extremely simple and suitable for automated

1 performance, especially as only three soldering or welding
operations are required. Due to the offset d of the
individual connection points 32,33,34, there results
5 automatically the correct positioning of the coil ends
relative to the associated collector lamellas.

The individual rotor coils are preferably fabricated
with a cementing or binding lacquer or varnish causing the
coils to be inherently shape-retaining, so that they may
be mounted, as described below, in a self-supporting or
10 cantilevered fashion. Where the aforementioned transitional
portions of the constituent conductor cross the coils, such
lacquer or varnish is absent. For example, the
transitional portion 36 (Fig 3) extending from coil B to coil
C is not provided with such lacquer or varnish along segment
15 37 thereof. The same is true in similar fashion for the
other coils. In the assembled condition of the machine,
the transitional portions of the rotor coils' constituent
conductor are located beneath the collector, where they can
be securely cemented.

20 Fig 4 depicts, on a greatly enlarged scale, a
preferred embodiment of the mechanical construction of such
a machine, in this instance a drive motor for the capstan
of a signal-recording device for video signals. This device
comprises a carrier pipe 40 with a mounting flange 41. A
25 motor shaft 43 is journaled in roller bearings in the
carrier pipe 40, only one roller bearing unit 42 being
illustrated. A carrier member 44, made of non-magnetic
material, such as aluminum, is secured at a hub portion 45
thereof to the motor shaft 43. Secured to the underside
30 46 of the carrier member 44, for instance, by means of
cement, are the radially inward portions of the rotor
coils A-F, of which two are illustrated in Fig 4 and are
denoted at 47 and 48, the remaining portions of the rotor
coils extending radially outwardly therefrom in cantilevered
35 fashion. The carrier member 44 can, for example, have an

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1 external diameter of 4.4 cm, whereas the overall circular
outer periphery of the set of six rotor coils may have a
diameter of about 7.8 cm. In this way, the axial moment
of inertia is determined for the most part only by the six
5 rotor coils themselves. Accordingly, the axial moment
of inertia, the so-called GD^2 , of such a rotor 50 is very
small and, at the same time, the individual coils 47,48
experience a very effective cooling action and thus can be
safely subjected to high thermal loading.

10 The rotor coils 47,48 freely extend radially
outwardly, with their magnetically active segments projecting
into a flat air gap 53 formed between a stator magnet ring
54 and an annular flux-return or yoke plate 55 made of iron.
As shown in Fig 1, the stator magnet ring 54 has eight
15 poles and is axially magnetized. The yoke plate 55 is
held in place, by magnetic attractive force, against the
edge of the outer peripheral wall 56 of an annular channel-
like stator housing 57. The stator housing 57 is a deep-
drawn sheet-steel part and accommodates in its interior
20 the magnet ring 54 which is cemented in place. Stator
housing 57 is secured to the mounting flange 41 at loca-
tions 58,59 by any appropriate conventional means and,
as shown in Fig 4, has an inner peripheral wall 61 which
is centered on the carrier pipe 40.

25 Secured to the bottom face of the yoke plate 55 is
a moulded part 62 made of electrically insulating material
and mounting the two brushes 30,31 of which only brush 30
is, in part, visible in the sectional view of Fig 4. The
brush 30 is secured at the base portion thereof to a
30 damping mass 63 which serves to attenuate mechanical
oscillations of the elongate body of the brush. The
collector 22 is secured on the hub portion 45 of the
carrier member 44. The collector 22 comprises a hub
member 65 made of an electrically insulating material
35 in which are embedded the radially inner portions of the

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1 collector lamellas 1-12. The construction and manner of
production of the collector 22 and its embedding hub member
65 will be explained below in greater detail in conjunction
with Figs 5-10.

5 In fabricating the collector 22, one commences
with a sheet-metal blank 66 which has been stamped out to
provide the configuration depicted in Fig 8. As shown in
Fig 8, at this stage of fabrication the twelve collector
lamellas 1-12 are still all electrically interconnected
10 with one another. The first cross-connecting means 26,
however, is already present in the stamped blank of
Fig 8 and, as shown, electrically connects together the
collector lamellas 2,5,8,11 at the radially inner portions
thereof. The first cross-connecting means 26 is already
15 electrically separated from the other eight collector
lamellas by virtue of arcuate cut-outs 67. The bent-up
conductive tabs 4A,8A,12A, schematically depicted in Fig 2,
are already present on the stamped-out blank of Fig 8 in
bent-up condition, as better seen in Fig 9, described below.
20 The tabs 4A,8A,12A are located radially outwardly of the
circular zone swept over by the brushes 30,31.

Fig 9 is a section through the stamped-out blank 66
of Fig 8, taken along line IX-IX. It is to be noted that in
Fig 9 the blank 66 is shown upside-down with respect to its
25 depiction in Fig 8. Thus, in Fig 8, tab 4A appears above
tab 12A, whereas in Fig 9 tab 12A appears above tab 4A. The
orientation of the blank, as depicted in Fig 8, corresponds,
however, with the orientation of the blank as viewed in Fig
5, yet to be described.

30 In the stamped-out blank 66 of Fig 8, the second
cross-connecting means 27 is present only in rudimentary
form, to the extent of four arcuate cut-outs 68 located
radially outwardly of the operative range of the brushes.
In the circular zone in which the brushes will sweep across
35 the collector lamellas 1-12, the collector lamellas are,

1 in the stamped-out blank of Fig 8, already separated one
from the next by radial gaps 69. The radial lamella-
separating gaps 69 extend radially outward past a circle
72 and, in the region of circle 72, have enlarged portions.
5 The bent-up conductive tabs 4A, 8A, 12A are likewise locat-
ed on the circle 72.

After fabrication of the collector blank 66 of
Figs 8 and 9, the blank is embedded in a moulded body of
synthetic plastics material, preferably a polyamide, the
10 moulded body having the form shown in Fig 10 and, in plan
view, in Fig 5. As shown in Fig 10, such a moulded body
has a central hub portion 65 which completely envelops
the first cross-connecting means 26, completely fills the
aforementioned arcuate cut-outs 67, and entirely envelops
15 and embeds the radially inner portions of the collector
lamellas 1-12. In the vicinity of circle 72, Figs 8, 10
and 5, the moulded insulating member comprises a ring
portion 75 which is located to both axial sides of the
collector blank 67 and, in this vicinity, envelops the
20 collector lamellas from both sides. The material of ring
portion 75 passes through the enlarged portions of the radial
gaps 69 (Fig 8) at the region of the circle 72, and,
likewise, passes through the circular apertures located
intermediate adjoining enlarged portions of the gaps
25 69. Spoke-like portions 76 extend integrally from the
radially inner hub portion 65 to the ring portion 75.

After the stamped-out collector blank 66 has been
thus embedded in insulating material, it is then subjected
to a further stamping procedure, serving to complete the
30 fabrication of the second cross-connecting means 27, such
that the latter is electrically continuous only with the
collector lamellas 1,4,7,10. One example of the way in
which this may be accomplished can be seen in Fig 8 wherein
further cut-outs, 77,78,79 may be stamped out to extend the
35 three associated radial gaps 69 out to the associated

1 arcuate cut-out 68. This serves to electrically separate
the two collector lamellas 11,12 from the second cross-
connecting means 27. Three further sets of such cut-outs
5 77,78,79 are likewise formed, to electrically separate
the second cross-connecting means 27 from the two collector
lamellas 2,3 from the two collector lamellas 5,6, and from
the two collector lamellas 8,9. When this further
stamping-out procedure has been completed, the radially
outward zone of the collector blank will now have the
10 appearance shown in Fig 5.

The first group of four collector lamellas 2,5,8,11
are continuous only with the radially inward first cross-
connecting means 26, and this first continuous area from the
original blank is shown in Fig 5 hatched in by tiny dots.

15 The second group of four collector lamellas 1,4,7,10
are continuous only with the radially outward second cross-
connecting means 27, and this second continuous area, formed
from the original blank, is shown in Fig 5 hatched in by
short fleck-like straight lines.

20 The third group of four collector lamellas 3,6,9,12
not hatched in Fig 5, are, at this stage of fabrication,
discontinuous from one another and discontinuous from all
the remainder of the original blank. The third cross-
connecting means 28, which electrically connects these four
25 lamellas together, is yet to be provided in a manner
described below.

Before that, it is to be noted from Fig 10 that the
three bent-up conductive tabs 4A,8A,12A, already described
project axially out of the insulating ring portion 75 and
30 are spaced angularly by 120° as shown in Fig 8. The three
tabs 4A, 8A, 12A are employed as electrical contacts and
electrically engage three electrical contacts of an annular
anti-interference circuit module 82. The annular module
82 may, for example, be a cast or moulded synthetic plastics
35 body whose interior accommodates the three anti-interference

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1 capacitors 23,24,25 of Fig 2. The insulating ring portion
75 is provided with three integral centering pins 83
which serve to centre the annular circuit module 82. The
three centering pins 83 are received in recesses in the
5 axial end face of the annular housing of module 82, to
positively define the position of the circuit module.
However, the right end face, as viewed in Fig 10, of the
circuit module 82 axially bears only against the three
bent-up contact tabs 4A,8A,12A, in order to establish a
10 purely three-point support against the contact tabs. This
assures that electrical engagement will be reliably
established and maintained with the three contact tabs.

The annular circuit module 82 is axially pressed
against the tabs 4A,8A,12A by means of a spring member 84
15 shown mounted in place in Fig 4, and shown separately
in Figs 6 and 7. The spring member 84 has a central annular
portion 85 which encircles the hub member 65, as shown in
Fig 4. The central portion 85 bears axially against the anti-
interference circuit module 82, pressing the latter against
20 the conductive tabs. Extending radially outwardly from
central portion 85 are four identical spoke-like spring
arms 86,87,88,89 of somewhat Z-shaped configuration. The
free ends of these four spring arms are planar and extend
approximately parallel to the plane of the central annular
25 portion 85.

This spring member 84 is simultaneously employed as
the third cross-connecting means 28. As shown in Fig 5, the
planar ends of the four spring arms 86,87,88,89 are each
permanently welded to a respective one of the four collector
30 lamellas 3,6,9,12 of the third collector lamella group,
electrically interconnecting them. The welding location is
radially outwardly of the insulating ring portion 75.

As shown in Fig 5, the connection points 32,33,34 for
the rotor coil-pairs are respectively connected, by
35 soldering, to the collector lamellas 1,5,9, radially

1 outwardly of the insulating ring portion 75.

From the foregoing description, it will be appreciated that the collector arrangement depicted in Fig 5 constitutes an extraordinarily compact structure whose fabrication
5 can be performed with a remarkably low number of operations. The span of the coils is, as illustrated, preferably greater than 180 electrical degrees. Sector-shaped coils such as here illustrated are preferred, but circular coils could likewise be employed.

10 If it should be desired to replace the three cross-connecting means 26, 27, 28 by brushes, then in addition to brush 31, three further such brushes must be provided, respectively offset relative thereto by 90°, by 180° and by 270° and all electrically connected to brush 31. Likewise,
15 in addition to brush 30, three further brushes would be required, likewise offset relative thereto by 90°, 180° and 270° and all electrically connected to brush 30.

Self-evidently, the collector 22 can have an angular position relative to the coils A-F other than the one
20 illustrated, provided that the brushes 30, 31 are likewise shifted by such angle. The spacing d of Fig 3 will then have a different magnitude and could also be of zero magnitude.

The illustrated motor has a power consumption of
25 0.6 W and at 1500 rpm produces a torque of 0.2 Ncm (20 cmp), and is a miniature motor which supplies a torque of very good constancy with a very low axial moment of inertia.

Fig 11 depicts, at a scale considerably greater than typical true scale, a second embodiment of the invention.
30 Here a drive motor is used for a signal-recording device for video signals. This device comprises a carrier pipe 140 with a radial mounting flange 141. A motor shaft 143 is journaled in roller bearings accommodated within the carrier pipe 140, only one roller bearing unit 142 being
35 illustrated. A carrier member 144 of non-magnetic material,

1 e.g. aluminium or a suitable synthetic plastics material,
is secured to the motor shaft 143 at an axial extension 145
of the carrier member 144. The rotor coils 147,148,
of Fig 16, are secured at their radially inward portions
5 to a peripheral stepped face of the carrier member 144
by means of cement. For instance, as illustrated by means
of a thin fabric layer 151 impregnated with epoxy resin.
The carrier member 144 can have an outer diameter of, say,
2.8 cm, whereas the circular arrangement of six rotor coils
10 has a general outer periphery having a diameter of 5.7 cm.
For example, the axial moment of inertia is determined
substantially exclusively by the six rotor coils per se,
so that the rotor 150 has a very small GD^2 value, while at
the same time the individual rotor coils 147,148 experience
15 very good cooling action and can be safely subjected to high
thermal loading.

The coils 147,148 extend with their magnetically
active sections into a flat air gap 153 formed between an
upper stator magnet ring 154 and a lower stator magnet
20 ring 155. The two stator magnet rings 154,155 are axially
magnetized at each of eight poles. An annular flux-return
or yoke plate 152 made of iron carries the magnet ring 155
and is held, by magnetic holding force, against the rim of
the outer peripheral wall 156 of a cup-like stator housing
25 157. Stator housing 157 is a deep-drawn sheet-steel part,
and the upper magnet ring 154 accommodated therein is
cemented in place. The stator housing 157 is secured, by
means of screws 158, to a flange 141 and, as illustrated,
is at its radially inner rim 161 centered on the carrier
30 pipe 140.

Secured to the bottom face of the yoke plate 152,
by means of screws 183, is a moulded member 182 made of an
electrically insulating material and mounting two brushes,
of which only the brush 130 is visible in Fig 11. The screws
35 183 extend through apertures 184 in the moulded insulating

1 member 182. The apertures 184 are, if viewed axially
of the motor, of elongate or arcuate extent, thereby
permitting angular shifting of the member 162 relative
to the rotor axis of the motor, say, before tightening
5 of screws 183. This makes it possible during assembly
to establish an optimum position for the brushes 130
relative to the stator magnet rings 154, 155.

A collector 122 of planar geometry is mounted on the
axial extension 145 of the carrier member 144. The
10 collector 122 includes a hub member 165, made of an
electrically insulating material, which securely embeds the
radially inward ends of the collector's twelve collector
lamellas. The collector 122 may be of the same construction,
and fabricated in the same way, as already described with
15 respect to Figs 5-10. Likewise, the eight-pole magnetiza-
tion of the magnet rings 154, 155 may be the same as already
described with reference to Fig 1. Also, the arrangement
of the rotor coils and their electrical connections to one
another and to the collector lamellas may be the same as
20 already described with regard to Figs 1-3. As shown in Fig
16, the rotor coils may here be circular, and fabricated with
cementing or binding varnish or lacquer, to impart to the
coils shape-retaining properties permitting them to be
mounted in cantilevered or self-supporting manner. Of course,
25 use could alternatively be made of one or more discrete coil
carrier member, although the illustrated cantilevered
mounting of the rotor coils is preferred.

Located above the collector 122 is an annular anti-
interference circuit module 182 containing three capacitors,
30 whose manner of connection is shown in Fig 2 as is also the
arrangement of its collector brushes.

As furthermore shown in Fig 11, the carrier member
144 has a maximum outer diameter which is smaller by only
about 2 mm than the inner diameter of the magnet ring 155
35 which encircles it, so that the gap 160 between the lower

1 magnet ring 155 and the outer periphery of the carrier
member 144 amounts to only about 1-1.5mm. So small a gap
is important, in order that there be provided in the
vicinity of the magnetically active sections of coils 147,
5 148 a magnetic field of the greatest possible homogeneity.

If now the connecting lines for the coils 147, 148
were to be led through this narrow gap 160, then during
assembly or later repairs the connecting lines could easily
become wedged in the gap, and thereby be badly damaged
10 or destroyed. For this reason, as shown in Figs 12 and 14,
the carrier member 144 is of non-circular configuration at
its outer periphery. In particular, the carrier member 144
is of greatest radius at those locations thereof where a
coil 147 is to be secured thereto. Between such locations
15 it is of somewhat reduced radius, so that at such locations
the connecting lines 185 for the collector 122 can be fed
through and fixed in place by means of cement, or the
like, at a location such as indicated in Fig 14 at 166.

At its inner periphery 167, the carrier member 144
20 encircles the carrier pipe 140, forming therewith a long and
very narrow gap 168, so that grease or oil from the
bearings 142 cannot migrate through this narrow gap to the
collector 122, and thus not interfere with proper operation
of the collector. To this end, the carrier member 144 is
25 provided at its upper face with a relatively long collar-
like extension 169.

The lower axial extension 145 of carrier member 144
is, as shown in Figs 11 and 12, provided with two flattened
portions 171, 172 which extend to the inner opening 173
30 provided for the shaft 143. Shaft 143 is likewise provided
with two corresponding flattened portions, of which, in Fig
11 only, the flattened portion 174 is visible. A moulded
part 175, as shown in Fig 13, has an internal opening 176
which is complementary to these flattened portions. As
35 shown in Fig 11, the moulded part 175 is fitted on to the

1 axial extension 145 and connects the latter with the shaft
143 for joint rotation therewith. Two dish springs 177
are provided, one bearing against a nut 178 screwed on to
the lower end of shaft 143, the other bearing on the axial
5 extension 145. The dish springs thus press the carrier
member 144 upwardly against a shoulder 179 on the shaft
143, establishing a definite axial position for the carrier
member 144. This same construction is employed in the case
of the third embodiment, yet to be described.

10 Figs 15 and 16 depict the carrier member 144 when
the collector 122 and the six rotor coils are in assembled
and mounted condition. The scale of the illustration is
here likewise slightly larger than typical true scale. One
can appreciate the very compact construction of the rotor
15 150 and its small axial moment of inertia, which makes
possible very quick start-up of the motor in response to
energization.

At an operating voltage of 10 V, the illustrated motor
has a current consumption of 55 mA at 1500 rpm and rated
20 load, that is, the load presented by the driven capstan.
The type of motor here involved is a miniature motor
exhibiting good efficiency, achieved with very compact
construction. Tests have shown that such motors can be
expected to have a very long service life.

25 Figs 17-23 depict a third embodiment of a D.C.
machine according to the invention, here in the form of a
miniature motor 200 which, as shown, has an axial thickness
of about 8 mm and a diameter of about 40 mm, and is thus
extremely compact. This motor has a current consumption of
30 about 180 mA at a D.C. voltage of 10 V at rated power, and
at 1500 r p m produces a torque of about 0.2 Ncm with a starting
torque of 0.95 Ncm. Because of its extremely small
dimensions, the motor 200 is illustrated on a considerably
enlarged scale, especially in Figs 19-23. To facilitate
35 appreciation of the correspondence between the scale of

those Figures and that of Fig 17 and 18, a "1 cm" scale indication is provided for all those Figures. Motor 200 serves, for example, as the drive motor for a video-signal signal-recording device. A carrier structure 239 has a longitudinal bore 240 in which are mounted two roller bearings 241, 242 for a motor shaft 243. Mounted on the shaft 243, by means of a synthetic plastics hub member 245, as shown in Fig 19, is a carrier member 244 which simultaneously serves for the motor's collector. The carrier member 244 is made of a glass-fibre-reinforced synthetic plastics material, such as, an epoxy resin, hard-as-glass web, having a thickness of 1.5 mm and laminated on both axial end faces with a thin copper layer of, say, 17.5 microns, the collector lamellas and the various requisite conductor paths being formed by etching away the portions of the copper layer not required therefor, in a manner described below. On the upper face 246 of the carrier member 244, the individual rotor coils 247, 248 are directly secured thereto, at their radially inward portions, by means of cement, for example by means of an epoxy resin. In this third embodiment, the rotor coils have, as shown, a diameter of about 13 mm and a thickness of about 2.5 mm. The axial moment of inertia of the rotor is determined substantially exclusively by the rotor coils themselves.

The rotor coils 247, 248 are provided with a cementing or binding varnish or lacquer imparting shape-retaining properties and they project radially outwardly in cantilevered fashion into a flat air gap 253 which is formed by the upper face of a set of eight round permanent magnets 254 of tablet-like shape having, say, a diameter of about 6 mm. As shown in Fig 18, these magnets 254 are mounted on an annular yoke plate 255 at equal distances from the rotor axis and at equiangular intervals. The permanent magnets 254 are axially magnetized and have at the sides thereof, facing the air gap 253, alternately north and south poles, as

1 shown in Fig 18, forming an eight-pole stator magnet
arrangement. The magnets 254 are advantageously samarium-
cobalt magnets of high energy density. This makes it
possible to dispense with the upper magnet ring 154
5 employed in the second embodiment, thereby decreasing
the axial length of the motor.

Arranged on the yoke plate 255 are two brushes.
Their insulated brush holders 256 are, in space-saving
manner, each arranged in a respective interspace between
10 two adjoining permanent magnets 254, the two brush holders
256 being angularly spaced by 135° from each other. The
brush holders 256 have a shape mating with the outer
peripheries of the permanent magnets 254 as shown in Fig 18.
The brush springs per se are angled members. Projecting
15 from each brush holder 256 is a radial spring portion 257
from which, at an angle of about 158° thereto, there extends
a further portion forming the actual brush 258. The brushes
258 are, as illustrated, longitudinally divided and extend
tangential to the aperture 260 on the yoke plate 255. The
20 actual contact locations of the brushes 258, indicated in
Fig 18 by radially extending dash-dot lines at the brush ends
are, in the case of one brush, lined up with a south-pole
magnet 254, and in the case of the other brush lined up with
a north-pole magnet 254, with these two contact locations
25 being spaced by an angular interval of 135° . Reference is
made to the discussion of angle in α in connection with
Fig 2. The yoke plate 255 is provided at its outer rim 255
with centering projections 259, of which one can be seen in
sectional view in Fig 17. The yoke plate 255 has a central
30 aperture 260 through which the free end of shaft 243 projects.
This end of the shaft 243 is provided with an external
thread, on to which is screwed a nut 263 which, through the
intermediary of two dish springs 264, presses the hub member
245 upwardly. Hub member 245 has a flattened portion 265
35 as shown in Fig 19, which engages with a corresponding

1. flattened portion 266 of shaft 243, as shown in Fig 17,
to prevent the hub member 245 from turning relative to the
latter.

5 A pan-like stator housing 271 is secured by means of
screws 270 to the carrier structure 239 and is made of
a magnetically conductive material, serving as part of
the motor's magnetic-flux circuit. The flat base of the
stator housing 271 has a central aperture which is centered
on an axial projection 272 of the carrier structure 239.
10 The bottom rim of the peripheral wall of the stator housing
271 mounts the yoke plate 255 which is held against such
rim by the force of magnetic attraction, the marginal
projections 259 of yoke plate 255 serving to centre the
latter with respect to the rim of stator housing 271.

15 The air gap 253 is accordingly formed between the
permanent magnets 254 on the one hand and, on the other hand,
the flat base of the pan-like stator housing 271. The
brushes 258 are each provided with a lead 273 which exits
the motor downwardly from out of the yoke plate 255.

20 Figs 21 and 22 illustrate the fabrication of the
collector on the lower axial face 230 of the carrier member
244. As shown in Fig 21, twelve collector lamellas 201-212
are formed by etching away those portions of a copper
coating not needed therefor, the copper coating being
25 provided on a plate 244' which is later cut to form the
carrier member 244. In similar fashion, there is formed a
radially outer cross-connecting means 228 which electric-
ally connects together the four collector lamellas 203, 206,
209, 212, in correspondence to cross-connecting means 28 of
30 Fig 2. Likewise, by removing the portions of the copper
coating not needed therefor, there is formed a radially
inner cross-connecting means 226 which electrically connects
together the four collector lamellas 202, 205, 208, 211
in correspondence to cross-connecting means 26 of Fig 2.

35 Lastly, on the reverse face of the plate 244', corresponding

1 to the bottom face 230 of carrier member 244, there is
formed, as shown in Fig 20, yet another such cross-
connecting means 227 which electrically connects together
the collector lamellas 201, 204, 207, 210 corresponding to
5 the cross-connecting means 27 of Fig 2. Also, and as shown
in Fig 21, for purposes of fabrication, there is addition-
ally formed a conductive path 229 connecting together the
collector lamellas 210, 211 and 212 and located radially
outwardly of the cross-connecting means 228.

10 The plate 244' is furthermore provided with six
through-conductive circuit holes 231-236 which electrically
connect together conductive regions located on opposite
faces of the plate 244'. The mechanical apertures of the
circuit holes are provided on their inner peripheral walls
15 with a layer of deposited copper which is continuous with
the copper layer surrounding each circuit hole at both
faces of the plate 244'. The circuit hole 231 electrically
connects lamella 207 with the cross-connecting conductor path
227 and with a soldering land 214 to which the rotor
20 winding 247, 248 will be connected. The circuit hole 232
electrically connects collector lamella 204 with the
cross-connecting conductor path 227. The circuit hole 233
electrically connects collector lamella 203, as well as the
cross-connecting conductor path 228 to a soldering land 215
25 to which the rotor winding 247, 248 is to be connected.
The circuit hole 234 electrically connects collector lamella
201 to the cross-connecting conductor path 227. The circuit
hole 235 electrically connects collector lamella 211 and
the cross-connecting conductor path 226 to the soldering
30 land 216 to which the rotor winding 247, 248 is to be con-
nected. The circuit hole 236 electrically connects collector
lamella 210 to the cross-connecting conductor path 227.

After production of the circuit holes 231-236 and
the electrical through-conductive connections thereof,
35 which conductively connect together the conductive zones

1 surrounding each circuit hole at the two opposite faces of
plate 244', say, in the state shown in Fig 21, all
conductor paths and lamellas on both faces of the plate 244'
are thus now electrically interconnected as required in the
5 final assembly. With the collector plate 244' in this
state, firstly the thickness of these metallic components
is approximately tripled by galvanic deposition of copper.
Then, a thin layer of nickel is galvanically deposited on
the copper layer, on both sides of the plate 244'. The
10 best mode is to apply a thin nickel layer only on the
surface 230 upon which the brushes actually ride.
Thereafter, there is galvanically deposited on the nickel
layer a hard gold coating, having a thickness of a few
microns, and forming the surface of the collector upon
15 which the brushes actually ride. Finally, the carrier
member 244, as shown in Fig 22, is stamped-out from the
preliminary plate 244' and provided with a central aperture
276 into which the hub member 245, as shown in Fig 20, is
then provided, say, by an injection-moulding process. As a
20 consequence of such stamping-out of the final carrier
member 244, the conductor path 229, needed for the afore-
mentioned galvanic deposition steps, is removed, and the
three cross-connecting conductor paths 226, 227, 228 become
electrically discontinuous from one another.

25 Fig 23 depicts the carrier member 244 with six
rotor coils secured thereto at its upper face 246. These
coils, denoted 247 and 248 in Fig 17 are in Fig 23
denoted A'-E' in correspondence to the description of
Figs 1 and 3. Starting clockwise from the 1-o'clock
30 position in Fig 23 the sequence of rotor coils is E', D',
A', F', C', B'. These circular coils A'-E' are, in
exactly the same way as in Fig 3, constituted by a single,
uninterrupted conductor and provided with similar connection
points for connection to collector lamella groups. The
35 connections between individual coils are expressly depicted

1 in Fig 23, as is the winding sense of the coils.

Specifically, the coils A' and B' are connected in series with each other between the soldering lands 216 and 214, namely, between the cross-connecting conductor paths 226 and 227, the coils C' and D' are connected in series with each other between the soldering lands 216 and 215, namely, between the cross-connecting conductor paths 226 and 228, and the coils E' and F' are connected in series with each other between the soldering lands 215 and 214, namely, between the cross-connecting conductor paths 228 and 227.

Further provided is a capacitor module 280 accommodating three delta-connected capacitors which serve to suppress interference effects. The module 280 is electrically insulating at its underface, at which face it is secured to the carrier member 244, e.g., by cementing. The upper face of the module 280 is provided with three soldering lands, to which, as illustrated, the three connecting points from the three delta-connected coil-pairs A'-B', C'-D', E'-F' are respectively soldered. For example, the connection point 281 between the coils B' and C' extends out to the soldering land 216, soldered thereto, and from there, furthermore, extends to the top one of the three soldering lands on the upper face of the capacitor module 280, being soldered to the top land. The two other connection points are analogously connected, and their connections expressly shown in Fig 23. The circuit depiction of the connection of the three capacitors to the rotor coils and the collector lamellas is the same as in Fig 2.

The motor of this third embodiment constitutes a particularly small variant of the invention, especially suitable for use in battery powered video recorders, for which application low motor weight is of special importance. Self-evidently, however, the motor of the third embodiment

1 is not limited to such application, nor to the stated
dimensions, voltages, etc. In comparison to the motor
of the first embodiment, that of the third embodiment
has a somewhat inferior efficiency. However, its dimensions
5 are a fraction of those of the motor of the first
embodiment and its power about the same. It will be apparent
that the form of construction exhibited by the third
embodiment is equally applicable to motors where the number
of rotor coils, stator poles and/or collector lamellas
10 differs from those illustrated herein, merely for example
as shown in Federal Republic of German Offenlegungsschrift
DE-OS 32 17 283, the disclosure of which is incorporated
herein by reference.



CLAIMS

1. A method of manufacturing a planar-geometry collector having a circular succession of collector lamellas and at least one cross-connecting means which electrically connects together predetermined associated ones of the collector lamellas to form a collector lamella group, the method comprising initially forming such a collector in which the cross-connecting means electrically connects together collector lamellas in addition to the predetermined associated ones, and then destroying the electrical connection between the cross-connecting means and the collector lamellas other than the predetermined associated ones.

2. A method as claimed in claim 1 wherein the forming step comprises forming the at least one cross-connecting means and its associated collector lamellas as remaining portions of at least one larger conductive layer by removing superfluous portions thereof.

3. A method as claimed in claim 1 wherein the forming step comprises forming the at least one cross-connecting means and its associated lamellas from a single larger conductive layer by removing superfluous portions thereof, in such a fashion that the or each cross-connecting means and its associated lamellas are portions of a respective single one-piece body of conductive material.

4. A method as claimed in claim 1, 2 or 3 wherein the collector has at least two cross-connecting means each electrically connecting together respective predetermined associated ones of the collector lamellas to form a respective collector lamella group.

5. A method as claimed in claim 4 wherein one cross-connecting means is formed at one side of the circular succession of collector lamellas, and another cross-connecting means is formed at the other side of



the circular succession of collector lamellas.

6. A method as claimed in claim 4 wherein one cross-connecting means is formed at the radially inner side, and another cross-connecting means is formed at the radially outer side, of the circular succession of collector lamellas.

7. A method as claimed in any preceding claim wherein there is used for the or each collector lamella group a metallic layer deposited on an insulating substrate serving as an insulating carrier.

8. A method as claimed in claim 1 wherein the forming step comprises forming the circular succession of collector lamellas on the first face of a flat insulating carrier, and forming the cross-connecting means on the opposite second face of the flat insulating carrier.

9. A method as claimed in claim 8 wherein the circular succession of collector lamellas and the cross-connecting means are each formed as remaining portions of a respective larger conductive layer by removal of superfluous portions thereof.

10. A method as claimed in claim 8 or 9 wherein the forming step comprises establishing electrical connection between conductive connectors on the second face of the carrier and predetermined lamellas on the first face of the carrier, providing motor coils at the second face of the carrier, and establishing electrical connection between the motor coils and the conductive connectors to thereby establish electrical connection between the motor coils and the predetermined lamellas on the first face of the flat insulating carrier.

11. A method as claimed in claim 8, 9 or 10 wherein there is used for the or each collector lamella group a metallic layer deposited on an insulating substrate serving as the insulating carrier.



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12. A method as claimed in claim 7 or 11 wherein the forming step comprises etching away portions of the metallic layer to leave remaining portions which constitute the at least one collector lamella group and superfluous portions electrically connecting the cross-connecting means to collector lamellas other than the predetermined associated ones, and utilizing the superfluous portions during subsequent galvanic deposition of additional metallic material onto the remaining portions of the metallic layer, and wherein the destroying step comprises thereafter removing the superfluous portions.

13. A method as claimed in any one of claims 1-6, wherein a sheet metal layer is used for the or each conductive layer.

14. A method as claimed in claim 13 wherein the forming step comprises initially forming a collector blank of sheet metal in which gaps separate the collector lamellas from one another, the step of destroying comprising forming the blank with apertures rendering the cross-connecting means discontinuous from collector lamellas other than the predetermined associated ones of the collector lamellas.

15. A method as claimed in claim 14 comprising initially forming the collector blank with at least two cross-connecting means each electrically connecting together respective collector lamellas of a respective collector lamella group, bending up a portion of each cross-connecting means to form a bent-up conductive contact tab, and embedding at least portions of the collector blank in electrically insulating material which envelops the bent-up conductive contact tabs except for the free end portions of the tabs.

16. A method as claimed in any preceding claim including the step of establishing electrical



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connection between a plurality of motor coils and collector lamellas while the coils are still constituted by a single uninterrupted conductor.

17. A method of manufacturing a planar-geometry collector for a direct-current machine substantially as hereinbefore described.

18. A planar-geometry collector when manufactured by a method as claimed in any preceding claim.
