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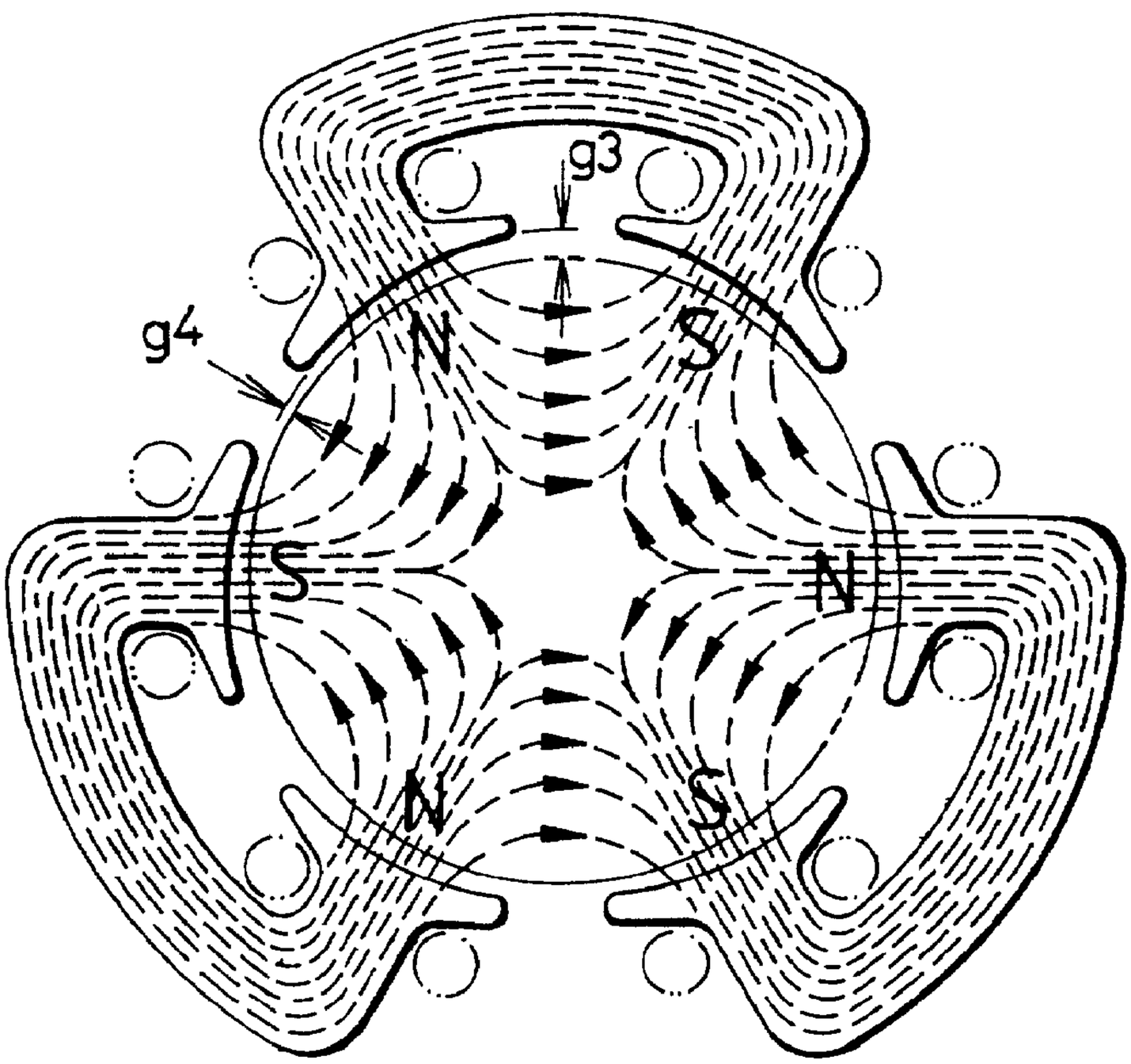
(72) Inventeur/Inventor:
YANG, TAI-HER, TW

(73) Propriétaire/Owner:
YANG, TAI-HER, TW

(74) Agent: GOWLING LAFLEUR HENDERSON LLP

(54) Titre : STRUCTURE DE CIRCUIT MAGNETIQUE A COUPLAGE INTERCROISE OFFRANT UNE RESISTANCE MAGNETIQUE UNIFORME POUR PERMETTRE L'AJUSTEMENT DU DEGAGEMENT D'AIR

(54) Title: THE INTERCROSS COUPLED MAGNETIC CIRCUIT STRUCTURE WITH UNIFORM MAGNETIC RESISTANCE TO ADJUST AIR CLEARANCE



(57) Abrégé/Abstract:
The intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it is characterized that the clearance between the particular magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased

CA 2230958 C 2005/08/30

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(57) Abrégé(suite)/Abstract(continued):
when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement by matching with the narrower inter-pole magnetic circuit, provides a new method to effectively dissipate the accumulated heat inside the electrical machine, as well as by utilizing the intercrossed lamination concept, while maintaining the magnetic force line distribution status of the conventional electrical machine magnetic circuit and the aforesaid easy heat dissipating narrower inter-pole structure, whereby to provide the field magnetic circuit structure with radial ventilation holes and to have the patch-up type iron core at the same time, thereby to have the advantage of lowering down the casting die and machining costs without hindering its electrical machine characteristics.

ABSTRACT

The intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it is characterized that the clearance between the particular magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement by matching with the narrower inter-pole magnetic circuit, provides a new method to effectively dissipate the accumulated heat inside the electrical machine, as well as by utilizing the intercrossed lamination concept, while maintaining the magnetic force line distribution status of the conventional electrical machine magnetic circuit and the aforesaid easy heat dissipating narrower inter-pole structure, whereby to provide the field magnetic circuit structure with radial ventilation holes and to have the patch-up type iron core at the same time, thereby to have the advantage of lowering down the casting die and machining costs without hindering its electrical machine characteristics.

THE INTERCROSS COUPLED MAGNETIC CIRCUIT STRUCTURE WITH UNIFORM MAGNETIC RESISTANCE TO ADJUST AIR CLEARANCE

SUMMARY OF THE INVENTION

The intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it is characterized that the clearance between the particular magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement by matching with the narrower inter-pole magnetic circuit, provides a new method to effectively dissipate the accumulated heat inside the electrical machine, as well as by utilizing the intercrossed lamination concept, while maintaining the magnetic force line distribution status of the conventional electrical machine magnetic circuit and the aforesaid easy heat dissipating narrower inter-pole structure, whereby to provide the field magnetic circuit structure with radial ventilation holes and to have the patch-up type iron core at the same time, thereby to have the advantage of

lowering down the casting die and machining costs without hindering its electrical machine characteristics.

BRIEF DESCRIPTION OF THE DRAWINS

Figure 1 shows the -uniform magnetic flux distribution diagram caused by the combination of the independent magnetic circuit constituted by the magnetic pole pairs and the symmetrical air clearances.

Figure 2 is an example of an uniformly symmetrical-approaching magnetic flux distribution produced by the invention.

Figure 3 is a schematic diagram of the embodying example of the invention illustrating a magnetic field circuit structure constituted by the intercrossed laminated magnetic conductor sheets.

Figure 4 is the side view of figure 3

Figure 5 is a three-dimensional schematic diagram of the structure in figure 3.

Figure 6 is the embodying examples of the electrical machine structure of figure 3~5 illustrating their applications on the linear driving embodiments.

Figure 7 is an embodying example illustrating that the wrapped excitation winding can be installed on the magnetic structure constituted by the intercrossed laminated magnetic conductor sheets.

Figure 8 is an embodying example of the electrical machine structure in figure 7 illustrating its application on the linear driving embodiments.

figure 9 is a embodying example illustrating a four-pole electrical machine structure is constituted by two pairs of field magnetic circuit structures, each is comprised of

an independent inter-pole magnetic circuit and magnetic poles, thereby they are commonly coupled with the interactive electrical machine structure.

Figure 10 is the embodying example of the electrical machine structure in figure 9 illustrating its application in linear driving embodiments.

Figure 11 is the embodying example illustrating the combined installation of the field winding excitation type magnetic pole and the permanent magnet type magnetic pole.

Figure 12 is the embodying example of the electrical machine structure in figure 11 illustrating its application in linear driving embodying types.

Figure 13 is the schematic diagram of the invention illustrating the double-side obliquely extending inter-magnetic circuit.

Figure 14 is the front view of figure 13

Figure 15 is the embodying example of the electrical machine structure illustrating its application on the linear driving types.

DETAILED DESCRIPTION OF THE INVENTION

The conventional generators or motors are mostly constructed by the inter-pole ring shaped magnetic circuit in single side or double side envelopes, whereby the accumulated heat of the rotor and the magnetic field are usually cooled by the axial fan, thereof when the electrical machine rotor is embodied to has a smaller diameter and a longer axial accumulated thickness, due to the air clearance between the rotor and the magnetic pole is around 0.2~1 mm (according to the parameters of power intensity, rotor diameter and rated rotating speed, etc.),

the ventilation is poor; thereof the intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance is constituted by the intercross coupled inter-pole magnetic circuit structure which is narrower than the rotor axial accumulated thickness for easy direct heat dissipation with its coupled interactive electrical machine structure (usually is the rotor), wherein the magnetic pole axial accumulated thickness is maintained the same as that of the rotor, while the total cross-section area of the inter-pole magnetic circuit is increased/decreased according to the axial size, the clearance between the particular magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance between the magnetic pole and the correspondingly driven rotor and the magnetic resistance of each corresponding position of the common structured magnetic circuit of the same pair appear in reverse proportion; i.e. the shorter of the magnetic circuit of the corresponding magnetic pole surface and the position of the lower magnetic resistance, the larger clearance to its correspondingly driven rotor is given, and the smaller clearance for vice verse, thereby the clearance along the symmetrical positions along the two sides of the pole axis appear asymmetrical clearances in order to maintain the uniformed distribution of magnetic force line on the magnetic pole surface and to

let the magnetic force lines appear symmetrical at the two sides of the magnetic pole in order to meet the electrical machine requirements; therein the inter-pole magnetic circuit is installed between the magnetic poles with one or more than one intercrossed circuit structure extending at both sides to couple with the neighboring poles, or with one or more than one magnetic circuit structures appeared in linear or single side slanted to couple with the neighboring magnetic poles, whereby the clearances of the inter-pole magnetic circuits form the intercrossed cooling holes, and the magnetic circuit structure of the magnetic poles with different polarities at the two ends as well as the interactive electrical structure in relative movements with them are periodically facing the cooling holes, wherein the inter-pole magnetic circuit structure is either constituted by an integral construction or laminated by blocks or sheets.

The aforesaid magnetic circuit structure with magnetic poles of different polarities at two ends is the basic unit status, since the magnetic circuit lengths of the exterior of the two magnetic poles a-a' and the interior of the two magnetic poles b~b' are different, the passing magnetic flux densities under the conventional structure of symmetrical clearances along the two sides of the pole axis(g1=g2)have different values, whereby the magnetic pole axis formed by the magnetic force lines are moved inward (as shown in figure 1), and cause the two magnetic poles formed by the magnetic force lines unable to maintain at 180 ° electromechanical angle resulting in increased loss and lowering efficiency, thereof the design

is by changing the clearance between the exterior side and the interior side of the aforesaid magnetic poles as well as their coupling interactive rotational electrical machine structure (usually refer to the rotor), thereby to provide larger clearance g3 between the interior side surface and its coupling interactive rotational electrical machine structure, while to provide a smaller clearance g4 between the exterior side surface and its coupling interactive rotational electrical machine structure, i.e. g3 > g4, thereby to adjust the magnetic force lines distribution densities (as shown in figure 2) in order to maintain the two magnetic poles formed by the magnetic force lines at 180° electromechanical angle.

Based on the above described principle, the intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance can obtain the following functions and economical effectiveness:

1) The magnetic circuit structure is intercross constructed by the smaller area independent iron core sheets instead of the conventional method of patch-up, wherein the clearance between the magnetic polar surface and the rotor are characterized to increase clearance following the shortening length or reducing magnetic resistance of the corresponding magnetic circuit between the magnetic poles of the same pair, thereby to allow the electrical machine have the advantage of maintaining the conventional magnetic circuit structure and provide uniform and symmetrical magnetic fluxes at the two sides, thereof the molding die used is smaller than the conventional integrated

type, whereby the cost of the molding die can be lowered without ultra-large punching equipment;

2) The rotor which constitutes the interactive electrical machine structure is facing the radial ventilation holes directly and is helpful for the heat dissipation of the electrical machine.

The innovative design is for application in the rotational type or linear translation type generators, motors or other rotational or linear translation type electrical machine devices with magnetic poles constituted by electric power excitation or permanent magnets to interact with its coupled interactive electrical machine structure and to constitute a high heat dissipating electrical machine structure through intercross coupling with interpole magnetic circuits to couple with the magnetic force lines between magnetic poles, wherein its field magnetic circuit structure is comprised of the following:

- The magnetic poles are comprised of at least two or more than two poles which are constituted by the permanent magnet or excited winding, wherein the front side of the magnetic pole is for coupling with the interactive electrical machine structure, thereby to generate rotational or linear driven translations;

- The magnetic circuit coupled between the magnetic poles are made of good magnetic conducting material, whereof its embodiment can be extended at one side or both sides, and the combining position of he inter-pole magnetic circuits with different pointing directions and each of the magnetic poles can be symmetrically or

asymmetrically intercrossed, thereof the coupling position of the inter-pole magnetic circuits with the same pointing direction and each of the magnetic poles are perpendicularly extended in intercrossed symmetry, or are obliquely extended at an asymmetrical position;

- The interactive electrical machine structure corresponding to the magnetic pole is comprised of alternator type armature, or inductive type or winding type or permanent magnet type or good magnetic conductor type or magnetic hysteresys type structural components for providing interaction with the aforesaid field magnetic structure, wherein it includes that one of the two is a fix body and the other is a moving body or both of them are moving bodies, whereof their operating structure include rotational or linear driving types and are mainly characterized in the following:
- It is characterized that the clearance between the magnetic pole and its correspondingly driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical in order to meet the

electrical machine requirement

Figures 3~5 are the embodying examples of the intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance illustrating that the field magnetic circuit structure is constituted by the intercrossed magnetic conductor laminations, Figure 3 is the front view of the embodying example, figure 4 is the side view of the embodying example, and figure 5 is a three-dimensional schematic diagram of the embodying example, wherein it is mainly comprised of the following:

- A field magnetic circuit structure 300: It is comprised of good magnetic conducting material such as silicon steel sheets and appear in non-closed shape, whereof its two ends are the positions of magnetic poles for series installed with the excited windings 311, 312, 313, 314 or comprised of the combined permanent magnet type magnetic poles, wherein the silicon steel sheets are intercross laminated to constitute a ring-shaped field magnetic circuit structure with radial ventilating holes, or comprised of a linear electrical machine field magnetic circuit structure extended in chain shaped intercrossed laminations
- An interactive electrical machine structure 301 corresponding to the magnetic pole: It is a interactive electrical machine structure constituted by the alternator type armature or induced type or winding type or permanent magnet type or good magnetic conductor type or magnetic hysteresys type structure components, whereby to interact with the aforesaid field magnetic structure including that one of the two is a fixed body,

the other is a moving body or both of them are moving bodies, wherein its operating structure includes the rotational or linear driving embodiment types, and is mainly characterized in the following:

- The clearance between the magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement

Figure 6 is the embodying examples of the electrical machine structure of figure 3~5 illustrating their applications on the linear driving embodiments, whereof its embodying types can be treated as similar to the extension of a large diameter and multiple poles rotational electrical machine structure, wherein the embodying examples of the aforesaid figures 3~6 are the basic embodying examples.

In practical applications, the following electrical machine embodying types can be selected, such as that figure 7 is an embodying example illustrating that the

wrapped excitation winding can be installed on the magnetic structure constituted by the intercrossed laminated magnetic conductor sheets, wherein it is mainly comprised of the following:

- A field magnetic circuit structure 700: It is comprised of good magnetic conducting material such as silicon steel sheets and appear in non-closed shape, whereof its two ends are the positions of magnetic poles, wherein the each polar surface of its main magnetic circuit structure and auxiliary magnetic circuit structure facing the interactive electrical machine structure has at least one line slot for wrapping the excited winding, wherein the silicon steel sheets are intercross laminated to constitute a ring-shaped field magnetic circuit structure with radial ventilating holes, or it can be comprised of a linear electrical machine field magnetic circuit structure extended in chain shaped intercrossed laminations;
- An interactive electrical machine structure 701 corresponding to the magnetic pole: It is a interactive electrical machine structure constituted by the alternator type armature or induced type or winding type or permanent magnet type or good magnetic conductor type or magnetic hysteresys type structure components, whereby to interact with the aforesaid field magnetic structure including that one of the two is a fixed body, the other is a moving body or both of them are moving bodies, wherein its operating structure includes the rotational or linear driving embodiment types, and is mainly characterized in the following:

- The clearance between the magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement, whereof its embodying types can be treated as similar to the extension of a large diameter and multiple poles rotational electrical machine structure.

The aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, whereof when its magnetic poles are more than two pairs, its magnetic circuits can be constituted by the independently installed inter-pole magnetic circuit of each pair of magnetic poles, wherein figure 9 is a embodying example illustrating a four-pole electrical machine structure is constituted by two pairs of field magnetic circuit structures 900, each is comprised of an independent inter-pole magnetic circuit and magnetic poles, thereby they are commonly coupled with the interactive electrical machine structure 901, wherein it is mainly

comprised of the following:

- A field magnetic circuit structure 900: It is constituted by two pairs of magnetic poles, each has an independent inter-pole magnetic circuit to constitute four poles, whereof the field magnetic circuit structure is integrally constituted by good magnetic conducting material such as silicon steel sheets or other material sheets or blocks, wherein each pair of magnetic poles is treated as an individual unit of the field magnetic circuit structure, and is independently coupled with the interactive electrical machine structure in the radial direction, whereof each magnetic pole is intercross distributed in N-S-N-S sequence, wherein the field magnetic pole can be constituted by permanent magnets or single magnetic poles installed with excited winding or multiple tooth shaped magnetic poles with conductor slots for wrapping the excited windings;
- An interactive electrical machine structure 901 corresponding to the magnetic pole: It is a interactive electrical machine structure constituted by the alternator type armature or induced type or winding type or permanent magnet type or good magnetic conductor type or magnetic hysteresys type structure components, wherein the windings are distributed corresponding to the number of poles of the magnetic field, i.e. each magnetic pole can generate motor or generator effect with the interactive electrical machine structure including that one of the two is a fixed body, the other is a moving body or both of them are moving bodies, wherein its operating structure includes the rotational

or linear driving embodiment types, and is mainly characterized in the following:

- The clearance between the magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement.

The aforesaid embodying examples are for four magnetic poles constituted by two pairs of magnetic poles, whereas for applications of more than two pairs of magnetic poles of the field magnetic circuit structure, the same concept an be expanded, whereof its operating structures include the rotational or linear driving embodiment types, thereof figure 10 is the embodying example of the electrical machine structure in figure 9 illustrating its application in linear driving embodiments, whereof its embodying types can be treated as similar to the extension of a large diameter and multiple poles rotational electrical machine structure.

Besides, for practical application of the intercross

coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, if the field magnetic poles are constituted by permanent magnets, i.e. the permanent magnet type magnetic pole is coupled with the DC armature or coupled with an interactive electrical machine structure installed with at least two phase of windings to generate rotational magnetic field, wherein if the field magnetic pole is of the electric power excited winding, then it is constituted by either a DC excited magnetic pole or AC excited winding, whereby to produce the electromagnetic interacting effect of motor or generator functions with its coupled interactive electrical machine structure, or it is constituted by the combined installation of the field winding excitation type magnetic pole and the permanent magnet type magnetic pole.

The aforesaid combined installation of the interactive electrical machine structure as shown in figure 11 is comprised of the combined installation of four or more than four magnetic poles, whereof at least one pair of the magnetic poles are constituted by permanent magnet 1101, and the other poles are constituted by energizing the power excitation type magnetic pole 1102 through the excited windings 1111, 1112, or at least one pair of the magnetic poles are constituted by the field winding excitation type magnetic poles 1102, while the other magnetic poles are constituted by the permanent magnet type poles 1101, thereof the electrical machine operating structures include the rotational or linear driving embodying types and is mainly characterized in the following:

- The clearance between the magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement.

Figure 12 is the embodying example of the electrical machine structure in figure 11 illustrating its application in linear driving embodying types.

When the permanent magnet type magnetic poles and the winding excitation type magnetic poles combined installation type electrical machine structure is used for motor or generator operations, since the permanent magnet type magnetic pole has a fixed polarity, the excited winding of the winding excitation type magnetic pole can be series combined with the armature, whereby the series combined polarity relation can be controlled to select for the electrical machine to appear auxiliary excitation or differential excitation characteristics after the magnetic pole excited by the excited winding is combined with the whole electrical machine magnetic poles, wherein it is

mainly characterized in the following:

- The clearance between the magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, whereby to meet the electrical machine requirement.

The aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance can also be constituted by the magnetic conducting material in multiple-sections of independent magnetic circuit structures along the axial direction, i.e. the magnetic conducting material appears in the multiple-sections divided structures along the axial direction following the geometric staged variations and is intercross assembled to couple with the interactive electrical machine structures.

The single side or double side extended one or more than one inter-pole magnetic circuits of the aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance can also be

obliquely extended to allow the surface of the interactive electrical machine structure to intercross with the slant slots and face the heat dissipating hole sequentially for easy heat dissipation, thereof figure 13 is the schematic diagram of the intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance

illustrating the double-side obliquely extended inter-pole magnetic circuit, and figure 14 is the front view of figure 13.

The operating structure of the aforesaid embodying example in figure 13 includes the rotational or linear driving embodying types, thereof figure 15 is the embodying example of the electrical machine structure in figure 13 illustrating its application on the linear driving types, whereof its embodying types can be treated as similar to the extension of a large diameter and multiple poles rotational electrical machine structure.

As corresponding to the applicable electrical machine types of the intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance are in wider range, the clearance between the aforesaid magnetic pole and its corresponding driven rotor is increased when the magnetic circuit is shorter or the magnetic resistance is smaller between the two magnetic poles of the same pair, or is decreased when the magnetic circuit is longer or the magnetic resistance is larger between the two magnetic poles of the same pair, whereby to cause the clearance appears asymmetrical along the symmetrical positions at the two sides of the magnetic

axis, thereby the magnetic force lines on the pole surface of the magnetic pole can be maintained uniformly distributed and is characterized to let the magnetic force line distribution at the two sides of the magnetic pole appear symmetrical, thereby in order to meet the electrical machine requirement, its various flexible matching structures can be selected as needed to include all or part of the following embodying types:

- An aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, whereof the sizes of the individual circuits of the multiple type inter-pole magnetic circuits can be the same or different, i.e. if the inter-pole magnetic circuit coupled between the magnetic poles at single side or double sides is of the multiple circuits structure, then each of the circuit can be of the same size or different size;
- An aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it can be the structure of two or more than two poles, i.e. under the same principle, different number of magnetic poles can be selected;
- An aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it includes applications in AC or DC, brushed or brushless, synchronous or asynchronous rotational electrical machine structure;
- An aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein its coupled interactive electrical

machine of the electromagnetic effect includes rotors of the AC or DC, brushed or brushless, synchronous or asynchronous rotational electrical machine structure, or appears in reverse interaction, i.e. the outside magnetic field is a rotational body while the inside rotor is fixed, or both of the outside and inside can be interactively rotated;

- An aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, wherein it includes the coupling of a attractable magnetic conductor to constitute an AC or DC electrical magnet;
- As shown by an aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, the single side coupled or double side coupled intercrossed magnetic circuits are constituted by the two-ends non-closed type magnetic conducting sheet material, wherein its magnetic pole can be integrally constituted by the inter-pole magnetic circuits of the laminates, or each magnetic pole is separately installed and then combined with the inter-pole magnetic circuits;
- For the various embodying examples of the aforesaid intercross coupled magnetic circuit structure with uniform magnetic resistance to adjust air clearance, besides of the field magnetic circuit structure shown in figure 11, its coupled interactive electrical machine of electromagnetic effect is characterized to include the attractable magnetic conductive interacting body, or alternator type armature, or inductive type interacting

body, or permanent magnet type interacting body, or the eddy current or magnetic hysteresys interacting electrical machine structures, thereof the alternator type armature coupled by the field magnetic circuit structure of the embodying example of figure 11 is mainly composed of wave winding, thereof by particularly arranging the average magnetic field intensity of the permanent magnet type pole and the winding excitation type magnetic pole, it can also be matched to couple with the aforesaid various interactive electrical machine structures.

What is claimed is:

1. An arrangement of magnetic circuit structures, comprising:

a plurality of magnetic circuit units, each unit comprising at least two magnetic poles connected by a magnetic circuit structure with an end pole at each end of the magnetic circuit structure,

wherein said magnetic poles are arranged to face an interactive electrical machine structure such that magnetic flux lines from said magnetic poles pass through said interactive electrical machine structure and cause relative motion between the magnetic circuit units and the interactive electrical machine structure,

wherein said magnetic circuit units are stacked such that an accumulated thickness of the magnetic circuit units is approximately equal to a length in an axial direction of said interactive electrical machine structure, and

wherein said stacked magnetic circuit units are intercrossed such each of said magnetic circuit structures in a first group of magnetic circuit units whose end poles are aligned in said axial direction is axially separated by a magnetic circuit structure having less than all of its end poles aligned with the end poles of the first group, thereby forming ventilation openings between said stacked magnetic circuit units.

2. An arrangement as claimed in claim 1, wherein a clearance between each of said magnetic poles and said interactive electrical machine structure varies asymmetrically so that said magnetic flux lines are uniformly distributed and appear to be symmetrical across a width of each of said

poles.

3. An arrangement as claimed in claim 1, wherein said magnetic poles include electrical field windings.

4. An arrangement as claimed in claim 1, wherein said magnetic poles are permanent magnet poles.

5. An arrangement as claimed in claim 1, wherein said magnetic poles include field winding excitation poles and permanent magnetic poles.

6. An arrangement as claimed in claim 1, wherein said magnetic circuit structures comprise laminated sheets of magnetically conductive material.

7. An arrangement as claimed in claim 1, wherein said magnetic circuit units are combined to form a ring-shaped structure.

8. An arrangement as claimed in claim 1, wherein said magnetic circuit units are combined to form a linear structure.

9. An arrangement as claimed in claim 1, wherein a number of said at least two poles of each of said magnetic circuit units is greater than two, and said poles of each of said magnetic circuit units are arranged in N--S--N--S . . . sequence.

10. An arrangement of magnetic circuit structures, comprising:

a plurality of magnetic circuit units, each unit comprising at least two magnetic poles connected by a magnetic circuit structure with an end pole at each end of the magnetic

circuit structure,

wherein said magnetic poles are arranged to face an interactive electrical machine structure such that magnetic flux lines from said magnetic poles pass through said interactive electrical machine structure and cause relative motion between the magnetic circuit units and the interactive electrical machine structure,

wherein said magnetic circuit units are stacked such that an accumulated thickness of the magnetic circuit units is approximately equal to a length in an axial direction of said interactive electrical machine structure,

wherein at least two of said stacked magnetic circuit units are overlapped with less than all of their end poles axially aligned such that said ventilation openings are formed between said magnetic circuit units, and

wherein a clearance between each of said magnetic poles and said interactive electrical machine structure varies asymmetrically so that said magnetic flux lines are uniformly distributed and appear to be symmetrical across a width of each of said poles.

11. An arrangement as claimed in claim 10, wherein said magnetic poles include electrical field windings.

12. An arrangement as claimed in claim 10, wherein said magnetic poles are permanent magnet poles.

13. An arrangement as claimed in claim 10, wherein said magnetic poles including field winding excitation poles are permanent magnet poles.

14. An arrangement as claimed in claim 10, wherein said

magnetic circuit structures comprise laminated sheets of magnetically conductive material.

15. An arrangement as claimed in claim 10, wherein said magnetic circuit units are combined to form a ring-shaped structure.

16. An arrangement as claimed in claim 10, wherein said magnetic circuit units are combined to form a linear structure.

17. An arrangement as claimed in claim 10, wherein a number of said at least two poles of each of said magnetic circuit units is greater than two, and said poles of each of said magnetic circuit units are arranged in N--S--N--S . . . sequence.

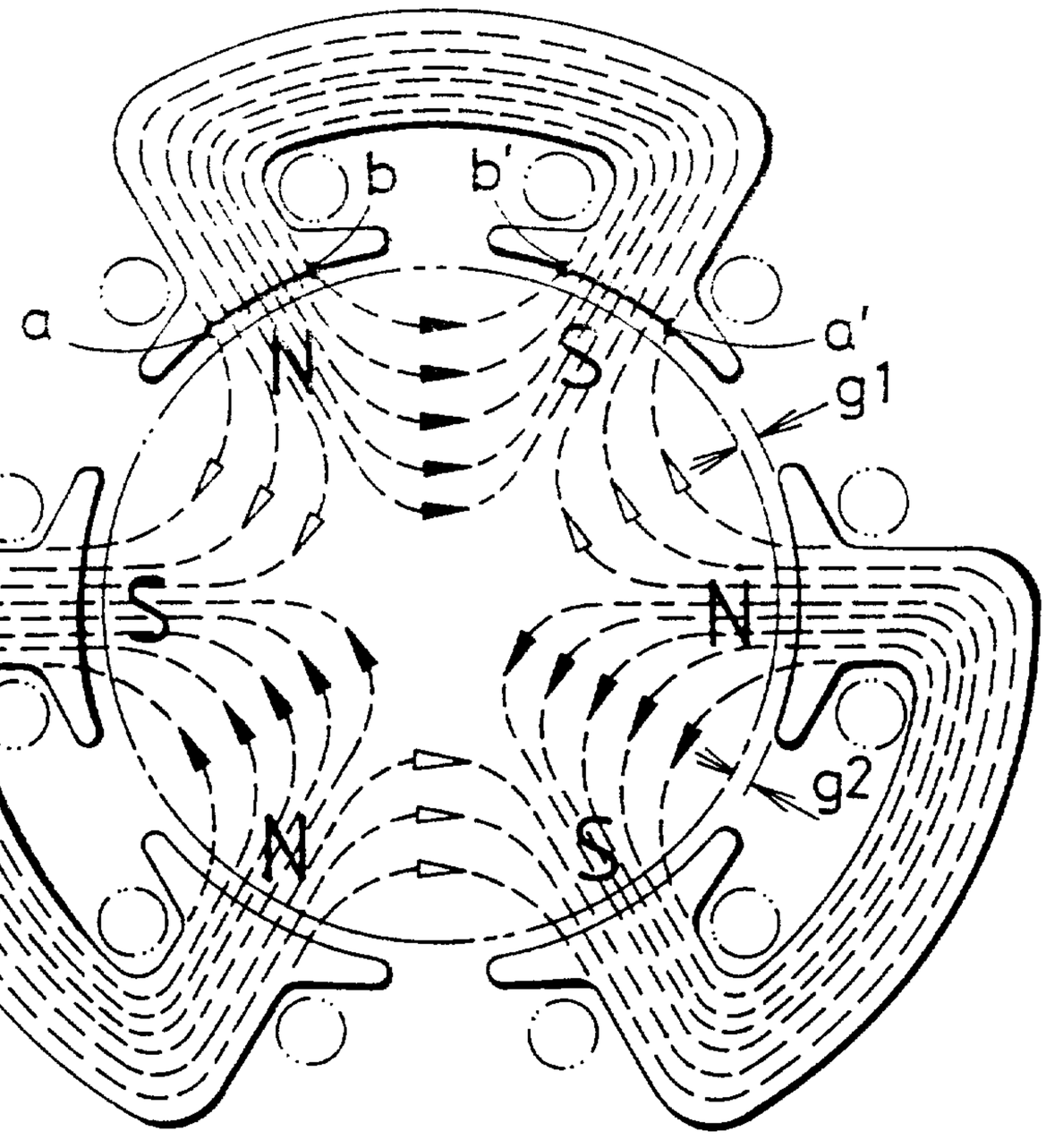

FIG. 1

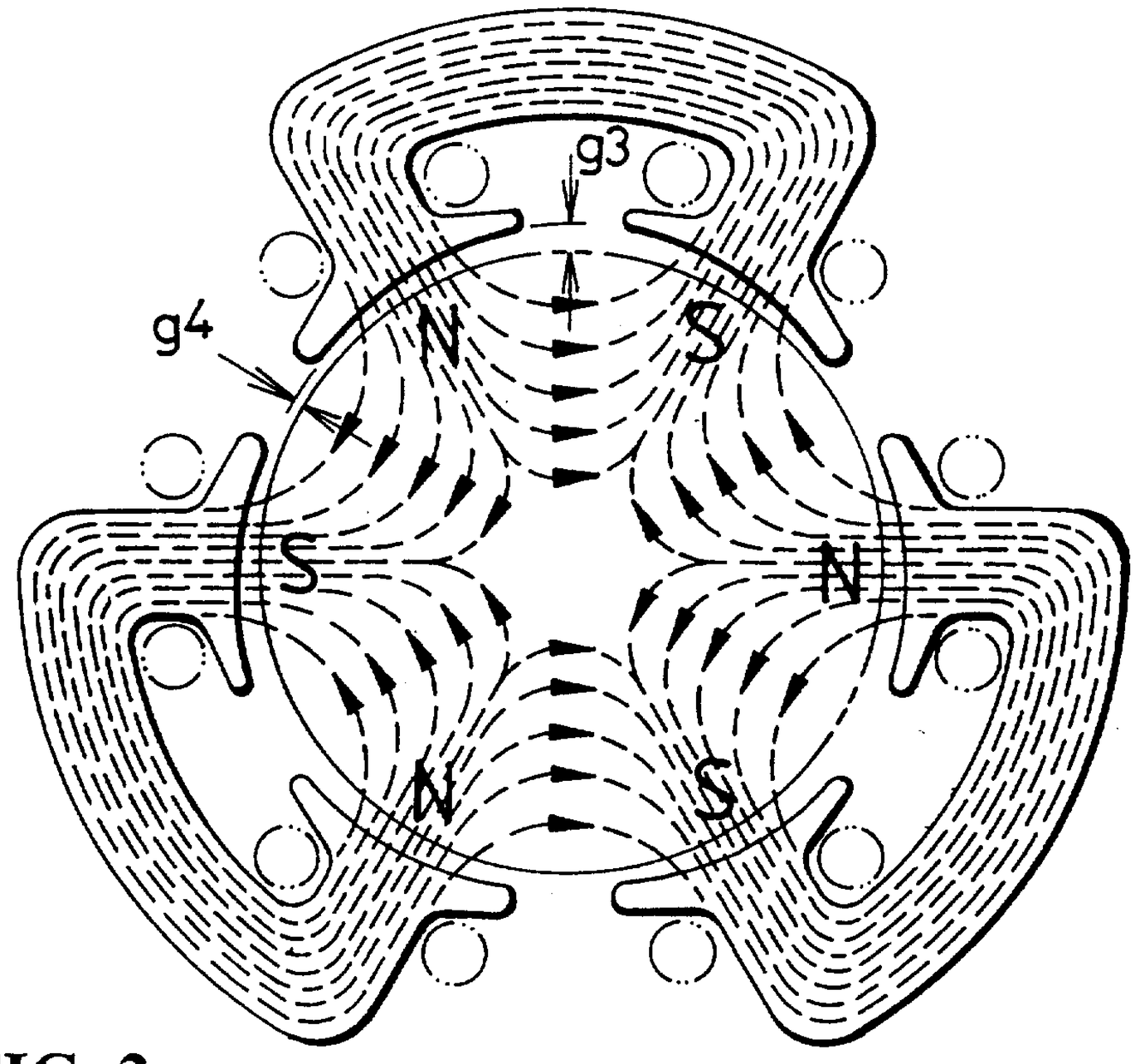

FIG. 2

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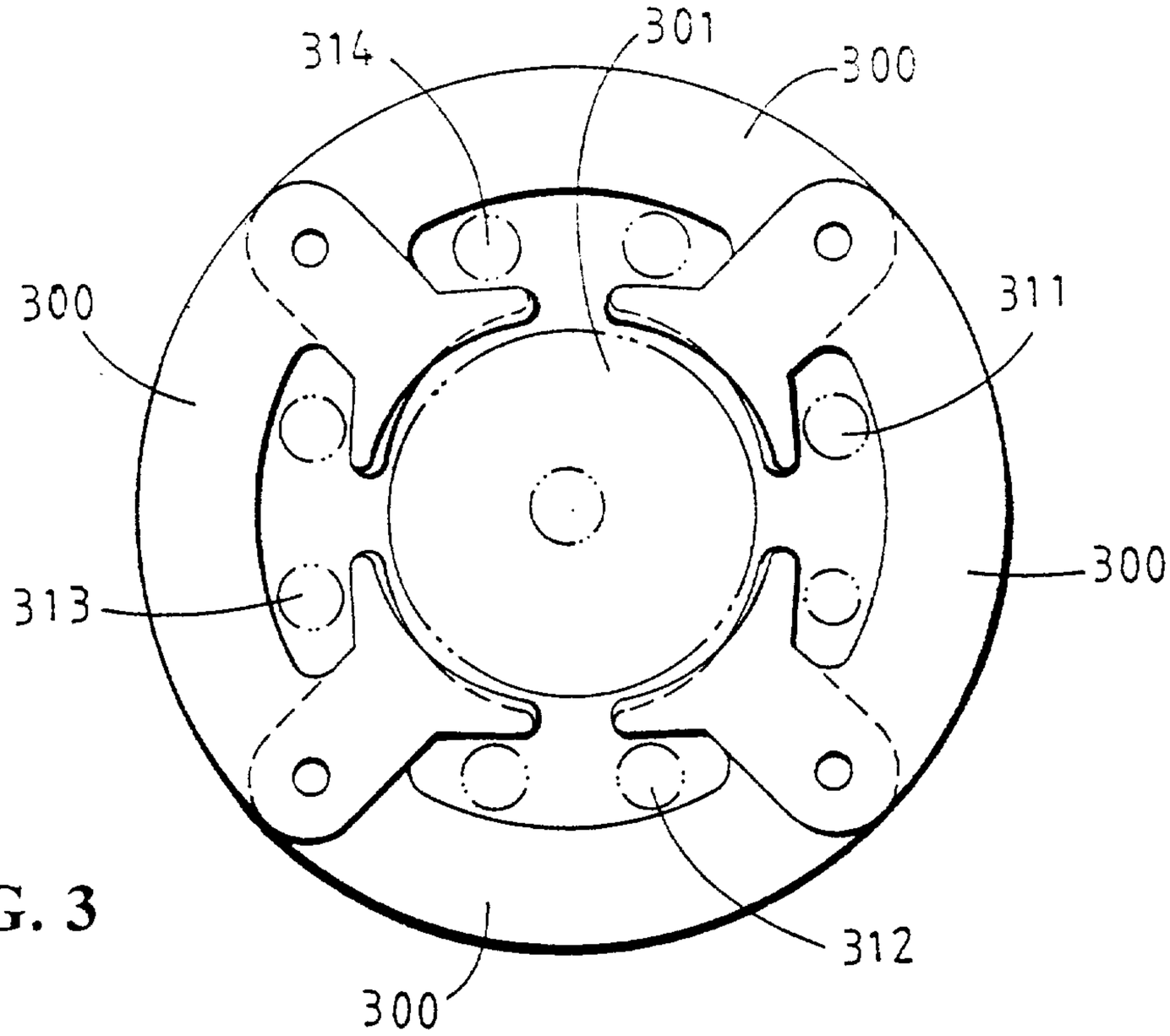

FIG. 3

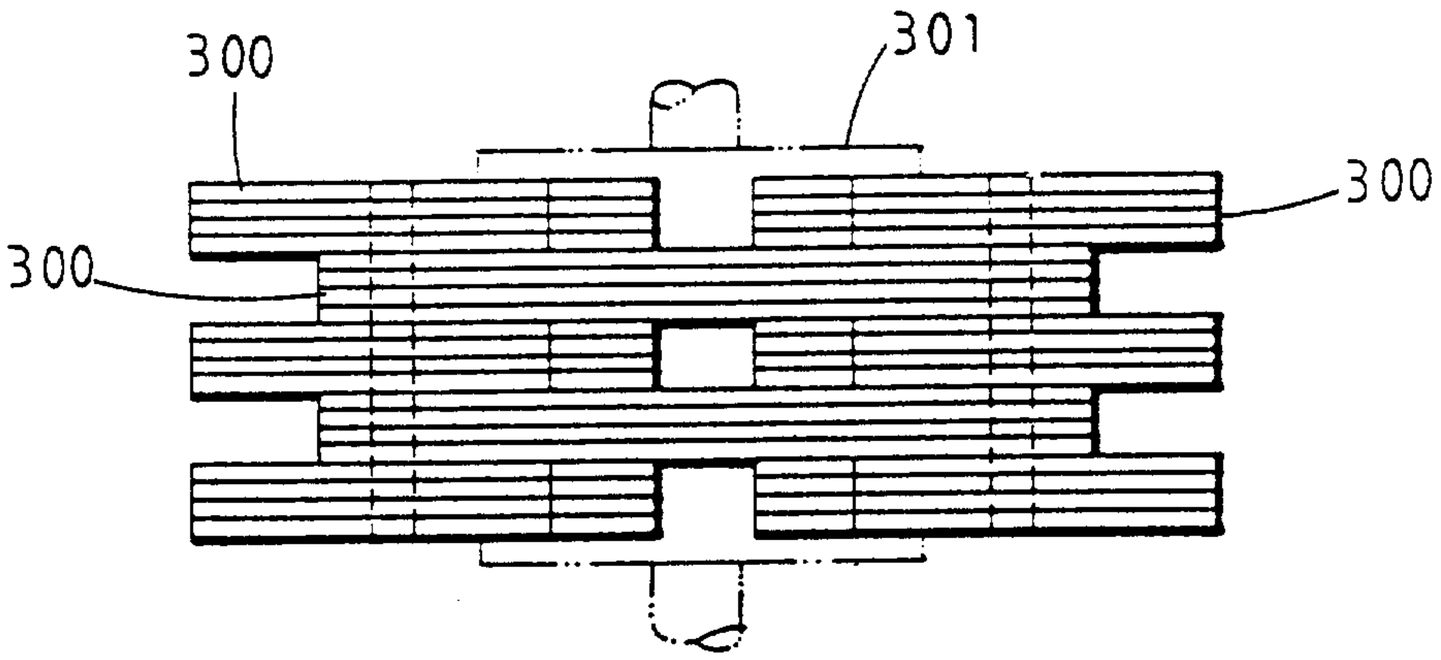

FIG. 4

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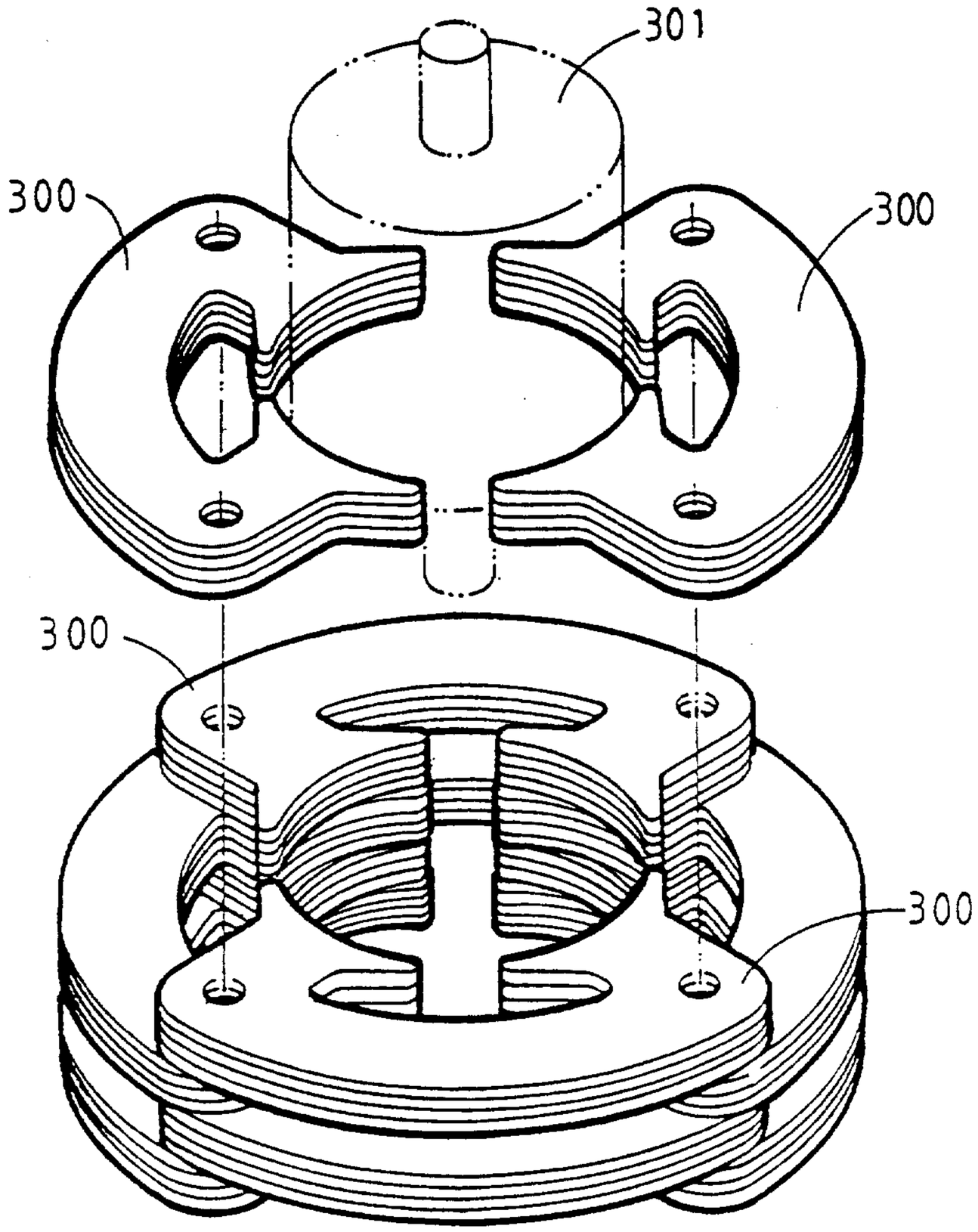

FIG. 5

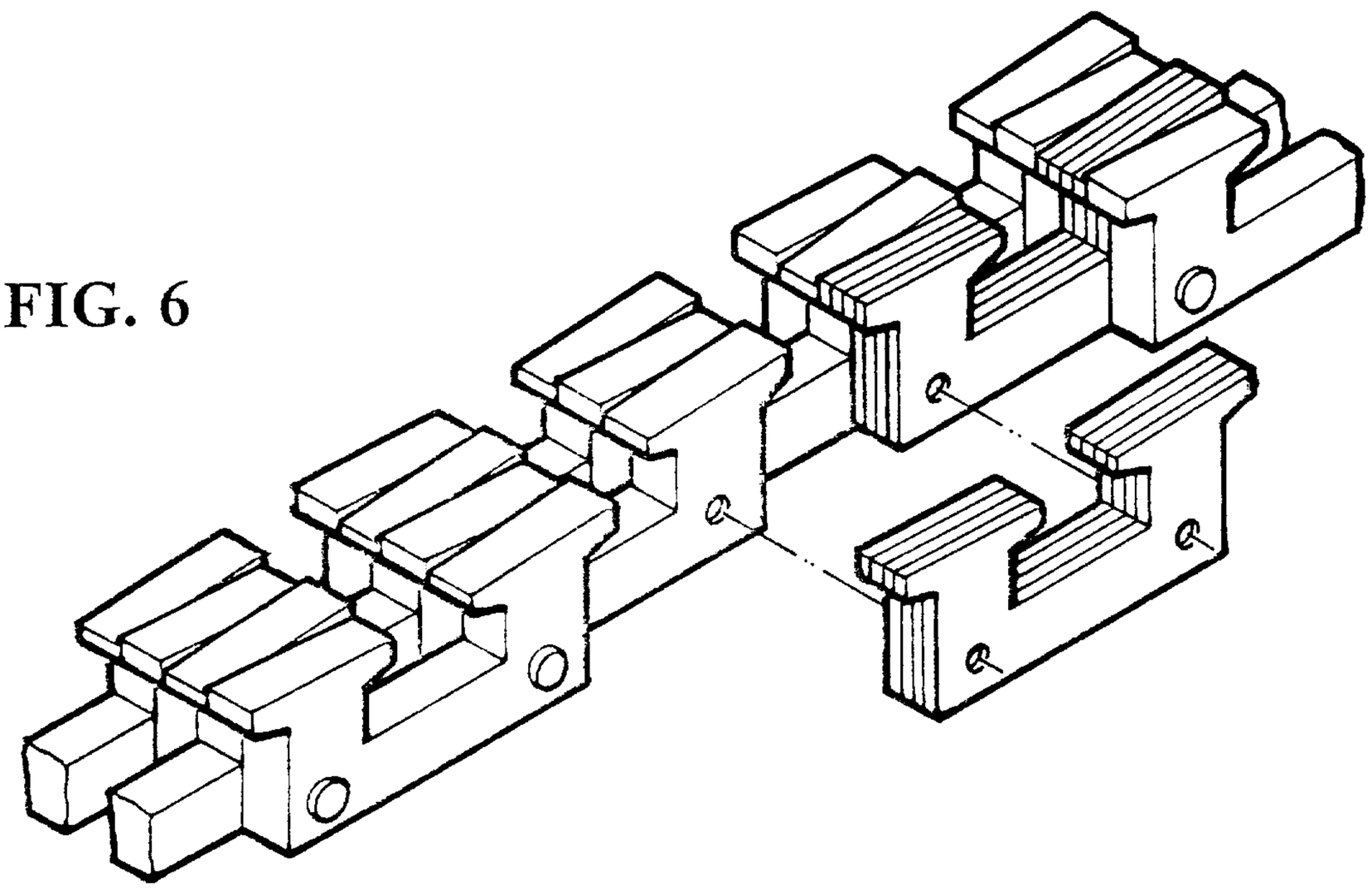

FIG. 6

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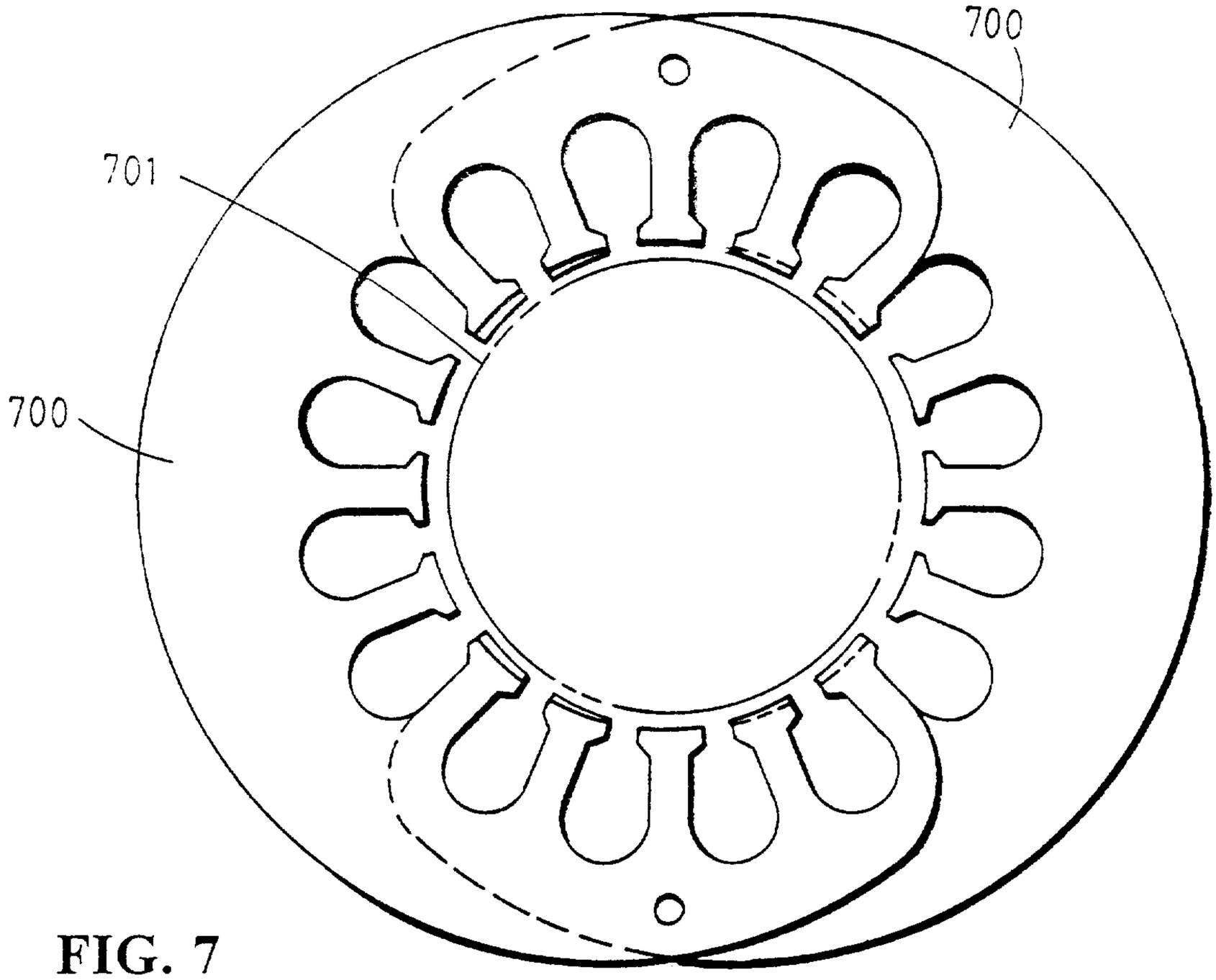

FIG. 7

FIG. 8

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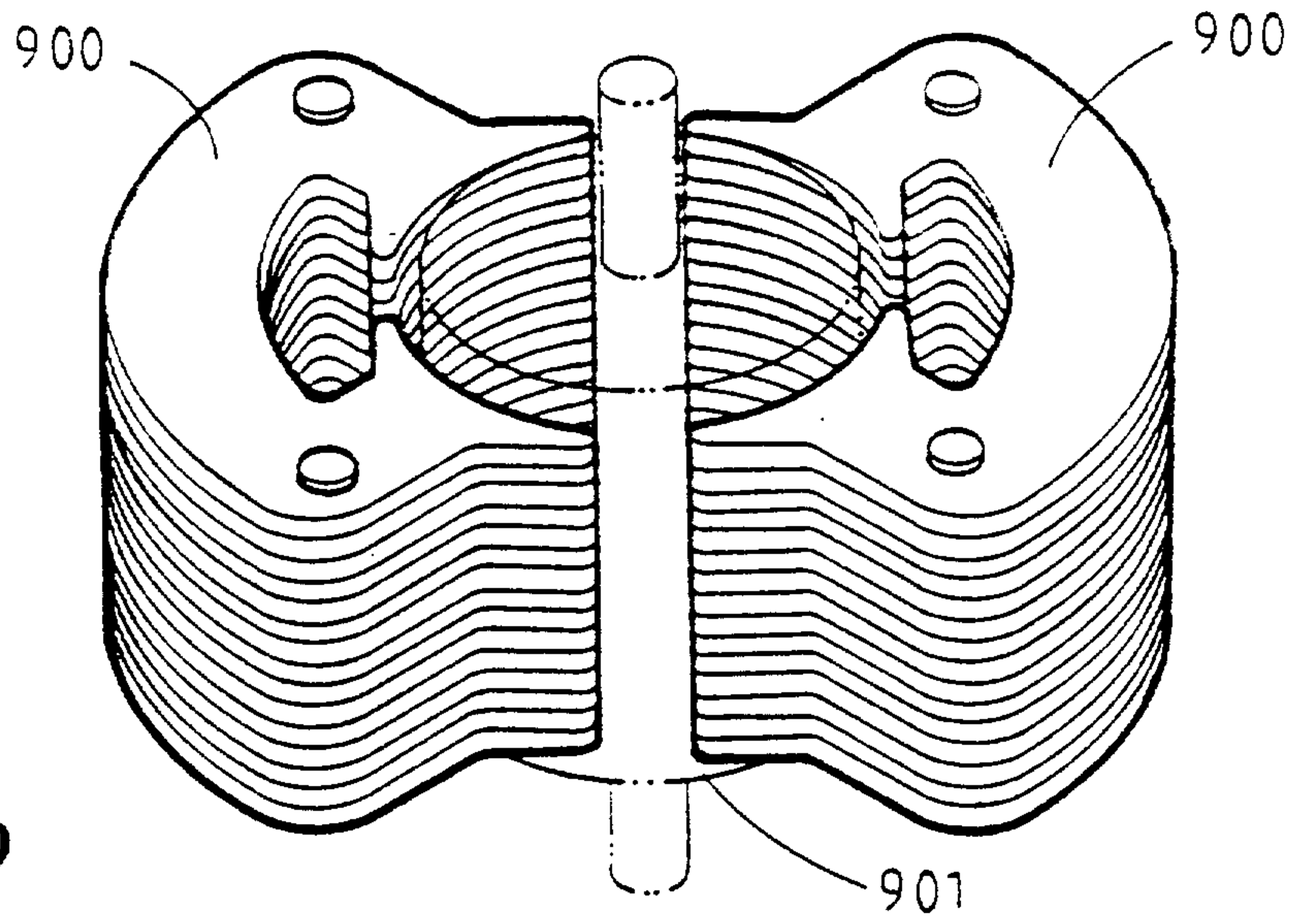


FIG. 9

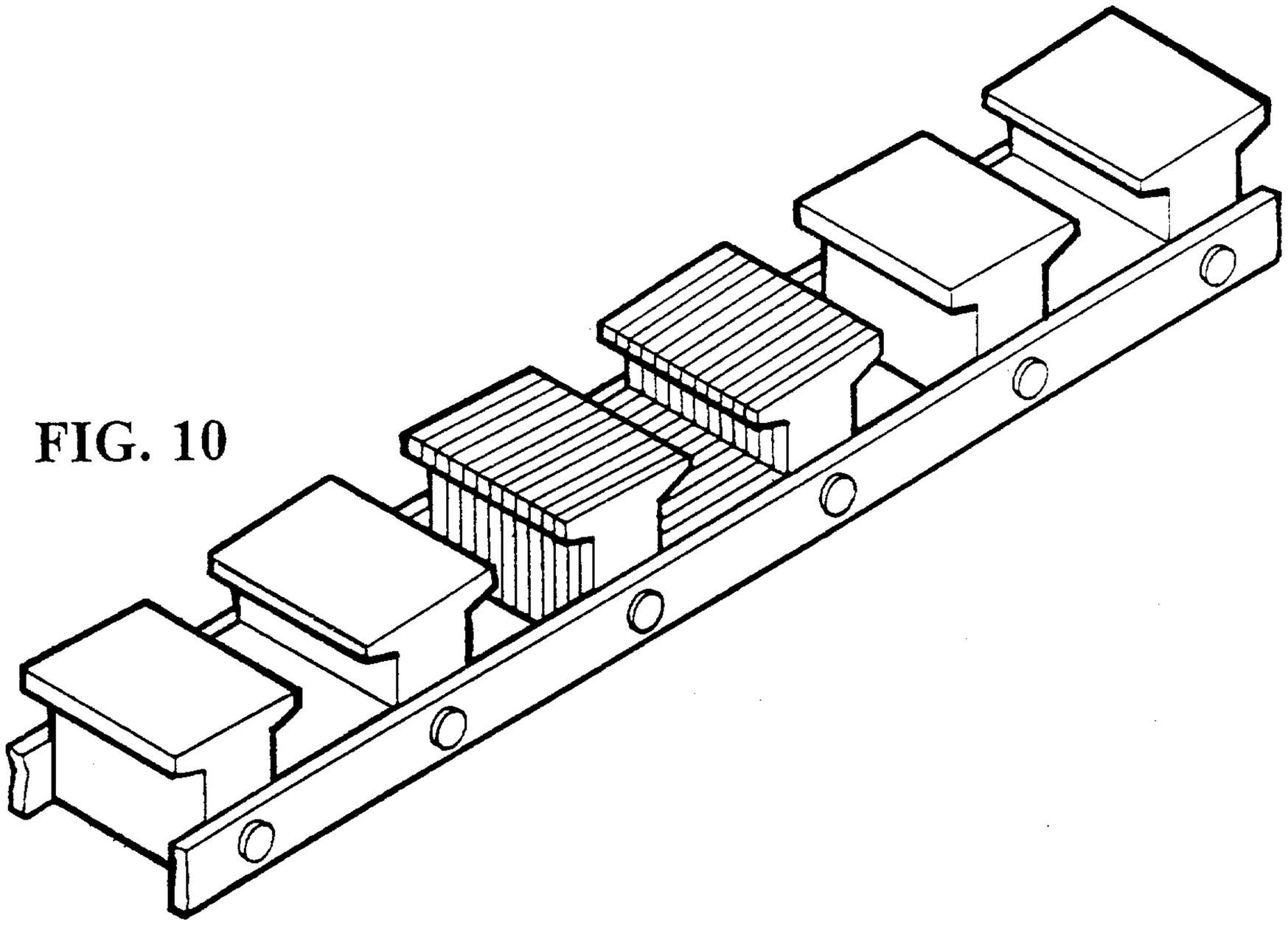


FIG. 10

Cooley, Straby & Henderson

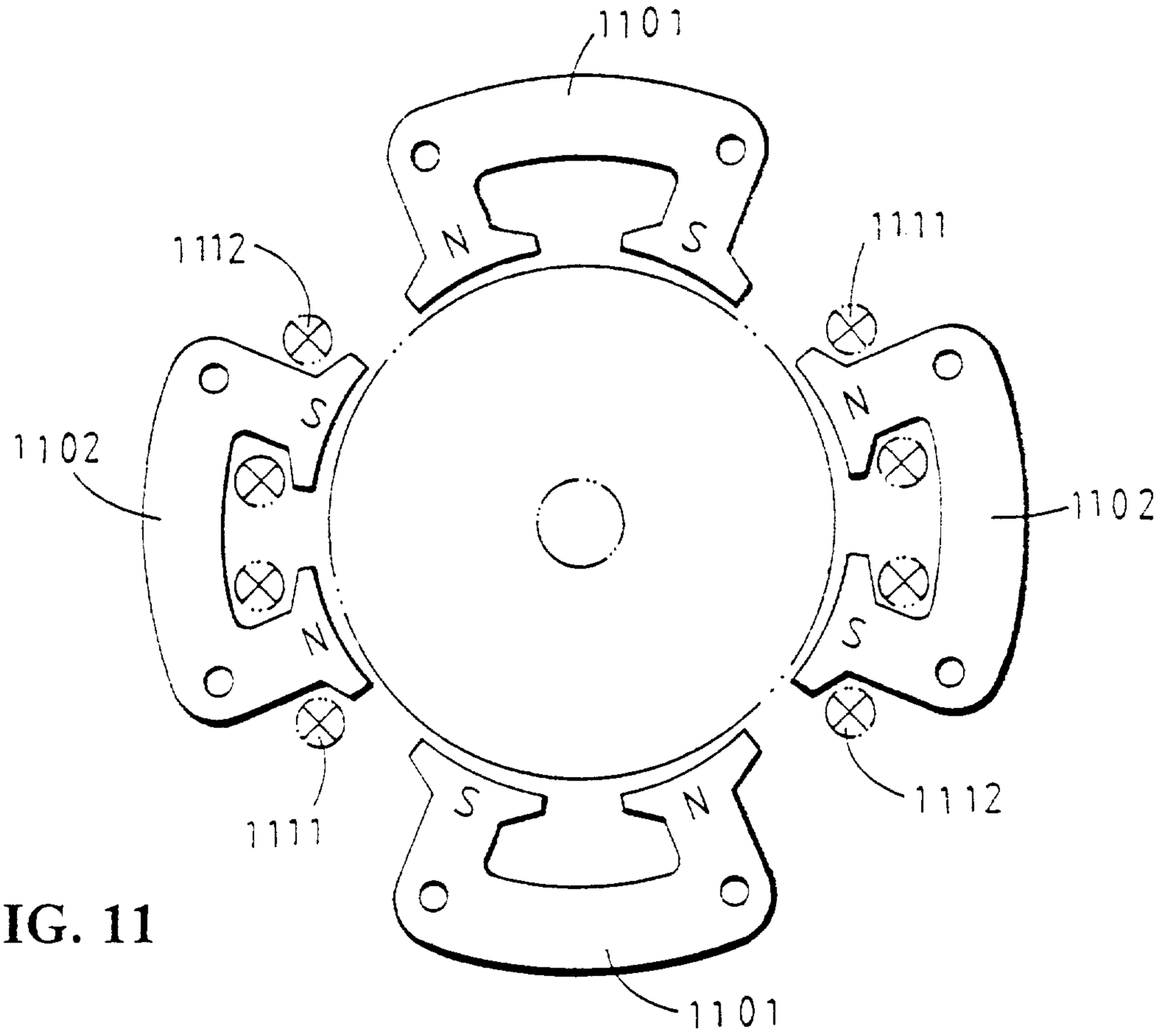
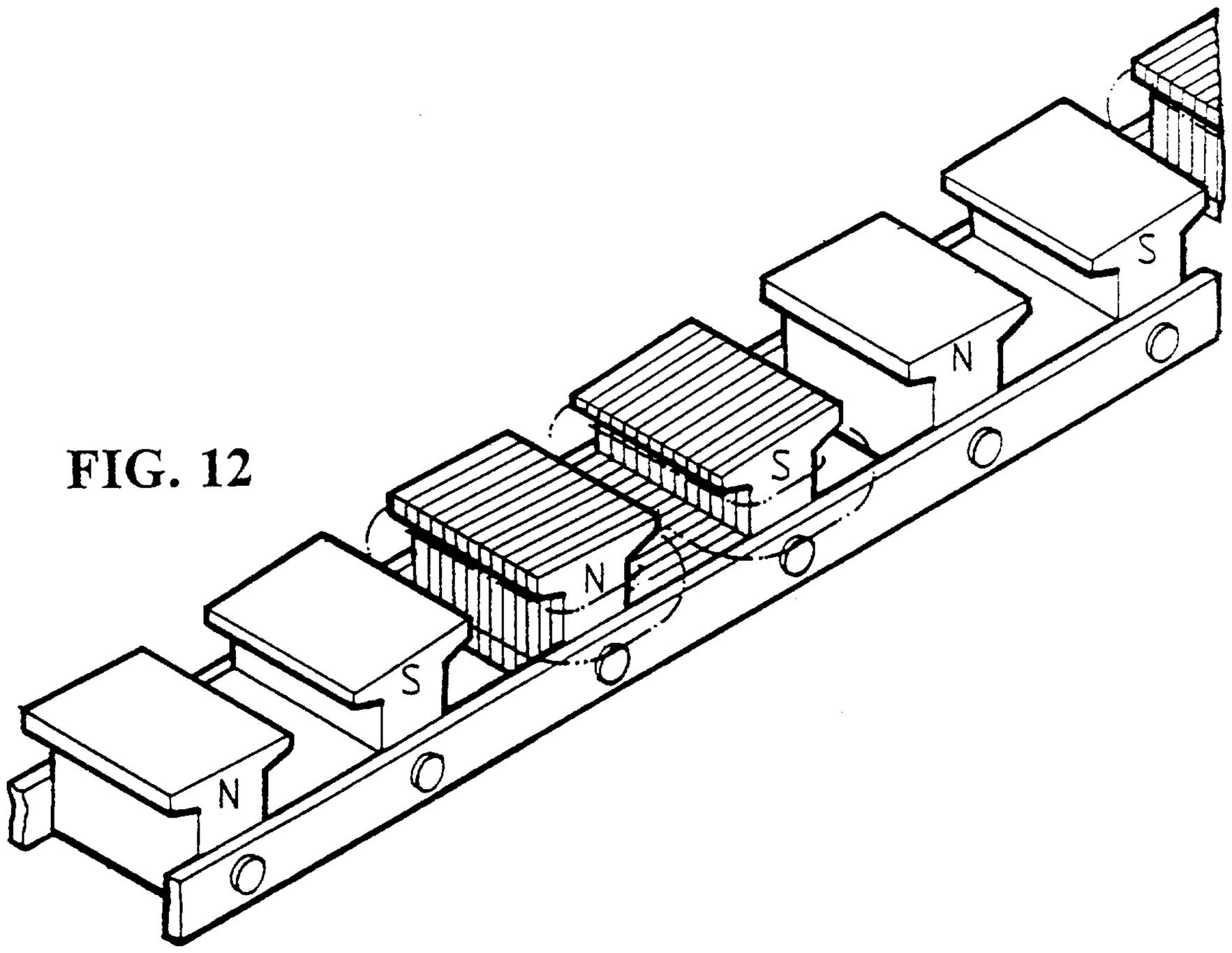


FIG. 11

FIG. 12



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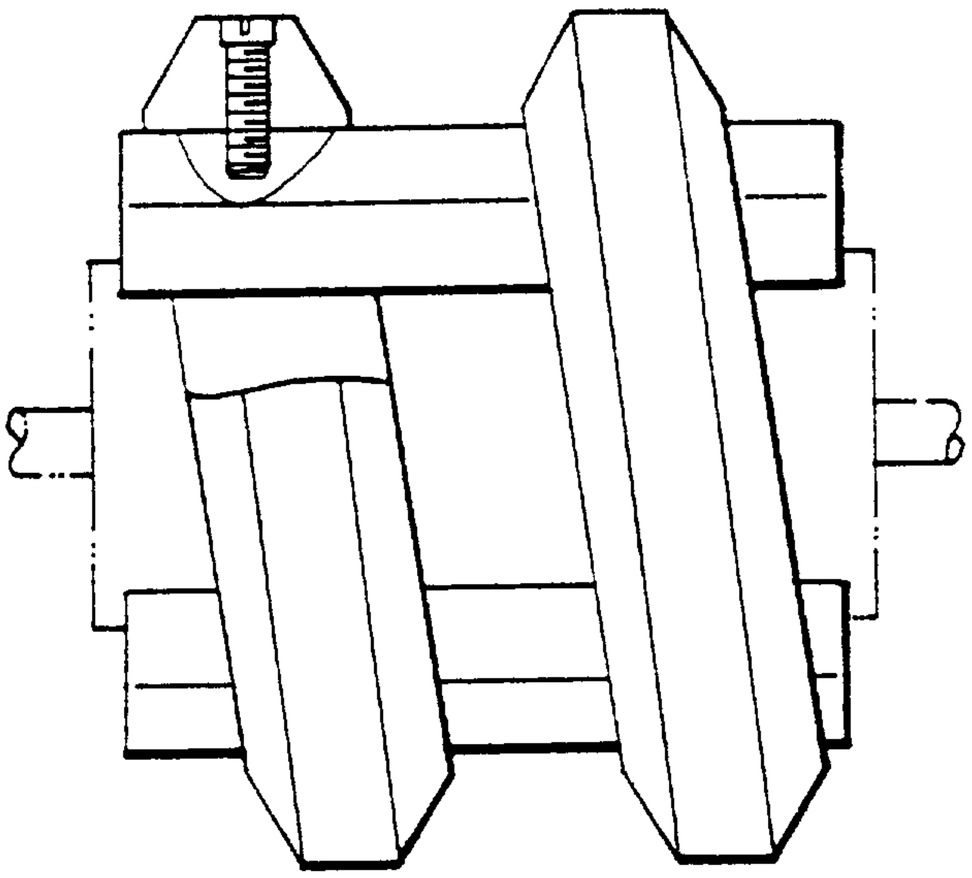

FIG. 13

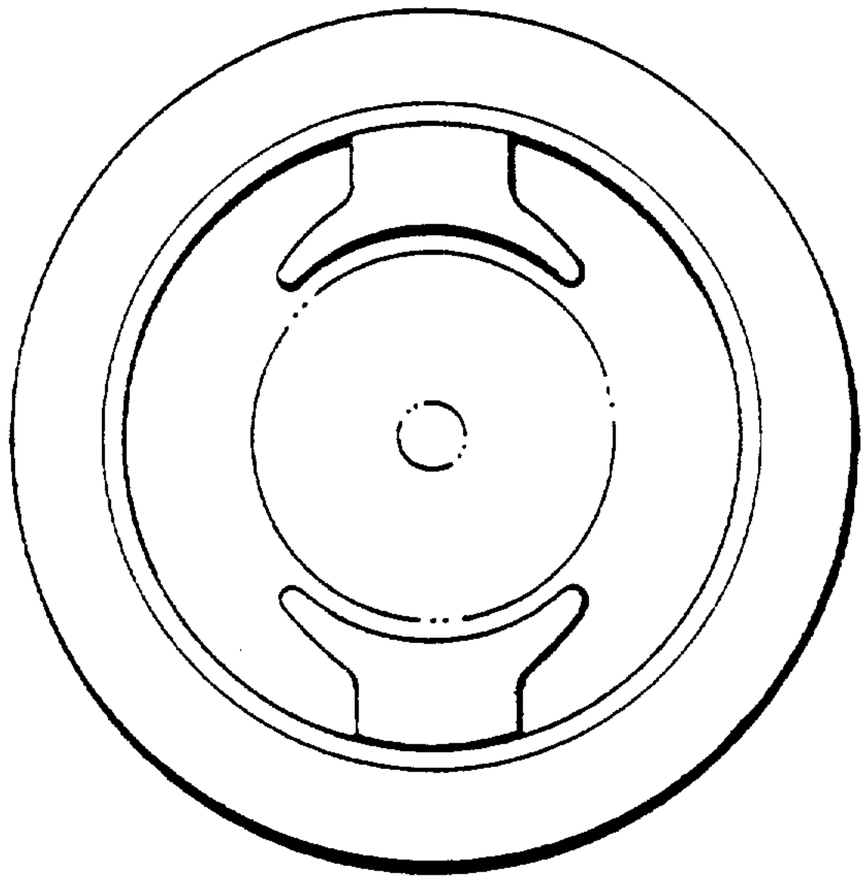

FIG. 14

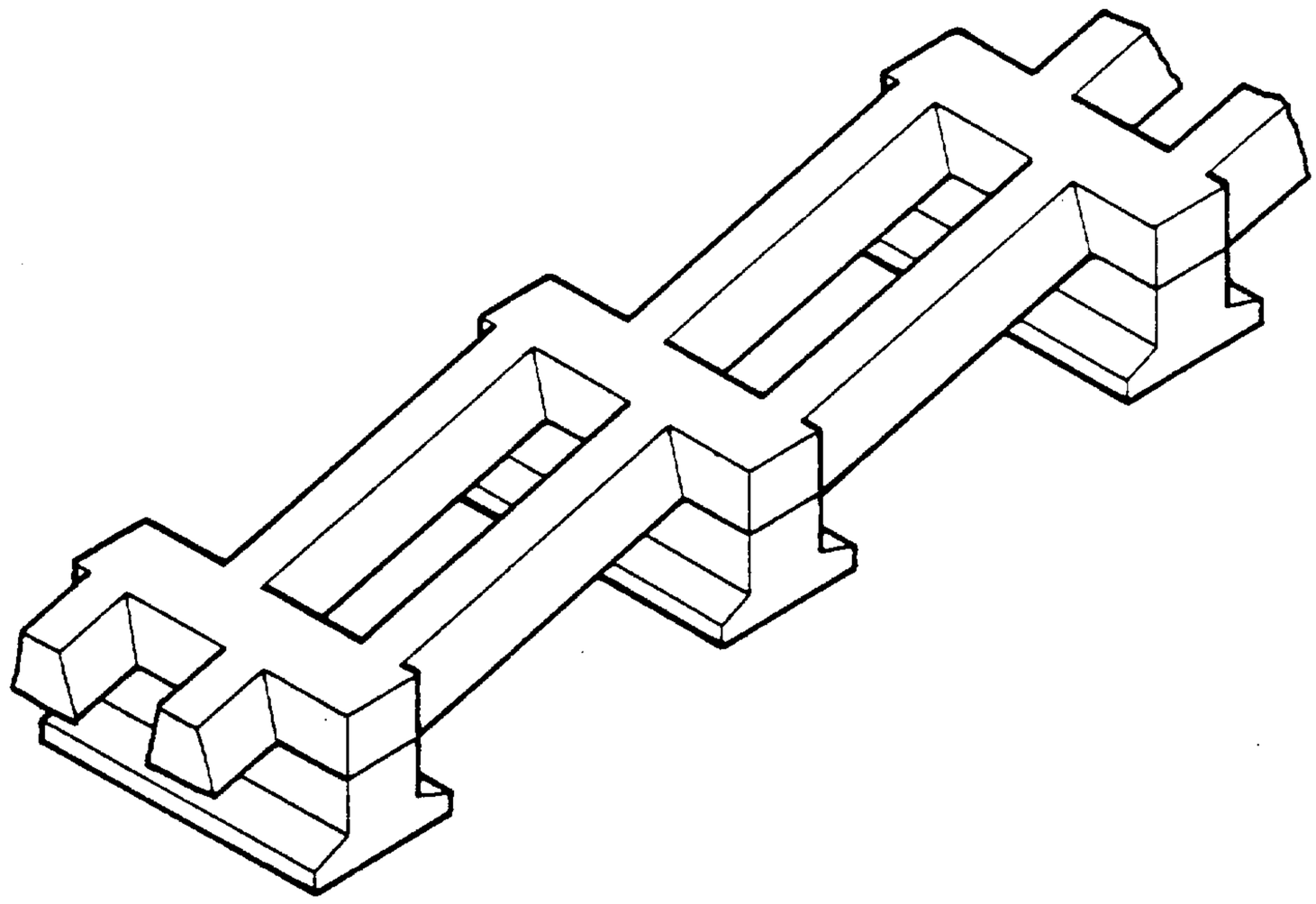

FIG. 15

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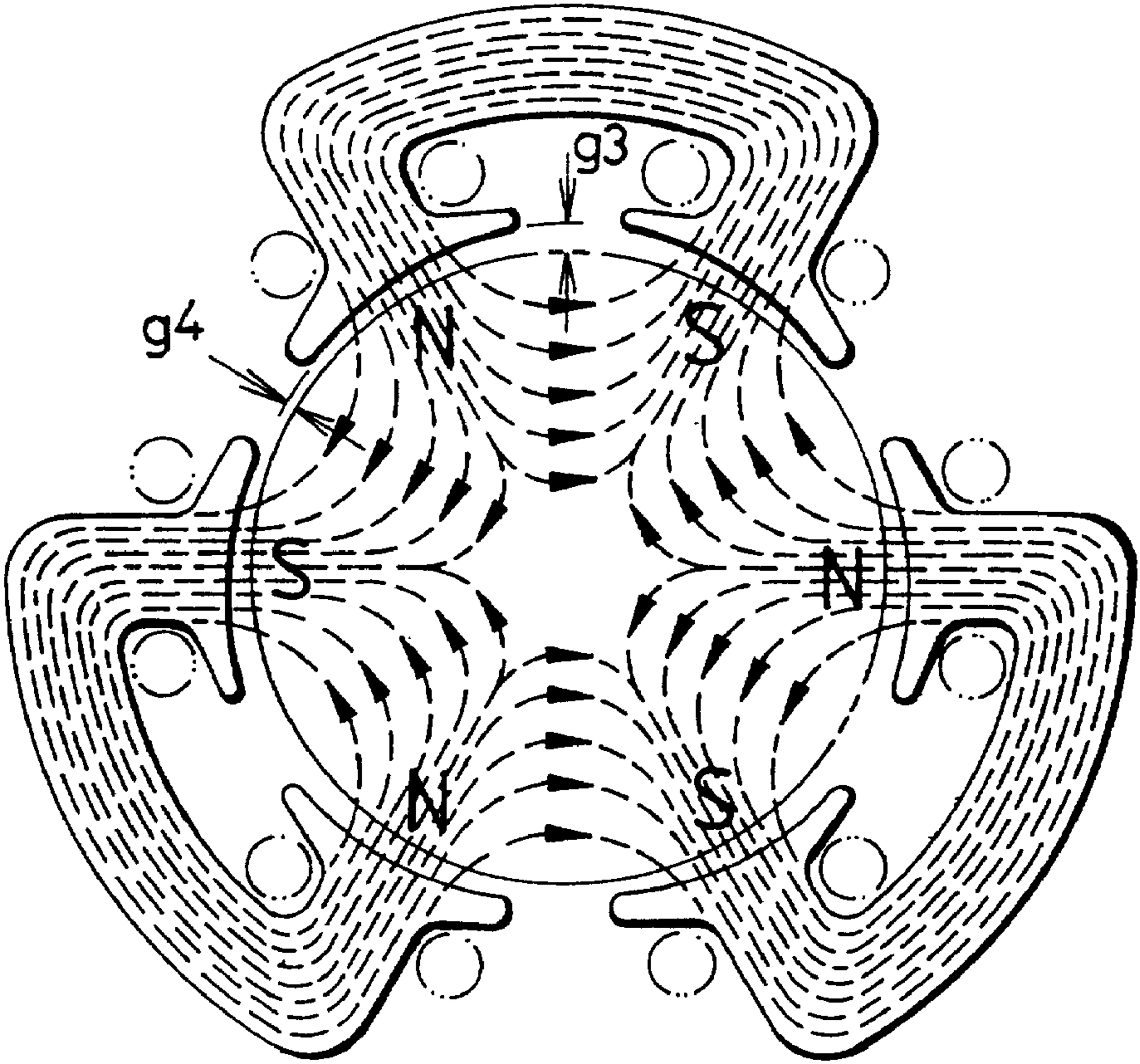
g3
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