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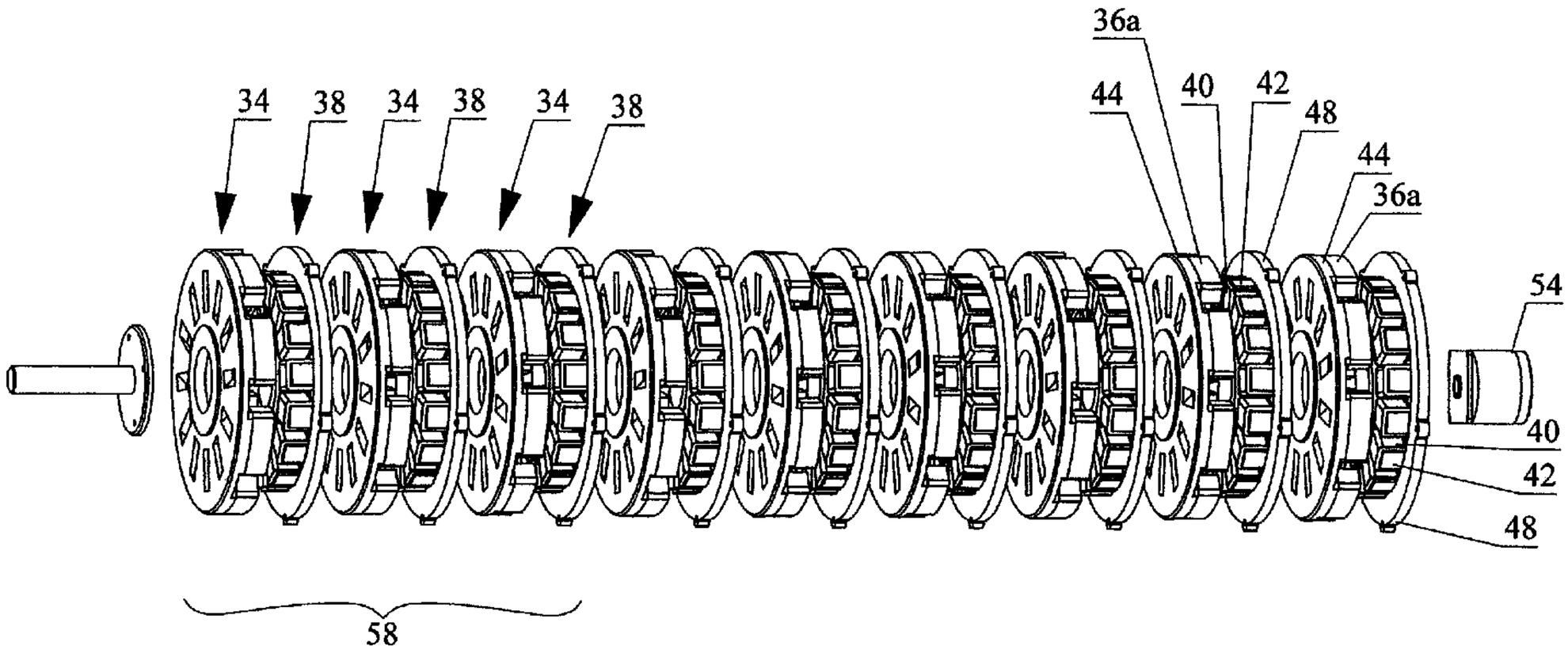
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(72) Inventeur/Inventor:
RITCHEY, JONATHAN G., CA

(73) Propriétaire/Owner:
EXRO TECHNOLOGIES INC., CA

(74) Agent: FASKEN MARTINEAU DUMOULIN LLP

(54) Titre : DISPOSITIF A SERPENTINS MULTIPLES POLYPHASIQUES
(54) Title: POLYPHASIC MULTI-COIL DEVICE



(57) Abrégé/Abstract:
A polyphasic multi-coil generator includes a driveshaft, at least first and second rotors rigidly mounted on the driveshaft so as to simultaneously synchronously rotate with rotation of the driveshaft, and at least one stator sandwiched between the first and second rotors. The stator has an aperture through which the driveshaft is rotatably journalled. A stator array on the stator has an equally radially spaced-apart array of electrically conductive coils mounted to the stator in a first angular orientation about the driveshaft. The stator array is radially spaced apart about the driveshaft. The rotors and the stator lie in substantially parallel planes. The first and second rotors have, respectively, first and second rotor arrays. The first rotor array has a first equally radially spaced apart array of magnets radially spaced around the driveshaft at a first angular orientation relative to the driveshaft. The second rotor array having a second equally spaced apart array of magnets at a second angular orientation relative to the driveshaft. The first and second angular orientations are off-set by an angular offset so that the first and second rotor arrays are offset relative to one another.

Abstract of the Disclosure

A polyphasic multi-coil generator includes a driveshaft, at least first and second rotors rigidly mounted on the driveshaft so as to simultaneously synchronously rotate with rotation of the driveshaft, and at least one stator sandwiched between the first and second rotors. The stator has an aperture through which the driveshaft is rotatably journalled. A stator array on the stator has an equally radially spaced-apart array of electrically conductive coils mounted to the stator in a first angular orientation about the driveshaft. The stator array is radially spaced apart about the driveshaft. The rotors and the stator lie in substantially parallel planes. The first and second rotors have, respectively, first and second rotor arrays. The first rotor array has a first equally radially spaced apart array of magnets radially spaced around the driveshaft at a first angular orientation relative to the driveshaft. The second rotor array having a second equally spaced apart array of magnets at a second angular orientation relative to the driveshaft. The first and second angular orientations are off-set by an angular offset so that the first and second rotor arrays are offset relative to one another.

POLYPHASIC MULTI-COIL DEVICE

Field of the Invention

The present invention relates to the field of generators, and more particularly, it relates to a generator having polyphasic multiple coils in staged staggered arrays.

Background of the Invention

Conventional electric motors employ magnetic forces to produce either rotational or linear motion. Electric motors operate on the principle that when a conductor, which carries a current, is located in the magnetic field, a magnetic force is exerted upon the conductor resulting in movement. Conventional generators operate through the movement of magnetic fields thereby producing a current in a conductor situated within the magnetic fields. As a result of the relationship between conventional motors and generators, conventional generator technologies have focused mainly on modifying electric motor designs, for example, by reversing the operation of an electric motor.

In a conventional design for an electric motor, adding an electrical current to the coils of an induction system creates a force through the interaction of the magnetic fields and the conducting wire. The force rotates a shaft. Conventional electric generator design is the opposite. By rotating the shaft, an electric current is created in the conductor coils. However the electric current will continue to oppose the force rotating the shaft. This resistance will continue to grow as the speed of the shaft is increased, thus reducing the efficiency of the generator. In a generator where a wire is coiled around a soft iron core (ferromagnetic), a magnet may be drawn by the coil and a current will be produced in the coil wire. However, the system would not create an efficient generator due to the physical reality that it takes more energy to pull the magnet away from the soft iron core of the coil than would be created in the form of electricity by the passing of the magnet.

As a result, there is a need for a generator wherein the magnetic drag may be substantially reduced such that there is little resistance while the magnets are being drawn away from the coils. Furthermore, there is a need for a generator that minimizes the impact of the magnetic drag produced on the generator. In the prior art, Applicant is aware of United States Patent No. 4,879,484 which issued to Huss on November 7, 1989 for an Alternating Current Generator and Method of Angularly Adjusting the Relative Positions of Rotors Thereof. Huss describes an actuator for angularly adjusting a pair of rotors relative to each other about a common axis, the invention being described as solving a problem with voltage control as generator load varies where the output voltage of a dual permanent magnet generator is described as being controlled by shifting the two rotors in and out of phase.

Applicant also is aware of United States Patent No. 4,535,263 which issued August 13, 1985 to Avery for Electric D.C. Motors with a Plurality of Units, Each Including a Permanent Magnet Field Device and a Wound Armature for Producing Poles. In that reference, Avery discloses an electric motor having spaced stators enclosing respective rotors on a common shaft wherein circumferential, spaced permanent magnets are mounted on the rotors and the stator windings are angularly offset with respect to adjacent stators slots so that cogging that occurs as the magnets pass a stator slot are out of phase and thus substantially cancelled out.

Applicant is also aware of United States Patent No. 4,477,745 which issued to Lux on October 16, 1984 for a Disc Rotor Permanent Magnet Generator. Lux discloses mounting an array of magnets on a rotor so as to pass the magnets between inner and outer stator coils. The inner and outer stators each have a plurality of coils so that for each revolution of the rotor more magnets pass by more coils than in what are described as standard prior art generators having only an outer coil-carrying stator with fewer, more spaced apart magnets.

Applicant is also aware of United States Patent No. 4,305,031 which issued Wharton on December 8, 1981 for a Rotary Electrical Machine. Wharton purports to address the problem wherein a generator's use of permanent magnet rotors gives rise to difficulties in regulating output voltage under varying external load and shaft speed and so describes a servo control of the relative positions of the permanent magnets by providing a rotor having a plurality of first circumferentially spaced permanent magnet pole pieces and a plurality of second circumferentially spaced permanent magnet pole pieces, where the servo causes relative movement between the first and second pole pieces, a stator winding surrounding the rotor.

Summary of the Invention

In summary, the polyphasic multi-coil generator includes a driveshaft, at least first and second rotors rigidly mounted on the driveshaft so as to simultaneously synchronously rotate with rotation of the driveshaft, and at least one stator sandwiched between the first and second rotors. The stator has an aperture through which the driveshaft is rotatably journalled. A stator array on the stator has a radially spaced-apart array of electrically conductive coils mounted to the stator in a first angular orientation about the driveshaft. The stator array is radially spaced apart about the driveshaft and may, without intending to be limiting be equally radially spaced apart. The rotors and the stator lie in substantially parallel planes. The first and second rotors have, respectively, first and second rotor arrays. The first rotor array has a first radially spaced apart array of magnets radially spaced around the driveshaft at a first angular orientation relative to the driveshaft. The second rotor array has a second equally spaced apart array of magnets at a second angular orientation relative to the driveshaft. Without intending to be limiting, the rotor arrays may be equally radially spaced apart. The first and second angular orientations are off-set by an angular offset so that the first and second rotor arrays are offset relative to one another. The radially spaced apart stator and rotor arrays may be constructed without the symmetry of their being equally radially spaced apart and still function.

The angular offset is such that, as the driveshaft and the rotors are rotated in a direction of rotation of the rotors so as to rotate relative to the stator, an attractive magnetic force of the magnets of the first rotor array attracts the magnets of the first rotor array towards corresponding next adjacent coils in the stator array which lie in the direction of rotation of the rotors so as to substantially balance with and provide a withdrawing force applied to the magnets of the second rotor array to draw the magnets of the second rotor array away from corresponding past adjacent coils in the stator array as the magnets of the second rotor array are withdrawn in the direction of rotation of the rotors away from the past adjacent coils. Similarly, as the driveshaft and the rotors are rotated in the direction of rotation of the rotors, an attractive magnetic force of the magnets of the second rotor array attracts the magnets of the second rotor array towards corresponding next adjacent coils in the stator array which lie in the direction of rotation of the rotors so as to substantially balance with and provide a withdrawing force applied to the magnets of the first rotor array to draw the magnets of the first rotor array away from corresponding past adjacent coils in the stator array as the magnets of the first rotor array are withdrawn in the direction of rotation of the rotors away from the past adjacent coils.

In one embodiment, a further stator is mounted on the driveshaft, so that the driveshaft is rotatably journalled through a driveshaft aperture in the further stator. A further stator array is mounted on the further stator. The further stator array has an angular orientation about the driveshaft which, while not intending to be limiting, may be substantially the same angular orientation as the first angular orientation of the stator array of first stator. A third rotor is mounted on the driveshaft so as to simultaneously synchronously rotate with rotation of the first and second rotors. A third rotor array is mounted on the third rotor. The third rotor array has a third equally radially spaced apart array of magnets radially spaced around the driveshaft at a third angular orientation relative to the driveshaft. The third angular orientation is angularly offset for example, by the angular offset of the first and second rotor arrays so that the third rotor array is offset relative to the second rotor array by the same angular offset as between the first and second rotor arrays. The further stator and the third rotor lay in planes

substantially parallel to the substantially parallel planes the first stator and the first and second rotors. Advantageously the third rotor array is both offset by the same angular offset as between the first and second rotor arrays from the second rotor array and by twice the angular offset as between the first and second rotor arrays, that is, their angular offset multiplied by two, from the first rotor array. Thus the first, second and third rotor arrays are sequentially angularly staggered about the driveshaft.

The sequentially angularly staggered first, second and third rotors, the first stator and the further stators may be referred to as together forming a first generator stage. A plurality of such stages, that is, substantially the same as the first generator stage, may be mounted on the driveshaft.

The magnets in the rotor arrays may be pairs of magnets, each pair of magnets may advantageously be arranged with one magnet of the pair radially inner relative to the driveshaft and the other magnet of the pair radially outer relative to the driveshaft. This arrangement of the magnets, and depending on the relative position of the corresponding coils on the corresponding stator, provides either radial flux rotors or axial flux rotors. For example, each pair of magnets may be aligned along a common radial axis, that is, one common axis for each pair of magnets, where each radial axis extends radially outwardly of the driveshaft, and each coil in the stator array may be aligned so that the each coil is wrapped substantially symmetrically around corresponding radial axes. Thus, advantageously, the magnetic flux of the pair of magnets is orthogonally end-coupled, that is, coupled at ninety degrees to the corresponding coil as each pair of magnets are rotated past the corresponding coil.

In one embodiment not intended to be limiting, the first rotor array is at least in part co-planar with the corresponding stator array as the first rotor array is rotated past the stator array, and the second rotor array is at least in part co-planar with the corresponding stator array as the second rotor is rotated past the stator array.

The rotors may include rotor plates wherein the rotor arrays are mounted to the rotor plates, and wherein the rotor plates are mounted orthogonally onto the driveshaft. The stators may include stator plates and the stator arrays are mounted to the stator plates, and wherein the stator plates are orthogonal to the driveshaft.

The rotors may be mounted on the driveshaft by mounting means which may include clutches mounted between each of the first and second rotors and the driveshaft. In such an embodiment, the driveshaft includes means for selectively engaging each clutch in sequence along the driveshaft by selective longitudinal translation of the driveshaft by selective translation means. The clutches may be centrifugal clutches adapted for mating engagement with the driveshaft when the driveshaft is longitudinally translated by the selective translation means into a first position for mating engagement with, firstly, a first clutch for example, although not necessarily, on the first rotor and, secondly sequentially into a second position for mating engagement with also a second clutch for example on the second rotor and so on to sequentially add load to the driveshaft, for example during start-up. Thus in a three rotor stage, some or all of the rotors may have clutches between the rotors and the driveshaft. As described above, the stages may be repeated along the driveshaft.

In an alternative embodiment, the mounting means may be a rigid mounting mounted between the third rotor, each of the first and second rotors and the driveshaft. Instead of the use of clutches, the electrical windings on the rotor arrays in successive stages may be selectively electrically energized, that is, between open and closed circuits for selective windings wherein rotational resistance for rotating the driveshaft is reduced when the circuits are open and increased when the circuits are closed. Staging of the closing of the circuits for successive stator arrays, that is, in successive stages, provides for the selective gradual loading of the generator.

Brief Description of the Drawings

Various other objects, features and attendant advantages of the present invention will become fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

Figure 1a is, in partially cut away perspective view, one embodiment of the polyphasic multi-coil generator showing a single stator sandwiched between opposed facing rotors.

Figure 1 is, in front perspective view, a further embodiment of the polyphasic multi-coil generator according to the present invention illustrating by way of example nine rotor and stator pairs wherein the nine pairs are grouped into three stages having three rotor and stator pairs within each stage, the radially spaced arrays of magnets on each successive rotor within a single stage staggered so as to be angularly offset with respect to each other.

Figure 2 is, in front perspective exploded view, the generator of Figure 1.

Figure 3 is the generator of Figure 2 in rear perspective exploded view.

Figure 4 is a partially exploded view of the generator of Figure 1 illustrating the grouping of the rotor and stator pairs into three pairs per stage.

Figure 4a is, in front elevation view, the generator of Figure 1 with the front rotor plate removed so as to show the radially spaced apart magnet and coil arrangement.

Figure 5 is, in perspective view, the generator of Figure 1 within a housing.

Figure 6 is a sectional view along line 6-6 in Figure 1.

Figure 7 is, in front perspective exploded view a single rotor and stator pair of the generator of Figure 1.

Figure 8 is the rotor and stator pair of Figure 7 in rear perspective exploded view.

Figure 9 is, in cross sectional view, an alternative embodiment of a single rotor and stator pair illustrating the use of a centrifugal clutch between the rotor and the driveshaft.

Figure 9a is a cross sectional view through an exploded front perspective view of the rotor and stator pair of Figure 9.

Figure 10 is, in partially cut away front elevation view, an alternative embodiment of the present invention illustrating an alternative radially spaced apart arrangement of rotor and stator arrays.

Figure 11a is in side elevation a further alternative embodiment of the generator according to the present invention wherein the stator coils are parallel to the driveshaft on a single stage.

Figure 11b is in side elevation two stages according to the design of Figure 11a.

Figure 11c is, in side elevation, three stages of a further alternative embodiment wherein the stator coils are inclined relative to the driveshaft.

Detailed Description of Embodiments of the Invention

In Figure 1a, wherein like reference numerals denote corresponding parts in each view, a single stage 10 of the polyphasic multi-coil generator according to the present invention includes a pair of rotors 12 and 14 lying in parallel planes and sandwiching therebetween so as to be interleaved in a plane parallel and lying between the planes of the rotors, a stator 16. Rotors 12 and 14 are rigidly mounted to a driveshaft 18 so that when driveshaft 18 is rotated by a prime mover (not shown) for example in direction A, rotors 12 and 14 rotate simultaneously at the same rate about axis of rotation B. Feet 32 are provided to mount stator 16 down onto a base or floor surface. Rotors 12 and 14 each have a central hub 19 and mounted thereon extending in an equally radially spaced apart array around driveshaft 18 are pairs of magnets 22a and 22b. Although only one pair of magnets, that is, only two separate magnets are illustrated, with a keeper shown between to increase flux, a single magnet with the polarities of either end inducing the coils may be used with substantially equal results. Each pair of magnets is mounted on a corresponding rigid arm 24 extended cantilevered radially outwardly from hub 19. Each pair of magnets 22a and 22b are spaced apart along the length of their corresponding arm 24 so as to define a passage or channel 26 between the pair of magnets.

Electrically conductive wire coils 28 are wrapped around iron-ferrite cores 30. Cores 30 and coils 28 are mounted so as to protrude from both sides 16a and 16b of stator 16. Coils 28 are sized so as to pass snugly between the distal ends 22a and 22b of magnets 22, that is, through channel 26 so as to end couple the magnetic flux of the magnets with the ends of the coils. In the embodiment illustrated in Figure 1a, again which is not intended to be

limiting, eight coils 28 and corresponding cores 30 are mounted equally radially spaced apart around stator 16, so that an equal number of coils and cores extend from the opposite sides of stator 16 aligned so that each coil and core portion on side 16a has a corresponding coil and core immediately behind it on the opposite side of stator 16, that is, on side 16b. It is to be understood that although this embodiment employs an eight coil array, however, any number of coils with corresponding magnet assemblies may by employed. For example, in one embodiment, this design uses eight coils and two sets of armatures (that is rotors) with six sets of magnets each.

Rotor 14 is a mirror image of rotor 12. Rotors 12 and 14 are mounted in opposed facing relation on opposite sides of stator 16. The angular orientation of rotors 12 and 14 about driveshaft 18 differs between the two rotors. That is, the magnets 22 on rotor 14 are angularly offset about axis of rotation B relative to the magnets mounted on rotor 12. For example, each of the pairs of magnets on rotor 14 may be angularly offset by, for example, and offset angle α (better defined below) of five degrees or ten degrees or fifteen degrees relative to the angular orientation of the pairs of magnets on rotor 12. Thus, as rotors 12 and 14 are simultaneously being driven by rotation of shaft 18, as a magnet 22 on rotor 12 is being magnetically attracted towards a next adjacent core 30 portion on side 16a of the stator, the attractive force is assisting in pushing or drawing the corresponding magnet on rotor 14 past and away from the corresponding core portion on side 16b of stator 16. Thus the attractive force of incoming magnets (incoming relative to the coil) on one rotor substantially balances the force required to push the corresponding magnets on the other rotor away from the coil/core. Consequently, any one magnet on either of the rotors is not rotated past a core merely by the force of the rotation applied to driveshaft 18, and the amount of force required to rotate the rotors relative to the stator is reduced. The efficiency of the generator is thus increased by the angular offsetting of the magnet pairs on opposite sides of the stator acting to balance or effectively cancel out the effects of the drawing of the magnets past the cores.

Further stages may be mounted onto driveshaft 18 for example further opposed facing pairs of rotors 12 and 14 having a stator 16 interleaved therebetween. In such an embodiment, further efficiency of the generator may be obtained by progressive angular offsetting of the magnets so as to angularly stagger each successive rotors' array of magnets relative to the angular orientation of the magnets on adjacent rotors. Thus, with sufficient number of stages, the magnetic forces may be relatively seamlessly balanced so that at any point during rotation of driveshaft 18, the attractive force of the magnet approaching the next adjacent cores in the direction of rotation balances the force required to push or draw the magnet pairs on other rotors away from that core thus reducing the force required to rotate driveshaft 18.

A further embodiment of the invention is illustrated in Figures 1-9, again wherein similar characters of reference denote corresponding parts in each view. In the illustrated embodiment nine banks of rotors 34 each have radially spaced apart arrays of magnet pairs 36a and 36b wherein the arrays are angularly displaced or staggered relative to adjacent arrays on adjacent rotors. Thus each magnet pair 36a and 36b in the equally radially spaced array of magnet pairs 36a and 36b, radially spaced about axis of rotation B are angularly offset by the same offset angle α, for example, five degrees, ten degrees or fifteen degrees, between adjacent rotors. Thus the successive banks of rotors are cumulatively staggered by the same angular displacement between each successive rotor so as to achieve a more seamlessly magnetically balanced rotation of the rotors relative to the stators 38 and in particular relative to the coils 40 and cores 42 mounted on stators 38.

Magnets 36a and 36b are mounted onto a carrier plate 44. The carrier plate 44 for each rotor 34 is rigidly mounted onto driveshaft 46. Coils 40 and their corresponding cores 42 are mounted onto a stator plate 48. Stator plate 48 is rigidly mounted to housing 56, which itself may be mounted down onto a base or floor by means of rigid supports (not shown).

In one alternative embodiment not intending to be limiting, a small motor 54, which is in addition to the prime mover (not shown), may be employed to engage additional stages or banks having further progressively angularly displaced or staggered stages or banks of magnet pairs in radially spaced array on successive rotors. For example motor 54 may selectively drive a shifter rod so as to sequentially engage centrifugal clutch mechanisms on each rotor as described below.

A housing 56 may be provided to enclose stators 38 and the armatures or rotors 34. Housing 56 may be mounted on a supporting frame (not shown), and both may be made of non-magnetic and non-conductive materials to eliminate eddy currents. In one embodiment of the invention, not intended to be limiting, a single stage 58 of the generator includes three stators 38 interleaved with three rotors 34. The generator may include multiple stages 58 along the driveshaft to reduce the magnetic drag by offsetting any resistances created within generator.

Stators 38 may include a plurality of induction coils 40 made of electrically conducting materials, such as copper wire. Each induction coil 40 may be wrapped around a highly ferromagnetic core such as a soft iron core 42. Alternatively, induction coils 40 may be air coils (that is, not wrapped around any core) for applications where less output current is required or where less mechanical force is available to be applied to rotors 38. In the illustrated embodiment of the invention, the stators are disk shaped. The embodiment of Figure 1a includes eight induction coils 28 mounted equidistant and equally radially spaced apart from each other on a plate or disk made of non-magnetic and non-conductive materials. In the embodiment of the remaining figures, stators 38 include sixteen induction coils 40 on each stator disk or plate 48. The number of induction coils 40 may vary depending on the application of the generator, and may be only limited by the physical space available on the stator plate.

The induction coils 40 may be configured such that a first set of induction coils 40 produce a first independent phase signal and a second set of induction coils 40 produce a second independent phase signal with opposing wave signals. The induction coils 40 are alternately orientated such that an induction coil 40 producing the first independent phase signal is positioned in between induction coils 40 producing the second independent phase signal. In such dual phase design, the two independent phases are exact reciprocals of each other wherein one independent phase may be inverted to combine the potential current of the two into one phase with a synchronous wave pattern. Preferably, each of the first set and second set of induction coils 40 have an equal number of induction coils 40 wrapped around their cores 42 in a first direction and an equal number of induction coils 40 wrapped around their cores 42 in an opposite second direction to align the currents of the two phases. For example, in the embodiment wherein the stators 38 include sixteen, that is, two sets of eight induction coils 40 (alternate phases), each of the first set of eight induction coils 40 will produce a first independent phase signal and the second set of eight induction coils 40 will produce a second independent phase signal.

Rotors 34 may have magnets 36 of any magnetic materials such as neodymium magnets. Rotors 34 each include an array of equally spaced apart pairs of magnets 36a and 36b which are mounted on rotor plates made of non-magnetic and non-conductive materials so as to discourage straying flux lines or eddy currents. In the embodiment having sixteen induction coils 40 on each stator, the rotor array of magnets (the "rotor array") includes eight "U"-shaped opposed facing pairs of magnets 36 on each rotor 34. Each end of each "U"-shaped magnet 36, sixteen ends in all on the radially outer ring and sixteen on the inner ring, are paired to the corresponding sixteen coils as the ends of the magnets are rotated closely past the opposite ends of the coils.

In the illustrated embodiment of Figure 1 the rotor arrays between successive rotors 34 in stage 58 are angularly offset about the axis of rotation B of the driveshaft by an offset angle α of for example fifteen degrees. It is understood that an offset of fifteen degrees is merely one preferred offset, but it may be any number of degrees of offset. Offset angle α is

seen best in Figure 4a as the angle between the radial axes 60 and 60' of magnets 36a and 36a' of successive rotors 34. In one embodiment of the invention, the magnetic fields of the magnets pass induction coils 40 at ninety degrees. In applicant's view this may be one of the most efficient means by which to separate the magnets from the cores 42 of induction coils 40. As the array of magnets are at right angles to the cores, less energy is required to remove the magnets from the cores, thus promoting higher efficiencies in the generator.

As the rotors are driven to rotate about the driveshaft by an outside motive force, such as for example wind or water or other prime movers, the magnets 36 travel towards induction coils 40 by attraction of the magnets to the cores 42. AC pulse is created in all the induction coils on the stators as the induction coils are designed to draw the magnetic flux from the magnets 36. In the embodiment of Figure 1a, which is illustrative, the opposing polarity of the magnets between each rotor and the angularly offset alignment of the rotor array relative to each other permits the magnets to be drawn away from one core and towards the next core. For example, the north, south (N,S) polarity configuration of the magnets on the first rotor 12 is drawn by the opposing south, north (S,N) polarity configuration of the magnets on is the second rotor 14, where the first rotor array is offset by fifteen degrees relative to the second rotor array such that the magnetic attraction between the magnets on the first rotor and the magnets on the second rotor draws the magnets away from the core. The balancing of magnetic forces between magnets on the rotors reduces the work required from the driveshaft to draw magnets off the induction coils, thereby increasing the efficiency of the generator.

The rotating magnetic fields created by the configuration of the magnets with alternating magnetic orientation between rotors and the alternating multi phase configuration of the induction coils create multiple reciprocal AC phase signals. As the induction coils are stationary, AC power may be harnessed directly from the induction coils without brushes. The regulation and attenuation of these currents may be achieved by methods known in the art. As the magnets pass the induction coils, they induce a current that alternates in direction. Magnets may be configured such that for example an equal number of magnets influence the

first set of induction coils by a N,S magnetic polarity as the number of magnets influencing the second set of induction coils by a S,N magnetic polarity. The configuration of the rotors create an alternating current in each of the two phases of the single stage embodiment of Figure 1a. The configuration of magnetic forces allow for a balancing of the resistances within the generator.

In an alternative embodiment, such as seen in Figures 1-9, there is a significant advantage to the addition of multiple stages on the driveshaft. The work required to rotate the driveshaft may be even further reduced through the addition of multiple stages 58. The alignment of the multiple stages may be offset such that additional stages further reduces resistance in the generator by accomplishing even greater balancing of forces than can be done with a single stage design. Alignment of stator arrays of coils ("stator arrays") may be offset or alternatively, the alignment of the rotor arrays may be offset to reduce resistance. Consequently, adding additional stages may increase electrical output without proportionally increasing resistance within the generator. While additional induction coils will increase magnetic drag, the greater balancing of forces achieved by the orientation of the stator arrays and rotor arrays of the additional stages offsets the increase in drag and further increases the overall efficiency of the generator. Additional stages may be engaged so as to rotate the additional rotors by any number of mechanisms, such as current driven sensors that use solenoids, or clutches such as the centrifugal driven clutch mechanisms of Figures 7-9, 9a which may be used to engage the next stage when the rotor of a subsequent stage achieves a predetermined speed. An example of a clutch is illustrated. Clutch 62 is mounted within the hub of each of rotors 34. Rotation of a clutch arm 64, once the clutch is engaged by the splines on the splined portion 18b of driveshaft 18 engaging matching splines within the arm hub 66, drives the arm against stops 68. This drives the clutch shoes 70 radially outwardly so as to engage the periphery of the shoes against the interior surface of the rotor carrier plate hub 44a. A linear actuator, for example such as motor 54, actuates shifter rod 72 in direction D so as to engage splined portion 18b with firstly, the splines within the arm hub 66. Then, once the clutch engages and the rotor comes up to nearly match the rotational speed of the

driveshaft, the splined portion is further translated so as to engage the splines 74a within the rotor hub 74. Subsequent rotor/stator pairs or subsequent stages, such as stages 58, may be added by further translation of the shifter rod into the splines of subsequent clutches and their corresponding rotor hubs. Rotor hubs are supported by needle bearings 76 within stator hub 38a. In the further alternative, linear motor driven mechanisms or spline and spring mechanisms may be used. Figure 10 is a further alternative embodiment wherein the coils are offset in a concentric circle around the driveshaft to achieve the magnetic balancing. The coils are aligned end to end in a concentric circle around the driveshaft in the further alternative embodiment seen in Figures 11a-11c. The induction coils 40 are mounted parallel, or slightly inclined as in Figure 11c, relative to the driveshaft to reduce the draw of magnetic flux from between the rotors due to the close proximity and the strength of the magnets. A further advantage of positioning the induction coils parallel to the driveshaft is that drawing magnets directly past the end of each induction coil rather than from the side may be more efficient in inducing current in the induction coils. A horizontal orientation of the induction coils may also permit doubling the number of induction coils in the generator, resulting in greater output. In the embodiment of Figure 11b, the two stator arrays 80 and 80' have an angular offset relative to each other that is one half of the desired total angular offset, that is, the alignment that provides for optimum balance. The next successive stator array may then have the same angular offset as between stator arrays 80 and 80'. As in the other embodiments the angular offset may be appropriately offset for any number of stages. This embodiment shows that the coils may be offset while leaving the magnet arrays in the armatures/rotors in alignment, that is without an angular offset between successive rotor arrays, and still accomplish the balancing effect.

As stated above, multiple stages reduce resistance as each stage is added. For example, within a stage having three rotor/stator pairs, rather than a single induction coil being induced by the passing of two magnets with opposing magnetic poles, such an embodiment allows two induction coils to effectively align between the magnetic influences of the rotor arrays. In addition to increasing the number of induction coils, the rotors arrays are

much further apart, thus significantly reducing the incidence of straying magnetic flux across the space between the rotors.

To appropriately orientate additional stages for a staging application, the rotor arrays may be appropriately angularly offset as described above. Alternatively as seen in Figure 11c, the induction coils may be angled such that the rotor arrays are not perfectly aligned in parallel to each other. As induction coils 40 and their corresponding cores 42 are on a slight angle, magnets (not shown) on rotors 78 on either side of the stator arrays 80 are preferably misaligned too as the magnetic influence from the magnets should induce each of the induction coils from both ends simultaneously for optimum function. In an embodiment of the invention, the misalignment of rotor arrays is increasingly smaller, becoming negligible as more stages are added. As additional stages are added, the less of an angular offset exists between the subsequent rotor arrays with the stages. Any number on of stages may be added to the driveshaft and additional stages may be aligned or misaligned with other stages within the generator, depending on the desired function.

The optimum number of stages may be determined by the degrees of offset of each stage relative to the previous stage. The number of induction coils in the stator arrays need not depend on the corresponding number of magnets in the rotor arrays. The stator arrays may include any number of induction coils.

There are many applications for a generator according to the present invention. For example, rather than having a wind turbine that requires significant energy to start rotating driveshaft 18 and which may be overloaded when too much wind is applied, the generator may be reconfigured allow the maximum current to be produced regardless of how much wind is driving the generator. This may be accomplished by engaging a greater number of stages, such as stages 58 for example as the wind increases and decreasing the engagement of stages to reducing the number of engaged stages when the wind decreases. Furthermore, the first stage of the generator may include air coils such that very little wind energy is required to start

rotating the driveshaft, and subsequent stages may include induction coils having iron cores such that greater currents may be generated when there is greater wind energy. Further, additional stages may increase is size and diameter so as to create greater physical resistance when greater wind energy is present but as well to create more electrical output from the system when input energy is high. When wind energy is minimal, the generator may thus still allow for rotor 30 to rotate as it will engage only one, that is the first stage of the generator. As the wind energy increases, the generator may engage additional stages, thus increasing the output current. As wind energy continues to increase, more stages may be added or engaged to allow for the maximum current to be drawn off the generator. As wind energy decreases in intensity, the generator may disengage the additional stages and thus reduce mechanical resistance, allowing the blades of the wind turbine or other wind driven mechanism to continue to turn regardless of how much wind is present above a low threshold. This generator configuration allows for maximized energy collection.

In an alternative design, all of the rotors in all of the stages are rigidly mounted to the driveshaft, so that all of the rotors are rotating simultaneously. Instead of clutches, the windings circuits are left open on, at least initially, many or most of the stages to reduce turning resistance, and only those windings on the stages to be engaged are closed, that is engergized. This allows for reduced resistance on the driveshaft overall when a lesser number of stages are electrically engaged. As additional circuits are closed and more windings thus added to the system, this will result in increasing the load of the generator and thus it will increase resistance on the driveshaft. By not requiring clutching mechanisms, the generator may be less expensive to construct and maintain as there are no maintenance issues regarding any clutch mechanisms. This "electrical" staging system may be applied to the magnetically balanced generator design according to the present invention or any other conventional design applicable for the staging application.

It should also be noted that the staging application, mechanical with clutches, or electrical by engaging and disengaging coil array circuitry may be applied to existing

generator designs that are appropriately constructed into short, stout sections so as to accommodate the staging application.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

WHAT IS CLAIMED IS:

1. A polyphasic multi-coil device comprising:

a driveshaft,

first and second rotors rotatable with said driveshaft,

first and second stators interleaved with said first and second rotors wherein said stators each have an aperture therethrough through which said driveshaft is rotatably journalled and wherein said stators each have a stator array including circumferentially spaced-apart electrically conductive coils mounted to said stator, the stator array of the first stator having a first stator array angular orientation and the stator array of the second stator having a second stator array angular orientation relative to said driveshaft, and wherein said rotors and said stators lie in substantially parallel planes,

wherein said first and second rotors have, respectively, first and second rotor arrays, said first rotor array including a first circumferentially spaced apart array of magnets at a first rotor array angular orientation relative to said driveshaft, said second rotor array including a second circumferentially spaced apart array of magnets at a second rotor array angular orientation relative to said driveshaft, wherein said magnets of said first rotor array and said second rotor array are pairs of magnets, each pair of magnets arranged with one magnet of said pair closer to the driveshaft than the other magnet of said pair,

wherein (i) said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle, (ii) said first stator array angular orientation is off-set from said second stator array angular orientation by a stator offset angle, or (iii) said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle and said first stator array angular orientation is off-set from said second stator array angular orientation by a stator offset angle.

2. The device of claim 1, wherein said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle..

3. The device of claim 1 wherein each pair of magnets is aligned along a radial axis extending radially outward from said driveshaft.

4. The device of claim 3 wherein each of said coils in said stator arrays are aligned so that said each coil is wrapped substantially symmetrically around a radial axis extending radially outward from said driveshaft.

5. The device of claim 1, further comprising:
a third stator, said driveshaft rotatably journalled through a driveshaft aperture in said third stator, a third stator array including circumferentially spaced-apart electrically conductive coils mounted to said third stator and having a third stator array angular orientation relative to said driveshaft which is substantially the same as said first stator array angular orientation,

a third rotor rotatable with said driveshaft , a third rotor array including a third circumferentially spaced apart array of magnets at a third rotor array angular orientation relative to said driveshaft, said third stator and said third rotor lying in planes substantially parallel to said first and second rotors and stators.

6. The device of claim 5 wherein said third rotor array is offset from said second rotor array by said rotor offset angle, and is offset from said first rotor array by said rotor offset angle multiplied by two.

7. The device of claim 1 wherein said first rotor array is at least in part co-planar with said stator array of said first stator and wherein said second rotor array is at least in part

co-planar with said stator array of said second stator.

8. The device of claim 5 wherein said first rotor array is at least in part co-planar with said stator array of said first stator and wherein said second rotor array is at least in part co-planar with said stator array of said second stator.

9. The device of claim 6 wherein said first, second and third rotors and said first, second, and third stators together form a first device stage, and wherein a plurality of stages substantially the same as said first device stage are axially spaced along said driveshaft for rotation of rotors within said plurality of stages relative to stators within said plurality of stages.

10. The device of claim 1 wherein said first rotor includes a rotor plate and said rotor array is mounted to said rotor plate, and wherein said rotor plate is coupled orthogonally to said driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said stator plate, and wherein said stator plate is orthogonal to said driveshaft.

11. The device of claim 5 wherein said first rotor includes a rotor plate and said first rotor array is mounted to said rotor plate, and wherein said rotor plate is coupled to said driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said stator plate, and wherein said stator plate is orthogonal to said driveshaft.

12. The device of claim 9 wherein said first rotor includes a rotor plate and said first rotor array is coupled to said rotor plate, and wherein said rotor plate is coupled to said driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said first stator plate, and wherein said first stator plate is orthogonal to said driveshaft.

13. The device of claim 1 further comprising a clutch mounted between each of said first rotor and second rotor and said driveshaft, and wherein said driveshaft includes means for

selectively engaging each clutch in sequence along said driveshaft by selective longitudinal translation of said driveshaft by means for selectively translating the driveshaft.

14. The device of claim 13 wherein said each clutch is a centrifugal clutch for engaging said driveshaft when said driveshaft is longitudinally translated by said means for selectively translating the driveshaft into a first position for engaging with, firstly, a first clutch of said clutches and, secondly, into a second position for engaging with a second clutch of said clutches.

15. The device of claim 5 further comprising clutches mounted between each of said first rotor, said second rotor and said third rotor and said driveshaft, wherein said driveshaft includes means for selectively engaging each clutch in sequence along said driveshaft by selective longitudinal translation of said driveshaft by means for selectively translating the driveshaft.

16. The device of claim 15 wherein said each clutch is a centrifugal clutch for engaging said driveshaft when said driveshaft is longitudinally translated into a first position for engagement with, firstly, a first clutch and secondly, sequentially into a second position for engagement with a second clutch, and thirdly, sequentially into a third position for engagement with a third clutch.

17. The device of claim 1 wherein said first rotor and said first stator and said second rotor and said second stator form rotor/stator pairs wherein said first and second rotor arrays are angularly offset from one another by said rotor offset angle and are mountable into a device with further rotor and stator pairs wherein rotor arrays in said further rotor and stator pairs are successively angularly offset from adjacent rotor arrays by said rotor offset angle.

18. The device of claim 1 wherein said magnets in said rotor arrays are equally circumferentially spaced apart.

19. The device of claim 1 wherein said coils in said stator arrays are equally circumferentially spaced apart.

20. The device of claim 9 wherein said first rotors, second rotors, and third rotors are rigidly mounted to said driveshaft, and wherein said electrically conductive coils on said stator arrays in successive stages may be selectively electrically energized between an open circuit for selective windings and a closed circuit for said selective coils wherein rotational resistance for rotating said driveshaft is reduced when an open circuit exists for said selective coils and increased when a closed circuit exists for said selective coils.

21. The device of claim 1 wherein the device is a generator.

22. A polyphasic multi-coil device comprising:

a driveshaft,

first and second rotors rotatable with said driveshaft,

first and second stators interleaved with said first and second rotors wherein said stators each have an aperture therethrough through which said driveshaft is rotatably journalled and wherein said stators each have a stator array including circumferentially spaced-apart electrically conductive coils mounted to said stator, the stator array of the first stator having a first stator array angular orientation and the stator array of the second stator having a second stator array angular orientation relative to said driveshaft, and wherein said rotors and said stators lie in substantially parallel planes,

wherein said first and second rotors have, respectively, first and second rotor arrays, said first rotor array including a first circumferentially spaced apart array of magnets at a first rotor array angular orientation relative to said driveshaft, said second rotor array

including a second circumferentially spaced apart array of magnets at a second rotor array angular orientation relative to said driveshaft,

wherein said first rotor array is at least in part co-planar with said stator array of said first stator and wherein said second rotor array is at least in part co-planar with said stator array of said second stator, wherein (i) said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle, (ii) said first stator array angular orientation is off-set from said second stator array angular orientation by a stator offset angle, or (iii) said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle and said first stator array angular orientation is off-set from said second stator array angular orientation by a stator offset angle

23. The device of claim 22, wherein said first rotor array angular orientation is off-set from said second rotor array angular orientation by a rotor offset angle.

24. The device of claim 22, wherein said magnets of said first rotor array and said second rotor array are pairs of magnets, each pair of magnets arranged with one magnet of said pair closer to the driveshaft than the other magnet of said pair.

25. The device of claim 24 wherein each pair of magnets is aligned along a radial axis extending radially outward from said driveshaft.

26. The device of claim 25 wherein each of said coils in said stator arrays is aligned so that said each coil is wrapped substantially symmetrically around a radial axis extending radially outward from said driveshaft.

27. The device of claim 22, further comprising:

a third stator, said driveshaft rotatably journalled through a driveshaft aperture in said third stator, a third stator array including circumferentially spaced-apart electrically conductive coils mounted to said third stator and having a third stator array angular

orientation relative to said driveshaft which is substantially the same as said first stator array angular orientation,

a third rotor rotatable with said driveshaft , a third rotor array including a third circumferentially spaced apart array of magnets at a third rotor array angular orientation relative to said driveshaft, said third stator and said third rotor lying in planes substantially parallel to said first and second rotors and stators.

28. The device of claim 27 wherein said third rotor array is offset from said second rotor array by said rotor offset angle, and is offset from said first rotor array by said rotor offset angle multiplied by two.

29. The device of claim 28 wherein said first, second and third rotors and said first, second, and third stators together form a first device stage, and wherein a plurality of stages substantially the same as said first device stage are axially aligned along said driveshaft for rotation of rotors within said plurality of stages relative to stators within said plurality of stages.

30. The device of claim 22 wherein said first rotor includes a rotor plate and said first rotor array is mounted to said rotor plate, and wherein said rotor plate is coupled orthogonally to said driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said stator plate, and wherein said stator plate is orthogonal to said driveshaft.

31. The device of claim 27 wherein said first rotor includes a rotor plate and said first rotor array is mounted to said rotor plate, and wherein said rotor plate is coupled to said driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said stator plate, and wherein said stator plate is orthogonal to said driveshaft.

32. The device of claim 29 wherein said first rotor includes a rotor plate and said first rotor array is coupled to said rotor plate, and wherein said rotor plate is coupled to said

driveshaft, and wherein said first stator includes a stator plate and said first stator array is mounted to said first stator plate, and wherein said first stator plate is orthogonal to said driveshaft.

33. The device of claim 22 further comprising a clutch mounted between each of said first rotor and second rotor and said driveshaft, and wherein said driveshaft includes means for selectively engaging each clutch in sequence along said driveshaft by selective longitudinal translation of said driveshaft by means for selectively translating the driveshaft.

34. The device of claim 33 wherein said each clutch is a centrifugal clutch for engaging said driveshaft when said driveshaft is longitudinally translated by said means for selectively translating the driveshaft into a first position for engaging with, firstly, a first clutch of said clutches and, secondly, into a second position for engaging with a second clutch of said clutches.

35. The device of claim 27 further comprising clutches mounted between each of said first rotor, said second rotor and said third rotor and said driveshaft, wherein said driveshaft includes means for selectively engaging said clutch in sequence along said driveshaft by selective longitudinal translation of said driveshaft by means for selectively translating the driveshaft.

36. The device of claim 35 wherein said each clutch is a centrifugal clutch for engaging said driveshaft when said driveshaft is longitudinally translated into a first position for engagement with, firstly, a first clutch between said first rotor and said driveshaft, and secondly, sequentially into a second position for engagement with a second clutch between said second rotor and said driveshaft, and thirdly, sequentially into a third position for engagement with a third clutch between said third rotor and said driveshaft.

37. The device of claim 22 wherein said first rotor and said first stator and said second rotor and said second stator form rotor/stator pairs wherein said first and second rotor

arrays are angularly offset from one another by said rotor offset angle and are mountable into a device with further rotor and stator pairs wherein rotor arrays in said further rotor and stator pairs are successively angularly offset from adjacent rotor arrays by said rotor offset angle.

38. The device of claim 22 wherein said magnets in said rotor arrays are equally circumferentially spaced apart.

39. The device of claim 22 wherein said coils in said stator arrays are equally circumferentially spaced apart.

40. The device of claim 27 wherein said first rotors, second rotors, and third rotors are rigidly mounted to said driveshaft, and wherein said electrically conductive coils on said stator arrays in successive stages may be selectively electrically energized between an open circuit for selective coils and a closed circuit for said selective coils wherein rotational resistance for rotating said driveshaft is reduced when an open circuit exists for said selective coils and increased when a closed circuit exists for said selective coils.

41. The device of claim 22 wherein the device is a generator.

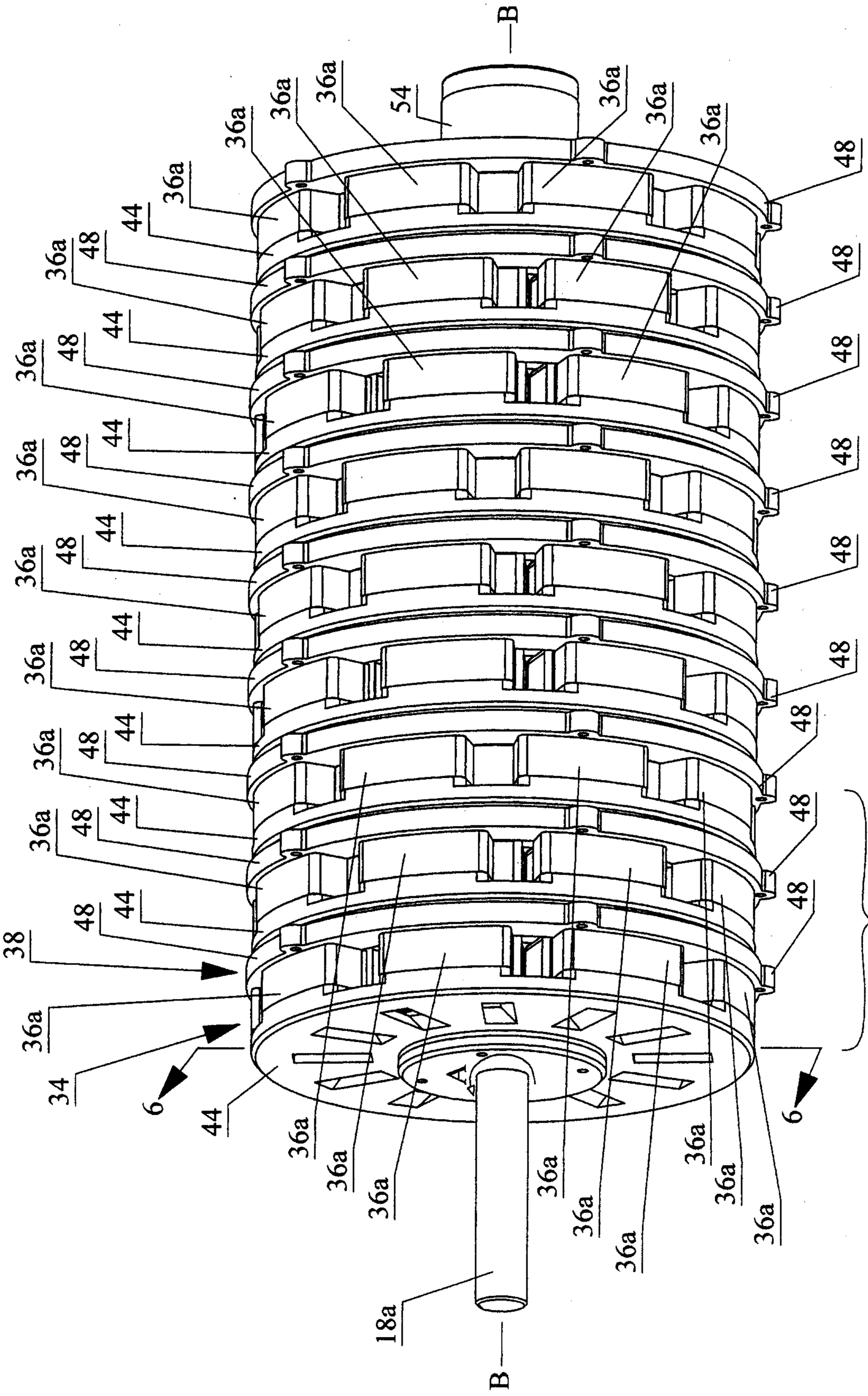


Fig 1

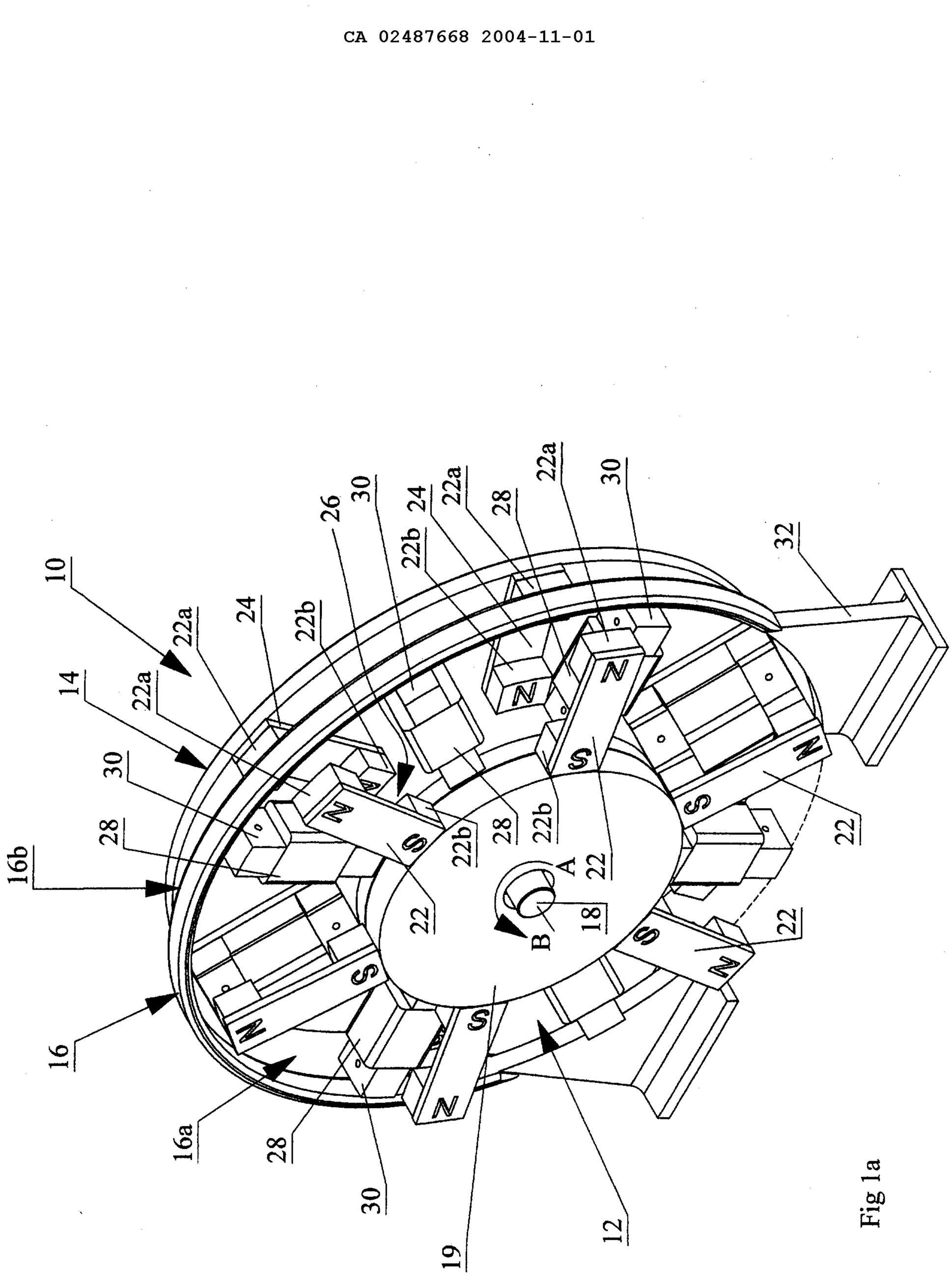


Fig 1a

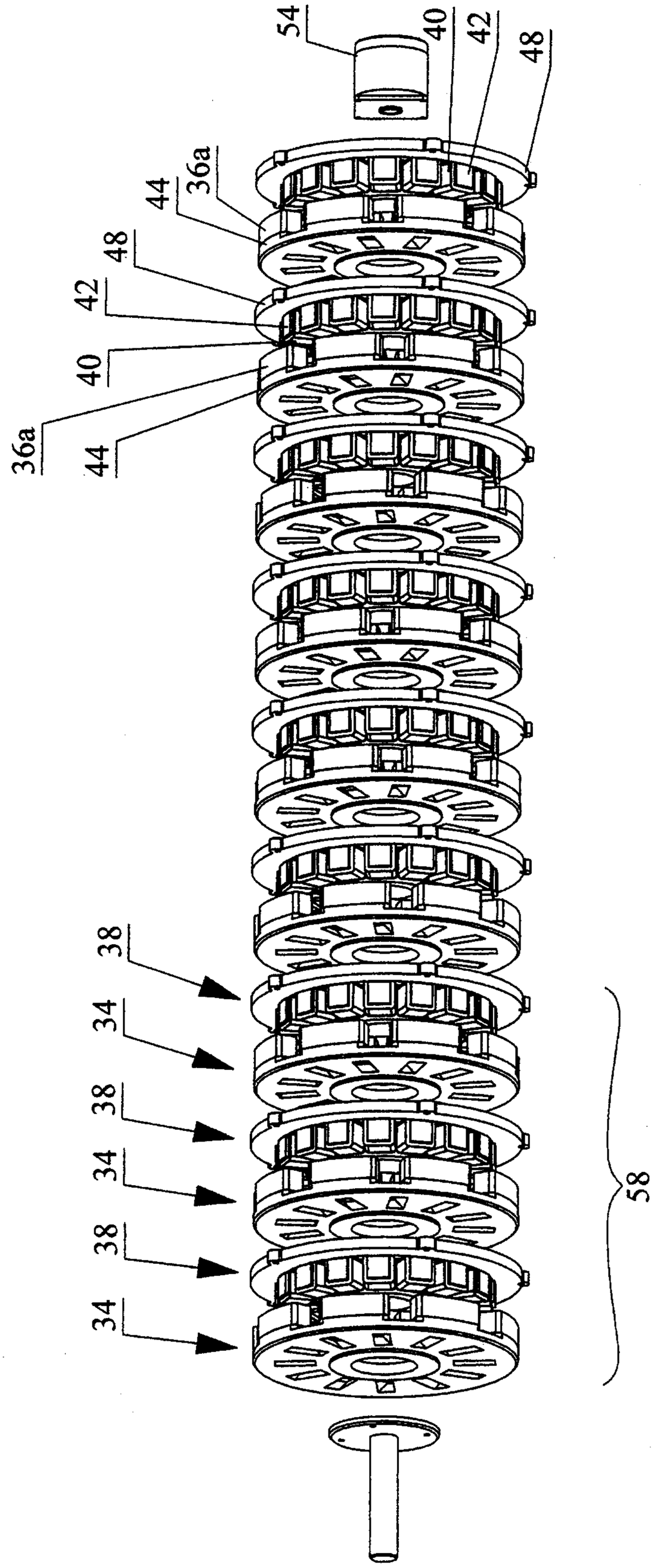


Fig 2

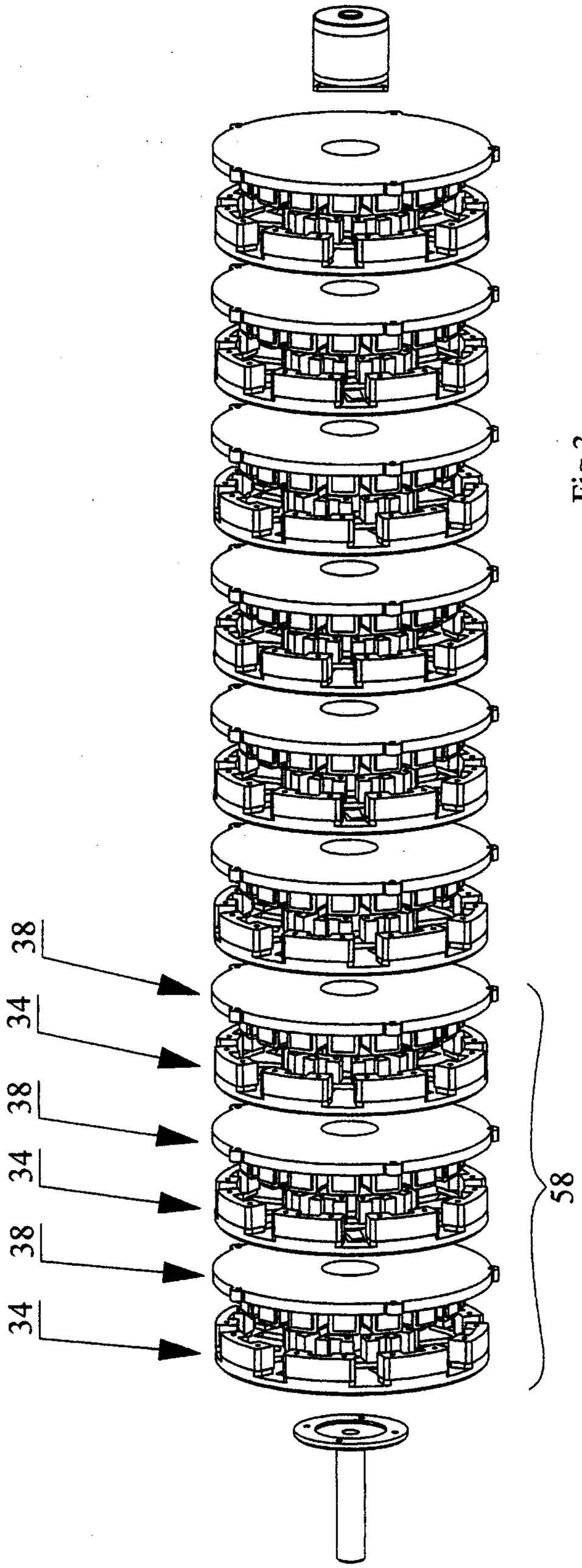


Fig 3

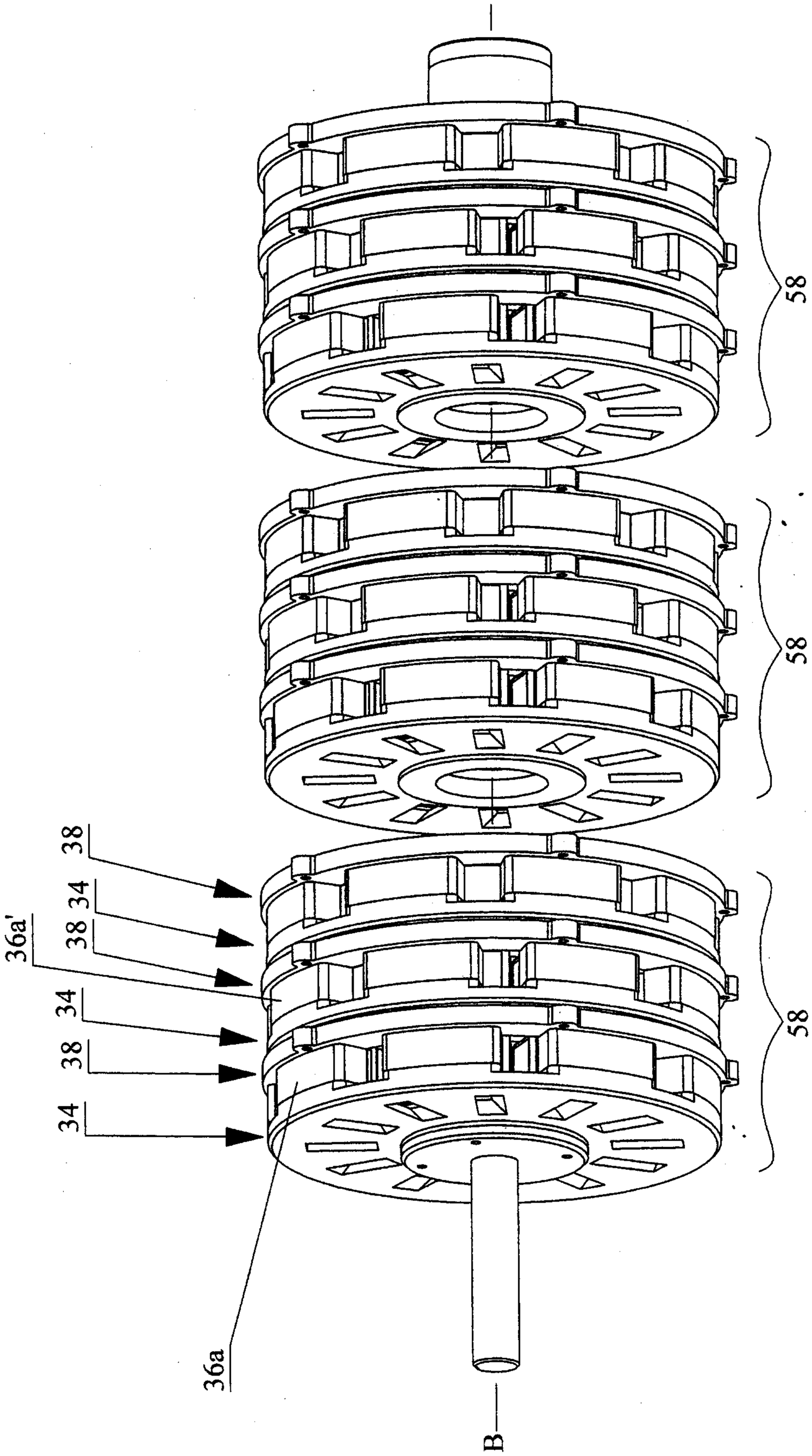


Fig 4

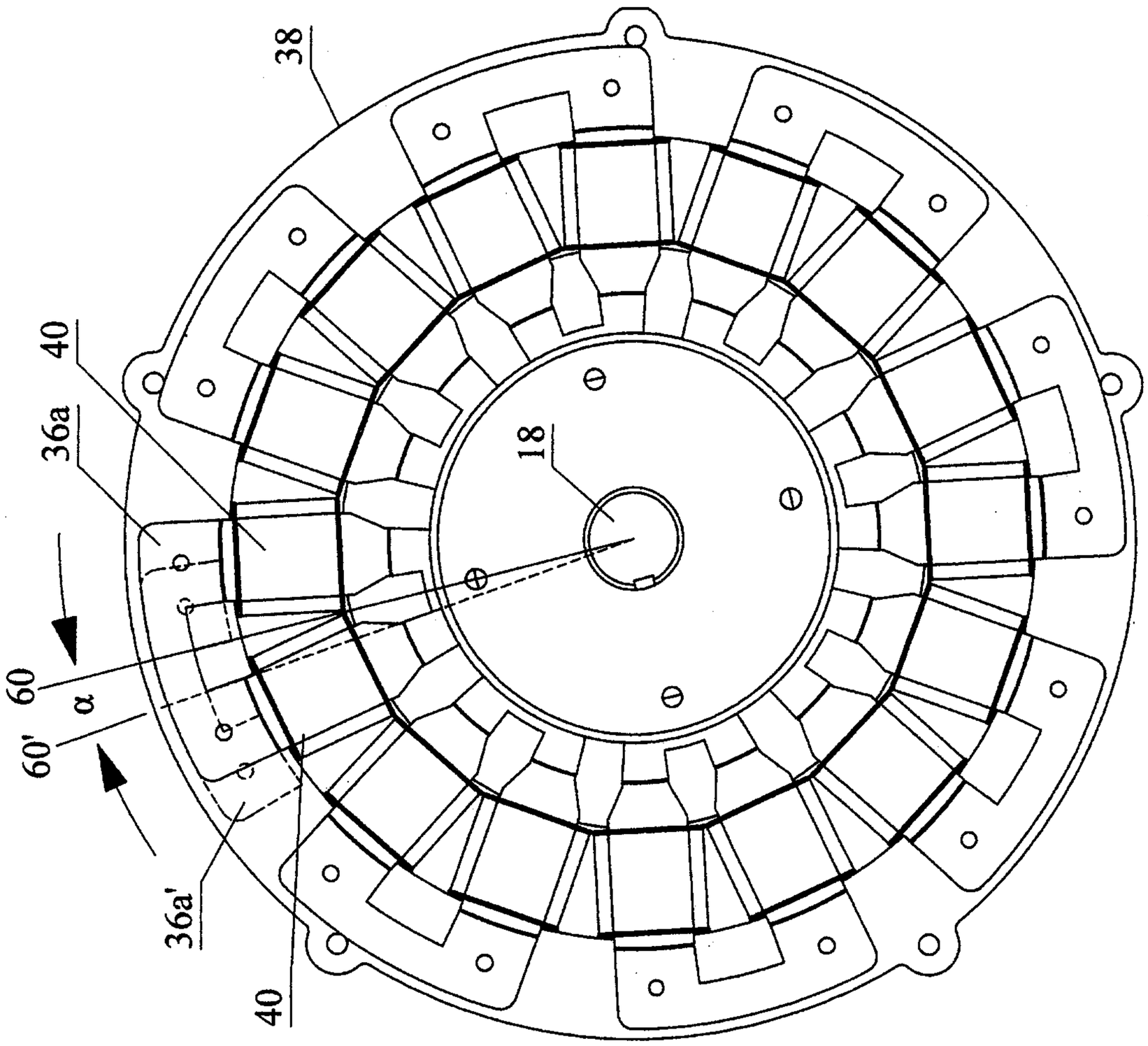


Fig 4a

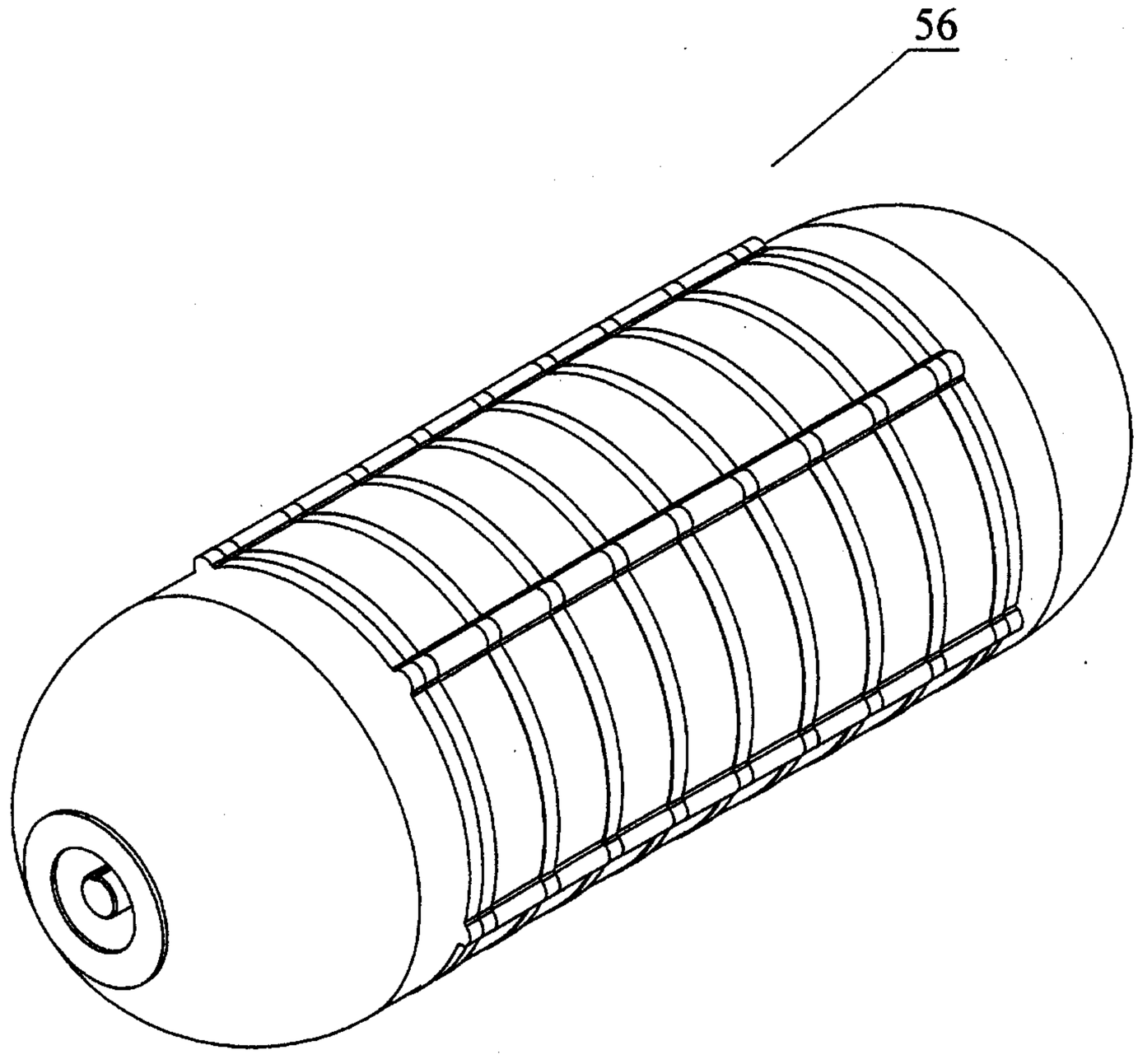


Fig 5

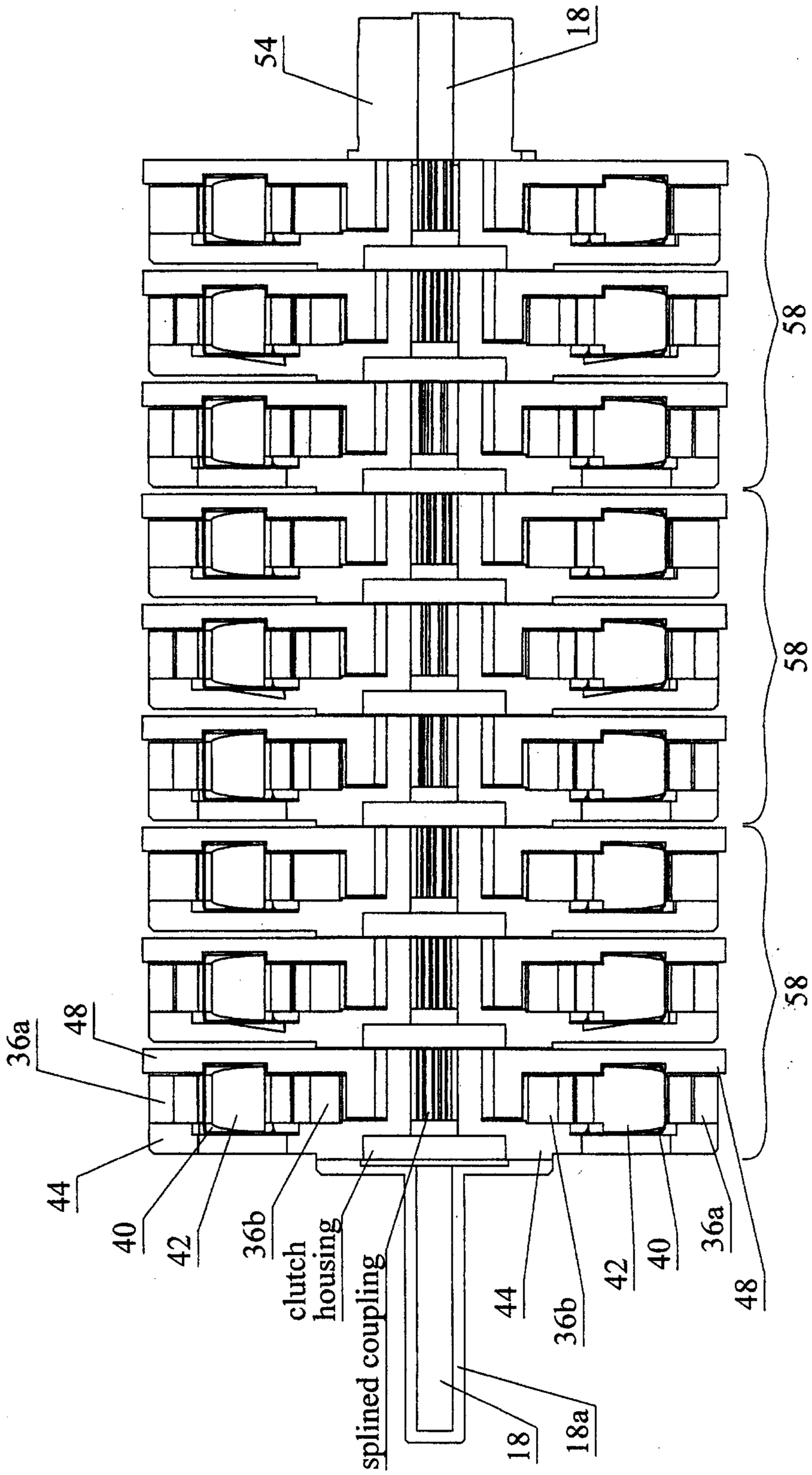

54
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58
58
58
36a
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44
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42
36b
clutch housing
splined coupling
18
18a
44
36b
42
40
36a
48

Fig 6

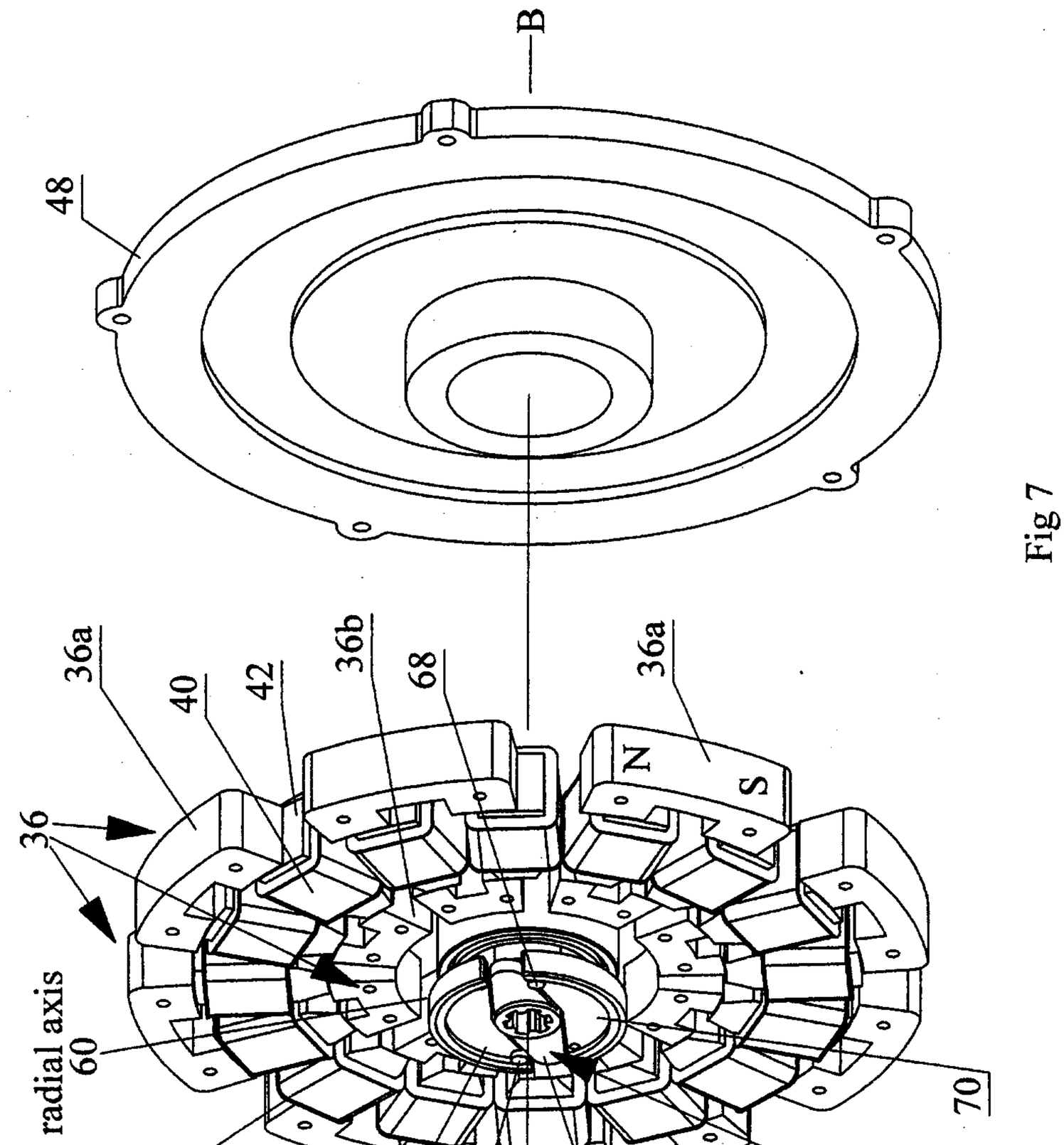
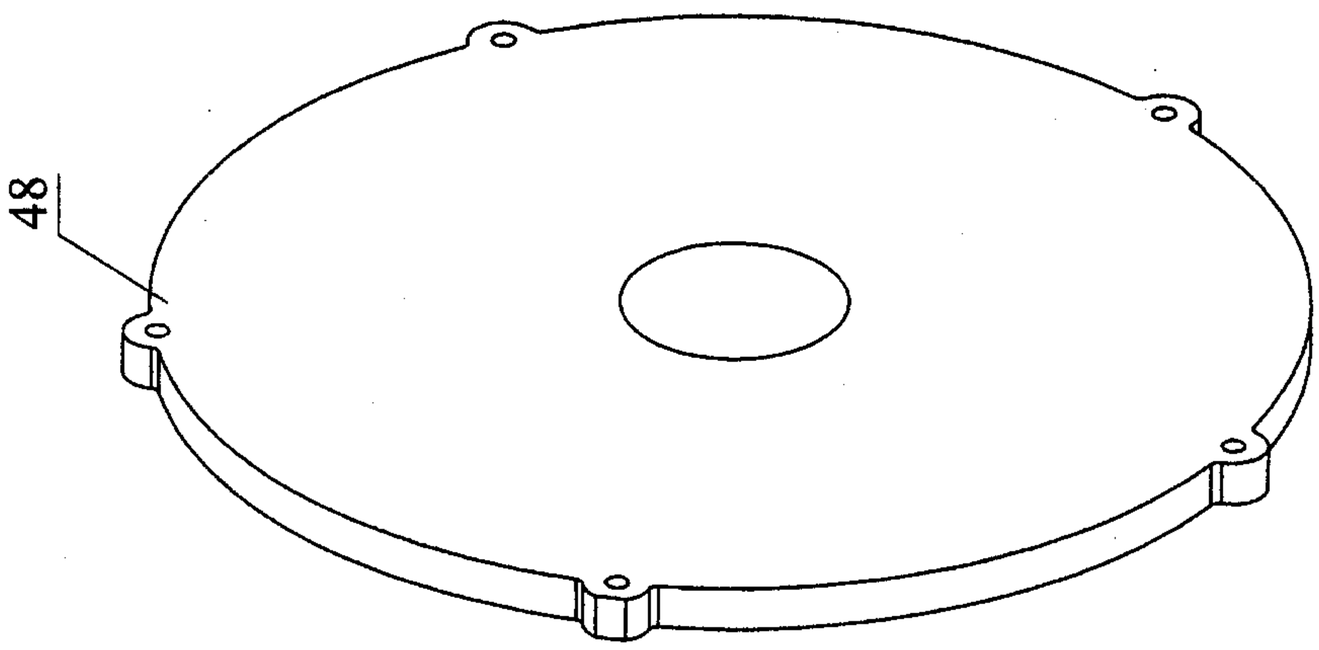
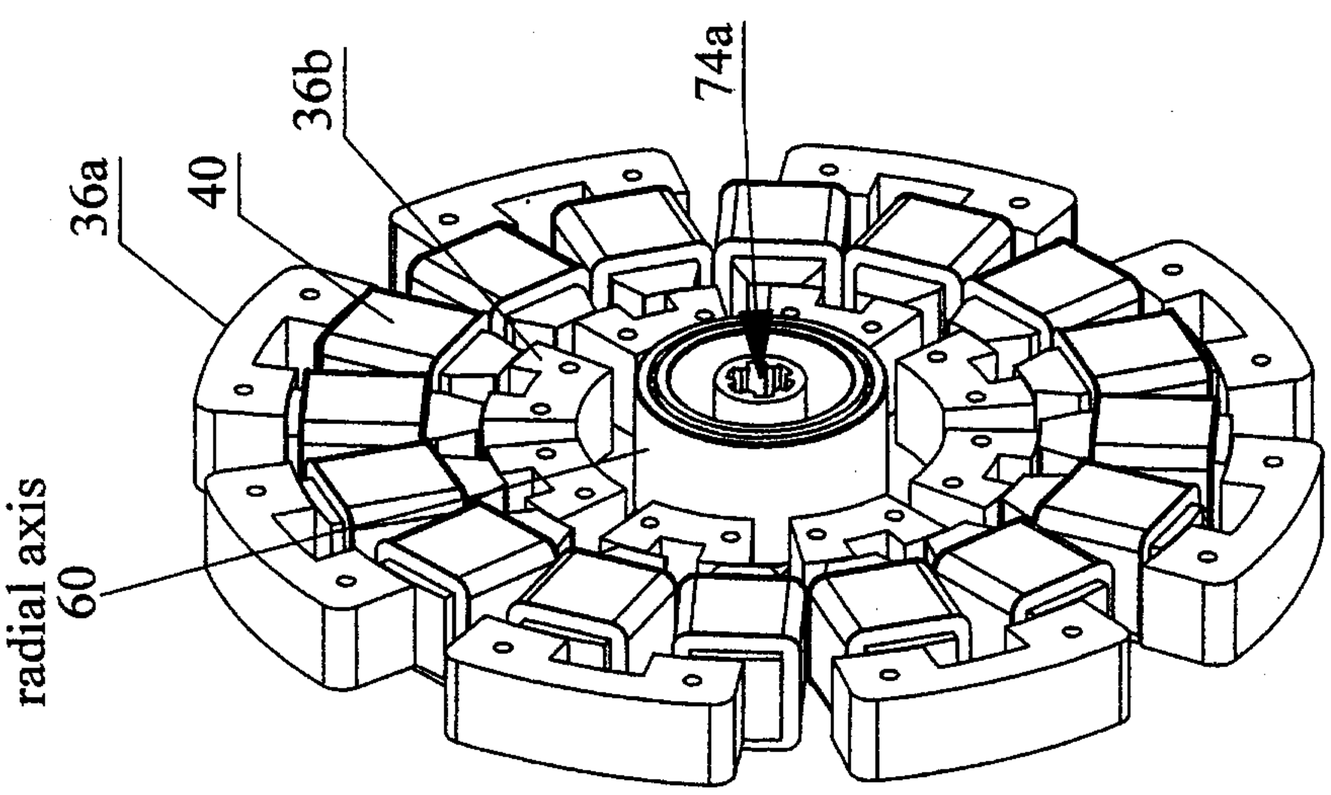

B
48
36a
40
42
36b
68
36a
N
S
36
radial axis
60
36b
70
68
64
70
centrifugal clutch
62
44
B

Fig 7





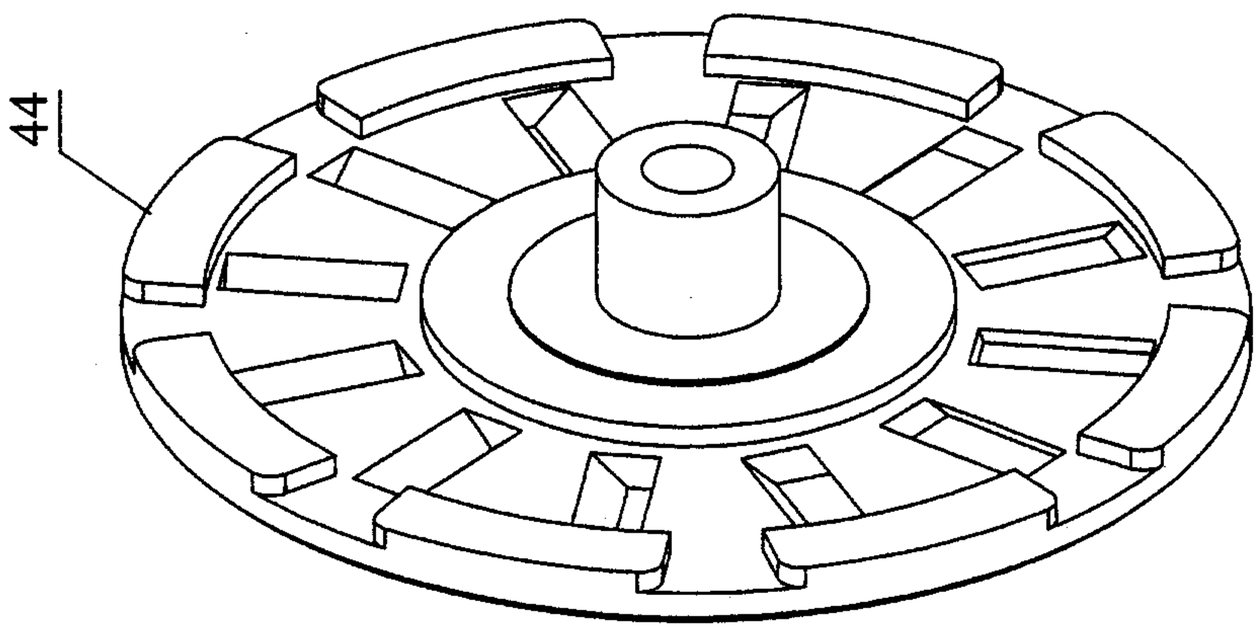


Fig 8

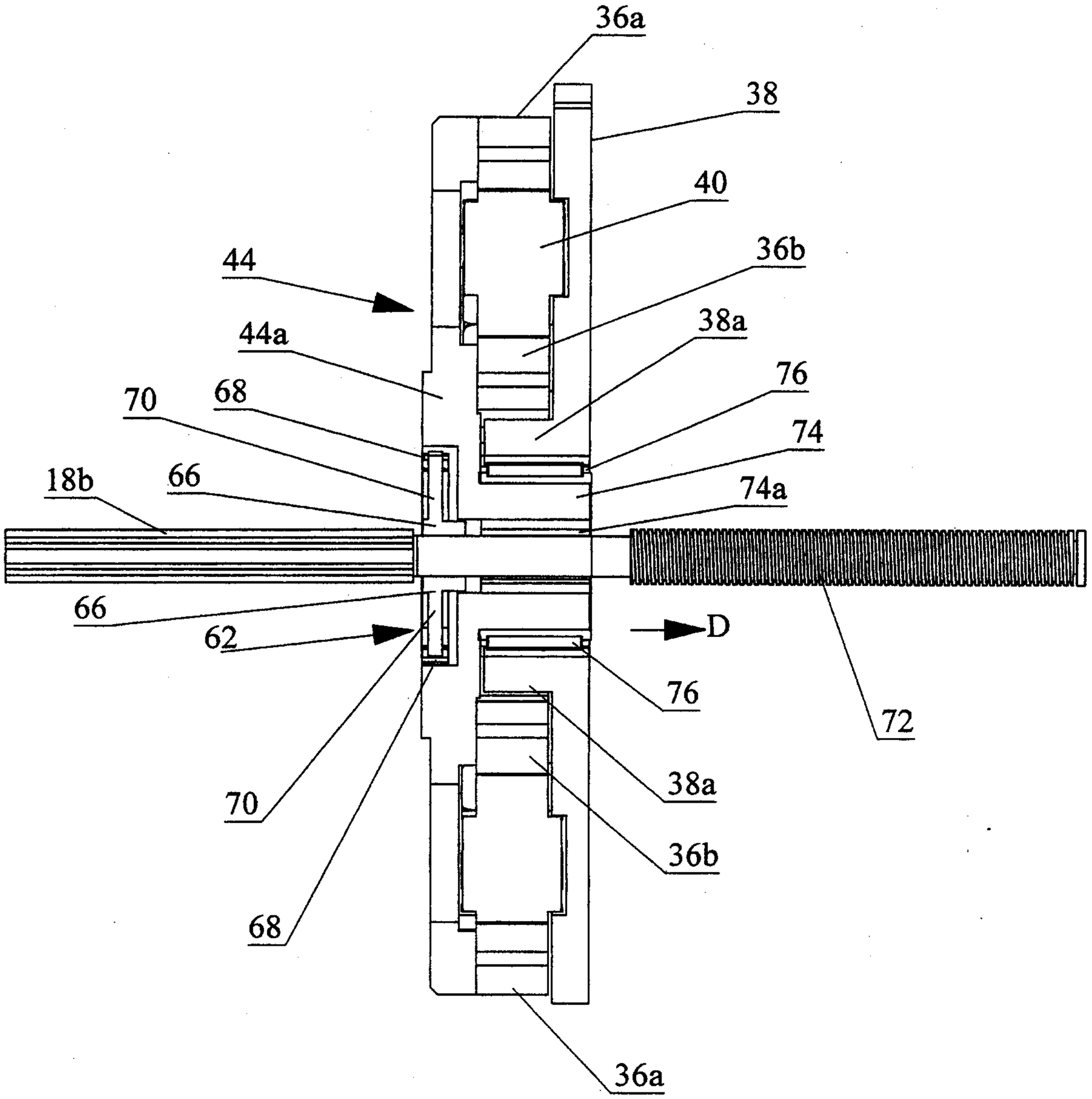

36a
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38a
36b
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36a

Fig 9

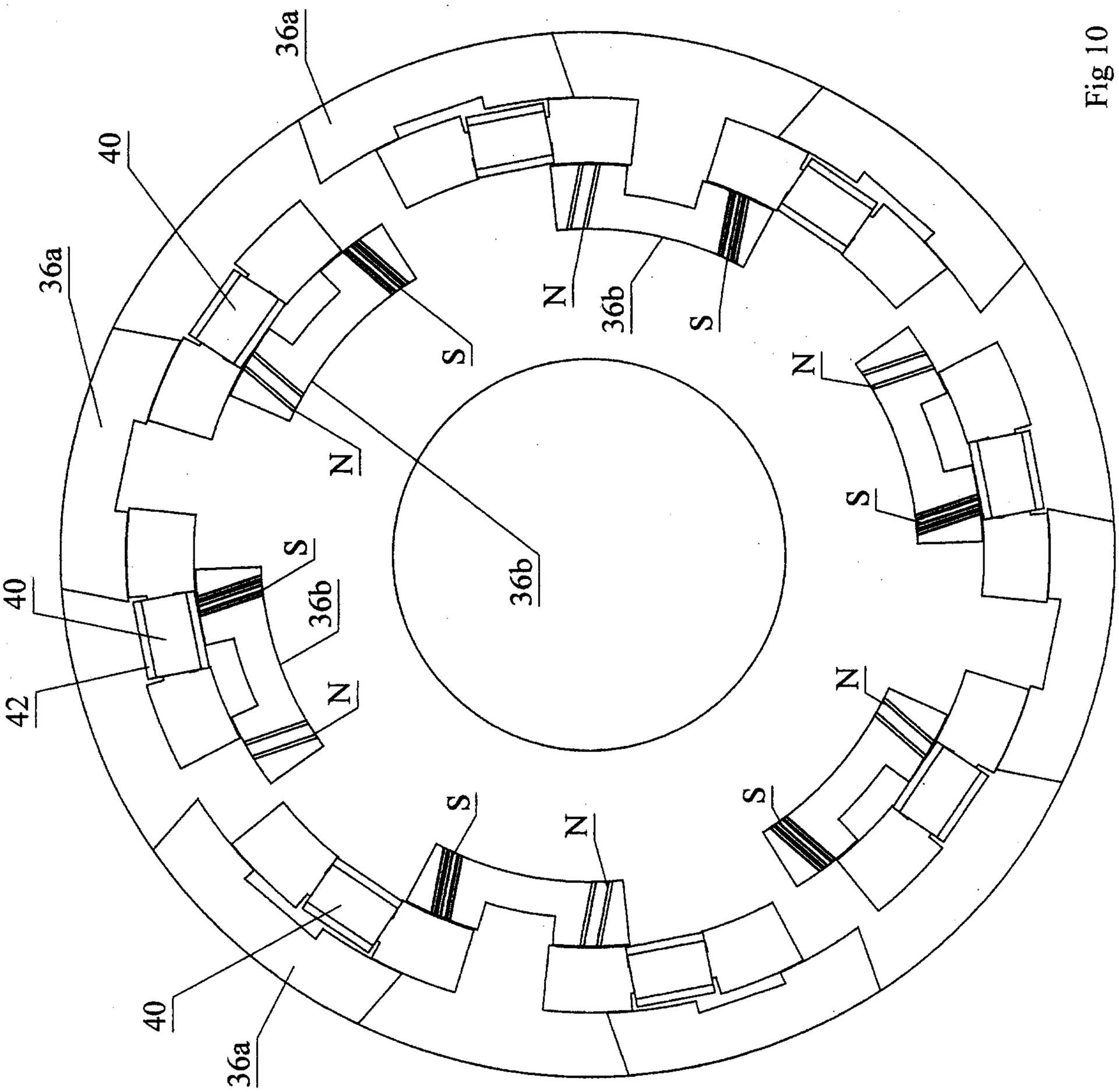


Fig 10

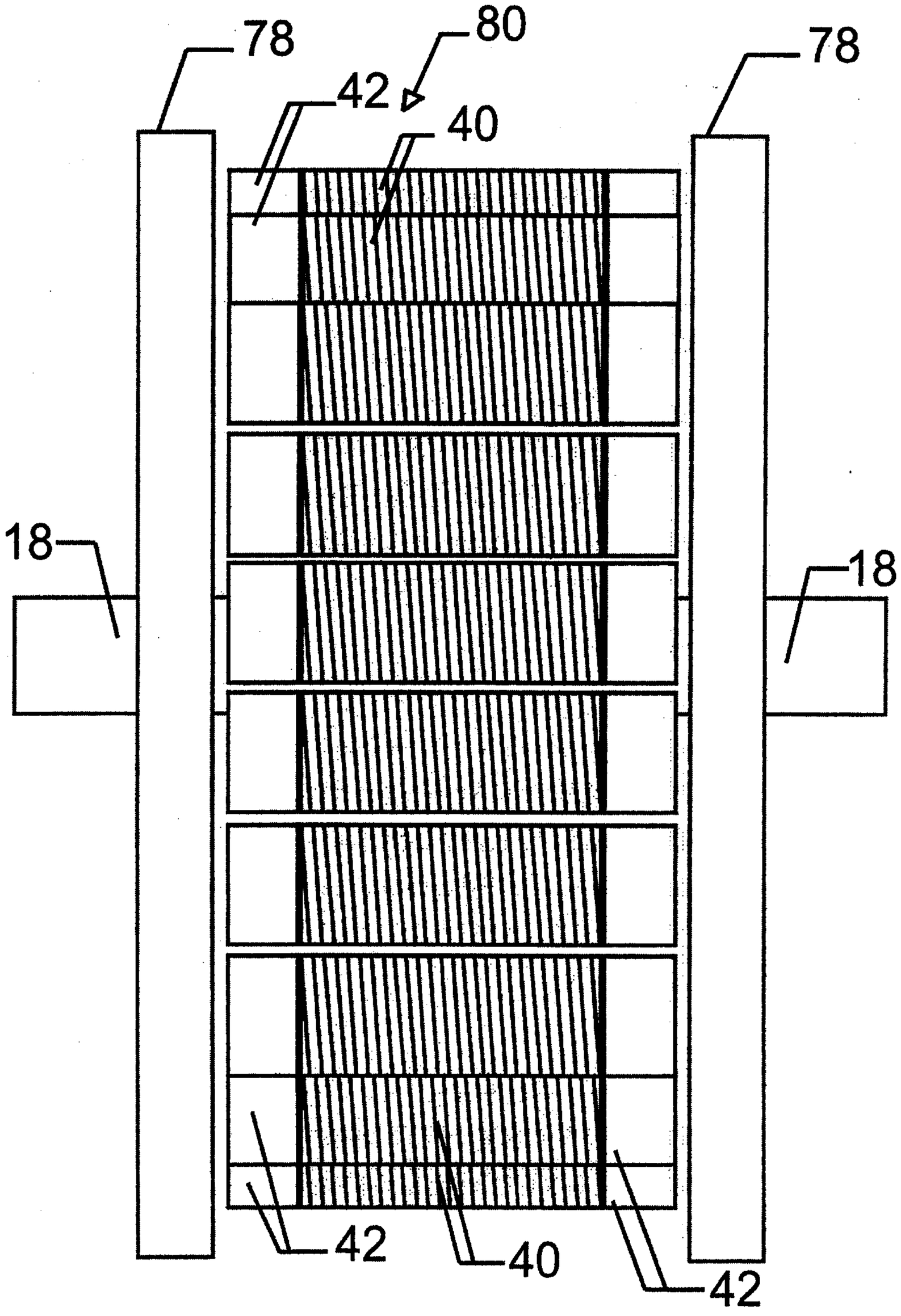


Fig 11 a

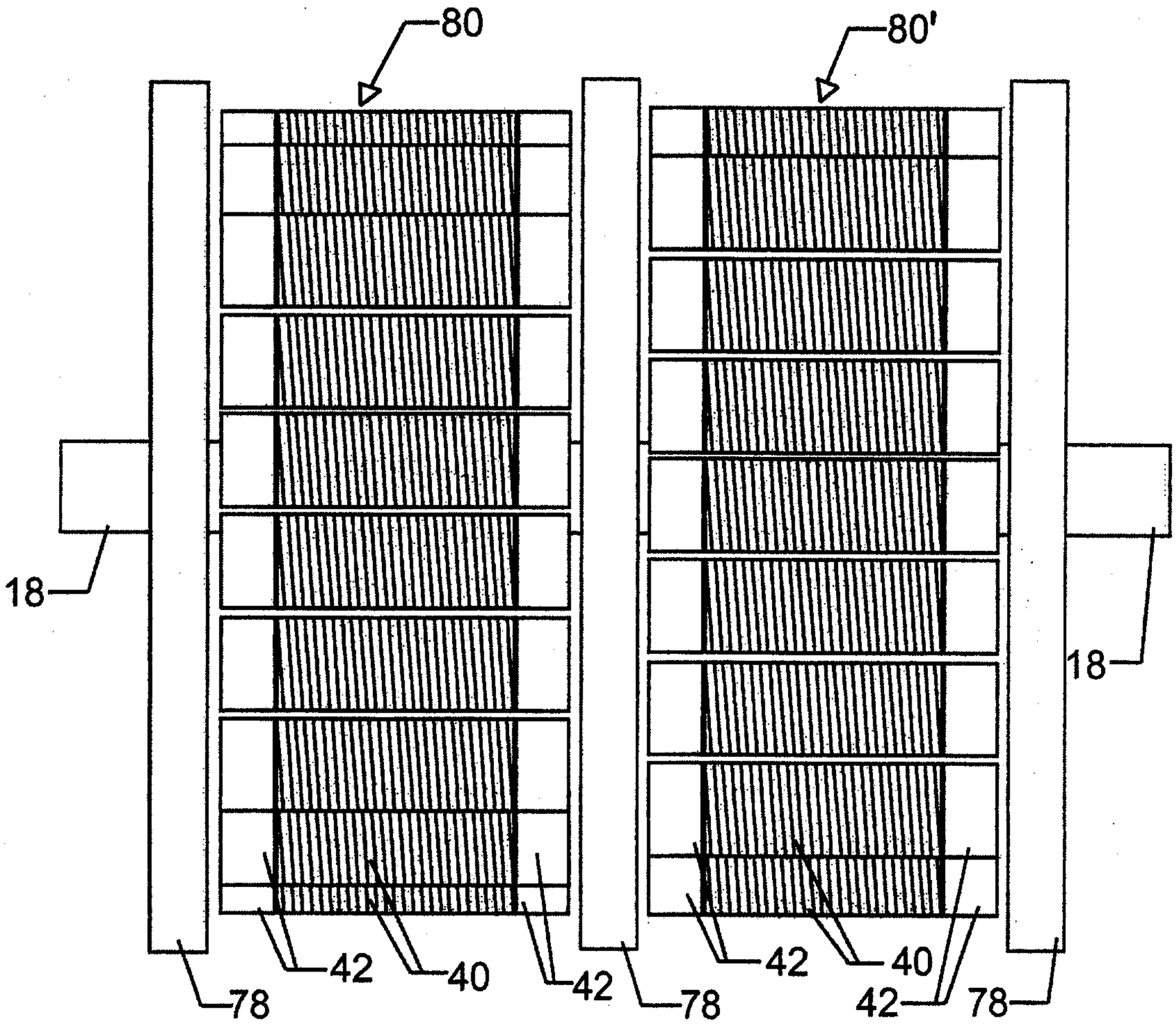


Fig 11 b

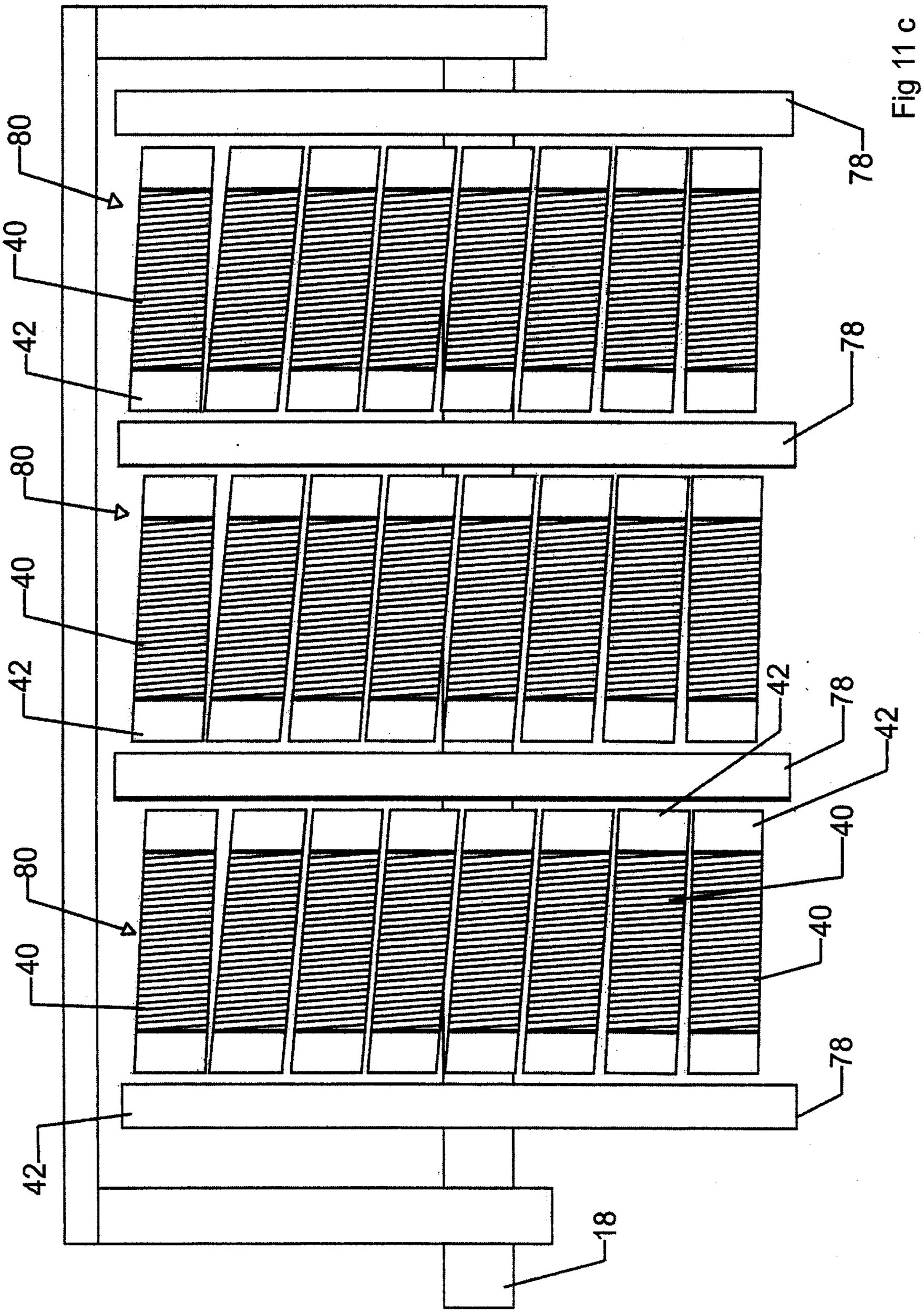
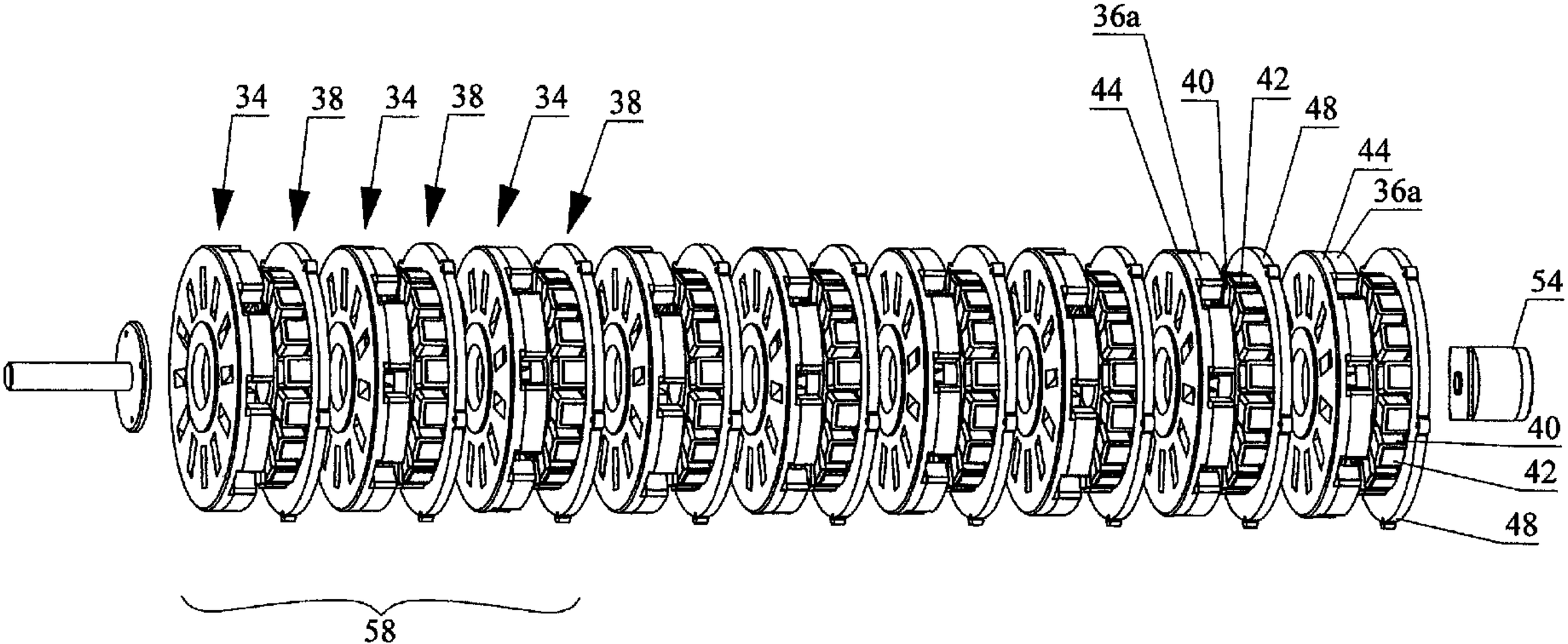


Fig 11 c


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