MOTOR

The invention relates to a motor. For example, but not limited thereto, the motor may be a stepper motor or a brushless DC motor.

Such a motor is known per se. Said known motor may have a rotor and at least two drive elements, said two drive elements being arranged to drive the rotor in a rotational direction.

It is an object of the invention to improve said known motor. This is achieved by a motor comprising:

- at least two rotors, wherein the rotors are arranged at different axial locations as seen in an axial direction;

- at least three drive elements, wherein each drive element is arranged to drive at least one rotor in a rotational direction, and at least one drive element is arranged to drive at least two rotors simultaneously.

An advantage of the motor of the invention is that the number of drive elements per rotor may be reduced with respect to said known motor, because at least one drive element is arranged to drive at least two rotors simultaneously. An additional or alternative advantage thereof may be that the motor may be cheaper and/or more compact.

Even though said at least two rotors are driven simultaneously, the applicant has found that the velocity and/or positioning of each or some of these at least two rotors may be controlled rather accurately and/or independent or different of the other of the at least two rotors.

The number of rotors may be chosen as desired. For example, but not limited thereto, the number of rotors may be two, three, four, five, six, seven, eight, nine, or even more.

The number of drive elements may be chosen as desired, preferably in accordance with the number of rotors. For example, but not limited thereto, the number of drive elements may be three, four, five, six, seven, eight, nine, ten, or even more.

The drive elements may alternatively be referred to as transducers and/or as elements which generate torque on the rotors from another energy source.

Optionally each rotor may be driven by the drive elements to rotate in two opposing rotational directions, i.e. back and forth. Alternatively each rotor may be driven by the drive elements in one continuous rotational direction.

The axial direction may be substantially orthogonal to the rotational direction and/or a radial direction of the rotors. The axial direction may be substantially parallel to the rotation axis of the rotors, wherein the rotational direction of the rotors is defined about the rotation axis.

The rotors may be arranged substantially parallel to each other, more in particular with a main plane thereof. Said main planes may be substantially orthogonal to the axial direction and/or substantially parallel to the radial direction of the rotors.

In an embodiment of the motor according to the invention said rotors can be driven in a semi-independent way.

Semi-independent may for example include that:

- some rotors can be driven simultaneously by a shared drive element while others are not, and/or

- some rotors can be driven independent of the other rotors by means of their own drive element, which drive element does not drive other rotors, and/or

- some or each of the rotors that are driven simultaneously by a shared drive element can rotate at their own, independent velocity, and/or

- some or each of the rotors that are driven simultaneously by a shared drive element can rotate at linked, but, if desired, different velocities, and/or

- the position of some or each of the rotors that are driven simultaneously by a shared drive element can be chosen independent of the other rotors, and/or

- the position of some or each of the rotors that are driven simultaneously by a shared drive element can be chosen with an accuracy of between 95% - 100% and/or with a maximum deviation of 5 degrees and/or with a maximum deviation of 2 steps, and/or

- the direction of rotation of some or each of the rotors that are driven simultaneously by a shared drive element can be chosen independent of the other rotors.

Driving the rotors in a semi-independent way may be achieved in any suitable way. For example by choosing a suitable number of drive elements and/or by embodying said drive elements and/or said rotors in a suitable way. A few examples, but not limited thereto, are described below with respect to various embodiments of the motor according to the invention.

In an embodiment of the motor according to the invention no or a small axial distance is present between the at least two rotors.

In other words, said at least two rotors may be neighboring rotors as seen in the axial direction.

In an embodiment of the motor according to the invention the maximum number of rotors R is defined by $R=N(N-1)/2$, wherein N is the number of drive elements.

N may in particular be an integer ≥ 3. In said conventional motor $R=N/2$, wherein N is an even number of drive elements. This shows that the number of rotors used in the motor according to the invention with respect to the number of drive elements used in the motor according to the invention is increased with respect to said conventional motor, or, in other words, said number of drive elements is reduced for a same amount of rotors.

It is noted that the above equation for the maximum number of rotors may in particular be valid for motors having drive elements having two substantially opposing drive parts, which motors will be explained below.

In an embodiment of the motor according to the invention the at least two rotors each comprise a shaft, said shafts defining said axial direction in the longitudinal direction thereof, wherein the shafts of the at least two rotors have different diameters and at least the shaft having the larger diameter is hollow and thereby defines an interior space, wherein the shaft having a smaller diameter is arranged within said interior space, such that the shafts extend coaxially with respect to each other.

Such a motor may be relatively compact because the shafts extend coaxially with respect to each other.

If more than two rotors are provided all shafts may be arranged coaxially with respect to each other, wherein all shafts, optionally except for the smallest diameter shaft, are hollow and all shafts except for the largest diameter shaft extend within the interior space of a larger diameter shaft.

In an embodiment of the motor according to the invention the at least two rotors each comprise a shaft, said shafts defining said axial direction in the longitudinal direction thereof, wherein the shafts of the at least two rotors extend in opposing axial directions with respect to the rotors.

Such an embodiment may optionally be combined with the embodiment of coaxial shafts, such that coaxial shafts extending in opposing axial directions are obtained.

In an embodiment of the motor according to the invention each rotor may comprise a plurality of rotor elements extending in a substantially radial, outward direction, wherein each drive element comprises two substantially opposing drive parts, and wherein said opposing drive parts are arranged for driving at least one rotor element of at least one of said rotors in said rotational direction by alternatingly attracting and repulsing at least one rotor element.

Such an embodiment may also be referred to as an electric stepper motor.

The rotor elements may alternatively or additionally be referred to as pole pairs.

Said drive elements, in particular the pairs of opposing drive parts, are substantially directed towards and/or facing the rotor elements.

Practically each drive part comprises an activatable electromagnetic coil, for example wrapped around a beam or leg that is for example made of steel, and at least the rotor elements of the rotors are made of a magnetic material.

Upon activating the electromagnetic coil of the drive parts the rotor elements are attracted or repulsed thereby, thereby driving the rotor in said rotational direction.

Practically each drive part comprises at least two drive members that extend substantially in the direction of a center of a respective one of the at least two rotors and that are arranged at different axial locations as seen in an axial direction, said axial locations corresponding to the axial locations of the at least two rotors.

The drive members may attract a nearby, not-aligned rotor element at the same axial location, such that the rotor is rotated into a position that that nearby rotor element is aligned with the drive member, and repulse an aligned rotor element such that that rotor element is moved to a non-aligned position. The direction of alignment may be defined here in a substantial radial direction.

At each axial location at least one drive member may be provided. Practically a plurality, such as two, three, or four drive members may be provided at each axial location for each drive part. The plurality of drive members of each drive part are preferable spaced apart in a substantially tangential direction as defined with respect to the rotors, i.e. a direction substantially orthogonal to both the axial and radial direction.

Practically at least some of the drive members that are arranged at different axial locations of a said drive part are offset with respect to each other in a substantially tangential direction as defined with respect to the rotors, i.e. a direction substantially orthogonal to both the axial and radial direction. In other words, some of the drive members of a said drive element may be unaligned with other drive members of that drive element as seen in the axial direction.

An advantage of this embodiment is that a semi-independent drive of the at least two rotors can be obtained, because at least some of the drive members are arranged at different positions in the tangential direction for the at least two rotors. This may in particular be advantageous when the at least two rotors are substantially identical.

The drive members of a said drive part may be provided at all or some axial locations of the rotors, such that all or some of the rotors are driven in said rotational direction upon activating a said drive part.

The drive members and rotor elements may have any suitable shape, such as non-sharp teeth. Practically the drive element including the drive members may have the shape of a fork.

The shape and/or size of the rotor elements and/or drive members may be the same or different for the optionally plurality of rotor elements and/or drive members.

The number of drive elements and/or drive parts may be suitably chosen. By choosing a sufficiently high number of drive elements and/or drive parts the velocity and/or position of simultaneously driven rotors may be independent of each other.

In an embodiment of the motor according to the invention each rotor comprises a plurality of rotor elements extending in a substantially radial, outward direction, wherein each drive element is moveable in a substantially radial direction with respect to the axial direction of the shafts in a direction towards and away from said rotor elements, wherein each drive element comprises at least one engaging element arranged for engaging a said rotor element, wherein upon moving the drive element towards the rotor elements said engaging element engages said rotor element and thereby moves said rotor in said rotational direction.

Such an embodiment may also be referred to as an stepper motor.

Practically said rotor elements and said engaging element are teeth-shaped, more particular sharp teeth-shaped.

Practically said at least one engaging element extends substantially in the direction of a center of a respective one of the at least two rotors.

Practically each drive element is moveable in said substantially radial direction by means of pneumatic or hydraulic power.

Such embodiments may also be referred to as pneumatic or hydraulic stepper motors, respectively.

Practically each drive element comprises two opposing drive parts, each drive part comprising a said at least one engaging element. In such an embodiment the opposing drive parts of a said drive element are actuated to alternatingly move towards and away from said rotor, such that the engaging element of the drive part moving towards said rotor engages a said rotor element and thereby moves said rotor element in said rotational direction, while the drive part moving away does not engage a said rotor element while retracting, and next the retracted drive part is actuated to move towards said rotor and thereby engages a said rotor element and thus rotates the rotor. The opposing drive parts are mechanically linked to each other. Said pneumatic or hydraulic power may be used for moving that drive part out of the two drive parts that is at that moment in its retracted position in the direction towards said rotor, such that the other drive part is moved to its retracted position, and then the pneumatic or hydraulic power is used to drive that other drive part towards the rotor.

Practically the drive elements or the at least one engaging element thereof are arranged at different axial locations as seen in an axial direction of the shafts, said axial locations corresponding to the axial locations of the rotor elements.

Practically each drive element or drive part thereof may comprise a plurality of engaging elements, which may be provided at all or some axial locations of the rotors, such that all or some of the rotors are driven in said rotational direction upon moving a said drive element or drive part in said radial direction towards said rotor.

In particular drive elements or drive parts having engaging elements at some, but not all axial locations of the rotors, may be used for a semi-independent drive of the rotors.

Said drive elements or drive parts thereof may be accommodated in chambers and thereby moveably in said chambers, said chambers for example being part of a housing. The gas, for example air, or liquid for moving the drive elements or drive parts may be supplied to the chamber in an area facing the outer end of the drive element or drive part, thereby moving the drive element or drive part in a direction towards said rotor.

The shape and/or size of the rotor elements and/or engaging elements may be the same or different for the optionally plurality of rotor elements and/or engaging elements.

In particular drive elements or drive parts having engaging elements having a different shape and/or size may be used for a semi-independent drive of the rotors.

In an embodiment of the motor according to the invention the rotors are substantially ring shaped and the drive elements are arranged within the ring shaped rotors.

Such an embodiment may also be referred to as an brushless DC motor.

Practically each rotor comprises a plurality of pole pairs that are arranged next to each other as seen in the circumferential direction of the ring shaped rotor, and wherein each drive element comprises an activatable electromagnetic coil.

In other words, the North and South poles are arranged alternatingly as seen in the circumferential direction of the ring shaped rotor.

Any suitable number of pole pairs can be provided, such as for example two, three, four, five, six, seven, eight, nine, ten, or even more.

The number of pole pairs can be the same or different for the at least two rotors.

Providing at least two rotors having a different number of pole pairs may provide a semi-independent drive of the at least two rotors.

In an embodiment of the motor according to the invention said motor may further comprise a housing for accommodating said at least two rotors and said at least three drive elements.

Said housing may for example comprise an upper housing part and a lower housing part, which can be connected to each other using any suitable kind of connection means, such as screws.

Said housing may for example comprise a plurality of chambers for accommodating said drive elements or drive parts, as is described above with respect to the pneumatic or hydraulic stepper motor.

Said motor may further comprise any other feature well known for the skilled person.

For example, said motor may further comprise or operatively connect to a controller for controlling the motor, such as a (micro)processor.

For example, said motor may further comprise electrical, pneumatic, or hydraulic connection(s). Said connections may for example be part of said housing.

The invention will be further elucidated with reference to figures, wherein:

Figures 1A – 1I schematically show a first embodiment of the motor according to the invention, wherein figure 1A is a perspective view, figure 1B is an exploded perspective view and figures 1C – 1I are cross-sectional views at different axial positions;

Figures 2A- 2D schematically show a second embodiment of the motor according to the invention, wherein figure 2A is a perspective view of the stator of the motor and figures 2B – 2D are cross-sectional views at different axial positions; and

Figures 3A and 3B are schematic cross-sectional views at different axial positions of a third embodiment of the motor according to the invention.

In the figures same or similar features are denoted by same reference numerals, increased by one hundred (100) and two hundred (200) for the second and third embodiment, respectively.

Figures 1A – 1I show a motor 1 according to a first exemplary embodiment of the invention.

Figure 1A shows that in this first exemplary embodiment the motor 1 comprises a housing comprising an upper part 2 and a lower part 3, wherein the upper part 2 is mounted on top of the lower part 3. Screw holes 4 are provided for receiving screws or other attachment means for attaching the upper part 2 to the lower part 3. In this example six coaxially extending shafts 5a – 5f are shown which extend partly outside of the upper part 2 of the housing. Each of the shafts 5a – 5f connects to a respective rotor 12a – 12f which rotors 12a – 12f are accommodated inside said housing, as will be explained in further detail with respect to figure 1B. Figure 1A further shows that in this embodiment five holes 6, each for receiving or otherwise connecting to a tube (not shown) for transporting air or a different gas to the housing, such that the motor 1 can be driven by pneumatic power. It is noted that if desired up to eight of such holes 6 could be provided, but that the applicant has found that five holes 6 can be sufficient for driving the four drive elements 8a – 8d (see figure 1B).

Figure 1B shows the motor 1 in an exploded view, wherein the upper part 2 of the housing is left away for the sake of simplicity. Figure 1B shows that the lower part 3 of the housing defines in this example eight chambers 7a – 7h. In total four drive elements 8a – 8d can be arranged in the chambers 7a – 7h, wherein each drive element 8a – 8d comprises two opposing drive parts 20a – 20h which are in this embodiment mechanically linked via a connecting element 9a – 9d, i.e. drive parts 20a, 20e are part of drive element 8a, drive parts 20b, 20f are part of drive element 8b, drive parts 20c, 20g are part of drive element 8c, and drive parts 20d, 20h are part of drive element 8d. Each chamber 7a – 7h thus accommodates a respective drive part. The connecting elements 9a – 9d are in this embodiment provided with slot-shaped holes 10a – 10d through which a pen 11 can extend in a substantially axial direction A. The drive elements 8a – 8d are moveable in the chambers 7a – 7h in a substantially radial direction R in a direction towards and away from in this embodiment sharp teeth-shaped rotor elements 13a – 13f of the rotors 12a – 12f, wherein the slot-shaped holes 10a – 10d allow for this movement. Moving of a said drive element 8a – 8d may take place by supplying said air or different gas to the respective chamber 7a - 7h in an area facing the outer end of a retracted one of the opposing drive parts 20a – 20h of that drive element 8a – 8d, thereby moving that drive part 20a - 20h in a direction towards said rotors 12a – 12f, while the opposing drive part 20a – 20h of that drive element 8a – 8d is thereby moved away from said rotors 12a – 12f towards its retracted position, such that next that drive part 20a – 20h can be moved towards said rotors 12a – 12f.

As can be further seen in figure 1B, the rotors 12a – 12f and thereby the rotor elements 13a – 13f thereof are arranged at in this embodiment six different axial locations as seen in the axial direction A defined by the longitudinal direction of the pen 11 and shafts 5a – 5f. In this embodiment no or a small axial distance is present between neighboring rotors 12a – 12f. Each opposing drive part 20a – 20h of the drive elements 8a – 8d comprises in this embodiment three engaging elements 14a – 14f that are arranged at three different axial locations out of the six axial locations, which three axial locations correspond to the axial locations of three rotors 12a – 12f out of the six rotors 12a – 12f, such that upon moving a drive part towards the rotors 12a – 12f the engaging elements 14a – 14f thereof engage with a respective rotor element 13a – 13f of those three rotors 12a – 12f and thereby moves said three rotors 12a – 12f in a rotational direction about the axis of rotation, which rotation axis is defined parallel to the longitudinal direction of pen 11 and/or parallel to the axial direction A. The engaging elements 14a – 14f are provided at different axial positions for the different drive parts of the drive elements 8a – 8d, such that the drive elements 8a – 8d each drive three different rotors 12a – 12f and in total all six rotors 12a – 12f can be driven by the four drive elements 8a – 8d. For example, it can be seen in figure 1B that drive element 8d is able to drive rotors 12f, 12d and 12b, because its engaging elements 14f, 14d and 14b are provided at three axial locations corresponding to the axial locations of rotors 12f, 12d and 12b.

As can be further seen in figure 1B, all shafts 5a – 5f are in this embodiment hollow and all have different diameters, such that the smaller diameter shafts 5b – 5f can all extend within the interior space of the larger diameter shafts 5a – 5e. The smallest diameter shaft 5f receives the pen 11 in its interior space. In this embodiment the shafts thus all extend coaxially in the same axial direction A. It is however additionally or alternatively possible that the shafts extend in opposing axial directions.

Figures 1 C – 1I show cross-sections in a direction orthogonal to the axial direction A at the six axial positions of the rotors 12a – 12f and at the axial position of the connecting element 9a, respectively. These figures show that as a results of moving the drive elements 8a – 8d in the radial direction towards and away from the rotors 12a – 12f, the opposing drive parts thereof are alternatingly in a retracted position in which the engaging elements thereof do not engage with the rotor elements of the rotors 12a – 12f and in an engaging position in which the engaging elements thereof do engage with the rotor elements of the rotors 12a – 12f.

It is noted that as will be clear for the skilled person the number of rotors and/or drive elements can be chosen as desired. According to an aspect of the invention the maximum number of rotors R is defined by R=N(N-1)/2, wherein N is the number of drive elements.

It is further noted that the number of rotor elements can be chosen as desired, wherein the number of rotor elements may define the angular step of the rotor. The number of rotor elements can be the same or different for the plurality of rotors.

Figures 2A – 2D show a motor 101 according to a second exemplary embodiment of the invention. This second embodiment is a so-called electric stepper motor.

Figure 2A shows the stator of the motor 101 comprising in this embodiment four drive elements 108a – 108d each having two substantially opposing drive parts 120a – 120h, i.e. drive parts 120a, 120e form one pair, drive parts 120b, 120f form a second pair, drive parts 120c, 120g form a third pair, and drive parts 120d, 120h form a fourth pair. Each drive part comprises in this embodiment three sets 122a – 122h, 123a – 123h, 124a – 124h of four drive members 114a – 114h.For example, drive part 120b comprises three sets 122b, 123b and 124b, drive part 120c comprises three sets 122c, 123c, 124c, etc. The drive members 114a – 114h are substantially directed towards a center of the motor 101 and thereby a center of the rotors 112a – 112c (see figures 2B – 2D). In other words, the drive members 114a – 114h extend in a substantially radially inward direction towards the rotors 112a – 112d. It can be seen that in this embodiment each drive part 120a – 120h with its respective drive members 114a - 114h are substantially fork-shaped. The three sets 122a – 122h, 123a – 123h, 124a – 124h of four drive members 114a – 114h are arranged at three different axial locations as seen in an axial direction A, such that each set 122a – 122h, 123a – 123h, 124a – 124h is able to drive a respective rotor 112a – 112c. As can be further seen in figure 2A is that in this embodiment one set 122a – 112h, 123a – 123h, 124a – 124h of drive members 114a – 114h is offset in a substantially tangential direction T with respect to the other two sets 122a – 122h, 123a – 123h, 124a – 124h. See for example set 123b that is offset with respect to sets 122b and 124b. As can be further seen in figure 2A is that in this embodiment for practical reasons the stator is made by providing three stator parts 125a – 125c which are mounted on top of each other. Not shown in figure 2a, but present at least in use of the motor 101 are electromagnetic coils which are wound around the drive parts 120a – 120h, in particular around the legs 121a – 121h thereof.

Figures 2B – 2D show transverse cross sections at three different axial positions in the axial direction A corresponding to the axial positions of the sets 122a – 122h, 123a – 123h, 124a – 124h of the drive members 114a – 114c, wherein a different rotor 112a – 112c out of in total three rotors 112a – 112c is provided at each axial position. In particular figure 2B is at the axial position of set 122a – 122h and rotor 112a, figure 2C is at the axial position of set 123a – 123h and rotor 112b, and figure 2D is at the axial position of set 124a – 124h and rotor 112c. Each rotor 112a – 112c comprises a plurality of rotor elements 113a – 113c. The rotors 112a – 112c can be driven in a rotational direction about the rotation axis which is parallel to the axial direction A, and which rotational direction is substantially parallel to the tangential direction T, by the drive parts 120a - 120h and in particular the drive members 114a – 114h thereof by feeding an alternating current through said electromagnetic coils, such that alternating opposing poles are formed by the opposing drive parts 120a – 120h and drive members 114a – 114h thereof and said rotors are rotated by alternatingly attracting and repulsing the rotor elements 113a – 113c. See for example figure 2B wherein the drive members 114d are aligned with respective rotor elements 113 and the opposing drive members 114h are not aligned with nearby rotor elements 113, such that the drive members 114d repulse said rotor elements 113 and the opposing drive members 114h attract the nearby rotor elements 113 and such that said rotor 112a is rotated. In this embodiment the three rotors 112a – 112c are thus rotated by in total four drive elements.

Figures 3A and 3B show a motor 201 according to a third exemplary embodiment of the invention. This third embodiment is a so-called brushless DC motor.

Figures 3A and 3B are schematic cross-sectional views at two different axial positions of the motor 201, wherein a rotor 212a and 212b out of in this embodiment in total two rotors 212a, 212b is provided. In total five drive elements 208a - 208e are provided. In this embodiment the rotors 112a, 112b are substantially ring shaped and the drive elements 208a – 208e are arranged within the ring shaped rotors. In this embodiment the first rotor 212a comprises three pole pairs 230a – 230f that are arranged next to each other as seen in the circumferential direction of the ring shaped rotor 212a, and the second rotor 212b comprises two pole pairs 231a - 231d that are arranged next to each other as seen in the circumferential direction of the ring shaped rotor. More in particular, the first rotor 212a comprises a first pole pair 230a, 230b, a second pole pair 230c, 230d, and a third pole pair 230e, 230f, and wherein the North and South poles are alternatingly provided. More in particular, the second rotor 212b comprises a first pole pair 231a, 231b and a second pole pair 231c, 231d, and wherein the North and South poles are alternatingly provided. It is thus clear for the skilled person that the number or pole pairs can be chosen as desired for each rotor and that in particular the number of pole pairs per rotor can be the same or different. Each drive element 208a – 208e comprises an activatable electromagnetic coil 231a – 231e. Upon activating the electromagnetic coils 231a – 231e the rotors 212a, 212b are driven in a continuous rotational direction about the rotation axis which is parallel to the axial direction A.

It is noted that the invention is not limited to the shown embodiments but also extends to variants within the scope of the appended claims.

CLAIMS

1. Motor, comprising:

- at least two rotors, wherein the rotors are arranged at different axial locations as seen in an axial direction;
- at least three drive elements, wherein each drive element is arranged to drive at least one rotor in a rotational direction, and at least one drive element is arranged to drive at least two rotors simultaneously.

2. Motor according to claim 1, wherein said rotors can be driven in a semi-independent way.

3. Motor according to claim 1 or 2, wherein no or a small axial distance is present between the at least two rotors.

4. Motor according to any of the preceding claims, wherein the maximum number of rotors R is defined by $R=N(N-1)/2$, wherein N is the number of drive elements.

5. Motor according to any of the preceding claims, wherein the at least two rotors each comprise a shaft, said shafts defining said axial direction in the longitudinal direction thereof, wherein the shafts of the at least two rotors have different diameters and at least the shaft having the largest diameter is hollow and thereby defines an interior space, wherein the shaft having a smaller diameter is arranged within said interior space, such that the shafts extend coaxially with respect to each other.

6. Motor according to any of the preceding claims, wherein the at least two rotors each comprise a shaft, said shafts defining said axial direction in the longitudinal direction thereof, wherein the shafts of the at least two rotors extend in opposing axial directions with respect to the rotors.

7. Motor according to any of the preceding claims, wherein each rotor comprises a plurality of rotor elements extending in a substantially radial, outward direction, wherein each drive element comprises two substantially opposing drive parts, and wherein said opposing drive parts are arranged for driving at least one rotor element of at least one of said rotors in said rotational direction by alternatingly attracting and repulsing at least one rotor element.

8. Motor according to claim 7, wherein each drive part comprises an activatable electromagnetic coil and at least the rotor elements of the rotors are made of a magnetic material.

9. Motor according to claim 8, wherein each drive part comprises at least two drive members that extend substantially in the direction of a center of a respective one of the at least two rotors and that are arranged at different axial locations as seen in an axial direction, said axial locations corresponding to the axial locations of the at least two rotors.

10. Motor according to claim 9, wherein at least some of the drive members of a said drive part are offset with respect to each other in a substantially tangential direction as defined with respect to the at least two rotors.

11. Motor according to any of claims 1 – 6, wherein each rotor comprises a plurality of rotor elements extending in a substantially radial, outward direction, wherein each drive element is moveable in a substantially radial direction with respect to the axial direction of the shafts in a direction towards and away from said rotor elements, wherein each drive element comprises at least one engaging element arranged for engaging a said rotor element, wherein upon moving the drive element towards the rotor elements said engaging element engages said rotor element and thereby moves said rotor in said rotational direction.

12. Motor according to claim 11, wherein said rotor elements and said engaging element are teeth-shaped.

13. Motor according to claim 11 or 12, wherein each drive element is moveable in said substantially radial direction by means of pneumatic or hydraulic power.

14. Motor according to any of the claims 11 - 13, wherein the drive elements or the at least one engaging element thereof are arranged at different axial locations as seen in an axial direction of the shafts, said axial locations corresponding to the axial locations of the rotor elements.

15. Motor according to any of the claims 1 – 6, wherein the rotors are substantially ring shaped and the drive elements are arranged within the ring shaped rotors.

16. Motor according to claim 15, wherein each rotor comprises a plurality of pole pairs that are arranged next to each other as seen in the circumferential direction of the ring shaped rotor, and wherein each drive element comprises an activatable electromagnetic coil.

17. Motor according to claim 15 or 16, wherein the number of pole pairs is different for the at least two rotors.

18. Motor, comprising a housing for accommodating said at least two rotors and said at least three drive elements.

ABSTRACT

The invention relates to a motor, comprising:

- at least two rotors, wherein the rotors are arranged at different axial locations as seen in an axial direction;
- at least three drive elements, wherein each drive element is arranged to drive at least one rotor in a rotational direction, and at least one drive element is arranged to drive at least two rotors simultaneously.

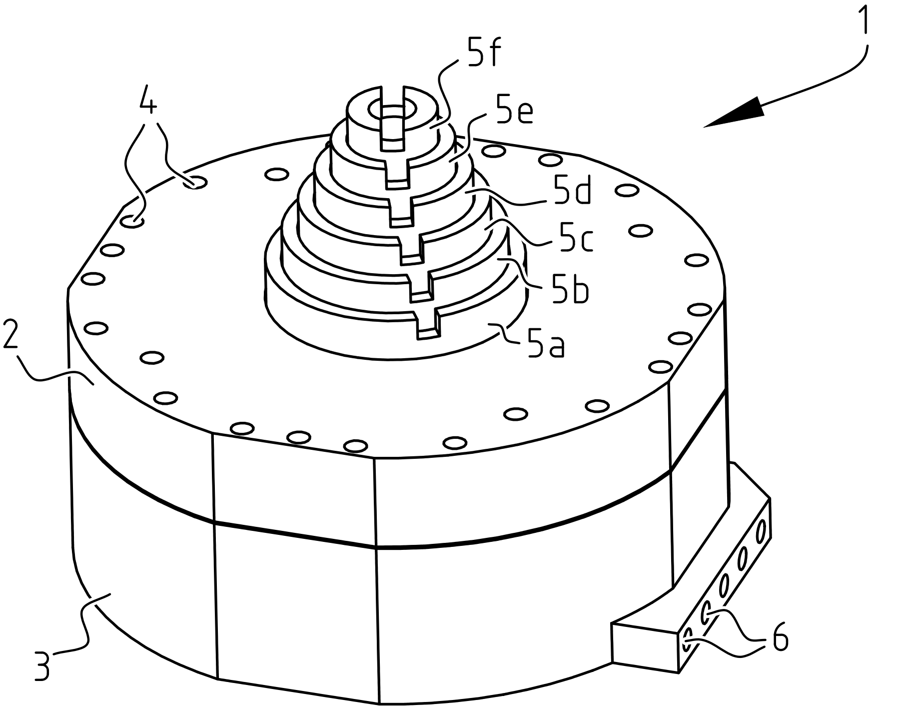
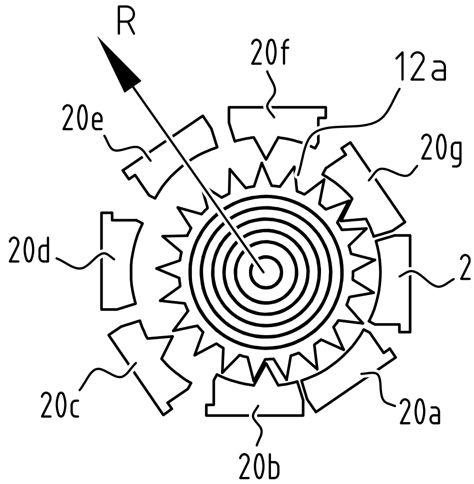
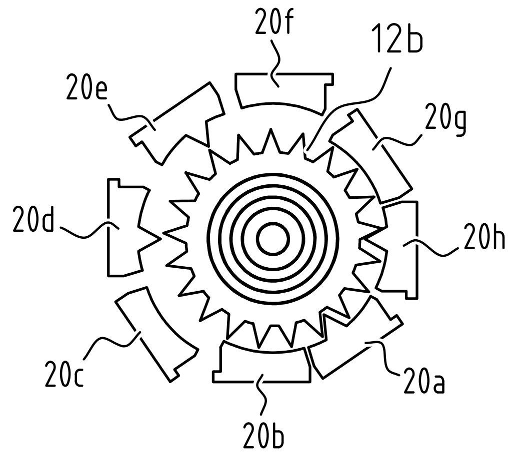


FIG. 1A



SECTION M-M

FIG. 1C



SECTION N-N

FIG. 1D

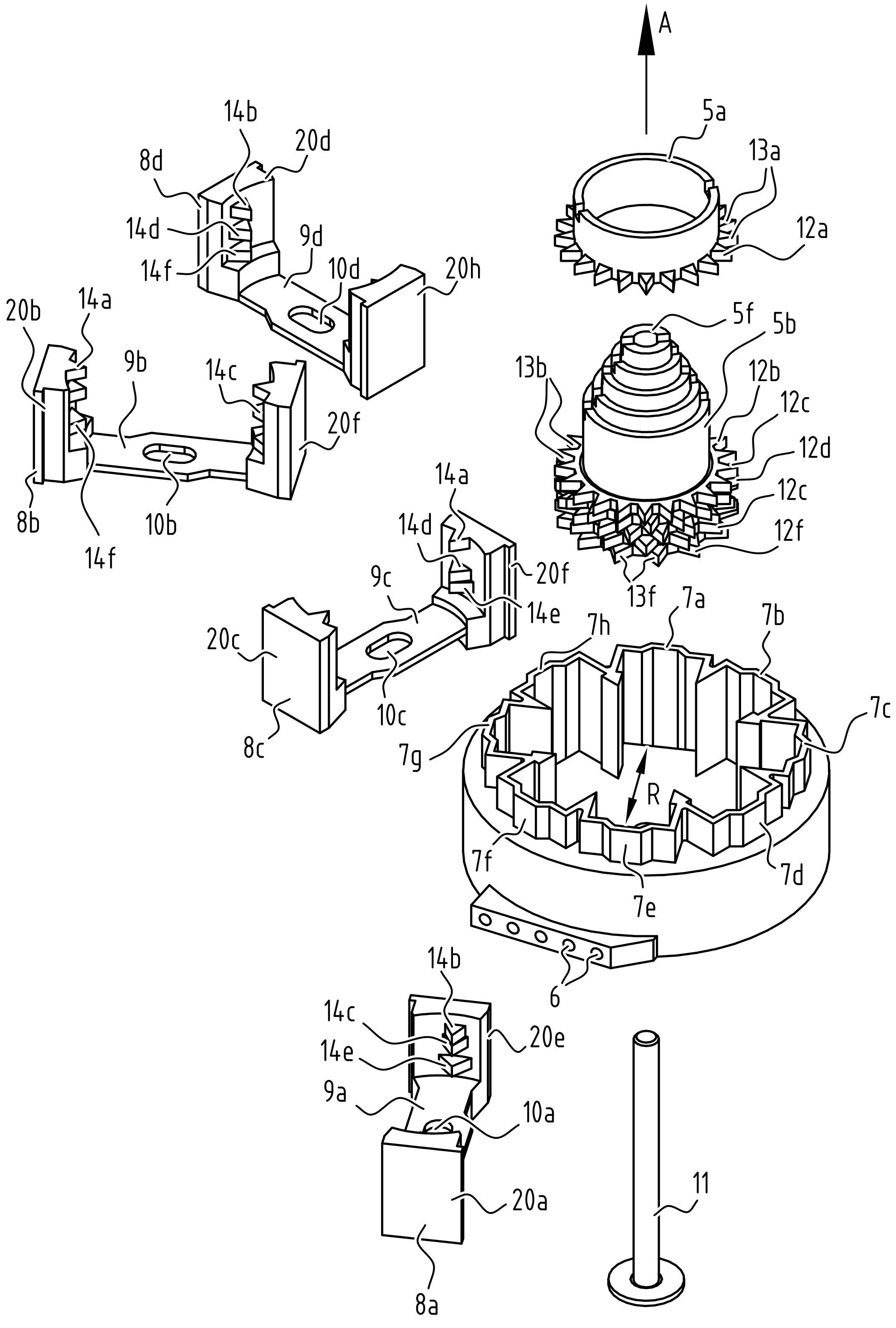
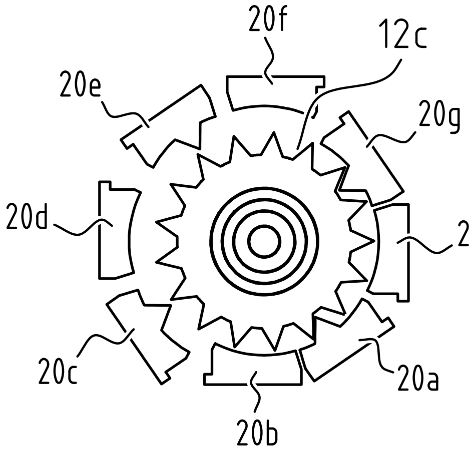
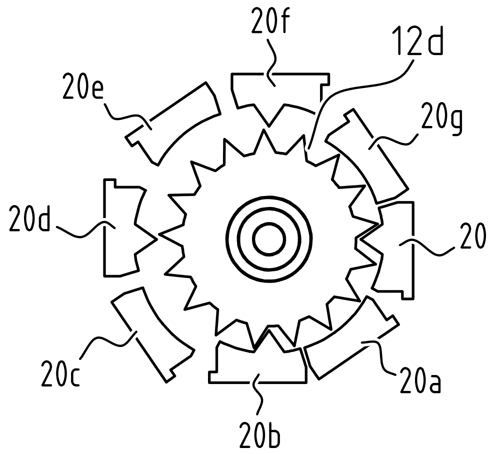

A
5a
13a
12a
14b
20d
8d
14d
14f
9d
10d
20h
20b
14a
9b
14c
20f
8b
10b
14f
5f
5b
13b
12b
12c
12d
12c
12f
13f
14a
14d
20f
9c
14e
20c
10c
8c
7a
7h
7b
7c
7g
R
7f
7e
7d
6
14b
14c
20e
14e
9a
10a
20a
8a
11

FIG. 1B



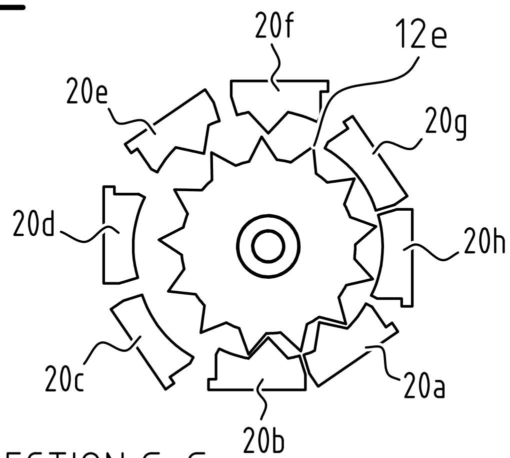
SECTION O-O

FIG. 1E



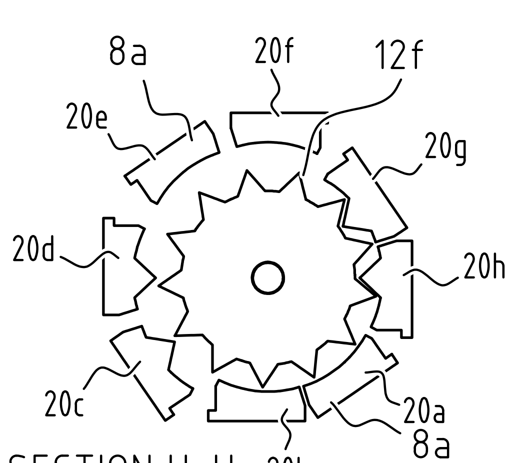
SECTION J-J

FIG. 1F



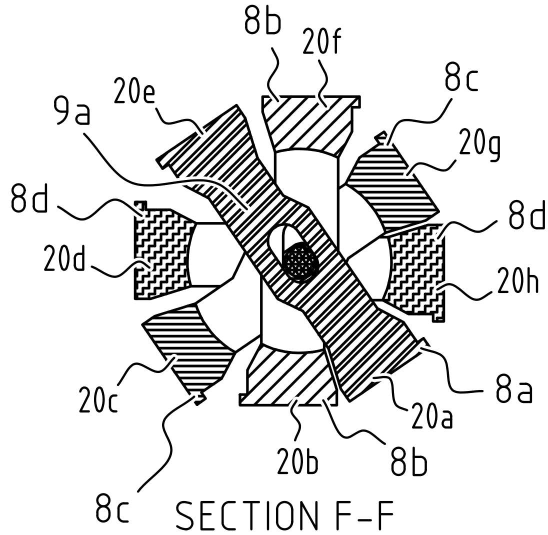
SECTION G-G

FIG. 1G



SECTION H-H

FIG. 1H



SECTION F-F

FIG. 1I

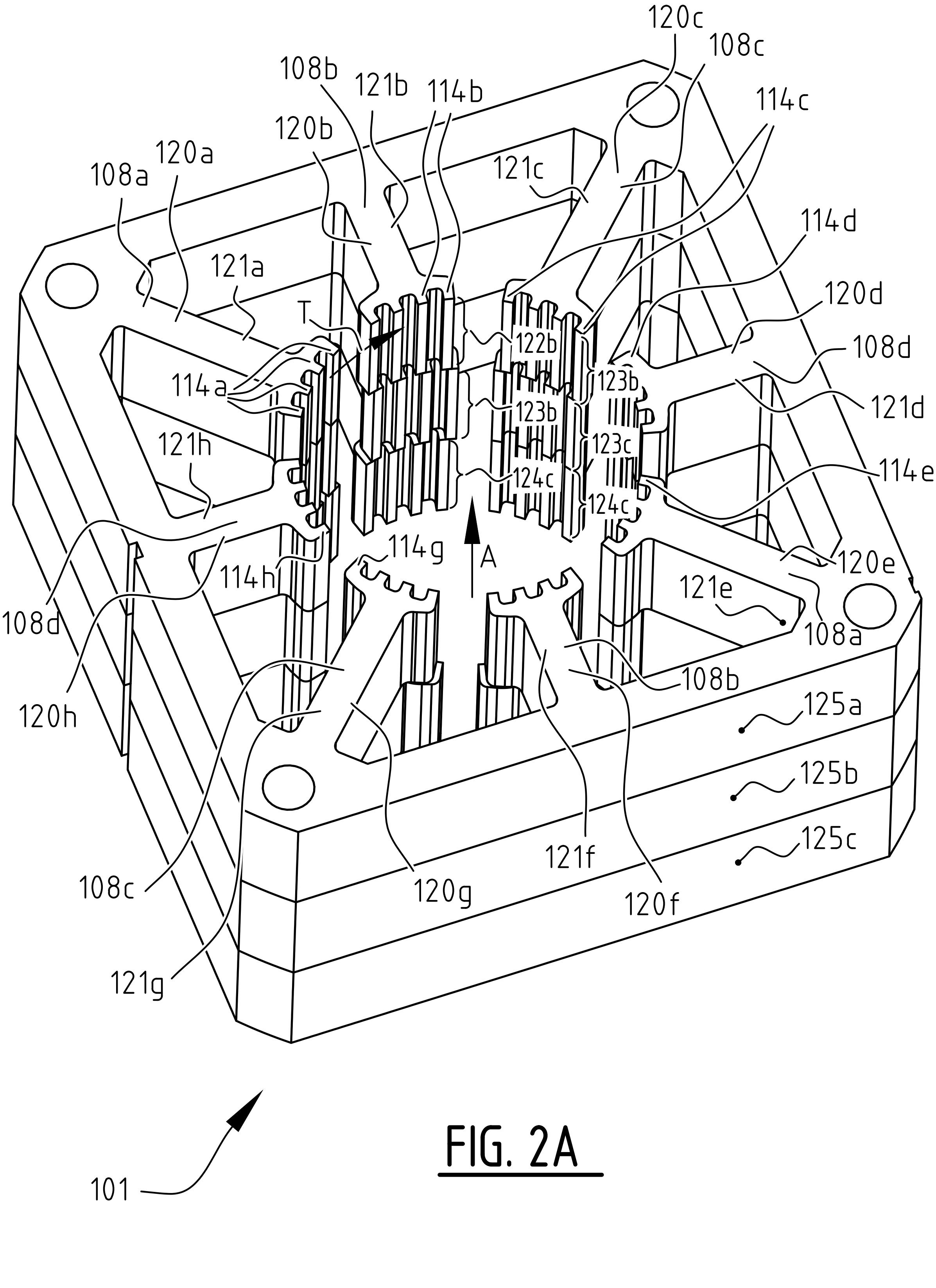

120c
108c
108b
121b
114b
114c
120b
120a
108a
121c
114d
121a
120d
T
122b
108d
114a
123b
123b
121d
121h
123c
124c
124c
114e
114g
A
114h
120e
121e
108d
108a
120h
108b
125a
125b
125c
108c
120g
121f
120f
121g
101

FIG. 2A

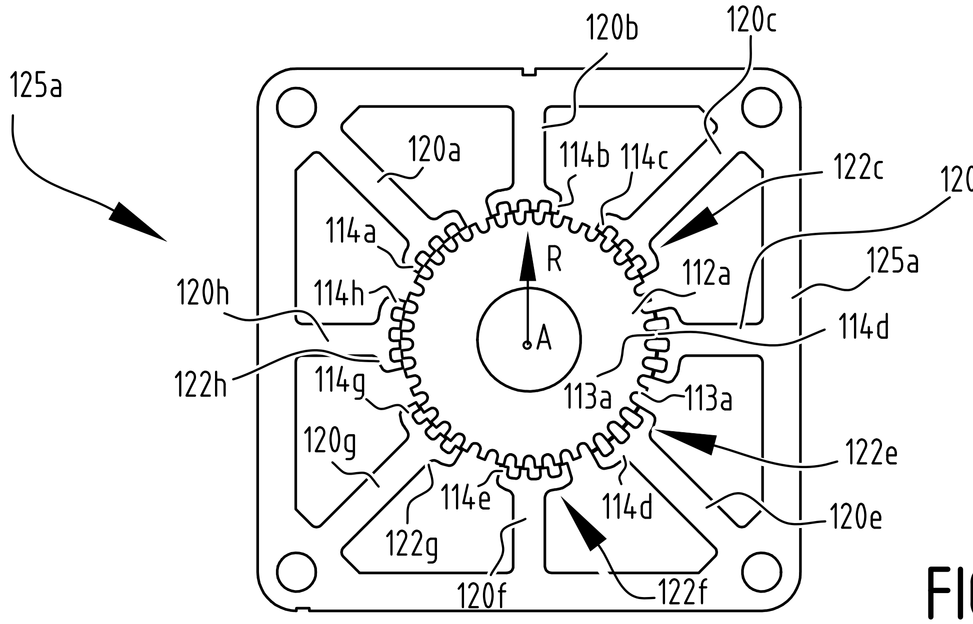


FIG. 2B

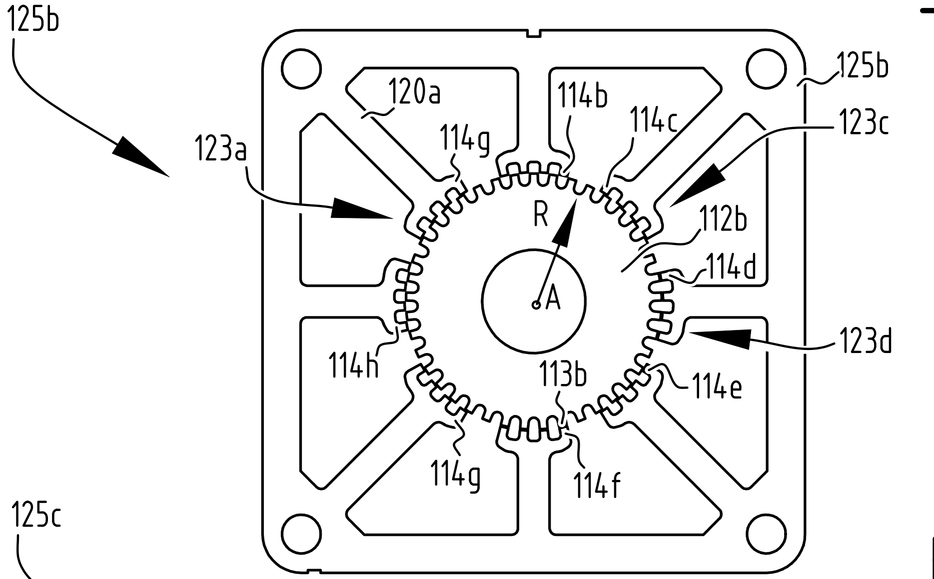


FIG. 2C

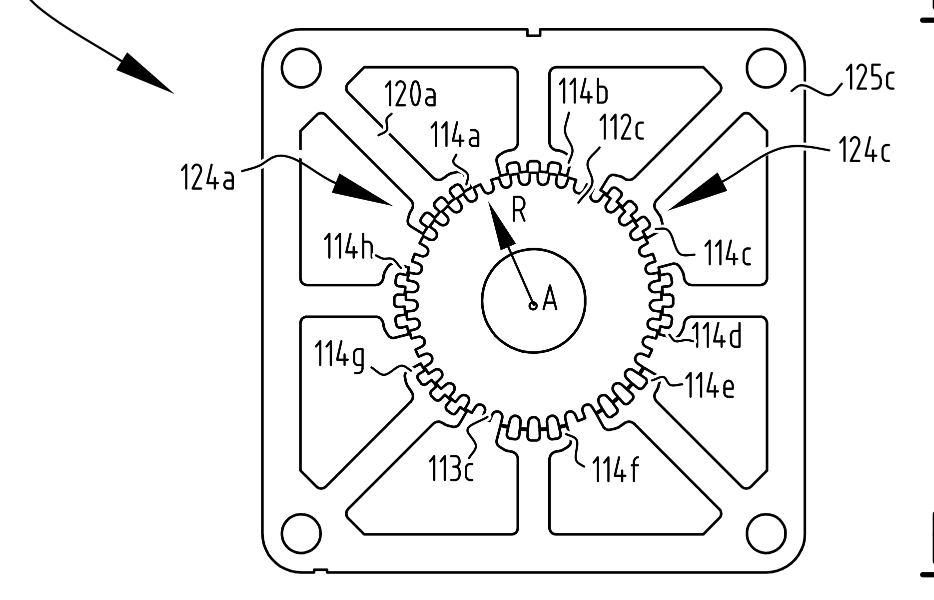


FIG. 2D

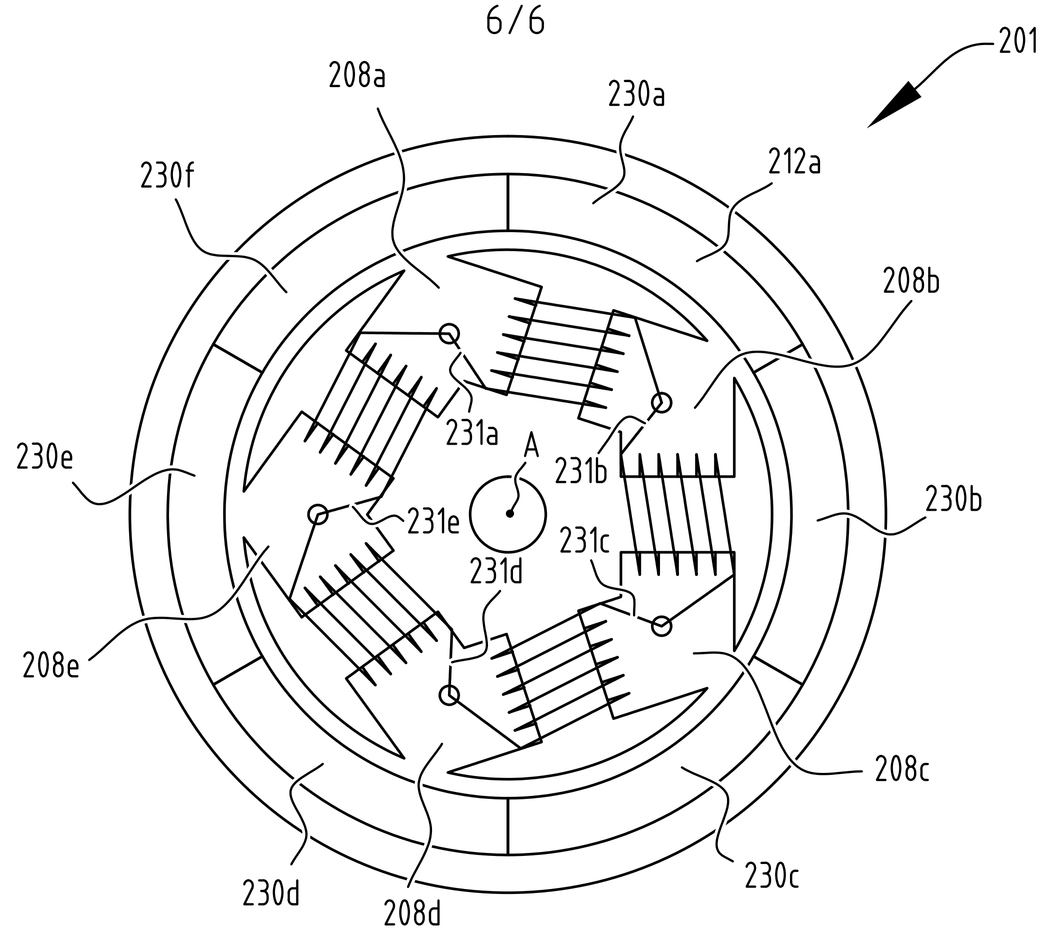

201
208a
230a
212a
230f
208b
231a
A
231b
230e
231e
230b
231c
231d
208e
208c
230d
208d
230c

FIG. 3A

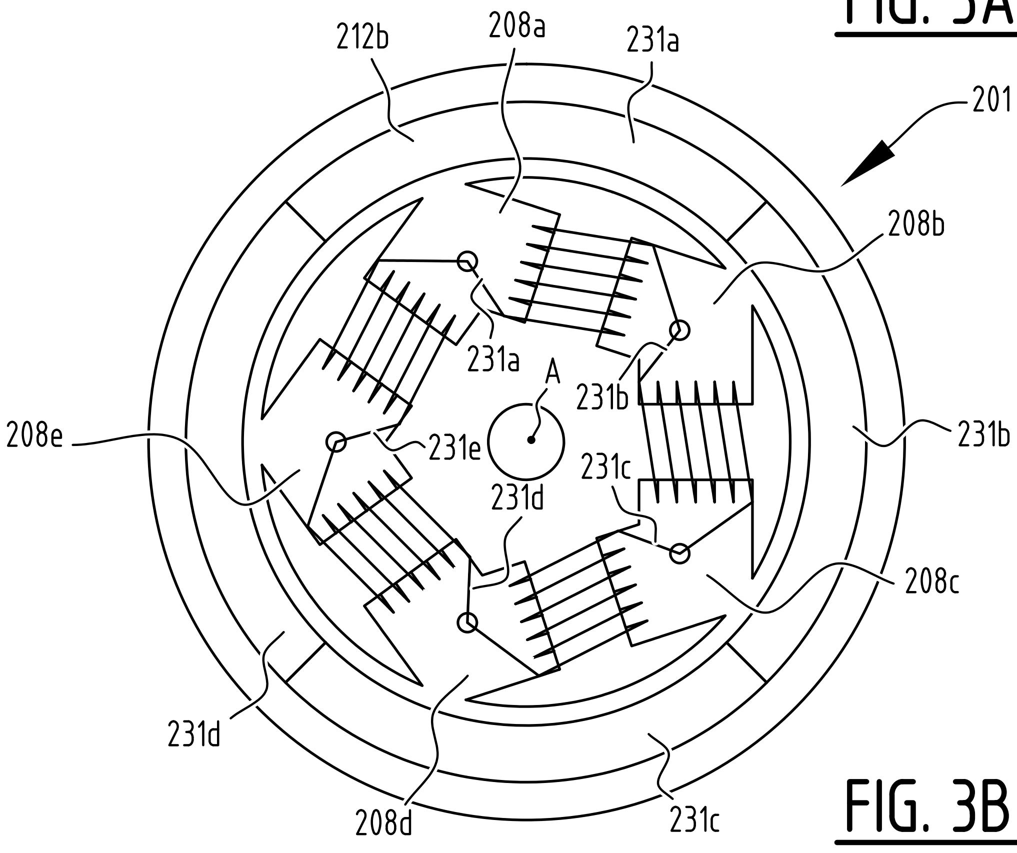

212b
208a
231a
201
208b
231a
A
231b
208e
231e
231b
231c
231d
208c
231d
208d
231c

FIG. 3B