

Description

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a strong magnetic thrust force type actuator producing a relatively large magnetic thrust for use in an industrial robot, or the like.

Prior Art

Conventional linear pulse motors comprise a primary member and secondary member. Generally the primary member is an electrically supplied member, in other words, an electromagnetically exciting member. Accordingly, the primary member travels along the secondary member in a linear to and fro direction when a pulse current is supplied to the primary member. In this case, the primary member is movable, while the secondary member is stationary, but either the primary or secondary member can be movable.

Fig. 1 shows a conventional linear pulse motor. Numeral 1 designates a secondary member which is an elongate magnetic material plate, the upper side of which forms rectangular teeth 1a and grooves 1b along the longitudinal direction at a constant pitch. Above the teeth 1a and grooves 1b, primary member 2 is positioned at a predetermined space therebetween. This primary member 2 is movably supported by a supporting member such as a roller, wheel, or the like.

Primary member 2 comprises core 4 for the A-phase and core 5 for the B-phase, both having magnetic poles 4a and 4b for core 4, and magnetic poles 5a and 5b for core 5; coils 6a and 6b wound around magnetic poles 4a and 4b, respectively; coils 7a and 7b wound around magnetic poles 5a and 5b, respectively; permanent magnets 8 and 9 disposed on cores 4 and 5, in which the N-pole of permanent magnet 8 faces the upper surface of core 4, while the S-pole of permanent magnet 9 faces the upper surface of core 5; cover plate 10, formed by a magnetic material, covers permanent magnets 8 and 9. The lower side of magnetic pole 4a has pole teeth 14a and grooves 14c, each of which is formed at a constant pitch. The lower side of magnetic poles 4b, 5a, and 5b has similar pole teeth 14b, 15a, and 15b, then grooves 14d, 15c, and 15d, respectively.

Assuming that the constant pitch of rectangular teeth 1a indicates the distance P, each of the pole teeth 14b, 15a, and 15b is shifted by a distance of P/4 with respect to rectangular teeth 1a as shown in Fig. 2, and the lower surface of these are positioned at a distance of G from the upper surface of

teeth 1a.

Accordingly, in turn, supplying the pulse current to coils 6a, 6b, 7a, and 7b generates a magnetic flux respectively. The magnetic flux and the magnetic flux from permanent magnets 8 and 9, in turn, act on respective magnetic poles 4a, 4b, 5a, and 5b, allowing primary member 2 to travel along secondary member 1 in the longitudinal direction.

Next, in Fig. 2(a) to Fig. 2(d), primary member 2 traveling along secondary member 1 is described based on the two-phase exciting system which supplies a pulse current to coils 6a and 6b in one group, and coils 7a and 7b in the other group. This pulse current energizes magnetic poles 4a, 4b, 5a, and 5b.

In Fig. 2(a), by supplying the pulse current from terminal 6c to terminal 6d through coils 6a and 6b as shown by the direction of the arrow, and also, by supplying this pulse current from terminal 7d to terminal 7c through coils 7a and 7b, as shown by the direction of the arrow, the magnetic flux generated from coil 6a is added to the magnetic flux generated from permanent magnet 8 at magnetic pole 4a for the A-phase, and each of these magnetic fluxes at magnetic pole 4b for the A-phase opposes the other. On the other hand, the magnetic flux generated from coil 7a is added to the magnetic flux generated from permanent magnet 9 at magnetic pole 5a for the B-phase, and each of these magnetic fluxes at magnetic pole 5b for the B-phase opposes the other. Magnetic flux ϕ_1 is thus generated in the direction of the arrow as shown in Fig. 2(a). As a result, the magnetic field acts on pole teeth 14a and 15a facing rectangular teeth 1a to produce a magnetic thrust.

In Fig. 2(b), by supplying the pulse current to coils 6a and 6b in the same direction as shown in Fig. 2(a), and also, by supplying this pulse current to coils 7a and 7b in the opposite direction against the direction shown in Fig. 2(a), magnetic flux ϕ_2 is thus generated in the direction of the arrow as shown in Fig. 2(b). As a result, the magnetic field acts on pole teeth 14a and 15b facing rectangular teeth 1a to produce magnetic thrust.

In Fig. 2(c), by supplying the pulse current to coils 6a and 6b in the opposite direction against the direction shown in Fig. 2(b), and by supplying this pulse current to coils 7a and 7b in the same direction as shown in Fig. 2(b), magnetic flux ϕ_3 is thus generated in the direction of the arrow direction as shown in Fig. 2(c). As a result, the magnetic field acts on pole teeth 14b and 15b facing rectangular teeth 1a to produce the magnetic thrust.

Similarly, in Fig. 2(d), by supplying the pulse current to coils 6a and 6b in the same direction as shown in Fig. 2(c), and to coils 7a and 7b in the opposite direction against the direction shown in Fig. 2(c), magnetic flux ϕ_4 is thus generated in the

direction of the arrow direction as shown in Fig. 2(d). As a result, the magnetic field acts on pole teeth 14b and 15a facing rectangular teeth 1a to produce the magnetic thrust.

Accordingly, the pulse current is, in turn, supplied to respective coils 6a, 6b, 7a, and 7b in the successive order of such Fig. 2(a), Fig. 2(b), Fig. 2(c), and Fig. 2(d). This allows primary member 2 to travel toward the right in the drawings, that is, from magnetic pole 4a to magnetic pole 5b, while the pulse current is, in turn, supplied to the respective coils in the decreasing order of such Fig. 2(d), Fig. 2(c), Fig. 2(b), and Fig. 2(a), causing primary member 2 to travel toward the left on the drawing, that is, from magnetic pole 5b to magnetic pole 4a.

Generally, such a linear pulse motor is thus used without a closed-loop control circuit for accurately positioning an object at a certain position, which makes the driving device useful for office automation equipment such as printers. However, it is difficult to use this type of device in industrial robots because of the high magnetic thrust required.

According to the linear pulse motor described in the above, in Fig. 2(a), while generating the magnetic thrust at magnetic poles 4a and 5a, each of the magnetic fluxes is counteracted at magnetic poles 4b and 5b, respectively. The magnetic thrust is thus not caused at magnetic poles 4b and 5b. A similar magnetic thrust is generated at magnetic poles 4a and 5b in Fig. 2(b), magnetic poles 4b and 5b in Fig. 2(c), and magnetic poles 4b and 5a in Fig. 2(d). As a result, the area of magnetic poles 4a, 4b, 5a, and 5b which can generate the magnetic thrust is only 50% of the area thereof. This area is significant in that it produces the magnetic thrust.

European Patent Application A-0 352 189, published on January 24, 1990, discloses a strong magnetic thrust force type actuator including a primary magnetic member having magnetic poles and a secondary magnetic member having facing portions facing the magnetic poles. In a first embodiment, the primary magnetic member comprises separate core members disposed at a first constant pitch, whereas the facing portions of the secondary magnetic member are disposed at a second constant pitch about twice as large as the first constant pitch. Permanent magnets are inserted between the separate core members. In another embodiment, the primary magnetic member comprise a core member having facing portions disposed at a first constant pitch, whereas the secondary magnetic member is formed of separate elements, between which are inserted the permanent magnets. Then, the first constant pitch is about twice as large as a second constant pitch between said separate elements.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a strong magnetic thrust force type actuator capable of effectively using area of the magnetic poles to produce a large magnetic thrust.

In an aspect of the present invention, there is provided a strong magnetic thrust force type actuator including:

a primary magnetic member supported by a support means moving along a predetermined direction, the primary magnetic member generating a magnetic field from magnetic poles thereof; and

a secondary magnetic member having a plurality of facing portions facing the magnetic poles of the primary magnetic member, in which the facing portions are disposed at a constant pitch in the predetermined direction, thus moving the primary magnetic member relative to the secondary magnetic member when a magnetic field acts on the facing portions formed by the secondary magnetic member, wherein

the primary magnetic member comprises:

a core member having facing portions and grooves alternately disposed at a first constant pitch in the predetermined direction, the facing portions and grooves extended to a direction transverse to the predetermined direction;

a permanent magnet inserted into respective said grooves in a perpendicular direction from a facing surface of the facing portions so that each of the adjacent permanent magnets is of an opposite polarity; and

an insulated wire wound around the core member to form said magnetic pole, wherein

the secondary magnetic member comprises:

the said facing portions being faced to the facing portions of the core member, the facing portions disposed at a second constant pitch in the predetermined direction, the second constant pitch is about twice as large as the first constant pitch of the facing portions formed by the primary magnetic member.

In a second aspect of the present invention, there is provided a strong magnetic thrust force type actuator including;

a primary magnetic member supported by a support means moving along a predetermined direction, the primary magnetic member generating a magnetic field from magnetic poles thereof; and

a secondary magnetic member having a plurality of facing portions facing the magnetic poles of the primary magnetic member, in which the facing portions are disposed at a constant pitch in the predetermined direction, thus moving the primary magnetic member relative to the secondary magnetic member when a magnetic field acts on the facing portions formed by the secondary magnetic

member, the improvement wherein

the primary magnetic member comprises:

a core member having facing portions disposed at a first constant pitch in the predetermined direction, the facing portions being extended in a direction transverse to the predetermined direction; and

an insulated wire wound around the core member to form magnetic pole wherein

the secondary magnetic member comprises:

facing portions and grooves faced to the facing portions of the core member, the facing portions and grooves alternately disposed at a second constant pitch in the predetermined direction, and extended in a direction transverse to the predetermined direction;

a permanent magnet inserted into respective grooves in a perpendicular direction from each facing surface of the facing portions so that each of the adjacent permanent magnets is of an opposite polarity, thus the first constant pitch is about twice as large as the second constant pitch of the facing portions formed by the secondary magnetic member.

Accordingly, when the magnetic poles are activated by supplying a pulse current to the insulated wires wound around the magnetic poles formed by the primary magnetic member, all facing portions of the magnetic poles can contribute to produce a strong magnetic thrust, which moves the primary magnetic member relative to the secondary magnetic member.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view showing the conventional linear pulse motor;

Fig. 2(a) to Fig. 2(d) are side views showing an operation of the conventional linear pulse motor;

Fig. 3 is a perspective view showing a linear pulse motor of the first embodiment;

Fig. 4(a) to Fig. 4(d) are side views showing the operation of the linear pulse motor;

Fig. 5 is a perspective view showing a linear pulse motor of the second embodiment;

Fig. 6 is a perspective view showing the details of A-phase block 23;

Fig. 7 is a side view showing the operation of the linear pulse motor when the coils are not energized;

Fig. 8(a) to Fig. 8(d) are side views showing the operation of the linear pulse motor when either coil is energized;

Fig. 9(a) to Fig. 9(d) are side views showing the operation of the linear pulse motor when both coils are energized;

Fig. 10 is a side view showing a linear pulse motor of the third embodiment;

Fig. 11 is a plan view shown by the arrows A-A in Fig. 10;

Fig. 12 is a side view showing a linear pulse motor of the fourth embodiment;

Fig. 13 is a time chart showing the wave forms of a pulse current supplied to the coils;

Fig. 14 is a thrust vector chart showing the magnetic thrust;

Fig. 15 is a plan view showing the secondary magnetic member of the fifth embodiment;

Fig. 16 is a side view showing the primary magnetic member of the fifth embodiment;

Fig. 17 is a side view, partially cut away, of the primary magnetic member shown by the arrows B-B in Fig. 16;

Fig. 18 is a side view showing a linear pulse motor of the sixth embodiment;

Fig. 19 is a side view showing a linear pulse motor of the seventh embodiment;

Fig. 20 is a side view showing a linear pulse motor of the eighth embodiment;

Fig. 21 is a section view, partially cut away, of a disk-rotor type pulse motor of the ninth embodiment;

Fig. 22 is an enlarged side view, partially cut away, of the disk-rotor;

Fig. 23 is a brief section view shown by the arrows C-C in Fig. 22;

Fig. 24 is an enlarged side view, partially cut away, of the stator portion shown by the arrows D-D in Fig. 21;

Fig. 25 is a brief section view showing an outer-rotor type pulse motor of the tenth embodiment;

Fig. 26 is a side view showing a linear pulse motor of the eleventh embodiment;

Fig. 27 is a side view showing the operation of the linear pulse motor when the coils are not energized;

Fig. 28(a) to Fig. 28(d) are side views showing the operation of the linear pulse motor when the coils are energized;

Fig. 29 is a perspective view showing a linear pulse motor of the twelfth embodiment;

Fig. 30 is a side view showing a linear pulse motor of the thirteenth embodiment;

Fig. 31 is a section view, partially cut away, of a disk-rotor type pulse motor of the fourteenth embodiment;

Fig. 32 is a section view shown by the arrows E-E in Fig. 33;

Fig. 33 is an enlarged side view, partially cut away, of the rotor;

Fig. 34 is an enlarged side view, partially cut away, of the stator portion shown by the arrows F-F in Fig. 31;

Fig. 35 is a simplified section view showing an outer-rotor type pulse motor of the fifteenth embodiment; and

Fig. 36 is a side view showing another type of primary magnetic member.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, an embodiment of the present invention is described by reference to drawings.

Fig. 3 shows a first embodiment of the invention as a strong magnetic force type actuator. This strong magnetic force type actuator is shown as a linear pulse motor. In this drawing, numeral 21 designates a secondary magnetic member at a fixed position, and numeral 22 designates a primary magnetic member movably supported at a constant distance G by a support means such as rollers, wheels, or the like. Primary magnetic member 22 thus travels along a longitudinal direction, or the traveling direction shown by arrow M . The support means is not shown in Fig. 3 for the sake of simplicity.

In the upper side of secondary magnetic member 21, the single-row of rectangular teeth 21a is formed in the longitudinal direction. Each of the rectangular teeth 21a is formed at a constant pitch, at the distance of P , and therefore, the longitudinal axis of rectangular teeth 21a is formed in the direction transverse to the longitudinal direction of secondary magnetic member 21.

A-phase block 23 comprises U-shaped core 24 having +A-phase magnetic pole 24A, and -A-phase magnetic pole 24a, both of which are faced to the rectangular teeth 21a of secondary magnetic member 21; and coil 25A and coil 25a both wound around +A-phase magnetic pole 24A and -A-phase magnetic pole 24a, respectively. Each lower surface of the +A-phase magnetic pole 24A and -A-phase magnetic pole 24a has grooves 24b and rectangular teeth 24c at constant pitch, at the distance of $P/2$, in the longitudinal direction, in other words, the longitudinal axis of teeth 24c is formed in a direction transverse to the longitudinal direction. Permanent magnet 26 is then inserted into respective grooves 24b so that each of the adjacent permanent magnets 26 is of an opposite polarity.

On the other hand, B-phase block 33 has an identical construction as A-phase block 23, that is, it has a U-shaped core 34 having +B-phase magnetic pole 34B and -B-phase magnetic pole 34b, both of which are faced to rectangular teeth 21a of secondary magnetic member 21; and coil 35B and coil 35a both wound around +B-phase magnetic pole 34B and -B-phase magnetic pole 34b, respectively. Each lower surface of the +B-phase magnetic pole 34B and -B-phase magnetic pole 34b has grooves 34a and rectangular teeth 34c at a constant pitch, at distance of $P/2$, and permanent

magnet 26 is inserted into respective grooves 34a so that each of the adjacent permanent magnets 26 is of an opposite polarity.

In Fig. 3, assuming that a reference line is set at the left end rectangular teeth 24c of +A-phase magnetic pole 24A as a vertical center line of the rectangular teeth 24c, the left end rectangular teeth 24c of -A-phase magnetic pole 24a is positioned at the distance of $2P + P/2$ with respect to the reference line. The left end rectangular teeth 34c of +B-phase magnetic pole 34B is positioned at a distance of $5P + P/4$ with respect to the reference line. The left end rectangular teeth 34c of -B-phase magnetic pole 34b is then positioned at the distance of $7P + 3P/4$ with respect to the reference line, or $2P + P/2$ with respect to a vertical center line of the left end rectangular teeth 34c formed by +B-phase magnetic pole 34B.

Accordingly, when the first and third rectangular teeth 24c of +A-phase magnetic pole 24A face directly above rectangular teeth 21a, each of the rectangular teeth 24c of -A-phase magnetic pole 24a is shifted by a distance of $P/2$ with respect to rectangular teeth 21a, each of the rectangular teeth 34c of +B-phase magnetic pole 34B is shifted by a distance of $P/4$ with respect to rectangular teeth 21a, and each of the rectangular teeth 34c of -B-phase magnetic pole 34b is shifted by a distance of $3P/4$ with respect to rectangular teeth 21a.

The operation of this linear pulse motor is described by reference to Fig. 4(a) through Fig. 4(d), in the case in which a pulse current is supplied to coils 25A and 25a in one group, and to coils 35B and 35b in the other group, to travel primary magnetic member 22 along secondary magnetic member 21 by the one-phase exciting system.

In Fig. 4(a), the pulse current flows from point X to point Y corresponding to coils 25A and 25a. This causes a magnetomotive force in core 24 to generate a magnetic flux from -A-phase magnetic pole 24a to +A-phase magnetic pole 24A. In +A-phase magnetic pole 24A, the magnetic flux flows into the S-pole side of permanent magnet 26, and emerges from the N-pole side of permanent magnet 26, then flows into rectangular teeth 24c. This magnetic flux flows from rectangular teeth 24c to rectangular teeth 21a of secondary magnetic member 21, and also flows into secondary magnetic member 21 toward the side of -A-phase magnetic pole 24a as shown by the arrow direction; the flux then flows into the S-pole side of permanent magnet 26 through rectangular teeth 24c of -A-phase magnetic pole 24a, then emerges from the N-pole side of the permanent magnet 26, and then passes into the adjacent rectangular teeth 24c to return to the S-pole side of permanent magnet 26 of +A-phase magnetic pole 24A. This constitutes magnetic flux loop ϕ_1 . Accordingly, as long as the

pulse current flows in the coils wound around A-phase block 23, all rectangular teeth 24c can contribute to produce a magnetic thrust which is much stronger than in the conventional linear pulse motor.

In Fig. 4(b), the pulse current flows from point X to point Y corresponding to coils 35B and 35b. This causes a magnetomotive force in core 34 to generate a magnetic flux from -B-phase magnetic pole 34b to +B-phase magnetic pole 34B. Thus, this magnetic flux flows into the S-pole side of permanent magnet 26, and emerges from the N-pole side of permanent magnet 26, then flows into rectangular teeth 34c. This magnetic flux flows from rectangular teeth 34c to rectangular teeth 21a of secondary magnetic member 21, also flows into secondary magnetic member 21 toward the side of -B-phase magnetic pole 34b as shown by the arrow direction, then flows into the S-pole side of permanent magnet 26 of -B-phase pole 34b, and emerges from the N-pole side of permanent magnet 26, then into the adjacent rectangular teeth 34c to return to the S-pole side of permanent magnet 26 of +B-phase magnetic pole 34B. This constitutes magnetic flux loop ϕ_2 . Accordingly, all rectangular teeth 34c of core 34 can contribute to produce a magnetic thrust.

Similarly, in Fig. 4(c), the pulse current flows from point X to point Y corresponding to coils 25A and 25a in the opposite direction in contrast to the direction shown in Fig. 4(a). This constitutes magnetic flux loop ϕ_3 . As a result, all rectangular teeth 24c can contribute to produce a magnetic thrust.

In Fig. 4(d), the pulse current flows from point X to point Y corresponding to coils 35B and 35b in the opposite direction in contrast to the direction shown in Fig. 4(b). This constitutes magnetic flux loop ϕ_4 . The same result can be achieved as in the above operation.

Accordingly, by supplying the pulse current to the coils in the order of the parts seen in Fig. 4(a), Fig. 4(b), Fig. 4(c), Fig. 4(d), and Fig. 4(a), primary magnetic member 22 travels along secondary magnetic member 21, by a distance of P, toward the left in the drawing. While by supplying the pulse current to the coils in the order of Fig. 4(d), Fig. 4(c), Fig. 4(b), Fig. 4(a), and Fig. 4(d), primary magnetic member 22 travels along secondary magnetic member 21, by a distance of P, toward the right. In other words, changing the direction of the pulse current from A-phase block 23 to B-phase block 33, or vice versa, primary magnetic member 22 travels along secondary magnetic member 21 by a distance of P/4 in either direction depending on the direction of current flow.

Fig. 5 shows a second embodiment of the invention. This linear pulse motor has different types of primary magnetic member 22 and second-

dary magnetic member 21 compared with the first embodiment.

In upper side of secondary magnetic member 21, triple-row rectangular teeth 21b, 21a, and 21c are formed parallel to the longitudinal direction, and the longitudinal axis of respective rectangular teeth 21b, 21a, and 21c is directed to a direction transverse to the longitudinal direction, respectively. Each of the rectangular teeth 21b, 21a, and 21c is formed at a constant pitch, at a distance of P, in the longitudinal direction. In addition, each position of the rectangular teeth 21a in the middle row is shifted by a distance of P/2 with respect to that of both rectangular teeth 21b and 21c.

Primary magnetic member 22 comprises A-phase block 23 and B-phase block 34, both of which are connected by a connecting means.

Fig. 6 shows the details of A-phase block 23. A-phase block 23 comprises an E-shaped core 24 having three projecting portions 36, 37, and 38; each end surface of the projecting portions 36, 37, and 38 is faced to respective rectangular teeth 21b, 21a, and 21c, and each end surface of the projecting portions 36, 37, and 38 has grooves 42 in a perpendicular direction transverse to each end surface thereof; each permanent magnet 26 is inserted into respective grooves 42 so that each of the adjacent permanent magnets 26 is of an opposite polarity; and A-phase coil 25A wound around the middle projecting portion 37. Accordingly, the middle projecting portion 37 has magnetic poles 37a, 37b, 37c, and 37d for +A-phase, which are sectioned by permanent magnets 26 so that magnetic poles 37a, 37b, 37c, and 37d are formed at a constant pitch, at a distance of P/2, in the longitudinal direction, these magnetic poles are not shown in Fig. 6, but are described later by reference to Fig. 7. Similarly, projecting portion 36 has magnetic poles 36a, 36b, 36c, and 36d for -A-phase, which are formed at a constant pitch at a same distance as the above construction, while projecting portion 38 has magnetic poles 38a, 38b, 38c, and 38d for -A-phase, which are formed at a constant pitch as well, in the longitudinal direction.

In such a case, when magnetic poles 37a, 37b, 37c, and 37d are faced directly above rectangular teeth 21a, both groups of magnetic poles 36a, 36b, 36c, and 36d; and magnetic poles 38a, 38b, 38c, and 38d, are shifted by a distance of P/2 with respect to rectangular teeth 21a, as shown in Fig. 7. Fig. 7 is described later.

On the other hand, B-phase block 33 is of a similar construction to A-phase block 23. B-phase block 33 is therefore described briefly. B-phase block 33 comprises an E-shaped core 34 having three projecting portions 39, 40, and 41, these are faced to respective rectangular teeth 21b, 21a, and 21c, and have grooves 42; permanent magnets 26

inserted into respective grooves 42; and B-phase coil 35B wound around the middle projection portion 40. Accordingly, the middle projection portion 40 has magnetic poles 40a, 40b, 40c, and 40d for +B-phase, projecting portion 39 has magnetic poles 39a, 39b, 39c, and 39d for -B-phase, while projecting portion 41 has magnetic poles 41a, 41b, 41c, and 41d for -B-phase. Similarly, when magnetic poles 40a, 40b, 40c, and 40d are faced directly above rectangular teeth 21a, both groups of magnetic poles 39a, 39b, 39c, and 39d; and magnetic poles 41a, 41b, 41c, and 41d are shifted by a distance of $P/2$ with respect to rectangular teeth 21a.

According to the above construction, A-phase block 23 and B-phase block 33 are connected by a connecting means so that B-phase block 33 is shifted by a distance of $P/4$ with respect to A-phase block 23.

Fig. 7 shows that A-phase block 23 and B-phase block 33 are stationary with respect to secondary magnetic member 21, that is, both A-phase coil 25A and B-phase coil 35B are not energized at this time. In this case, most of the magnetic flux produced by permanent magnets 26 circulates in A-phase block 23 and B-phase block 33 as shown by the direction of the arrow having dotted lines, and a small amount of the magnetic flux circulates from A-phase block 23 and B-phase block 33 to rectangular teeth 21a, 21b, and 21c as shown by the direction of the arrow having a dashed lines.

The operation is described by reference to Fig. 8(a) to Fig. 8(d), in the case where the pulse current is supplied to either A-phase coil 25A or B-phase coil 35B to travel A-phase block 23 and B-phase block 33 along secondary magnetic member 21 by the one-phase exciting system.

Fig. 8(a) shows that magnetic poles 37a, 37b, 37c, and 37d are formed by projecting portion 37. In Fig. 8(a), the pulse current flows from point X to point Y corresponding to A-phase coil 25A. This causes a magnetomotive force in magnetic poles 37a, 37b, 37c, and 37d to generate a magnetic flux from magnetic poles 37a, 37b, 37c, and 37d for +A-phase to both groups of magnetic poles 36a, 36b, 36c, and 36d; and magnetic poles 38a, 38b, 38c, and 38d for -A-phase. This magnetic flux is circulated in A-phase block 23 through secondary magnetic member 21. The magnetic flux coming from rectangular teeth 21a flows into magnetic poles 37b and 37d, then into permanent magnets 26, emerges from permanent magnets 26, and then passes into magnetic poles 37a and 37c, and also into magnetic poles 36a(38a) and 36c(38c), while magnetic poles 37a and 37c; and magnetic poles 36b(38b) and 36d(38d) do not act against secondary magnetic member 21. Accordingly, the magnetic flux flows from rectangular teeth 21a to mag-

netic poles 37b and 37d, and also flows into the adjacent magnetic poles 37a and 37c through permanent magnets 26. This constitutes magnetic flux loop ϕ_1 which flows from magnetic poles 36a(38a) and 36c(38c) to rectangular teeth 21b(21c). As a result, when magnetic poles 37b and 37d are faced directly above rectangular teeth 21a, and magnetic poles 36a(38a) and 36c(38c) are faced directly above rectangular teeth 21b(21c), all magnetic poles can contribute to produce a magnetic thrust.

In Fig. 8(b), the pulse current flows from point X to point Y corresponding to B-phase coil 35B. This constitutes magnetic flux loop ϕ_2 in accordance with the similar flow of the magnetic flux which has already been described above. As a result, when magnetic poles 40b and 40d are faced directly above rectangular teeth 21a, and magnetic poles 39b(41b) and 39c(41c) are faced directly above rectangular teeth 21b(21c), all magnetic poles can contribute to produce a magnetic thrust.

In Fig. 8(c), the pulse current flows in A-phase coil 25A in the opposite direction in contrast to the direction shown in Fig. 8(a). This constitutes magnetic flux loop ϕ_3 . As a result, when magnetic poles 37a and 37c are faced directly above rectangular teeth 21a, and magnetic poles 36b(38b) and 36d(38d) are faced directly above rectangular teeth 21b(21c), all magnetic poles can contribute to produce a magnetic thrust.

Similarly, in Fig. 8(d), the pulse current flows in B-phase coil 35B in the opposite direction to the direction shown in Fig. 8(b). This constitutes magnetic flux loop ϕ_4 . As a result, when magnetic poles 40a and 40c are faced directly above rectangular teeth 21a, and magnetic poles 39b(41b) and 39d(41d) are faced directly above rectangular teeth 21b(21c), all magnetic poles can contribute to produce a magnetic thrust.

Accordingly, by supplying the pulse current to the coils in the order of the parts shown in Fig. 8(a), Fig. 8(b), Fig. 8(c), Fig. 8(d), and Fig. 8(a), primary magnetic member 22 travels along secondary magnetic member 21 by a distance of P in the right in the drawings. While supplying the pulse current to the coils in the order of the parts shown in Fig. 8(d), Fig. 8(c), Fig. 8(b), Fig. 8(a), and Fig. 8(d), primary magnetic member 22 travels along secondary magnetic member 21 by a distance of P to the left in the drawings.

Assuming that primary magnetic member 22 travels along secondary magnetic member 21 by the two-phase exciting system, the pulse current is supplied as shown in Fig. 8(a) through Fig. 8(d). That is, the pulse current flows from point X to point Y corresponding to A-phase coil 25A and B-phase coil 35B in the order of Fig. 9(a), Fig. 9(b), Fig. 9(c), and Fig. 9(d), and vice versa. In this case, the magnetic flux is simultaneously circulated in A-

phase block 23 and B-phase block 33 through secondary magnetic member 21 to produce a magnetic thrust, so that all magnetic poles can contribute to produce a magnetic thrust.

Fig. 10 and Fig. 11 show a third embodiment of the invention. This primary magnetic member 22 has a solid core 42, this core 42 also has the right rectangular solid type of +A-phase magnetic pole 24A having rectangular teeth 24C, -A-phase magnetic pole 24a having rectangular teeth 24C, +B-phase magnetic pole 34B having rectangular teeth 34C, and -B-phase magnetic pole 34b having rectangular teeth 34C, these rectangular teeth 24C and 34C are formed at a constant pitch, at a distance of $P/2$, in the longitudinal direction, respectively. These +A-phase magnetic pole 24A, -A-phase magnetic pole 24a, +B-phase magnetic pole 34B, and -B-phase magnetic pole 34b, are arranged in a square with one block being placed at each vertex of the square, and perpendicularly extended from core 42, and each end surface of these magnetic poles is faced to rectangular teeth 21a of secondary magnetic member 21. In addition, permanent magnets 26 are inserted into grooves formed between respective rectangular teeth 24C and 34C in the direction transverse to the longitudinal direction so that each of the adjacent permanent magnets 26 is of an opposite polarity. Coils 25A, 25a, 35B, and 35b are then wound around +A-phase magnetic pole 24A, -A-phase magnetic pole 24a, +B-phase magnetic pole 34B, and -B-phase magnetic pole 34b, respectively. Accordingly, primary magnetic member 22 has two groups, +A-phase magnetic pole 24A and -A-phase magnetic pole 24a for one group; and +B-phase magnetic pole 34B and -B-phase magnetic pole 34b for the other group.

Fig. 12 shows a fourth embodiment of the invention. This linear pulse motor is of a three-phase type. This primary magnetic member 22 is composed of a core 42 having A-phase magnetic pole 42A wound by coil 43A, B-phase magnetic pole 42B wound by coil 43B, and C-phase magnetic pole 42C wound by coil 43C in the longitudinal direction. A-phase magnetic pole 42A, B-phase magnetic pole 42B, and C-phase magnetic pole 42C have rectangular teeth 44a, 44b, and 44c formed in the direction transverse to the longitudinal direction, respectively. Permanent magnets 26 are also inserted into grooves in a similar manner to the previous embodiments.

Assuming that a reference line is set at the left edge of A-phase magnetic pole 42A, the left edge of B-phase magnetic pole 42B is positioned at a distance of $3P + P/3$ with respect to the reference line. The left edge of C-phase magnetic pole 42C is positioned at a distance of $6P + 2/3P$ with respect to the reference line. In other words, when rectan-

gular teeth 44a face directly above rectangular teeth 21a, rectangular teeth 44b are shifted by a distance of $P/3$ with respect to rectangular teeth 21a, and rectangular teeth 44c is shifted by a distance of $2xP/3$ with respect to rectangular teeth 21a.

Secondary magnetic member 21 has rectangular teeth 21a similar to those of the first embodiment as shown in Fig. 3.

The operation of this embodiment is described based on Figs. 13 and 14. When the pulse current is supplied to coil 43A for A-phase, coil 43B for B-phase, and coil 43C for C-phase, the polarity combination of magnetic poles 42A, 42B, and 42C is inverted at every reference pulses having constant time intervals $T1$ to $T6$ shown in Fig. 13. That is, this linear pulse motor is operated by the bipolar driving system which means two of the three-phases become a positive state at every other reference pulses.

Fig. 14 shows a thrust vector diagram for the magnetic thrust which is generated between magnetic poles 42A, 42B, and 42C; and rectangular teeth 21a. In this diagram, the term of "+A" represents a thrust vector produced by supplying a pulse current to coil 43A for A-phase in the positive direction, and the term of "-A" represents a thrust vector produced by supplying a pulse current to coil 43A in the negative direction. Similarly, the terms of "+B" and "+C" represent respective thrust vectors produced by supplying the pulse current to coil 43B for B-phase and coil 43C for C-phase in the positive direction, respectively. The terms of "-B" and "-C" represent respective thrust vectors caused by supplying the pulse current to coil 43B and coil 43C in the negative direction, respectively. Accordingly, Fig. 14 shows a thrust vector in the case that the pulse current is supplied to coil 43A for A-phase in the positive direction, and supplied to coil 43B for B-phase in the negative direction, and also supplied to coil 43C for C-phase in the negative direction during the time interval $T1$ as shown in Fig. 13, so that a magnetic thrust is composed of thrust vector +A, thrust vector -B, and thrust vector -C to act between primary magnetic member 22 and secondary magnetic member 21. Afterward, the pulse current is supplied to respective coils 43A, 43B, and 43C in the order of time intervals $T2$, $T3$, $T4$, $T5$, and $T6$, which changes the thrust vector in the order of $T2$, $T3$, $T4$, $T5$, and $T6$ as shown in Fig. 14. Thus, when the thrust vector changes in the order of $T1$, $T2$, $T3$, $T4$, $T5$, and $T6$, the primary magnetic member 22 travels along secondary magnetic member 21 in one direction, while if the thrust vector changes in the order of $T6$, $T5$, $T4$, $T3$, $T2$ and $T1$, primary magnetic member 22 travels in the other direction.

Figs. 15, 16, and 17 show a fifth embodiment of the invention. In this case, triple-row rectangular teeth 21a, 21b, and 21c are formed on secondary magnetic member 21 in the longitudinal direction. Each of the rectangular teeth 21a, 21b, and 21c is formed at constant spaced intervals in a direction transverse to the longitudinal direction, and also at constant pitch, at a distance of P , in the longitudinal direction. In addition, each position of the rectangular teeth 21a is shifted by a distance of $P/3$ with respect to that of rectangular teeth 21c, and each position of the rectangular teeth 21b is shifted by a distance of $P/3$ with respect to that of rectangular teeth 21a.

Primary magnetic member 22 is of construction similar to that which has been described in the fourth embodiment. That is, rectangular teeth 44a, rectangular teeth 44b, and rectangular teeth 44c are faced to rectangular teeth 21a, rectangular teeth 21b, and rectangular teeth 21c in a direction transverse to the longitudinal direction, respectively. Another construction of primary magnetic member 22 is identical with the one in the fourth embodiment.

Fig. 18 shows a sixth embodiment of the invention. In this embodiment, secondary magnetic member 21 is of a construction similar to that described in the fourth embodiment, therefore, primary magnetic member 22 is only described in this embodiment. This primary magnetic member 22 is composed of core 42 having six magnetic poles in the longitudinal direction; in the order of +A-phase magnetic pole 42A wound coil 43A, -C-phase magnetic pole 42c wound coil 43c, +B-phase magnetic pole 42B wound coil 43B, -A-phase magnetic pole 42a wound coil 43a, +C-phase magnetic pole 42C wound coil 43C, and -B-phase magnetic pole 42b wound coil 43b, these magnetic poles are arranged from the left to right in the drawing. In addition, two permanent magnets 26 are inserted into grooves of respective magnetic poles. In such the construction of primary magnetic member 22, -C-phase magnetic pole 42c is positioned at a distance of $3P + (1/6)P$ with respect to the reference line which is set at a vertical center line of +A-phase magnetic pole 42A. +B-phase magnetic pole 42B is positioned at a distance of $6P + (2/6)P$, -A-phase magnetic pole 42a is positioned at a distance of $9P + (3/6)P$, +C-phase magnetic pole 42C is positioned at a distance of $12P + (4/6)P$, and -B-phase magnetic pole 42b is positioned at a distance of $15P + (5/6)P$ with respect to the reference line, respectively.

Fig. 19 shows a seventh embodiment of the invention. This primary magnetic member 22 is a construction similar to that of the sixth embodiment as shown in Fig. 18. The only differences in the order above are that the magnetic pole arrange-

ment is in the order of +A-phase magnetic pole 42A, -A-phase magnetic pole 42a, +B-phase magnetic pole 42B, -B-phase magnetic pole 42b, +C-phase magnetic pole 42C, and -C-phase magnetic pole 42c, these are arranged from the left to right in the drawing, and three permanent magnets 26 are inserted into grooves for each of the magnetic poles.

According to the construction of primary magnetic member 22, +B-phase magnetic pole 42B is positioned at a distance of $6P + (1/3)P$ with respect to the reference line, and +C-phase magnetic pole 42C is positioned at a distance of $12P + (2/3)P$ with respect to the reference line. In addition, the group of +B-phase magnetic pole 42B and -B-phase magnetic pole 42b is shifted by a distance of $P/3$ with respect to the group of +A-phase magnetic pole 42A and -A-phase magnetic pole 42a, then the group of +C-phase magnetic pole 42C and -C-phase magnetic pole 42c is shifted by a distance of $P/3$ with respect to the group of +B-phase magnetic pole 42B and -B-phase magnetic pole 42b.

The operation is similar to the first embodiment, the only difference is that this linear pulse motor is operated by three-phase in this case.

Fig. 20 shows a eighth embodiment of the invention. The feature of the embodiment is that permanent magnet 26 is of a wedge-shaped type having shorter and longer sides, both of which are parallel to each other, and also, having opposite sides inclining toward each other when viewed in cross section thereof. Primary magnetic member 22 is composed of core 24 having +A-phase magnetic pole 24A wound by coil 25A, and having -A-phase magnetic pole 24a wound by coil 25a. Each of +A-phase magnetic pole 24A and -A-phase magnetic pole 24a has a trough-shaped grooves 24b and 34b, both of which are formed in the direction transverse to the longitudinal direction of primary magnetic member 22. Wedge-shaped permanent magnet 26 is then inserted into respective grooves 24b and 34b so that the shorter and inclining sides of permanent magnet 26 are contacted to the dead-end and inclining walls of grooves 24b and 34b, and the longer side thereof is faced to secondary magnetic member 21. Secondary magnetic member 21 has rectangular teeth 21a similar to the construction of the first embodiment. Such the wedge-shaped permanent magnet 26 can be used for all previous embodiments.

In this embodiment, when each of +A-phase magnetic pole 24A and -A-phase magnetic pole 24a moves close to rectangular teeth 21a and faces directly above rectangular teeth 21a, the magnetic force is strongly exerted between the magnetic poles and rectangular teeth 21a so that a leakage flux which does not contribute to produce

a magnetic thrust is a minimum.

Fig. 21 shows an ninth embodiment of the invention. This embodiment describes a disk-rotor type pulse motor. In the drawing, numeral 50 designates a housing, and numeral 51 designates a shaft which rotatably supports housing 50 through bearings 52 and 53. In housing 50, shaft 51 has disk-like rotor 54 of a back-to-back type. This rotor 54 is formed around the outer peripheral surface of annular member 55, and this annular member 55 is fixed to shaft 51 by key 56. In addition, the annular type of stators 61 are fixed to the inside walls of housing 50 so that both surfaces of rotor 54 face stators 61.

The details of rotor 54 are shown in Fig. 22. In both the outside lateral surfaces of rotor 54, rectangular teeth 58 and grooves 59 are formed with these alternating at constant pitch, at a distance of P , along a concentric circle whose radius is midway between the outer arc and inner arc of rectangular teeth 58, in which each radial axis of the rectangular teeth 58 is intersected at the concentric circle, and the sides of grooves 59 are disposed so as to lie on a line which describes a radial direction of rotor 54.

Fig. 23 shows a sectional view of rotor 54 having rectangular teeth 58 and grooves 59.

Fig. 24 shows the details of stators 61. Stators 61 comprises an annular type core 64; coils 68a to 68d wound around core 64 at constant intervals to form magnetic poles 67a to 67d, these magnetic poles 67a to 67d having segments 65 and grooves 66, formed at a constant pitch, at a distance of $P/2$, along a concentric circle whose radius is midway between the outer arc and inner arc of segments 65, in which each radial axis of the segments 65 is intersected at the concentric circle; and permanent magnets 60 are inserted into respective grooves 66 so that each of the adjacent permanent magnets 60 is of an opposite polarity, and segments 65 face rectangular teeth 58 of rotor 54.

Accordingly, when magnetic pole 67a faces rectangular teeth 58, for example, a magnetic flux flows into segments 65 through permanent magnets 60. This constitutes a magnetic flux to flow into rectangular teeth 58 of rotor 54. As a result, all magnetic poles can contribute to produce a magnetic thrust. This is a principle similar to that which is described in the first embodiment. In this case, the wedge-shaped permanent magnet which is shown in Fig. 20 can be used in this embodiment.

Fig. 25 shows a tenth embodiment of the invention. This pulse motor is of an outer-rotor type. In the drawing, numeral 70 designates a cylinder type outer rotor made of a magnetic material, and having rectangular teeth 71a along an inner peripheral surface thereof. These rectangular teeth 71a are formed at a constant pitch, at a distance of P ,

along the inner peripheral surface thereof, in which each surface of the rectangular teeth 71a is intersected at each radial axis of the rectangular teeth 71a.

Stator 74 comprises a circular type core 75 having rectangular teeth 72a and grooves 72b along an outer peripheral surface portion thereof, these rectangular teeth 72a are formed at a constant pitch, at a distance of $P/2$, along the outer peripheral surface of stator 74, in which each surface of the rectangular teeth 72a is intersected at each radial axis of the rectangular teeth 72a, and also has +A-phase magnetic pole 75A, +B-phase magnetic pole 75B, +C-phase magnetic pole 75C, -A-phase magnetic pole 75a, -B-phase magnetic pole 75b, and -C-phase magnetic pole 75c; coils 76A to 76C, and 76a to 76c wound around cores +A-phase magnetic pole 75A, +B-phase magnetic pole 75B, +C-phase magnetic pole 75C, -A-phase magnetic pole 75a, -B-phase magnetic pole 75b, and -C-phase magnetic pole 75c, respectively; and permanent magnets 72 inserted into grooves 72b so that each of the adjacent permanent magnets 72 is of an opposite polarity. This stator 74 is fixed to shaft 78. thus outer rotor 70 can rotate around stator 74.

When the magnetic poles formed between permanent magnets 72 face rectangular teeth 71a of outer rotor 70, in stator 74, a magnetic flux flows into the magnetic poles formed between permanent magnets 72 from the adjacent magnetic poles through permanent magnets 72. This constitutes a magnetic flux to flow into rectangular teeth 71a of outer rotor 70. As a result, all magnetic poles can contribute to produce a magnetic thrust such as the disk-rotor type pulse motor in the eighth embodiment. In this case, the wedge-shaped permanent magnet which is shown in Fig. 20 can be used in this embodiment.

Fig. 26 shows an eleventh embodiment of the invention. The feature of this embodiment is that permanent magnets are inserted into grooves formed by secondary magnetic member 21.

Similarly, the single-row of rectangular teeth 21a is formed in the longitudinal direction of secondary magnetic member 21. Each of the rectangular teeth 21a is formed at a constant pitch, at a distance of $P/2$, in the longitudinal direction, thus, grooves 26a are formed between rectangular teeth 21a. Permanent magnet 26 is then inserted into respective grooves 26a so that each of the adjacent permanent magnets 26 is of an opposite polarity.

On the other hand, primary magnetic member 22 comprises core 24 having +A-phase magnetic pole 24A, -A-phase magnetic pole 24a, +B-phase magnetic pole 34B, and -B-phase magnetic pole 34b. These magnetic poles are wound by coils

25A, 25a, 35B, and 35b, respectively. +A-phase magnetic pole 24A has rectangular teeth 24Aa and 24Ab, both of which are formed at a constant pitch, at a distance of P each other, and formed in a direction transverse to the longitudinal direction. Similarly, -A-phase magnetic pole 24a has rectangular teeth 24aa and 24ab, and +B-phase magnetic pole 34B has rectangular teeth 34Ba and 34ba, and -B-phase magnetic pole 34b has rectangular teeth 34ba and 34bb. These magnetic poles are faced to secondary magnetic member 21 at a constant distance G from the surface of secondary magnetic member 21.

In Fig. 26, all distances from the reference line are similar to the construction of the first embodiment.

Fig. 27 shows that primary magnetic member 22 is stationary in reference to secondary magnetic member 21 with the flow of magnetic flux between them. That is, when coils 25A, 25a, 35B, and 35b are not energized, magnetic flux loops are formed from the N-pole side of permanent magnets 26 to the S-pole side thereof, and also other magnetic flux loops are formed from rectangular teeth 21a arranged at the N-pole side of permanent magnets 26, to +A-phase magnetic pole 24A, -A-phase magnetic pole 24a, +B-phase magnetic pole 34B, and -B-phase magnetic pole 34b, then returned to rectangular teeth 21a arranged at the S-pole side of permanent magnets 26 through the rectangular teeth of primary magnetic member 22.

The operation is described by reference to Fig. 28(a) to Fig. 28(d).

In Fig. 28(a), the pulse current flows from point X to point Y corresponding to coils 25A and 25a. This causes a magnetomotive force from -A-phase magnetic pole 24a to +A-phase magnetic pole 24A to generate a magnetic flux. This magnetic flux flows from rectangular teeth 24Aa and 24Ab into rectangular teeth 21a arranged at the S-pole side of permanent magnets 26, and emerges from the N-pole side of permanent magnets 26, then flows to the S-pole side of permanent magnets 26 arranged at the side of rectangular teeth 24aa and 24ab, and also emerges from the N-pole side of permanent magnets 26, then flows into rectangular teeth 24aa and 24ab to return to the -A-phase magnetic pole 24a. This constitutes magnetic flux loop ϕ_1 . Accordingly, all rectangular teeth 24Aa, 24Ab, 24aa, and 24ab can contribute to produce a magnetic thrust.

In Fig. 28(b), the pulse current flows from point X to point Y corresponding to coils 35B and 35b. A magnetic flux is generated from -B-phase magnetic pole 34b to +B-phase magnetic pole 34B. This magnetic flux flows into rectangular teeth 21a arranged at the S-pole side of permanent magnets 26, and emerges from the N-pole side of perma-

nent magnets 26, then flows to the S-pole side of permanent magnets 26 arranged at the side of -B-phase magnetic pole 34b, and also emerges from the N-pole side of permanent magnets 26, then flows into rectangular teeth 34ba and 34bb to return to -B-phase magnetic pole 34b. This constitutes magnetic flux loop ϕ_2 . Accordingly, all rectangular teeth 34Ba, 34Bb, 34ba, and 34bb can contribute to produce a magnetic thrust.

Similarly, in Fig. 28(c), the pulse current flows in coils 25A and 25a in the opposite direction in contrast to the direction shown in Fig. 28(a), and in Fig. 28(d), the pulse current flows in coils 35B and 35b in the opposite direction in contrast to the direction shown in Fig. 28(b), which constitute magnetic flux loops ϕ_3 and ϕ_4 , respectively, to produce the magnetic thrust.

Assuming that the pulse current is supplied to the coils in the order of the parts in Fig. 28(a), Fig. 28(b), Fig. 28(c), Fig. 28(d), and Fig. 28(a), primary magnetic member 22 travels along secondary magnetic member 21, for a distance of P, toward the left in the drawing. While supplying the pulse current to the coils in the order of the parts in Fig. 28(d), Fig. 28(c), Fig. 28(b), Fig. 28(a), and Fig. 28(d), primary magnetic member 22 travels toward the right in the drawing.

Fig. 29 shows a twelfth embodiment of the invention. In this embodiment, secondary magnetic member 21 is of a similar construction as described in the tenth embodiment, therefore, only primary magnetic member 22 is described for the eleventh embodiment. This primary magnetic member 22 is of a three-phase type. This primary magnetic member 22 comprises core 42 having A-phase magnetic pole 42A wound by coil 43A, B-phase magnetic pole 42B wound by coil 43B, and C-phase magnetic pole 42C wound by coil 43C. A-phase magnetic pole 42A, B-phase magnetic pole 42B, and C-phase magnetic pole 42C have rectangular teeth 44a, 44b, and 44c, respectively. These rectangular teeth 44a, 44b, and 44c are formed at a constant pitch, at a distance of P, in the longitudinal direction. In addition, B-phase magnetic pole 42B is shifted by a distance of P/3 with respect to A-phase magnetic pole 42A, and C-phase magnetic pole 42C is shifted by a distance of P/3 with respect to B-phase magnetic pole 42B in the longitudinal direction. Thus, when rectangular teeth 44a are directly faced above rectangular teeth 21a, rectangular teeth 44b are shifted by a distance of P(1/3) with respect to rectangular teeth 21a, and rectangular teeth 44c are shifted by a distance of P(2/3) with respect to rectangular teeth 21a.

Accordingly, the pulse current is supplied to respective coils 43A, 43B, and 43C, primary magnetic member 22 travels along secondary magnetic member 21 in a manner similar to that which is

already described in reference to Fig. 13 and Fig. 14 in the fourth embodiment. In this case, all rectangular teeth 44a, 44b, and 44c can also contribute to produce a magnetic thrust.

Fig. 30 shows a thirteenth embodiment of the invention. The feature of the embodiment is that permanent magnet 26 is of a wedge-shaped type having shorter and longer sides, both of which are parallel to each other, and also having opposite sides inclining toward each other when viewed in cross section. Secondary magnetic member 21 has trough-shaped grooves 26a and rectangular teeth 21a, both of which are alternately formed in the direction transverse to the longitudinal direction thereof. Wedge-shaped permanent magnet 26 is then inserted into each groove 26a so that the shorter and inclining sides of permanent magnet 26 are contacted to the dead-end and inclining walls of grooves 26a, and the longer side thereof is faced to primary magnetic member 22. While primary magnetic member 22 is composed of core 24 having +A-phase magnetic pole 24A wound by coil 25A, which only shows a part of primary magnetic member 22.

In this embodiment, the magnetic force is strongly exerted between the magnetic poles and rectangular teeth 21a, which is the same operation described in the ninth embodiment.

Figs. 31 to 34 show a fourteenth embodiment of the invention. This invention is partially similar to the ninth embodiment, therefore, the same reference numerals indicates in Fig. 31 in case of the same constructions as shown in Figs. 21 to 24, and the feature of this invention is only described in this embodiment.

This pulse motor includes a disk-like rotor 54 of a back-to-back type. In rotor 54, magnetic annular member 57 has grooves 58a formed on both the lateral surfaces thereof, which are extended along the radial direction of rotor 54, permanent magnets 60 is then inserted into respective grooves 58a so that each of the adjacent permanent magnets 60 is of an opposite polarity.

In Fig. 33, segments 62 are formed with an outer arc longer than an inner arc, and at a constant pitch, at a distance of $P/2$, along a concentric circle whose radius is midway between an outer arc and inner arc of segments 62, so that each radial axis of the segments 62 is intersected at the concentric circle. The peripheral surface of segments 62 or magnetic annular member 57 is then covered by outer annular member 63.

Fig. 34 partially shows the details of stator 61. An annular type core 64 has rectangular teeth 65 and grooves 66a formed with these alternating at constant intervals and disposed in the radial direction. Each of rectangular teeth 65 is formed at a constant pitch, at a distance of P , along a concen-

tric circle whose radius is midway between an outer arc and inner arc of rectangular teeth 65, in which each radial axis of the rectangular teeth 65 is intersected at the concentric circle. This disk-rotor type pulse motor is of a similar operation as described by reference to Figs. 21 to 24 in the ninth embodiment. In this case, the wedge-shaped permanent magnet which is shown in Fig. 30 can be used in this embodiment.

Fig. 35 shows a fifteenth embodiment of the invention. This invention is partially similar to the tenth embodiment, therefore, the same reference numerals indicates in Fig. 35 in case of the same construction as shown in Fig. 25, and the feature of this invention is only described in this embodiment.

This pulse motor in this embodiment is of an outer-rotor type. Rotor 70 has rectangular teeth 70a and grooves 70b along an inner peripheral surface thereof. These rectangular teeth 70a are formed at a constant pitch, at a distance of $P/2$, along the inner peripheral surface thereof, in which each surface of the rectangular teeth 70a is intersected at each radial axis of the rectangular teeth 70a. Permanent magnets 72 are then inserted into respective grooves 70b so that each of the adjacent permanent magnets 72 is of an opposite polarity.

Stator 74 has rectangular teeth 71a along an outer peripheral surface thereof, these rectangular teeth 71a are formed at a constant pitch, at a distance of P , along the outer peripheral surface of stator 74, in which each surface of the rectangular teeth 71a is intersected at each radial axis of the rectangular teeth 71a. The operation of this outer-rotor type pulse motor is the similar principle of the tenth embodiment. In this case, the wedge-shaped permanent magnet which is shown in Fig. 30 can be used in this embodiment.

Fig. 36 shows another type of primary magnetic member 22. In this case, permanent magnets 26 are inserted into grooves 26a leaving a space at the most distal portion of grooves 26a. These spaces can be maintained as shown in the drawing, even non-magnetic material can be inserted into the spaces. Furthermore, among the grooves formed by the secondary magnetic member, a space can be left at the most distal portion, and again, non-magnetic material can be inserted into the spaces.

In all embodiments described in the above, the constant pitch between the adjacent facing portions lacking a permanent magnet is twice that of the constant pitch between the adjacent facing portions having the permanent magnets, but one constant pitch can be twice that of the other constant pitch, plus or minus thirty percent.

The preferred embodiment described herein is illustrative and onto restrictive; the scope of the invention is indicated by the appended claims and

all variations which fall within the claims are intended to be embraced therein.

Claims

1. A strong magnetic thrust force type actuator including:

a primary magnetic member (22) supported by a support means moving along a predetermined direction (M), the primary magnetic member generating a magnetic field from magnetic poles (24a,24A,34b,34B) thereof; and

a secondary magnetic member (21) having a plurality of facing portions (21a,21b,21c) facing the magnetic poles of the primary magnetic member, in which the facing portions are disposed at a constant pitch in the predetermined direction (M), thus moving the primary magnetic member (22) relative to the secondary magnetic member (21) when a magnetic field acts on the facing portions formed by the secondary magnetic member, wherein

the primary magnetic member (22) comprises:

a core member (24,34) having facing portions (24c,34c) and grooves (24b,34a) alternately disposed at a first constant pitch in the predetermined direction (M), these facing portions and grooves extending in a direction transverse to the predetermined direction;

a permanent magnet (26) inserted into respective said grooves (24b,34a) in a perpendicular direction from a facing surface of the facing portions so that each of the adjacent permanent magnets is of an opposite polarity; and

an insulated wire (25a,25A,35b,35B) wound around the core member (24,34) to form said magnetic pole (24a,24A,34b,34B), and wherein

the secondary magnetic member (21) comprises:

the said facing portions (21a,21b,21c) being faced to the facing portions (24c,34c) of the core member (24,34), the facing portions of the second magnetic member being disposed at a second constant pitch in the predetermined direction, the second constant pitch being about twice as large as the first constant pitch of the facing portions formed by the primary magnetic member.

2. A strong magnetic thrust force type actuator according to claim 1, wherein the facing portions (21a,21b,21c) of the second magnetic member are shifted by approximately thirty percent of the second constant pitch, with respect to the facing portions (24c,34c) of the core member (24,34).

3. A strong magnetic thrust force type actuator according to claim 1, wherein the permanent magnet (26) is inserted into respective grooves (26a) leaving a space at the most distal portion of the grooves.

4. A strong magnetic thrust force type actuator according to claim 3, wherein a non-magnetic material is inserted into the non-occupied space of the grooves (26a).

5. A strong magnetic thrust force type actuator according to claim 1, wherein two identical primary magnetic members (23,33) are connected by a connecting means at a predetermined distance therebetween in the predetermined direction (M).

6. A strong magnetic thrust force type actuator according to claim 1, wherein

the primary magnetic member (22) comprises:

the core member (24,34) having three projections (39,40,41) in the direction transverse to the predetermined direction (M), each projection having facing portions (36a,...d,39a,...d) and grooves alternately disposed at the first constant pitch in the predetermined direction; and

the insulated wire (25A,35B) wound around the middle projection (37) to form magnetic poles, and wherein

the secondary magnetic member (21) comprises:

triple-row facing portions (21a,21b,21c) faced to the facing portions of respective projections of the core member (24,34), in which each facing portion of the middle-row is shifted by 1/2 of the second constant pitch with respect to each facing portion of the other two rows in the predetermined direction (M).

7. A strong magnetic thrust force type actuator according to claim 6, wherein two identical primary magnetic member (23, 33) are connected by a connecting means at a predetermined distance therebetween in the predetermined direction (M).

8. A strong magnetic thrust force type actuator according to claim 1, wherein the primary magnetic member (22) comprises four identical primary magnetic members arranged in a square magnetic plate (42) with one primary magnetic member being placed at each vertex of the square magnetic plate.

all variations which fall within the claims are intended to be embraced therein.

Claims

1. A strong magnetic thrust force type actuator including:

a primary magnetic member (22) supported by a support means moving along a predetermined direction (M), the primary magnetic member generating a magnetic field from magnetic poles (24a,24A,34b,34B) thereof; and

a secondary magnetic member (21) having a plurality of facing portions (21a,21b,21c) facing the magnetic poles of the primary magnetic member, in which the facing portions are disposed at a constant pitch in the predetermined direction (M), thus moving the primary magnetic member (22) relative to the secondary magnetic member (21) when a magnetic field acts on the facing portions formed by the secondary magnetic member, wherein

the primary magnetic member (22) comprises:

a core member (24,34) having facing portions (24c,34c) and grooves (24b,34a) alternately disposed at a first constant pitch in the predetermined direction (M), these facing portions and grooves extending in a direction transverse to the predetermined direction;

a permanent magnet (26) inserted into respective said grooves (24b,34a) in a perpendicular direction from a facing surface of the facing portions so that each of the adjacent permanent magnets is of an opposite polarity; and

an insulated wire (25a,25A,35b,35B) wound around the core member (24,34) to form said magnetic pole (24a,24A,34b,34B), and wherein

the secondary magnetic member (21) comprises:

the said facing portions (21a,21b,21c) being faced to the facing portions (24c,34c) of the core member (24,34), the facing portions of the second magnetic member being disposed at a second constant pitch in the predetermined direction, the second constant pitch being about twice as large as the first constant pitch of the facing portions formed by the primary magnetic member.

2. A strong magnetic thrust force type actuator according to claim 1, wherein the facing portions (21a,21b,21c) of the second magnetic member are shifted by approximately thirty percent of the second constant pitch, with respect to the facing portions (24c,34c) of the core member (24,34).

3. A strong magnetic thrust force type actuator according to claim 1, wherein the permanent magnet (26) is inserted into respective grooves (26a) leaving a space at the most distal portion of the grooves.

4. A strong magnetic thrust force type actuator according to claim 3, wherein a non-magnetic material is inserted into the non-occupied space of the grooves (26a).

5. A strong magnetic thrust force type actuator according to claim 1, wherein two identical primary magnetic members (23,33) are connected by a connecting means at a predetermined distance therebetween in the predetermined direction (M).

6. A strong magnetic thrust force type actuator according to claim 1, wherein the primary magnetic member (22) comprises:

the core member (24,34) having three projections (39,40,41) in the direction transverse to the predetermined direction (M), each projection having facing portions (36a,...d,39a,...d) and grooves alternately disposed at the first constant pitch in the predetermined direction; and

the insulated wire (25A,35B) wound around the middle projection (37) to form magnetic poles, and wherein

the secondary magnetic member (21) comprises:

triple-row facing portions (21a,21b,21c) faced to the facing portions of respective projections of the core member (24,34), in which each facing portion of the middle-row is shifted by 1/2 of the second constant pitch with respect to each facing portion of the other two rows in the predetermined direction (M).

7. A strong magnetic thrust force type actuator according to claim 6, wherein two identical primary magnetic member (23, 33) are connected by a connecting means at a predetermined distance therebetween in the predetermined direction (M).

8. A strong magnetic thrust force type actuator according to claim 1, wherein the primary magnetic member (22) comprises four identical primary magnetic members arranged in a square magnetic plate (42) with one primary magnetic member being placed at each vertex of the square magnetic plate.



9. A strong magnetic thrust force type actuator according to claim 1, wherein the primary magnetic member (22) comprises:

the core member (24,34) having a plurality of projections (24a,24A, 34a,34A) in the predetermined direction, each projection having facing portions (24c,34c) and grooves (24b) alternately disposed at a first constant pitch in the predetermined direction; and

the insulated wire (25a,25A,35b,35B) wound around respective projections to form magnetic poles.

10. A strong magnetic thrust force type actuator according to claim 1, wherein

the primary magnetic member (22) comprises:

the core member (24,34) having three projections (39,40,41) in the direction transverse to the predetermined direction, each projection having facing portions (36a,...d,39a..d) and grooves alternately disposed at the first constant pitch in the predetermined direction; and

the insulated wire (25a,25A,35b,35B) wound around respective projections to form magnetic poles, wherein

the secondary magnetic member (21) comprises:

triple-row facing portions (21a,21b,21c) faced to the facing portions of respective projections of the core member (24,34), in which each facing portion of a second row is shifted by 1/3 of the second constant pitch with respect to each facing portion of a first row, and each facing portion of a third row is shifted by 1/3 of the second constant pitch with respect to each facing portion of the second row in the predetermined direction.

11. A strong magnetic thrust force type actuator according to claim 1 wherein

the primary magnetic member (50) comprises:

the annular core member (64) having facing portions (65) and grooves (66) alternately disposed at a first constant arc length along a circular lateral surface thereof, and the facing portions and grooves extended to a radial direction of the circular lateral surface thereof;

the permanent magnet (60) inserted into respective grooves (66) so that each of the adjacent permanent magnets is of the opposite polarity; and

a plurality of windings (68a,...d) disposed along a concentric circle of the circular lateral surface of the annular core member to form magnetic poles (67a,...d), and wherein

the secondary magnetic member (54)

comprises:

the facing portions (58) faced to the facing portions (65) of the annular core member, the facing portions of the secondary magnetic member being disposed at a second constant arc length along a circular lateral surface of the secondary magnetic member.

12. A strong magnetic thrust force type actuator according to claim 11, wherein the secondary magnetic member is of a back-to-back type rotor (54), one side of which faces one primary magnetic member (61), and the other side of which faces the other primary magnetic member (61), respectively, which rotates the secondary magnetic member by activating the primary magnetic member.

13. A strong magnetic thrust force type actuator according to claim 1, wherein

the primary magnetic member (74) comprises:

the annular core member (75) having facing portions (72a) and grooves (72b) alternately disposed at first constant arc length along an outer peripheral surface thereof;

the permanent magnet (72) inserted into respective grooves (72b) in a radial direction from a facing surface of the facing portion so that each of the adjacent permanent magnets is of the opposite polarity; and

a plurality of windings (76a,b,A,B) disposed along a concentric circle of the circular lateral surface of the annular core member to form magnetic poles (75a,75b,75c,75A,B,C) and wherein

the secondary magnetic member (70) comprises:

the facing portions (71a) faced to the facing portions of the annular core member, the facing portions of the secondary magnetic member being disposed at a second constant arc length along an inner peripheral surface of the secondary magnetic member,

whereby the secondary magnetic member is rotated by activating the primary magnetic member.

14. A strong magnetic thrust force type actuator according to claim 3, 5, 7, 8, 9, 10, 12, or 13, wherein the permanent magnet (26) is of a wedge-shaped plate type having shorter and longer sides, both of which are parallel to each other, and having opposite sides inclining toward each other in cross section, and the primary magnetic member (22) having a plurality of trough-shaped grooves, each of which is alternately formed in a direction transverse to



the predetermined direction thereof, whereby the permanent magnet is inserted into each trough-shaped groove so that the longer side of the permanent magnet faces the secondary magnetic member (21).

15. A strong magnetic thrust force type actuator including:

a primary magnetic member (22) supported by a support means moving along a predetermined direction (M), the primary magnetic member generating a magnetic field from magnetic poles (24a,24A, 34b,34B) poles thereof; and

a secondary magnetic member (21) having a plurality of facing portions (21a) facing the magnetic poles of the primary magnetic member, in which the facing portions are disposed at a constant pitch in the predetermined direction (M), thus moving the primary magnetic member (22) relative to the secondary magnetic member (21) when a magnetic field acts on the facing portions formed by the secondary magnetic member, wherein

the primary magnetic member (22) comprises:

a core member (24) having facing portions (24Aa,24Ab,24aa,24ab..) disposed at a first constant pitch in the predetermined direction, these facing portions being extended in a direction transverse to the predetermined direction; and

an insulated wire (25A,a,35B,b) wound around the core member to form a said magnetic pole (24A,a,34B,b) and wherein

the secondary magnetic member (21) comprises:

facing portions (21a) and grooved (26a) being faced to the facing portions of the core member, the facing portions and grooves of the second magnetic member being alternately disposed at a second constant pitch in the predetermined direction, and extended in a direction transverse to the predetermined direction;

a permanent magnet (26) inserted into respective said grooves (26a) in a perpendicular direction from each facing surface of the facing portions of the second magnetic member so that each of the adjacent permanent magnets is of an opposite polarity, in such a way that the first constant pitch is about twice as large as the second constant pitch of the facing portions formed by the secondary magnetic member.

16. A strong magnetic thrust force type actuator according to claim 15, wherein the facing por-

tions (24Aa) of the primary magnetic member (22) are shifted by approximately thirty percent of the first constant pitch, with respect to the facing portions (21a) of the secondary magnetic member (21).

17. A strong magnetic thrust force type actuator according to claim 15, wherein the permanent magnet (26) is inserted into respective grooves (26a) leaving a space at the most distal portion of the grooves.

18. A strong magnetic thrust force type actuator according to claim 17, wherein a non-magnetic material is inserted into a non-occupied space of the grooves (26a).

19. A strong magnetic thrust force type actuator according to claim 15, wherein the primary magnetic member (22) comprises:

the core member (24) having a plurality of projections in the predetermined direction, each projection having facing portions (24Aa,Ab,ab,Ba,Bb,ba) disposed at the first constant pitch in the predetermined direction; and

the insulated wire (25A,a,35B,b) wound around respective projections to form magnetic poles (24A,a,34B,b).

20. A strong magnetic thrust force type actuator according to claim 15, wherein

the primary magnetic member (22) comprises:

the core members (24) having three projections (44a,44b,44c) in the direction transverse to the predetermined direction, each projection having facing portions disposed at the first constant pitch in the predetermined direction, in which a second projection (44b) among the three projections is shifted by 1/3 of the first constant pitch with respect to a first projection (44a) in the predetermined direction, and a third projection (44c) among the three projections is shifted by 1/3 of the first constant pitch with respect to the second projection (44b) in the predetermined direction; and

the insulated wire (43A,43B,43C) wound around respective projections to form magnetic poles (42A,42B,42C).

21. A strong magnetic thrust force type actuator according to claim 15, wherein

the primary magnetic member (50) comprises:

the annular core member (64) having facing portions (65) disposed at a first constant arc length along a circular lateral surface there-



of; and

a plurality of windings (68a,...d) disposed along a concentric circle of the circular lateral surface of the annular core member to form magnetic poles, and wherein

the secondary magnetic member (57) comprises:

the facing portions (62) and grooves (58a) faced the facing portions (65) of the annular core member, the facing portions and grooves of the secondary magnetic member being alternately disposed at a second constant arc length along a circular lateral surface of the secondary magnetic member, and these facing portions and grooves being extended to a radial direction of the circular lateral surface of the secondary magnetic member; and

the permanent magnet (26) inserted into respective grooves (58a) so that each of the adjacent permanent magnets is of the opposite polarity.

22. A strong magnetic thrust force type actuator according to claim 21, wherein the secondary magnetic member (57) is of a back-to-back type rotor, one side of which faces one primary magnetic member (61), and the other side of which faces the other primary magnetic member (61), respectively, which rotates the secondary magnetic member by activating the primary magnetic member.

23. A strong magnetic thrust force type actuator according to claim 15, wherein

the primary magnetic member (74) comprises:

the annular core member (75) having facing portions (71a) disposed at a first constant arc length along an outer peripheral surface thereof; and

a plurality of windings (76a,b,c,A,B,C) disposed along a concentric circle of the circular lateral surface of the annular core member to form magnetic poles (75a,b,c,A,B,C) and wherein

the secondary magnetic member (70) comprises:

the facing portions (70a) and grooves (70b) faced to the facing portions (71a) of the annular core member, these facing portions and grooves being alternately disposed at a second constant arc length along an inner peripheral surface of the secondary magnetic member; and

the permanent magnet (72) inserted into respective grooves (70b) in a radial direction from a facing surface of the facing portion of the secondary magnetic member, so that each

of the adjacent permanent magnets is of the opposite polarity,

whereby the secondary magnetic member is rotated by activating the primary magnetic member.

24. A strong magnetic thrust force type actuator according to claim 17, 19, 20, 22, or 23, wherein the permanent magnet (26) is of a wedge-shaped plate type having shorter and longer sides, both of which are parallel to each other, and having opposite sides inclining toward each other in cross section thereof, and the secondary magnetic member (21) having a plurality of trough-shaped grooves, each of which is alternately formed in a direction transverse to the predetermined direction thereof, whereby the permanent magnet is inserted into each trough-shaped groove so that the longer side of the permanent magnet faces the primary magnetic member (22).

Patentansprüche

1. Ein Betätigungsgerät mit starker magnetischer Schiebekraft, das folgende Merkmale aufweist: ein erstes Magnetteil (22), das durch eine Trägereinrichtung getragen ist, das sich entlang einer vorgegebenen Richtung (M) bewegt, wobei das erste Magnetteil ein Magnetfeld von seinen Magnetpolen (24a,24A,34b,34B) ausgehend erzeugt; und ein zweites Magnetteil (21), das eine Vielzahl von gegenüberliegenden Bereichen (21a,21b,21c) aufweist, die den Magnetpolen des ersten Magnetteils gegenüberliegend ausgerichtet sind, wobei die gegenüberliegenden Bereiche mit einem konstanten Zwischenraum in einer vorgegebenen Richtung (M) angeordnet sind, wobei sich das erste Magnetteil (22) relativ zu dem zweiten Magnetteil (21) bewegt, wenn ein Magnetfeld auf die gegenüberliegenden Bereiche, die durch das zweite Magnetteil gebildet sind, einwirkt, wobei das erste Magnetteil (22) folgende Merkmale aufweist: ein Kernteil (24,34), das gegenüberliegende Bereiche (24c,34c) und Ausnehmungen (24b,34a) aufweist, die alternierend mit einem ersten konstanten Zwischenraum in der vorgegebenen Richtung (M) angeordnet sind, wobei diese gegenüberliegenden Bereiche und Ausnehmungen in einer Richtung transversal zu der vorgegebenen Richtung erstreckt sind; einen Permanentmagneten (26), der in entsprechende Ausnehmungen (24b,34a) in einer rechtwinkligen Richtung von einer gegenüberliegenden Fläche der gegenüberliegenden Be-



- reiche so eingesetzt ist, daß jeder der benachbarten Permanentmagnete von entgegengesetzter Polarität ist; und einen isolierten Draht (25a,25A,35b,35B), der um das Kernteil (24,34) gewickelt ist, um den Magnetpol (24a,24A,34b,34B) zu bilden, und wobei das zweite Magnetteil (21) folgende Merkmale aufweist:
- die gegenüberliegenden Bereiche (21a,21b,21c) sind zu den gegenüberliegenden Bereichen (24c,34c) des Kernteils (24,34) hin ausgerichtet, wobei die gegenüberliegenden Bereiche des zweiten Magnetteils mit einem zweiten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind, wobei der zweite konstante Zwischenraum zweimal so groß wie der erste konstante Zwischenraum der gegenüberliegenden Bereiche, die an dem ersten Magnetteil gebildet sind, ist.
2. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei die gegenüberliegenden Bereiche (21a,21b,21c) des zweiten Magnetteils um etwa dreißig Prozent des zweiten konstanten Zwischenraums in Bezug auf die gegenüberliegenden Bereiche (24c,34c) des Kernteils (24,34) verschoben werden.
 3. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei der Permanentmagnet (26) in die jeweiligen Ausnehmungen (26a) unter Belassung eines Zwischenraumes an dem am weitesten distalen Bereich der Ausnehmungen eingesetzt ist.
 4. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 3, wobei ein nicht-magnetisches Material in den nichtbelegten Zwischenraum der Ausnehmungen (26a) eingesetzt ist.
 5. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei zwei identische erste Magnetteile (23,33) über ein Verbindungsteil in einem vorgegebenen Abstand dazwischen in einer vorgegebenen Richtung (M) miteinander verbunden sind.
 6. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (22) folgende Merkmale aufweist: das Kernteil (24,34) besitzt drei Vorsprünge (39,40,41) in der Richtung transversal zu der vorgegebenen Richtung (M), wobei jeder Vorsprung gegenüberliegende Bereiche (36a,...d,39a,...d) und Ausnehmungen aufweist, die alternierend mit dem ersten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind; und wobei der isolierte Draht (25A,35B) um den mittleren Vorsprung (37) gewickelt ist, um magnetische Pole zu bilden, und wobei das zweite Magnetteil (21) folgende Merkmale aufweist: in drei Reihen angeordnete, gegenüberliegende Bereiche (21a,21b,21c), die zu den gegenüberliegenden Bereichen der jeweiligen Vorsprünge des Kernteils (24,34) hin ausgerichtet sind, in denen jeder gegenüberliegende Bereich der mittleren Reihe um 1/2 des zweiten konstanten Zwischenraums in Bezug auf jeden gegenüberliegenden Bereich der anderen zwei Reihen in der vorgegebenen Richtung (M) verschoben ist.
 7. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 8, wobei zwei identische erste Magnetteile (23,33) über eine Verbindungseinrichtung in einem vorgegebenen Abstand dazwischen in der vorgegebenen Richtung (M) miteinander verbunden sind.
 8. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (22) vier identische Magnetteile aufweist, die in einer quadratischen Magnetplatte (42) mit einem ersten magnetischen Teil, das an jeder Ecke der quadratischen Magnetplatte platziert ist, angeordnet sind.
 9. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (22) folgende Merkmale aufweist: das Kernteil (24,34) besitzt eine Vielzahl von Vorsprüngen (24a,24A,34a,34A) in der vorgegebenen Richtung, wobei jeder Vorsprung gegenüberliegende Bereiche (24c,34c) und Ausnehmungen (24b) besitzt, die alternierend mit einem ersten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind; und wobei der isolierte Draht (25a,25A,35b,35B) um entsprechende Vorsprünge gewickelt ist, um magnetische Pole zu bilden.
 10. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (22) folgende Merkmale aufweist: das Kernteil (24,34) besitzt drei Vorsprünge (39,40,41) in der Richtung transversal zu der vorgegebenen Richtung, wobei jeder Vorsprung gegenüberliegende Bereiche (36a,...d,39a,...d) und Ausnehmungen aufweist,



die alternierend mit dem ersten konstanten Zwischenraum der vorgegebenen Richtung angeordnet sind; und wobei der isolierte Draht (25a,25A,35b,35B) um entsprechende Vorsprünge gewickelt ist, um magnetische Pole zu bilden, wobei das zweite Magnetteil (21) folgende Merkmale aufweist:

in drei Reihen angeordnete, gegenüberliegende Bereiche (21a,21b,21c), die zu den gegenüberliegenden Bereichen der jeweiligen Vorsprünge des Kernteils (24,34) hin ausgerichtet sind, in denen jeder gegenüberliegende Bereich einer zweiten Reihe um 1/3 des zweiten konstanten Zwischenraums in Bezug auf jeden gegenüberliegenden Bereich einer ersten Reihe verschoben ist und jeder gegenüberliegende Bereich einer dritten Reihe um 1/3 des zweiten konstanten Zwischenraums in Bezug auf jeden gegenüberliegenden Bereich der zweiten Reihe in der vorgegebenen Richtung verschoben ist.

11. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (50) folgende Merkmale aufweist:

das ringförmige Kernteil (64), das gegenüberliegende Bereiche (65) und Ausnehmungen (66) aufweist, die alternierend mit einer ersten konstanten Bogenlänge entlang einer kreisförmigen, lateralen Oberfläche davon angeordnet sind, und wobei die gegenüberliegenden Bereiche und Ausnehmungen in einer radialen Richtung der kreisförmigen, lateralen Fläche davon erstreckt sind;

der Permanentmagnet (60) ist in die entsprechenden Ausnehmungen (66) so eingesetzt, daß jeder der benachbarten Permanentmagnete eine entgegengesetzte Polarität aufweist; und

eine Vielzahl von Windungen (68a,...d) ist entlang eines konzentrischen Kreises der kreisförmigen, lateralen Fläche des ringförmigen Kernteils angeordnet, um Magnetpole (67a,...d) zu bilden, und wobei

das zweite Magnetteil (54) folgende Merkmale aufweist:

die gegenüberliegenden Bereiche (58) sind zu den gegenüberliegenden Bereichen (65) des ringförmigen Kernteils hin ausgerichtet, wobei die gegenüberliegenden Bereiche des zweiten Magnetteils mit einer zweiten konstanten Bogenlänge entlang einer kreisförmigen, lateralen Fläche des zweiten Magnetteils angeordnet sind.

12. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 11, wobei das zweite Magnetteil ein Rotor (54) vom stegverbundenen Typ ist, wobei eine Seite davon einem ersten Magnetteil (61) gegenüberliegend angeordnet ist und die andere Seite davon dem anderen ersten Magnetteil (61) jeweils gegenüberliegend ausgerichtet ist, das das zweite Magnetteil bei Betätigung des ersten Magnetteils dreht.

13. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 1, wobei das erste Magnetteil (74) folgende Merkmale aufweist:

das ringförmige Kernteil (75), das gegenüberliegende Bereiche (72a) und (72b) und Ausnehmungen (72b) aufweist, die alternierend mit einer ersten konstanten Bogenlänge entlang der äußeren Umfangsfläche davon angeordnet sind;

der Permanentmagnet (72) ist in entsprechende Ausnehmungen (72b) in einer radialen Richtung von einer gegenüberliegenden Fläche des gegenüberliegenden Bereichs so eingesetzt, daß jeder der benachbarten Permanentmagnete von entgegengesetzter Polarität ist; und eine Vielzahl von Windungen (76a,b,A,B) sind entlang eines konzentrischen Kreises der kreisförmigen, lateralen Oberfläche des ringförmigen Kernteils angeordnet, um Magnetpole (75,75b,75c,75A,B,C) zu bilden, und wobei das zweite Magnetteil (70) folgende Merkmale aufweist:

die gegenüberliegenden Bereiche (71a) sind zu den gegenüberliegenden Bereichen des ringförmigen Kernteils hin ausgerichtet, die gegenüberliegenden Bereiche des zweiten magnetischen Teils sind mit einer zweiten konstanten Bogenlänge entlang einer inneren Umfangsfläche des zweiten Magnetteils gegenüberliegend ausgerichtet,

wobei das zweite Magnetteil durch Betätigung des ersten Magnetteils gedreht wird.

14. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 3, 5, 7, 8, 9, 10, 12 oder 13, wobei der Permanentmagnet (26) ein keilförmig geformter Plattentyp ist, der kürzere und längere Seiten aufweist, von denen beide parallel zueinander verlaufen, und der gegenüberliegende Seiten aufweist, die zueinander im Querschnitt geneigt sind, und wobei das erste Magnetteil (22) eine Vielzahl von trogförmig geformten Ausnehmungen aufweist, von denen jede alternierend in einer Richtung transversal zu der vorgegebenen Richtung davon gebildet ist, wobei der Permanentmagnet



in jede trogförmig geformte Ausnehmung so eingesetzt ist, daß die längere Seite des Permanentmagneten dem zweiten Magnetteil (21) gegenüberliegend ausgerichtet ist.

15. Ein Betätigungsgerät mit starker magnetischer Schiebekraft, das folgende Merkmale aufweist: ein erstes Magnetteil (22), das durch eine Trägereinrichtung getragen wird, die sich entlang einer vorgegebenen Richtung (M) bewegt, wobei das erste Magnetteil ein Magnetfeld von seinen Magnetpolen (24a,24A,34b,34B) ausgehend erzeugt; und ein zweites Magnetteil (21), das eine Vielzahl von gegenüberliegenden Bereichen (21a) aufweist, die zu den Magnetpolen des ersten Magnetteils gegenüberliegend ausgerichtet sind, in denen die gegenüberliegenden Bereiche mit einem konstanten Zwischenraum in der vorgegebenen Richtung (M) angeordnet sind, wodurch sie das erste Magnetteil (22) relativ zu dem zweiten Magnetteil (21) bewegen, wenn ein Magnetfeld auf die gegenüberliegenden Bereiche, die durch das zweite Magnetteil gebildet sind, wirkt, wobei das erste Magnetteil (22) folgende Merkmale aufweist:
- ein Kernteil (24), das gegenüberliegende Bereiche (24Aa,24Ab,24aa,24ab..) aufweist, die mit einem ersten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind, wobei diese gegenüberliegenden Bereiche in einer Richtung transversal zu der vorgegebenen Richtung erstreckt sind; und einen isolierten Draht (25A,a,35B,b), der um das Kernteil herum gewickelt ist, um den Magnetpol (24A,a,34B,b) zu bilden, und wobei das zweite Magnetteil (21) folgende Merkmal aufweist:
- gegenüberliegende Bereiche (21a) und Ausnehmungen (26a), die zu den gegenüberliegenden Bereichen des Kernteils hin ausgerichtet sind, wobei die gegenüberliegenden Bereiche und die Ausnehmungen des zweiten Magnetteils alternierend mit einem zweiten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind und in einer Richtung transversal zu der vorgegebenen Richtung erstreckt sind;
- einen Permanentmagneten (26), der in die entsprechenden Ausnehmungen (26a) in einer rechtwinkligen Richtung von jeder gegenüberliegenden Fläche der gegenüberliegenden Bereiche des zweiten Magnetteils eingesetzt ist, so daß jeder der benachbarten Permanentmagnete eine entgegengesetzte Polarität aufweist, wodurch der erste konstante Zwischenraum etwa zweimal so groß wie der zweite konstante

Zwischenraum der gegenüberliegenden Bereiche, die durch das zweite Magnetteil gebildet sind, ist.

16. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 15, wobei die gegenüberliegenden Bereiche (24A,a) des ersten Magnetteils (22) um etwa dreißig Prozent des ersten konstanten Zwischenraums verschoben werden in Bezug auf die gegenüberliegenden Bereiche (21a) des zweiten Magnetteils (21).
17. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 15, wobei der Permanentmagnet (26) in entsprechende Ausnehmungen (26a) eingesetzt ist, die einen Zwischenraum an dem am weitesten distalen Bereich der Ausnehmungen belassen.
18. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 17, wobei ein nichtmagnetisches Material in einen nichtbesetzten Zwischenraum der Ausnehmungen (26a) eingesetzt ist.
19. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 15, wobei das erste Magnetteil (22) folgende Merkmale aufweist:
- das Kernteil (24), das eine Vielzahl von Vorsprüngen in der vorgegebenen Richtung besitzt, wobei jeder Vorsprung gegenüberliegende Bereiche (24Aa,Ab,ab,Ba,Bb,ba) aufweist, die mit einem ersten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind; und den isolierten Draht (25A,a,35B,b), der um entsprechende Vorsprünge gewickelt ist, um Magnetpole (24A,a,34B,b) zu bilden.
20. Ein Betätigungsgerät mit starker magnetischer Schiebekraft gemäß Anspruch 15, wobei das erste Magnetteil (22) folgende Merkmale aufweist:
- das Kernteil (24), das drei Vorsprünge (44a,44b,44c) in der Richtung transversal zu der vorgegebenen Richtung besitzt, wobei jeder Vorsprung gegenüberliegende Bereiche aufweist, die mit dem ersten konstanten Zwischenraum in der vorgegebenen Richtung angeordnet sind, in dem ein zweiter Vorsprung (44b) von den drei Vorsprüngen um 1/3 des ersten konstanten Zwischenraums in Bezug auf einen ersten Vorsprung (44a) in der vorgegebenen Richtung verschoben ist, und ein dritter Zwischenraum (44c) von den drei Vorsprüngen um 1/3 des ersten konstanten Abstandes in Bezug auf den zweiten Vorsprung (44b) in der



vorgegebenen Richtung verschoben ist; und den isolierten Draht (43A,43B,43C), der um entsprechende Vorsprünge gewickelt ist, um Magnetpole (42A,42B,42C) zu bilden.

21. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 15, wobei das erste Magnetteil (50) folgende Merkmale aufweist:

ein ringförmiges Kernteil (64), das gegenüberliegende Bereiche (65) aufweist, die mit einer ersten konstanten Bogenlänge entlang einer kreisförmigen, lateralen Fläche davon angeordnet sind; und

eine Vielzahl von Windungen (68a,...d), die entlang eines konzentrischen Kreises der kreisförmigen, lateralen Oberfläche des ringförmigen Kernteils angeordnet sind, um Magnetpole zu bilden, und

wobei das zweite Magnetteil (57) folgende Merkmale aufweist:

die gegenüberliegenden Bereiche (62) und die Ausnehmungen (58a), die zu den gegenüberliegenden Bereichen (65) des ringförmigen Kernteils gegenüberliegend ausgerichtet sind, wobei die gegenüberliegenden Bereiche und die Ausnehmungen des zweiten magnetischen Teils alternierend mit einer zweiten konstanten Bogenlänge entlang einer kreisförmigen, lateralen Oberfläche des zweiten Magnetteils angeordnet sind und wobei diese gegenüberliegenden Bereiche und Ausnehmungen in eine radiale Richtung der kreisförmigen, lateralen Oberfläche des zweiten Magnetteils erstreckt sind; und

den Permanentmagneten (26), der in entsprechende Ausnehmungen (58a) so eingesetzt ist, daß jeder der benachbarte Permanentmagnete von entgegengesetzter Polarität ist.

22. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 21, wobei das zweite Magnetteil (57) von einem stegverbundenen Rotortyp ist, wobei eine Seite davon einem ersten Magnetteil (61) gegenüberliegend ausgerichtet ist und die andere Seite davon dem anderen ersten Magnetteil 61 jeweils gegenüberliegend ausgerichtet ist, die das zweite Magnetteil durch Wirkung des ersten Magnetteils dreht.

23. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 15, wobei das erste Magnetteil (74) folgende Merkmale aufweist:

das ringförmige Kernteil (75), das gegenüberliegende Bereiche (71a) aufweist, die mit einer ersten konstanten Bogenlänge entlang einer

äußeren Umfangsfläche davon angeordnet sind; und

eine Vielzahl von Windungen (76a,b,c,A,B,C), die entlang eines konzentrischen Kreises der kreisförmigen, lateralen Fläche des ringförmigen Kernteils angeordnet sind, um Magnetpole (75a,b,c,A,B,C) zu bilden, und wobei das zweite Magnetteil (70) folgende Merkmale aufweist:

die gegenüberliegenden Bereiche (70a) und Ausnehmungen (70b), die zu den gegenüberliegenden Bereichen (71a) des ringförmigen Kernteils ausgerichtet sind, wobei die gegenüberliegenden Bereiche und die Ausnehmungen alternierend mit einer zweiten konstanten Bogenlänge entlang einer inneren Oberfläche des zweiten Magnetteils angeordnet sind; und den Permanentmagneten (72), der in entsprechende Ausnehmungen (70b) in einer radialen Richtung von einer gegenüberliegenden Oberfläche des gegenüberliegenden Bereichs des zweiten Magnetteils hin ausgerichtet sind, so daß jeder der benachbarten Permanentmagnete von entgegengesetzter Polarität ist, wobei das zweite Magnetteil durch Betätigung des ersten Magnetteils gedreht wird.

24. Ein Betätigungsgerät mit starker magnetischer Schiebekraft nach Anspruch 17, 19, 20, 22 oder 23, wobei der Permanentmagnet (26) ein keilförmig geformter Plattentyp ist, der eine kürzere und eine längere Seite aufweist, die beide parallel zueinander verlaufen, und der gegenüberliegende Seiten aufweist, die zueinander im Querschnitt geneigt sind, und wobei das zweite Magnetteil (21) eine Vielzahl von trogförmig geformten Ausnehmungen aufweist, von denen jede alternierend in einer Richtung transversal zu der vorgegebenen Richtung gebildet ist, wobei der Permanentmagnet in jede trogförmige Ausnehmung so eingesetzt ist, daß die längere Seite des Permanentmagneten zu dem ersten Magnetteil (22) hin ausgerichtet ist.

Revendications

1. Actionneur à force de poussée magnétique élevée incluant :

- un organe magnétique primaire (22) supporté par des moyens de support, se déplaçant le long d'une direction prédéterminée (M), l'organe magnétique primaire engendrant un champ magnétique à partir de pôles magnétiques (24a,24A,34b,34B) de celui-ci; et
- un organe magnétique secondaire (21) ayant une pluralité de portions en vis-à-vis (21a,21b,21c) faisant face aux pôles



magnétiques de l'organe magnétique primaire, dans lequel les portions en vis-à-vis sont disposées avec un écartement constant dans la direction prédéterminée (M), faisant donc se déplacer l'organe magnétique primaire (22) par rapport à l'organe magnétique secondaire (21) lorsqu'un champ magnétique agit sur les portions en vis-à-vis formées par l'organe magnétique secondaire, dans lequel

l'organe magnétique primaire (22) comprend :

- un organe formant noyau (24,34) ayant des portions en vis-à-vis (24c,34c) et des rainures (24b,34a) disposées en alternance avec un premier écartement constant dans la direction prédéterminée (M), ces portions en vis-à-vis et ces rainures s'étendant dans une direction transversale par rapport à la direction prédéterminée;
- des aimants permanents (26) insérés dans lesdites rainures respectives (24b,34a) dans une direction perpendiculaire à partir de chaque surface en vis-à-vis des portions en vis-à-vis, de telle sorte que chacun des aimants permanents adjacents a une polarité opposée; et
- un fil isolé (25a,25A,35b,35B) enroulé autour de l'organe formant noyau (24,34) pour former ledit pôle magnétique (24a,24A,34b,34B), et dans lequel

l'organe magnétique secondaire (21) comprend :

- lesdites portions en vis-à-vis (21a,21b,21c) faisant face aux portions en vis-à-vis (24c,34c) de l'organe formant noyau (24,34), les portions en vis-à-vis de l'organe magnétique secondaire étant disposées avec un deuxième écartement constant dans la direction prédéterminée, le deuxième écartement constant valant environ le double du premier écartement constant des portions en vis-à-vis formées par l'organe magnétique primaire.

2. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel les portions en vis-à-vis (21a,21b,21c) de l'organe magnétique secondaire sont décalées d'approximativement trente pour cent du deuxième écartement constant, par rapport aux portions en vis-à-vis (24c,34c) de l'organe formant noyau (24,34).

3. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel les aimants permanents (26) sont insérés dans les rainures respectives (26a), laissant un espace au niveau de la portion la plus distale des rainures.

4. Actionneur à force de poussée magnétique élevée selon la revendication 3, dans lequel un matériau non magnétique est inséré dans l'espace non occupé des cannelures (26a).

5. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel deux organes magnétiques primaires (23,33) identiques sont connectés par des moyens de connexion avec une distance prédéterminée entre eux dans la direction prédéterminée (M).

6. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (22) comprend :

- l'organe formant noyau (24,34) ayant trois projections (39,40,41) dans la direction transversale par rapport à la direction prédéterminée (M), chaque projection ayant des portions en vis-à-vis (38a-d,39a-d) et des rainures disposées en alternance avec le premier écartement constant dans la direction prédéterminée; et
- le fil isolé (25A,35B) enroulé autour de la projection du milieu (37) pour former des pôles magnétiques, et dans lequel

l'organe magnétique secondaire (21) comprend :

- des portions en vis-à-vis (21a,21b,21c) formant une triple rangée, faisant face aux portions en vis-à-vis des projections respectives de l'organe formant noyau (24,34) dans lequel chaque portion en vis-à-vis de la rangée du milieu est décalée de la moitié du deuxième écartement constant par rapport à chaque portion en vis-à-vis des deux autres rangées dans la direction prédéterminée (M).

7. Actionneur à force de poussée magnétique élevée selon la revendication 6, dans lequel deux organes magnétiques primaires (23,33) identiques sont connectés par des moyens de connexion avec une distance prédéterminée entre eux dans la direction prédéterminée (M).

8. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (22) comprend



quatre organes magnétiques primaires identiques arrangés dans une plaque magnétique carrée (42), un organe magnétique primaire étant placé dans chaque angle de la plaque magnétique carrée.

9. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (22) comprend :

- l'organe formant noyau (24,34) ayant une pluralité de projections (24a,24A,34a,34A) dans la direction prédéterminée, chaque projection ayant des portions en vis-à-vis (24c,34c) et des rainures (24b) disposées en alternance avec un premier écartement constant dans la direction prédéterminée; et
- le fil isolé (25a,25A,35b,35B) enroulé autour des projections respectives pour former des pôles magnétiques.

10. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (22) comprend :

- l'organe formant noyau (24,34) ayant trois projections (39,40,41) dans la direction transversale par rapport à la direction prédéterminée, chaque projection ayant des portions en vis-à-vis (38a-d,39a-d) et des cannelures disposées en alternance avec le premier écartement constant dans la direction prédéterminée; et
- le fil isolé (25a,25A,35b,35B) enroulé autour des projections respectives pour former des pôles magnétiques, et dans lequel

l'organe magnétique secondaire (21) comprend :

- des portions en vis-à-vis (21a,21b,21c) formant une triple rangée, faisant face aux portions en vis-à-vis des projections respectives de l'organe formant noyau (24,34) dans lequel chaque portion en vis-à-vis d'une deuxième rangée est décalée du tiers du deuxième écartement constant par rapport à chaque portion en vis-à-vis d'une première rangée, et chaque portion en vis-à-vis d'une troisième rangée est décalée du tiers du deuxième écartement constant par rapport à chaque portion en vis-à-vis de la deuxième rangée, dans la direction prédéterminée.

11. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (50) com-

prend :

- l'organe formant noyau annulaire (64) ayant des portions en vis-à-vis (65) et des rainures (66) disposées en alternance avec une première longueur d'arc constante le long d'une surface latérale circulaire de celui-ci, ces portions en vis-à-vis et ces rainures s'étendant dans une direction radiale par rapport à sa surface latérale circulaire;
- les aimants permanents (60) insérés dans les respectives (66) de telle sorte que chacun des aimants permanents adjacents a une polarité opposée; et
- une pluralité d'enroulements (68a-d), disposés le long d'un cercle concentrique de la surface latérale circulaire de l'organe formant noyau annulaire, pour former des pôles magnétiques (67a-d), et dans lequel

l'organe magnétique secondaire (54) comprend :

- les portions en vis-à-vis (58) faisant face aux portions en vis-à-vis (65) de l'organe formant noyau annulaire, les portions en vis-à-vis de l'organe magnétique secondaire étant disposées avec une deuxième longueur d'arc constante le long d'une surface latérale circulaire de l'organe magnétique secondaire.

12. Actionneur à force de poussée magnétique élevée selon la revendication 11, dans lequel l'organe magnétique secondaire est un rotor à opposition (54), un côté de celui-ci faisant face à un organe magnétique primaire (61), l'autre côté de celui-ci faisant face à l'autre organe magnétique primaire (61), respectivement, ce qui fait tourner l'organe magnétique secondaire par l'activation de l'organe magnétique primaire.

13. Actionneur à force de poussée magnétique élevée selon la revendication 1, dans lequel l'organe magnétique primaire (74) comprend :

- l'organe formant noyau annulaire (75) ayant des portions en vis-à-vis (72a) et des rainures (72b) disposées en alternance avec une première longueur d'arc constante le long d'une surface périphérique extérieure de celui-ci;
- les aimants permanents (72) insérés dans les rainures respectives (72b) dans une direction radiale à partir d'une surface en vis-à-vis de la portion en vis-à-vis de telle sorte que chacun des aimants permanents adjacents a une polarité op-



- posée; et
- une pluralité d'enroulements (76a,b,A,B), disposés le long d'un cercle concentrique de la surface latérale circulaire de l'organe formant noyau annulaire, pour former des pôles magnétiques (75a,75b,75c,75A,75B,75C), et dans lequel l'organe magnétique secondaire (70) comprend :
 - les portions en vis-à-vis (71a) faisant face aux portions en vis-à-vis de l'organe formant noyau annulaire, les portions en vis-à-vis de l'organe magnétique secondaire étant disposées avec une deuxième longueur d'arc constante le long d'une surface périphérique intérieure de l'organe magnétique secondaire, de telle sorte que l'organe magnétique secondaire tourne par l'activation de l'organe magnétique primaire.
14. Actionneur à force de poussée magnétique élevée selon la revendication 3, 5, 7, 8, 9, 10, 12 ou 13, dans lequel l'aimant permanent (26) est une plaque en forme de coin ayant un côté plus court et un côté plus long, tous deux étant parallèles l'un à l'autre, ayant des côtés opposés inclinés l'un vers l'autre en coupe transversale, et l'organe magnétique primaire (22) ayant une pluralité de rainures en forme d'auge, chacune d'elles étant formée en alternance dans une direction transversale par rapport à la direction prédéterminée de cet organe, de telle sorte que les aimants permanents sont insérés dans chaque rainure en forme d'auge de sorte que le côté le plus long de l'aimant permanent fait face à l'organe magnétique secondaire (21).
15. Actionneur à force de poussée magnétique élevée incluant :
 - un organe magnétique primaire (22) supporté par des moyens de support, se déplaçant le long d'une direction prédéterminée (M), l'organe magnétique primaire engendrant un champ magnétique à partir de pôles magnétiques (24a,24A,34b,34B) de celui-ci; et
 - un organe magnétique secondaire (21) ayant une pluralité de portions en vis-à-vis (21a) faisant face aux pôles magnétiques de l'organe magnétique primaire, dans lequel les portions en vis-à-vis sont disposées avec un écartement constant dans la direction prédéterminée (M), faisant donc se déplacer l'organe magnétique primaire (22) par rapport à l'organe magnétique secondaire (21) lorsqu'un champ magnétique agit sur les portions en vis-à-vis formées par l'organe magnétique secondaire, dans lequel l'organe magnétique primaire (22) comprend :
 - un organe formant noyau (24) ayant des portions en vis-à-vis (24Aa,24Ab,24aa,24ab,...) disposées avec un premier écartement constant dans la direction prédéterminée, ces portions en vis-à-vis s'étendant dans une direction transversale par rapport à la direction prédéterminée; et
 - un fil isolé (25A-a,35B-b) enroulé autour de l'organe formant noyau, pour former ledit pôle magnétique (24A-a,34B-b), et dans lequel l'organe magnétique secondaire (21) comprend :
 - des portions en vis-à-vis (21a) et des rainures (26a) faisant face aux portions en vis-à-vis de l'organe formant noyau, les portions en vis-à-vis et les rainures de l'organe magnétique secondaire étant disposées en alternance avec un deuxième écartement constant dans la direction prédéterminée, s'étendant dans une direction transversale par rapport à la direction prédéterminée;
 - des aimants permanents (26) insérés dans lesdites rainures respectives (26a) dans une direction perpendiculaire à partir de chaque surface en vis-à-vis des portions en vis-à-vis de l'organe magnétique secondaire, de telle sorte que chacun des aimants permanents adjacents a une polarité opposée, d'une manière telle que le premier écartement constant vaut environ le double du deuxième écartement constant des portions en vis-à-vis formées par l'organe magnétique secondaire.

16. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel les portions en vis-à-vis (24Aa,...) de l'organe magnétique primaire (22) sont décalées d'approximativement trente pour cent du premier écartement constant, par rapport aux portions en vis-à-vis (21a) de l'organe magnétique secondaire (21).

17. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel les aimants permanents (26) sont insérés dans les rainures respectives (26a), laissant un espace au niveau de la portion la plus distale des



rainures.

18. Actionneur à force de poussée magnétique élevée selon la revendication 17, dans lequel un matériau non magnétique est inséré dans l'espace non occupé des rainures (26a).

19. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel l'organe magnétique primaire (22) comprend :

- l'organe formant noyau (24) ayant une pluralité de projections dans la direction prédéterminée, chaque projection ayant des portions en vis-à-vis (24Aa-Ab-ab, Ba-Bb-Ba) disposées avec un premier écartement constant dans la direction prédéterminée; et
- le fil isolé (25A-a, 35B-b) enroulé autour des projections respectives pour former des pôles magnétiques (24A-a, 34B-b).

20. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel l'organe magnétique primaire (22) comprend :

- l'organe formant noyau (24) ayant trois projections (44a, 44b, 44c) dans la direction transversale par rapport à la direction prédéterminée, chaque projection ayant des portions en vis-à-vis disposées avec le premier écartement constant dans la direction prédéterminée, dans lequel une deuxième projection (44b) parmi les trois projections est décalée du tiers du premier écartement constant par rapport à une première projection (44a) dans la direction prédéterminée, et une troisième projection (44c) parmi les trois projections est décalée du tiers du premier écartement constant par rapport à la deuxième projection (44b) dans la direction prédéterminée; et
- le fil isolé (43A, 43B, 43C) enroulé autour des projections respectives pour former des pôles magnétiques (42A, 42B, 42C).

21. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel l'organe magnétique primaire (50) comprend :

- l'organe formant noyau annulaire (64) ayant des portions en vis-à-vis (65) disposées avec une première longueur d'arc constante le long d'une surface latérale circulaire de celui-ci; et
- une pluralité d'enroulements (68a-d), disposés le long d'un cercle concentrique de la surface latérale circulaire de l'orga-

ne formant noyau annulaire, pour former des pôles magnétiques, et dans lequel

l'organe magnétique secondaire (57) comprend :

- les portions en vis-à-vis (62) et les rainures (58a) faisant face aux portions en vis-à-vis (65) de l'organe formant noyau annulaire, les portions en vis-à-vis et les rainures de l'organe magnétique secondaire étant disposées en alternance avec une deuxième longueur d'arc constante le long d'une surface latérale circulaire de l'organe magnétique secondaire, ces portions en vis-à-vis et ces rainures s'étendant dans une direction radiale par rapport à la surface latérale circulaire de l'organe magnétique secondaire; et
- les aimants permanents (26) insérés dans les rainures respectives (58a) de telle sorte que chacun des aimants permanents adjacents a une polarité opposée.

22. Actionneur à force de poussée magnétique élevée selon la revendication 21, dans lequel l'organe magnétique secondaire (57) est un rotor à opposition, un côté de celui-ci faisant face à un organe magnétique primaire (61), l'autre côté de celui-ci faisant face à l'autre organe magnétique primaire (61), respectivement, ce qui fait tourner l'organe magnétique secondaire par l'activation de l'organe magnétique primaire.

23. Actionneur à force de poussée magnétique élevée selon la revendication 15, dans lequel l'organe magnétique primaire (74) comprend :

- l'organe formant noyau annulaire (75) ayant des portions en vis-à-vis (71a) disposées avec une première longueur d'arc constante le long d'une surface périphérique extérieure de celui-ci; et
- une pluralité d'enroulements (76a, b, c, A, B, C), disposés le long d'un cercle concentrique de la surface latérale circulaire de l'organe formant noyau annulaire, pour former des pôles magnétiques (75a, b, c, A, B, C), et dans lequel l'organe magnétique secondaire (70) comprend :
- les portions en vis-à-vis (70a) et les rainures (70b) faisant face aux portions en vis-à-vis (71a) de l'organe formant noyau annulaire, ces portions en vis-à-vis et ces rainures étant disposées en alternance avec une deuxième longueur d'arc constante le long de la surface périphéri-



que intérieure de l'organe magnétique secondaire; et

- les aimants permanents (72) insérés dans les rainures respectives (70b) dans une direction radiale à partir d'une surface en vis-à-vis de la portion en vis-à-vis de l'organe magnétique secondaire, de telle sorte que chacun des aimants permanents adjacents a une polarité opposée,

de telle sorte que l'organe magnétique secondaire tourne par l'activation de l'organe magnétique primaire.

24. Actionneur à force de poussée magnétique élevée selon la revendication 17, 19, 20, 22 ou 23, dans lequel l'aimant permanent (26) est une plaque en forme de coin ayant un côté plus court et un côté plus long, tous deux étant parallèles l'un à l'autre, ayant des côtés opposés inclinés l'un vers l'autre dans sa coupe transversale, et l'organe magnétique secondaire (21) ayant une pluralité de rainures en forme d'auge, chacune d'elles étant formée en alternance dans une direction transversale par rapport à la direction prédéterminée de cet organe, de telle sorte que les aimants permanents sont insérés dans chaque rainure en forme d'auge de sorte que le côté le plus long de l'aimant permanent fait face à l'organe magnétique primaire (22).

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