[54] **DEVICE FOR PRODUCING A ROTATING MOVEMENT BY MEANS OF AT LEAST ONE PULSATING DRIVING FORCE**

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[51] **Int. Cl.**.......................... **H02k 7/10,** H02k 7/06

[58] **Field of Search**................................ 310/80, 82

[56] **References Cited**

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Primary Examiner—J. D. Miller
Assistant Examiner—Robert J. Hickey
Attorney, Agent, or Firm—Dwight H. Smiley, Imirie and Smiley

[57] **ABSTRACT**

A device for producing a rotating movement by means of at least one pulsating or alternating driving force acting on a displaceable element such as a tumbler disc or wobble disc for imparting to this element a motion such that a track of this element rolls along a track of another element, a slow differential rotating movement between such elements being thereby produced due to a difference in length of the tracks on the elements. The tracks may be toothed rims meshing with each other. The device is particularly usefull in synchronous motors, wherein the pulsating driving force is produced by means of an exciting coil connected to an alternating current source.

18 Claims, 14 Drawing Figures

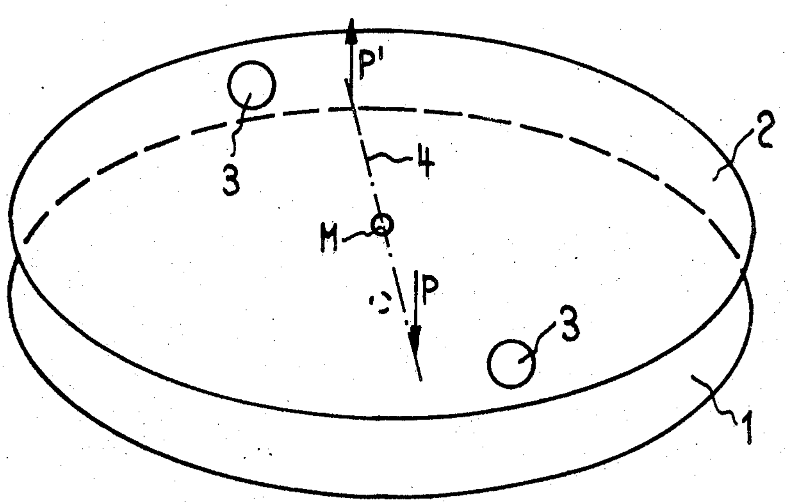


FIG.1

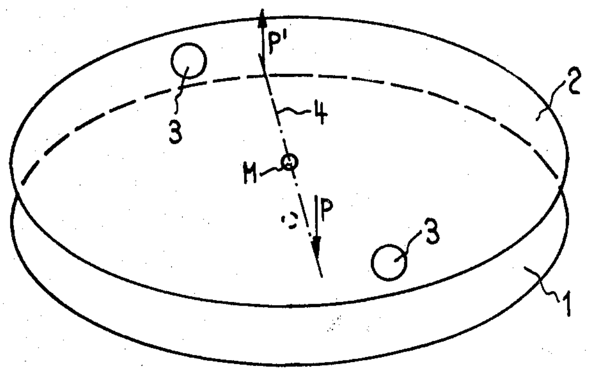


FIG.2

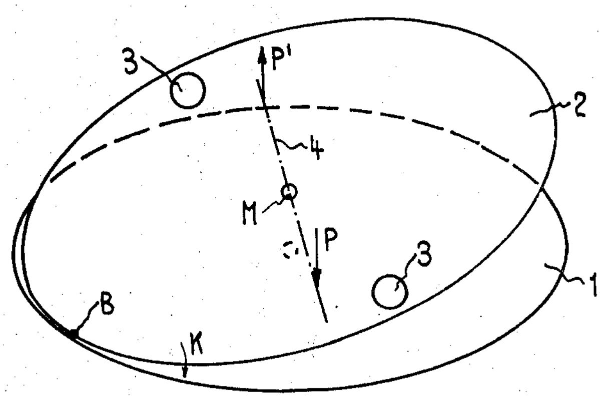


FIG.3

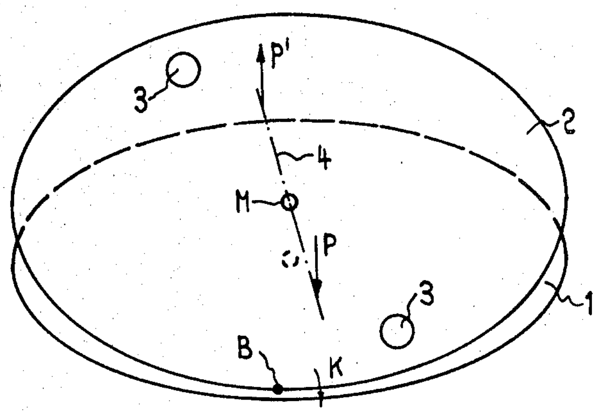


FIG.7

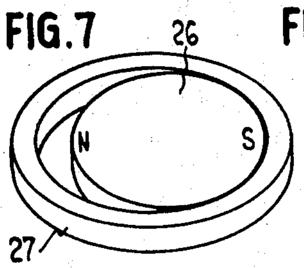


FIG.8

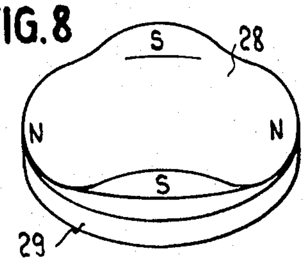


FIG.9

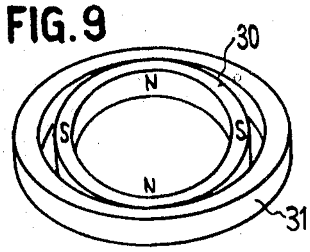


FIG. 4

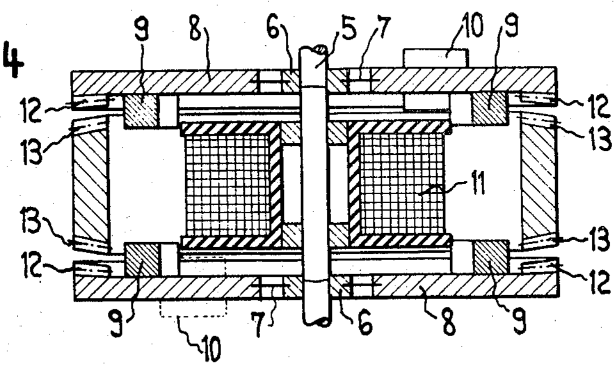


FIG. 5

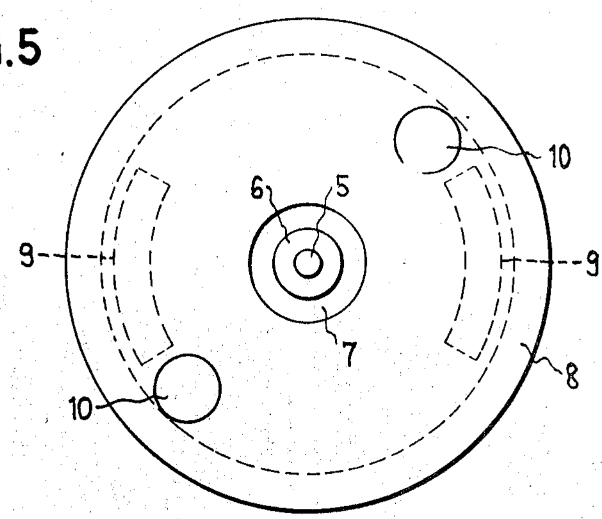


FIG. 6

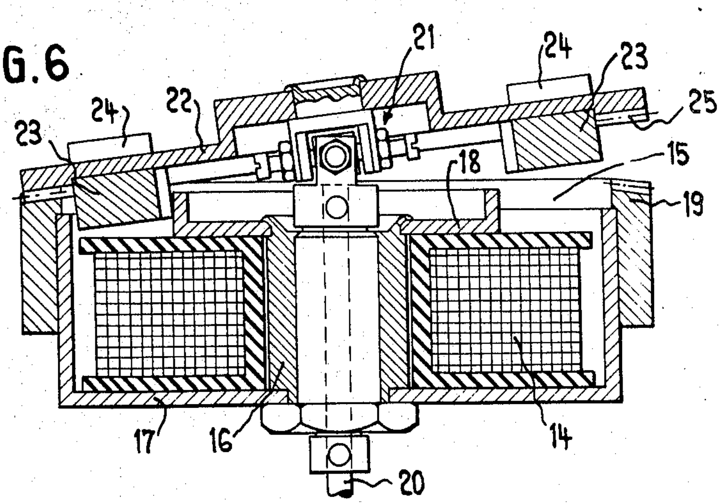


FIG. 10

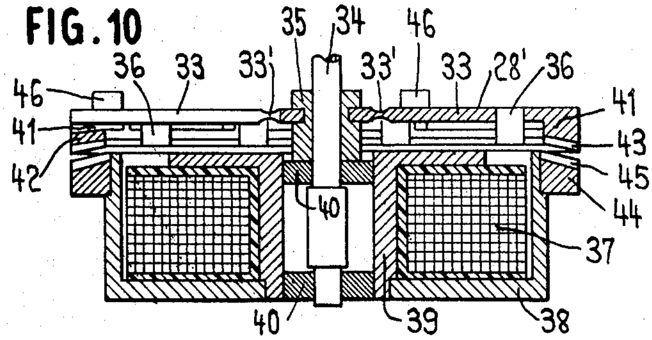


FIG. 11

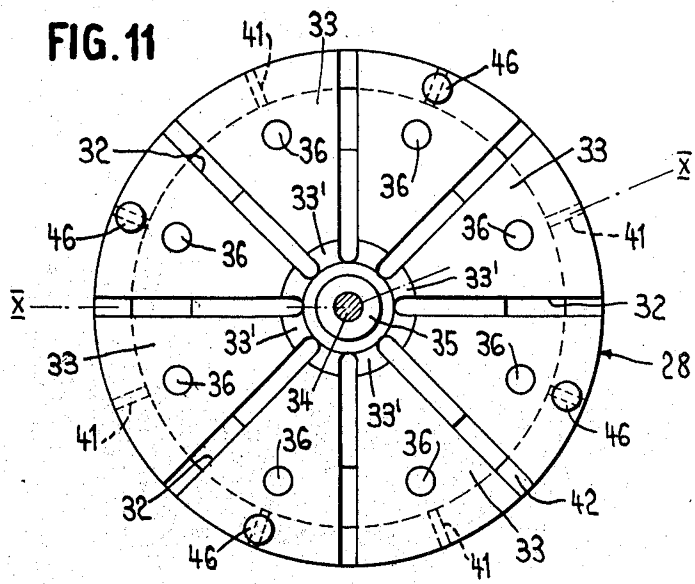


FIG. 12

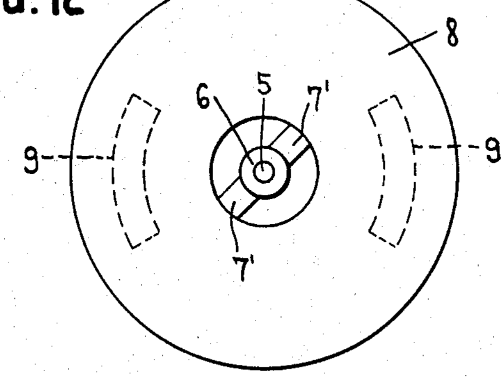


FIG. 13

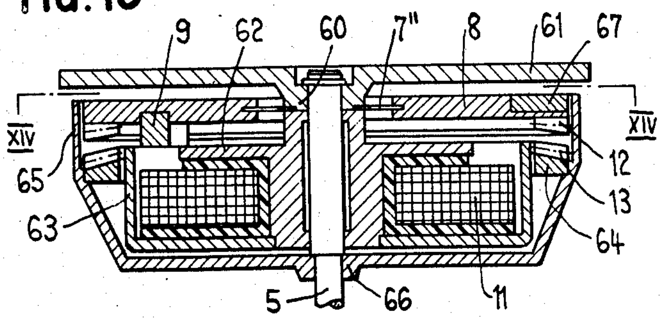
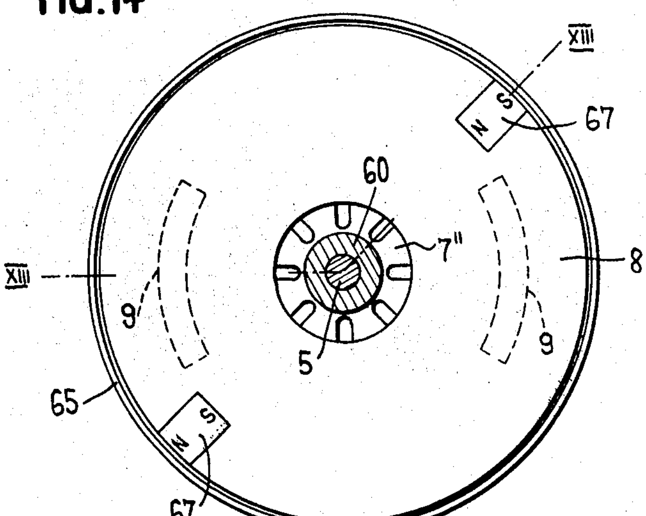

9
62
60
7"
8
61
67
XIV
XIV
65
12
13
63
64
5
66
11

FIG. 14


XIII
67
N
S
60
7"
8
XIII
9
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65
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S
67

DEVICE FOR PRODUCING A ROTATING MOVEMENT BY MEANS OF AT LEAST ONE PULSATING DRIVING FORCE

BACKGROUND OF THE INVENTION

This invention relates to a device for transforming a pulsating or alternating driving force into a rotating movement. The problem of transforming reciprocating movement into rotating movement is usually solved by means of crank shafts for high power rating or by means of pawls acting onto a ratchet wheel for medium or small powers, for instance for transforming the oscillation of a tuning fork into a rotating movement in a watch. However, pawl transmissions for medium and small power rating are complicated and expensive in manufacture and sensitive in operation.

On the other hand, self-starting synchronous motors usually need a rotating field determining the starting direction. However, the production of a rotating field in a small single- phase synchronous motor by means of short-circuiting discs or by means of an auxiliary winding is quite expensive and consumes a good deal of power.

It has already been proposed to act by means of a magnetic field rotating stepwise onto a tumbler disc or wobbling disc in such a manner that the rim of this disc rolls off along a stationary track, whereby a slow relative rotation between the tumbler disc and the stationary track is obtained due to a small difference in length between the stationary track and the track of the disc rolling off thereon. Of course the relative rotation is much slower than the rotating speed of the field acting onto the tumbler disc. However, this stepping gear is extremely complicated in that a stepwise rotating magnetic field has to be produced by means of a number of individual exciting coils and commuator means allowing to cyclically connect different coils to a power source.

SUMMARY OF THE INVENTION

It is a primary object of this invention to make use of elements of the prior art but to avoid the drawbacks of pawl gears and rotating magnetic fields. In its broadest aspect the motion-transducing device according to this invention comprises parts adapted to roll off upon each other along rolling tracks of different length, the one of said parts being applicable with its track against the track of the other part by said driving force, means for producing an auxiliary force of which the line of application does not coincide with the line of application of said driving force such that said one part is applied with its track against the track of the other part outside the line of application of said driving force under the combined action of said driving force and auxiliary force, the driving force and the reaction upon application of said tracks against each other initiating a rolling motion of said parts upon each other along said tracks, this rolling motion causing relative rotation between said parts due to the difference in length of said tracks. An auxiliary force produced by inertia of masses suitably distributed on the driven part of the device of an elastic force may preferably be used. It may thus be possible to use an extremely simple tumbler disc or wobbling disc having an asymmetrical mass distribution relatively to the points of application of the driving force or forces in order to obtain self - starting of the rotating movement in the desired direction.

In the above prior motion transducer comprising a tumbler disc or wobbling disc driven by means of a field rotating stepwise, the point of application of the force acting onto the tumbler disc rotates round the disc. It is another object of this invention to substantially simplify the device in that the driving force may always be applied in the same place of the driven part. Therefore, the force may be applied by simply mounting permanent magnets on the driven part and to produce an alternating magnetic field within reach of such magnets.

This invention will now be explained in further detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** – **3** are schematic illustrations of the basic operation of the invention,

FIGS. **4** and **5** schematically show a synchronous motor making use of the invention,

FIG. **6** is a sectional view of another embodiment of a synchronous motor according to the invention,

FIG. **7** – **9** schematically show further embodiments of the invention,

FIG. **10** and **11** show a practical embodiment of the device of FIG. **8**,

FIG. **12** illustrates a modified form of the disc of FIG. **5** and

FIGS. **13** and **14** show another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** – **3** serving for explanation of the basic idea and operation of the invention illustrate a lower stationary disc **1** and an upper disc **2** suspended by means of a ball joint preferably an elastical joint, in its center M. The upper disc **2** has two masses **3** located in symmetrically opposite positions relatively to the center M so that disc **2** is in an equilibrium position parallel to disc **1** as shown in FIG. **1** when no further forces act onto it. For practical embodiments, this equilibrium position or rest position may be determined by a suitable restoring force, for instance by means of a spring as will be shown below.

If a pair of forces P an P′ is applied to the disc **2**, whereby the points of application of such forces define a line or axis **4** at the side of masses **3**, disc **2** is tilted round its ball joint at M. With a homogeneous distruibution of masses on disc **2**, that is, without masses **3**, the tilting motion of disc **2** would be parallel to a vertical plane comprising axis **4** until the rim of disc **2** would abut against disc **1** where the axis **4** intersects the edge of disc **2** in the front portion thereof. The system would then again be in equilibrium condition and no further movement would occur. With a pair of oscillating forces P and P′ the disc would simply execute a tilting oscillation round an axis perpendicular to the axis **4**, and no usefull effect might be obtained.

However, with the additional masses **3**, such masses impede the tilting movement of the disc described above. Therefore, the downward movement of the right - hand front portion of disc **2** and the upward movement of the left- hand rear portion of disc **2** will be impeded or slowed down by masses **3**. Therefore, the disc **2** will tilt round an axis which is not perpendicular to axis 4 and will now abut against the lower disc 1 for instance in a point B which is obviously outside the axis 4 as shown in FIG. 3. If forces P and P′ continue to act, a tilting moment will now act onto disc 2 in a direction as indicated by arrow K in FIG. 2 so that disc 2 starts to roll with its rim along the rim of disc 1 whereby the point of contact between discs 2 and 1 is displaced to the right in FIG. 2. FIG. 3 shows that somewhat later the point of contact B has been displaced near the axis 4, but that forces P and P′ still produce a tilting moment K further assisting the rolling motion of disc 2 on disc 1 in anticlockwise direction. When the forces P and P′ stop to act on disc 2 the rolling motion continues due to the inertia of disc 2. It is a matter of design of disc 2 and its additional masses 3 and of the magnitude and frequency of the alternating driving forces P and P′ whether the rolling motion of disc 2 may be synchronized with the pulsating or oscillating driving forces or not. Practical experiments have shown, that not only starting but also starting in a predetermined direction and fast synchronisation of the rolling or tumbling motion of the disc with the oscillating driving forces may be obtained. If the lengths of the tracks along which the discs 1 and 2 roll off upon each other are slightly different, a slow rotating movement of disc 2 occurs, this rotating movement being superposed to the tumbling or wobbling movement. Therefore, the device not only operates as a motion tranducer for producing a rotating movement from a pulsating force or movement, but also as a frequency transducer because the rotating speed is much slower than the driving frequency.

FIGS. 4 and 5 shematically show a possible embodiment of a synchronous motor according to this invention. The shaft 5 of the motor which is rotatably mounted in bearings not shown in the drawing, carries two discs 8 by means of hubs 6 and spring discs 7 mounted between hubs 6 and discs 8. Permanent magnets 9 and additional masses 10 are mounted on discs 8 whereby pairs of magnets mounted on the same disc are of opposite polarity, so that pairs of opposite forces as shown in FIG. 1 – 3 are produced. Magnets 9 are located in the field of an exciting coil 11. The discs 8 have toothed rims 12 adapted to mesh with slightly conical toothed rims 13 formed on the annular stator accomodated between discs 8. The toothed rims 12 have a number of teeth differing as little as possible from the number of teeth of toothed rims 13.

If coil 11 is excited with alternating current, alternating forces act onto magnets 9 and pairs of alternating but opposite forces as shown in FIGS. 1 – 3 act on each disc 8. As explained above the additional masses 10 and their intertia respectively cooperate with the driving forces of magnets 9 to initiate a rolling motion and in the end a tumbling or wobbling motion of discs 8 with the toothed rims 12 and 13 continuously meshing with each other. As set out above, the discs are synchronized with the alternating forces after a short starting phase. Since the numbers of teeth of toothings 12 and 13 slightly differ from each other, the discs 8 slowly rotate in the same direction. Therefore a most desirable reduction of the rotating speed and increase of the torque is obtained, the rotating movement of discs 8 being transmitted through spring discs 7 to the hubs 6 and to shaft 5. For the sake of completeness it may be pointed out that spring discs 7 are so designed that they maintain discs 8 in the rest position as shown in FIG. 4 with toothings 12 and 13 disengaged as long as coil 4 is not excited, but spring discs 7 allow the wobbling motion of discs 8 when coil 11 is excited.

FIG. 6 shows an axial section of another embodiment of a synchronous motor. The exciting coil 14 of this motor is surrounded by a stator of soft iron forming an air gap 15 at one side of coil 14. The stator has a tube 16 and two portions 17 and 18 made of sheet-iron riveted thereto. A toothed rim 19 is provided outside portion 17. The motor shaft 20 is pivoted in tube 16 and the one end of shaft 20 carries a tumbling or wobbling disc 22 by means of a Cardan joint 21. Magnets 23 of opposite polarity and additional weights 24 are fixed on disc 22. A toothed rim 25 is provided at the circumference of disc 22. In this embodiment the number of teeth of part 19 of the stator is 119 and the number of teeth of the toothed rim of disc 22 is 120. With a wobbling frequency of 50 sec^{-1} the rotating speed is

$$n = 50\ (120 - 119)/120\ sec^{-1}\ \text{or}$$

$$n = (50 \cdot 1/120) \cdot 60 = 25\ min^{-1}$$

This invention is not limited to the use of tumbling or wobbling discs or to the application of forces as explained above. Although use of the inventive principle may advantageously be made in small synchronous motors, other embodiments are feasible, for instance in electronic watches synchronous clocks or the like.

FIG. 7 schematically shows another embodiment wherein a disc 26 on which the mass distribution is irregular and having two magnet poles N and S is accomodated with suitable clearance in a ring 27. If radial forces act on poles N and S the disc 26 is applied towards the ring 27 at the side of the lines of application of the radially directed magnetic forces and a rolling motion along the inner side of ring 27 is initiated as explained with reference to FIGS. 1 – 3.

In the embodiment schematically shown in FIG. 8 the rolling-off motion is no longer obtained by applying forces to a rigid disc as explained with reference to FIGS. 1 – 6, but by elastical deformation of a disc 28. Four magnets or poles of disc 28 are so disposed in an alternating magnetic field that in the situation illustrated in FIG. 8 the north poles N are applied against a lower disc 29. During the next half wave of the alternating magnetic field the south poles will be applied against the lower disc 29 while the north poles are lifted off disc 29. In order to obtain rolling off of the discs upon each other in a predetermined direction, an asymmetric mass distribution relatively to the magnet poles has to be provided on disc 28.

A more practical embodiment of the principle shown in FIG. 8 will now be explained with reference to FIGS. 10 an 11. Disc 28′ is subdivided by slits 32 into segments 33 elastically coupled with each other by the yokes left in the center of disc 28′ between segments 33, but such segments are substantially free for individual axial vibration due to weakened portions 33′ at their inner ends. Disc 28′ is fixed on the motor shaft 34 by means of a hub 35. Each segment 33 has a permanent magnet 36 at its inner side facing the exciting coil 37 of the motor, and every second segment 33 has a weight 46. The magnets 36 of each pair of adjacent segments 33 are of the same polarity such that the forces excerted onto pairs of segments are alternatively directed outwardly and inwardly according to the polarity of the magnets when coil 37 is excited with alternating current. Coil 37 is enclosed in a pot formed of soft iron sheets 38 and 39, bearings 40 for the motor shaft

34 being inserted into the tubular portion of sheet 39.

Each segment 33 of disc 28' has a web 41 connected to an elastic ring 42 made for instance of plastic material and having a toothing 43. A ring 44 mounted on sheet portion 38 has a similar toothing 45, the number of teeth of toothings 43 and 45 differing as little as possible from each other. However, since two portions of the tooting 43 will always engage simultaneously the toothing 45, it is necessary that the numbers of teeth differ from each other by an even number, that is by at least 2.

When coil 37 is excited with alternating current, the magnets of two opposite pairs of segments 33 are pulled into the annular air gap formed between pot portions 38 and 39 while the magnets of the two other pairs of magnets are pushed away from coil 37. Displacement of the segments 33 loaded by weights 46 lags relatively to the displacement of the unloaded segments. In this way a wave-like axial displacement propagating in circumferential direction is transmitted through webs 41 to ring 42 so that two places of this ring will roll off on the stationary rigid ring 44 as explained above, this rolling movement by elastic deformation of segments 33 and of ring 42 respectively falling into synchronism with the exciting frequency.

FIG. 9 shematically shows another embodiment similar in its basic conception to the embodiment explained above with reference to FIGS. 8 and 10. According to FIG. 9 an elastically deformable inner ring 30 is accomodated within an outer rigid ring 31. Poles N and S on ring 30 designate the points of application of radial forces by which diametrially opposite places of the ring 30 are alternatively applied against the outer ring 31 when an alternating magnetic field is acting on poles N and S. By means of auxiliary forces, for instance inertia forces as explained above, rolling off of the inner ring on the outer ring in a predetermined direction may be obtained.

The driving forces and auxiliary forces may be produced by means differing from those explained above. Instead of adding auxiliary masses or weights for obtaining the desired dynamic asymmetriy of the tumbler disc, parts of the disc may be made lighter by cutting out portions of the disc. The auxiliary forces may also be produced in another way, the only condition being that the displacement of the disc is impeded or assisted.

As an example, the Caradan joint illustrated in FIG. 6 may so be designed that tilting of the disc round the one shaft of the joint is opposed by increasing friction between the one shaft and its bearing. Of course the direction of this one shaft has to be properly selected with reference to the driving force or forces. The auxiliary forces may also be produced by means of an eddy current brake, by means of suitable auxiliary magnets or by means of a restoring spring offering different resistance to tilting of the tumbler disc in one direction than in the other.

FIG. 12 illustrates a modified embodiment of disc 8 of the motor shown in FIGS. 4 and 5 wherein the circular spring 7 is replaced by springs 7' disposed at an angle to the common symmetry axis of magnets 9. Masses or weights 10 as shown in FIG. 5 are omitted and replaced by the unhomogeneous restoring force of springs 7'. In operation the tilting movement of disc 8 round an axis parallel to the common symmetry axis of springs 7' produces only a slight torsion of springs 7' while tilting of disc 8 round an axis perpendicular to the common symmetriy axis of springs 7' produces bending of springs 7'. If the bending resistance of springs 7' is much higher than their torsion resistance, the desired dynamic asymmetry relatively to the driving forces produced by magnets 9 is obtained and the motor will start in a predetermined direction.

Driving forces other than magnetic forces, for instance pneumatic or hydraulic forces, may be applied. Instead of oscillating forces pulsating forces may be used, that is, in the embodiments explained above the permanent magnets may be replaced by soft iron parts so that pulling forces only act onto the discs. Of course one soft iron part instead of two magnets should be provided in order to avoid compensation of the pulling forces of two diametrally opposite parts.

The invention may be used whereever oscillating or pulsating driving forces are available and where such forces should be transformed into a rotating movement. As an example the oscillation of a tuning fork or of a vibrating electrodynamic motor in an electronic watch is usually transformed into a rotating motion by means of a pawl acting onto a ratchet wheel. A strictly synchronous transmission is also required in this type of time measurement and at the same time a slow rotation should be produced with a relatively high frequency of the driving force. However, in case of a transducer for obtaining a rotating movement from the oscillation of a resonator, it may be difficult to transmit the oscillating or pulsating force always to the same place of a rotating element. In order to overcome this difficulty, it is feasible to have a non-rotatable tumber disc or wobble disc executing only a wobbling movement but not a rotating motion as explained in the above embodiments, and wherein the other toothing meshing with the toothing of the tumbler disc or wobble disc is provided on a rotating part. In this case, this rotating part will turn at a speed determined by the ratio of the lengths of the tracks rolling off upon each other or by the ratio of numbers of teeth of such tracks. With such a transmission a mechanical coupling member may be disposed between an oscillating part, for instance a tuning fork, and the tumbling member, the wobbling motion of the tumbling member being continuously sustained by the pulsating or oscillating driving force.

One practical embodiment of such a device having a non-rotatable tumbler disc will now be explained with reference to FIGS. 13 and 14. This embodiment is similar to the one shown in FIG. 4 and 5 and corresponding parts are designated by the same reference numbers. The embodiment illustrated in FIGS. 13 and 14 differs from the one shown in FIG. 4 and 5 in that one disc 8 only is provided. This disc is elastically but non - rotatably mounted on a bearing portion 60 by means of a spring 7' of which the flexibility is increased by subdividing it into individual arms. Bearing portion 60 is mounted in a flange or bracket 61 by means of which the motor may be fixed on a support. The efficiency of the exciting coil 11 is improved by means of a pot made of soft iron sheet portions 62 and 63. Ring 64 with toothing 13 is now mounted on a rotor 65 made of sheet metal and mounted on motor shaft 5 by means of a hub 66. Instead of masses or weights 10 the wobbling disc 8 carries two auxiliary magnets 67, the fields of such magnets intersecting the rim of rotor 65.

In operation driving forces are applied to disc **8** by magnets **9** as explained above with reference to FIGS. **4** and **5**. The tilting motion of disc **8** is opposed by eddy currents induced in rotor **65** when magnets **67** are axially displaced inside the rim of rotor **65** due to the tilting motion of disc **8**. An eddy current brake is thus formed having an effect similar to the effect of the inertia forces of masses or weights **10** shown in FIGS. **4** and **5**. Disc **8** will therefore start to roll off along toothed track **13** as explained above when coil **11** is excited. However, since disc **8** cannot rotate, toothing **13** and ring **64** mounted on the rotor **65** now rotates at a speed determined by the ratio of numbers of teeth of toothings **12** and **13**.

Auxiliary forces may be produced by means of eddy currents in another way. As an example, a conducting sheet portion may extend into the magnetic field of magnets **9** at one end thereof, whereby an eddy-current braking force is produced outside the resultant driving force. No additional magnets such as magnets **67** are required in this case.

One particular advantages of all embodiments shown herein and explained above resides in the fact that the driving forces and auxiliary forces always act in the same places of the tumbling or wobbling element. Particularly in an embodiment as shown in FIGS. **13** and **14**, wherein the wobbling disc does not rotate, any type of driving force acting always in the same place may be used.

Another effect of the invention may be of particular importance in many applications. As explained above and as clearly shown at least in FIGS. **4** and **5** and in FIGS. **13** and **14** respectively, the toothings of the device should be maintained in a disengaged rest position when no driving forces are applied. The rotor is thus free to rotate, and this may be desirable in many instances, for instance where the motor has to drive a mechanism in one direction and where this mechanism should return into its initial position for instance by gravity or spring force when the motor is deenergized.

What I claim is:

1. A device for producing a rotating movement by means of at least one externally applied pulsating driving force, comprising parts adapted to roll off upon each other along rolling tracks of different length, one of said parts being movable with its track against the track of the other part, means applying said external driving force to said one part along a single line of application, means cooperating with said one part and responsive to movement of same for impeding movement of said one part in a direction displaced with respect to said line of application of said driving force such that said one part is applied with its track against the track of the other part outside the line of application of said driving force under the combined action of said driving force and said impeding means, the driving force and the reaction upon application of said tracks against each other initiating a rolling motion of said parts upon each other along said tracks, this rolling motion causing relative rotation between said parts due to the difference in length of said tracks.

2. A device according to claim **1**, comprising resetting means keeping said one part in a rest position with its track spaced from the track of the other part during the absence of a driving force.

3. A device according to claim **1**, wherein said one part is symmetrically formed and means are provided for applying driving forces in symmetrically located places of the part.

4. A device according to claim **1**, wherein said one part driven by said driving force is a tumbler member loosely suspended at a point of suspension, said driving force acting onto said tumbler member at a point of application, and said line of force being defined by said point of suspension and said point of application of the driving force.

5. A device according to claim **4**, wherein said tumbler member has a circular rolling track.

6. A device according claim **5**, wherein said parts comprise toothed rolling tracks, the number of teeth of the one track exceeding the number of teeth of the other track.

7. A synchronous motor comprising the elements as claimed in claim **1** and having permanent magnets mounted on said one part, and means for producing an alternating magnetic field acting onto said permant magnets for producing said driving force.

8. A synchronous motor according to claim **7**, comprising two magnets disposed with opposite polarity on a tumbler disc or wobble disc in diametrally opposite position in order to produce a pair of opposite alternating driving forces.

9. A synchronous motor according to claim **9**, wherein said permanent magnets are accomodated in an annular air gap formed in the core of an exciting coil, said magnets being adapted for circumferential displacement along said air gap upon rotation of said one part.

10. A synchronous motor according to claim **9**, comprising two parts disposed symmetrically relatively to an exciting coil, each of said parts carrying permanent magnets.

11. A device according to claim **1**, wherein said impeding means comprises means coupling said one part to a shaft.

12. A device according to claim **11**, wherein said coupling means is a leaf spring.

13. A device according to claim **1**, wherein said one part exposed to the driving force is an elastically deformable body adapted to roll off with its rolling track along the track of said other part due to periodical elastic deformation.

14. A device according to claim **15**, wherein the resonance frequency of said elastically deformable part is tuned to the frequency of the pulsating driving force.

15. A device according to claim **1**, comprising means for producing said auxiliary forces by means of an eddy-current brake.

16. A device according to claim **1**, wherein said one part is non-rotatably mounted while said other part is rotatably mounted.

17. A device for producing a rotating movement by means of at least one pulsating driving force, comprising parts adapted to roll off upon each other along rolling tracks of different length, the one of said parts being applicable with its track against the track of the other part by said driving force, a mass distribution on said one part for producing an auxiliary force due to inertia of which the line of application does not coincide with the line of application of said driving force such that said one part is applied with its track against the track of the other part outside the line of application of said driving force under the combined action of said driving force and auxiliary force, the driving force and the reaction upon application of said tracks against each other initiating a rolling motion of said parts upon each other along said tracks, this rolling motion causing relative rotation between said parts due to the difference in length of said tracks.

18. A device for producing a rotating movement by means of at least one external pulsating driving force, comprising parts adapted to roll off upon each other along rolling tracks of different length, one of said parts being a tumbler disc adapted to execute a tumbling motion round a suspension point with its track against the track of the other part, means applying said driving force to said disc only along a single axis passing through said suspension point, eddy-current brake means for producing an auxiliary force of which the line of application does not coincide with said axis, said brake means including at least one permanent magnet cooperating with said disc and reacting to movement of same to produce said auxiliary force, said one part being moved with its track against the track of the other part outside said axis and the line of application of said driving force under the initial combined action of said driving force and auxiliary force, the driving force and the reaction upon application of said tracks against each other initiating a rolling motion of said parts upon each other along said tracks, this rolling motion causing relative rotation between said parts due to the difference in length of said tracks.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,794,865 Dated February 26, 1974

Inventor(s) Kurt Guttinger

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Heading: Assignee is domiciled at Murten, Canton of Fribourg, Switzerland

In the Claims: In the first line of Claims 9 and 10, "Claim 9" should read --- Claim 7 ---.

In the first line of Claim 14, "Claim 15" should read --- Claim 13--.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents