

[54] **OSCILLATING MOTOR**
 [75] Inventor: **Max Hetzel**, Bienne, Switzerland
 [73] Assignee: **OMEGA Louis Brandt & Freres SA**,
 Bienne, Canton of Berne, Switzerland

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310/21

[51] Int. Cl.**G04c 3/02**

[58] Field of Search.....310/21, 22, 25, 37,
310/51; 58/23 D, 23 TF, 23 V, 28 D, 23 R;
74/126, 133, 142

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Primary Examiner—Richard B. Wilkinson
Assistant Examiner—U. Weldon
Attorney—Dwight H. Smiley

[57] **ABSTRACT**

An oscillating motor for a watch comprises a driven tuning fork or mechanical resonator driving a ratchet wheel. The fork carries a hermetically sealed housing on one of its tines, the housing enclosing a ratchet wheel fixed with a magnetized disc which constitutes part of a magnetic coupling. The ratchet wheel floats on a liquid film in the housing and is driven by pawls when the fork vibrates. The rotation of the ratchet is conveyed to the watch mechanism by the other half of the magnetic coupling, which is pivotally mounted outside the housing.

9 Claims, 10 Drawing Figures

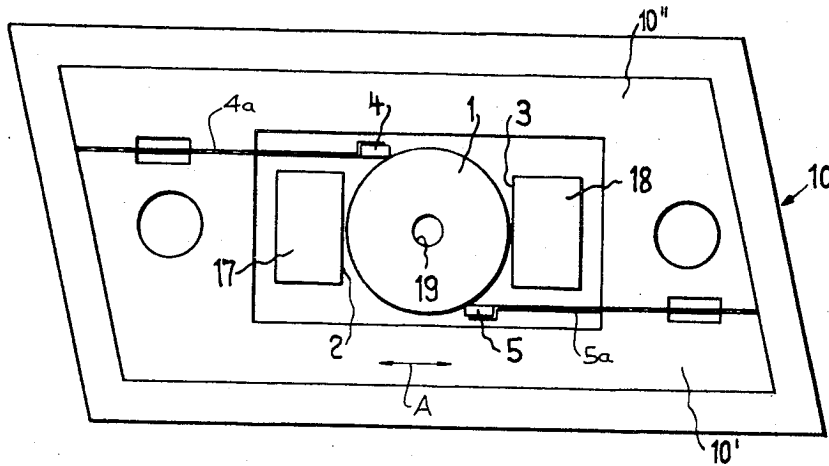


FIG. 1

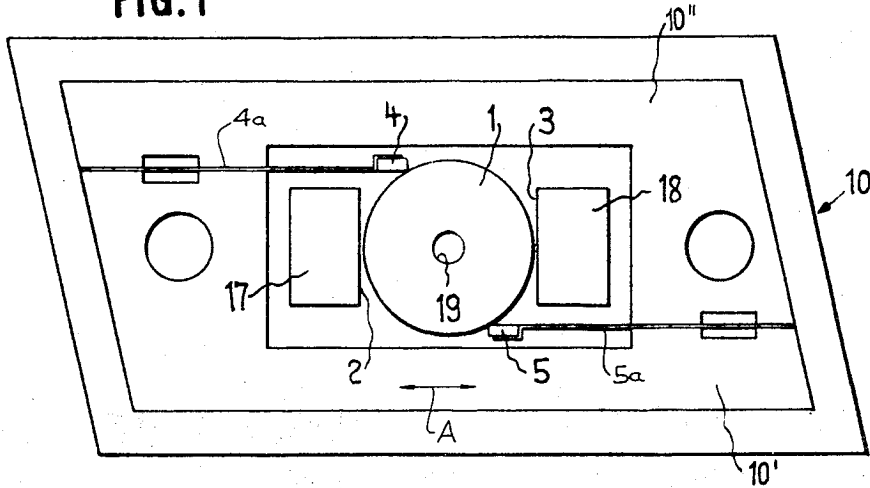


FIG. 2

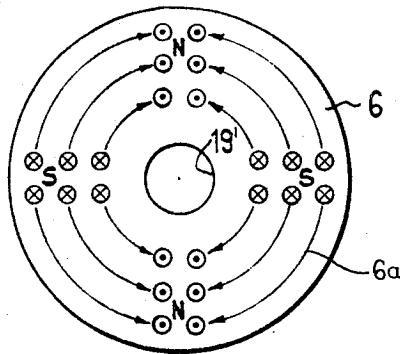


FIG. 4

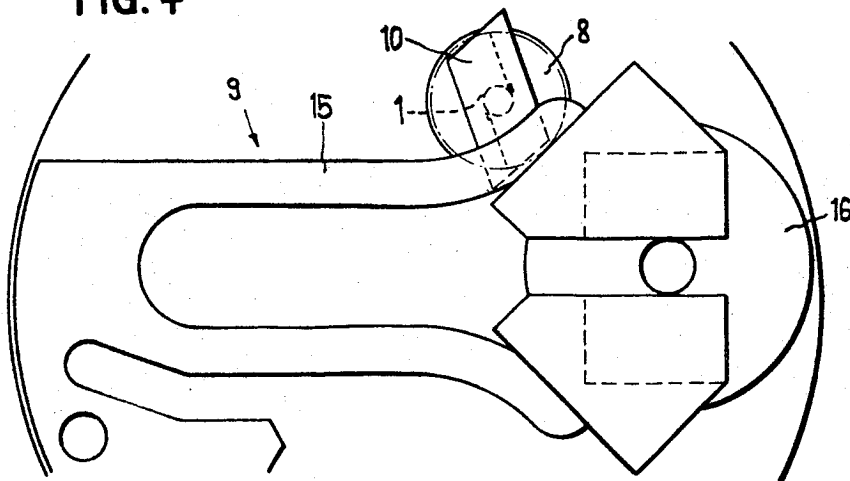


FIG. 3

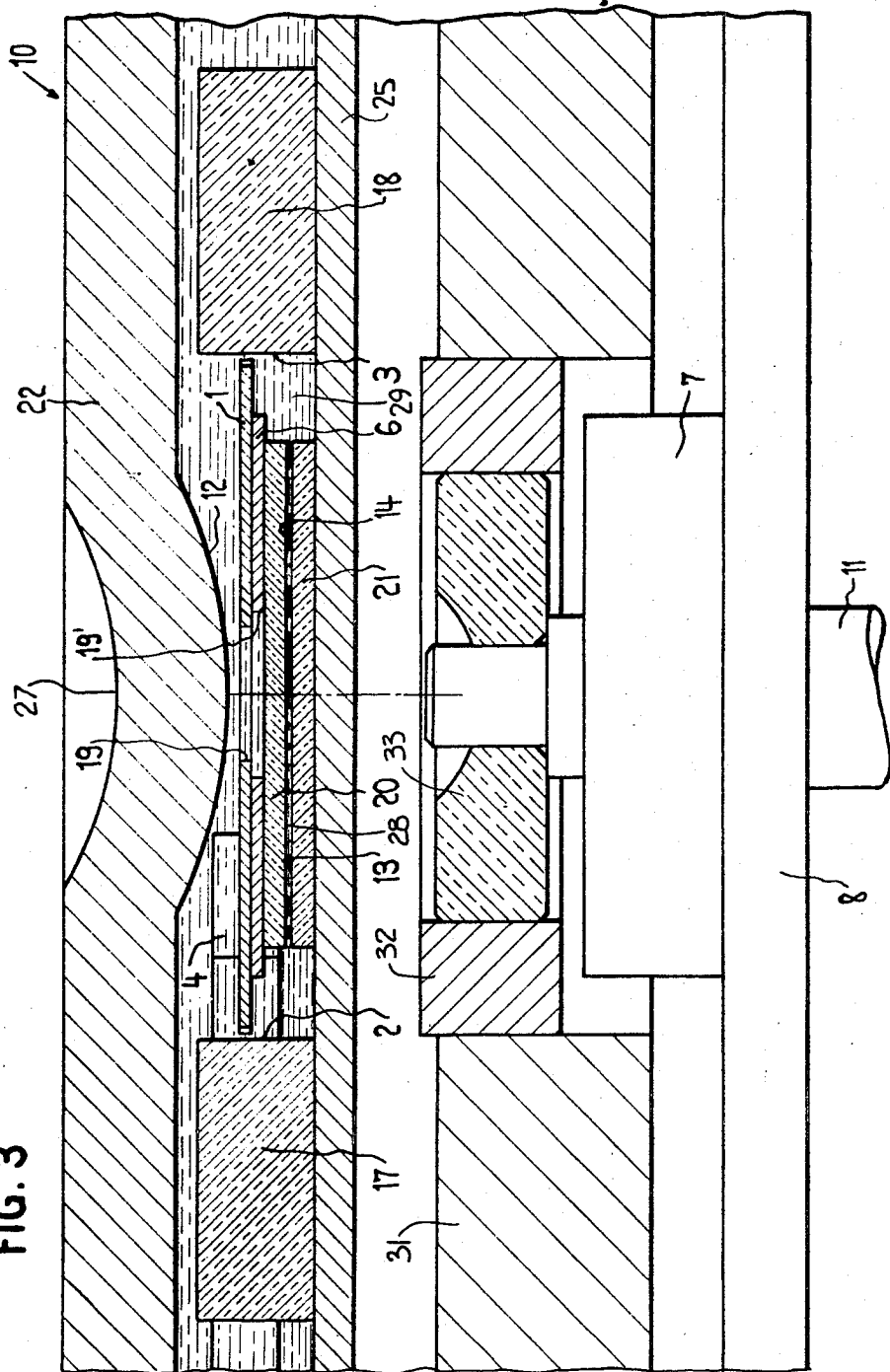


FIG. 5

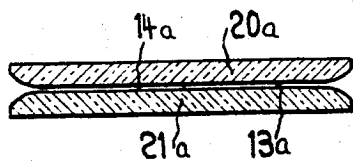


FIG. 8

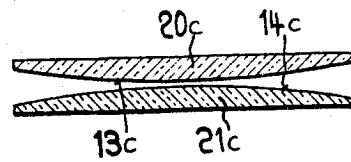


FIG. 6

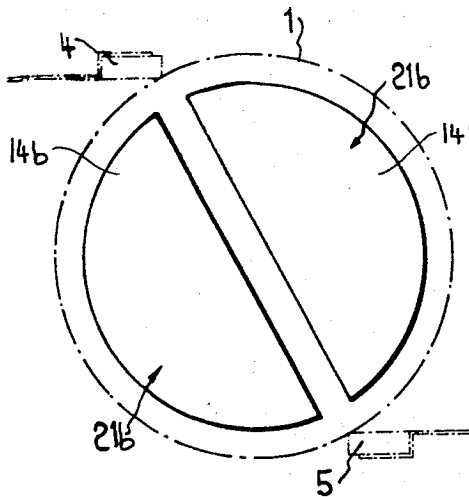


FIG. 9

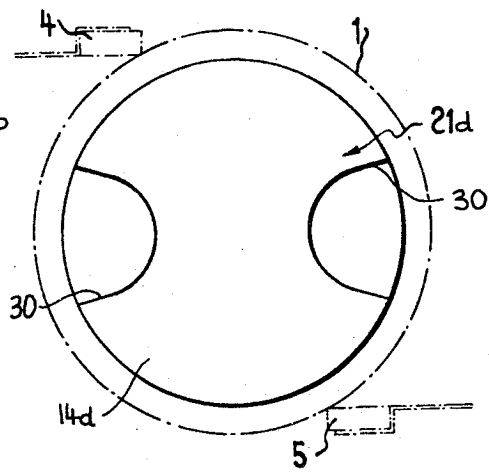


FIG. 7

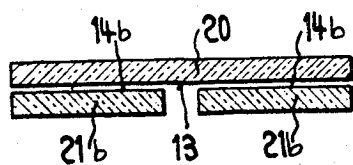
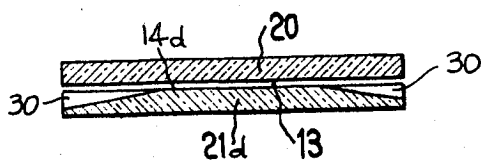


FIG. 10



OSCILLATING MOTOR

BACKGROUND OF THE INVENTION

An oscillating motor mechanism including a tuning fork mounted on an arm, the oscillatory movement of which is converted into a rotary movement used in time measuring devices such as wristwatches and wall clocks. In known mechanisms for performing this conversion, a ratchet wheel is mounted near the oscillating element for engagement by a pawl carried by the oscillating member so that it acts during movement of the oscillating member on the teeth of the ratchet wheel to thereby convert oscillating movement into rotary movement. These known mechanisms, despite attempted improvements thereof, have certain inherent disadvantages, such as; sensitivity to mechanical impact, temperature variation, and difficulty in maintaining the prescribed mechanical limits.

SUMMARY OF THE INVENTION

In accordance with the present invention, an oscillating motor includes a liquid-filled housing enclosing a pair of constraining blocks, and a rotor including a ratchet wheel located between the constraining blocks. The diameter of the ratchet wheel is smaller than the distance between the constraining blocks and a pair of pawls is mounted within the housing to cooperate with the ratchet wheel at diametrically located points. The housing is reciprocated and its reciprocating movement is transmitted by the pawls to the ratchet wheel and thereby converted into a unidirectional rotary movement of the rotor. A magnetic coupling means is associated with the rotor and couples the rotor movement to a coupling member mounted externally of the housing or a wheel for driving a watch mechanism.

This structure provides an oscillating motor of simple and reliable construction and converts reciprocity to rotary movement with a high degree of efficiency. The rotor is fitted in an axial direction between upper and lower stops with small clearance, the abutting surfaces of the rotor and the lower stop being so profiled that during rotation of the rotor a liquid circulation occurs and provides a hydrodynamic bearing effect. The housing may be carried by an arm of an electrically actuated tuning fork.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic plan view of the housing portion of an oscillatory motor according to the present invention and illustrates the arrangement of the principal operative elements of the motor;

FIG. 2 is a schematic plan view of the magnetic disc portion of the rotor and illustrates the magnetic field of the said disc;

FIG. 3 is a section through the housing of FIG. 1, and a part of the coupling member;

FIG. 4 is a schematic depiction setting forth the arrangement of the housing when mounted in a wristwatch; and

FIGS. 5 to 10 are plan and sectional views of mounting embodiments incorporating a hydrodynamic bearing, which are utilizable in the present invention.

DETAILED DESCRIPTION OF INVENTION

The oscillating motor shown in FIGS. 1-3 comprises a rotor including a ratchet wheel, which is provided on its circumference with fine ratchet teeth, not shown in the drawings. The ratchet wheel is mounted so as to be freely rotatable between stop surfaces 2 and 3, of constraining blocks 17, 18. The wheel is displaceable at right angles to its axis within certain limits and the surfaces 2 and 3, which are spaced a distance slightly exceeding the diameter of wheel 1, act as constraints upon reciprocating, side to side movement of the wheel. The wheel 1 and blocks 17, 18 are enclosed within a housing 10 which is reciprocated, as indicated by arrow A, as will be hereinafter described. On diametrically opposite points, pawls 4 and 5, mounted within housing 10, engage the teeth of the ratchet wheel 1, these acting in a manner also described hereinafter.

These ratchet wheel 1 is firmly joined to a magnetic disc or ring 6, FIG. 3, which in turn is joined to a disc-shaped bearing block 20. The ratchet wheel 1 and magnetic disc 6 are annular and formed with central holes 19, 19'. In both cases the hole facilitates the injection of adhesive used to join the parts 1, 6 and 20 together. In the case of the ratchet wheel 1 the hole helps to locate the teeth and in the case of the magnetic disc 6 the hole serves to reduce the weight.

As shown in FIG. 2, the disc 6 is magnetized so that four poles are formed with the lines of force 6a emanating at right angles to the disc plane, as indicated by the vector notation at the respective N and S poles, and extending in the disc material between the adjacent opposite poles. The disc 6 is coupled magnetically to a second magnet disc 7, FIG. 3, which with the first gear wheel 8 of the watch movement is coaxially mounted on an axle 11 fastened on a plate or bridge 31 of the watch. The disc 7 and wheel 8 are pivotally mounted within an amagnetic bushing 32 and jewel bearing 33.

The constraining blocks 17 and 18 are secured to the bottom 25 of the housing 10. The housing edge or rim is formed by two L-shaped parts 10' and 10''. The pawls 4 and 5 are carried by flat leaf springs 4a and 5a which are retained between the abutting surfaces of the rim parts 10', 10''. A cover or lid 22, FIG. 3, is tightly connected with the rim providing a hermetic space, filled with a liquid 29, within which the parts 1, 4, 4a, 5, 5a, 6, 17, 18 and 20, and a second disc-shaped bearing block 21, connected to the bottom 25 of the housing 10, are located. The liquid 29 must be non-corrosive and non-poisonous, and have a low viscosity, and may, for example, comprise kerosene or a similar light oil.

The housing 10, as shown in FIG. 4, is fastened to an arm 15 of a turning fork 9 so that the direction of reciprocation of the housing 10, as indicated by arrow A, is substantially parallel to the springs 4a and 5a of stepping pawls 4 and 5. The tuning fork is coupled to a driving coil 16 and the latter is connected to an amplifier or oscillator (not shown) to excite the turning fork into oscillation. The resultant oscillatory movement executed by the arm 15 of the turning fork 9 reciprocates the housing 10 and the parts 4, 5, 17 and 18 to rotate the ratchet wheel 1 and thereby drive, through the magnetic coupling 6-7, the gear wheel 8.

The ratchet wheel 1 with the magnetic disc 6 fastened thereto and the bearing block also coaxially

located thereto follow the reciprocating movement slowly due to their inertia. Hence, a relative movement occurs between a pawl and the momentarily engaged tooth of the ratchet wheel, whereby the tooth concerned leaves the pawl and allows it to engage in the next tooth. This reciprocating movement rotates the ratchet wheel 1, retained by the pawls 4 and 5, one tooth at a time about its axis.

To permit these movements to be carried out as smoothly as possible, a hydrodynamic mounting for the rotor is provided in the hermetically sealed housing 10. As shown in FIG. 3, the liquid 29, filling the housing 10, forms a film 28 between the lower bearing surface 13 of the bearing block 20 secured to the magnetic disc 6 and the upper bearing surface 14 of the bearing block 21 mounted on the bottom housing wall 25, the oil or other liquid 29 circulating between the two surfaces 13 and 14. Due to the liquid film 28 located between the bearing surfaces 13 and 14, the rotation and radial relative displacement of the rotor in the housing occurs extremely smoothly.

It will be understood that the rotor, consisting of the parts 1, 6 and 20, remains substantially in the axial position shown, even when the housing 10 is inverted, or when axial impacts act in a downward direction because the axial force of attraction between the two magnetic coupling members 6-7 is several times the weight of the rotor. The cover or lid 22 of the housing 10 has a depression 27 formed therein, the inside surface of 12 of which acts as an axial stop for shock displacements. The liquid located between the cover surface 12 and the ratchet wheel 1 damps the impacts and prevents friction and wear.

The hydrodynamic mounting has the advantage that the rotor is subject to a minimum of bearing resistance in any direction of movement parallel to the surfaces 13, 14. The hydrodynamic mounting of the rotor produces a substantial improvement in the efficiency and shock-resistance of the drive mechanism and watch movement.

FIG. 5 discloses a modification according to which the facing surfaces 13a and 14a of bearing blocks 20a and 21a have rounded outer edge portions which enables easier penetration of the liquid between the surfaces 13a and 14a.

FIGS. 6 and 7, show a further embodiment wherein the lower bearing block is divided into two spaced segments 21b which enables improved liquid circulation between the surfaces 13 and 14b as well as between the segments. The two segments may be further subdivided into four segments.

The modified embodiment shown in FIG. 8 comprises two bearing blocks 20c and 21c formed as plano-convex lenses the curved surfaces 13c and 14c of which have an approximate radius of curvature of 2.5cm. The opposed convex surfaces 13c and 14c accommodates greater liquid circulation.

In the alternative embodiment shown in FIGS. 9 and 10, the bearing block 21d has in its bearing surface 14d two U-notches 30 which project inwards by half the radius of the bearing block 21d and do not occupy more than a quarter of the whole surface. Two or more such notches may be located on the same diametral engagement points of the pawls 4 and 5.

As shown in FIG. 3, the bearing block 20 may be provided with a central bore, to promote the liquid supply and circulation between the bearing surfaces.

I claim:

1. An oscillating motor for mounting on a reciprocating vibratory member and particularly for driving a timepiece movement, comprising:

a liquid filled housing;

a rotor within said housing, and including a ratchet wheel and a first magnetic coupling member coaxially secured to said ratchet wheel;

a pair of constraining blocks mounted in said housing and spaced from one another in the direction of reciprocation of said member, said blocks enclosing therebetween the said ratchet wheel, the diameter of said wheel being smaller than the distance between said blocks, whereby said wheel is moveable to and fro between the bounding surfaces of said constraining blocks;

a pair of pawls within said housing in cooperation with said ratchet wheel so that reciprocating movement transmitted to said housing by the vibratory member moves said rotor to and fro between said blocks, said motion of said rotor by interaction with said pawls being converted into unidirectional rotary movement of said rotor;

upper and lower stops in said housing for said rotor; abutting surfaces being defined between said rotor and said lower stop, the said surfaces being so profiled that on rotation of said rotor a liquid circulation occurs therebetween to provide a hydrodynamic bearing; and

a second magnetic coupling member external of said housing and magnetically coupled to said first magnetic coupling member, for transmitting the rotary motion thereof to a mechanical movement.

2. An oscillating motor in accordance with claim 1, wherein said first magnetic coupling member comprises a magnetized disc fixed to the ratchet wheel, and said rotor also comprises a bearing block fixed therewith and carrying one of said abutting surfaces.

3. An oscillating motor in accordance with claim 2, wherein the magnetization of said disc is such that lines of force emerge at substantially right-angles to the disc plane at a plurality of predetermined points along the periphery of said disc, the magnetic circuit between poles of opposite polarity being completed within the material of said disc.

4. An oscillating motor in accordance with claim 1, wherein each of said abutting surfaces is flat with a rounded outer edge.

5. An oscillating motor in accordance with claim 1, wherein said lower stop comprises a circular block, the upper face of which defines one of said bearing surfaces for said rotor.

6. An oscillating motor in accordance with claim 5, wherein said lower bearing block is provided with U-shaped recesses in its bearing surface, the recesses extending not more than half the block radius toward the center of said block and subtending less than a quarter of the block circumference.

7. An oscillating motor in accordance with claim 5, wherein said lower bearing block is provided with at least two inclined bearing surfaces to assist entry of liquid between said inclined surfaces and cooperating surfaces on said rotor.

8. An oscillating motor in accordance with claim 5, wherein at least one of said blocks is in the form of a plano-convex lens.

9. An oscillating motor is accordance with claim 8, wherein the radius of curvature of the convex face of said block is approximately 2.5cm.

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