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AGENT
DEVICE FOR CONVERTING ROTARY MOTION INTO RECIPROCATING MOTION OR CONVERSELY


Application January 21, 1953, Serial No. 332,452

Claims priority, application Netherlands March 6, 1952

7 Claims. (Cl. 310—103)

The invention relates to a device for converting rotary motion in one direction into reciprocating motion, and conversely. In conventional devices of this type, conversion of motion is effected by means of an eccentric, a connecting rod and a crank shaft, a sweat-plate, a cam-disc or the like. Such mechanical devices for converting motion have a limitation in that considerable frictional losses may occur.

The invention has for its object to provide a device permitting under circumstances substantially loss-free conversion of motion. According to the invention the device comprises two mechanisms, each of which comprises a magnetic circuit which, measured along a pitch line, produces a magnetic field, and a mechanism of the device is secured to a plate-shaped diaphragm.

Fig. 1 shows a device similar to that shown in Fig. 1 but comprising three disc-shaped magnetic circuits.

Fig. 4 shows a variant of the device represented in Fig. 4.

Fig. 2 shows a method of polarisation of the magnetic circuits, for explaining Figs. 4 and 5.

In the example shown in Fig. 1, A is a sectional view of the whole device, and B is a lateral view of one of the magnetic circuits of the device. The device comprises a first rotary mechanism 1, whose rotation is to be converted such that a mechanism 2 performs a reciprocating motion. To this end, in accordance with the invention, the mechanism 1 comprises a disc-shaped magnetic circuit 3 made from permanent magnetic material, wherein poles N and S are magnetised in an axial direction, said poles, measured along the circular pitch line T, producing a magnetic field which alternately changes its direction. The mechanism 2 carries a similar magnetic circuit 4 having the same number of poles, so that magnetic forces are produced between the magnetic circuits 3 and 4.

The mechanism 1 is prevented from performing a reciprocating motion by a suitable ball bearing 5 (shown diagrammatically), rotation of the mechanism 2 being prevented by tangential springs 6 and 6' (shown diagrammatically), which do permit reciprocating motion of the mechanism 2. Thus, upon rotation of the mechanism 1, the mechanism 2 will perform a reciprocating motion due to the magnetic forces created between the two magnetic circuits 3 and 4.

In a practical example the example the diameter of the magnet circuits 3 and 4, consisting of separate magnet discs arranged in the form of a crown, was 12 cm., and an axial force averaging 10 kg. with an average air-gap of 2 mm. was measured. This considerable force renders the device suitable for many industrial applications, for example a diaphragm pump, a shaking side, fillers, for mechanical working e. g. filing, grinding, polishing for test apparatus and the like.

Fig. 2 shows a variant of the device shown in Fig. 1, wherein the mechanism 2 consists only of the magnetic circuit 4 which is secured to a rotation-preventing diaphragm 7. This diaphragm 7 may, for example, form part of a diaphragm pump or a siren, for which purposes the aforesaid device is eminently suitable. It may also be advantageous to secure the magnetic circuit 4 to a plate-shaped diaphragm of ferrormagnetic material 7' (Fig. 2A) by which the poles of the circuit 4 facing said diaphragm are magnetically short-circuited.

Fig. 3 shows a device comprising three disc-shaped magnetic circuits 8, 9 and 10 shown in Fig. 3B. The circuits 8 and 10 are secured to the rotation mechanism 1, the circuit 9 being secured to the reciprocating mechanism 2. The poles of the same sign of circuits 8 and 10 face each other, so that the magnetic circuit 9 either is attracted by the poles of circuit 10 and simultaneously repelled by those of the circuit 8 (this position is shown in Fig. 3) or, upon rotation of the circuit 1 through a distance corresponding to the pitch length s of the pole, is attracted by the magnetic circuit 8 and simultaneously repelled by those of the magnetic circuit 10.

Said device also permits reciprocating motion to be converted into rotary motion in a constrained manner. If, in effect, the mechanism 2 is caused to reciprocate, the poles of the magnetic circuit 9 will repel the poles of opposite sign of the circuit 8 and will attract the poles of the same sign of this circuit with the result that the mechanism 1 tends to rotate over a pitch length s. If the magnetic circuit 9 subsequently moves in a direction of the magnetic circuit 10, the poles of the same sign of circuits 9 and 10 have meanwhile reached positions in front of each other and cause the mechanism 1 to rotate further.

If desired, the mechanism 2 may also be furnished with a second plate-shaped magnetic circuit 11 likewise co-operating with circuit 10 and consequently partaking in the moment produced.

Alternatively, for example, one of both mechanisms may be caused to perform both motions, for example by complete immobilisation of the other mechanism. If, for example, the mechanism 2 is retained, whereas the bearing of the mechanism 1 permits both a reciprocating and a rotary motion, the conversion of motion concerned will be effected only by the mechanism 1.

If, for example, the mass connected to the mechanism 1 highly exceeds that of the mechanism 2, the mechanism 1 need not comprise means preventing a reciprocating motion, since its momentous causes the mechanism 2 to assume an average position, the reciprocating motion being primarily performed by the mechanism 2. Fig. 4 shows an example of such a device, which may, for example, be used for a siren.

Fig. 4A is a front view of a device similar to that shown in Fig. 3, the mechanism 1 carrying two cylindrical magnetic circuits 12, 13 and the other mechanism 2 comprising a cylindrical magnetic circuit 14. As will be seen from the side view in Fig. 4B, the poles of the circuits 12, 13 and 14 produce, measured along the circular pitch line T, a magnetic field alternately changing its direction, the circuits 12 and 13 shown in Fig. 4A being situated with their poles of opposite sign adjacent each other. Upon rotation of the mechanism 1 the mechanism 2, whose rotation is prevented by the diaphragm 7, will consequently perform a reciprocating
motion, the simultaneous axial motion of the mechanism 1 being negligible if this mechanism is connected to a sufficiently heavy mass. The speed of rotation of the mechanism 1 will preferably be so chosen as to set the mechanism 2 into mechanical resonance.

Of course, a plurality of magnetic circuits may similarly be fitted to the rotary mechanism 1, said circuits causing a number of mechanisms 2 to perform reciprocating motions, if desired different from one another, for example multi-tone sirens. Conversely, a reciprocating mechanism 2 may be caused to co-operate with a plurality of rotary mechanisms 1.

The mechanism 2 may be prevented from participating in the rotation not only by the diaphragm 7 but also by a stationary cylindrical magnetic circuit 15 (Fig. 4B, C) whose poles, similarly to circuits 12, 13 and 14, produce a magnetic field alternately changing its direction.

Fig. 5 shows a variant of the device shown in Fig. 4, wherein the mechanism 1, which only comprises cylindrical magnetic circuits 12 and 13, is stationary, whereas the other mechanism 2 comprises a circuit 14 co-acting with the magnetic circuits 12, 13 and in addition a ferromagnetic, for example a soft iron cylinder 18, upon which passage of current through one winding 19 of a sucking magnet 20 is drawn to the left, whereas upon disappearance of the current through the winding 19 a spring 21 urges the mechanism 2 again to the right. In this case, by means of mechanism 2, in the case of current alternating through the winding 19 will simultaneously perform a reciprocating and a rotary movement. It may be advantageous to choose the mechanical resonance of the mechanism 2 for the reciprocating movement equal to double the frequency of the alternating current through the winding 19.

Instead of introducing poles N and S of rectangular shape into the magnetic circuits 12, 13, 14 in accordance with the exploded view shown in Fig. 6A, in which case the direction in which the mechanism 2 tends to rotate on operating the device is accidental, the poles of one sign (N), may, for example as shown in Fig. 6B, be introduced in a continuous zigzag into the circuit 12, 13 whereas the corresponding zigzag poles of opposite sign (S) are interrupted in the first-mentioned poles (N) at the broken lines. If the circuit 14, into which north poles (N) south poles (S) and neutral zones (C) are alternately introduced, then moves to and fro in front of the circuit 12, 13 a direction of rotation corresponding with a shift of the circuit 14 in front of the circuit 12, 13, in Fig. 6D downwards, will be preferred, since the poles at the broken lines tend to prevent upward displacement. Such a device is very suitable, for example, for counting current impulses.

The magnetic circuits as shown are preferably made from a material with a ratio smaller than 4 between the remanent induction Br in Gauss and the coercive field strength Bc in Oersted.

What we claim is:

1. A device for converting continuous rotary motion into reciprocating motion or vice versa comprising a base member, a first member including a plurality of permanent magnetic segments forming a thin-walled body having one dimension thereof smaller than the other dimensions thereof, each of said segments being arranged with the polarized direction thereof in substantially the same direction as the smallest dimension of said first member, said segments defining a first magnetic circuit, said first member being rotatably mounted on said base member, means for rotating said first member, means for preventing reciprocating movement of said first member, a second member including a plurality of permanent magnetic segments forming a second magnetic circuit mounted on said base member, means coupling said second member to said base member for preventing rotational movement of said second member, said magnetic circuits coacting to produce a magnetic field between said members which alternately changes its direction to thereby cause said second member to reciprocate.

2. A device as set forth in claim 1 wherein at least one of said members is plate-shaped and is magnetized in the axial direction thereof.

3. A device as set forth in claim 1 wherein at least one of said members is cylindrical in shape whereby forming a cylindrical magnetic circuit magnetized in a radial direction.

4. A device for converting continuous rotary motion into reciprocating motion or vice versa comprising a base member a first member having a cylindrical shape and including plurality of permanent magnet segments forming at least two circular magnetic circuits on the circumference thereof, said first member being rotatably mounted on said base member, means for rotating said first member, a second member flexibly mounted on said base member having an annular shape and including a plurality of permanent magnetic segments forming another magnetic circuit, said magnets being magnetized in the radial direction of said cylindrical and annular members respectively, magnetic circuits being coaxially arranged, said two magnetic circuits of the first member coacting with the magnetic circuit of the second member to produce a magnetic field between said members which alternately changes direction thereby converting the rotary motion of one of said members into reciprocating motion of the other of said members.

5. A device as set forth in claim 4 wherein said two magnetic circuits have poles of one sign in a continuous zigzag arrangement and poles of an opposite sign in a zigzag arrangement interrupted by said former poles.

6. A device as set forth in claim 4 wherein said magnetic circuits consist of permanent magnetic material having a remanent induction Br, which, measured in Gauss, is smaller than four times the coercive field strength Bc measured in Oersted.

7. A device as set forth in claim 4 in which said magnetic segments are arranged to rotate the annular and cylindrical members in the same predetermined sense of direction relative to one another when one of said first and second members is linearly displaced relative to the other.

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