Oct. 13, 1959 M. HETZEL 2,908,174

MOTION TRANSFORMER

Filed April 26, 1956

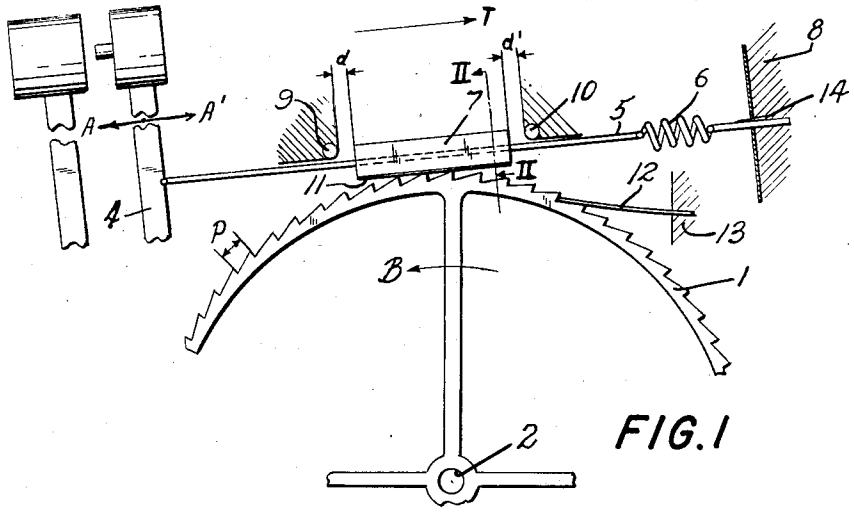

FIG. 1

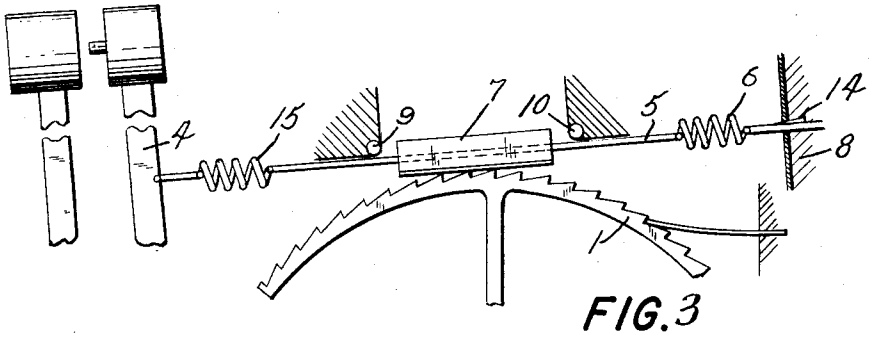

FIG. 3

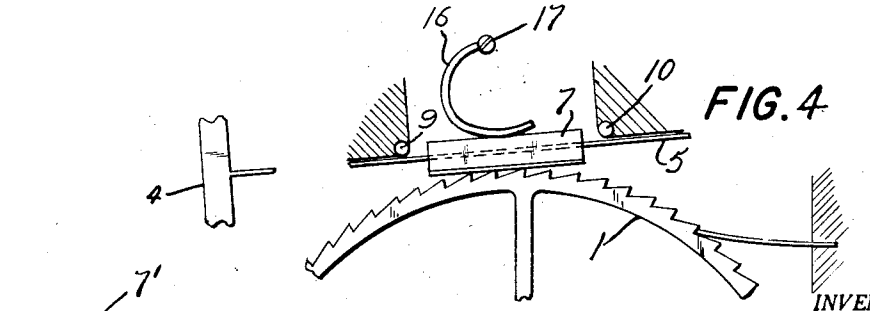

FIG. 4

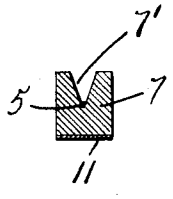

FIG. 2

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MOTION TRANSFORMER

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13 Claims. (Cl. 74—128)

The present invention relates to a motion transformer.

More particularly, the present invention relates to an electric timepiece incorporating a motion transformer capable of transforming the oscillations of a vibrator into rotary movement, the electric timepiece being of the type disclosed in copending applications Serial No. 436,949, filed June 15, 1954, now abandoned, Serial No. 547,510, filed November 17, 1955, now abandoned (said application Serial No. 547,510 being a continuation of application Serial No. 463,462, filed October 20, 1954, now abandoned), Serial No. 565,451, filed February 14, 1956, Serial No. 565,452, filed February 14, 1956, and Serial No. 570,958, filed March 12, 1956.

It is an object of the present invention to provide an electric timepiece which incorporates a motion transformer adapted to transform the oscillations of a vibrator into the rotary movement of the hands of the timepiece.

It is another object of the present invention to provide an electric timepiece wherein the action of the vibrator is controlled in such a manner as to insure the accuracy of the timepiece.

The objects of the present invention further include the provision of an electric timepiece which is composed of simple and ruggedly constructed elements which are very reliable in operation.

It is still another object of the present invention to provide an electric timepiece which may be mass produced at low cost.

With the above objects in view, the present invention mainly consists in that improvement in a timepiece which incorporates a mechanism for transforming vibration into a rotary motion, the mechanism including a support means, rotary means mounted on the support means for rotation relative thereto, a vibrator mounted on the support means, driving means connected to the vibrator for movement therewith and frictionally engaging the rotary means for turning the latter, and means operatively associated with the rotary means for limiting the same to one direction of rotation.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view of one form of the invention,

Fig. 2 is a section on the line II—II of Fig. 1,

Fig. 3 is an elevational view of another form of the invention, and

Fig. 4 is an elevational view of a constructional detail applicable to either of the two forms of invention shown.

The mechanism shown in Fig. 1 comprises the ratchet wheel 1, which is fulcrumed at 2 and which forms part

of a watch or clock mechanism. A mechanical vibrator 4 oscillates in the direction of the arrows A and A'. Above wheel 1 is disposed a wire 5 of which one end is fixed to the vibrator 4 and of which the other end is connected to a coil spring 6 fixed to a portion 8 of the case of the clockwork. Spring 6 is fixed to case 8 by one of its ends being introduced into a bore provided in case 8, the spring being retained in said bore by means of a tapered pin 14. Such disposition not only provides a resilient coupling of the wire with vibrator, but also permits to regulate the tension of spring 6, and, thus, the tension of wire 5 by shifting the spring-end in case 8. When the vibrator 4 oscillates, wire 5 also oscillates.

On wire 5 and in engagement with wheel 1 is disposed a friction element 7 so that the underside thereof bears with slight pressure on the teeth 3 of wheel 1. Element 7 is made of a very light material and, as may be taken from Fig. 2, is provided over its entire length with a groove 7' of which the sidewalls are inclined towards the interior thereof, and in which the wire 5 is engaged.

Owing to the friction between wire 5 and the sidewalls of groove 7', the element 7 normally participates in the vibrations of wire 5. But when, for any reason whatever, element 7 is prevented from moving, wire 5 slides in groove 7'. The movements of element 7 are limited on both sides by two stops of which one, 9, is fixed to case 8 at a distance d from that end of element 7 which points towards vibrator 4, and the other stop, 10, is fixed to the case 8 at a distance d' from the other end of the element.

The underside of element 7, extending longitudinally to the wire 5 and tangentially to the ratchet wheel, bears on the teeth 3 of ratchet wheel 1. In the form of invention described, the underside of the element is covered by a plastic material 11 (Fig. 2). The latter serves for the purpose of improving the friction between the underside of the element and the teeth of the wheel and of preventing a rapid wear of said underside.

On a portion 13 of the case of the clockwork is mounted a pawl 12 formed by a very thin resilient leaf, preferably made of a plastic, of which the free ends bear with a slight pressure on a tooth 3 of wheel 1.

When vibrator 4 swings in the direction of arrow A, wire 5, being fixed thereto, moves in the same direction, stretching spring 6 and carrying away element 7. The underside of the latter, bearing on the teeth 3, turns wheel 1 through a certain angle in the direction of arrow B. At the same time, pawl 12 slides off a tooth 3 and abuts against the following tooth. When vibrator 4 swings in the direction of arrow A', wire 5 through the action of spring 6 is returned into its initial position carrying away with it element 7. But during such movement pawl 12 abuts against a tooth 3 of wheel 1 and thus prevents the latter from turning in the direction opposite to arrow B. Owing to the resilience of the suspension of element 7, the underside of the latter slides on the teeth 3 of wheel 1.

In order that the device described above may function in a satisfactory manner, it is important that element 7 turns wheel 1 always through the same angle, independently of the amplitude of oscillation of vibrator 4 and wire 5, which amplitude from accidental causes may not be constant. To such end, the two stops 9 and 10 maintain the reciprocations of element 7 within limits which have exactly been predetermined.

On the other hand, the device described being destined to actuate a clockwork, wheel 1 each and every time has to rotate through an angle corresponding to the pitch p of the teeth 3. Fig. 1 clearly shows that the conditions are satisfactory when the total displacement of $d+d'$ of

element 7 is greater than pitch p but less than $2p$, or in other words, when $2p>d+d'>p$.

It further is obvious that the amplitude A_0 of oscillations of vibrator 4 has to be maintained greater than the value of pitch p, but wheel 1 still must be capable of rotation so as not to stop the clockwork. Consequently, the following other relation holds true for the good functioning of the device: $A_0>p$.

It has to be noted, finally, that for regular operation of the device, it is necessary that the natural frequency of all the moving parts and members, i.e. of wire 5, element 7, spring 6 and wheel 1, be higher than the frequency of oscillation of the mechanical vibrator 4.

As has been set forth above, wire 5 is engaged in groove 7' by simple friction in order to damp the shocks of element 7 striking against the stops 9 and 10, so that the wire may slide in groove 7'.

In another form of invention, shown in Fig. 3, the wire 5 is fixed to the element 7. In order to damp the shocks when the latter abuts against one of the stops 9 or 10, the wire is connected to vibrator 4 through a second coil spring 15. As in the first form of invention, the natural frequency of spring 15 must be higher than that of the oscillations of vibrator 4. The device shown in Fig. 3 otherwise is similar to that shown in Fig. 1.

In the two forms of invention described, wire 5 is so disposed that element 7 bears on wheel 1 with sufficient pressure to impart a rotary movement thereto. In some special cases it may be desirable to exert a pressure on element 7 in order to ensure contact between the element and the teeth of the ratchet wheel during the active movement of the element. Such positive contact may be attained by means of the construction shown in Fig. 4. An arched leaf spring 16 fixed at one end on the case to a pin 17 bears with its free end on the upper side of element 7. Spring 16 is convex towards vibrator 4 so that, when element 7 moves in order to rotate wheel 1, spring 16 tends to increase its pressure, while, when element 7 moves in the other direction, the pressure of the spring 16 tends to decrease.

What is claimed is:

1. A mechanism for transforming mechanical vibrations of a vibrator into a rotary movement for actuating a watch or clock mechanism including a ratchet wheel, comprising a wire resiliently coupled to the vibrator and vibrating therewith, a friction element associated to said wire, one side of said element extending longitudinally of said wire and tangentially to said ratchet wheel, bearing on some of the teeth of said ratchet to cause rotation of said wheel in one direction, a pawl coacting with the teeth of said wheel so as to prevent the latter from rotating in the other direction, means for defining the movements of said element within predetermined limits independently of the amplitude of said vibrator, and means for damping the shocks of said element.

2. A mechanism as set out in claim 1, in which the resilient coupling between said wire and vibrator is constituted by a coil spring connected at one end to said wire and at the other end to the vibrator.

3. A mechanism as set out in claim 1, in which the connection between said wire and element is attained by the friction of the wire in a longitudinal groove provided in the element, the wire being capable of sliding in said groove when the element is prevented from moving.

4. A mechanism as set out in claim 1, in which said element is rigidly fixed to the vibrating wire, and a spring is provided between the wire and the vibrator for damping the shocks of said element.

5. A mechanism as set out in claim 1, in which the means for limiting the movements of the element are constituted by two stops disposed adjacent to the two ends of said element at a distance therefrom equal to d and d' respectively, so as to satisfy the relation $2P>d+d'>P$, wherein P is the tooth pitch of said ratchet wheel.

6. A mechanism as set out in claim 1, in which the element-underside which bears on the teeth of said wheel is provided with a lining of plastic.

7. A mechanism as set out in claim 1, in which the pitch of the teeth of said wheel is smaller than the maximum amplitude of the oscillations of said vibrator.

8. A mechanism as set out in claim 1, in which said pawl is constituted by a resilient leaf of which one end is fixed to a fixed support and the other end bears on a tooth of said wheel.

9. A mechanism as set out in claim 8, in which said pawl is constituted by a leaf made of plastic.

10. A mechanism as set out in claim 1, in which means are provided for exerting a pressure on said element in order to maintain the latter in contact with the teeth of said ratchet wheel.

11. A mechanism as set out in claim 10, in which said means are constituted by an arched leaf spring of which one end is fixed to a fixed support, and of which the other end bears on the upper side of said element, said leaf spring being so disposed as to increase the pressure on the element when the latter moves in order to turn said wheel, and to decrease said pressure when the element moves in the other direction.

12. A mechanism for transforming mechanical vibrations of a vibrator into a rotary movement for actuating a watch or clock mechanism including a ratchet wheel, comprising a wire coupled to the vibrator and vibrating therewith, a friction element associated with said wire, one side of said element extending longitudinally of said wire and tangentially to said ratchet wheel, bearing on some of the teeth of said ratchet to cause rotation of said wheel in one direction, a pawl coacting with the teeth of said wheel so as to prevent the latter from rotating in the other direction, means for defining the movements of said element within predetermined limits independently of the amplitude of said vibrator, and means for damping the shocks of said element; the natural frequencies of said wire, element, ratchet wheel and of the damping means being higher than the frequency of the oscillations of said vibrator.

13. A mechanism for transforming vibrations into rotary motion, comprising, in combination, a ratchet wheel turnable about its axis; a friction block having one face in frictional engagement with a peripheral portion of said ratchet wheel and having another face opposed to said one face and formed with an elongated channel extending substantially along said peripheral portion of said ratchet wheel; an elongated wire extending through and beyond opposite ends of said channel and engaging said block at a part of said channel nearest to said ratchet wheel; vibrating means connected to one end of said wire located beyond said block; and resilient means connected to an opposite end of said wire located beyond said block.

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