United States Patent

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[33] **Switzerland**
[31] **16466/68**

[54] **SYNCHRONIZABLE CLOCK**
4 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** .... **58/28 D,** 58/116
[51] **Int. Cl.** **G04c 3/04**
[50] **Field of Search** .... 58/28, 28 A, 28 B, 28 D, 109, 110, 116

[56] **References Cited**

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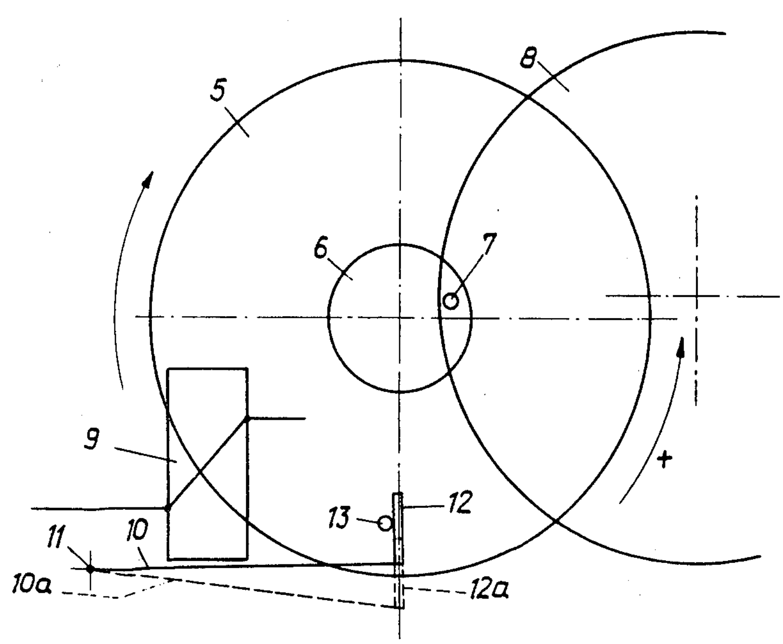
ABSTRACT: Synchronizable clock with a mechanical resonator as regulator, especially receiver clocks synchronized by wireless signals and synchronous clocks driven by alternating current having a mechanical regulator forming a principal part of a running reserve. A coupling is provided between the resonator and the hand mechanism, which only transmits one half of the counting impulses. There is also a regulating mechanism which is connectable to the resonator and which alters the spring force in the resonator according to intensity and position in proportion to the oscillating masses in such a manner that a reversal of the motion of the oscillating masses occurs in the region of the normal dead center.



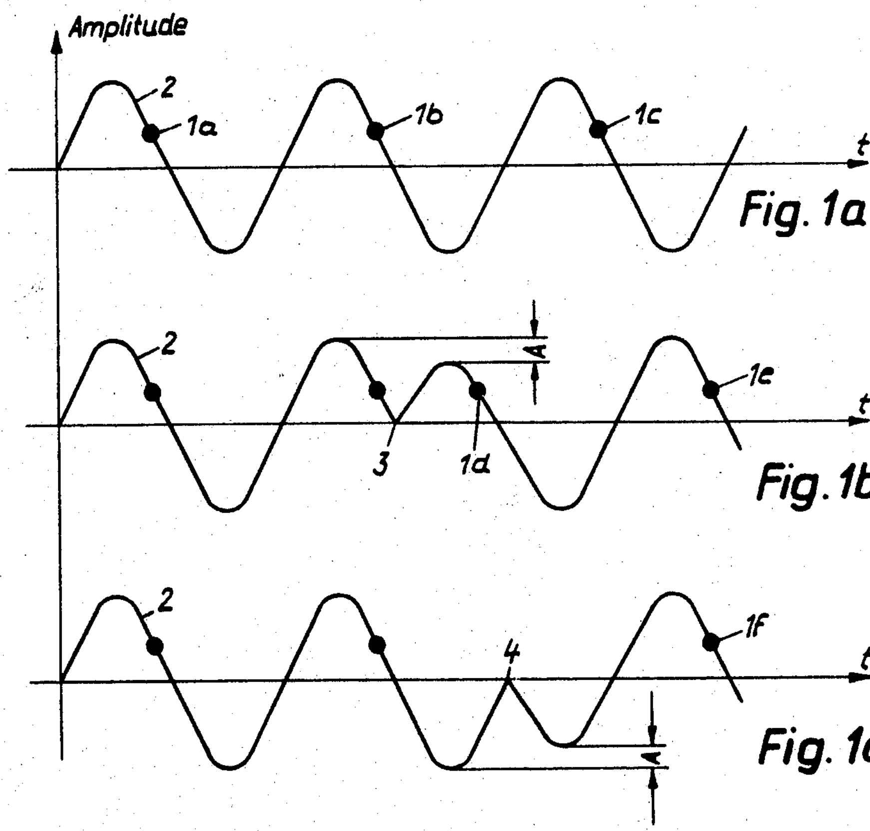


Fig. 1a

Fig. 1b

Fig. 1c

Fig. 2

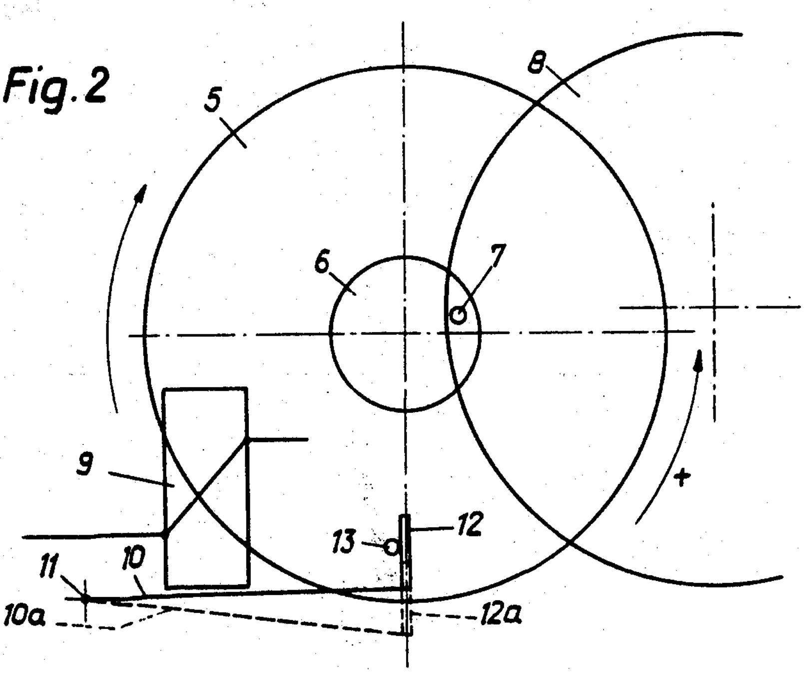
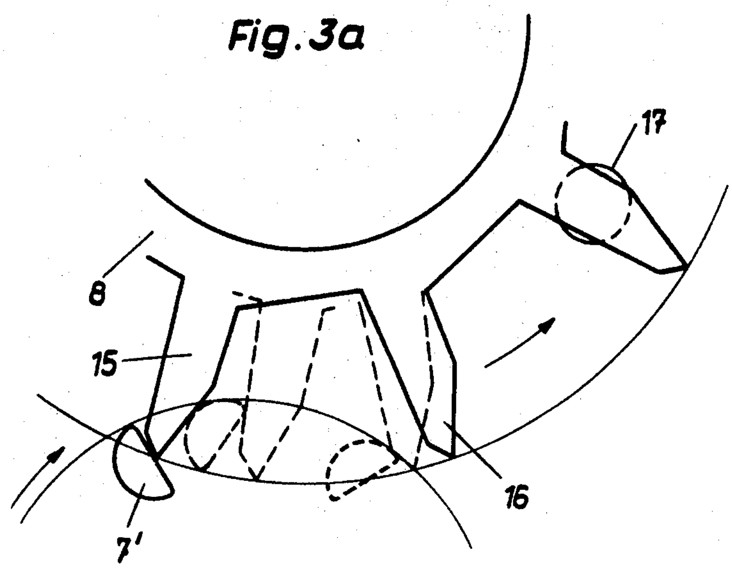


Fig. 3a



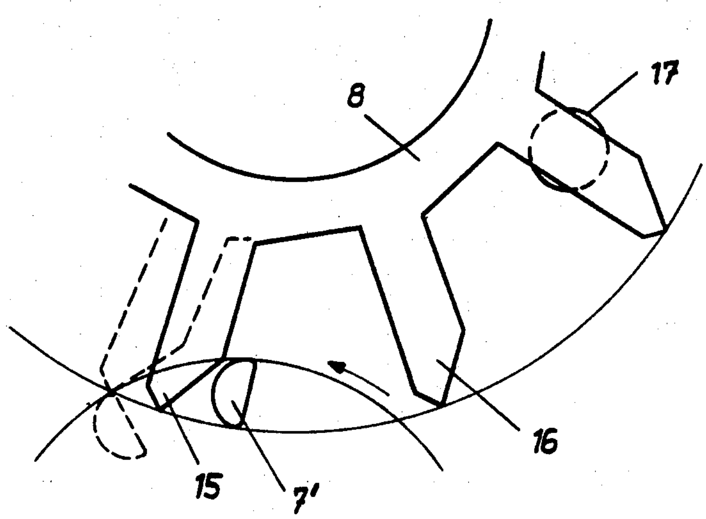


Fig. 3b

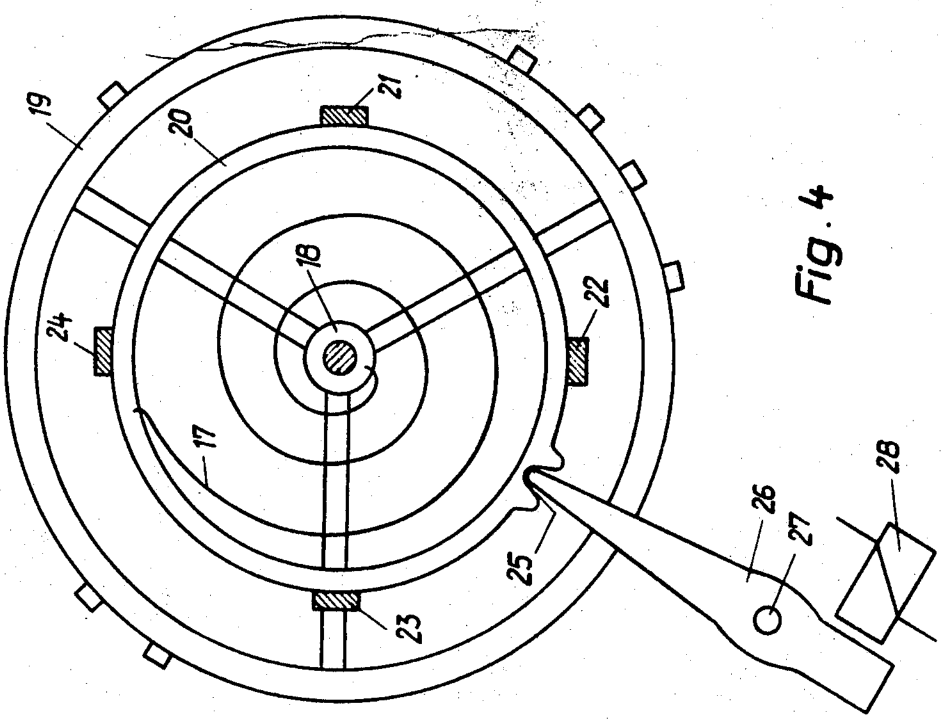


Fig. 4

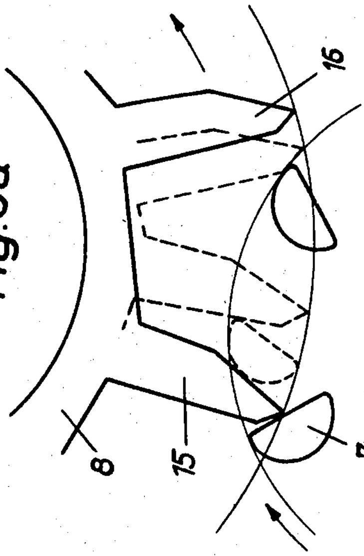


Fig. 3a

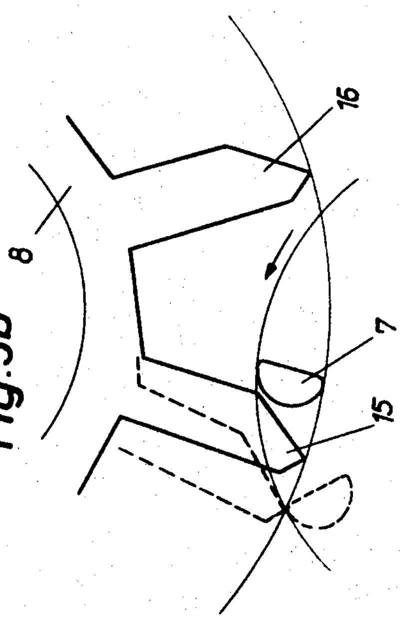


Fig. 3b

SYNCHRONIZABLE CLOCK

BACKGROUND OF INVENTION

Synchronous clocks driven by alternating current, in which in case of a current interruption a mechanical regulator maintains the clock running, are already widely known. In their case, however the synchronous driving mechanism and the running reserve form two functionally completely separate components of the clock.

It has been proposed to construct a receiver clock controlled by wireless signals, which comprises its own electric oscillator. This oscillator serves on the one hand as the regulator of a running reserve should the time controlled wireless signals fail. In addition, the oscillator of the proposed clock is destined to control receiving interruptions during periodically successive time intervals and thus contribute to the suppression of signal interference occurring during these time intervals. In addition provision is made for the automatic correction of the time indication of the proposed receiver clock at given time intervals, when the time indication, owing to some source of error, no longer corresponds to a given time signal transmitted by wireless.

Purely electronic oscillators are generally not very reliable as regulators in clocks, because their output frequency depends too much on the operating temperature and on the operating voltage. In such clocks there is therefore a need for mechanical oscillators acting as regulators. These can be driven electromechanically.

OBJECT OF THE INVENTION

The general purpose of the invention is therefore to provide a synchronizable clock with a mechanical resonator as regulator, which is of simple design and makes it possible to correct very small deviations of the motion of the mechanical resonator by means of synchronizing signals following relatively quickly on one another. A particular purpose of the invention is to provide a receiver clock with a mechanical resonator as regulator, in which automatic regulation correction is effected by means of synchronizing signals.

The task on which the invention is based, consists in providing a mechanical clockwork, in which the number of counted oscillations may be automatically increased or decreased.

DEFINITION OF THE INVENTION

The said task is solved in the case of a synchronizable clock with a mechanical resonator as regulator by means of a coupling between the resonator and the hand mechanism which only transmits one-half of the counting impulses and by means of a regulating mechanism which is connectable to the resonator and which alters the spring force in the resonator according to intensity and position in proportion to the oscillating masses in such a manner that a reversal of the motion of the oscillating masses occurs in the region of the normal dead center. It is not therefore the counting operation itself which is influenced, but it is the resonator which is influenced in such a manner that a greater or lesser number of countable events occur in it.

It is true that it is already known to influence resonators in such a manner that a greater or lesser number of countable events occur in them. In the case of the known clockworks with resonators having a variable output frequency however, the output frequency can essentially only be varied continuously within very narrow limits. On the other hand the invention enables the events in the regulator counted for the time indication to be doubled or completely suppressed for any length of time.

PREFERRED EMBODIMENTS

A particular embodiment of the clock according to the invention is characterized in that the oscillating masses of the resonator are provided with striking surfaces directed against the motion and in that the adjusting mechanism comprises stop springs which are arranged in such a manner that they can be pushed into the path of the motion of the striking surfaces. When such a clock comprises a spiral spring balance resonator as a regulator, a pin on the balance, can form two striking surfaces, in the path of the motion of which a stop spring pivoted on one side may be arranged to swing. The region of the angle of rotation of the balance in which counting at the balance takes place must in this case lie outside the angular region in which the pin can come into contact with the stop spring.

In another embodiment of the clock according to the invention the adjusting mechanism acts on the securing points of the resonator springs, and forms for the securing points paths of motion which run nearly equidistant to the paths of motion of the centers of gravity of the oscillating masses. When such a clock comprises a spiral spring balance as regulator, the adjusting mechanism expediently acts on one end of the spiral spring and forms a path of motion running momentarily nearly tangentially to the spring force at the end of the spiral spring.

The last-named condition is nearly approximately fulfilled by a ring rotatably mounted coaxially to the balance axis, and to which one end of the spiral spring is secured. The ring together with the end of the spiral spring may for instance, under the influence of an electromagnet mechanism, be turned for a short time in the direction opposite to that of the motion of the balance in such a manner that the latter reverses its motion in the region of the normal dead center.

The dead center may be defined as the position of the oscillating masses in which under normal conditions the spring force disappears and the oscillating masses have the greatest kinetic energy.

The invention will be described more fully in the following in connection with various embodiments with the help of the accompanying drawings. In these drawings:

FIGS. 1*a*, 1*b*, 1*c* show diagrams of the oscillating motion of the mechanical oscillator of the clock according to the invention, in which the amplitude of oscillation is plotted over the time of oscillation.

FIG. 2 shows a schematical sketch of the principal components of a first embodiment of the clock according to the invention.

FIGS. 3*a*, 3*b* show schematic enlargements of individual parts of a coupling between the spiral spring balance resonator and a time indicating mechanism of the clock, in which only each half of each oscillation of the resonator is counted.

In FIG. 1*a* the amplitude of a mechanical resonator is plotted as a sinusoidal oscillation over a period of time. The counting operation at the resonator takes place for instance in the third quarter of the first half-oscillation in a local region of oscillation and at times which are indicated on a sinusoidal curve 2 by round black spots 1*a*, 1*b* and 1*c*.

According to the representation in FIG. 1*b* an external intervention in the conditions of free oscillation of the mechanical resonator at a dead center 3 after the counting operation in the local and time region 1*b* causes a reversal of the oscillating motion, leading to a single reduction of the amplitude by a quantity A. A counting operation not normally provided for follows this in the local and time region 1*d*, which approximately corresponds in time to the seven-eighths of the second full oscillation of the normal condition of oscillation according to FIG. 1*a*. If then the resonator is not further influenced in the sense of synchronization, the following counting operation takes place in the local and time region 1*e*, which in relation to the time region 1*c* of the normal condition of oscillation according to FIG. 1*a* is shifted by approximately half an oscillation.

According to the representation in FIG. 1*c*, a synchronizing action interferes with the conditions of oscillation of a resonator towards the end of the second full oscillation, so that a reversal of the motion takes place at a dead center 4, which in relation to the dead center 3 is shifted by half an oscillation. After the reversal of the motion at the dead center 4, there follows an oscillating motion the amplitude of which is smaller by a quantity A than the normal amplitude. If the resonator is not further influenced in the synchronizing sense, the next counting operation occurs in the local and time region *1f*, which corresponds to the region *1e* in FIG. *1b*. It is of course not to be expected that a period between counting operations of the oscillating motion will automatically be multiplied or divided by an integer owing to the forced reversal of motion at a dead center. To obtain this would require special measures.

In FIG. 2 the circle indicated by the reference **5** represents schematically a spiral spring balance resonator. A central disk **6** is provided with an adjusting finger **7** parallel to the axis of the balance, which in the local and time region of a counting operation engages the teeth of a ratchet wheel **8**.

The adjusting mechanism of the clock comprises principally an electromagnet **9**, which is actively connected to a magnet armature **10** pivoted to be able to swing to one side. The bearing is represented in the plane of the drawing by a dot **11**. A stop spring **12** is arranged at the free end of the magnet armature perpendicularly to the latter and can be swung in the path of a striking pin **13**. The strike pin **13** is secured to the balance and is approximately parallel to the axis of the balance. The dotted lines **10*a*** and **12*a*** represent the magnet armature and the stop spring in the inactive position when the electromagnet **9** is not excited.

In the active position, when it is swung inwards, the stop spring **12** forms a supplementary spring, which increases the elastic return force in the whole of the resonant system in one direction. The resonant system then comprises the balance, which forms an oscillating mass, and the spiral spring which is not shown as well as the stop spring **12**. In the withdrawn state the resonant system only comprises the balance and the spiral spring.

The striking pin **13** could obviously also be some kind of elastic component, which in the active state of the magnet armature **10** would transiently form a part of the oscillating system not only on account of its mass but also on account of its elastic properties.

Details of the control finger and of the ratchet wheel **8** may be seen in FIGS. *3a* and *3b*. According to these a rotation of the balance in the clockwise direction causes the control finger **7** to rotate the ratchet wheel **8** by one tooth **15** in the counterclockwise direction. Intermediate positions and an end position of the control finger **7'** and of the tooth **15** are shown in broken lines in both figures.

In FIG. *3a* one may see that the control finger **7'** first moves the tooth **15** of the ratchet wheel **8** through a relatively small angular rotation in the counterclockwise direction when the balance effects a rotation in the clockwise direction. As soon as the control finger **7'** is moved out of reach of the tooth **15**, the ratchet wheel **8** is turned back with all its teeth to its initial position by means of a permanent magnet **17**. The permanent magnet **17** is a simple circular pin held over against the teeth of the wheel **8** and which attracts the tooth which is nearest to it.

According to the illustration of FIG. *3b* the control finger **7'** by a rotation of the balance in the reverse clockwise direction comes into contact with another striking face of the tooth **15** and the ratchet wheel **8** until it comes to an end position in which it again comes under the influence of the permanent magnet.

The permanent magnet then automatically moves the ratchet wheel to such a position that the tooth **15** occupies the position which had been occupied at the beginning of the control operation by a neighboring tooth **16**.

The rotation of the balance in the reverse clockwise direction is thus not counted in the time indicating mechanism, while a rotation of the balance in the clockwise direction causes a rotation of one tooth of the ratchet wheel **8**.

We claim:

1. A synchronizable clock comprising a mechanical resonator having oscillating masses; a hand mechanism, a coupling positioned between said resonator and said hand mechanism, said coupling only transmitting the oscillation of the resonator during a half-period of oscillation; a regulating mechanism connectable to said resonator for producing a reversal of the motion of the oscillating masses of said resonator when the resonator is in the region of the normal dead center, said coupling thereby adding or suppressing a counting pulse during each period of oscillation when said regulating mechanism is connected.

2. Clock according to claim **1** wherein the oscillating masses of the resonator are provided with striking faces directed against the direction of motion, and wherein the regulating mechanism is provided with a stop spring arranged so that it can be brought into the path of the striking faces.

3. Clock according to claim **2**, wherein the regulating mechanism is provided with at least one electromagnet the armature of which can be swung to one side and carries a stop spring.

4. Clock according to claim **3**, with a spiral spring balance resonator as regulator, wherein a pin on the balance forms two striking faces in the path of motion of which a stop spring which is pivoted on one side can be moved, and wherein the region of angular rotation of the balance in which the counting operation is effected at the balance lies outside the angular region in which the pin can come into contact with the stop spring.

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