United States Patent

Zeter et al.

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[54] **STRIKING MECHANISMS FOR CLOCKS**

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[51] **Int. Cl.**.....**G04b 25/00**

[58] **Field of Search**.....58/8, 9, 10, 12, 13, 38

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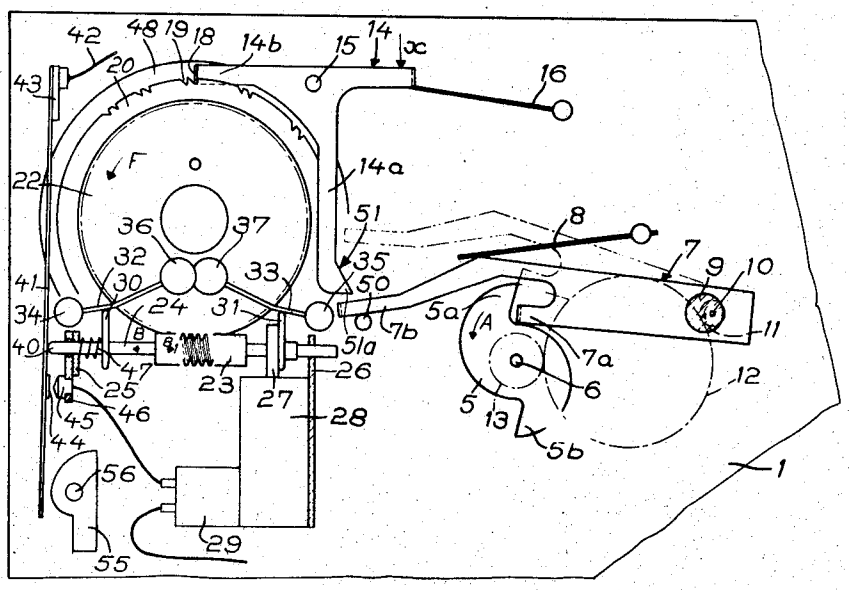
[57] **ABSTRACT**

A clock striking mechanism includes a counting wheel having peripheral notches spaced by amounts which differ and related to the number of strikes at each striking action, a gear wheel fast with the counting wheel and meshing with a worm. A cam driven by the minute spindle of the clock movement raises a lever when the hour or half-hour is to be struck and a projection on the lever is raised thus leaving the counting wheel free to rotate. The worm is mounted on a spindle which is arranged to open and close a pair of contacts in a supply circuit of a motor and release of the counting wheel frees the worm and its spindle to close the contacts under the bias of a spring. The motor is energized and rotates the spindle to actuate striking mechanism by means of a cam or cams mounted on the spindle. The worm simultaneously drives the gear wheel and hence the counting wheel and striking ceases when the next notch is reached and the lever projection engages therein.

14 Claims, 8 Drawing Figures



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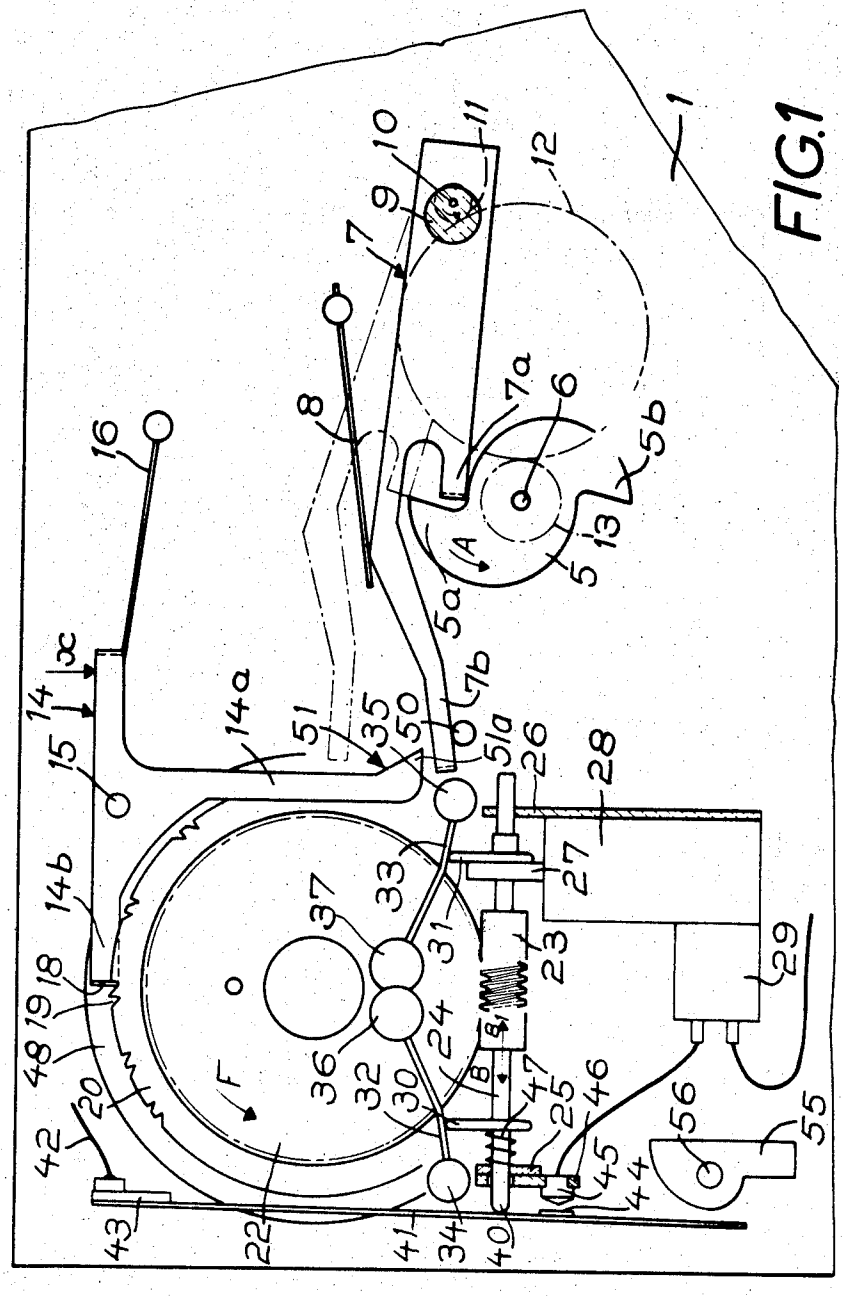

FIG.1

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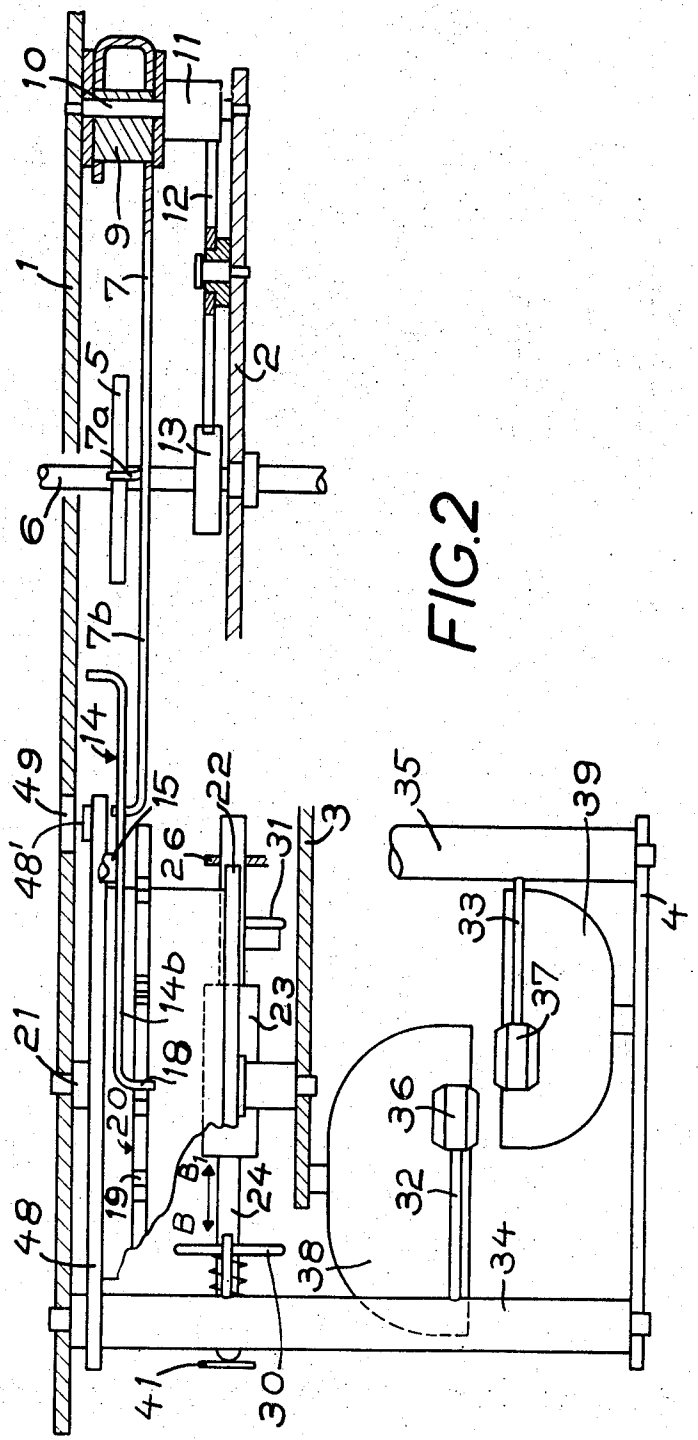
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FIG.2

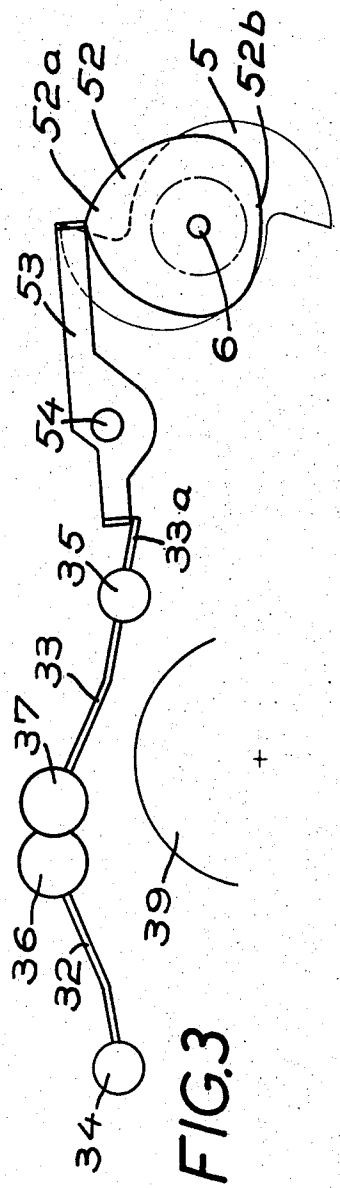
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FIG.3

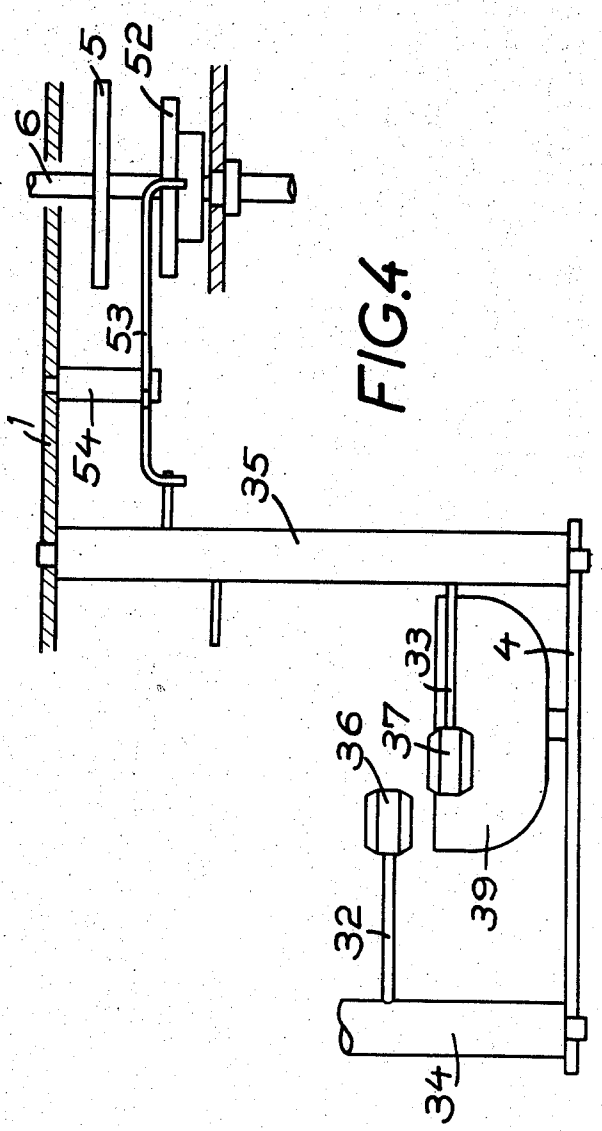
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FIG.4

FIG.5

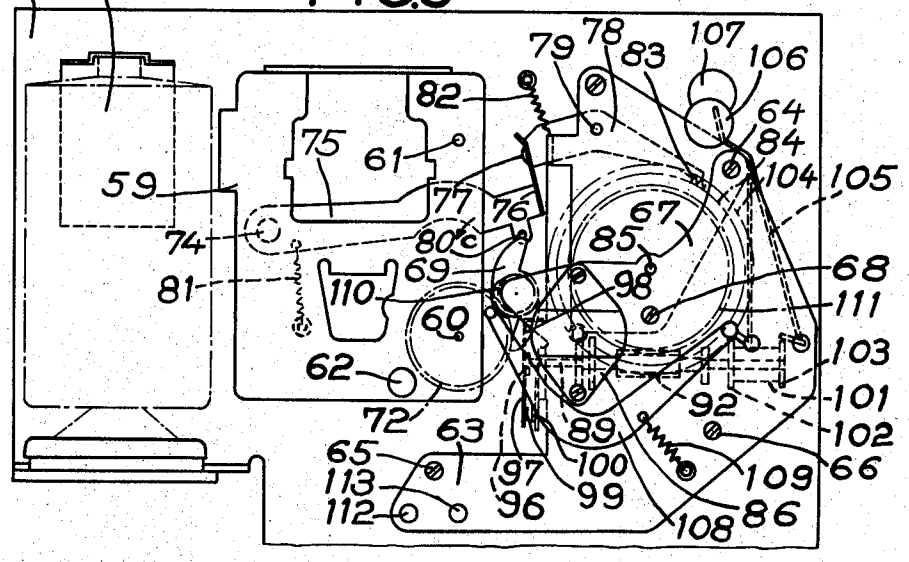


FIG.6

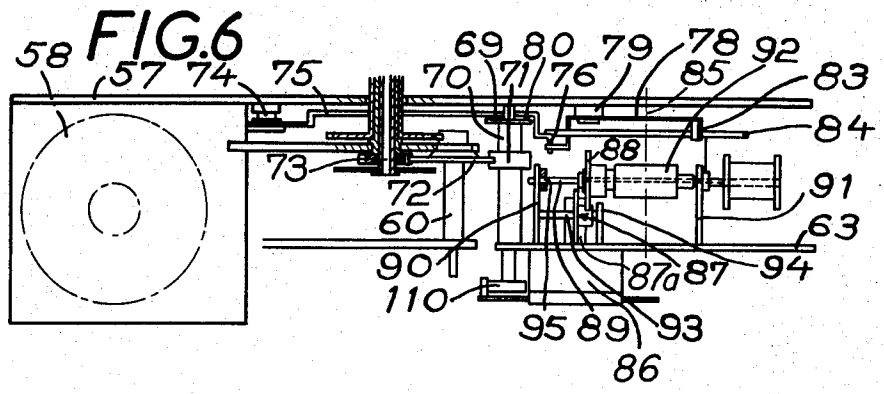
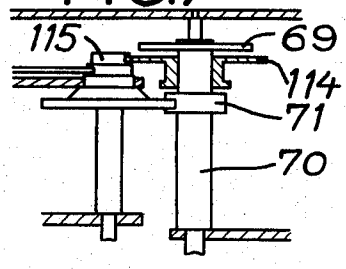


FIG.7



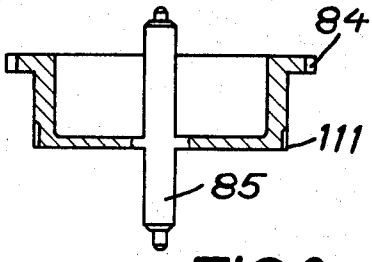


FIG.8

STRIKING MECHANISMS FOR CLOCKS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to striking mechanisms for clocks.

2. Description of the Prior Art

Striking mechanisms have been proposed which comprise release means constituted by an assembly of levers actuated from a cam driven by the horological movement at a speed of one revolution per hour, one of the levers co-operating with a counting wheel determining the number of strikes.

Furthermore, striking devices have been proposed in which the striking is effected by an electric motor. Now these proposed striking mechanisms are intended more particularly for conventional mechanically actuated horological movements. On the other hand it is appreciated that it is not desirable to require horological movements, particularly those with a balance wheel drive to effect substantial work which engenders the risk of disturbing the operation of the movement itself.

Accordingly, it is an object of the invention to provide a striking mechanism which can be used with an electrical movement and which can be stopped and restarted without disturbing the movement.

SUMMARY OF THE INVENTION

According to the present invention there is provided in a striking mechanism for a clock, a counting wheel for determining the number of strikes at each striking action, a gear wheel fast with the counting wheel, a worm meshing with the gear wheel, a spindle carrying the worm, said spindle being rotatable and axially displaceable in a direction perpendicular to the axis of rotation of the counting wheel and the gear wheel, an electric motor for rotating said spindle, sound-generating striking means, a supply circuit of the electric motor, contact means in the supply circuit operable to close or open the circuit by said axial displacement of the spindle, and means for releasing the counting wheel and gear wheel whereby to initiate the axial displacement of the spindle of close the contact means, energization of the electric motor and actuation to the sound-generating striking means by rotational movement of the spindle for a period of time determined by rotation of the counting wheel.

In a preferred embodiment, the striking mechanism constitutes a unit assembly with completely independent operation on which a location is reserved for the addition of a strictly conventional horological movement, with a balance wheel drive and capable of being assembled on an automatic assembly line in order to provide the best possible conditions for cost price with a novel type of electrical horological movement with a striking mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Certain embodiments of clock striking mechanisms in accordance with the invention will now be described, by way of example with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is an elevation of one embodiment of a clock striking mechanism in accordance with the invention;

FIG. 2 is a plan view of the striking mechanism shown in FIG. 1;

FIG. 3 is an elevation of one embodiment of control means for the striking members of the mechanism;

FIG. 4 is a plan view of the control means for the striking members shown in FIG. 3;

FIG. 5 is a rear view in elevation of the mounting plate of the striking mechanism and showing its incorporation with respect to the horological movement;

FIG. 6 is a plan view of the assembly of the striking mechanism shown in FIG. 5;

FIG. 7 is a plan view of means enabling automatic stopping of the action of the striking mechanism during a twelve hour period; and

FIG. 8 is a view in section of one embodiment of a counting wheel and of a toothed wheel formed by moulding integrally.

In FIGS. 1 and 2, there are shown a main plate 1 and rear plates 2, 3 and 4, interconnected by posts or other cross-pieces and on which there is mounted a striking mechanism which includes release or starting means constituted by a cam 5 fast with a spindle 6 of the horological movement making one revolution per hour. The cam 5 is rotated in the sense A and has two noses 5*a*, 5*b*, each having an inclined ramp followed by a substantially radial face.

A control lever 7 is pivotally mounted on a support 9 and presses under the action of a spring 8 operative at an elbow part of one of its arms 7*a* on the cam 5, the support 9 being mounted eccentrically on a spindle 10 carrying a pinion 11 meshing through the intermediary of a toothed wheel 12 with a pinion 13 fast with the spindle 6 of the movement.

The arm 7*b* is also adapted to abut against a stop which co-operates at its end with one of the limbs 14*a* of a stop lever 14 pivotally mounted on a spindle 15 secured on the plate 1; the lever 14 which is subject to the action of a spring 16 at another limb 14*b* of which the end 18 is engaged in one of the notches of a counting wheel 20. This counting wheel 20 which has on its periphery a series of notches 19 has between them angular spacing corresponding to the number of strikes for each striking action, is fast on a spindle 21 rotatably mounted between the plates 1 and 3 and carrying a gear wheel 22.

The gear wheel 22 meshes with a worm 23 secured on a spindle 24 disposed perpendicularly to the axis 21 and capable of sliding axially as indicated by the double arrow B, B_1, the support members 25, 26 being constituted by arms or tabs rigid with the plates. A gear wheel 27 is mounted on the spindle 24 which is driven through the intermediary of a speed-reducing gear 28 by means of an electric motor 29.

The spindle 24 also carries two rotary cams 30, 31, which are respectively in contact with rods 32, 33, fixed on the spindles 34, 35, pivotally mounted between the plates 1 and 4, the said rods 32, 33, carrying at their ends hammers 36, 37 arranged to contact bells 38, 39 secured respectively on the plates 3 and 4. It should be understood that the bells can be replaced by gongs or any other sound-producing means.

During their rotation, the cams 30, 31 raise the hammers 36, 37 which fall again coming into contact with the bells 38, 39.

At one of its ends 40, the spindle 24 is in contact with a flexible conductive strip 41 mounted on a support 43 and connected at 42 to one of the terminals of an electric current source, the said strip 41 carrying at its free

end a contact 44 arranged to contact a contact 45 fixed on an insulating support 46 and electrically connected to the other of the terminals of the electric current source for supplying the motor 29. The spindle 24 which can be displaced axially, is normally biased in the direction of the arrow B_1 by a spring 47 supported by the support member 25.

A disc 48 carrying graduations 48' corresponding to the notches 19 of the counting wheel is fast with the spindle 21 and can be seen through a slit 49 provided in the plate 1. This arrangement enables the position of the counting wheel 20 to be adjusted in order to control the number of strikes.

The striking mechanism operates as follows:

As indicated in FIGS. 1 and 2, the counting wheel 20 is normally locked by the stop lever 14 of which the end 18 is engaged in one of the notches 19 and the spindle 24 is in the position in which it is in the sense of the arrow B, compressing the spring 47 so that the contacts 40, 45 are spaced apart from one another, and thus interrupting the supply circuit of the motor 29 which is therefore at rest.

The cam 5 is rotated in the sense of the arrow A, at the speed of one rotation per hour, the arm 7*a* of the control lever 7 follows along the inclined ramp of the nose 5*b*, so as to raise the lever 7 which rests on the abutment 50 and to bring it into the position shown in chain line in FIG. 1.

To avoid contact between the arm 7*b* and the toe 51 of the arm 14*a* of the stop lever 14, use is made of the eccentric mounting of the pivot of the lever 7. In effect, by the rotation of the pinion 11 driven by the gear wheel 12 and the pinion 13, because of a complete rotation in thirty minutes, there is imposed by the action of the eccentric 9 on the lever 7 an elliptical trajectory to the end of the arm 7*b* and, as a consequence, there is no engagement between the latter and the toe 51, during the upwards path of the lever 7. A surface of said toe 51 defines an inclined plane 51*a*. It is also possible to conceive a simplified device in which the lever 7 pivots about a fixed pin, the traverse of the toe 51 being effected by making use of the resilient deformation of the end of the arm 7*b* in the direction perpendicular to the displacement of the lever 7. In order to allow sliding, the rear edge of the arm 7*b* must be inclined.

This latter proposal, which is simpler than that of an eccentric, requires nevertheless, a larger energy output from the horological movement.

When the arm is at the peak of the nose 5*b*, that is to say at an hour position or at a half-hour position, the lever 7 moves rapidly into a trough of the cam 5, whilst passing from the position shown in chain lines to the position shown in full lines. During downwards passage the end of the arm 7*b* encounters the toe 51 of the stop lever 14, which latter pivots about the spindle 15 and momentarily disengages from one notch 19 of the counting wheel 20.

Under the action of the thrust of the spring 47, the worm 23 operates as a toothed rack causing the wheel 20 to turn through several degrees in the sense of the arrow F, so that the end 18 of the lever 14 then rests on the periphery of the wheel 20.

After displacement of the spindle 24 in the direction of the arrow B_1, the resilient strip 41 being no longer biased by the end 40 of the spindle 24, allows the contacts 44 and 45 to make contact, thus completing the supply circuit of the motor 29 which can then drive the spindle 24 and the worm 23 through the speed-reducing gear 28. The worm 23 drives rotationally the gear wheel 22 and as a result the counting wheel 20 with which it is rigid.

At each rotation of the spindle 24, the cams 30 and 31 move angularly raising successively the hammers 36, 37 which in their fall strike the bells 38 and 39.

As soon as a notch 19 of the counting wheel 20 presents itself below the end 18 of the lever 14, the latter, forced by the spring 16, pivots into the notch and stops the rotation of the counting wheel and of the spindle 24 carrying the cams 30, 31.

The counting wheel 20 being locked by the lever 14 and the motor 29 being energized since the contacts 44 and 45 are in contact, it follows that the gear wheel 22 rigid with the counting wheel cannot turn and that by reaction the worm 23 thus engages the spindle 24 in the direction of the arrow B by the action of screwing on the teeth of the wheel 22.

The spring 47 being compressed and the end 40 of the spindle 24 returning the resilient strip 41, the electrical contact is interrupted between the contacts 44 and 45, so that the motor 29 is no longer energized and thus stops.

The striking mechanism is thus again in the initial condition as shown in FIGS. 1 and 2 and it is thus ready for a fresh striking action at the following full hour or half-hour.

According to one embodiment of the mechanism, a complete rotation of the counting wheel 20 corresponds to a program of striking extending over a period of twelve hours. This period of time corresponds to a total of 90 strikes of each of the two bells ($1 + 2 + 3 \ldots + 12$), that is 78 times for the hours and 12 for each of the half hours. The ratio of de-multiplication between the worm 23 and the wheel 22 is thus exactly 90, because one turn of the spindle 24 corresponds to one striking action.

Normally the striking mechanism hereinbefore described and shown in FIGS. 1 and 2 enables the production of identical strikes "bim-bam" or "ding-dong" both for the hours and for the half-hours. It is however possible to differentiate these latter by striking only one of the bells, by means of the mechanism illustrated in FIGS. 3 and 4. On the spindle 6 carrying the cam 5, there is mounted a second cam 52 which cooperates with one of the ends of an intermediate lever 53 pivotally mounted on a spindle 54 secured on the plate 1 and of which the other end is in contact with an extension 33*a* of the rod 33 of one of the hammers 37.

By the rotation of the cam 52 and through the intermediary of the lever 53 after its passage over the nose 52*a* of the cam, it is possible to hold raised once an hour and at the instant of the striking, the hammer 37. Only the hammer 36 can strike the bell 38 at this moment. At the following initiating or triggering action, that is to say, after half a rotation of the spindle 6, the hammer 37 is freed; when the lever 53 is on the lower portion 52*b* of the cam which is closest to the spindle 6. It is clear that according to the relative disposition of the cams 5 and 52, the striking on a single bell or on both bells will be produced either at the hours or at the half-hours.

In order to match the striking mechanism with the horological movement, provision is made for acting on the lever **14**, by means of a push-button not shown, acting in the direction of the arrow X, in order to free, at will, the counting wheel **20**.

This operation must be effected prior to starting the clock or after a voluntary, prolonged, stoppage of the striking mechanism. Stoppage of the striking mechanism is effected by displacing a finger **55** pivotally mounted about a spindle **56**, in such a manner as to act on the end of the strip **41** and to hold apart the contacts **44**, **45** in order to interrupt the supply to the motor **29**.

Finally, the temporary stoppage of the striking mechanism, particularly during the night, may be provided by means of another lever not shown, which holds the hammers **36**, **37** away from the bells. In this case, the mechanism continues to operate but without striking, and it is not necessary to re-match the striking mechanism when it is brought into operation again.

In FIGS. **5** and **6**, there is illustrated another embodiment of the striking mechanism in accordance with the invention in which the striking mechanism constitutes a unit assembly with completely automatic operation, in which a space is reserved for the addition of a strictly conventional horological movement, and particularly a balance wheel movement. This arrangement enables assembly on a single automatic assembly belt in order to bring about the best conditions for the cost of manufacture of a novel kind of electrical horological movement with a striking mechanism.

In FIG. **5**, a rear view is illustrated of the mounting plate **57** which comprises on one side a space for a battery **58** and in its central part for the horological movement outlined by the shape of its front main plate **59**, the indication of its central axis with the spindles driving the hands, as well as the spindle **60** of the pinion and of the counter-wheel. The horological movement is secured at the points **61** and **62** onto the plate **57**.

Most of the members forming the striking mechanism are mounted on the side opposite that of the battery, on the plate **57**, between the latter and the rear plate **63**, the pillars **64**, **65**, **66** providing the connection between the plate **63** and the front plate **57**. An intermediate plate **67** is secured by the pillars **64** and **68**.

As in the embodiment hereinbefore described, a starting or initiating cam **69** and a cam **110** for raising the hammers are mounted on a spindle **70** which carries a pinion **71** driven by a gear **72** of the horological movement, which rotates in the sense of the arrow C, at the same speed as the minute spindle **73**, viz. one turn per hour.

On the mounting plate **57** there is secured a pivot **74** on which is pivoted a control or detent lever **75** carrying at one of its ends a resilient strip **76** having an opening in which is engaged a nose **77** of a stop lever **78** pivotal about a pin **79**.

The control lever **75** likewise carries a pin **80** which abuts the cam **69** under the action of a spring **81** secured to the plate **59**.

Furthermore, the lever **78** subject to the action of a return spring **82**, has a nose **83** which follows precisely the profile of a counting wheel **84** pivotally mounted between the plates **57** and **63**, about a pin **85**. As in the embodiment hereinbefore described, the stop wheel **84** comprises notches in which the nose **83** of the stop lever **78** is capable of being engaged thus locking the counting wheel.

A micro-electric motor **86** is mounted on the plate **63** and provides control of the striking mechanism and of which the rotor is prolonged by a worm not shown in the drawing and driving an intermediate transmission **87** comprising a second worm **87***a* meshing with a wheel **88** secured on a rotary shaft **89** slidably axially mounted in arms **90** and **91**, the said shaft **89** carrying a worm **92** meshing with a control wheel **111** rigid with the counting wheel **84**.

The intermediate transmission **87** is secured on a spindle **93** rotatably mounted in flexible arms **90** and **94** of the plate **63**. The end **95** of the spindle **89** is arranged to contact with the plate contra-pivot **96** of the resilient strip **97** secured at **98** on a bent arm of the main plate **63**. The strip **97** is connected to the supply circuit of the electric motor, carrying at its free end a contact **99**, "movable contact," which is arranged to contact a contact **100**, "fixed contact", connected to the other end of the electrical circuit. A cylindrical member **101** comprising two cams **101**, **102** is secured on the spindle **89**, on which cams the ends of rods **104**, **105** of the hammers **106**, **107**, abut, which strike the bells or gongs as are hereinbefore described.

One of the rods **104** of the hammer **107** is connected to a lever **108** which is held by a spring **109** against the cam **110** which raises one of the hammers of one of the striking mechanisms, so as to differentiate sounding of the hours and half-hours.

Furthermore, two additional openings **112** and **113** are provided in the plate **63**, which accommodate two auxiliary hammer shafts for striking a horizontal gong, these hammers being controlled by a conventional system of rods from the shafts of the rods of the hammers **104**, **105**.

As in the hereinbefore described embodiment, the cam **69** making one revolution per hour, acts on one of its noses on the pin **80** which falls into one of the troughs of the cam and the lever **75** biased by the spring **81** drives through the resilient strip **76**, the toe **77** of the stop lever **78**.

When the end **83** of the lever **78** is disengaged from one notch of the counting wheel **84**, the latter is freed and can freely turn through the axial force of the worm **92** which forces on it the resilient strip **97**, in such a manner that in falling the stop lever **78** rests on a tooth of which the size determines the duration of the striking action.

The disengagement of the strip **97** leads the movable contact **99** into abutment against the fixed contact **100**, thus closing the electrical circuit and energizing the motor **86** which drives through the spindle **89** the cams **102**, **103**, acting on the rods of the hammers **106**, **107** and the counting wheel **84**, through the worm **92** and the gear wheel **111**.

As soon as the counting wheel **84** is again locked by the toe **83** of the lever **78**, the reaction of the axial thrust on the worm **92** increases, loading as hereinbefore described the strip **97** and causing the separation of the contacts **99** and **100** and cutting off of the current.

Because of the inertia of the motor **86**, the latter continues to turn after cutting off the current so that the distance between the contacts **99** and **100** is sufficient.

In FIG. 7 there is shown an embodiment of the striking device with an automatic stop of the striking action during twelve of the 24 hours.

On the control shaft **70** there is freely mounted for rotation between the cam **69** and the toothed wheel **71**, a wheel **114** driven by a pinion **115** on the countershaft **60** of the horological movement which rotates at a speed of one revolution for each period of 24 hours.

The cam **116** automatically actuates during twelve hours of the 24 hours a lever for raising the hammers, not shown, which prevents the latter from striking, particularly during the 12 hours of the night.

In FIG. **8**, there is shown an embodiment of the counting wheel **84** moulded integrally with the control wheel **111** and its spindle **85**.

What is claimed is:

1. In a striking mechanism for a clock,
- a counting wheel for determining the number of strikes at each striking action,
- a gear wheel fast with the counting wheel,
- a worm meshing with the gear wheel,
- a spindle carrying the worm, said spindle being rotatable and axially displaceable in a direction perpendicular to the axis of rotation of the counting wheel and the gear wheel,
- an electric motor for rotating said spindle,
- sound-generating striking means,
- means driven by the motor to actuate said striking means,
- a supply circuit of the electric motor,
- contact means in the supply circuit operable to close or open the circuit by said axial displacement of the spindle,
- resilient means biasing the spindle in the axial direction to close the contact means,
- means for releasing the counting wheel and gear wheel whereby to initiate the axial displacement of the spindle to close the contact means, energization of the electric motor and actuation of the sound-generation striking means by rotational movement of the spindle for a period of time determined by rotation of the counting wheel, and
- a clock movement controlling said releasing means.

2. A striking mechanism according to claim **1** wherein the contact means comprises
- a flexible conductive strip electrically connected to the said supply circuit,
- a movable contact member on said strip, and
- a fixed contact connected to the supply circuit,
- said contact, when in abutting relationship, serving to complete said supply circuit.

3. A striking mechanism according to claim **1** comprising
- a spindle supporting the counting and gear wheels, the counting wheel being a moulding integral with the gear wheel and the spindle.

4. A striking mechanism according to claim **1**, comprising
- a second worm mounted fast for rotation with the motor,
- a gear wheel meshing with the second worm and serving to drive the spindle of the first worm,
- two main support plates,
- two arms bent through 90° carried by said support plates and themselves supporting the spindle of the first-mentioned worm,
- said sound-producing striking means including
  - a first bell,
  - a second bell,
  - respective first and second striking hammers, and
  - cams co-operating with the striking hammers and mounted on the spindle,
- the axes of the motor, of the counting wheel and the shafts of the striking hammers being orientated parallel to the two said main plates.

5. A striking mechanism according to claim **1**, wherein said release means comprises
- a two-armed pivotal control lever,
- a cam making one revolution per hour and having two noses,
- means biasing one arm of the two-armed lever into contact with the cam, and
- a stop lever of generally bell-crank form one branch of which is engageable by the other arm of the control lever and the other branch of which co-operates with the periphery of the counting wheel, said other branch being movable away from the counting wheel by the action of the said other arm of the control lever as the said one arm of the control lever disengages from one or other of the noses of the said cam.

6. A striking mechanism according to claim **5**, comprising
- a shaft eccentric with respect to the axis of a spindle of a horological movement arranged to drive the shaft,
- said shaft carrying the control lever and being rotatable at such a speed that the stop lever is disengaged from the counting wheel at the same time as the control lever is driven by the cam.

7. A striking mechanism according to claim **5** comprising
- a resilient strip having an opening therein mounted on the end of that arm of the control lever which co-operates with one of the branches of the stop lever, the said arm of the control lever being engaged on the said branch of the stop lever by said opening.

8. A striking mechanism according to claim **5** wherein the tip of the arm of the control lever which co-operates with one of the branches of the stop lever is resiliently deformable and has on one of its faces an inclined plane.

9. A striking mechanism according to claim **5** wherein said sound-generating striking means comprises two sound generators and two respective strikers and the release means comprises
- a second cam rotating once per hour mounted co-axially with the first-mentioned cam and operative selectively to de-activate one of said strikers.

10. A striking mechanism according to claim **1** wherein
- said sound-generating striking means includes
  - at least one sound generator and
  - a striker, and
- said spindle carries a cam for actuating the striker.

11. A striking mechanism according to claim **10** comprising
- a gear wheel mounted on the cam-carrying spindle, said gear wheel being driven by the pinion of the counter shaft of the horological movement at a speed of one revolution for every 24 hours, and
- a cam fast for rotation with said gear wheel,

said cam being effective during 12 hours out of every 24 hour period to render the striker of one sound generator inoperative.

12. A striking mechanism according to claim 1 wherein the counting wheel has peripheral notches and the mechanism further comprises a disc fast for rotation with the counting wheel and having graduations corresponding to the notches of the counting wheel.

13. A clock including a striking mechanism according to claim 1, wherein the striking mechanism forms an independently operable unit assembly comprising

an assembly plate forming a false casing,

a conventional horological movement, and

an electric supply source mounted on the assembly plate.

14. A striking mechanism according to claim 1 comprising means for selectively maintaining the contact means in an open condition in which the supply circuit is interrupted.

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