Dec. 15, 1953 W. H. FARR 2,662,365

HOUR METER

Filed Oct. 13, 1951 2 Sheets-Sheet 1

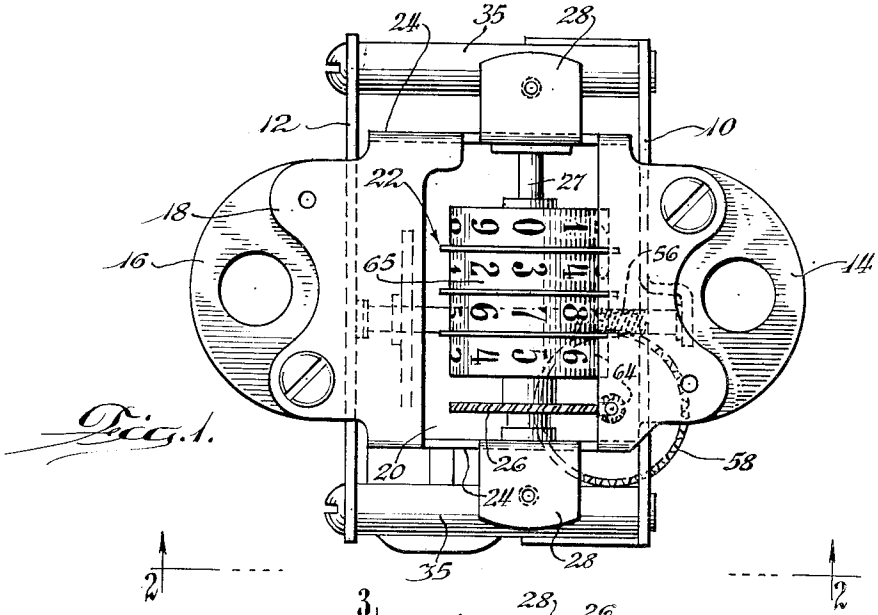


Fig. 1.

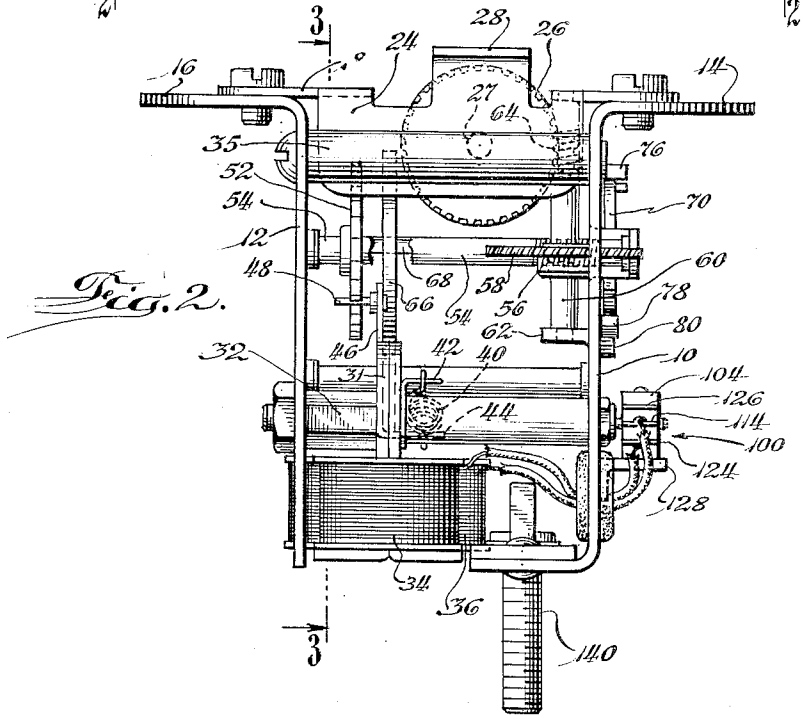


Fig. 2.

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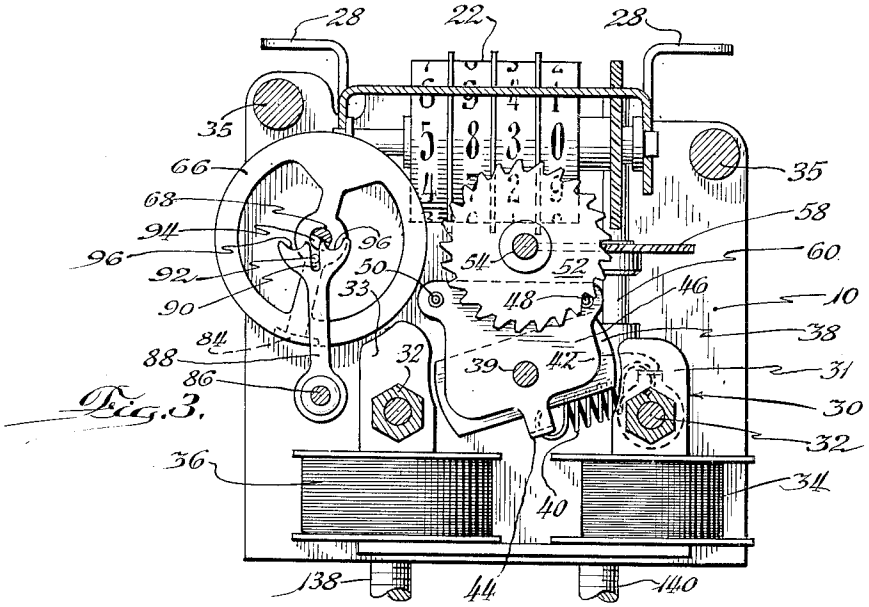


Fig. 3.

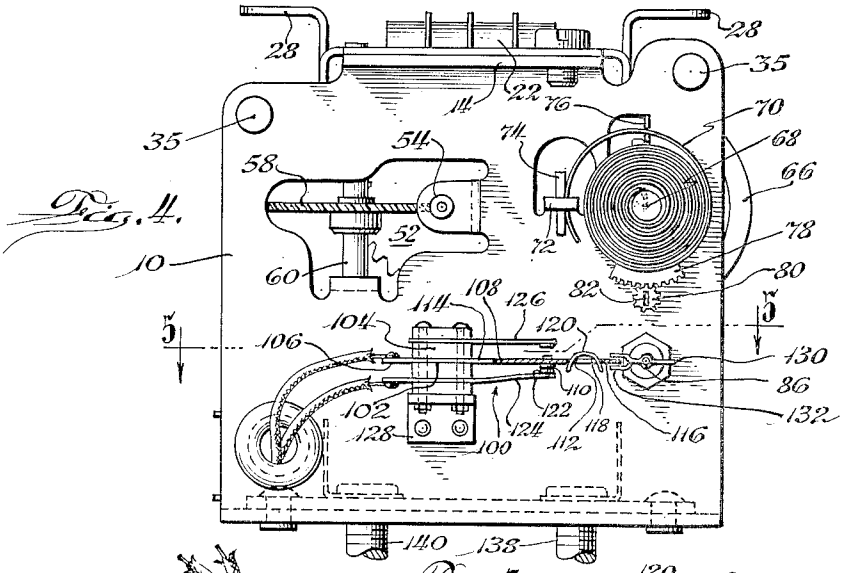


Fig. 4.

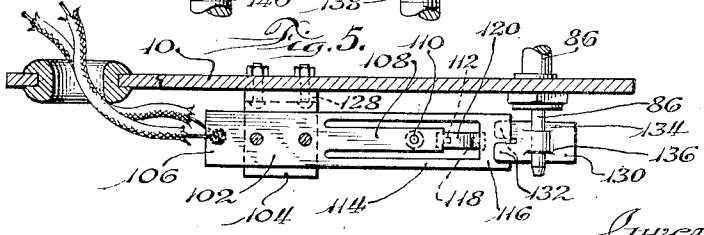


Fig. 5.

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UNITED STATES PATENT OFFICE

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HOUR METER

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Application October 13, 1951, Serial No. 251,238

3 Claims. (Cl. 58—28)

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The present invention relates to hour meters of the type which continuously accumulate and record the passage of time whenever the meter is energized by a direct current source of electric power. This application is a continuation in part of my copending application Serial No. 131,610, filed December 7, 1949, now abandoned and entitled "Hour Meter."

The hour meter of the present invention is of the type in which periodic electric impulses intermittently drive a balance wheel assembly directly, without intervening mechanical linkage, and in which the balance wheel establishes the impulse rate to the driving electromagnet. The electromagnet also independently supplies a field of comparatively high flux density to operate a motor armature, which drives the recording mechanism. Such a device, in order to have utility for the present purpose, must be self-starting.

Devices of this general character have been proposed previously, but so far as I know, none has a sufficiently high order of accuracy to be generally useful.

The principal object of the present invention, therefore, is to provide an hour meter of the above described general character, which has an extremely high order of accuracy even with fluctuating voltage, and which can be manufactured at low cost and is rugged and durable in use.

Another object is to accomplish the above through the use of a single electromagnet, for driving both the motor mechanism and the timing mechanism, but in such arrangement that the magnetic field for the motor armature has almost no effect upon the operation of the timing mechanism.

Other objects and advantages will become apparent from the following description, reference being had to the accompanying drawing, in which

Fig. 1 is a front view of an hour meter embodying the present invention, with the case of the device is removed so as better to disclose the operating mechanism;

Fig. 2 is a side view of the device, taken at right angles to the view of Fig. 1, as indicated by the arrows along the line 2—2 of Fig. 1;

Fig. 3 is a sectional view, taken on the line 3—3 of Fig. 2, and is essentially a view of the mechanism with the bottom plate removed;

Fig. 4 is a top view of the operating mechanism; and

Fig. 5 is a fractional sectional view, taken on the line 5—5 of Fig. 4, for the purpose of showing the construction of the electric switch used for actuating the electromagnet of the device.

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The operating mechanism of the hour meter is mounted between parallel top and bottom plates 10 and 12, respectively. At the front of the device these two plates are bent outwardly to form ears 14 and 16 for mounting the instrument and for supporting a front plate 18 with an opening 20 therethrough to expose a cyclometer dial mechanism 22. At its side edges, portions of the plate 18 are bent backwardly to form parallel tabs 24 which support the end shafts of the cyclometer dial mechanism, which needs no specific description since it may be of any well known and standard type having a driving gear 26 near one end of a supporting shaft 27. The front plate 18 also has a pair of ears 28 which are bent into a plane parallel to that of the front plate, but somewhat ahead thereof. These ears 28 serve to support and attach the case for the operating mechanism. The case has not been illustrated in the drawings, since it may be of any well known type, and in fact, the mechanism will, of course, be operative without any enclosing case.

As best shown in Figs. 2 and 3, a horseshoe electromagnet, indicated generally by the numeral 30, is mounted near the back of the mechanism by a pair of bolts and spacers 32 which are secured to the front and back plates 12 and 10, and which pass through the pole pieces 31 and 33. Similar posts or bolts and spacers 35 secure the front and back plates together near the front of the case.

Each of the legs of the horseshoe magnet is enclosed within a magnetic coil 34 and 36, which are connected in series. Of these two, the coil 36 is somewhat the larger. This was found necessary to produce the required magnetic leakage to maintain the balance wheel in oscillation with minimum current consumption.

A generally rectangular motor armature 38, with rounded ends, is mounted upon a shaft 39 in a position between the pole pieces 31 and 33. It has such clearance, and is of such massiveness, that almost all of the magnetic flux between the two pole pieces passes through this armature. When at rest, it is tilted to one side as shown in Fig. 3, by a coil spring 40 secured at one end through a hole in an angular bracket 42 secured to the back of the pole piece 31 by its mounting bolt 32. The other end of this coil spring is hooked through a hole in a tab 44 at the lower end of a pallet plate 46 secured in face to face relation to the armature 38, so that it rocks therewith. This pallet plate carries a pair of pallet pins 48 and 50, which serve to drive a notched ratchet or stepping wheel 52 in a clockwise direction, as seen in Fig. 3, as the pallet plate oscil-

lates backwardly and forwardly under the influence of the rocking armature 38. Thus, whenever the magnetic coils 36 and 34 are energized, the armature 38 will be swung into a substantially horizontal position, thereby causing pin 50 to swing upwardly and advance the stepping wheel 52 approximately half the distance between the adjacent notches at its edge. Meanwhile, of course, the stepping wheel has been released for movement by withdrawal of the pin 48.

When the coils 34 and 36 are deenergized and the armature 38 returns to the position shown in Fig. 3 under the influence of the spring 40, the pallet pin 48 will again be brought in contact with the wheel 52 and advance it the remaining portion of the distance between adjacent notches. It is apparent, therefore, that a single current impulse will rotate the stepping wheel 52 one notch. This rotation is communicated to the stepping wheel shaft 54 upon which the wheel 52 is mounted, this shaft being journaled at its ends in bearings carried by the top and bottom plates 12 and 10.

The shaft 54 includes a portion formed as a worm 56 meshed with a gear 58 carried upon a vertical shaft 60. The shaft is journaled at its upper end in a bearing in the top plate 18 and at its lower end in a similar bearing formed in an inwardly bent tap 62 bent from the top plate 10 at an appropriate point.

The shaft 60 also is provided with a worm 64 which meshes with and drives the previously referred to gear wheel 26 of the cyclometer mechanism.

From the above, it is apparent that electric impulses supplied to the coils 36 and 34 will cause rotation of the cyclometer drive gear 26, and hence the cyclometer dial mechanism 65 will record these electric impulses in appropriate groups.

The timing mechanism for switching the electric power on and off to the coils 34 and 36 at appropriate intervals, such that the cyclometer mechanism will record hours, is primarily shown to the left of Fig. 3 and to the right and bottom of Fig. 4, although portions of this mechanism are also apparent in the other figures. It consists of a balance wheel 66 mounted upon a vertical staff 68, which is shown horizontally in Figs. 3 and 4. The staff is journaled at one end in a bearing, preferably a jewel, mounted in the bottom plate 12 and also somewhat short of its opposite end in a similar jewel secured in the top plate 10. The overhanging end of this staff 68 is secured to the inner end of a hair spring 70, the outer end of which passes through a hole in a tab 72 bent outwardly from the top plate 10. The spring is secured therein in customary fashion by a wedge 74 which may be loosened for adjusting the overall length of the hair spring. The timing adjustment is achieved by the usual pivoted adjustment plate 76 which has a slot for embracing the hair spring at a short distance from its fixed end at 72, this plate being pivoted to the upper jewel housing and extending at its opposite side beyond the hair spring to form a gear sector 78 engaged with a small adjusting pinion 80, such that rotation of the pinion 80 will move the sector slightly from side to side, thereby shortening or lengthening the effective length of the hair spring. The shaft of the gear 80 may be brought out through the side wall of the case if it is believed desirable, but in the embodiment shown, it is simply provided with a screwdriver slot 82, which may be reached through an opening in the case wall.

The balance wheel 66 is equipped at its rim with a small piece of iron 84 which forms the driving armature, the balance wheel otherwise being of nonmagnetic material. This armature takes approximately the position shown in Fig. 3 when the instrument is at rest. That is, it is somewhat to one side of the pole piece 33, and since under these conditions the hair spring is at rest, the armature is in the position of approximately maximum velocity when the balance wheel is oscillating; or in other words, near the center of its stroke. Inasmuch as almost all of the magnetic flux from the coils 34 and 36 passes through the motor armature 38, only an extremely small portion thereof, or in other words, a portion of the leakage flux, influences the timing armature 84. The coils 36 and 34 should be so adjusted that the flux affecting the timing armature 84 is such that although the timing armature is sufficiently within the leakage magnetic field to move toward the pole piece 33 when the coils are energized, it is just barely so at the lowest voltage the device is designed for.

Behind the balance staff 68 and behind the balance wheel, there is a switch shaft 86 parallel to the balance staff. It is preferably jewel mounted at its ends, with the top end projecting through the top plate 10. Intermediate its ends, the switch shaft is equipped with a pallet fork 88 which extends almost to the center of the balance staff and is slotted at its end as at 90 to take a transverse pallet pin 92 secured to the balance wheel at a short distance from the center of rotation. The balance staff is notched transversely as at 94, approximately half way through to permit passage of the end of the fork 88 from side to side of the balance staff under the influence of the pin 92 operating in the slot 90 as the balance wheel oscillates past its midpoint from side to side. At each side beyond the slot 90, the end of the pallet fork is fanned out and provided with circular notches 96 in its edge, which conform to the shape of the balance staff, thereby locking the pallet fork 88 against return movement after the fork has been shifted to one side or the other by the pallet pin 92.

It will be apparent that the mechanism described in the last paragraph is physically similar to a lever type clock or watch escapement, but whereas in an ordinary escapement mechanism the balance wheel is driven by the pallet fork, in the present instance the drive is in the opposite direction. For purpose of convenience, therefore, this mechanism will be referred to as being of "escapement type," although it is not a true escapement. In any event, as the balance wheel swings from side to side through an angle of 180 to almost 360 degrees, the pallet fork and switch shaft 86 will be rocked from side to side through only a few degrees at the instant the balance wheel is moving at its highest velocity.

Referring principally to Figs. 4 and 5, it will be seen that a snap action leaf switch 100 is mounted to one side of the switch shaft 86, with its actuating leaf axially aligned therewith. Switches of this general character are known as precision switches, and have several desirable qualities for this application. They very reliably snap from side to side at the same position of the actuating member each time, their amount of differential in actuation is easily adjustable, and they require very little application of force for their actuation. They are also capable of oper-

ating for long periods without attention. The particular switch shown is of the rolling spring type, which consists primarily of a main leaf, best shown in Fig. 5, formed of a thin spring strip. It is cut to form a base end 102 anchored in an insulating block 104. A portion of this end may extend beyond the block to form a terminal 106. The opposite end and main portion of the leaf form an inner tongue 108 which carries a contact 110 near its free end, which end is squared with a small projecting tab 112 in the center. This tongue is surrounded by a yoke 114 which is spaced internally at its free end 116 from the free end of the tongue and is provided with a small projecting tab 118 in alignment with the tab 112. The two tabs 112 and 118 are connected by a rolling, generally U-shaped, spring 120 which has perforations near its ends to fit loosely over the tabs 112 and 118. With this construction, when the free end 116 of the yoke is raised or lowered above or below the tongue 108, the tongue will be snapped in the opposite direction.

The contact 110 on the tongue cooperates with a contact 122, conveniently supported upon a stiff leaf 124 anchored in the same insulating block 104. This stationary contact 122 is shown below the movable contact 110 in Fig. 4. A similar stiff leaf 126 above the movable contact acts as a stop to prevent overtravel of the tongue 108 in the contact opening direction. The switch is shown as mounted upon an angle bracket 128 attached to the top plate 10.

The switch actuator 130 consists of a short strip of sheet metal which is slit lengthwise at one end to form two fingers 132 which are pressed apart out of the plane of the strip so that as shown, these fingers may lie one above and the other below the free end 116 of the yoke. At a short distance from the end of the medial slit which forms the fingers 132, the strip is provided with two parallel slits 134 and 136, and is deformed in one direction between the slits and in the opposite direction at the two side edges so that the strip can be press fitted over the end of the switch shaft 86. The actuator, therefore, grips the switch shaft tightly, but can be forcefully rotated thereon for purposes of adjustment. Rocking of the switch shaft 86 therefore raises and lowers the free end of the switch yoke and snaps the switch open and closed.

With this construction, the balance wheel does not supply any power to actuate the switch, excepting during an instant during each swing at the time when the wheel is moving most rapidly, and therefore least sensitive to disturbances. Also, the length of the fork 88 is several times the distance between the switch shaft 86 and the ends of the actuator fingers 132. The force multiplication is therefore considerable, thereby reducing the strength of the disturbing impulse upon the balance wheel. In addition, the timing armature 84 comes within the influence of the magnetic field and power is therefore supplied to the balance wheel at the instant it is traveling most rapidly, and at the instant the wheel is supplying power to actuate the switch to the off position.

During the return stroke of the balance wheel, the wheel swings freely excepting at the instant of most rapid movement, when it trips the switch to on position. Because of the relatively large switch differential of actuation, the electromagnet is not energized until the armature 84 has moved almost entirely beyond the range of the magnet's influence. There is therefore almost no

disturbing magnetic impulse to affect the balance wheel during its return swing. It should be noted also that since the motor armature spring 40 is relatively stiff, this armature will have a short natural frequency of oscillation. That is, it will move in a somewhat jerky fashion as compared to the regular, smooth oscillation of the balance wheel. That is important, since it makes it possible to adjust the timing portion of the mechanism without adjusting the motor portion. Also, wide variation in manufacturing tolerance in the motor portion of the device will not impair its satisfactory operation.

Electrically, the two coils 34 and 36 and the switch contacts 110 and 122, are connected in series and to a pair of terminals 138 and 140 mounted at the back of the frame upon tabs bent inwardly from the rearward end of the top plate 10. Thus, whenever these terminals are energized, the meter will start and run until deenergized.

From the above description of a preferred embodiment of my invention, it will be seen that I have provided an hour meter which is easy to adjust, economical to manufacture, and superior in its accuracy of performance. Also, since friction in the timing mechanism and the work done by this portion of the device is small, reasonable variations in voltage will cause somewhat greater or less swing of the balance wheel, but will not appreciably affect its accuracy of running. Actually, however, the balance wheel does not increase its angularity of swing as much as might be expected with increased voltage, because any increase in the angularity of swing will be accompanied by a greater velocity of movement of the armature during the forward swing at the time it is shifting the switch to off position, and this causes the current to the coils to be switched off more quickly. Increased voltage therefore increases the strength of the magnetic field, but decreases the duration of the impulse.

Having described my invention, what I claim as new and useful, and desire to secure by Letters Patent of the United States is:

1. In a time recording device, the combination of a balance wheel, a hair spring for said balance wheel, an escapement type lever adapted to be rocked abruptly from side to side by said balance wheel as said balance wheel passes its center of oscillation, a precision snap switch actuated solely by energy supplied by said lever having a differential between its on and off positions, said balance wheel having a single armature of magnetic material secured thereto, an electromagnet connected to be energized through said switch, said electromagnet having a pair of pole pieces, an oscillating motor armature mounted between said pole pieces, a recording mechanism adapted to be driven in steps by said motor armature, one of said pole pieces being disposed in proximity to said balance wheel armature in a position to one side of said balance wheel such that only a small amount of leakage flux affects said balance wheel armature, said balance wheel armature, said lever, and said switch being so related that when said balance wheel is at rest said switch is closed and said balance wheel armature is just within the effective influence of the last said pole piece so that said balance wheel armature is moved in a forward direction toward the last said pole piece when said electromagnet is energized, and the differential of said switch being such that said switch is shifted to off position before the attracted balance wheel armature reaches the last

said pole piece, whereby said balance wheel armature can under the influence of its own inertia move beyond the last said pole piece in the forward direction, and whereby said armature when moving in the reverse direction is almost beyond the influence of said electromagnet and is moving at its highest speed at the instant said switch closes, and whereby said time recording device is self-starting when energized.

2. In a time recording device, the combination of a balance wheel, a hair spring for said balance wheel, an escapement type lever adapted to be rocked abruptly from side to side by said balance wheel as said balance wheel passes its center of oscillation, a precision snap switch actuated solely by energy supplied by said lever having a differential between its on and off positions, said balance wheel having a single armature of magnetic material secured thereto, an electromagnet connected to be energized through said switch, said electromagnet being disposed in proximity to said balance wheel armature in a position such that only a small amount of flux affects said balance wheel armature, said balance wheel armature, said lever, and said switch being so related that when said balance wheel is at rest said switch is closed and said balance wheel armature is just within the effective influence of said electromagnet such that said balance wheel armature is moved in a forward direction toward said electromagnet when said electromagnet is energized, and the differential of said switch being such that said switch is shifted to off position before the attracted balance wheel armature reaches the electromagnet, whereby

said balance wheel armature can under the influence of its own inertia move beyond said electromagnet in the forward direction, and whereby said armature when moving in the reverse direction is almost beyond the influence of said electromagnet and is moving at its highest speed at the instant said switch closes, and whereby said time recording device is self-starting when energized.

3. In a time recording device, means forming a frame, a balance staff carried for rotation in said frame, a balance wheel carried by said staff, a single armature means attached to said balance wheel, an electromagnet for attracting said armature, a switch shaft carried by said frame for oscillation therein, a precision snap action switch connected for actuation solely by rocking motion of said switch shaft, and an escapement type mechanism connected to said switch shaft and actuated solely by said balance wheel to rock said switch shaft abruptly from side to side as said balance wheel passes its center of oscillation.

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