(No Model.)

C. E. EMERY.

BALANCE ESCAPEMENT.

No. 443,165. Patented Dec. 23, 1890.

Fig. 1.

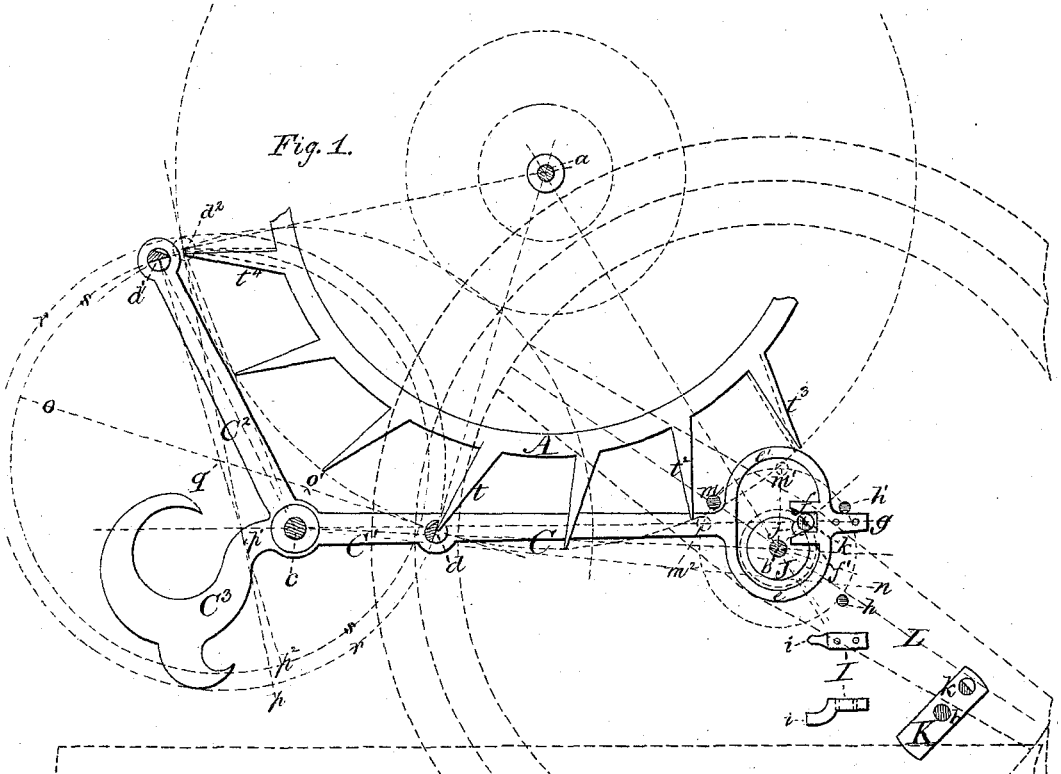


Fig. 2.

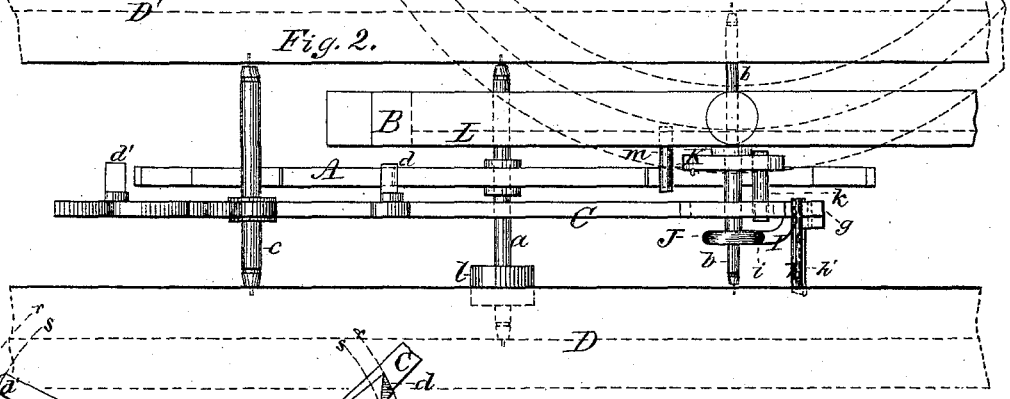


Fig. 3.

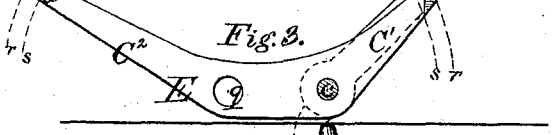
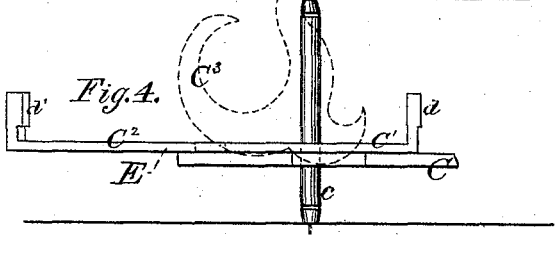


Fig. 4.



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BALANCE-ESCAPEMENT.

SPECIFICATION forming part of Letters Patent No. 443,165, dated December 23, 1890.

Application filed January 20, 1890. Serial No. 337,413. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. EMERY, of Brooklyn, Kings county, New York, (office, New York city,) have invented a new and Improved Lever Chronometer-Escapement; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification.

In chronometers of special design the locking-stone has heretofore been mounted on one arm of a lever or anchor and a second stone set angularly in the other end of the anchor, so as to receive on its inclined surface a tooth of the escape-wheel immediately after the impulse, and thereby bring the anchor and locking-stone back into position, thereby obviating the necessity of a spring for that purpose. It has been suggested, also, that a locking-anchor can be operated by a forked lever and pin the same as in ordinary lever watches. The anchor in such case would be like that of the ordinary anchor-escapement without the impulse-faces. One stone or pallet, which we will call the "releasing-pallet," releasing the escape-wheel for the impulse and the other stone or pallet, which we will call the "transfer-pallet," stopping the escape-wheel after the impulse and simply acting to transfer the lock with a very small drop to the releasing-pallet. Evidently the motion required for such a lever would be very small, as the pallets would need to move only through the locking-angles. Consequently the lever-operating pin would run out of the fork immediately after the release and the lever be only held in place during the impulse by the banking-pin on one side and the safety-pin on the other, requiring a very nice adjustment of the latter and making it impossible to determine with certainty the friction caused by the lever during the impulse as it might at times be left with the safety-pin against the roller, so as to cause friction and at others rest against a banking-pin; but there is nothing in the apparatus itself to positively produce the latter condition, and an objectionable spring-catch or other device would be required to secure it with certainty. This difficulty may be overcome by making the lever travel through a long arc while engaged with the fork; but in such case, evidently, the transfer-pallet would necessarily move back through this arc with one of the teeth of the escape-wheel resting upon its moving surface, causing friction, as in the Graham dead-beat escapement for clocks. It has been attempted to palliate this difficulty by making the arm carrying the transfer-pallet shorter than the other; but this remedy makes it impossible with the ordinary construction to secure for both pallets the proper "draw" to hold the lever against the banking-pins. These various difficulties undoubtedly explain why such an escapement is not in general use. Keeping in mind the arrangement of an ordinary detached lever-escapement and distinguishing the locking-pallet on the hook end as the "inner" locking-pallet and the other as the "outer" locking-pallet, it will be seen that with such an arrangement the release must be made by the outer locking-pallet and the transfer made from the inner locking-pallet.

This invention relates to an improvement whereby the release is effected by the inner locking-pallet, (or hook end of the anchor,) and the transfer to the same made from the outer locking-pallet, and means are provided whereby the lever during impulse is moved in a contrary direction from what it would be with the ordinary arrangement of a lever-escapement. The effect of this improvement is that the proper draw or leverage equivalent to draw can be secured at both ends of the anchor when the arms are of unequal length, and the lever can be kept under the control of the fork at all times when it is not held in position by the pressure of a tooth of the escape-wheel on one or the other of the locking-pallets. With this improvement all the advantages are gained of both the lever and chronometer escapements without the defects of either. For instance, the impulse instead of being received on the inclined surfaces of the pallets, as in the lever escapement, is imparted directly by a tooth of the escape-wheel upon an impulse pin or stone in a roller on the balance-staff, the same as in the chronometer and duplex escapements, while the fork prevents the balance-wheel from making more than two full revolutions,

the same as in a lever escapement, so that the train cannot "run" or make two beats in the proper time for one, as is possible with the chronometer and duplex escapements. The result is secured without the friction caused by the pressure of a tooth of the escape-wheel on the balance-staff incident to the duplex escapement, and the delicate slip-spring necessarily employed in the chronometer-escapement to permit the return of the unlocking cam, as well as the spring generally used to secure the retraction of the locking-stone, is dispensed with.

In the drawings, Figure 1 is a plan view of the principal parts of the improved escapement. Fig. 2 is a side view of the same. Fig. 3 is a plan view of an attached anchor with locking-pallets, and Fig. 4 is a vertical elevation of same.

A is the escape-wheel, of which a fragment only is shown in Fig. 1. *a* is the staff of the same. It is to be understood that this wheel receives rotary motion from a train (not shown) through a pinion *l*, Fig. 2, or in any customary way.

B is a view of the greater part of the balance-wheel, (shown only in dotted lines in Fig. 1,) and *b* the staff of the same.

C represents in general the lever provided with arms C′ and C^2 and counter-balance C^3. The staff of the lever is designated *c*. It is planted outside the greatest diameters of the escape-wheel and balance, thereby making it possible to pivot it in the main plates.

The locking-pallets are designated *d* and *d′*, *d* being the outer locking-pallet and acting as the transfer-pallet in this arrangement, and *d′* being the inner locking-pallet and the releasing-pallet in this arrangement.

D and D′ represent, respectively, the lower and upper plates of the watch, each illustrated double in this particular case.

The jaws of the fork are designated *f* and *f′*. It will be observed that in this arrangement the opening of the fork is in the direction of the staff *c* of the lever instead of away from it, as in the ordinary construction. The jaws *f* and *f′* of the fork are connected with the lever by two curved portions *e e′*, forming a yoke, although, evidently, one of these may be dispensed with, if desired. In the arrangement shown the lever is continued beyond the fork by an extension *g*, which comes in contact, as the lever moves in either direction, with the banking-pins *h h′*. Secured to the extension *g* is a safety-piece I. (Shown detached in plan and elevation below the lever and corresponding to a safety-pin.) The wedge-shaped point *i* of the piece I passes first one side and then the other of a safety-roller J, crossing mid-position through a notch *j* in the same.

The lever-operating pin is designated *k*. Its outer half is cut away, as shown, and the pin mounted in a roller or crank-arm K, secured to the balance-staff; but, if desired, such pin may be secured in the arm of the balance. The impulse pin or stone is designated *m*, and may be secured in a separate roller, but is shown as secured in the arm L of the balance-wheel. (Illustrated by dotted lines.)

The operation is as follows: The bottom of the escape-wheel A tends to move toward the left by its connection with the train; but in the position shown motion is prevented by the tooth *t* engaging with the transfer-pallet *d*. From the position of the parts it will be seen that the top of the balance-wheel B has made its full movement from right to left and is now returning, so that the lever-operating pin *k* has entered the fork from left to right. As motion continues, the lever-operating pin *k* will carry the fork as drawn down, so that in due time the transfer-pallet *d* will release the tooth *t*; but before the release actually takes place releasing-pallet *d′* will have moved nearly to the position d^2, so that when the transfer-pallet *d* actually unlocks the tooth *t* the escape-wheel will move slightly forward and tooth t^4 drop upon releasing-pallet d^2, and be locked thereby in the position shown by the dotted lines. As the top of the balance-wheel B continues its motion from left to right, the lever-operating pin *k* will run out of the fork past the jaw *f′*, when the center of the lever will be substantially in the position of the dotted line *cn*, and the balance be completely detached from the escapement until returned by the hair-spring. (Supposed to be attached to the staff *b*, but not shown.) On the return movement (top of balance-wheel moving from right to left) the lever-operating pin *k* will again engage with the fork, the center of the lever be carried up slightly until the releasing-pallet *d′* unlocks tooth t^4, when the tooth t^3 of the escape-wheel, which has been held previously in the position of the dotted lines, will fall upon impulse-pin *m*, which will then be at or near the position *m′* and keep in contact with it, thereby impulsing the balance-wheel until the tooth t^3 slips off the pin *m*, when the latter is in the position m^2. The tooth will then drop a short distance upon the transfer-pallet *d*, thus locking the train. The top of the balance will then continue its motion from right to left detached from the escapement and return to the position shown and the operation be repeated. The lever is held against a banking-pin on each side when the balance-wheel is detached from the escapement by leverage due to the position of the locking-surfaces of the pallets *d d′* in relation to the center *c* of the lever, producing the same result as the draw given the pallets of a common anchor escapement. Using the letters designating the pallets and staves as referring geometrically to the centers of same, it will be observed that the line *do* is tangent to the radius *ad*, passing through the point of the tooth *t*. This tangent *do*, as will be seen, passes above the center *c* of the lever, so that the pressure of the tooth *t* upon the

pallet d tends to carry the lever C up with the leverage co' and thereby hold it against the banking-pin h'. So, also, when releasing-pallet d' is in the position d^2, the tangent at that point lies in the direction $d^2\,p$ to the left of the center c of the lever a distance cp', and the lever C is held against the banking-pin h by a leverage cp'. This result is secured even when the locking-faces are in radial lines from the center a of the escape-wheel. The line $d'\,p^2$ will correspond with the tangent $d^2\,p$ when releasing-pallet moves to position d^2, and the proper angle of the locking-faces of d and d' to give the leverage stated may be secured by forming the same with tools moving relatively around the point q, where the line $d'\,p^2$ intersects the tangent do.

Fig. 3, from a different point of view, represents the pallets d and d', formed on a separate piece of metal E. The locking-surfaces may be formed on a circular piece of metal in the lathe by an outside cut on the circle r r, and an inside cut on the circle s s. A hole q being also formed concentric with the center q, a cup-shaped piece may be cut off the stock, the anchor formed by milling, then hardened, then mounted on a mandrel engaging with hole q, and the locking-surfaces of the pallets d d' polished with a small rapidly-revolving lap or stone acting, while anchor is also revolved, on center q. The anchor E can then be mounted on the staff c, as shown in Fig. 4.

In Figs. 1 and 2 the pallets are shown as made of separate bits of stone or metal socketed in the lever. Evidently these may be set from a center q even when their faces are flat, as it will be a simple way of making such faces radial from the center of the escape-wheel, or such faces may be formed or polished from the center q, so as to be arcs of circles, as in Fig. 3.

Evidently the pressure on pallet d with the leverage co' tends to hold the lever against banking-pin h' the same as would an angle of draw cdo'—that is, the same as if the center c were located in the line do of the tangent—and the locking-face of the pallet d revolved from left to right through an angle equal to the angle cdo. The angle imparted to the locking-faces to hold the lever against the banking-pins is known technically as "draw" and the equivalent result produced by the leverage described, whether or not combined with draw, as above, may be called "effective draw." Similarly the leverage in relation to pallet d' is the same as an angle of draw $cd'\,p^2$ or $cd^2\,p$, so when the tendency to lie against the banking-pins produced by leverage is too little or too great the angles of the locking-faces of pallets d and d' may be slightly changed, so that in combination with the angles between the tangents and center of lever above referred to give the desired angle of effective draw. The leverage and draw, which combined make the effective draw, may be modified on the principles above expressed when the surfaces are circular or struck from a center. For instance, if the locking-faces of the pallets be concentric with a center to the right of the intersection q in the direction of the center a of the escape-wheel, the effective draw will be reduced on pallet d', (becoming zero if carried to the line cd',) and will increase the effective draw on pallet d. Similarly, if the center be carried outside of q away from a, the draw on pallet d will be decreased and that on pallet d' increased. In general, the proper position of the center from which the pallets are to be struck is at the intersection of lines drawn at right angles to the locking-faces when set at the desired angle of draw. This principle may be applied to secure circular locking-faces from a common center on the anchor of an ordinary lever escapement. By turning the roller K (of which a separate view is shown at the right) on the staff b, the lever-operating pin k may be adjusted at such angle as to release the escape-wheel when the impulse-pin m has sufficiently moved within the path of the points of the teeth of the escape-wheel to be sure of its receiving without fail the point of the tooth t^8 when it drops upon the pin to give the impulse.

The relative lengths of the arms of the lever C and the distance of the lever-operating pin k from the center b of the balance-wheel may be so adjusted in relation to each other that the lever-operating pin k will be between the parallel sides of the jaws f f' of the fork throughout the whole impulse, thus preventing the safety-point i from falling against the roller J and producing friction during such impulse. In the particular escapement laid down the lever-operating pin k moves out from between the parallel sides of the jaws f f' when the impulsing-pin m is in the position shown or a little before the completion of the impulse; but in moving through the small angle from m to m^2 the lever-operating pin k does not become disengaged from the inclined edge of the jaw f of the fork, and therefore the safety-point i is still held away from the roller J. With different proportions the lever-operating pin k may be kept between the parallel portions of the jaws of the fork throughout the entire impulse, if thought desirable, particularly for fine watches, in which the angle of impulse would be less than that shown. It will be observed that if the pin k engaged with a fork opening away from the staff c of the lever it would be necessary to release the tooth of the escape-wheel to give the impulse by an outer pallet on a long arm and to transfer from a hook or inner pallet on a short arm, and while it might be possible to obtain the proper leverage corresponding to draw on the long arm it would be impossible to do so for the short one, as can be seen by supposing the locking-faces and escape-wheel as drawn reversed in direction, so that the bottom of the latter would move from left to right, the le-

ver remaining as it is drawn. In such case, evidently, the tendency would be for the tooth *t*, in contact with a reversed or inner surface at *d*, to throw the lever away from banking-pin *h'* and to cause the safety-pin *i* to bear upon safety-roller J, making the arrangement impracticable. In the arrangement shown, where the release takes place from the hook or inner pallet, the angles of draw can be secured without difficulty, and to make this plan operative it is necessary that the anchor be moved in the opposite direction from what it would be with the ordinary arrangement of pin and fork—that is, the operating-pin must be thrown on the other side of the balance-staff and operated in connection with an inside fork, or one of which the opening points toward the staff of the lever. Any motion, however, which will throw the anchor in the opposite direction to that in which it would be moved in an ordinary lever-escapement will answer the purpose. For instance, if the ordinary arrangement of fork and pin were used on an intermediate shaft operated by gearing from the balance-staff the necessary motion of the lever in a direction opposite that produced in the ordinary arrangement would be secured.

Evidently the lever may be carried below the roller J, be curved around one side of staff *b*, brought back to receive a safety-pin substantially in the position of the point *i*, and then run out and be bent upward and backward, with the end in the form of a fork to engage with the pin *k* without altering the general arrangement or operation of all the parts.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In the construction of a lever chronometer-escapement in which the locking-pallets are spaced the same or a little greater distance apart than the included teeth of the escape-wheel, a lever provided with a transfer-pallet near the fulcrum, a releasing-pallet at a greater distance from the fulcrum, and a fork opening toward the fulcrum, in combination with an escape-wheel and with a balance-wheel provided with customary means for operating the lever and receiving the impulse, all arranged and operating substantially as and for the purposes specified.

2. In the construction of a lever chronometer-escapement, a transfer-pallet, and a hook or inner pallet operating to release the escape-wheel to impulse the balance-wheel, in combination with such escape-wheel and with a balance-wheel provided with customary means to receive the impulse and customary means for operating the lever in the proper direction to secure the release at the proper time to produce the impulse, substantially as and for the purposes specified.

3. In the construction of a lever chronometer-escapement, in combination with the fork *ff'*, opening toward the lever-staff and the lever-operating pin *k*, an impulse-pin *m*, arranged relatively on the opposite side of the center of staff *b*, substantially as and for the purposes specified.

4. In the construction of a lever chronometer-escapement, in combination with a fork *ff'*, opening toward the lever-staff, a safety-point *i*, operating in connection with a safety-roller J, substantially as and for the purposes specified.

5. In the construction of escapements, in combination with a balance-wheel, an escape-wheel and an anchor, and customary means for operating the anchor from the balance, outer and inner pallets with locking-faces formed on arcs of circles from a common center eccentric with that of the anchor-staff to facilitate construction and secure correct adjustment, substantially as and for the purposes specified.

6. In a lever chronometer-escapement, in combination with an escape-wheel and a balance-wheel provided with customary means for operating a lever and receiving the impulse, and necessary banking-pins, a lever provided with locking-pallets set in substantially radial lines from the center of the escape-wheel and so arranged in relation to the fulcrum of the lever that the force of the train transmitted through the escape-wheel will tend to hold the lever against the banking-pins, substantially as and for the purposes specified.

7. In the construction of a lever chronometer-escapement, an anchor with circular locking-faces provided with a hole or equivalent at *q* for centering it concentric with the locking-faces during construction, and with a hole or equivalent means of attachment to a staff *c*, located in relation to the pallets so as to secure effective draw, substantially as and for the purposes herein specified.

8. In the construction of a lever escapement, in combination with an escape-wheel, a balance-wheel and customary connecting parts to operate a lever and receive the impulse, and suitable banking-pins for such lever, a lever provided with locking-pallets at unequal distances from the lever-staff and with the staff arranged outside a tangent drawn from the point of contact of the outer locking-pallet with a tooth of the escape-wheel and inside a tangent drawn from the point of contact of the inner locking-pallet with a tooth of the escape-wheel, whereby the pressure upon the locking-faces will tend to hold the lever against the banking-pins by leverage, substantially as and for the purposes specified.

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