Nov. 3, 1942. W. G. LASKEY 2,301,056

TIMING DEVICE

Filed Oct. 4, 1939 2 Sheets-Sheet 1

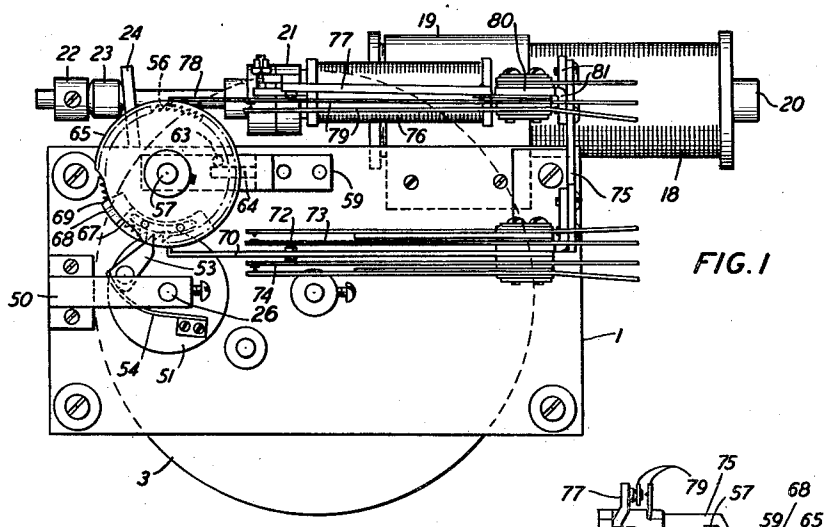

FIG. 1

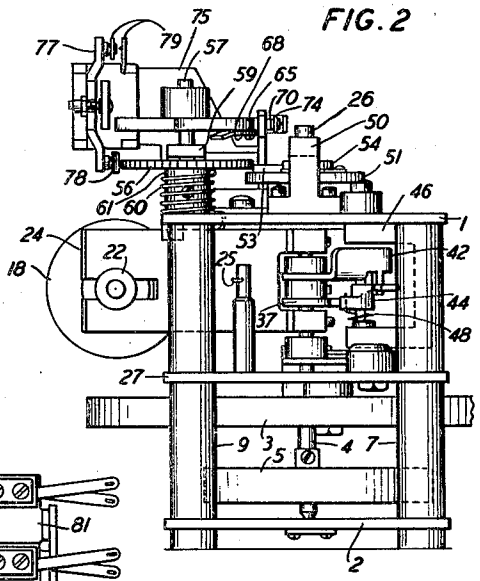

FIG. 2

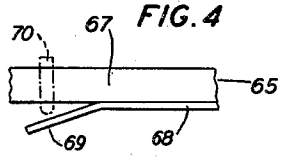

FIG. 4

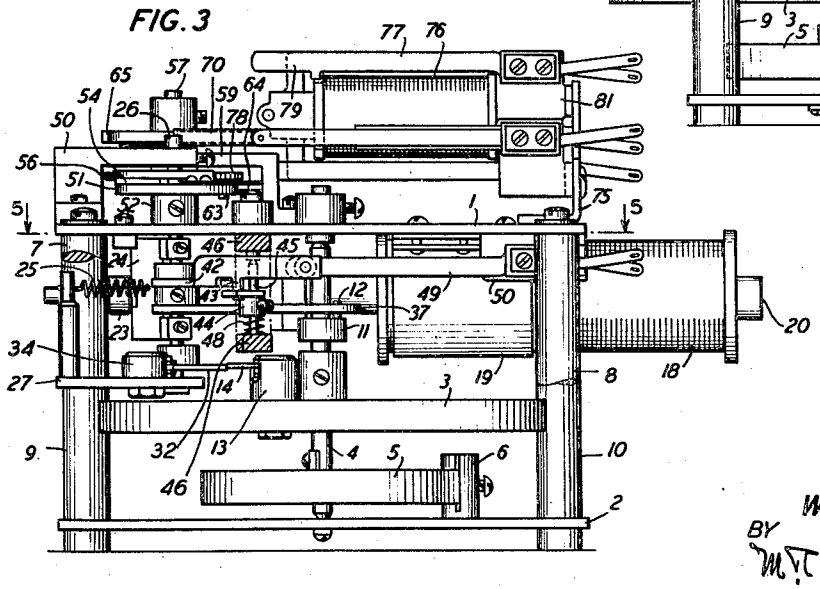

FIG. 3

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TIMING DEVICE

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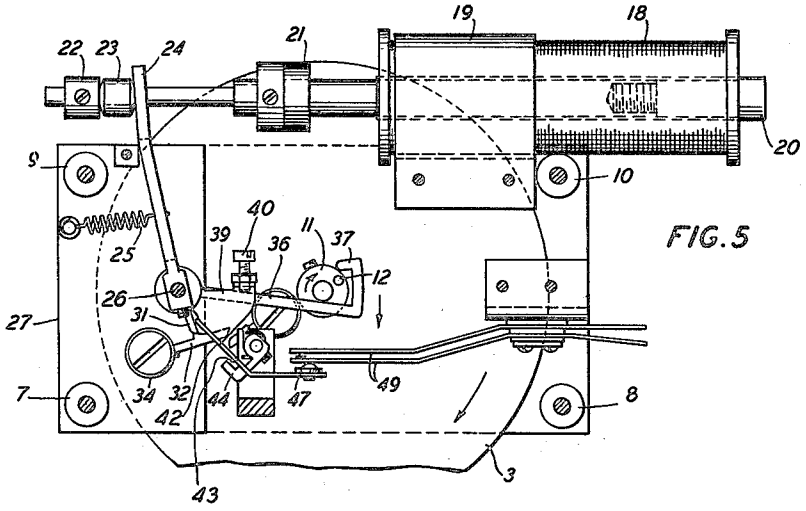


FIG. 5

FIG. 6

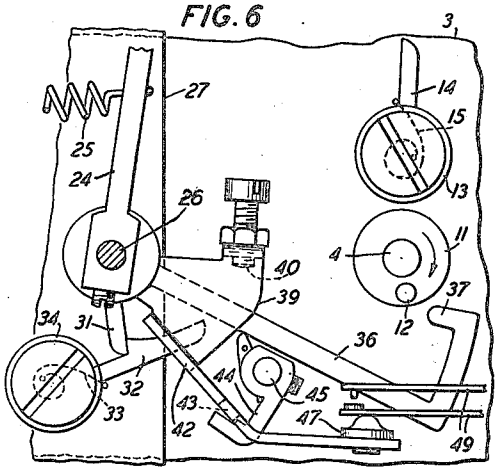


FIG. 7

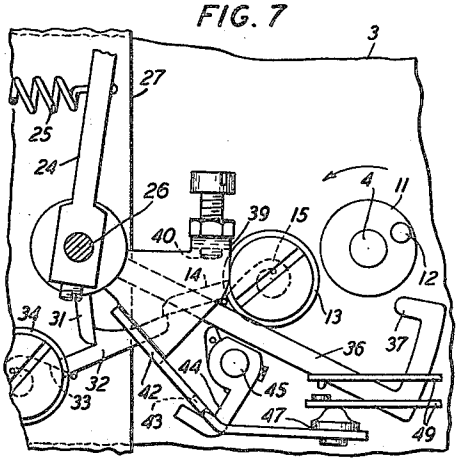


FIG. 8

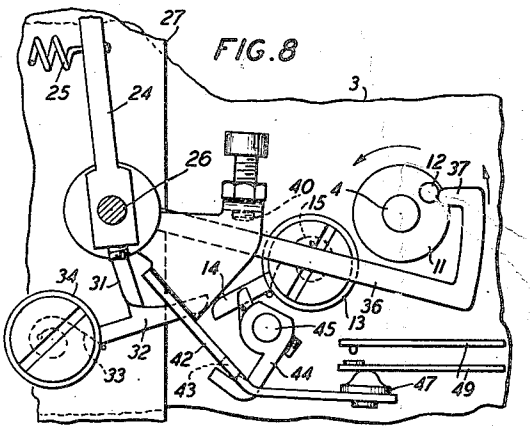
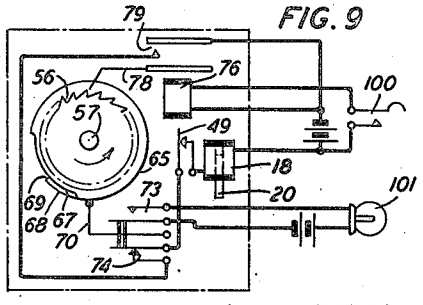


FIG. 9



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Patented Nov. 3, 1942 2,301,056

UNITED STATES PATENT OFFICE

2,301,056

TIMING DEVICE

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Application October 4, 1939, Serial No. 297,883

14 Claims. (Cl. 161—15)

This invention relates to timing devices and particularly to mechanisms for registering the passage of time.

An object of this invention is to improve such devices to accurately and reliably measure and register the passage of time.

Heretofore mechanisms of this type have been provided including balance wheel or pendulum operated devices for measuring of time intervals in which various means were provided for regulating the action of the balance wheel or pendulum to register the time intervals. For such mechanisms energy was directly or indirectly applied to start the balance wheel or pendulum and keep it in operation, and regulate its action and clockworks were employed for indicating the time intervals.

It is a feature of the present invention to provide a mechanism of this general type in which the operation may be started at will, continued and stopped at the end of accurately fixed periods of time and to control an indicating signal at the end of this period. The mechanism consists of a balance means, a magnet, levers and circuit means cooperating to start the balance means to oscillate and to maintain its oscillation at its natural frequency under control of energy stored in a spring by the magnet. It also includes a step-by-step mechanism controlled by the lever means, a means for stopping said mechanism when a certain number of steps have been taken, and means for then operating a signal.

The invention has been illustrated in the accompanying drawings in which Fig. 1 shows a top view of a mechanism embodying the applicant's invention;

Fig. 2 shows a left-hand side view of this mechanism;

Fig. 3 shows a front view of this mechanism;

Fig. 4 shows a detail of the mechanism;

Figs. 5, 6, 7 and 8 show various positions of the oscillating lever mechanism to illustrate the actions thereof; and,

Fig. 9 is a diagrammatic drawing of the circuit elements involved in this mechanism.

Referring now to the drawings and particularly to Figs. 1 to 4, the mechanism may conveniently be divided, for the sake of clearness in describing it in two groups of parts, to wit, an oscillating mechanism which has practically all of its parts located below the mounting plate 1 and a signal operating mechanism which is located above this plate.

The oscillating mechanism is mounted between the plates 1 and 2 and consists of a balance wheel 3 mounted on a shaft 4 which is journaled in bearings located respectively in plates 1 and 2 as clearly shown in Fig. 3. This balance wheel may be oscillated by a spiral spring 5 which has its inner end connected to the shaft 4 and its outer end connected to a post 6 secured to plate 2. The plates 1 and 2 are held together by four posts, 7, 8, 9 and 10. On the shaft 4 is also located a hub 11 having a pin 12 which is operated upon as will be hereinafter described to start the balance wheel to oscillate and to maintain it in oscillation. On the upper flat surface of balance wheel 3 is also located a hub or post 13 in which is secured a tripping member 14 shown more in detail, for example, in Fig. 6, mounted under control of a spring 15 to yieldingly turn in a counter-clockwise direction looking at Fig. 6 but held in an unyielding normal position by the spring 15 in the post 13 as far as movement of this member is concerned in a clockwise direction. The purpose of this member will be described hereinafter. Below plate 1 looking at Fig. 1 is mounted a solenoid coil 18 in a bracket 19 secured to plate 1. This solenoid coil operates on a plunger 20 to move it from a normal position as shown in Fig. 5 to a position where the buffer bushing 21 on the plunger 20 touches the left-hand spoolhead of the solenoid coil 18. This plunger 20 is provided with a bushing 22 on a buffer bushing 23 to operate a lever 24 against the tension of a spring 25 for purposes as will be described hereinafter. This lever 24 is mounted on a shaft 26 which is journaled at its lower end in a bearing on a supporting plate 27, secured between posts 7 and 9 as shown in Figs. 2 and 3 in particular, and protrudes through a bearing in plate 1 above this plate. Secured to this shaft 26 is also a trigger 31 which may be engaged by a strip lever 32 mounted rotatably in one direction against the tension of a spring 33 on a bushing or bearing post 34 which is secured to the plate 27 as shown clearly in Figs. 3, 6, 7 and 8. The purpose of this particular lever is to hold the lever 24 in operated position when it has been moved by the plunger 20 against the tension of spring 25. Secured to shaft 26 is also an operating lever 36 which is shaped at its free end in the form of a U and terminates into a shank or projection 37 which may engage pin 12 to start and maintain the oscillation of the balance wheel 3. Mounted loosely on shaft 26 is also another lever mechanism 39 which is provided with a stop screw 40 that may engage or be engaged by lever 36 during the operation of the mechanism. The lever mechanism 39 is also provided with a shank or extension 42 having a latch projection 43 that may be engaged by a latch hook 44 mounted on a shaft 45 secured in a bracket 46 which in turn is secured to plate 1 as shown particularly in Figs. 2 and 3. This latch hook 44 is held in the normal position as shown in Fig. 5 by a helical spring 48 to latch the lever mechanism 39 in this normal position by engaging the projection 43,

The arm 42 also extends at an oblique angle outwardly to terminate in an insulation bushing 47 that normally holds the operating springs 49 closed. These operating springs 49 are mounted on a bracket secured to plate 1. Each time the plunger 20 is operated it is evident that shaft 26 will be rotated and when the plunger is released it will be returned to normal position. Thus shaft 26 will oscillate back and forth during the operation of the mechanism as will hereinafter be described. The upper end of shaft 26 is also journaled in a bracket 50 mounted on plate 1 and between this bracket and plate 1 is located a disc 51 secured to the shaft by a hub 52. On the upper surface of this disc 51 is secured an operating pawl 53 held in a normal position by a flat spring 54, this pawl will operate the signal operating mechanism as will hereinafter be described.

The signal operating mechanism consists of a ratchet wheel 56 mounted on a shaft 57 which in turn is rotatably mounted in a bearing on plate 1 and in a bearing in a bracket 59. This ratchet wheel 56 may be held in a normal position by a helical spring 60, one end of which is secured to plate 1 and the other to the ratchet wheel hub 61 by means of which the ratchet wheel is connected to the shaft 57. This normal position of the ratchet wheel is determined by a pin 63 on this wheel which engages a projection 64 on the bracket 59. Above the bracket 59 on shaft 57 is mounted a disc 65 which as shown in Figs. 1 and 4 is provided with an indentation 67 and below this indentation is mounted a flexible spring 68 which may be moved in any desired position in the indented portion 67 of disc 65 to form a downwardly slanting end 69 at any desired radial position. This spring 68 may be engaged on its outer edge by the hooked shaped end of spring 70, if the disc is rotated in anti-clockwise direction looking at Fig. 1, and after it has been rotated a certain distance as determined by the location of the slanting end 69 the hooked shaped end of spring 70 will be disengaged from the spring 68 as shown in Fig. 4. Thus the rotation of this disc 65 by the ratchet wheel as controlled by the pawl 57 will cause the hooked shaped end of spring 70 after a certain number of steps have been taken to enter the indentation 67. When this takes place, the spring 70 will be moved inwardly looking at Fig. 1 to cause bushing 72 thereon to close a connection between springs 73 and to open the connection between springs 74, the purpose of which will be described hereinafter. These springs 73, 74 and 70 are all mounted on a bracket 75 connected to plate 1. The downwardly slanting end 69 on spring 68 permits the spring 70 to return to normal position when the ratchet wheel is returned to normal as the hook shaped end will slide over the slanting end 69 and be engaged by the wheel 65 as it passes out of the indentation 67. On bracket 75 is also mounted a relay structure 76 having an armature 77, which when attracted by the energization of the relay coil 76 is moved downwardly, looking at Fig. 1, to cause the spring 78 which is provided with a pawl shaped end to engage a tooth in the ratchet wheel 56 and thus serves as a holding pawl for the ratchet wheel when operated. This armature 77 also operates to close a connection between the springs 79 when actuated. Springs 79 and 78 as well as armature 77 are mounted at the rear of the relay structure on projections 80 on the core of the relay which is mounted through other projections 81 on the brackets 75.

The operation of the oscillating and signal operating mechanism will now be described in connection particularly with Figs. 5 to 9. To start the oscillating mechanism to measure the passage of time a key 100 as shown in Fig. 9 may be closed. The operation of this key closes a circuit for relay 76 from battery through the winding of this relay, contacts of key 100 back to battery. The operation of relay 76 causes the armature 77 to bring the pawl 78 in contact with a tooth in the ratchet wheel 56 to serve as a holding pawl and closes a connection between the contacts 79. This in turn causes a circuit to be closed for the operation of the solenoid coil 18 from battery through this coil, contacts 49, 74 and 79 back to battery. The solenoid 18 now operates and attracts the plunger 20 towards the right, looking at Fig. 5 to operate the lever 24 to store energy in spring 25 and to rotate shaft 26. When the solenoid has attracted the plunger 20 to the point where the bushing 21 touches the left-hand spoolhead of the solenoid, the trigger 31 will be locked by the trip lever 32 as shown in Figs. 6 and 7. The normal positions of lever 24 and the operating lever 36 are shown in Fig. 5 and when operated the lever 36 will be drawn downwardly to the position shown in Figs. 6 and 7 and thus the projection 37 on its inner side will hit the pin 12 on the upper side and cause the balance wheel 3 to be rotated in a clockwise direction and store energy in spring 5. The position of the balance wheel 3, after it has been rotated in this direction, is indicated in Fig. 6. It will be noted that tripping member 14 is located directly above the shaft 4 and this indicates the limits of the travel of the balance wheel in the clockwise direction as controlled by the projection 37 at this time. When the lever 36 reaches this position as shown in Fig. 6, it will operate on catch hook 44 to cause it to unlatch itself from the latch projection 43 on the extension 42 which is then moved into the position as shown in Fig. 6 under tension of the springs 49 which are now opened. This, of course, opens the circuit for the solenoid coil 18 which deenergizes and the plunger 20 is now free to return to normal although it will not be returned until lever 24 pushes it back to the normal position. The balance wheel 3 will now start to rotate back under tension of spring 5 in a counter-clockwise direction until the tripping member 14 strikes the trip lever 32 as shown in Fig. 7 and the member 14 will therefore by continuing further in this direction cause lever 32 to release the trigger 31 which in turn causes the levers 24 and 36 to be returned to normal position under tension of spring 25. It should be noted at this time that pin 12 will be in a position where it will be hit on the under side by the projection 37 on the upper side on the return of the lever 36 to normal and thus the balance wheel will receive an additional impulse to continue to rotate in the counter-clockwise direction for a short distance to store energy in the spring 5 in the opposite direction. Fig. 8 shows the position of the parts mentioned after the projection 37 has struck pin 12 and the pin is about to leave the projection. The balance wheel rotates in this direction for a certain distance and the tension in the spring 5 will then cause it to be rotated back in a clockwise direction. As the member 14 now passes the trip lever 32 it will merely yield and pass by this lever 32 and cause no operations to take place at this time. The balance wheel will continue to rotate in the clockwise direction until energy has

been stored in spring 5 in the opposite direction. It should be noted that on the return of lever 36 to normal position it will strike the stop screw 40 on the lever mechanism 39 and thus cause this lever mechanism to be rotated in a counter-clockwise direction to cause the latch projection 43 to be latched by the hook 44. The connection between the springs 49 will therefore now be restored. As the circuit for the solenoid 18 is now closed the levers 24 and 36 will again be operated to take the position shown in Figs. 6 and 7 and when the balance wheel starts to return in the counter-clockwise direction, the member 14 will again operate on the lever 32 to unlatch the trigger 31 and the projection 37 on lever 36 will again deliver an operating stroke to the pin 12 to cause the balance wheel to continue in the counter-clockwise direction to store energy in the spring 5. The operations are then repeated as described and consequently the operation of the solenoid 18 causes the shaft 26 to be rotated in one direction and the release of the lever 24 under tension of the spring 25 causes the shaft 26 to be rotated in the opposite direction. As determined by the mass of the balance wheel 3, the tension of the spring 5, the energy stored in spring 25 and the consequent force of the blow that the projection 37 delivers to the pin 12 the balance wheel will continue to oscillate at a uniform and accurately determined frequency, that is, if these factors are properly adjusted, the shaft 26 will be oscillated back and forth at an extremely accurate rate. The force of the blow delivered by the projection 37 will always be the same as it is determined by the energy stored in spring 25 and is not dependent on any variations in the current that actuates the plunger 20. A very accurate measuring means of the passage of time is therefore obtained by this oscillating mechanism.

The effect of the oscillations of the shaft 26 on the signal operating mechanism will now be described. For each forward or clockwise movement of the disc 51, the pawl 53 will engage a tooth in the ratchet wheel 56 and cause it to be stepped one step or the equivalent of one tooth and the ratchet wheel will be held in the operated position by the holding pawl 78. This rotation of the ratchet wheel will continue until the hook shaped end of the member 70 passes over the slanting end 69 of the member 68 and takes the position shown in Fig. 4 when this member will press inward towards the center of disc 65. When the spring 70 is thus operated contacts 74 will be opened and 73 will be closed. The circuit for the solenoid 18 is now opened by the contacts 74 and prevent the levers 24 and 36 from being further operated by the plunger 20. The contacts 73 close an obvious circuit for the lighting of the lamp 101 to indicate that a definite time interval has elapsed since the closure of key 100. The mechanisms now remain in this position until reset by the release of the key 100 which releases magnet 76, which in turn releases the holding pawl 78. This causes the ratchet wheel to return to normal under the tension of the spring 60 and the arm 70 will be pushed out of its operated position due to the fact that it will engage the slanting end 69 and be restored to normal by riding up and out of the indentation 67 on disk 65. This in turn causes the closure of contacts 74 and the opening of contacts 73 causing the extinction of the lamp 101. A measurement of the same interval of time may be repeated each time the key 100 is operated. It is evident that different periods of time may be measured by this apparatus by merely shifting the spring 68 to different positions on the disc 65 so that different numbers of steps may be taken by the ratchet wheel before the signal is operated and that the key 100 may start the apparatus moving automatically without setting the balance wheel in motion manually.

What is claimed is:

1. In a signal operating system, a signal, a balance means, a magnet, an armature for said magnet, circuit means for causing said magnet to be energized to attract said armature, means controlled by said armature for starting said balance means to oscillate during the attractive operation of said armature, a lever mechanism cooperating with said armature through said means controlled thereby, cooperating with said circuit means and with said balance means during succeeding attractive operations of said armature to maintain said balance means in oscillation at its natural frequency under control of said armature, a shaft controlled by said armature to oscillate at the same frequency as the balance means, a ratchet mechanism controlled by the oscillation of said shaft to operate in a step-by-step manner to take one step for each oscillation of the shaft, means controlled by said ratchet mechanism when it has taken a certain number of steps for discontinuing to maintain said balance means and said shaft in oscillation, and means operated by said last-mentioned means when the ratchet mechanism has stopped operating for actuating said signal.

2. In a signal operating mechanism, a signal, a mechanism for measuring the passage of time comprising an oscillating device, operating means comprising a single magnet, an armature therefor, circuit means and a lever mechanism for starting said oscillating device to oscillate and for maintaining said oscillating device in oscillation at its natural frequency, manually operated means for starting said operating means, counting means controlled by said oscillating device to count the oscillations of said oscillating device, means operative by said counting means when it has operated a definite number of times for stopping the oscillating device and for actuating said signal.

3. In a signal operating system, a signal, a balance wheel, operating means comprising a single magnet, an armature therefor, circuit means and a lever mechanism for starting said balance wheel to oscillate and for maintaining said balance wheel in oscillation at its natural frequency, manual means for starting said operating means, a ratchet mechanism operative to take one step for each oscillation of said wheel, means controlled by said ratchet mechanism for stopping said operating means after the balance wheel has completed a certain number of oscillations and for thereafter actuating said signal.

4. In a signal operating system, a signal, a mechanism for measuring the passage of time, operating means comprising a single magnet, an armature therefor, circuit means and a lever mechanism for starting said time measuring mechanism to function and for maintaining its function at a constant rate, a ratchet mechanism operative to take steps at a rate controlled by said operating means, and means controlled by said ratchet mechanism when it has taken a certain number of steps for disabling said operating means and actuating said signal.

5. In a signal operating system, a signal, a

mechanism for measuring the passage of time, operating means comprising a single magnet, an armature therefor, circuit means and a lever mechanism for starting said time measuring mechanism to function and for maintaining its function at a constant rate, manually operative means for starting said operating means to function, a ratchet mechanism operative to take steps at a rate controlled by said first-mentioned operating means, and means controlled by said ratchet mechanism when it has taken a certain number of steps for stopping the function of said first-mentioned operating means and for actuating said signal.

6. In a signal operating system, a signal, a balance wheel, a magnet, an armature for said magnet, a spring for said armature, a lever mechanism, said balance wheel, magnet, armature, spring and lever mechanism being so arranged that said armature when first attracted by said magnet starts said balance wheel to oscillate and said armature stores a certain amount of energy in said spring each time said armature is attracted and so that said spring in turn delivers said certain amounts of energy through said armature and said lever mechanism to said balance wheel each time said armature is released to cause said balance wheel to oscillate at its natural frequency, a ratchet mechanism controlled by said armature to take one step for each oscillation of said armature and means controlled by said ratchet mechanism when it has taken a certain number of steps for discontinuing said cooperative function of said balance wheel, lever mechanism, magnet, armature and spring and for operating said signal.

7. In a time measuring device, a signal, a mechanism for measuring the passage of time comprising a balance wheel, a spring for controlling the oscillations of said wheel, a switch, a circuit controlled by said switch, a relay in said circuit operative when said circuit is closed, a second circuit closed by said relay when operated, a magnet in said second circuit operative when said second circuit is closed, a lever operated from a normal to an actuated position when said magnet is energized, means for locking said lever in its actuated position, a spring controlled by said lever to store energy when said lever is operated to its actuated position, means controlled by said lever when first operated to actuated position to start the wheel to oscillate and controlled by said lever each time it is subsequently released to normal under tension of said spring for continuing the oscillations of said wheel, contacts in said second circuit, a second lever for closing and opening said contacts, a third lever for locking said second lever in its contact closing position, means operative by said first lever in actuated position for causing said third lever to unlock said second lever for the operation of said contacts thereby, means operative each time said wheel has oscillated once for actuating said locking means for the first lever to release said lever from the actuated position, means operative by said first lever when released for actuating said second lever to close said contacts and to cause said second lever to be locked by said third lever, and means controlled by said mechanism when it has operated a certain interval of time for stopping its operation and for then operating said signal.

8. In a time measuring device, a signal, a mechanism for measuring the passage of time comprising a balanced wheel, a spring for controlling the oscillations of said wheel, a switch, a circuit controlled by said switch, a relay in said circuit operative when said circuit is closed, a second circuit closed by said relay when operated, a magnet in said second circuit operative when said second circuit is closed, a lever operated from a normal to an actuated position when said magnet is energized, means for locking said lever in actuated position, a spring controlled by said lever to store energy when said lever is operated to its actuated position, means controlled by said lever when first operated to actuated position to start the wheel to oscillate and controlled by said lever each time it is subsequently released to normal under tension of said spring for continuing the oscillations of said wheel, contacts in said second circuit, a second lever for closing and opening said contacts, a third lever for locking said second lever in its contact closing position, means operative by said first lever in actuated position for causing said third lever to unlock said second lever for the operation of said contacts thereby, means operative each time said wheel has oscillated once for actuating said locking means for the first lever to release said first lever from the actuated position, means operative by said first lever when released for actuating said second lever to close said contacts and to cause said second lever to be locked by said third lever, a second mechanism controlled by said first mechanism when it has operated a certain interval of time for stopping its operations comprising a ratchet wheel, pawl mechanism operative each time said first lever is released for causing said ratchet wheel to take one step, a holding pawl for said ratchet wheel operative to hold said ratchet wheel in an actuated position when said relay is operated, a wheel having a detent therein and attached to said ratchet wheel, a lever normally resting against the edge of said last-mentioned wheel and so arranged that it operates to an actuated position when the wheel has rotated to a position where the lever drops into said detent, means actuated by the last-mentioned lever when it is in operated position for opening said second circuit to stop the first-mentioned mechanism and for actuating said signal.

9. In a signal operating system, a signal, a balance means, a magnet, an armature therefor, circuit means for actuating said magnet to attract said armature, means controlled directly by said armature when first attracted by said magnet for starting said balance means to oscillate, a lever mechanism cooperating with said armature, said circuit means and said balance means when started for controlling said circuit means to alternately release and actuate said magnet at the natural frequency of oscillations of said balance means to control said balance means and to continue to oscillate at its natural frequency, a shaft controlled by said armature to oscillate at the same frequency as the balance means, a ratchet mechanism controlled by the oscillations of said shaft to operate in a step-by-step manner to take one step for each oscillation of the shaft, means controlled by said ratchet mechanism when it has taken a certain number of steps for discontinuing the oscillatory movements of said balance means, said shaft and said ratchet mechanism, and means operated by said last-mentioned means when the ratchet mechanism stops for actuating said signal.

10. In a signal operating mechanism, a signal, a mechanism for measuring the passage of time comprising an oscillatory device, a magnet, an

armature therefor, circuit means for actuating said magnet to attract said armature, means controlled directly by said armature when first attracted by said magnet for starting said device to oscillate, a lever mechanism cooperating with said armature, said circuit means and said device when started for controlling said circuit means to alternately release and actuate said magnet at the natural frequency of oscillations of said device to control said device to continue to oscillate at its natural frequency, a relay for controlling said circuit means, manually operative means for actuating said relay for closing said circuit means, counting means controlled by said armature for automatically counting the oscillations of said oscillatory device, and means operative by said counting device when it has operated a certain number of times for opening said circuit means to stop the oscillatory device and for actuating said signal.

11. In a signal operating mechanism, a signal, a balance means, a magnet, an armature for said magnet, a spring for returning said armature to normal position after it has been attracted by said magnet, means cooperating with said armature and said balance means to start said balance means to oscillate on the first attractive movement of said armature and to maintain said balance means in oscillation at its natural frequency under control of said spring, each time the armature is released, a circuit for energizing said magnet, means controlled by said balance means when oscillating and by said means cooperating with said armature for opening and closing said circuit to regulate the energizing and deenergizing of said magnet to take place once for each cycle of oscillations of said balance means, a mechanism controlled by said armature for opening said circuit after a certain number of operations of said armature and for thereafter actuating said signal.

12. In a signal operating system, a signal, a balance means, a magnet, an armature for said magnet a member associated with said armature to partake of the movements thereof, a spring for returning said armature and member to normal position after the armature has been actuated by said magnet, an extension on said member cooperating with said balance means to maintain said balance means in oscillation at its natural frequency when said armature is released under control of the energy stored in said spring when the armature was attracted by the magnet, a circuit for energizing said magnet, a lever mechanism controlled by said member for opening said circuit when the armature has been attracted by said magnet and for closing said circuit when the armature is released, a lever mechanism for locking said member in its actuated position, means for actuating said last-mentioned lever mechanism to unlock said member controlled by said balance means once for each cycle of oscillation of said balance means, a shaft controlled by said member to oscillate at the same frequency as said member, a ratchet mechanism controlled by the oscillations of said shaft to operate in a step-by-step manner to take one step for each oscillation of the shaft, means controlled by said ratchet mechanism when it has taken a certain number of steps for opening the circuit for said magnet to discontinue the control by its armature over said balance means and for thereafter actuating said signal.

13. In a signal operating system, a signal, a balance wheel, a magnet, a circuit for energizing said magnet, an armature mechanism for said magnet, a spring for returning said armature mechanism to normal after it has been actuated by said magnet, means for locking said armature mechanism in actuated position, a lever mechanism controlled by said armature mechanism and said balance wheel so arranged that each time the magnet is energized and attracts this armature mechanism, the circuit is broken and when the magnet is deenergized the circuit is closed and so that on the first energization of the magnet the armature mechanism starts the balance wheel to oscillate and on subsequent releases of the magnet the armature mechanism maintains the balance wheel in oscillation at its natural frequency by expending the energy stored in the spring and so that the armature mechanism is released from said locking means under the control of said balance wheel for each cycle of oscillations of the balance wheel, and a mechanism controlled by the oscillation of said armature mechanism after it has oscillated a certain number of times for opening said circuit permanently to stop the balance wheel and the operations of said magnet, armature and lever mechanism and to actuate said signal.

14. In a signal operating system, a signal, a balance wheel, a magnet, an energizing circuit for said magnet, an armature for said magnet, a lever arranged to oscillate with the armature, a spring for returning said armature and lever to normal after the armature has been attracted and released by said magnet, means controlled by the movement of said lever to actuated position when said magnet is first energized by said circuit for starting said balance wheel to oscillate, for locking said lever in actuated position and for opening the energizing circuit for said magnet and maintaining said energizing circuit locked in the open condition, means controlled by the oscillatory movement of said balance wheel for unlocking said lever to permit it to return to normal under tension of said spring, means on said lever and said balance wheel operative when the lever returns to normal for imparting to said wheel an impulse of energy to cause it to continue to oscillate, the energy being derived from the energy stored in the spring when the armature was attracted by said magnet, means controlled by said lever when it returns to normal for unlocking the circuit opening means to close said circuit to permit the repeated energizing and deenergizing of said magnet at a rate determined by the natural oscillatory frequency of the balance wheel, a cam mechanism, means controlled by the repeated operation and release of said lever for actuating said cam mechanism one step for each operation of the armature, means controlled by said cam mechanism when a certain number of steps have been taken for actuating said signal and for opening said circuit to permanently stop the energization and deenergization of the magnet and stop the oscillations of said wheel.

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