Oct. 20, 1959 R. WITTE 2,909,029

D.-C. TIMING DEVICE

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FIG. 1.

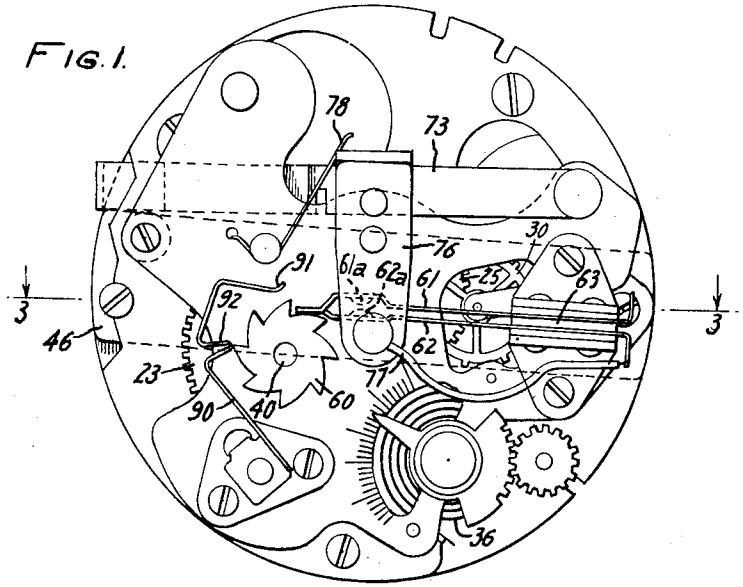


FIG. 2.

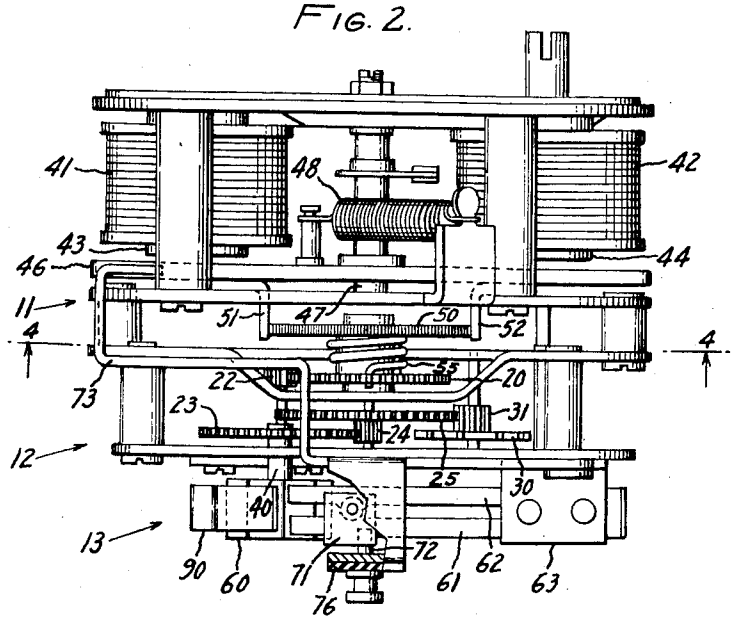
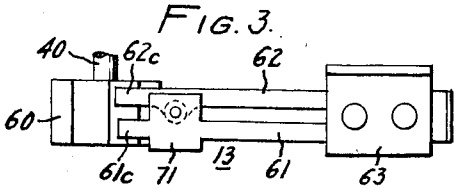


FIG. 3.



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FIG. 4.

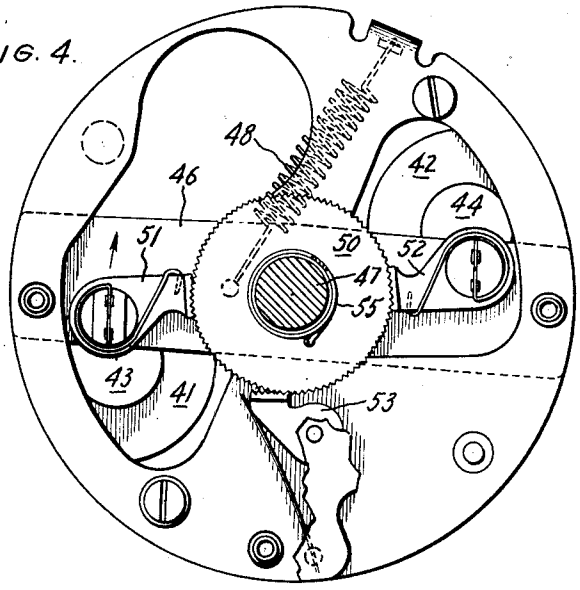
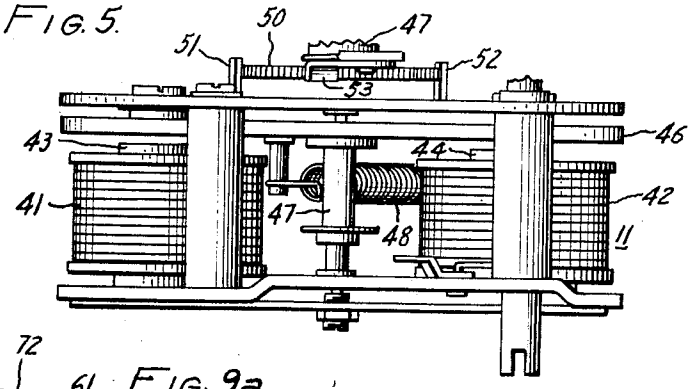


FIG. 5.



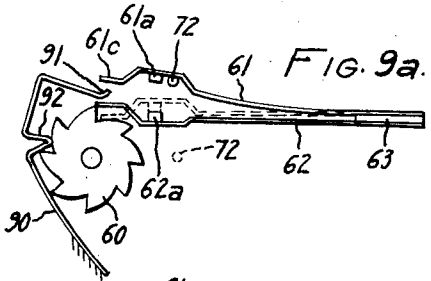


FIG. 9a.

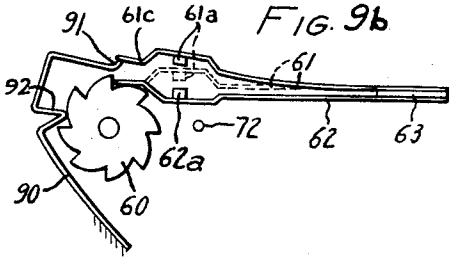


FIG. 9b

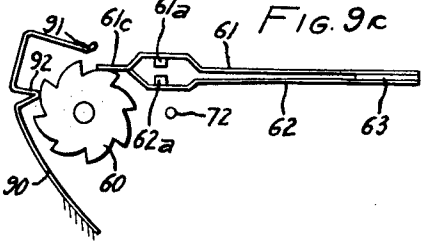


FIG. 9c

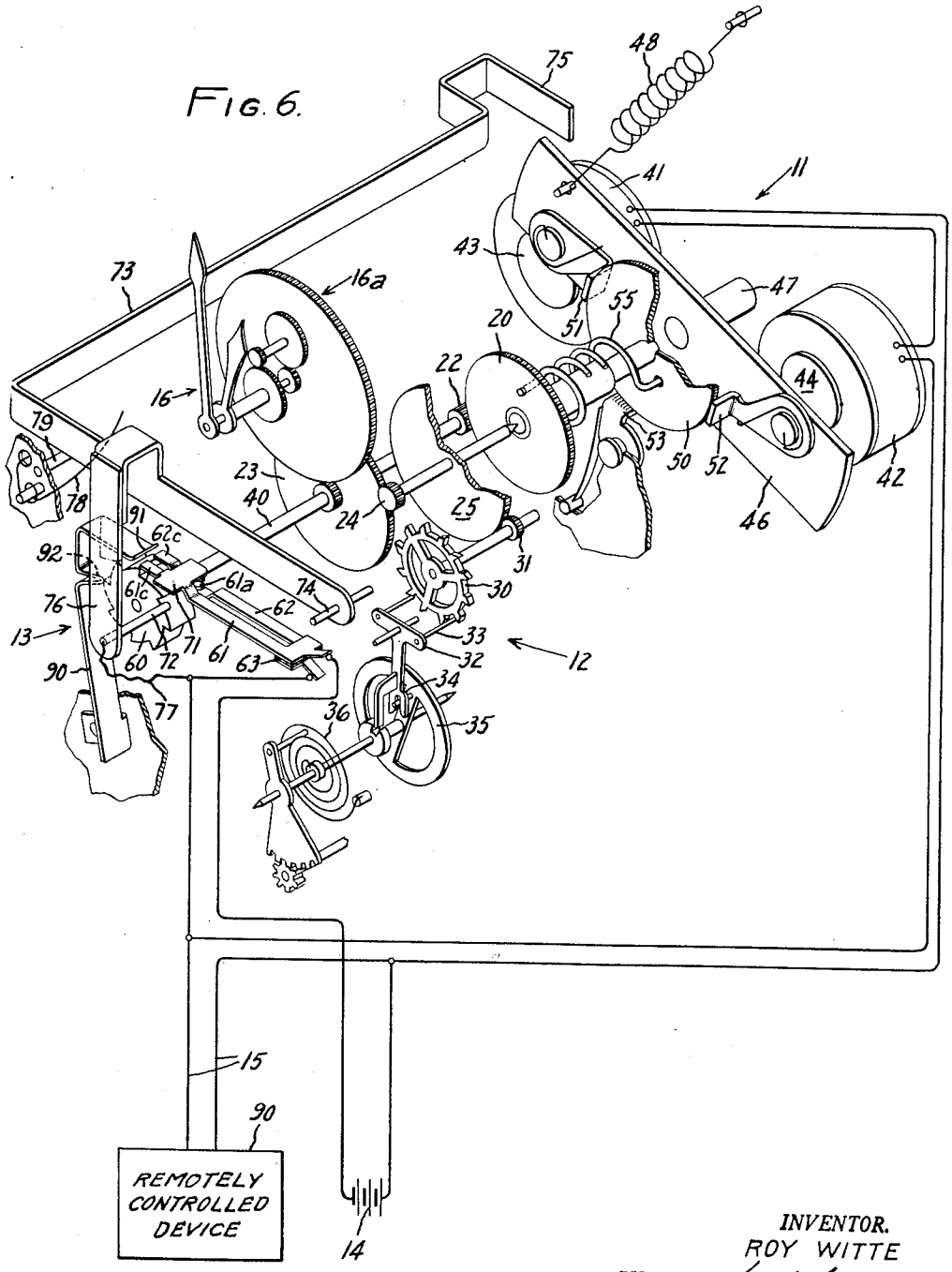
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FIG. 6.



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FIG. 7a.

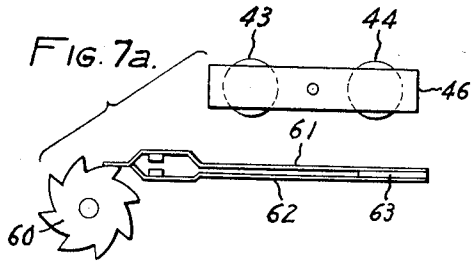


FIG. 7b.

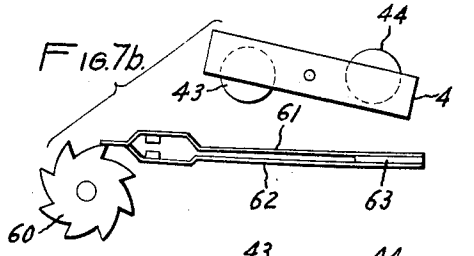


FIG. 7c.

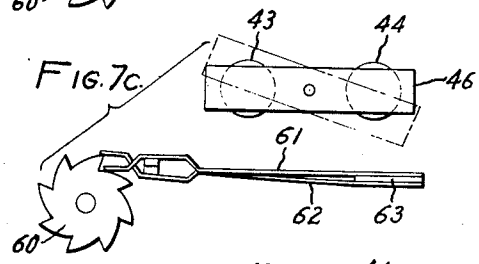


FIG. 7d.

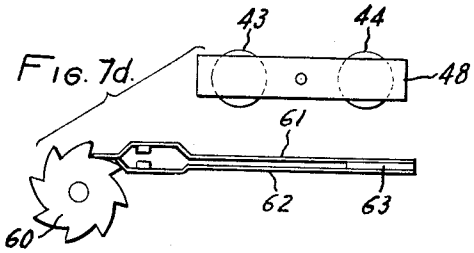


FIG. 8a.

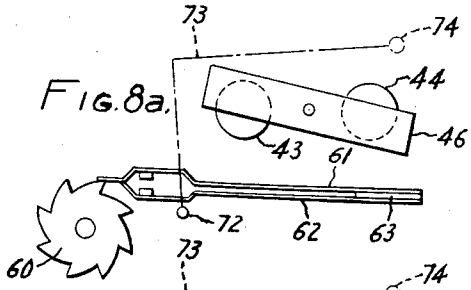


FIG. 8b.

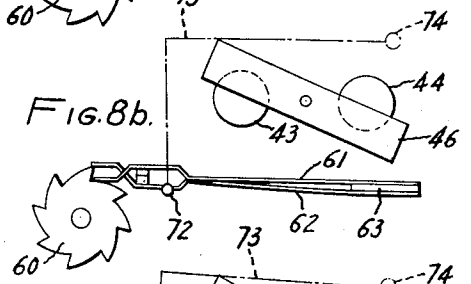


FIG. 8c.

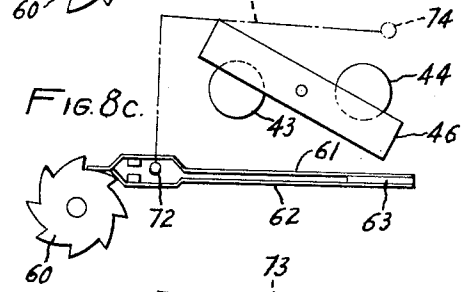


FIG. 8d.

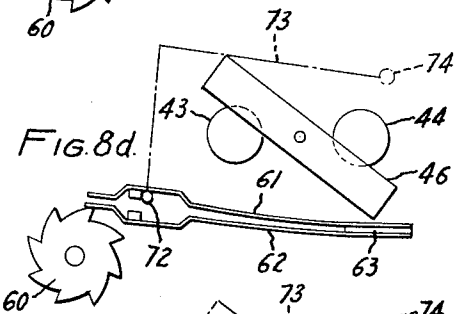
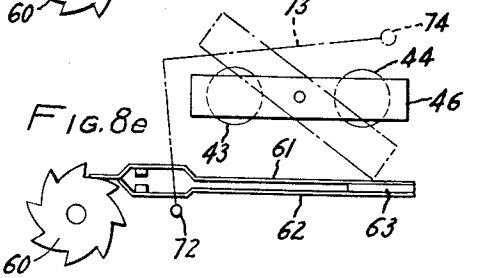


FIG. 8e



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United States Patent Office 2,909,029 Patented Oct. 20, 1959

2,909,029

D.-C. TIMING DEVICE

Roy Witte, Wheaton, Ill., assignor to General Time Corporation, New York, N.Y., a corporation of Delaware

Application May 17, 1957, Serial No. 659,912

8 Claims. (Cl. 58—41)

The present invention relates to timing devices and more particularly to a D.-C. operated timing device for generating accurately timed electrical impulses.

D.-C. timing devices in common use, for example, as vehicle clocks, are conventionally powered by an armature which is picked up periodically by an electromagnet, serving to wind a short-term spring whenever the armature retrogrades to its "unwound" position, the cycle being on the order of several minutes in length. Such devices are usually capable of starting automatically when voltage is reapplied following disconnection, since the contacts are left in the closed condition when the mechanism is completely run down. However, the winding cycle cannot be utilized for timing purposes since the period varies in accordance with changes in voltage and other extraneous factors. Another type of D.-C. timing device known in the art includes provision for winding periodically under the control of the timing train, which provides a more precise timing cycle; however, such devices have been subject to a number of disadvantages.

It is an object of the present invention to provide a D.-C. timing device which is capable of putting out an accurately timed series of impulses, for example, once per minute, for control purposes and which is so arranged as to insure positive and immediate restarting when voltage is reapplied following a sustained interruption of the normal power supply line. It is a general object to provide a D.-C. timing device which is not only accurate but which is reliable in applications subject to possible or frequent interruption in electric power. It is moreover an object to provide a D.-C. timing device which starts dependably when voltage is reapplied following a long interruption as, for example, incident to use in a guided missile or other apparatus which must be stored for long periods of time under standby conditions.

It is another object of the invention to provide a D.-C. timing device of the type described in which a single set of contacts serves both to wind the device and to generate accurately timed control impulses for synchronized operation of various slave devices.

It is a further object of the present invention to provide a D.-C. timing device which is inherently simple and which may be added as an improvement to existing designs of D.-C. timers and clocks, for example, vehicle clocks.

It is still another object of the present invention to provide a D.-C. operated device for generating timed impulses and which may be constructed for any desired degree of accuracy using parts of the type conventionally employed in the clock art and without adhering to unusually exact tolerances in manufacture or assembly. It is a related object to provide a timing device which may be manufactured inexpensively on a quantity production basis and which will operate reliably over long periods of time even in the face of the shock and vibration encountered in rough military and commercial usage. Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

Figure 1 is a front view of a timing device constructed in accordance with the present invention with the minute and hour hands and the gearing usually associated therewith omitted.

Fig. 2 is a top view of the device shown in Fig. 1.

Fig. 3 is a fragmentary top view of the contact arms taken along the line 3—3 in Fig. 1.

Fig. 4 shows the electromagnet and armature construction taken along the line 4—4 in Fig. 2.

Fig. 5 is an end view corresponding to Fig. 4.

Fig. 6 is a distorted perspective of the mechanism for facilitating an understanding of the operation.

Figs. 7*a*–7*d* are diagrams showing a typical winding cycle under ordinary operating conditions.

Figs. 8*a*–8*e* are diagrams showing the running down of the mechanism upon disconnection of power and the automatic restarting when power is reapplied.

Figs. 9*a*–9*c* are diagrams showing the operation of the latch mechanism.

While the invention has been described in connection with a preferred embodiment, it will be understood that I do not intend to be limited to the embodiment shown, but intend to cover all alternative and equivalent constructions falling within the spirit and scope of the appended claims.

Turning now to the drawings, there is shown a mechanism embodying the invention which may, for convenience, be considered as three sub-assemblies, namely, a motor portion **11**, a timing train **12** and a switching arrangement **13**, energized by a battery **14** and cooperating to produce timed impulses in a control line **15**. Minute and hours hands, and the gears which couple them, have been indicated diagrammatically at **16**, **16***a*, it being understood that the present device is primarily intended for the purpose of producing precisely timed voltage impulses and that addition of hands for display purposes constitutes a useful but optional feature.

It is convenient to give consideration first to the timing train. Such timing train includes an input gear **20**, which is kept under torsion by the motor portion **11**. Meshing with the input gear **20** is a pinion **22** directly coupled to a gear **23**. Compound reduction is effected by a pinion **24** meshed with the gear **23** and rigidly connected to a gear **25**. To cause rotation of the driving train at a timed rate, an escapement of conventional type is employed including an escapement wheel **30** having a pinion **31** meshing with the gear **25**. Cooperating with the escapement wheel is a verge **32** having pallets **33** and a forked arm **34**. The arm engages a balance wheel **35** having an associated hair spring **36**. Thus, as long as torque is applied, rotation of the train will occur at a timed rate. A shaft **40** connected to the gear **23** serves as the output shaft, and it is to this shaft that the indicating hands, indicated at **16**, may be coupled with appropriate gearing (Fig. 6).

For the purpose of applying torque to the input of the driving train, the motor portion **11** includes an electromagnet having coils **41**, **42** which are connected in series with one another and provide oppositely-poled pole pieces **43**, **44**. Arranged in front of the coils **41**, **42** and centrally pivoted for oscillation in a plane parallel to them is an armature **46** having a shaft **47**. For the purpose of tensioning the armature **46** in a retrograde direction, i.e., away from the pole pieces, a coil spring **48** is provided. This spring may be referred to as a "short term" spring since it need only store enough energy to drive the mechanism for a period of two minutes or so. Moreover, to permit free winding movement of the armature when the electromagnet is energized, a one-way force transmitting

coupling is employed. The latter consists of a ratchet wheel **50** having a serrated edge engaged by pawls **51, 52** mounted symmetrically on the armature, such pawls being provided with suitable springs to keep them in engagement with the wheel **50**. And to prevent movement of the wheel **50** during the winding operation, a keeper pawl **53** is used which is pivoted to the frame and which also has a suitable spring for keeping the teeth thereof in engagement with the wheel. It will be understood as the discussion proceeds that the pawl **53** clicks idly during the time that the armature rotates clockwise under the influence of the coil spring **48**.

For the purpose of coupling the ratchet wheel **50** to the gear **20** of the driving train and for insuring that torque continues to be applied to the timing train even during the winding interval, a coil spring **55** is used having its ends anchored in the members **20, 50**, and sandwiched concentrically between them. With regard to the operation of the device, as thus far described, it will be apparent that energization of the electromagnet causes the armature **46** to be attracted in a winding or counterclockwise direction, with clicking taking place at the pawls **51, 52** and accompanied by tensioning of the return coil spring **48**. During winding, the ratchet wheel **50** is blocked by the pawl **53** and the energy previously stored in the auxiliary spring **55** continues to supply torque to the timing train. Following the winding operation, the coil spring **48** urges the armature clockwise, resulting in timed rotation of the output shaft **40**.

In carrying out the present invention, a switch coupled to the output shaft **40** is provided for energizing the electromagnet at precisely spaced intervals of time, such intervals being sufficiently short so that the energy stored by the armature during a single winding operation is more than sufficient to drive the timing train through a single interval. In the present embodiment, the momentary making of contact is brought about by a saw toothed cam **60** mounted on the end of the shaft **40** and engaged by contact arms **61, 62** having contacts **61***a*, **62***a*. The contact arms **61, 62** are mounted at their base in a suitable insulating support **63** so that their tips **61***c*, **62***c* ride side by side on the surface of the cam **60**. The arm **61** is preferably a few thousandths of an inch shorter than the arm **62** so that as the saw toothed cam **60** rotates, the arm tip **61***c* drops, followed, after a short time interval on the order of two seconds, by the arm tip **62***c*. The arms are so constructed and arranged that contact is made during this two second time interval, as is set forth in the sequential diagram, Figs. 7*a*–7*d*, to which reference is made.

In these figures, Fig. 7*a* represents the fully wound condition while 7*b* shows the position of the armature and switch arms a half minute or so thereafter. Upon further unwinding, switch arm **61** drops from a lobe of the saw toothed cam, bringing the contacts together and causing the armature to be attracted and restored to its wound position. Two seconds later, the continued rotation of the cam causes the arm **62** to drop off into the position shown in Fig. 7*d* where the contacts are separated, thereby to begin a new cycle of timed operation.

Since the contacts are in the open condition 58 seconds of each minute, the probabilities are that the contacts will be in the open condition when the device completely runs down due to disconnection of the power source as, for example, upon changing the supply battery. Consequently, when power is reapplied, the electromagnet will be open circuited and will not pick-up automatically to restart the timing mechanism. In accordance with the present invention, a set of auxiliary contacts is provided in shunt with the normal contacts, together with means for making contact whenever the armature reaches its fully unwound or retrograde position. In the present embodiment, the auxiliary contacts are indicated at **71, 72**, respectively, the contact **71** being formed integrally with, and in the plane of, the contact arm **61** (see Figs. 3 and 6) the contact **72** being secured to an auxiliary contact arm **73**. Such contact arm is pivoted at a pivot **74** and has a tip portion **75** which is arranged in the path of movement of the armature. Electrically, the contact **72** is mounted on a depending insulated bracket **76** secured to the arm **73** and the contact is moreover connected to the contact arm **62** by means of a pig-tail **77**. Under normal running conditions, the arm is biased downwardly by means of a spring **78** and rests against a stop **79**, the contact **72** thereon thus occuping an out-of-the-way position.

The function of the auxiliary contacts **71, 72** will be apparent upon reviewing a typical disconnect cycle as set forth in Figs. 8*a*–8*c* which shows the position of the contact **72** at various points in such cycle. In Fig. 8*a*, the armature is partially unwound and the contact arms are approaching drop-off. Assuming that the power source has been disconnected, when drop-off occurs as shown in Fig. 8*b*, the contacts will close but there will be no resulting rewinding of the armature. Since the energy stored in the spring **48** is more than sufficient for a single cycle of operation, the saw toothed cam **60** will continue its timed rotation. The additional movement of the armature which occurs thereafter causes the auxiliary arm **73** to be picked up, thereby advancing the contact **72** upwardly as shown in Fig. 8*c*. When the device comes to rest with the armature in its completely unwound position, firm contact is assured between the movable contact **72** and contact **71** on the switch blade **61**. Consequently, when power is reapplied, the circuit is closed through contacts **71, 72** to re-energize the electromagnet causing the armature to rotate to its wound position. This movement is accompanied by downward movement of the arm **73** under the influence of the spring **78**, thereby breaking the circuit of the electromagnet and restoring the contact **72** to a lowered out-of-the-way position. It will be apparent that with the armature thus wound, the regular contacts **61***a*, **62***a* will be effective to cause periodic energization of the electromagnet.

Further in accordance with the present invention, means are provided for temporarily disabling the normal contacts for a predetermined time interval following reapplication of voltage after a sustained interruption of electric power. In order to insure that torque is applied to the driving train even in the event that the mechanism should run down and come to a rest with the cam in the position shown in Fig. 8*d*, pick-up will occur by reason of contacts **71, 72** as described above. However, the resultant lowering of the auxiliary arm **73** will, under such conditions, cause contact **61***a* to be lowered into engagement with contact **62***a*, thereby causing a sustained current to flow through the electromagnet. With current flowing through the electromagnet, the armature **46** is held immobile, thus preventing torque from being applied to the driving train by the coil spring **48**. Under re-start conditions, there is no torque in the auxiliary spring **55** and consequently, no movement of the driving train so that the mechanism will simply "hang-up" and fail to begin its regular timing cycle.

Accordingly, my invention contemplates the providing of a latch mechanism for latching the regular contacts **61***a*, **62***a* so that they cannot come together when voltage is reapplied following a sustained power interruption, which latch mechanism is effective whenever the cam **60** is in that phase of its cycle where contact is normally made between the contacts **61***a*, **62***a*. More specifically, I provide a latch member **90** which is cycled by the saw toothed cam **60** so as to be brought into latching position whenever the switch arms **61, 62** are in the vicinity of their drop-off positions relative to the cam. When the latch member **90** is active, a tip **91** thereon is in overhanging position relative to the tip of the switch arm **61**. Moreover, the tip **91** of the latch member is so spaced above the arm **61** that the tip of the arm **61** tends to wipe past the latch member into latching position when

lifted by the auxiliary contact **72** incident to complete run down of the armature **46**. For the purpose of oscillating the latch member **90** back and forth between its active position and its inactive position, such latch member includes a cam follower portion **92** riding on cam **60**.

The operation of the latch member will be apparent upon reference to a typical cycle of latching operation set forth in Figs. 9*a*–9*c*, where it will be assumed that the cam is so phased that at complete run-down, the cam occupies its contact-making position, i.e., with the arm **61** in position to re-establish contact with the cooperating arm **62**. Such condition, as stated, exists only during two seconds out of each minute and thus the odds against this condition are about 30:1. Nevertheless it is a possible condition and must be accounted for. Referring more specifically to Fig. 9*a*, it will be noted that the latch member **90** is in its active position and that the switch arm **61** has wiped past the tip **91** thereof into latched or blocking position. The position which the arm **61** would occupy, but for the latch and but for the contact **72**, is indicated by the dotted line. Upon reapplication of voltage after a sustained interruption, current flows through contacts **71**, **72** as described above to energize the electromagnet, causing the contact **72** to be lowered into the position shown dotted in Fig. 9*a*. This lowers the arm **61** onto the latch **90** but because of the latch the arm **61** is maintained in its out-of-contact position. This insures that the electromagnet is, after its initial energization, de-energized, and consequently the armature **46** is free to apply torque to the input gear **20** of the timing train. Upon passage of a few seconds of time, Fig. 9*b*, rotation of the cam **60** occurs thereby allowing arm **62** to drop off, the arm **61** remaining latched. Upon further passage of time, Fig. 9*c*, the latch **90** is cammed to its left-hand or inactive position and allowing the switch arm **61** to be lowered into its normal running position. Since by this time, the critical two-second interval during which contact is normally made is safely past, the device will continue to cycle in the normal way previously discussed in connection with Figs. 7*a*–7*d*.

It will be apparent from the foregoing that the device is capable of re-starting positively upon reapplication of power regardless of the phasing of the mechanism, and particularly the phasing of the cam **60**, at the time that final run-down occurs.

Since periodic contact is made at the output of the timing train, such contact is entirely under the control of the escapement mechanism and consequently can be caused to occur with any desired order of accuracy. This is particularly true since each lobe of the cam occupies ⅛ of a full circle; consequently appreciable movement, or at least detectable movement, takes place at the cam **60** during an interval of time as short as one second. Provided that the cam is accurately formed with sharp edges, the drop-off may be made consistent in timing from lobe to lobe. If still further accuracy is desired, the size of the cam or the arcuate length of the lobes may be increased. For example, a four lobed cam could be employed, operating at a speed of ¼ r.p.m. This is a matter which is well within the skill of the art.

The accuracy and reliability of the present arrangement causes it to be particularly well adapted for use in precision devices where a remotely controlled device, such, for example, as indicated at **90** in Fig. 6, must be impulsed at regular intervals. It is particularly noteworthy that a single set of contacts suffices for both winding up the armature and for controlling the remotely controlled device, thereby making it unnecessary to secure synchronization by separate sets of contacts. The remotely controlled device may, for example, consist of a slave clock or timer.

The above, it will be noted, has been accomplished using standard parts of a type normally employed in an automobile clock or the like; consequently, the construction is durable and susceptible to inexpensive production line manufacture.

Where the device described above is used in an automobile, it may be placed in an out-of-the-way position under the hood and slave clocks, for example, of the type employing a simple electromagnetic ratchet may be mounted in the dash and also in a convenient back seat position. Since the slave clocks may be made silent in operation, any noise arising from the use of the present clock system as may be caused, for example, by the periodic winding of the armature is isolated under the hood of the automobile.

I claim as my invention:

1. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement, an electromagnet, a spring biased armature cooperating with said electromagnet for tensioning said spring when the electromagnet is momentarily energized, a ratchet mechanism for coupling said armature to the input of the timing train, a switch operating cam coupled to the output of said timing train, contact members having cooperating electrical contacts thereon electrically connected to said electromagnet, said contact members being so arranged with respect to said cam that momentary contact takes place periodically incident to cam rotation, the rate of movement of said cam being such as to cause said momentary contact to occur when the armature has undergone only a portion of its retrograde movement, and auxiliary contact means connected to said electromagnet and so arranged as to make contact when said armature is at its limit of retrograde movement thereby to effect restarting of the mechanism when voltage is reapplied to the device following a sustained interruption.

2. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and output together with an escapement, an electromagnet, a spring biased armature cooperating with said electromagnet for tensioning said spring when the electromagnet is momentarily energized, a ratchet mechanism for coupling said armature to the input of the timing train, a switch operating cam coupled to the output of said timing train, contact members having cooperating electrical contacts thereon electrically connected to said electromagnet, said contact members being so arranged with respect to said cam that momentary contact takes place periodically incident to cam rotation, and means operated incident to said armature's approaching its limit of retrograde movement for completing a shunt circuit around said contacts, thereby to effect restarting of the mechanism when voltage is reapplied to the device following a sustained interruption.

3. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement, a short term spring coupled to the input, an electromagnet, a ratcheted armature cooperating with said electromagnet for tensioning said spring when the electromagnet is momentarily energized, a saw toothed cam coupled to the output of said timing train, contact members having cooperating electrical contacts thereon riding on said saw toothed cam and so arranged that the arms drop off of the lobes of the cam in closely spaced sequence with contact being made during the sequence interval, and means including auxiliary electrical contacts operated incident to the arrival of said armature at its limit of retrograde movement for completing a shunt circuit around said contacts, thereby to insure restarting of the timing train when voltage is reapplied to the device following a sustained interruption.

4. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement for controlling the rate of the output, a short term spring coupled to the input, an electromagnet, means including

an armature cooperating with said electromagnet for winding said spring when the electromagnet is momentarily energized, a saw toothed cam coupled to said output, switch arms riding side by side on said saw toothed cam and dimensioned for drop-off in rapid sequence, said switch arms being so constructed and arranged that contact is made between them only during the sequence interval, auxiliary contact means having contacts arranged in shunt with said switch arms for making contact incident to said armature's reaching the limit of its retrograde movement for energizing said electromagnet when voltage is reapplied following a sustained interruption, and means for disabling said normal contacts for a predetermined time interval following an interruption of electrical power.

5. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement for controlling the rate of the output, a short term spring coupled to the input, an electromagnet, means including an armature cooperating with said electromagnet for winding said spring when the electromagnet is momentarily energized, a saw toothed cam coupled to said output, switch arms riding side by side on said saw toothed cam and dimensioned for drop-off in rapid sequence, said switch arms being so constructed and arranged that contact is made between them only during the sequence interval, auxiliary contact means having contacts arranged in shunt with said switch arms for making contact incident to said armature's reaching the limit of its retrograde movement for energizing said electromagnet when voltage is reapplied following a sustained interruption, and a latch adjacent said contact members for temporarily holding the contact members out of engagement with one another following operation of said auxiliary contact means.

6. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement for controlling the rate of the output, an electromagnet, a spring biased armature cooperating with said electromagnet for winding said spring when the electromagnet is momentarily energized, switch means coupled to said output for periodically connecting said electromagnet to said voltage source for periodic winding of said spring prior to said armature's reaching its limit of retrograde movement, auxiliary means for closing an electrical circuit to said electromagnet incident to said armature's reaching its limit of retrograde movement thereby to insure restarting upon reapplication of voltage following sustained interruption at said voltage source and means for disabling said switch means for a predetermined time interval following said reapplication of voltage.

7. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and an output together with an escapement for controlling the rate of the output, an electromagnet, a spring biased armature cooperating with said electromagnet for winding said spring when the electromagnet is momentarily energized, switch means including a cam coupled to said output for periodically connecting said electromagnet to said voltage source for periodic winding of said spring prior to said armature's reaching its limit of retrograde movement, auxiliary means for closing an electrical circuit to said electromagnet incident to said armature's reaching its limit of retrograde movement thereby to insure restarting upon reapplication of voltage following a sustained interruption at said voltage source, and means operated by said cam for disabling said switch means for a predetermined time interval following said reapplication of voltage.

8. In a timing device for use with a D.-C. voltage source, the combination comprising a timing train having an input and output together with an escapement for controlling the rate of the output, an electromagnet, a short term spring, an armature cooperating with said electromagnet and connected to said spring for tensioning said spring when the electromagnet is engaged, means for coupling said armature to the input of said timing train so that the armature moves toward retrograde position incident to passage of time, contact means coupled to the output of said timing train for making contact periodically during the operation of the latter, auxiliary contacts in shunt with said periodic contact means, and means including a member engaged by said armature as the latter moves into its fully retrograde position for closing said auxiliary contacts and for temporarily disabling said periodic contact means so that said armature is wound by said electromagnet upon reapplication of voltage following a sustained interruption thereof while insuring that the circuit of said electromagnet is broken immediately following the closure of the auxiliary contacts.

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