April 29, 1930. A. F. POOLE 1,756,437

CLOCK AND SIMILAR INDICATOR

Filed Jan. 6, 1927 4 Sheets-Sheet 1

Fig. 1.

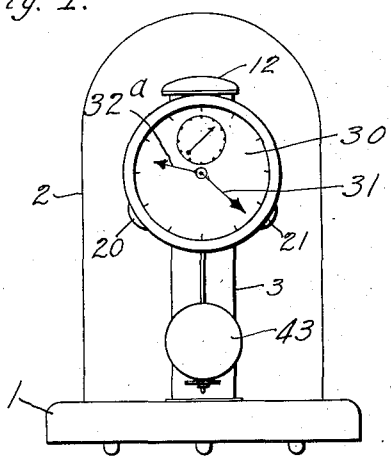
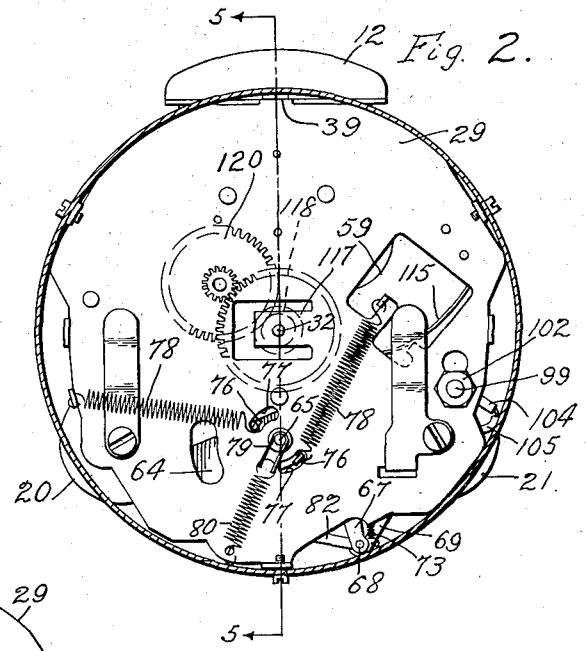


Fig. 2.



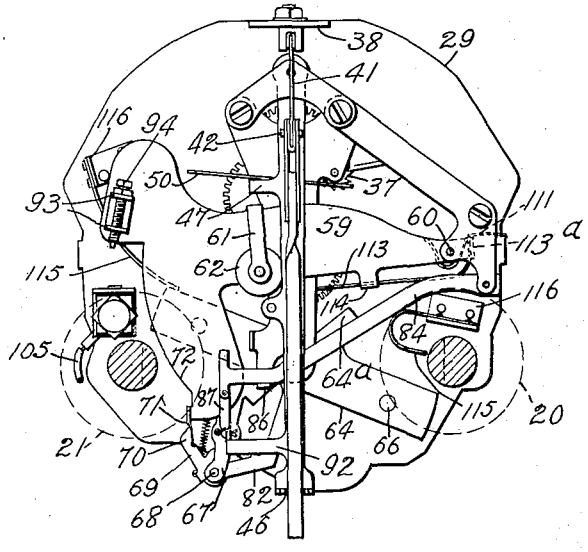
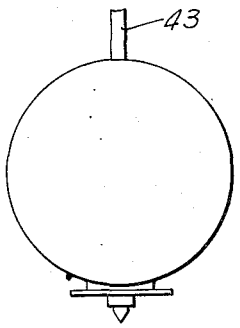


Fig. 3.



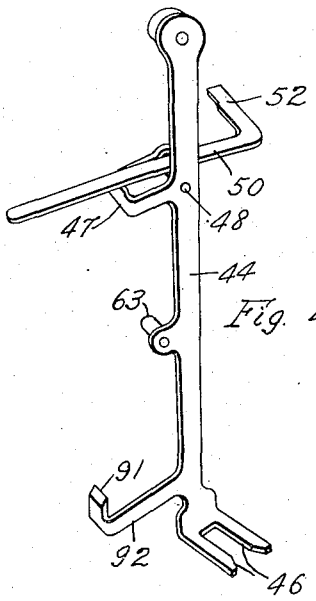


Fig. 4.

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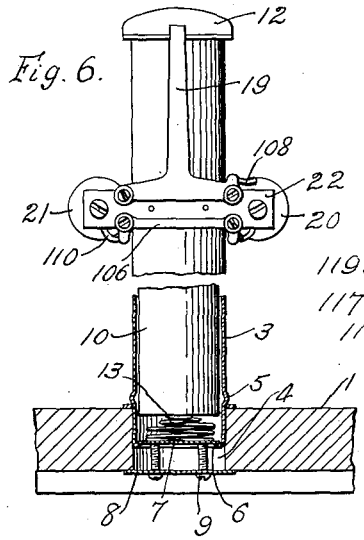

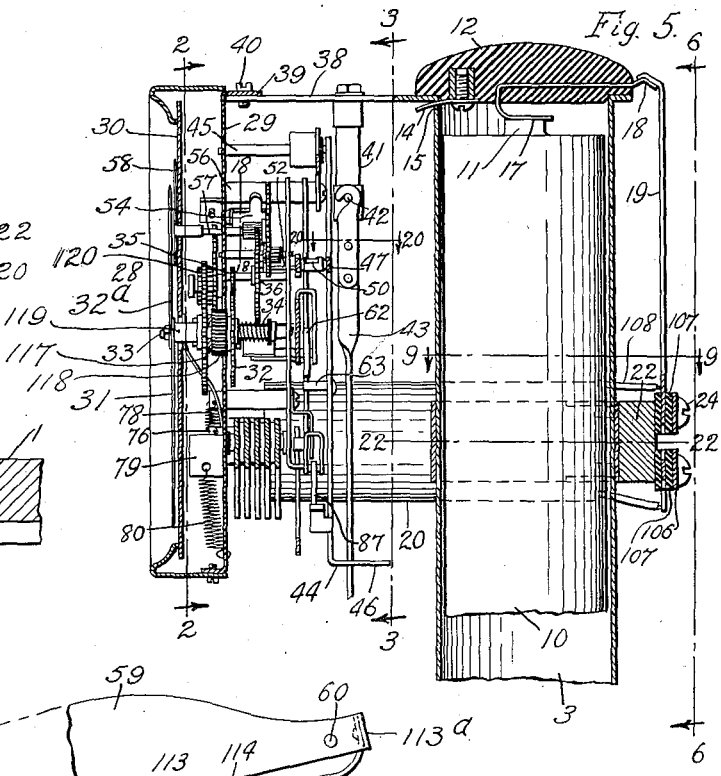

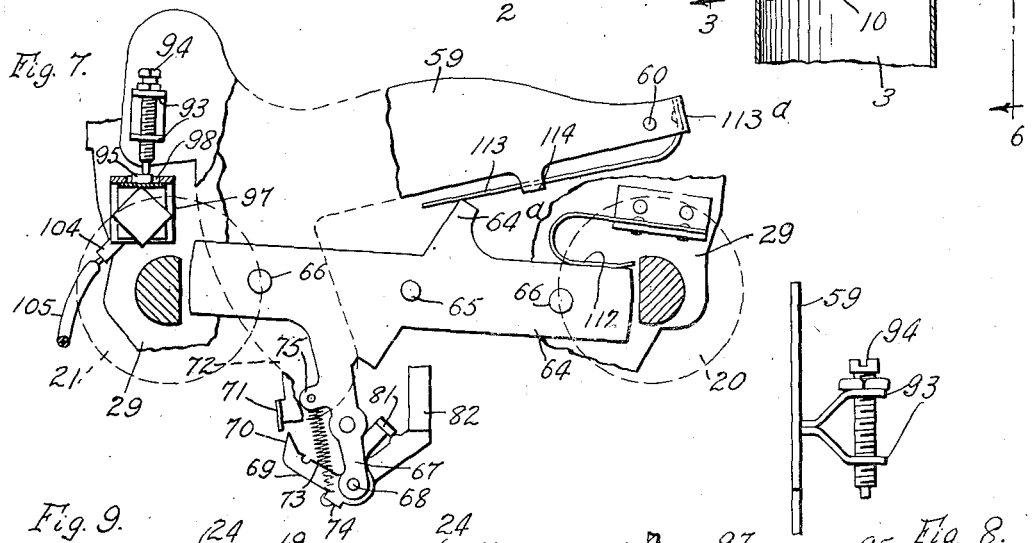

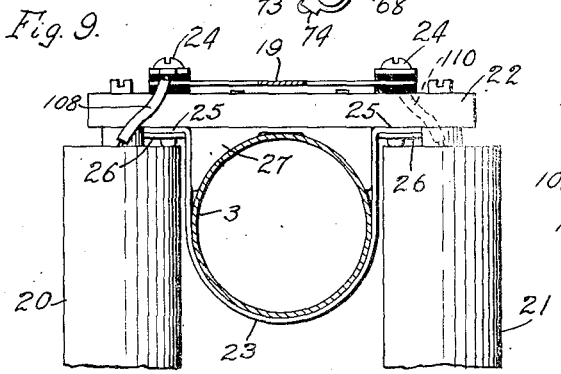

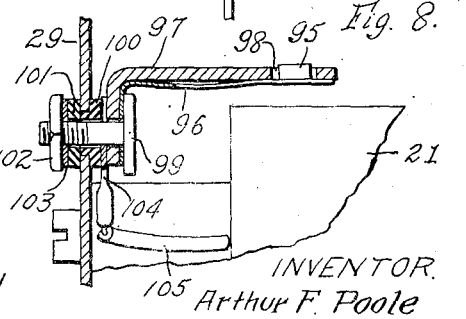

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Fig. 10.

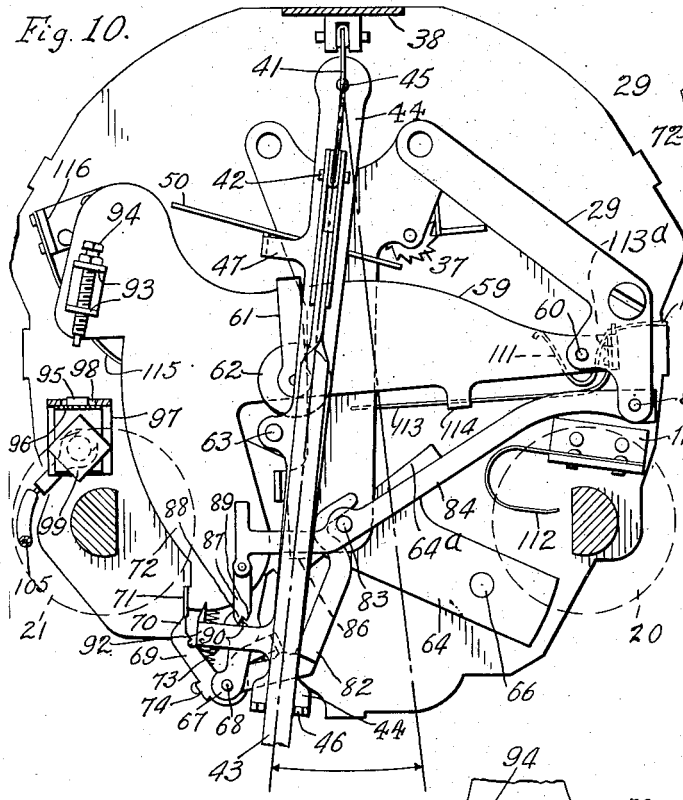


Fig. 11.

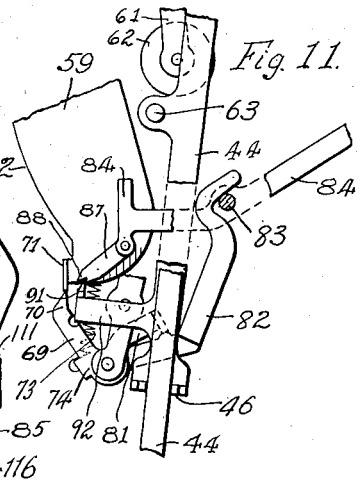


Fig. 12.

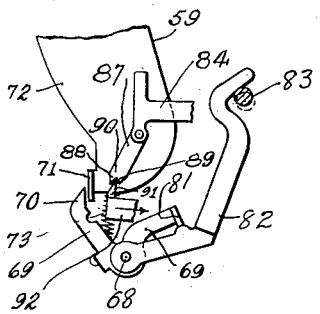


Fig. 13.

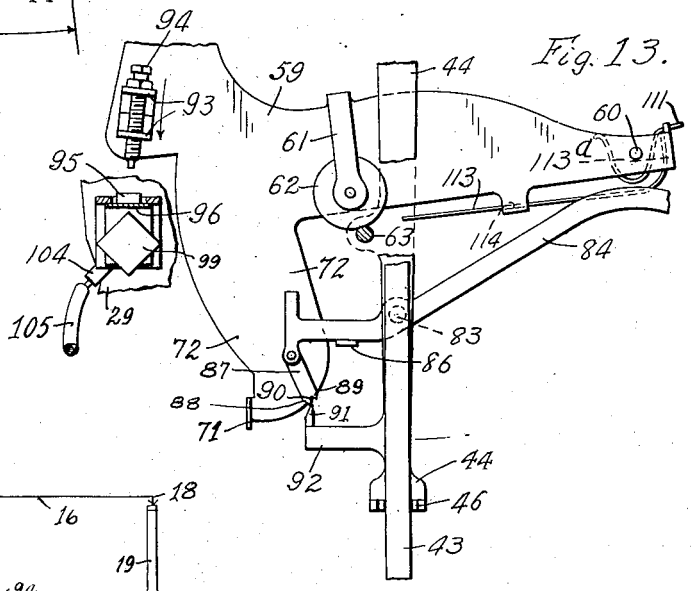
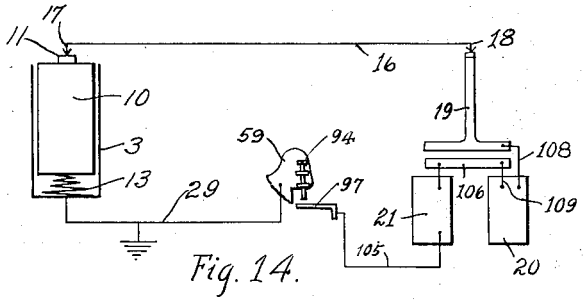


Fig. 14.



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CLOCK AND SIMILAR INDICATOR

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Fig. 15.

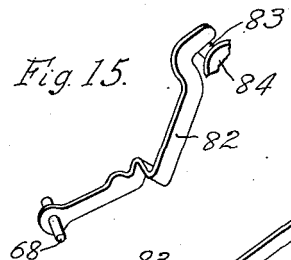


Fig. 16.

Fig. 17.

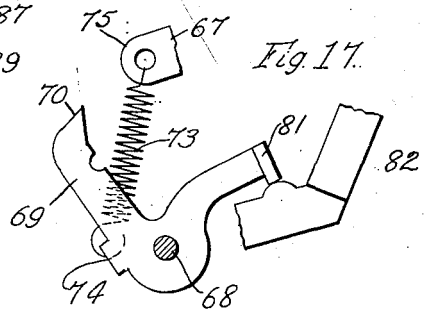


Fig. 18.

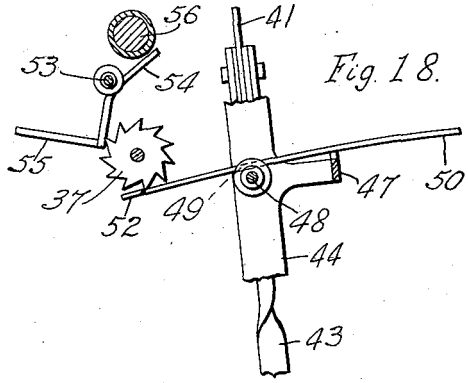


Fig 19.

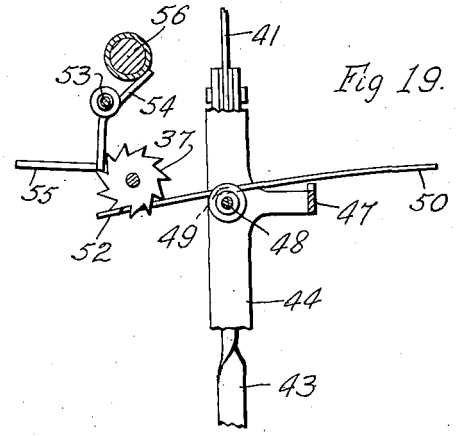
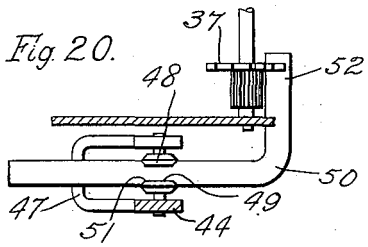


Fig. 20.



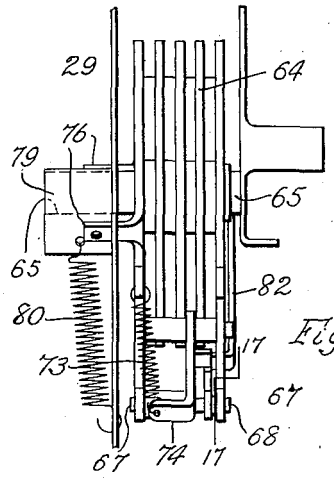
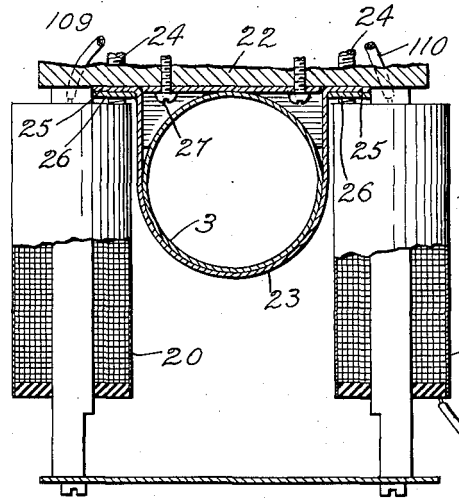


Fig. 21.

Fig. 22.



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Patented Apr. 29, 1930 1,756,437

UNITED STATES PATENT OFFICE

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CLOCK AND SIMILAR INDICATOR

Application filed January 6, 1927. Serial No. 159,323.

This invention relates to electric clocks and the like, and is in the nature of an improvement upon the type of electric clock disclosed and claimed in my prior co-pending application, Serial Number 685,387, filed January 10, 1924. In electric clocks of the type disclosed in said prior application, an impulse element is normally held in poised position and is released to impart a propelling force to an oscillating member driving the time train whenever the amplitude of oscillation of said oscillating member falls below a given value, thus increasing the amplitude and causing a continuance of operation of the time train.

One object of the invention is to improve and simplify the control of said impulse element and its restoration to poised position.

A further object of the invention is to provide improved controlling and resetting means for the impulse element which will be relatively compact, simple, durable and inexpensive in construction, which may be formed largely from stamped sheet metal; which will be dependable and precise in action; with which arcing of the contacts controlling the electric circuit may be avoided; which will be exceptionally silent in operation; and which will require a minimum of attention in use.

A further object of the invention is to generally improve and simplify various details of the propelling means for the time train, by which the cost of manufacture may be materially reduced.

A further object and advantage is to provide improved means for mounting the various parts in an attractive and convenient manner and for simplifying the various electrical connections.

Various other objects and advantages will be apparent from the following description of an embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawings:

Fig. 1 is a front elevation of a clock constructed in accordance with this invention;

Fig. 2 is a sectional elevation of the same, the section being taken approximately along the line 2—2 of Fig. 5;

Fig. 3 is a sectional elevation of the same, with the section taken approximately along the line 3—3 of Fig. 5;

Fig. 4 is a perspective of the crutch and driving pawl of the same;

Fig. 5 is a sectional elevation of the same from front to rear, the section being taken approximately along the line 5—5 of Fig. 2;

Fig. 6 is a sectional elevation of a portion of the same, as viewed from the rear and approximately along the line 6—6 of Fig. 5;

Fig. 7 is a reverse of the impulse element and various parts for resetting the same and illustrating the relative position of a number of parts at one point of the cycle of operation of the clock;

Fig. 8 is an elevation of the contact mechanism of the same;

Fig. 9 is a sectional plan of a portion of the clock, the section being taken approximately along the line 9—9 of Fig. 5;

Fig. 10 is a sectional elevation somewhat similar to Fig. 3, but illustrating the pendulum in a different position, and illustrating the normal operation of the clock when the pendulum has its full swing;

Fig. 11 is a sectional elevation of a part of the mechanism shown in Fig. 10, and illustrating an intermediate step in the tripping or release of the impulse member when the amplitude of oscillation of the pendulum falls below a desired amount;

Fig. 12 is an elevation somewhat similar to Fig. 11, but illustrating the position of parts an instant after the impulse member has been tripped;

Fig. 13 illustrates the impulse element acting upon the pendulum;

Fig. 14 is a diagram of the electrical connections of the clock;

Fig. 15 is a perspective of the latch releasing lever;

Fig. 16 is a perspective of the trip lever which operates upon the lever shown in Fig. 15;

Fig. 17 is a sectional elevation illustrating the operation of the lever shown in Fig. 15 upon the latch which obstructs movement of

the impulse element, the section being taken approximately along the line 17—17 of Fig. 21;

Fig. 18 is a sectional elevation through the mechanism for driving the ratchet wheel and preventing reverse movement of the time train, the section being taken approximately along the line 18—18 of Fig. 5;

Fig. 19 is a similar elevation, but with the parts in a different operative relation to one another;

Fig. 20 is a sectional plan of the same, with the section taken approximately along the line 20 of Fig. 5;

Fig. 21 is an elevation of the armature and its mounting; and

Fig. 22 is a sectional plan of the magnets and support, the section being taken approximately along the line 22—22 of Fig. 5.

In the illustrated embodiment of the invention, the mechanism may be supported upon any suitable base 1 and enclosed by an inverted transparent bell 2. A cylindrical tubular standard or shell 3 (Figs. 5, 6, 9 and 22) is received at one end in an opening 4 of the base 1, its movement through the opening 4 being limited by the rib or corrugation 5 provided peripherally in the standard a short distance from its lower end, as shown in Fig. 6. The lower end of the tube or standard 3 is flanged inwardly as at 6, so as to confine therein a plate 7. A plate 8 fits over the lower end of the opening 4, and one or more screws 9 are passed through the plate 8 and threaded into the plate 7 so as to hold the tube or standard within the opening 4 and extending upright from the base 1. A battery unit 10, such as one of the dry cell type, is mounted within the tube or standard 3, with an end contact terminal 11 uppermost therein, as shown in Fig. 5. A cap 12 fits the upper open end of the tube 3 and holds the battery unit there within and compressed against a spring 13 disposed in the bottom of the standard and between the battery unit and the plate 7. The spring 13 grounds the other battery unit terminal to the tube 3 through plate 7.

The cap 12 is preferably made of molded insulating material and is provided with a projecting finger 14 from its under face which is adapted to hook into an aperture 15 in the tube 3 adjacent one end of the latter, so as to confine the cap 12 releasably at one edge to the tube 3. The cap is provided with a conducting strip 16 which may be imbedded therein, this strip extending from a side edge of the cap into the cap and then outwardly through the interior of the lower face of the cap, so as to form a spring contact finger 17 which presses, preferably yieldingly, against the terminal 11 of the battery unit and forms an electrical connection therewith. The outer end of the strip 16 may be provided with a latch hump 18 over which may be releasably hooked or latched an end of a contact spring or member 19, the contact spring being mounted so that its free end will normally be snapped over the hump 18 and hold the cap 12 upon the tube 3. The contact finger 19, however, may be sprung laterally to release the hump 18 and permit removal of the cap when a battery is to be inserted or removed.

A pair of electromagnets 20 and 21 are disposed on opposite sides of the tube 3, intermediate the height of the tube and so as to extend substantially parallel to one another and transversely of the axis of the tube. The cores at corresponding ends of the magnets are connected to a cross bar 22 which extends crosswise of the tube 3 at one side thereof, the bar 22 being of magnetic material or material having large permeability. A strap 23 extends partially around the tube 3 on the side opposite the bar 22, and at its ends is connected to the bar 22 in any suitable manner, such as by screw bolts 24 passing through the bar 22 and through bent angular ends 25 of the strap 23 and carrying nuts 26 upon the projecting ends. A filler block 27 is disposed between the bar 22 and the adjacent side of the tube 3, so that when the bolts 24 are tightened against the tube, the strap will rigidly clamp the electromagnets to the tube.

The filler block 27 may be of any suitable construction, but preferably it is made of a channel of sheet material disposed with its bottom portion or wall flat against a face of the bar 22 and with its sides extending edgewise into contact with the periphery of the tube 3. The sides or arms of the channel are cut or notched arcuately so as to receive into them the periphery of the tube 3 and fit closely against the same throughout their length. Such a channel may be easily formed by stamping a flat blank with two opposite edges curved in accordance with the curvature of the periphery of the tube 3, and then bent into the form of a channel with the notched sides of the blank forming the sides of the channel.

A time train 28 (Fig. 5) of any suitable construction is mounted on a clock frame 29 formed of spaced plates in the rear of a dial plate 30, and carries the usual hour hand 31 and minute hand 32^a in front of the dial plate. A gear 32 is mounted on the minute hand shaft 33 and is frictionally clamped against a shoulder on that shaft by a compression spring 34, as usual in clock mechanisms. The gear 32 is driven by pinion 35, and the latter is driven by a reduction train of gears 36 from a ratchet wheel 37 (Figs. 3, 10, 18, 19 and 20). An arm 38 (Fig. 5) extends from the upper end of the tube 3 to the upper edge of the forward plate of the frame 29, being connected to a rearwardly turned ear 39 thereof in any suitable manner such

as by a screw 40. A spring suspension element 41 is secured to and depends from the arm 38, in the rear of the clock mechanism and the clock frame formed by the plates 29, and at its lower end carries pendulum supporting pins 42 projecting from opposite faces therefrom and in alinement with one another. A pendulum 43 is hooked over the pins 42, so as to oscillate from side to side of the clock as permitted by the flexure of the suspension element 41.

A pendulum crutch 44 (Figs. 4 and 5) is fixed upon a shaft 45 which is rotatably mounted in the clock frame, so as to depend just in front of the pendulum, and carries a forked lateral extension 46 which embraces the pendulum 43, so that the pendulum and crutch will oscillate in unison. The crutch is provided intermediate of its ends with an arm 47 (Fig. 3), which extends in its plane, then laterally therefrom and then parallel to its first section, and the free end of this arm and the crutch body together serve to rotatably support the ends of a shaft 48 (see also Fig. 20). The portion of the shaft 48 between the arm 47 and the body of the crutch 44 is larger than its ends, which are mounted in the crutch and its arm, and at one side thereof is provided with a transversely extending groove 49 (Fig. 20).

A driving pawl 50, which may be formed of a strip of stamped or rolled sheet metal, is provided intermediate of its ends with a notched portion 51 which is fitted into the groove 49 of the shaft, and the material of the shaft immediately along the groove 49 is upset somewhat over the outer face of the strip 50 so as to rigidly confine the strip 50 to the shaft 48. One end of the strip 50 engages with the arm 47 to limit the movement of the strip in one direction, and the other end 52 of the strip 50 is bent or formed angularly so as to make the strip L-shaped. This free, angular end 52 of the strip extends into proximity to the ratchet wheel 37 and co-acts with the teeth thereof, to drive the same. Thus the pawl formed by the strip 50 and pivotally mounted on the crutch which oscillates with the pendulum serves to propel the ratchet wheel by increments corresponding to the oscillations of the pendulum. Thus the pendulum directly transmits increments of movement to the time train.

A shaft 53 (Figs. 18 and 19) is rotatably mounted in the clock frame 29 and mounts a strip 54 (Figs. 18 and 19) of sheet metal in a side thereof in the same manner as described for the mounting of the strip 50 in the shaft 48. One end of the strip 54 extends into engagement with the ratchet wheel teeth in a manner to prevent movement thereof in a direction reverse to that imparted by the driving pawl 50 on the pendulum crutch, the strip 54 then extending angularly as at 55 to serve as a weight urging that end of the strip 54 into yielding engagement with the teeth of the ratchet wheel. The other end of the strip 54 is engageable with a stud 56 of the clock frame to limit movement of the pawl formed by the strip 54 toward the ratchet wheel, thereby permitting movement of the pawl into engagement with the teeth of the ratchet wheel while limiting such movement before the pawl reaches the bottoms of the tooth spaces. One of the shafts 57 (Fig. 5) of the time train extends forwardly through the dial plate 30 and removably and frictionally carries a second hand 58 for indicating the seconds.

The means for keeping the pendulum in motion and thereby causing a continued operation of the time train will next be described. For this purpose an impulse element 59, which may be in the nature of a gravity arm or lever, is mounted in the clock frame 29 and normally in an approximately horizontal position. The gravity arm may be formed by stamping it from sheet metal, with one end bent angularly thereon so as to form therewith a U, through the arms of which passes a shaft 60 which is mounted in the clock frame 29 and serves as a pivotal mounting for the impulse element or gravity arm.

A small arm 61 extends from the upper edge of the arm or element 59 and is bent over into parallel and spaced relation to a face of the arm 59. An impulse roller 62 is rotatably mounted between the free end of the small arm 61 and the body of the arm 59. When the impulse element or arm 59 is released and falls by gravity, the roller 62 engages with an impulse pin 63 carried by the crutch 44 at one side of its axis, and by its pressure thereon causes a swinging movement of the crutch in the direction of the latter's oscillation. Inasmuch as the crutch is connected at its forked end, to the pendulum, the falling arm or weight 59 acts to propel the crutch 44 and pendulum 43 in a direction of oscillation of the latter, thereby increasing the amplitude of oscillation of the pendulum.

An armature element 64 is provided with oppositely extending bearing studs 65, which are rotatably mounted in the clock frame with the ends of the armature element movable into and out of alinement with the free ends of the cores of the electromagnets 20 and 21. Thus when the electromagnets are energized, the armature will be rocked about its bearing studs from the position shown in Figs. 3 and 10, for example, into the position shown in Fig. 7, that is, in a direction to reduce the air gap between the ends of the armature and the free ends of the electromagnets.

The armature element may be formed of a series of parallel plates spaced apart by suitable studs 66, Fig. 7, and the two outer plates have depending arms 67 which support between them a bearing shaft 68. A

bell crank lever 69 is pivotally mounted on the shaft 68, and one end of this bell crank has a latch nose 70 which is engageable with an ear 71 extending laterally from a depending branch 72 of the impulse element or arm 59. A tension spring 73 is connected between a laterally extending ear 74 on the bell crank 69 and an ear 75 on one of the arms 67, so as to urge the bell crank 69 in a direction to latch the nose 70 beneath the ear 71.

One of the plates of the armature element is provided with a pair of ears 76 (Figs. 2 and 21) on opposite sides of the axis of the bearing studs 65, and these ears extend through arcuate slots 77 in one of the plates in the clock frame 29. A tension spring 78 is connected to each ear 76 of the armature and also to suitable ears struck out of one of the plates of the clock frame 29, so as to yieldingly urge or bias the armature into a retracted position such as shown in Figs. 2, 3 and 10, and when the armature is so retracted, it acts through the bell crank latch 69 to hold the impulse element or gravity element 59 poised, with the impulse roller 62 above and out of the path of oscillation of the impulse pin 63.

A strap 79 is fitted over that bearing stud 65 which extends through and has a bearing in that plate of the clock frame 29 through which the ears 76 of the armature extend and a spring 80 is connected at one end to the free ends of this strap and at its other end is anchored, with the spring under tension, to a suitable part of the clock frame 29, so that the spring strap will exert a frictional action on that stud 65 of the armature element and tend to snub minor oscillations or rebounds of the armature element under the action of the retracting spring 78 or a buffer to be described hereinafter. One arm of the bell crank latch 69 is bent angularly as at 81, which bears upon a lever 82 also pivoted at one end upon the shaft 68.

The spring 73 tends to rock the latch lever or bell crank 69 in a direction to force the lever 82 in one direction and move the lever 82 in one direction, and movement of the lever 82 in that direction is limited by the engagement of the free end of the lever 82 with a pin 83 projecting from another lever 84. The lever 84 at one end is bent into the form of a U, the arms of which are pivotally mounted upon a shaft 85 carried by the clock frame 29, and downward movement of the lever 84 is limited by its engagement with an ear 86 (Fig. 13) of the clock frame. The lever 84 normally rests upon the ear 86, and the lever 82 bears against the pin 83 which in turn limits the movement of the bell crank latch 69 beyond its latching position shown in Fig. 10.

A dog 87 (Figs. 10 to 13) is pivoted to the free end of the lever 84 so as to depend therefrom and oscillate freely thereon in a plane parallel to the oscillation of the pendulum. The lower or free end of this dog 87 is provided with two spaced apart pointed ends 88 and 89, Fig. 10, both points being beveled upon both faces, and the point 88 being the longer of the two. These pointed teeth 88 and 89 include between them a notch 90 (Fig. 13) which cooperates with a knife edge of a lug 91 carried by an arm 92 on the crutch 44 (see Fig. 4), the action between the dog 87 and the knife edge of the lug 91 constituting what is known in this art as a "Hipp" contact.

As the crutch oscillates back and forth, the lug 91 will rock the dog 87 idly back and forth so long as the lug 91 passes sufficiently beyond the dog to clear it and permit descent of the dog 87 before the lug 91 returns in the oscillation or swing in the reverse direction. The dog 87 is hung at such a point relative to the oscillation of the lug 91 that when the pendulum exceeds a certain minimum amplitude of oscillation, the lug 91 will clear the dog, but when the amplitude drops below this minimum, the lug 91 will not clear the notched end of the dog 87, but will merely pass the shorter point 89 in the free end of the same, such condition being shown in Fig. 11. Thereupon when the pendulum starts in the reverse direction, the lug 91 and the dog 87 will have a toggle like action with one another and cause a raising of the lever 84.

As the lever 84 rises, its pin 83 will engage with the free end of the lever 82 and rock the same in a direction to rock the bell crank latch 69 out of latching engagement with the impulse element or gravity arm 59, whereupon the latter falls and its impulse roller 62 delivers a driving impulse to the impulse pin 63, and through the crutch 44 to the pendulum, thus increasing the amplitude or swing of the pendulum beyond the selected minimum.

By having the point 88 of the dog 87 longer than the other point 89, the knife edge of the lug 91 will only engage in the notch 90 when passing thereby in one direction. That is, when the knife edge engages the longer point first and then passes over it, it will clear the shorter point and not cause a release of the impulse element. The longer point is so positioned as to cause a release of the impulse element only at the beginning of a swing of the pendulum which may be assisted by the action of the impulse roller 62 upon the impulse pin 63.

The impulse element or gravity arm 59 may be provided with forked arms 93 (Fig. 8) through which is threaded a contact screw 94. At the end of the downward or impulse movement of the arm 59, the contact screw 94 engages with a contact tip 95 carried by the free end of a leaf spring 96. The spring 96 extends along both arms of an L-shaped bracket 97, and the latter has an opening 98

in its free end through which the contact tip 95 loosely projects, so as to permit direct engagement of the tip 95 by the screw at the end of the impulse movement of the element or arm 59. The leaf spring 96 is normally urged against the under face of the bracket so as to project the tip 95 as far as possible through the opening 98.

The spring 96 and bracket 97 are secured to one of the plates of the clock frame by a screw 99 which is insulated from the plate of the frame 29 by a flanged insulating bushing 100 and an insulating washer 101 which surround the shank of the screw 99 where it passes through the plate of the clock frame, and abut against both faces of the plate adjacent the opening through which the screw 99 passes. The screw may have a nut 102 and a washer 103 by which the parts may be firmly clamped together and to the plate of the clock frame. An electrical connector 104 may be interposed between the bushing 100 and a face of the bracket 97 so as to be clamped between the same and make an electrical contact with the bracket and also with the spring 96. A wire 105 connects the connector 104 with one end of one of the electromagnets, such as 21. The bracket 97, contact tip 95 and spring 96 together serve as a contact member which not only stops or limits the impulse movement of said impulse element, but also makes an electrical connection between the impulse element and the electromagnet 21. The purpose of the electrical connection will appear shortly.

The combination contact spring and latch member 19 which is mounted by screws 24 upon the connecting magnetic bar 22 may be T-shaped with the leg or tail of the T forming the free spring contact or latch engaging with the hump 18 on the cap 12 (Fig. 5), and with a head of the T extending along the upper edge of the bar 22 and secured at its ends to the bar 22 by the screws 24. A conducting strip 106 (Figs. 5 and 6) is disposed along the lower edge of the bar 22 and secured thereto by another pair of the screws 24. The contact spring and latch member 19 and the strip 106 are insulated from the screws 24 and from the bar 22 by suitable bushings and washers 107, so that the member 19 and strip 106 will be electrically separate from one another and from the bar 22. One end of the head of the T of member 19 may be connected by a wire 108 to one terminal of one of the magnets, such as 20 (Figs. 5, 6 and 9), the other terminal of the magnet being connected by a wire 109 to one end of the conducting strip 106. The other end of strip 106 may be connected by a wire 110 to one terminal of the electromagnet 21, the other end or terminal of the magnet 21 being connected as before explained by wire 105 to the contact member 97.

One end of the battery unit 10 is grounded to the tube 3 and through it to the clock frame 29 which mounts the impulse arm 59, so that when the impulse element or arm 59 falls and its screw 94 engages with the contact tip 95, a circuit will be closed as follows: From the terminal 11 of the battery unit 10 through contact finger 17, conducting strip 16, latch hump 18, contact member 19, wire 108, electromagnet 20, wire 109, strip 106, wire 110, electromagnet 21, wire 105, contact bracket 97, contact tip 95, contact screw 94, impulse element 59, clock frame 29, back to the tube 3, to which is grounded the other end of the battery unit 10. To prevent oil in the bearings of the pivot 60 of the arm 59 preventing a good ground contact between the arm 59 and the remainder of the clock frame, a flexible wire 111 (Figs. 10 and 15) is soldered at one end to the arm 59 near its pivotal support, and at its other end to a suitable part of the clock frame 29.

When the circuit just described is closed, the electromagnets will be energized and will attract the armature element 64 from the retracted position shown in Figs. 3 and 10 against the action of springs 78, into the position shown in Fig. 7. At the time that the impulse element 59 was released by the disengagement of latch nose 70 from the ear 71 of the element 59 (Fig. 7) the ear 71 fell or moved with the element 59 in the direction in which the armature would move when attracted, and therefore as the armature closely approaches the attracted position shown in Fig. 7, the latch nose 70 of the bell crank latch 69 will snap past the ear 71 and therefore into latched engagement with the impulse element 59. This relatching of the bell crank 69 to the impulse element occurs as the armature is approaching its attracted position shown in Fig. 7, and just prior to the completion of this relatching of the bell crank to the impulse arm, the armature element engages with a resilient buffer 112 in the form of a leaf spring secured to the clock frame.

Since the armature element has considerable inertia while moving into attracted position, it will continue to move in the same direction against the action of the buffer 112 for some distance sufficient to effect a relatching thereof to the element 59, and then it will be given a rebound movement by the buffer 112. This rebound is of sufficient extent to partially return the armature element and through it partially return the impulse element to which it has been relatched, this return being sufficient to carry the contact screw 94 out of contact with the contact member against which it had struck and by which it had been stopped. This opens the circuit of the electromagnets, and the resulting deenergization of the electromagnets permits a complete return of the armature element to retracted position under the influence of springs 78. The armature element in return-

ing, of course elevates or resets the impulse element in poised or inoperative position, ready for release and reactuation of the pendulum. The friction of the plate 79 on a bearing stud 65 of the armature element snubs the minor oscillations of the armature element at the ends of its limits of movement, so that there will be no danger of an immediate remaking of the circuit by the contact screw, 94 and contact tip 95.

In the operation of an electric clock constructed in the manner hereinabove described and illustrated, the pendulum when set in oscillation drives the ratchet wheel 37 and through it drives the time train. At this time the impulse element 59 is in its raised or poised position and latched in that position by the bell crank 69 carried by the armature element 64, which is in turn held in retracted position by the springs 78 because the electrical circuit through the electromagnets is at this time broken by the separation of the contact screw 94 and contact tip 95. When the amplitude of oscillation of the pendulum decreases below a selected minimum, that is a minimum below which the ratchet wheel will not be given the desired increments of movement at each swing of the pendulum, the knife edge of the lug 91 fails to completely pass the depending dog 87 and passes only the shorter point 89, which position of the parts is shown in Fig. 11 at one end of the swing of the pendulum in its shorter arc.

As the pendulum starts to swing in the reverse direction, the lug 91 engaging in the notch 90 acts to elevate the dog 87 and through it the lever 84, and the latter through its pin 83, which is elevated therewith, rocks the release lever 82 which in turn rocks the bell crank 69 out of latching engagement with the ear 71 of the impulse element 59. This approximate condition of parts is shown in Fig. 12. Thereupon the impulse element 59 falls under the influence of gravity, and its impulse roller 62 engages with the impulse pin 63 of the crutch as shown in Fig. 13. The pressure of the roller 62 upon the pin 63 tends to force the crutch 44 and the pendulum 43 more rapidly in the swing or oscillation just started, with the result that the amplitude of the pendulum 43 is very materially increased by the pressure from the impulse element before the contact screw 94 reaches and is stopped by the contact tip 95.

Immediately upon the closing of the circuit and the stopping of the impulse element or actuator 59, the armature element is attracted into the position shown in Fig. 7 and relatched to the impulse element, the rebound caused by the buffer 112 causing a return of these parts sufficient to open the circuit by a separation of the contact screw 94 and contact tip 95, whereupon the springs 78 return the armature element to retracted position and elevate the impulse element 59 into its poised or inoperative position ready for a new release and a new actuation of the pendulum when the amplitude of oscillation of the latter again falls to the selected minimum. By adjusting the contact screw 94 through the forked arms 93 of the impulse element the instant at which the impulse element is stopped and the circuit closed may be varied within limitations, so that the instant of relatching of the armature element to the impulse element may be varied sufficiently to insure an opening of the circuit by partial return of the impulse element during the rebound caused by the buffer 112.

In order to insure opening of the circuit of the electromagnets at the end of the armature stroke, I may provide a leaf spring 113 (Figs. 3, 7, 10 and 13) which is rigidly secured at one end to the cross arm 113^a (Fig. 7) of the U-shaped bearing end of the impulse element, arm or lever 59, and bears yieldingly against an ear 114 projecting from the lower edge of the arm or lever 59, so as to position the free end of the spring in a position to be engaged by an arm 64^a of the armature 64, just prior to the completion of the attraction stroke of the armature. The arm 64^a will elevate and flex the spring 113 as the armature completes its movement into attracted position, and the spring 113 will yieldingly elevate the arm 59 sufficiently to break the circuit at the screw 94 and tip 95. Upon the breaking of the circuit following separation of the screw 94 and tip 95, the armature is retracted sufficiently to engage and directly elevate the arm 59 before the latter can fall when the armature releases the spring 113 thus preventing immediate reclosing of the circuit. To this extent either the buffer spring 112 or spring 113 may be dispensed with, without making the device inoperative, but the use of both gives greater insurance of an opening of the circuit, and greater smoothness of action, and less noise.

In order to cushion the armature element as it reaches retracted position and thus minimize the noise caused by the operation of the clock I may also provide a leaf spring 115 mounted at one end upon a bracket 116 and bearing at its free end upon the armature when the latter is in retracted position and yieldingly urging the armature element toward attracted position against the action of the springs 78. The spring 115, however, is weaker than the springs 78, so that no material return movement of the armature element results, but at the same time the spring 115 cushions the return of the armature element into retracted position.

It will be noted, Figs. 2 and 5, that the minute hand shaft 33 is mounted in an ear or tongue 117 which is struck out from the forward plate of the clock frame 29 and offset forwardly thereof so as to mount the hour hand drive pinion 118 fixedly thereon and in

a plane forwardly of the forward plate of the frame 29. A part of the pinion may lie in the opening 118[a] formed in the frame by the striking out of the tongue or ear 117. The gear 32 may be frictionally pressed against a boss or hub of the pinion 118 by the spring 34 as explained hereinbefore. The minute hand shaft may be mounted at its rear end in another plate of the frame 29. An hour hand sleeve or cannon pinion 119 is rotatably mounted on the forward end of the minute hand shaft in front of the tongue or ear 117, and the cannon pinion and pinion 118 both mesh with a combination pinion and gear 120 which is mounted by a stud upon the forward face of the forward plate of the frame 29. To remove the minute hand shaft 32 it is merely necessary to remove the frame plate from the rear end of the shaft, remove the minute hand, hour hand and cannon pinion, and then draw the shaft 32 rearwardly out of the ear or tongue 117 without removal of the pinion 118 from the shaft 32, as has heretofore always been necessary. The pinion 118 is commonly secured to the shaft 32 by a drive fit and after it has been removed a few times it fails to fit tightly and often becomes loose in use with resulting irregularities in the time keeping of the clock or watch. With this construction however it is never necessary to remove the pinion 118 in disassembling the clock and therefore it never becomes loose.

Inasmuch as the pendulum swings at a uniform rate within a considerable range of amplitude, the time train will be driven at a uniform rate regardless of the weight or propelling force of the impulse element, which merely increases the amplitude of swing of the pendulum sufficiently to keep the pendulum swinging within the range of amplitudes at which its period is substantially constant. Consequently, a clock constructed in accordance with this invention will keep exceptionally accurate time because the time will not vary with the unwinding of a spring, and inasmuch as the amount of current utilized is relatively small, a relatively small battery unit will operate the clock for a very considerable length of time without attention. A clock constructed in this manner also presents an attractive appearance owing to the fact that the battery unit is concealed in the tube 3, and the works of the clock are exposed to view.

It will be obvious that various changes in the details which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim as my invention:—

1. In an electric clock, an oscillating element, a propulsion element operable on said oscillating element to impart impulses to the latter, a magnetic element including a movable part, a latch carried by said part and having latched engagement with said propulsion element to hold the latter in poised position where it is inoperable upon said oscillating element, resilient means normally holding said movable part in retracted position with its latch holding the propulsion element in said poised position, means operable automatically when the amplitude of the oscillating element falls below a selected minimum for operating said latch to release the propulsion element at the beginning of an oscillation of said oscillating element, a contact member disposed for engagement by said propulsion element when the latter is released and imparts an impulse to said oscillating element, said contact element limiting the movement of said propulsion element, an electrical circuit including said magnetic and propulsion elements and contact member, for producing a movement of said movable part in a direction to carry its latch into latching engagement with said propulsion element, a resilient buffer engaged by said part, when the latter moves under the influence of the closed circuit, just prior to the relatching of the latch to said propulsion element, whereby said part will be given a rebound at the end of its movement under attraction and after said latch has been relatched to said propulsion element, the rebound being sufficient to return said propulsion element sufficiently to open the circuit which it closed when propelling said oscillating element, and permit retraction of said part by said resilient means and a complete return of said propulsion element to poised position.

2. In an electric clock, an oscillating element, a propulsion element operable on said oscillating element to impart impulses to the latter, a magnetic element including a movable part, a latch carried by said part and having latched engagement with said propulsion element to hold the latter in poised position where it is inoperable upon said oscillating element, resilient means normally holding said movable part in retracted position with its latch holding the propulsion element in said poised position, means operable automatically when the amplitude of the oscillating element falls below a selected minimum for operating said latch to release the propulsion element at approximately the beginning of an oscillation of said oscillating element, a contact member disposed for engagement by and limiting movement of said propulsion element when the latter is released and imparts an impulse to said oscillating element, an electrical circuit including said magnetic and propulsion elements and contact member, for moving said movable part in a direction to carry its latch into latching engagement with said propulsion

element, a resilient buffer engaged by said part, just prior to the relatching of the latch to said propulsion element, whereby said part will be given a rebound at the end of its movement under attraction and after said latch has been relatched to said propulsion element, the rebound being sufficient to return said propulsion element sufficiently to open the circuit which it closed when propelling said oscillating element, and permit retraction of said part by said resilient means and a complete return of said propulsion element to poised position, said propulsion element and contact member having relatively adjustable contact portions whereby the limit of travel of the propulsion element in a propelling direction and the point at which relatching occurs between said propulsion element and said part may be varied.

3. In an electric clock, an oscillating element, a biased propulsion element operable when released to drive said oscillating element in one direction, a circuit closed by said propulsion element and including a magnetic device with a movable part operated in one direction when said circuit is closed, means for urging said part to retracted position when said circuit is open, a latch carried by said part and holding said propulsion element in poised inactive position when said part is retracted, means operable automatically, when the amplitude of oscillation of the oscillating element decreases below a selected amount, for unlatching said propulsion element, a resilient buffer engaged by said part as it approaches the end of its movement under attraction caused by the closed circuit and prior to its relatching engagement with said propulsion element, so as to cause a rebound of said part, and a resetting of the propulsion element sufficiently to open the circuit and permit a return of said part and propulsion element to retracted and poised positions respectively.

4. In an electric clock, an oscillating driver element, an impulse element operable upon said driver element to increase its amplitude of oscillation, means for holding said impulse element in poised inoperative position, means operable automatically upon said holding means, when the amplitude of oscillation of said driver element decreases below a selected value, for causing a release of said impulse element, said holding means including a magnetically responsive part, yieldingly biased to retracted and holding position, means including an electric circuit closed by said impulse element at the end of its movement when released for causing an attraction of said part into reengagement with said impulse element, and a resilient buffer engageable by said part just prior to the end of its reengagement with the impulse element, whereby the rebound caused thereby will return said impulse element sufficiently to cause an opening of said circuit and a magnetic release of said part.

5. In an electric clock, an impulse element biased for movement in one direction, an oscillating element impelled thereby by its movement in said one direction means for releasing said impulse element when the amplitude of oscillations of said oscillating element decreases below a desired value, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably engageable with said impulse element to hold it inoperative when in retracted position, an electric circuit including said device closeable by the impulse element at the end of its driving action, to cause an attraction of said part to reengage said impulse element, and means for causing a rebound of said part immediately after its reengagement with said impulse element, the extent of rebound being sufficient to move the engaged impulse element in a return direction and cause an opening of said circuit permitting retraction of said part and resetting of said impulse member.

6. In an electric clock, an impulse element biased for movement in one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, an electric circuit including said device and controlled by said element whereby at the end of movement of said element in said one direction a movement of said part to reengage said element will be caused, and means engageable by said part at approximately the end of the last mentioned movement for causing a rebound of said part just after its reengagement with said element whereby said element will be returned toward initial poised position sufficiently to restore said circuit to its original condition, permit retraction of said part, and complete return to initial poised position of said element by said part.

7. In an electric clock, an impulse element biased for movement in one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, an electric circuit including said device and controlled by said element whereby at the end of movement of said element in said one direction a movement of said part to reengage said element will be caused, means engageable by said part at approximately the end of the last mentioned movement for causing a rebound of said part just after its reengagement with said element whereby said element will be returned toward initial poised position sufficiently to restore said circuit to its original condition, permit retraction of said part, and complete return to initial poised position of

said element by said part, and means for snubbing minor movements of said part.

8. In an electric clock, an impulse element biased for movement in one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, an electric circuit including said device and controlled by said element whereby at the end of movement of said element in said one direction, a movement of said part to reengage said element will be caused, means engageable by said part at approximately the end of the last mentioned movement for causing a rebound of said part just after its reengagement with said element whereby said element will be returned toward initial poised position sufficiently to restore said circuit to its orignal condition, permit retraction of said part, and complete return to initial poised position of said element by said part, and a frictional device acting upon said part for snubbing its minor movements.

9. In an electric clock, an impulse element biased for movement in one direction and having a contact member adjustably projecting therefrom in said one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, a contact member disposed in the path of said impulse member when the latter is released, whereby the impulse movement of said element will be limited by the engagement of its contact member with said second contact member, the adjustment of said first member varying the extent of movement of said second impulse element, and an electric circuit including said contact members and said device, whereby when the circuit is closed by engagement of said contact members, said part will be magnetically shifted into reengagement with said element, and means engageable by said part at approximately the end of its movement following the closure of said circuit for causing a rebound of said part immediately after its reengagement with said element, whereby said element will be returned toward initial poised position during such rebound, sufficiently to open said circuit and permit retraction of said part and also a complete return to initial poised position of said element by said part.

10. In an electric clock, an impulse element biased for movement in one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, said element having a contact projection, an abutment, a contact element resiliently pressed against said abutment and having a contact section within the path of said projection on said element whereby the movement of said element in one direction will be resiliently checked by the engagement of said projection with said contact member, the engagement of the contact member with said abutment limiting the movement of said contact member toward said projection, an electric circuit including said element, said contact member, and said device, whereby at the end of movement of said element in said one direction said circuit will be closed, and said part moved by magnetic attraction in one direction to reengage said element, and a buffer engageable by said part at approximately the end of its movement under attraction for causing a rebound of said part immediately after its reengagement with said element, whereby said element will be returned toward initial poised position sufficiently to open said circuit and permit a complete return of said element by said part.

11. In an electric clock, an impulse element biased for movement in one direction, a contact screw carried thereby and projecting therefrom in said one direction, a contact member disposed in the path of movement of said screw with said element and limiting the movement of said element in said one direction, a magnetic device having a movable magnetically responsive part biased to retracted position and releasably holding said element against movement in said one direction, an electric circuit including said contact member and said device and closed by engagement of said screw and contact member to cause a movement of said part in a direction to reengage said element, and means operable by said part at approximately the end of its movement following the closing of said circuit for causing a rebound of said part immediately after its reengagement with said element, whereby said element will be returned by said part toward initial poised position sufficiently to open the circuit and permit complete return of said element by said part, said contact member being resiliently held in contact position and resiliently opposing movement thereof by contact thereagainst of said contact screw.

12. In an electric clock, an oscillating element, an impulse element biased for movement in a direction to engage said oscillating element and increase its amplitude of oscillation, an electromagnet having a movable part, means for yieldingly operating said part in one direction when said electromagnet is deenergized, a latch element carried by said part and engaging with said impulse element to hold it in poised inoperative position while said part is in retracted position, means operable upon said latch to release said impulse element when the amplitude of oscillation of said oscillating element falls below a selected minimum, contact members operable to check movement of said

impulse element when released, a circuit including said electromagnet and controlled by said contact members, whereby when said impulse element is checked by said members said movable part will be shifted in a direction to carry its latch into relatched engagement with said impulse element, a resilient buffer engaged by said part at the end of its relatching movement for causing a rebound of said part after relatching of said part to said impulse element, of an extent sufficient to separate said contact members and permit a complete return of said part and impulse element to initial position.

13. In an electric clock, an oscillating element, an impulse element biased for movement in a direction to engage said oscillating element and increase its amplitude of oscillation, an electromagnet having a movable part, means for yieldingly operating said part in one directon when said electromagnet is deenergized, a latch element carried by said part and engaging with said impulse element to hold it in poised inoperative position while said part is in retracted position, means operable upon said latch to release said impulse element while the amplitude of oscillation of said oscillating element falls below a selected minimum, contact members operable to check movement of said impulse element when released, a circuit including said electromagnet and controlled by said contact members, whereby when said impulse element is checked by said members said movable part will be shifted in a direction to carry its latch into relatched engagement with said impulse element, a resilient buffer engaged by said part at the end of its relatching movement for causing a rebound of said part after relatching of said part to said impulse element of an extent sufficient to separate said contact members and permit a complete return of said part and impulse element to intial position, one of said contact members being carried by said impulse element and the other being mounted in a position to be engaged thereby at the end of the impulse movement of said impulse element.

14. In an electric clock, an oscillating element, an impulse element biased for movement in a direction to engage said oscillating element and increase its amplitude of oscillation, an electromagnet having a movable part, means for yieldingly operating said part in one direction when said electromagnet is deenergized, a latch element carried by said part and engaging with said impulse element to hold it in poised inoperative position while said part is in retracted position, means operable upon said latch to release said impulse element when the amplitude of oscillation of said oscillating element falls below a selected minimum, contact members operable to check movement of said impulse element when released, a circuit including said electromagnet and controlled by said contact members, whereby when said impulse element is checked by said members said movable part will be shifted in a direction to carry its latch into relatched engagement with said impulse element, a resilient buffer engaged by said part at the end of its relatching movement for causing a rebound of said part after relatching of said part to said impulse element, of an extent sufficient to separate said contact members and permit a complete return of said part and impulse element to initial position, one of said contact members being carried by said impulse element and the other being mounted in a position to be engaged thereby at the end of the impulse movement of said impulse element, one of said contact members being adjustable toward and from the other so as to vary the extent of movement of said impulse element before engagement of said members.

15. In an electric clock, an oscillating element, an impulse element biased for movement in a direction to engage said oscillating element and increase its amplitude of oscillation, an electromagnet having a movable part, means for yieldingly operating said part in one direction when said electromagnet is deenergized, a latch element carried by said part and engaging with said impulse element to hold it in poised inoperative position while said part is in retracted position, means operable upon said latch to release said impulse element when the amplitude of oscillation of said oscillating element falls below a selected minimum, contact members operable to check movement of said impulse element when released, a circuit including said electromagnet and controlled by said contact members, whereby when said impulse element is checked by said members said movable part will be shifted in a direction to carry its latch into relatched engagement with said impulse element, a resilient buffer engaged by said part at the end of its relatching movement for causing a rebound of said part after relatching of said part to said impulse element, of an extent sufficient to separate said contact members and permit a complete return of said part and impulse element to initial position, one of said contact members being carried by said impulse element and the other being mounted in a position to be engaged thereby at the end of the impulse movement of said impulse element, one of said contact members being resiliently mounted to reduce the noise of impact.

16. In an electric clock, an oscillating element, an impulse element biased for movement in a direction to engage said oscillating element and increase its amplitude of oscillation, an electromagnet having a movable part, means for yieldingly operating said part in one direction when said electromagnet is deenergized, a latch element carried by

said part and engaging with said impulse element to hold it in poised inoperative position while said part is in retracted position, means operable upon said latch to release said impulse element when the amplitude of oscillation of said oscillating element falls below a selected minimum, contact members operable to check movement of said impulse element when released, a circuit including said electromagnet and controlled by said contact members, whereby when said impulse element is checked by said members said movable part will be shifted in a direction to carry its latch into relatched engagement with said impulse element, a resilient buffer engaged by said part at the end of its relatching movement for causing a rebound of said part after relatching of said part to said impulse element of an extent sufficient to separate said contact members and permit a complete return of said part and impulse element to initial position, one of said contact members being carried by said impulse element and the other being mounted in a position to be engaged thereby at the end of the impulse movement of said impulse element, one of said contact members being adjustable toward and from the other so as to vary the extent of movement of said impulse element before engagement of said members, one of said contact members being resiliently mounted to reduce the noise of impact.

17. In an electric clock, a pivoted impulse arm biased for movement in one direction, an electromagnet device having an armature mounted for oscillation in proximity to said arm, said armature being biased for movement in a direction reverse to that caused by said electromagnet, a latch pivoted on said armature and engaging with said arm to hold the latter against movement in said one direction, a circuit including said electromagnetic device, means operable by said arm at the end of its movement when released for changing the condition of said circuit and causing movement of said armature in a direction to carry said latch into reengagement with said arm, and a resilient buffer engaged by said armature just prior to the reengagement of said latch with said arm for causing a rebound of said armature after reengagement of said latch with said arm sufficient in extent to return the arm sufficiently to restore said circuit to initial condition and thus cause a complete return of said armature and arm to initial positions.

18. In an electric clock, an impulse element biased for movement in one direction, a movable holding member having a latch engaging said element for releasably holding said element against movement in said one direction, means for urging said member in one direction to cause movement of said element in one direction into poised inoperative position, said latch being operable to release said element while said member remains stationary, means for urging said member in a reverse direction to carry said latch into relatched engagement with said element, means rendered operative by said element at the end of its biased movement for rendering said second mentioned means effective to cause a movement of said member into relatched engagement with said element, a resilient buffer effective upon said member after movement in a direction to cause its relatched engagement with said element for causing a rebound of said member after reengagement of said latch with said element, said rebound being of an extent sufficient to partially return said member and element and thus render ineffective the means rendered effective by said element at the end of its movement in said one direction, and thus permit complete return of said element and said member under the influence of said first mentioned means.

19. In an electric clock, an impulse lever biased for movement in one direction, an electromagnet having an armature biased into retracted position, a latch pivotally mounted on said armature and engaging with said lever to obstruct movement of said lever in said one direction and hold said lever in poised position when said armature is retracted, a circuit having controlling means operable by said lever at the end of its movement in said one direction for causing an energization of said magnet and an attraction of said armature, a resilient buffer for stopping the movement of said armature under attraction and causing rebound of said armature after reengagement of said latch with said lever, said rebound being sufficient to cause a partial return of said armature and a partial return of said lever sufficient in extent to open said circuit, permit a retraction of said armature, and through it a return of said lever to poised position, and means for operating said latch to release said lever.

20. In an electric clock, an impulse lever biased for movement in one direction, an electromagnet having an armature biased into retracted position, a latch pivotally mounted on said armature and engaging with said lever to obstruct movement of said lever in said one direction and hold said lever in poised position when said armature is retracted, a circuit having controlling means operable by said lever at the end of its movement in said one direction for causing an energization of said magnet and an attraction of said armature, a resilient buffer for stopping the movement of said armature under attraction and causing rebound of said armature after reengagement of said latch with said lever, said rebound being sufficient to cause a partial return of said armature and a partial return of said lever sufficient in extent to open said circuit, permit a retraction of said armature, and through it a return of said lever to poised

position, and means for operating said latch to release said lever, said circuit controlling means including a contact device for limiting movement of said lever in said one direction and adjustable to vary the extent of movement of said lever in said one direction.

21. In an electric clock, an impulse lever biased for movement in one direction, an electromagnet having an armature biased into retracted position, a latch pivotally mounted on said armature and engaging with said lever to obstruct movement of said lever in said one direction and hold said lever in poised position when said armature is retracted, a circuit having controlling means operable by said lever at the end of its movement in said one direction for causing an energization of said magnet and an attraction of said armature, a resilient buffer for stopping the movement of said armature under attraction and causing rebound of said armature after reengagement of said latch with said lever, said rebound being sufficient to cause a partial return of said armature and a partial return of said lever sufficient in extent to open said circuit, permit a retraction of said armature, and through it a return of said lever to poised position, and means for operating said latch to release said lever, said circuit controlling means including a screw carried by said lever and adjustable in said one direction, and a contact device with which said screw engages to limit movement of said lever in said one direction and close said circuit.

22. In an electric clock, an impulse lever biased for movement in one direction, an electromagnet having an armature biased into retracted position, a latch pivotally mounted on said armature and engaging with said lever to obstruct movement of said lever in said one direction and hold said lever in poised position when said armature is retracted, a circuit having controlling means operable by said lever at the end of its movement in said one direction for causing an energization of said magnet and an attraction of said armature, a resilient buffer for stopping the movement of said armature under attraction and causing rebound of said armature after reengagement of said latch with said lever, said rebound being sufficient to cause a partial return of said armature and a partial return of said lever sufficient in extent to open said circuit, permit a retraction of said armature, and through it a return of said lever to poised position, and means for operating said latch to release said lever, said circuit controlling means including a contact screw adjustable on said lever in said one direction, and a relatively fixed resilient contact member in the path of movement of said screw with said lever in said one direction so as to variably limit movement of said lever in said one direction and also close said circuit.

23. In an electric clock, a time train, a ratchet wheel geared to said time train to drive the same, a crutch, a shaft oscillatably mounted in said crutch and having a groove extending transversely across the same, a strip of material having a portion intermediate of its ends fitting closely in said groove, the material of the shaft adjacent the groove being upset over said strap to confine the same within the groove, one end of said strip being formed to engage said ratchet wheel and drive the same when said crutch is oscillated.

24. In an electric clock, a time train, a ratchet wheel geared to said time train to drive the same, a crutch, a shaft oscillatably mounted in said crutch and having a groove extending transversely across the same, a strip of material having a portion intermediate of its ends fitting closely in said groove, the material of the shaft adjacent the groove being upset over said strap to confine the same within the groove, one end of said strip being formed to engage said ratchet wheel and drive the same when said crutch is oscillated, said strip being extended from said shaft in a manner to be biased by gravity in a direction to carry its driving portion into contact with the teeth of the ratchet wheel.

25. In an electric clock, a time train, a ratchet wheel geared to said time train to drive the same, a crutch, a shaft oscillatably mounted in said crutch and having a groove extending transversely across the same, a strip of material having a portion intermediate of its ends fitting closely in said groove, the material of the shaft adjacent the groove being upset over said strap to confine the same within the groove, one end of said strip being formed to engage said ratchet wheel and drive the same when said crutch is oscillated, said strip being extended from said shaft in a manner to be biased by gravity in a direction to carry its driving portion into contact with the teeth of the ratchet wheel, said crutch having a stop limiting movement of said strip toward the ratchet wheel under the influence of gravity.

26. In an electric clock, an oscillating crutch, a time train, a ratchet wheel geared to said time train to drive the same, a shaft mounted in said crutch for oscillation about an axis parallel to the axis of said ratchet wheel, said shaft having a transversely extending groove in one side thereof, a strip of ribbon metal having intermediate of its ends a portion reduced in width to closely fit said groove in said shaft, the material of the shaft along the groove being upset over said strip to confine it within the groove, one end of said strip being extended angularly for driving engagement with said ratchet wheel, the other end of said strip extending sufficiently in the opposite direction to overbalance said strip and bias it in a direction to carry the angular end into driving engagement with said ratchet wheel.

27. In an electric clock, a time train, a ratchet wheel geared to said time train to drive the same, means for imparting increments of movements to said ratchet wheel and through it to said time train, a holding pawl engaging with said ratchet wheel to prevent movement thereof in a reverse direction, said holding pawl comprising a pivotally mounted shaft having a groove extending transversely thereof at one side thereof, a metal strip disposed intermediate of its ends in said groove, the material of the shaft along the groove being upset against said strip to confine it within the groove and against movement thereon, one end of said strip being extended for contact with the ratchet teeth, and also having another portion bent angularly thereto to serve as a weight urging said strip into contact with the teeth of said ratchet wheel, the other end of said strip extending beyond the shaft and serving as a stop limiting movement of the ratchet wheel engaging end of said pawl in a direction toward said ratchet wheel but permitting movement of the ratchet engaging end of said pawl to some extent into spaces between the teeth of said ratchet wheel.

28. In an electric clock, the combination of a battery, an electromagnet, a circuit including said battery and magnet, an armature, contact means for said circuit releasably held in open circuit condition by said armature and when released operable into closed circuit condition, a buffer spring engaged by said armature when it approaches its attracted position, said armature automatically reengaging said means as it approaches attracted position, whereby said armature during its rebound from said spring will restore said means to open circuit condition to permit complete retraction of the armature.

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