

Oct. 27, 1964

T. J. SMULSKI
ELECTRIC CLOCK

3,153,896

Filed Nov. 9, 1961

4 Sheets-Sheet 1

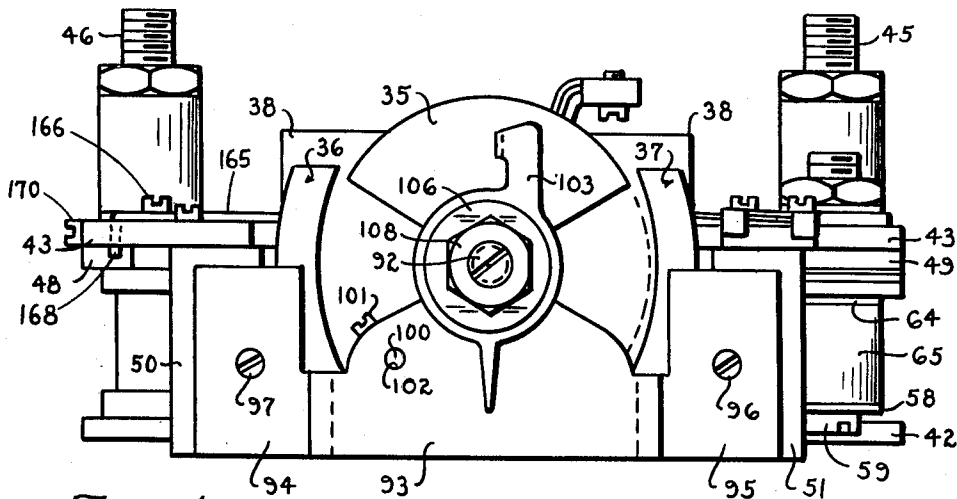


Fig.-1

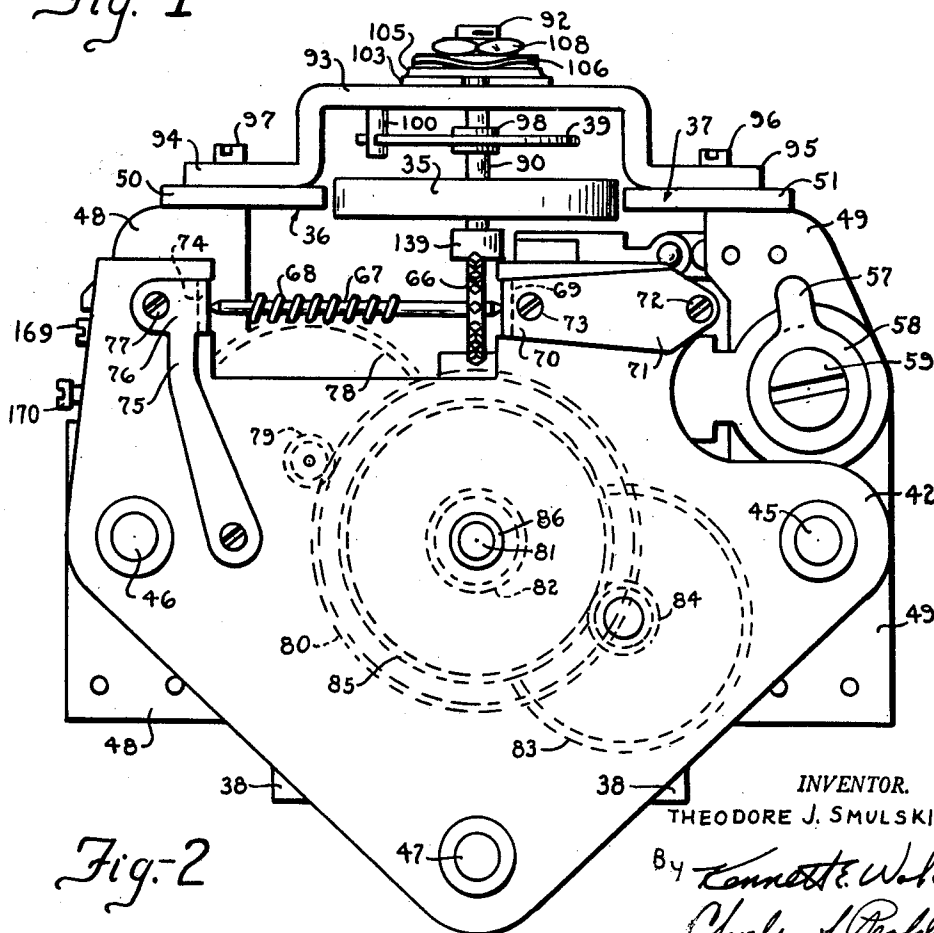


Fig.-2

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4 Sheets-Sheet 2

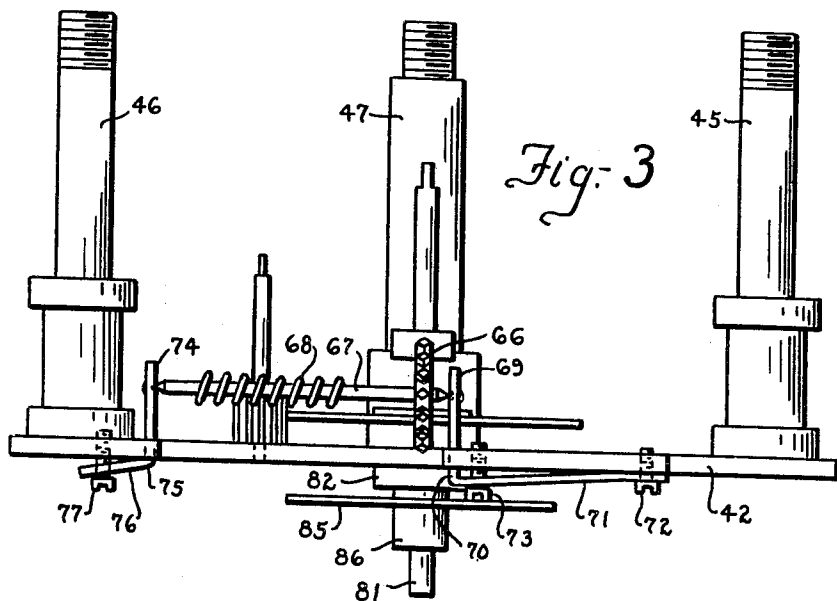


Fig. 3

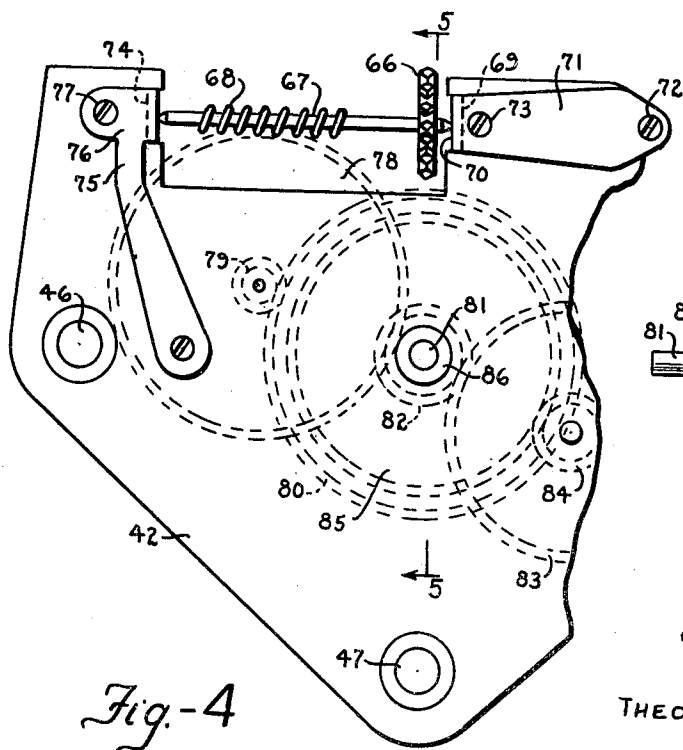


Fig. 4

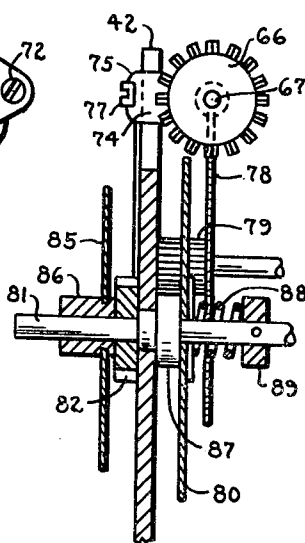


Fig. 5

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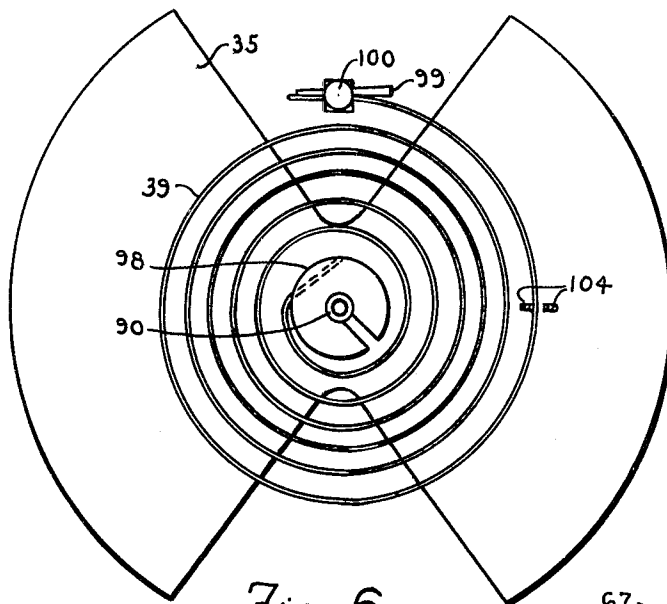


Fig. 6

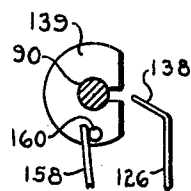


Fig. 8

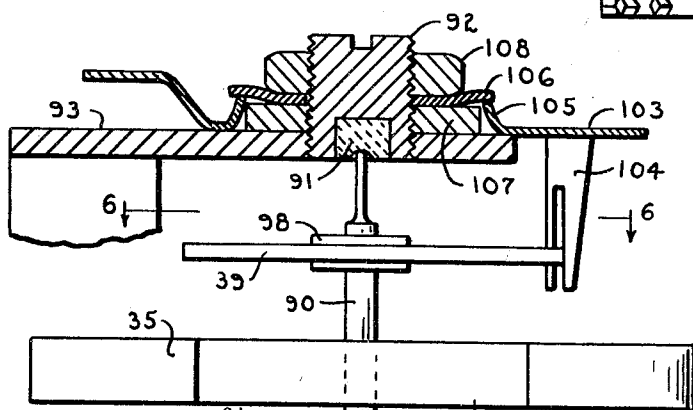


Fig. 9

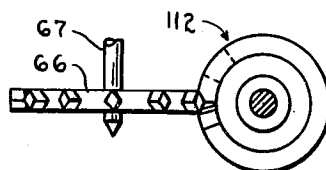


Fig. 10

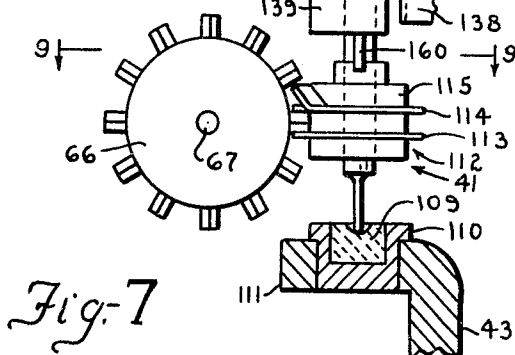


Fig. 7

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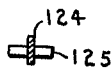
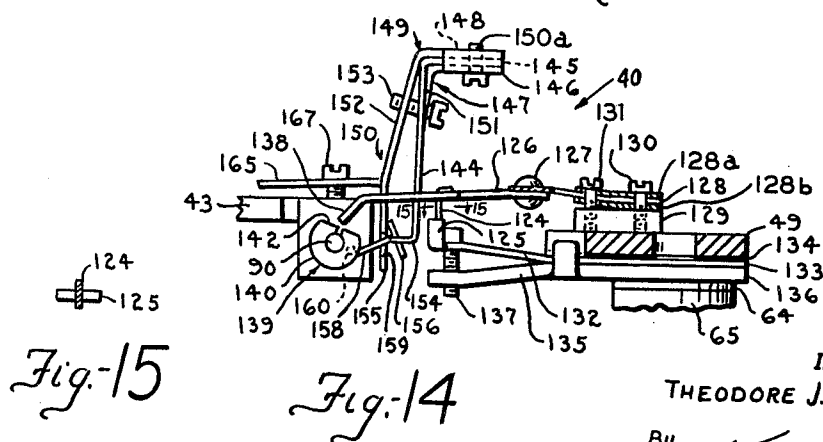
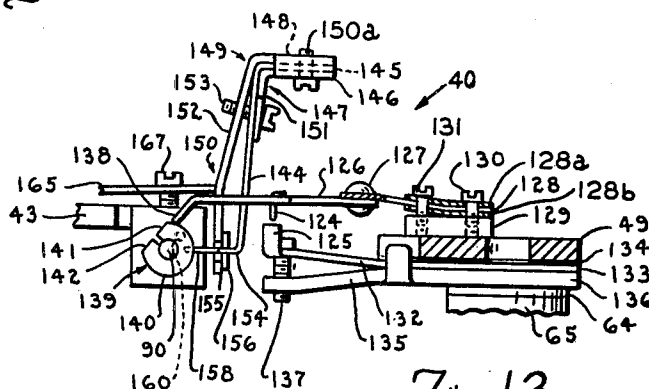
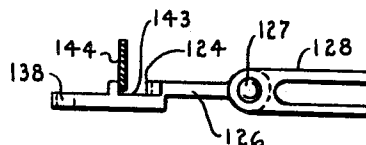
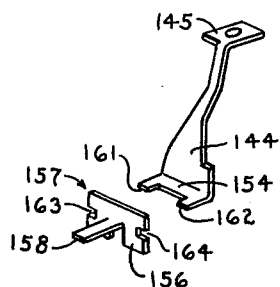
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4 Sheets-Sheet 4



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ELECTRIC CLOCK

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Filed Nov. 9, 1961, Ser. No. 151,213
6 Claims. (Cl. 58—28)

This invention relates generally to a clock and more particularly to an electric clock.

This application is a continuation-in-part of my co-pending application Serial No. 757,884, now abandoned, which is a division of my application Serial No. 549,709, filed November 29, 1955, now Patent No. 2,979,629, issued April 11, 1961, to which reference of the latter may be made for details of structure of subsidiary items alluded to herein.

In the clock of this invention, a pivotal oscillatory element is arranged to drive suitable clock mechanism as it oscillates, and electromechanical transducer means are provided for driving the oscillatory element, such means being energized in synchronism with the movement of the oscillatory element. The electromechanical transducer means is preferably an electromagnetic arrangement in which the oscillatory element forms an armature of a magnetic material, such as soft iron, disposed between two poles of an electromagnet, the armature being urged by magnetic forces into alignment with the magnetic flux path between the poles when the electromagnet is energized.

The oscillatory element may be urged toward a neutral position by a restoring force, preferably from a suitable hairspring, and may move in one direction from a first position through such neutral position to a second position and then in a reverse direction back through the neutral position to the first position. The transducer means is preferably such that it acts generally in opposition to the restoring force so that when the oscillatory element is between the first position and the neutral position, energization of the transducer means will urge the element toward such first position while, when the element is between the neutral position and the second position, energization of the transducer means will urge the element toward such second position. Contact means and circuitry are controlled by movement of the oscillatory element for energizing the transducer means when the element moves in either direction beyond such neutral position.

The clock preferably incorporates a mechanism driven in one direction from oscillatory movement of the element, the drive arrangement preferably being such that drive is actuated in about the same portions of the cycle as those in which the transducer means is energized to minimize any effect on the time period of the oscillatory movement.

The primary object of this invention is to provide a clock mechanism having a pair of rotatable shafts, with improved means whereby one shaft may be readily adjustably connected to the other shaft.

Other objects and advantages of the invention will become apparent after the description hereinafter set forth is considered in conjunction with the drawings annexed hereto.

In the drawings:

FIGURE 1 is a top plan view of the mechanism of this invention removed from its casing;

FIGURE 2 is a front elevational view of the mechanism;

FIGURE 3 is a top plan view of an assembly of only certain elements of the mechanism of FIGURE 2;

FIGURE 4 is a rear elevational view of the assembly of FIGURE 3;

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FIGURE 5 is a cross-sectional view taken substantially along the line 5—5 of FIGURE 4;

FIGURE 6 is a top plan view of the oscillatory armature element and associated spring of the mechanism of FIGURE 2;

FIGURE 7 is a side elevational view of the arrangement of FIGURE 6;

FIGURES 8, 9 and 10 are detail views of certain portions of the mechanism of FIGURES 6 and 7;

FIGURES 11 and 12 are detail views of certain elements of a contacting mechanism;

FIGURES 13 and 14 are top plan views of the contacting mechanism, showing alternative positions of the element; and

FIGURE 15 is a fragmentary sectional view taken along the plane 15—15 of FIGURE 14.

In general, the mechanism of the clock includes a pivotal oscillatory element 35 in the form of an armature of magnetic material movable between a pair of pole elements 36 and 37 of an electromagnet having an energizing coil 38. The armature element 35 is urged by a suitable spiral hairspring 39 to a neutral position such as illustrated in the plan view of FIGURE 1 and, when the coil 38 of the electromagnet is energized, the armature 35 will be oscillated by the magnetic forces of the electromagnet into alignment with the flux between the poles 36 and 37.

It will be appreciated that the element 35 will tend to oscillate at a rate determined by its inertia and the characteristics of the spring 39 and, by energizing the electromagnet coil 38 at appropriate portions of the cycle of movement of the element 35, it may be maintained in oscillation. Accordingly, a contact arrangement, generally designated 40, is provided which is actuated by movement of the element 35 to control energization of the coil 38, the details of which are described hereinafter.

Means generally are provided for transforming the reciprocating oscillatory movement of the element 35 into rotary movement which is used to drive the clock hands through a suitable gear train, as will be described.

The mechanism of the clock may be supported from a forward vertical frame plate 42 and a rearward frame plate 43 which are supported in fixed parallel relation to each other and to the clock casing by means of posts 45, 46 and 47. The frame plates 42 and 43, and especially the rearward plate 43, are preferably of a nonmagnetic material such as brass and a pair of plates 48 and 49 of magnetic material, such as iron or steel, are disposed on the forward face of the rearward plate 43, adjacent opposite side portions thereof, the plates 48 and 49 having forwardly turned upper end portions 50 and 51 which may be formed to define the poles 36 and 37. There is a core element of magnetic material inside the coil 38 bridging plates 48 and 49 and thus conducting pulses of coil 38 to poles 36 and 37.

It is sufficient here to state that energization of coil 38 is triggered to maintain element 35 in oscillation. This is accomplished through circuitry to said coil including make-and-break contacts spring biased toward engagement. Pin 160 carried by an end face of a cam 139 on shaft 90 actuates a leg portion 158 for making the contact, while cam 139 actuates leg 138 of arm 126 for breaking the contact. Both the contact making and contact breaking mechanisms are adjustable and, combined with the adjustability of pole pieces 36 and 37 (described below), permit precise synchronization of oscillatory element 35. The adjusting means per se are part of the subject matter of the parent application, and reference is made thereto for full disclosure of the details.

As above indicated, mechanism is arranged to convert the oscillatory movement of the element 35 into rotating

movement. This mechanism is arranged to drive a toothed wheel 66 which, as best shown in FIGURES 3 and 4, is secured on a shaft 67 which carries a worm 68. A specific feature of the invention is in the mounting of the shaft 67. In accordance with this feature, the end of the shaft 67 adjacent the wheel 66 is journaled by one leg 69 of a generally L-shaped bracket 70 having a second leg 71 secured at its end against the forward face of the plate 42 by a screw 72. The bracket 70 is so formed that, through its own inherent resiliency, the leg 69 is urged forwardly with the inner end of the leg 71 being spaced from the plate 42, and an adjustment screw 73 extends through the inner end portion of the leg 71 and is threaded into the plate 42 so that, by adjustment of the screw 73, the leg 69 may be moved forwardly or rearwardly to thus move the end of the shaft 67 forwardly or rearwardly, this adjustment being desirable to obtain accurate and reliable operation of the mechanism 41 as will appear hereinafter. The other end of the shaft 67 is journaled by one leg 74 of a generally L-shaped bracket 75 having a second leg 76 secured to the plate 42 by a screw 77. The plate or bracket 75 is so formed that the pressure between the leg 74 and the shaft 67 may be adjusted by means of the screw 77.

The worm 68 (FIGURE 4) meshes with a worm wheel 78 which carries a pinion 79 which meshes with a gear 80 secured on a shaft 81 which carries the minute hand 34. The shaft 81 may carry a pinion 82 meshed with a wheel 83 which carries a pinion 84 meshed with a gear 85 on a sleeve 86 which may support the hour hand 33. To allow setting of the hands of the clock, there may be a frictional drive between the wheel 80 and the shaft 81 in which the wheel 80 may be urged against a collar 87 on the shaft 81 by a coiled compression spring 88 acting between the wheel 80 and a collar 89 secured to the shaft 81.

The oscillatory armature element 35 (FIGURE 7) is supported on a vertical shaft 90, the upper end of which is journaled by a bearing 91 fitted into the lower end of a screw 92 threaded into a bracket 93 having ends 94 and 95 (FIGURE 2) secured by screws 96 and 97 to the flange portions 50 and 51 of the members 48 and 49.

The spiral hairspring 39 (FIGURES 6 and 7) has its inner end secured in a collar 98 on the shaft 90 and its outer end secured by a locking wedge 99 in an opening in a plug 100 secured by a screw 101 in an opening 102 in the bracket 93.

For adjusting the effective action of the coiled hairspring 39, a plate 103 pivotal about the axis of the screw 92 has a downturned bifurcated portion 104 embracing a point of the outer convolution of the hairspring 39, the effective tension of the spring 39 being adjustable by rotation of the plate 103. To journal the plate 103, it may have an upturned annular flange portion 105 engaged by a corrugated resilient washer 106, the washer 106 being spaced from the bracket 93 by a washer 107 with a nut 108 threaded on the screw 92 to hold the washer 106 against the annular flange 105 of the plate 103. It will be appreciated, of course, that the pressure between the bearing 91 and the upper end of the shaft 90 may be adjusted by means of the screw 92.

As shown in FIGURE 7, the lower end of the shaft 90 is journaled in a bearing plug 109 carried by a collar 110 which is press-fitted into a lug portion 111 of the rearward frame plate 43.

The mechanism for transforming the oscillatory movement of the element 35 into rotary movement comprises the toothed wheel 66 above described and a device 112 secured on the shaft 90 and illustrated in FIGURES 7 and 10. The device 112 comprises a pair of vertically spaced discs 113 and 114 secured on a hub 115 which is in turn secured on the shaft 90, the upper disc 114 having an annularly upwardly projecting struckout portion 116 defining an opening 117 therein, and the lower disc 113 having a struckout portion 118 extending upwardly to one

side of the opening 117 and defining an opening 119 on the periphery of the disc 113.

In operation, a tooth of the wheel 66 may be disposed between the discs 113 and 114; and when the shaft 90 is rotated in one direction (clockwise, as viewed from below), the portion 118 of the disc 113 will cammingly engage such tooth and force it downwardly through the opening 119. The next tooth of the wheel 66 will then be disposed just above the upper disc 114; and when the shaft 90 is rotated in a reverse direction (counterclockwise, as viewed from below), the portion 116 of the upper disc 114 will cammingly engage such tooth and force it downwardly through the opening 117 into the space between the discs 114 and 113. This cycle will be repeated with each oscillation of the shaft 90 and it will be appreciated that a drive of the wheel 66 in one direction is achieved.

It might here be noted that, by virtue of the support arrangement for the end of the shaft 67 adjacent the wheel 66, the position of the wheel 66 relative to the device 112 may be readily adjusted so as to obtain efficient operation of the motion-converting mechanism.

The poles 36 and 37 are constructed so that they may be readily adjusted into optimum relation to the armature element 35. The flange portions 50 and 51 of the members 48 and 49, which flange portions define the poles 36 and 37, have arcuate edges complementary to the periphery of the element 35, and slots are formed in the flange portions 50 and 51 in spaced generally parallel relation to said edges. By inserting the blade of a screwdriver or similar tool into the slots, the edges may be readily brought into properly spaced relation to the periphery of the element 35 as disclosed in detail in the parent application.

A highly important feature of the structure is in the construction of the contact means 40 for energizing the coil 38 in synchronism with the oscillatory movement of the element 35. In particular, the contact means 40 (FIGURES 13 and 14) comprises a movable contact 124 engageable with a stationary contact 125, the contact 125 being connected to the plate 64 and thus to one side of the coil 38 with the movable contact 124 being electrically connected to the frame of the mechanism so that when the contact 124 is engaged with the contact 125, a circuit is completed through the coil 38.

The movable contact 124 is preferably formed of a separate piece of flat stock of a suitable electric contact material, such as silver or platinum, and is fixedly secured by welding or soldering to a relatively rigid actuating arm 126. The contact 124 actually lies normal to the plane of the arm 126 and depends therefrom so that only the free edge of the contact proper is utilized as the contacting area, as will be later apparent. The arm 126 is riveted, as at 127, or otherwise secured to one end of a flat spring 128, the other end of the spring being interposed between a pair of spring plates 128a and 128b secured to a portion 129 of the rearward frame plate 43 by a screw 130. A second screw 131 is threadably received by the plate portion 129 and serves to urge the offset outer ends of the spring plates 128a and 128b toward the frame plate portion 129. Obviously, adjustment of the screw 131 toward the portion 129 will urge the contact 124 downwardly (as viewed in FIGURE 13) to increase the contact pressure between the contacts 124 and 125. Conversely, loosening of the screw 131 will relieve the contact pressure.

The stationary, but adjustable contact 125 is similar to the contact 124 and is a separate contact element secured to a resilient arm 132 having a portion 133 secured to the terminal post 59, an insulating washer 134 being disposed between the portion 133 and the member 49. A second arm 135 of configuration similar to the arm 132, but rigid throughout its length, has a portion in spaced relation in front of the arm 132 and a portion 136 disposed between the portion 133 of the member

132 and the plate 64 on the terminal post 59 to complete an electrical circuit therebetween. A screw 137 extends through the arm 132 and is threaded into the arm 135 so that, by rotation of the screw 137, the position of the fixed contact 125 may be adjusted. It will be noted from FIGURE 15 that the contacting edges of the contacts 124 and 125 lie normal to one another, and the resulting very small contact area requires very little contact pressure thereby reducing the load on the contact-actuating mechanism.

The contact arm 126 is so supported that it urges the contact 124 into engagement with the contact 125. To disengage the contact 124 from the contact 125, the arm 126 has an end portion 138 actuated by a cam member 139 affixed to the shaft 90. The cam 139 has a cylindrical surface portion 140 concentric to the axis of the shaft 90 and a pair of coplanar flat surfaces 141 and 142. When the shaft 90 rotates in a counterclockwise direction, the surface 140 may engage the end portion 138 of the arm 126 to move the contact 124 out of engagement with the contact 125, as shown in FIGURE 13; and when the shaft 90 is rotated in a clockwise direction, and portion 138 of arm 126 is over either coplanar surface 141 or 142, as shown in FIGURE 14, arm 126 is allowed to move so as to engage the contact 124 with the contact 125 after which the surface 140 may again engage the end portion 138 of the arm 126 to disengage the contact 124 from the contact 125.

Means are provided for releasably maintaining the arm 126 in a position with the contacts disengaged. In particular (FIGURE 12), a slot 143 is formed in the arm 126 in proximity to the contact 124 and a resilient control arm 144 is arranged to frictionally engage one side edge of the slot to maintain the arm in a position with the contacts disengaged when it is moved by the cam faces 141, 142 into such a position.

The control arm 144 has a supporting leg or flange portion 145 extending normally from its rearward end, the flange portion 145 being disposed between one leg 146 of a generally L-shaped clamping member 147 and one leg 148 of a generally L-shaped portion 149 of a support bracket generally designated by reference numeral 150. A screw 150a extends through the flange portion 146 and the leg 145 and is threaded into the leg 148 to rigidly secure the flange portion 145 to the bracket 150 (FIGURE 13).

To adjust the frictional engagement between the control arm 144 and the edge of the slot 143 in the arm 126, a rearward end portion of the arm 144 (referring especially to FIGURES 13 and 14) is disposed between a first arm 151 of the clamping member 147 and a second leg 152 of the L-shaped portion 149 of the bracket 150 with a screw 153 extending through the leg 151 and threaded into the leg 152, the control arm 144 being moved toward or away from the leg 152 by rotation of the screw 153 to adjust the frictional engagement between the arm 144 and that edge of the slot 143 in the arm 126 which is remote from the contact 124.

For actuating the control arm 144 to release the contact arm 126 so that the contacts 124 and 125 may abut, the arm 144 has a forwardly projecting flange 154 at its lower end (FIGURE 11). The flange 154 engages a base portion 156 of a rockable or reciprocable release plate 157 which has an integral leg portion 158 extending through an opening 159 in the control bracket 150 to lie in the path of an actuating pin 160 (FIGURE 8) carried by the cam member 139. The flange 154 of the control arm 144 has a pair of projections 161 and 162 extending into slots 163 and 164 in the base portion 156 of the plate 157 to maintain the plate 157 and the arm 144 in proper relation.

In operation, when the shaft 90 rotates in one direction, for example, clockwise as viewed in FIGURES 13 and 14, the pin 160 will engage the leg 158 of the plate 157 to rock the plate about the point of engagement of

the rearward edge of the base portion 156 thereof with the portion 155 of the support bracket 150 and the base portion 156 will serve to move the forward end of the control arm 144 to the right, as illustrated in FIGURE 14, moving the arm 144 to reduce frictional engagement with the edge of the slot 143 in the contact arm 126 to thus release the arm 126 and allow the contact 124 to engage the contact 125. Similarly, when the shaft 90 is rotated in a counterclockwise direction, the pin 160 may engage the leg 158 of the device 157 to rock the device about the point of engagement of the base portion 156 with the portion 155 of the support bracket 150 and thus move the control arm 144 and reduce frictional engagement with the edge of the slot 143 and thus again allow movement of the arm 126 to engage the contact 124 with the contact 125.

It will, accordingly, be appreciated that the disengagement or opening of the contacts 124, 125 is controlled by the engagement of the cam faces 141, 142 with the end portion 138 of the arm 126 while engagement or closing of the contacts 124, 125 is controlled by the operation of the rockable device 157 which also is responsive to oscillation of the shaft 90. The opening time can be adjusted by adjusting the position of the screw 137, this adjustment being independent of the adjustment of the closing time.

To equalize the closing time of the contacts 124 and 125 in each oscillatory cycle of the shaft 90, the relative positions of the portions 149, 155 of the support bracket 150 may be adjusted. For this purpose, the support bracket 150 has a base portion 165 having one end integrally secured to the portions 149 and 155 with the other end thereof secured tightly against the rearward face of the rearward frame plate 43 by a screw 166 which extends through an opening in the base portion 165 of the bracket 150 (FIGURE 1). The base portion 165 of the bracket 150 is so formed that the end thereof adjacent the portions 149, 155 is urged by the inherent resiliency of the portion 165 in a rearward direction away from the rearward face of the rearward frame plate 43, and a screw 167 extends through the portion 165 adjacent the portions 149, 155 and is threaded into the frame plate 43. Rotation of the screw 167 adjusts the leg 152 to position the release plate 157 relative to the cam plate 139 and particularly with relation to the cam plate pin 160. By this adjustment, the plate 157 can be set so that the contacts 124, 125 are closed for the same length of time regardless of the direction of oscillation of the shaft 90.

As mentioned above, the screw 153 is used to initially set the frictional pressure between the control arm 144 and the edge of the slot 143 in the contact arm 126. The support bracket 150 is assembled on the frame plate 43 by the screws 166, 167, 169 and 170 to retain the release plate 157 between the leg 152 and the end 154 of the control arm 144. The release plate 157 is free to be rocked by the pin 160, and a certain degree of such rocking motion can be accommodated without releasing the contact arm 126. The time of closing of the contacts 124 and 125 can thus be regulated by varying the free rocking motion of the plate 157, i.e., the amount of movement of the plate 157 which is tolerated before release of the arm 126. For this purpose, the opening in the base portion 165 of the support bracket 150 through which the screw 166 extends is in the form of a slot to allow movement of the bracket 150 to the right or left, as viewed in FIGURE 1, for example. To control this movement, the base portion 165 of the support bracket 150 has a forwardly turned flange portion 168 adjacent one edge of the frame plate 43 and a first adjustment screw 169 extends through the flange portion 168 and is threaded into the plate 43 with a second adjustment screw 170 threaded through the flange portion 168 and engageable with the edge of the plate 43. Thus, by adjustment of the screws 169 and 170, the support bracket

150 may be moved to the right or to the left, as viewed in FIGURE 19. After such adjustment, the bracket can be locked in position by the screws 170, 169 and 166.

Operation

For reasons to be explained in detail later, the normal position of the contacts 124 and 125 is closed, i.e., the positions of FIGURE 14. When the clock 30 is energized, as by connecting a suitable direct current source, such as a battery, between the terminal post 59 and the frame of the mechanism, the coil 38 will be energized. The armature element 35 will be moved in one or the other direction of oscillation, the direction of initial movement depending upon the position of the armature relative to the pole pieces 36 and 37.

The contacts 124 and 125 remain closed for a relatively limited displacement of the shaft 90 from its neutral position at which the armature 35 is positioned symmetrically between the pole pieces 36 and 37. A relatively greater displacement of the shaft 90 is required to open the contacts by the cam faces 141, 142 of the cam 139.

Upon deenergization of the device, the armature 35 continues to oscillate, because of its inertia, the arcuate displacement of the armature diminishing. Initially upon deenergization, the cam faces 141 and 142 and the pin 160 sequentially open and close the contacts 124, 125, but as the magnitude of armature displacement becomes less, the cam faces 141 and 142 do not open the contacts 124, 125, although the pin 160 will rock the release plate 157 to close the contacts. Thus, the contacts remain closed when the armature comes to rest.

Of course, the armature is never exactly centralized between the pole pieces, but will lie approximately centrally therebetween. This random positioning of the armature 35 causes the armature to move initially in accordance with its position and without effect upon the operation of the device.

Considering first clockwise movement of the armature element 35, the cam surface 142 of the cam member 139 will engage the end portion 138 of the contact arm 126 to move the contact 124 out of engagement with the contact 125, and thus deenergize the coil 38. Rotation of the armature element 35 may continue in a clockwise direction from the kinetic energy resulting from its motion, but eventually due to the restoring force of the spring 39, the armature element 35 will be urged back in a counterclockwise direction. When the armature element 35 and shaft 90 rotate to a position with the face 142 of the cam member 139 opposite the end portion 138 of the contact arm 126, the arm 126 will not move back to engage the contact 124 with the contact 125, due to the frictional engagement of the arm 144 with the edge of the slot 143 in the contact arm 126. However, with further counterclockwise movement of the armature element 35, the pin 160 will engage the leg 158 of the rockable device 157 to effect a clockwise movement of the device about its forward edge portion to move the forward end of the control arm 144 so as to reduce the frictional engagement pressure with the edge of the slot 143 and allow the contact arm 126 to move to engage the contact 124 with the contact 125.

This will reenergize the coil 38 of the electromagnet to exert a force which cooperates with the kinetic energy of the element 35 in effecting further counterclockwise movement of the element 35.

With such further counterclockwise movement, the face 141 of the cam member 139 will engage the end portion 138 of the contact arm 126 to move the arm 126 to a position such as illustrated in FIGURE 13 and disengage the contact 124 from the contact 125. The counterclockwise movement will continue until stopped by the increasing force of the spring 39, after which the armature element 35 will move back in a clockwise direction from the force of the spring 39.

In this clockwise movement, when the shaft 90 reaches a position such that the face 141 of the cam member 139 is opposite the end portion 138 of the contact arm 126, the arm 126 will not move into contact-engaging position due to the frictional engagement between the control arm 144, engagement of the control arm 144 with the edge of the slot 143, and the contacts will not be re-engaged until with further clockwise movement the pin 160 actuates the rockable device 157. This cycle will, of course, be repeated over and over again, and the movement will oscillate at an amplitude dependent upon the relation of the energy supplied by the electromagnet to the energy dissipated as heat from friction, etc. While the amplitude of oscillation may vary with variations in the supply of voltage, the elapsed time of each cycle of operation will remain the same so that the accuracy of the instrument will not be affected.

It should be noted that the mechanism 41 which converts the oscillatory movement of the shaft 90 into rotational movement of the wheel 66 is so related to the contacting assembly 40 that the drive is imparted to the wheel 66 during substantially the same portions of the cycle that the coil 38 is energized. Accordingly, the effect on the natural vibratory movement of the element 35 is minimized to thus minimize the effect on the accuracy of operation of the instrument. By virtue of the contact arrangement of this invention, it is possible to accurately adjust the portions of each cycle when the contacts are closed so as to achieve this highly accurate operation.

When the clock is disconnected from the source of electricity, the electromagnet will, of course, no longer impart driving force to the oscillatory element 35 and the amplitude of oscillation will gradually reduce. The friction between the end 138 of the contact arm 126 and the cam member 139 is low enough relative to the restoring force exerted by the spring 39 that if the oscillatory element 35 swings in either direction to an extent sufficient to open the contacts, it will swing back in the reverse direction to an extent sufficient to actuate the device 157 and close the contacts. Accordingly, if the clock is deenergized, the oscillatory element will ultimately reach a position with the contacts closed so that when the clock is reenergized, the coil 38 will be energized and operation of the oscillatory mechanism must be initiated. Hence, there is no "dead" position of the mechanism.

Having thus described my invention, it is obvious that various modifications may be made in the same without departing from the spirit of the invention; and, therefore, I do not wish to be understood as limiting myself to the exact forms, constructions, arrangements and combinations of parts herein shown and described.

I claim:

1. In an electric clock or the like, an oscillatory element including a first shaft, electromechanical transducer means for imparting drive impulses to said element and shaft, a rotatable member, means coupling said oscillatory element and said rotatable member for effecting incremental positive drive of said member in one direction, said coupling including two spaced rings encircling and fixed upon said first shaft, a second shaft rotatably mounted transversely to said first shaft and drivingly geared to said member, a toothed wheel fixed upon said second shaft with its tooth adapted to be received serially between said rings, each of said rings being formed with a radial slit and the contiguous portion on one side of the slit of each ring being struck upwardly to form a cam portion, the cam portions of the rings being oppositely directed and the struck portions defining a passageway for a tooth of said gear whereby upon each cycle of said oscillatory element, said wheel will be rotated the increment of one tooth, means for energizing said transducer during the period of engagement of said tooth and cam portions, means for supporting said end of said second

shaft whereby said wheel can be moved toward and away from said rings, and means supporting an opposite end of said second shaft whereby the latter can be moved axially toward said first-mentioned supporting means.

2. A clock comprising a frame, an oscillatory element including a shaft mounted by said frame, a hairspring connected to said shaft for biasing it toward a neutral position, means for adjusting said hairspring, means for imparting pulsed force to said element for maintaining it in oscillation, a pointer shaft, means coupling the shaft of said element for incremental actuation of said pointer shaft comprising a rotatable shaft mounted transversely to said element shaft and having a toothed wheel fixed adjacent one end thereof, the opposite end of said rotatable shaft being connected by gear train to said pointer shaft, there being spaced discs fixed on said element shaft for receiving a tooth of said wheel, each disc being formed with a radial slot and a contiguous area on one side of the slot being struck up to form cam surfaces facing in opposite directions and defining a passageway for a tooth of said wheel whereby upon each cycle of said oscillatory element, said wheel will be rotated the increment of one tooth, said means for imparting impulses being triggered by means carried by said element shaft and timed to pulse said element substantially at the instant one of said cam surfaces engages a tooth of said wheel, supporting means adjacent said end of said rotatable shaft for adjusting said wheel toward and away from said discs, and supporting means adjacent an opposite end of said rotatable shaft for adjusting the latter axially toward said first-mentioned supporting means.

3. A clock comprising a frame, an oscillatory element including a shaft mounted by said frame, a hairspring connected to said shaft for biasing it toward a neutral position, means for adjusting said hairspring, means for imparting pulsed force to said element for maintaining it in oscillation, a pointer shaft, means coupling the shaft of said element for incremental actuation of said pointer shaft comprising a rotatable shaft mounted transversely to said element shaft and having a toothed wheel fixed adjacent one end thereof, the opposite end of said element shaft being connected by gear train to said pointer shaft, there being spaced discs fixed on said element shaft for receiving a tooth of said wheel, each disc being formed with a radial slot and a contiguous area on one side of the slot being struck up to form cam surfaces facing in opposite directions and defining a passageway for a tooth of said wheel whereby upon each cycle of said oscillatory element, said wheel will be rotated the increment of one tooth, supporting means adjacent said end of said rotatable shaft for adjusting said wheel toward and away from said discs, and supporting means adjacent an opposite end of said rotatable shaft for adjusting the latter axially toward said first-mentioned supporting means, said means for imparting impulses being triggered by means carried by said element shaft and spaced from said element for timing the pulse to said element substantially at the instant one of said cam surfaces engages a tooth of said wheel.

4. A clock comprising a frame, a support carried by said frame, an oscillatory element including an oscillatory

drive shaft having one end engaging said support, means supporting the opposite end of said shaft, a hairspring connected to said shaft for biasing it toward a neutral position, means carried by said support and receiving said spring for adjusting the same, means for imparting pulsed force to said element for maintaining it in oscillation, a rotatable shaft, means coupling the drive shaft for incremental actuation of said pointer shaft comprising a driven shaft mounted transversely to said drive shaft and having a toothed wheel, a gear train operatively connecting said driven shaft and said pointer shaft, spaced discs fixed on said drive shaft for receiving a tooth of said wheel, each disc being formed with a radial slot and a contiguous area on one side of the slot being struck up to form cam surfaces facing in opposite directions and defining a passageway for a tooth of said wheel whereby upon each cycle of said oscillatory element, said wheel will be rotated the increment of one tooth, said means for imparting impulses being triggered by means carried by said drive shaft and timed to pulse said element substantially at the instant one of said cam surfaces engages a tooth of said wheel, means for supporting one end of said driven shaft for adjusting said wheel toward and away from said discs, and means for supporting an opposite end of said driven shaft for adjusting the latter axially toward said first-mentioned supporting means.

5. In an electric clock, an oscillatory shaft, an element carried by said oscillatory shaft, means for imparting pulsed driving forces to said element, a rotatable member, means coupling said oscillatory shaft and said rotatable member for effecting incremental positive drive in one direction during a portion of the movement of said element in either direction, means including contact means spaced from said element for controlling the operation of said first means during said portion of movement of said element, a pair of spaced means respectively supporting said rotatable member at its opposite ends, one of said supporting means serving to move said rotatable member toward and away from said oscillatory shaft for adjusting said coupling means, and the other of said supporting means serving to axially move said rotatable member toward said one supporting means.

6. In combination: a pair of spaced supports, a drive shaft extending between said supports and having ends journaled thereon, a driven shaft extending transverse to said drive shaft and having coupling means therebetween, means carried by said drive shaft and means carried by said driven shaft, and means supporting said driven shaft at opposite ends, one of said supporting means being adjustable to move said driven shaft axially, said other supporting means being resilient to permit such axial movement and being adjustable to move said driven shaft laterally for adjusting said coupling means.

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