March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 1

Fig. 1.

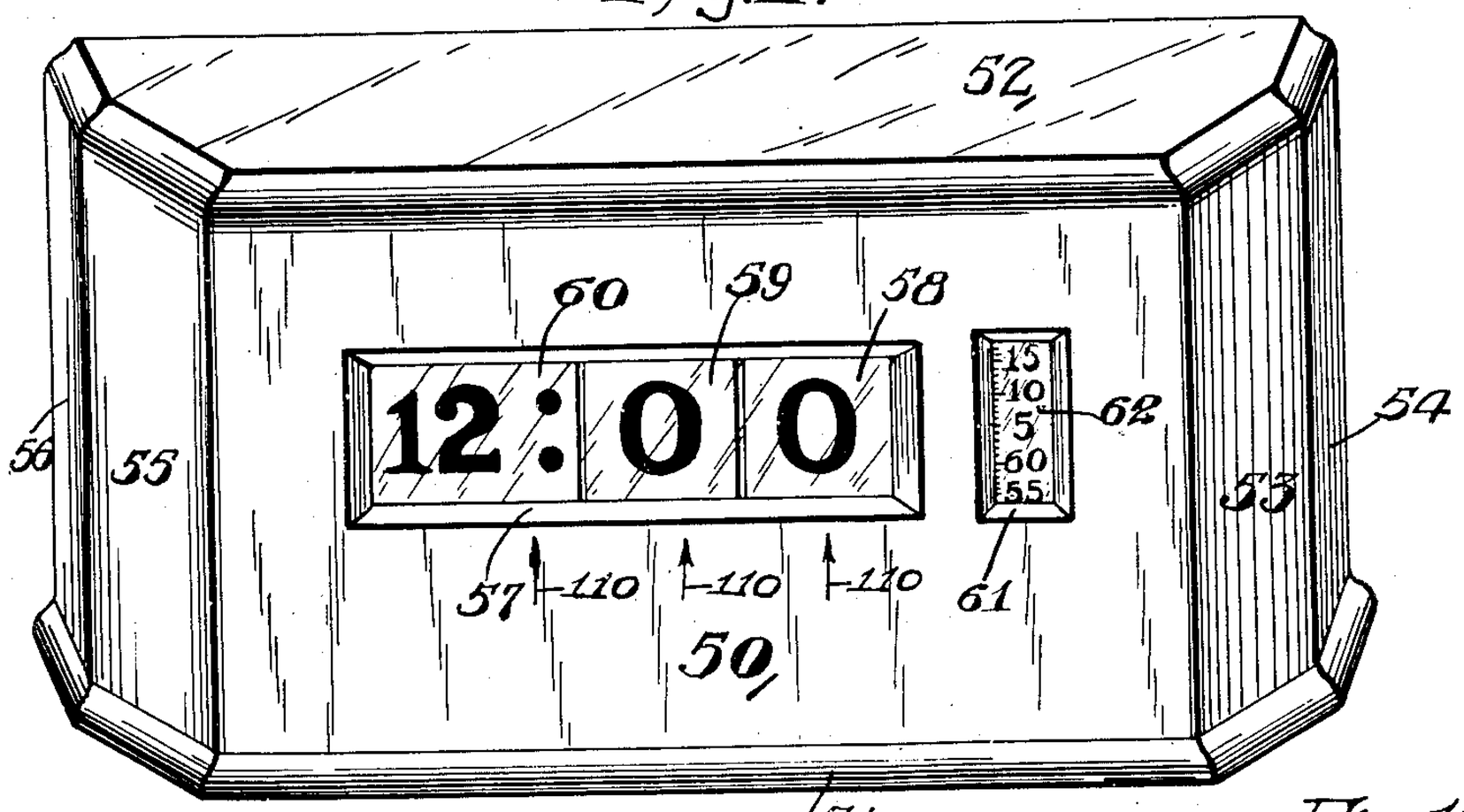


Fig. 17.

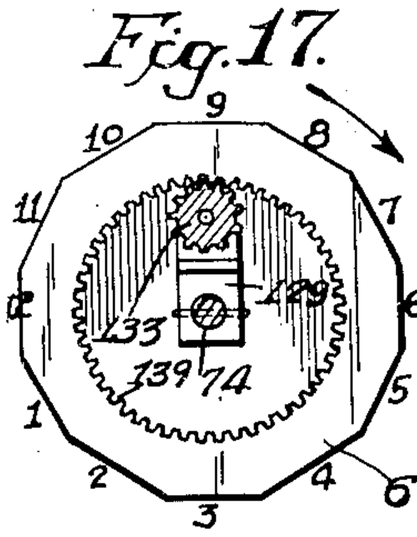


Fig. 16

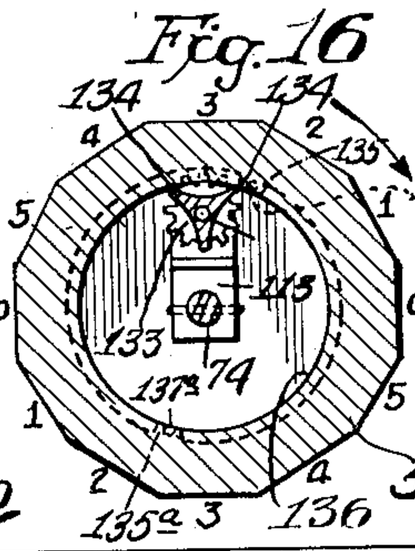


Fig. 15

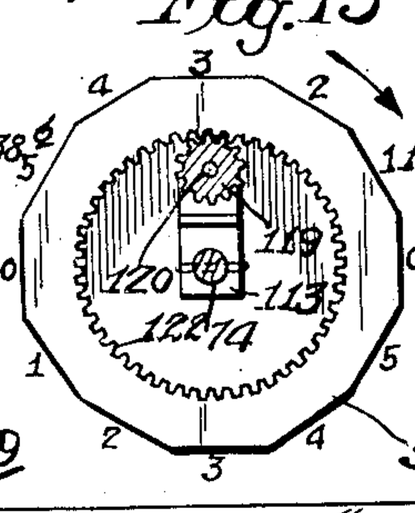
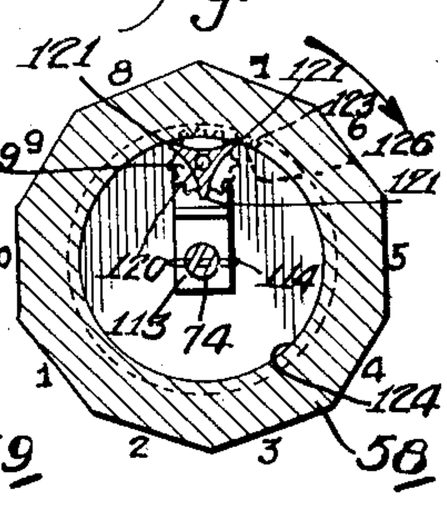


Fig. 14



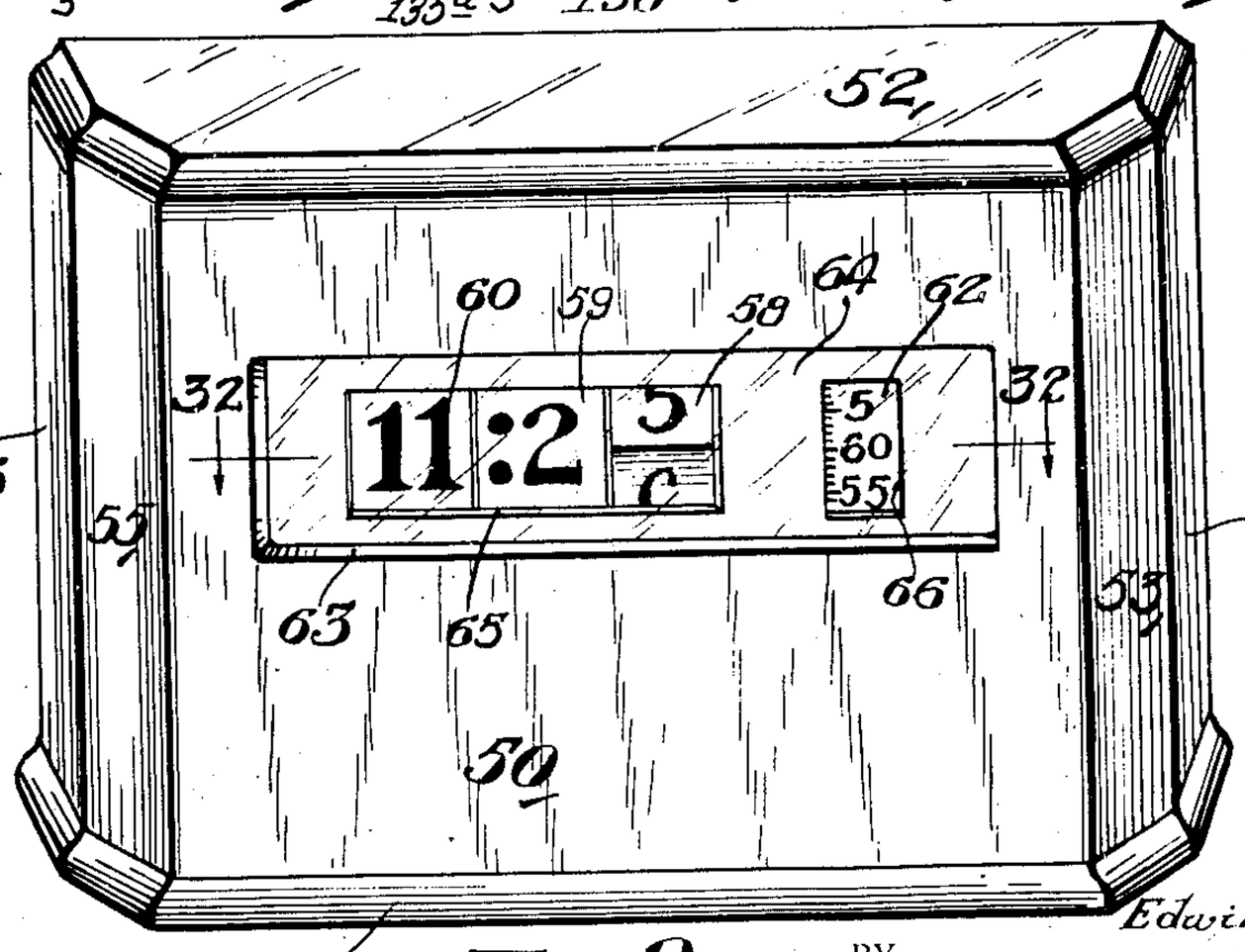


Fig. 2.

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March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 2

Fig. 3.

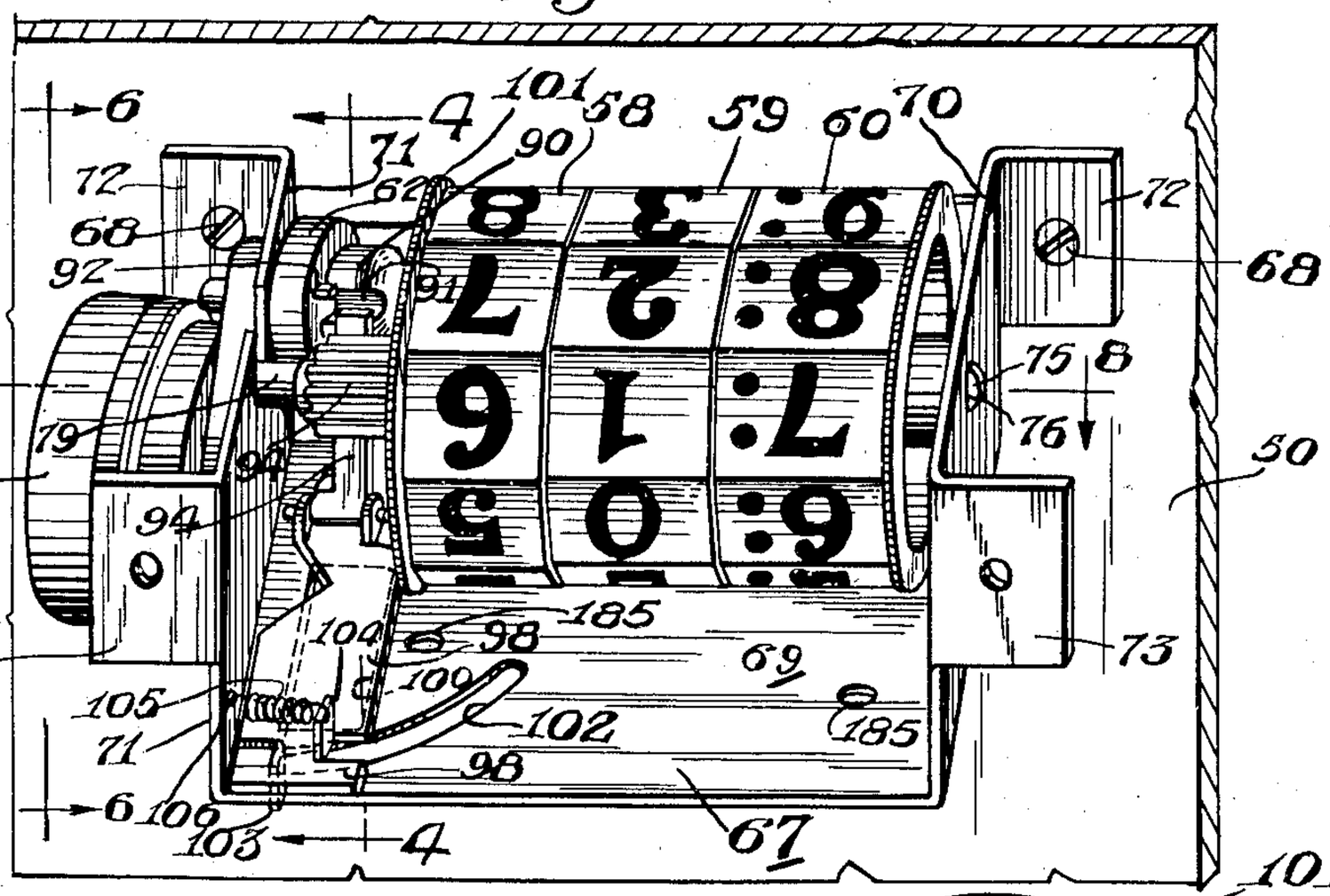


Fig. 5.

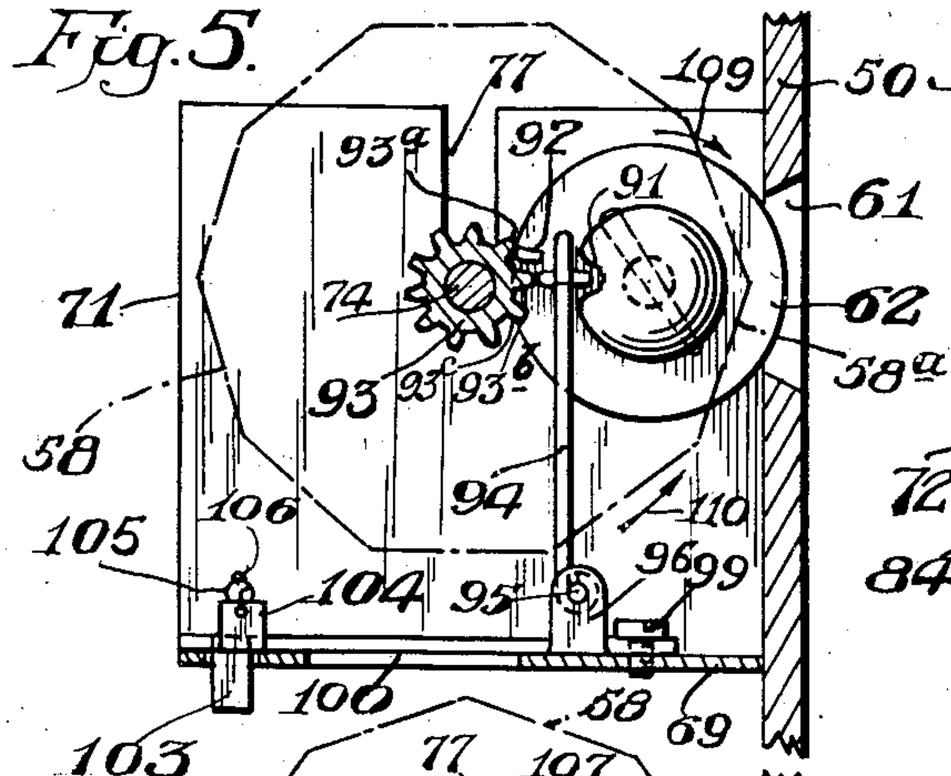


Fig. 6.

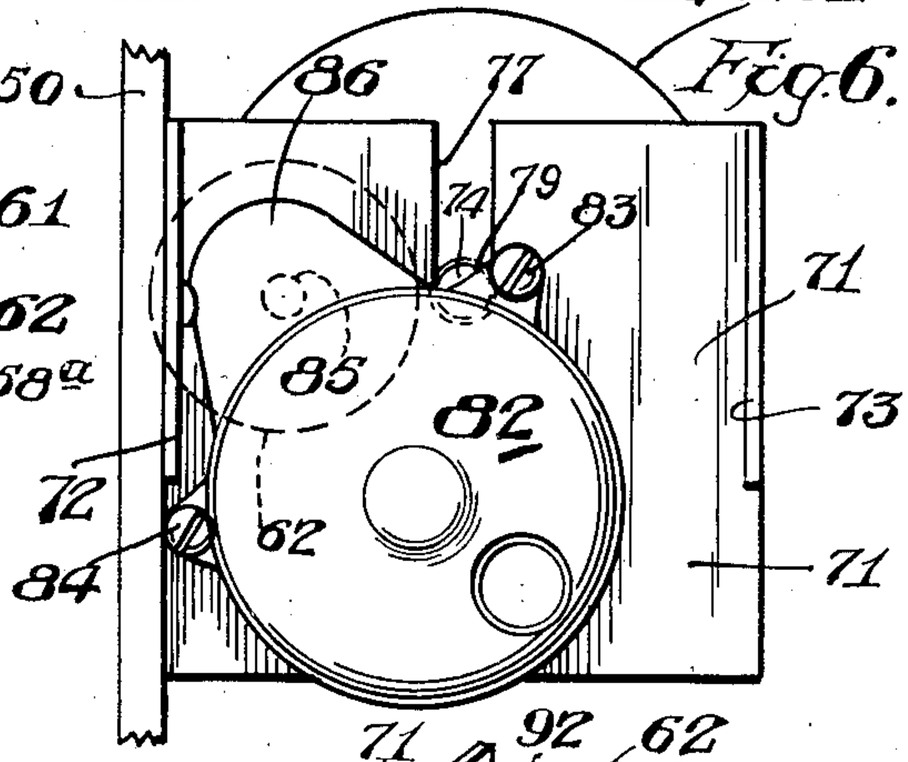


Fig. 4.

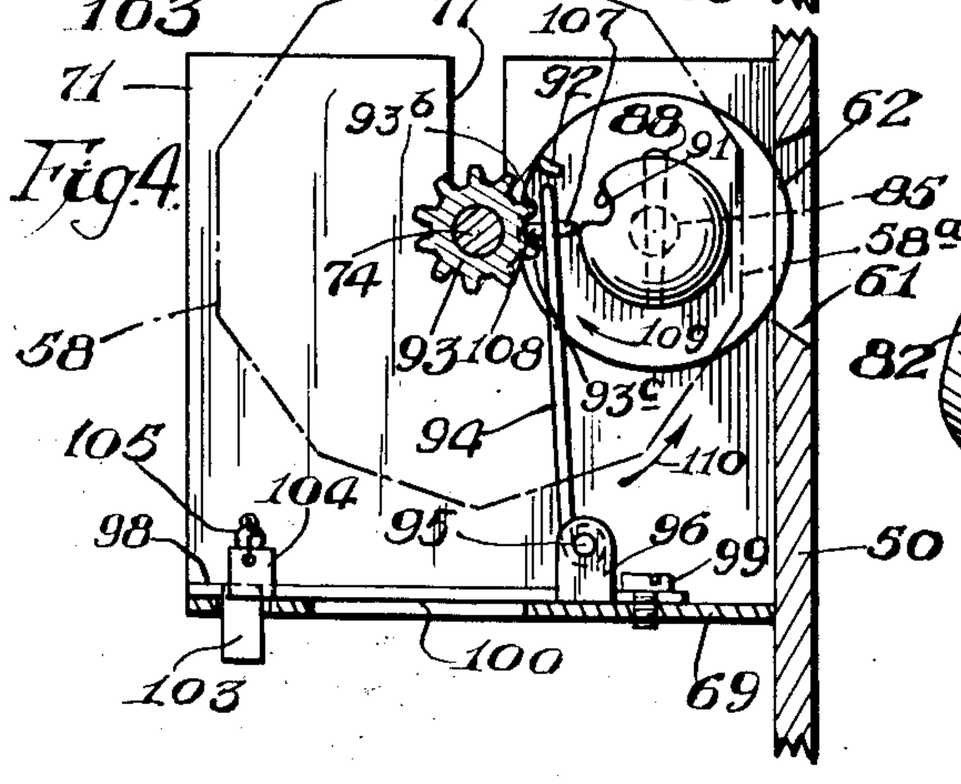
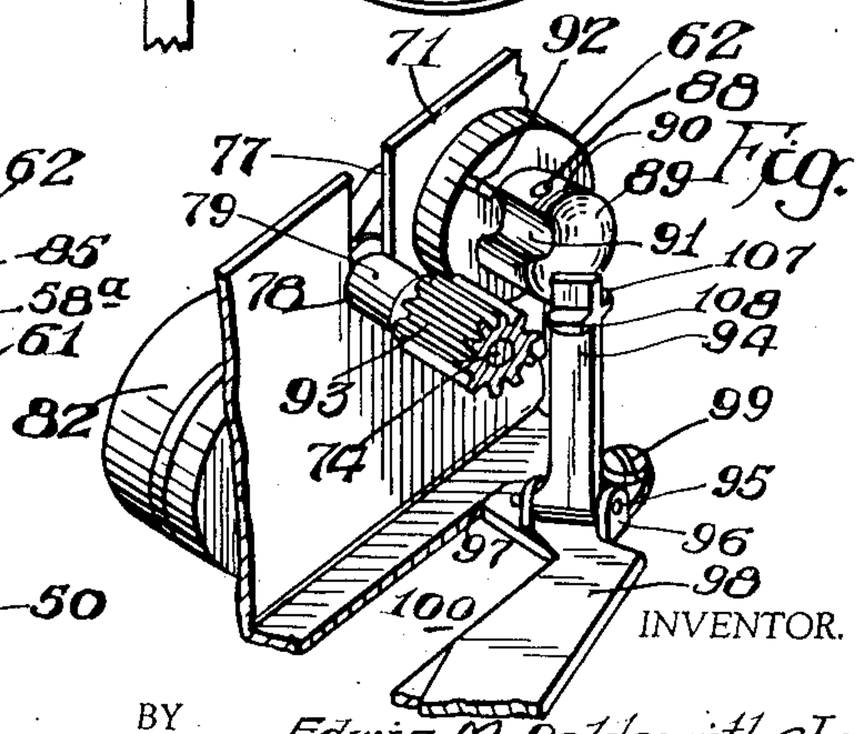


Fig. 7.



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March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 3

Fig. 13.

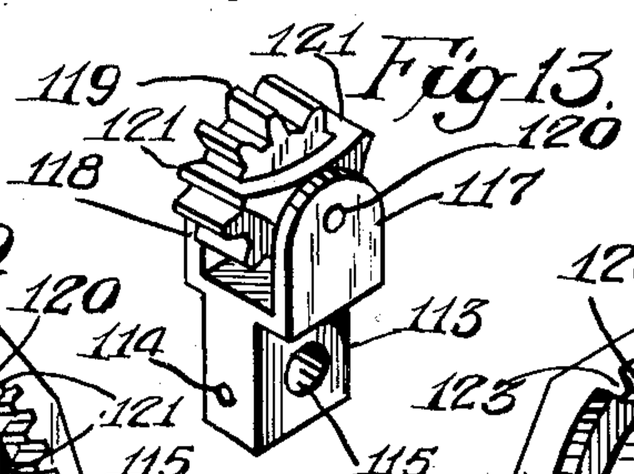


Fig. 10.

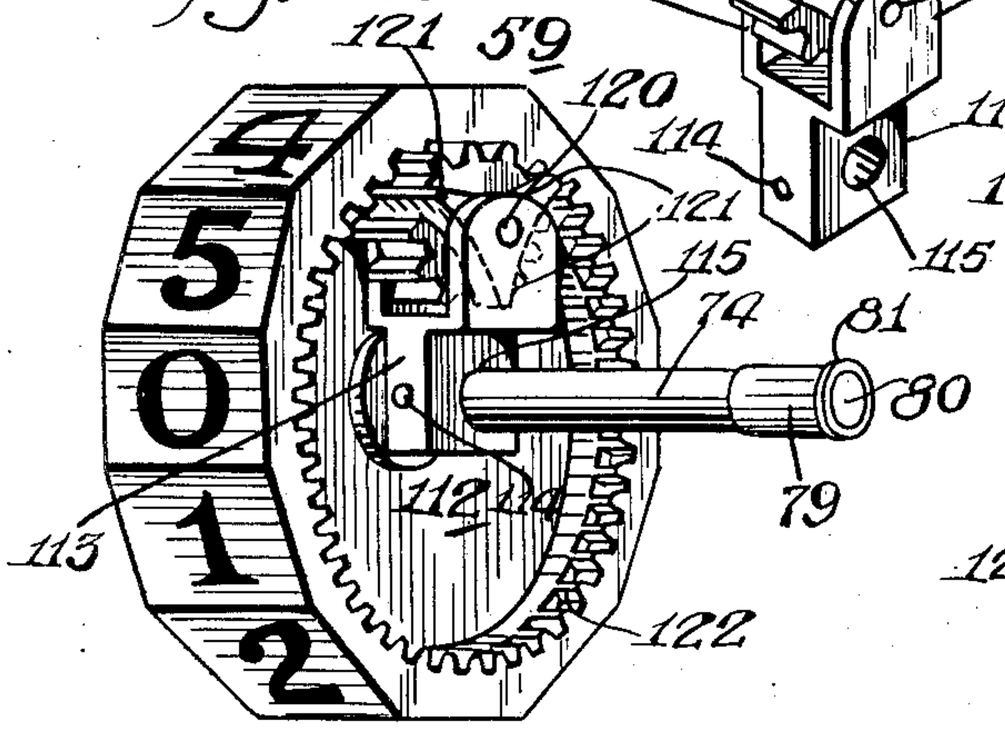


Fig. 9.

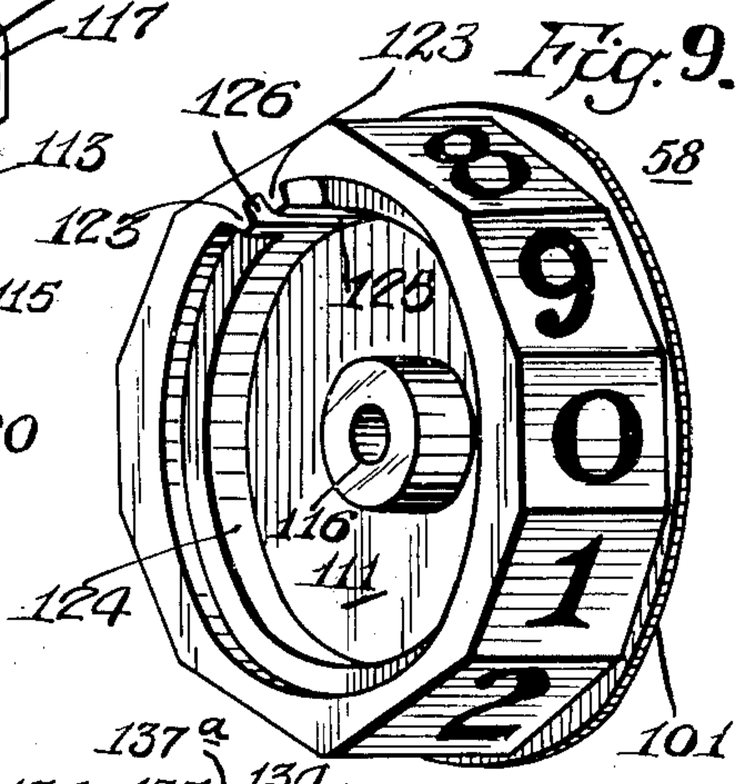


Fig. 12.

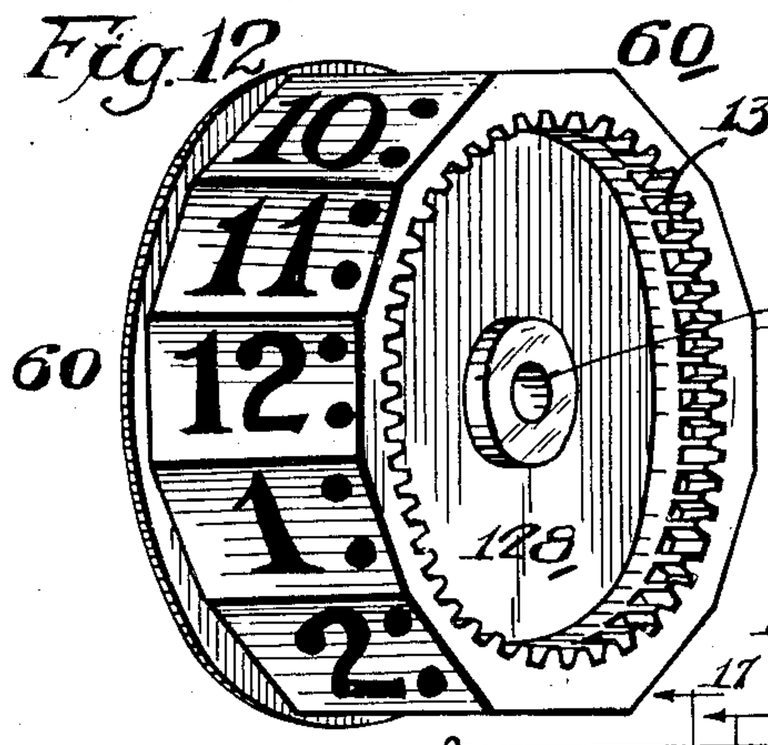


Fig. 11.

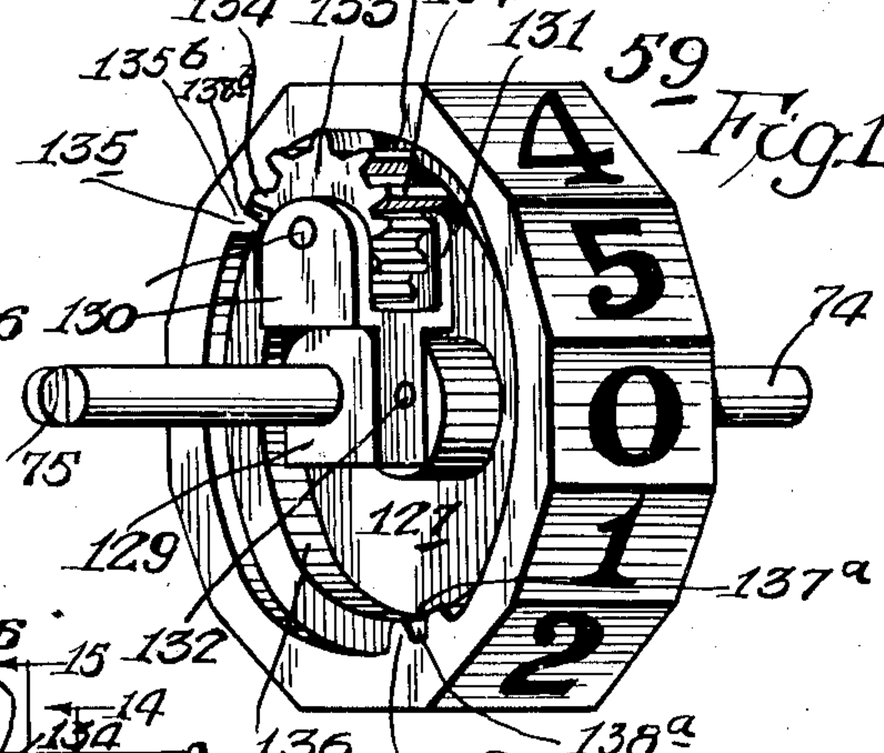
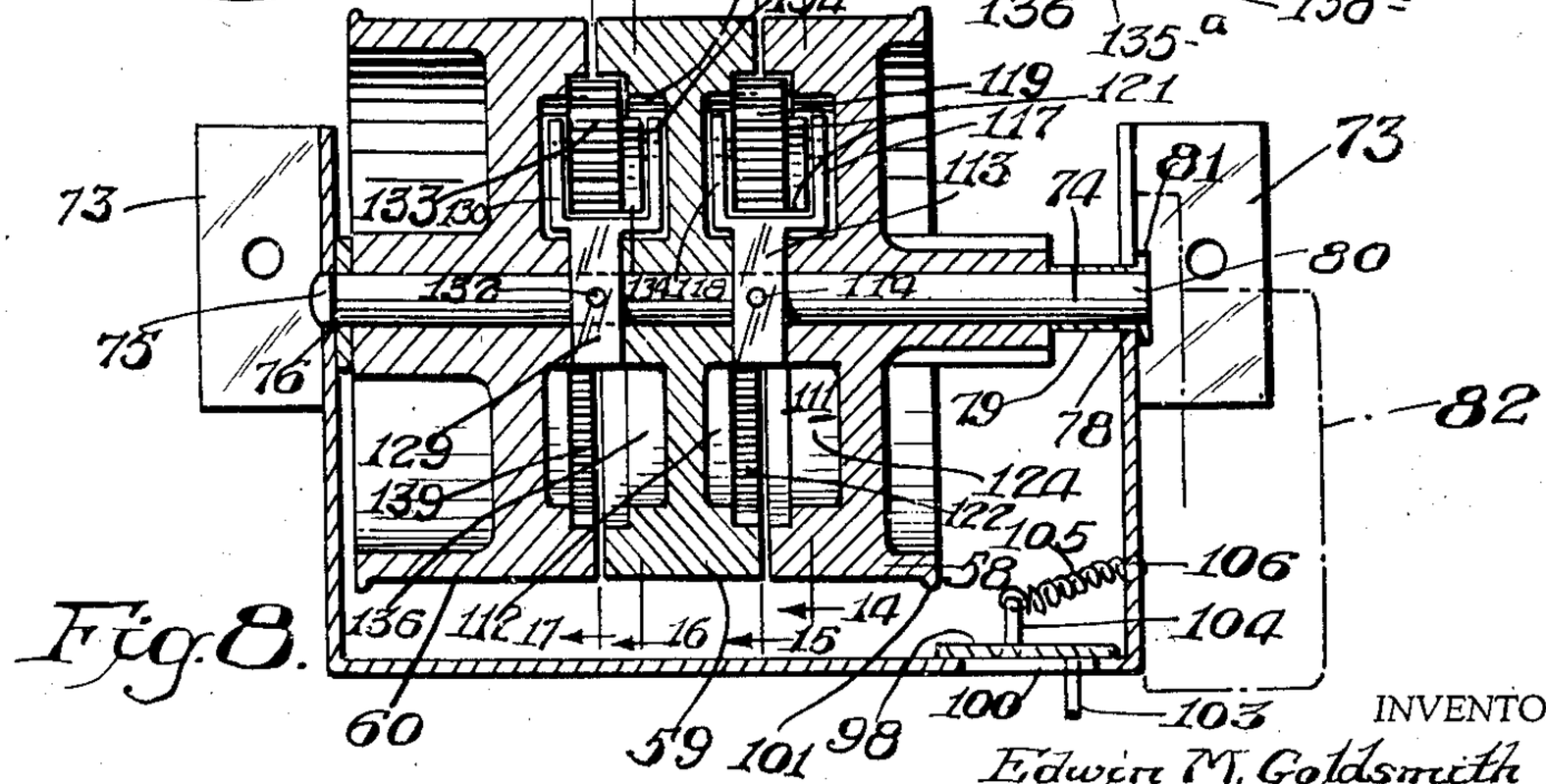


Fig. 8.



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March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 4

Fig. 18.

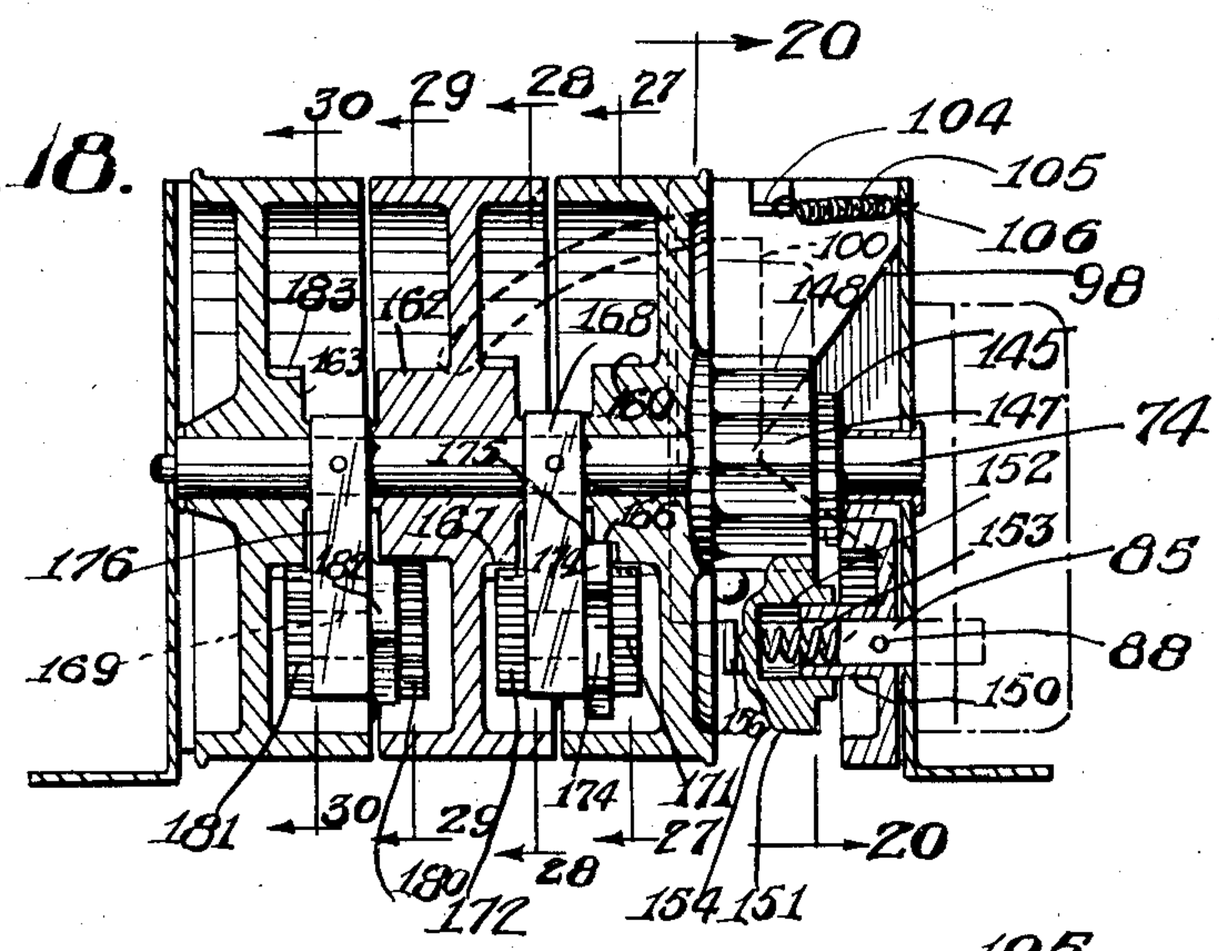


Fig. 19.

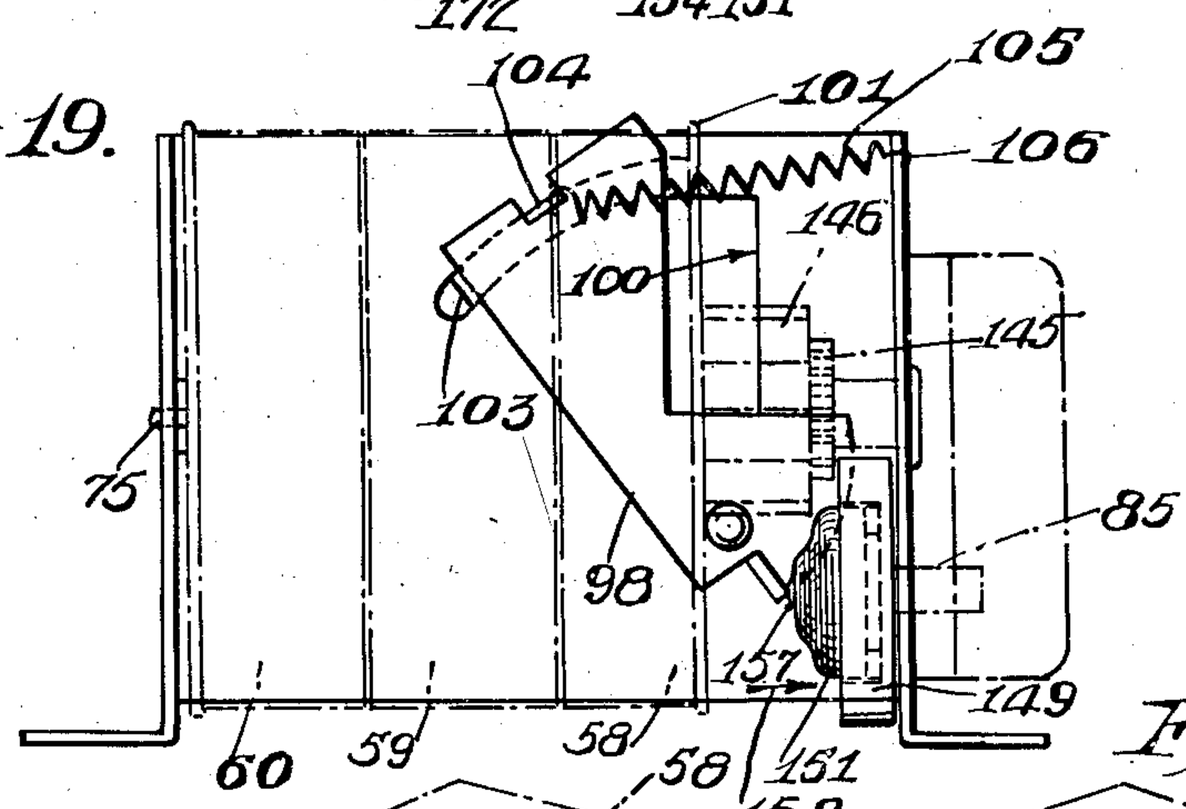


Fig. 20.

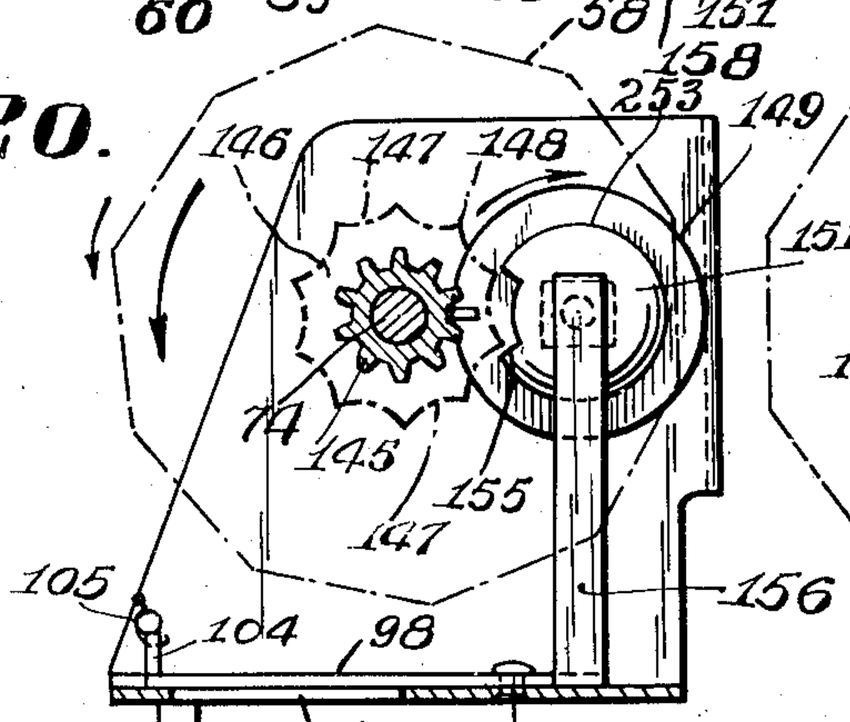
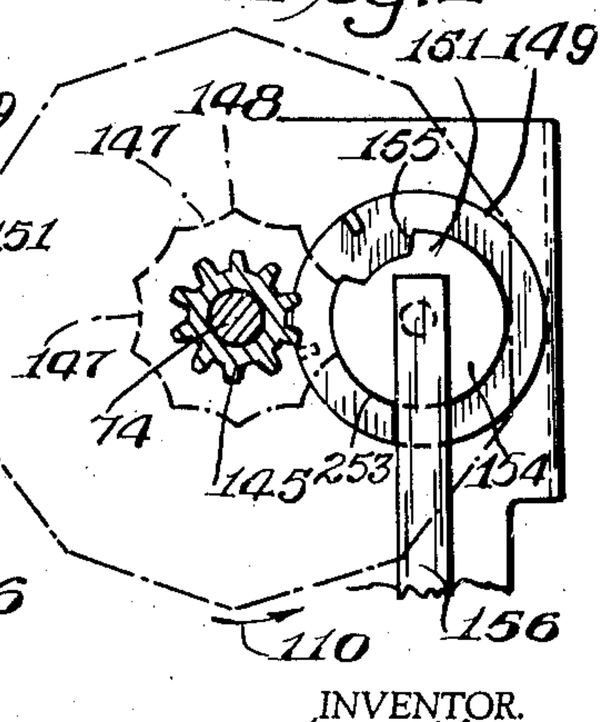


Fig. 20a



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March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 5

Fig. 21.

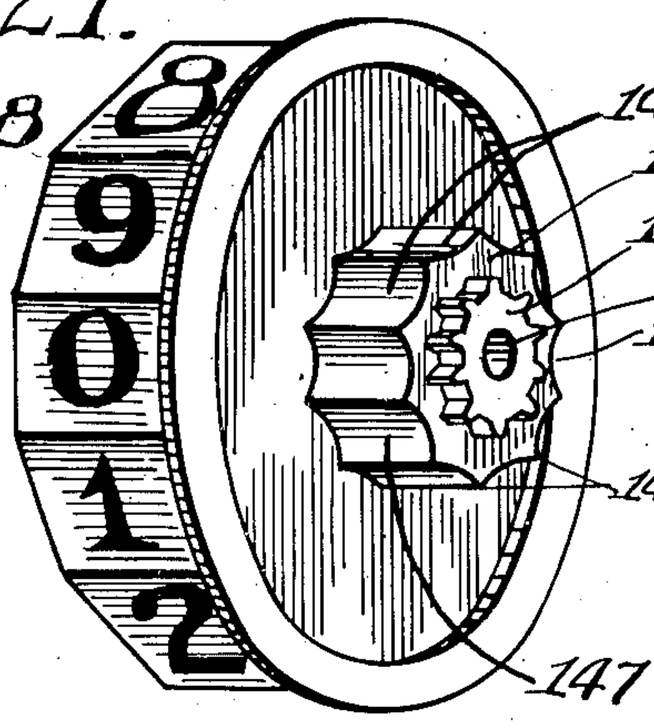


Fig. 22.

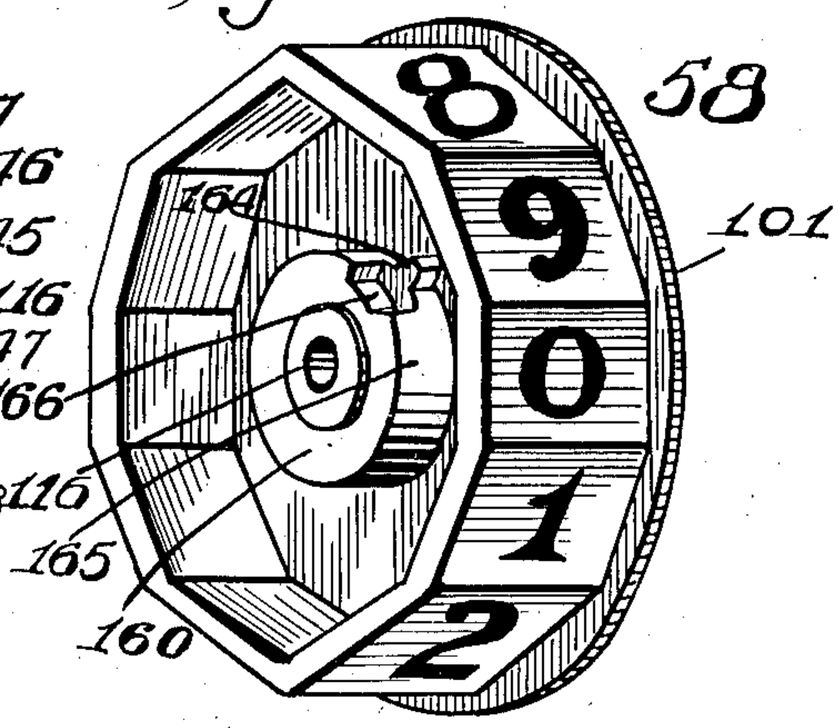


Fig. 23.

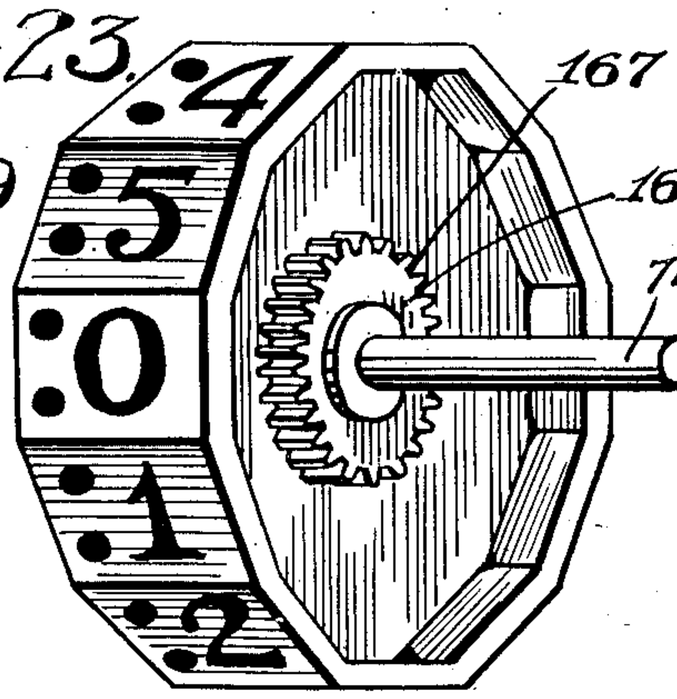


Fig. 24

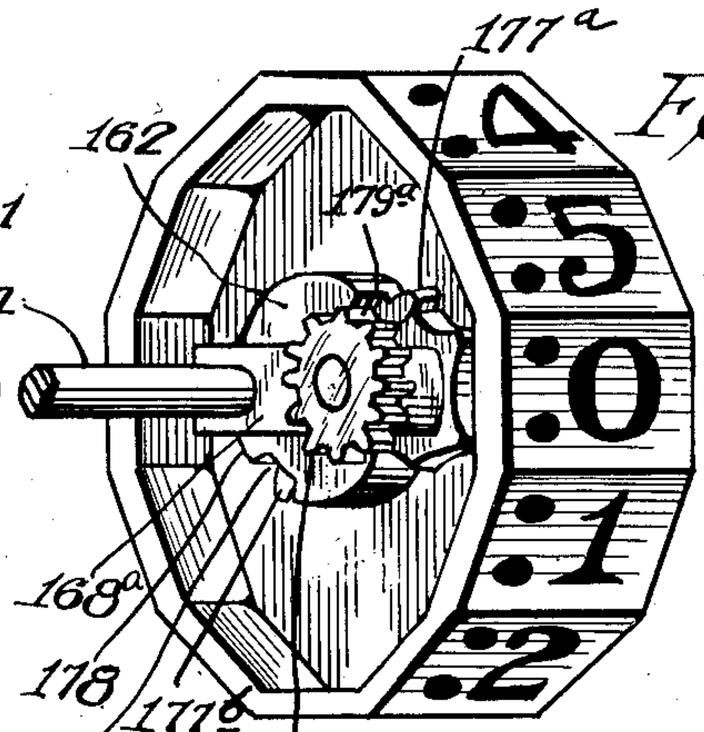


Fig. 25.

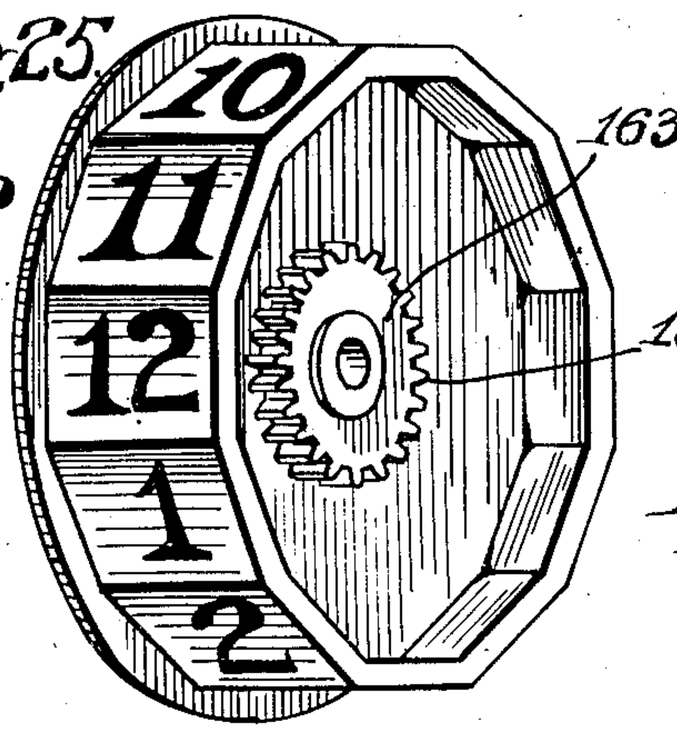
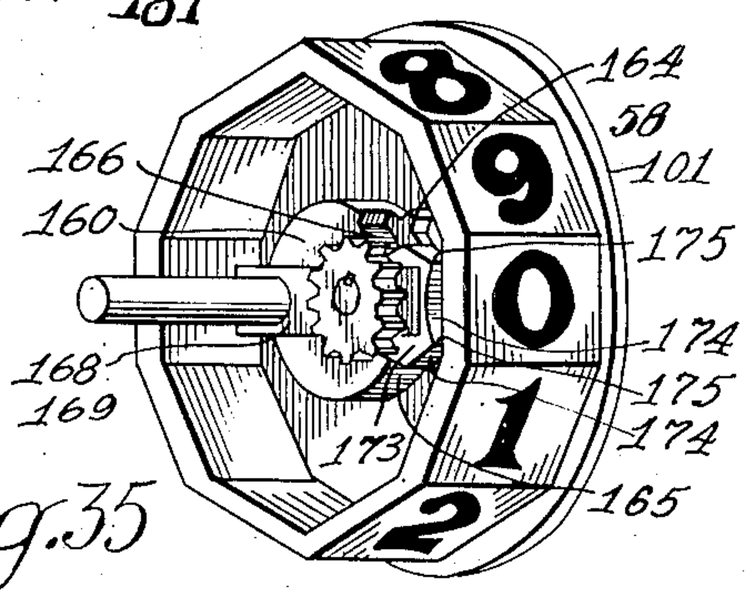


Fig. 35



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March 7, 1944. E. M. GOLDSMITH, JR 2,343,613

CLOCK

Filed April 8, 1940 6 Sheets-Sheet 6

Fig. 30.

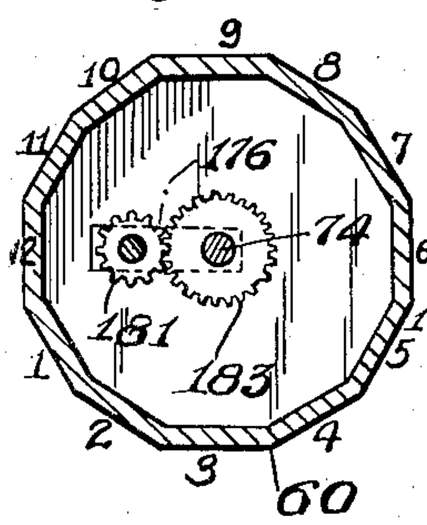


Fig. 29

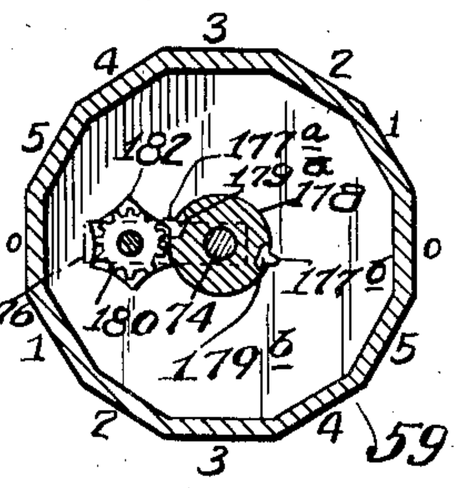


Fig. 28.

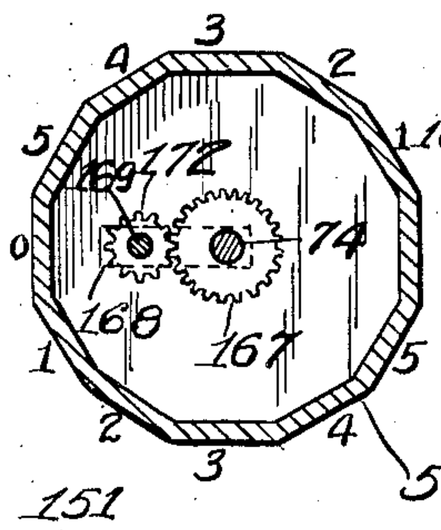
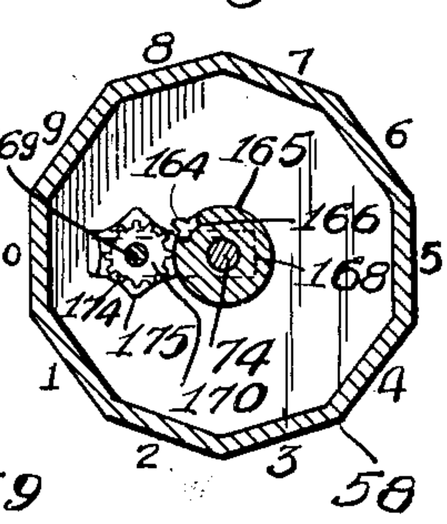


Fig. 27



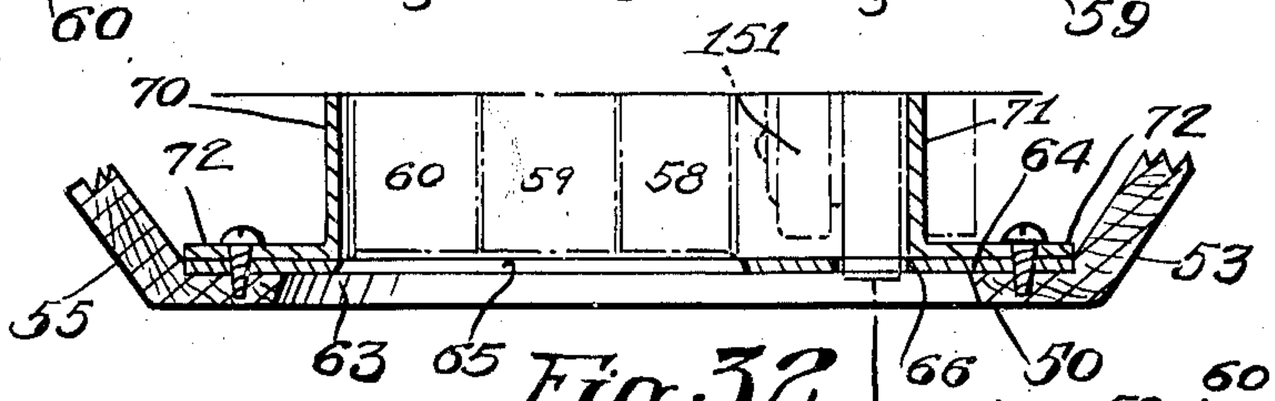


Fig. 32

Fig. 33.

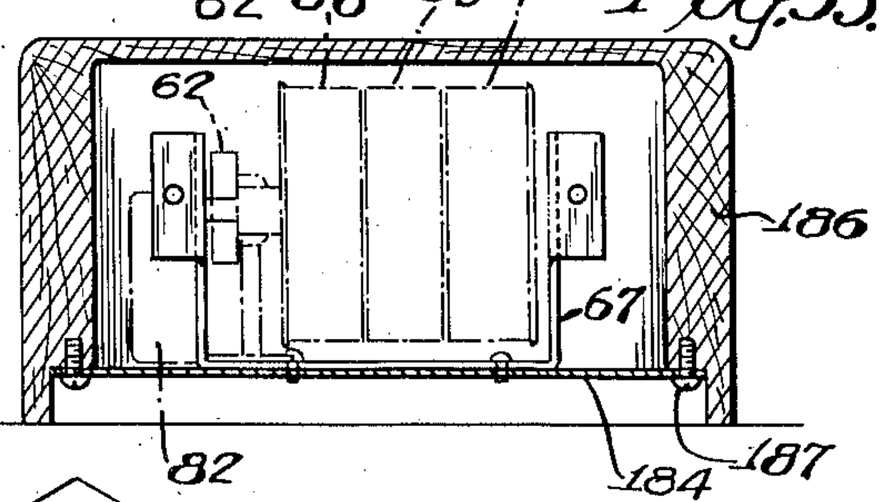


Fig. 31

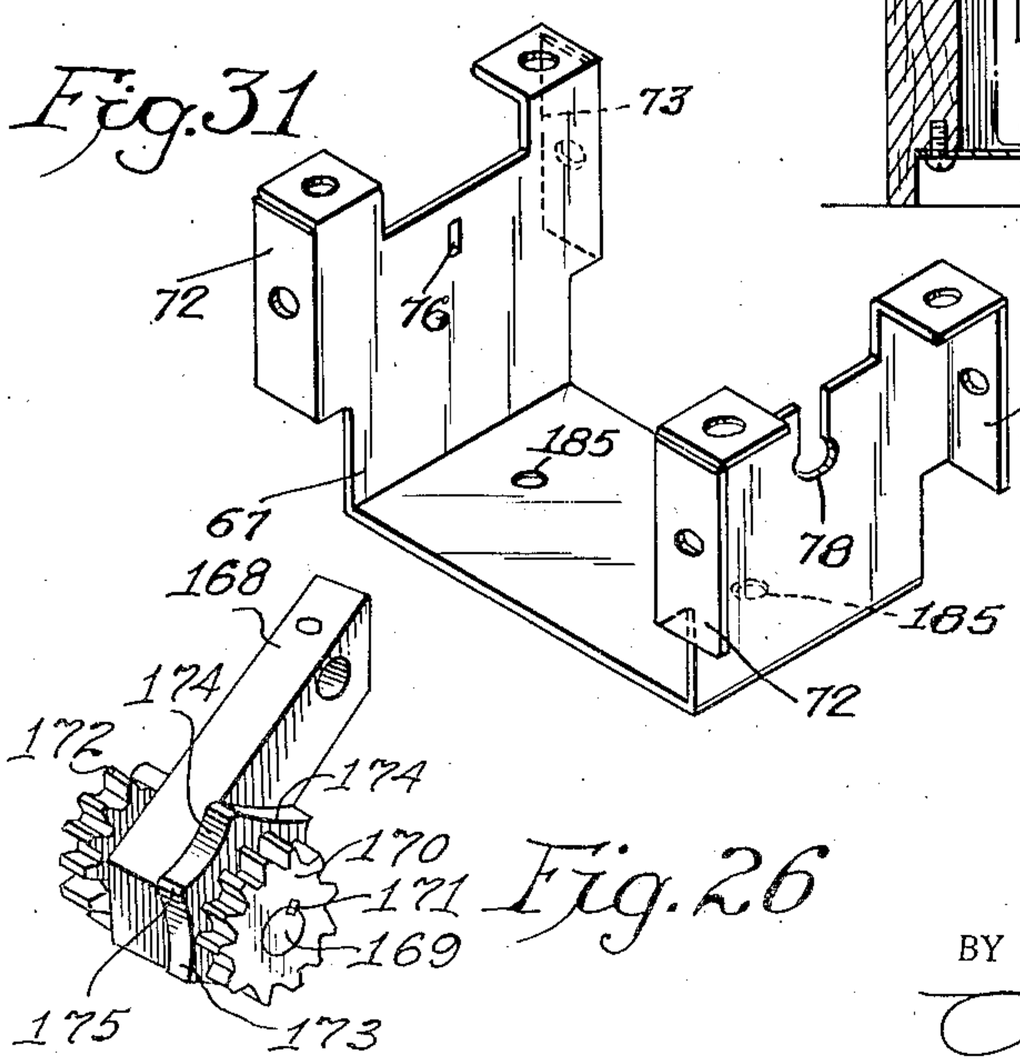


Fig. 26

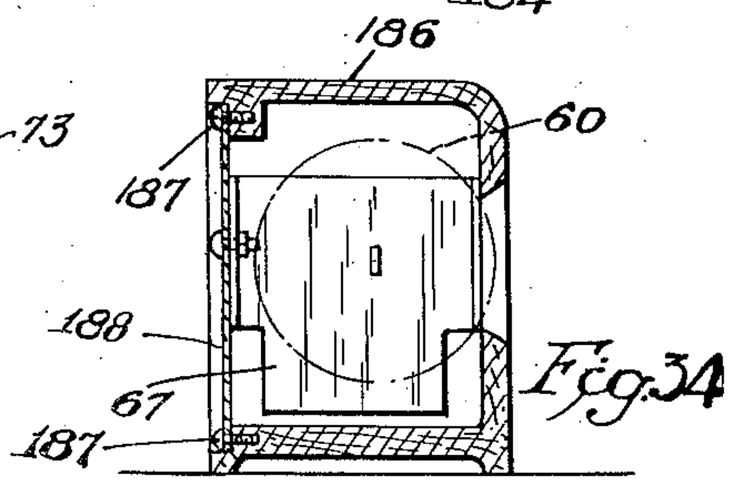


Fig. 34

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Patented Mar. 7, 1944 2,343,613

UNITED STATES PATENT OFFICE

2,343,613

CLOCK

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Application April 8, 1940, Serial No. 328,487

6 Claims. (Cl. 58—125)

The present invention relates to a certain new and useful "numeral clock."

One of the objects of the present invention is a numeral clock which will be more positive in action and less subject to disturbance by vibrations or accidental jarring, and which may be readily adjusted or "set" whenever necessary, and which may be manufactured and assembled readily and at low cost, and which may be conveniently installed in a casing or housing.

With the above and other objects in view, which will appear more fully from the following detailed description and accompanying drawings, the present invention consists of other novel phases and features of invention and also certain improved mechanisms and forms of construction, all of which will appear more fully in the following description:

For the purpose of illustrating the invention, there are shown in the accompanying drawings forms thereof which are at present preferred, since the same have been found in practice to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which the invention consists can be variously arranged and organized and that the invention is not limited to the precise arrangement and organization of the instrumentalities as herein shown and described.

In the accompanying drawings, in which like reference characters indicate like parts,

Figure 1 represents a perspective view of a clock embodying the present invention;

Figure 2 represents a perspective view of another clock embodying the present invention, showing a somewhat modified form of construction in one phase thereof;

Figure 3 represents a perspective view, viewed from the rear, of the internal construction of the clock, showing one embodiment of the present invention;

Figure 4 represents a section generally on line 4—4 of Figure 3;

Figure 5 represents a section similar to that shown in Figure 4, but showing the mechanism at a different point of its cycle of operation;

Figure 6 represents a side view on line 6—6 of Figure 3;

Figure 7 represents a fragmentary perspective view of the "seconds" indicating drum and the disconnectible escapement means intermediate the latter and the first "minute" indicating drum, with the mechanism shown in the disconnected or inoperative position;

Figure 8 represents a vertical section on line 8—8 of Figure 3;

Figure 9 represents a perspective view of the first "minute" drum;

Figure 10 represents a perspective view of the second "minute" drum, showing the side thereof which is adjacent the exposed side of the first "minute" drum shown in Figure 9;

Figure 11 represents another perspective view of the second "minute" drum, showing the opposite side thereof, which is adjacent the "hour" drum;

Figure 12 represents a perspective view of the "hour" drum showing the side thereof which adjoins the exposed side of the second "minute" drum shown in Figure 11;

Figure 13 represents a perspective view of one of the two similar transfer arms shown in Figures 10 and 11, namely, one intermediate the first "minute" drum and the second "minute" drum, which is shown in Figure 10, and the other intermediate the second "minute" drum and the "hour" drum which is shown in Figure 11;

Figures 14 to 17 inclusive represent similar cross-sectional views (on a somewhat smaller scale) on line 14—14, 15—15, 16—16, and 17—17, respectively, of Figure 8;

Figure 18 represents a generally horizontal cross-sectional view of a clock mechanism of a modified form of construction;

Figure 19 represents a top plan view of portions of the clock mechanism shown in Figure 18;

Figures 20 and 20a represent sections on line 20—20 of Figure 18;

Figure 21 represents a perspective view of the first "minute" drum of the form of construction shown in Figures 18 to 20 inclusive, showing the side thereof which receives the driving impulses from the "second" shaft;

Figure 22 represents another perspective view of the same first "minute" drum, but showing the opposite side thereof, namely the side which is adjacent to the second "minute" drum;

Figure 23 represents a perspective view of the second "minute" drum of the form of construction shown in Figures 18 to 20 inclusive, showing the side thereof which is adjacent to the side of the first "minute" drum exposed in Figure 22;

Figure 24 represents another perspective view of the second "minute" drum, showing the opposite side thereof, namely, the side which is adjacent to the "hour" drum;

Figure 25 represents a perspective view of the "hour" drum of the form of construction shown in Figures 18 to 20 inclusive, showing the side thereof which is adjacent to the second "minute" drum, namely, that side of the second "minute" drum which is exposed in Figure 24;

Figure 26 represents a perspective view of one of the two transfer arms and associated pinions and escapement wheels similar to that shown in Figure 24, one of which is intermediate the two sides of the first and second "minute" drums shown in Figures 22 and 23, and the other of which is intermediate the two sides of the second "minute" drum and "hour" drum shown in Figures 24 and 25;

Figures 27 to 30 inclusive represent cross-sectional views, on lines 27—27, 28—28, 29—29, and 30—30, respectively, of Figure 18;

Figure 31 represents a perspective view of a modified frame construction for the clock of the present invention;

Figure 32 represents a cross-sectional view, on line 32—32 of Figure 2;

Figure 33 represents a diagrammatic vertical cross-sectional view of a modified form of construction, wherein the drums and driving mechanism are mounted upon a bottom mounting plate which forms a bottom closure for the outer housing;

Figure 34 represents a diagrammatic vertical cross-sectional view (taken across the front and back of the clock) of a modified form of construction in which the drums and driving mechanism are supported upon a rear vertical mounting plate which constitutes a removable back panel of the clock.

Figure 35 represents a perspective view of the first "minute" drum shown in Figure 22 as it appears after the shaft 74 and the transfer arm 168 have been assembled with respect thereto.

The clock of the present invention includes a suitable housing having a front wall or panel 50 and having bottom and top walls or panels 51 and 52, respectively, and having side walls 53, 54, 55 and 56. The housing may be formed of wood or of a more plastic composition, or of any other suitable material, and may be either open in the back or closed in the back.

The front wall or panel 50 may be provided with a bezel opening 57, to expose to view one set of "minute" and "hour" numerals or one line of "minute" and "hour" numerals across the "minute" and "hour" drums 58, 59 and 60, and a separate bezel opening 61, to expose to view a substantial part of the periphery of the "second" drum 62. The edges of the openings 57 and 61 are preferably beveled to a comparatively thin inner edge, to give a bezel effect and so as to bring the innermost edges close to the plane or surface of the drums 58, 59, 60 and 62.

In the form of construction shown in Figure 2, a single opening 63 is provided in the front wall 50, for exposing both the "minute," "hour," and "second" drums, and a separate panel or bezel plate 64 is then placed behind the opening 63 to expose one line of numerals across the "minute" and "hour" drums 58, 59 and 60, and another opening 66, to expose the "second" drum 62. The bezel plate 64 is preferably of a material substantially thinner than the front panel 50 of the housing.

To the front wall 50 of the housing a frame 67 is secured by means of screws 68. The frame, in the form shown in Figures 3 to 8 inclusive, includes the base plate 69, side portions 70 and 71, and the anchorage flanges or lugs 72 and 73—the latter providing alternate means of securement or anchorage, as for instance, when it is desired to secure the frame 67 to the rear panel of the housing instead of to the front panel of the housing.

The side members 70 and 71 serve to support a main shaft 74 which, in the form of construction here shown, is stationary or non-revoluble. One end of the shaft is flattened as at 75 or provided with any other irregular formation, while the end frame member 70 is provided with a similar opening 76 therethrough, for receiving the end 75 and thereby both giving support to that end of the shaft 74 and also preventing its rotation relative to the frame 67.

The other side frame member 71 is provided with a vertical slot 77 of a width approximately the same as the diameter of the shaft 74 so that the shaft 74 can be lowered down through the slot 77. The bottom of the slot 77 is rounded and enlarged at 78 to a diameter larger than the diameter of the shaft 74, to an extent sufficient to permit the insertion of a retainer sleeve or bushing 79 between the edge of the enlarged portions 78 and the end 80 of the shaft 74 so as to prevent the shaft 74 from thereafter passing upwardly through the slot 77. The sleeve or bushing 79 has a slight flange 81 which overlaps the marginal zone of the enlarged portion 78 of the slot and is in turn overlapped by and held in place by the housing of the motor 82 which is superimposed thereon and held in place by the screws 83 and 84 which secure the motor 82 to the side frame member 71. The motor 82 may be any conventional synchronous electric motor, preferably with a geared delivery shaft 85 extending from a gear housing 86 and having a speed of one revolution per minute. An opening is provided through the side frame member 71 for permitting the delivery shaft 85 of the motor 82 to pass through the side frame member.

The details of the motor 82 and of the gearing contained in the adjoining gear housing 86 are not shown in detail because such motor with the geared delivery shaft may be of any conventional form of construction, as for instance, that shown in Patents Nos. 1,936,208, 1,996,375, 2,049,261, 1,977,184, 1,977,185 and 1,977,186.

In the form of construction shown in Figures 3 to 8 inclusive, a seconds drum 62 carrying (and preferably, although not necessarily, formed integrally therewith) an escapement cam 89 having a generally cylindrical periphery 90 except for the recess 91 therein. The seconds drum 62 and escapement cam 89 may be detachably secured to the geared motor shaft 85 by any suitable keying means, as for instance, the tapered pin 88 extending through the cam 89 and shaft 85.

The seconds drum 62 also carries a single tooth 92 in operative alignment with a ten-toothed pinion 93 formed integrally with or otherwise fixedly associated with the first "minute" drum 58 as shown particularly in Figures 3, 4, 5, 7 and 8. The ten-toothed pinion 93 is of such axial extent as to extend substantially beyond the tooth 92 in an axial direction and the extended portion thereof is in alignment with the escapement cam 89 carried by the seconds drum 62.

Intermediate the ten-toothed pinion 93 and the escapement cam 89, an oscillating locking lever 94 is provided, preferably pivoted at its lower end

about a pivot pin 95, carried by journal flanges 96 and 97 carried by the base plate 69 or preferably carried by a pivoted gate plate 98 secured to the base plate about and by a pivot screw 99, so as to permit the lever 94 to be swung out into an inoperative position shown in Figure 7. The pivoted plate 98 also serves as a cover or gate over a "re-set" opening 100 in the base plate 69 through which the knurled rim or flange 101 may be reached for "setting" or "re-setting" the clock. An arcuate slot 102 may also be provided in the base plate 69 about the pivot screw 99 as a center, adapted to receive a downwardly projecting finger or knob 103 which may be struck or formed from the hinged gate plate 98 to serve as a means for gripping and engaging the gate plate 98 from beneath the base plate 69 and which also serves to limit the swinging motion of the gate by the limits of the slot 102, through which the knob 103 extends and in which the knob 103 is adapted to ride. A similar projection 104 may also be extended upwardly from the gate plate 98 in a similar manner, to act as a spring anchorage for receiving one end of the helical tension spring 105, the other end of which is secured in a hole or other anchorage means 106 in the side frame member 71, thereby normally retaining the gate 98 in a closed position and retaining the escapement lever 94 in its operative position intermediate the ten-toothed pinion 93 and the escapement cam 89 as shown in Figures 3, 4, 5 and 8 (as distinguished from its inoperative position shown in Figure 7). The escapement lever 94 carries a pair of juxtaposed detents 107 and 108. The detent 107 is adapted to ride on the cylindrical surface 90 of the escapement cam 89 for more or less approximately nineteen-twentieths (19/20) of every minute, thereby positively to retain the other detent 108 in locking position between two consecutive teeth of the ten-toothed pinion 93 in the manner shown in Figure 4, and then to enter the recess 91 in the escapement cam 89 for more or less approximately a twentieth (1/20) of a minute and thereby to recede from the ten-toothed pinion 93 in timed relation to the engagement of one of the teeth of said pinion by the single tooth 92 carried by the seconds drum 62.

The effective distance of the tooth 92 from the axis of its rotation is twice the radius of the pinion 93, so that the tooth 92 displaces the engaged tooth of the pinion 93 in a ratio of 2 to 1. Thus, during the short interval the tooth 92 is in engagement with one of the teeth of the pinion 93, the pinion 93 is rotated to an arcuate extent twice as great as the arcuate extent of the rotation of the seconds drum 62 during the interval of engagement between tooth 92 and pinion-tooth 93. The parts are so arranged or proportioned that the tooth 92 will be in engagement with a tooth of pinion 93 for only one-twentieth (1/20) of a minute or less, thereby imparting to the pinion 93 about a tenth of a revolution, while the tooth 92 is in engagement about a twentieth of a revolution. If the rotation imparted to the pinion 93 is less than one-tenth of a revolution then the balance of that one-tenth of a revolution is completed by the detent 108 as it is again projected between two teeth of the pinion 93 by a cylindrical dwell 90 of the escapement cam 89. However, whether the entire one-tenth of a revolution of pinion 92 and unit minute drum 58 is derived entirely from contact with the tooth 92 or whether it is derived in part, or completed in part, by the detent 103, the tenth-revolution motions of the pinion 93 and drum 58 are accomplished in one-twentieth of a minute or in more or less approximately 3 seconds.

The single tooth 92 is preferably placed more or less diametrically opposite to the sixty-second mark or perhaps the fifty five-second mark or the five-second mark appearing on the periphery of the seconds drum 62 (see Figures 1 and 2) so that when the seconds drum has its sixty second or zero point exposed, the first minute drum 58 will be turned one-tenth of a revolution so as to bring into view the next succeeding numeral thereon—the seconds drum 62 moving in the direction of the arrow 109 while the first minute drum 58 (as well as the second minute drum 59 and hour drum 60) moves in the direction of the arrow 110.

Figure 5 shows the position of the parts as the detent lever 94 has been retracted from the pinion 93 and as the single tooth 92 has almost completed moving the one tooth 93–*a* in the direction of the arrow 110 and as the escapement cam 89 is about to force the detent 107 out of the recess 91 thereof and to force the detent 108 in between the next two teeth 93–*b* and 93–*c*, thereby again positively to lock the first minute drum 58 in its next position with the next face or numeral area 58–*a* exposed through the bezel opening 57 or through the opening 65 (Figures 1 and 2, respectively) in the manner shown in Figure 4. This cycle of steps is then repeated with each revolution of the seconds drum 62—the seconds drum 62 continuously revolving while the first minute drum or unit-minute drum 58, which remains stationary for the major portion of each revolution of the seconds drum 62, is rotated a tenth of a revolution during approximately a twentieth (1/20) of a minute, namely, while the sixty second position of the drum 62 is being exposed through the openings 61 or 66 as indicated particularly in Figure 2.

As shown particularly in Figures 4, 5 and 7, the single tooth 92 is off-set from the center or deepest portion of the recess 91 toward the "leading" side thereof. That is, the tooth 92 is so positioned with respect to the recess 91 that during rotation of the seconds drum 62 and the cam 89, the tooth 92 will approach the pinion 93 simultaneously with the leading edge of the recess 91. In this way, the tooth 92 will enter the space between the teeth 93–*a* and 93–*b* just as the leading edge of the recess 91 comes in alignment with the detent 107. At this point (which would be the phase just before that shown in Figure 5) the tooth 93–*a* would be held against upward movement by the detent 108. However, as the tooth 92 would move upward, the deepest portion of the recess 91 would be opposite the detent 107 so that said detent 107 would be moved into the recess 91. Thus detent 108 would unlock the pinion 93 and permit the tooth 92 to move the tooth 93–*b* upward past the detent 108 (as shown in Figure 5) before the detent 108 would be forced back into the locking position shown in Figure 4 by the trailing edge of the recess 91. It can therefore be seen that it is necessary to off-set the detent 92 toward the leading edge of the recess 91 in order that the tooth 92 clear the pinion 93 before the detent 108 is forced back into locking position. If the tooth 92 were placed opposite the center of the recess 91 or were off-set toward the trailing edge of the recess 91, the detents 107 and 108 would be in the unlocking position at the moment when the tooth 92 entered the recess between the teeth

93–*a* and 93–*b* and said detents 107 and 108 would be forced back into locking position (by the trailing edge of the recess 91) blocking tooth 93–*b* before the tooth 92 cleared the tooth 93–*a* Thus, the entire mechanism would jam since the tooth 92 (and therefore the seconds drum 62 and the motor) would be locked in the pinion 93 by the detent 107. This can readily be demonstrated by attempting to reverse the rotation of the drum 62 shown in Figure 5 to a counter-clockwise direction which would have the effect of placing the tooth 92 off-set toward the trailing edge of the recess 91. If it were attempted to rotate the drum 62 counter-clockwise from the position shown in Figure 5 it can be seen that, although the tooth 92 is starting through its arc of engagement with the pinion 93 the detent member has already reached the deepest portion of the recess 91. If the tooth 92 were now to be moved counter-clockwise an additional distance corresponding to the movement of one tooth 93–*b* past the detent 107, said detent 107 would come in contact with the trailing upper edge of the recess 91 and would be forced into locking position with the tooth 93–*a* before the tooth 92 would reach its clearing position with respect to the tooth 93–*b*. Thus it can be seen that the embodiment shown in Figures 3 to 7 cannot be reversed to make the drums move downward instead of upward without changing the position of the tooth 92 to make it off-set toward the leading edge of the recess 91.

According to the present invention, fully concealed transfer means are operatively disposed within and between each pair of adjacent drums, namely, one transfer means between the first minute drum 58 and the second minute drum 59, and another transfer means between the second minute drum 59 and the hour drum 60.

In order to understand the transfer means and the operation of the several drums 58, 59 and 60, it should be remembered that the shaft 74 is stationary or non-revoluble while each of the drums 58, 59 and 60 are freely revoluble thereon except as they may be locked in predetermined positions corresponding to their face positions or their time numerals by the locking means hereinbelow described.

The side of the first minute drum 58 which is adjacent to the second minute drum 59 (exposed in Figure 9), is recessed, dished out or hollowed as at 111 and the juxtaposed side of the second minute drum 59 (exposed in Figure 10) is similarly dished out or hollowed as at 112, and in the contiguous spaces 111 and 112 so provided, a transfer arm 113 is fixedly mounted on the shaft 74 in any desired position, as for instance, the upright position as shown in Figure 10, or it may be in a horizontal position or in any other position. The transfer arm 113 may be keyed or affixed to the shaft 74 by a taper pin 114 extending therethrough and through the shaft or by any other suitable means. Thus, for instance, the shaft 74 may be made square or of other non-circular cross-section (instead of round), and the hole 115 in the transfer arm 113 would then be similarly square or non-circular snugly to receive the shaft 74. In this event, the drums 58, 59 and 60 may be journalled on corresponding thin sleeves or bushings having square or other non-circular center holes through which the shaft 74 would then pass, with outer cylindrical peripheries which would freely fit within the holes 116 in the drums 58, 59 and 60. If desired, however, the shaft 74 may merely have one or more "flats" formed on it for interlockingly engaging the transfer arms in a non-rotational relationship, but over which the drums may still revolve. If desired, the shaft 74 may be more or less square, but with corners rounded to a substantial extent and formed as parts of a cylinder around which the journal sleeves or bushings may be placed with cylindrical holes riding on the cylindrical edge portions of the shaft.

In the form of construction shown in Figures 8 to 17 inclusive, the transfer arm 113 is bifurcated as at 117 and 118 and between the bifurcated ends 117 and 118 an idler transfer pinion 119 is pivotally mounted upon a pivot pin 120 whose teeth are of an axial width sufficiently great to overlap (internally) both drums 58 and 59, as will be seen particularly from Figure 8.

The pinion also has formed integrally therewith or otherwise affixed thereto a plurality of locking and escapement detents 121, which, in the particular form shown, are in line with every fourth tooth of the pinion 119—the three locking and escapement detents 121 being related to each other as three points of an equilateral triangle, as will be seen in Figure 14 (and also Figure 16).

A continuous internal gear 122 is provided in the transfer-receiving side of the second minute drum 59, with which one-half of the pinion 119 is constantly in mesh as shown in Figure 10 and as also shown in Figures 8 and 15. An interrupted or fragmentary internal gear 123 containing but two teeth is provided on the inside of the transfer-delivery side of the first minute drum 58 as shown in Figure 9 which is adapted to make a limited engagement with the pinion 119 during each revolution of the first minute drum 58, thereby transferring that part of its motion (during such limited engagement) to the second minute drum 59 shown in Figure 10 and also shown in Figure 8, the gear ratios being such that the motion imparted to the pinion 119 by the interrupted or fragmentary gear 123 will rotate the second minute drum 59 one-twelfth of a revolution.

Thus, the first minute has ten numeral-bearing faces or areas bearing numbers from zero to 9 inclusive, as indicated in Figures 3, 9 and 14, while the second minute drum 59 has twelve numeral-bearing faces or areas bearing two sets of numbers each running from zero to 5, both inclusive, as shown particularly in Figures 3, 10, 11, 15 and 16.

Adjacent the fragmentary or interrupted internal gear 123 is a generally annular internal surface 124 having but a single recess 125 therein formed in direct continuation of the space 126 between the two internal gear teeth 123, said recess 125 being adapted to receive one of the locking and escapement detents 121 during the interval of engagement between the fragmentary internal gear 123 and the pinion 119 so as to permit the rotation of said pinion 119 while otherwise two of the locking and escapement detents 121 ride on the annular surface 124 and thus lock the pinion 119 against rotation in the manner indicated in Figure 14.

Thus, throughout about eleven-twelfths ($\frac{11}{12}$) of the rotation of the first minute drum 58, the pinion 119 is locked against rotation by a pair of the detents 121 riding on the internal annular locking surface 124, thereby positively locking the second minute drum against all rotation. Only during about a twelfth ($\frac{1}{12}$) of a revolution of the

first minute drum 58 or unit minute drum 58 (namely, during the interval when the interrupted or fragmentary internal gear 123 is in engagement with the pinion and the recess 125 receives one of the detents 121) is the pinion 119 unlocked so that it may then be positively driven in predetermined ratio by the fragmentary internal gear 123—the circumferential spacing of the internal gear teeth 123 being about the same as circumferential spacing of the teeth of the internal gear 122 so that a twelfth ($\frac{1}{12}$) of a revolution of the first minute drum 58 (during the interval of the cyclic engagement between the interrupted internal gear 123 and the pinion 119) will cause a twelfth of a revolution of the second minute drum or tens minute drum 59.

Thus, as a result of the final 36 degrees turn of the first minute drum 58, the second minute drum or the tens minute drum 59 turns 30 degrees. The fragmentary internal gear teeth 123 are so disposed or spaced in relation to the zero position or zero face of the unit minute drum 58, that the 36 degree motion of the drum 58 which would bring the zero face thereof into view, is initiated approximately 6 degrees ahead of the engagement of the teeth 123 with the transfer pinion 119. This permits the first minute drum 58 to be set into motion and thus to acquire some momentum before the second minute drum 59 is contacted and set into motion—thereby imposing a lesser torque load on the driving motor 82.

The transfer-delivery side of the second minute drum 59 shown in Figure 11 is likewise dished or recessed as at 127 while the transfer-receiving side of the hour drum 60 shown in Figure 12 is likewise dished or recessed as at 128 to receive a similar transfer arm 129 having bifurcated ends 130 and 131 secured to the shaft 74 by the pin 132 and carrying a similar transfer pinion 133 and locking and escapement detents 134. The transfer-delivery side of the second minute drum 59 is provided with an interrupted or fragmentary internal gear 135 similar to the internal gear 123 except that it contains two fragments of gear teeth 135–*a* and 135–*b* at diametrically opposite points. The transfer-delivery side of the second minute drum 59 is provided with a generally annular internal surface 136 similar to the surface 124 in the transfer-delivery side of the first minute drum 58 wherein two diametrically opposed escapement recesses 137–*a* and 137–*b* are provided in continuation of the spaces 138–*a* and 138–*b* between the pairs of teeth 135–*a* and 135–*b*, respectively so that the transfer pinion 133 will be actuated twice during each revolution of the second minute drum 59, and during approximately one-twelfth of a revolution thereof. The receiving side of the hour drum 60 shown in Figure 12 is dished out to form the opening 128 and is provided with an internal gear 139, similar to gear 122 of the drum 59, but whose teeth have a circumferential spacing equal to the circumferential spacing of the teeth 135–*a* and 135–*b*, so that a twelfth of a revolution of the second minute drum 59 (during either one of its two intervals of engagement with the transfer pinion 133) will impart a rotation to the hour drum 60 of a twelfth of a revolution thereby moving the hour drum 60 the distance of one of its numeral faces or zones—the hour drum 60 having twelve numeral faces or zones numbered from 1 to 12 inclusive.

In this manner, it will be seen that each of the minute drums 58 and 59 and the hour drum 60 will remain positively locked except during the interval when the numeral-bearing faces or zones thereof are changed.

In Figures 18 to 30 inclusive, I have shown a modified form of construction wherein the impulse-receiving side of the first minute drum 58, shown in Figures 20 and 21, is provided with a pinion 145 similar to the pinion 93 but of a lesser axial dimension. Adjacent the pinion 145 and also preferably formed integrally therewith or in fixed relation thereto is a detent wheel 146 having ten similar shallow arcuate recesses 147 therein, corresponding to the ten teeth of the pinion 145, and having ten corresponding tooth-like projections or ridges 148 intermediate the recesses. The seconds drum 149 in this form of construction is likewise secured directly to the geared motor shaft 85, by means of a pin 88 or by any other suitable keying means (as for instance, by making the end of the shaft 85 square or flat on one side and correspondingly shaping the shaft-receiving hole in the drum 149). The seconds drum 149 is provided with a hub 150 having preferably a square or other equivalent external shape, over which a generally annular escapement locking member 151 is adapted to slide—the hole 152 being likewise square or of a shape corresponding to the exterior of the hub 150, so as to cause the member 151 always to rotate in unison with the second drum 149, but so as to permit it to slide axially in relation thereto for a limited distance. A helical compression spring 153 is inserted into the hollow opening 152 and into the end of the hub 150, tending to urge the escapement locking member 151 into its outer position, namely, into its engagement position in relation to the detent wheel 146 as shown particularly in Figure 18. The detent locking member 151 has a generally cylindrical circumference 253, but rounded at the peripheral corner 154 and the diameter of the periphery 253, is such as to fit within any of the recesses 147 of the wheel 146, and to lock said wheel 146 against rotation when the cylindrical portion 253 of the member 151 is within one of the recesses 147.

The member 151 is also provided with an escapement recess 155 of a depth and length sufficient to permit the passage therethrough of any of the points or ridges 148 of the escapement wheel 146, and is so positioned in relation to the single tooth 92 carried by the seconds drum 149, that it will permit the turning of the first minute drum 58 just one-tenth of a revolution with each engagement during each passage of the tooth 92 and thereafter lock the drum in the manner shown in Figure 20*a*.

In the embodiment shown in Figures 20 and 20*a* the single tooth 92 carried by the seconds drum 149 is placed opposite the central portion of the recess 155. Thus, as the drum 149 rotates, one of the projections 148 moves into unlocking position within the recess 155 before engagement of said tooth 92 with one of the teeth of the pinion 145—said projection 148 remaining in unlocking position within the recess 155 until the tooth 92 has completed its engagement with one tooth of the pinion 145 and has turned said pinion 145 through one-tenth of a revolution. Therefore, it can be seen that, in the embodiment shown in Figures 20 and 20*a* the drums can be rotated equally well either clockwise or counter-clockwise without any modification of the construction (as distinguished from the embodiment shown in Figures 4, 5 and

7 in which said reversal of rotation is not possible).

In order to permit the "setting" of the clock, a shifting arm 156 is rigidly carried by the gate plate 98 and extends up to the central knob 157 of the spring-pressed detent locking element 151, so that when the gate plate 98 is swung into the open position shown in Figure 19, the detent locking element 151 is moved axially in the direction of the arrow 158 and shifted out of engagement with the detent wheel 146, thereby permitting the latter as well as the first minute drum 58 (and hence, also the second minute drum 59 and hour drum 60) to be rotated in either direction by engagement of the flange 101 thereof through the opening 100.

In the form of construction shown in Figures 18 to 30 inclusive, the continuous and fragmentary gears as well as the annular locking surfaces are made of an external form on the hub portions 160, 161, 162 and 163 (instead of being of the internal form shown in Figures 8 to 17 inclusive).

Thus, the hub 160 carries a single-toothed external gear 164 and an external annular locking surface 165 adjacent thereto of the root diameter (or smaller or larger than the root diameter) of the gear tooth 164, in which latter surface a single escapement recess 166 is provided.

The transfer-receiving side of the second minute drum 59 (shown in Figure 23) is in turn provided with a continuous external gear 167 on the hub 161 thereof.

The transfer arm 168 shown in Figure 26 is similarly fastened to the shaft 74 as illustrated in Figure 35 but is here shown in the horizontal position instead of the vertical position as in the modification first hereinabove discussed. The transfer arm 168 has journalled in it a pinion shaft 169 to one end of which the transfer-receiving pinion 170 is keyed by means of the key 171 or any other suitable keying means, and to the other end of which a transfer delivery pinion 172 is similarly secured. Intermediate the pinion 170 and the transfer arm 168, an escapement locking member or wheel 173 is provided either integrally with the pinion 170 or otherwise fixedly related thereto so as to revolve with it at all times.

The escapement wheel 173 is provided with a series of arcuate or cylindrical recesses 174 of a curvature corresponding generally to the curvature of the cylindrical locking surface 165 and with intermediate points or ridges 175. The transfer-receiving pinion 170 is in operative alignment with the single-toothed external gear 164, while the escapement locking wheel 173 is in operative alignment with the locking surface 165.

As the tooth 164 moves around the circle, it engages one of the teeth of the transfer-receiving pinion 170 and moves said pinion a sixth of a revolution (the pinion 170 having twelve or six teeth and the escapement-locking wheel having six recesses 174 and six ridges 175). As the tooth 164 begins to engage one of the teeth of the transfer-receiving pinion 170, the corresponding point or ridge 175 enters the recess 166 and passes through the recess and comes out of the other side as the tooth 164 passes between the adjoining teeth of the pinion 170 and leaves them, thereby bringing the next adjacent recess 174 into sliding contact with the locking surface 165. The transfer-delivery pinion 172 has one-half the number of teeth of the gear 167 in the transfer-receiving side of the second minute drum 59 (shown in Figure 23) so that a sixth of a revolution of the pinion 172 will cause a twelfth of a revolution of the second minute drum 59. Another transfer arm 168–*a* identical with the transfer arm 168 shown in Figures 26 and 35 is provided intermediate the second minute drum 59 and hour drum 60 in a similar manner as shown in Figure 24, but the hub portion 162 on the transfer-delivery side of the second minute drum (shown particularly in Figure 24) has two diametrically opposite teeth 177–*a* and 177–*b*, so that motion will be transferred from the second minute drum 59 to the hour drum 60 twice during each revolution of the second minute drum 59.

The external cylindrical locking surface 178 on the hub 162 is similar to the locking surface 165 and is provided with two similar escapement recesses 179–*a* and 179–*b* corresponding to the teeth 177–*a* and 177–*b*. The transfer-arm 168–*a* carries a transfer-receiving pinion 180 similar to the transfer-receiving pinion 170 and a transfer-delivery pinion 181 similar to the pinion 172 and an escapement wheel 182 similar to the escapement wheel 174, all in the manner shown in Figure 18. The transfer-delivery pinion 181 is in mesh with the continuous gear 133 on the hub portion 163 of the hour drum 60.

The drums 58, 59 and 60 may either have a generally polygonal periphery, as indicated in Figures 14 to 17 inclusive, and in Figures 27 to 30 inclusive, with a successive series of flat numeral bearing faces, or they may be with a round periphery, with the time-telling numerals arranged in the same sequence as indicated in Figures 14 to 17 inclusive and in Figures 27 to 30 inclusive, and in the same relative positions along the periphery.

The drums 58, 59 and 60, whether of the form of construction shown in Figures 10 to 12 and 14 to 17 inclusive, or whether of the form of construction shown in Figures 21 to 25 and 27 to 30 inclusive, and preferably also the drum 62, are molded or cast, preferably under pressure, from a suitable metallic or non-metallic composition. I prefer to make the drums, particularly the drums 58, 59 and 60, of a relatively light-weight or low specific gravity organic molding composition, such as synthetic resins and similar synthetic organic molding compositions, in order to reduce the weight of the drums and thus to minimize the power required for starting them into motion at each of the time-changing points in the cycle of operation of the clock. Likewise, the walls of the drums are preferably made thin, particularly as illustrated in Figures 21 to 30 inclusive. The central web which supports the periphery of the drum may likewise be perforated so as further to reduce the weight. The wall thicknesses of the drums shown in Figures 14 to 17 inclusive may, in actual practice, be considerably less than the wall thicknesses indicated in Figures 14 to 17 inclusive.

The time-telling numerals may be raised from the numeral bearing surfaces, or may be depressed into the numeral bearing surfaces, or they may be applied merely with a contrasting color.

The motor 32, while preferably a synchronous electric motor, may also be a spring motor, either hand wound or wound periodically by an electric motor drive whenever the tension of the spring motor is reduced or whenever the spring unwinds to a predetermined extent. If a spring motor is

used the spring motor is of any suitable constant-speed form.

The frame **67**, or the universal frame shown in Figure 31, may be either formed of sheet metal as indicated in the drawings, or it may be die-cast under pressure, of any suitable casting material, such as die casting alloys, or it may also be made of organic molding compositions. The frame or housing **67** may be mounted directly to one of the walls of the outer casing, as for instance, the wall **50**, or it may be mounted upon a mounting plate **184** by fastening means going through the holes **185**, and the mounting plate may in turn be mounted to the back of the casing **186**, by screw fastening means **187**. Instead of having a mounting plate act as a base or bottom closure for the casing as in Figure 33, the mounting plate may serve as a rear wall or closure panel of the case, as indicated in Figure 34—the frame **67** being there fastened to the rear mounting plate **188**.

By being free of spring retainers or spring tensioned detents to retain the drums against rotation during the stationary phases of their cycle, the power required to drive the clock is reduced so as to permit the use of a comparatively lower powered electric motor.

In the preferred form of construction the exposed faces of the drums **58**, **59** and **60** move upwardly while the drums change from one position to another. In the first form of construction shown in the drawings and hereinabove described the motion of the drums are limited to such upward motion because of the relative position of the tooth **92** and the recess **91**, while in the second form of construction the motion may be reversed by reversing the motor, although, as stated, in the preferred embodiment of the invention the drive is so related to the drums **58**, **59** and **60**, that the exposed numerals move upwardly.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

Having thus described the invention, what is hereby claimed as new and desired to be secured by Letters Patent is:

1. A clock including a motor, a plurality of drums, means intermediate said motor and one of said drums for positively and intermittently driving said drum one tenth of a revolution at minute intervals and for retaining said drum locked against rotation for the major part of each minute, said driving and retaining means including a detent member and a rotary locking escapement member, and manually operable means for disengaging said driving means by moving said detent member out of alignment with said rotary locking escapement member for permitting the setting of said drums.

2. A clock including a motor, a plurality of drums, means intermediate said motor and one of said drums for positively and intermittently driving said drum one tenth of a revolution at minute intervals and for retaining said drum locked against rotation for the major part of each minute, said driving and retaining means including a detent member and a rotary locking escapement member, and manually operable spring tensioned means for disengaging said driving means by moving said detent member out of alignment with said rotary locking escapement member for permitting the setting of said drums, said last named means being normally spring urged into its operative and engaging position and automatically returning to its operative and engaging position when not manually influenced.

3. A clock including a frame, a motor carried by said frame, a unit minute drum, a tens minute drum and an hour drum carried by said frame, means intermediate said motor and said unit minute drum for intermittently driving said drum one tenth of a revolution at minute intervals, said driving means including a detent member and a rotary locking escapement member, means intermediate said unit minute drum and said tens minute drum for intermittently driving the latter at ten minute intervals, means intermediate said tens minute drum and said hour drum for intermittently driving the latter at hour intervals, and an opening through said frame for affording manual access to said unit minute drum whereby said detent member can be moved out of alignment with said rotary locking escapement member to permit the setting of the said unit minute drum.

4. A clock including a frame, a motor carried by said frame, a unit minute drum, a tens minute drum and an hour drum carried by said frame, means including a detent member and a rotary locking escapement member intermediate said motor and said unit minute drum for intermittently driving said drum one tenth of a revolution at minute intervals, means intermediate said unit minute drum and said tens minute drum for intermittently driving the latter at ten minute intervals, means intermediate said tens minute drum and said hour drum for intermittently driving the latter at hour intervals, an opening through said frame for affording manual access to said unit minute drum for setting the latter, and manually operable means for disconnecting said driving means between motor and unit minute drum by moving said detent member out of alignment with said rotary locking escapement member to permit the setting of said unit minute drum.

5. A clock including a frame, a motor carried by said frame, a unit minute drum, a tens minute drum and an hour drum carried by said frame, means intermediate said motor and said unit minute drum for intermittently driving said drum one tenth of a revolution at minute intervals, means intermediate said unit minute drum and said tens minute drum for intermittently driving the latter at ten minute intervals, means intermediate said tens minute drum and said hour drum for intermittently driving the latter at hour intervals, an opening through said frame for affording manual access to said unit minute drum for the setting of the latter, a normally closed closure member in operative juxtaposition to said opening in said frame capable of being manually opened, and means carried by said closure member for disengaging said driving means intermediate said motor and said unit minute drum when the closure member is placed into its open position.

6. A clock including a motor, having a driving shaft adapted to revolve at a speed of one revolution a minute, a seconds indicating drum directly driven by said motor drive shaft, a unit minute drum, a tens minute drum driven by said unit minute drum, an hour drum, means for driving said hour drum intermittently from

said tens minute drum, a drive-receiving gear operatively connected with said unit minute drum, an interrupted gear carried by said motor drive shaft in operative alignment with said drive-receiving gear of the unit minute drum for operatively engaging the latter at minute intervals and for driving the latter more or less approximately one tenth of a revolution during not substantially more than one twentieth of a minute, a locking wheel carried by said unit minute drum in operative juxtaposition to the drive-receiving gear thereof, a rotary locking escapement member carried by said motor drive shaft in operative juxtaposition to said interrupted gear, for locking the unit minute drum during the non-driven portions of each minute, and manually operable means for rendering said rotary locking escapement member inoperative so as to permit the free rotation of said unit minute drum independently thereof, said manually operable means including a detent intermediate said locking wheel on said unit minute drum and said rotary locking escapement member, said detent being manually movable out of operative alignment with said locking wheel and said rotary locking escapement member.

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