March 29, 1938. E. D. MEAD 2,112,375

TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 1

FIG. 1

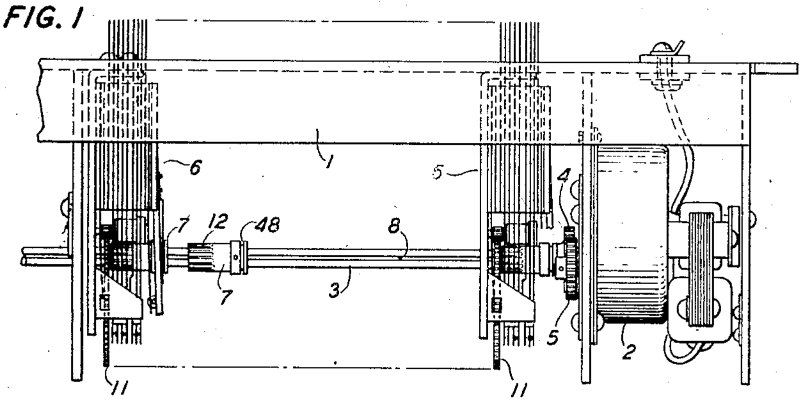


FIG. 2

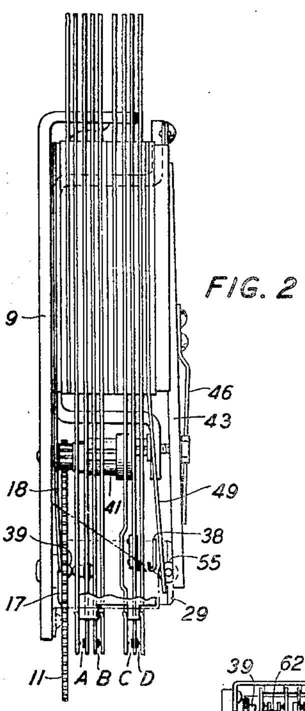


FIG. 3

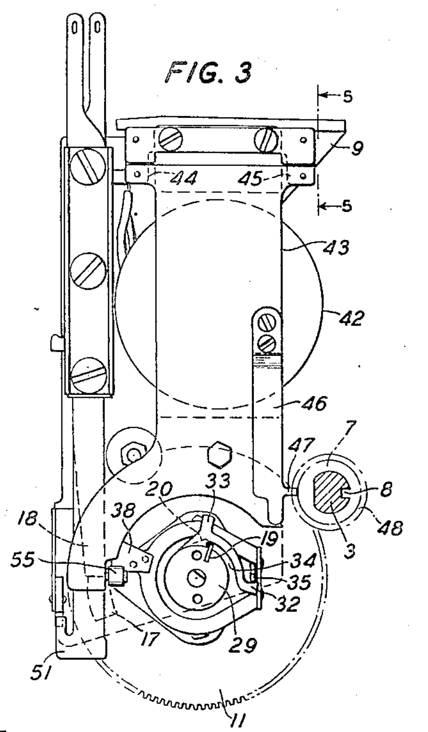


FIG. 4

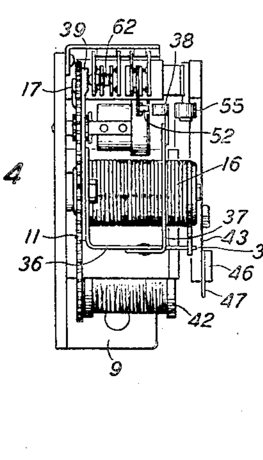
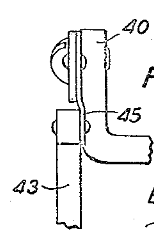


FIG. 5



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March 29, 1938. E. D. MEAD 2,112,375

TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 2

FIG. 6

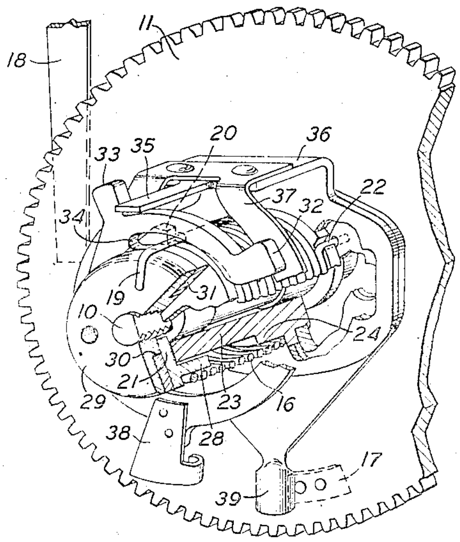


FIG. 7

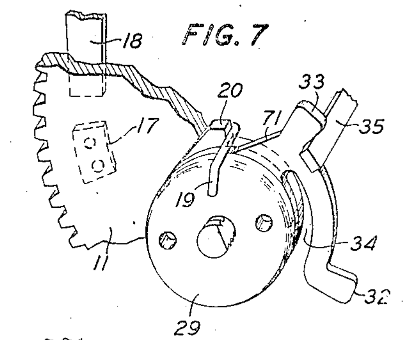


FIG. 8

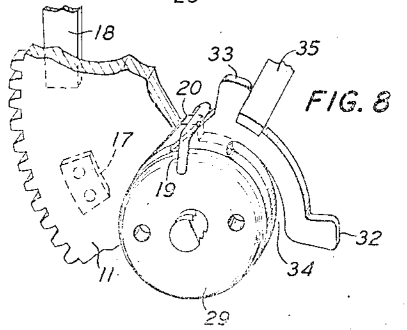
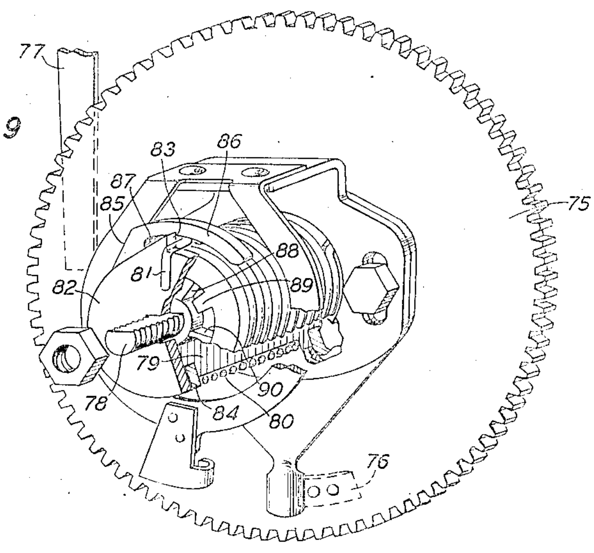


FIG. 9



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March 29, 1938.

E. D. MEAD

2,112,375

TIMING MECHANISM

Filed March 10, 1936

8 Sheets-Sheet 3

FIG. 10

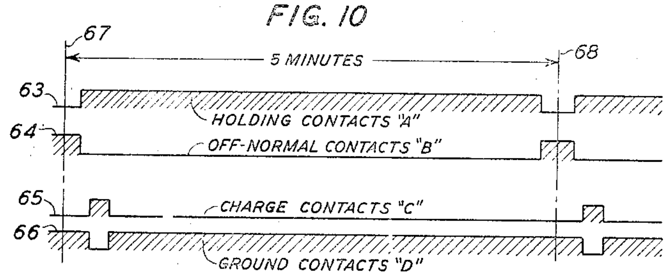


FIG. 11

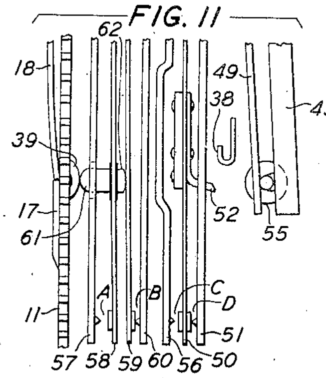


FIG. 12

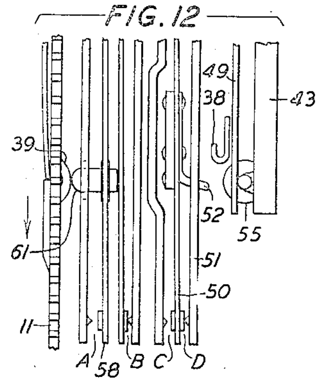


FIG. 13

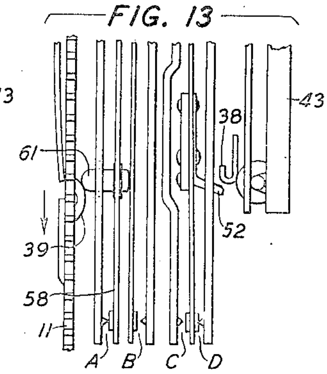


FIG. 14

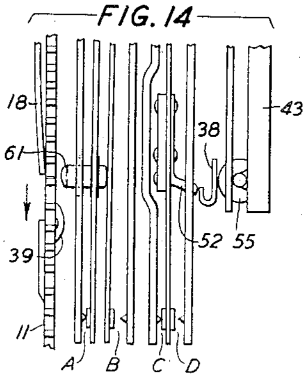


FIG. 15

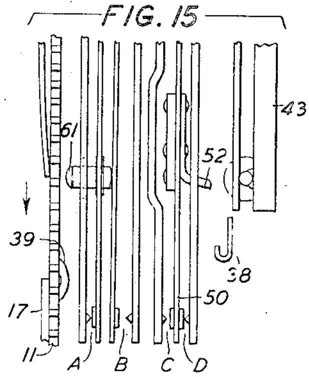
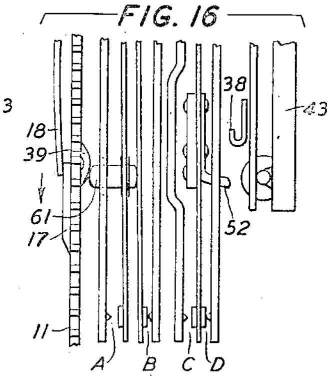


FIG. 16



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TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 4

FIG. 17

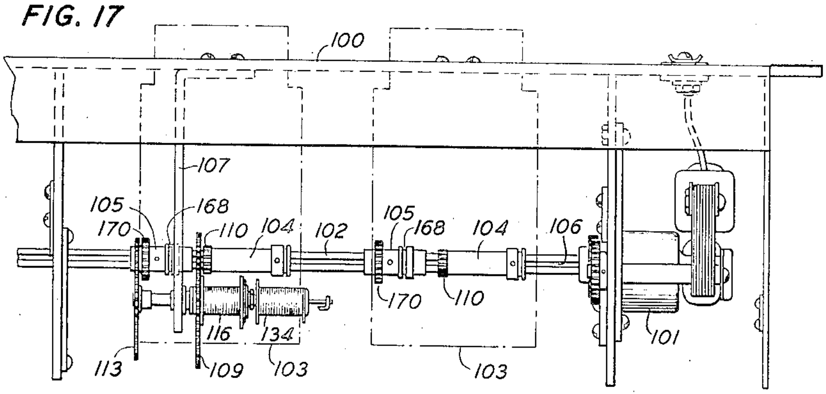


FIG. 18

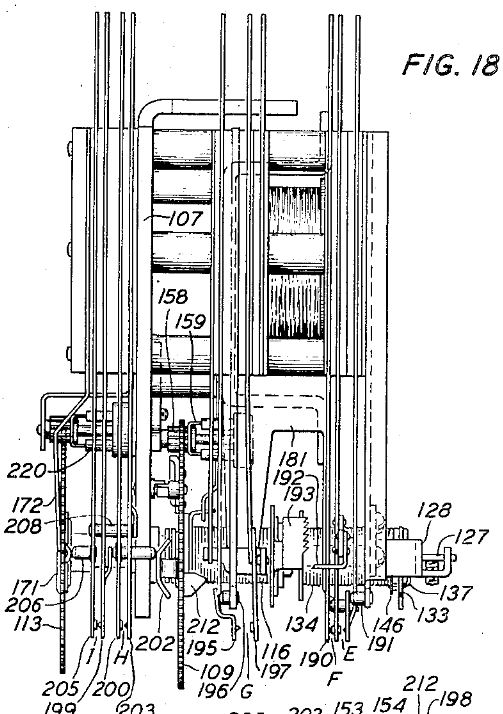


FIG. 19

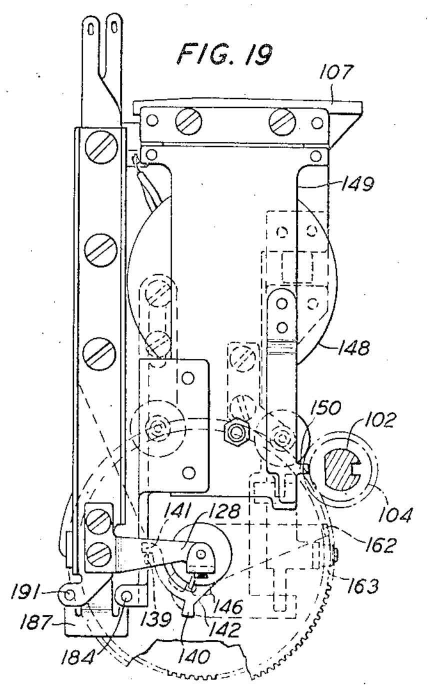
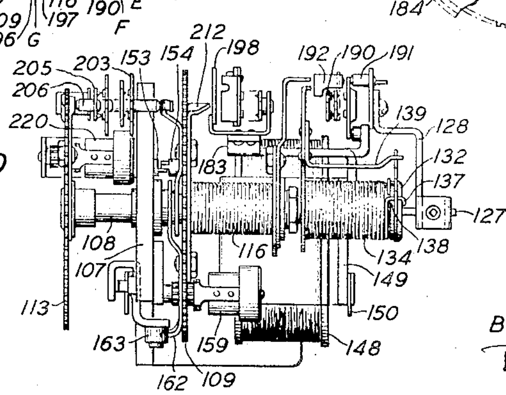


FIG. 20



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March 29, 1938. E. D. MEAD 2,112,375

TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 5

FIG. 21

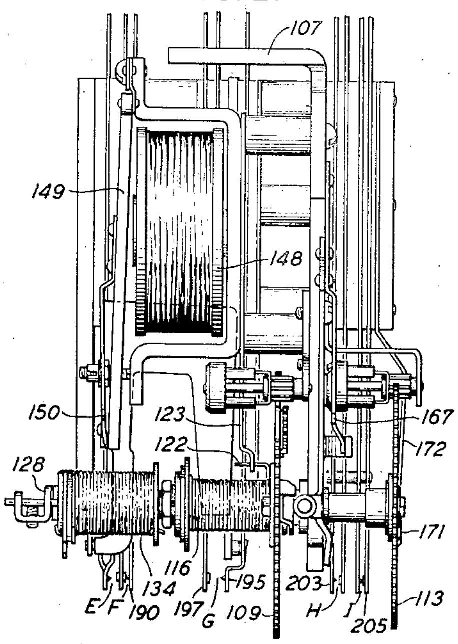


FIG. 22

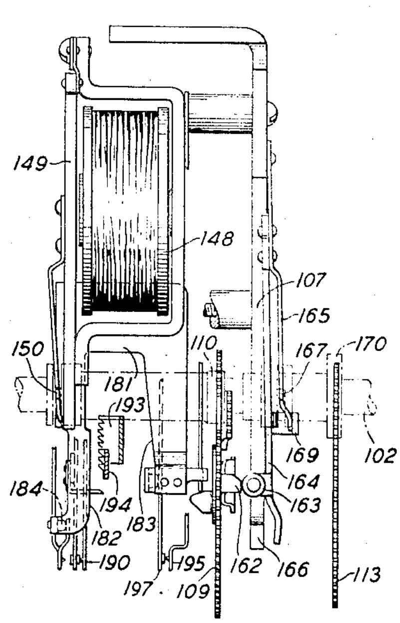


FIG. 23

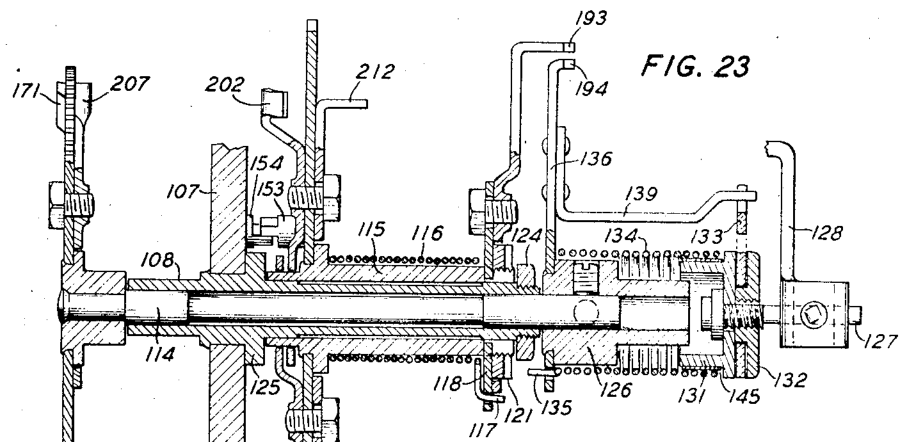
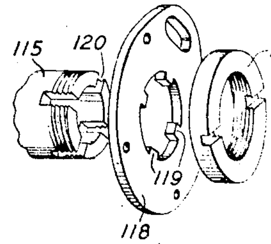


FIG. 24



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March 29, 1938. E. D. MEAD 2,112,375
TIMING MECHANISM
Filed March 10, 1936 8 Sheets-Sheet 6

FIG. 25

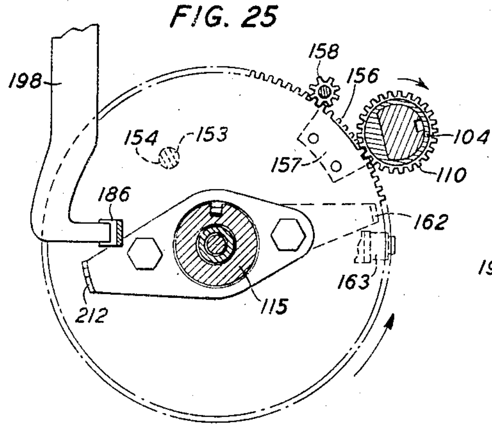


FIG. 26

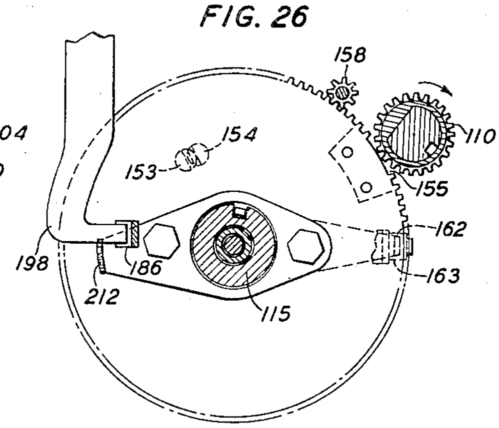
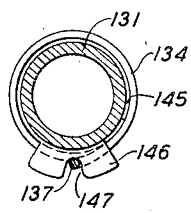


FIG. 27



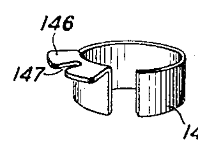
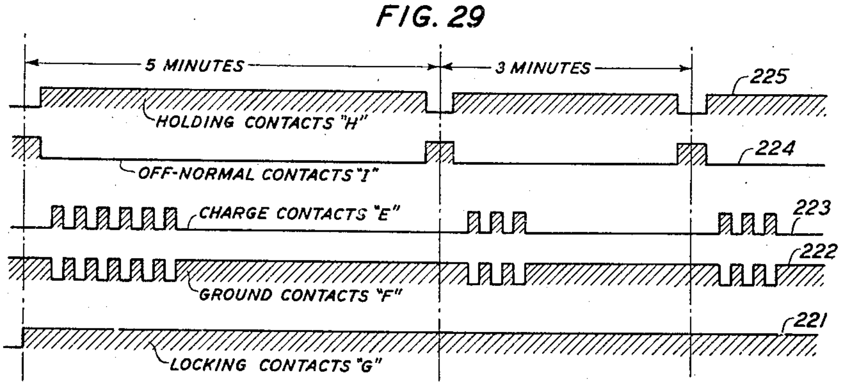


FIG. 28

FIG. 29



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March 29, 1938. E. D. MEAD 2,112,375

TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 7

FIG. 30

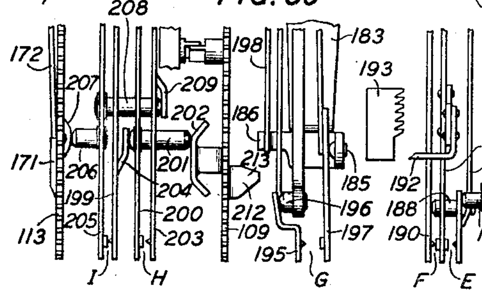


FIG. 31

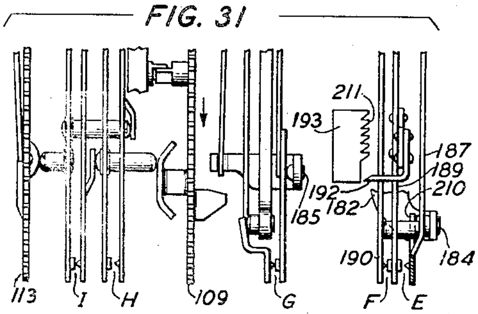


FIG. 32

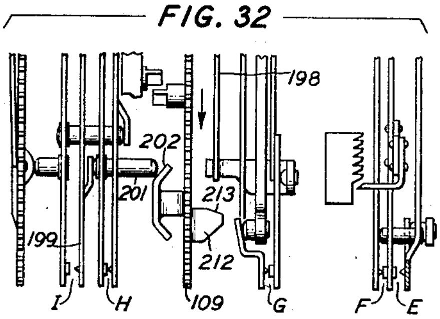


FIG. 33

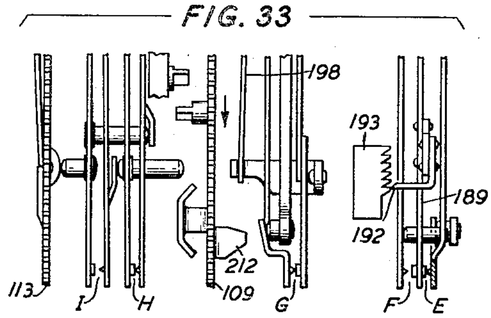


FIG. 34

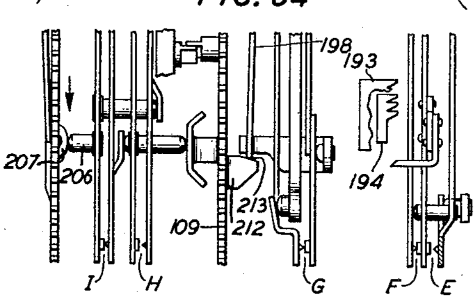


FIG. 35

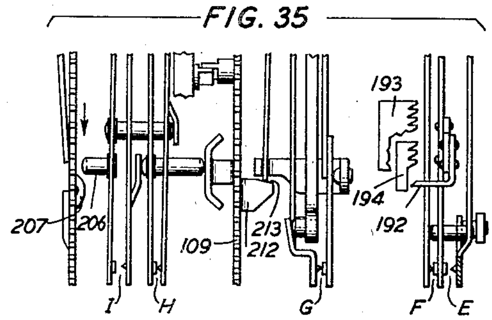


FIG. 36

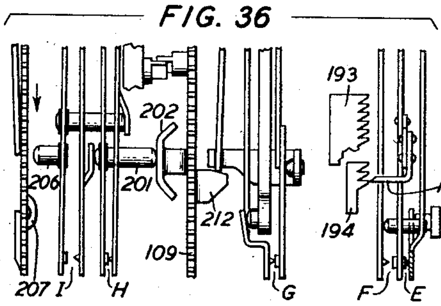
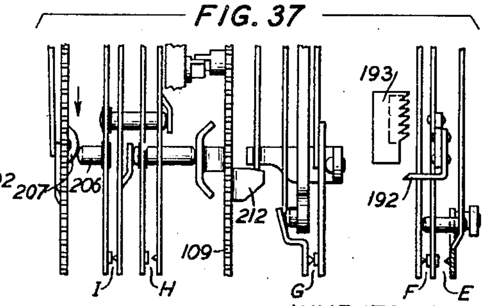


FIG. 37



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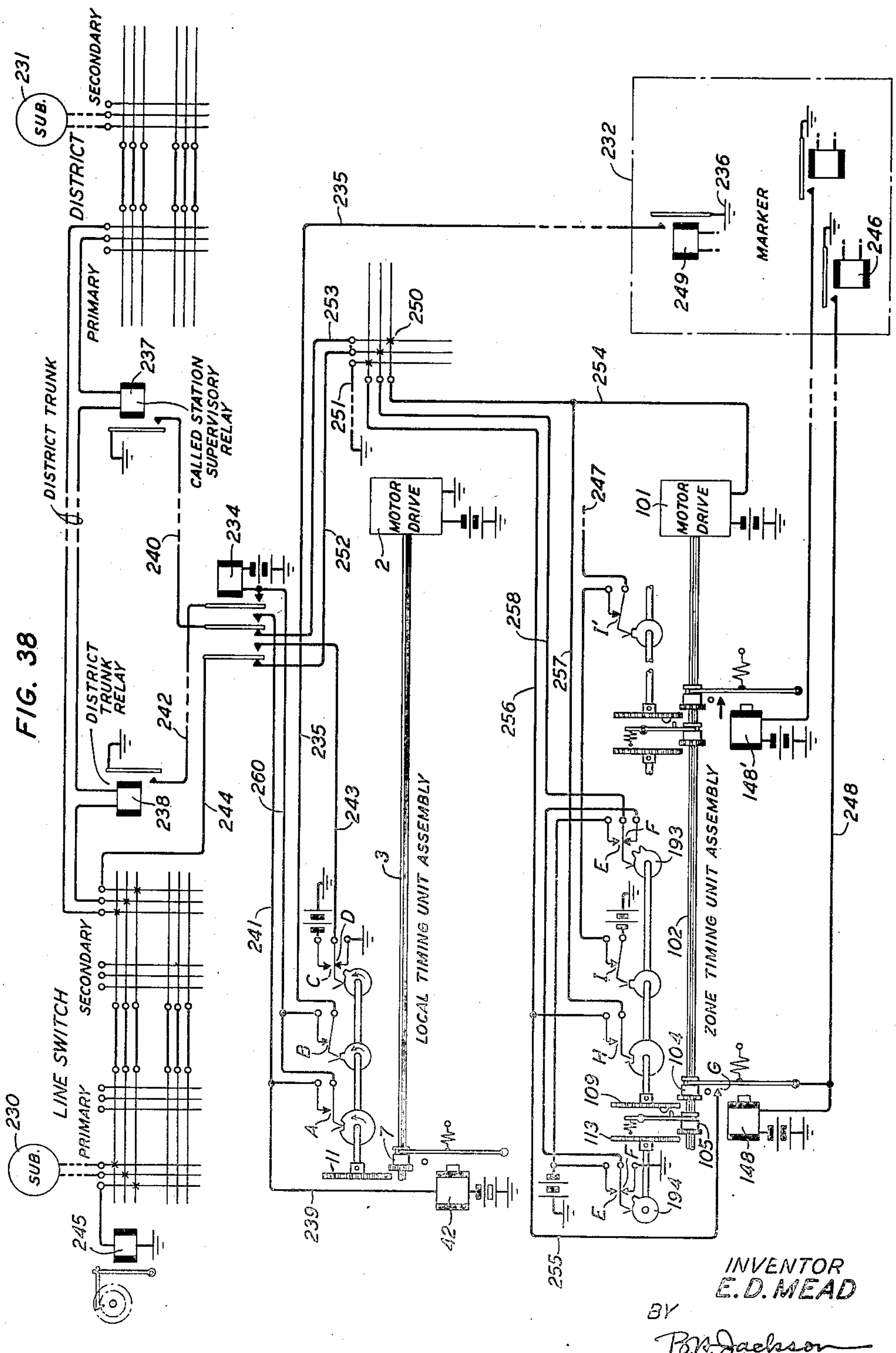
March 29, 1938. E. D. MEAD 2,112,375

TIMING MECHANISM

Filed March 10, 1936 8 Sheets-Sheet 8

FIG. 38



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Patented Mar. 29, 1938

2,112,375

UNITED STATES PATENT OFFICE

2,112,375

TIMING MECHANISM

Edward D. Mead, Caldwell, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 10, 1936, Serial No. 68,073

11 Claims. (Cl. 161—19)

This invention relates to timing mechanisms and particularly to devices of this character used for measuring intervals of conversation in a telephone system to determine thereby the appropriate charge for the service rendered. The invention is applicable not only to local calls from subscribers' lines or coin box lines where the charges may be uniform for the initial period and each overtime period but is also applicable where the charges depend upon the zone called as well as the duration of the call.

An object of the invention is to simplify and improve devices used for measuring and indicating intervals of time to render them more accurate and reliable in their operation and to render them capable, with only minor alterations, of assessing charges according to a variety of requirements with respect to initial and overtime charges.

The timing mechanism of this invention is particularly applicable for use with the message register circuits disclosed in the copending application of F. J. Scudder Serial No. 68,044, filed March 10, 1936, issued as United States Patent 2,089,438 on August 10, 1937.

In its preferred form, the invention utilizes a common driving shaft which may be rotated at a constant speed and a number of electromagnetic devices having timing elements which are arranged to be engaged with and disengaged from the driving shaft much in the manner disclosed in my earlier Patent No. 1,993,793 issued March 12, 1935.

Each electromagnet has an armature which is actuated when a given telephone connection is established to move a slidable pinion on the driving shaft into engagement with a gear wheel of a suitable timing unit. The consequent rotation of the gear wheel controls the timing and charging functions in accordance with the circuit requirements. In one form of the invention applicable for a telephone connection where the charging for the initial period is the same as for an overtime period of the same duration, the said gear wheel is adapted to rotate as many revolutions as needed to measure a given call, closing the charging circuit shortly after the beginning of each revolution. A tensioned spring serves to restore the gear wheel to its normal position after the connection has been broken and special means are provided for maintaining a substantially constant tension on said spring when said wheel makes more than one complete revolution in the measurement of a given connection before being returned to its normal position. In another form applicable for a telephone connection where the charging rate for the initial period differs from the charging rate for an overtime period of the same duration each timing unit has one gear wheel engageable with the constant speed shaft for measuring the initial period and a second gear wheel engageable with said shaft after the completion of the initial period for measuring any overtime period and for closing the charging circuit in accordance with the number of revolutions required to measure the overtime period. Tensioned spring means may be employed for restoring each wheel to normal after the given connection has been broken. Other features of the invention will appear in the following detailed description.

Referring to the drawings:

Fig. 1 is an assembly view of the timing mechanism for local telephone calls illustrating the driving shaft and the manner in which the several timing units are mounted;

Fig. 2 is a top view of one of the timing units;

Fig. 3 is a side view and Fig. 4 an end view of one of these units;

Fig. 5 is an end view of the armature hinge of Fig. 3;

Fig. 6 is an enlarged view in perspective of an arrangement for keeping under constant tension the restoring spring for the rotatable member of the timing unit;

Figs. 7 and 8 illustrate the apparatus of Fig. 6 in different positions;

Fig. 9 is an alternative to the apparatus of Fig. 6;

Fig. 10 is a diagram illustrating the manner of operation of the timing unit electrical contacts during a conversation period being measured thereby;

Figs. 11 to 16, inclusive, are schematic drawings illustrating the timing device in its various stages of operation;

Fig. 17 is an assembly view of another type of timing mechanism for zone calls where the charging for the overtime period is on a different basis than the initial period;

Fig. 18 is a top view, Fig. 19 a side view and Fig. 20 an end view of one of the timing units of Fig. 17;

Figs. 21 and 22 are bottom views of the timing unit of Fig. 18;

Fig. 23 is an enlarged sectional view of a part of the timing unit of Fig. 18;

Fig. 24 illustrates details of the overtime measuring element of Fig. 18;

Figs. 25 and 26 are end views of the gear wheel of the initial period charging unit of Fig. 18;

Figs. 27 and 28 illustrate details of the restoring spring restraining means;

Fig. 29 is a diagram illustrating the manner of operation of the electrical contacts of the timing unit of Fig. 18 during a conversation period being measured thereby;

Figs. 30 to 37, inclusive, are schematic drawings illustrating the timing device of Fig. 18 in its various stages of operation; and

Fig. 38 shows a portion of a machine switching system of the cross-bar type utilizing a local timing unit assembly of the type of Fig. 1 and a zone timing unit assembly of the type of Fig. 17.

A detailed description will first be given of the timing device of Figs. 1 to 16, inclusive. This device (Fig. 1) comprises a mounting frame 1 on which is supported a driving motor 2 and also a shaft 3. The motor 2 is connected to shaft 3 by means of gear wheels 4 and 5. Motor 2 is arranged to be operated at a constant speed so that the rotation of shaft 3 may serve to accurately measure intervals of time. Frame 1 also supports a plurality of timing elements only two of which are shown as indicated generally by the reference character 6. The driving shaft 3 is equipped with a series of slidable pinions 7 one for each timing element, and the pinions are keyed to the shaft in the longitudinal groove 8. Each pinion 7 is adapted to be moved into engagement with the gear wheel forming a part of the corresponding timing element.

The individual timing element, the details of which are shown more particularly in Figs. 2 to 6, comprises a bracket 9 supported by the main frame 1 and supporting a fixed shaft 10 on which is rotatably mounted a large gear wheel 11. This gear wheel 11 is normally disengaged from its driving pinion but when its driving pinion 7 is moved a short distance to the left as viewed in Fig. 1 the teeth of the gear wheel 11 mesh with the teeth 12 on its driving pinion, thereby rotating the wheel 11 as long as it is in engagement with its pinion.

Gear wheel 11 is normally biased to a zero position by a tensioned helical spring 16 which tends to keep a lug 17 on the wheel against a spring stop 18 (Fig. 2), that is, the restoring spring 16 tends to rotate wheel 11 clockwise as viewed in Figs. 3 and 6. Referring more particularly to Fig. 6, one end 19 of this restoring spring is held against a shoulder 20 of a collar 21 fastened to fixed shaft 10. The other end 22 of the helical spring is suitably fastened to the inner face of wheel 11 so that the counter-clockwise rotation of wheel 11 (Fig. 6) by its pinion 7 tends to wind up the helical spring as the rotation continues. Attached to wheel 11 and rotatable therewith is an elongated sleeve 23 surrounding the fixed shaft 10 and acting as a support or guide for the turns of the spring. The first few turns of the spring adjacent wheel 11 are supported on the collar 24 of sleeve 23 while intermediate turns are normally out of contact with sleeve 23. The outer turns of the helical spring rest on a sleeve 28 formed as a part of stationary collar 21. The outer end of sleeve 23 freely rotates within the stationary sleeve 28. Located on the outer end of fixed shaft 10 is a nut 29 having an inner shoulder 30 acting as a bearing for an annular ring-shaped cam 31 having two upwardly extending projections 32, 33 and an arcuate slot 34 normally containing end 19 of helical spring 16. Cam 31 is driven by a tongue 35 projecting from a bracket 36 fastened to the inner face of the gear wheel 11. The purpose of cam 31 is to maintain a substantially constant tension on helical spring 16 in spite of the number of complete revolutions made by wheel 11 in timing a given telephone connection as will be explained later. Also mounted on bracket 36 is an annular ring 37 which supports a flexible cam 38 for operating certain electrical contacts to be described later. For the purpose of operating still other electrical contacts there is mounted on the inner face of wheel 11 a cam 39.

Each timing unit has an electromagnet 42 best seen in Fig. 3. One end of its armature 43 rests upon the flattened portion 40 of the magnet core and the armature is hinged by two non-magnetic spring strips 44, 45 (Figs. 3 and 5) which are riveted to the corners of the rear end of the armature and are clamped to core portion 40. These springs 44, 45 are given an initial bias so that when they are clamped to the core they press the rear end of the armature firmly against the core to avoid magnetic leakage while still affording a knife edge pivot for the armature.

Armature 43 carries a spring member 46 (Fig. 3) having a tongue 47 which rides in the annular groove 48 in its associated pinion 7. When the electromagnet 42 is energized the movement of armature 43 to the left as viewed in Fig. 2 is sufficient to cause the teeth on pinion 7 to engage the teeth on wheel 11 and start the rotation of wheel 11 in a counterclockwise direction as viewed in Fig. 3, wheel 11 before engagement with pinion 7 being in a definite zero position as determined by lug 17 against spring stop 18. It is, of course, to be assumed that electromagnet 42 is energized at the moment the called station has answered and that electromagnet 42 is deenergized when the connection is broken so that the amount of rotation of wheel 11 while electromagnet 42 is energized is a measure of the duration of the telephone connection and can be utilized in making the appropriate charges therefor.

The bracket 9 supports a plurality of electrical spring contacts which will be best explained by reference to Figs. 2 and 11 both of which show the gear wheel 11 in its normal zero position with lug 17 against spring stop 18. The subsequent Figs. 12 to 16 show the wheel 11 and its related apparatus in other relative positions. With the electromagnet 42 deenergized its armature 43 is maintained in its outer position by a spring 49 acting against the armature. Spring contact 50 is normally biased to make electrical contact with the stiff contact spring 51, contacts 50, 51 being termed the ground contacts D. Spring 50 carries a lug 52 projecting towards the flexible cam 38 carried by the bracket 36 on wheel 11 but the normal path of movement of cam 38 does not lie in the path of lug 52. However, armature 43 carries a roller 55 with which the flexible cam 38 will contact when the wheel 11 is rotated counterclockwise to throw cam 38 into the path of lug 52 to cause spring 50 to break its contact with member 51 and make contact with the spring 56. Contacts 50, 56 are termed the charging contacts C.

The spring pile-up also includes two stiff springs 57 and 60 and two flexible springs 58, 59. Flexible spring 58 is normally biased to make contact with stiff spring 57 but when the wheel 11 is in its zero position as in Fig. 11 the cam 39 on wheel 11 presses against a lug 61 mounted on spring 58 to keep electrical spring contacts 57, 58 separated as long as wheel 11 is in its zero position. Lug 61 also has an extension 62 which serves to press the flexible spring contact 59 against spring 60 as long as cam 39 is opposite lug 61. Contacts 57, 58 are hereinafter termed the holding contacts A and contacts 59, 60 the off-normal contacts B. Therefore, with the wheel 11 in its zero position against stop 18, the holding contacts A are open, the off-normal contacts B are closed, the charge contacts C are open and the ground contacts D are closed. The functions of these contacts will be described briefly later but for a more detailed description reference is made to the Scudder application mentioned above.

When the electromagnet 42 is energized its armature 43 acting against retracting spring 49 brings pinion 7 into engagement with the gear wheel 11 and also by means of roller 55 bends flexible cam 38 into the path of lug 52 on spring 50. The armature is shown in its actuated position in Fig. 12 whereupon the gear wheel 11 starts turning in the direction indicated by the arrow. Shortly after the turning movement has started, cam 39 rides off lug 61 and flexible spring 58 is then free to follow its natural bias to close holding contacts A and open the off-normal contacts B as shown in Fig. 13. Contacts A remain closed and contacts B remain open until cam 39 has again reached lug 61. Shortly after the holding contacts A have been closed the flexible cam 38 contacts momentarily with lug 52 to open the ground contacts D and close the charging contacts C as shown in Fig. 14. As soon as lug 52 becomes free of flexible cam 38 the flexible spring 50 follows its natural bias to open the charging contacts C and close the ground contacts D as shown in Fig. 15. The condition of the contacts shown in Fig. 15 holds during the greater part of a complete revolution of wheel 11. Fig. 16 shows the condition just before wheel 11 has finished a complete revolution and one complete revolution will have taken place as soon as wheel 11 has moved far enough from its position of Fig. 16 to allow spring stop 18 to drop behind the rear edge of lug 17. It will be apparent from Fig. 16 that just prior to the completion of one revolution of wheel 11, lug 61 rides up on cam 39 to again open holding contacts A and close off-normal contacts B.

It will be apparent that gear wheel 11 may make only a partial revolution or as many complete revolutions as are needed for timing the particular telephone connection for which the timing unit has been selected. If the telephone connection lasts for a time corresponding to less than one complete revolution of wheel 11 it will be apparent that the charging contacts C will be operated only once but if the telephone connection continues for a fraction of an additional turn of wheel 11 the charging contacts will again be actuated as it will be seen from Fig. 16 that only a small additional movement of flexible contact 38 is needed to cause the second closing of the charging contacts C.

The diagram of Fig. 10 illustrates the manner in which the contacts are operated with respect to time. In Fig. 10 it is assumed that the time required for a complete revolution of wheel 11 is five minutes and that the charging contacts are to be operated once for each five-minute period or fraction thereof. The two vertical lines 67 and 68 are intended to represent the duration of a five-minute period where vertical line 67 represents the beginning of the period with wheel 11 in zero position, and vertical line 68 represents the end of the five-minute period with the wheel having completed exactly one revolution. Lines 63, 64, 65 and 66 represent the condition during the measured period of the holding contacts A, the off-normal contacts B, the charging contacts C and the ground contacts D, respectively. It will be seen that shortly after the beginning of the measured period the holding contacts are closed and the off-normal contacts are opened and they continue in their altered position until just prior to the elapse of the five-minute period when the holding contacts are opened and the off-normal contacts closed. At the beginning of the initial period and shortly after the holding contacts and off-normal contacts are operated the charging contacts C are momentarily closed, accompanied by the momentary opening of the ground contacts D. If the measured period extends beyond the initial five-minute period it will be obvious that the contacts again are operated in the same manner as at the beginning of the initial period.

As previously stated, the timing unit of this invention as above described contemplates having gear wheel 11 make one complete revolution for the initial period of a conversation being measured and to have the wheel make as many additional revolutions or fractions thereof as are needed to measure the overtime period. It is, therefore, necessary to provide means for preventing the restoring spring 16 from becoming wound too tightly. Preferably, automatic means are provided for unwinding the helical spring 16 one turn whenever the wheel 11 by its rotation has wound the spring up substantially one turn. A preferred arrangement is disclosed in Figs. 6, 7 and 8. As previously described, with reference to Fig. 6, one end of helical spring is fastened to wheel 11 and the other end lies against the stationary stop 20 so that as the wheel 11 revolves counter-clockwise the spring is wound up. The normal position for driving tongue 35 with the wheel in zero position is adjacent shoulder 32 of cam ring 31 as shown in Fig. 3. Fig. 6 shows wheel 11 after it has been rotated about 90 degrees from its normal position as indicated in that figure by the angular relation of spring stop 18 to lug 17. When the wheel 11 starts revolving counter-clockwise under the action of pinion 7 tongue 35 moves with the wheel and after the wheel has moved about 90 degrees as shown in Fig. 6 the tongue 35 contacts with shoulder 33 and rotates cam ring 31 along with the wheel. Tongue 35 continues to drive cam ring 31 counter-clockwise and finally reaches the position shown in Fig. 7 where the wheel has completed one revolution and has also turned through a small fraction of another revolution. At this position of Fig. 7 cam surface 71 contacts with end 19 of the helical spring and with the further counter-clockwise movement of cam ring 31 as shown in Fig. 8 raises the spring end 19 over the top of stationary stop 20 thereby freeing that end of the spring and allowing it to start unwinding. However, spring end 19 in flying around the nut 29 enters slot 34 in the cam ring and pushes cam ring 31 forwardly until the spring end again comes to rest against stop 20. The spring, therefore, unwinds only one turn at a time and will not unwind another turn until the wheel 11 has completed another revolution from its position in Fig. 8. If the wheel 11 is disengaged from its driving pinion 7 prior to the completion of its first revolution it will be obvious that whatever winding-up of spring 16 took place will be annulled by the clockwise restoring movement of the wheel. If we assume that the wheel 11 is disconnected from its driving pinion when the wheel has reached its position of Fig. 7 it follows that the wheel will be restored to its normal position by only a small clockwise movement required to bring lug 17 into engagement with stop 18 and with such an assumption the helical spring remains wound by one additional turn until the wheel is again driven by pinion 7 whereupon the spring end 19 will be released from stop 20 as soon as the wheel has been moved away from its zero position through an angle indicated by the difference in the positions of shoulder 33 in Figs. 7 and 8. In order that this unwinding mechanism may be effective without impairing the main function of the spring to supply a restoring force to return the wheel 11 to its normal position, a lost motion connection between driving tongue 35 and cam ring 31 is desirable. The arcuate slot 34 should extend far enough towards shoulder 33 that there will be no danger when tongue 35 is against shoulder 32 that spring end 19 will contact with the closed end of slot 34 instead of stop 20.

An alternative form of the unwinding mechanism for the helical spring is shown in Fig. 9. The portion of a timing unit shown in Fig. 9 is identical with that disclosed in the earlier figures except for the unwinding mechanism. The gear wheel 7 is shown turned substantially 90 degrees counter-clockwise from its zero position which is determined by having lug 76 against spring stop 77. Wheel 75 is suitably mounted for rotation about a fixed shaft 78 and the wheel 75 carries a drum 79 about which is wrapped the helical restoring spring 80 one end of which is fastened to wheel 75 and the other end 81 passes over a stationary nut 82 and is held against a shoulder 83 on said nut. The outer end of drum 79 is cut away to form a bearing for a cam ring 84 which has a cam surface 85 and an arcuate shaped arm 86 above an elongated slot 87. The outer edge of drum 79 which is of reduced diameter to support the cam ring 84 also has a radial wedge-shaped slot defined by shoulders 88 and 90 therein into which fits loosely a projection 89 from the inner side of the cam ring 84. With wheel 75 in its zero position, projection 89 is normally adjacent shoulder 90. As the wheel begins rotating counter-clockwise, projection 89 advances until it strikes shoulder 88 and thereafter the cam ring is rotated with the wheel 75, which rotation, if continued more than a complete revolution, will cause cam surface 85 to contact with spring end 81 and raise the end of the spring over the top of stop 83 thereby allowing the spring to unwind one turn in the same manner as described for Fig. 6. The main difference between Figs. 6 and 9 is in the manner of actuating the cam which temporarily frees the spring end from its retaining stop. Further description of Fig. 9 is, therefore, believed unnecessary.

A detailed description will now be given of an alternative form of the timing mechanism disclosed in Figs. 17 to 37. The timing mechanism of these figures is particularly designed for use in operating message registers where the charge for and the duration of each overtime period may be different from the charge for and duration of the initial period.

The assembly of these timing devices for zone calls comprises, as shown in Fig. 17, a mounting frame 100 on which is supported a constant speed driving motor 101 and a shaft 102 connected therewith by suitable gearing. Frame 100 also supports a plurality of timing units only two of which are shown indicated generally by the reference character 103. The driving shaft 102 adjacent each timing unit is equipped with two slidable pinions 104, 105 keyed to the shaft in the longitudinal groove 106. The pinions 104 and 105 are adapted to be selectively engaged with gear wheels individual to each timing unit.

The individual zone timing unit the details of which are shown more clearly in Figs. 18 to 28 comprises an L-shaped bracket 107 fastened to the main frame 100, said bracket supporting a fixed hollow shaft 108 (Fig. 23) on which is rotatably mounted a large gear wheel 109. This gear wheel 109 is normally disengaged from its driving pinion 104 but when its driving pinion is moved by means hereinafter described, the teeth of gear wheel 109 mesh with teeth 110 on driving pinion 104 thereby rotating wheel 109 until their engagement is broken. Gear wheel 109 is utilized for timing the initial period while another gear wheel 113 is employed for timing any overtime period. Means hereinafter described are provided responsive to the substantial completion of a revolution by wheel 109 for moving pinion 105 so that its teeth mesh with the teeth of gear wheel 113 whereby wheel 113 may be rotated as many revolutions as required to measure the length of the overtime period.

Referring more particularly to Fig. 23, the overtime wheel 113 is fastened to a shaft 114 which is rotatably mounted within the fixed hollow shaft 108 and projects beyond it at both ends. The initial wheel 109 does not bear directly on fixed shaft 108 but is fastened to one end of an elongated sleeve 115 which is rotatable about shaft 108. Around sleeve 115 is a helical restoring spring 116 one end 117 of which (Figs. 23, 24) is anchored by insertion in a hole in a rotatable annular disc 118 fastened on sleeve 115, and therefore, rotatable therewith. Disc 118 may have projecting lugs 119 (Fig. 24) which fit into slots 120 in the end of sleeve 115, the disc 118 being held in place by a threaded collar 121. The other end 122 of helical spring 116 is held stationary by passing through a hole in stationary arm 123 (Fig. 21). The rotatable sleeve 115 is held in place by a nut 124 threaded on the end of stationary shaft 108 the opposite end of sleeve 115 bearing against shoulder 125.

The rotatable shaft 114 at one end carries the overtime wheel 113 and its other end has fastened thereto a sleeve 126 which extends beyond the end of shaft 114. Aligned with the axis of shaft 114 but supported independently thereof is a stationary pin 127 fastened to a mounting bracket 128. On stationary pin 127 is mounted a sleeve 131 the open end of which overlaps the adjacent end of rotatable sleeve 126. Sleeve 131 is held in place by a threaded nut 132 having a portion of reduced diameter which acts as a bearing for a cam member 133. Rotatable sleeve 126 and stationary sleeve 131 act as supports for the tensioned helical spring 134 used for biasing the overtime gear wheel 113 to its normal position. One end 135 of the spring is anchored in a hole in a cam member 136 mounted on rotatable sleeve 126 while its other end 137 (Fig. 20) normally lies against a shoulder 138 on sleeve 131 (similar to shoulder 20 of Fig. 7).

Since gear wheel 113 is adapted to rotate any desired number of revolutions it, therefore, is necessary to provide means for preventing its restoring spring 134 from becoming wound too tightly and the means provided is essentially the same as that of Figs. 6, 7 and 8 in that the spring is allowed to unwind one turn every time gear wheel 113 rotates slightly more than one complete revolution. Fastened to bracket 136 is a laterally extending arm 139 which extends between two spaced upwardly extending shoulders 140, 141 (Fig. 19) on cam ring 133 so that the rotation of bracket 136 also rotates cam ring 133. This insures that cam surface 142 of cam ring 133 once each revolution will serve to lift spring end 137 over shoulder 138 to permit the spring to unwind one turn as previously described with respect to Figs. 6, 7 and 8.

The unwinding arrangement for spring 134 differs in one respect from that of Figs. 6, 7 and 8 in that a thin metal collar 145 (Figs. 27, 28) is inserted between stationary sleeve 131 and the last few turns of the spring. This sleeve 145 has an upturned edge 146 with a slot 147 into which fits the end 137 of the restoring spring. When cam surface 142 lifts spring end 137 over shoulder 138 the spring end is still retained in slot 147 so that collar 145 rides around with the spring end in the unwinding process. Collar 145 serves to reduce the velocity with which end 137 travels around nut 132 and hence reduces the danger that end 137 will be broken by the force with which it hits against shoulder 138.

Each timing unit 103 has an electromagnet 148 (Fig. 19) which is energized over suitable circuits when the telephone connection is established the duration of which is to be measured by the timing unit. Its armature 149 has a spring extension 150 which rides in a groove in pinion 104 so that the attraction of armature 149 moves pinion 104 into engagement with initial timing wheel 109. Restoring spring 116 normally holds initial wheel 109 in its zero position with lug 153 against stop 154 (Fig. 20). Pinion 104 causes the counter-clockwise rotation of initial wheel 109 as viewed from the right in Fig. 18. Wheel 109 being used for timing only the initial period, is adapted to make only one revolution. Just prior to the time that in the counter-clockwise movement of wheel 109, lug 153 would again hit against stop 154, the teeth 110 on pinion 104 encounter a toothless portion 155 on the wheel periphery (Fig. 26) so that the driving pinion is no longer effective. This toothless portion, however, is bridged by teeth 156 on a separate plate 157 attached to the wheel, teeth 156 being displaced far enough from the main teeth on wheel 109 that they are not engaged by pinion 104 but are engaged by the gear 158 attached to the speed governor 159 (Fig. 18). The initial timing wheel 109, therefore, ceases rotation as soon as pinion 104 reaches this toothless region at which time wheel 109 has completed substantially one revolution.

Just prior to the completion of the rotation of initial wheel 109 the initial wheel sets into rotation the overtime wheel 113 in the following manner providing, of course, that the conversation to be measured is still continuing. Initial wheel 109 carries a lug 162 (Fig. 22) which just prior to pinion 104 reaching toothless segment 155, contacts with a roller 163 carried by an arm 164 hinged to frame 107 by a spring member 165 which normally biases roller 163 towards wheel 109 against a stop 166 which is an extension of frame 107 (Figs. 21 and 22). An extension of spring member 165 carries an extension 167 which rides in groove 168 in pinion 105. The free end of spring 165 is normally biased against an angle piece 169 formed from arm 164. When cam 162 comes into contact with roller 163 the consequent movement of arm 164 serves to bring teeth 170 on pinion 105 into engagement with the teeth on gear wheel 113 and start its rotation. Overtime wheel 113 is normally biased to its zero position with lug 171 against spring stop 172 (Fig. 21) due to its restoring helical spring 134. Wheel 113 will now begin rotating to measure the overtime period of the telephone connection and will continue rotating as many complete revolutions as are needed. During the movement of wheel 113 spring 134 will unwind one turn for each complete revolution of the wheel in the same manner as described in connection with Figs. 6 to 8.

Certain electrical contacts are controlled by initial wheel 109 and overtime wheel 113 and the operation of these contacts will now be described with special reference to Figs. 30 to 37.

Fig. 30 shows the wheels and the contacts controlled thereby in their normal position before the timing unit has been seized to measure a particular connection. Armature 149 has a laterally extending member 181 having two separated arms 182, 183 (Figs. 22, 30, 31). Arm 182 supports a stud 184, while arm 183 has a stud 185 and a projection 186 acting as a stop as will be explained later. Contact spring 187 carries a stud 188 which passes through an aperture in contact spring 189 to contact with the stiff contact spring 190. Spring 190 is biased to press on stud 187 and normally maintain an extension of spring 187 against a stationary stop 191. This arrangement normally maintains open the charging contacts 187, 189 hereinafter called E and normally maintains closed the ground contacts 190, 189 hereinafter called F. Intermediate spring 189 carries angle piece 192 adapted to be moved into the path of the toothed charging cam 193 driven by initial wheel 109 and into the path of the toothed charging cam 194 driven by overtime wheel 113.

The stiff contact spring 195 is normally biased against a stationary stop 196 and stiff contact spring 197 is normally biased against stud 185 carried by the armature to bias the armature to its non-operated position. Hence the attraction of armature 149 serves to close contacts 195, 197 hereinafter called locking contacts G. Spring 198 is not an electrical contact spring and its purpose will be described later, but it may be noted that spring 198 is normally biased against stop 186 carried by the armature. Contact spring 200 carries a stud 201 which passes through an aperture in contact spring 203 and is pressed against cam 202 mounted on initial wheel 109 so that the holding contacts H between springs 200, 203 will be closed as soon as cam 202 has moved away from stud 201. Stiff contact spring 199 is also biased towards wheel 109 but is restrained by spring projection 204 acting against stud 201. Contact spring 205 has a stud 206 which normally rests on cam 207 mounted on wheel 113 and spring 205 has a second stud 208 which passes through apertures in springs 199, 200 to contact with a projection 209 on spring 203. It will also be apparent that as long as cam 207 is opposite stud 206, and cam 202 is opposite stud 201, spring 205 is pressed against spring 199 to maintain closed the off-normal contacts I.

As previously stated, Fig. 30 shows the condition of the electrical contacts with wheels 109 and 113 in their zero positions. The charging contacts E are opened, the ground contacts F closed, the locking contacts G opened, the holding contacts H opened and the off-normal contacts I closed. When the timing unit is seized for the measurement of the duration of an established telephone connection the electromagnet 148 is energized to attract its armature 149 as shown in Fig. 31. Armature 149 when attracted closes the locking contacts G due to the movement to the left of stud 185 carried by the armature. Stud 184, also carried by the armature, contacts with projection 210 and serves to move the three contact springs 187, 189, 190 to the left to bring projection 192 into the path of the toothed cams 193, 194 while still preserving the ground contacts F closed and the charge contacts E open. The attraction of armature 149 also brings pinion 104 into engagement with initial wheel 109 which starts rotating in the direction indicated by the arrow.

Shortly after initial wheel 109 starts turning, cam 202 rides off stud 201, allowing the biased spring 199 to move to the right to open the off-normal contacts I and close the holding contacts H as shown in Fig. 32. Cam 193 which is mounted on disc 118 and which, therefore, rotates with wheel 109 now comes into contact with projection 192 (Fig. 33) and hence moves spring 189 to the right once for each tooth 211 on the rotating cam 193. This movement serves to temporarily close the charging contacts E and temporarily open the ground contacts F and in the particular timing unit disclosed it will be seen that the charging contacts will thus be closed six times, it being assumed that for the particular call being measured the calling station's message register should be operated six times as the appropriate charge for the initial period.

Just prior to the time that pinion 104 reaches the toothless segment on wheel 109 cam 212 comes into contact with spring 198 and spring 198 is pressed to the right by the front sloping edge of cam 212. The arrangement is such that at the moment pinion 104 reaches toothless segment 155 of wheel 109 cam 212 has caused the maximum movement to the right of spring 198 and the spring is starting to ride down the rear sloping edge 213 of the cam. The pressure of spring 198 on cam 212 is sufficient to move wheel 109 slightly forward as spring 198 slides down slope 213 to positively separate the teeth on pinion 104 from the last tooth on wheel 109. That is, spring 198 serves to keep wheel 109 in the position shown in Fig. 26. Fig. 34 shows wheel 109 in its maximum advanced position where it will remain until the magnet 148 is deenergized. Just prior to pinion 104 reaching toothless segment 155 cam 202 again contacts with stud 201 to close the off-normal contacts I and open the holding contacts H as shown in Fig. 34. Also just prior to the completion of the movement of wheel 109 lug 162 on wheel 109 (Figs. 20, 22) comes into contact with roller 163 to cause projection 167 to move pinion 105 into engagement with overtime wheel 113 as previously described. Fig. 34, therefore, shows the overtime wheel 113 about to begin its movement.

As the rotation of wheel 113 begins (Fig. 35) cam 207 moves off stud 206 to open the off-normal contacts I and close the holding contacts H in a manner previously described. Since electromagnet 148 is still energized, projection 192 is still in the path of the toothed cam 194 which as shown in Fig. 23, is a portion of member 136 and hence rotatable with wheel 113. After wheel 113 has moved an appreciable distance the toothed cam 194 (Fig. 36) serves to momentarily open the ground contacts F three times and momentarily close the charging contacts E three times since there are three teeth on cam 194. This means that for each complete revolution of wheel 113 or fraction of a revolution the calling station's message register will be operated three times, it being assumed that such is the appropriate charge for each overtime period.

As overtime wheel 113 nears the completion of a revolution as shown in Fig. 37 stud 206 is moved to the right by cam 207 to momentarily close the off-normal contacts I and momentarily open the holding contacts H, but as soon as cam 207 has passed and the wheel 113 has started on its next revolution the off-normal contacts I will again be opened and the holding contacts H again be closed until stud 206 again encounters cam 207.

When electromagnet 148 is deenergized restoring spring 116 will restore initial wheel 109 to its zero position with lug 154 against stop 153 and spring 134 will restore overtime wheel 113 to its zero position with lug 171 against spring stop 172 as shown in Fig. 30. The retraction of armature 149 withdraws pinion 104 and pulls spring 198 out of the path of cam 212 to allow restoring spring 116 to restore wheel 109, while the restoring movement of wheel 109 causes cam 162 to ride off roller 163 (Figs. 21, 23) and permits the spring pressed member 164 to disengage pinion 105 from wheel 113.

In the preferred form of the invention, motor 2 of the local time unit assembly is continuously operated while motor 101 for the zone timing unit assembly is normally idle and operated only when one of its associated timing units is seized but it will be apparent that both motors may be normally idle or normally rotating if desired.

A suitable speed governor is provided for controlling the return speed of each gear wheel. Governor 159 which engages initial wheel 109 has already been referred to while a similar governor 220 is provided for overtime wheel 113.

In the particular example of zone timing unit chosen for illustration it has been assumed that the initial period was five minutes for which the message register would be operated six times, and that the duration of each overtime period was three minutes, for which the message register would be operated three times. It will be noted from Fig. 17 that gear 170 on pinion 105 is larger than gear 110 on pinion 104 and that overtime wheel 113 is smaller than initial wheel 109, the relation being such that initial wheel 109 makes a complete revolution in five minutes while overtime wheel 113 makes a complete revolution in three minutes.

Fig. 29 graphically represents the condition of the various contacts during the initial and first overtime period for the zone timing unit. Line 221 shows that the locking contacts G are closed at the instant the armature 149 is attracted at the beginning of the initial period and that the locking contacts are not broken in going from the initial period to the overtime period. Line 225 shows that the holding contacts E are closed shortly after initial wheel 109 starts rotating, are opened shortly before wheel 109 stops rotating and are closed again shortly after overtime wheel 113 starts rotating. Line 224 shows that the off-normal contacts I are opened shortly after the initial wheel 109 starts rotating, are closed shortly before wheel 109 ceases rotating and are opened again shortly after overtime wheel 113 starts rotating. Line 222 shows that the ground contacts F are closed except when the charging contacts E are operated. Line 223 shows that the charging contacts E are operated shortly after the holding and off-normal contacts have been operated, to operate six times the message register associated therewith, and that shortly after the beginning of each overtime period the charging contacts are closed three times.

In the disclosed zone timer it has been assumed that gears 170 and 113 are so designed with respect to the speed of shaft 102, that wheel 113 completes a revolution once every three minutes and that gears 109 and 110 are so designed that the revolution of wheel 109 takes five minutes. These gear combinations, however, may be readily altered to give any desired initial period or overtime period for other zone timing mechanisms which may be required to charge for calls to the various zones to which the calling subscriber's line may be extended. It is also obvious that other zone timing mechanisms may have any desired number of teeth on the initial period charging segment 193 and the overtime charging segment 194.

Fig. 38 is intended to illustrate certain of the circuits and circuit connections involved in a cross-bar machine switching system in the selection of the proper timing unit for timing a particular telephone connection. The complete circuits are not disclosed but are shown in greater detail in the above-mentioned Scudder application.

It will first be assumed that the dialed call is between exchanges within the local area. The calling subscriber's station 230 will be connected through the primary and secondary switches of the line switch through a district trunk and the district primary and secondary switches to the called subscriber's station 231. The district trunk relay 238 will be energized in the usual manner. The dialed information sent to the decoder marker 232 causes it to connect ground to conductor 235 thereby energizing relay 234 providing the local timing unit associated with the selected district trunk is in its normal position with its off-normal contacts B closed. The energization of relay 234 takes place over a circuit from battery, winding of relay 234, conductor 260, closed contacts B, conductor 235, to ground 236. Relay 234, therefore, pulls up its contacts and is locked up over a circuit from battery, winding 234, left inner front contact relay 234, conductor 242, contact relay 238 to ground.

When the called party answers, the called station supervisory relay 237 is energized and after a certain delay indicated by the dotted character of conductor 240 a circuit is established for starting the operation of the local timing unit associated with the particular district trunk circuit employed in establishing the connection. This circuit may be traced from battery, winding relay magnet 42, conductors 239, 241, left middle front contact relay 234, conductor 240, and front contact relay 237 to ground. Magnet 42 pulls the pinion 7 into engagement with gear wheel 11 and the local timing unit begins to function to measure the duration of the connection between stations 230 and 231. Motor 2 which drives pinion 7 is constantly operating as shown in the figure.

Gear wheel 11 in rotating will first open the off-normal contacts B and close the holding contacts A and shortly thereafter will open ground contacts D and momentarily close charging contacts C. Contacts A in closing establish a holding circuit for relay magnet 42 which may be traced from battery, winding relay 42, conductor 239, closed contacts A, conductor 260, left inner front contact relay 234, conductor 242, front contact district trunk relay 238 to ground.

With relay 234 energized the normally closed ground contacts D are connected through conductor 243, left outer front contact relay 234, conductor 244 over the lowest contacts of the primary and secondary line switch cross-points, winding message register relay 245, thereby short-circuiting the message register to prevent its false operation as long as the ground contacts D are closed. When wheel 11 has opened ground contacts D and momentarily closed charging contacts C, it will be obvious that the message register relay 245 will be operated.

Whenever the calling subscriber places his receiver back on the switch-hook, relay 238 releases, in turn releasing relay 234 which opens the operating and holding circuits for relay magnet 42. The gear wheel 11 will thereupon be restored to normal by its restoring spring as previously described.

It will now be assumed that the call initiated by the calling station 230 is to a station served by an exchange located outside the local area. The connections between the calling subscriber's district trunk and the decoder marker are established in the manner described in the above-mentioned Scudder application. The marker 232 knowing the office code information transmitted to it by the sender (not shown) operates one of its zone relays such as relay 246, the particular zone relay operating being dependent upon the zone in which the called station exchange is located. It will be assumed that shaft 102 is adapted to operate only one at a time the several zone timing units associated therewith, each timing unit being adapted to serve for a different zone, it further being assumed that there are a number of such shafts 102 available for selection, each shaft controlling its respective zone timing units. The decoder marker acting under the dialed office code designation supplied to it controls apparatus (disclosed in the Scudder application) which tests for a zone timing unit assembly which has all of its timing units idle as indicated by the fact that all of the off-normal contacts of its timing units are closed. It will be noted that conductor 247 is connected to battery through the closed off-normal contacts of all of the timing units associated with the disclosed zone assembly. Consequently when a test relay (not shown) is operated when connected to conductor 247 it is indicated that the particular zone assembly under test is idle and hence available for timing the call. The marker, therefore, connects ground to that relay magnet of the zone assembly which is associated with a timing unit having the proper charging rate for the called zone. Thus, it may be assumed that the timing unit associated with relay magnet 148 is the desired unit and hence the marker connects ground to conductor 248 leading to winding relay 148, battery and ground, causing relay 148 to operate. In the meantime the district trunk relay 238 has operated but the marker does not operate its local relay 249 and hence for a zone call relay 234 is left unoperated. Also under control of the marker the cross-bar switch mechanism 250 is operated to connect conductors 251, 252 and 253 to the selected idle zone assembly as will now be described.

Relay magnet 148 when operated serves to engage pinion 104 with the initial wheel 109 but shaft 102 is normally idle. Relay magnet 148 in operating locks up over a circuit from battery, winding relay 148, locking contacts G, conductors 255, 256, switch 250 and conductor 251 to ground. As soon as the called party 231 answers, the called station supervisory relay 237 is operated and starts the motor 101 by closing the following circuit from battery, motor 101, conductor 254, switch 250, conductor 253, left middle back contact relay 234, conductor 240 and front contact relay 237 to ground. Motor 101, therefore, starts rotating shaft 102 and hence the initial wheel 109 starts rotating to measure the initial time interval. The movement of wheel 109 first opens the off-normal contacts I so that no other trunk circuit may seize a timing unit driven by motor 101, and also closes the holding contacts H to establish a holding circuit for motor 101 from battery, motor 101, conductors 254, 257, closed contacts H, conductor 256, switch 250 and conductor 251 to ground.

It will also be noted that switch 250 serves to connect the ground contacts F to the message register 245 over a circuit which may be traced from ground, closed contacts F, conductor 258, switch 250, conductor 252, left outer back contact relay 234, and the primary and secondary line switches to the winding of the message register relay 245. The continued movement of wheel 109 and cam 193 will open ground contacts F and close the charging contacts E to connect battery to the message register relay a number of times, depending upon the number of teeth on cam 193. After wheel 109 has made substantially a complete revolution corresponding to the end of the initial period, wheel 109 causes overtime wheel 113 and cam 194 to start rotating for measuring the overtime interval. Wheel 113 will also operate the charging contacts E a number of times depending upon the number of teeth on cam 194 as previously described, thereby operating the message register 245 in accordance with the proper charges for each overtime interval.

When the calling party 230 hangs up, the release of relay 238 serves to open the energizing circuits for motor 101 and relay magnet 148 whereupon the timing wheels 109 and 113 restore to their normal positions under the action of their restoring springs and are, therefore, ready to be selected for another call.

For convenience in simplifying the schematic showing of the zone timing unit of Fig. 38 one set of ground and charging contacts have been shown for the initial wheel and another set of ground and charging contacts have been shown for the overtime wheel, but it is to be understood as described in connection with the earlier figures that the preferred arrangement is such that the initial and overtime wheels actuate the same set of charging and ground contacts. For purposes of simplification there is also omitted from Fig. 38 the manner in which the overtime wheel 113 controls the holding contacts H and off-normal contacts I as explained in connection with Figs. 30 to 37.

What is claimed is:

1. A timing device comprising a driving member, a rotatable driven member normally disengaged from said driving member, an electromagnet having an armature which when attracted controls the engagement of one of said members with the other of said members, electrical contacts operated by the advance of said driven member from its normal position, a tensioned helical spring for restoring said driven member to its normal position after disengagement from said driving member, a stationary shoulder normally engaging one end of said spring, the other end of said spring rotating with the rotation of said driven member tending to wind up said spring as said driven member rotates, a cam member driven by said driven member for periodically releasing said first spring end from said shoulder to cause said released end to make a revolution before coming again to rest against said shoulder.

2. A timing device comprising a driving member, a rotatable driven member normally disengaged from said driving member, an electromagnet having an armature which when attracted controls the engagement of one of said members with the other of said members, electrical contacts operated by the advance of said driven member from its normal position, a tensioned helical spring for restoring said driven member to its normal position after disengagement from said driving member, a stationary cylindrical surface on which one end of said spring rests, the other end of said spring rotating with said driven member, a stationary shoulder acting as a stop for said first end to hold said spring under tension, a cam member driven by said driven member for periodically releasing said first spring end from said shoulder to permit said first end to complete a revolution about said cylinder before again coming to rest against said shoulder.

3. A timing device comprising a driving member, a rotatable driven member normally disengaged from said driving member, an electromagnet having an armature which when attracted controls the engagement of one of said members with the other of said members, electrical contacts operated by the advance of said driven member from its normal position, a tensioned helical spring for restoring said driven member to its normal position after disengagement from said driving member, a stationary cylindrical surface on which one end of said spring rests, the other end of said spring rotating with said driven member, a stationary shoulder acting as a stop for said first end to hold said spring under tension, a rotatable cam member for periodically releasing said spring end from said shoulder to permit said one end to complete a revolution about said cylinder before again coming to rest against said shoulder, means rotatable with said wheel for rotating said cam, said means being disengaged from said cam when said driven member is in its normal position.

4. A timing device comprising a driving member, a rotatable driven member normally disengaged from said driving member, an electromagnet having an armature which when attracted controls the engagement of one of said members with the other of said members, electrical contacts operated by the advance of said driven member from its normal position, a tensioned helical spring for restoring said driven member to its normal position after disengagement from said driving member, a stationary cylindrical surface on which one end of said spring rests, the other end of said spring rotating with said driven member, a stationary shoulder acting as a stop for said first end to hold said spring under tension, a rotatable cam member for periodically releasing said spring end from said shoulder to permit said one end to complete a revolution about said cylinder before again coming to rest against said shoulder, means rotatable with said wheel for rotating said cam, said cam member having an elongated arcuate slot for guiding the

released end of said spring back again to said shoulder, said slot when said driven member is in its normal position preventing said first spring end from being released from said shoulder.

5. A timing device comprising a driving member, a gear wheel mounted for rotation about a fixed axis, an electromagnet for causing the engagement of said wheel and said member, electrical contacts actuated by the advance of said wheel from its normal position, a spring stop for determining the normal position of said wheel, means rotatable with said wheel normally engaging said stop, a tensioned helical spring for restoring said wheel to its normal position against said stop after the disengagement of said driving member and said wheel, a stationary cylindrical surface aligned with said axis and on which one end of said spring rests, the other end of said spring being rotatable with said wheel, a sleeve mounted on said wheel for supporting a plurality of the turns of said spring, a stationary shoulder normally engaged by said first spring end to hold said spring under tension, a cam member rotatable about said axis, said cam member having spaced shoulders, a projection rotatable with said wheel and located between said spaced shoulders, said projection driving said cam member after said wheel has been moved a substantial distance from its normal position, said cam member after making a substantially complete revolution acting on said first spring end to release said first spring end from said shoulder to permit said first spring end to rotate around said cylindrical surface and again come to rest against said shoulder, said cam member having an elongated arcuate slot normally preventing the release of said first spring end from said shoulder.

6. A timing device for measuring the duration of a telephone conversation for which the subscriber is charged at a certain rate for a given initial period or any fraction thereof and is charged at a certain rate for an overtime period, said device comprising a driving member, a rotatable driven member, electromagnetic means for moving one of said members into engagement with the other of said members to cause said driven member to be rotated through a definite angle but not beyond said angle, electrical contacts for controlling a subscriber's charging circuit, said contacts being actuated by said driven member when advanced from its normal position, a second rotatable driven member, means under the control of said first driven member for rotating said second driven member after said first driven member has advanced to a definite position, said second driven member during its rotation also actuating said contacts.

7. A timing device for measuring the duration of a telephone connection for which the subscriber is charged at a certain rate for a given initial period or any fraction thereof and is charged at a different rate for an overtime period, said device comprising a driving member, a rotatable driven member, electromagnetic means for moving said members into engagement with each other to cause said driven member to be rotated through a definite angle but not beyond that angle, electrical contacts for controlling a subscriber's charging circuit and actuated by the advance of said driven member, a second driven member, means driven by said driving member and adapted to engage said second driven member for rotating the same but normally disengaged therefrom, cam means rotatable with said driven member for actuating said means to start the rotation of said second driven member after said first driven member has reached a definite advanced position, and means controlled by said second driven member for controlling said contacts.

8. A timing device for measuring the duration of a telephone connection comprising a rotatable shaft, slidable pinions on said shaft, a rotatable wheel, electromagnetic means for moving one of said pinions into engagement with said wheel, a second rotatable wheel, cam means rotatable with said first wheel for actuating a second of said pinions to move said second pinion into engagement with said second wheel when said first wheel has reached a definite advanced position, electrical contacts controlled by said wheels and means for restoring each of said wheels to a definite normal position when said electromagnetic means has disengaged said first wheel from said first pinion.

9. A timing device for measuring the duration of a telephone connection comprising a rotatable shaft, slidable pinions on said shaft, a rotatable toothed gear wheel, electromagnetic means for moving one of said pinions into engagement with said wheel, said wheel having a toothless segment to render said pinion ineffective after said wheel has been advanced to a definite position, a second gear wheel, means controlled by the advance of said first wheel for causing a second pinion to engage said second wheel, electrical contacts controlled by said wheels and means for restoring each of said wheels to a definite normal position when said electromagnetic means has disengaged said first pinion from said first wheel.

10. A timing device for measuring the duration of a telephone conversation comprising a rotatable shaft, gears driven by said shaft, a rotatable driven member comprising a gear wheel, electromagnetic means for engaging said wheel with one of said gears, said wheel having a toothless segment to render said first gear ineffective after said wheel has been advanced to a definite position, spring means for preventing contact between the teeth on said wheel and the teeth on said first gear when said first gear reaches said toothless segment, a second rotatable driven member comprising a second gear wheel, means controlled by said first member for engaging said second wheel with a second of said gears when said first member has reached a definite advanced position, electrical contacts controlled by said members and means for restoring each of said gear wheels to a definite normal position when said electromagnetic means has disengaged said first gear from said first wheel.

11. A timing device for measuring the duration of a telephone conversation for which a subscriber is charged at a certain rate for a given initial period or any fraction thereof and is charged at a certain rate for an overtime period, said device comprising a driving member, a rotatable driven member for measuring said initial period, a rotatable driven member for measuring said overtime period, electromagnetic means for engaging said driving member and said initial member, means for disengaging said driving member and said initial member after said initial member has rotated for a time interval substantially equal to said initial period, means controlled by said initial member and effective only after said initial member has advanced sufficiently to substantially complete the measurement of said initial period for engaging said driving member and said overtime member, said

initial member and said overtime member each being biased to a definite normal position, electrical contacts for controlling a subscriber's charging circuit and actuated both by said initial member and said overtime member when said initial member and said overtime member are advanced a predetermined amount by said driving member from their normal positions, and means effective after the disengagement of said driving member and initial member for holding said initial member in its advanced position during the time interval said driving member is in engagement with said overtime member.

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