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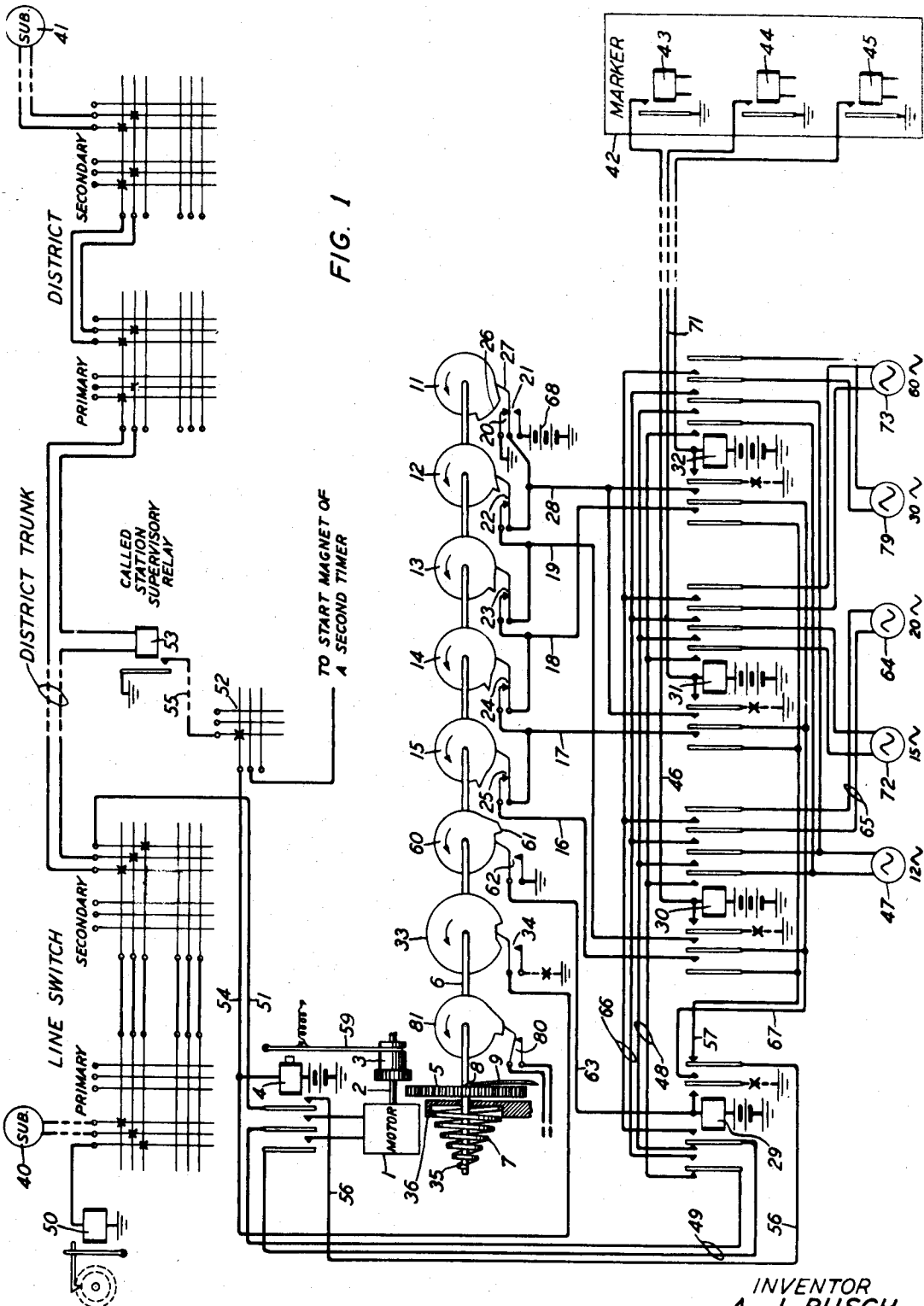
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2,094,060

TIMING APPARATUS

Filed June 20, 1936

2 Sheets-Sheet 1



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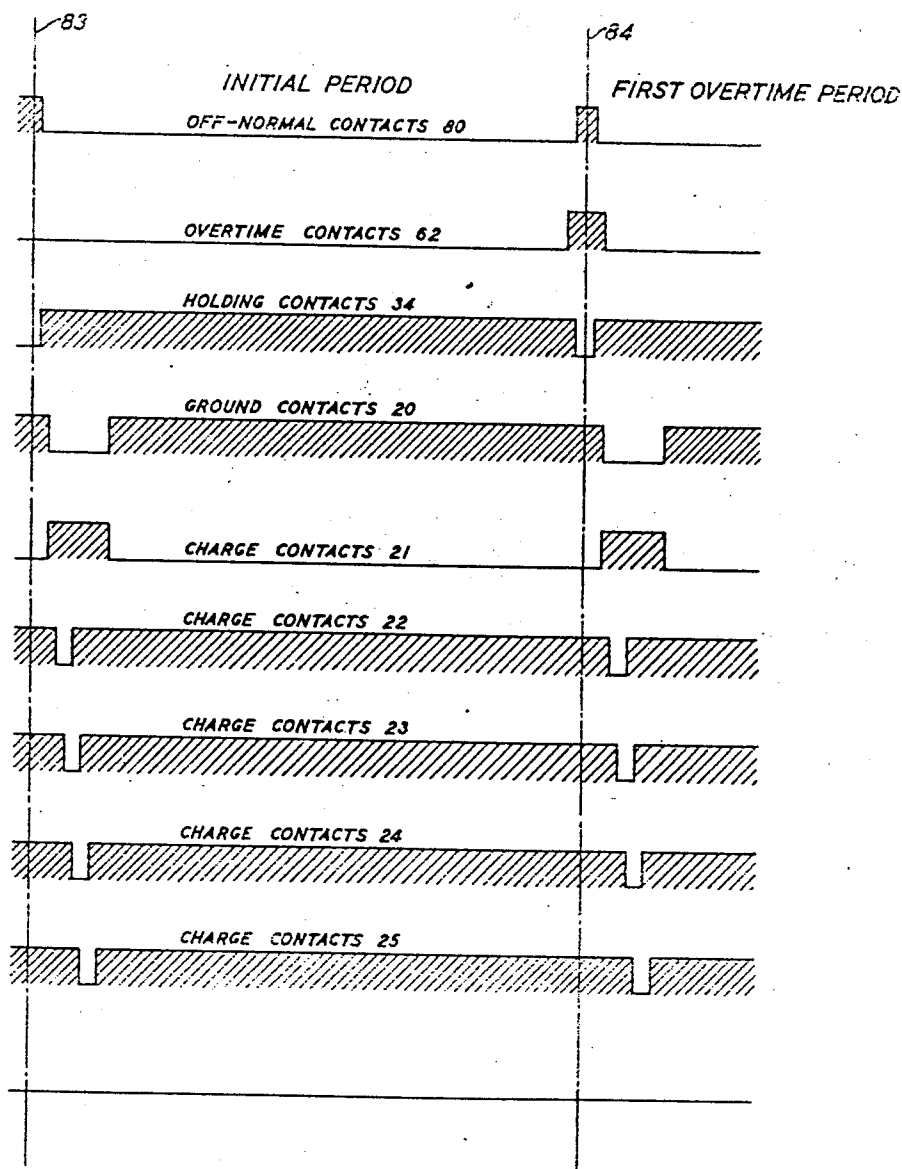
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Sheets-Sheet 2

FIG. 2



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TIMING APPARATUS

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Application June 20, 1936, Serial No. 86,242

11 Claims. (Cl. 179-7.1)

This invention relates to timing apparatus and particularly to arrangements of this character for measuring intervals of conversation in a telephone system to determine thereby the appropriate charges for the service rendered, 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 of assessing charges according to a variety of requirements with respect to initial and overtime charges.

In its preferred form the invention provides means for operating the calling subscriber's register the desired number of times for the initial period and the desired number of times for each overtime period in accordance with the requirements for the zone called and the duration of the call. Each timing unit preferably comprises an alternating current motor suitably coupled to a shaft carrying means for operating in sequence a series of electrical contacts. The motor is preferably of the type whose speed depends upon the frequency of the power supply. By selecting the frequency of the power supply the shaft controlling the contacts may be caused to make one complete revolution in the time interval equal to the initial period for the zone called and at the termination of the initial period another frequency may be selected to rotate the shaft one complete revolution for each overtime period so that all of the charging contacts will be operated once for the initial period regardless of its duration and will be operated once during each overtime period. Means are also provided for connecting the calling subscriber's charging circuit to include the desired number of charging contacts for both the initial and the overtime periods. Thus, the motor and associated gearing may be so chosen that for a power supply frequency of twelve cycles per second the driven shaft will complete one revolution in five minutes and for a frequency of twenty cycles will complete one revolution in three minutes. For example, if the initial period for a given call is five minutes for which the subscriber's meter should be operated five times and the overtime period is three minutes for which the meter should be operated twice, means are provided responsive to the completion of the telephone connection to connect a twelve cycle source to the motor and connect the calling subscriber's charging circuit to the charging contacts in such

a manner that the meter will be operated five times at the beginning of the initial period; and means responsive to the completion of the initial period will connect the meter to a twenty cycle power supply and change the connection to the charging contacts to cause the subscriber's meter to be operated twice at the beginning of each overtime period.

Such a timing mechanism is, therefore, not individual to the charging requirements of a particular zone but may be automatically adjusted to time calls for any one of a number of zones having different initial and overtime periods and different charging rates for each period. The invention preferably uses the same charging cam mechanism for the initial period and overtime period for all zones with a universal timing mechanism for which the timing intervals are made variable as required by supplying alternating current of various frequencies to obtain the different timing cycles.

Referring to the drawings:

Fig. 1 represents this invention embodied as a universal timing and charging mechanism for a machine switching telephone system; and

Fig. 2 is a diagram representing the manner of operation of certain of the electrical contacts of Fig. 1.

Fig. 1 shows a portion of a machine switching system of the cross-bar type utilizing the universal timing mechanism of this invention. For a more detailed disclosure of the circuits involved in such a system reference may be had to the copending application of F. J. Scudder, Serial No. 68,044, filed March 10, 1936, entitled Telephone systems.

The timing unit disclosed comprises a synchronous motor 1 capable of operating with a power supply varying in frequency from twelve cycles to sixty cycles per second with the speed of the motor being directly proportional to the applied frequency. The motor shaft 2 has a slidable driving pinion 3 adapted when relay 4 is energized to engage gear 5 to rotate the cam shaft 6 counter-clockwise. Shaft 6, due to a suitable means such as a spiral spring 7, is biased to a definite zero position with lug 8 on gear 5 pressed against the spring stop 9. Motor 1 and the gearing between shafts 2 and 6 are chosen so that, for a typical example, shaft 6 makes one complete revolution in five minutes when the motor is supplied with a frequency of twelve cycles per second, one revolution of four minutes with a power supply frequency of fifteen cycles, one revolution in three minutes with a power supply

frequency of twenty cycles, one revolution in two minutes for a power supply frequency of thirty cycles and one revolution in one minute for a power supply frequency of sixty cycles. Other frequencies between twelve cycles and sixty cycles may be employed to give other desired time intervals.

Shaft 6 carries five cams 11 to 15, inclusive, each controlling one of the associated charging contacts 21 to 25, inclusive. When shaft 6 is in its normal position the charge lead 16 is connected through closed contacts 25, 24, 23, 22 and 20 to ground. Shortly after shaft 6 starts rotating counterclockwise, cam 11 opens ground contacts 20 and closes contacts 21 to apply battery to conductor 16 through the other contacts 22 to 25, inclusive. As described later, this closure of battery contacts 21 is maintained for an appreciable time interval due to the length of cam surface 26. Shortly after contacts 21 are closed, cam 12 momentarily opens and closes contacts 22 followed in order by the momentary opening and closing of contacts 23, 24 and 25. After contacts 25 have been opened and closed, spring 27 rides off cam surface 26 and closes contacts 20 to ground. It, therefore, follows that when the charge lead 16 is connected to a message register the register will receive five charging impulses at the beginning of each revolution of shaft 6 due to the sequential operation of contacts 21 to 25, inclusive. It will be equally apparent that if the message register is connected to conductor 17 the register will receive four charging impulses; if connected to conductor 18 will receive three charging impulses; if connected to conductor 19 will receive two charging impulses; and if connected to conductor 28 will receive one charging impulse for each revolution of cam shaft 6.

Each timing unit with a motor 1 and cam shaft 6 has a plurality of zone relays individual thereto such as relays 30, 31 and 32 which control the frequency of the power supply for motor 1 to obtain the desired length of initial period and overtime period and also control the connections from the serially connected charging contacts to the subscriber's message register to obtain the proper charging for each period. It will be apparent that each timing unit should have as many zone relays, such as relay 30, as are required to provide one of such relays for each combination of initial period and overtime period and charging rates therefor for which the timing unit is to be employed. Each timing unit is also provided with a relay such as relay 29 for changing the frequency supply to the motor at the expiration of the initial period where the duration of the overtime period is different from the initial period and relay 29 may also serve to change the connection of the calling subscriber's message register at the expiration of the initial period to provide for the new charging rate for the overtime period.

The manner in which the timing unit of this invention operates for timing a particular telephone call will now be explained in connection with the portion of a cross-bar machine switching telephone system disclosed in Fig. 1.

It will first be assumed that the dialed call from calling subscriber 40 is to a station 41 served by an exchange outside the local area, for example, to a zone where the calling subscriber's message register 50 should be operated five times for an initial period of five minutes and should be operated twice for each overtime pe-

riod of three minutes or a fraction thereof. The calling subscriber's station 40 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 41. The dialed information actuates apparatus not shown for seizing an idle timing unit and serves to connect the proper zone relay of the idle unit, such as relay 30, to its control relay of the decoder marker 42, such as relay 43. The dialed information also actuates appropriate apparatus to connect start relay 4 of the seized timing unit by suitable switching mechanism 52 to the front contact of the called station supervisory relay 53 associated with the district trunk utilized in establishing the connection. The dialed information sent to the decoder marker 42 causes it to actuate the proper control relay such as relay 43 which will establish that the seized timing unit will operate with a five minute initial period and a three minute overtime period. The particular apparatus employed in seizing an idle timing unit may be similar to that disclosed in the above-mentioned copending application of F. J. Scudder.

The actuation of relay 43 in the manner above described energizes zone relay 30 over a circuit from battery, winding relay 30, conductor 46 and contact relay 43 to ground. Control relay 43 of the decoder marker will release shortly after its zone relay 30 has operated. Relay 30 in operating locks up over its left innermost contact including a connection to ground which is under the control of the calling subscriber. Operated relay 30 connects the twelve cycle frequency source 47 over its two right inner back contacts, conductors 48, left back contacts of relay 29, conductors 49 to the open contacts of relay 4 so that when relay 4 is energized the motor 1 will be supplied with current having a frequency of twelve cycles to cause cam shaft 6 to make one complete revolution in five minutes. However, the motor 1 is not started until relay 4 is energized.

As soon as the called station 41 has answered, the called station supervisory relay 53 is operated to energize relay 4 over a circuit from battery, winding relay 4, conductor 54, switch 52, conductor 55 and contact relay 53 to ground. Relay 4 in operating closes the previously traced circuit which supplies motor 1 with current from the twelve cycle source 47 over contacts of operated relay 30 and unoperated relay 29. At the same time start relay 4 moves its armature 59 to slide pinion 3 into engagement with gear 5 to enable motor 1 to start rotating cam shaft 6 and begin the measurement of the duration of the telephone connection between stations 40 and 41.

Due to the operation of relays 4 and 30 the calling subscriber's message register relay 50 is connected over a circuit from ground, winding relay 50, the lowest contacts of the primary and secondary line switch cross points, conductor 51, left inner front contact relay 4, conductor 56, right outer front contact of unoperated relay 29, conductor 57, left outer front contact relay 30, conductor 16 and normally closed contacts 25, 24, 23, 22 and 20 to ground.

As soon as shaft 6 begins to turn to time the initial period of five minutes, holding cam 33 on shaft 6 closes contacts 34 to establish an obvious holding circuit for relay 4, which holding circuit is due to a ground under the control of the calling subscriber. Cam surface 26 on cam 11 now opens

ground contacts 20 and closes contacts 21 to apply battery to the message register relay 50 by a previously traced circuit. The further rotation of cam shaft 6 causes the successive opening and closing of contacts 22, 23, 24 and 25. Shortly after the last contacts 25 in the series have been opened and closed, spring 27 rides off cam surface 26, removes battery from the charging circuit and applies ground instead. It will be apparent that this successive operation of the charging contacts 21 to 25, inclusive, by cams 11 to 15, inclusive, will apply five charging impulses to the message register relay 50, all of these impulses being applied at the beginning of the five minute initial period.

Assuming that the telephone connection between stations 41 and 40 continues beyond the initial period, cam 60 at the termination of the initial period of five minutes causes its cam surface 61 to close contacts 62 to operate overtime relay 29 over a circuit from battery, winding relay 29, conductor 63, contacts 62 to ground. Relay 29 locks up over its right inner contact to ground over a connection under the control of the calling subscriber. The operation of relay 29 connects the motor 1 to a different frequency source to give the proper new speed to the motor to cause the next revolution of shaft 6 to require three minutes as required for the assumed telephone connection and also changes the charging connections to the message register. As soon as relay 29 operates, frequency source 47 is disconnected from motor 1 and a source 64 of a frequency of twenty cycles is connected thereto over conductors 65, right outer contacts of operated relay 30, conductors 66, left front contacts of operated relay 29, conductors 49 to motor 1, thereby causing shaft 6 to rotate at a speed of one complete revolution for every three minutes. The operation of relay 29 also changes the charging circuit which is now traced from winding message register relay 50 over the primary and secondary line switches, conductors 51, 56, right outer front contact operated relay 29, conductor 67, left middle front contact relay 30, conductor 19, and closed contacts 22 and 20 to ground. The effective charging cam operation for this overtime period includes in the recited order the closing of contacts 21 to apply battery to relay 50, the opening of contacts 22, the closing of contacts 22, followed by the opening of battery contacts 21 and the closing of ground contacts 20, thereby causing the application of two charging impulses to the message register relay 50 for each overtime period or fraction thereof. If the assumed telephone connection continues for a second overtime period or fraction thereof, causing shaft 6 to begin its third revolution, it will be obvious that the motor 1 will still be supplied with power from the twenty cycle source and two charging impulses from battery 68 will be applied to the message register relay 50.

When the telephone connection has ceased and the calling party has hung up, the called station supervisory relay 53 will be released and the holding circuit for motor relay 4 will be opened since the ground over contacts 34 is under the control of the calling party. The consequent release of relay 4 opens the power supply circuit for motor 1, opens the message register charging circuit and disengages pinion 3 from gear 5 allowing shaft 6 to rotate clockwise under the action of restoring spring 7 to cause shaft 6 to assume its normal position with lug 8 against spring stop 9. The termination of the telephone connection as will be well understood will also re-

lease zone relay 30 since its holding circuit will be broken. The timing unit is now ready for use for another call either to the same zone or a different zone.

The restoring spring arrangement for cam shaft 6 may be of any suitable type which will permit the shaft 6 to make any desired number of complete revolutions before being restored to normal by the spring 7. One way this may be accomplished is to have the inner end 35 of the spring connected to the shaft 6 with the outer end of the spring frictionally engaging the inner surface of a stationary drum 36 so that spring 7 will partially unwind itself when cam shaft 6 makes several complete revolutions before being restored to normal. For example, the restoring spring may be of the type disclosed in the copending application of E. D. Mead, Serial No. 68,073, filed March 10, 1936, on Timing mechanisms, or the restoring spring may be of the type disclosed in the copending application of Harvell and Slye, Serial No. 627,286, filed August 2, 1932 on Registers.

It may be assumed that the next call for which the disclosed timer is used, is to a zone in which there should be four charging impulses to the calling subscriber's message register relay for an initial period of four minutes and one charging impulse for each overtime period of one minute or a fraction thereof. The dialed information transmitted to the decoder marker 42 for such a call will cause control relay 44 to operate, thereby operating relay 31 of the selected timer over conductor 71. Motor relay 4 will be operated by the called station supervisory relay 53 as previously described. The motor 1 will now be supplied with power from a fifteen cycle source 72 by a circuit which may be traced from source 72, the two right inner contacts relay 31, conductors 48, left back contacts unoperated relay 29, conductors 49, whereupon the motor will start turning cam shaft 6 at a speed of one revolution in four minutes. The operation of zone relay 31 also connects the message register relay 50 of the calling subscriber over the line switches, conductor 51, right inner contact relay 4, conductor 56, right outer back contact relay 29, conductor 57, left outer front contact relay 31, conductor 17 and through the closed contacts 24, 23, 22 and 20 to ground. Immediately after the starting of cam shaft 6, charging contacts 21 to 24, inclusive, will be operated by their respective cams to apply four charging impulses to the message register relay 50. At the completion of the initial period overtime cam 60 will operate relay 29 to supply motor 1 with current from a sixty cycle source 73 over the right outer contacts relay 31 and will also connect the calling subscriber's charging circuit to conductors 67 and 28 so that for each overtime period of one minute there will be only one charging impulse due to the closing and opening of contacts 21.

It will be apparent from the foregoing description that if the dialed information transmitted to the decoder marker 42 should cause the operation of control relay 45, zone relay 32 would be operated to connect motor 1 to source 47 of twelve cycles for an initial period of five minutes with the charging circuit connected through conductor 18 to three sets of the charging contacts to cause three charging impulses for the initial period, and relay 32 for an overtime period of two minutes would connect motor 1 to source 79 of a frequency of thirty cycles for which the charging circuit would be connected through con-

ductor 28 to give one charging impulse for each overtime period or fraction thereof.

It will be readily understood that the zones available to the calling subscriber 40 may require charging rates and initial and overtime periods differing from the simple embodiment just described. For example, it may be advisable to have available sources of frequency that will give initial and overtime periods from one minute to five minutes in one-half minute steps with a greater variation in the number of charging rates for each period. For example, each timing unit might have ten sets of sequentially operated charging contacts instead of the five sets shown and each timing unit might have available a twelve cycle source for a five minute period, thirteen and a third cycle source for a four and one-half minute period, fifteen cycle source for a four minute period, a seventeen and one-seventh cycle source for a three and one-half minute period, a twenty cycle source for a three minute period, a twenty-four cycle source for a two and one-half minute period, a thirty cycle source for a two minute period, a forty cycle source for a one and one-half minute period and a sixty cycle source for a one minute period, assuming that the motor of each timing unit is designed to give these speeds to cam shaft 6 for the designated frequencies. Each timing unit would then have a zone relay such as relay 30 to set up each desired combination of initial and overtime periods with appropriate charging rates therefor to accommodate all of the various zones available to the calling subscriber 40. The decoder marker 42 would also be provided with a control relay such as relay 43 individual to each of the zone relays.

It is also to be understood that a plurality of timing units such as that described should be available for selection by one of the control relays such as relay 43 of the decoder marker, each timing unit having a series of zone relays such as relays 30 to 32 for setting up the duration of the initial and overtime periods and the charging rates therefor, an overtime relay 29 for establishing the connections at the end of the initial period, a driving motor 1, a motor control relay 4, a cam shaft 6 and associated contacts. The frequency sources may, of course, be common to all of these timing units.

In selecting an idle timer to be controlled by the decoder marker 42 selecting apparatus may be employed for finding an idle timing unit similar to the apparatus employed, for example, in the above-mentioned application of F. J. Scudder. For example, apparatus may be provided for hunting until a timer is found which has its contacts 80 closed by cam 81 to indicate that its cam shaft 6 is in its normal position and, therefore, idle.

The diagrams of Fig. 2 illustrate the manner in which the various sets of contacts are operated with respect to time by the cam shaft 6. It will be assumed that the distance between the vertical lines 83 and 84 represents a given initial period of, say, two minutes, with vertical line 83 representing the beginning of the initial period with cam shaft 6 in its normal position and line 84 representing the end of the initial period. With the shaft 6 in its normal position before its rotation is started it will be seen from Fig. 2 that the overtime contacts 62, the holding contacts 34 and the primary charging contacts 21 are open, while the off-normal contacts 80, the ground contacts 20 and the subordinate charging contacts 22 to 25 are closed. As soon as shaft 6 begins turning, the off-normal contacts 80 are

opened to show that the timing unit is busy and the holding contacts 34 are closed to provide a locking circuit for the motor relay 4. The off-normal contacts 80 remain open until just before the expiration of the initial period when they are again closed but are opened again at the beginning of the overtime period. The holding contacts 34 remain closed until just before the expiration of the initial period when they are momentarily opened and then closed at the beginning of the overtime period. The overtime contacts 62 remain open during most of the initial period but are momentarily closed at the end of the initial period and the beginning of the overtime period. Shortly after the beginning of the initial period the ground contacts 20 are opened and the primary charging contacts 21 are closed for an appreciable time interval. The closing of the primary charging contacts 21 is followed by the momentary opening and closing of charging contacts 22, the momentary opening and closing of charging contacts 23, the momentary opening and closing of the charging contacts 24, and the momentary opening and closing of the charging contacts 25, whereupon the primary charging contacts 21 are opened and the ground contacts 20 are closed. The contacts 20 to 25, inclusive, are operated in a similar manner at the beginning of each overtime period.

Still other embodiments of this invention are contemplated commensurate with the scope of the appended claims.

What is claimed is:

1. A timing device comprising a rotatable driven member, a second rotatable member, electromagnetic means for engaging said members, a plurality of relays, means controlled over the contacts of one of said relays for driving said second member at a certain speed, means controlled over the contacts of a second of said relays for driving said second member at a different speed, means for selectively operating one of said relays when a timing operation is desired, and electrical contacts operated by said driven member during each revolution thereof for the period of said engagement.

2. A timing device comprising a rotatable driven member, a second rotatable member, electromagnetic means for engaging said members, an alternating current motor for driving said second member, means adapted to supply current of one frequency to said motor, means adapted to supply current of a different frequency to said motor, means for rendering one of said supply means effective when a particular timing operation is desired, and electrical contacts periodically operated by said driven member for the period of said engagement.

3. A timing device for timing the duration of a telephone connection where the duration of the initial charging period is different from the duration of each overtime charging period, comprising a rotatable driven member, an alternating current motor for driving said member, means for supplying a current of one frequency to said motor for the duration of said initial period, means for supplying a current of a different frequency to said motor for the duration of the overtime period and electrical contacts operated by said member during each revolution thereof.

4. A timing device comprising a rotatable driven member biased to a definite normal position, an alternating current motor for driving said member, a plurality of sources of alternating

current of different frequencies, means for connecting one of said sources to said motor for an initial period, and means controlled by said driven member for disconnecting said first source from said motor and for connecting a second source of a different frequency to said motor at the expiration of said initial period.

5. A timing device for timing the duration of a telephone connection where the duration of the initial charging period is different from the duration of each overtime charging period, said device comprising a rotatable driven member biased to a definite normal position, an alternating current motor for driving said member, means for supplying alternating current of one frequency to said motor for the duration of said initial period, means controlled by said driven member at the expiration of said initial period for supplying current of a different frequency to said motor for said overtime period, electrical contacts for controlling a subscriber's charging circuit, and means controlled by said driven member for operating said contacts.

6. A timing device for timing the duration of a telephone connection where the duration of the initial charging period is different from the duration of each overtime period, said device comprising a rotatable driven member biased to a definite normal position, an alternating current motor for driving said member, means for supplying current of one frequency to said motor to cause said driven member to be driven at such a speed that it completes one revolution in a time substantially equal to the length of said initial period, means comprising electrical contacts actuated by said driven member substantially at the expiration of the first complete revolution of said driven member from said normal position for supplying said motor with alternating current of such a frequency that the time for said driven member to make a second complete revolution is substantially equal to the length of said overtime period, other electrical contacts for controlling a subscriber's charging circuit, and means controlled by said driven member for operating said other contacts.

7. A timing device comprising a rotatable driven member biased to a definite normal position, means adapted to drive said member at a speed to cause said member to complete one revolution in a certain time, a second means adapted to drive said member at a speed to cause said member to complete one revolution in a different length of time, a relay adapted when operated to connect said first means to said member, a relay adapted when operated to connect said second means to said member, means for selectively operating one of said relays when a timing operation is desired, a series of electrical contacts and cam means carried by said member for operating said contacts in a progressive sequence during each revolution of said member.

8. A timing device for measuring the duration of a telephone connection where the duration of the initial charging period is different from the duration of each overtime period, said device comprising a driven member biased to a definite normal position, an alternating current motor for driving said member, a plurality of electrical contacts serially connected, cam means carried by said member for progressively operating said contacts in sequence at the beginning of each revolution of said member, means for supplying alternating current of a certain frequency to said

motor to cause said member to make one complete revolution in a time substantially equal to said initial period, and means controlled by said driven member at the expiration of said initial period for supplying alternating current of a different frequency to said motor to cause said member to make one revolution in a time substantially equal to said overtime period.

9. A universal timing device for measuring initial periods and overtime periods of durations differing from time to time, said device comprising a driven member biased to a definite normal position, an alternating current motor, electromagnetic means for engaging said motor and said member, a plurality of sources of alternating current of different frequencies, a first relay for connecting one of said sources to said motor to cause said member to complete one revolution in a given time interval, a second relay controlled by said driven member at the completion of its first revolution to connect a source of a different frequency to said motor, electrical contacts operated by said member during each revolution thereof and connections to said contacts controlled by said second relay.

10. In a zone timing mechanism for measuring the duration of a telephone connection adapted to be extended to any one of a plurality of zones for initial and overtime periods of different duration, a rotatable driven member biased to a definite normal position, an alternating current motor, electromagnetic means for coupling said motor to said member, a zone relay individual to each zone to which said connection may be extended, a plurality of sources of alternating current of different frequencies, means controlled by the operation of one of said zone relays for connecting one of said sources to said motor for the duration of the initial period, electrical contacts operated by said driven member substantially at the expiration of said initial period, an overtime relay controlled by said contacts for disconnecting said first source from said motor and for connecting a second source of a different frequency to said motor under the control of the operated zone relay for the duration of the overtime period, a plurality of sets of electrical contacts operated in sequence by said driven member for controlling a subscriber's charging circuit, means controlled by said operated zone relay for rendering certain of said sets effective for said initial period, and means controlled by said overtime relay for rendering a different number of said sets effective for the duration of the overtime period.

11. A timing device for measuring the duration of a telephone connection and for assessing charges for the initial and overtime periods of said connection where the duration of the initial period and overtime period depends upon the zone to which the connection is extended, said device comprising a plurality of zone relays each individual to a zone to which said connection may be extended and one of said zone relays being operated in the establishment of said connection, a rotatable driven member biased to a definite normal position, an alternating current motor, electromagnetic means for coupling said motor to said member, a plurality of sources of alternating current each of a different frequency, means controlled by the operated zone relay for connecting one of said sources to said motor, subscribers' charging contacts serially connected and operated in progressive sequence during each revolution of said driven member, an initial pe-

riod charging lead connected to one of said series of contacts under the control of said operated zone relay, means responsive to the completion of one revolution of said member for disconnect-
5 ing said first source and for connecting a second source to said motor, an overtime period charg-

ing lead connected to one of said charging contacts under the control of said last means, and means for restoring said member to normal position when said telephone connection has ceased.

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