

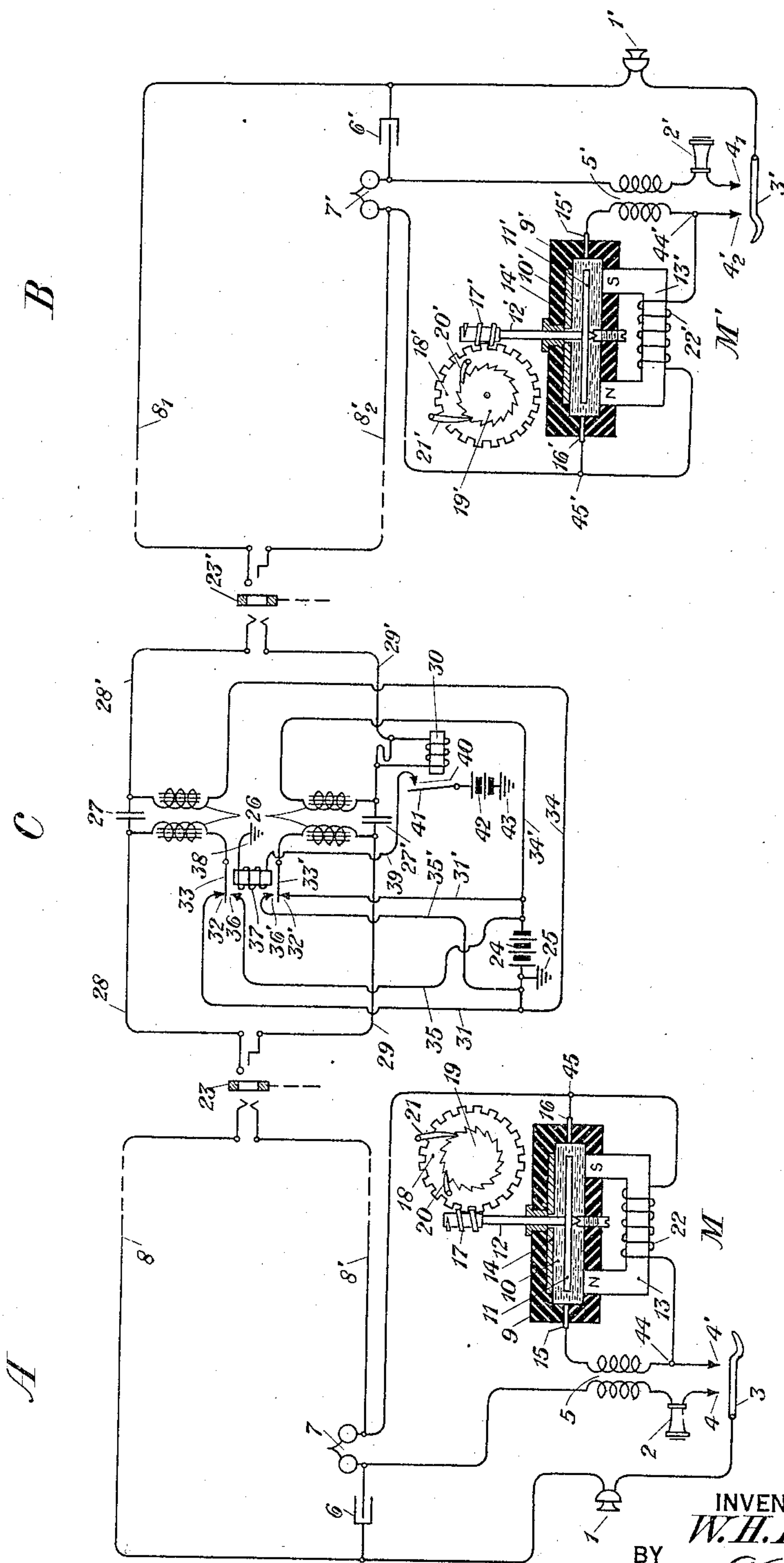
May 24, 1932.

W. H. EDWARDS

1,859,385

TELEPHONE SYSTEM

Filed Aug. 1, 1929



INVENTOR  
W. H. Edwards  
BY *g v y o r*  
ATTORNEY



## UNITED STATES PATENT OFFICE

WILLIAM H. EDWARDS, OF GREAT NECK, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

## TELEPHONE SYSTEM

Application filed August 1, 1929. Serial No. 382,740.

This invention relates to telephone systems and more particularly to a telephone metering system having a constant speed and constant load mercury motor meter located at the subscriber's station for measuring the length of time the telephone is in use.

Heretofore, it has been proposed to measure the length of time the telephone is in use by providing at the subscriber's station a direct current motor meter of the coil armature type. In order to render this type of motor responsive to the small current normally flowing in the telephone circuit, it was found necessary to provide a motor of complicated structure and of very fine adjustment, thus rendering it very expensive in initial cost and subsequent maintenance. Also the friction caused by the constant contact of the commutator brushes with the moving commutator bars and by the rotation of the relatively heavy armature on its bearings seriously decreased the efficiency of the motor and necessitated frequent replacement of parts. Furthermore, in order that the motor rotate at a constant speed, it was necessary to provide some sort of mechanical means, such as a centrifugal governor, to regulate its speed. Obviously, the use of such means necessitated extremely accurate and frequent adjustment and at the same time rendered said motor less sensitive to the small current in the circuit.

According to this invention, a telephone metering system is provided which includes a motor meter which is simple and rugged in structure, inexpensive in initial cost and subsequent maintenance, sensitive to the small current present in the telephone circuit, and accurate in operation regardless of current variations in the line.

A better understanding of the invention may be had from the detailed description hereinafter following.

The drawing represents diagrammatically a telephone system illustrating one embodiment of the invention.

In the drawing, two subscribers' stations A and B are shown with subscribers' loops extending to the central office and terminating in the jacks 23 and 23'. As shown, A rep-

resents the station of the calling subscriber and B that of the called subscriber. Substation A comprises the usual transmitter 1, receiver 2, receiver hook 3, contacts 4 and 4', induction coil 5, capacity 6, ringer 7, and line conductors 8 and 8'. In addition there is located at the substation a motor meter M the armature of which is connected in series with the substation circuit.

The motor meter M as shown includes a receptacle 9 of insulating material adapted to contain a quantity of mercury 10, a disk armature 11 submerged in said mercury and fastened to and supported by a pivoted shaft 12, a permanent magnet 13 adapted to provide the magnetic field, a plate member 14 adapted to provide a return path for the magnetic lines of force, and terminals 15 and 16. As stated above, the armature is connected in series with the substation circuit through the terminals 15 and 16 and the mercury 10. Secured to one end of the shaft 12 is the gear member 17 adapted to rotate the gear wheel 18. The gear wheel 18 when rotated in one direction, rotates a ratchet wheel 19 by means of the pawl 20, but when driven in the other direction, does not rotate said ratchet wheel due to the fact that the pawl passes idly over the teeth and does not engage them. A holding pawl 21 is provided to hold said ratchet wheel in its operated position. There is also provided a winding 22 which is wound around the permanent magnet 13 in opposition thereto when the current through the substation is in the reverse direction. This winding is connected in shunt around a constant resistance portion of the substation circuit such as the winding of the coil 5, and when the telephone is in use for conversational purposes creates a field opposing that of the permanent magnet. The resistance and the number of turns of the shunt winding 22 are such that when the current in the substation circuit is in the reverse direction, the change in the shunt and permanent magnet fields, caused by the current variations in the substation circuit, will be inversely proportional to the change in the current through the armature. Thus this winding automatically and accurately compensates for central



office battery voltage fluctuations, variations in transmitter resistance, differences in resistances of station loops, and in general, all variations of current through the disk armature, and insures a constant speed of operation and accurate time measurement of the telephone conversation.

The arrangement at substation B is the same as that shown at substation A and described above.

The cord circuit C of the central office is here illustrated as the impedance coil feed type. Obviously, a cord circuit of the repeating coil feed type may be used, if desired. The cord circuit shown comprises the usual current source 24 grounded at 25, a current supply bridge comprising impedance coils 26, capacities 27 and 27', cord conductors 28 and 28', 29 and 29', and the supervisory relay 30. The current is normally supplied to the calling line through the leads 31 and 31', the contacts 32 and 32', the armatures 33 and 33', the left-hand impedance coils 26 and the cord conductors 28 and 29, and to the called line through the leads 34 and 34', the right-hand impedance coils 26 and the cord conductors 28' and 29'. In addition, a switching means under the control of relay 30 is provided to reverse the polarity of the current in the calling line through the leads 35 and 35' and the contacts 36 and 36'. This switching means includes a relay 37 grounded at 38, a lead 39, the contact 40, the armature 41 and the battery 42 grounded at 43.

The operation of the system is as follows: When the subscriber at station A removes his receiver from the hook to initiate a call, the operator in response to the signal establishes a connection to the central office through the jack 23 in the well known manner. At this time the current flows from the positive terminal of the source 24 through the lead 31, the contact 32, the armature 33, the upper left impedance coil 26, the cord conductor 28, the jack 23, the line conductor 8, the transmitter 1, the receiver hook 3, the contact 4', the induction coil 5, the terminal 15, the mercury 10, the disk armature 11, the mercury 10, the terminal 16, the line conductor 8' back through the jack 23, the cord conductor 29, the lower left impedance coil 26, the armature 33', the contact 32' and the lead 31' to the negative terminal of the source 24. A part of the current is shunted through the winding 22 from the connecting post 44 to the connecting post 45. The current flow through winding 22 in this direction sets up a magnetic field aiding that of the permanent magnet and increases its magnetic field. With this direction of current flow through the armature it rotates, for example, from left to right. The rotation of the armature from left to right rotates by means of the gear member 17 and the gear wheel 18 in a counter clock-wise direction. With this di-

rection of rotation of the gear wheel 18, the pawl 20 passes idly over the teeth of the ratchet wheel 19. Hence no rotation of the ratchet wheel occurs and no registration takes place. The operator completes the connection to the called subscriber B through the jack 23' and transmits the ringing current over the line. This ringing current does not operate the meter of the called subscriber because the receiver hook contacts of the called subscriber's station are normally open. However, even if the called subscriber should remove his receiver from the hook during the transmission of the ringing signals, the meter would not be operated because it is made sufficiently sluggish in operation to prevent its response to the rapid variation of the ringing current. When the called subscriber removes his receiver from the hook a circuit including the relay 30 is closed in the well known manner. The closure of this circuit and the resulting energization of relay 30 causes relay 37 to be energized by the closure of the connection between the contact 40 and the armature 41. When it is energized, the relay 37 attracts its armatures 33 and 33' to break their connection with contacts 32 and 32', respectively, and to establish their connection with contacts 36 and 36', respectively. This reverses the polarity of the current in the calling line, said current now flowing from the positive terminal of the source 24 through the lead 35', the contact 36', the armature 33', the lower left impedance coil 26, the cord conductor 29, the jack 23, the line conductor 8', the terminal 16, the mercury 10, the disk armature 11, the mercury 10, the terminal 15, the induction coil 5, the contact 4', the receiver hook 3, the transmitter 1, the line conductor 8 back through the jack 23, the cord conductor 28, the upper left impedance coil 26, the armature 33', the contact 36 and the lead 35 to the negative terminal of the source 24. Part of the current is again shunted through the winding 22 but this time from the connecting post 45 to the connecting post 44. The current through the winding 22 in this direction sets up a magnetic field opposing that of the permanent magnet and decreases its field. With this direction of current flow through the armature 11 it rotates in the opposite direction, for example, from right to left. This rotation of the armature from right to left rotates the gear wheel 18 in a clock-wise direction. With this direction of rotation of the gear wheel 18 the pawl 20 engages the teeth of the ratchet wheel 19 and causes it to rotate and to start registering the time of the conversation. If, for any reason, while the registration is taking place, the current in the line and hence in the armature should be increased either momentarily or for an appreciable length of time, the rate of rotation of the armature 11 and hence the rate of registration would tend to



increase correspondingly. However, with any increase in the armature current there will be a corresponding increase of current through the winding 22. This increases the magnetic field opposing that of the permanent magnet and decreases the ultimate magnetic field acting upon the armature. Since the resistance and the number of turns of the winding 22 are such that the change in the shunt and permanent magnet fields is inversely proportional to any change in the armature current, this decrease of the ultimate magnetic field is proportional to the increase of the armature current, and the speed of the armature remains constant regardless of current variations therethrough. Conversely, if for any reason the current in the line and hence in the armature should be decreased, the speed of the armature would tend to decrease. However, with any decrease in armature current there will be a corresponding decrease of current through the winding 22. This decreases the magnetic field opposing that of the permanent magnet and increases the ultimate magnetic field acting on the armature. This increase of the ultimate magnetic field is proportional to the decrease in the armature current, and the speed of the armature still remains constant. During this time that the conversation is being carried on, the ratchet wheel 19' of the called subscriber is not being operated because, the current in the called line not having been reversed, the armature 11' is rotating in such a direction that the pawl 20 is passing idly over the teeth of the ratchet wheel and not engaging them. As soon as the called subscriber returns his receiver to the hook the direction of current flow in the calling line is changed back to normal, the armature 11 rotates idly in its normal direction and the ratchet wheel 19 stops rotating. When the calling subscriber returns his receiver to the hook the current through the armature ceases and the armature stops rotating.

As shown and described, the current reversing means is connected on one side of the cord circuit only since in general it is desirable to charge the call to the calling subscriber only. It is obvious, however, that the same mechanism could be applied on the other side of the cord circuit or on both sides of the cord circuit, if desired. Likewise, the association of said reversing means with the cord circuit may be under the control of other means than the relay 30 and in such a manner that the operation of the meter will begin at any desired time during the connection.

While this invention has been illustrated in connection with a typical cord circuit using manual operation, it is apparent that it is equally applicable to machine switching apparatus.

What is claimed is:

1. In a telephone system, subscribers' sta-

tions, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations, and a motor meter located at each of said stations in series therewith and having an armature circuit including a rotatable armature, a variable magnetic field and a counter mechanism adapted to be operated by the rotation of said armature, the variation of said magnetic field being inversely proportional to changes in current through said armature.

2. In a telephone system, subscribers' stations, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations and a mercury motor meter located in each of said stations in series therewith and including a permanent magnet, a rotatable armature immersed in mercury, a counter mechanism adapted to be operated by the rotation of said armature and a variable magnetic field opposing that of said permanent magnet, the variation of said variable magnetic field being of such magnitude that the resultant field of said variable field and said permanent magnet is inversely proportional to any change in current through said armature.

3. In a telephone system, subscribers' stations, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations and a motor meter located at each of said stations in series therewith and including a permanent magnet, a rotatable armature, a counter mechanism adapted to be operated by the rotation of said armature, and a coil adapted to create a magnetic field opposing that of said permanent magnet, the resistance and number of turns of said coil being such that a change in the resultant magnetic field of said coil and said permanent magnet is inversely proportional to any change in current through said armature.

4. In a telephone system, subscribers' stations, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations and a mercury motor meter located at each of said stations and having a permanent magnet, an armature circuit including a rotatable armature connected in series with the circuit of said station and immersed in mercury, a counter mechanism adapted to be operated by the rotation of said armature and a coil connected in parallel with said armature circuit and adapted to create a magnetic field opposing that of said permanent magnet, the resistance and number of turns of said coil being such that a change in the resultant magnetic field of said coil and said permanent magnet is in-



versely proportional to any change in current through said armature circuit.

5. In a telephone system, a calling subscriber's station and a called subscriber's station, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations, means controlled by the closure of the circuit of said called subscriber's station for reversing the polarity of the current in said calling subscriber's station and measuring apparatus located at said calling subscriber's station including a permanent magnet, a receptacle containing mercury, a rotatable disk electrically connected in series with the circuit of said calling subscriber's station, terminals in electrical contact with said mercury, counter mechanism adapted to be rotated by the reverse rotation of said disk, and a coil connected in parallel with said terminals and adapted to create a magnetic field opposing that of said permanent magnet when the current in said calling subscriber's station is in its reverse direction, the resistance and number of turns of said coil being such that a change in the resultant magnetic field of said coil and said permanent magnet is inversely proportional to any change in the reversed current through said disk.

6. In a telephone system, subscribers' stations, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations and a motor meter located at each of said stations and having a permanent magnet, an armature circuit including a rotatable armature connected in series with the circuit of said station, counter mechanism adapted to be operated by the rotation of said armature and a coil connected in parallel with said armature circuit and a constant resistance portion of said station and adapted to create a variable magnetic field opposing that of said permanent magnet, the variation of said variable magnetic field being of such magnitude that the resultant field of said variable field and said permanent magnet is inversely proportional to any change in current through said armature circuit.

7. In a telephone system, a calling subscriber's station including an induction coil and a called subscriber's station, connecting circuits for establishing talking connections between said stations, a current source for supplying talking current to said stations, means controlled by the closure of the circuit of said called station for reversing the polarity of the current in said calling station and a mercury motor meter located at said calling station and having a permanent magnet, an armature circuit including a rotatable armature immersed in mercury and connected in series with the circuit of said call-

ing station, counter mechanism adapted to be operated by the rotation of said armature in its reverse direction, and a coil connected in parallel with said armature circuit and said induction coil and adapted to create a magnetic field opposing that of said permanent magnet when the current in said calling subscriber's station is in its reverse direction, the resistance and number of turns of said coil being such that a change in the resultant magnetic field of said coil and said permanent magnet is inversely proportional to any change in current through said armature circuit.

In testimony whereof, I have signed my name to this specification this 26th day of July, 1929.

WILLIAM H. EDWARDS.