W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 1.

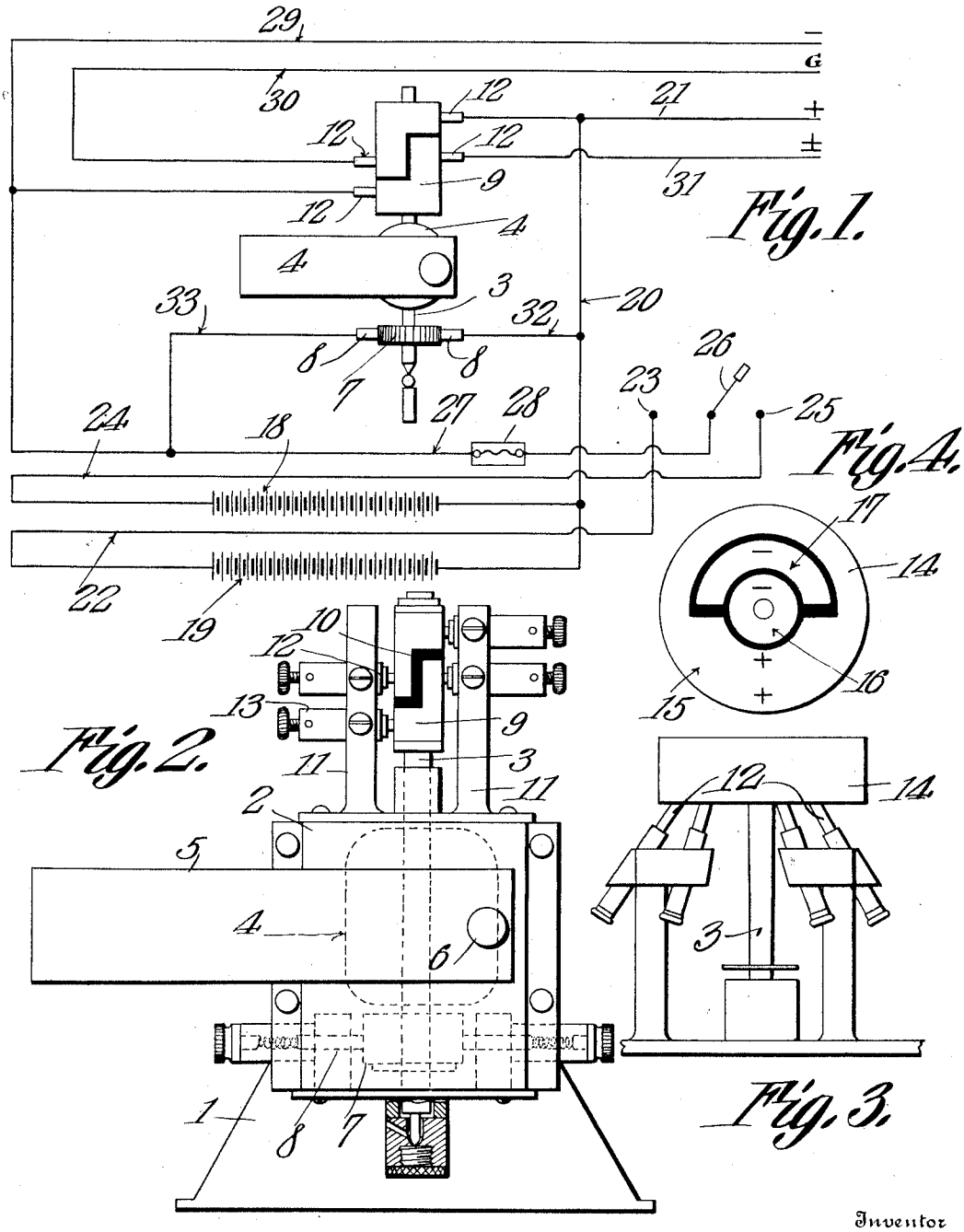


Fig. 1.

Fig. 4.

Fig. 2.

Fig. 3.

Inventor

William E. Butler.

Witnesses

E. G. Steinmetz

F. T. Chapman.

By Cashow & Co.

Attorneys

W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 2.

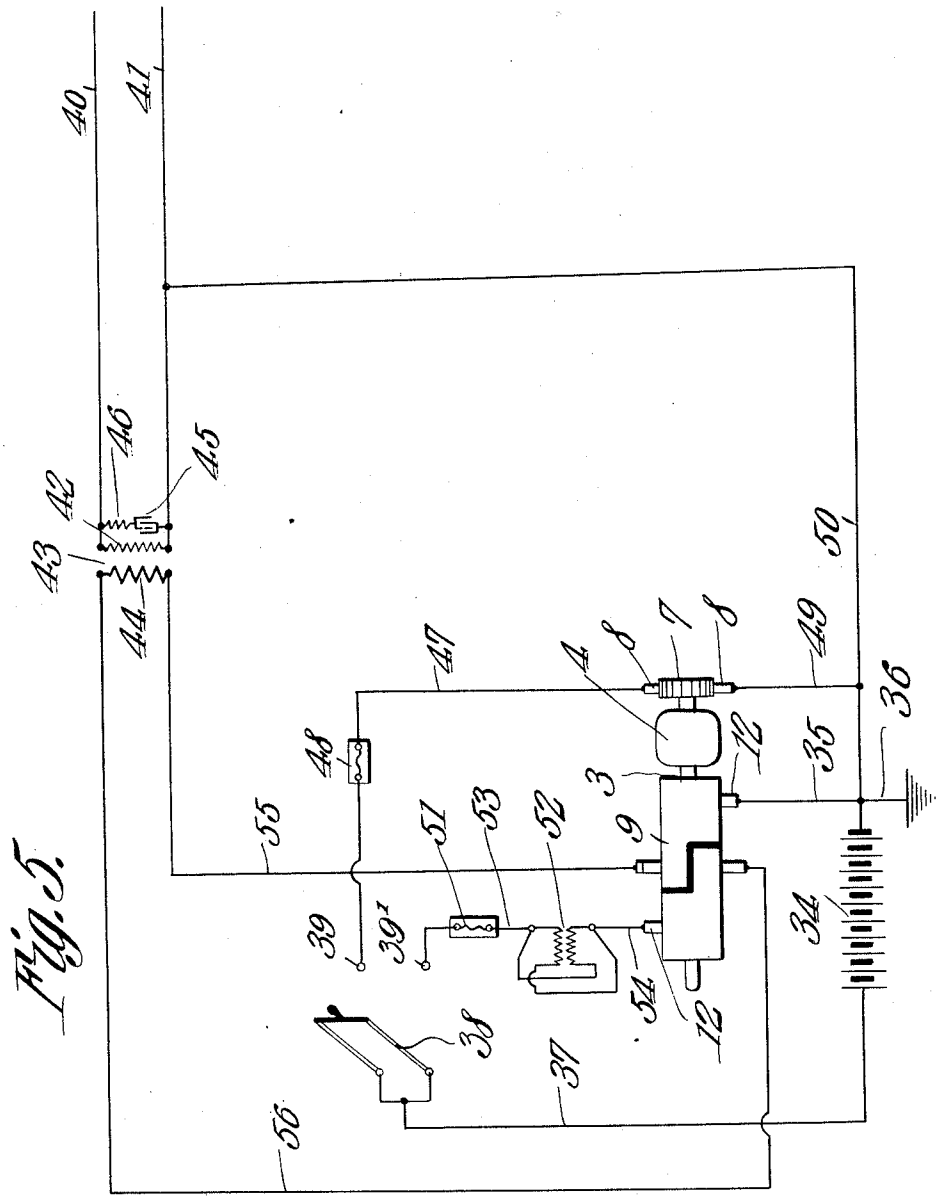


Fig. 5.

Witnesses

E. J. Stewart

F. T. Chapman

Inventor

William E. Butler.

By C. A. Snow & Co.

Attorneys

W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 3.

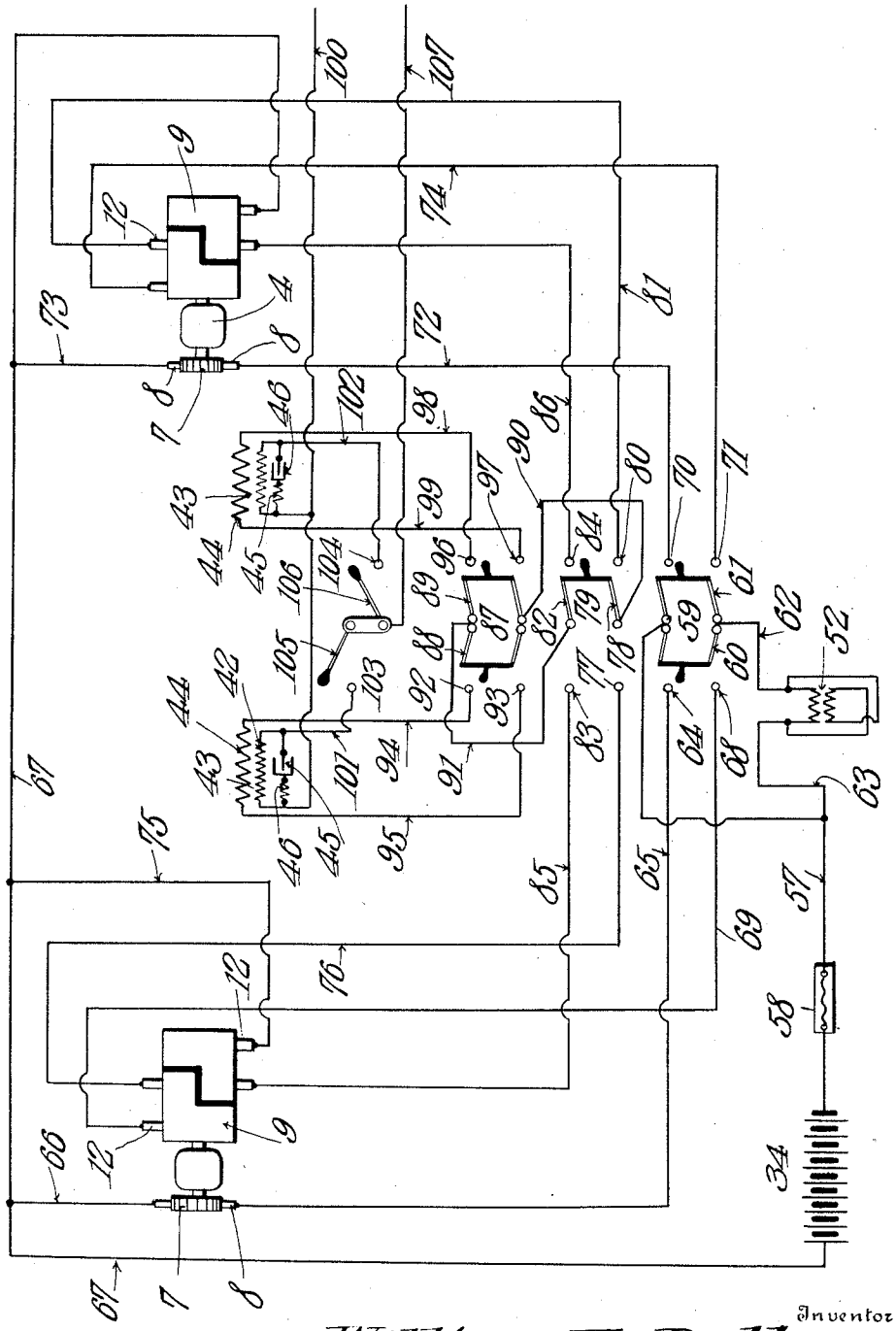


Fig. 6.

Witnesses

E. F. Clement

F. T. Chapman

Inventor

William E. Butler.

By Cushman & Co.

Attorneys

W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 4.

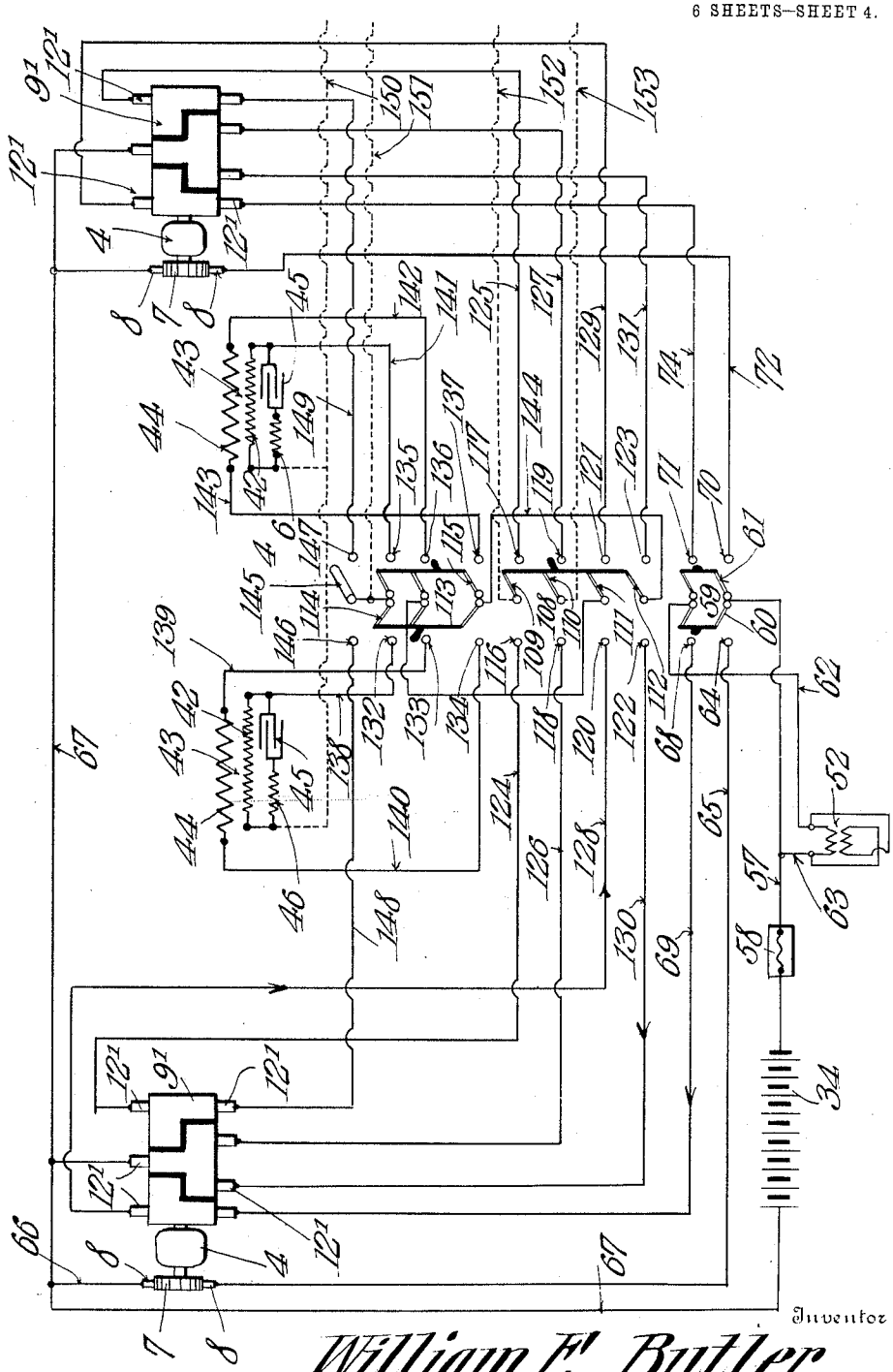


Fig. 1.

Witnesses

E. J. Stewart

F. T. Chapman

Inventor

William E. Butler.

By C. A. Snow & Co.

Attorneys

W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 5.

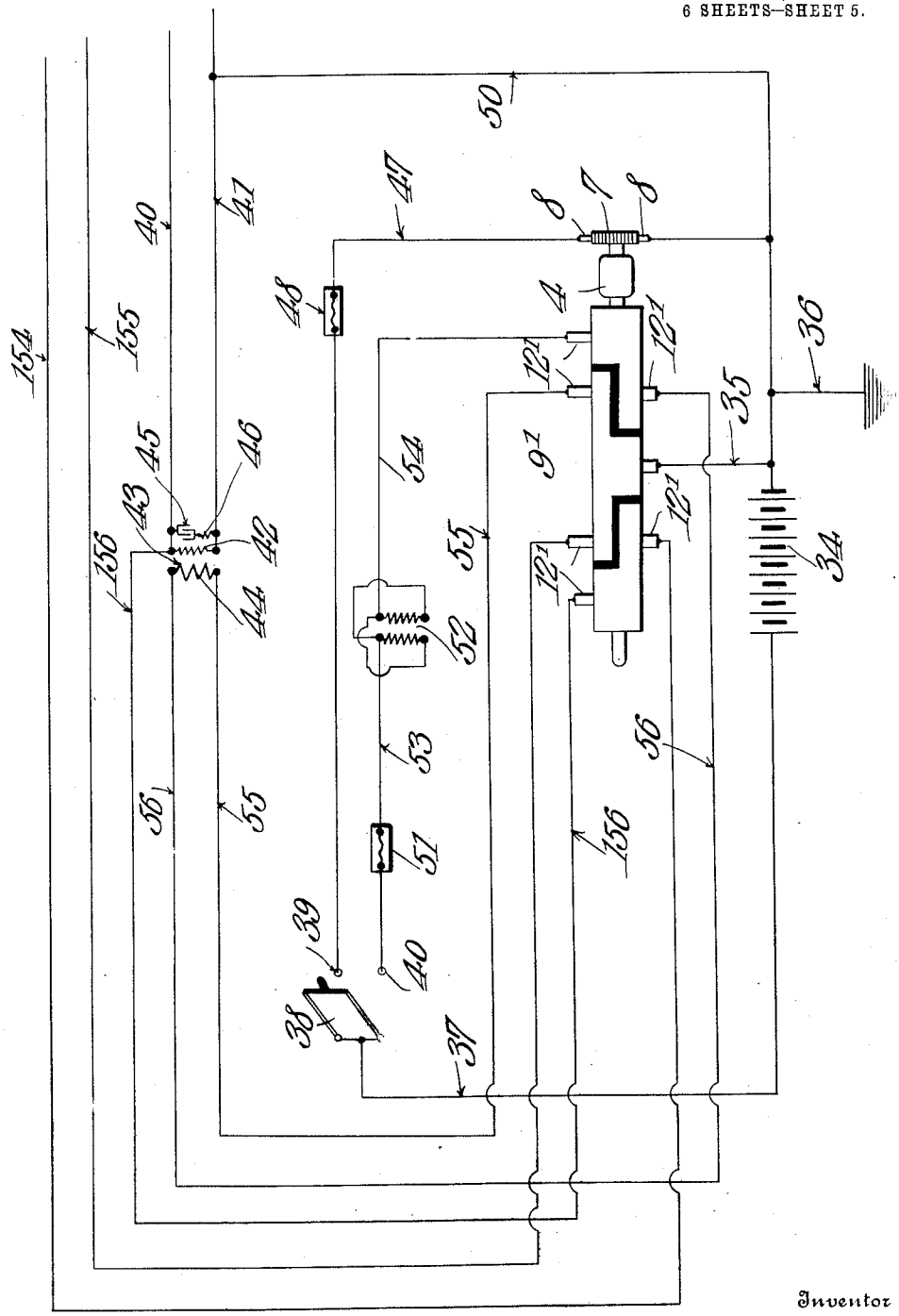


Fig. 1.

Witnesses

E. G. Hamilton

F. T. Chapman

Inventor

William E. Butler.

By Cushman & Co.

Attorneys

W. E. BUTLER.

CENTRAL STATION CALL SYSTEM FOR TELEPHONE LINES.

APPLICATION FILED FEB. 15, 1909.

977,067. Patented Nov. 29, 1910.

6 SHEETS—SHEET 6.

Fig. 10.

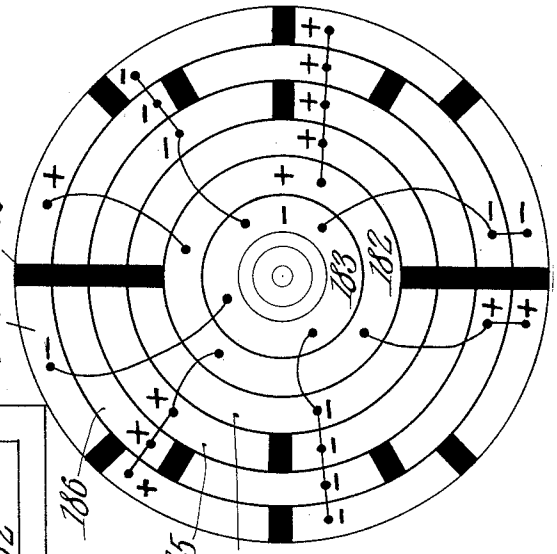
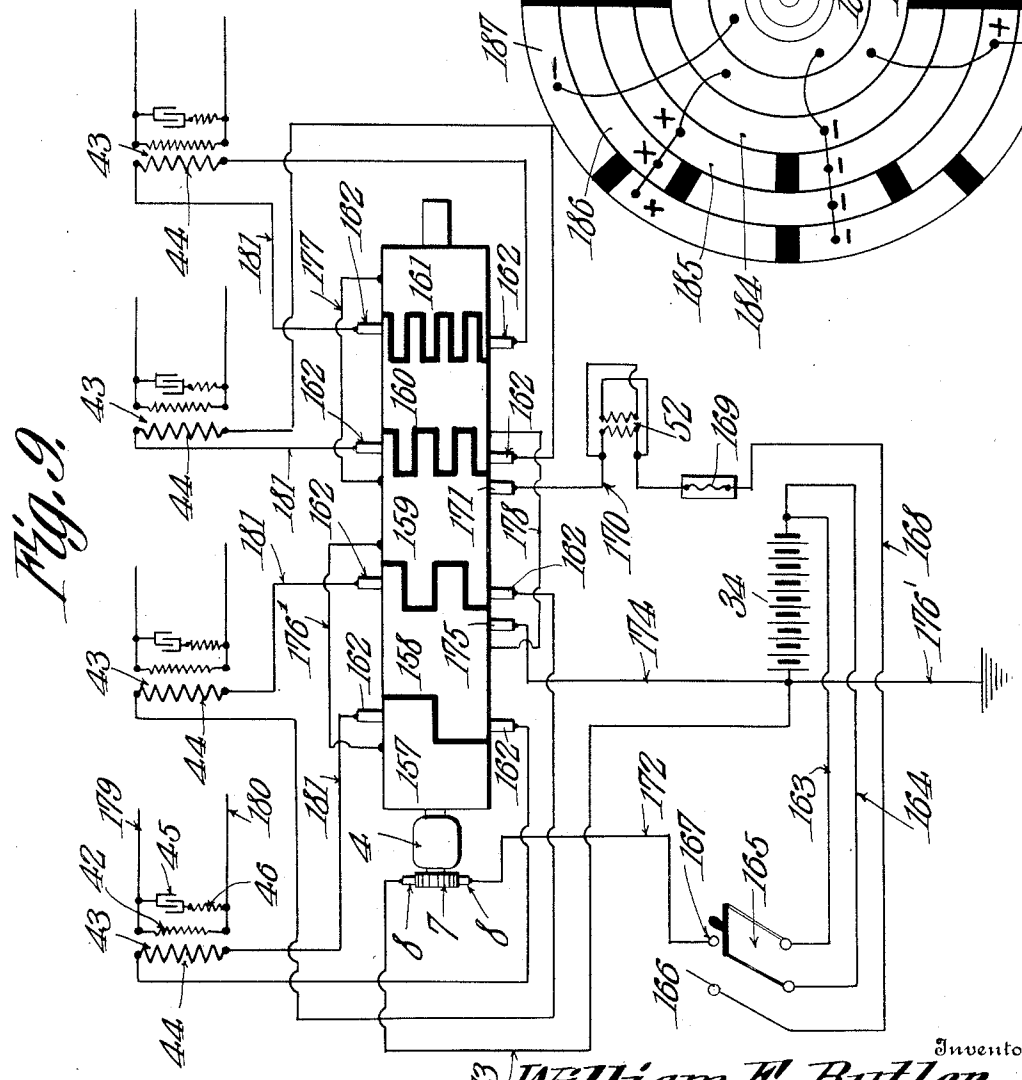


Fig. 9.



Witnesses

E. F. Edmonds

F. T. Chapman

Inventor

William E. Butler.

By C. A. Snow & Co.

Attorneys

UNITED STATES PATENT OFFICE.

WILLIAM E. BUTLER, OF DAVID CITY, NEBRASKA.

CENTRAL-STATION CALL SYSTEM FOR TELEPHONE-LINES.

977,067. Specification of Letters Patent. **Patented Nov. 29, 1910.**

Application filed February 15, 1909. Serial No. 478,003.

To all whom it may concern:

Be it known that I, WILLIAM E. BUTLER, a citizen of the United States, residing at David City, in the county of Butler and State of Nebraska, have invented a new and useful Central-Station Call System for Telephone-Lines, of which the following is a specification.

This invention has reference to improvements in central station call systems for telephone lines, and is designed to provide a central station ringing equipment whereby currents having different characteristics may be sent to line for the selective operation of multi-party lines and whereby a much clearer ringing of the bell is obtained than in prior designs, and the system also provides means whereby batteries or like sources of constant current may be utilized at the central station, and the current furnished thereby may be converted into alternating current and sent to line while at the same time the switch board is kept free from ringing induction and the kick-back into the batteries is prevented.

The invention will be best understood from a consideration of the following detail description taken in connection with the accompanying drawings forming a part of this specification in which drawings,

Figure 1 is a diagram whereby positive, negative or alternating current may be sent to line at the will of the operator. Fig. 2 is an elevation with parts in section of an electric motor and a circuit controlling commutator especially adapted for use in connection with the systems herein shown. Fig. 3 is a side elevation of the commutator end of the motor showing a somewhat modified form of commutator. Fig. 4 is a bottom plan view of the commutator shown in Fig. 3. Fig. 5 is a diagram showing a common battery ringing machine circuit for alternating systems. Fig. 6 is a diagram of a more complex or extended system than shown in Fig. 5. Fig. 7 is a diagram showing a still further development of the circuit shown in Fig. 5. Fig. 8 is a diagram of a ringing machine circuit for common battery alternating and pulsating systems. Fig. 9 is a diagram of a harmonic ringing machine. Fig. 10 is a view of a commutator of the disk type for the harmonic ringing machine of Fig. 9.

Referring first to Fig. 2 there is shown a motor especially adapted for the purposes of the present invention, although this does not preclude the use of other motors.

Upon a base or stand 1 there is erected a frame 2 through which extends the armature shaft 3 of the machine, the armature being indicated by dotted lines at 4, and since it may be an armature of ordinary type, such armature needs no description.

The field of the motor is made of a permanent magnet 5, provision being made to divert part of the flow of the magnet lines of force away from the armature windings and core at will so as to weaken or strengthen the field and so regulate the speed. A thumb nut 6 is provided for this purpose. Of course any other means for regulating the speed of the motor may be used if so desired. The armature shaft 3 carries the usual commutator 7 engaged by brushes 8, both commutator and brushes being shown in dotted lines and need not differ from structures of like character in common use.

Upon the end of the shaft 3 remote from the commutator 7 is a pole changing commutator 9 comprising, in the particular structure shown in Fig. 2 two overlapping members separated by insulating material 10 at the contiguous ends. Mounted on the frame 2 are two posts 11 carrying brush holders 12 each of which is formed with a binding post 13 for the attachment of electric conductors to each brush holder 12. These brush holders may be arranged in the same vertical plane with one pair diametrically opposite to the other pair, one member of one pair of brush holders engaging one of the members of the commutator 9 continuously, and the other member of the same pair arranged to engage the overlapping portion of the two members of the commutator alternately.

In Fig. 2 the commutator 9 is of the drum type. This may be replaced by a disk commutator 14 shown in Figs. 3 and 4, in which case the brush holders 12 are located to correspond to the changed shape of the commutator. In the structure in Figs. 3 and 4 and best illustrated in Fig. 4 the commutator comprises two concentric members 15 and 16 upon which bear brushes respectively connected to the positive and negative sides of the current source, these two members of the commutator being suitably insulated one from the other. The brushes in the brush holders 12 bear constantly upon the active face of the commutator 14, one brush being

in constant engagement with the member 15 and another brush in constant engagement with the member 16 while the other two brushes are so located as to engage alternately the member 15 and the member 17. Conductors connected to the brushes will receive constant current or alternating current in accordance with the portion of the commutator 14 upon which they bear.

In the diagram of Fig. 1 there are illustrated two current sources 18 and 19 which may comprise each a suitable number of battery cells connected up in series. These batteries may be composed of either primary or secondary cells and are coupled together in sufficient number to deliver the desired voltage, and for certain purposes it may be desirable to use the type of battery known as the dry battery.

One side of each battery 18 and 19 is connected to a conductor 20 and this conductor may be connected to another conductor 21 leading to the central station switch board which however is not illustrated in the drawings. The same conductor 21 is connected to one of the brushes 12 in constant contact with one of the members of the commutator 9. The other side of each battery is connected one by a conductor 22 to a switch terminal 23 and the other by a conductor 24 to a switch terminal 25, the terminals 23 and 25 being individually in the path of the switch arms 26 connected by a conductor 27 through a fuse 28 to one of the brushes 12 in constant contact with the other member of the commutator 9. Another conductor 29 is connected to the conductor 27 and leads to the switchboard which, as before stated, is not shown in the drawings. The conductors 21 and 29 constitute the positive and negative conductors respectively whereby such current may be delivered directly to the switchboard from either group of battery cells 18 or 19.

One of the intermediate conductors 12 is connected by a conductor 30 to the switchboard ground and the other intermediate brush 12 is connected by a conductor 31 to the switch board and constitutes the alternating current lead to the switch board from the commutator 9.

Let it be assumed that the motor 4 has its brushes 8 connected up by conductors 32 and 33 to the conductors 20 and 27 respectively. Now as soon as the switch arm 26 is brought into contact with either the terminal 23 or 25 there is established a circuit, assuming that the switch arm 26 is in contact with the terminal 23, from the battery 19 through the conductor 20 and through the conductor 32 to the commutator 7 of the motor, the return circuit being traced through the conductor 33, conductor 27, switch arm 26 by contact 23 and conductor 22 back to the battery 19. The motor is thus energized by the current from the battery 19 and is caused to rotate.

The operator at the switch board now has under control a number of currents of different characteristics. For instance, a steady current of the constant type may be sent by coupling to line the positive and negative conductors 21 and 29, when the circuit may be traced from the battery 18 or 19, as the case may be, to the conductor 20 and from the latter to the conductor 21 and returning by way of the conductor 29 to the conductor 27 thence by the switch 26 to the conductor 24 or 22 and back to the respective battery; or a pulsating negative current may be sent to line by coupling the conductor 29 to the line which is assumed to be grounded at the other end, the return being through the ground conductor 30, in which case the circuit may be traced from the battery through the conductor 20 to the conductor 21 and brush 12 connected thereto, thence through one of the segments of the commutator and out through the ground conductor 30, thence by way of the conductor 29, conductor 27 and switch 26 back to the battery; or a positive pulsating current may be sent to line by coupling up the conductor 21 with the return through the ground 30, in which case the circuit may be traced from the battery through the conductor 21 to the central station, returning by the ground wire 30 to the commutator 9 and, when the latter has turned to the proper point, from the said commutator to the conductor 27 and switch 26 and back to the battery, conductor 12, commutator 9, conductor 30, to the ground, returning by conductor 31 to the commutator 9, conductor 27, to the battery, the commutator constantly reversing the current; or by coupling the conductor 31 to line an alternating current may be sent to the line with the return through the ground 30. By providing two series of batteries 18 and 19 the service need not be interrupted because of the weakening of one battery group since the other is available while the weakened group is being renewed.

Referring now to Fig. 5 there is shown a system for furnishing alternating currents to the line without producing noises at the switchboard and without any kickback from the main line circuit into the battery used as the prime source of power. In this figure the battery is indicated at 34 and may if desired be of the type known as a storage battery. In this drawing the motor is shown simply by the armature 4 and commutator 7 while the circuit controlling commutator driven by the motor is the same as the commutator shown in Fig. 1 and is indicated by the same numeral 9.

One side of the battery 34 is connected to one of the brushes 12 constantly bearing

upon one member of the commutator 9, the connection being through a conductor 35 and the same side of the battery is also connected to ground through a conductor 36. The other side of the battery 34 is connected by a conductor 37 to a double knife switch 38 and in the path of this switch are two contacts 39 and 39′ so that when the switch is closed onto the contacts both are simultaneously in circuit with the conductor 37.

There are two conductors 40 and 41 leading to the switchboard and these conductors are connected to opposite sides of the secondary winding 42 of a transformer 43, the primary winding of which is indicated at 44. This transformer is properly wound to raise the potential of currents furnished to it and deliver high voltage currents to the conductors 40 and 41. Bridged across the terminals of the secondary 42 of the transformer 43 is a condenser and a non-inductive resistance designated by the numerals 45 and 46 respectively, the said condenser and non-inductive resistance being coupled together in series but bridged across the conductors 40 and 41 in multiple with the secondary of the transformer 43.

The condenser and resistance bridged across the secondary of the transformer has been shown in practice to take up the discharge at all times from the transformer and to cut down the spark at the commutator. The condenser and resistance in series acts similar to a counter electromotive force, when properly balanced with the transformer design, but is found to be much better and more economical in action and also consumes less current.

The terminal 39 is connected by a conductor 47 through a fuse 48 to one brush 8 of the commutator 7 of the motor while the other brush 8 of this commutator is connected by a conductor 49 to a conductor 50 leading from the battery 34 at the point of junction of the conductors 35 and 36 therewith, to the conductor 41. The other terminal 39′ of the switch 38 is connected through a fuse 51 to one side of a retardation or choke coil 52 by a conductor 53 and the other side of this coil 52 is connected by a conductor 54 to one of the brushes 12 in constant communication with the member of the commutator 9 other than that to which the brush 12 connected to the conductor 35 is in constant contact.

The coil 52 is provided with two windings which may be connected together either in series or in multiple or may be used singly thus permitting a change in resistance and choking effect in the primary circuit.

The particular arrangement shown in the drawings is that of the multiple arrangement of the two windings of the coil 52.

The two brushes 12 which make alternate contact with the respective members of the commutator 9 are connected one by a conductor 55 to one side of the primary winding 44 of the coil 43 and the other brush by a conductor 56 to the other side of the said primary winding 44.

When the switch 38 is opened then the battery 34 will furnish no current, being on open circuit, but when the switch 38 is closed onto the two contacts 39 and 39′ there is established a circuit from the battery 34 through the commutator 7 and armature 4 of the motor, thence by the conductor 47 through the fuse 48 to the terminal 39, thence by way of the switch 38 and conductor 37 back to the battery. The current furnished through this circuit will cause the rotation of the motor and the like movement of the commutator 9. Another circuit may be traced from the battery 34 by way of the conductor 35 to one member of the commutator 9 thence by the conductor 55 through the coil 44 returning by the conductor 56 to the other member of the commutator 9 thence by way of the conductor 54 and coil 52 to the conductor 53 and through the fuse 51 to the terminal or contact 40, and from thence by way of the switch 38 and conductor 37 back to the battery 34. During the rotative movement of the motor and commutator 9 this circuit is maintained except that the direction of currents through the conductors 55 and 56 and the winding 44 of the coil 43 is reversed at every rotation of the commutator 9. This reversal of the current through the primary winding of the coil 43 will set up alternating currents in the secondary winding 42 and the line wires 40 and 41 and such currents may be utilized by an operator for charging a line and ringing bells responsive to such current. Of course the voltage of the currents sent to line through the conductors 40 and 41 will depend upon the relation of the turns of the coil 42 to the turns of the coil 44 thus permitting the sending to line of as high voltage current as may be desired. The condenser 45 and resistance coil 46 bridged across the terminals of the secondary winding 42 of the coil 43 cause the transformer to discharge through the secondary and this makes a perfect discharge with each and every reversal of the current and the ringing of the bells controlled by the current thus furnished is clearer and more pronounced than with other designs. The path of discharge furnished by the condenser and coil on the secondary side of the transformer 43 prevents the kickback into the battery and keeps the switchboard free from ringing induction.

In the arrangement shown in Fig. 6 there are provided two motor driven commutators 9 and two transformers 43 while for the energization of the circuit and the driving of the motors but one current source 34 is

required, although this does not preclude the use of more than one current source if desired.

From one side of the current source 34 which latter may be either a primary or a secondary battery, there leads a conductor 57 including a fuse 58 and which terminates at a switch 59 having two sets of switch arms 60 and 61, the conductor 57 being common to one switch arm 60 of a pair of switch arms and to an adjacent switch arm 61 of the other pair of switch arms. The other two adjacent switch arms 60 and 61 are connected by a conductor 62 to an adjustable choke coil 52 the other side of which is connected by a conductor 63 to the conductor 57. In the path of one of the switch arms 60 is a terminal 64 from which leads a conductor 65 to one of the brushes 8 of the commutator 7 of one of the motors. The other brush 8 of the commutator 7 is connected by a conductor 66 to a conductor 67 connected to the side of the battery 34 remote from the conductor 57. The other switch arm 60 of the switch 59 has in its path a circuit terminal 68 connected by a conductor 69 to one of the brushes 12 in constant engagement with one of the members of the commutator 9.

One of the switch arms 61 of the switch 59 has in its path a circuit terminal 70 while the other switch arm 61 has in its path a circuit terminal 71. The circuit terminal 70 is connected by a conductor 72 to one of the brushes 8 of the commutator 7 of the other motor while the other brush of this motor is connected by a conductor 73 to the conductor 67 before referred to. The other terminal 71 is connected by a conductor 74 to one of the brushes 12 in constant engagement with a member of the commutator 9 driven by the second motor.

The conductor 67 is connected by a conductor 75 to the brush 12 in constant engagement with the other member of the commutator 9 of the first named motor and the conductor 67 is itself also connected to the brush 12 in constant engagement with the other member of the commutator 9 of the second named motor from that with which the conductor 74 is connected.

One of the brushes 12 which are arranged to make alternate contact with the two members of the commutator 9 of the first named motor is connected by a conductor 76 to a circuit terminal 77 in the path of a switch arm 78 of a switch 79 and also in the path of the switch arm 78 is another circuit terminal 80 connected by a conductor 81 to the brush 12 of the commutator 9 of the second motor corresponding to the brush 12 of the first named motor to which the conductor 76 is connected.

The switch 79 is provided with another switch arm 82 in the path of which are two terminals 83 and 84. The terminal 83 is connected by a conductor 85 to the contact brush of the commutator 9 of the first named motor opposite that to which the conductor 76 is connected. The contact terminal 84 is connected by a conductor 86 to the corresponding brush 12 of the commutator 9 of the second named motor to that brush of the commutator 9 of the first named motor to which the conductor 85 is connected. There is also provided another switch 87 having two sets of arms 88 and 89 similar to the switch 59. The arm 78 of the switch 79 is permanently connected to the arms 88 and 89 on one side of the switch 87 by a conductor 90 while the arm 82 of the switch 79 is connected by a conductor 91 to the other arms 88 and 89 of the switch 87.

In the path of the two arms 88 of the switch 87 are two circuit terminals 92 and 93 connected by respective conductors 94 and 95 to the primary winding 44 of the transformer 43. In the path of the arms 89 of the switch 87 are other contacts 96 and 97 connected by respective conductors 98 and 99 to the primary winding 44 of another transformer 43.

Bridged across the secondary windings 42 of each transformer is a condenser 45 and a non-inductive resistance 46 in series one with the other. One side of each secondary winding 42 of the two transformers 43 is connected to a conductor 100 leading to the switchboard or to ringing bus-bars, which however are not shown and may be such as are in ordinary use. The other sides of the secondary coils of the two transformers 43 are connected by respective conductors 101 and 102 to respective circuit terminals 103 and 104. The circuit terminal 103 is in the path of a switch arm 105 and the circuit terminal 104 is in the path of the switch arm 106 and these two switch arms 105 and 106 have common connection to a conductor 107 leading to the switchboard or to the ringing bus-bars.

With the arrangement shown in Fig. 6 either side of the switch 59 may be closed down on the respective contact and in that case either motor will be energized or both motors may be charged at the same time. By a proper manipulation of the two members of the switch 87 either or both transformers 43 may be coupled to the switch 79 at will. However the commutators 9 of the two motors may be coupled up to the switch 87 only one at a time. Furthermore, the secondaries of the two transformers may be coupled up singly or together in multiple arc relation to the line conductors 100 and 107 by a proper manipulation of the switch arms 105 and 106.

The circuits may be traced as follows: from the battery 34 by conductor 57 thence to switch 59 and by way of conductor 65 to

the commutator 9, thence by conductor 66 to conductor 67 and back to the battery 34, considering the switch 59 as closed on the conductor 65. If the other side of the switch 59 be closed on the conductor 72 then the other motor will be energized, or if both switches be closed then both motors will run.

Considering the commutator 9 the circuit may be traced from the battery 34 to the conductor 57 to the conductor 63, through the inductors 52 and from thence by the conductor 62 to the switch 59, thence to the conductors 69 and 74 and to the respective commutator 9. Under the showing of the drawings the circuit may be continued from one commutator through the conductor 76 to the switch 79, if the latter be closed thereon, thence by way of the conductor 90 to the switch 87, and, if the latter be closed on the contact 97, then by way of the conductor 99 through the primary of the respective induction coil thence by way of the conductor 98 again to the switch 87 on the other side thereof, thence by conductor 91 to the switch 79 and, assuming that the latter is closed on the contact 83, from the said contact 83 to the conductor 85, thence through the respective segment of the commutator 9 by way of conductor 75 to conductor 67 and back to the battery 34. The circuit on the other side of the system shown in Fig. 6 is like that just described and so need not be repeated.

As the commutator 9 rotates, first a positive impulse and then a negative impulse will traverse the circuit and the transformer will be charged in the usual manner, sending alternating currents to the line conductors 100 and 107.

By running the motors at different speeds it is within the power of the operator to throw upon the line currents of correspondingly different frequency while complete control over the current produced upon the line 100 and 107 and also as to whether one or the other or both motors shall be operating is provided by the several switches 59, 79, 87, and 105 and 106.

The diagram in Fig. 7 illustrates a system similar to that of Fig. 6 but including means for sending pulsating currents to line for ringing purposes.

The two motors and two transformers are retained and also the current source represented by the battery 34 as well as the retardation or choke coil 52 and the switch 59. The commutators 9 are however replaced by other commutators 9′ differing from the commutators 9 in having a segment or member intermediate of and overlapping the two end members which are separated by the intermediate member. The conductor 65 is connected to the commutator 7 of the motor as in the arrangement shown in Fig. 6 and the conductor 72 is connected to the commutator 7 of the other motor as in Fig. 6. The conductor 69 is connected to a brush 12′ of the commutator 9′ of one motor which brush is in constant engagement with one of the end sections of said commutator. The conductor 74 is connected to a like brush 12′ of the commutator 9′ of the other motor. There is also provided another switch 108 provided with four switch arms 109, 110, 111, and 112 insulated one from the other but connected for simultaneous control. There is also provided still another switch 113, having two sets of arms 114 and 115, the several arms 114 being insulated one from the other and connected for simultaneous control and the same is true of the arms 115.

In the path of the switch arm 109 are two circuit terminals 116 and 117. In the path of the switch arm 110 are two circuit terminals 118 and 119. In the path of the switch arm 111 are two circuit terminals 120 and 121. In the path of the switch arm 112 are two circuit terminals 122 and 123.

The circuit terminal 116 is connected by a conductor 124 to one of the brushes 12′ of the commutator 9′ of the first named motor which brush is in constant engagement with the end member of the commutator 9′ remote from the member with which the conductor 69 is in constant engagement. The circuit terminal 117 is connected by a conductor 125 to a contact brush 12′ similar in arrangement to the commutator 9′ of the second named motor as is the brush of the commutator of the first named motor connected to the conductor 124. The contact terminal 118 is connected by a conductor 126 to a contact brush 12′ of the commutator 9′ of the first named motor arranged to make alternate contact with the intermediate member of the commutator 9′ of the first named motor and the end member with which the conductor 124 makes constant contact. The circuit terminal 119 is connected by a conductor 127 to a brush 12′ of the commutator 9′ of the second named motor corresponding to the connection of the conductor 126 to the first named motor.

The circuit terminal 120 is connected by a conductor 128 to a contact brush 12′ in constant engagement with that segment of the commutator 9′ of the first named motor with which the conductor 69 is in constant engagement. The contact 121 is connected by a conductor 129 in a similar manner to a brush 12′ in constant engagement with the commutator 9′ of the second named motor, this being the same segment with which the conductor 74 is in constant engagement. The circuit terminal 122 is connected by a conductor 130 to a brush 12′ in position to engage alternately with the intermediate member of the commutator 9′ of the first named motor and the end member with which the conductors 69 and 128 are in constant engagement. The circuit terminal 128

is connected by a conductor 131 with a brush 12′ related to the commutator 9′ of the second named motor similar to the brush of the commutator of the first named motor to which the conductor 130 is connected. In the path of the arms 114 of the switch 113 are circuit terminals 132, 133 and 134 and in the paths of the arms 115 of the switch 113 are other circuit terminals 135, 136 and 137.

The circuit terminal 132 is connected by a conductor 138 to one side of the secondary winding 42 of one of the transformers 43. The circuit terminal 133 is connected by a conductor 139 to one side of the primary winding of the transformer 43 referred to. The circuit terminal 134 is connected by a conductor 140 to the other side of the primary winding 44 of the transformer 43 referred to. The circuit terminal 135 is connected by a conductor 141 to one side of the secondary winding of the second transformer 43. The circuit terminal 136 is connected by a conductor 142 to one side of the primary winding 44 of the second named transformer. The circuit terminal 137 is connected by a conductor 143 to the other side of the primary winding of the second transformer.

The switch arms of the switch 113 in the paths of which are the circuit terminals 134 and 137 are connected by a conductor 144 to the switch arm 112. The switch arms of the switch 113 in the paths of which are the circuit terminals 132 and 135 are also connected to another switch arm 145 in the path of which are two circuit terminals 146 and 147. The circuit terminal 146 is connected by a conductor 148 to a brush 12′ of the commutator 9′ of the first named motor in constant engagement with that end of the said commutator with which the brush connected to the brush 124 is also in constant engagement. The contact circuit terminal 147 is connected by a conductor 149 to a brush 12′ of the commutator 9′ of the other motor corresponding to the brush with which the conductor 148 is connected.

In the diagram of Fig. 7 there are shown four line wires or conductors 150, 151, 152 and 153. It will be observed that these conductors are shown in dotted lines, but this is only for distinctive purposes and to clearly differentiate these conductors from other conductors.

The conductor 150 is coupled to the side of the secondary winding of the first named transformer remote from that to which the conductor 138 is connected, and the secondary winding of the other transformer is connected to this same conductor on the side remote from that to which the conductor 141 is connected. The conductor 151 is connected to the switch arm 145 and also to the switch arms 114 and 115 in the paths of which are the circuit terminals 132 and 135. The conductor 152 is connected to the switch arm 109 and conductor 153 is connected to the switch arm 110.

As already explained with relation to the system of Fig. 6 either or both motors may be set in operation by a suitable manipulation of the switch 59, and at the same time either or both conductors 69 and 74 are coupled up to the current source.

The switch arms 109, 110, 111, and 112 of the switch 108 can be brought into engagement with the circuit terminals 116, 118, 120 and 122 or with the switch terminals 117, 119, 121 and 123 but only with one set at a time.

The switch 113 may be manipulated to bring the switch arms 114 into engagement with the circuit terminals 132, 133 and 134 and the switch arms 115 into engagement with the circuit terminals 135, 136 and 137, the said switch arms 114 and 115 being capable of manipulation to close the circuit onto their respective circuit terminals at the same time if the operator so wills.

The switch arm 145 may be brought into contact with either circuit terminal 146 or 147 but not both at the same time.

Let it be assumed that both members of the switch 59 are closed and both members of the switch 113 are also closed, and that the switch 108 is closed onto the circuit terminals 116, 118, 120 and 122. Furthermore let it be assumed that the switch arm 145 is closed on the contact or circuit terminal 146. There is now transmitted to the conductors 150 and 151 alternating currents from the secondary of the first named transformer 43 while pulsating currents are sent to the conductors 152 and 153, the frequency of these currents depending upon the speed of the commutator 9′ of the first motor. By reversing the switch 108 and also the switch 145 the second commutator 9′ may be brought into action and currents of a frequency depending upon the speed of rotation of this commutator will be sent to line as before.

The circuits of Fig. 7 may be traced as follows: Leaving the battery 34 the circuit may be traced along the conductor 57 to the switch 59 thence by conductor 65 to the motor 4 and returning by conductor 66 to conductor 67 and back to the battery 34. Another circuit may be traced from the battery 34 by way of conductors 57 and 63 through the reaction coil 52 thence by conductor 62 to the switch 59 thence by conductor 69 to the commutator 9′ on the left hand side of the figure thence by conductor 128 to the terminal 120 thence by switch arm 111 and by conductor 120 to the switch 113, thence to contact 133 and to the primary coil of the transformer at the left hand side of Fig. 7. From this transformer the cir-

cuit may be traced by conductor 140 to contact 134, thence by the switch 113 to the conductor 144, thence to switch arm 112, contact 122, conductor 130, to the central block of the commutator 9′ first considered, thence to conductor 67 and back to the battery. Another circuit may be traced from the commutator 9′ by way of the conductor 126 to the terminal 118, switch arm 110, and by conductor 153 to the switch board. As the commutator 9′ rotates the transformer will receive alternating currents and deliver other alternating currents to the conductors 150 and 151.

In Fig. 8 there is shown the system of Fig. 5 with the addition of means for producing pulsating currents in addition to the alternating currents. For this purpose the commutator 9′ is used instead of the commutator 9.

The battery 34 is connected by the conductor 35 to a brush 12′ in constant contact with the intermediate member of the commutator 9′. This intermediate member takes the place of one of the end members of the commutator shown in Fig. 5. The alternating side of the system of Fig. 8 is like that of Fig. 5 and requires no further description.

There are other line conductors 154 and 155. The conductor 154 is connected to a brush 12′ arranged to engage alternately the end member of the commutator 9′, remote from that engaged by the brush connected to the conductor 54 and also to engage the intermediate member of the commutator 9′. The conductor 155 is connected to a brush 12′ which like the brush connected to the conductor 154 is designed to alternately engage the intermediate member of the commutator 9′ and that end member which is engaged by the brush connected to the conductor 154. However since these two brushes are in opposite relation one to the other they are never in engagement with the same member of the commutator at the same time. The end member of the commutator 9′ remote from that engaged by the brush connected to the conductor 54 is engaged by a brush 12′ connected by a conductor 156 to one side of the secondary winding 42 of the transformer 43.

With the system shown in Fig. 8 the switch 38 is closed to set the motor in operation and then alternating currents are produced upon the lines 40, 41 and pulsating currents upon the lines 154 and 155, the pulsating currents being positive or negative upon the conductors 154 and 155 in accordance with the connection of these conductors to the battery 34.

The circuits shown in Fig. 8 may be traced as follows. Starting from the battery 34 the current will flow through the motor 4, then by conductor 47 and fuse 48 to the switch 38, assuming the latter to be closed, then by conductor 37 back to the battery 34, thereby causing the motor to run and the commutator 9′ will be actuated thereby. In the particular position of the commutator shown in Fig. 8 the circuit may be traced from the battery 34 by way of conductor 35 to the middle segment of the commutator, thence by conductor 55 to the primary coil of the transformer, thence by the conductor 56 to one end segment of the commutator, thence by conductor 54, choke coil 52, conductor 53, fuse 51, contact 40, switch 38, and conductor 37 back to the battery 34, thus sending an impulse in one direction to the primary of the induction coil. As soon as the commutator has turned sufficiently then the relation of the conductors 55 and 56 has changed so that a current impulse will flow from the battery 34 through the conductor 35 thence directly to the conductor 56 and to the primary coil of the induction coil, thence by way of conductor 55 to the end segment of the commutator first considered, thence by conductor 54, choke coil 52, conductor 53, and switch 38, to the conductor 37 and back into the battery 34, thus sending an impulse in the reverse direction to the primary of the induction coil. There is therefore set up in the secondary of the induction coil a series of alternating impulses which may pass by the conductors 40 and 41 to the switch-board, or by the conductor 40 to the switch-board or other point of utilization and back by the ground conductor 36 and conductor 50 to the other side of the secondary of the induction coil.

A second impulse may traverse the conductor 156 to the other end segment of the commutator and from thence to the switch-board through the conductor 154, such impulses being intermittent and always in the same direction. On the turning of the commutator the conductor 156 will be coupled up with the conductor 155 and an impulse of the opposite sign will be sent through this conductor to the switch-board, the impulses being intermittent and always of the same opposite sign through the conductor 155. The return of the secondary winding of the induction coil may be through the ground conductor 36 thence by the conductor 50 and that portion of the conductor 41 included between the conductor 50 and the secondary winding of the induction coil, or the return to the secondary of the induction coil may be through the entire extent of the conductor 41 from the point of utilization.

In Fig. 9 there is shown a diagrammatic representation of a harmonic ringing machine. In the arrangement shown in Fig. 9 the commutator is made up of a number of sections 157, 158, 159, 160 and 161, although the number of sections may be greater or smaller as desired. For convenience it will

be assumed that the speed of rotation of the commutator and the arrangement of the sections is such that brushes engaging with the sections 157 and 158 will deliver $16\frac{2}{3}$ alternations per second, the sections 158 and 159 will deliver $33\frac{1}{3}$ alternations per second, the sections 159 and 160 will deliver 50 alternations per second and the sections 160 and 161 will deliver $66\frac{2}{3}$ alternations per second. It will be observed that the meeting ends of the several sections intermesh but are separated by insulating material to prevent electrical contact. On opposite sides of the commutator bear brushes 162 in position to engage the intermeshing portions of the sections.

One side of the battery 34 is connected by two conductors 163 and 164 to the respective arms of a double arm switch 165 and in the path of the arms of this switch are circuit terminals 166 and 167. The circuit terminal 166 is connected by a conductor 168 to a retardation or choke coil 52 and includes a fuse 169. The other side of the choke coil 52 is connected by a conductor 170 to a brush 171 in constant engagement with the commutator member 159.

The circuit terminal 167 is connected by a conductor 172 to one brush 8 of the commutator 7 of a motor such as has been heretofore described for driving the pole changing commutator made up of the segments 157, 158, 159, 160 and 161. The other brush 8 of the commutator 7 is connected by a conductor 173 to the side of the battery 34 remote from that connected to the conductors 163 and 164. The same side of the battery to which the conductor 173 is connected is also connected by a conductor 174 to a brush 175 in constant engagement with the commutator member 158 and this same side of the battery is also connected to ground through a conductor 176'.

The commutator member 157 is permanently connected to the commutator member 159 by a conductor 176 and the commutator member 159 is permanently connected to the member 161 by a conductor 177, thus the members 157, 159 and 161 are in constant electrical connection. The commutator member 158 is permanently connected to the commutator member 160 by a conductor 178. The conductors 176, 177 and 178 are only diagrammatically represented in the drawings but it will be understood that in practice these conductors will be concealed within the interior of the commutator.

It will be observed that there are four brushes 162 on each side of the commutator. All the brushes 162 on one side of the commutator are connected respectively to one side of an equal number of primary windings 44 of respective induction coils 43 while the other sides of these same windings are connected respectively to the other brushes 162 on the opposite side of the commutator.

The secondary windings 42 of each induction coil is connected to respective line conductors 179 and 180 and these conductors are bridged by a condenser 45 and non-inductive resistance 46 connected in series adjacent to each secondary winding 42.

When the switch 165 is closed onto the circuit terminals 166 and 167 the motor is set in motion and the pole changing commutator participates in such movement. Current passes from the battery 34 by the conductor 164 through the respective side of the switch 165 to the conductor 168, and from this conductor 168 the circuit may be traced through the fuse 169 and adjustable retardation or choke coil 52 by the conductor 170 to the brush 171 bearing on the commutator member 159. The circuit from the other side of the battery 34 may be traced by the conductor 174 to the brush 175 bearing on the commutator member 158.

If it be assumed that the brush 171 is connected to the positive side of the battery 34 then the brush 175 is connected to the negative side of such battery. The circuit from the battery 34 may be traced by way of the conductor 164 and switch 165 to the conductor 168, assuming the switch to be closed, thence to brush 171 and to section 159 of the commutator, thence by conductor 177 to section 161 of the commutator and from the latter by way of the brush 162 to the primary of the respective one of the induction coils, thence by way of conductor 181 to a brush 162 and to section 160 of the commutator, thence by conductor 178 to section 158 of the commutator and thence by way of brush 175 and conductor 174 back to the battery. Under these conditions the circuit may be further traced through the several brushes 162 on the same side of the pole changing commutator as is the brush 171 to one side of each of the primary coils of the several transformers 43, the circuit returning by conductors 181 to the brushes 162 on the opposite side of the pole changing commutator. As the said pole changing commutator is rotated the relation of the polar ends of the battery 34 to the primary windings 44 is alternated a number of times per revolution of the pole changing commutator depending upon the number of intermeshing portions of the members picking up such commutator. In the particular arrangement under consideration it is assumed that if the number of alternations per second between the brushes bearing upon the commutator members 157 and 158 is $16\frac{2}{3}$ times per second then the number of alternations of the other brushes and primary coils will increase in the ratio of 2, 3 and 4 toward the other end of the commutator. These ratios are to be taken as examples and the invention is by no means bound to them. However whatever ratios of alternation be chosen they

remain absolutely fixed since the several members of the commutator are mounted upon the same shaft and have the same speed of rotation at all times. By means of the system displayed in Fig. 9 the ringing circuits are assumed to be responsive to the several frequencies produced upon the line.

Instead of the drum shaped commutator shown in Fig. 9, a disk commutator such as shown in Fig. 10 may be used wherein there are provided two concentric rings 182 and 183 around which are annuli 184, 185, 186 and 187 concentric with the axis of rotation of the commutator and insulated one from the other and from the rings 182 and 183. The several annuli are divided into a number of sections so as to produce the requisite number of alternations in the electric current as may be desired. The adjacent ends of the sections of each annulus are separated by insulating material 188. The width of the insulation 188 is sufficient to prevent the brushes from bridging the contiguous ends of the sections of the different annuli.

What is claimed is:—

1. In a ringing system for telephone lines, a source of direct current, a rotatable pole changer, a direct current motor for driving the pole changer, means for coupling the source of current to the motor and at the same time to the pole changer and through the latter to the line conductors, and a transformer coupled to the source of current through the pole changer.

2. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, means for coupling the source of current to the motor and at the same time to the pole changer and through the latter to the line conductors, a transformer coupled to the source of current through the pole changer, and a condenser and resistance in series bridged across the secondary winding of the transformer.

3. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, means for coupling the source of current to the motor and at the same time to the pole changer and through the latter to the line conductors, a transformer coupled to the source of constant current through the pole changer, and a condenser and a non-inductive resistance in series bridged across the secondary winding of the transformer.

4. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, an adjustable retardation or choke coil in the circuit of the pole changer, a transformer for converting the current supplied by the constant current source into alternating current, and a condenser and resistance in series bridged across the secondary of the transformer.

5. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, an adjustable retardation or choke coil in the circuit of the pole changer, a transformer for converting the current supplied by the constant current source into alternating currents, and a condenser and non-inductive resistance in series bridged across the secondary of the transformer.

6. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, a retardation or choke coil in the circuit of the pole changer, said retardation coil having two windings, a transformer for converting the current supplied by the constant current source into alternating current, and a condenser and resistance in series bridged across the secondary of the transformer.

7. In a ringing system for telephone lines, a source of constant current, a rotatable pole changer, a constant current motor for driving the pole changer, a retardation or choke coil in the circuit of the pole changer, said retardation coil having two windings, a transformer for converting the current supplied by the constant current source into alternating currents, and a condenser and non-inductive resistance in series bridged across the secondary of the transformer.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

WILLIAM E. BUTLER.

Witnesses:
WILLIAM E. HEWIT,
J. K. MASHEK.