July 26, 1932. C. A. ANDERSON 1,868,960

TEST SET

Filed Feb. 9, 1931 2 Sheets-Sheet 1

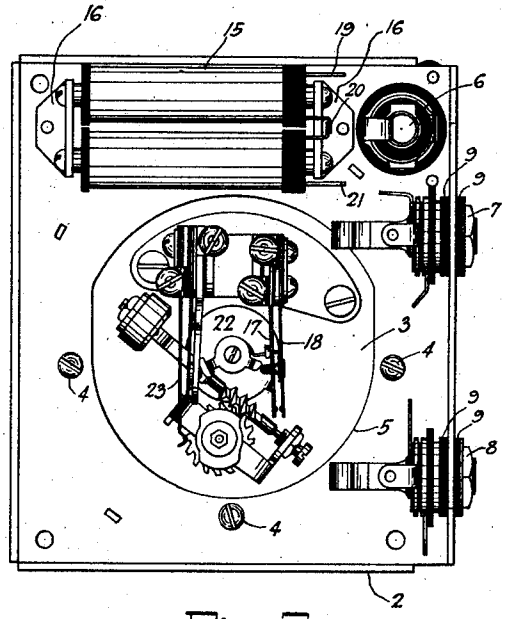


Fig. 2

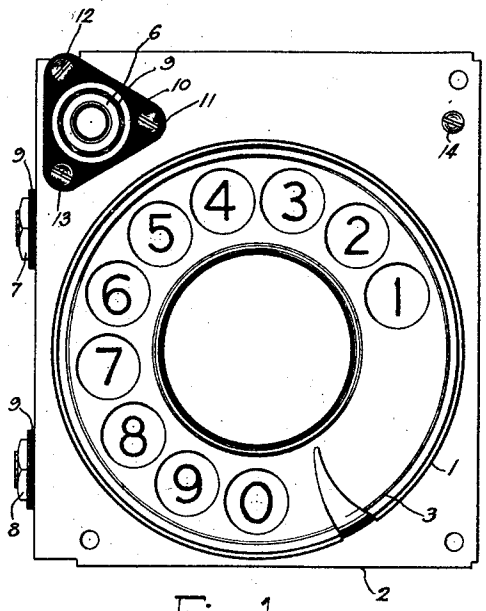


Fig. 1

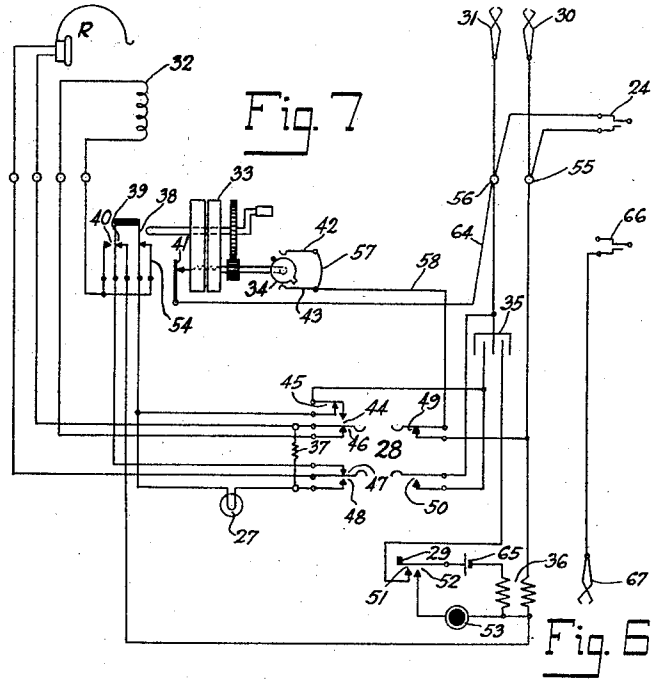


Fig. 7

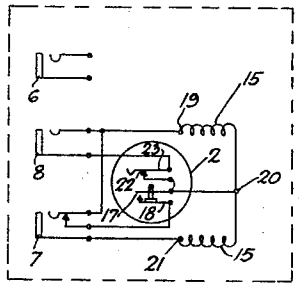


Fig. 5

Fig. 6

Inventor
Clarence A. Anderson

R. G. Richardson
Atty.

July 26, 1932. C. A. ANDERSON 1,868,960

TEST SET

Filed Feb. 9, 1931 2 Sheets-Sheet 2

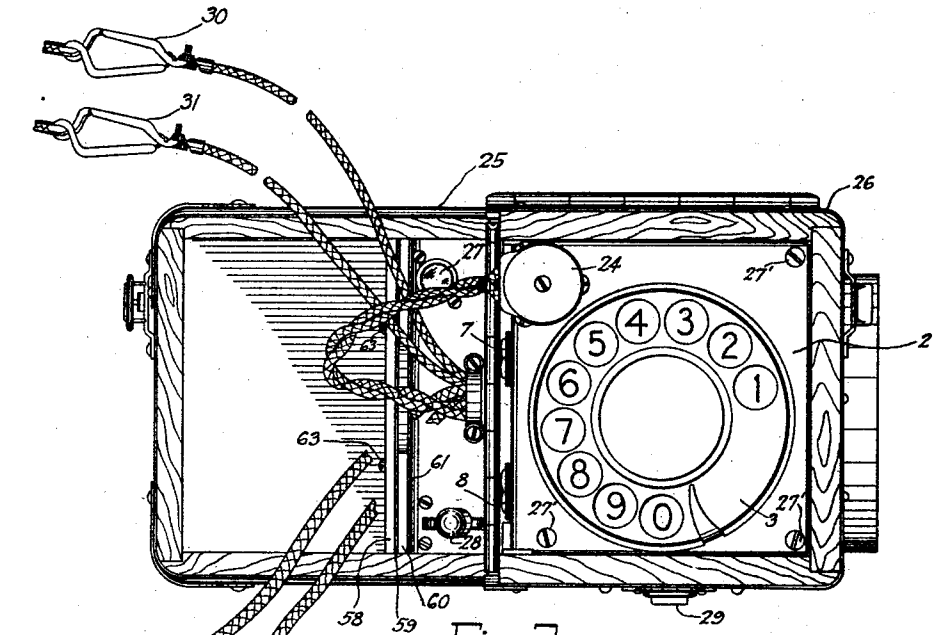
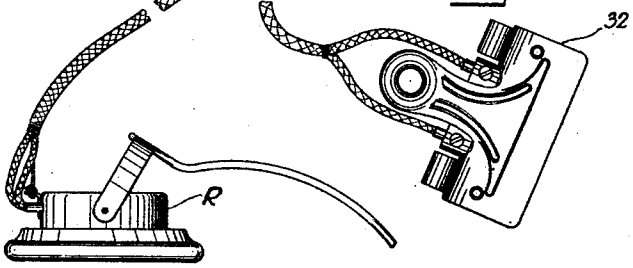


Fig. 3



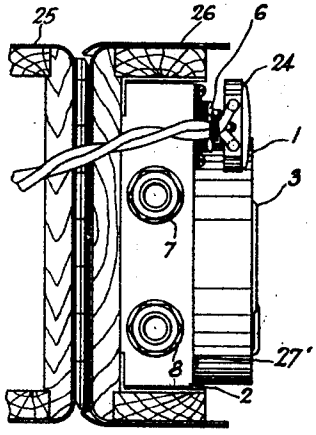


Fig. 4

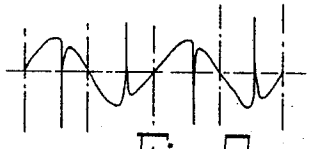


Fig. 9

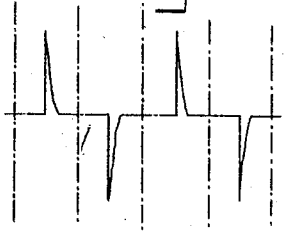


Fig. 10

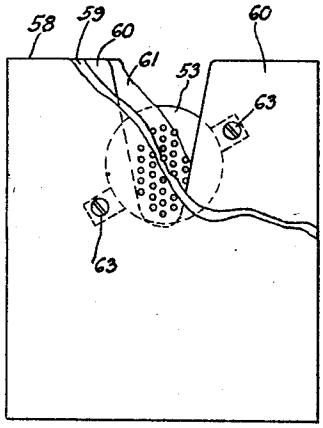


Fig. 8

Inventor

Clarence A. Anderson

R B Richardson

Atty.

Patented July 26, 1932 1,868,960

UNITED STATES PATENT OFFICE

CLARENCE A. ANDERSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASSOCIATED ELECTRIC LABORATORIES, INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE

TEST SET

Application filed February 9, 1931. Serial No. 514,367.

This invention relates to portable test sets in general but is concerned more particularly with portable test sets for locating faults in transmission lines by means of alternating or pulsating current and an exploring coil.

Portable test sets of the above type of which a representative set is shown in applicant's Patent No. 1,728,207, granted October 14, 1930, are commonly provided with a transmitter which, with the receiver required for testing purposes, permits the use of the test set as a telephone instrument. This arrangement enables a lineman to communicate with the central office attendant from any point in the system and thus obtain quickly and easily, any assistance or information required. When such sets are used in telephone systems employing automatic switching, the calling range of the lineman has been more or less restricted since, in the past, it has been considered impractical for various reasons to equip the test set with a calling device.

Applicant has now produced a calling device or dial unit which may readily be incorporated with any of the commonly used test sets, including that above referred to, without requiring any extensive changes in the set and without interfering in any way with its normal testing functions. This unit is a simple and practical device adapted to be mounted in the cover of the test set case. The unit occupies space which is normally unused and, as it is small, it adds relatively little to the weight of the set. With the set equipped in this manner the lineman can operate the switching apparatus of the automatic exchange over either loop or simplex lines to establish whatever connections are required.

While as above stated, the auxiliary dial unit is adapted to operate with any of the commonly used test sets, applicant has shown the unit incorporated in a test set which differs in a number of particulars from prior sets. These differences are the results of various modifications introduced to improve the operating characteristics of the set and comprise additional features of the present invention. One of these features is the tone generating arrangement in which a condenser, charged in a local circuit, is periodically discharged over the line under test. The low resistance of the local circuit permits full charging of the condenser and when this point is reached, mechanically controlled cam springs on the generator connect both the generator and condenser across the line under test. The resulting surge of current over the line produces a very distinctive and penetrating tone. In prior test sets a somewhat similar tone is produced by charging a condenser in series with the line under test and then periodically short-circuiting the generator. With the present arrangement the generator current is applied to the line only while the condenser is being discharged.

Another feature is the provision of a generator cam with a single projection engaging two oppositely disposed springs in the place of the double projection cam and single spring ordinarily provided. This arrangement permits the separate employment of current of either polarity by the simple expedient of disconnecting one or the other of the springs. The particular polarity which has the least effect on relays or other apparatus connected to the line under test will be employed. Both springs may be used simultaneously if desired, in which case the tone current produced will be somewhat similar to that produced by the old arrangement in that an impulse of tone current will be applied to the line for each half cycle of the generator current.

Another feature is the arrangement for shunting a condenser across the receiver of the set when the transmitter circuit is closed. This arrangement increases the transmission efficiency of the set.

Another feature designed to increase the transmission efficiency of the set is the provision of a special tone chamber for the transmitter. This chamber is placed behind the metal plate which divides the test set case into two compartments and may be easily installed in existing sets.

Another feature designed to increase the efficiency of the receiver is the arrangement whereby the finder coil, which is normally connected in series with the receiver, is shunt-

ed by a non-inductive resistance. The operation of the generator automatically removes the shunt and permits the coil to be used in the regular manner.

Still another feature is the arrangement for shunting the receiver with a low resistance when the lamp test is made to determine the resistance of a line.

The foregoing features together with others not specifically mentioned, will be discussed in more detail hereinafter in connection with the description of the construction and operation of the test set and the dial unit, reference being had to the accompanying drawings. The drawings comprise Figs. 1 to 10, inclusive, of which Fig. 1 shows a top view of the auxiliary dial unit, Fig. 2 shows a view of the underside of the unit with the wiring removed, Fig. 3 is a top view of a portable test set showing the dial unit mounted in the cover of the carrying case, Fig. 4 is a front view of the unit as it appears when mounted in the cover of the test set case, Fig. 5 is a circuit diagram of the dial unit, Fig. 6 shows a ground cord for use in connection with the unit, Fig. 7 shows the circuit for a portable test set incorporating the various features of the invention, Fig. 8 is a front view of the plate dividing the test set case into two compartments with sections cut away to show the construction of the transmitter tone chamber, Fig. 9 represents the wave form of the tone current produced by the generator and interrupter of a test set of the type disclosed in applicant's Patent No. 1,728,207, previously referred to, and Fig. 10 represents the wave form of the tone current produced by the generator and interrupter of the present invention when both cam springs are connected up.

The construction of the auxiliary dial unit may be readily seen in Figs. 1 and 2. The base 2, on which the apparatus is mounted, consists of a metal plate with the four sides bent down to form a shallow open rectangular box. On the upper side of the base is mounted the calling device or dial 3 which is fastened to the plate by means of screws 4. The hole 5 in the top of the base permits the dial mechanism to extend into the interior of the base thus affording easy access thereto for assembly and adjustment. The dial may be of any suitable type, that shown being similar to the dial disclosed in Patent No. 1,642,822, granted September 20, 1927, to H. F. Obergfell. A circular metal rim 1, slightly larger in diameter than the dial is staked to the top of the base. This rim forms a well in which the dial is set and protects it from injury. Three small jacks of the type commonly known as radio jacks are mounted on the base. Jack 6 is mounted on the face and jacks 7 and 8 are mounted on one side, which will hereinafter be referred to as the front side of the base. The jacks shown are similar to the one disclosed in Patent No. 1,620,755, granted March 15, 1927, to A. J. Carter. The jacks are insulated from the base by fibre washers 9. Jack 6 is fastened to a triangular metal plate instead of to the base itself. The plate in turn is fastened to the base by three machine screws 11, 12, and 13. This arrangement permits the use of a lower base while still providing sufficient space for the jack springs. Screw 11, together with screw 14, serve to fasten the impedance coils 15 to the under side of the base. The two coils are rigidly held between two metal brackets 16 which are threaded to accommodate screws 11 and 14, above referred to. Each of the jacks is provided with a break spring combination in addition to the usual tip and sleeve contact. In the present case, however, only the spring combination in jack 7 is used as will be explained hereinafter.

Referring to Fig. 5 is will be seen that terminal 19 of the upper impedance coil is wired to the tip contacts of jacks 7 and 8. The inside terminals 20 of the coils are soldered together and wired to off-normal spring 17 of the dial, which in turn is permanently connected with impulse spring 22. Terminal 21 of the lower coil is wired to the sleeve of jack 7 and impulse spring 23 is wired to the sleeve of jack 8. Off-normal spring 18 is wired to the contact spring which normally engages the tip spring of jack 7. It will be noted that jack 6 has no circuit connections whatever with the set. The jack has no function of the operation of the unit but provides a place for carrying the plug 24 when the cover 26 is shut. Plug 24 incidentally is a short, flat-ended plug commonly known as a radio plug, of the type disclosed in Patent No. 1,726,692, granted September 3, 1929, to A. J. Carter. The tip and sleeve elements of the plug are connected to terminals 55 and 56 of the test set, with which the unit is to be used. The operation of the dial unit will be described in connection with the test set in later paragraphs.

The mounting of the dial unit in the test set case is shown in Figs. 3 and 4. The test set case of which only a part is shown is similar to the case shown in Patent No. 1,778,207, previously referred to. The body 25 of the case is provided with a double hinged cover of which the section 26 is adapted to fold back, as shown. The unit is held in place by screws 27 and is so placed that jacks 7 and 8 face the front of the set and are accessible when the cover is open. With the unit in place the "1" finger hold of the dial will be opposite the right end or rear of the case. This is the most convenient location for the lineman who will normally carry the set so that the generator crank can be turned with the right hand. The plug 24 will be carried

in jack 6, as shown in Fig. 4, when the set is not in use.

Test set, Fig. 7, mechanically is similar to test set shown in Patent No. 1,778,207. The circuit, however, has been modified to incorporate various new features as hereinbefore pointed out. Receiver R, finder coil 32, magneto generator 33 and its spring combination, transmitter 53, induction coil 36, key 29, lamp 27, and line clips 30 and 31 are exactly the same as the corresponding parts shown in the above patent. The various elements of the test set including transmitter 53 and the metal plate 58 are assembled as a unit as shown in applicant's patent above referred to. Plate 58 divides the test set into two compartments, one for the equipment unit and the other for the storage of the receiver, cords, finder coil, etc. In the prior test set, the plate 58 was perforated to permit sound waves to pass from the storage compartment to the transmitter in the equipment compartment. The storage compartment acted as a sound box for directing the speaker's voice to the transmitter. With the present arrangement as shown in Fig. 8, a separate, properly shaped sound chamber is inserted between the plate 58 and the transmitter. This chamber is formed by a V-shaped slot in a sheet 60 of leather, cork or other similar material approximately one eighth of an inch thick which is interposed between the plate and the transmitter. The mouth of the slot is at the top of the sheet and can be readily spoken into by the lineman using the set. A sheet 61 of stiff, fibrous material is placed between the sheet 60 and the transmitter. This sheet is perforated directly opposite the transmitter and serves to direct the sound waves to the proper point. In case this arrangement is applied to a test set already equipped with a perforated plate 58, an unperforated sheet 59 of fibrous material is inserted between the plate and the sheet 60 to cover the perforations in the plate. The transmitter, plate, and fibrous sheets are firmly held in place by screws 63 which extend through the plate to the transmitter mounting bracket. The tones produced by a second chamber of this character are much clearer and sharper than those produced by the storage compartment when used as a tone chamber.

Another point on which the present invention differs from prior test sets is in the arrangement of the cam springs. The cam 34 is mounted in a fixed position on the generator shaft and is in electrical contact with the frame of the generator according to the usual practice. The cam, however, is provided with only one effective projection which makes contact with springs 42 and 43, respectively, on alternate half revolutions of the generator shaft. A projection of insulating material may be placed opposite the working projection of the cam if desired but this serves no purpose other than to balance the rotating cam. The setting or timing of the cam is such that the working projection makes contact with the springs immediately after the peak of the generator current wave is passed.

Springs 42 and 43 are normally connected by conductor 57. This conductor is provided with spade clips at each end to engage the terminal screws of the respective springs. Conductor 58 is soldered to one of these spade clips and extends through contacts 49 of key 28 to terminal 55. Terminal 55 may, therefore, be connected individually with either cam spring by removing one or the other of the spade clips from the other terminal. Conductor 64 is connected permanently at one end to the armature spring or commutator of the generator and is provided with a spade clip at the other end for connection with either of terminals 55 or 56. With this conductor connected to terminal 55, condenser 35 is bridged across the generator while with the conductor connected to terminal 55, the condenser is connected in series with one of the line conductors as will be explained in later paragraphs.

When the generator is operated with the cam springs connected up as shown, condenser 35 will be charged as the generator current rises since it is connected across the terminals of the generator. The current may be traced from the armature of the generator, contacts 41, conductor 64, condenser 35, contacts 45, spring 38 to the frame or grounded terminal of the generator. Shortly after the peak of the generator current is reached, that is, when the condenser is charged to a maximum, the working projection of cam 34 engages one or the other of springs 42 or 43, thereby connecting the condenser across the line clips and line under test through which the condenser discharges. On the next half revolution of the generator, the condenser will be charged in the opposite direction and will again be discharged across the line as before. A series of current surges of opposite polarity will, therefore, be impressed on the line. The wave form will be similar to that shown diagrammatically in Fig. 10.

By disconnecting one or the other of springs 42 or 43, the condenser will be discharged into the line on alternate charged periods and the current surges on the line will, therefore, be of the same polarity. This is particularly useful when testing a line to which a polarized relay or other relay apparatus is connected as the lineman can select the polarity which has the least effect on such apparatus.

Connecting conductor 64 to terminal 55 instead of to terminal 56 as shown, causes the condenser to be charged in series with the line when the generator is operated. The

circuit may be traced from the armature of the generator, contacts 41, conductor 64, terminal 55, line clip 30, thence over the line under test, line clip 31, condenser 35, contacts 45, spring 38 to the frame terminal of the generator. Shortly after the current peak is reached, the working projection of cam 34 engages either spring 42 or 43, thereby short-circuiting the generator and permitting the condenser to discharge back over the line. The current wave produced is shown diagrammatically in Fig. 9. It may be noted that the form of the current wave produced by prior sets is also similar to that shown in Fig. 9. This type of tone current is desirable for certain tests, for example the lamp test to determine line resistance which will be described in later paragraphs.

The talking circuit of the test set is somewhat different from that of prior sets. When monitoring a line, for example, line clips 30 and 31 are connected to the line conductors in the usual way. The receiver R is now bridged across the line over a circuit extending from line clip 30, terminal 55, secondary winding of coil 36, normally closed contacts 39 and 47, receiver R, normally closed contacts 46, finder coil 32, normally closed contacts 38 and 45, condenser 35, terminal 56 to line clip 31. The finder coil is shunted by the non-inductive resistance 37 and lamp 27. When the lineman wishes to talk over the line, key 29 is operated thereby completing at contacts 52 a local circuit for transmitter 53, battery 65 and the primary winding of coil 36 in series. At contacts 51, the right side of condenser 35 is connected in series with transmitter 53 across the line conductors thereby shunting the receiver to improve transmission.

The various tests, with the exception of the lamp test, are made in exactly the same manner as described in applicant's prior patent to which reference has been made. In making the lamp test, conductor 64 is connected to terminal 55 and key 28 is operated to the left. Receiver R is shunted by resistance 37 on the closure of contacts 48. When the generator is operated, current flows from the generator armature, contacts 41, conductor 64, terminal 55, line clip 30, over the line under test, line clip 31, left side of condenser 35, contacts 44, resistance 37, lamp 27, spring 38 to the frame terminal of the generator. The resistance of the line under test will govern the amount of current flowing in the above circuit and will be indicated by the relative brightness with which lamp 27 glows.

The generator current may be applied directly to the line under test by operating key 28 to the right. The interrupter circuit is opened at contacts 49 and condenser 35 is short-circuited at contacts 50.

The operation of the test set and auxiliary dial unit in the establishment of a connection in an automatic telephone system will now be considered. The dial unit, as previously stated, is arranged for either loop or simplex dialling. It will first be assumed that line clips 30 and 31 have been connected to the conductors of a line arranged for loop operation. Receiver R is bridged across the line in series with condenser 35 as previously described. The lineman will now insert plug 24 into jack 8 of the dial unit thereby completing a loop circuit over the tip contacts of the plug and jack, upper winding of impedance coil 15, impulse springs 22 and 23 of the dial, and sleeve contacts of the jack and plug. The line relay of the switch terminating the line will operate over this loop circuit with the usual results. The dial is operated in accordance with the digit to be sent and the loop circuit is opened accordingly by the momentary separations of impulse springs 22 and 23. Impedance 15 is shunted by off-normal springs 17 and 18 which make contact when the dial is tuned off-normal. On the completion of the impulse transmission the original loop is again closed and the short circuit removed from the impedance which now serves to prevent the dialling loop from interfering with the functioning of the transmitter and receiver.

To dial over a simplex line, plug 24 will be inserted into jack 7 of the dial unit. Plug 66 of the ground cord will be inserted into jack 8 and the clip 67 will be attached to any convenient grounded conductor. A circuit will thus be completed from ground over the cord, sleeve conductors of the plug and jack, impulse springs 23 and 22, thence in two parallel circuits including the two windings of impedance coil 15, tip and sleeve contacts of jack 7 and plug 24 to the two sides of the line. The operation of the dial will interrupt the ground circuit at impulse springs 22 and 23 in accordance with the digit dialled.

What is claimed is:

1. The combination with a portable test set for determining the direction of a fault on a line, of a calling device for transmitting impulses corresponding to numerical digits, and circuit connections for connecting the calling device with the test set.

2. In combination with a portable test set for determining the direction of a fault on a line, of means for connecting the test set to a line, a calling device, and means for operatively connecting the calling device with the test set to enable the calling device to transmit directive digit impulses over the line.

3. An automatic telephone set comprising the transmitter, receiver and circuit connections of a lineman's portable test set, a calling device temporarily connected to the test

set, and conductors for connecting the test set and calling device with a line.

4. The combination with a lineman's portable test set, of means for connecting the test set with a line comprising two conductors, a calling device, and circuit connections for connecting the calling device with the test set for transmitting impulses either over the two conductors of the line in series or over the two conductors of the line in parallel.

5. The combination with a lineman's portable test set, of means for connecting the test set with a line, an auxiliary unit comprising a direct current bridge including impulse contacts of a calling device, and means for connecting said unit with said test set whereby said bridge is connected across the line.

6. The combination with a lineman's test set enclosed in a portable case, of an auxiliary calling device unit adapted to be mounted in said case, and circuit connections for operatively connecting the unit and the test set.

7. The combination with a lineman's test set enclosed in a portable multi-compartment case, of a calling device unit mounted in one compartment of the case, and circuit connections for temporarily connecting the unit and the test set.

8. The combination with a lineman's portable test set, a calling device and an associated spring jack, and a cord equipped with a plug adapted to cooperate with said jack for operatively connecting the test set with said calling device.

9. The combination with a lineman's portable test set, of a calling device, a first spring jack for enabling the calling device to transmit impulses over two conductors of a line in series, a second spring jack for enabling the calling device to transmit impulses over two conductors of a line in parallel, and a cord connected at one end to the test set and at the other end to a plug adapted to engage either of said jacks.

10. An auxiliary calling device unit comprising a base supporting a dial, two spring jacks, a double wound impedance coil, and circuit connections between the jacks and the dial and coil.

11. An auxiliary calling device unit comprising a base adapted to mount in the cover of a lineman's portable test set, an impulse dial mounted on the top of the base and two spring jacks mounted on one side of the base and electrically connected with said dial.

12. An auxiliary calling device comprising an impulse dial, impedance coils, spring jacks electrically connected with the dial and said coils, and a hollow, rectangular metal base supporting the dial, coils and jacks.

13. A calling device unit comprising an impulse dial mounted on a rectangular metal base, a spring jack for connecting a line with the dial for impulsing over two conductors of the line in series, and a second spring jack for connecting a line with the dial for impulsing over two conductors of the line in parallel.

14. A calling device unit comprising a dial provided with impulse contacts, two double contact spring jacks, an impedance coil comprising two connected windings, circuit connections bridging said impulse contacts across the contacts of the first jack in series with one winding of said coil, and other circuit connections connecting the impulse contacts through the windings of said coil in parallel to the respective contacts of the second jack.

15. An auxiliary calling device unit comprising a dial provided with a pair of impulse springs, two impedance coils each having one free terminal and a common terminal, two spring jacks each provided with a tip contact spring and a sleeve contact spring, and conductors connecting the free terminal of one coil to the tip springs of both jacks, the free terminal of the other coil to the sleeve spring of one jack, one impulse spring of the dial to the sleeve spring of the other jack, and the other impulse spring of the dial to the common terminals of said coils.

16. A line test set wherein a telephone receiver and a finder coil are connected in series across two line clips, a non-inductive shunt around the finder coil, a generator, a switch, and circuit connections controlled by the switch for connecting the generator across the line clips in place of the receiver and coil, for removing the shunt from the coil, and for connecting the receiver and coil in a closed loop circuit.

17. A line test set wherein a receiver and a finder coil are connected in series across a pair of line clips, a shunt including a resistance element normally connected across the coil, a generator, a switch controlled by the generator for removing said shunt from the coil and for connecting the receiver and coil in series in a closed loop, and a manually operable key for connecting said resistance element in said closed loop in place of said coil.

18. A test set comprising a case having mounted therein a generator and a transmitter, a plate dividing the case into two compartments, a second plate, a sheet of fibrous material held between said first plate and said second plate, a sound chamber formed by a slot in the sheet of fibrous material, and perforations in said second plate to permit sound waves to pass from said chamber to the transmitter.

19. A line test set comprising a telephone receiver connected across two line clips, a telephone transmitter included in a normally open local circuit, and a manually operable key for closing said local circuit and for connecting a condenser across said receiver.

20. A line test set in which a telephone receiver is connected across a pair of line clips in series with one side of a split condenser and the secondary winding of an induction coil, a telephone transmitter included in a normally open circuit including the primary winding of said coil, and a manually operable key for closing said circuit and for shunting the other side of said condenser across the receiver.

21. In combination, a magneto generator, a condenser bridged across said generator, a pair of terminals, and a switch controlled by the generator for periodically connecting said generator across said terminals.

22. In combination, a magneto generator, a pair of terminals, one of which is connected to one pole of said generator, a condenser connected to said one terminal and the other pole of said generator, and a switch for periodically connecting the condenser and said other pole of the generator to the other of said terminals.

23. In combination, a magneto generator, a cam on the armature shaft of the generator and in electrical contact with the frame of the generator, two springs adapted to be engaged by said cam on alternate half revolutions of the generator shaft, two terminals connected respectively to the frame and to the free pole of the generator, and circuit connections for connecting either or both of said springs to either of said terminals.

24. A tone generating device comprising a condenser, a generator for charging the condenser, a pair of tone leads, and a generator controlled switch for periodically connecting the generator and condenser in parallel across said two leads.

25. A tone generating device comprising a condenser, an alternating current generator for charging the condenser, a pair of tone leads, and a pair of generator controlled contacts operative respectively for connecting the condenser across said tone leads on alternate half cycles of the current wave produced by the generator.

26. The combination with a portable telephone set carrying case, of a partition dividing the case into two compartments, a transmitter in one compartment, a section of said partition comprising two walls spaced apart to form a sound chamber, and perforations in the wall adjacent to the compartment containing said transmitter.

27. The combination with an electrical instrument carrying case, of a partition dividing the case into two compartments, a telephone transmitter in one compartment, a recess in one edge of the partition, and perforations in one face of the partition connecting said recess with the compartment containing said transmitter.

28. The combination with a portable telephone set including a carrying case, of a partition dividing the case into two compartments, said partition comprising two metal plates, a sheet of fibrous material held between said plates, a slot in said sheet forming a sound chamber, perforations in one of said plates to permit sound waves to pass from said chamber to one of said compartments, and a telephone transmitter mounted in said one compartment.

29. The combination with a telephone transmitter, of a sound wave collecting unit comprising two metal plates, a sheet of fibrous material held between said plates, a slot in said sheet forming a sound chamber, perforations in one of said plates, and means for mounting the transmitter opposite the perforations in said one plate.

30. In a local battery telephone set, an induction coil, a condenser, an impedance, a receiver connected across two line conductors in series with said impedance, said condenser, and the secondary winding of said coil, a transmitter, a normally open circuit for said transmitter including the primary winding of said coil, a second condenser, and a key for closing said transmitter circuit and for connecting the transmitter and the secondary winding of said coil across the two line conductors in series with said second condenser.

31. In a local battery telephone set, an induction coil, a split condenser, an impedance, a receiver connected across two line conductors in series with said impedance, one side of said condenser and the secondary winding of said coil, a transmitter, a normally open circuit for the transmitter including the primary winding of said coil, and a key for closing the transmitter circuit and for connecting the transmitter and the other side of said condenser in series across the line conductors in parallel with said receiver, said impedance and said one side of the condenser.

In witness whereof, I hereunto subscribe my name this 4th day of February, A. D. 1931.

CLARENCE A. ANDERSON.