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TESTING APPARATUS

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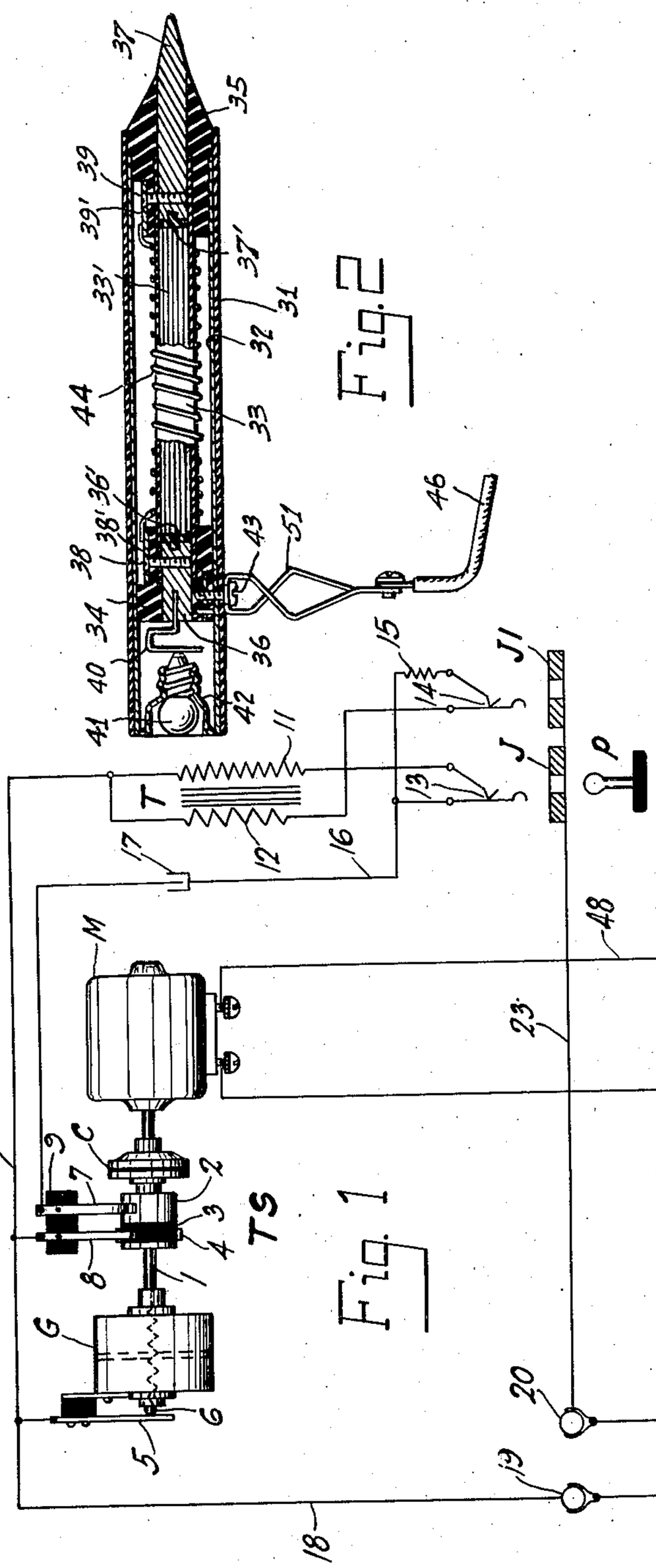


Fig. 2

Fig. 1

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## TESTING APPARATUS

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This invention relates to testing apparatus in general, and particularly to apparatus for locating faults in electrical distribution systems. The object of the invention is to provide a simple and reliable device for indicating the location crosses between conductors of such systems and adjacent metal framework.

The invention is particularly suitable for locating crosses between the lighting circuit conductors and the frames or shells of steel railway coaches, between the lighting or ignition system conductors and the chassis of motor vehicles, and between cable conductors and metal framework or runways of telephone exchanges, etc. By way of illustration the operation of the apparatus constituting the invention will be described in connection with railway coach testing.

Referring now to the accompanying drawing, Fig. 1 shows the circuit arrangement of the tone generating set TS, a pick-up coil PC, and a part of the wiring system of a railway coach. Fig. 2 is a cross-sectional view of a test lamp for use in conjunction with the test set.

The tone generator, Fig. 1, produces a tone current similar to that produced by the hand operated tone generator disclosed in applicant's Patent No. 1,384,734, granted July 19, 1921. It consists of a magneto generator G driven by the motor M through the shaft 1 and coupling C. A metal collar 2 fitted on the shaft and in electrical contact therewith is engaged by brush 7, which serves as one terminal of the generator. Collar 3 is also fitted on the shaft and is made of fibre or other insulating material. The metal pin 4 extends through the collar and shaft, protruding slightly on each side whereby it engages brush 8 on each half revolution of the shaft. Brush 5 is mounted on the generator frame but insulated therefrom, and serves as the other terminal of the generator. Brushes 5 and 8 are directly connected so that the generator is short-circuited each time the latter brush engages pin 4.

Terminal posts 19 and 20 are provided for connecting the tone generator to a circuit under test. Terminal post 19 is connected by way of conductor 18 to brushes 5 and 8 and these in turn are connected to the upper terminals of transformer T by way of conductor 10. Terminal post 20 is connected to the sleeve of jacks J and J1 by conductor 23. A plug P is provided for connecting this terminal directly with the frame terminal of the generator or with the secondary winding of the transformer. It will be noted that with plug P in jack J, terminal 20 is connected by way of conductor 16 and condenser 17 to brush 7, while the circuit of winding 11 of the transformer is open at contacts 13. It is apparent that under these conditions, with the generator operating, condenser 17 will be charged in series with the external circuit connecting the terminals 19 and 20 and will periodically discharge into this circuit.

With plug P in jack J1, the secondary winding 12 of the step-down transformer will be connected across terminal posts 19 and 20, and the primary winding 11 of the transformer will be bridged across the generator. Condenser 17 will accordingly be alternately charged and discharged in the circuit including the primary winding of the transformer and a low-voltage tone current will be applied to the terminal posts.

In the car wiring plan WP, 61 represents a steel plate forming a part of the outer shell of a railway coach. An inner shell consisting of plates such as 57 is separated from the outer shell by suitable spacing members (not shown). The lighting system conductors are carried through the space between the inner and outer plates from the distributing panel to the light sockets located in various parts of the car. A separate circuit is ordinarily provided for each group of lights. The distributing panel is provided with two bus bars B and B1, connected, respectively, to the two terminals of the car storage battery as indicated. The lighting conductors are connected to the bus bars by removable fuses, such as 59 and 60, which are shown connecting up conductors 53 and 54. The particular lighting circuit shown by way of illustrating the operation of the invention consists of conductors 55 and 56 which serve a group of lamps including the lamp L. These conductors are connected by branch circuits with the various light sockets of which only the socket S has been shown.

The pick-up coil PC consists of a coil 24 wound on an iron core 25. The core is rigidly attached at one end to a handle 28 of fibre or other similar material to which the terminal pins 26 and 27 are attached. A tip 29 of fibre protects the other end of the core and coil from injury. The terminals of the coil are brought out to the pins 26 and 27, which in turn are connected to the receiver R by means of a flexible cord 30. When this coil is brought into a magnetic field which is rapidly fluctuating, a current will be induced in the winding and produces an audible tone in the receiver.

The test lamp, Fig. 2, as will be readily seen

from the drawing, is made up of a fibre tube **31** with a metal liner or inner tube **32**. Within this tube a smaller tube of fibre **33** is held in place by the fibre blocks **34** and **35**. Metal rods **36** and **37** are fitted into opposite ends of the small fibre tube and are held in place by screws **38** and **39** which also serve to hold the tube firmly attached to the fibre blocks. Inside the fiber tube **33** there is a laminated iron core **33'** which is insulated from the metal rods **36** and **37** by fiber discs **36'** and **37'**. The laminated core **33'** is not shown in section and may consist of iron wires or the like. The tube **33** has been cut away to show the iron core and the coil **44** is clearly shown on the center part of tube **33**. Rod **36** is electrically connected by screw **38** and metal piece **38'** to one end of the coil **44** which is wound on the small fibre tube, the other end of the coil being connected by way of screw **39** and metal piece **39'** to metal rod **37**. Rod **37** incidentally protrudes slightly beyond the fibre block **35** and is adapted to engage a conductor to be tested. Spring **40**, fitted into the end of rod **36**, engages one contact of lamp **41**. This lamp may be of the type ordinarily used in three cell flash lights, and is held in the metal socket **42**, which is threaded to permit screwing into the inner tube **32**. A screw **43** provides a terminal for connecting a source of current to the metal tube **32**. It will be seen from the foregoing that a circuit for lighting the lamp extends from the generator terminal connected to clip **51**, terminal **43**, tube **32**, socket **42**, lamp **41**, spring **40**, rod **36**, screw **38**, resistance coil **44**, screw **39**, tip of rod **37**, and the conductor in contact therewith, which is connected to the other terminal of the generator.

In actual railway operation, it has been found that the lighting circuits very frequently become crossed on the metal framework of the steel railway coaches. These faults usually occur around the lamp sockets, but, due to the hidden wiring, it is extremely difficult to locate them. Further, disconnecting the various sockets and testing them individually is a slow and expensive job. This method of testing, however, has been the only practical one with testing apparatus heretofore available.

With the present testing device, frame crosses in car lighting systems of the above type may be located easily and quickly without disturbing any of the sockets or wiring. To locate a fault, the motor is first connected across the bus-bars B and B1 by means of the flexible ends **47** and **48** and their terminating clips **49** and **50**. The motor drives the generator, which produces a distinctive tone current as previously explained. If the particular conductor in trouble is not known, this is first located by means of the test lamp, Fig. 2. Clip **69**, which is connected to terminal post **19** by conductor **45**, is attached to the metal shell of the car. Clip **51**, which is connected to terminal post **20** by conductor **46**, is attached to terminal **43** of the test lamp. Plug P is inserted into jack J1, thereby bridging the secondary winding of step-down transformer T across the terminals **19** and **20**. The fuse terminals of the lighting conductors are now touched successively with the metal tip of the test pencil. When a circuit crossed with the frame is found, the lamp will glow brightly to indicate this condition. High resistance crosses will cause the lamp to glow dimly.

After locating the particular lighting conductor in trouble, clip **51** is detached from the test lamp and attached to the fuse terminal of the conductor. Plug P is then shifted to jack J, thereby bridging the generator and condenser directly across terminals **19** and **20**. By way of illustration, it will be assumed that conductor **56** is shorted on the inner shell **57** of the car at the point **58** at which the conductor is connected with socket S. The tone current will accordingly flow in a circuit including conductor **56** and plate **57**. The current density in the metal plate will be greatest at the point of contact with the conductor and the magnetic field around this point will be proportionately large. If the finder coil, P. C., is now held fairly close to plate **57** at any point between clip **49** and socket S, the current flowing in the plate will induce a similar current in the coil **24**, and a tone will be heard in receiver R. The coil is then moved away from the clip, and, when it arrives in the vicinity of the fault, the tone will increase rapidly, the point of maximum tone indicating the exact point at which the conductor is short circuited on the frame.

The method of locating faults in the lighting or ignition systems of motor cars or similar vehicles is substantially the same as that above described for railway coach testing. One terminal of the generator is connected to the metal frame of the vehicle and the other terminal is connected to the faulty conductor. The finder coil is then moved about in the vicinity of the frame until the point is formed at which the tone in the receiver is loudest. The method of locating faults in telephone exchanges and the like will be readily apparent.

What is claimed is:

1. A testing device comprising a tone generator, a pair of terminals for connecting the device with a circuit to be tested, a transformer, a pair of manual jacks, a plug for cooperation with either jack, circuit connections completed upon the insertion of the plug into one of said jacks for connecting the generator to said terminals directly, and other circuit connections completed responsive to the insertion of said plug into the other of said jacks for connecting the generator to said terminals through said transformer.

2. A testing device comprising a generator, a transformer having its primary and secondary windings both normally connected across the generator, two terminals, two switches, circuit connections controlled by one switch for disconnecting the primary winding of the transformer from the generator and for connecting the generator directly across said terminals, and circuit connections controlled by the other switch for disconnecting the secondary winding of the transformer from the generator and for connecting it across said terminals.

3. An electrical testing device comprising a generator, a condenser, a transformer having its primary and secondary windings both connected across the generator in series with said condenser, a pair of terminals, a switch for disconnecting the primary winding of the transformer from the generator and for connecting the generator and condenser in series across said terminals, and a second switch for disconnecting the secondary winding of the transformer from the generator and for connecting it across said terminals.

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