J. A. VAHEY.

CIRCUIT INTERRUPTER.

APPLICATION FILED JAN. 15, 1912.

1,158,086.

Patented Oct. 26, 1915.

2 SHEETS—SHEET 1.

Fig. 1.

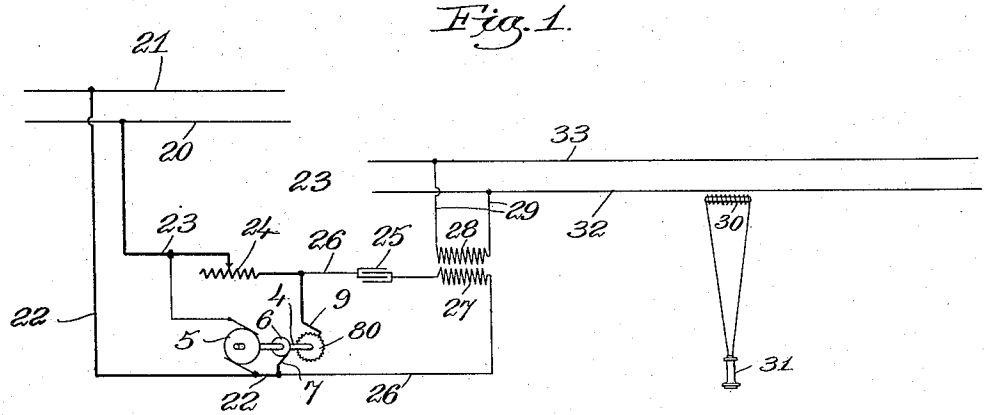


Fig. 2.

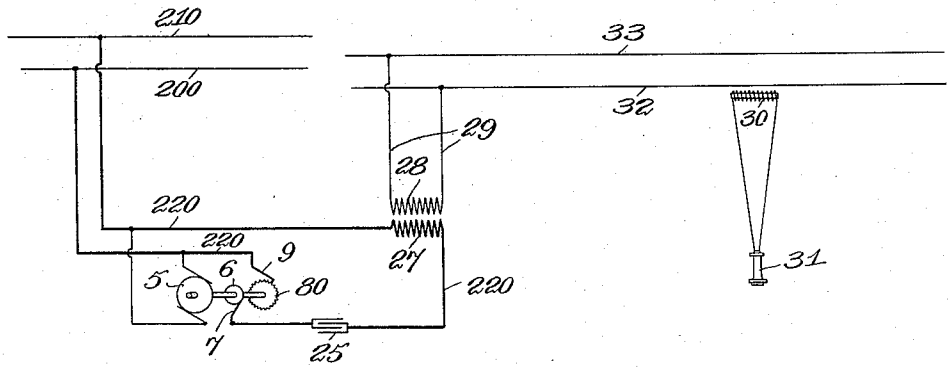
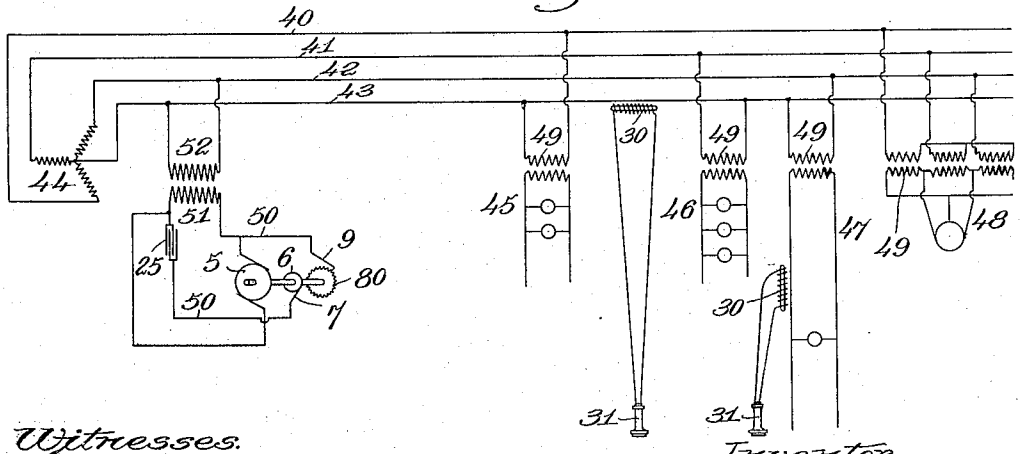


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

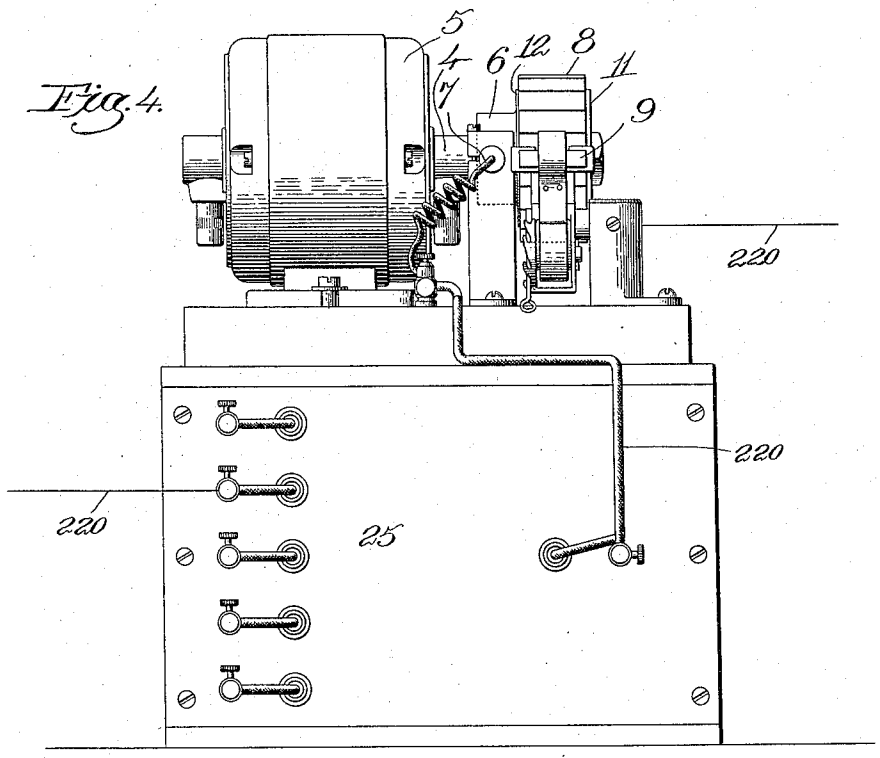


Fig. 5.

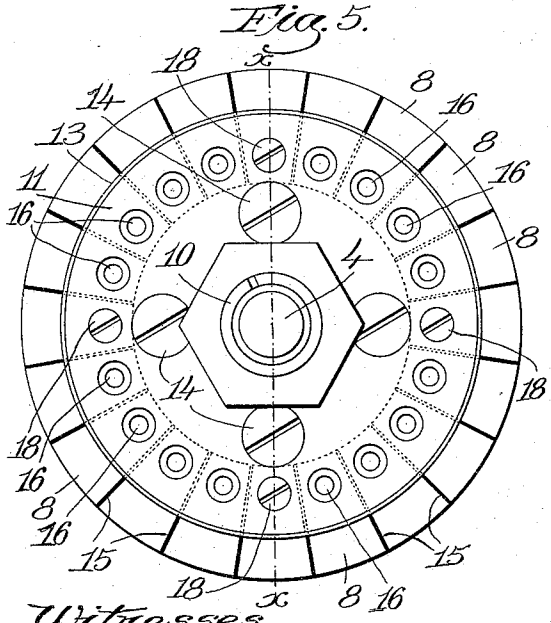
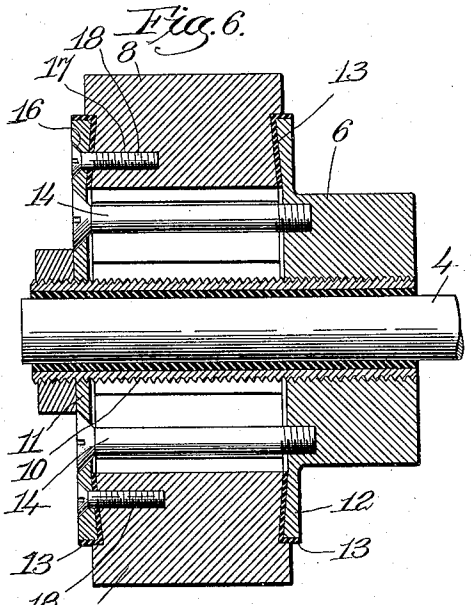


Fig. 6.



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UNITED STATES PATENT OFFICE.

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CIRCUIT-INTERRUPTER.

1,158,086. Specification of Letters Patent. Patented Oct. 26, 1915.

Application filed January 15, 1912. Serial No. 671,373.

To all whom it may concern:

Be it known that I, JAMES A. VAHEY, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Circuit-Interrupters, of which the following description, in connection with the accompanying drawing, is a specification, like characters on the drawing representing like parts.

This invention relates to a device which is adapted to detect or locate faults or grounds in either a direct current or an alternating current distributing system, and which also can be used for picking out and identifying the different wires or legs of a live mutiphase alternating current distributing system.

One method which has heretofore been used for locating grounds or faults in electric conductors has been to impress on the faulted or grounded conductor a signaling current and then to locate the fault or ground by means of a portable exploring coil to which a telephone receiver is connected, and which is moved along the conductor or cable in making the test. When a signaling current is thus impressed on the conductor and the exploring coil is placed on the conductor, said signaling current will induce a current in the exploring coil, which current will produce an audible signal by means of the telephone receiver. If the conductor has a fault therein, said signaling current will pass through the fault, or if the conductor is grounded at any point the signaling current will pass to the ground at such point. As a result the signaling current has a greater strength between the faulted or grounded point and the source of supply than it has beyond the fault or ground, and the current which is induced in the exploring coil will be different when the exploring coil is on the supply side of the fault or grounded point than when it is on the opposite side thereof. The operator who is using the exploring coil will, therefore, detect the differences in the sound issued by the receiver when he passes the fault or ground and by this means the fault or ground can be located.

In devices of this nature as heretofore used, however, it has not been possible to secure any audible signal through the telephone receiver unless a fairly strong signaling current was used, and as a consequence the usefulness of such devices has been rather limited.

One of the objects of my invention is to provide a novel fault or ground detector by which the location of the fault or ground can be accurately detected with the use of a very small signaling current and notwithstanding the fact that the conductor being tested is carrying a working current of commercial frequency.

Other objects of the invention are to provide an apparatus for this purpose by which the signaling current can be generated from either an alternating current system or from a direct current system at standard voltages and in connection with standard apparatus; to provide an apparatus which will give a different sound when the signaling current is generated from an alternating current than when it is generated from a direct current; to provide a device of this character which can be used as a means for changing the frequency of an alternating current as well as for detecting faults or grounds; and to otherwise improve fault or ground detectors, all as will be more fully hereinafter described.

My improved apparatus can also be used for changing a direct to an alternating current.

Referring to the drawings wherein I have illustrated some embodiments of my invention, Figure 1 is a diagrammatic view showing the operation of my device in connection with a direct current distributing system; Fig. 2 shows the operation of the device in connection with an alternating current distributing system; Fig. 3 shows how the device is used in identifying different wires or legs of a live alternating current circuit; Fig. 4 is a view of the interrupting device and the variable condenser; Fig. 5 is a side view of the sectional ring; Fig. 6 is a section on the line x—x, Fig. 5.

As stated above, one of the objects of my invention is to provide an apparatus by which a fault or ground can be accurately detected in a cable carrying a heavy current of commercial frequency by the use of a comparatively small signaling current, and in accomplishing this end I make use of the fact that a telephone receiver is most responsive to a current having a frequency of approximately six hundred cycles per second. I have demonstrated that when a comparatively weak signaling current of this nature is impressed on a cable carrying a current of commercial frequency, the current which is induced in the exploring coil

by said signaling current will cause an audible sound to be given out by the telephone receiver which can be easily distinguished from any sound induced by the current of commercial frequency which the cable carries. This is a decided advantage because since the telephone receiver is responsive to a very weak induced current in the exploring coil, a current in the exploring coil of sufficient strength to produce a signal can be generated even though said coil is not placed in contact with or in close proximity to the cable. In fact with my apparatus it is possible to detect a ground or fault even when the exploring coil is situated at some distance from the cable, and this makes it possible with my apparatus to detect a fault or ground in an underground cable. The mechanism I provide for securing this particular type of signaling current comprises a special interrupter capable of making and breaking the circuit in a particular manner, a variable condenser and a transformer combined in a novel manner. The interrupter which I use is shown best in Figs. 4, 5 and 6, and it is illustrated as being operated by a motor 5, although the manner of its operation is not essential to the invention. This interrupter comprises a continuous ring 6 which is mounted on but insulated from the driving shaft 4 (said shaft being driven by the motor 5) and with which a brush or carbon 7 has constant engagement, and a plurality of insulated sections 8, certain of which are adapted to be electrically connected to the collector ring and which are engaged successively by a brush or carbon 9 as the shaft rotates. These insulated sections 8 may be sustained in any appropriate way without departing from my invention. As herein shown the collector ring 6 has connected thereto a sleeve 10 which extends longitudinally of the shaft 4, but is insulated therefrom, and this sleeve has screw-threaded thereto a clamping collar 11. The collector ring 6 is formed with a flange 12 and the sections 8 are clamped between the flange 12 and the clamping ring 11, said sections being insulated from both of these parts by suitable insulation 13. The clamping ring 11 is also connected to the collector ring 6 by means of screws 14, and said clamping ring 11 is, therefore, electrically connected with the collector ring. The sections 8, however, are all insulated from each other by means of insulation 15 and are also insulated from the collector ring. Means are provided for electrically connecting any one or more of the sections 8 to the collector ring, and I provide for this herein by forming the clamping ring with an aperture 16 opposite each insulated section 8 and forming each insulated section 8 with a recess 17 in alinement with the aperture 16 so that by inserting a plug 18 through the aperture 16 and into the recess 17 said section is electrically connected to the collector ring. These plugs can conveniently be made in the form of screws, as shown in Fig. 6, although they may have any suitable construction.

In Fig. 5 I have shown four of the sections 8 as connected to the collector ring, so that the circuit will be made and broken four times during each rotation of the shaft.

The condenser and the transformer used may have any appropriate construction. The manner of wiring up the apparatus or generating a signaling current from a direct current is slightly different from what it is when the signaling current is generated from an alternating current. In Fig. 1 I have shown diagrammatically the manner of wiring up the apparatus where the signaling current is generated by a direct current, and in this figure 20 and 21 designate the direct current mains. The interrupter is shown diagrammatically, 6 indicating the collector ring on the shaft 4 with which the brush 7 contacts and 80 indicating the commutator having the insulated sections 8 with which the brush 9 successively engages. The contacts 7 and 9 of the interrupter are connected to the two sides of the direct current system by the wires 22, 23, respectively.

24 is a regulating resistance which is used in series with the interrupter. The variable condenser is shown at 25 and it is in a circuit 26 which is shunted across the interrupter and which contains one coil 27 of an ordinary transformer, the other coil 28 of which is in the signaling circuit 29 that leads to and is connected to the conductor to be tested. The coil 27 of the transformer may be either a low voltage or high voltage coil, depending on whether it is desired to use the transformer as a step-up transformer or a step-down transformer. The interrupter is shown as being rotated by the motor 5 which may be driven in any suitable way and can be conveniently driven from current taken from the circuit 22, 23, as shown. In the operation of the device the interrupter makes and breaks the direct current circuit 22, 23 a predetermined number of times per second, depending on the arrangement of the plugs 17. This making and breaking of the circuit, together with the operation of the variable condenser 25 and the inductance of the coil 27 results in inducing an alternating current in the circuit 26 having the desired frequency, that is, approximately six hundred cycles per second, and this alternating current induces in the signaling circuit 29 an alternating signaling current which is impressed on the conductor being tested. By changing the position of the plugs 17 or by using more or less of said plugs the character of the signaling circuit can be varied, but it is possible with this interrupter and by properly regulating the

variable condenser, to secure the signaling current of the desired frequency.

Having generated such a signaling current it is impressed on the faulted or grounded conductor 32, and the location of the fault or ground in the conductor is determined by means of an exploring coil 30 to which a telephone receiver 31 is connected. If the conductor 32 is being tested for a short circuit, then one side of the signaling circuit 29 will be connected to said conductor 32 and the other side will be connected to the return 33. If, however, the conductor 32 is being tested for a ground then one side of the circuit 29 will be connected to the grounded conductor and the other connected to the ground. In either event, the signaling current having the desired characteristics is impressed on the conductor 32, and when the exploring coil is brought into proximity to the conductor, the signaling current in the conductor will induce a corresponding current in the exploring coil which will cause an audible signal to be given by the telephone receiver. Owing to the fact that the signaling current is of that type to which the telephone receiver is most responsive it is possible to detect the signal even though the signaling current or that induced in the exploring coil thereby is very weak. The fact that the conructor 32 is carrying a more or less heavy working current does not interfere at all with the operation of the exploring coil because of the peculiar characteristic of the signaling current which is used.

In Fig. 2 I have illustrated the manner in which the device may be used where the signaling current is generated from an alternating current. In this embodiment of the invention the interrupter, the condenser and the coil 27 of the transformer are connected in series across the low tension mains 200 and 210 by the circuit 220. The cail 28 of the transformer is connected to the signaling circuit 29 which is connected with the conductor 32 to be tested. Where the device is used in this way, the making and breaking of the alternating current by means of the interrupter, together with the action of the variable condenser 25 and coil 27 will induce in the signaling circuit 29 a signaling current of the desired frequency, and this signaling current is then used in the manner above described for locating a fault or ground. The motor 5 which drives the interrupter is shown as taking its current from the circuit 220, although it may be driven in any suitable way.

In Fig. 3 I have illustrated my invention as it might be used for identifying different legs of a live high tension alternating current distributing system. In said figure I have shown a four-wire three-phase distributing system having the different legs 40, 41, 42, 43 all connected to the source of supply 44. At 45, 46, 47 and 48 I have shown different working loops connected to the different legs, and each includes some form of translating device. These loops receive their current through a step down transformer 49, as usual in this manner of electrical distribution. What has thus far been described in Fig. 3 is merely a well-known manner of electrical distribution. It often happens that it is very desirable to be able to pick out and identify the wires of the different legs 40, 41, 42 and 43 at a distance from the source of supply and with my apparatus it is possible to accomplish this without cutting off the current from any one of the legs or without interfering at all with the operation of the electrical-distributing system in any way. This is done by impressing on the various legs in succession a signaling current having the above-described characteristics, and then by testing each leg or a loop connected thereto by means of an exploring coil 30, as above described. The leg or loop which has the signaling current impressed thereon will yield a responsive signal from the telephone receiver when the exploring coil is placed adjacent thereto, and by impressing this signaling circuit on first one and then another of the legs and by testing the various legs with the exploring coil the identification of said legs can be readily made.

In connecting up the interrupter to the system for the purpose of generating the signaling current and impressing it thereon, I propose to use the wiring shown in Fig. 3 wherein the interrupter is connected in the circuit 50 in series with the variable condenser 25 and the low voltage coil 51 of a transformer, the high voltage coil 52 of which is connected to two of the legs which it is desired to identify.

The current induced in the circuit 50 is interrupted by the interrupter, and this action, together with that of the condenser 25 and the inductance of the coil 51 induces a signaling current of the desired frequency in the coil 52 of the transformer, which signaling current may be impressed on any pair of the legs of the distributing system. In making a test with this apparatus the signaling current will be impressed on the various legs in a predetermined order by one operator, and the other operator with the exploring coil will test the loops or the legs at a distance from the station to note the presence or absence of the signal given by the signaling current.

My apparatus is also capable of being used for varying the frequency of an alternating current, for when it is used as illustrated in Fig. 2, the frequency of the signaling current is different from that of the current which is interrupted, and this dif-

ference in frequency can be varied by varying the arrangement of the plugs 18 and by varying the capacity of the condenser and the character of the transformer.

My apparatus is also capable of being used for changing a direct into an alternating current, for by connecting up the apparatus as shown in Fig. 1 an alternating current is developed in the circuit 29. The frequency of the alternating current produced in this manner can be varied by changing the position and arrangement of the plugs 18 and by connecting up more or less of the sections 8 to the collector ring and also by varying the capacity of the variable condenser.

In Fig. 4 I have shown the motor and interrupter as mounted directly on the variable condenser 25, this making a compact structure which can be readily moved about from place to place.

I have demonstrated that with my apparatus a very weak signaling current will produce a signaling sound in the receiver which can be distinctly heard over and above any sounds produced by the working current of commercial frequency in the conductor, and my apparatus can, therefore, be used without interfering at all with the ordinary use of the cable. Moreover, since the apparatus is of such a type that a very weak signaling current will produce an audible sound, it is possible to detect the presence or absence of a signaling current in the conductor even though the exploring coil is situated some distance away from the latter.

Since my apparatus is capable of producing a clearly distinguishable signal with a very weak signaling circuit, it is possible with my apparatus to detect grounds and faults much more accurately than is possible with other apparatus and in many locations where other apparatus cannot be used.

Another feature of my apparatus which I attach some importance to is that aside from the interrupter, the complete system includes only standard apparatus of a commercial type, that is, the condenser 25 and transformer 27, 28 can be such as are commonly used in electrical distribution systems and, therefore, if a person has the interrupter he can readily collect the other parts of the system and wire them up to secure the desired results.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a device of the class described, the combination with a current-carrying circuit, of a rotary collector ring connected to one side thereof, a plurality of insulated sections associated with the collector ring, but insulated therefrom, a clamping ring to clamp said sections to the collector ring in electrical connection with the collector ring, means to electrically connect anyone of said sections to said clamping ring, and thereby to said collector ring, and a brush or contact engaging said sections successively and connected to the other side of said circuit.

2. In a device of the class described, the combination with a shaft, of a collector ring mounted thereon but insulated therefrom, a clamping ring also mounted on said shaft but in electrical connection with the collector ring, a plurality of separate sections clamped between said collector ring and clamping ring, but insulated from both and from each other, said clamping ring having an aperture opposite each section and each section having a recess opposite the corresponding aperture, removable plugs adapted to be inserted through said apertures and into said recesses to connect electrically anyone of said sections to said clamping ring, and a current-carrying circuit having one side connected to said collector ring, and a brush connected to the other side of said circuit and engaging said sections successively as the shaft is rotated.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JAMES A. VAHEY.

Witnesses:

LOUIS C. SMITH,

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