Oct. 13, 1936. E. R. BONDS 2,057,472

CURRENT INTERRUPTER EQUIPMENT

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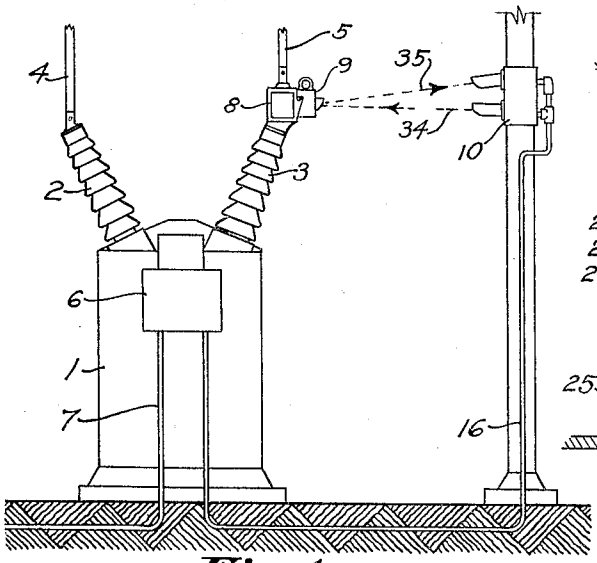


Fig. 1

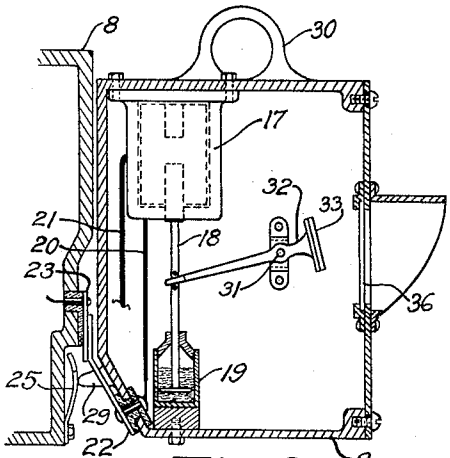


Fig. 3

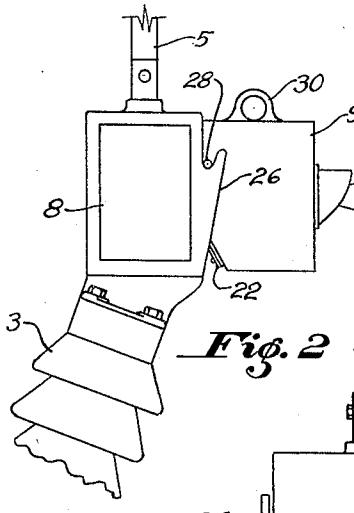


Fig. 2

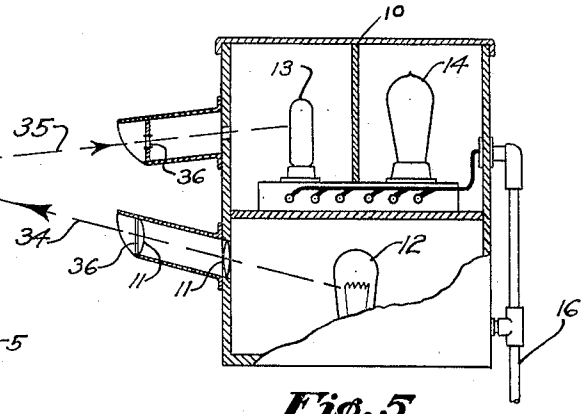


Fig. 5

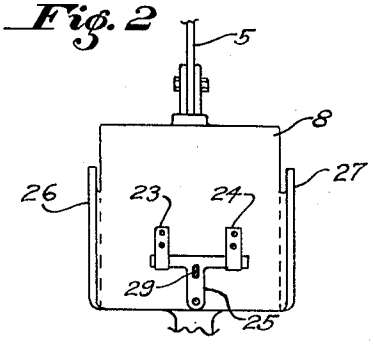


Fig. 4

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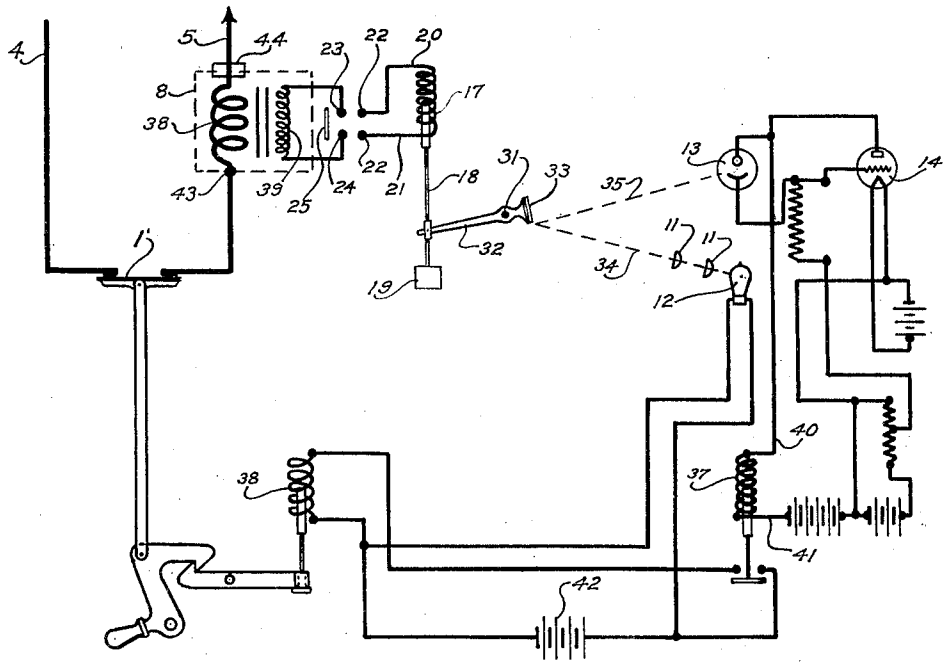


Fig. 7

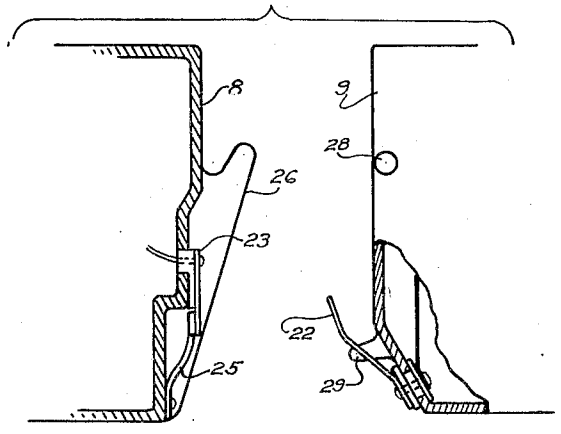


Fig. 6

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2,057,472

CURRENT INTERRUPTER EQUIPMENT

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Application February 7, 1931, Serial No. 514,175

12 Claims. (Cl. 175—294)

It has long been customary to install a current transformer in series in an electric circuit and operate an oil circuit breaker by the secondary current of the transformer. For unimportant low voltage circuits this secondary current often operates directly the solenoid which trips open the circuit breaker.

On important circuits, such as a long high voltage transmission line which supplies a number of substations and is sectionalized at several places, each oil circuit breaker is controlled through a relay, and these relays are so coordinated that they operate successively in a predetermined sequence. Adjustments of such relays are gauged not by seconds but by "cycles", each "cycle" being 1/60 of a second, and therefore a quarter of a second may differentiate between correct and incorrect operation of the breaker.

But, though current transformers for low voltage are not costly, the cost of a single high voltage current transformer suitable for this use may be several hundred dollars, as both porcelain bushing and internal intercoil insulation must be sufficient to withstand the full line voltage supplemented by such surges as may occur on the system. Various other plans have been tried to reduce this expense, but the accuracy and adaptability of the current-transformer principle are most desirable in spite of its cost.

Furthermore, relays ought to be inspected regularly and sometimes adjustments must be changed to meet changing conditions on the transmission system; and this must be done without any interruption to the flow of current in the transmission line. Of course, any metal which is within a few inches of a high voltage conductor becomes charged with the high voltage, unless it is heavily insulated therefrom.

For service at 50,000 volts or more, the insulation required becomes an important factor in the cost of the apparatus. The circuit-breaker shown in Fig. 1 is approximately the size for 110,000-volt use. From the base to the top of the porcelain bushings its height is eight or ten feet, and its cost would be several thousand dollars.

The purpose of my invention is to utilize the accuracy of a current transformer for opening such a circuit breaker, or current interrupter, without incurring the cost of additional high-voltage insulation.

I place in the main line, a current transformer with its associated relay and reflector mechanism and support them, if desired, on a porcelain insulator which is already serving as the entrance bushing for the breaker, so that no additional cost for porcelain has to be incurred. A beam of light and the well known photo-electric cell coordinate the low-voltage tripping mechanism with the current-flow in the secondary of the transformer. Since there is no metallic path between the current transformer and ground, expensive insulation is not needed. Insulation for 100 volts is not costly and there will seldom be more than 100 volts between any two of the parts which are supported on the bushing, though they all are charged with high-voltage.

Current flow in the main line, whatever the operating voltage, will cause the relay to operate correspondingly; and when the condition has been reached at which it was predetermined the breaker should open, then the reflector and the light beam act to open it. The breaker-opening solenoid and all circuits connected with it are preferably operated at not over 125 volts, and so no expensive insulation is needed anywhere on my breaker-opening device. In fact the light beam is used as the connecting means between the highly charged parts which are in contact with the main line conductor and the low voltage tripping solenoid and its associated equipment.

In order that the relay may be inspected, tested, and re-set when desired, with no interruption to current flow in the main line, I provide the removable housing in which it is mounted. The current transformer itself does not need readjustment, but it must always have its secondary circuit closed. This requirement I meet by providing contact closing members which automatically keep the secondary circuit closed even though the relay and its housing have been removed.

Referring to the drawings, Fig. 1 is a general view of a current interrupter with which my invention is used; Fig. 2 shows an enlarged view of the apparatus on the high voltage insulator; Fig. 3 is a partial cross section of the removable portion of the same apparatus; Fig. 4 is a side view of the housing on the insulator after the removable part is off; Fig. 5 is a detail of the housing which is apart from the high voltage conductors; Fig. 6 is a detail of the contact members on 8 and 9 when these two members are separated from one another; and Fig. 7 is a diagram of electrical connections for one method of using my device. The same designating members are used in all figures.

A current interrupter 1 carries two bushings 2 and 3 through which the conductors 4 and 5 pass. A housing 6 carries the operating mechanism

which is controlled by conductors which enter the housing through the conduit 7. This is usual practice. Inside the housing 6 I also place a solenoid 38 which operates to open the contacts 1' of the interrupter 1 when the contacts of the relay 37 are closed. On a convenient terminal I place the current transformer in its housing 8; this in turn supports the mechanism in the housing 9. The housing 8 is connected to the main conductor at one place 43, and insulated therefrom as at 44 in Fig. 7.

Conveniently located, and attached to a suitable support is the housing 10 which carries projector lenses 11, 11 through which light from the lamp 12 is concentrated in a beam sent in the direction 34 towards 9. The housing 10 also carries a photoelectric device 13. Such devices are now commercially available and they function to allow more current to flow through the device when it is in a strong light that when it is less strongly illuminated. The photoelectric cell itself 13 is here used in conjunction with an amplifying tube 14, which increases the output of the complete device. A description and wiring diagram of such a device are shown in a catalogue of the Westinghouse Electric & Mfg. Co. dated October, 1930, section 211. The connecting wires may be placed in the conduit 16, or may be protected in any other suitable manner. Conduit 16 may also carry the lighting circuit for the lamp 12. The batteries are placed in any suitable housing.

Inside the housing 9 is a solenoid coil 17 with a plunger 18, to which is connected the dash-pot 19. The coil 17, through the conductors 20, 21 and the spring contact members 22, 22, can be connected with the terminals 23, 24 of the current transformer secondary coil 39. The primary coil 38 of the current transformer is in series circuit with the conductor 5 and normally the secondary coil 39 is short-circuited by the spring conductor 25. On the housing 8 are two projections 26, 27 for engaging two pins 28 on the housing 9, and thereby supporting 9 in a fixed position. When it is so placed, a projection 29 on the housing 9 pushes 25 away from 23 and 24. At the same time the terminal 22, 22' connect with 23 and 24 and thereby the solenoid coil 17 is connected in series with the secondaries of the current transformer which is housed in 8.

A ring 30 on top of the housing 9 provides a means for an insulated hook to lift 9, disengage it from 8, and remove it completely from the high voltage field, leaving the transformer secondaries short circuited by 25.

Upon the pivot 31 is mounted the arm 32 which engages with the plunger 18 so that the arm 32 is rocked up and down as the plunger operates. Mounted on the arm 32 is a mirror 33, and the parts are so assembled that when the plunger 18 is fully raised light from the lamp 12 following the path 34 strikes the mirror 33 and is reflected back along the path 35 against the light-sensitive cell 13.

Protective glass panes 36 keep insects and rain out of the housings.

The operation is as follows: When current through the main conductor 5 exceeds a predetermined amount, the pull of the solenoid 17 starts to lift the plunger 18. If the excess current flow continues, the drag of the dash-pot is overcome, 18 is lifted fully, and the mirror 33 is brought into such a position that the beam of light from the lamp 12 is reflected back against the device 13. Thereupon in accordance with the well known action of such equipment, additional current flows through the conductors 40, 41, and this energizes the relay 37 and closes its circuit. This energizes the coil 38 by current from the battery 42 and trips open the circuit breaker contacts 1'. This action is repeated whenever similar conditions occur.

Whenever it is desired to change the adjustment or setting of the solenoid plunger or of the dash-pot, an insulating stick with a hook thereon is used to lift the housing 9 up and away from the transformer housing 8. This automatically leaves the secondaries of the transformer short-circuited by the spring conductor 25 as in Figs. 4 and 6. When adjustments have been made, the housing 9 and its contacts are replaced in a similar way.

For the sake of economy it is often best to support the transformer and the associated solenoid mechanism upon the bushing of an oil circuit breaker, or current interrupter, as shown in Fig. 1. Under some conditions it might be advisable to mount the transformer upon a separate insulator, so that the bushing 3 would be unhampered like the bushing 2.

A porcelain insulator of proper size would then be used to support the transformer 8, and the solenoid housing 9 would be carried by 8 just as it now is. Such an arrangement still retains the important features of my invention and thereby provides a means to open the current interrupter automatically with the well known accuracy of a current transformer having a solenoid in its secondary circuit, but without incurring the heavy cost of a standard high-voltage current transformer.

I claim:

1. In an electric circuit, a high voltage current interrupter, a conductor connected with the circuit of the high voltage current interrupter, means to highly insulate the same from ground, and a protective system including a coil in the circuit of the conductor, a housing, means for readily removably supporting said housing adjacent to the coil in circuit with the conductor, a movable reflector within the housing and responsive to flow of current in said coil, together with a remote source of light, a light-sensitive tripping mechanism for the current interrupter, and said source of light projecting a beam of light from the source to the reflector and thence to the light-sensitive tripping mechanism.

2. In an electric circuit, a current interrupter, a conductor connected with the circuit, means to highly insulate the same from ground, and a protective system including a series transformer in circuit with the conductor, a movable reflector and operating means therefor operable by current from the said transformer, a source of light remote from the said conductor, a mechanism to operate the current interrupter, said mechanism being remote from the said conductor and being controlled by a light-sensitive device, said source of light projecting a beam of light from the said source of light to the said reflector and thence to the said light sensitive device, and means for mounting said movable reflector and its operating means readily removably in position near the said conductor.

3. In high voltage electrical apparatus, a high voltage tubular insulator bushing, conducting means extending therein to said electrical apparatus and a line terminal adjacent one end of the bushing, a device mounted on said insulator bushing adjacent the line terminal end thereof and insulated for low potential only from said line ter-

minal, said device being responsive to a condition in the circuit of said electrical apparatus, a low voltage circuit insulated for high potential from the circuit of said electrical apparatus, and a light reactive element responsive to a beam of light between said device mounted on the insulator bushing and said low voltage circuit for causing said low voltage circuit to respond to said condition in the circuit of said electrical apparatus.

4. In a circuit breaker, separable contacts for opening and closing a high voltage circuit, a high voltage insulator bushing having a terminal adjacent one end and conducting means connecting said terminal to said contacts, a device mounted on said insulator bushing adjacent said terminal and insulated for low potential only from said terminal, said device being responsive to an electrical condition of the circuit through said contacts, a low voltage circuit for controlling the actuation of said contacts in the high voltage circuit, said low voltage circuit being insulated for high potential from said high voltage circuit, and a light reactive element responsive to a beam of light controlled by said device mounted on the insulator bushing for causing said low voltage circuit to actuate said contacts in the high voltage circuit.

5. In high voltage electrical apparatus, a high voltage insulator bushing having a terminal adjacent one end and conducting means extending from said terminal into the bushing to said electrical apparatus, a housing mounted on said insulator bushing adjacent said terminal, electro-responsive means in said housing and responsive to an electrical condition of the circuit of said electrical apparatus, said electro-responsive means being insulated for low potential only from the circuit of said electrical apparatus, a low voltage circuit insulated for high potential from the high voltage parts of the electrical apparatus, a light reactive element in said low voltage circuit, said light reactive element being responsive to a beam of light extending thereto from said electro-responsive means in the housing, and said electro-responsive means causing variation of said light beam and thereby causing said low-voltage circuit to respond to the electrical condition of said high voltage circuit.

6. In electrical apparatus, a high voltage circuit, an electro-responsive device responsive to a predetermined condition in said high voltage circuit, said electro-responsive device being positioned adjacent said high voltage circuit and insulated for low potential only therefrom, and means for readily removing said electro-responsive device from its position adjacent said high voltage circuit without interrupting the current flow therein, a low voltage circuit insulated for high potential from said high voltage circuit, a light reactive element in said low voltage circuit, said light reactive element being responsive to a beam of light extending thereto from said electro-responsive device, and said electro-responsive device causing variation of said light beam and thereby causing said low voltage circuit to respond to the electrical condition of said high voltage circuit.

7. In electrical apparatus, a high voltage circuit, a current transformer connected in said high voltage circuit, said current transformer having insulation for only low potential between the coils thereof, a control circuit for said electrical apparatus, said control circuit having one portion at high potential and another portion at low potential, a current responsive device in the high potential portion of said control circuit and connected to said current transformer, control means in the low potential portion of the control circuit, and a light reactive element connected in the control circuit and responsive to a beam of light extending between and operatively connecting said high and low potential portions of the control circuit.

8. In a high voltage circuit breaker separable contacts for opening and closing the high voltage circuit, a control circuit for controlling the actuation of said separable contacts in the high voltage circuit, said control circuit having one portion insulated for low potential only from said high voltage circuit so as to be at high potential and having another portion insulated for high potential from said high voltage circuit so as to be at low potential, a current responsive device in said high potential portion of said control circuit, said current responsive device being energized from the high voltage circuit through said separable contacts in response to an electrical condition of said high voltage circuit, control means in the low potential portion of said control circuit, and a light reactive element responsive to a beam of light extending between and operatively connecting said high and low potential portions of the control circuit.

9. In a high voltage circuit breaker separable contacts for opening and closing the high voltage circuit, a control circuit for controlling the actuation of said separable contacts in the high voltage circuit, said control circuit having one portion insulated for low potential only from said high voltage circuit so as to be at high potential and having another portion insulated for high potential from said high voltage circuit so as to be at low potential, a current responsive device in said high potential portion of said control circuit, said current responsive device being energized from the high voltage circuit through said separable contacts in response to an electrical condition of said high voltage circuit, control means in the low potential portion of said control circuit, and a light reactive element responsive to a beam of light extending between and operatively connecting said high and low potential portions of the control circuit and means for readily removing said current responsive device from the high potential portion of the control circuit without interrupting the current flow in the high voltage circuit.

10. In electrical apparatus, a main high voltage circuit, a control circuit, said control circuit having one portion insulated for only low potential from said main high voltage circuit so as to be at high potential and having another portion insulated for high potential from said main high voltage circuit so as to be at low potential, a current responsive device in said high potential portion of said control circuit, said high potential portion of the control circuit and said current responsive device being supplied with energy from said main high voltage circuit in response to an electrical condition of said high voltage circuit, control means in the low potential portion of said control circuit, and a light reactive element responsive to a beam of light extending between and operatively connecting said high and low potential portions of the control circuit.

11. In electrical apparatus, a main high potential electrical circuit, a control circuit also at high potential, said main high potential circuit and said high potential control circuit being operatively connected so that one of said high potential circuits is electrically responsive to a change in an electrical condition of the other of said high

potential circuits, a control circuit at low potential, a light reactive element in one of said control circuits, means in the other control circuit responsive to its electrical condition for altering the light falling on said light reactive element to cause a change in the electrical condition of the control circuit having the light reactive element therein, whereby said main high potential circuit and said low potential control circuit are operatively connected through said high potential control circuit and the light falling on said light reactive element.

12. In electrical apparatus, a circuit breaker having contacts connected to a high potential circuit so as to have high potential between its contacts when in open-circuit position, a control circuit for the circuit breaker at high potential above ground, said high potential circuit connected to the circuit breaker and said high potential control circuit being operatively connected so that one of said high potential circuits is electrically responsive to a change in an electrical condition of the other of said high potential circuits, a control circuit at low potential, a light reactive element in one of said control circuits, means in the other control circuit responsive to its electrical condition for altering the light falling on said light reactive element to cause a change in the electrical condition of the control circuit having the light reactive element therein.

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