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HIGH VOLTAGE TRANSMISSION LINE CONNECTION

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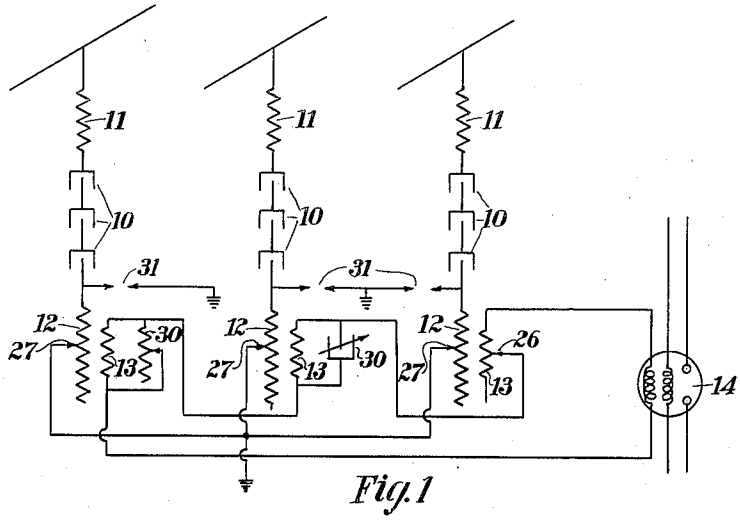


Fig. 1

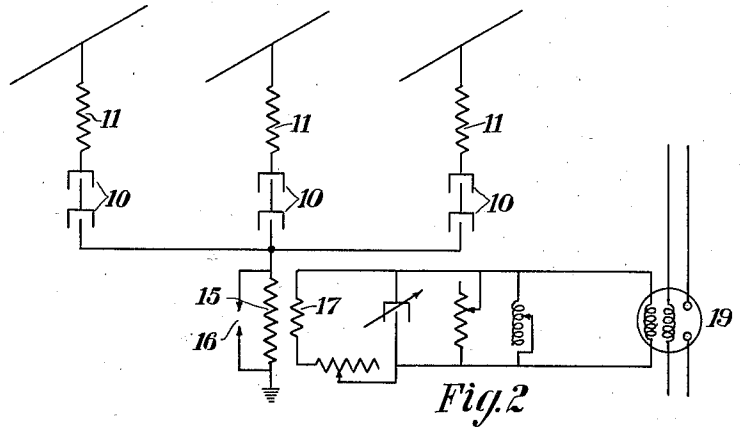


Fig. 2

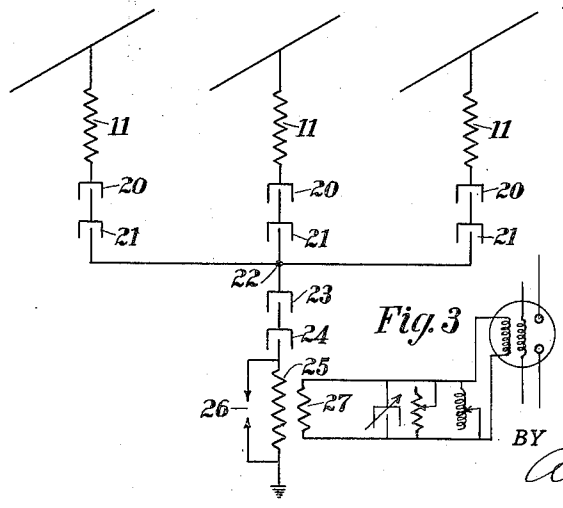


Fig. 3

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HIGH VOLTAGE TRANSMISSION LINE CONNECTION

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3 Claims. (Cl. 175—294)

This invention relates to means for connecting relays or other apparatus with high voltage transmission lines and has for one of its objects the provision of a connection which shall be more reliable and more economical than connections heretofore provided.

Another object is to provide a transmission line connection which shall be of improved construction and operation.

Other objects and advantages will appear from the following description.

The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawing and described in the following specification, and it is more particularly pointed out in the appended claims.

In the drawing:

Fig. 1 is a diagrammatic view showing features embodied in the present invention.

Fig. 2 is a view similar to Fig. 1 showing a different arrangement of the invention.

Fig. 3 is a view similar to Figs. 1 and 2 showing still a further arrangement.

In the operation of high voltage transmission lines it is desirable to supply current or potential for the operation of relays for clearing circuits which are in trouble or become overloaded. Current for this purpose cannot, of course, be conveniently used at line voltage and it has been customary to use potential transformers connected in various ways to step down the voltage, one method being to connect the high voltage side of a potential transformer to each phase of the high voltage line. The low voltage windings of the transformers will be connected in delta, one corner of which is open so that an unbalanced voltage for the different phases of the transmission line will set up a circulating current in the delta, this current passing through suitable coils in the relay.

In place of transformers at high voltage, condensers may be used with low voltage potential transformers as shown in Fig. 1 in which the condensers 10 are shown connected to the three phases of a high voltage line through absorbing resistances 11. The current, after passing through the resistances and condensers, traverses the high potenial windings of transformers 12. With this arrangement, if the neutral is shifted, due to a greater electrostatic capacity of some of the conductors to ground, this will produce a current in the transformer secondaries 13. This may be corrected by an adjustable load or duty placed upon the transformers as indicated at 30 or by the use of taps 26. It is evident that the taps may be placed on the high voltage winding of the transformer as at 27. The correcting means may be a resistance, capacity, or reactance as desired, the adjustment being made so that the current or voltage under normal operating conditions will be reduced to zero or to a point sufficiently low so that the relay will not operate until an abnormal condition causes an increase in current which will operate the relay.

The combination of condensers with low potential transformers has distinct advantages for the operation of relays as the cost is much lower than that of potential transformers operating at line voltage and greater reliability can be secured. An absorbing resistance may be used in series with the condenser so that under the most severe disturbances produced by lightning the drop in voltage from conductors to ground will be largely taken up by the absorbing resistance without placing a dangerous voltage upon the condenser units. This is due to the fact that for a given voltage condensers will pass current in proportion to the frequency or steepness of wave front. If, therefore, the disturbance is equivalent to a very high frequency, it is seen that this current will pass through the condenser without an abnormal rise in voltage, and the current flowing into the condenser may be made to produce a very high IR drop in the absorbing resistance. The flow of current to the condenser may be very small under normal operating conditions so that the drop in voltage over the absorbing resistance will be negligible.

The transformers used in series with the condensers are frequently provided with limiting gaps 31 as shown in my prior Patent #1,709,826, granted April 23, 1929. Under an abnormally high voltage surge upon the line the voltage across the transformer primary will rise until the limiting gap discharges and relieves the voltage. The drop in potential is then entirely across the absorbing resistance and the condenser units. As soon as the abnormal disturbance passes the current will be so limited by the condensers at normal frequency that the discharge across the protecting gap will clear. The discharges are of such short duration that in general there is not sufficient time for the operation of the relays due to an unbalanced condition from the discharge of the gap.

One end of the high potential winding of each transformer is connected to the corresponding ends of the high potential windings of the other transformers forming a neutral which is usually

grounded. The corresponding low voltage windings 13 are shown connected in delta, the circuit being completed through a suitable relay or other instrument 14. The instrument 14 shown in the drawing is indicated as an induction type relay such as is used for controlling an operating circuit to open a disconnecting switch in the transmission line.

Where a transformer is connected to each phase, considerable care is necessary in order to provide transformers with balanced characteristics as a difference in the magnetizing current or in the ratio will cause a current to flow in the delta winding, even through the low voltage is balanced. With the improved construction shown in Fig. 2, however, it is possible to reduce the number of transformers required to one and since only a single transformer is used, it is not necessary to maintain the same characteristics in a plurality of transformers as in Fig. 1.

In Fig. 2 the low voltage sides of the condensers 10 are connected to a common point and the primary winding 15 of the transformer is connected to the common point. The high voltage winding of the transformer is protected by a limiting gap 16. The low voltage winding 17 of the transformer is connected to a relay or other suitable apparatus 19. If desired, the phase angle of the current flowing through the low voltage winding 17 and the relay or other piece of apparatus 19 may be varied by the use of capacity, reactance, or resistance as indicated in the drawing. The capacity, reactance or resistance may be placed either in multiple with the load or in series depending upon the characteristics desired.

Where it is not desired to change the phase angle but simply to prevent an abnormally high voltage on the transformer due to open circuit, a resistance may be placed across the winding 17. It is evident that the arrangement of Fig. 2 reduces the transformers required and simplifies the connection to the high voltage line for many installations. In most transmission lines, the abnormal voltage between phases is usually limited to very much lower values than the abnormal voltage from the different phases to ground.

During disturbances, there is a tendency for all conductors to have at the same time a higher voltage to ground induced by lightning, although the normal frequency may produce a difference in voltage between the conductors. From this it naturally follows that more insulation is needed between the conductors and ground than between separate conductors making up the different phases of the same system.

In Fig. 3 the absorbing resistor units 11 are connected to condensers 20 and 21 which may be placed in series. The common point 22 is connected to condenser units 23 and 24 which in turn are connected to the primary winding 25 of the transformer. This transformer is protected by a gap 26 and has a low voltage winding 27 which may be used for supplying the desired current or potential for relay operation or other purposes. The condensers made up of units 23 and 24 may have any suitable relation as compared to the condensers 20 and 21. Where the electrostatic capacity of the condensers 23 and 24 is three times that of the condensers attached to different phases, a uniform rise in voltage on the several phases will produce the same drop in potential on the condensers above the common point as below the common point. Where the voltage rise is different, the condensers on the ground side of the common point may, however, be of even lower electrostatic capacity, if these condensers will supply the desired current.

This arrangement makes it possible to provide more insulation to ground for a given number of condenser units or a greater range of voltage for a given number of condenser units between line and ground.

The current or potential supplied by the condenser systems together with their transformers may be used with any suitable relay scheme.

The present invention is of especial value when applied to the operation of relays for polyphase transmission lines because by it the voltage made available for relay operation will be proportional to the drop in voltage of any phase conductor of the system when that phase is grounded. This is true of the arrangement in which the potential transformers have their high potential windings Y connected and their low potential winding connected in delta, the relay being connected in series with the low potential winding as shown in Fig. 1. This relation of the voltage in the secondary to the fall in potential of the grounded phase conductor is true where the potential transformers are connected directly to the conductors of the transmission line in the manner explained even without the interposed resistance and condensers shown in the drawing; but, where the condensers and resistance are used, the desired result is secured much more economically and with a much greater degree of reliability than where the transformer windings are connected directly to the transmission line conductors. It is difficult and expensive to insulate a transformer sufficiently where it is connected directly to the high potential conductors of modern transmission lines but condensers having high insulating values and consequently good reliability can be produced at comparatively small expense, so that with the arrangement shown in Fig. 1, it is possible to impress a voltage on the relay 14, proportional to the drop in voltage on the grounded conductor, at a very considerable reduction in expense and a very considerable gain in reliability over the arrangement in which high potential transformers are connected directly to the transmission line.

The same relation of voltage impressed on the relay to the drop in the potential of the grounded phase conductor is secured in the connection shown in Fig. 2 but with a still further decrease in cost and increase in reliability for the reason that only one transformer is required in this case as compared with three in the connection shown in Fig. 1.

In Fig. 3, the same ratio of voltage in the secondary of the transformer to the drop in the conductor is produced but a still greater degree of reliability is secured because of the addition of the condensers 23 and 24.

In the connections shown, it is important to use condensers of relatively high capacity as compared to the conductivity of the leakage path over the condensers. One form of condenser especially adapted for this use is that shown in Patent No. 1,810,385, granted June 16, 1931. The condenser there shown has a leakage path protected by weather shields so that even in case of bad weather conditions, a high resistance leakage path is maintained. We have found in operation that condensers of the form shown in the patent referred to above each having a capacity of approximately .001 microfarads and a leakage resistance of not less than 250 megohms give very satisfactory results. We have also found

that for satisfactory operation the resistance of the leakage path around the condenser should not be less than approximately forty times the capacity reactance of the condenser for the operating frequency.

The leakage path of a condenser is an uncertain quantity and varies with accumulated surface dirt, weather conditions and other factors. Any unbalance in the leakage paths of the condensers for the different phases in the connections shown will tend to set up a current in the secondary winding of the transformer and this tendency will depend upon the proportion between the conductivity of the leakage paths and the capacity of the condensers. If the connection be used for metering, the error due to leakage will be magnified in direct proportion to the conductivity of the leakage path for a given capacity. It is therefore apparent that the form of condenser used is important and that the conductivity of the leakage path should be kept low for a given capacity. Condensers of very low capacity such as the usual form of bushing insulator are therefore not well suited for this form of connection and it is also important to use condensers, the leakage paths of which are not apt to be materially changed by accumulation of dirt or weather conditions. For this reason, we have found the form of condenser shown in the application mentioned above especially suitable.

We claim:

1. The combination with a polyphase transmission line, of a potential transformer, a plurality of circuits, each of which is connected with one of the conductors of said transmission line, the other end of said circuits being connected together, each of said circuits including condenser in series therewith, a potential transformer having its high potential winding connected with the common point of said circuits, and a condenser interposed in the connection between said high potential winding and said common point.

2. The combination with a polyphase transmission line, of a plurality of circuits, each having one end connected with one phase conductor of said transmission line, said circuits having the other ends thereof joined together, each circuit comprising a resistance and a condenser in series, a potential transformer having one end of the high potential winding thereof grounded and having the other end thereof connected to the joined ends of said circuit, a condenser interposed in series between said high potential winding and the joined ends of said circuits, and a relay connected to the low potential winding of said transformer.

3. The combination with a polyphase transmission line, of a plurality of circuits, each connected to one of the phase conductors of said transmission line, each of said circuits comprising a resistance and a condenser in series, the ends of said circuits opposite said transmission line being joined together, a potential transformer having one end of the high potential winding thereof grounded and having the other end connected through a condenser in series therewith to the joined ends of said circuits, a limiting arcing gap in parallel with said high potential winding, a relay connected with the low potential winding of said transformer, and means for adjusting the phase angle of the current flowing through said secondary winding.

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