Feb. 4, 1930. J. STOECKLIN ET AL 1,745,386

RELAY SYSTEM

Filed May 28, 1927

Fig. 1.

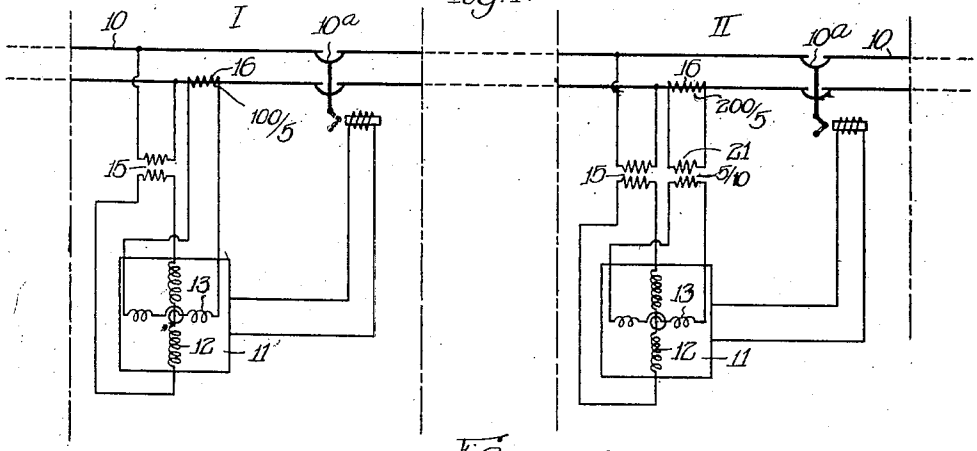


Fig. 2.

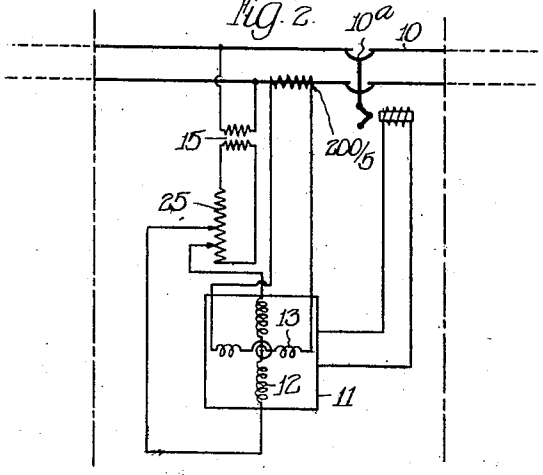
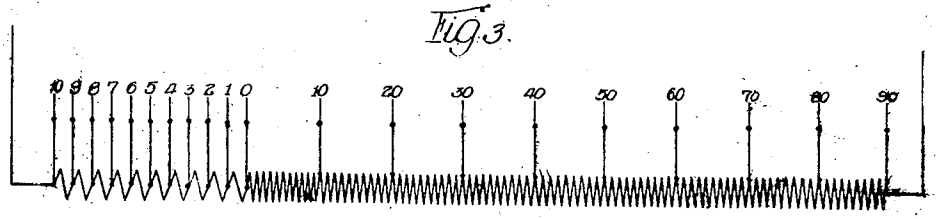


Fig. 3.



Witness:
R. Burkhardt.

Inventors
Josef Stoecklin
Arnold Roth
By Cromwell, Greist & Warden
Attys

Patented Feb. 4, 1930

1,745,386

UNITED STATES PATENT OFFICE

JOSEF STOECKLIN, OF ZURICH, SWITZERLAND, AND ARNOLD ROTH, OF BRON, NEAR LYON, FRANCE, ASSIGNORS TO AKTIENGESELLSCHAFT BROWN BOVERI & CIE., OF BADEN, SWITZERLAND, A COMPANY OF SWITZERLAND

RELAY SYSTEM

Application filed May 28, 1927, Serial No. 194,879½, and in Germany March 6, 1926.

Our invention relates to relay systems, and it has particular relation to systems employing impedance responsive relays or like instruments, that is, instruments that act in response to the differential action of the current and voltage of the line with which they are associated. Relays of this type are described in the co-pending application of Josef Stoecklin, Serial No. 147,791, filed November 11, 1926.

In systems of the above described character, the circuit breakers at the various substations are provided with relays arranged to vary the tripping time of the circuit breakers in accordance with the impedance of the line to the point where a fault occurred. This causes the circuit breaker nearest to the fault to open first, and thus to disconnect only the faulty sections from the remainder of the system.

Among the objects of the present invention is the provision of an improved relay system of the foregoing character, utilizing improved means for compensating for the difference of the transformation ratio of the transformers energizing such relays at the various points of the system in order to secure definite relationship between the operating characteristics of the relay devices at the several points of the system. More particularly, our invention is directed to the compensation or correction of the difference in the transformation ratios of the transformers supplying the relays of the various points of the system by adjustment of the voltage applied to the voltage element of such relays.

Our invention will be best understood from the accompanying drawings wherein:

Fig. 1 is a circuit diagram of a distribution system to which our invention is applicable;

Fig. 2 is a diagram similar to Fig. 1, illustrating a relay system embodying our invention; and

Fig. 3 is an enlarged circuit diagram of the compensating transformer shown in Fig. 2.

A distribution system of the type referred to hereinabove is shown diagrammatically in Fig. 1 of the drawing wherein at substations I, II, etc., of a long high-voltage transmission line 10 there are provided circuit breakers 10^a arranged to be tripped by means of impedance relays II. The impedance relays II are so connected to the distribution line that, upon the occurrence of a fault, the times within which the individual relays cause the tripping of the associated circuit breakers are proportional to the impedance of the line between the respective circuit breaker and the fault. In most cases, this discriminating action of the relay is obtained by means of a pair of co-operating voltage and current elements, namely, a voltage coil 12 and a current coil 13. The voltage coil 12 is supplied through a voltage transformer 15 with a current corresponding to the voltage of the line at said point. The current coil 13 is supplied through a current transformer 16 by a current corresponding to the line current at said point of the system. By suitably bringing into co-operation the voltage coil and current coil, 12 and 13 of the relay, its action may be made dependent on the ratio of the voltage to the current of the line, that is, to its impedance.

In any practical system of the foregoing character the voltage and current coils of the relay are not directly connected to the line but through the intermediary of suitable voltage and current transformers, since it is impractical and also dangerous to operate the relays directly from the high voltage system.

The current and voltage transformers utilized for supplying such relays serve very often a variety of additional purposes, such as for the control of the circuit breakers in response to other characteristics of the system, for the supply of various meters at the substation, etc. Very often the voltage and current transformers at the various points of the distribution system have different transformation ratios. Accordingly, if the relays at the several substations were directly connected to the secondaries of the voltage and current transformers at the different substations, the relays would not respond to the actual resistance of the line in the same manner. For instance, if one substation, say sub-

station I, has a current transformer 16 with the transformation ratio 100 to 5, and the current transformer at the other substation II has a transformation ratio 200 to 5, and the voltage transformers at the two substations have the same transformation ratio, the action of the relays at the two substations would not be correlated in the way required in order to secure proper discriminative action, as explained hereinabove. Only if the current and voltage transformers at the substations all have the same transformation ratio, the relays at the several points of the system will exercise the same discriminative action.

In order to secure correlated discriminative effect with relays supplied from instrument transformers that differ in their transformation ratio, special auxiliary or compensating transformers are provided, such as shown in Fig. 1 at substation II, where the compensating transformer 21 is connected between the current transformer 16 and the current coil 13 of the impedance relay. The transformation ratio of the compensating transformer 21 is so chosen with respect to the transformation ratio of the transformer 16 that the total transformation ratio obtained by connecting the two transformers in the series is again 100 to 5, like in the current transformer at substation I. In other words, the auxiliary current transformer 21 serves to compensate for the higher transformation ratio of the current transformer at substation II, as against other substations of the system. The compensation for the differences of the transformation at the various stations could also be effected by providing auxiliary tappings on the current transformers in order to assure that the ratios of the current and voltage supplied to the relays at the several substations reflect the impedance of the system in the same way. Lack of such compensation would distort the relationship between the tripping times of the relays of the several substations.

The above described arrangements for correcting for the different transformation ratios of the instrument transformers at the several substations, have certain disadvantages, from the view point of the practical operation of such systems. Thus, when an auxiliary current transformer is used, its secondary current increases with an increase of the ratio of the main current transformer. For example, if the main current transformer at the first substation has a ratio of 100 to 5, the normal current supplied to the current coil of the relay will be 5 amperes. If now at another substation the current transformer has a ratio of 200 to 5, the auxiliary correcting transformer must have a ratio of 5 to 10. Under such conditions, the normal current supplied by the current coil of the relay from the secondary winding of the compensating transformer, will be 10 amperes. The relay will thus be overloaded under normal working conditions as compared to a relay that is operated with a current transformer having a 100 to 5 ratio. The other type of compensation, by means of auxiliary taps on the current transformer, is not practicable because the limited number of turns used on the current transformers makes it difficult to obtain thereby close graduation of the transformation ratios.

A distinct feature of the present invention resides in the utilization of the voltage circuit of the relay for correcting discrepancies in the transformation ratios of the current transformer supplying the relays. More generally our invention contemplates the confining of the adjustment or corrections in the transformation ratio of the instrument transformers supplying the relays to the voltage circuit of such relays, irrespective of whether the correction is required by reason of improper ratio of the current transformer or of the voltage transformer.

Thus, taking the example considered above of a substation, indicated in Fig. 2, where the current transformer has transformation ratio of 200 to 5, and we desire to compensate this ratio with respect to a substation, utilizing a current transformer having a ratio 100 to 5, we connect the current coil 13 of the relay directly to the 200 to 5, current transformer. The correction is secured by reducing the voltage supplied to the voltage coil 12 of the relay, in the same ratio as the current supplied to the current coil 13 is reduced, as by means of an auxiliary compensating transformer 25 connected between the voltage coil 12 and the voltage transformer 15 of the substation. Assuming, for instance, that the secondary voltage of the voltage transformer at substation I is 110 volts, the compensating transformer 25 is adjusted so that the voltage supplied to the voltage coil 12 of the impedance relay is only 55 volts, corresponding to the higher rate of current transformation at said substation.

The arrangements for applying to the voltage coil 12 of the impedance relay only a fraction of the voltage derived from the secondary winding of the voltage transformer 15 may have a variety of forms familiar to those skilled in the art. In the preferred construction we utilize an auto transformer, such as shown in detail in Fig. 3. The relay that is to be used on the system is designed so as to operate satisfactorily when supplied directly from such current transformer of the system as has the lowest transformation ratio, with the normal voltage, say 110 volts, applied to the voltage coil. Under such conditions, the relays are suitable for operation with transformers having higher transformation ratios, it being only required to include a suitable cor-

recting transformer in the voltage circuit of the relay to reduce the voltage applied to the voltage coil, as explained above.

In the preferred construction of the compensating transformer, shown in Fig. 3, we provide a large number of taps graduated in accordance with the decimal system to permit the tapping of as many per cent of the total voltage of the transformer as desired. Starting from the tap marked 0, at an intermediate point of the winding, there are taps 10 to 90 on one side of the transformer and taps 1 to 10 on the other side of the transformer. Such arrangement greatly facilitates adjustment of the sensitiveness at the various stations of the system by merely varying in the same ratio the voltage supplied to the voltage coils of the relays at all stations.

The foregoing system for compensating differences in the transformation ratios of the instrument transformers, secures correct operation of the relays independently of the differences in the instrument transformers used at the several stations; eliminates the possibility of overloading the relays by reason of the employment of higher ratio current transformers; and readily permits adjustments of the sensitiveness of the relays throughout the system.

We claim as our invention:

1. In a distribution system, a relay device having current and voltage elements cooperating to produce an effect responsive to a ratio of the voltage and current of said system, a circuit including a current transformer for supplying said main current element, a circuit including a main voltage transformer for supplying said voltage element, and a second voltage transformer connected between said main voltage transformer and said voltage element to so vary the current supplied thereto as to cause said relay device to respond to the conditions of said system with a predetermined sensitiveness irrespective of the transformation ratios of the main current and voltage transformers supplying said relay device.

2. In a distribution system having a plurality of station, a plurality of relay devices at said stations, each relay device comprising a voltage element and a current element cooperating in response to a ratio of the voltage and current of said system, voltage transformers at said stations for supplying the voltage elements of said relays, current transformers at said stations for supplying the current elements of said relays, the transformation ratios of the current transformers at the several stations varying with respect to each other, and means associated exclusively with circuits of said voltage elements for compensating the differences in the transformation ratios of said transformers at the different stations to secure the same character of response of the relay devices at the several stations.

3. The combination as defined by the claim 2, characterized by an auxiliary voltage transformer for adjusting the voltage applied to the voltage element of said relay devices, said voltage transformer having a plurality of tappings permitting application of any desired integer percentage of the full voltage of the voltage transformer to the voltage element of said relay devices.

4. In a distribution system, a plurality of relay devices, each having a current element and a voltage element cooperating to produce an effect corresponding to a predetermined relation of the current and voltage of a system, a plurality of current transformers of different transformation ratios for supplying the current elements of the individual relay devices, and a plurality of voltage transformer means associated with the individual relay devices for supplying the voltage elements of said devices, said voltage transformer means having different transformation ratios so related to the different transformation ratios of said current transformers, as to secure said predetermined relation of the current and voltage of the system in said relay devices.

5. In a distribution system, an alternating current transmission line, a plurality of circuit breakers at spaced points along said line, a plurality of relay means for individually operating said circuit breakers, said relay means having current elements and voltage elements operating in response to a predetermined relationship of the current and voltage of said line, current transformers of different transformation ratios for individually supplying the current elements of said relays, and voltage transformer means of different transformation ratios for individually supplying the voltage elements of said relays, the voltage transformation ratios being so adjusted to the transformation ratios of the associated current transformers as to secure the predetermined relation of line current and line voltage in the individual relays.

6. In a distribution system, an alternating current transmission line, a plurality of circuit breakers at spaced points along said line, a plurality of relay means for individually operating said circuit breakers, said relay means having current elements and voltage elements operating in response to a predetermined relationship of the current and voltage of said line, current transformers of different transformation ratios for individually supplying the current elements of said relays, main voltage transformers of different transformation ratios for individually supplying the voltage elements of said relays, the voltage transformation ratios being so adjusted to the transformation ratios of the

associated current transformers as to secure the predetermined relation of line current and line voltage in the individual relays, and additional voltage transformer means interposed between one of said main voltage transformers and the voltage element of the associated relay for compensating for the difference of the transformation ratio of the associated current transformer against that of a transformer associated with another relay.

In testimony whereof I have hereunto subscribed my name this 6th day of September, A. D. 1927, at Zurich, Switzerland.

JOSEF STOECKLIN.

In testimony whereof I have hereunto subscribed my name this 27th day of October, A. D. 1927, at Lyon, France.

ARNOLD ROTH.