April 11, 1939. P. H. ESTES 2,154,379

METHOD OF AND APPARATUS FOR TESTING RELAYS

Filed May 23, 1936

FIG. 1

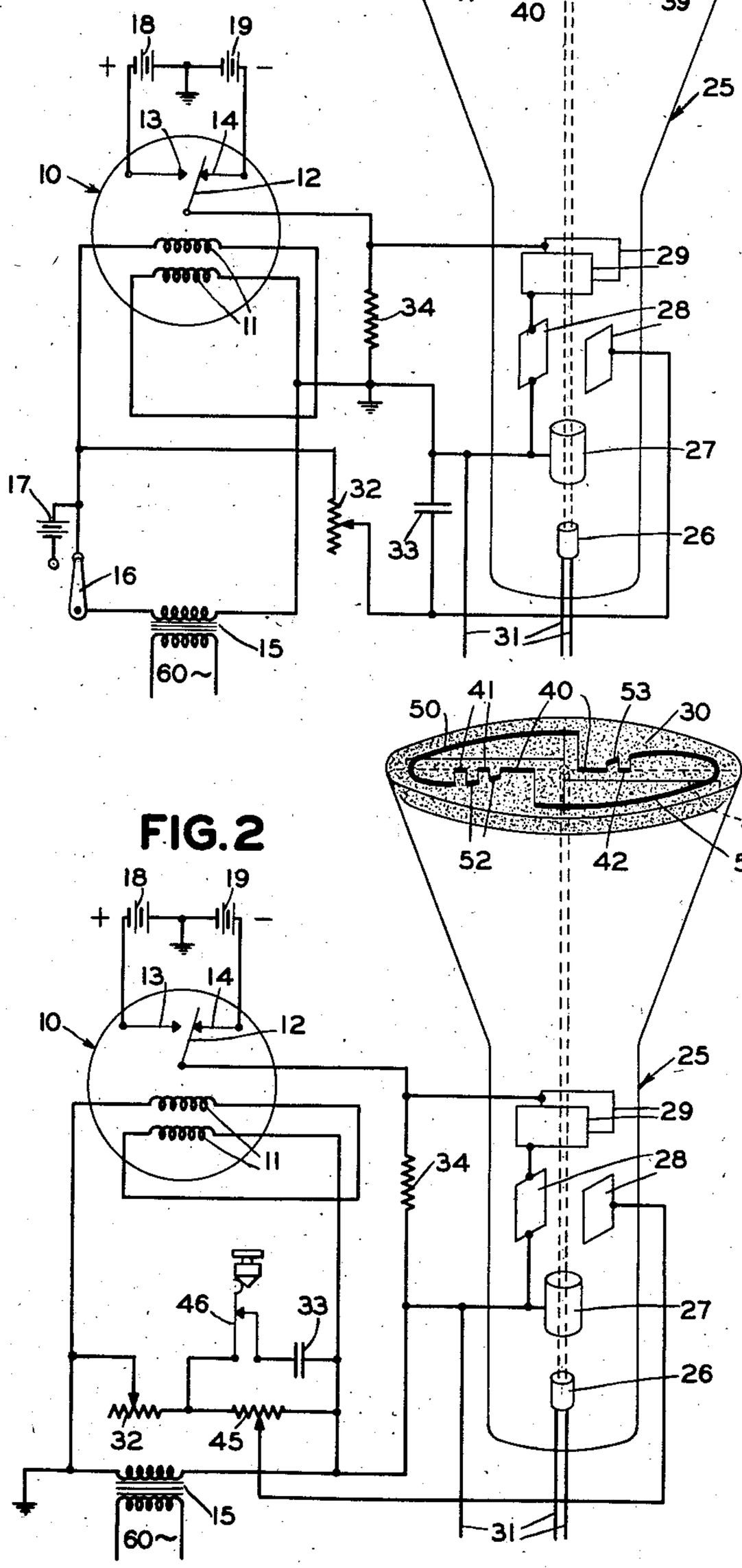


FIG. 2

FIG. 3

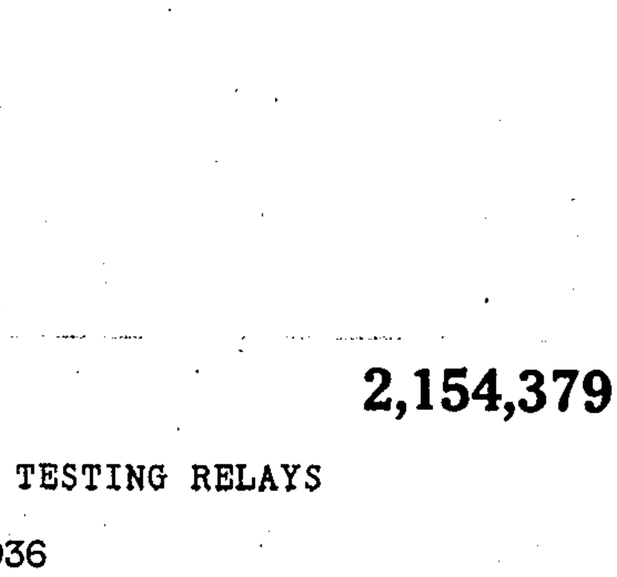


FIG. 4

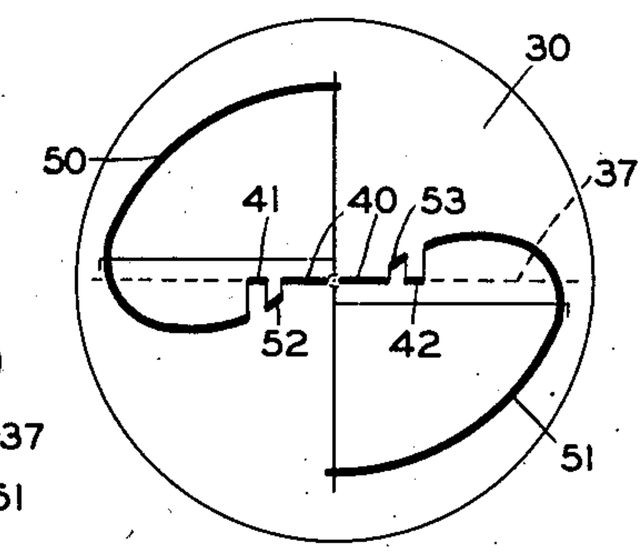
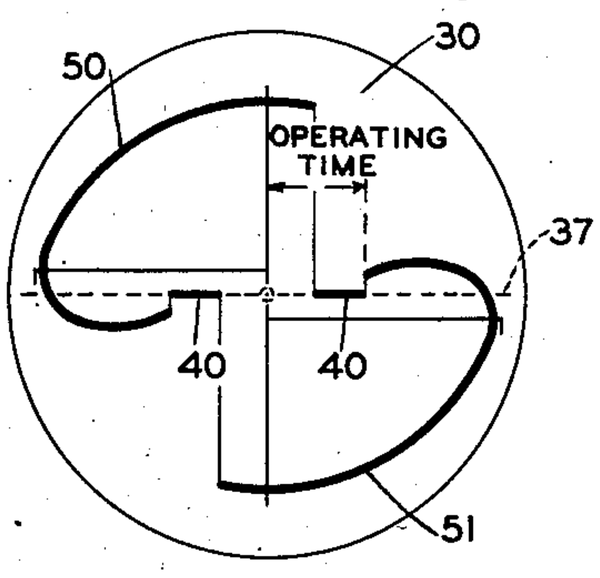


FIG. 5



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METHOD OF AND APPARATUS FOR TESTING RELAYS

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Application May 23, 1936, Serial No. 81,530

11 Claims. (Cl. 175—183)

This invention relates to methods and apparatus for testing relays and for indicating certain operating characteristics of a relay under test and the existence of contact chatter in a manner to facilitate the proper adjustment of the relay. The present application is directed to an improvement or modification of the method and apparatus broadly claimed in the copending application of W. D. Buckingham, Ser. No. 81,499, filed May 23, 1936.

A large number of relays are employed in signalling and communication systems and the operation of the systems depends upon the proper functioning of the individual relays. As an example, in multiplex and simplex telegraph systems for high speed telegraph communication, the operation of the systems depends upon the correct functioning of polarized repeating or line relays. These relays which may, for example, be of the type disclosed in the patents to William Finn, No. 1,160,097, dated November 9, 1915, or Reissue 14,304, dated May 22, 1917, must be so adjusted that they are not biased, that the travel time of the armature between contacts is between certain limits and contact chatter or bounce is substantially eliminated in order that the system may operate reliably at high speeds. Since the transmission depends upon the operative characteristics of these relays, each relay must be tested frequently and readjusted if necessary to maintain the system in operation.

In general terms the object of this invention is to provide an improved and simplified method of testing relays, including polarized and neutral relays, in order that the same may be adjusted to obtain the desired operating characteristics.

A further object of the invention is to arrange a cathode ray oscillograph to indicate one or more of the following characteristics of the relay: first, the travel time of the armature between contacts; second, the number and character of the contact bounces as the armature engages each contact; third, the firmness of contact between movable and stationary contacts of the relay as affected by the surface of the contacts and freedom from dirt; fourth the existence of mechanical or electrical bias in the relay; fifth, the equality or lack of equality of contact time on opposite contacts; sixth, the operating time or the time that elapses between the application of operating voltage to the relay and the time when the relay armature starts to move or completes its movement.

Other objects and advantages of the invention will appear from the following description of the embodiments thereof shown in the accompanying drawing, wherein:

Fig. 1 is a circuit diagram of test apparatus embodying the invention;

Fig. 2 is a similar diagram of a modification; and

Figs. 3, 4 and 5 are graphs of the traces obtained by the oscillograph in a test set arranged as shown in Fig. 2.

Referring to Fig. 1, the relay 10 under test is shown as comprising two operating windings 11 and a movable armature 12 adapted to engage stationary contacts 13 and 14, respectively. While the invention may be utilized in connection with various types of relays, the relay 10 may be assumed to be a polarized relay having differential or opposing windings which for the purposes of the test are connected in series to a source of periodically varying current represented by the transformer 15 supplied with sixty-cycle sinusoidal alternating current. The ordinary polarized line relay extensively used in high speed telegraph systems is adapted to respond to signals of a frequency of the order of sixty cycles or from about twenty to one hundred cycles per second, and therefore may be adequately tested by connecting the differential windings so that they are cumulative and operating the relay from a source of sixty-cycle alternating current of suitable potential. The accelerating or other additional windings of the relay may be left open during this test and hence are not illustrated in the drawing. In order to test other types of relays, other suitable operating voltages may be employed as will be apparent to those skilled in the art and in the case of neutral relays, a switch 16 may be provided to connect a battery 17 in series with the transformer 15 and the operating coils of the relay. If the potential of the battery 17 is approximately equal to the peak voltage derived from the transformer 15, a neutral relay connected in series relation therewith will be energized and deenergized at a rate dependent upon the frequency of the alternating current source. In the system shown, batteries 18 and 19 are further provided to impress direct-current potentials of opposite polarity upon the contacts 13 and 14. The potential of each of the batteries is sufficient to produce an appreciable deflection of the beam of a cathode ray tube.

The operating characteristics of the relay 10 including contact chatter are determined by utilizing a cathode ray oscillograph 25. The cath-

ode ray oscillograph illustrated is of a conventional type and comprises a heated cathode 26, an anode 27, a pair of plates 28 for producing a sweep of the electron beam and a pair of deflection plates 29 at right angles to the sweep plates 28 for deflecting the beam in accordance with the operation of the relay under test. The electron beam impinges upon a luminescent screen 30 formed on or adjacent the upper end of the cathode ray tube to form a visible trace representing the movements of the electron beam as it is deflected by the sweep plates 28 and the deflection plates 29. Operating potentials for the cathode 26 and the anode 27 are supplied through the conductors 31 in the usual manner. While an oscillograph of conventional type is illustrated for the purpose of explaining the invention, other types of oscillographs may be employed if desired.

An alternating potential is applied to the sweep plates 28 to deflect the electron beam of the oscillograph periodically in synchronism with the periodic phenomena to be observed. In the case of a relay energized from a source of alternating potential as illustrated, the sweep circuit may conveniently be energized directly from the relay circuit as shown, an adjustable resistor 32 being provided in series relation with the sweep circuit and a condenser 33 in shunt relation to the sweep circuit for adjusting the phase relation between the potential applied to the relay 10 and that impressed upon the sweep plates 28. Either the resistor 32 or the condenser 33 may be adjustable in order to vary the phase relation between said circuits or these elements of the circuit may be omitted in case no phase adjustment is required. The deflection plates 29 are connected to the terminals of a resistor 34 which may be adjustable if desired. The resistor 34 is connected in series relation with the armature 12 and with the battery 18 or 19 depending upon whether the armature 12 is in engagement with the contact 13 or 14, and thus the potential between the deflection plates 29 is reversed as the armature engages first one and then the other of the relay contacts 13 and 14.

The trace or pattern obtained upon the screen portion 30 of the cathode ray tube as the relay 10 operates in response to the alternating current applied to the relay windings is shown for an assumed operating condition in Fig. 1. When zero or equal potentials are applied to the pair of sweep plates 28 and to the pair of deflection plates 29, the cathode ray beam remains stationary and impinges upon the center of the screen 30. The alternating potential applied to the sweep plates 28 from the supply circuit deflects the cathode ray beam alternately in the directions indicated by the arrows 36 along the central axis 37 of the screen. The potentials applied to the rear deflection plate 29 with respect to the grounded front plate as the relay armature 12 engages the stationary relay contacts 13 and 14, respectively, deflects the cathode ray beam at right angles to the axis 37 thereby forming the trace 38 while the armature 12 is in engagement with one contact and the trace 39 while the armature 12 is in engagement with the other contact. The trace 40 upon the screen of the cathode ray tube is formed while the armature is travelling between the respective relay contacts, the portion of the trace to the left of the center of the screen being formed while the armature is travelling in one direction and that to the right while the armature is travelling in the opposite direction. If there is contact chatter when the relay armature engages one or the other of the contacts, one or more dots 41, 42 are formed upon the screen 30 indicating the number and duration of the contact bounces. Thus the pattern produced by the movement of the cathode ray beam indicates the travel time of the relay armature and the character and severity of the contact chatter, if any. The pattern will also be affected if the contact between the armature and one of the relay contacts is imperfect to such an extent as to affect the contact resistance materially as a decrease in the normal current traversing the relay contacts will alter the potential drop in the resistor 34.

In Fig. 2 is shown a modification in which the deflection plates 29 are subjected to the alternating sinusoidal potential of the supply circuit in addition to the potential of the batteries 18 and 19 associated with the relay contacts. In order to effect this result, the armature 12 and resistor 34 are connected in series relation with the secondary winding of the transformer 15 whereby when the circuit of the battery 18 or 19 is closed through the relay armature 12, the deflecting potential applied to the deflection plates 28 consists of the potential of said battery plus that existing across the terminals of the secondary winding of the transformer.

The circuit of the sweep plates 28 further comprises a potentiometer 45 to permit adjustment of the extent of sweep of the cathode ray beam. A switch or key 46 is also provided in the circuit of the condenser 33 in order to permit the operation of the test set with the potentials applied to the relay windings and to the sweep plates 28 in phase.

As shown in the diagram upon the screen portion of the cathode ray tube, a different pattern is obtained in this case. When the relay armature is travelling from one contact to the other, the traces 40 on the axis 37 of the screen are obtained as in the modification of Fig. 1. If there is any contact chatter, this is indicated by the dots 41 and 42 as in Fig. 1. However, the trace formed during the interval when the armature is in engagement with one or the other of the relay contacts is arcuate in shape as indicated at 50 and 51 and may contain dots 52 and 53 representing contact chatter.

In the pattern shown in Fig. 2, the ends of the arcuate traces 50 and 51 overlap and the inner ends of the traces 40 are separated by a gap. Such a pattern indicates that the sweep of the beam starts before the relay armature 12 commences to move away from the stationary contact 13 or 14. In order to bring the sweep of the beam of the cathode ray tube in phase with the movement of the armature of the relay under test, the adjustment of the resistor 32 is changed until the gap between the traces 40 is substantially eliminated, thereby obtaining the pattern shown in Fig. 3. This pattern, however, is unsymmetrical with respect to the axis of the screen of the cathode ray tube, indicating that the relay is mechanically or electrically biased. After the relay is adjusted to eliminate this bias, the symmetrical pattern of Fig. 4 is obtained. The relay may also be adjusted to eliminate the contact chatter and is then in proper operating condition.

If the key 46 is then opened, so that the alternating potential applied to the relay windings 11 is in phase with that impressed upon the sweep circuit, a pattern similar to that shown in Fig. 5 is obtained. The distance from the

axis of the screen to the end of the trace 40 represents the operating time of the relay; i. e. the time elapsing between the beginning of the cycle of the alternating potential from the source connected to the relay windings and the engagement of the armature with one of its contacts in response to the energization of the relay. If the frequency of the alternating potential is known and the potential is sinusoidal, the operating time may be readily determined in hundredths of a second.

The invention is not limited to the particular embodiments disclosed herein for purposes of illustration as such embodiments may be modified without departing from the scope of the invention as defined in the appended claims. No claim is made herein to the subject matter of the above mentioned Buckingham application.

I claim:

1. The method of testing a movable-armature relay with a cathode ray oscillograph having sweep plates and deflection plates which comprises impressing alternating substantially sinusoidal potentials of the same frequency upon the relay and the sweep plates of the oscillograph respectively, and deflecting the beam of the oscillograph laterally of the sweep movement in accordance with the position of the relay armature and with one of said alternating potentials.

2. The method of testing a contact-making relay with a cathode ray oscillograph having sweep plates and deflection plates which comprises impressing alternating substantially sinusoidal potentials of the same frequency upon the relay and the sweep plates of the oscillograph respectively, and deflecting the beam of the oscillograph laterally of the sweep movement in accordance with the opening and closing of the relay contacts and with one of said alternating potentials.

3. The method of testing a movable-armature relay with a cathode ray oscillograph having sweep plates and deflection plates which comprises periodically energizing said relay and the sweep plates of the oscillograph and deflecting the beam of the oscillograph laterally of the sweep movement in accordance with the potential applied to said relay and with the movement of the relay armature.

4. Apparatus for testing relays provided with contacts comprising a cathode ray oscillograph having sweep plates and deflection plates, means including a source of current for periodically energizing the relay under test and the sweep plates of said oscillograph, a second source of current, a connection from said second source of current through a contact of said relay to the deflection plates of the oscillograph and means for further controlling the potential impressed upon said deflection plates in accordance with the relay operating potential.

5. Apparatus for testing relays provided with contacts comprising a cathode ray oscillograph having sweep plates and deflection plates, means including a source of current for periodically energizing the relay under test and the sweep plates of said oscillograph, means for impressing different potentials through the respective contacts of said relay to the deflection plates of the oscillograph and means for further controlling the potential impressed upon said deflection plates in accordance with the relay operating potential.

6. Apparatus for testing relays provided with contacts comprising a cathode ray oscillograph having sweep plates and deflection plates, a source of alternating current connected to the relay under test and to said sweep plates, a second source of current, a resistor connected in series relation with both said sources of current and with a contact of said relay and connections from the terminals of said resistor to the deflection plates of the oscillograph.

7. Apparatus for indicating contact chatter in a relay comprising a cathode ray oscillograph having means for producing and deflecting a beam of electrons, a source of alternating current connected to the relay and means for impressing upon the deflecting means of the oscillograph a potential varying with the relay operating potential and the open and closed condition of the relay contacts.

8. Apparatus for testing relays provided with contacts comprising a cathode ray oscillograph having sweep plates and deflection plates, means for applying alternating potentials to the relay under test and said sweep plates, respectively, means for varying the phase relation of said potentials and means including a contact of the relay for varying the potential impressed upon said deflection plates as the relay operates.

9. Apparatus for testing relays provided with contacts comprising a cathode ray oscillograph having sweep plates and deflection plates, a source of alternating current, circuits connecting said source to the relay under test and to said sweep plates, respectively, phase shifting means in one of said circuits, a source of current connected to one of the contacts of said relay, and a connection from another relay contact to one of said deflection plates of the oscillograph.

10. Apparatus for testing relays comprising a cathode ray oscillograph having sweep plates and deflection plates, a common source of potential for the relay under test and the sweep plates of said oscillograph, connections between said source and the relay and sweep plates, respectively, phase adjusting means in one of said connections and a connection between a contact of the relay and one of the deflection plates of the oscillograph.

11. Apparatus for testing relays comprising a cathode ray oscillograph having sweep plates and deflection plates, means for energizing the sweep plates of the oscillograph concurrently with the operation of the relay under test, means for altering the potential of the deflecting plates of the oscillograph as the relay armature moves, phase shifting means for varying the phase relation between the potentials applied to the sweep plates of the oscillograph and to the relay, respectively, and a switch arranged to control said phase shifting means.

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