

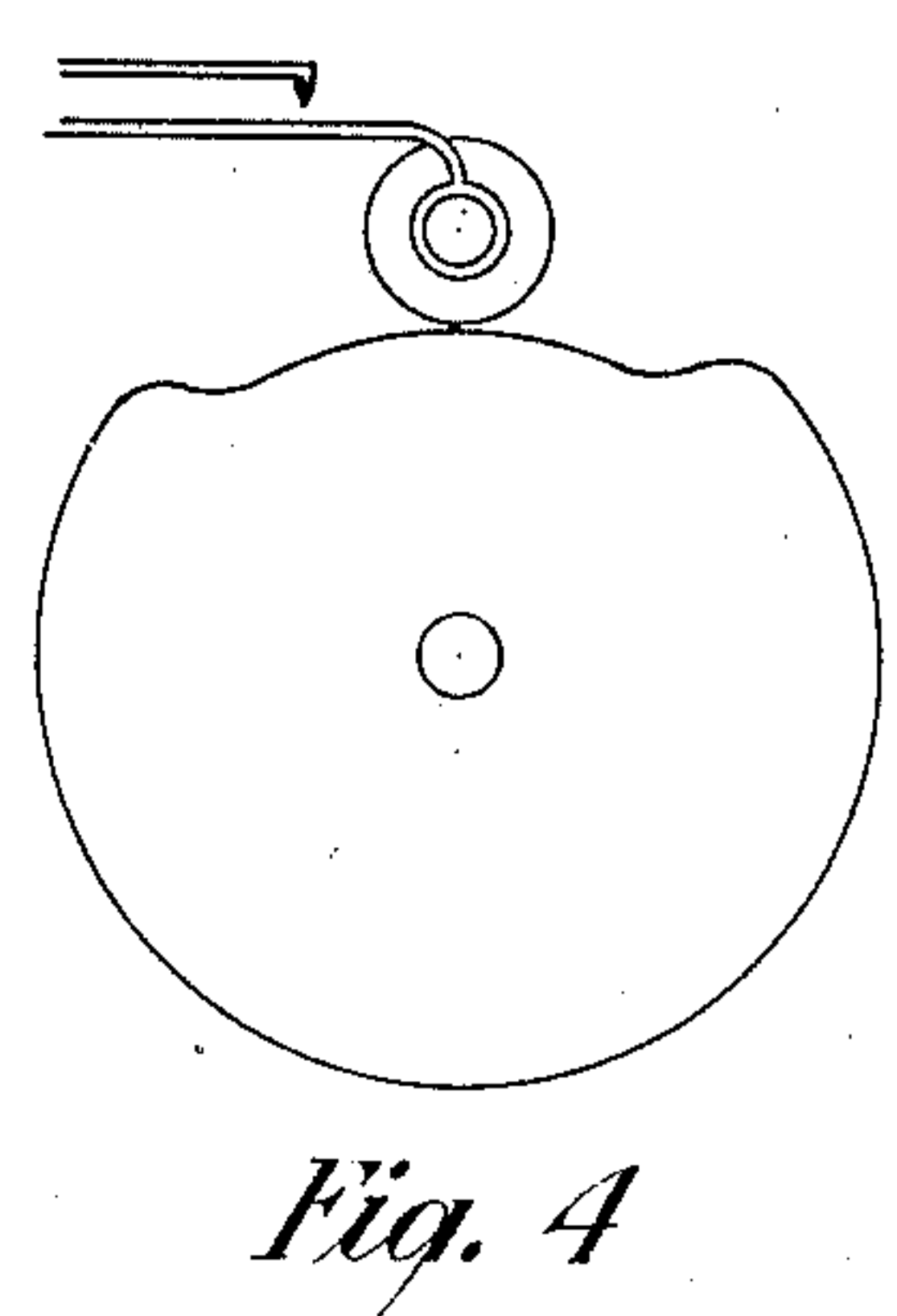
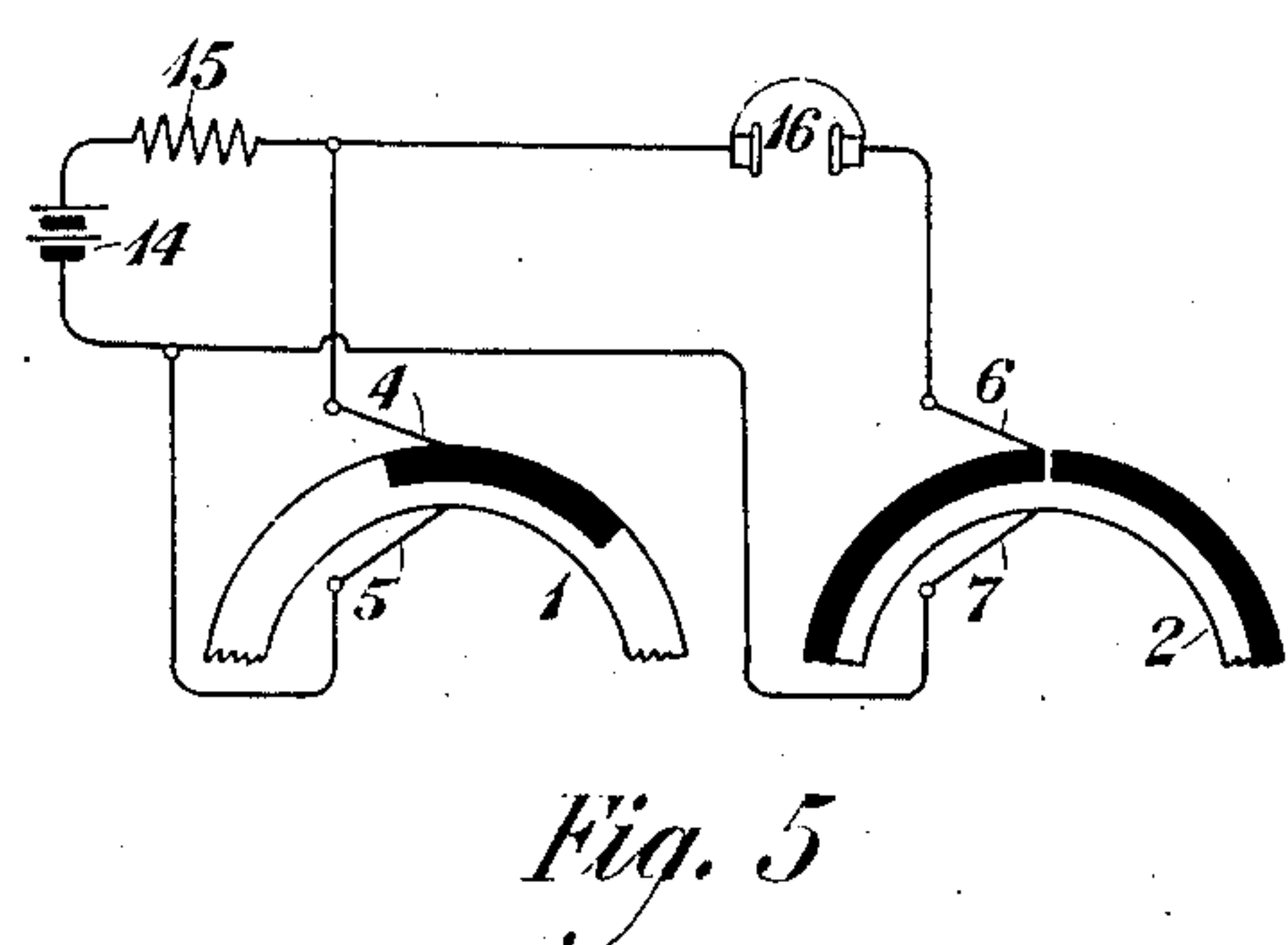
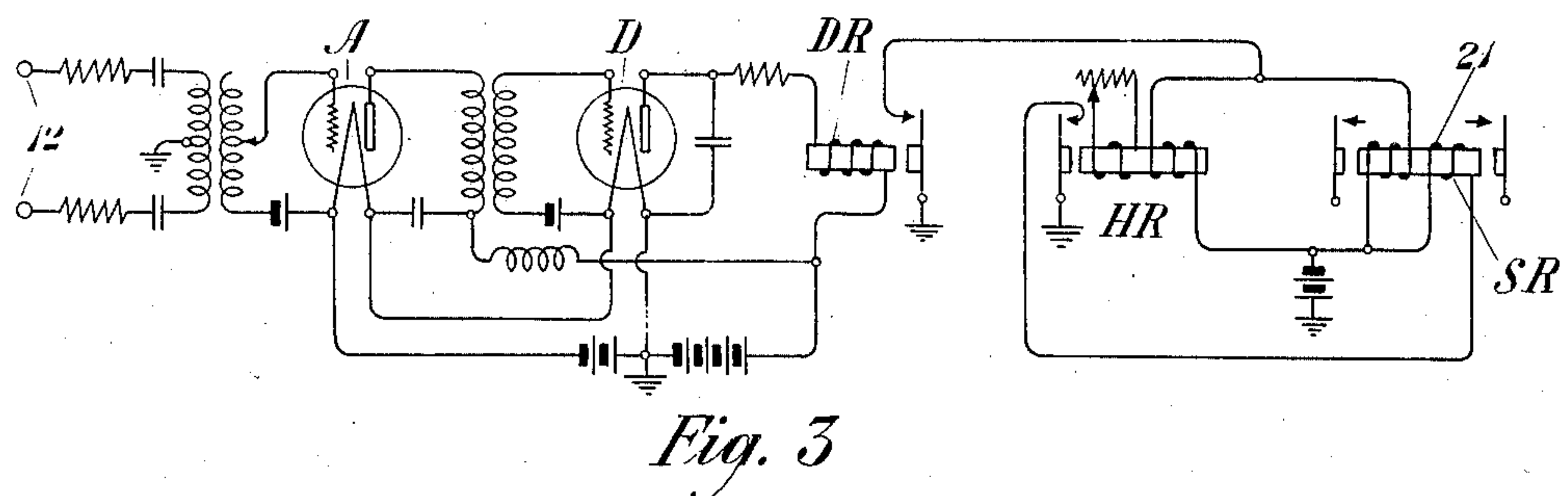
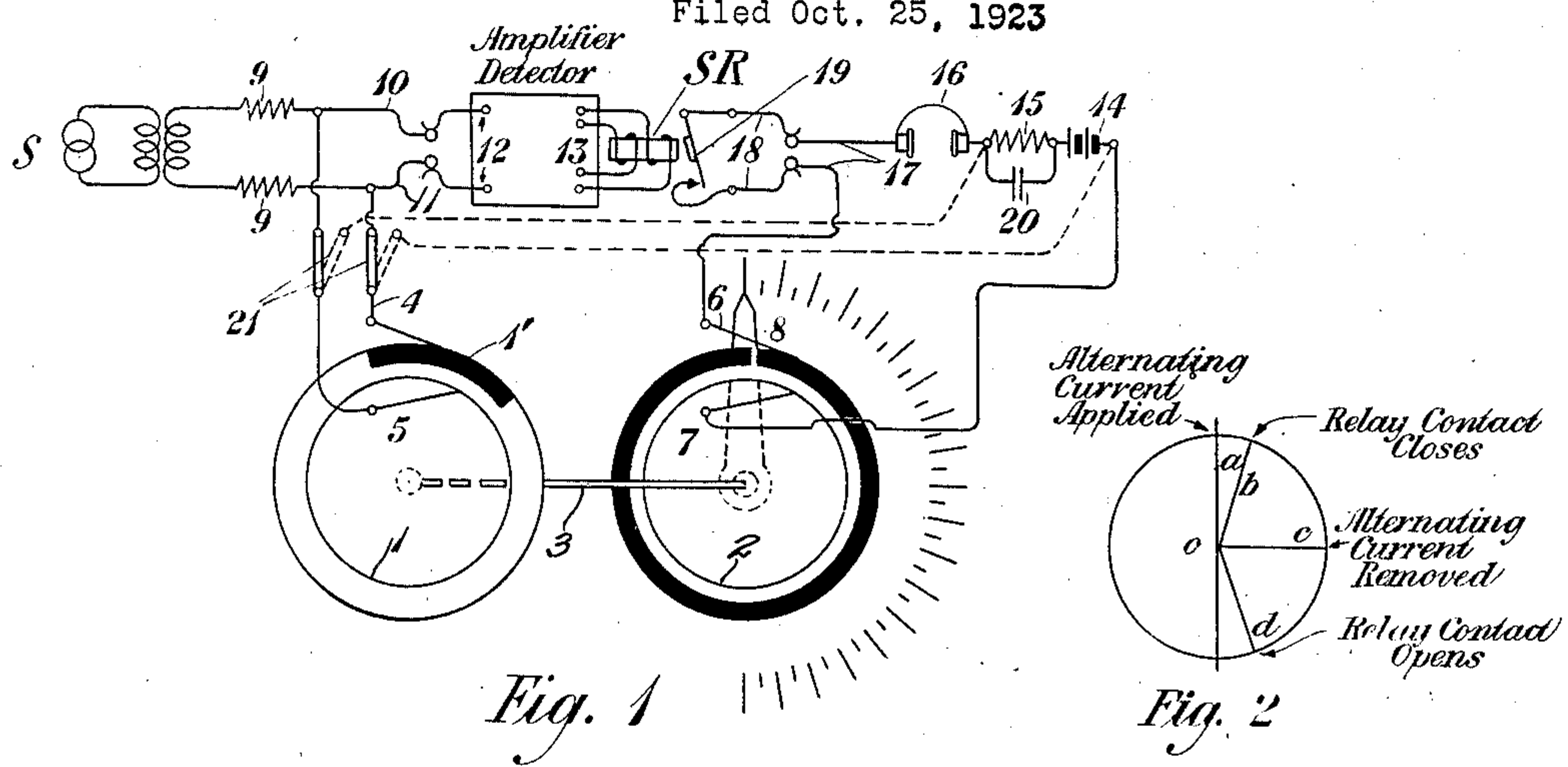
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G. CRISSON

TESTING CIRCUITS FOR ECHO SUPPRESSORS

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TESTING CIRCUITS FOR ECHO SUPPRESSORS.

Application filed October 25, 1923. Serial No. 670,740.

To all whom it may concern:

Be it known that I, GEORGE CRISSON, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain Improvements in Testing Circuits for Echo Suppressors, of which the following is a specification.

This invention relates to echo suppressing arrangements for long telephone circuits and more particularly to a method and means for testing the operating time of echo suppressor circuits.

In long telephone circuits, particularly circuits of the four-wire type, it has been proposed to overcome the difficulty due to echoes which are reflected back from terminal points or points of impedance irregularities in the circuit by providing so-called echo suppressors which operate in response to talking currents transmitted in one direction to disable the circuit for transmission in the opposite direction. In the case of the four-wire circuit, for example, a voice operated relay may be arranged to operate in response to voice currents transmitted in one direction to short circuit the line transmitting in the opposite direction. The operating time of the echo suppressor in such a system is of importance for the reason that when the suppressor is actuated in response to voice currents it must not release until the last wave which has actuated the suppressor has had time to be transmitted to the terminal and back to the point at which the suppressor short circuits the return path.

In accordance with the present invention it is proposed to determine both the time required for the suppressor relay to operate after a tone has been applied and for the suppressor relay to release after the tone has been withdrawn, by using a pair of commutators. One of the commutators applies the tone during a definite interval while the other commutator is arranged to send clicks through a telephone receiver when the suppressor relay is actuated. By adjusting the brush of the second commutator to either of two points at which the clicks cease to be heard, the point in the cycle of the commutator at which the suppressor relay attracts its armature and also the point at which it releases its armature are determined. The angular displacement of these two points from the corresponding known points at

which the tone is applied and withdrawn indicates the duration of the "make" time and "holding" time of the suppressor relay in a simple manner.

The invention may now be more fully understood by reference to the accompanying drawing, Figure 1 of which shows the connections of the commutator arrangement for determining the time of the echo suppressors, Fig. 2 of which is a diagram illustrating the sequence of events in the circuit arrangement of Fig. 1, Fig. 3 of which is a circuit arrangement showing in some detail the nature of the echo suppressor, Fig. 4 of which illustrates a cam arrangement which may be substituted for the commutator arrangement of Fig. 1 and Fig. 5 of which shows the circuit connections determining the zero positions of the indicating arm associated with the commutator.

In order to understand the invention the nature of the echo suppressor to which the invention is applied will first be described. Referring to Fig. 3, the echo suppressor arrangement comprises a vacuum tube amplifier A, working into a vacuum tube detector D, in the output circuit of which is a detector relay DR. The input terminals 12 of the arrangement are in practice bridged across one line of a four-wire circuit so that voice currents transmitted over said circuit will be impressed upon the amplifier. These voice currents are amplified by the amplifier A and are rectified by the detector D, whose grid has such a potential that normally no current will flow through the detector relay, but when the voice currents are received a rectified current component is caused to flow through the detector relay to actuate the same. The detector relay DR controls the circuits of a hangover relay HR and a suppressor relay SR in such a manner as to energize both relays. The hangover relay closes a locking circuit through an additional winding of the suppressor relay SR, so that the latter will remain locked up so long as the hangover relay HR remains energized. The latter relay is made slow releasing by means of an additional short circuiting winding and the time required for the hangover relay to release may be adjusted by means of a suitable resistance in circuit with the extra winding. Consequently, after the voice currents cease and

the detector relay DR becomes deenergized a definite interval of time must elapse before the suppressor relay SR releases its contacts, this interval of time being determined by the hangover relay, which in turn is regulated by means of the resistance, already referred to.

The result is that the arrangement as a whole causes the suppressor relay SR to close its contacts very quickly when voice currents are applied to the terminals 12 but a definite interval of time must elapse after the voice currents cease before the suppressor relay SR will release its armature.

The purpose of the present invention is to determine the time required for the suppressor relay SR to "make" its contact after the tone is applied and also to determine the "holding" time of the suppressor relay SR, that is, the time required for the relay to release its armature after the tone has ceased.

Referring to Fig. 1, the echo suppressor arrangement schematically indicated at 13 has its input terminals 12 connected to a tone source S through a resistance arrangement 9, designed to give the tone the proper amplitude. The connection to the tone source may be made through a suitable plug and jack arrangement, illustrated at 10 and 11. Two commutators, illustrated at 1 and 2, are shown mounted rigidly upon a common shaft 3. Two brushes, illustrated at 4 and 5, bear upon commutator 1, the arrangement of the commutator being such that the brush 4 is electrically connected with the brush 5 during the greater part of a revolution but is insulated therefrom during the period that the insulating segment 1' passes under the brush 4. The brushes 4 and 5 are connected across the input of the echo suppressor through a two-pole switch 21. Consequently, the tone is only applied to the echo suppressor while the brush 4 bears upon the insulating segment 1'.

The second commutator 2 is somewhat similar to the first, except that it is arranged to close the circuit between its brushes 6 and 7 for a very brief interval during each revolution. This commutator and its brushes constitute the timing element of the arrangement. The brushes 4, 5 and 7 are fixed with respect to the frame of the device while the brush 6 is mounted upon an arm 8 so that it can be revolved about the axis of the commutator. This arm carries an index moving over an arc, graduated in degrees or in other convenient divisions. The shaft carrying the two commutators is driven at a known constant speed by means of any suitably governed motor arrangement. The brushes 6 and 7 of the second commutator control a local circuit including a battery 14, a resistance 15 and a telephone receiver 16. This cir-

cuit may be connected to the contact 19 of the suppressor relay SR by means of a plug and jack arrangement, indicated at 17 and 18, so that when the contact 19 of the suppressor relay is closed a click will be heard in the telephone receiver 16 each time the live segment of the commutator 2 passes under the brush 6. If desired, a condenser 20 may be bridged around the resistance 15 for the purpose of increasing the noise in the receiver caused by the closure of the battery circuit.

Fig. 2 shows the sequence of events during one revolution of the commutators. In this figure the point *a* represents the position of the commutator shaft at the instant that the circuit between brushes 4 and 5 opens, applying the alternating current to the amplifier detector. A short time after this occurs the contact 19 of the suppressor relay is closed, during which time the commutator rotates through the angle *acb*. The system remains in this condition until the position *c* is attained at which moment the connection between brushes 4 and 5 is re-established, cutting off the alternating current from the echo suppressor. Due to the delay caused by the hangover relay, the commutator will rotate through a considerable angle to position *d* before the suppressor relay contacts, 19, finally open. The proportion of time during which the alternating current is on and off and the speed of rotation of the commutator, should be so chosen that the magnetism in the cores of the various relays will have an opportunity to reach a steady state between the successive events of the revolution of the commutator shaft.

If the setting of the apparatus is such that the connection between brushes 6 and 7 occurs when the relay contact 19 is closed, a click will be heard in the receiver, 16, at each revolution of the commutator shaft. If, then, the arm carrying the brush 6 is moved either in the direction of rotation or against it, the time of the contact of the brush 6 will be shifted until it occurs when the contact 19 is open, in which case there will be no sound in the receiver 16.

It is desired to measure the time elapsing between the application of the alternating current to the input of the amplifier detector and the closure of the relay contacts 19 and also the time elapsing between the removal of the alternating current from the input of the amplifier detector and the opening of the relay contacts 19, that is, the time required for the commutator to rotate through the angle *acb* and the angle *cod*, respectively, in Fig. 2.

It would, of course, be possible to design and assemble the apparatus so that the break of the contact on commutator 2 would coincide with the break on commutator 1

when the index 8 is at the zero of the scale, but it would be difficult to attain this adjustment in the first place or to maintain it after it was once made, because of the wear of the brushes and other changes in the apparatus. For this reason, it is desirable to make a preliminary calibration by connecting the contacts as shown in Fig. 5. The preliminary calibration is made by shifting the two-pole switch 21 of Fig. 1 to the position indicated in dotted lines so that the brushes 4 and 5 operate to short circuit the telephone receiver 16. The switch 21, when shifted to this position, prevents the tone source S from being short circuited and consequently the tone is constantly applied to the echo suppressor to hold the contact 19 of the suppressor relay SR closed. The calibrating circuit will then be as illustrated schematically in Fig. 5.

The operation is as follows: With the switch 21 thrown to the right and the circuit as shown in Fig. 5, clicks will be reproduced in the receiver 16 if the brush 6 passes over the live segment of the commutator 2 during the time that the brush 4 is on the insulated segment of the commutator 1 and one click will occur for each revolution of the commutator. If, now, the arm 8, carrying the brush 6, is moved against the direction of rotation of the commutator, a point will be reached at which the clicks will just cease. When this occurs, the instant at which the brush 6 breaks contact with the live segment of the commutator 2 coincides with the instant at which the brush 4 is leaving the live sector of the commutator 1 and passing on to the insulated segment 1'. Consequently, the setting of the pointer carried by the arm 8 under this condition corresponds to the point at which the alternating current is applied to the terminals 12 of the echo suppressor, during the test of the suppressor. This point is indicated at *a* in the diagram of Fig. 2.

The point at which the alternating current is removed from the suppressor may be determined by moving the timing brush 6 in the direction of rotation of the commutator until the click in the receiver once more ceases. The instant at which the brush 6 makes contact with the live segment of the timing commutator 2 then coincides with the instant at which the brush 4 leaves the insulated segment 1' of the commutator 1 and passes on to the live sector thereof. When the connections are changed to the measuring conditions of Fig. 1, this setting of the pointer carried by the arm 8 will correspond to the instant of removal of the alternating current from the input of the echo suppressor, or, in other words, to the point designated *c* in the diagram of Fig. 2.

Having determined the points at which the alternating current is applied and re-

moved from the suppressor, the connections are shifted to the condition shown in Fig. 1, with the switch 21 in its full line position. As the commutator 1 rotates, the alternating current will be applied to the suppressor at the instant the brush 4 passes on to the insulated segment 1' and will be removed as the brush 4 leaves the insulated segment. If, now, the brush 6 passes over the live segment of the commutator 2 during the time that the suppressor relay SR is energized and its contact 19 is closed, clicks will be heard in the receiver 16, one click occurring each revolution of the commutator 2. The arm 8 carrying the brush 6 is then moved in the direction opposite to the rotation of the commutator until clicks in the receiver just cease. The instant of the break of the timing brush 6 with the live segment of the commutator 2 now coincides with the instant of the make of the suppressor relay contact 19 and the point indicated by the pointer carried by the arm 8 will correspond to the point *b* of the diagram of Fig. 2.

The brush 6 is next moved in the same direction as that in which the commutator 2 rotates and this movement is continued until the clicks in the receiver again cease. The instant that the brush 6 makes contact with the timing segment of the commutator now coincides with the time of the break of the suppressor relay contact 19. The setting of the pointer carried by the arm 8 under this condition corresponds to the point marked *d* in the diagram of Fig. 2.

The angular difference between the positions *a* and *b* of the pointer corresponds to the make interval of the echo suppressor. Let this angular difference be called *M*. Similarly, the angular difference between the positions *c* and *d* corresponds to the time of break or the hangover time of the system. Let this angular difference be called *H*. The time in seconds in the latter case can be calculated by the following formula:

$$T_H = \frac{H}{6 \times R. P. M.}$$

where *R. P. M.* represents the revolutions per minute of the commutator shaft and T_H stands for the hangover time interval. Similarly, the make time may be calculated from the formula

$$T_M = \frac{M}{6 \times R. P. M.}$$

where T_M is the make time of the system.

The arrangement hereinbefore described has the advantage that the proportion of time during which the alternating current is on and off and the speed of rotation of the commutators may be so chosen that the magnetism in the cores of the various relays involved in the echo suppressor system will have an opportunity to reach a steady state

between successive events of the revolution of the commutator shaft. In some instances, it may be found that the arrangement involving the sliding contacts of the brushes upon a commutator will not be reliable. In such case the contacts may be made in the form of a spring carrying a roller at one end which is moved toward and away from a fixed contact by means of a cam, as illustrated in Fig. 4. The principle is, however, the same as the arrangement shown in Fig. 1.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. The method of testing the make time of a translating arrangement including a relay responsive to electric current by means of an indicator in an indicating circuit controlled by said relay, which consists in applying current to the translating arrangement during successive intervals of pre-assigned duration, producing signals in said indicating circuit of shorter duration than said intervals for each successive application of current to the translating arrangement, and varying the time at which the signals are produced with respect to the instant of the application of current to the translating arrangement until the instant that the signal is produced corresponds to the instant at which the translating arrangement operates.

2. The method of testing the holding time of a translating arrangement including a relay responsive to electric current by means of an indicator in an indicating circuit controlled by said relay, which consists in applying current to the translating arrangement during successive intervals of pre-assigned duration, producing signals in said indicating circuit of shorter duration than said intervals for each successive application of current to the translating arrangement, and varying the time at which the signals are produced with respect to the instant at which the current ceases to be applied to the translating arrangement until the instant that the signal is produced corresponds to the instant at which the translating arrangement ceases to operate.

3. The method of testing the make time of a translating arrangement including a relay responsive to electric current by means of an indicator in an indicating circuit controlled by said relay, which consists in applying current to the translating arrangement during successive intervals of pre-assigned duration, producing clicks in said indicator for each successive application of current to the translating arrangement, and

varying the time at which the clicks are produced with reference to the time of application of current to the translating arrangement until the instant at which a click is produced corresponds with the instant at which the translating arrangement operates.

4. The method of testing the make time of a translating arrangement including a relay responsive to electric current by means of an indicator in an indicating circuit controlled by said relay, which consists in applying current to the translating arrangement during successive intervals of pre-assigned duration, producing clicks in said indicator for each successive application of current to the translating arrangement, and varying the time at which the clicks are produced with reference to the instant at which the current ceases to be applied to the translating arrangement until the instant at which a click is produced corresponds to the instant at which the translating arrangement ceases to operate.

5. A system for testing the make time of a translating arrangement including a relay operating in response to electric current, said system comprising means for applying current to said relay during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, means to produce signals in said circuit corresponding to successive applications of current, and means to vary the time of the production of the signals with respect to the instant at which the current is applied until a signal is produced at the instant the translating arrangement operates.

6. A system for testing the holding time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying current to the translating arrangement during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, means to produce signals in said circuit corresponding to successive applications of current, and means to vary the time of the production of the signals with respect to the instant at which the current ceases to be applied until a signal is produced at the instant at which the translating arrangement ceases to operate.

7. A system for testing the operating time of a translating arrangement including a relay responsive to electric current, said system comprising a cyclically operating device for applying current to said translating arrangement during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, a second cyclically operating device for producing signals in said signaling circuit for each cycle of said first mentioned cyclically operating device, and means associated with said second cyclically operating device for

varying the point in its cycle at which the signal is produced.

8. A system for testing the operating time of a translating arrangement including a relay responsive to electric current, said system comprising a cyclically operating device for applying current to said translating arrangement during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, a second cyclically operating device for producing signals in said signaling circuit for each cycle of said first mentioned cyclically operating device, and means associated with said second cyclically operating device for varying the point in its cycle at which the signal is produced, whereby said point may be made to coincide with the point corresponding to the instant at which current is applied, with the point corresponding to the instant at which the translating arrangement operates, with the point corresponding to the instant at which the current ceases to be applied, or with the point corresponding to the instant at which the translating arrangement ceases to operate.

9. A system for testing the operation of a translating arrangement comprising a relay responsive to electric current, said system comprising a rotating commutating device for applying current to said translating arrangement during successive intervals of predetermined duration, a signaling circuit controlled by said translating arrangement, a second rotating commutating device for producing signals in said signaling circuit, one for each cycle of said first mentioned rotating commutating device, and means to shift the point at which the signal is produced with respect to the rotation of said second mentioned commutating device.

10. A system for testing the operation of a translating arrangement comprising a relay responsive to electric current, said system comprising a rotating commutating device for applying current to said translating arrangement during successive intervals of predetermined duration, a signaling circuit controlled by said translating arrangement, a second rotating commutating device for producing signals in said signaling circuit, one for each cycle of said first mentioned rotating commutating device, and means to shift the point at which the signal is produced with respect to the rotation of said

second mentioned commutating device so that said point may be made to coincide with the point corresponding to the instant at which the current is applied, the point corresponding to the instant at which the translating arrangement operates, the point corresponding to the instant at which the current ceases to be applied, or the point corresponding to the instant at which the translating arrangement ceases to operate.

11. A system for testing the operation of a translating arrangement including a relay responsive to electric current, said system comprising a pair of rotating commutators, means controlled by one of said commutators for applying current to said translating arrangement during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, a switch controlled by the other commutator for producing signals in said signaling circuit corresponding to each cycle of said first commutator, and means to vary the position of the switch with respect to the rotation of said commutator.

12. A system for testing the operation of a translating arrangement including a relay responsive to electric current, said system comprising a pair of rotating commutators, means controlled by one of said commutators for applying current to said translating arrangement during successive intervals of pre-assigned duration, a signaling circuit controlled by said translating arrangement, a switch controlled by the other commutator for producing signals in said signaling circuit corresponding to each cycle of said first commutator, and means to vary the position of the switch with respect to the rotation of said commutator so that said signaling circuit will produce a signal at a point during the rotation of said second commutator corresponding to the instant at which current is applied, a point corresponding to the instant at which the translating arrangement operates, a point corresponding to the instant at which the current ceases to be applied, or a point corresponding to the instant at which the translating arrangement ceases to be operated.

In testimony whereof, I have signed my name to this specification this 22nd day of October, 1923.

GEORGE CRISSON.