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G. CRISSON

TESTING CIRCUITS FOR ECHO SUPPRESSORS

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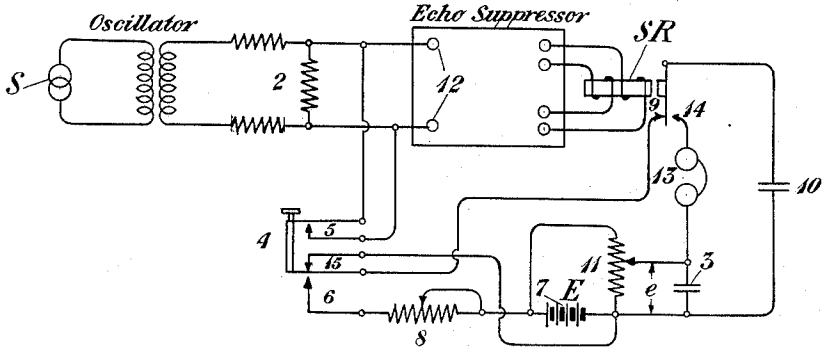


Fig. 1

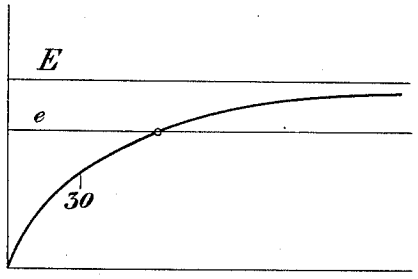


Fig. 2

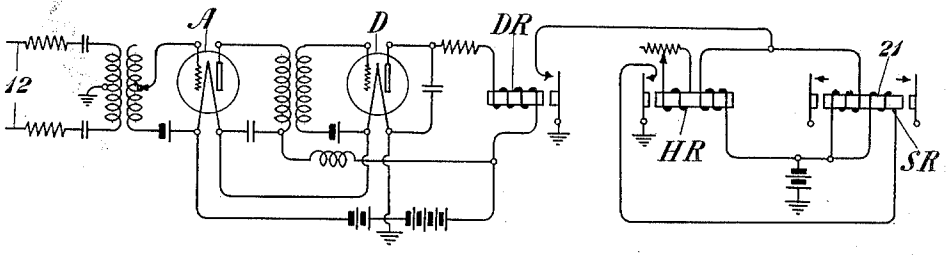


Fig. 3

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TESTING CIRCUITS FOR ECHO SUPPRESSORS.

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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 circut 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 test the operation of the echo suppressor by applying an alternating current to the suppressor arrangement of such frequency and amplitude as to approximate the effect of voice currents. A switching device is provided which interrupts the alternating current and at the same time switches a condenser into circuit with the contact of the suppressor relay so that the condenser is being charged up during the interval that the suppressor relay holds over after the alternating current is interrupted, the potential to which the condenser is charged is determined by balancing it against a known potential. The time that the suppressor relay held over may then be determined from simple formulæ in terms of the charge of the condenser.

The invention may now be more fully understood by reference to the accompanying drawings, in which Figure 1 illustrates a form of testing circuit for an echo suppressor, Fig. 2 is a curve illustrating the operation of the arrangement of Fig. 1 and Fig. 3 illustrates the circuit details of the echo suppressor.

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 relase its armature.

In order to determine the time required for the suppressor relay to release its armature after the alternating current has ceased to be applied to the suppressor the circuit arrangement of Fig. 1 may be utilized. In Fig. 1, a source of alternating current, such as an oscillator S, is connected through a system of resistances 2 to the input terminals 12 of the echo suppressor. The source S generates an alternating current which, for purposes of the test, will be equivalent to a voice current, and the resistances are proportioned to give a suitable voltage value for applications to the terminals of the echo suppressor. A switch 4, with two make contacts, has one of its contacts, 5, bridged across the input terminals of the echo suppressor so as to short circuit it when the key is operated. The other contact, 6, is included in the test circuit, to be described later. This switch is preferably so consructed that it closes with a snap action in a manner well known in the art and the two contacts close within a negligibly small fraction of a second of each other. The closure of the contact 5 interrupts the application of alternating current to the suppressor and starts the releasing action which culminates in the release of the suppressor relay SR.

The closure of the contact 6 completes a circuit from the left-hand terminal of the battery 7 through the high resistance 8, contact 6 of the switch 4, front contact 9 of the suppressor relay and through the condenser 10 to the other terminal of the battery. This circuit is completed at the instant the alternating current is interrupted, and during the holdover time elasping before the suppressor relay SR releases its armature the condenser 10 begins to charge up according to the well known exponential law, gradually approaching the voltage E of the battery 7, as shown by the curve 30 of Fig. 2. The resistance 8 and the condenser 10 are so proportioned that the voltage of the condenser will not have reached a steady value by the time the suppressor relay contact 9 opens and consequently the opening of the contact 9 of the suppressor relay SR leaves the condenser charged to some voltage lower than E, depending upon the time elapsing between the instant the alternating current is interrupted and the instant that the contact 9 opens. It will be apparent that if the voltage to which the condenser is charged is determined, the time required for the echo suppressor to release may be at once determined.

To measure the voltage of the condenser 10, a potentiometer 11 is connected around the battery 7 so that a portion *e* of its voltage is impressed upon another condenser 3, which is connected through a telephone receiver 13 to a back contact 14 of the suppressor relay. Obviously, if the condenser 3 is charged to the same potential as the condenser 10, at the instant the armature of the suppressor relay SR releases and closes its back contact 14, no sound will be heard in the receiver 13. On the other hand, if the potentials to which the two condensers are charged are not the same a click will be heard, due to the flow of an equalizing current from one condenser to the other. By repeatedly operating the switch 4 and adjusting the potentiometer 11 until no click is heard the potential, to which the condenser 3 is charged, may be made equal to the potential built up in the condenser 10. Since when no click is heard this potential will be the potential to which the condenser 10 is charged, the ratio of *e* to E can be found from the setting of the potentiometer 11, so that the time in seconds may be readily computed. It should be noted that a back contact 15 is provided on the switch 4 and establishes a connection from the right-hand terminal of the battery 7 over the front contact 9 of the suppressor relay SR to the condenser 10. This insures that the condenser will be completely discharged at the start of any measurement.

By giving the resistance 8 and the condenser 10 definite values, the potentiometer 11 may be designed to indicate time in any convenient units by means of a pointer moving with its contact and playing over a scale. It is desirable that *e* be not too close to E, as the test becomes less sensitive and accurate. The time required for the condenser to charge up to a given fraction of the voltage E can be increased by increasing the resistance 8 or the capacity of the condenser 10, which makes it possible to adjust the constant by which the time scale in the potentiometer should be multiplied to any desired value.

For this test it is important that the condenser 10 be of good quality and that it and the associated circuit through resistance 8 and over contacts 6 and 9 should be free from leakage. The condenser 3 is not so important, it being merely necessary to have the insulation good enough to avoid a leakage current, which would disturb the voltage on the contact of the potentiometer. If the resistance of the potentiometer is moderate this requirement will not be severe.

The relation between the hangover time

of the echo suppressor and the voltage to which the condenser is charged may be obtained from the following equation:

$$\frac{e}{E} = 1 - \epsilon^{-\frac{t}{RC}}$$

in which t is the time in seconds, R is the resistance in ohms, C is the capacity of the condenser 10 in farads, and ϵ is the base of the natural logarithms.

The ratio $\frac{e}{E}$ is also the ratio of the resistance of that part of the potentiometer 11 that is in parallel with the condenser 3 to the total resistance of the potentiometer. From this relation can be obtained the resistance at which the potentiometer contact must be set to give any desired time t.

It will also 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 operating time of a translating arrangement including a relay responsive to electric current, which consists in applying current to the input terminals of the translating arrangement for a period of time, and gradually building up a potential during the time that it takes for the translating arrangement to respond to the conditions of current and no current at its input.

2. The method of testing the operating time of a translating arrangement including a relay responsive to electric current, which consists in applying current to the input terminals of the translating arangement for a period of time, gradually building up a potential during the time that it takes for the translating arrangement to respond to the conditions of current and no current at its input, and balancing the potential thus built up against a variable known potential.

3. The method of testing the hangover time of a translating arrangement including a relay responsive to electric current, which consists in applying current to the input terminals of the translating arrangement, interrupting the current thus applied, and gradually building up a potential from the instant that the interruption occurs until the translating arrangement responds to the interruption.

4. The method of testing the hangover time of a translating arrangement including a relay responsive to electric current, which consists in applying current to the input terminals of the translating arrangement, interrupting the current thus applied, gradually building up a potential from the instant that the interruption occurs until the translating arrangement responds to the interruption, and balancing the potential thus built up against a variable known potential.

5. A system for testing the operating time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying and then interrupting the application of current to the input terminals of the translating arrangement, a condenser, and means to charge said condenser during the time that the translating arrangement utilizes in responding to a change in the current condition at its input terminals.

6. A system for testing the operating time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying and then interrupting the application of current to the input terminals of the translating arrangement, a condenser, means to charge said condenser during the time that the translating arrangement utilizes in responding to a change in the current condition at its input terminals, and means to balance the potential to which the condenser is charged against a known and variable potential.

7. A system for testing the hangover time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying and then interrupting the application of current to the input terminals of the translating arrangement, a condenser, means whereby the condenser will begin to charge up at the instant the alternating current is interrupted, and means to prevent further charge of the condenser when the translating arrangement ceases to operate after the alternating current has been interrupted.

8. A system for testing the hangover time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying and then interrupting the application of current to the input terminals of the translating arrangement, a condenser, means whereby the condenser will begin to charge up at the instant the current is interrupted, means to prevent further charge of the condenser when the translating arrangement ceases to operate after the current has been interrupted, and means to balance the potential to which the condenser has been charged against a known and variable potential.

9. A system for testing the hangover time of a translating arrangement including a relay responsive to electric current, said system comprising means for applying and then interrupting the application of current to the input terminals of the translating arrangement, a condenser, means whereby the condenser will begin to charge up at the instant the current is interrupted, means to prevent further charge of the condenser

when the translating arrangement ceases to operate after the current has been interrupted, a second condenser, a potentiometer and circuit connections therefor whereby said second condenser may be charged to any desired known potential, and means to balance the potential to which said first mentioned condenser was charged against the charge of said second mentioned condenser.

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

GEORGE CRISSON.