April 3, 1945. H. S. BLACK 2,372,759

ELECTRICAL TRANSMISSION TESTING SYSTEM

Filed Nov. 21, 1942

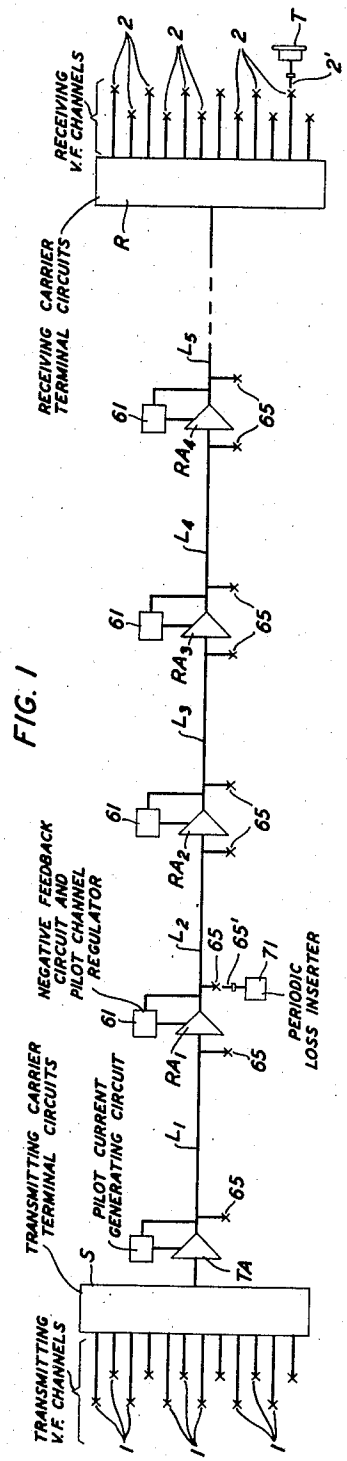

FIG. 1

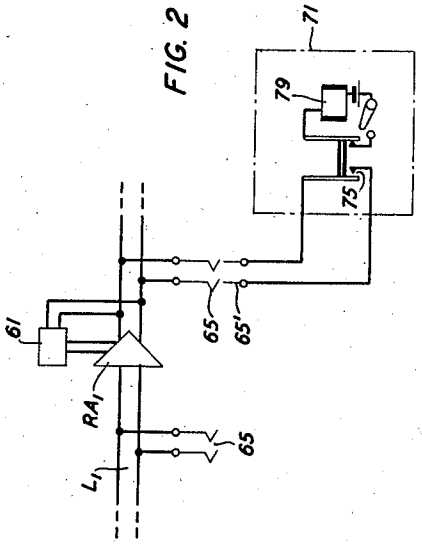

FIG. 2

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Patented Apr. 3, 1945

2,372,759

UNITED STATES PATENT OFFICE

2,372,759

ELECTRICAL TRANSMISSION TESTING SYSTEM

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Application November 21, 1942, Serial No. 466,411

5 Claims. (Cl. 179—175.31)

This invention relates to location of sources or points of entry, in repeatered transmission systems, of excessive noise, such, for example, as tube noise, power supply noise, amplifier singing, inductive interference or cross-talk.

An object of the invention is to locate such disturbances in a system or line having pilot channel transmission regulation of gains of repeater amplifiers that are included in the line, or having other level responsive or dynamic gain control of the amplifiers.

In one specific aspect of the invention this is accomplished by periodically short-circuiting the line, or introducing large transmission loss in the line, successively at spaced points along the line and observing at the receiving end or a receiving point of the line, the effect of the periodic loss insertions on the disturbance as evidenced at the observation point. For example, a buzzer current or current pulses of a frequency of 20 cycles per second, for instance, may be used to operate a line short-circuiting switch which may be plugged across the line successively at various points along the line, as, for instance, at the inputs and outputs of the repeater amplifiers and for each point the effect of the short circuiting upon the noise may be observed with a telephone receiver at the receiving terminal of the line. The excessive noise as heard at the receiving terminal will not be affected by the intermittent short circuiting if the short-circuiting point is a point preceding the noise source, but will be periodically interrupted by the short circuiting if the short-circuiting point is a point following the noise source, and thus the noise source can be located or sectionalized to a particular portion of the line or equipment. The duration of each application of a short circuit can be made sufficiently short, and the intervals between the short circuits sufficiently long, to insure that the short circuiting will not cause the pilot channel regulators or other transmission level responsive gain regulators to so raise the gains of the amplifiers following the short-circuiting points as to produce such added noise as would over-shadow the effect that it is desired to observe. For example, if the operation of the buzzer gives short-circuit durations equal to the intervals between the short circuits, so the line is short-circuited half the time of the operation of the buzzer and not short-circuited the other half, the buzzer operation will reduce the level at the short-circuiting point only 3 decibels and this will not interfere with the disturbance location test. If desired, when the buzzer is in operation, the time the line is short-circuited and the time it is not may be unequal; and the rate of vibration of the buzzer can be given any suitable value.

Other objects and aspects of the invention will be apparent from the following description and claims.

Fig. 1 is a single line schematic showing of a system embodying a form of the invention; and

Fig. 2 shows a short-circuiting switch and its actuating buzzer circuit that may be used as the periodic loss insertion means in the system of Fig. 1.

Fig. 1 shows a repeatered line comprising sections, such as L_1, L_2, L_3, L_4, and L_5, and repeaters such as RA_1, RA_2, RA_3, and RA_4 (and in practice many more line sections and repeaters may be included) for transmitting carrier telephone signals from a transmitting amplifier TA at the output of carrier terminal S to a receiving carrier terminal R. Jacks 1 are adapted for connection to twelve transmitting voice frequency circuits (not shown), and jacks 2 are connected to twelve receiving voice frequency circuits (not shown). A plug 2' is adapted to plug a telephone receiver T into any of the twelve pairs of jacks 2 for observing the effect of any excessive noise generated in or entering the system between jacks 1 and 2. The system of Fig. 1 as so far described may be, for example, of the type disclosed in Fig. 1 of J. H. Bollman Patent 2,231,558, February 11, 1941; and reference characters common to the two figures may designate like elements, or, if desired, the transmitting amplifier may be, for example, as shown in Fig. 5 of that patent or as shown in Fig. 4 of C. O. Mallinckrodt Patent 2,231,542, February 11, 1941.

Pilot frequency current generated or transmitted by amplifier TA controls pilot channel regulators 61, which are associated with the repeater amplifiers and which may be, for example, of the type shown associated with repeater amplifiers RA in Fig. 1 of the Bollman patent. As indicated in that patent, a duplicate of the system of Fig. 1 as so far described may be provided for transmission in the opposite direction.

Jacks 65 are shown at the inputs and the outputs of the repeater amplifiers and the output of the amplifier TA. These jacks are bridged across the line at these points and a plug 65' is adapted to plug into each pair of these jacks a loss inserting device 71, as indicated in Fig. 2, in connection with the amplifier RA_1. This device is for periodically or intermittently inserting or in-

troducing a large loss to transmission in the line, and may be, for example, a line short-circuiting switch 75 operated by the familiar make and break or buzzer circuit 79. As pointed out, for example, in an article by H. M. Lewis on "Wave form circuits for cathode ray tubes," in Electronics, July, 1942, page 44, in the familiar make and break or buzzer circuit the periodicity of operation can be determined by the mechanical period of the vibrating element or the duration of each closed circuit period for the buzzer circuit can be controlled and made long relative to the intervals between the closed circuit periods by suitable choice of the magnitudes of the resistance and inductance effectively in series in the circuit of the buzzer winding.

To locate or sectionalize excessive noise in the system (with the jacks 1 and 2 disconnected from the transmitting and receiving voice frequency lines), the telephone receiver T may be plugged into a pair of jacks 2 and while an observer listens with T, the device 71 may be plugged into jacks 65 at the various points along the line, beginning, for example, at the end remote from the receiver. If, upon the insertion of plug 65′ in jacks 65 at a particular point along the line, the excessive noise as heard in the receiver T is heard as interrupted noise, the interruptions are an indication that the source of noise is in the line or equipment ahead of that point. On the other hand, if the excessive noise is heard uninterrupted, the source of noise is in some following portion of the line or equipment, or, in other words, the source lies between the short-circuiting point and the telephone T or monitoring or observation point.

A prolonged steady short circuit or loss insertion at a point in the line might cause such decrease of feed back and increase of gain in a following repeater amplifier provided with transmission level responsive gain control means that the resulting additional noise would interfere with the desired test. The interrupted or intermittent or periodic nature of the loss insertion avoids such difficulty.

The invention is applicable not only to carrier systems of the type specifically described above, but likewise to carrier systems of other types, as, for example, systems using pilot channel amplifier regulators of the types shown in H. K. Krist Patent 2,246,307, June 17, 1941, and R. R. Blair Patent 2,178,333, October 31, 1939, and to voice or other types of communication channels using transmission level responsive amplifier gain controls or transmission regulators.

What is claimed is:

1. The method of noise source location in a transmission line including an amplifier having transmission level responsive gain control means, which comprises periodically introducing large transmission loss in the line at each of a plurality of points remotely spaced from each other along the line including points preceding said amplifier while observing the effect of the noise at a receiving point on the line following said amplifier.

2. The method of noise source location in a repeatered line including an amplifier having transmission level responsive gain control means increasing gain with decrease of level, which comprises intermittently short-circuiting the line successively at repeater points along the line ahead of said amplifier, observing the effect of said intermittent short circuiting on the noise arriving at the receiving terminal of the line and maintaining the short-circuiting periods sufficiently short and the intervals therebetween sufficiently long to prevent the short circuiting from causing the gain control means to so increase the gain of said amplifier as to produce additional noise deleteriously affecting said observation.

3. A multiplex carrier telephone system comprising transmitting voice frequency channels, transmitting carrier terminal circuits for translating waves received from said voice frequency channels to carrier waves of frequency range extending above audibility, a carrier frequency transmission line including amplifiers for transmitting said carrier waves, means responsive to transmission level at one of said amplifiers of waves transmitted over said line to said one amplifier, said means increasing the gain of said amplifier upon decrease of said lever, periodically operating means for short-circuiting said line at a point ahead of said amplifier, receiving voice frequency channels, receiving carrier terminal circuits connected to said line at a point following said one amplifier for translating carrier waves received from said line to voice frequency waves for transmission to said receiving voice frequency channels, and noise indicating means for indicating the effect in said receiving voice frequency channels of said periodic short circuiting upon noise introduced in said line at a point preceding said first-mentioned point.

4. A system comprising a wave transmission line including amplifiers, means for supplying a control current to said line for transmission thereover, means influenced by the amplitude of said control current at one of said amplifiers for controlling the gain of said one amplifier, periodically operating means for inserting in said line high attenuation for noise currents and said control current at a point in advance of said one amplifier, and wave indicating means at a point of said system following said one amplifier responsive to noise currents in said system transmitted by said line to said wave indicating means.

5. A wave translating system comprising a signal transmission line including amplifiers, means for supplying a pilot wave to said line at constant amplitude for transmission thereover, said pilot wave having a frequency lying outside of the portions of the frequency spectrum allocated to the signals, transmission level regulating means responsive to decrease of amplitude of said pilot wave at one of said amplifiers for increasing the gain of said amplifier, means for introducing in said line intermittently at audio frequency and at a point in advance of said amplifier high attenuation for said pilot wave and for noise currents in said portions of the frequency spectrum, and wave receiving means connected to said line at a point following said amplifier selectively responsive to waves in said portions of the frequency spectrum to the exclusion of said pilot wave for producing sound energy.

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