June 30, 1931. V. E. LEGG 1,811,947

NOISE SUPPRESSING CIRCUIT

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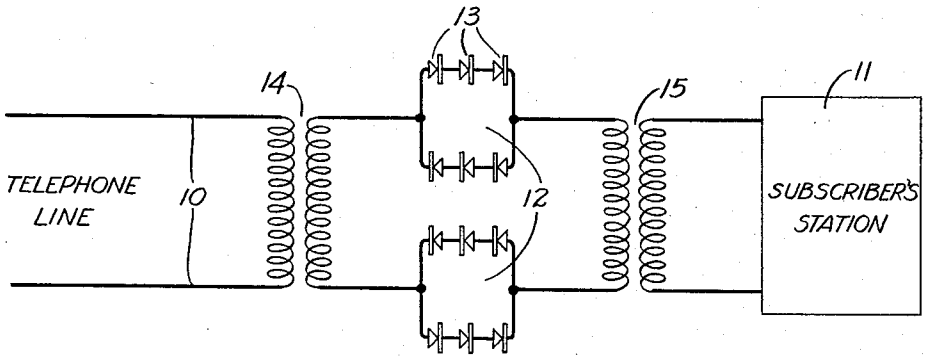

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NOISE SUPPRESSING CIRCUIT

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This invention relates to the problem of discriminating between currents of different magnitude, particularly in signaling systems such as telephone systems. The invention has particular reference to the suppression of crosstalk currents or other noise currents which are of small magnitude relative to the signaling currents.

Noise or crosstalk is mostly objectionable during pauses in conversation, the crosstalk currents being most evident during such pauses but being less apparent when the relatively stronger speech currents are being transmitted and received.

An object of the invention is to suppress the transmission of crosstalk currents or other small disturbing currents while at the same time freely permitting the transmission of speech currents.

A feature of the invention is the use of variable series impedances in a telephone line or similar system for the purpose of suppressing small noise currents such as crosstalk. These series impedances may be any elements whose impedance is high at the low applied crosstalk voltages and low at the relatively higher signal voltages. Specifically such elements may consist of static rectifier elements such as crystals, copper oxide rectifiers etc.

Rectifiers such as crystals have been used in radio reception and for other purposes making use of the unsymmetrical transmitting properties which the crystal exhibits for different polarities of current. They have also been used in much the same way as spark gaps and other types of discharge apparatus to protect circuits from excessive voltages by shunting off the resultant large currents from the circuit to be protected. In this latter use of crystals it is not the unsymmetrical transmitting characteristic for opposite polarities of current which is important but rather the non-linear voltage-impedance characteristic which the crystal possesses for applied voltages in the direction corresponding to greatest current transmission. As is well known, for voltages in this direction, the impedance is higher at lowest applied voltages and decreases as the applied voltage increases.

A device for suppressing crosstalk currents while permitting the transmission of speech currents must operate at current levels of quite a different order of magnitude from the case of an apparatus for protecting a telephone circuit or other signaling circuit from excessive voltages. Assuming maximum speech current of a telephone line to be of the order of 4 milliamperes, a crosstalk suppressor to be most efficient at a level of 1000 crosstalk units must discriminate between currents of the magnitudes of 4 milliamperes and .004 milliampere. Applicant has found that certain rectifiers particularly of the copper oxide-lead type, are capable of giving a marked discrimination between currents of the small orders of magnitude mentioned while at the same time not introducing too high an impedance into the series talking circuit.

In accordance with the invention one or more rectifiers are provided in series in each side of the talking circuit for each direction of transmission thereover.

The invention will be more fully understood from the following specification in connection with the accompanying drawing of which the single figure shows in simple diagrammatic form a subscriber's telephone line equipped with crosstalk suppressors in accordance with the invention.

While the invention is applicable to different types of signaling systems and to telephone lines of different character, the drawing illustrates crosstalk suppressors in the subscriber's loop. It will, of course, be obvious to locate the suppressors elsewhere in the system, for example, at a central office station or in a toll line.

Referring to the drawing, the subscriber's line 10 is shown leading to subscriber's station 11 which is not illustrated in detail since it may be of any desired type, dependent in no way upon the present invention. Crosstalk suppressor circuits 12 are shown included in series in each side of the telephone line 10. These suppressors are disclosed as comprising a number of rectifiers

13 connected in series for each direction of transmission over the conductor in which they are included. It is within the invention to insert the suppressors directly in the series talking circuit but transformers such as 14 and 15 may be used where the existing terminal impedances are not of the proper magniude, the purpose of these transformers being to transform the impedances between which the suppressor circuits operate to the appropriate values for most effective operation. Instead of changing the effective terminating impedances to suit the rectifier characteristics, rectifiers may, of course, be chosen of the proper characteristics to suit the existing terminating impedances where possible.

Three rectifier elements have been shown connected in series in each transmission path through the suppressor circuits but the number of such elements may vary to suit the different line and transmission conditions and depending also on the size of the individual rectifiers.

Applicant has employed a type of copper oxide rectifier known to the trade as "Kuprox" rectifier, type A—10, with a rated current capacity of .8 to 1.0 ampere. With three of these connected in series in each current transmitting path as shown in the drawing, applicant has obtained a discrimination in transmitted energy of the order of 3 db. to 8 db. between currents of the order of magnitude of 4 milliamperes and a few thousandths of a milliampere respectively. The number of "db.'s," or "decibels," is a logarithmic measure of the ratio of the powers represented by the respective currents and is determined quantitively by the expression:

$$N = 10 \log_{10} \frac{P_1}{P_2}.$$

The order of 3 db. discrimination was obtained when the suppressor circuits operated between terminating impedances of about 600 ohms whereas the order of 8 db. discrimination was obtained where the terminating impedances were 100 ohms. Intermediate amounts of discrimination were obtained by terminating impedances intermediate those given. The loss of currents of the 4 milliampere level was computed as 1.8 db. for the 600 ohm termination and 7.6 db. for the 100 ohm termination.

It will be understood that the invention is not to be construed as limited to the particular type of rectifier mentioned above nor to the particular number disclosed nor their magnitudes but it is within the scope and spirit of the invention to use equivalent transmission elements whose impedance changes in inverse relation to the applied voltage at the necessary levels and by the necessary extent to suppress crosstalk or similar currents while transmitting the speech currents.

What is claimed is:

1. The combination with a telephone line of means for suppressing crosstalk currents while transmitting speech currents, said means comprising resistive material in series in the line, the impedance of which decreases with increasing applied voltages.

2. The combination with a telephone line of a resistance element in series in said line of high impedance to currents of crosstalk levels, the impedance of said element decreasing appreciably with increasing applied voltages immediately above the voltage range of crosstalk currents.

3. The combination in a telephone circuit of a series element whose resistance varies in inverse manner to the applied voltages, said element having a low impedance for normal speech currents traversing the line and relatively high impedance to currents of crosstalk magnitude.

4. The combination defined in claim 3 in which a separate element is provided in each side of the telephone circuit for each direction of transmission thereover.

5. The combination with a telephone circuit of unilaterally conducting material in each side of the circuit for each direction of current flow, and means for altering the effective impedance presented by said material to the telephone circuit whereby said material effectively discriminates against transmission of currents of crosstalk level while transmitting normal speech currents.

6. A variable impedance for a telephone line comprising a copper oxide rectifier connected in series in each side of the line and dimensioned to transmit normal speech currents while suppressing currents of crosstalk level.

7. A crosstalk suppressor circuit for a telephone line comprising rectifying crystal elements connected to provide paths of free transmission for normal speech currents in both directions over the telephone line but only paths of high impedance to currents of crosstalk level.

8. The combination in a telephone circuit of means for suppressing crosstalk comprising in series in said circuit unilaterally conducting material presenting high impedance to currents of crosstalk magnitude and relatively low impedance to normal speech currents.

9. The combination with a circuit for the transmission of signal waves of mechanically static transmission means associated with said circuit having the property of bilaterally freely transmitting said signal waves practically undistorted while suppressing the transmission of disturbing currents having amplitudes small in comparison with said signal waves.

10. The combination with a circuit for the transmission of signal waves of a transmission element associated with said circuit comprising a crystal having the property of freely transmitting said signal waves practically undistorted while suppressing the transmission of disturbing currents having amplitudes small in comparison with said signal waves.

11. In a current amplitude discriminating circuit for translating signals, discriminating means in said circuit comprising a crystal the impedance of which is nonlinear, said impedance being large to small currents but comparatively small to normal currents, and a work circuit utilizing currents transmitted through said discriminating means within the frequency range of the waves impressed on said discriminating means.

In witness whereof, I hereunto subscribe my name this 11th day of May, 1929.

VICTOR E. LEGG.