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TESTING SYSTEM

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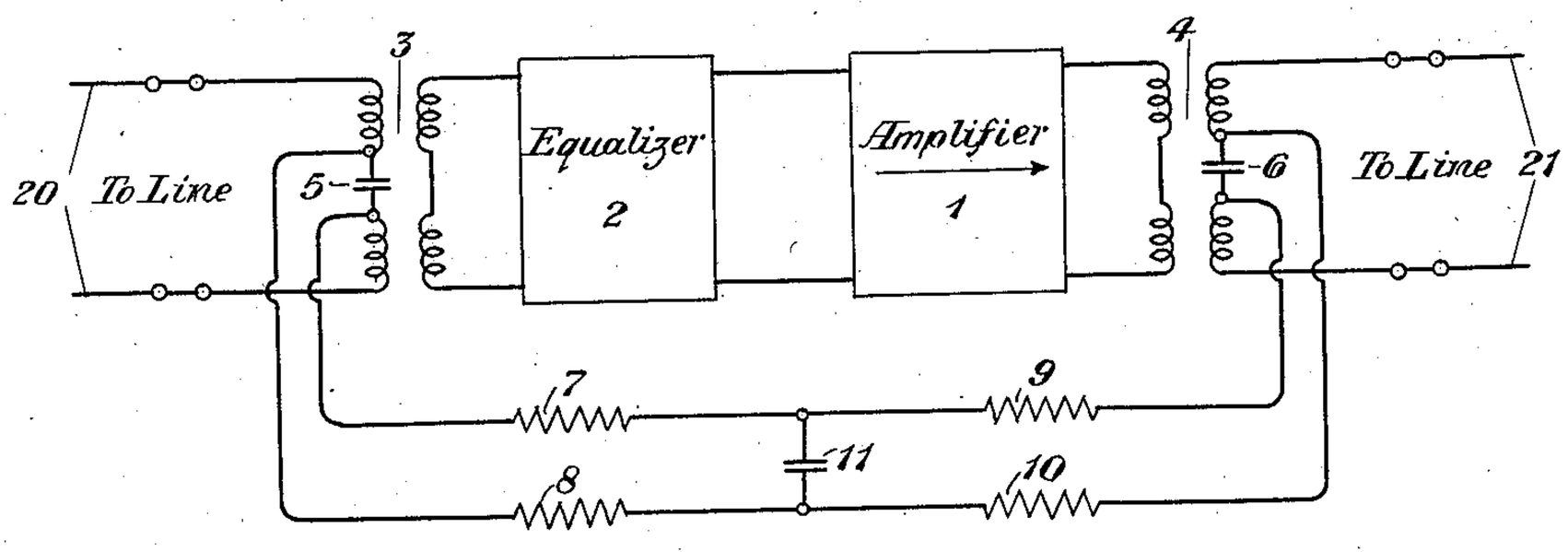

Fig. 1

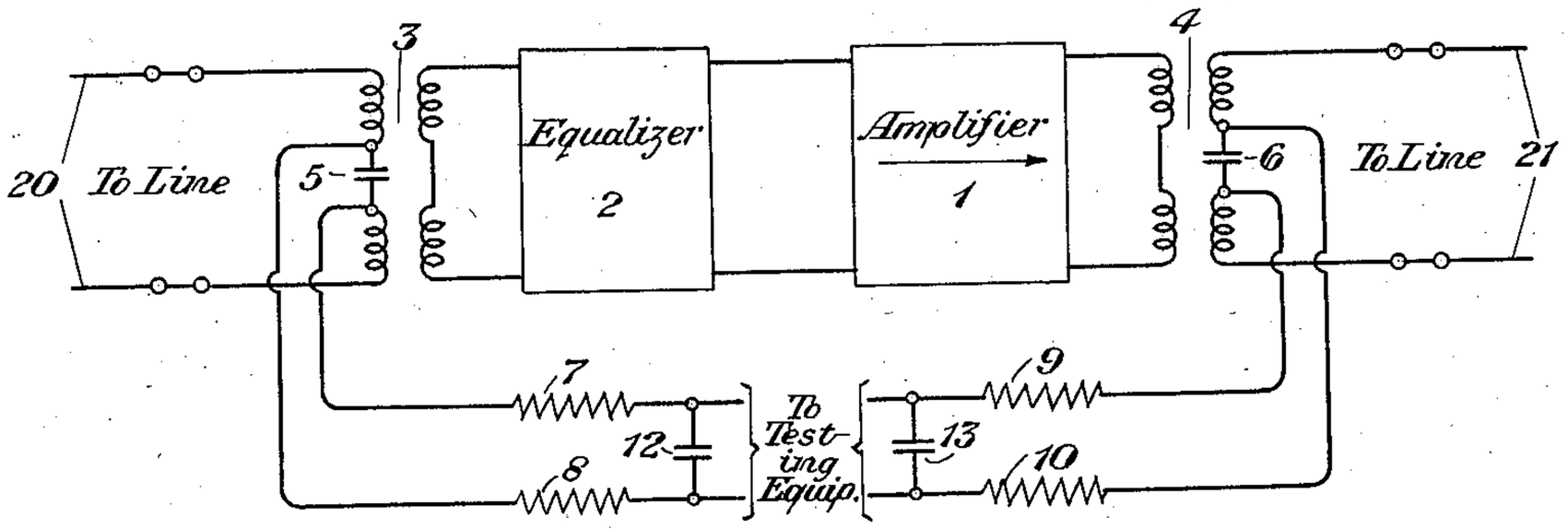

Fig. 2

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TESTING SYSTEM

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5 Claims. (Cl. 179—175.3)

This invention relates to electrical testing systems. More particularly, this invention provides means for by-passing direct currents or very low frequency alternating currents at telephone repeater points in order to permit tests to be made on the lines extending to those points.

In accordance with this invention arrangements are provided whereby tests can be made on lines having for example, an unattended repeater station placed between two testing points. This invention is particularly adaptable in the case of cable carrier systems where additional stations for carrier repeaters are required between the attended stations now provided on existing cable routes. These added stations are unattended except for periodic visits of a maintenance man. In such cases it is not possible to make fault location and other similar tests common to this type of plant without providing means somewhat similar to that described hereinafter, or without sending a test man to the unattended office. In many cases of an emergency character the latter procedure would add considerable delay and expense as well as contribute to the possibility of complete failure of the facilities.

The nature of the tests which it is contemplated can be made by means of this invention is primarily concerned with the detection and location of faults, but normal routine tests of insulation, series resistance, etc., can be made as well. In addition, channels can be so provided for control of unattended equipment, for the transmission of power, or, in short, for any operation requiring a direct current or a low frequency alternating current path. It is to be pointed out that these functions can be performed without in any way interfering with the normal operation of the repeater, if such is the desired result.

It becomes necessary in such a system to keep the by-pass circuit low in resistance and at the same time introducing sufficient high frequency alternating current loss so that the singing margin in the transmitted band is great enough not to change the gain-frequency characteristic of the amplifier and the margin outside the band sufficient to prevent singing. In the embodiment of the invention disclosed in this application, this purpose is accomplished by means of a network consisting of series resistances and parallel capacitances in a sufficient number of elements to afford the desired attenuation. The use of other equipment, such as filters having a greater or smaller number of sections employing inductance coils or inductively wound resistances, and in which any or all of the condensers may be of the well known compound type in which the midpoint or midpoints are grounded in order to reduce longitudinal induction, or of other filter arrangements well known in the art, shall not be construed as in any way departing in sense from the embodiment of the invention described hereinafter when read in connection with the accompanying drawing, and for which particular claims are made, inasmuch as the embodiment described in this case has been selected from a number of available embodiments merely for the purpose of illustration.

The embodiment to be used for the purpose of illustration is shown in Figures 1 and 2 of the accompanying drawing. Figure 1 describes an arrangement for a station around which it is desired to make tests and Fig. 2 describes an arrangement whereby the through arrangement of Fig. 1 can be split for the introduction of testing or other equipment. Thus, it is possible to use the same kind of equipment at testing and non-testing stations or readily to arrange to convert a non-testing station to a testing station, without affecting the normal transmission over the circuit, if so desired. In this connection it may be pointed out that it is contemplated that the order of frequencies to be transmitted over the normal circuit may range from voice frequencies to any high frequencies as, for instance, frequencies up to 100 kilocycles.

With reference to both Figs. 1 and 2, the reference character 1 designates an amplifier of any known type and 2 an equalizer which, while shown as one of the elements in the drawing need not be included in the circuit, or if it is included, it may, if desired, be connected in bridge arrangement with the amplifier rather than as shown. In this application a one-way amplifier is preferred, but the invention does not preclude the use of two-way amplifiers with, for example, their associated hybrid coils. In any event, it will, in general, be necessary to couple the amplifier to the lines by means of coils, and these are shown as input coils at 3 and as output coils at 4, in the line sides of which are included condensers 5 and 6.

The line connections of Fig. 1 are then effectively connected together for direct current and very low frequency alternating current purposes by resistances 7 and 9 and 8 and 10. A third condenser 11 is introduced across the line as shown. It follows that the high-frequency alternating current attenuation between the lines, i. e., the attenuation from the input side to the output side of the repeater, can be made very great,

of the order of 100 decibels or more, and of comparatively no loss for direct current. Thus, the amplifier will not sing due to the nature of the connection from its input circuit to its output circuit, nor is the high-frequency transmission characteristic appreciably different with the by-pass connected around the amplifier or entirely disconnected from it. Yet when the by-pass circuit is included it is possible to perform tests around the amplifier, using direct currents or low-frequency alternating currents.

In the arrangement of Fig. 2, the condenser 11 of Fig. 1 is replaced by two condensers 12 and 13, so that the two lines extending to the amplifier can be segregated in order that either may be tested independently, if so desired.

A characteristic set of values for the elements of the by-pass circuits when associated with an amplifier which may amplify currents of frequencies between 4 and 100 kilocycles may include 100 ohms each for the resistances 7, 8, 9 and 10 and 1 microfarad of capacitance for condensers 5, 6 and 11. These values are given merely for illustration and do not represent limitations on the scope of the invention, for other values may be assigned to these elements, if desired.

It is, of course, important that the resistances 7 and 9 be carefully balanced against resistances 8 and 10 and their absolute values well known and constant in character so that their magnitudes may be accounted for and adequate allowances made in fault location work. Condensers 5, 6 and 11 and the condensers 12 and 13 should be possessed of high insulation resistance and the insulation resistances of coils 3 and 4 should be such that the insulation resistances of one of the conductors of the line to the other conductor of that line and to ground are not appreciably affected. If alternating current measurements are to be made employing a low frequency, such as, for instance, a frequency of four cycles per second, the capacitance of the condensers 5, 6 and 11, or the capacitance of condensers 12 and 13, should be known and substantially constant in their absolute value of capacitance.

The methods of making fault and other test locations with the arrangements of this invention consist in eliminating from the gross measured resistances the known values of resistance of the introduced networks, leaving the resistive value of the line alone which is then used in any one of a number of well known ways in order to determine the location of the fault. Similar means can be employed in the case of low-frequency alternating current measurements. It is assumed in the case of insulation resistance measurements that the insulation resistances of the equipment can be neglected.

While this invention has been described in certain arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of an amplifier through which are transmitted currents of one frequency band, two lines extending from different directions to said amplifier and coupled to opposite sides of said amplifier, two auxiliary lines each connected to one of the lines and coupled to said amplifier, each of said auxiliary lines including series resistance elements and shunt capacitance elements for freely transmitting currents within a second frequency band and preventing the transmission therethrough of currents within the first frequency band, and testing equipment which may be connected to either or both of said auxiliary lines.

2. A system for testing a circuit which includes an unattended repeater and not permitting any of the testing currents to pass through the repeater, comprising a by-pass circuit bridged across the repeater and in series with the circuit to be tested and adapted to freely transmit direct currents, said by-pass circuit including two parallel conductors, two equal non-inductive resistances one of which is in series with each of the conductors, and a condenser bridged across said conductors.

3. In an arrangement for testing a circuit which includes an unattended repeater station at which there is an amplifier for amplifying speech and high frequency currents, the combination of a first circuit extending to said amplifier, a second circuit extending from said amplifier, third and fourth circuits each formed of two conductors which are shunted across said first and second circuits, respectively, and means comprising equal resistances in each of said conductors included in said third and fourth circuits and a condenser directly bridged across the junctions of said equal resistances for permitting the free transmission of direct currents and alternating currents of frequencies lower than the frequencies amplified by the amplifier, the direct currents and alternating currents of lower frequencies being employed for testing purposes.

4. The combination of an amplifier which employs speech currents or currents of high frequencies, a line extending to the amplifier from one direction, another line extending to the amplifier from another direction, means for independently testing over said lines comprising third and fourth lines connected respectively across the two lines which extend to the amplifier from different directions, said third and fourth lines each including two conductors, four equal resistances each of which is in series with one of the conductors, and two condensers each bridged across the two resistances of the third and fourth lines, respectively.

5. The combination of an amplifier for high frequency alternating currents, two lines extending in different directions from the amplifier and coupled to opposite sides of said amplifier, means for independently transmitting direct currents or low frequency alternating currents over said lines for testing said lines without interfering with the amplification of the high frequency alternating currents by said amplifier, said means including two two-wire circuits, respectively, bridged across the two lines extending to said amplifier, each two-wire circuit including two equal non-inductive resistances and a condenser connected in shunt with said resistances for preventing the transmission therethrough of the high frequency alternating currents amplified by the amplifier and for freely transmitting the direct currents or low frequency alternating currents employed for testing purposes.

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