Sept. 15, 1925. 1,553,465

H. S. OSBORNE

TESTING APPARATUS

Filed Aug. 9, 1920

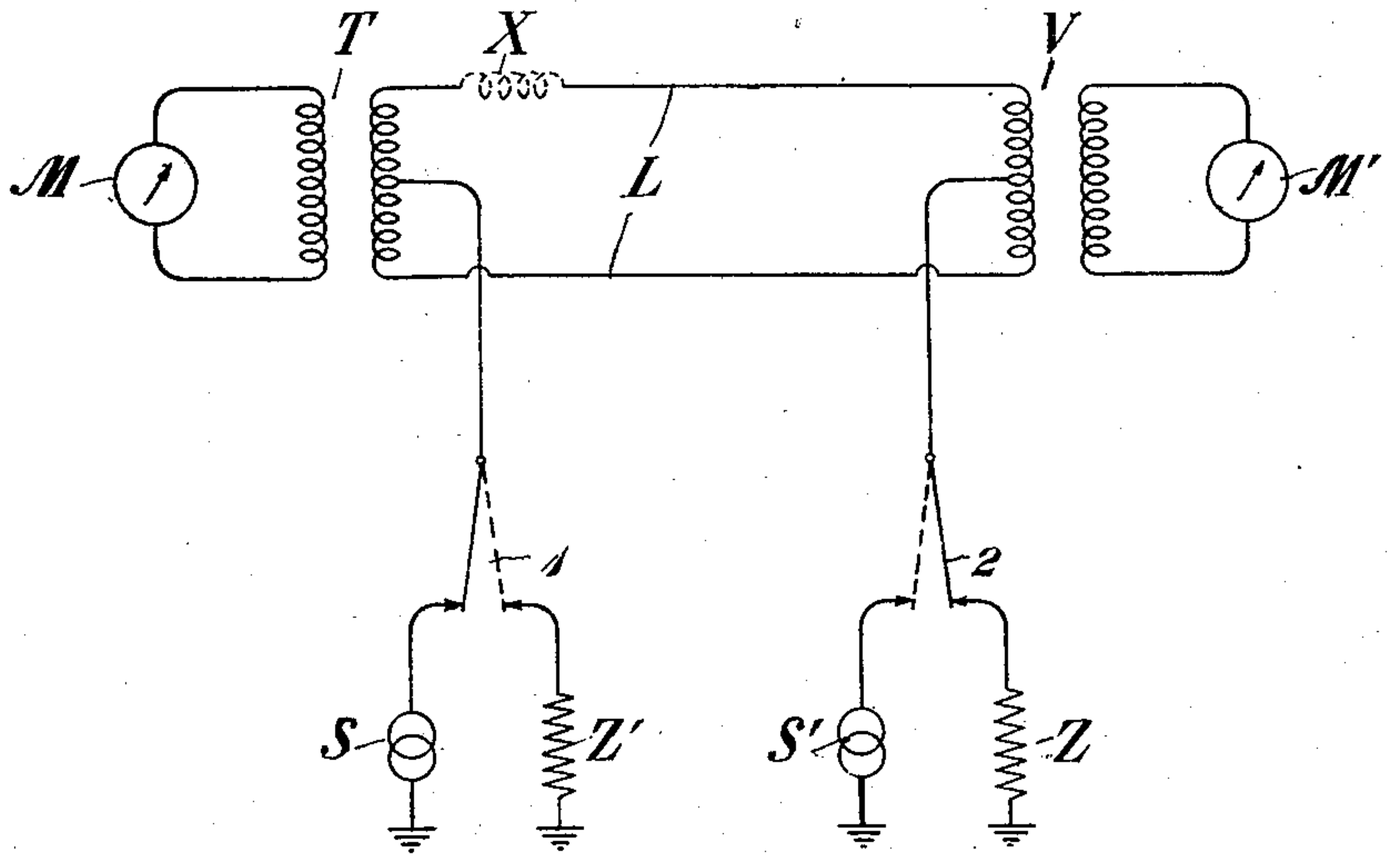

Fig. 1

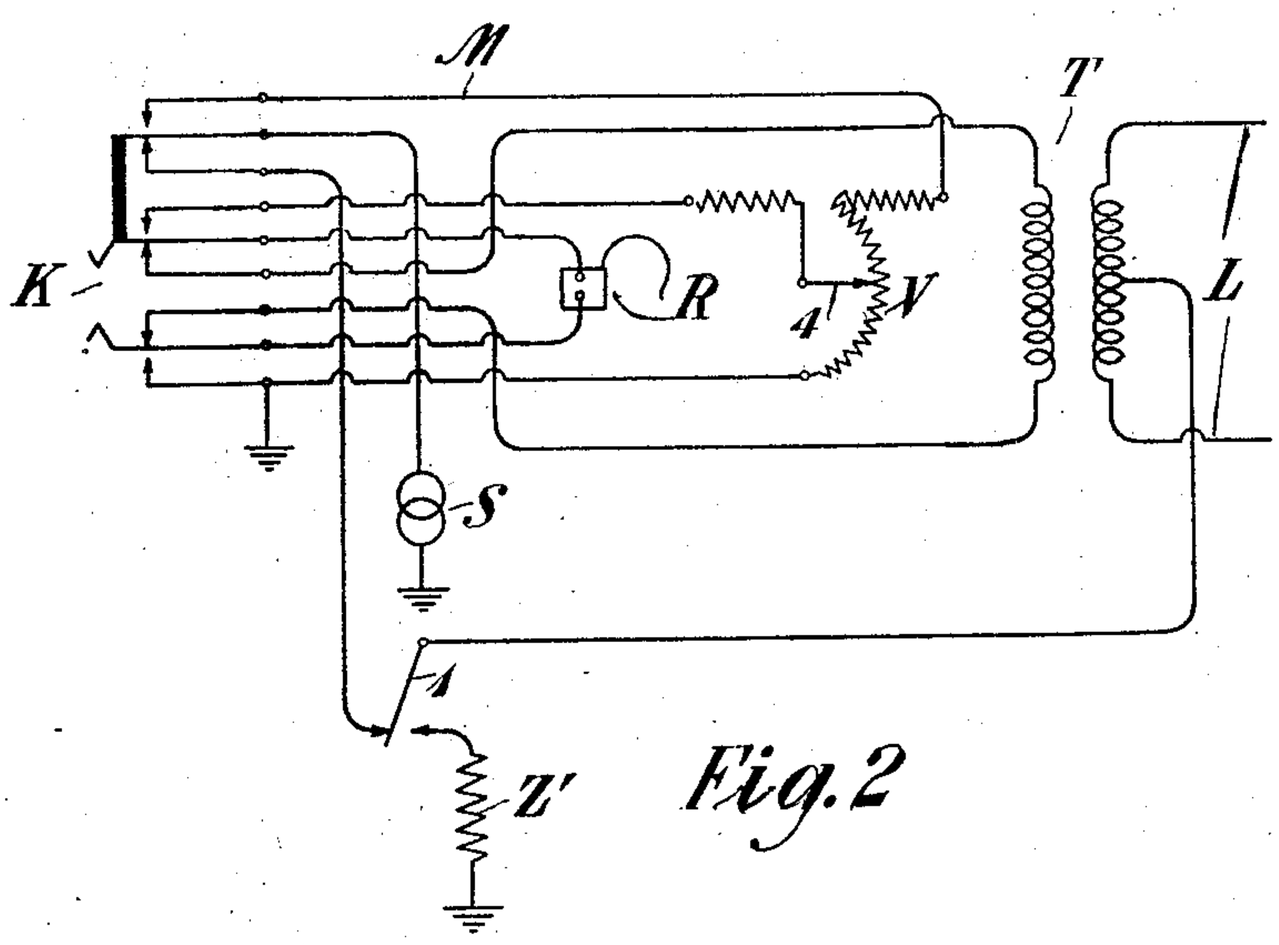

Fig. 2

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UNITED STATES PATENT OFFICE.

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TESTING APPARATUS.

Application filed August 9, 1920. Serial No. 402,238.

To all whom it may concern:

Be it known that I, HAROLD S. OSBORNE, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Testing Apparatus, of which the following is a specification.

This invention relates to methods of and means for detecting unbalances in transmission lines. It is described herein with particular reference to telephone lines, but it is to be understood that the same is not thus limited, being applicable to many other transmission circuits.

The term unbalance as employed herein designates an unsymmetrical condition of the wires of a circuit with respect to adjacent wires or to ground, which unbalance gives rise to cross-talk or noise in the unbalanced circuit, as is well known to those familiar with the art. The unbalance may be due to any number of causes, such as high resistance joints in the line wires, defective loading coils, transposition irregularities, broken insulators and various other circumstances.

The present invention proposes means whereby the existence of unbalances of this character may be rapidly determined. The magnitude of the effect of the unbalance in causing noise and cross-talk in telephone instruments associated with the line may also be ascertained so that the testing operator is enabled to determine whether or not the unbalance is of such nature that its location should be ascertained and the cause thereof removed.

A good understanding of the invention may be had from the following description thereof, reference being had to the accompanying drawing, in which,

Figure 1 is a diagrammatic view showing one form of embodiment of the invention, and

Fig. 2 is a similar view showing one form of measuring device for use with the apparatus of Fig. 1.

Similar characters of reference designate similar parts in each of the views.

In Fig. 1 of the drawing reference character L designates the transmission line, the unbalance of which is to be ascertained. S is a frequency band oscillator covering substantially the range of the voice, which oscillator may be associated with the line L adjacent its western terminal by means of a switch 1 connected to the midpoint of the winding of a transformer T. At its eastern end, the line is terminated by means of a transformer V, the midpoint of which is associated with a switch 2, which in the position shown in the drawing, makes contact with one terminal of an impedance Z, the other terminal of which is connected to ground. With switches 1 and 2 in their left and right positions respectively, current from the oscillator flows over the sides of circuit L in parallel through impedance Z, to ground return. This circuit, it will be observed, is a grounded phantom and the impedance Z is provided to so terminate the eastern end of the line that reflection losses in the phantom circuit are substantially eliminated. This impedance is herein illustrated as composed of a simple resistance, but it may consist of a combination of impedance elements where greater accuracy of termination is desired. An oscillator S′ similar to S, is provided at the eastern terminal of the line for at times causing flow of current from east to west, and an impedance Z′ is provided at the western end of the line to properly terminate the same for current from S′. Current measuring instruments, M and M′ are associated with the secondary windings of transformers T and V.

If the line is in perfect balance, the impedance of one side of the line is equal to that of the other, so that current applied thereto by S or S′ divides equally and traverses the windings of transformers T and V in opposite directions, so that the measuring instruments M and M′ show zero current. However, if an unbalance is present, such as the series inductance indicated in dotted lines at the point X, the drop of potential across this unbalance causes a flow of current which circulates in the circuit composed of the line conductors in series with each other and the windings of the transformers T and V. The measuring instruments, therefore, show a current, the value of which is dependent upon the magnitude of the unbalance, the location thereof, and the direction of flow of the phantom current.

Suppose, for illustration, that the unbal-

ance X is close to the western terminal of the line, then in case (*a*) current is applied to the line by the source S, the measuring instrument M will indicate a much larger value of current than M′ for the reason that the circulating current has substantially its full value at the western terminal of the line, whereas, when it reaches the eastern end it has been decreased in value owing to the attenuation of the metallic circuit. However, in case (*b*) current is applied to the line by source S′ the indication of the instrument M′ is very small, owing to the fact that the circulating current is reduced in amplitude owing to the attenuation of the metallic circuit. The indication of the instrument M in case (*a*) is larger than that of M′ in case (*b*) for the reason that the circulating current is substantially unattenuated in the former case. The readings of M in case (*a*) and M′ in case (*b*) serve to give an approximate indication of the location of the unbalance.

The reading of M′ in case (*a*) and M in case (*b*) are of the same order of magnitude, provided the attenuation of the metallic circuit is substantially equal to that of the grounded circuit. In other words, the location of the unbalance does not have any pronounced effect on the said readings. The last mentioned measurements are therefore of service in arriving at an estimate of the quality of the line from the standpoint of balance. If the readings are below a predetermined maximum, the line may be regarded as in good condition and if it exceeds said value, steps must be taken to remove the irregularities which cause the unbalance.

The devices M and M′ may be any suitable instruments for measuring weak currents. They may, for example, each consist of the arrangement, shown in Fig. 2, in which R is a telephone receiver which is normally associated with the secondary of transformer T by means of the contact springs of the key K.

The source S is associated with the line by another spring of the key and the switch 1. The circulating current caused in the line by the current from S flows through transformer T and causes a response of receiver R. The test-operator now reverses the key, thus connecting S to the variable impedance device V and the receiver R to the movable contact 4, so that part of the current in V enters the receiver. He varies the position of contact 4 until the sound in the receiver has the same loudness for either position of switch K. He then reads a scale associated with the contact 4, which scale is calibrated in any convenient units. The impedance of the device V is arranged to be the same as that of the phantom circuit over the line L, so that the current flowing from S is the same for either position of the key. The position of contact 4 consequently shows the fraction of the total current from S which is caused to circulate in the line owing to irregularities. The impedance of the receiver circuit is made so high that the variation in the position of contact 4 has no appreciable effect on the impedance of V. If the phantom current is applied to the line at its other end, the operator throws switch 1 into its other position, and determines the value of the circulating current in the same manner.

Although only one form of apparatus and circuits embodying the invention and only one form of method of practicing the same are described herein, it is readily understood that various changes and modifications may be made therein within the scope of the following claims without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of testing a transmission circuit for unbalances of the character described, which consists in associating with one end of the conductors of the line in parallel with each other a source of current and measuring the current flowing from one conductor of the line to the other at the opposite end of the line.

2. The method of testing a transmission line for unbalances of the character described, which consists in causing the flow of current of a plurality of frequencies over the conductors of the line in parallel with each other, and measuring the current flowing through said conductors in series with each other.

3. The method of arriving at a rough approximation of the location of an unbalance of the nature described, which consists in associating current of a plurality of frequencies, first with one end of the conductors of the line in parallel with each other, and then with the other, and measuring for each case the current flowing from one conductor to the other at the same end of the conductors.

4. In an apparatus for testing a transmission circuit for unbalances of the nature described, a source of current and connections associated therewith for causing flow of current through the conductors of the circuit in parallel with each other, and a measuring instrument for determining at the distant end of said circuit the flow of current from the conductor of one side into the conductor of the other side.

5. In an apparatus for testing a transmission circuit for unbalances of the nature described, a source of current of a plurality of frequencies, means for associating said source with said line so as to cause flow of current through the conductors thereof in parallel with each other, and measuring apparatus associated with a part of the circuit remote from said source, said

apparatus being responsive only to current circulating in said conductors in series with each other.

6. In an apparatus for testing a transmission line for unbalances of the nature described, a plurality of sources of current, each source having a plurality of frequencies, connecting devices for associating one or the other of said sources with said line to cause flow of current in one direction or the other over said conductors thereof in parallel with each other, impedance devices for terminating the line at the end remote from the source associated therewith to reduce reflection losses thereat, and measuring apparatus associated with the terminals of said line and responsive to current circulating in said conductors in series with each other, but nonresponsive to current traversing said conductors in parallel with each other.

7. The method of testing a transmission circuit for unbalance between its two conductors, which consists in connecting a source of current to said conductors in parallel, and measuring the current flow across said conductors at their distant end.

8. The method of testing a transmission circuit for unbalance between its two conductors, which consists in connecting a source of current at one end to said conductors in parallel, and measuring the current flow across said conductors at both the near and distant ends thereof.

9. The method of locating a cause of unbalance between the two conductors of a transmission circuit, which consists in applying a source of current at one end through said conductors in parallel, measuring the current flow across said conductors at both the near and distant ends thereof, and thereby getting an indication of the location of said cause by the relative magnitudes of the said currents across the ends.

In testimony whereof, I have signed my name to this specification this 5th day of August 1920.

HAROLD S. OSBORNE.