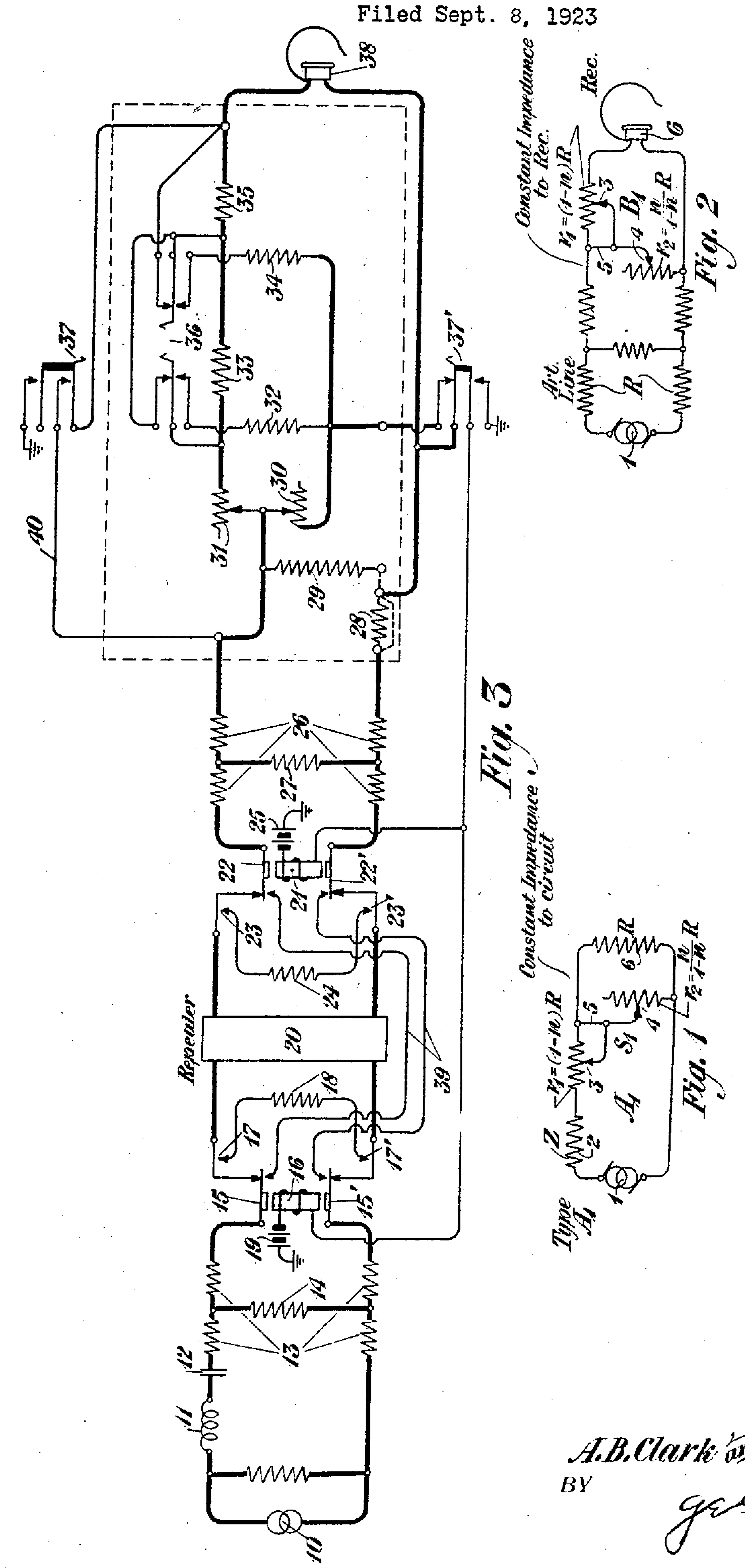
Dec. 8, 1925. A. B. CLARK ET AL 1,564,203

RECEIVER SHUNT

Filed Sept. 8, 1923



INVENTORS

A.B.Clark and G.Crisson

BY

ATTORNEY

Patented Dec. 8, 1925. 1,564,203

UNITED STATES PATENT OFFICE.

ALVA B. CLARK, OF BROOKLYN, NEW YORK, AND GEORGE CRISSON, OF HACKENSACK, NEW JERSEY, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

RECEIVER SHUNT.

Application filed September 8, 1923. Serial No. 661,655.

To all whom it may concern:

Be it known that we, ALVA B. CLARK and GEORGE CRISSON, residing at Brooklyn and Hackensack, in the counties of Kings and Bergen and States of New York and New Jersey, respectively, have invented certain Improvements in Receiver Shunts, of which the following is a specification.

This invention relates to transmission measuring devices and particularly to that form of such devices known as a receiver shunt.

A receiver shunt is a device which may be connected between a circuit and a telephone receiver or other receiving apparatus in order to reduce the current entering the receiver in any desired and predetermined ratio.

A receiver shunt consists of an impedance element in series with the receiver and one in parallel with it, which are varied simultaneously in order to secure the result mentioned above. Such a shunt has associated with it a calibrated dial which indicates the loss produced by it in miles of standard cable.

In the use of a receiver shunt of the type heretofore known in the art, certain errors of measurement have been introduced, due to the assumption that the impedance of the telephone receiver is pure resistance. For the sake of simplicity of construction it has been the practice to assume that the impedance of the receiver is a pure resistance and to proportion the series and shunt elements of the receiver shunt to produce the desired reduction of the current in the receiver at each step and at the same time to keep the impedance of the receiver and receiver shunt together constant and equal to the assumed value of the receiver impedance. If this assumption were true the accuracy of the shunt would not depend upon the impedance of the circuit to which it is connected even if it were different from that of the receiver because the current taken by the combination of receiver and shunt would not depend upon the setting of the shunt. In the past where great precision was necessary it has been customary to associate auxiliary impedance elements, sometimes called pads, with the receiver which cause the combination of receiver and pad to approximate a pure resistance. This practice increases the cost of the apparatus and wastes part of the electrical power that would otherwise be available to actuate the receiver. When pads are not used there is a loss at the junction between the receiver and the shunt which depends upon the impedance of the receiver and the impedance presented by the shunt and the rest of the circuit toward the receiver. Since, as pointed out above, the latter impedance varies with the setting of the shunt this loss varies with the setting and causes the effect of the shunt to be different from the value calculated on the assumption mentioned above.

In our invention the shunt is used in connection with an artificial line whose impedance is a constant pure resistance and is so designed that the impedance presented toward the receiver is a constant pure resistance equal in value to that of the line. Since the impedance presented toward the receiver does not vary with the setting of the shunt the loss at the junction due to the fact that the impedance of the receiver differs from that of the shunt likewise is constant. The change in the receiver current caused by changing the shunt is therefore accurately equal to the change the shunt was designed to give and there is no error due to the impedance of the receiver differing from that which it faces. In this way accuracy is attained without the expense and power losses that would be produced by padding, and the necessity of using receivers having a particular value of impedance is avoided.

It is the object of this invention to provide a shunt which, when combined with the line circuit and the telephone receiver in a manner set forth hereinafter, will produce greater accuracy of measurement than heretofore attained.

This invention will be clearly understood from the following description when read in connection with the attached drawing, of which Figure 1 shows an electrical network involving the type of shunt heretofore used; Fig. 2 shows a network involving an improved type of shunt, and Fig. 3 shows the use of the improved type of shunt in a circuit for measuring the transmission gain produced by a telephone repeater.

In the network shown in Fig. 1, a source of potential 1 is bridged across the network so as to transmit therethrough current of a predetermined frequency. The line circuit represented by 2 is assumed to have an impedance Z. The receiver shunt S_1 comprises a series element r_1 and a shunt element r_2. The magnitudes of the parts of the series and the shunt elements effectively connected with the network, may be varied by the simultaneous movement of the contact points 3 and 4 by means of the arm 5. Connected in parallel with the shunt element, is a telephone receiver or other receiving apparatus 6, which is assumed to be pure resistance R. The series resistance r_1 varies in such a way that the impedance of the shunt and the current entering it are constant. This current divides between the shunt resistance r_2 and the receiver impedance R, consequently the loss ratio produced by the shunt is

$$n=\frac{r_2}{r_2+\mathrm{R}} \quad (1)$$

where n is the current ratio corresponding to the loss caused by the shunt. Since the impedance presented by the shunt to the circuit is kept equal to R by the resistance r_1

$$\mathrm{R}=r_1+\frac{r_2\mathrm{R}}{r_2+\mathrm{R}} \quad (2)$$

solving for r_1 and r_2:

$$r_1=(1-n)\mathrm{R} \quad (3)$$

$$r_2=\frac{n}{1-n}\mathrm{R} \quad (4)$$

R may be considered the characteristic resistance of the receiver shunt.

From the foregoing discussion it will be seen that neither the design nor performance of the type of receiver shunt shown in Fig. 1 depends upon Z, the circuit impedance. Any reflection loss between R and Z is constant at all settings of the shunt and is not included in the loss indicated by the shunt.

The errors in such type of shunt are as follows: Since the impedance of a telephone receiver is not a pure resistance R certain errors occur in using the shunt. Both the resistance and reactance of a receiver increase with frequency, hence a value of R is chosen which approximates the receiver impedance at 1000 cycles. The impedance presented to the line and the current entering the shunt therefore vary with the setting of the shunt. The impedance presented by the shunt toward the receiver decreases as the loss is increased. Because of this and the change of the receiver impedance with frequency the loss caused by the shunt tends to be less than the indicated value at frequencies below 1000 cycles and greater at higher frequencies. When an impure testing current is used this action causes the quality of the sound heard in the receiver to vary with the setting of the shunt because the loss caused to the fundamental of the testing current is different from the loss encountered by the harmonics.

A method that has been suggested for correcting the errors arising from the use of the type of shunt shown for example in Fig. 1, which errors arise from the reactance effect of the receiver 6, consists in inserting a network or pad between the shunt per se and the receiver, which pad consists of impedance elements so proportioned that the impedance of the receiver and the pad together is a pure resistance R. This arrangement, however, introduces a loss between the shunt and the receiver which is objectionable because it tends to make the sound in the receiver too faint for accurate comparison of volumes.

Our invention consists in an improvement upon the type of shunt heretofore used whereby not only may the errors arising from the use of that type of shunt be eliminated but also the reduction in efficiency incidental to the use of a pad as mentioned above may be avoided.

Since the artificial lines used in repeater testing circuits may be made up of pure resistance elements, it has been found that the errors present in the earlier type of receiver shunt could be eliminated by providing a shunt which has constant impedance for all settings when viewed from the telephone receiver. Our invention consists not only in a receiver shunt having a constant impedance when viewed from the receiver but also in the combination of a shunt having the characteristic mentioned above in combination with other apparatus comprising a repeater testing circuit.

This improved type of shunt is shown schematically in Fig. 2 and in detail in connection with a repeater testing circuit in Fig. 3. In Fig. 2 a source 1 of sinusoidal alternating potential is connected across an artificial line, the elements of which are pure resistance. The opposite terminals of this artificial line are connected with the receiver shunt B_1 comprising a series element 3 and a shunt element 4 having resistances r_1 and r_2 respectively. The shunt B_1 is so designed as to have constant impedance for all settings when viewed from the receiver. Since the impedance of the artificial line is always pure resistance R, the loss caused by the shunt will always be that indicated by the reading of the dials associated with the shunt.

The manner in which a receiver shunt in combination with an artificial line of pure resistance may be practically used is shown in Fig. 3, which represents a testing circuit for determining the gain attained by the use of a repeater. In this figure, the source of testing electromotive force 10 is effectively connected across the sides of the artificial line, the elements of which, 13 and 14, are pure resistances having a definite value. Interposed between the source 10 and the said artificial line is a simple type of filter consisting of an inductance 11 and a condenser 12, which are so proportioned as to transmit readily the fundamental frequency produced by the source 10, and to suppress the harmonics of this frequency. The opposite terminals of the artificial line are connected with the armatures 15 and 15′ of the relay 16. One terminal of the winding of this relay is connected with a source of potential 19 and the other terminal thereof is connected with a contact of the key 37′. The outer contacts of relay 16 are connected with conductors leading to the input side of the repeater 20 which may be of any well known type. The inner contacts of the relay 16 are connected by the conductors 39 with the inner contacts of relay 21. Connected between contacts 17 and 17′ of this relay is a network 18 which serves to prevent singing of the repeater when the repeater is disconnected from the source 10 and the measuring circuit (to be described later). Outer contacts of relay 21 are connected by conductors with the output side of the repeater 20 and the armatures 22 and 22′ of the said relay are connected with terminals of an artificial line interposed between the repeater and the receiver shunt. A network 24 similar to 18, is connected between contacts 23 and 23′. A source of potential 25 is connected with one terminal of the winding of relay 21, the other terminal of which is connected with the same contact of key 37′ with which the corresponding terminal of the winding of relay 16 is connected. The artificial line comprises a plurality of pure resistances 26 and 27 having a predetermined value. This artificial line is connected with receiver shunt which comprises the apparatus shown within the dotted rectangular space. The resistances 28 and 29 may be effectively connected or disconnected, (as shown by the dotted lines) depending upon the character of the artificial line used, that is, whether it simulates heavy, medium or non-loaded real lines. The resistances 30 and 31 represent respectively, the shunt and series resistances of the receiver shunt. The resistances 32, 33, 34 and 35 may be effectively connected or disconnected from the shunt circuit, depending upon the position of the key 36. The object of these resistances is to increase the range of loss through which the receiver shunt may be operated. Receiver 38 is also connected with the receiver shunt. The keys 37 and 37′ are designed respectively to cut out the receiver shunt and to operate the relays 16 and 21 in order to disconnect the repeater.

The manner in which this circuit operates is as follows: The testing potential of predetermined frequency, would be applied across the artificial line, made up of the resistances 13 and 14; the current resulting therefrom is amplified by the repeater 20 and the resultant potential would cause current to flow through the artificial line, made up of resistances 26 and 27, through the receiver shunt to the receiver 38. The keys 37 and 37′ would then be operated. By the operation of key 37, the series elements of the receiver shunt would be shunted out by the conductor 40. By the operation of key 37′, relays 16 and 21 would be operated by the flow of current from the sources 19 and 25 to ground at key 37′. Key 37′ also opens the branches of the shunt in which are located the shunt elements 30, 32 and 34.

The source of potential 10 would then be connected through the first artificial line, thence over conductor 39 through the second artificial line to the receiver shunt and the receiver 38. The volume of the tone given by the receiver 38 under the latter condition, will be different from the volume produced when the repeater is connected in the circuit. Accordingly, the keys 37 and 37′ are restored to their normal position and the receiver shunt is adjusted to cut down the volume of the tone given in the receiver. By alternately connecting and disconnecting the repeater and by adjusting the shunt, the volume produced when the repeater is connected into the circuit will equal that when it is disconnected. This adjustment of the receiver shunt is effected by varying the resistances 30 and 31 and also by manipulating the key 36 which, when operated in one direction, connects into the receiver shunt one series and one shunt element having an impedance of different magnitude from that which may be connected with the receiver shunt when the key is operated in the opposite direction. It would, of course, be possible to make a receiver shunt having only one series and one shunt element such as 31 and 30. If, however, the range of the receiver shunt is great the switching arrangement necessary for one series and one shunt element is quite complex. It has accordingly been found desirable to use a plurality of series and also of shunt elements. Thus, for example, the elements 30 and 31 may be designed to measure from zero to ten miles of standard cable in one mile steps. Furthermore, the elements 32 and 33 may be designed to represent 20 miles of cable and elements 34 and 35 ten miles of cable. The shunt has a maximum range of 30 miles and measurements can be made to within one mile by the proper combination of the various groups of series and shunt elements. The reading of the dials of the receiver shunt is the gain produced by using the repeater.

While this invention has been disclosed as embodying a particular form and arrangement of parts, it is to be understood that it is not so limited but is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a transmission measuring system, the combination with a line circuit, the impedance of which is substantially pure resistance of a source of alternating current connected therewith, a telephone receiver and a variable receiver shunt connected between the said artificial line and said receiver adapted to vary the current in the said receiver, and having constant impedance when viewed from the said receiver.

2. In a transmission measuring system, the combination with a source of alternating current of predetermined frequency, of frequency selecting means connected with said source and designed to transmit current of a predetermined frequency, an artificial line of pure resistance connected with the said frequency selecting means, a telephone receiver, and a variable receiver shunt connected between the said artificial line and said receiver adapted to vary the current in the said receiver and having a constant impedance when viewed from the said receiver.

3. In a receiver shunt, the combination with a line circuit of substantially pure resistance having a source of alternating potential connected therewith of a receiving device, and a variable shunt comprising a series and a shunt resistance element connected between the said circuit and the said receiving device adapted to vary the current in the said device and having a constant impedance when viewed from the said receiving device.

4. The combination with a receiver of a variable receiver shunt connected therewith, comprising a series resistance element and a shunt resistance element adapted to vary the current in the said receiver, and so proportioned that the impedance of the said shunt is always constant when viewed from the said receiver.

In testimony whereof, we have signed our names to this specification this 6th day of September 1923.

ALVA B. CLARK.
GEORGE CRISSON.