Apr. 10, 1923. 1,450,969

J. R. CARSON

RECEIVING CIRCUITS FOR WEAK SIGNAL CURRENTS

Filed June 18, 1918

Fig. 1

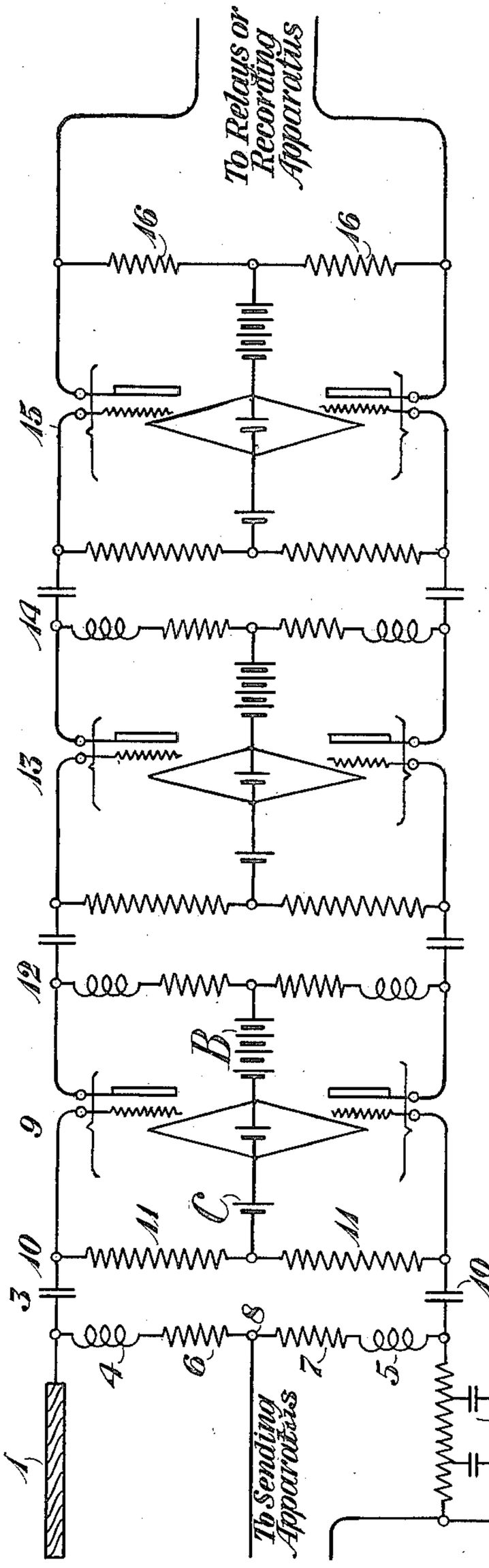
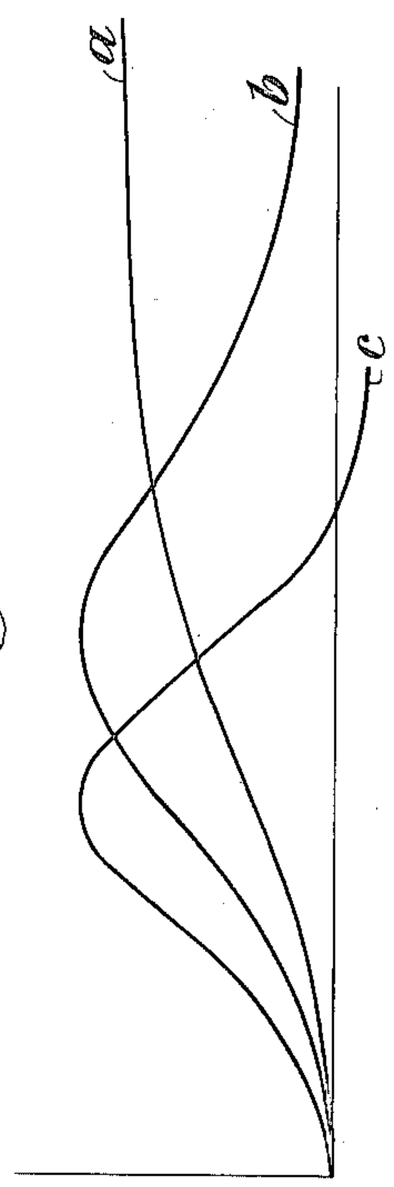


Fig. 2



INVENTOR.
John R. Carson
BY William P. Ballard
ATTORNEY

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UNITED STATES PATENT OFFICE.

JOHN R. CARSON, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

RECEIVING CIRCUITS FOR WEAK SIGNAL CURRENTS.

Application filed June 18, 1918. Serial No. 240,632.

To all whom it may concern:

Be it known that I, JOHN R. CARSON, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Receiving Circuits for Weak Signal Currents, of which the following is a specification.

This invention relates to signal transmitting systems and is concerned especially with the receiving end of transmission lines in which there is a considerable amount of distortion and attenuation, as in long submarine cables.

It is well known that in signaling over lines of the character mentioned, the speed is very limited because of the characteristics of the line and many efforts have been made to overcome this difficulty. It has recently been proposed to combine with circuits of this sort correcting networks which restore, to a considerable extent, the original form of the current impulses though adding to the attenuation, and then to amplify the faint but corrected impulses by an amplifier of the thermionic type in which large amplification, without substantial distortion, can be secured. It has also been proposed to connect correcting networks and amplifiers alternately in the circuit so that both the correcting and amplifying are done in successive stages. By this means improved results are obtainable. It is the object of the present invention to provide an efficient circuit of this type suitable for duplex operation.

The invention will be described in connection with the accompanying drawing in which Figure 1 illustrates diagrammatically one embodiment thereof and Figure 2 shows current curves illustrating the operation thereof.

Referring to Figure 1, the main line circuit, here shown as a cable, is indicated at 1 and the balancing artificial line, used for duplex operation is shown at 2. Between the main line and the artificial line is connected the first stage 3 of the correcting network, consisting essentially of inductance elements 4 and 5 and resistance elements 6 and 7. These are symmetrically arranged to provide a central or neutral point 8, to which the sending branch of the duplex set may conveniently be connected as shown on the drawing. The correcting network is connected to the first stage of the amplifier 9 through condensers 10, which, for telegraph purposes, should be of large capacity. The circuits from the condensers run to the grids of the first stage of the amplifier, here shown as a duplex thermionic amplifier. It will be understood that any arrangement of amplifier elements, which is symmetrical with respect to the opposite sides of the circuit, will serve the purpose. As shown, each duplex amplifier has two plates, two grids and two filaments, one of each on each side of the neutral conductor. This showing is merely diagrammatic and not intended to indicate the relative physical location of these elements, but merely the symmetry with respect to the circuit. Various arrangements for the elements of duplex amplifiers are shown in the patent to Colpitts, No. 1,128,292. Where all of the elements are included in a single bulb, a single filament may be used at a time and will serve for both sets of grid-plate electrodes. A single C battery on the input side of the amplifier may be used as indicated and should be connected to the grids through very high resistances 11 to prevent short circuiting the amplifier.

The output circuit from each side of the duplex amplifier runs to one extremity of the next succeeding correcting network 12 and the B battery is connected between the mid point of the network 12 and the filament. The network 12 and succeeding stages of networks and amplifiers shown at 13, 14 and 15 resemble in all particulars the corresponding elements already described. The neutral point for the connection of the B battery of the last amplifier may be conveniently obtained by connecting two equal resistances 16 of high value across the circuit as indicated.

If the circuit at the transmitting end of the line is closed and held closed, the arrival current over the line of the kind under consideration will be represented roughly by curve "*a*" in Figure 2. The effect of the inductances 4 and 5 in the first network will be to give a first derivative of this current which may be represented by the curve "*b*" in Figure 2. The resistances 6 and 7 preserve the arrival curve itself as a component. The combined effect of these components will be to give a current having a sharper rise than the arrival current alone, and which is yet more maintained than the de-

rivative. Each succeeding stage of the network serves to add a derivative, each added derivative having a sharper rise than its predecessor. It also has a more rapid fall, as in the curve *c*, but by maintaining the preceding components and properly proportioning the elements of the network, the combination can be made to show a quite rapid rise with a very well sustained current.

By providing a system of correcting networks and amplifiers which is perfectly symmetrical, as above described, substantially all unbalance in the receiving circuit may be avoided. In many instances this may be of considerable importance as the received impulses, originally quite feeble, are rendered still more attenuated by the correcting networks and it is important to preserve as clearly as possible the characteristics of the signals. The thermionic amplifier as a type has peculiar value for systems of the kind under consideration because of its ability to amplify without re-introducing substantial distortion, and the balanced form here shown is even freer from distortion than the ordinary form. This balanced arrangement also avoids unbalanced ground connections for the batteries and permits of connecting the networks and amplifiers directly to the main line, as shown, without the intervention of a transformer.

The invention is not limited to the details of the circuit arrangements shown as various modifications within the scope of the invention will suggest themselves to those skilled in the art.

What is claimed is:

1. In a signal transmitting system a main line, an artificial line, means for correcting the form of received impulses, comprising a plurality of elements symmetrically connected between said main and artificial lines and an amplifier connected to said correcting means and having both its input and output circuits symmetrically arranged with respect to the opposite terminals of said correcting means.

2. In a signal transmitting system, a main line, an artificial line, a correcting network comprising inductance and resistance symmetrically connected between said main and artificial lines to provide a mid or neutral point, and a duplex amplifier connected symmetrically with respect to said correcting network.

3. In a signal transmitting system, a main line, an artificial line, a correcting network having its elements symmetrically connected between said main and artificial lines to provide a mid or neutral point, a sending circuit connected to said mid point, and a duplex amplifier connected symmetrically with respect to said correcting network.

4. In a signal transmitting system, a plurality of correcting networks each comprising inductance and resistance arranged symmetrically with respect to the transmitting circuit, and amplifiers located between the successive networks and symmetrically arranged with respect thereto.

5. In a signal transmitting system, a correcting network connected across the circuit at the receiving end and comprising inductance and resistance symmetrically arranged with respect to said circuit, a duplex thermionic amplifier connected to said correcting network and symmetrically arranged with respect thereto, condensers located in the leads between said network and grids of said amplifier, and high resistances connecting the grids and filament of said amplifier.

6. In a signal transmitting system, a plurality of networks for restoring the wave form of transmitted impulses, each network having its elements arranged symmetrically with respect to the opposite sides of the circuit and amplifiers located between the successive networks and symmetrically arranged with respect thereto.

7. In a signal transmitting system, a correcting network at the receiving end for restoring the wave form of transmitted impulses, said network having its elements symmetrically arranged with respect to the opposite sides of the circuit to provide a mid or neutral point and a duplex amplifier connected symmetrically with respect to said correcting network.

In testimony whereof, I have signed my name to this specification this 17th day of June 1918.

JOHN R. CARSON.