

June 21, 1932.

V. P. THORP
MEANS FOR REDUCING LIGHTNING INTERFERENCE
IN CARRIER TELEGRAPH CIRCUITS
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2 Sheets-Sheet 1

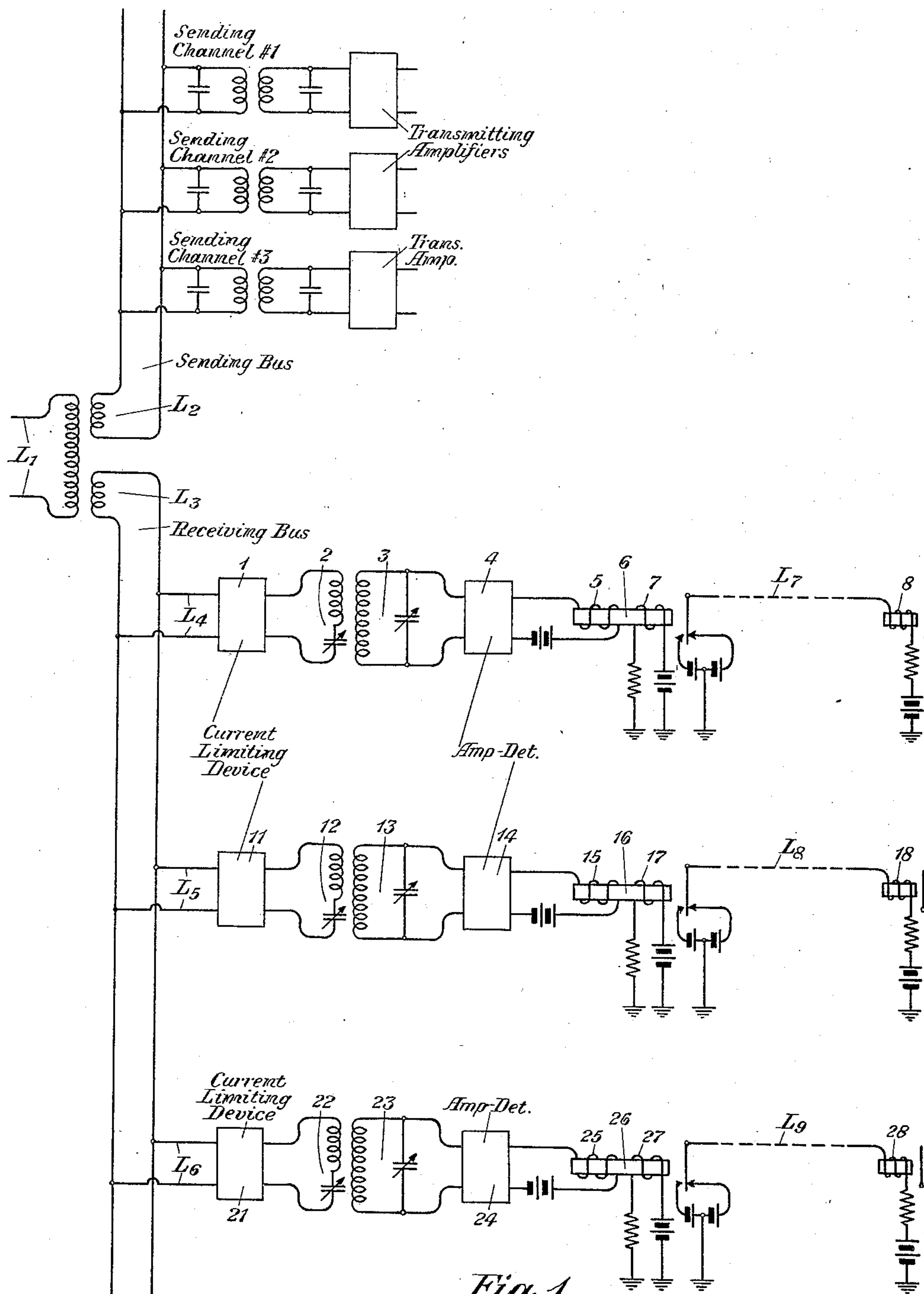


Fig. 1

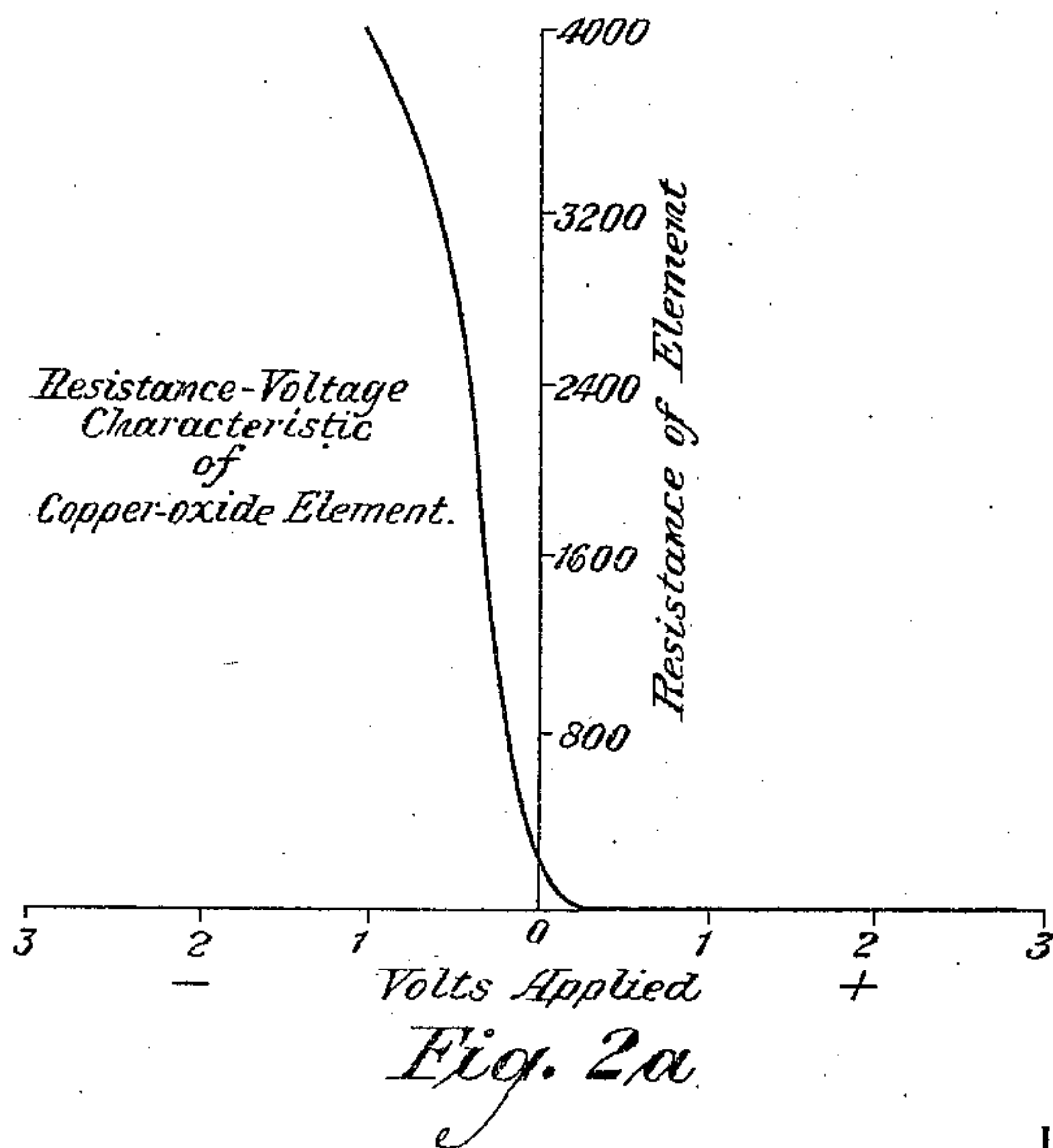
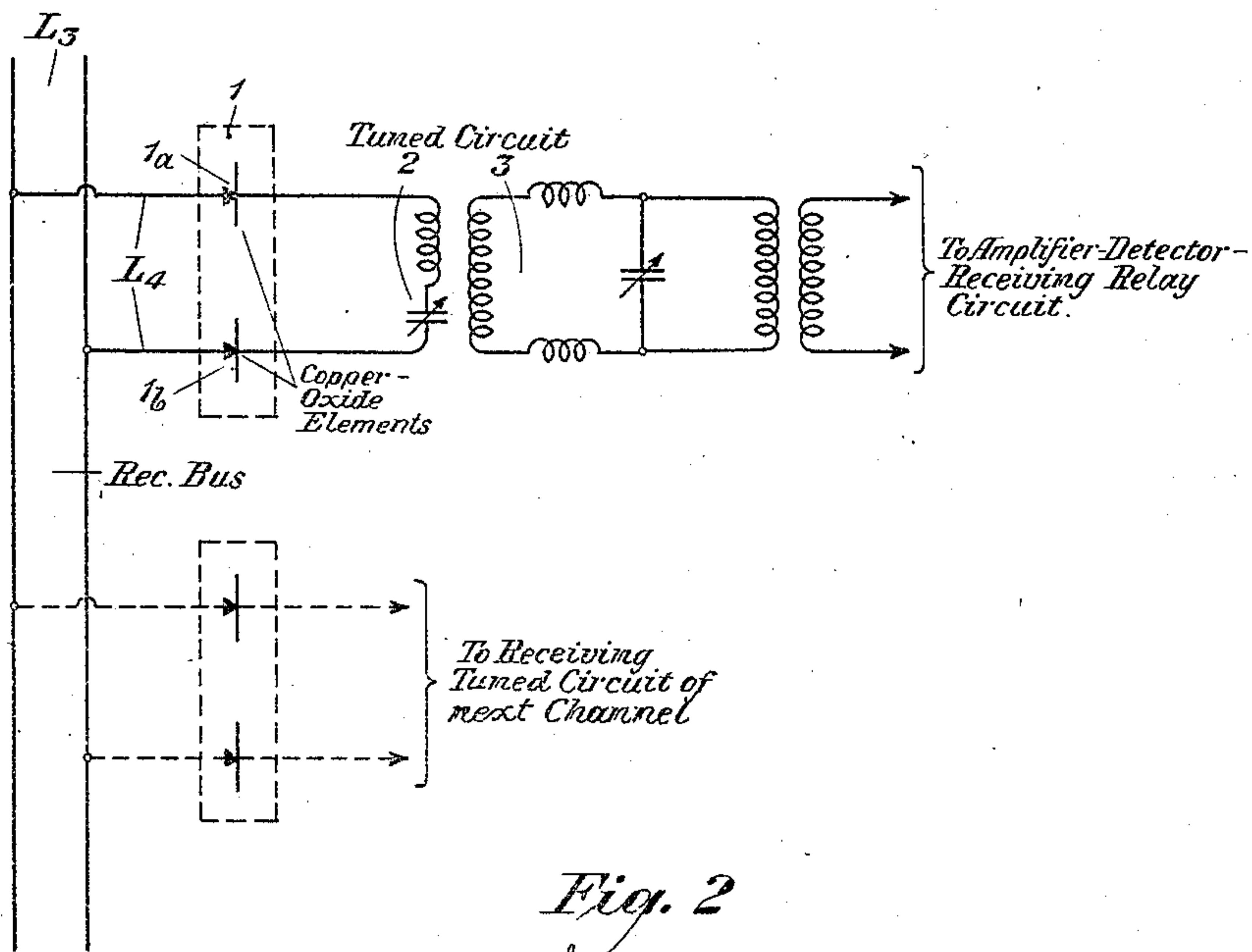
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MEANS FOR REDUCING LIGHTNING INTERFERENCE IN CARRIER TELEGRAPH CIRCUITS

Application filed June 19, 1930. Serial No. 462,380.

This invention relates to means for reducing lightning interference upon carrier telegraph circuits, and particularly to an arrangement for preventing the shock excitation by lightning impulses of the tuned circuits in the receiving branches of the carrier telegraph system.

In the operation of carrier telegraph circuits interference from lightning impulses produces distortion of the received signals, and various means have been devised to eliminate or reduce the effects of such interference. It has been found from experience that the impulses produced by lightning in a circuit, such as a carrier telegraph circuit, are of short duration but of large amplitude. When those impulses enter the receiving circuits and shock-excite the tuned circuits therein, the effect of such excitation is to prolong the lightning impulse sufficiently to cause the operation of the receiving relay connected with the receiving circuit. Were it not for the prolongation of the impulse produced by the tuned circuits, the relays would seldom be affected by the lightning impulse, because the normal duration of that impulse is less than the time required to build up the required operating current of the receiving relay.

My invention resides in a method and means for preventing the shock excitation by lightning impulses of the tuned circuits in the receiving branches of a carrier telegraph system.

This invention will be clearly understood from the following description when read in connection with the attached drawings of which Figure 1 shows schematically the application of the invention to a carrier telegraph system; Fig. 2 shows the use of a specific type of current-limiting device, namely, a copper oxide rectifier to prevent shock excitation of the tuned circuits, and Fig. 2A is a characteristic curve illustrating the description of the principle underlying the invention.

In Fig. 1, L_1 represents the transmission circuit over which carrier telegraph signals may be transmitted in both directions between stations each equipped with apparatus

as represented by the terminal circuit of the drawings. The line L_1 has connected therewith the sending bus L_2 , and the receiving bus L_3 . Connected with the sending bus is a plurality of branch circuits designated as channels Nos. 1, 2 and 3, each having associated therewith a tuned circuit by means of which currents of the various frequencies of transmitted signals are impressed upon the sending bus L_2 . The sending branches may also have associated therewith transmitting amplifiers and transmitting apparatus of the type customarily employed for carrier telegraph transmission. Since the invention herein involved relates to the receiving circuits, it will be unnecessary to describe in detail the transmitting circuits.

The receiving bus L_3 has connected therewith a plurality of branch circuits L_4 , L_5 and L_6 , each intended and capable of receiving the signal transmitted by a carrier frequency over the line L_1 from a distant station. The branch circuit L_4 contains a current-limiting device 1, that may be a copper oxide rectifier as shown in Fig. 2, or any of a plurality of devices capable of limiting the magnitude of the voltage that they will transmit to the series resonant circuit 2. That resonant circuit is coupled with a parallel resonant circuit 3 that is connected with the input of the amplifier-detector 4, the output of which is connected with one of the windings 5 of the receiving relay 6. That relay which also has a biasing winding 7 controls the transmission of impulses over the loop circuit L_7 to the subscriber's circuit represented schematically by the relay 8. L_5 and L_6 represent other branch receiving circuits similar, preferably, to L_4 , for the reception of other carrier telegraph channels.

The current-limiting devices represented schematically by 1, 11 and 21, may be of any type whose impedance is relatively small for the normal operating voltages of the system, but which increases rapidly with an increase in the applied voltage. It will accordingly be seen that the presence in a receiving branch of such a device permits the flow through the series tuned circuit 2 of current of the resonant frequency of that circuit, when the ap-

plied voltage does not exceed a predetermined value, without appreciable loss due to the presence of the current-limiting device. However, the presence of such a device prevents a voltage of large magnitude from causing a flow of current through the circuit 2 that would produce oscillations in the circuit 3 of sufficient duration to cause the response of the receiving relay 6 and thereby introduce error in the received signals.

The ability of the system to eliminate such errors will be apparent from consideration of the arrangement shown in Fig. 2 in which the same numerals have been employed to designate parts similar to those shown in Fig. 1. In Fig. 2 the apparatus enclosed in the dotted block is the current-limiting device 1 by means of which the shock excitation of the tuned circuits 2 and 3 is prevented or substantially reduced in frequency of occurrence. The elements of the current-limiting device shown in Fig. 2 are copper oxide rectifiers of the type fully described in the paper by Grondahl and Geiger entitled, "A new electronic rectifier" published in the Journal of the A. I. E. E. March 1927 (pages 215-222). The current-limiting device as shown in Fig. 2 comprises two copper oxide elements 1_a and 1_b , each of which has the characteristic shown in Fig. 2—A. The arrowheads of the elements 1_a and 1_b indicate the low resistance direction of flow of current through them. As shown in Fig. 2 the resistance of each of the elements 1_a and 1_b is the same in each direction for zero applied voltage, and very nearly the same in each direction for voltages of small magnitudes, such, for example, as the incoming carrier voltage that is of the order of one-tenth volt. Under that condition very little rectification will occur in the elements 1_a and 1_b . The principal effect of those elements at the low operating voltages is to introduce a constant resistance of about 400 ohms in series with each receiving branch. Accordingly, the voltages of the carrier telegraph impulses will cause current to flow through the tuned circuit 2 which in turn will produce oscillations in circuit 3 that will be amplified and detected by 4 and impressed upon the receiving relay 6 to cause its operation.

If, however, a high voltage such as that produced by lightning, should be impressed by the line L_1 upon the receiving bus L_3 , and in turn upon the branches L_4 , L_5 and L_6 , the effect of the devices 1, 11 and 21 in those branches will be to prevent an abnormal current flowing in the series resonant circuits. It will be seen from Fig. 2—A that the resistance of one of the copper oxide elements will increase greatly in one direction of applied voltage, and will decrease in the other direction, which decrease however, is of comparatively small magnitude. For example, assume the instant when the phase of

the impressed voltage due to lightning makes the upper wire of L_4 positive with respect to the lower wire. From Fig. 2 it will be apparent that while current will readily flow through the element 1_b , the resistance introduced by the element 1_b will be so great for a relatively small increase of negative voltage that the current flowing through the series resonant circuit 2 will be kept down to a relatively low value by the joint action of the elements. Consequently, the oscillations set up in the tuned circuit 3 will not cause the operation of the receiving relay 6. With the phase reversal of the interfering voltage wave in the branch L_4 the element 1_a will similarly serve to introduce a large resistance in series with the tuned circuit.

A device of the copper oxide type, as described in the Grondahl and Geiger article above referred to, has been shown as a current-limiting device, but it will be apparent that other forms of such devices, either of the contact type, or the thermionic type, such as a vacuum tube, may be employed to limit the magnitude of the current that will flow through the series resonant circuit 2 as the result of the voltage impressed thereon by the input circuit. The important thing is to prevent the shock excitation of the tuned circuits that would tend to effectively lengthen the impulse impressed upon the receiving branches of the carrier telegraph circuit, which impulse, as in the case of a lightning surge, would not, in the absence of such prolongation, be of sufficient duration to build up a current of sufficient magnitude to operate the receiving relay.

While the invention has been disclosed schematically, it is to be understood that it is capable of embodiment in forms other than those shown, without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a carrier telegraph system, the combination with a transmission circuit exposed to lightning interference, of a receiving circuit connected with the said transmission circuit and containing a tuned circuit, and means connected in series with each side of said tuned circuit to automatically dampen the tuning thereof, each of said damping means offering low resistance to current of one polarity and high resistance to the other polarity, the said damping means being connected effectively in opposition.

2. In a carrier telegraph system the combination with a transmission circuit exposed to static interference, of a circuit tuned to the frequency of a carrier channel, a signal responsive device intended to be actuated by voltage impulses of the carrier frequency effectively connected to the said tuned circuit, and means connected in series with each side of said tuned circuit to automatically dampen the tuning thereof, each of said damping

means offering low resistance to current of the polarity and high resistance to that of the other polarity, the said damping means being connected effectively in opposition.

In testimony whereof, I have signed my name to this specification this 18th day of June 1930.

VAUGHN P. THORP

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