

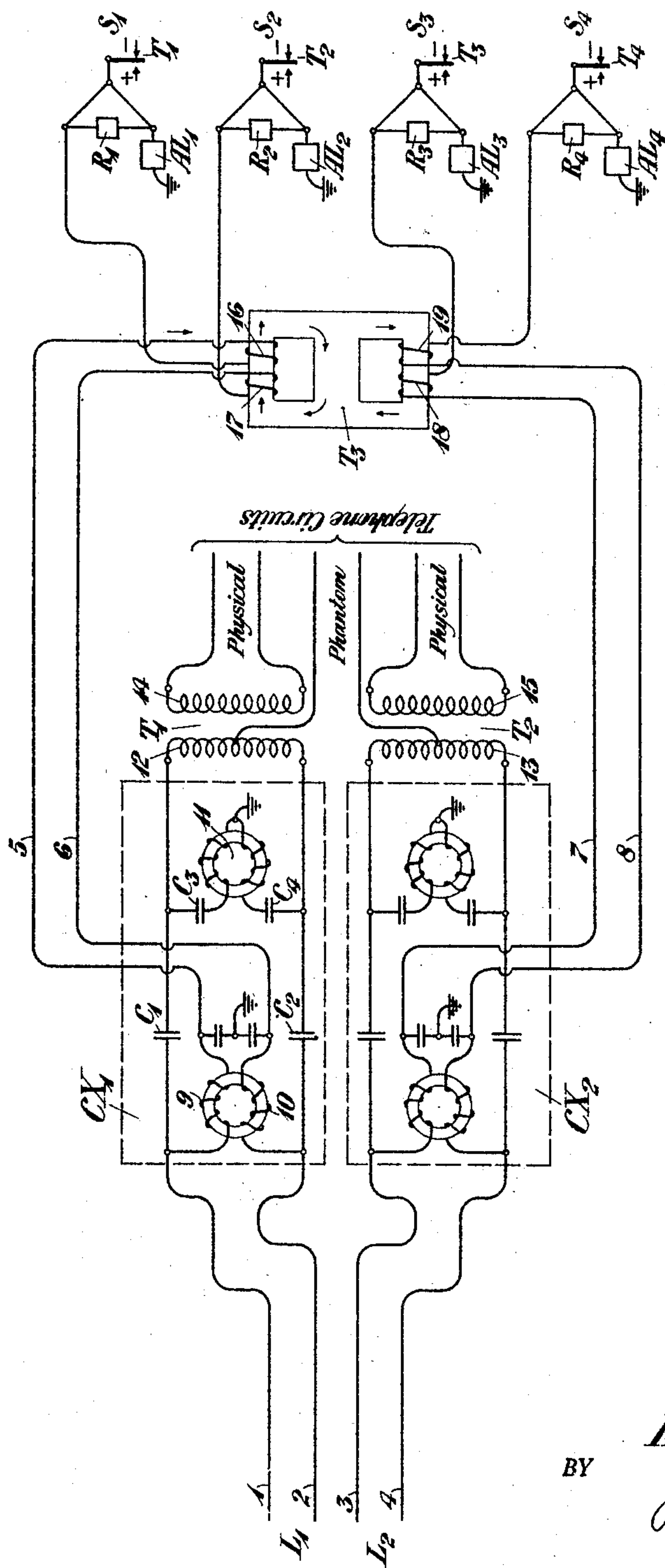
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H. NYQUIST

TRANSFORMER

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UNITED STATES PATENT OFFICE

HARRY NYQUIST, OF ELMHURST, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSFORMER.

Application filed December 2, 1920. Serial No. 427,902.

To all whom it may concern:

Be it known that I, HARRY NYQUIST, residing at Elmhurst, in the county of Queens and State of New York, have invented certain Improvements in Transformers, of which the following is a specification.

This invention relates to inductive disturbance neutralizing devices and especially to an arrangement for suppressing or minimizing the inductive effects commonly known as "cross-fire" between adjacent telegraph circuits.

It is well known to those familiar with the signaling art that when circuits are maintained in close juxtaposition throughout their length an inductive effect may be produced in each of the circuits by currents traversing the others.

It is the object of this invention to provide an arrangement for neutralizing that form of inductive disturbance known as "cross-fire" which occurs between adjacent telegraph circuits especially when such circuits are superimposed upon four conductors which constitute a phantom telephone circuit.

This invention will be better understood from the following description when read in connection with the attached drawing, showing one form of embodiment of the invention.

In the drawing L_1 and L_2 represent two line circuits comprising the conductors 1, 2 and 3, 4, respectively which are adapted for the simultaneous transmission of telephone and telegraph currents. Associated with the circuits L_1 and L_2 are the composite sets CX_1 and CX_2 , which comprise the apparatus shown diagrammatically within the dotted lines. These composite sets are of the well known type by means of which the telegraph legs are connected with the conductors of the line circuits so that the telegraph impulses may be diverted into their proper channels and thereby separated from the telephone currents. The composite set CX_1 , for example, comprises condensers C_1 and C_2 serially connected in the line circuit, which are designed to prevent the passage therethrough of telegraphic impulses, but to offer a minimum impedance to the tele-

phone currents. The telegraph legs 5 and 6, for example, are connected with the conductors 1 and 2, respectively, through impedance coils 9 and 10, which are designed to offer low impedance to the telegraph impulses, but to greatly retard passage therethrough of telephone currents. The function of the condensers C_3 and C_4 , connected with the windings of the coil 11, is to offer low impedance paths to ground for any telegraphic impulses that may pass through the condensers C_1 and C_2 , and thereby prevent said telegraphic impulses from passing to the telephone apparatus connected with the line circuits. The apparatus connected with the composite set CX_2 is similar to that described in connection with CX_1 and needs no further description.

Bridged across the conductors 1 and 2 and also across the conductors 3 and 4 are the windings 12 and 13, respectively, of the phantom repeating coils T_1 and T_2 , respectively, the other windings of which, designated 14 and 15 respectively, are connected with the terminal telephone apparatus to provide two physical telephone circuits. By means of a tap taken from the mid-point of the windings 12 and 13, respectively, a phantom telephone circuit is obtained.

Each of the telegraph legs 5, 6, 7 and 8 is connected with its respective terminal of the windings 16, 17, 18 and 19, of the inductive neutralizing transformer T_3 , and the other terminal of each winding 16, 17, 18 and 19 is connected with a terminal telegraph set represented diagrammatically by S_1 , S_2 , S_3 and S_4 . This invention is not limited to the use of any particular type of terminal telegraph apparatus, and the type represented in the drawing has been chosen for the purpose of illustration only. Thus S_1 , S_2 , S_3 and S_4 represent the terminal arrangement of a bridge polar system, in which AL_1 , AL_2 , AL_3 and AL_4 represent artificial lines for balancing the telegraph lines 1, 2, 3 and 4; R_1 , R_2 , R_3 and R_4 represent receiving relays bridged across the ratio arms; and T_1 , T_2 , T_3 and T_4 represent the transmitting arrangement for ap-

plying impulses of opposite polarity to the telegraph circuits.

With the foregoing description in mind of the parts of the apparatus comprising the circuit arrangement, the invention will now be clearly understood from the following description of the mode of operation of this circuit. Since each of the conductors 1, 2, 3 and 4 has connected therewith telegraph apparatus, the transmission of telegraphic impulses over the said conductors will produce inductive effects in each of the adjacent telegraph circuits, and the effect produced will be proportional to the strength of the transmitted impulse and the separation between the conductors.

The phantom telephone circuits, which in the drawing have been composited in order to obtain the telegraph circuits, are generally arranged symmetrically along the pole lines so as to produce a well balanced condition. In a well designed telephone system these circuits and the conductors constituting them would be transposed at frequent intervals, and in such predetermined manner that the inductive effect from telephone currents, known as cross-talk between the adjacent circuits, physical and phantom, would be substantially prevented.

This transposition scheme does not reduce the inductive effects resulting from the transmission over said conductors of telegraphic impulses. However it apportions the total effect among the various conductors in such a manner that the total inductive effect between conductors 1 and 2 equals that between 3 and 4 and the total inductive effect between 1 and 3, 1 and 4, 2 and 3, or 2 and 4 is less than that between 1 and 2. Further, these four inductive effects are equal to each other. In order to neutralize this inductive effect, it is desirable to set up in each of the adjacent conductors a potential opposite in direction to that induced in the line circuit, and having magnitude equal to the induced voltage. This desired effect is obtained by means of the neutralizing transformer T_n , in which the direction and distribution of the flux resulting from the transmission of an impulse over a conductor will be such as to create a potential in the other windings of the transformer equal and opposite to that induced by said first conductor in the other conductors connected with other windings. Thus a flow of current in conductor 5 in the direction of the arrow will produce a flux in the core as represented by the arrows therein. Since windings 16 and 17 are upon the same branch of the core, the greatest voltage will be induced in the winding 17 which is connected with conductor 2, in which the greatest potential has been induced by conductor 1 which is adjacent thereto on the transmission line and similarly a lesser potential will be in-

duced in the windings 18 and 19 connected respectively with the conductors 3 and 4, in which along the line a potential of lesser magnitude has been induced.

It will be seen therefore that this invention provides means for producing a neutralizing potential whose magnitude is in proportion to the magnitude of the potential induced by one telegraphic circuit upon another, which is dependent upon the strength of the current and the spacing of the conductors along the transmission line.

Although this invention has been disclosed in a specific form, it 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 signaling system adapted for the simultaneous transmission of telephone and telegraph signals, the combination with a line circuit of a terminal telephone circuit and a plurality of terminal telegraph circuits, a composite set adapted to guide the telephone and telegraph signaling currents into their respective terminal circuits, and a transformer having a winding individual to and in series with each telegraph circuit, the said windings being so inductively coupled and poled that the transmission of a telegraph impulse through one of them will induce an impulse in a second winding of such magnitude and in such direction as to minimize the current set up in the circuit with which the said second winding is connected by the transmission of the signaling impulse over the circuit with which the said first mentioned winding is connected, due to the admittance between the said circuits.

2. In a signaling system adapted for the simultaneous transmission of telephone and telegraph signals, the combination with a transmission line comprising a plurality of conductors, of composite sets adapted to connect terminal telegraph apparatus with the conductors of the transmission line, and cross-fire neutralizing means inserted between the composite sets and the terminal apparatus comprising a winding for each telegraph circuit, all of said windings being coupled and poled so that the signaling current through one will induce a neutralizing current in each of the others the magnitude of which is proportional to the cross-fire current.

3. In a system for reducing cross-fire between telegraph circuits, the combination with a number of adjacent conductors greater than two forming a transmission line, of terminal telegraph apparatus, and a transformer having a winding individual to and connected with each conductor and interposed between the said line and the said terminal apparatus, the said windings being

so coupled and poled that a potential will be induced in the other windings by current flowing through any winding, the induced potentials being less in the wind-
5 ings connected with conductors more remote from the conductor connected with the inducing winding, the magnitudes being ap-

proximately inversely proportional to the relative separation of the conductors.

In testimony whereof, I have signed my 10
name to this specification this 1st day of
December 1920.

HARRY NYQUIST.