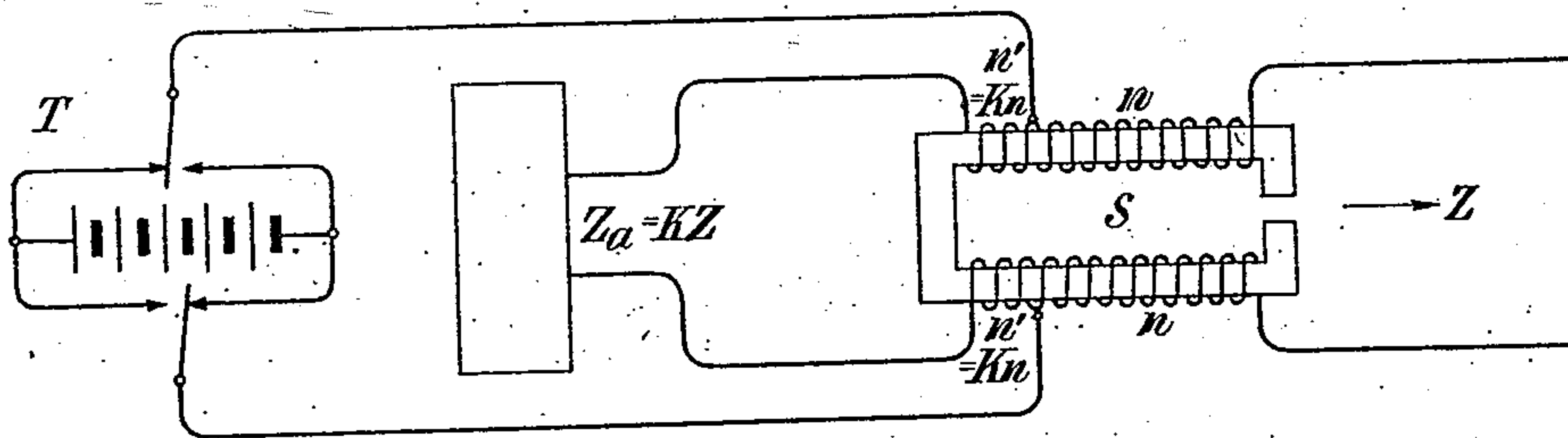


Nov. 9, 1926.

1,605,933

D. K. GANNETT
DUPLEX TELEGRAPH SYSTEM
Original Filed Dec. 24, 1921



INVENTOR
D. K. Gannett
BY *J. H. Gannett*
ATTORNEY

UNITED STATES PATENT OFFICE.

DANFORTH K. GANNETT, OF JACKSON HEIGHTS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

DUPLEX TELEGRAPH SYSTEM.

Original application filed December 24, 1921, Serial No. 524,671. Divided and this application filed November 8, 1924. Serial No. 748,653.

The principal object of my invention is to provide a new and improved duplex telegraph system. Another object of my invention is to provide a telegraph system with bridge arms of such relative impedance values that the received energy shall go in large measure to the receiving element. Another object of my invention is to provide a differential polar system with certain parts proportioned so that the received currents shall be highly effective in the production of signals. These and other objects of my invention will become apparent on consideration of an example which I will disclose by way of illustration. It will be understood that the invention is defined in the appended claims and the following description will refer specifically to this example of the invention.

Referring to the accompanying drawing, this is a diagram showing my invention embodied in a differential duplex system.

A metallic line is shown extending to the right and having the impedance Z . The symbol S designates a polar receiving relay, with windings connected as shown, the various connections of the windings having the respective number of turns indicated by the letters n and $n' = Kn$ where K is a properly chosen constant of value less than unity.

A balancing artificial line is provided having the impedance $Z_a = KZ$.

The transmitter T is connected to the relay S differentially as shown in the drawing. The relations indicated in the drawing are the conditions for exact balance. It has been a common practice to make K equal approximately to unity. However, according to my invention, K is made less than unity and thereby the effective power available in the relay for receiving is increased. The truth of this statement will become apparent from the following discussion.

Designate as i the current transmitted by the transmitting circuit T to the line whose impedance is Z and designate as i_a the current transmitted to the artificial line whose impedance is Z_a . Then

$$\frac{i}{i_a} = \frac{Z_a}{Z} = \frac{KZ}{Z} = K \quad (1)$$

The magnetizing flux ϕ in the relay due to i is $Ai2n$ where A is a constant. The flux

ϕ_a due to i_a is $-Ai_a2Kn$. The negative sign indicates that ϕ_a is of opposite polarity to ϕ . The resultant flux due to both currents is

$$\phi + \phi_a = Ai2n - Ai_a2Kn.$$

But from (1), $i_a = \frac{i}{K}$, so that

$$\phi + \phi_a = Ai2n - A\frac{i}{K}2Kn = 0.$$

Therefore the relation shown is one of exact balance.

In any duplex circuit which is exactly balanced, it is easily shown that an alteration of the impedance of the transmitting circuit has no effect in the receiving system. In this case, then, the transmitting branch T may be opened without affecting the operation of relay S by the current received from the line. In order to simplify the discussion this will be assumed to be the case. The maximum power will be absorbed in relay S when the impedance Z_s of its windings in series is equal to the impedance of the connecting circuit, or when

$$Z_s = Z_a + Z \quad (2)$$

When this relation is true, the power utilized in the relay may be easily shown to be

$$E = \frac{e^2}{4(Z_a + Z)} = \frac{e^2}{4Z(K + 1)} \quad (3)$$

In this expression, e is the received voltage of the line, acting in series with Z . From (3) it is evident that the smaller K is made, the larger is E . If K is made equal to .2, for example, the power available for the relay is increased 67 per cent. as compared with $K=1$. It is not practicable to make K infinitely small but a large proportion of the theoretical maximum increase in power indicated by the formula when $K=0$, is realizable without exceeding practical limits.

Thus it will be seen that the polar receiving relay S is always balanced for electromotive forces applied by the transmitter T , but the received electromotive forces coming in over the line set up fluxes in the relay core with an effect which is substantially cumulative in the various parts of the windings, so that the received current gives a substantial development of power in the receiving relay.

This application is a division of my appli-

cation, Serial No. 524,671, filed December 24, 1921.

I claim:

1. In a duplex telegraph system, an artificial line having its ratio to the geographical line different from unity and in combination two inductance windings having their turns in the same ratio whereby the transmitting element of the system is balanced in its effect on the adjacent receiving element.

2. In a duplex telegraph system, an artificial line and inductance elements having unequal values related (as compared with equal values) to increase the proportion of received power in the receiving element, but to preserve the balance of the transmitting element on the receiving element.

3. In a duplex telegraph system, an artificial line having its ratio to the geographical line different from unity, and the receiving element comprising inductances having their windings in this same ratio.

4. In a duplex telegraph system, an artificial line having its impedance in a ratio to the geographical line different from unity, and a receiving element comprising inductances having impedance values in the same ratio.

5. In a duplex telegraph system, an artificial line having the ratio of its impedance to the impedance of the geographical line a real number different from unity, and a receiving element having two inductances with their turns in the same ratio.

6. In combination a geographical line, a differential polar relay with unequal windings and an artificial line with its impedance value in the same ratio to said geographical line as the impedance ratio between said windings.

In testimony whereof, I have signed my name to this specification this 7th day of November, 1924.

DANFORTH K. GANNETT.