

L. ESPENSCHIED.
 DUPLEX CIRCUIT.
 APPLICATION FILED OCT. 13, 1915.

1,233,767.

Patented July 17, 1917.

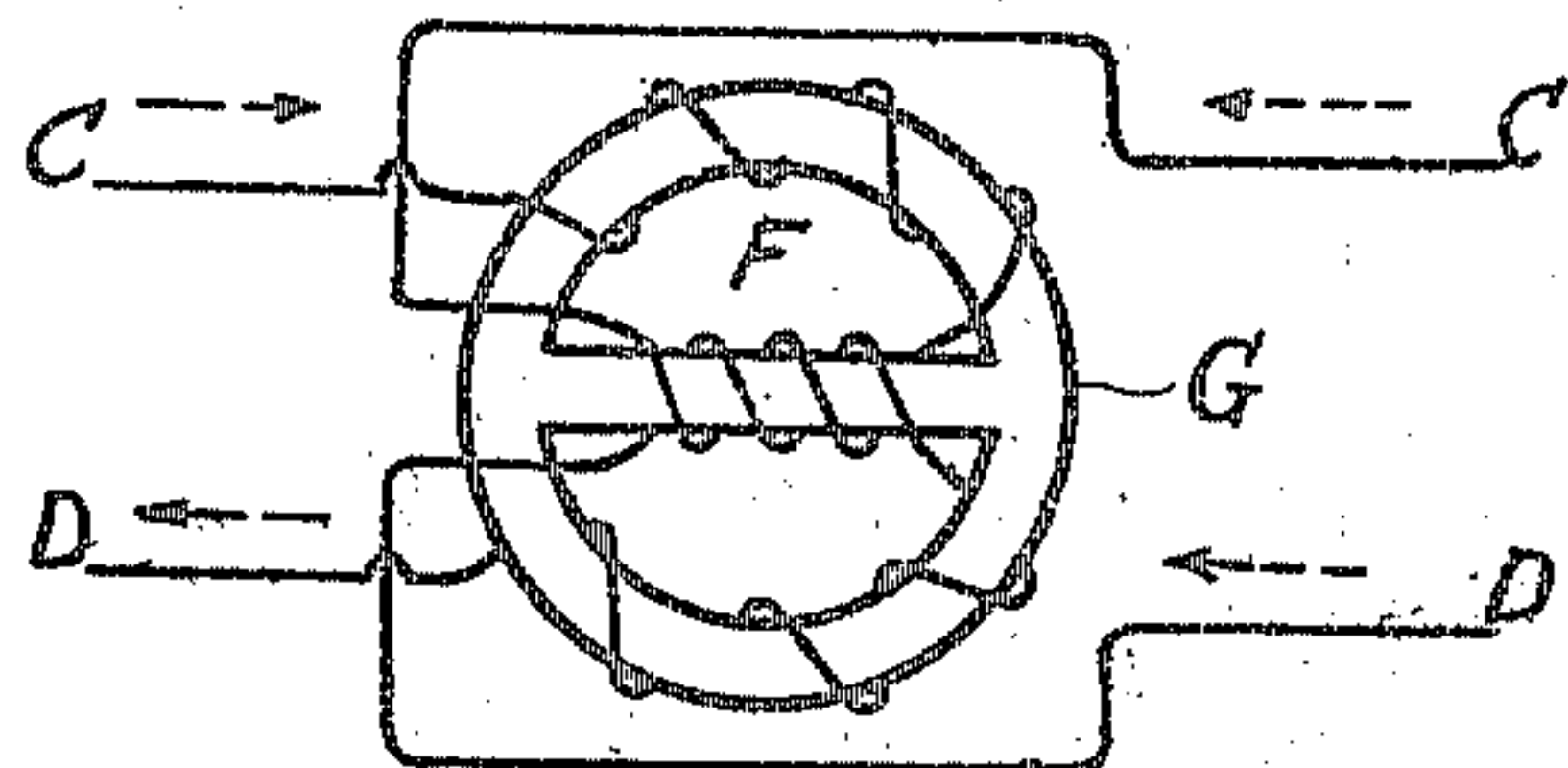
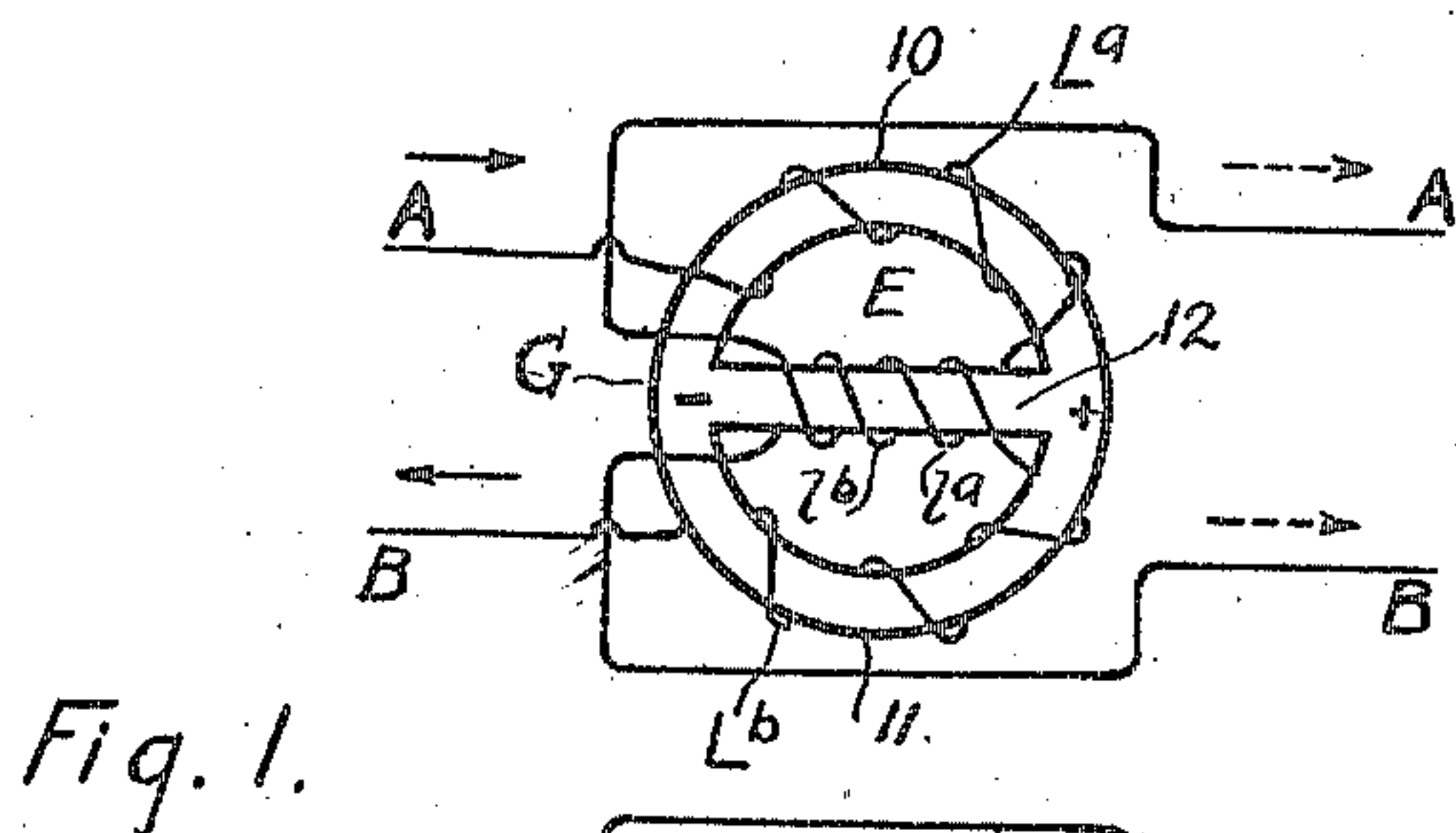


Fig. 5.

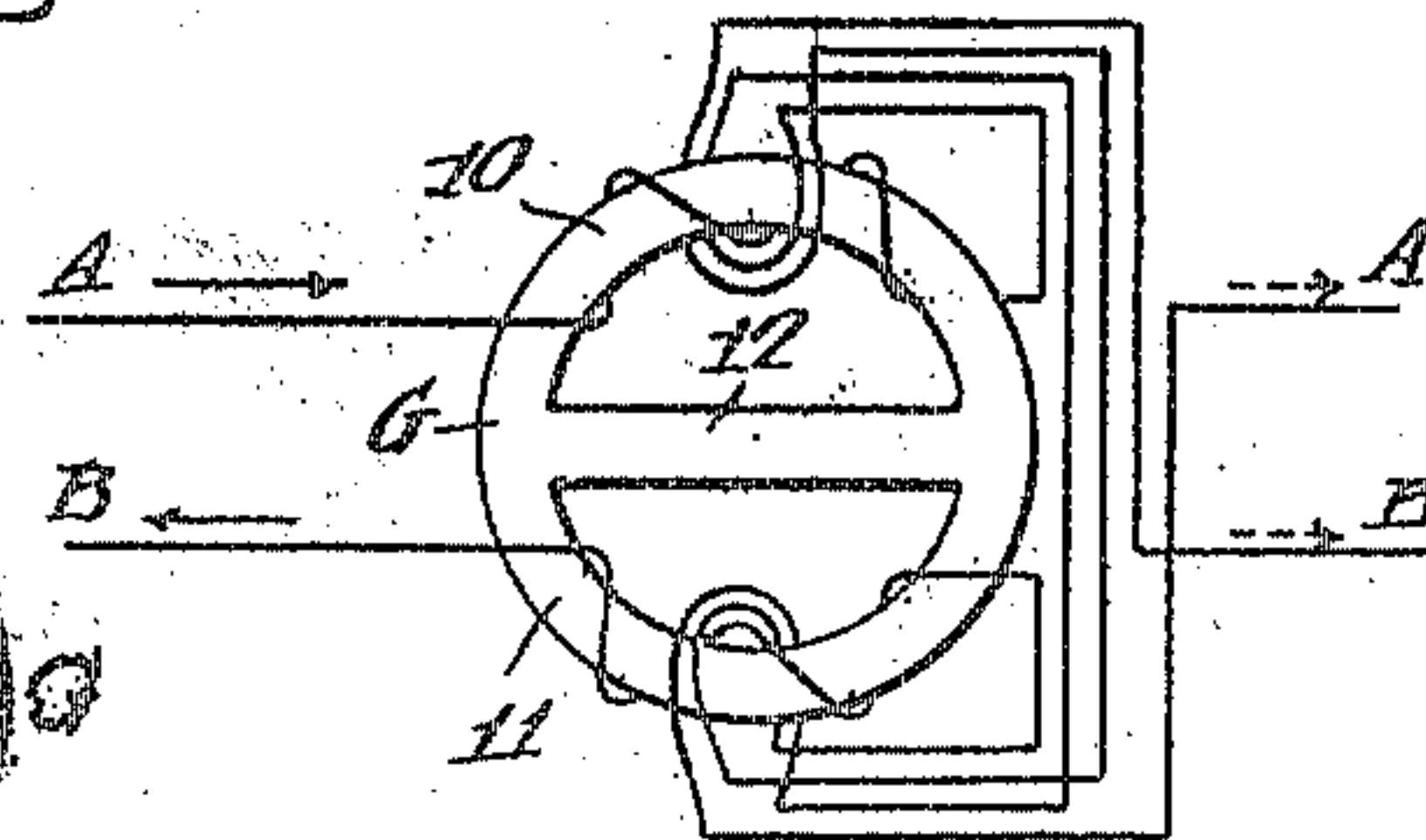


Fig. 4.

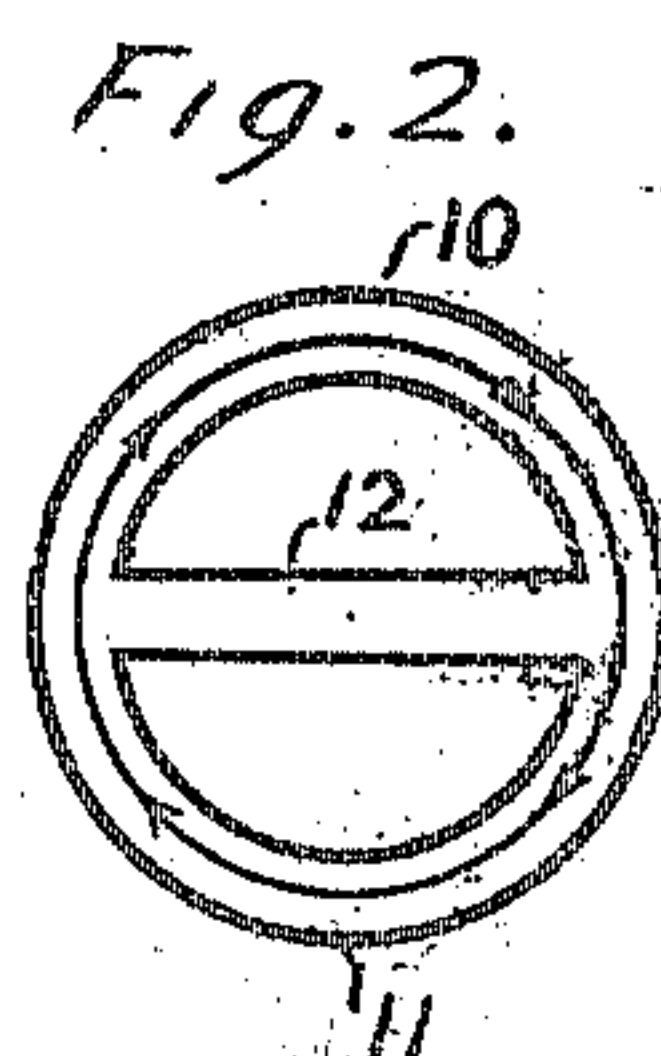
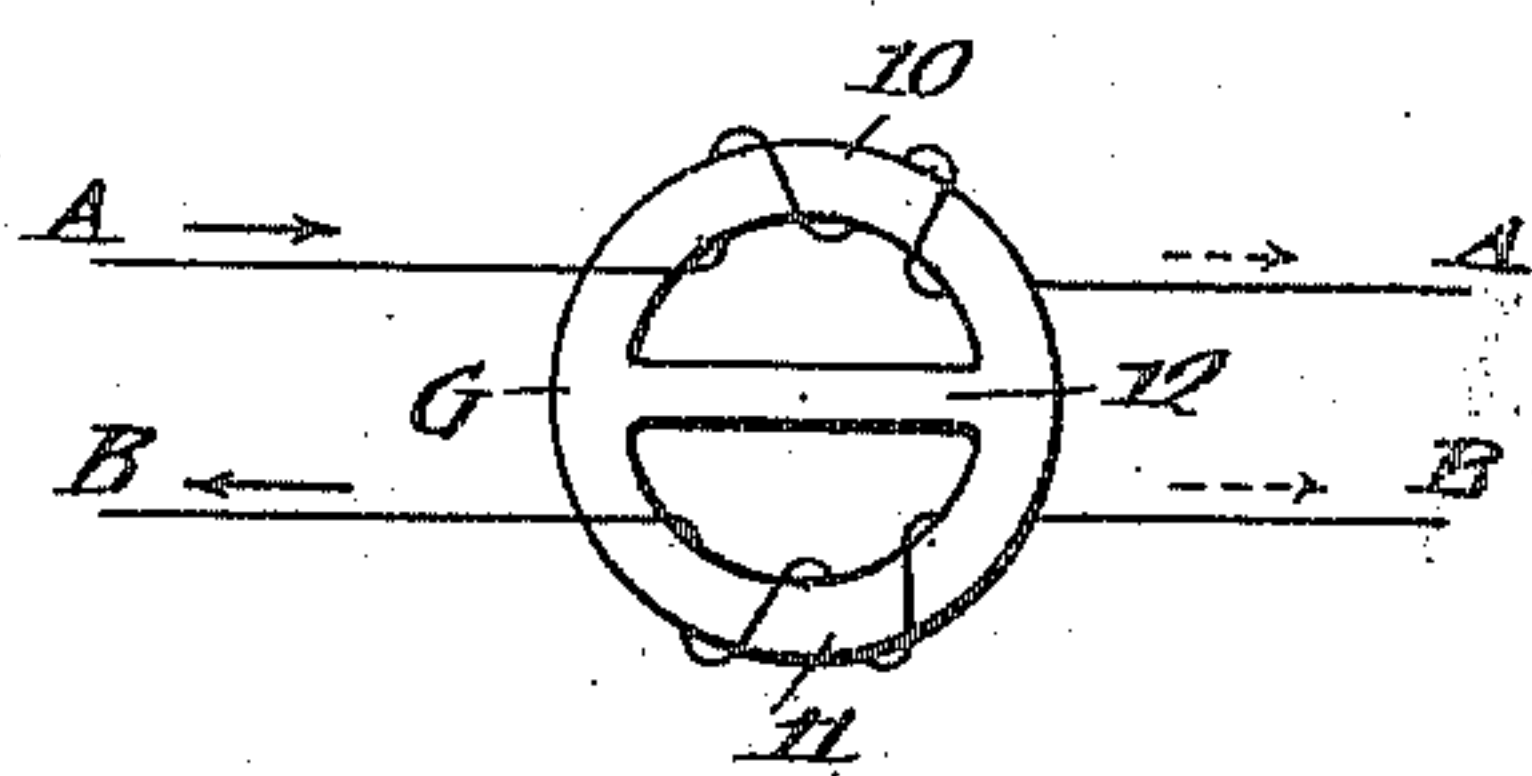
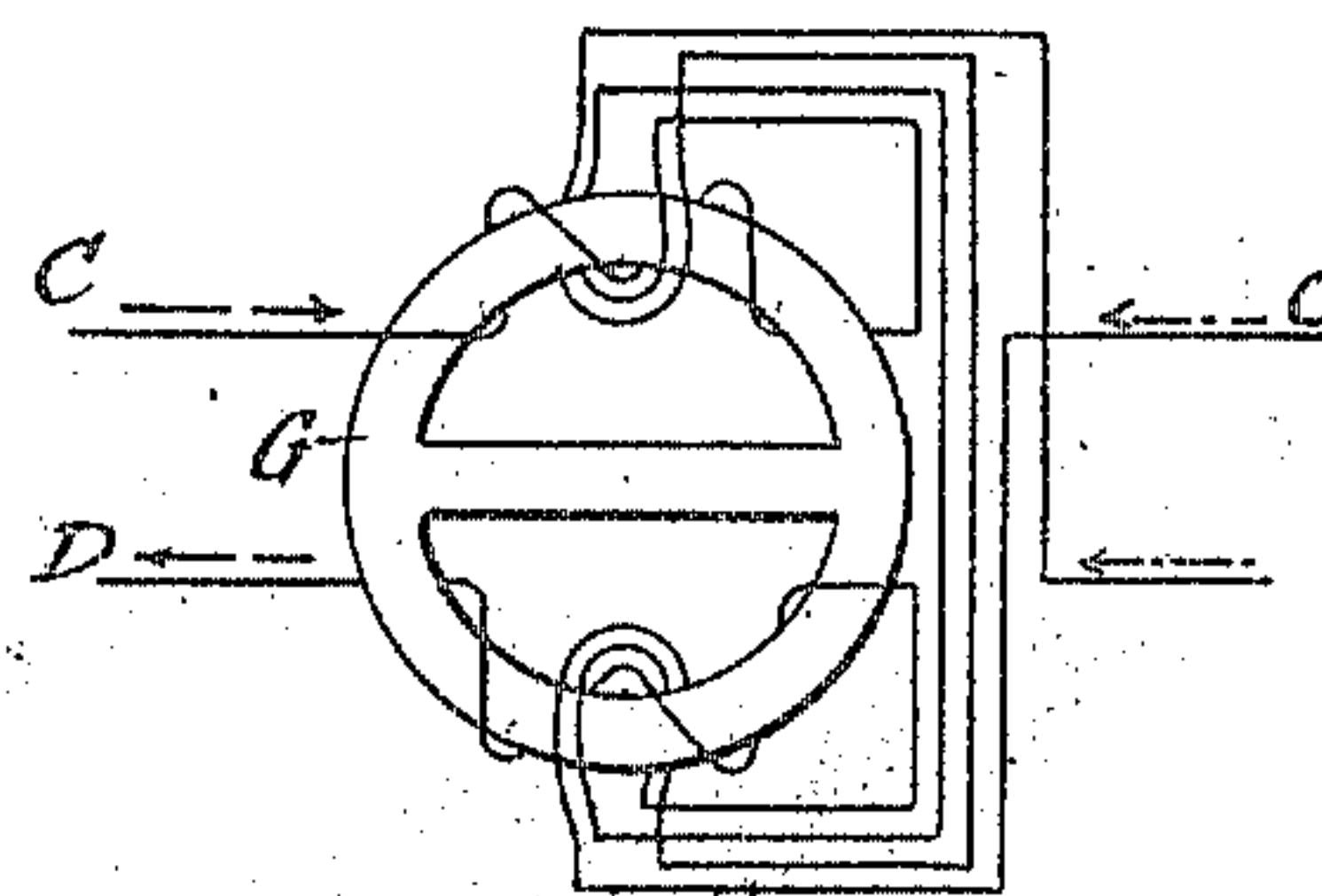
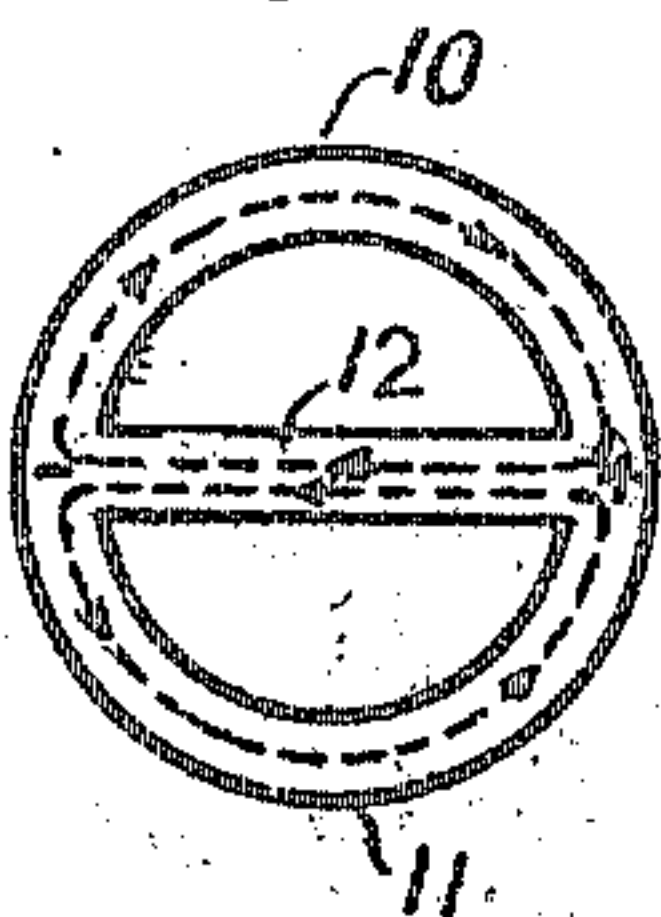


Fig. 3.



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 Attys.

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

DUPLEX CIRCUIT.

1,233,767.

Specification of Letters Patent.

Patented July 17, 1917.

Application filed October 13, 1915. Serial No. 55,715.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Duplex Circuits, of which the following is a specification.

This invention concerns duplex circuits, as those employed in telephony and comprising physical and phantom circuits, and especially such inductance devices as loading coils adapted for use therein. Its purpose is to provide a device of this character, which, independently of the other inductance devices of the duplex circuit, shall produce its effect in a plurality of component circuits. The invention further has for its object the furnishing of means for controlling the ratio of the plural inductance effects.

Figures 1, 4 and 5 of the accompanying drawing show the invention diagrammatically in its application to the loading of a duplex telephone circuit; and Figs. 2 and 3 illustrate, respectively, the paths followed by the flux due to the side circuit and phantom circuit currents in the core of the device shown in Fig. 1.

The characters A, B and C, D designate the line conductors of two physical telephone circuits in which talking current flows in series through both pairs of conductors, as indicated by the full and dashed arrows, respectively. By any suitable means these physical circuits are made to serve also as a phantom circuit through which talking current passes in series through the pairs of conductors each joined in parallel, as the dotted arrows indicate. At proper intervals in these physical or side circuits A, B and C, D, loading coils E and F are respectively connected, these being related as is customary in loading coil practice so that they have no mutual inductive action. As these coils are identical, but one will be referred to in detail.

A core G of magnetic material is formed in two half portions 10 and 11, preferably integral. These portions, as illustrated, form a toroid, though any other closed fig-

ure, preferably symmetrical, as a rectangle, may be employed, and even the toroid is not to be understood as necessarily circular in cross-section. Confined to each half portion of the core is a line winding included in the conductor of a side circuit, the winding L^a , for example, being united with the conductor A and the winding L^b with the conductor B. These windings may be so arranged that their chief effect is upon the side circuit in which the coil is located, or upon the phantom circuit, by respectively connecting L^a and L^b with their inductances mutually aiding for side circuit current and mutually opposing for phantom circuit current, as exemplified in Fig. 1, or mutually opposing for side circuit current and mutually aiding for phantom circuit current, as in Fig. 4. Only the former, as illustrated in Fig. 1 of the drawing will be particularly considered. Between windings L^a and L^b the junctions of the halves of the toroid or primary core portion are joined by a preferably integral magnetic inner secondary portion in the form of a diametric yoke 12.

Upon the windings between traversed by side circuit current, a magnetic flux is generated in the core, which is as appears in Fig. 2, and under such conditions the mutual inductances of the two windings are added to their self inductances to load the side circuit A, B. When, however, phantom current flows through the windings, consequent poles are produced at the junctions of the half portions 10 and 11, the polarity of which at any instant may be indicated by the signs + and -, Figs. 1 and 3. Connecting these consequent poles the yoke or branch core 12 serves as a return path of low reluctance for the phantom flux, as illustrated in Fig. 3. Because of the loose inductive coupling caused by separating the line windings upon different portions of the core and giving a path of low reluctance to divert the flux generated by each winding from its companion, the inductances for phantom current do not neutralize as they do in the closely coupled standard loading coils, in which the windings are superposed

about practically the entire circumference of a simple toroidal core. An appreciable inductance or loading effect is therefore introduced into the phantom circuit.

5 The mutual inductances which affect the electromagnetic balance between circuits are those between line windings of different side circuits. In the present arrangement, these mutual inductances are zero and therefore
10 there is no possibility of a mutual inductance unbalance between circuits. By virtue of the symmetrical design, the coil units are balanced with respect to resistance, inductance and admittance. Therefore, there will
15 be theoretically no crosstalk between the circuits.

Such an arrangement as has just been described gives a relatively low ratio, about 0.2, between the phantom circuit and side
20 circuit inductances, while a much higher ratio than this is usually desired. To enable this ratio to be controlled so that the proper relation may be established, auxiliary means are provided for varying either the
25 side circuit or phantom circuit inductances. As illustrated in Fig. 1 this means takes the form of windings 1^a and 1^b , belonging respectively to the primary inductance windings L^a and L^b . In the present instance it
30 is assumed that the ratio of the phantom to the side circuit inductance is to be increased. In such case, though the auxiliary windings may be upon the outer core portions, as indicated in Fig. 5, they are preferably placed,
35 as shown in Fig. 1, upon the yoke 12 which is traversed by all the flux due to the phantom circuit. This requires but half as many turns of auxiliary winding as would be necessary were they upon the portions 10 and 11
40 in which the phantom flux is divided (see Fig. 3.). The auxiliary windings 1^a and 1^b are so connected as to be mutually opposing for side circuit current and hence, mutually aiding for phantom circuit current, while to-
45 gether they aid the primary windings for phantom current. The ratio sought may be obtained by altering the number of their turns.

In addition to the function of the auxiliary windings of controlling the ratio of
50 phantom to side circuit inductances, their effect should be noted in decreasing the magnetic leakage produced by the phantom current from the consequent poles between the
55 core portions 10 and 11. At these points flux, in addition to traversing the yoke 12 leaves and enters the core in proportion to the magnetic reluctance of the yoke. This leakage flux passing through surrounding
60 metallic objects, as the iron containing case, would cause eddy current losses and thereby lessen the efficiency of the device. But the yoke windings, when increasing the inductance of the phantom, create poles at the

points indicated opposite in sign to those
65 caused by the primary windings. These tend to neutralize each other and thereby reduce the leakage flux and consequently increase the efficiency.

The structure herein illustrated and de-
70 scribed constitutes another embodiment of the invention claimed in my copending application Serial No. 55,714, filed October 13, 1915.

I claim:

1. The combination with two physical cir-
75 cuits consisting of line conductors together furnishing a phantom circuit, of devices having windings included in the conductors of said physical circuits to produce induc-
80 tance effects therein, said devices being inductively independent, and the windings of each device being loosely coupled inductively whereby they produce inductance effects in the phantom circuit.

2. The combination with two physical cir-
85 cuits consisting of line conductors together furnishing a phantom circuit, of devices having windings included in the conductors of said physical circuits to produce induc-
90 tance effects therein, said devices being inductively independent, and the self inductances of the windings being effective in the phantom circuit.

3. The combination with two physical cir-
95 cuits consisting of line conductors together furnishing a phantom circuit, of an inductance device individual to one of the physical circuits and having a toroidal core and a diametric yoke, and a winding for each
100 conductor of the physical circuit extending about the toroid at each side of the yoke.

4. An inductance device comprising a core having primary portions and a connecting
105 portion, primary magnetizing windings upon the primary portions of the core, and auxiliary windings upon the connecting portion of the core.

5. An inductance device comprising a core having an outer portion forming a closed
110 figure and a portion connecting the sides thereof, primary magnetizing windings upon the outer portion of the core, and auxiliary windings for the magnetizing windings upon the connecting portion.

6. A loading coil comprising a toroidal core having a diametric yoke, inductance
115 windings upon the toroid, and an inductance controlling winding upon the yoke.

7. The combination with physical circuits
120 consisting of line conductors together furnishing a phantom circuit, of a loading coil comprising a toroidal core having a diametric yoke, primary inductance windings upon the toroid included in the conductors,
125 and an inductance controlling winding for each primary winding, said controlling windings being situated upon the yoke.

8. An inductance device comprising a magnetic core having winding portions and a portion connecting the junctions of the winding portions, a magnetizing winding
5 upon each of the first-named portions, and auxiliary windings associated with the core.
In testimony whereof, I have signed my

name to this specification, in the presence of two subscribing witnesses, this 27th day of September, 1915.

LLOYD ESPENSCHIED.

Witnesses:

CHAS. G. HEISER, Jr.,
A. C. FANCA.