June 2, 1931. H. P. DONLE 1,808,726

AUDIO FREQUENCY COUPLING

Filed May 9, 1928

Fig. 1.

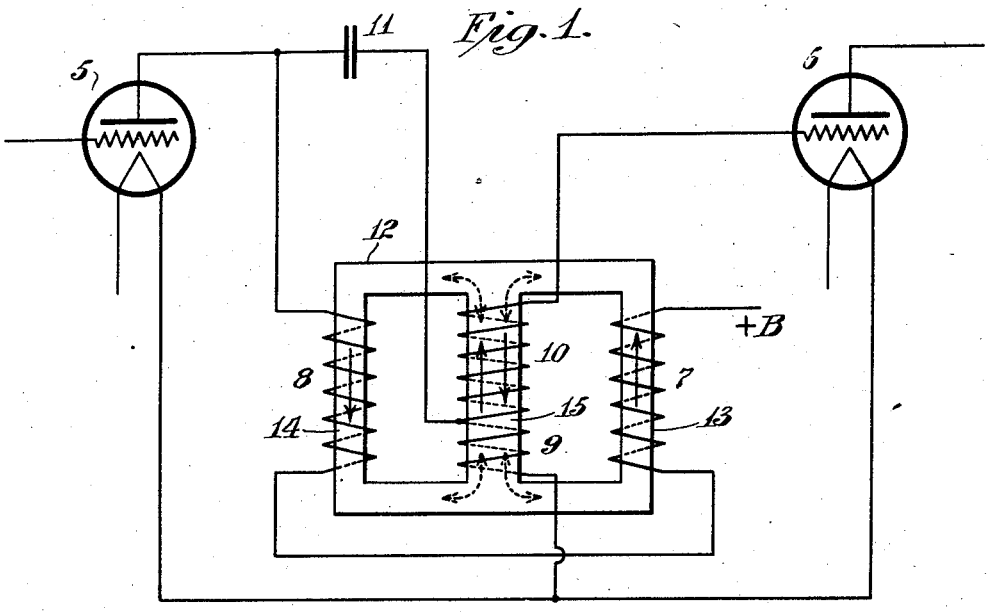
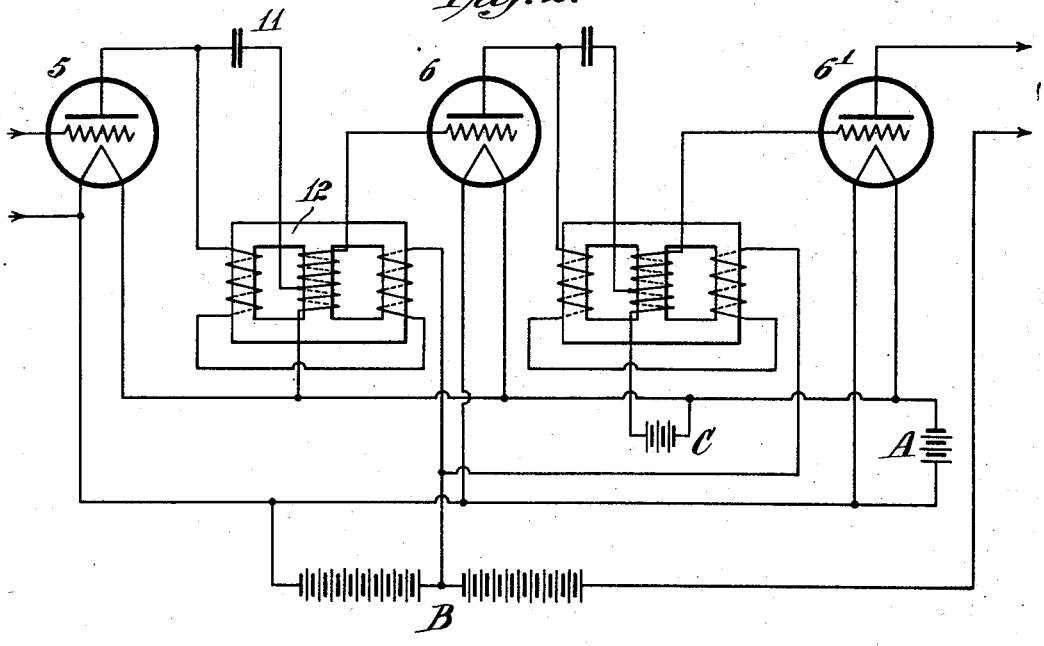


Fig. 2.



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UNITED STATES PATENT OFFICE

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AUDIO FREQUENCY COUPLING

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My invention relates particularly to multi-stage vacuum tube amplification systems.

The main object is to provide apparatus for coupling tubes to produce a maximum amplification throughout a wide range of frequencies and without distortion.

Another object is to provide a compact device which will have as high a degree of efficiency as possible for a minimum cost of construction.

A specific object is to utilize the magnetic core to a maximum degree.

I accordingly utilize a combination of impedance and auto transformer coupling with all of the coils mounted on a single closed magnetic core having a cross bar. The choke coil is formed of two similar parts mounted on opposite ends of the core and so connected that the lines of force in the cross bar are substantially balanced and the transformer is mounted on the cross bar so as to utilize the same magnetic core without being coupled to the choke coil. A condenser is inserted between the plate circuit of the first tube and the transformer at a point to provide a step-up ratio of say 1 to 7 or 8.

Fig. 1 shows one form of coupling device embodying my invention.

Fig. 2 shows one form of circuit with coupling devices according to my invention.

In Fig. 1 I have illustrated the coupling between two vacuum tubes 5 and 6 which may be of any suitable type. The inductive part of the coupling device includes the coils 7, 8, 9 and 10 and the capacitative part includes the condenser 11. The coils 7 and 8 constitute two substantially equal choke coils inserted in the plate circuit of the first tube. The coils 9 and 10 constitute two sections of an auto transformer which is connected in the grid circuit of the second tube. The condenser 11 is connected to a point between the coil sections 9 and 10 and to the plate circuit of the first tube.

The coils are all mounted on a core 12 which may be laminated and of material suitable for audio frequency transformers. The sections 7 and 8 are mounted on the opposite end bars 13 and 14 of the core and the sections 9 and 10 are mounted on the central cross bar 15 of the core. The coil sections 7 and 8 are so wound and connected that the magnetic flux produced by them in the central cross bar 15 is in opposite directions so that in effect the central cross bar is neutral so far as the magnetic effect of the coils 7 and 8 is concerned. The heavy arrows indicate the direction of the lines of force produced by the direct current in the choke sections.

The dotted arrows indicate the direction of the lines of force produced by the alternating current in the transformer.

Although the proportions and values of the various components of this coupling system may be varied considerably I have found satisfactory results may be attained by using a magnetic core the cross section of the end and side bars of which is say ½" square. The choke coil sections may each consist of six thousand turns and the auto transformer coil sections may consist respectively of three thousand turns and twenty thousand turns. A suitable condenser may have a capacity of say .02 mf. It should be understood however that I do not consider the invention as limited to these specific values.

In the diagram of Fig. 2 I have illustrated the invention as applied to two stages of audio frequency coupling. In this diagram I have also illustrated a biasing or C battery for the grid of the tube 6'. I also wish it to be understood that the A and B batteries illustrated are merely symbolic of any suitable source of current supply.

If the effect of the choke coils 7 and 8 is not balanced as above set forth there will be a residual magnetic effect upon the auto transformer which will affect its ratio.

By varying the capacity coupling for the various stages each may be adjusted to a maximum sensitivity.

The step-up ratio for the various stages may differ if desired.

I claim:

1. An audio frequency coupling device having capacitative and inductive elements for a vacuum tube amplifier, the latter consisting of a closed iron core having a central leg and two outer legs, windings upon said outer legs connected in series, said windings being so

directioned as to cause their magnetic paths to include substantially only the periphery of the core and serving to feed plate potential to the plate of the previous tube and a step-up auto transformer having windings carried by said central leg the input to said auto transformer being through said capacity element and having its output connected to the succeeding vacuum tube.

2. An audio frequency coupling device comprising a closed ferrous core having end bars and an intermediate bar, substantially equivalent windings mounted on the end bars, an auto transformer coil mounted on the intermediate bar and a condenser coupling between the windings on the end bars and the input to the transformer, the ratio of the two parts of the auto transformer being between 1 to 7 and 1 to 8.

3. An intertube coupling device having two choke windings for supplying direct current to the plate of a preceding tube and an auto transformer winding for transferring and stepping-up the alternating voltage from the plate circuit of the preceding tube to the grid circuit of the following tube, said windings being carried upon a single ferrous core and said windings being so directioned that substantially no coupling exists between the direct and alternating current windings, and capacity inserted between the plate of the first tube and the input to the auto transformer which supplies alternating current to the following tube.

4. A coupling device comprising two oppositely disposed choke coils adapted to be connected in series between the plate of one tube and the plate power supply, an auto transformer having its input terminals connected in series with a condenser between the plate of the first tube and the filaments and having its output terminals connected between the filament and the grid of the next tube and a single core structure for the choke and transformer coils so constructed and arranged that there are no substantial common flux linkages or energy transfer between the choke coils and the auto transformer.

5. An audio frequency coupling device comprising a closed core having end and intermediate bars with substantially equal choke coils on the end bars and an auto transformer coil on the intermediate bar together with a capacitative coupling between the choke coils and the transformer coil.

6. A multi-stage audio frequency amplifier system including relay elements and inductive and capacitative coupling between said elements said inductive coupling comprising choke and auto transformer coils having a common magnetic core, the choke winding being divided into two substantially equal parts and the transformer winding being divided into two unequal parts the capacitative coupling being connected at one end between the parts of the transformer winding and being connected at its other end between the choke coil and the plate of the preceding tube.

7. An audio frequency coupling comprising two choke windings each having approximately six thousand turns and a transformer winding consisting of approximately twenty-four thousand turns and a magnetic core common to the choke and transformer windings together with a capacitative coupling connected between one end of the choke and at a point intermediate the ends of the transformer winding such that the step-up ratio is approximately 1 to 7.67.

HAROLD P. DONLE.