April 19, 1932. W. L. CARLSON 1,854,884

ELECTRICAL COMMUNICATION

Original Filed Sept. 21, 1922

Fig. 1

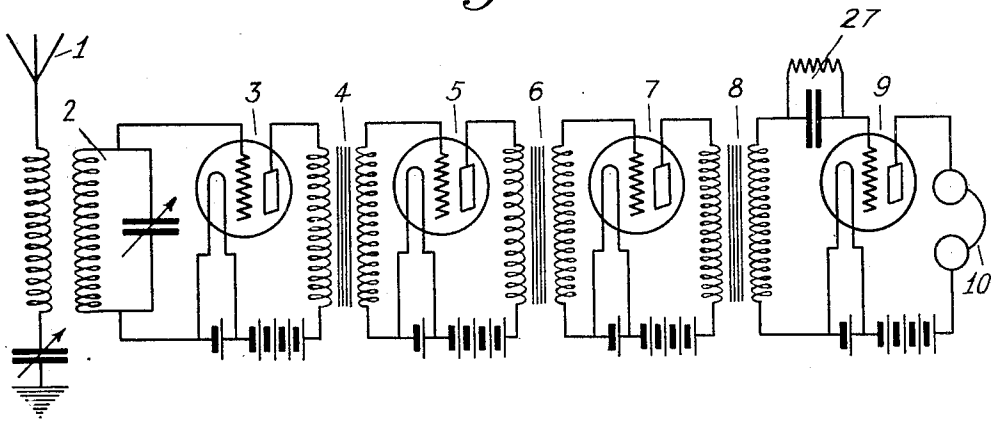


Fig. 2

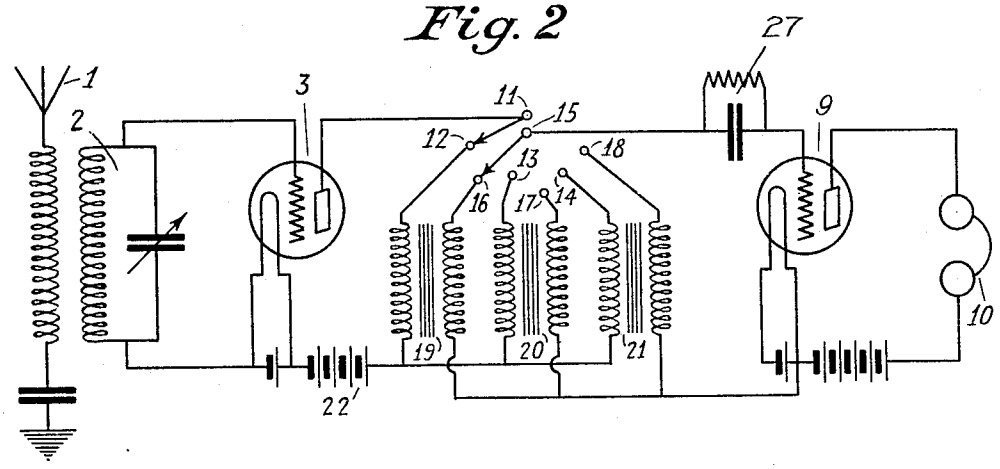
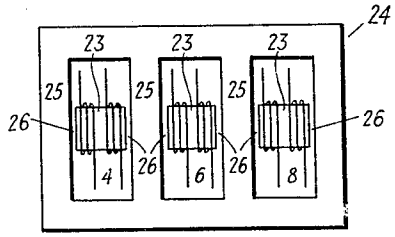


Fig. 3



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UNITED STATES PATENT OFFICE

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ELECTRICAL COMMUNICATION

Original application filed September 21, 1922, Serial No. 589,726. Patent No. 1,649,098, dated November 15, 1927. Divided and this application filed June 22, 1926. Serial No. 117,714.

This invention relates to electrical communication and more particularly to amplifiers used in the reception of electrical signals.

This application is a division of my prior copending application Serial No. 589,726 filed Sept. 21, 1922, patented November 15, 1927, as U. S. Patent No. 1,649,098.

The object of this invention is to embody certain new combinations in the construction of a plurality of iron core inter-valve amplifier transformers in a unit of extreme compactness.

A further object is to provide a construction which will greatly reduce the manufacturing cost of a plurality of intervalve amplifier transformers.

My invention is especially adapted for use in radio frequency transformers and will be described as such herein, but it is to be understood that the invention is broad enough to cover audio frequency transformer constructions as well.

Heretofore it has been customary to construct individual transformers for each stage of a cascade thermionic vacuum tube amplifier. I propose to assemble the various transformer windings of a cascade amplifier all in one iron core shell in such a way that part of the iron magnetic path will be common to adjacent windings.

In other cases where the amplifier is to operate over an extremely wide range of frequencies, I intend to design the individual windings in the transformer units differently, though employing one shell, and to connect their leads to a suitable switch so as to connect alternately the proper transformer with the amplifier circuit to operate on the particular frequency range it is designed for.

Referring to the drawings, Fig. 1 is a radio receiving circuit employing three radio frequency stages of amplification and a detector. Fig. 2 is a radio receiving circuit employing one radio frequency stage of amplification and a detector tube with three radio frequency transformers each designed to operate over a different frequency range. Fig. 3 is a plan view of three radio frequency transformers disclosing the arrangement of the iron core and windings as employed in Figs. 1 and 2.

In Fig. 1 the tuned antenna circuit is designated by numeral 1 which is coupled to a secondary tuned circuit 2 which in turn connects to the input of the amplifying thermionic vacuum tube 3. The output of tube 3 is coupled through the radio frequency transformer 4 to the input of amplifying tube 5. The output of the tube 5 is in like manner coupled to the input of the third amplifying tube 7 through the transformer 6. Transformer 8 couples the output of tube 7 to the input of a detector tube 9 which has a telephone receiver 10 connected in its output circuit.

The antenna circuit 1 in Fig. 2 is coupled to the secondary tuned circuit 2 which connects to the input of the amplifying tube 3. The plate lead of tube 3 connects to a switch arm 11 which makes contact with points 12, 13 and 14 alternately as the arm is rotated at the will of the operator. In like manner switch arm 15 is rotated simultaneously with arm 11 to make contact with points 16, 17 and 18. The primary windings of transformers 4, 6 and 8 are connected at one end respectively to the contact points 12, 13 and 14 and the other ends known as the low potential terminals are connected to a common terminal and to the plate battery 22. The secondary windings of transformers 4, 6 and 8 are connected at their high potential ends to contact points 16, 17 and 18 and their low potential ends are connected commonly to the filament of detector tube 9. The grid of tube 9 connects through stopping condenser and grid leak unit 27 to the switch arm 15. Telephone receiver 10 is connected in the output circuit of tube 9.

In Fig. 3 the radio frequency transformers 4, 6 and 8 in Fig. 1 or Fig. 2 are shown as they are constructed in the transformer unit. Each individual transformer has its own primary and secondary winding wound on a small laminated iron core plug 23. The laminated iron shell 24, having legs 25, completes the magnetic path around the coils thus forming what is generally known as shell type transformers. A certain degree of air gap

26 is usually allowed between each core plug 23 and each leg 25 so as to reduce the iron losses and regulate the permeability of the magnetic path.

The operation of the circuit in Fig. 1 is so well known in the art that it need not be dwelt on extensively here, it being sufficient to say that the radio frequency carrier wave of the incoming signal is amplified through the three vacuum tubes 3, 5 and 7 and that the modulating component of the carrier frequency actuates the telephone receiver 10 due to the rectifying action of the detector tube 9. It has heretofore been thought that magnetic coupling between adjacent individual transformers in the construction herein disclosed would create local oscillations in the accompanying tube circuits. In practical tests it has been found that the stray magnetic coupling obtained with such a transformer construction on short wave lengths is practically negligible insofar as creating local tube oscillations is concerned. If on low radio frequencies or audio frequencies it is found that due to the greater penetration of the magnetic field in the iron that coupling between the adjacent individual transformers creates troublesome effects, then by properly connecting the adjacent windings of the transformers, i. e., all windings in same direction, the oscillating tendency of the circuit can be eliminated.

The operation of the circuit in Fig. 2 is identical to the operation of circuit in Fig. 1 except that only one amplifying tube 3 is employed in conjunction with the individual transformers 4, 6 and 8 and the detector tube 9. The successive individual transformers 4, 6 and 8 are designed to cover different wave length ranges, i. e., they differ in construction in the number of turns and air gaps 26 between the legs 25 and plugs 23, and by switching to the proper transformer good amplification can be had over the range which the transformer is designed to cover. While one radio stage is shown in this circuit it is obvious that any practical number of stages with a corresponding number of transformer units can be employed.

Having described my invention, I claim:

1. The combination in an amplifying system of a plurality of electron discharge amplifiers connected in cascade and an iron core having mounted thereon a plurality of sets of transformer windings, said transformer windings serving to connect the output circuits of a plurality of amplifiers to the input circuits of a plurality of amplifiers.

2. The combination in an amplifying system of a plurality of electron discharge amplifiers connected in cascade and an iron core having mounted thereon a plurality of sets of transformer windings, said transformer windings serving to connect the output circuits of a plurality of amplifiers to the input circuits of a plurality of amplifiers, and adjacent windings of said transformers being arranged to prevent coupling between successive stages at low radio frequencies.

3. The combination in an amplifying system of a plurality of electron discharge amplifiers connected in cascade and an iron core having mounted thereon a plurality of sets of transformer windings, arranged for amplifying different frequency bands said transformer windings serving to connect the output circuit of an amplifier which is connected to amplify radio frequency currents to the input circuit of another amplifier and switching means for selecting either of said sets of windings.

4. The combination in an amplifying system of a plurality of electron discharge amplifiers connected in cascade and an iron core having mounted thereon a plurality of sets of transformer windings, adjacent windings of said sets being wound in the same direction, said transformer windings serving to connect the output circuits of a plurality of amplifiers to the input circuits of a plurality of amplifiers at least one of said amplifiers being connected to amplify radio frequency currents of a received signaling frequency.

5. In a signalling system, at least three amplifiers each having input and output circuits, means for impressing a signal wave on the input circuit of the first amplifier, a pair of transformer windings for coupling the output circuit of the first to the input circuit of the second amplifier, a second pair of transformer windings for coupling the output circuit of the second to the input circuit of the third amplifier, said pairs of windings being wound in such direction as to prevent coupling between successive amplifiers at the lower frequency band a structure of magnetic material comprising a common portion for the flux paths of both said pairs of transformer windings and means coupled to the output circuit of said third amplifier.

6. The device of claim 5 in which both pairs of transformer windings are wound to give maximum response at the same frequency.

7. A signalling system comprising a pair of vacuum tube amplifiers each having an input and an output circuit, the output circuit of one of said amplifiers comprising a pair of windings having different impedances and the input circuit of said other amplifier comprising a pair of windings having different impedances and means for selectively coupling either of the windings of said first named amplifier with a winding in the input circuit of said second named amplifier.

8. A signalling system comprising a pair of vacuum tube amplifiers each having an input and an output circuit, two impedances of different value, means for including either of said impedances in the input circuit of one

of said amplifiers and means for coupling the output circuit of said other amplifier with the included impedance.

9. In an amplifying system, a plurality of cascade thermionic amplifiers, means for coupling the output elements of an amplifier to the input elements of another amplifier including a plurality of transformer primaries and secondaries on a common magnetic core and means for connecting a selected primary between the output elements of an amplifier and a selected secondary winding between the input elements of another amplifier.

10. In combination, in an electrical transmission system, a plurality of electron discharge tubes connected in cascade, each of said tubes including an input and output circuit, an iron core, a plurality of sets of transformer windings mounted on said core, at least one of said sets of windings serving to connect the output circuit of one tube to the input circuit of another tube, adjacent windings of said sets being arranged to prevent coupling between successive tubes at low frequency.

11. In combination, in a radio receiver, a plurality of electron discharge tubes connected in cascade, said tubes each including an input and output circuit, an iron core, a plurality of sets of radio frequency transformer windings mounted on said core, at least one of said sets of windings serving to connect the output circuit of one tube to the input circuit of another tube, the adjacent windings of all of said sets being so arranged on said core that part of the iron magnetic path thereof is common to said adjacent windings.

June 18th, 1926.

WENDELL L. CARLSON.