

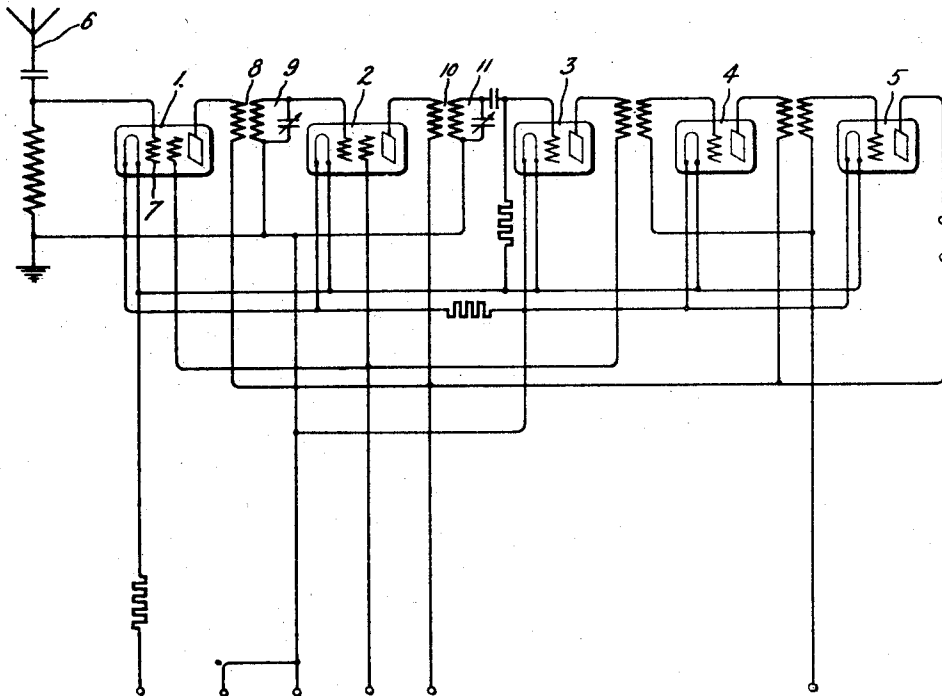
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RADIO FREQUENCY AMPLIFICATION

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UNITED STATES PATENT OFFICE

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RADIO-FREQUENCY AMPLIFICATION

Application filed April 7, 1928. Serial No. 268,358.

Our present invention relates to systems for the amplification of radio frequency currents, and more particularly to systems involving the use of a plurality of electron discharge amplifiers connected in cascade.

The object of our invention is to provide an amplifying system adapted to amplify a considerable range of frequencies such, for example, as the range of frequencies used in broadcasting, extending from about 550 kilocycles to 1500 kilocycles, which will be capable of giving a substantially uniform degree of amplification over the entire operating range.

Difficulty is experienced in providing an amplifying system to cover such a wide range of frequencies which will give the same amount of amplification for the lower frequencies of the range as for the higher, or vice versa, as the coupling arrangements which are used between successive amplifying devices tend to give a much more efficient energy transfer at one frequency than at another. To overcome this difficulty in accordance with our invention, we provide energy transfer means between different devices which have different frequency characteristics. For example, we provide a transformer between the output circuit of one device and the input circuit of the succeeding device, which is most effective at the higher frequencies of the range and a second transformer between the output circuit of the second device and the input circuit of a third device, which is most efficient at the opposite end of the frequency range. By suitably correlating these devices we are able to obtain a substantially uniform degree of overall amplification throughout the entire frequency range for which the apparatus is intended to operate.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention, itself, however, both as to its organization and method of operation will best be understood by reference to the following specification taken in connection with the accompanying drawing in which we have

shown diagrammatically a circuit organization to which our invention is applied.

We have indicated in the drawing two radio frequency amplifying devices 1 and 2 of the screen grid type a detector 3 and two audio amplifiers 4 and 5, the detector and audio amplifiers being of the ordinary three-electrode type. The radio frequency currents to be amplified are received upon the antenna 6 and impressed upon the control grid 7 of the amplifying transformer 8 for supplying energy to the tunable input circuit 9 of the device 2. A transformer 10 connected in the output circuit of the device 2 supplies energy to the tunable input circuit of the device 3.

The transformer 8 may have a substantially one to one ratio of primary and secondary turns closely coupled and this transformer is most effective at the higher frequencies to be amplified. The second transformer 10, on the other hand, may have a primary winding of high inductance made up of a large number of turns coupled to a secondary winding of much fewer turns. This primary winding may be so designed that it has a resonant frequency near or below the lowest frequencies of the frequency range which is to be amplified. Under these circumstances the energy transfer will be most efficient at the lower frequencies. The total amplification of the two devices is equal to the product of the individual amplifications of the separate devices and by proper design of the transformers this product may be made to be substantially constant over the entire operating range.

As an example of the manner in which transformers described above may be constructed for utilization to cover the broadcast range of frequencies, I have obtained satisfactory results with the transformer 8 made as follows:

Secondary, 85 turns of .0126" D. S. wire on 1½" tubing;

Primary, 84 turns of .0126" D. S. wire with one layer of .002" paper separation. Both coils were wound in the same direction, and the grid and plate connections were made to adjacent ends.

The transformer 10 was made as follows:

Secondary, 85 turns of .0126" D. S. wire on 1½" tubing;

Primary, 650 turns of .005" B. & S. wire, universal wound on ⅜" core, ¼" wide. The primary coil was mounted so that its lower edge was just even with the top of the secondary winding, with the polarity such that, with the plate of the preceding tube connected to the outside end, the direction of winding when followed through from the plate was opposite to that of the secondary when followed through from the grid.

With the four-element screen grid electron discharge device one of the most important factors in determining the amplification ratio is the impedance of the output circuit, and this is dependent to a large extent upon the impedance of the input circuit of the succeeding device and the manner in which the coupling is arranged. In the case of device 1 the impedance of the tuned input circuit 9 is introduced very effectively into the output circuit, but the impedance in the output circuit of device 1 is materially higher at the high frequencies than at the lower frequencies. Hence the ratio of amplification obtained by device 1 is materially greater at the higher frequencies than at the low frequencies. The term "amplification ratio" is here used to indicate the ratio between the alternating current voltages on the grids of devices 1 and 2.

In the case of the transformer 10, the fact that the output circuit itself is near resonance at the lower frequencies causes the greatest transfer of voltage at the low frequency end of the range, for, although the impedance of the tunable input circuit 11 is greatest at the high frequencies, the natural period of the primary circuit and the conditions of coupling as above mentioned do not permit this high impedance to be effectively transferred to the plate circuit of the tube. Hence the transformer 10 has the characteristic that the amplification ratio obtained by its use decreases as the frequency increases.

While we have shown and described only one embodiment of our invention it will be apparent that many modifications in the circuit connections and arrangement and design of the coupling transformers may be made without departing from the scope of our invention as set forth in the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. The combination in a radio frequency amplifying system adapted to amplify radio frequency currents over a specified range of frequencies, of a plurality of electron discharge amplifiers connected in cascade, each having an output circuit connected to a tunable input circuit of a succeeding device, a transformer connected in the output circuit of one of said devices having a primary wind-

ing the resonant frequency of which is below the lowest frequency of said frequency range, and a transformer connected in another of said output circuits having a primary winding the resonant frequency of which is above the highest frequency of said frequency range.

2. The combination in a radio frequency amplifying system adapted to amplify radio frequency currents over a specified range of frequencies, of a plurality of electron discharge amplifiers connected in cascade, each having an output circuit connected to a tunable input circuit of a succeeding device, a transformer connected in the output circuit of one of said devices having a primary winding the resonant frequency of which is below the lowest frequency of said frequency range, and a transformer connected in another of said output circuits having a primary winding the resonant frequency of which is above the highest frequency of said frequency range, whereby the over all amplification of the system is substantially constant over the entire operating range of frequencies.

In witness whereof, we have hereunto set our hands this 6th day of April, 1928.

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