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HIGH FREQUENCY TRANSLATING CIRCUITS

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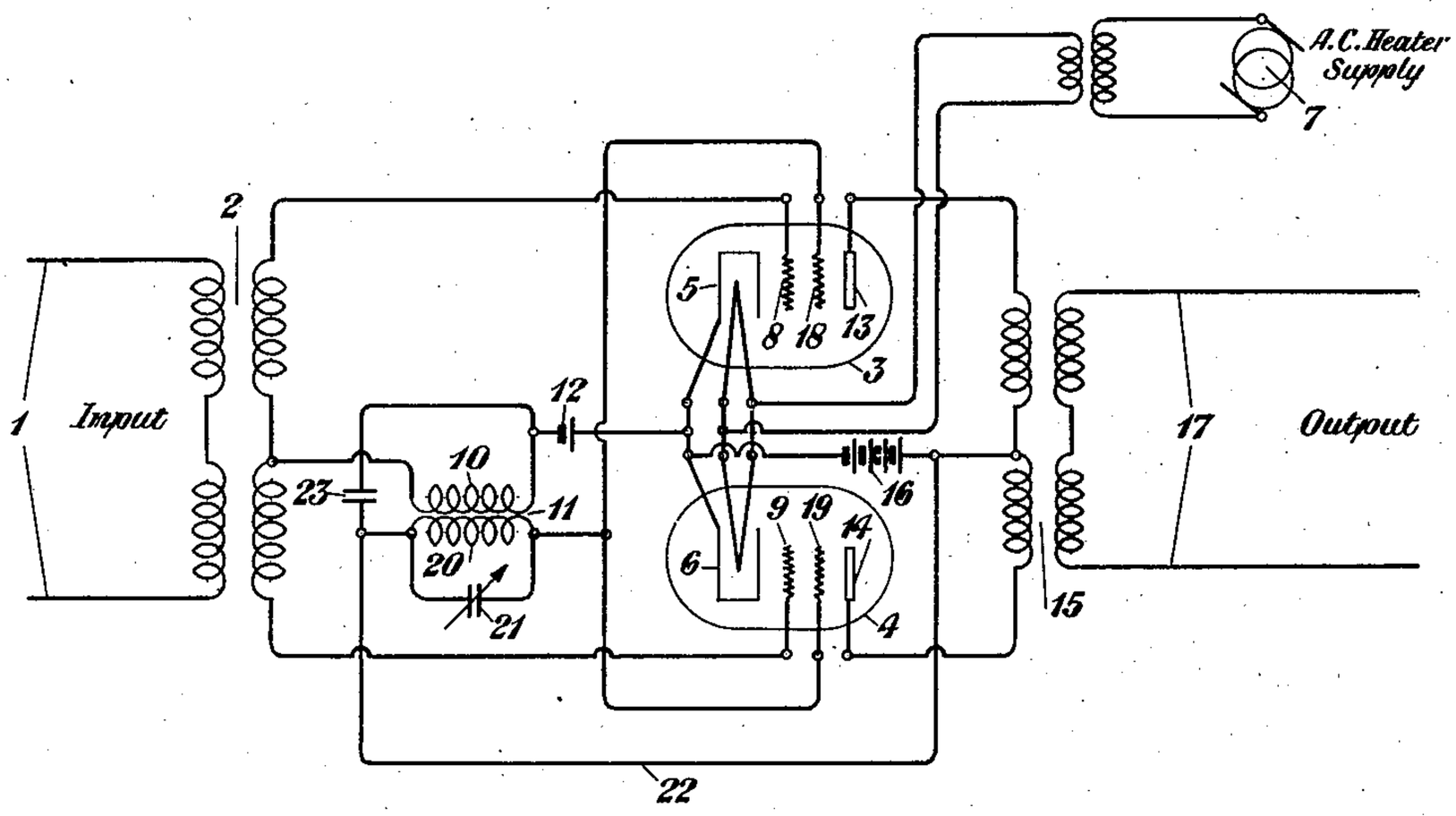

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HIGH-FREQUENCY TRANSLATING CIRCUITS.

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This invention relates to high frequency translating systems and particularly to a balanced oscillator-modulator or demodulator characterized by the use of multi-grid unipotential cathode vacuum tubes, and suppression of the carrier frequency.

Balanced oscillators and modulators or demodulators have been designed and used in the radio and carrier art but in all of the arrangements of the prior art three-electrode tubes have been employed. In these circuits of the prior art the same input and output circuit must perform not only the function of creating oscillations but also the function of modulating the oscillations as thus created by other oscillations. Since the same circuits are employed for different functions it is impracticable to make the impedance of these circuits of such value as to be efficient for one function without tending to render them inefficient to carry out the other function. Accordingly, with circuits of the prior art it is necessary to adopt a value of impedance that will give fair results in carrying out both functions. In my copending application, Serial No. 757,017, filed December 19, 1924, I have described a multi-grid unipotential cathode tube and have shown the method of using a tube of that type in an amplifying circuit whereby different degrees of amplification may be produced. I have found that by using a tube of the type therein described in a balanced oscillator-modulator or demodulator circuit it is practicable to attain high efficiency for each of the functions produced by the device.

This invention resides in a balanced translating device of high efficiency capable of producing oscillations and of modulating or demodulating other oscillations by those created therein.

This invention will be apparent from the following description, read in connection with the attached drawing, showing schematically a form of the invention.

In the drawing, the input circuit 1 is coupled with the translating circuit by means of the transformer 2. This input circuit is designed to impress upon the translating circuit either frequencies intended to modulate the oscillations generated by the translating circuit or frequencies intended to be demodulated by beating with the oscillations created by the translating circuit. The translating circuit includes two multi-grid unipotential cathode vacuum tubes 3 and 4, which are of the type described in the copending application referred to hereinbefore. The cathodes of these tubes are rendered electron-emitting by radiation of heat from the heating elements associated therewith, which heating elements are energized by alternating current from the source 7. One terminal of the secondary winding of the transformer 2 is connected with the grid 8 of the tube 3 and the other terminal of this winding is connected with the grid 9 of the tube 4. The midpoint of this winding is connected with the cathodes 5 and 6, the connection including the winding 10 of the coupling transformer 11 and the negative biasing battery 12. In like manner, each of the plates 13 and 14 of the tubes 3 and 4 is connected through one half of the primary winding of the transformer 15 with both of the cathodes, the connection including the source of plate potential 16. The secondary winding of the transformer 15 is connected with the output circuit 17. The grids 18 and 19 are connected together with the positive pole of the source 16 of plate potential, the connection including the tuned circuit made up of the inductance of the winding 20 and the capacitance of the condenser 21. It should be noted that the positive potential of the source 16 is connected not only to the plates 13 and 14 but also through the conductor 22 and the tuned circuit 20—21 with the grids 18 and 19. This is important to bear in mind because it helps to understand the subsequent action of the tube. A by-pass condenser 23 for high frequency currents is connected from conductor 22 with the negative side of the biasing battery 12.

The energization of the heating elements associated with the cathodes of the tubes will result in electronic emission by these cathodes and the electrons will flow to the positively charged electrodes, viz, the grid 18 and the plate 13 of the tube 3 and the grid 19 and the plate 14 of the tube 4. Considering the oscillating function of the tube, current will flow from the grid 18 to the

cathode 5 of the tube 3 and from the grid 19 to the cathode 6 of the tube 4. As in balanced circuits employing three-electrode tubes, each tube of the four-electrode type has an input circuit which may be considered as extending from the cathode to the grid of each tube, each circuit including one-half of an input impedance which in ordinary practice in half of a secondary winding of the input transformer. Since the cathodes are strapped together and are connected with the midpoint of this secondary winding, the negative biasing battery is inserted in this common conductor, as also is one of the windings of the coupling transformer by means of which the feeding back of the oscillations is effected when the translating circuit functions as an oscillator. There are two output circuits, one of which functions in the generation of oscillations, and the other of which functions in the modulation and demodulation of oscillations. The output circuit of the generator may be considered as extending from the positive pole of the source of plate potential 16 over conducton 22, through the resonant circuit made up of the winding 20 and the condenser 21, to the grids 18 and 19, thence to the cathodes 5 and 6 respectively, to the negative pole of the source 16. This circuit is coupled with the input circuit through the transformer 11. The grids 18 and 19 having positive potential applied thereto by the source 16 will produce electron flow through the tubes between the said grids and their cathodes, which flow will produce a current through the winding 20, which in turn will cause a variation of the current through the winding 10, thereby varying the charge upon the grids 8 and 9. This action is, of course, the same as in generators of the prior art. These oscillations, which are fed back to the input circuit, will combine with the oscillations impressed upon the input circuit by the circuit 1, which oscillations would probably be of different frequency, as in heterodyning. The oscillations of the two frequencies would then be impressed upon the grids 5 and 6, thus producing variations in the space current between the plates 13 and 14 and the cathodes 5 and 6 respectively, which variations would be manifested in the output circuit 17 as a current the frequency of which would be dependent upon the frequencies beaten together within the modulating device. The ability to employ separate output circuits for the oscillating and the demodulating (or modulating) function, which is rendered practicable by having separate anodes in each tube, renders it possible to operate the tube so as to obtain the maximum efficiency as an oscillator and as a modulator or demodulator by virtue of the fact that the impedance of each output circuit may be fixed at whatever value is necessary in order to produce the maximum efficiency of the translating circuit for each function.

A further advantage of the circuit shown arises from the use of unipotential cathode tubes which renders it practicable to employ a source of alternating current as, for example, a house lighting system, to render the cathodes electron-emitting.

While this invention has been disclosed as embodied in a particular form it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In an oscillating-modulating device the combination with a pair of tubes each having an electron-emitting cathode, a plate, a main grid and an auxiliary grid, an input impedance having each terminal connected with the main grid of each tube and having its midpoint connected with the cathodes of both tubes, the connection including a negative biasing battery and one winding of a feed-back transformer, an output impedance having each terminal connected with the plate of each tube, a source of potential having its negative pole connected with both cathodes and having its positive pole connected with the midpoint of said output impedance and with the auxiliary grid of each tube, the latter connection including a resonant circuit comprising another winding of the feed-back transformer shunted by a condenser, the said resonant circuit being tuned to the desired beating frequency.

2. In a balanced translating circuit the combination with an input circuit of an output circuit, a balanced translating circuit, a transformer connecting the said input circuit with the said translating circuit, a second transformer connecting the output circuit with the said translating circuit, the said translating circuit containing two tubes each having a cathode, means to heat the said cathode, an anode, a main grid and an auxiliary grid, a source of direct current potential having its positive pole connected with the anode of each tube and also with the auxiliary grid of each tube, a negative biasing battery connected between both cathodes and the main grid of each tube, and a coupling transformer having one winding connected between the said source of direct current potential and the said auxiliary grid and the other winding connected between the said negative biasing battery and the said main grid.

3. In an oscillating-modulating device, the combination with a plurality of vacuum tubes each having a unipotential cathode, a plate, a main grid, an auxiliary grid, and means to render the said cathode electron-emitting, an input circuit for each tube, a

negative biasing battery common to both input circuits, an output circuit for each tube, a source of plate potential connected with the plates of each tube and also with the auxiliary grids of each tube, and a feedback transformer having one winding connected between the said source of plate potential and the said auxiliary grid and the other winding connected in the common conductor of the input circuits of the said tubes.

In testimony whereof, I have signed my name to this specification this 23rd day of December, 1924.

WILLIAM H. T. HOLDEN.