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SHORT WAVE TRANSMITTER

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Fig. 1a

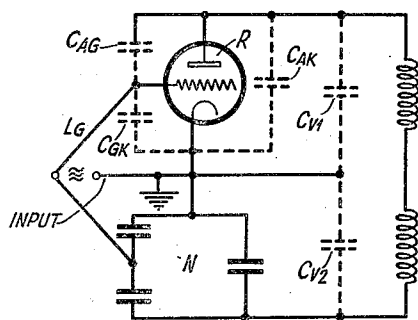


Fig. 1b

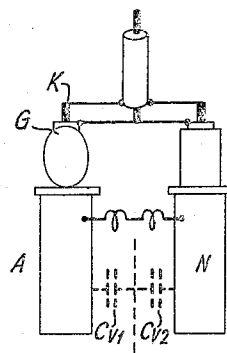


Fig. 2a

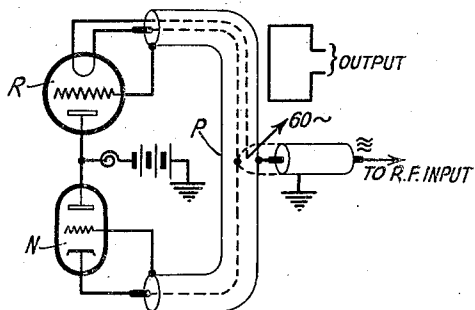


Fig. 2b

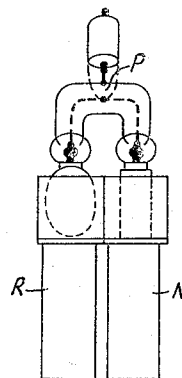
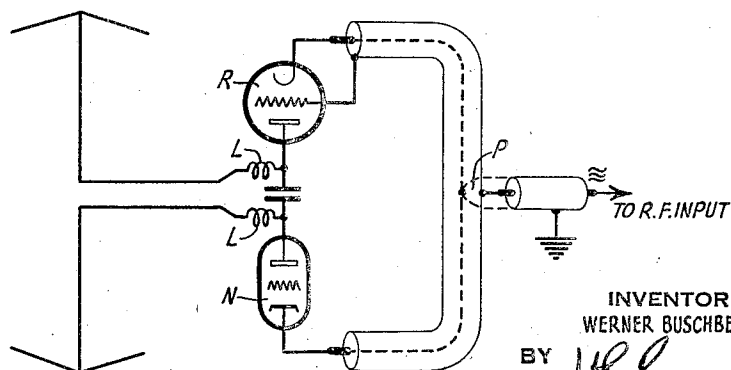


Fig. 3



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SHORT WAVE TRANSMITTER

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14 Claims. (Cl. 179—171)

In the construction of transmitters for short waves and more particularly for ultra-short waves, there is encountered the difficulty that the dimensions of the transmitter tubes which increase with an increase in power, enhance the capacities. Before enlarging upon the principle of the invention, whose object resides in reducing these capacities, the difficulties existing will be further explained in the following.

If the capacities are high, the inductances of the oscillatory circuits must be chosen correspondingly low, in order to arrive at sufficiently short waves. This entails various disadvantages resulting from the fact that at an increase in the capacity the blind power, i. e., wattless volt-amperes, increases. The larger blind currents, i. e., those components of current whose phase is in quadrature with the voltage, entail higher losses, since the transmitter for structural reasons cannot be dimensioned at all places with a view to obtaining a loss-free conduction of the larger currents. Hence, the efficiency obviously decreases in this case, which requires a correspondingly larger transmitter to attain a predetermined power, which condition again increases the difficulties.

In transmitters with wide modulation bands (television transmitters), the high blind power, i. e., wattless volt-amperes, causes a further disturbance in view of the fact that the damping becomes too low, for which reason the entire band width cannot be transmitted. The reason for this lies in the fact that owing to the blind resistance (i. e., reactance), the damping is equal to the effective resistance. (Hereby the term "effective resistance" is understood to be the entire ohmic load considered inserted as series resistance in the oscillatory circuit.) Through multiplication of the two resistances with the square of the current of the oscillatory circuit there is:

$$\text{damping} = \frac{\text{effective power}}{\text{blind power}}$$

An increase in power by increasing the direct plate potential has its limitation, since the damping will be too greatly decreased, thus making it impossible to attain a sufficient band width. The cause of this resides in that at increased direct plate potential, it is necessary in order to attain a high alternating plate potential at the same current, to increase the outer resistance, i. e., to loosen up the load coupling. The useful power then increases in proportion with the direct plate potential. However, since the blind resist-

ances (i. e. reactances) have not been changed, the blind power (i. e. wattless power) increases with the square at an increase in the plate potential.

It can be seen from the above equation that the damping in this case undergoes a linear decrease. But such reduction in the damping is not permissible at a large band width.

The only possibility of reducing the blind power (i. e. wattless power) at a given potential resides in the reduction of the capacity of the oscillatory circuit. There is a limit to such an attempt, at least so far as the inner capacities of the tubes are concerned, in view of the natural dimensions of the tube which cannot be reduced beyond a certain degree.

In accordance with the invention, a transmitter for short waves and more especially for ultra-short waves is arranged in such manner that in order to reduce the capacity of the oscillatory circuit, the anode of the tube and the anode of the duplicate (dummy, i. e., corresponding electrode of an artificial network) serving for neutralization, are directly connected to each other or across a capacitance, and the grid line and cathode lines are concentrically arranged, with the grid line especially at the outside, and the control energy and heating energy are supplied at the symmetrical point of these lines between tube and duplicate.

A detailed description follows, accompanied by a drawing wherein, for a better understanding of the invention, the conventional circuit and structure of an ultra-short wave transmitter are shown in the Figs. 1a and 1b, Fig. 1a showing the circuit arrangement and Fig. 1b the mechanical constructional features; while Figs. 2a and 3 show circuit embodiments of the invention, Fig. 2b showing the mechanical constructional features of the circuit of these last two figures.

Referring to Figs. 1a and 1b, at the side of the tube R, and also at the side of the duplicate (dummy tube) N serving for the neutralization, there are placed the unavoidable inner tube capacities C_{AG} and C_{AK} and furthermore the distributed outer capacities C_{V1} and C_{V2} , which especially in water cooled tubes whose anodes take up considerable space, assume considerable values coming near the order of the inner capacities. In order to exclude these outer capacities, attempts have already been made to build tubes with inner anodes, but hitherto no practical result has been achieved owing to difficulties in construction. When using the invention, the same advantage will be obtained with

ordinary three electrode tubes, i. e., tubes having an inner cathode and an outer anode, in that in the circuit arrangement the plate is brought completely or almost completely to ground potential. This is accomplished in that contrary to the usual methods, the tube and duplicate thereof serving for neutralization instead of being connected together at their cathode sides, have the anodes connected together either directly or across a low blind resistance (Figs. 2a, 2b, 3).

Through this measure, however, ordinarily the entire grid circuit including its energy line which is usually of considerable length would be brought to high frequency potential relative to ground, which certainly would involve much higher distributed capacities than in the case of the ordinary circuit. In accordance with an important feature of the invention, the grid and cathode lines are therefore constructed concentrically to each other with the cathode line as the inner line, so that the alternating potential at the grid of the tube will be transmitted to the cathode with exactly the same value relative to ground. In view of this condition, the alternating grid potential and also the heating potential can be applied to the equi-potential point P corresponding to the point in which the anodes are connected together. An exactly identical transmission of voltage can only then be fully achieved when the grid line through which flows the total current of the oscillatory circuit, surrounds the cathode line, since in the reverse case not all magnetic field lines of the grid line surround the cathode line.

The desired wave is obtained by varying the length of the bend-like connection line between the grids of the tube and the duplicate arrangement, and eventually winding this line into a coil. For the purpose of wave adjustment the bent connection can furthermore be adapted for lengthening in the manner of a trombone.

In principle, it is immaterial whether the actual grounding is carried out at the anode surface, or at the center point P of the cathode line located within the grid line.

The useful energy can be derived either solely by means of transformation from the field of the grid line, or in a capacitive fashion according to Fig. 3, by means of the coupling capacity connected between the two anodes, and which is suitably high as compared with the inner tube capacity. Since this coupling capacity is connected in series with the grid and plate capacities, it also affords the advantage of reducing the capacity of the oscillatory circuit.

In order to avoid unnecessarily increasing the blind energy through the capacitive coupling, the effective plate resistance is suitably so transformed that it appears at the transmitter as a possibly low ohmic resistance thus requiring only a low coupling voltage. Hence, a high coupling capacity can be chosen. Since in order to obtain a maximum output energy a definite alternating plate current is required, the blind energy is low at a high coupling capacity, due to the series connection.

The stepping down may be carried out suitably in the following manner: By means of a power line which is symmetrical to ground and matched to the antenna, the latter is brought near the transmitter up to a distance that is equal to an electrical length of

$$\frac{\lambda}{4}, \frac{3\lambda}{4}, \left(\frac{2n+1}{4}\right)\lambda$$

i. e., an odd multiple of a quarter wave length.

This piece of the energy line shall have a lower wave resistance (i. e., surge impedance) W_2 than the energy line situated at the antenna side and having the wave resistance (i. e., surge impedance) W_1 . Since the antenna together with the actual energy line (hence without the additional part of the energy line) was matched to the transmitter, the input resistance at the transmitter thus remains a purely ohmic resistance and has the value

$$R = \frac{W_2^2}{W_1}$$

which is always lower than W_1 . In rendering the wave resistance of this short energy line variable, the respective optimum impedance matching can be easily achieved (for instance in the case of two parallel wires through varying the distance therebetween). Obviously, if necessary, the capacitive coupling resistance can be compensated by means of two corresponding inductances L.

It will be easily understood that push-pull arrangements may likewise be constructed in the manner set forth, in that two tubes and two duplicate arrangements are provided. It will also be understood, of course, that the term "network" used in the appended claims includes a dummy tube or any suitable arrangement of reactances simulating the characteristics of a dummy tube.

What is claimed is:

1. In combination, an electron discharge device having a grid, cathode and plate, a neutralization dummy tube also having a grid, cathode and plate, a connection between said two plates; a concentric transmission line having an inner and an outer conductor, connections from said grids to opposite ends of said outer conductor, connections from said cathodes to opposite ends of said inner conductor, whereby said line and the connections between said plates form part of an oscillatory circuit, and means for applying radio frequency input potentials to said transmission line at points thereon which are symmetrically located between said device and dummy tube.

2. In combination, an electron discharge device having a grid, cathode and plate, a neutralization dummy tube also having a grid, cathode and plate, a connection between said two plates, a concentric transmission line having an inner and outer conductor, connections from said grids to opposite ends of said outer conductor, connections from said cathodes to opposite ends of said inner conductor, whereby said line and the connection between said plates form part of an oscillatory circuit, and means for applying heating energy for the cathode of said device, and radio frequency energy for said grid of said device to points on said transmission line which are at low radio frequency potential and symmetrically located with respect to said device and dummy tube.

3. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a

conductor arranged concentrically within said hollow conductor, and an input circuit coupled between a point of low radio frequency potential on said hollow conductor and a point on said inner conductor.

4. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, means for maintaining the connection between the anode of said device and the corresponding element of said network at a radio frequency potential which is low relative to the radio frequency potential of the cathode, the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a conductor arranged concentrically within said hollow conductor, and an input circuit coupled between a point of low radio frequency potential on said hollow conductor and a point on said inner conductor.

5. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, means for maintaining the connection between the anode of said device and the corresponding element of said network at a radio frequency potential which is low relative to the radio frequency potential of the cathode, the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a conductor arranged concentrically within said hollow conductor, and means for applying signal energy to said grid and heating energy to said cathode at points on said hollow conductor and said inner conductor which are symmetrically located with respect to the ends thereof.

6. An ultra short wave amplifier system comprising an electron discharge device having an anode, a cathode and a grid, a concentric line having an outer conductor and an inner conductor, said outer conductor having a point thereon of high radio frequency potential, means for impressing between said grid and cathode the potential difference between the potential on said point on said hollow conductor and the potential at an adjacent point on said inner conductor, said inner conductor constituting part of the anode-cathode circuit of said device, and means for impressing a signal voltage between a point on said outer conductor having relatively low radio frequency potential and another point on said inner conductor.

7. An ultra short wave amplifier system comprising an electron discharge device having an anode, a cathode and a grid, a concentric line having an outer conductor and an inner conductor, said outer conductor having a point thereon of high radio frequency potential, means for impressing between said grid and cathode the potential difference between the potential on said

point on said hollow conductor and the potential at an adjacent point on said inner conductor, said inner conductor constituting part of the anode-cathode circuit of said device, means for impressing a signal voltage between a point on said outer conductor having relatively low radio frequency potential and another point on said inner conductor, and means for neutralizing the effect of capacity between said grid and anode.

8. An ultra short wave amplifier system comprising an electron discharge device having an anode, a cathode and a grid, a concentric line having an outer conductor and an inner conductor, said outer conductor having a point thereon of high radio frequency potential, means for impressing between said grid and cathode the potential difference between the potential on said point on said hollow conductor and the potential at an adjacent point on said inner conductor, said inner conductor constituting part of the anode-cathode circuit of said device, means for impressing a signal voltage between a point on said outer conductor having relatively low radio frequency potential and another point on said inner conductor, and means for neutralizing the effect of capacity between said grid and anode, said last means comprising a network having capacitive elements so spaced that their characteristics simulate those of the electrodes of said electron discharge device.

9. In an amplifier circuit, a multi-electrode electron discharge device having a cathode and a grid, a section of concentric line whose outer conductor forms a part of a resonant circuit, means for supplying input signals between the inner and outer conductors of said line at a voltage nodal point on said resonant circuit, and connections for impressing upon said grid and cathode the potential difference existing between said conductors at a point on said resonant circuit having relatively high radio frequency potentials, said resonant circuit forming a tank for said electron discharge device.

10. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, the connection between said anode and the corresponding element of said network including a capacity whose value is higher than the interelectrode capacity of the electron discharge device, the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a conductor arranged concentrically within said hollow conductor, and an input circuit coupled between a point of low radio frequency potential on said hollow conductor and a point on said inner conductor.

11. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, the connection between said anode and the corresponding element of said network including a capacity,

the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a conductor arranged concentrically within said hollow conductor, a utilization circuit coupled to both sides of said capacity, and an input circuit coupled between a point of low radio frequency potential on said hollow conductor and a point on said inner conductor.

12. An ultra short wave transmitter circuit comprising an electron discharge device having an anode, a cathode, and a grid, a network having capacitive elements so arranged and spaced that their characteristics simulate those of the electrodes of said electron discharge device, connections between corresponding elements of said electron discharge device and network, the connection between said anode and the corresponding element of said network including a capacity whose value is higher than the interelectrode capacity of the electron discharge device, the connection between the grid of said device and the corresponding element of said network consisting of a hollow electrical conductor, the connection between the cathode of said device and the corresponding element of said network comprising a conductor arranged concentrically within said hollow conductor, a symmetrical load circuit coupled to both sides of said capacity through a feeder which matches the impedance of said load and that portion of said amplifier to which said feeder is connected, and an input circuit coupled between a point of low radio frequency potential on said hollow conductor and a point on said inner conductor.

13. In a short wave amplifier circuit, an electron discharge device having an anode, a cathode and a grid, a network having capacitive elements whose characteristics simulate those of the electrodes of said electron discharge device, connections including a section of line having an outer conductor and an inner conductor for respectively coupling together certain electrodes of said device to corresponding elements of said network, said outer conductor forming part of a resonant circuit, and means for maintaining the connection between said anode and the corresponding element of said network at substantially zero radio frequency potential.

14. In a short wave amplifier circuit, an electron discharge device having an anode, a cathode and a grid, a network having capacitive elements whose characteristics simulate those of the electrodes of said electron discharge device, connections including a section of line having an outer conductor and an inner conductor for respectively coupling together the electrodes of said device to corresponding elements of said network, one of said conductors comprising the connection between said grid and the corresponding element of said network while the other conductor comprises the connection between said cathode and the corresponding element of said network, said outer conductor forming part of a resonant circuit, and means for maintaining the connection between said anode and the corresponding element of said network at substantially zero radio frequency potential.

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