

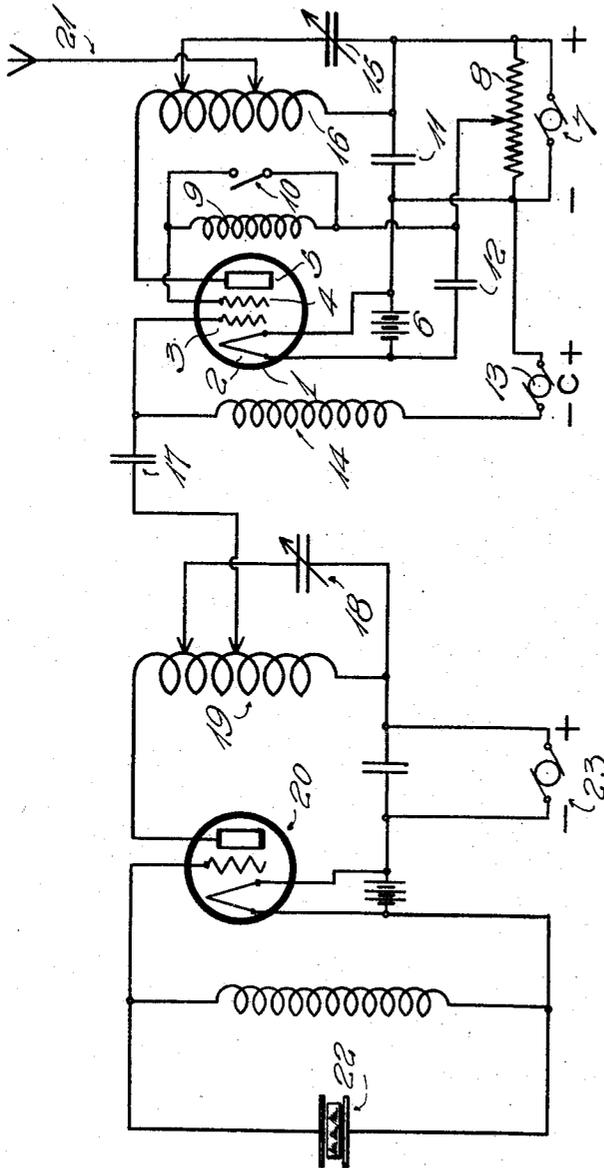
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A. H. TAYLOR

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FREQUENCY MULTIPLICATION SYSTEM

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Inventor

Albert H. Taylor,

by Harold Dodd.

Attorney

# UNITED STATES PATENT OFFICE

ALBERT H. TAYLOR, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

## FREQUENCY MULTIPLICATION SYSTEM

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My invention relates broadly to signaling systems and more specifically to frequency multiplication and amplification circuit arrangements useful in electromagnetic wave signaling systems.

One of the objects of my invention is to provide a circuit arrangement in which an electron tube power amplifier system may be readily converted into a frequency multiplier.

Another object of my invention is to provide a circuit arrangement which will function readily and efficiently either as a frequency multiplication system or as an amplifying system.

A further object of my invention is to provide a circuit arrangement employing a four electrode electron discharge device which will function efficiently either as a frequency multiplication system or as a high frequency oscillation amplification system in a signal transmission system.

Other and further objects will be understood from the following specification and the accompanying drawing which diagrammatically shows the circuit of my invention.

In transmitters covering a wide band of frequencies it is often highly desirable to use "shield" grid tubes in certain of the amplifier stages. When the transmitter is operated on certain frequencies these "shield" grid tubes are used as amplifiers only, whereas when the transmitter is operated on higher frequencies certain of these "shield" grid tubes are used not only as amplifiers but also as frequency multipliers. Experiments have shown that the "shield" grid tube used as a frequency multiplier and amplifier is not as efficient as the tube without the "shield" grid. The increased capacity between the working grid and the filament which is brought about by the use of the "shield" grid and the bypass condenser that is commonly connected between "shield" grid and filament, necessitates the use of greater excitation energy when "shield" grid tubes are employed as frequency multipliers than in the case where tubes without the "shield" grid are employed. The "shield" grid with its automatically neutralizing or balancing properties is not only useless when the tube is acting as a multiplier

but introduces certain losses and disagreeable heating effects from the double frequency currents caused to flow in this grid and its connections. The ideal tube for a transmitter covering a wide range of frequencies, therefore, would be one which would function as a "shield" grid tube when amplifying without frequency multiplication and as a simple three element tube when it is amplifying with frequency multiplication.

In the circuit arrangement of my invention I accomplish this result by causing the "shield" grid tube to function as an ordinary three element tube by opening one switch, which when the tube is operating normally as a "shield" grid tube is maintained in closed position.

Referring to the drawing in detail, reference character 1 designates an electron discharge device having cathode electrode 2, grid electrode 3, "shield" grid electrode 4 and anode electrode 5. A source of power supply 6 is connected to the cathode electrode. A source of anode current supply 7 is connected to the anode electrode and to the cathode electrode. A voltage divider 8 is connected across the source of anode supply 7. A choke coil 9 is connected to the "shield" grid electrode and to the voltage divider 8. A switch 10 is connected across the choke coil 9. A source of grid bias potential 13 is connected to the grid electrode 3 through the choke coil 14 and to the cathode electrode 1. High frequency current bypass capacity 11 is connected across the source 7. An electrostatic capacity 12 is connected from the voltage divider 8 and choke coil 9 to the cathode electrode. A frequency selective circuit comprising capacity 15 and inductance 16 is connected into the anode and cathode electrode circuit. An antenna 21 or another amplifier input circuit may be connected to the inductance 16. A high frequency oscillation generator including an electron discharge device 20 having a frequency stabilizing element, such as a piezo electric crystal 22, connected into its input and a frequency selective circuit 18, 19 connected to its output circuit is connected to excite the grid circuit of the

electron discharge device 1 through the condenser 17.

Other types of high frequency oscillation generators may be employed in place of the type disclosed in the drawing in conjunction with the amplifier arrangement herein disclosed. In the master oscillator power amplifier arrangement comprising this invention the high frequency oscillation generator 20 is used to excite the grid of the electron discharge tube 1 which has a "shield" grid electrode. Usually high negative grid bias potential is applied to the control electrode of the electron discharge tube 1 in order that it may, when desired, function efficiently as a frequency multiplier. In order to completely nullify the shielding action of the "shield" grid electrode a choke coil 9 which is designed to cover a range of frequencies suitable for the transmitter used is connected into the external circuit of the "shield" grid electrode. The electron discharge tube 1 then operates efficiently as a frequency multiplier. When the switch 10 is closed and the choke coil 9 is short circuited the electron discharge device operates most efficiently as an amplifier. This arrangement permits more satisfactory operation of the "shield" grid electrode tube in circuits where frequency multiplication is necessary and permits full realization of the remarkable advantages of the "shield" grid tube when straight amplification with frequency multiplication is desired.

This circuit arrangement also may be used in heterodynes or oscillators employed in receiving sets where it is desirable to bring out the high frequency harmonics under certain conditions and to operate on fundamental frequencies under other conditions.

While I have described my invention in certain particular embodiments, I desire that it be understood that modifications may be made and that I intend no limitations upon my invention other than those imposed by the scope of the appended claims.

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

1. In combination a thermionic electron discharge device operative as a frequency multiplier or a power amplifier having a cathode, a plurality of grid electrodes and an anode, an output circuit connected to said anode, a source of supply for said anode, one of said grid electrodes being connected to said source of supply, and a choke coil having a switch connected thereto, said choke coil and switch being included in the circuit of said last mentioned grid electrode, said switch being movable to open position for rendering said choke coil effective for utilizing the frequency multiplication properties of said device and being movable to closed po-

sition for effecting the operation of said device as a power amplifier.

2. In combination a thermionic electron discharge device operative as a frequency multiplier or a power amplifier having a cathode, a plurality of grid electrodes and an anode, an output circuit associated with said anode, a source of supply for said electron discharge device, a choke coil, an electrical circuit interrupting device connected to said choke coil, said choke coil being connected to one of said grid electrodes and to said source of supply, a source of high frequency oscillations, and connections between another one of said grid electrodes and said source of oscillations, said circuit interrupting device having either of two limiting positions for effectively including said choke coil in circuit with one of said grid electrodes for operating said device as a frequency multiplier or effectively eliminating said choke coil from said circuit for utilizing said device as a power amplifier.

3. In combination, a thermionic electron discharge device operative as a frequency multiplier or a power amplifier having a cathode, a plurality of grid electrodes and an anode, an output circuit associated with said anode, a source of supply, connections between said source of supply and one of said grid electrodes, said connections including a choke coil, connections between said source of supply and said anode electrode, a source of high frequency oscillations, connections between another one of said grid electrodes and said source of oscillations, and means for rendering said choke coil effective in said circuit for operating said device as a frequency multiplier or rendering said choke coil ineffective for operating said device as a power amplifier without frequency multiplication.

4. In combination a thermionic electron discharge device operative as a frequency multiplier or a power amplifier having a cathode, a plurality of grid electrodes and an anode, a source of high frequency oscillations connected to one of said grid electrodes for impressing high frequency oscillations thereon, a source of supply for said anode, connections between another one of said grid electrodes and said source of supply, a choke coil included in said last mentioned grid electrode connections and circuit interrupting means connected across said choke coil for rendering said choke coil effective or ineffective for the operation of said device as a power amplifier or as a frequency multiplier.

5. In combination, a thermionic electron discharge device operative as a frequency multiplier or a power amplifier, said device having a cathode, a plurality of grid electrodes, one of said grid electrodes being a shield grid electrode, and an anode, an output circuit connected to said anode, a source of supply for said anode, connections between

said shield grid electrode and said source, said last mentioned connection including a choke coil and an electrical circuit interrupting device connected across said coil for rendering said choke coil effective or ineffective for the operation of said device as a power amplifier or as a frequency multiplier.

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6. In combination, a thermionic electron discharge device operative as a frequency multiplier or a power amplifier having a cathode, a control grid electrode, a shield grid electrode and an anode, a source of current supply for said anode, an oscillating circuit connected with said anode, connections between said source and said shield grid electrode, said connections including a choke coil and a circuit interrupting device connected to said choke coil, and a source of high frequency oscillations associated with said control grid electrode for impressing high frequency energy thereon for rendering said choke coil effective or ineffective for the operation of said device as a power amplifier or as a frequency multiplier.

ALBERT H. TAYLOR.

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