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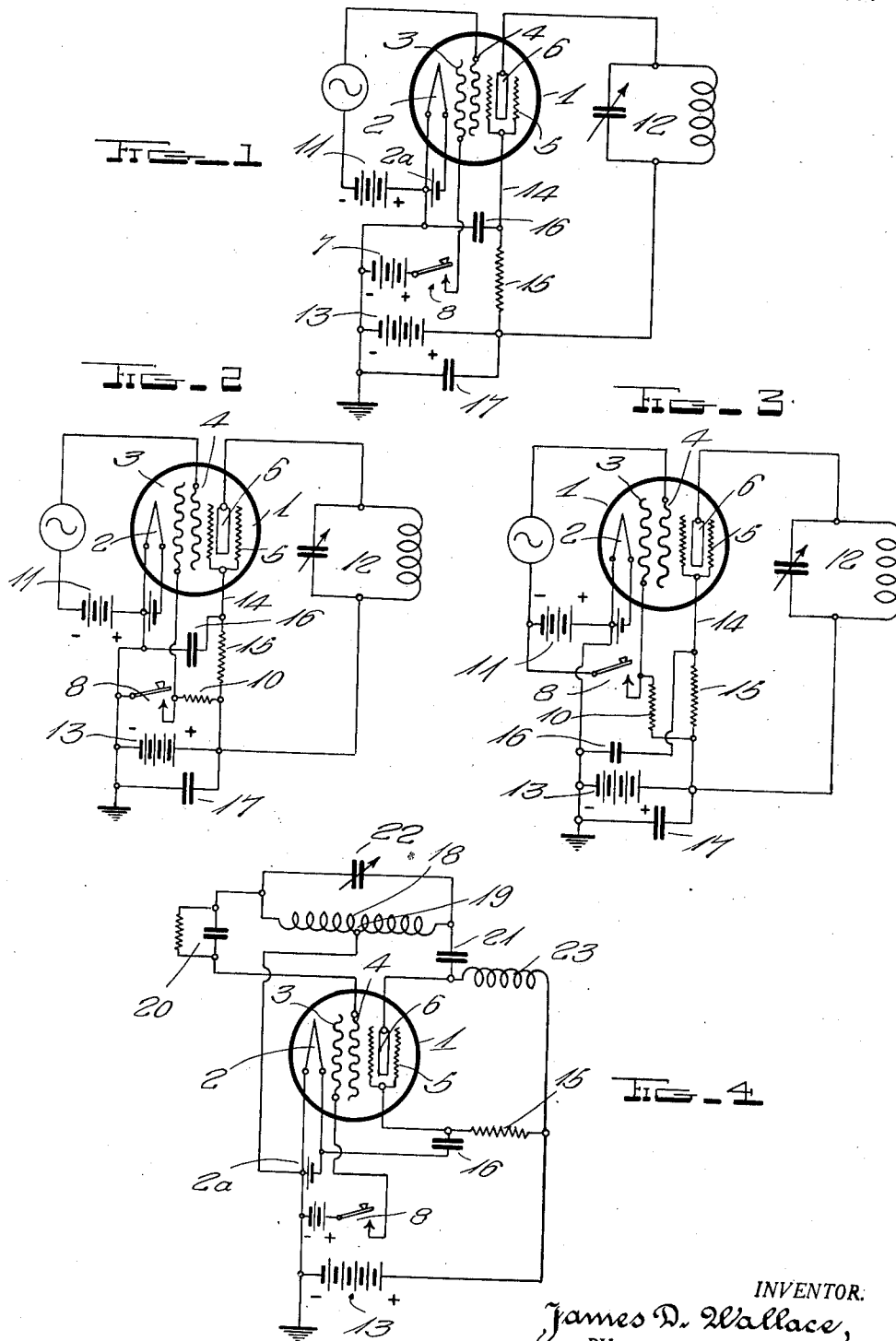
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1,923,345

TELEGRAPHIC KEYING SYSTEM FOR ELECTRON TUBE CIRCUITS

Filed March 13, 1931

2 Sheets-Sheet 1



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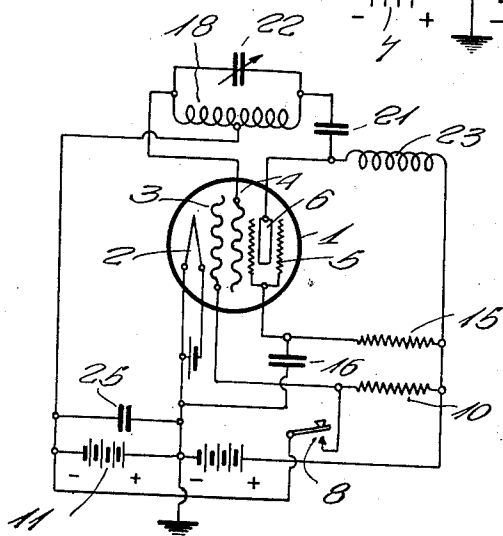
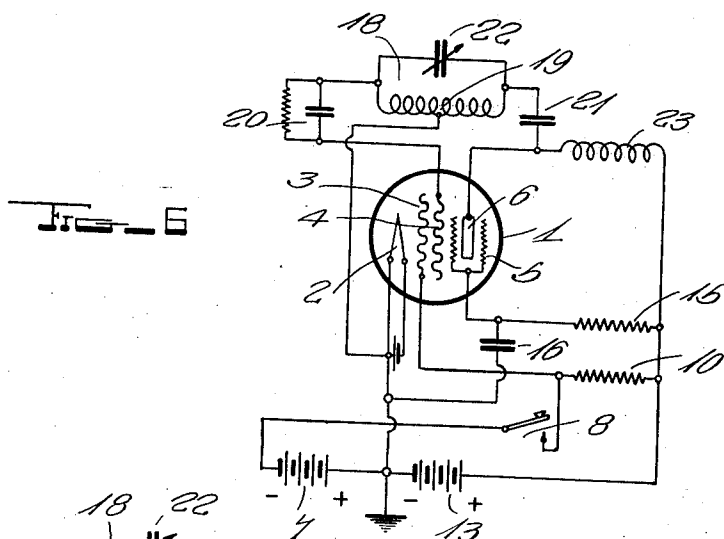
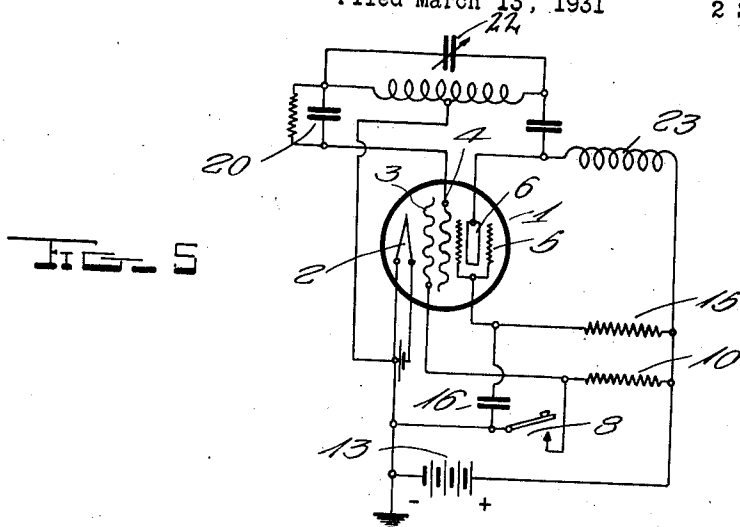
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TELEGRAPHIC KEYING SYSTEM FOR
ELECTRON TUBE CIRCUITS

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8 Claims. (Cl. 250—17)

My invention relates broadly to telegraphic signaling systems and more particularly to a control circuit for effecting the rapid transmission of telegraphic signals.

One of the objects of my invention is to provide a method of keying a power amplifier or oscillator circuit in a high frequency signaling system employing an electron tube utilizing a space charge grid as distinguished from the control grid and shield grid employed in electron tubes.

Another object of my invention is to provide a circuit arrangement for keying an electron tube system by varying the potential on a space charge grid in the electron tube system according to telegraphic signals.

Still another object of my invention is to provide a keying circuit for a multiple electrode tube having means for varying the space charge within the tube in accordance with telegraphic signals for blocking or unblocking the operation of the tube at a telegraphic rate.

A further object of my invention is to provide a method of modulating an electron tube which employs a space charge grid by impressing a negative potential on the space charge grid for blocking the oscillatory or amplification operation of the tube in accordance with telegraphic signals.

Other and further objects of my invention reside in the circuit arrangements for a keying system for electron tube control circuits as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, wherein:

Figure 1 diagrammatically illustrates one form of keying circuit embodying the principles of my invention; Fig. 2 shows a modified circuit arrangement operating in accordance with my invention; Fig. 3 shows a still further modified form of power amplifier circuit utilizing the principles of my invention; Fig. 4 illustrates a method of keying an oscillator according to my invention; Fig. 5 illustrates a modified form of keying circuit for an oscillator arranged according to my invention; Fig. 6 shows a still further modification of keying system for an oscillator embodying the elements of my invention; and Fig. 7 shows an oscillator circuit in which an independent potential source is employed for biasing the control grid of the oscillator and telegraphically impressing selected potentials upon the space charge grid in accordance with telegraphic signals.

My invention is directed to a method of telegraphically keying an electron tube system employing an electron tube utilizing five electrodes. The circuit arrangement of my invention provides thorough protection for the multiple electrode tube system and prevents excessive current from passing to any one of the electrodes which often

occurs in a multiple electrode tube system with the resulting destructive effects thereon.

Figure 1 of the drawings shows a five electrode tube 1 connected in an amplifier circuit. This tube has a filament 2 heated from the source of potential 2a, a space charge grid 3, a control grid 4, a shield grid 5 and a plate 6. The battery 7 supplies potential for the space charge grid when the key 8 is closed. The battery 13 supplies the required plate potential for tube 1. A connection 14 through an impedance 15 is taken from the battery 13 to the shield grid 5 as shown. A resonant circuit 12 is connected in the output circuit of the system. By-pass condensers 16 and 17 are connected in the tube system as shown, condenser 16 being disposed between the shield grid 5 and the cathode 2 and condenser 17 being connected in shunt around battery 13. When key 8 is closed a positive potential is applied to the space charge grid 3, which decreases the magnitude of the repelling force of the space charge and allows an electron flow to the space charge grid and to the other elements within the tube. Consequently, it is seen that the application of voltage to the space charge grid decreases the plate resistance of the tube. Now, if key 8 is opened, the positive potential is removed from the space charge grid and consequently the plate resistance increases. Also, when key 8 is open, electrons which accumulate on the space charge grid would have no leakage path to filament, and therefore the space charge grid would accumulate a high negative potential with respect to the filament. This negative potential on the space charge grid completely stops the flow of plate current and will therefore interrupt the radio frequency output of the amplifier. Consequently, a key placed in the position 8 serves as a method of keying a five electrode tube. It is to be understood that in place of battery 7, a portion of the plate battery may be used, or the entire plate battery through a series resistor of proper value may be utilized.

Fig. 2 shows a modified form of keying circuit for a five electrode tube in connection with a typical amplifier circuit. In this arrangement the space charge grid 3 receives its proper potential from the plate battery 13 through a suitable resistor 10. Now if key 8 is closed, the space charge grid 3 is placed at filament potential and therefore the space charge within the tube becomes great enough to stop the flow of electrons from filament to plate. Consequently the output of the amplifier may be keyed by alternately opening and closing key 8.

Now the methods hereinbefore described will not always work in connection with certain types of tubes. The magnitude of the space charge effect is not always sufficient to block the amplifier. Also, the method shown in Fig. 1 when used in connection with certain types of tubes may fail to

block the amplifier. This is because the combined effects of the space charge with the tube 1 and the accumulation of a negative potential on the space charge grid 3 is not enough to block the electron flow within the tube. To overcome this difficulty, the positive potential may be removed from the space charge grid 3 and a negative potential placed thereon. Usually, if a negative potential as great as the control grid bias is applied, the tube will be blocked. However, more negative potential may be applied if necessary. The circuit for this type of keying system is shown in Fig. 3.

When key 8 in Fig. 3 is open the space charge grid 3 receives its potential through a suitably valued resistance 10, but when key 8 is closed, the space charge grid 3 is connected directly to the negative terminal of the control grid bias battery 11 which applies a negative potential to the space charge grid 3, thereby blocking the tube. Therefore the amplifier may be keyed by operation of key 8.

Space charge grid keying is preferable to many other types of keying used in connection with five electrode tubes. If the tube is keyed by breaking the plate circuit, then a large portion of the emitted electrons from the filament will go to the other three electrodes when the key is up. The shield and space charge grid will draw much higher currents when the plate voltage is removed, and more rectified grid current will be drawn by the control grid. If the tube is keyed by removing the shield grid potential, the control grid will draw more rectified current and the space charge grid will also draw more current when the key is up. If the tube is keyed by means of the control grid, the space charge grid draws an excessive current with the key up. Consequently, if when the key is up certain electrodes draw more current than normal, a large quantity of heat is dissipated on these electrodes which may burn them up if they are not very ruggedly designed. Consequently the use of space charge grid keying may prevent the necessity of greatly increasing the normal dissipating power of certain elements within the tube. Also, since no current is drawn by any electrodes when the key is up, there is no waste of power on the electrodes, thereby increasing the overall efficiency of the amplifier.

It is to be understood that these aforementioned circuits do not function only in connection with five electrode tubes. The method of keying functions satisfactorily if a four electrode tube is used, using the inner grid as a space charge grid and the outer one as a control grid. A self oscillating five electrode tube may be keyed in accordance with the principles of my invention by variation of the potential of the space charge grid.

Referring to Fig. 4, a method of keying the space charge grid of a self oscillating tube is shown. The key is designated at 8. The action of this circuit is identical to that explained in connection with the amplifier in Fig. 1. It will be understood that the space charge grid may receive its potential from a portion of the plate battery or the entire plate battery through a suitable resistance. The oscillatory system includes an inductance 18 having the midpoint 19 thereof connected to a cathode 2. One end of the inductance 18 connects through grid condenser and grid leak 20 with the control grid 4. The opposite end of inductance 18 connects to plate 6 through condenser 21. The inductance 18 is shunted by the variable tuning condenser 22. The potential impressed upon plate electrode 6

is supplied through radio frequency choke 23 from plate battery 13 while the potential for the shield grid 5 is supplied through resistance 15 from the plate battery 13. The by-pass condenser 16 is arranged in a manner similar to the arrangement described in the preceding figures.

The circuit in Fig. 5 shows another method of keying the space charge grid of a self oscillating tube. The key 8 will interrupt the output of the tube in the same manner as explained for an amplifier in Fig. 2. In this arrangement the potential on the space charge grid 3 as well as the potential for the shield grid 5 and plate electrode 6 is obtained from battery 13. The potential is selected by means of impedances 15 and 10 disposed in series between the source 13 and the space charge grid 3 and the shield grid 5 as illustrated. The by-pass condenser 16 is arranged in a manner similar to that illustrated in connection with Fig. 4.

The circuit in Fig. 6 shows another method of keying the space charge grid 3 of a self oscillator. The key 8 functions in a similar manner to the method explained in Fig. 3. The battery 7 supplies separate negative potential which is applied to the space charge grid 3, when it is necessary to stop the electronic flow from the filament to the other elements within the tube. The arrangement shown in Fig. 6 includes a connection from battery 7 through key 8 to the space charge grid 3 of the oscillator which is charged in accordance with the signals transmitted under control of the key 8. The required potential is selected to completely stop the flow of electronic current from the filament to the other electrodes within the tube when the key is in that position.

If it is desirable to use a "C" battery in connection with an oscillator, this same battery may supply the negative potential for space charge grid 3 as illustrated in Fig. 7. In this arrangement the battery 11 serves as a means for impressing the selected negative potential on control grid 4 at the same time that a negative potential may be derived therefrom and impressed on the space charge grid 3 to key 8 in accordance with telegraphic signaling. In this arrangement the by-pass condenser 25 is connected across the battery 11 and the grid leak and grid condenser illustrated in Figs. 4, 5 and 6 are omitted, although they may be used, if desirable.

When a self oscillator is keyed by variation of the space charge grid potential certain advantages are present which are not found in other types of keying. If any electrode other than the space charge grid is keyed, when the key is up, the space charge grid draws an excessive current and may damage the tube. Also this current represents some expended power, and the overall efficiency of the oscillator will be increased if no space charge grid current flows when the key is up.

The tubes shown in all the illustrated diagrams have been of the shield grid type. A four element space charge grid tube may be substituted for those shown in Figs. 1, 2 and 3 if desirable; however, if this is done and the amplifier amplifies the frequency impressed upon its grid, neutralization circuits must be added, but if it is a frequency multiplication circuit, neutralization is not necessary. A four element space charge grid tube may be substituted for those shown in the oscillator circuits in Figs. 4, 5, 6 and 7, thereby eliminating the shield grid and its associated circuits.

It may be necessary to explain the keys to be

used in connection with the circuits discussed hereinbefore. The keys used in connection with the circuits shown in Figs. 1 and 4 have contacts which are normally open, but are closed when the key is depressed. It is understood that a relay could be used instead of the key, the spring of which holds the contacts apart when no current is flowing through its coil. The keys used with the circuits shown in Figs. 2, 3, 5, 6 and 7 have contacts which are normally closed, but are opened when the key is depressed. It is understood that a relay may be used for keying, but it must be of the back contact type—that is, the spring holds the contacts together normally, but when current passes through its coil, the contacts are pulled apart.

While I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are 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 a signaling system, an oscillator circuit, an electron tube system including a cathode, a space charge grid, a control grid, an anode, and a shield grid, an input circuit connected between said control grid, said cathode and said oscillator circuit, an output circuit connected between said anode and cathode, a source of potential in said output circuit, a connection between a point on said source of potential and said shield grid, and a keying circuit connected between said space charge grid and a source of potential for applying a positive potential to said space charge grid in accordance with telegraphic signals for correspondingly rendering said oscillator circuit effective upon said electron tube system.

2. In a signaling system, an oscillator circuit, an electron tube system including a cathode, a space charge grid, a control grid, an anode and a shield grid, an input circuit connected between said control grid, said cathode and said oscillator circuit, an output circuit connected between said anode and cathode, a source of potential in said output circuit, a connection between a point on said source of potential and said shield grid, a circuit interrupter connected between said space charge grid, and a source of potential connected with said cathode, said circuit interrupter being adapted for operation at telegraphic speeds for applying a predetermined fixed potential to said space charge grid for modifying the effect of said oscillator circuit upon said electron tube circuit in accordance with telegraphic signals.

3. An oscillator system including an electron tube having a cathode, a control grid, an anode, a space charge grid and a shield grid, circuits interconnecting said cathode, control grid and anode for establishing oscillations, a source of potential connected with said circuits, a connection between said source of potential and said shield grid, a circuit extending between said source of potential and said space charge grid, and means for closing said circuit telegraphically for applying a predetermined fixed potential to said space charge grid for correspondingly starting and stopping oscillations in said circuits in accordance with telegraphic signals.

4. An oscillator system including an electron tube having a cathode, a control grid, an anode, a space charge grid and a shield grid, circuits interconnecting said cathode, control grid and anode for establishing oscillations, a source of potential connected with said circuits, a connection between said source of potential and said shield grid, a circuit extending between said source of potential and said space charge grid, and means for abruptly changing the potential on said space charge grid to a predetermined fixed value from a different value at a telegraphic rate for correspondingly starting and stopping oscillations in said circuits.

5. An oscillator system including an electron tube having a cathode, a control grid, an anode, a space charge grid and a shield grid, circuits interconnecting said cathode control grid and anode for establishing oscillations, a source of potential connected with said circuits, a connection between said source of potential and said shield grid, a circuit extending between said source of potential and said space charge grid, and means for applying a positive potential to said space charge grid according to telegraphic signals for modifying the oscillatory current in said circuits.

6. In a signaling system, an electron tube including grid, filament and plate electrodes, a shield grid electrode, a space charge grid, circuits interconnecting said grid, filament and plate electrodes for the establishment of an oscillatory path, a tuned circuit interposed in series with the circuit between said plate and filament electrodes, a source of potential for positively charging said plate electrode, means for applying a predetermined positive charge to said shield grid electrode from said source of potential, a keying circuit extending between said cathode and said space charge grid, an impedance connected between said space charge grid and said source of potential whereby a positive potential is applied to said space charge grid at telegraphic speeds for modifying the effect of said source of high frequency current upon said circuits.

7. In a signaling system, an electron tube including a cathode, a space charge grid, a control grid, a shield grid and an anode, an input circuit interconnecting said control grid and said cathode with said source of high frequency current, an output circuit interconnecting said anode, a source of potential and said cathode, a resonant circuit disposed in said output circuit, a connection between the source of potential in said output circuit and said shield grid, and means for applying a positive potential to said space charge grid for decreasing the resistance of said output circuit and rendering said output circuit conductive to high frequency energy from said source.

8. In a signaling system, a source of high frequency current, an electron tube including a cathode, a space charge grid, a control grid, a shield grid, and an anode, an input circuit interconnecting said control grid and said cathode with said source of high frequency current, an output circuit interconnecting said anode, a source of potential and said cathode, a resonant circuit disposed in said output circuit, a circuit interconnecting the positive terminal of the source of potential and said space charge grid, an impedance in said circuit, and a keying circuit extending between said space charge grid and said cathode for reducing the potential of said space charge grid to the potential of said cathode for blocking the electron discharge to said anode and rendering said resonance circuit non-conductive to high frequency current from said source.