April 17, 1934. J. D. WALLACE 1,955,352

METHOD OF PROTECTING POWER AMPLIFIER TUBES

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Fig. 1.

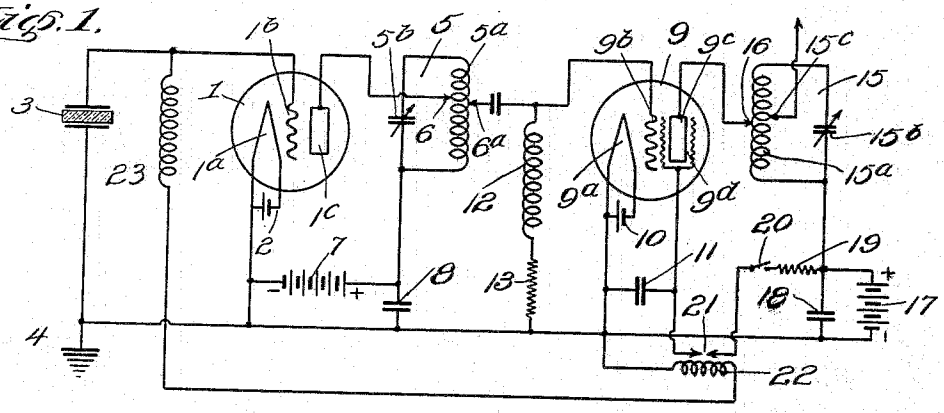


Fig. 2.

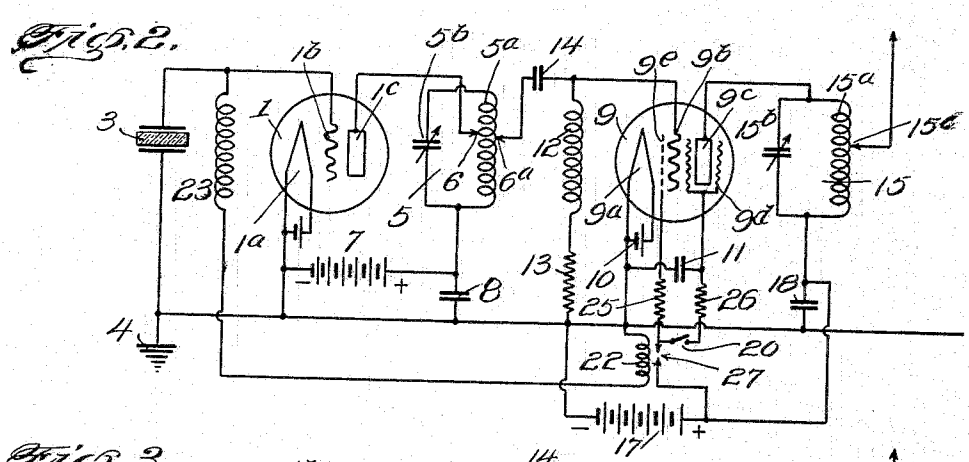
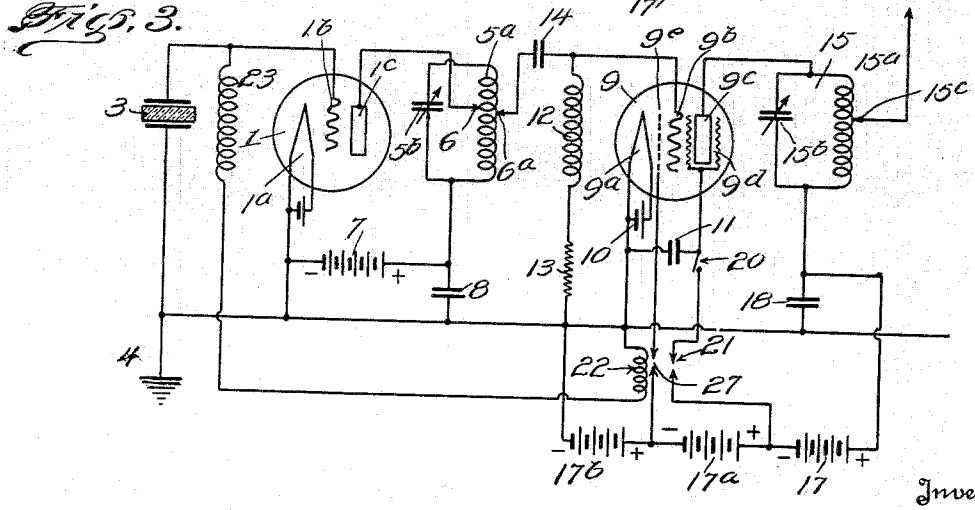


Fig. 3.



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METHOD OF PROTECTING POWER AMPLIFIER TUBES

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Fig. 4.

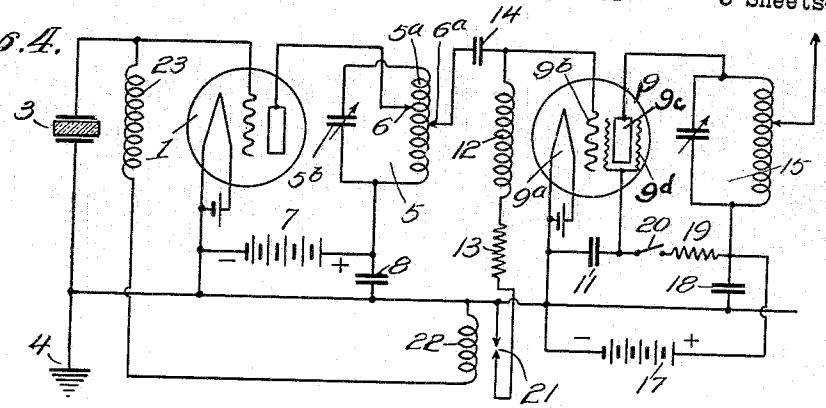


Fig. 5.

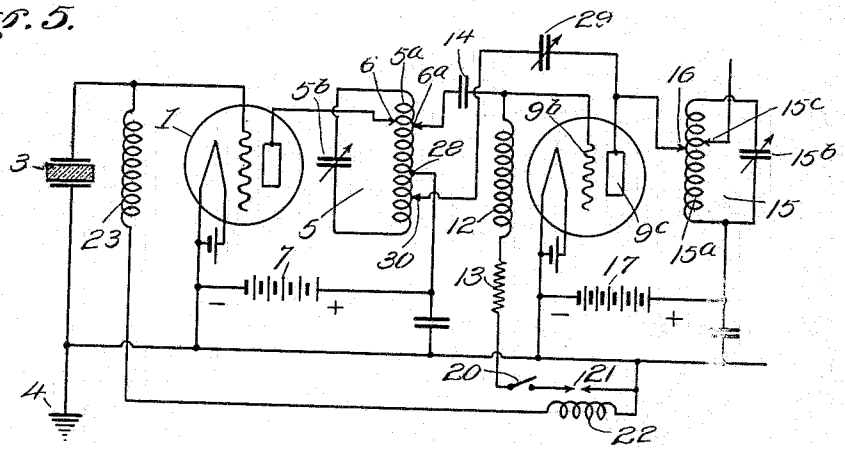
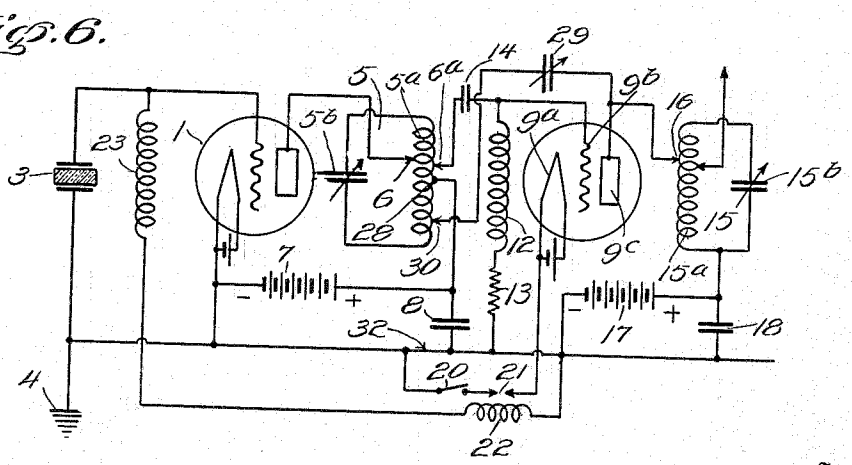


Fig. 6.



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METHOD OF PROTECTING POWER AMPLIFIER TUBES

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Fig. 7.

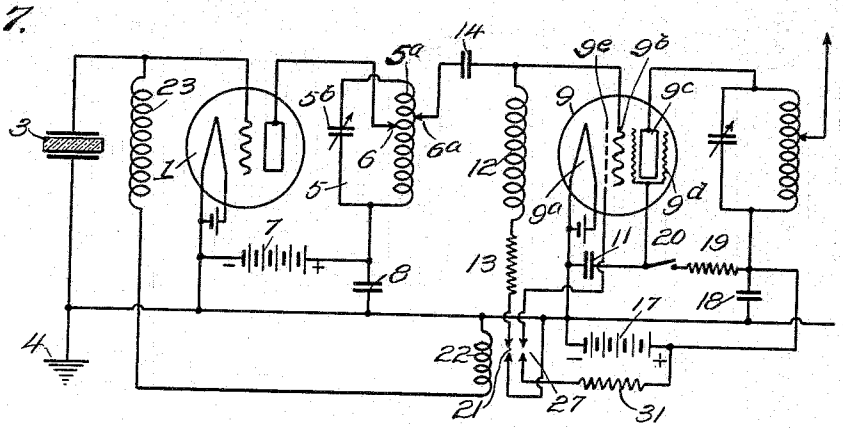


Fig. 8.

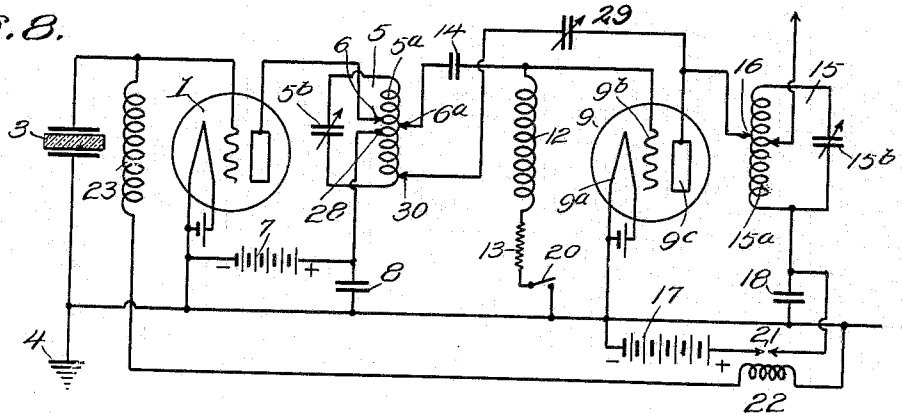
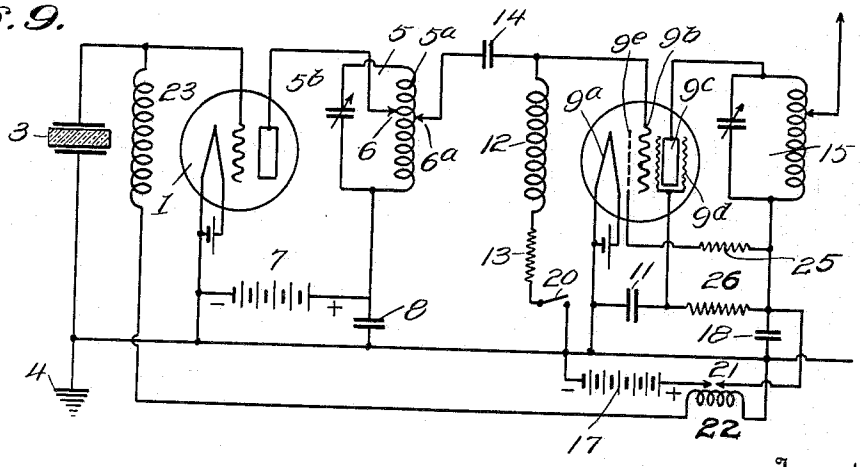


Fig. 9.



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Patented Apr. 17, 1934 1,955,352

UNITED STATES PATENT OFFICE

1,955,352

METHOD OF PROTECTING POWER AMPLIFIER TUBES

James D. Wallace, Washington, D. C.

Application October 31, 1931, Serial No. 572,379

17 Claims. (Cl. 250—17)

My invention relates broadly to signal transmission systems and more particularly to a safety circuit arrangement for protecting electron tubes of a signal transmission system.

One of the objects of my invention is to provide means for safely operating an electron tube transmission circuit and supplying negative grid potential to power amplifier tubes associated with the oscillator of the transmitter without employing the usual motor generator or other similar devices for supplying grid potential.

Another object of my invention is to provide a safety circuit for electron tube transmitters embodying an oscillator tube and a power amplifier having means for blocking the operation of the power amplifier in the event of failure of the oscillator tube circuit to generate oscillations.

Still another object of my invention is to provide a circuit arrangement for controlling the operation of a power amplifier system according to the amount of grid current drawn by the oscillator, whereby the operation of the power amplifier is blocked or the power input diminished in the event that the oscillator stops oscillating.

A further object of my invention is to provide a circuit arrangement for an electron tube oscillator and power amplifier system wherein a path for rectified grid current is provided for the oscillator, which path includes the winding of a relay device adapted to control circuits to the power amplifier tube for determining the operation of the power amplifier in accordance with the amplitude of the rectified grid current drawn by the oscillator tube.

Other and further objects of my invention are set forth in the specification hereinafter following, reference being had to the accompanying drawings in which:

Figure 1 diagrammatically illustrates a crystal controlled oscillator connected with a power amplifier including the protective circuit of my invention; Fig. 2 illustrates an arrangement of space charge grid tube employed in the power amplifier stage of a transmitter embodying my invention; Fig. 3 illustrates a modified circuit arrangement using a space charge grid power amplifier connected with an oscillator according to my invention; Fig. 4 shows a further modified form of protective circuit for the power amplifier stage of a high frequency transmitter; Fig. 5 illustrates the application of the protective circuit of my invention to a neutralized arrangement of power amplifier circuit; Fig. 6 illustrates a modified form of neutralized power amplifier system embodying the safety control system of my invention; Fig. 7 illustrates a further modified form of protective system for a power amplifier stage utilizing a shield grid and space charge grid type of tube; Fig. 8 shows a further modified form of protective circuit for a power amplifier in which the anode potential of a neutralized power amplifier stage is controlled in accordance with the condition of oscillation of the oscillation system associated with the power amplifier stage; and Fig. 9 illustrates another modified form of protective arrangement for a power amplifier tube of the shield grid and space charge grid type in which the continuity of the anode circuit is controlled in accordance with the operating condition of the oscillator system.

My invention is directed to an electron tube transmission system employing a crystal controlled electron tube oscillator or other types of electron tube generators, having an electron tube power amplifier coupled thereto. In the design of radio transmitters, it has been customary to supply grid bias voltage by means of batteries, generators, rectifiers, etc., or to put a voltage divider across the plate supply using part of this voltage for grid bias, or to in some other way rob the plate circuit of some of its potential to supply grid bias voltage. It has been suggested that the use of a grid leak in the rectified grid current circuit of the amplifier be used to supply the grid bias voltage. The grid leak method of biasing does not affect the efficiency of the amplifiers, and will obviously, by the elimination of the aforementioned methods of obtaining grid bias, reduce the cost of transmitter equipment, reduce the operating cost, and increase the overall efficiency of the transmitter. The serious difficulty with using the grid leak method of supplying grid bias is that the master oscillator of the transmitter may fail to, or discontinue to oscillate, and then no excitation will be applied to the amplifier input circuits, and no rectified grid current will flow, and no grid bias will be placed on the amplifiers. It is well known that a transmitting tube will be damaged if its full plate voltage is applied with no grid bias applied to the input circuit. For this reason, the grid leak method of biasing power amplifiers has not been heretofore widely used. My invention consists of the combination of a power amplifier, biased by means of a grid leak in the rectified grid current circuit, and a protective relay. This relay is connected in the circuit in such a manner that its magnetic circuit is energized only when the master oscillator is producing radio frequency power. The contacts of this relay are normally open, and close when

the magnetic circuit is energized. The contacts of this protective relay are connected in such a manner that the plate circuit power is reduced, or is completely cut off, when conditions are such as to damage a tube, as was discussed previously in this paragraph. My invention has completely eliminated the only serious disadvantage to the grid leak method of biasing a power amplifier.

In any type of electron tube generator, there is a flow of unidirectional current from the grid to the filament (rectified grid current) when the circuit is producing oscillations. If for any reason, the production of oscillations ceases, the flow of rectified grid current ceases. The coil of the protective relay mentioned hereinbefore may be placed in this rectified grid current circuit. The contacts of this relay will be closed only when the master oscillator circuit is producing oscillations, and will immediately open if, for any reason, the oscillations cease.

Three different methods of disabling an amplifier tube by means of a protective relay are shown in the drawings and will be hereinafter described in connection with illustrative embodiments of the invention. By one of these methods the filament is isolated from at least one of the other electrodes. By a second method at least one of the other electrodes is depolarized with respect to the filament; or, in other words, the filament potential is placed thereupon. A third method comprises a combination of the first two; as, for example, by arranging the contacts of the protective relay so that the filament is isolated from, say, the control grid while at the same time the filament potential is applied to at least one of the other electrodes.

Several forms of circuits are shown in Figs. 4, 5, 6 and 7 to illustrate the method first mentioned above. Other forms of circuits, illustrating the second method are shown in Figs. 1, 2, 3, 8 and 9. The third method, which is a combination of the first two, will be described in due course.

When a three-electrode transmitting tube is to be protected against damage from overheating in case the grid bias voltage is no longer applied to the input circuit, either the filament may be isolated from the grid, according to method No. 1, or the plate supply circuit may be broken according to method No. 2.

When a four-electrode transmitting tube is to be protected from this sort of damage, method No. 1 may be applied either by isolating the filament from either the control grid or the shield grid or both. Method No. 2 may be applied by removing the potential from the shield grid or the plate and shield grid.

A four-electrode space charge grid tube may be protected according to method No. 1 by isolating the filament from the space charge grid or from the latter in addition to the control grid. According to method No. 2, the potential may be removed from the space charge grid and the plate or by reducing the potential of the space charge grid alone to that of the filament.

A five-electrode tube may be protected from damage according to method No. 1 by isolating the filament from the space charge grid or from the latter in addition to the control grid. According to method No. 2 this tube may also be protected by placing the space charge grid at filament potential, by removing the potential from the shield and space charge grid, or by depolarizing the shield grid, space charge grid and the plate with respect to the filament. Method No. 3 may also be applied for the protection of a five-electrode tube by isolating the filament from the control grid and simultaneously connecting the space charge grid to the filament, or by isolating the filament from the control grid alone and depolarizing the shield and space charge grids with respect to the filament. The contacts of the aforementioned protective relay may give the amplifier tube protection in one of the methods previously mentioned. Some specific circuits will be shown, with a particular kind of protection adaptable to the type of tube and its power supply system. In some cases, it is necessary to use a relay with more than one pair of contacts to produce all the operations desirable.

Fig. 1 illustrates a circuit employing the aforesaid principles of my invention. The crystal oscillator tube is indicated by reference character 1, connected with the amplifier tube 9 and the protective relay 22. Relay 22 may be used in connection with any other system of shield grid keying by placing the relay contacts either in series or in parallel with the key contacts in such manner that when the coil of relay 22 is not energized, the shield grid potential is at a minimum.

I have designated the oscillator tube 1 as having cathode 1*a*, control grid 1*b* and anode 1*c*. The cathode is heated from any suitable source such as the battery 2. The input circuit of the oscillator connects between control grid 1*b* and cathode 1*a* and includes the piezo electric crystal element 3. One terminal of the input circuit is connected to ground as represented at 4. The output circuit of the oscillator tube 1 extends between anode 1*c* and cathode 1*a* through the tuned circuit 5 and the high potential source 7. The high potential source 7 has a radio frequency by-pass circuit shunted thereacross in the form of the condenser 8. The tuned circuit 5 includes the inductance 5*a* and the variable tuning condenser 5*b*, these being connected in parallel. A tap 6 is adjustable along inductance 5*a* for including the required impedance in the output circuit of the oscillator. The power amplifier tube 9 has its input circuit connected across control grid 9*b* and cathode 9*a*. The input circuit includes the resistance element 13 in series with the impedance 12. A connection extends from the input circuit of power amplifier tube 9 through coupling condenser 14 to the tap 6*a* on inductance 5*a*. One end of resistance 13 connects to one side of the cathode 9*a*. Cathode 9*a* is heated from any suitable source of potential such as the battery 10. The output circuit of the power amplifier extends from anode 9*c* to the tap 16 on inductance 15*a*, constituting part of resonant circuit 15. Inductance 15*a* is shunted by tuning condenser 15*b*. The output circuit of power amplifier 9 is completed through the source of high potential represented at 17 having by-pass condenser 18 connected in shunt thereto. The keying circuit for the power amplifier is connected between the shield grid 9*d* and the source of potential 17 through the resistance 19, the key 20 and the contacts 21 as shown. Condenser 11 is connected in shunt with the keying circuit and in shunt with the high potential source for the anode 9*c* as illustrated. This condenser causes the shield grid 9*d* and the cathode 9*a* to be at the same radio frequency potential. The control relay includes the winding 22 and the contacts 21. In Fig. 1 of the drawings the winding 22 is connected in series between the cathode circuit and the control grid 1*b* of the oscillator 1 through the impedance 23. When the tube 1 is oscillat-

ing under normal conditions there is a unidirectional current flow through the winding 22 and impedance 23 in the input circuit of the oscillator. This serves to close the circuit to the shield grid of the power amplifier tube 9 preparatory to keying. So long as contacts 21 are maintained closed by action of the oscillator tube 1 keying may be effected through the keying circuit by manipulating transmitting key 20, thus changing the potential on shield grid 9*d* for transmitting signals so long as oscillator tube 1 continues to function. However, if for any reason the tube 1 should fail to, or discontinue to oscillate, this unidirectional current would no longer flow through the relay coil 22; the contacts 21 would open and remove the positive potential with respect to the cathode 9*a* from the shield grid 9*d* thereby interrupting the flow of space current from the cathode 9*a* to the anode 9*c*, which would prevent any damage to the amplifier tube 9. Energy may be transferred from the power amplifier stage 9 to a succeeding stage of power amplification, or to a line wire system, or a radiating antenna ground system, through the tap connection 15*c* adjustable along inductance 15*a* as shown.

If a space charge grid tube be used, the same protective relay will function properly if connected in the space charge grid circuit. In connection with a five electrode tube this protective device may be applied to both shield and space charge grids using it in either of two ways—the relay may have one set of contacts which break both circuits, providing the potential supply to these circuits is arranged so that this may be done, or the relay may have two sets of contacts for breaking each grid circuit, shield and space charge, if the particular circuit used necessitates that the two circuits be isolated.

The circuit in Fig. 2 shows the protective relay 22 used where one set of contacts function satisfactorily to open and close both the circuit to the shield grid and the circuit to the space charge grid simultaneously. The keying circuit is shown in the shield grid circuit, which is arranged in a manner heretofore described. That is to say the shield grid shown at 9*d* is connected through resistance 26 and key 20 through contacts 27 with the positive side of the source of potential at 17. The contacts 27 connect through resistance 25 to the space charge grid 9*e*. The other parts of the oscillator and power amplifier system are arranged as heretofore described in connection with Fig. 1.

There is shown in Fig. 3 a circuit where a protective relay 22 having two pairs of contacts 21 and 27 is employed. I have shown the potential source divided into sections 17, 17*a* and 17*b* with a connection taken from the negative end of the source to the cathode 9*a*. The control relay has its winding 22 connected in the manner heretofore described but with a double set of contacts arranged to independently control the potential on the space charge grid 9*e* and the shield grid 9*d*. Contacts 21 are disposed in series with the circuit which includes the key 20 leading to the shield grid 9*d*. The contacts 27 are disposed in series with the space charge grid 9*e* leading to a tap intermediate to the sections 17*a* and 17*b* of the potential source.

It is possible to protect the amplifier from the injuries to which it might be subjected by arranging the relay coil so that the coil is energized by a flow of crystal oscillator rectified grid current, the contacts of which cause the amplifier control grid to be isolated from its filament when the coil is not energized. A circuit utilizing this method is shown in Fig. 4, the protective relay being shown at 22. The tube 9 includes the shield grid 9*d* in the keying circuit as shown. The contacts 21 are disposed in series with the amplifier rectified grid current circuit which leads to the control grid 9*b* to the cathode 9*a* of the power amplifier tube 9. When winding 22 is de-energized, contacts 21 open thereby isolating the control grid 9*b* of power amplifier tube 9 from the filament 9*a*, thereby interrupting the flow of space current from the filament 9*a* to the anode 9*c*.

The circuit in Fig. 5 shows a circuit using a neutralized three electrode tube 9 employed as a power amplifier. This circuit is similar to the one discussed in the preceding paragraph, except that a three element tube is used instead of a four element one. The keying system consists of isolating the amplifier control grid 9*b* from its filament 9*a*, thereby allowing the control grid 9*b* to acquire a negative potential with respect to the filament 9*a* which is sufficient to interrupt the flow of plate current within the tube when the key 20 is up. The adjustable condenser 29 connects between the anode 9*c* and an adjustable tap 30 on the coupling inductance 5*a* of the resonant circuit 5. The tap 30 is located below the fixed tap 28 which forms the return path for the output circuit of the oscillator. Neutralization of the circuits and balanced operation of the system is obtained by movement of tap 30 along inductance 5*a* and adjusting the capacity of condenser 29. If the amplifier is used as a frequency multiplier, the neutralization circuits may be eliminated. The keying circuit includes the key 20 in series with contacts 21 and in series with the grid circuit impedances shown at 12 and 13. The opening of contacts 21 by the de-energization of winding 22 results in interrupting the flow of plate current of power amplifier tube 9 and protecting it if the master oscillator circuit should fail to produce oscillations.

The circuit in Fig. 6 operates in a similar manner to the one shown in Fig. 5, but the protective relay contacts and keying system are connected in a slightly different manner. The neutralization circuits may be eliminated if the amplifier is used as a frequency multiplier. The keying circuit is shown connected between cathode 9*a* through contacts 21 and key 20 with the grid circuit to the control grid 9*b* through impedances 12 and 13. The power amplifier tube 9 is protected against damage in case the tube 1 and its associated circuits fail to produce oscillations.

However, if a space charge grid tube is to be used in a system having this protection, the space charge grid should have its positive potential removed when the control grid is isolated from its filament. If it kept its positive potential when the control grid is open and thereby acquired a negative potential, the space charge grid would attract many electrons from the filament, there being no other place to flow, and this electrode might be burned up from the heat generated from the electronic impact. For this reason, the space charge grid should be opened simultaneously with the control grid. This may be done by using a relay with two pairs of contacts, one to open the control grid circuit and the other to open the space charge grid circuit. The circuit of this last mentioned method is shown in Fig. 7. Contacts 21 are disposed in series with resistance 13 and impedance 12 to isolate the control grid 9*b* from the cathode 9*a*. The space charge grid 9*e*

connects through contacts 27 in series with resistance 31 which connects to the positive side of the potential source 17, the contacts 27 leading to the space charge grid 9*e*. The keying circuit connects from the shield grid 9*d* through key 20 and resistance 19 to the positive side of the potential source 17. If desirable, the shield grid and plate potential may be removed by additional pairs of contacts on the protective relay, but this will seldom, if ever, be necessary because the outer electrodes will draw little if any current when the two inner electrodes are isolated from the filament. In this manner the amplifier tube is protected.

Instead of using a shield grid tube as the amplifier in circuit in Fig. 7, a neutralization circuit in connection with a three element tube may be employed. It would then be necessary to use a different type of keying. This amplifier may be keyed by isolating the amplifier control grid from its cathode. If the amplifier is a frequency multiplier, the neutralization circuits may be eliminated. Protection may be afforded the amplifier tube by removing the amplifier plate potential when the master circuit is not oscillating. The circuit in Fig. 8 shows this protection applied to a three electrode amplifier. The neutralization circuit is shown extending between anode 9*c* and the adjustable tap 30 on inductance 5*a* through the adjustable condenser 29. The key 20 is directly in the rectified grid current circuit of the power amplifier tube 9 and is completed from cathode 9*a* through key 20 and impedances 12 and 13 to control grid 9*b*. The plate potential of tube 9 is interrupted upon the opening of contacts 21 under control of relay winding 22 which is connected as heretofore shown in the grid biasing circuit of tube 1. In this manner, the amplifier tube 9 may be protected.

The circuit in Fig. 9 is similar to the one shown in Fig. 8 except that a five instead of a three electrode tube is used as a power amplifier. The protective relay 22 has only one pair of contacts 21 which break plate, shield grid and space charge grid circuits. If necessary, a relay with several sets of contacts may be used, one pair to break the plate, another the shield grid, and another the space charge grid. It is necessary to remove the potentials from the space charge and shield grids when the plate potential is removed, or these electrodes might be damaged by the increased electronic impact under this condition. In Fig. 9, a four electrode tube can replace the five electrode one shown. A shield grid tube may be used, thereby eliminating the space charge grid and its circuits. Or the tube could be operated using the inner grid as a space charge grid, the outer as a control grid, and eliminating the shield grid and its associated circuits. However, it would then be necessary to use neutralization if no frequency multiplication system is used. The keying device is shown at 20 disposed in series with the impedances 12 and 13 which connect with the control grid 9*b*. The space charge grid 9*e* connects through regulating resistance 25 and the relay contacts 21 to the positive of the high potential source 17. The shield grid 9*d* connects through regulating resistance 26 and through the contacts 21 with the positive side of the source of potential shown at 17. The contacts 21 are controlled as heretofore described by means of winding 22 dependent upon the flow of rectified current of the oscillator. In this way, the amplifier tube is protected from damage, if the master oscillator circuit should fail to produce oscillations.

A keying system has been shown with each amplifier circuit. It is not necessary to use the one illustrated as any other system of keying which may be used with the type of tube shown in the circuit may be substituted therefor. If the first amplifier is used as a buffer stage, the key circuit may be eliminated altogether.

The protective system has been shown in the various diagrams as protecting only the first stage of power amplification. By the use of more contacts on the protective relay, if necessary, any of the protective systems may be applied to any or all succeeding amplification stages.

I have found the several circuits shown herein highly successful in operation and capable of functioning with a high degree of safety.

A crystal controlled master oscillator has been shown in the several drawings. This type of oscillator has been illustrated because it is more likely to cease oscillation from being out of adjustment than any other form of exciter. However, it is understood that any other form of a vacuum tube oscillator may be used in its stead. A self-oscillating master circuit is not as likely to cease oscillations from improper adjustments as a crystal oscillator, but it is possible for a self-oscillating master oscillator to cease oscillation if, for instance, the filament burns out, or the plate voltage goes off or other conditions detrimental to the sustaining of oscillations occur.

While I have described certain preferred embodiments of my invention, 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 transmission system, an oscillator network, a power amplifier network connected thereto, and a relay having a winding in circuit with a portion of said oscillator network and having contactor elements in circuit with a portion of said power amplifier network, said relay being energizable while said oscillator network functions and constituting means operative under a condition of cessation of oscillations in the oscillator network for disabling said power amplifier network.

2. In a transmission system, an oscillator network, a power amplifier network connected thereto, and a relay having a winding in circuit with a portion of said oscillator network and having contactor elements in circuit with a portion of said power amplifier network, said relay being energizable while said oscillation network functions and constituting means operative, when oscillations in the oscillator network cease, for controlling the continuity of parts of said power amplifier network.

3. In a power transmission system, an oscillator network, a power amplifier network connected thereto, and a protective relay having a winding in circuit with a portion of said oscillator network and having contactor elements in circuit with a portion of said power amplifier network, said contactor elements constituting means for blocking the operation of said power amplifier network in the event of failure of said oscillator network to generate oscillations, whereupon the winding of said relay would be de-energized.

4. In a high frequency signal transmission sys-

tem, a high frequency oscillator circuit, a power amplifier circuit connected therewith, a relay device having a contactor and an actuating winding, said actuating winding being connected to a part of said oscillator circuit and said contactor being disposed in circuit with at least one of the electrodes of said power amplifier and means for actuating said contactor upon the failure of oscillations in said high frequency oscillator circuit whereby said power amplifier is protected against the passage of destructive currents through any of its circuits.

5. In a high frequency signal transmission system, a high frequency oscillator constituted by an electron tube including a grid circuit and an anode circuit, a power amplifier including an electron tube having input and output circuits with the input circuit thereof connected with the anode circuit of said oscillator tube, a relay having a set of contacts and an actuating winding, said actuating winding being disposed in the grid circuit of said oscillator tube and said contacts being disposed in circuit with at least one of the electrodes of said power amplifier tube whereby cessation of oscillations in said oscillator circuit interrupts the continuity of the electrode circuit of said power amplifier.

6. In a signal transmission system, an electron tube oscillator having input and output circuits, a power amplifier constituted by an electron tube having input and output circuits with the input circuit thereof coupled with the output circuit of said oscillator, a relay constituted by an actuating winding and a set of contacts, said set of contacts being disposed in at least one of the electrode circuits of said power amplifier and said winding being connected in one of the circuits of said oscillator and effective upon cessation of oscillations in said oscillator for interrupting at least one of the electrode circuits in said power amplifier.

7. In a high frequency signal transmission system a high frequency oscillator, a power amplifier connected with said oscillator, said power amplifier including a multi-electrode tube, and means responsive upon cessation of oscillations in said oscillator for interrupting the continuity of at least a portion of the electrode circuits of said power amplifier to protect the same from the passage of destructive currents, said means including a relay having an actuating winding connected in circuit with a portion of said oscillator and switching contacts in circuit with said portion of the electrode circuits of said power amplifier.

8. In a signal transmission system an oscillator, a power amplifier circuit having a multiple electrode tube connected therewith, and means for depolarizing at least one of the electrodes of said tube with respect to the cathode thereof, upon cessation of oscillations in said oscillator, said means comprising a relay having an actuating winding in circuit with a portion of said oscillator and contactor means in circuit with at least one of the electrodes of said power amplifier tube.

9. In a signal transmission system, an electron tube oscillator, a power amplifier connected therewith having an electron tube which comprises a cathode, a control grid and other electrodes and a relay system connected with and operable from said electron tube oscillator comprising switching means connected to said control grid and at least one of the other electrodes, operable upon the cessation of oscillations through said electron tube oscillator for opening the circuit to said control grid and for depolarizing at least one of the other electrodes with respect to said cathode.

10. In a signal transmission system, an electron tube oscillator, a power amplifier connected with said oscillator, said power amplifier including a multiple electrode tube having a grid circuit and an output circuit, means including a relay having an actuating winding connected in the grid circuit of said electron tube oscillator, said relay also comprising contactor means disposed in series with one of the electrodes of said power amplifier tube and with the grid biasing circuit thereof, said contactor means being adapted to protectively modify the amplifier circuit, when oscillations through said electron tube oscillator cease.

11. In a signal transmission system, an electron tube oscillator, a power amplifier connected with said oscillator, said power amplifier including an electron tube having a cathode, a control grid for which a biasing circuit is provided, and an anode, a relay device including an actuating winding in circuit with the grid of said oscillator and including also contactor means disposed in said biasing circuit and adapted to render said control grid sufficiently negative to block the tube of said power amplifier when oscillations through said electron tube oscillator cease.

12. In a signal transmission system, an electron tube oscillator, a power amplifier connected with said oscillator, said power amplifier including an electron tube having a cathode, a control grid and an anode, a relay device including an actuating winding in circuit with the grid of said oscillator and including also contactor means operable when oscillations through said electron tube oscillator cease, to interrupt the potential supply to said anode.

13. In a signal transmission system, an electron tube oscillator, a power amplifier connected with said oscillator, said power amplifier including an electron tube having a cathode, a control grid and an anode, a relay device including an actuating winding in circuit with the grid of said oscillator and including also contactor means operable when oscillations through said electron tube oscillator cease, to isolate the control grid of said power amplifier from its cathode.

14. In a signal transmission system having an electron tube oscillator, an electron tube amplifier connected therewith, and a relay the winding whereof is in circuit with a portion of said oscillator, the method of protecting said amplifier against a destructive flow of space current, upon the cessation of oscillations in said oscillator, which comprises energizing said winding to normally maintain the continuity of parts of said electron tube amplifier and utilizing the condition of interruption of grid current flow in said oscillator to de-energize said winding and to disable said electron tube amplifier.

15. In a signal transmission system having an electron tube oscillator, an electron tube amplifier connected therewith, and a relay the winding whereof is in circuit with a portion of said oscillator, the method of protecting said amplifier against a destructive flow of space current, upon the cessation of oscillations in said oscillator, which comprises energizing said winding to normally maintain the continuity of parts of said electron tube amplifier and utilizing the condition of interruption of grid current flow in said oscillator to de-energize said winding and to effect an isolation of the tube cathode of said amplifier from the circuit of at least one of the other tube electrodes thereof.

16. In a signal transmission system having an electron tube oscillator, an electron tube amplifier connected therewith, and a relay the winding whereof is in circuit with a portion of said oscillator, the method of protecting said amplifier against a destructive flow of space current, upon the cessation of oscillations in said oscillator, which comprises energizing said winding to normally maintain the continuity of parts of said electron tube amplifier and utilizing the condition of interruption of grid current flow in said oscillator to de-energize said winding and to effect a depolarization of at least one of the tube electrodes of said amplifier with respect to its tube cathode.

17. In a signal transmission system having an electron tube oscillator, an electron tube amplifier connected therewith, and a relay the winding whereof is in circuit with a portion of said oscillator, the method of protecting said amplifier against a destructive flow of space current, upon the cessation of oscillations in said oscillator, which comprises energizing said winding to normally maintain the continuity of parts of said electron tube amplifier and utilizing the condition of interruption of said grid current flow in said oscillator to de-energize said winding and to effect a disconnection of at least one of the tube electrodes of said amplifier from its cathode and simultaneously depolarizing at least one other of said tube electrodes with respect to said cathode.

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