Jan. 5, 1932. J. W. COOK 1,839,650

TRANSMITTER SYSTEM

Filed Oct. 30, 1926

Fig. 1.

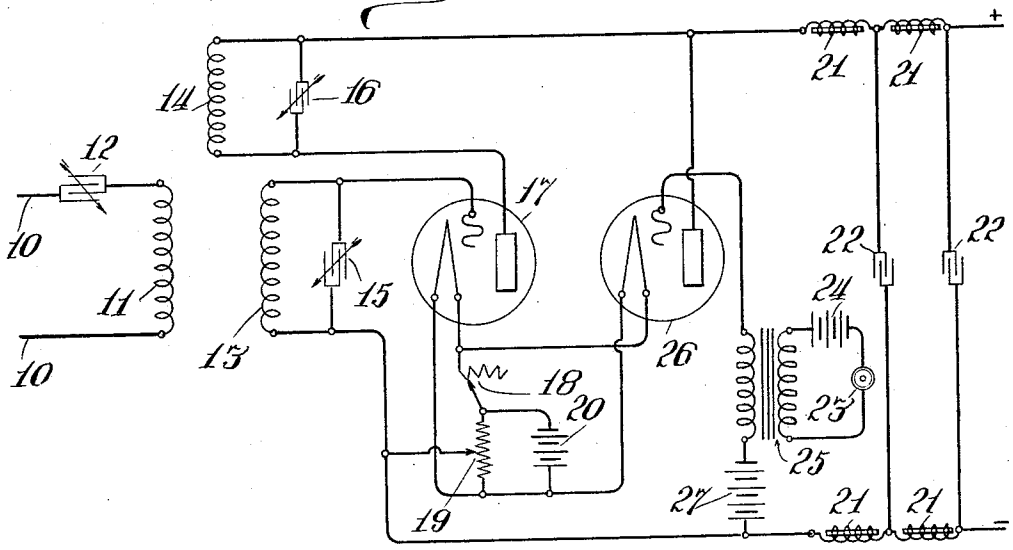
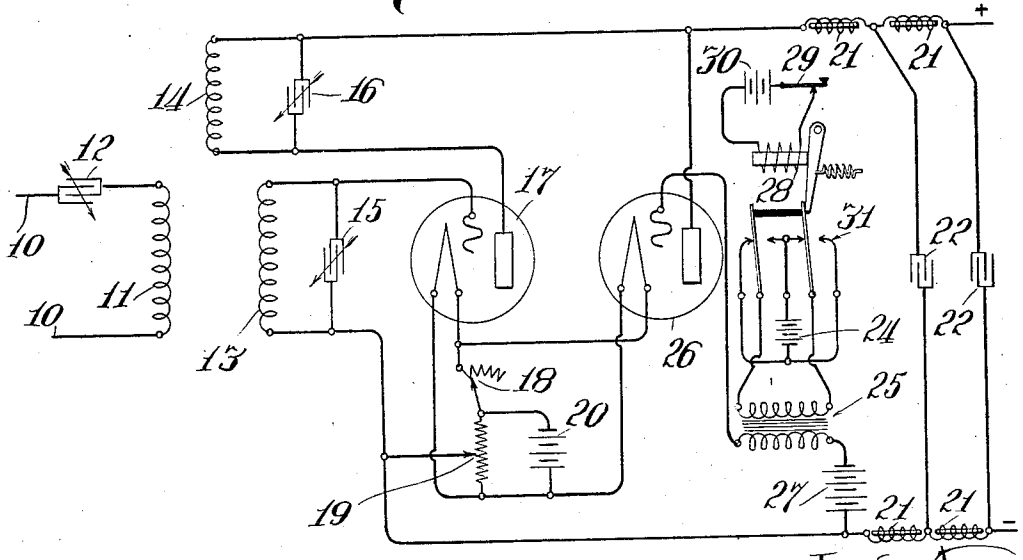


Fig. 2.



Witnesses
Milton Lenoir
Elmer L. Quickel

Inventor
John W. Cook
By George Herdman
Attorney

Patented Jan. 5, 1932 1,839,650

UNITED STATES PATENT OFFICE

JOHN W. COOK, OF TOPEKA, KANSAS

TRANSMITTER SYSTEM

Application filed October 30, 1926. Serial No. 145,117.

An object of the invention is to provide an oscillation and modulation system of an efficient and stable type wherein the plate current source can be taken from generators supplying telegraph circuits or other circuits, being particularly designed for wired wireless or multiplex telephone or signal service employing untransposed wires.

The system is also adapted for use in radio telephone or telegraph service.

The main object of the invention is an improved means for producing modulated high frequency currents or currents above audibility in which the modulated high frequency currents are not further modulated by the disturbances from the conductors connected to the output side of the transmitter. Such a condition would exist when the transmitter would be connected to un-transposed wires in signaling service. This is accomplished by inductively coupling the grid and plate circuits and inductively coupling the output coil to avoid direct connection between the elements of the generating means and between the output circuit. By directly connecting any part of the high frequency generating means to un-transposed wires would produce distortion due to inductive leakage from the wires modulating the high frequency currents. High frequency currents are currents above audibility in following references.

The inductance coils in the oscillation circuit are not a part of the line or antenna circuit and therefore the frequency of the wave radiated will not change with slight changes in the inductance of these coils.

The separation of tuning coils with associated condensers from direct contact one with the other produces a very stable and more powerful generator of high frequency currents due to the separate tuning of the different elements and by their arrangement in the circuit causes both tubes to mutually aid each other in producing high frequency currents and modulating same as will be described.

By the use of a transformer coil having a primary secondary ratio high enough to excite a voltage, on the grid of the second tube of one polarity and on the grid of the first tube of an opposite polarity, higher than the voltage on the plates of the respective tubes; and the high impedance of whose secondary coil also tends to keep the load on the secondary side of the transformer coil at a nearly constant value, no resistances or other means are required to hold the load on the transformer coil. Connected in series in the grid circuit of the second tube is a battery which provides a negative grid bias whereby the plate current is decreased through the second tube. This is necessary as the second tube acts as an oscillator with the first tube aiding its action. Just as each mutually aids in the modulation of the high frequency currents. If the plate filament current in the first tube and in the second tube were equal there would be no high frequency currents generated.

By means of two or more heavy choke coils of approximately two henries each in value in series in the positive lead and two or more heavy choke coils of values of approximately two henries each in the negative lead of the plate current source and shunting the current source between the choke coils with condenser capacities of one or more microfarads each it is possible to keep a nearly fixed current source on the plates of the tubes and by so doing keep back any varying of the current source; such as would be caused by the current source feeding other circuits. Machines supplying other circuits and the plate circuits of the tubes would be an example.

The heavy inductances and condenser shunts in plate power supply leads holds the positive negative voltages common to the plate circuit of the first and second tubes very nearly constant during the mutually aiding action between the first and second tube.

The above enumerated objects and the advantages of my improved system will all be more fully comprehended from the following detailed description of the accompanying drawings, wherein:—

Figure 1 is a diagrammatic view of a producer and transmitter of a high frequency modulated oscillator, wherein two valves or

tubes are connected in parallel through variable air condensers, for use in telephone or voice transmission.

Figure 2 is a diagrammatic view illustrating the systems shown in Figure 1, except that the system in Figure 2 has been modified for signal transmission.

Figures 1 and 2 are diagrams of the transmitter system in which the output terminals of the system are shown at 10, 10. Connected to these terminals are an air core inductance coil 11 and a variable air condenser 12. This coil 11 is in variable inductance relation to the air core inductance coils 13 and 14; coils 13 and 14 are shunted by variable air condensers 15 and 16. 17 and 26 illustrate vacuum tubes or valves containing grids, plates and filaments; 18 is a rheostat in the filament circuit; 19 is a potentiometer shown connected across a current source 20 for heating the filaments of the tubes 17 and 26 and variably connected to the grid circuits. 21 are impedance coils and 22 are fixed condensers arranged to prevent any inductive interference from the current source for the plate circuit and to prevent any reactance from the current source. 23 is a telephone transmitter and 24 is a current source connected in series with the primary coil of an induction coil 25 which is of a very high ratio.

As the general arrangement of the circuits is substantially the same in the various illustrations, similar elements have been designated by the same reference characters in the two figures.

Figure 2, where the same general arrangement of the circuit and elements shown in Figure 1 are employed, illustrates the adaptation of my improved system for the transmission of signals.

In this figure, instead of employing the transmitter 23, I employ a relay of low resistance 28, which has a key 29 and a battery 30 connected in series, in order that the relay armature may be opened and closed; the opening and closing of the relay armature being induced by the opening and closing of the key 29; the relay armature opens and closes a set of spring contacts 31 which produces positive and negative pulses from the battery 24 to the primary of coil 25.

The action of the improved transmitter system is described as follows: From the arrangement of the elements in the circuit, it can be seen that the circuit is in a condition for producing modulated high frequency currents. That is, the inductance coil 14 in series in the plate circuit of the generator tube 17 causes a magnetic excitation of inductance coil 13 in series in the grid circuit of the generator tube 17 when current source is supplied to the tubes and in turn excites back on coil 14 which continuous acting-back on the plate circuit causes generation of high frequency currents. By inductively connecting the inductance coils 14 and 13 with the output coil 11 without direct connection between the plate or grid or output circuits, any disturbances, due to inductive leakage from line wires connected to it are prevented from modulating the high frequency currents generated. This arrangement also permits a better adjustment of the grid and plate circuits of the transmitter as they are not directly connected. As the inductance coils in the generative or oscillation circuit are not a part of the line or antenna circuit, the frequency of the wave sent out or radiated will not change with slight variations in the inductances of these coils, thus making a more stable circuit.

Since the plate of tube 26 is directly connected to the magnetically excited coil 14 which is in the plate circuit of tube 17, and the grid circuit of tube 26 is directly connected to the magnetically excited coil 13 in the grid circuit of the tube 17, a condition is brought about whereby tube 26 also acts as a generator or oscillator of high frequency currents and which results in more powerful high frequency currents being produced by the transmitter circuit. This can be seen by removing tube 26 from the transmitter circuit and noting the decrease in high frequency currents generated as compared with tube 26 in circuit. The plate current source must be very nearly fixed in this circuit and this is accomplished by the insertion of two or more heavy choke coils of an approximate inductance of 2 henries each in the positive side of the plate current source and the insertion of two or more heavy choke coils of an approximate inductance of 2 henries each in the negative side of the plate current source and shunting the current source with capacities connected between the choke coils and connected between the current source and the choke coils.

A battery 27 is connected in series with the negative side to the grid of tube 26, whereby the plate space current in tube 26 is reduced to a value very much below the plate space current flowing through tube 17. In tests made, the best results were obtained with a current of .025 amperes flowing through the plate circuit of tube 26 and .125 amperes current flowing through the plate circuit of tube 17. It is necessary to have a greater flow of plate current through tube 17 than through tube 26, as providing the plate space current through tube 26 equals the plate space current through tube 17, tube 26 would act as a shunt to prevent starting-oscillations of the high frequency current. The secondary of a high ratio transformer coil 25 is also connected in series with this battery between the grids of tube 26 and of tube 17. This transformer coil 25 has a very high ratio so that when ac-

tuated by its primary circuit means, it exerts an alternating voltage charge on the grid of tube 26 higher in voltage than the voltage of the plate current supply of tube 26. Likewise, as the grid of tube 17 is connected at the opposite end of the secondary of transformer coil 25 and also through the filament path, the grid of tube 17 receives a grid voltage charge of opposite polarity to grid charge on tube 26. This grid action being opposite in both tubes at the same instant increases the plate current in one tube and decreases the plate current in the other tube and since the plate battery source is constant, a decrease in plate flow through one tube increases the plate flow through the other tube by its parallel connection, thus both actions accelerate the modulation effect.

It can be seen that tube 26 generates high frequency currents due to its connection in the circuit and this can be shown by removing tube 26 which decreases the line current. Thus it can be seen that both tubes act as modulators and as generators of high frequency currents. Variable resistance 18 shown in both figures is not a vital part of the circuit as the circuit will function satisfactorily without it. It allows a closer tuning of high frequency current generation however, although not necessary to the circuit action.

It was found desirable to produce the strongest modulation effect possible and this was accomplished after tests by use of the high ratio transformer coil 25 whereby a grid voltage charge could be obtained that would produce the greatest effect on the plate current possible, and likewise since tube 26 plate space current had been lowered by connecting battery 27 in the grid circuit to prevent shunting the generator action in tube 17, a much stronger varying voltage charge was required on the grid of tube 26.

The current action through the three element tubes may be explained as follows:

The grid filament circuit of tube 26 and the grid filament circuit of tube 17 are connected in series with a common circuit through the filament battery resistance shunt and filament connections. Tube 26 grid filament circuit is connected in series through the secondary of a high ratio transformer 25, high voltage battery 27 and filament resistance shunt 19. Tube 17 is connected in series with inductance coil 13 to the same resistance shunt 19, the negative side of battery 27 is connected to the grid of the tube 26, and the voltage of this battery is of such a value that it produces a high negative value on the grid of tube 26 through the high resistance of the transformer coil secondary. Thus the amount of plate space current through tube 26 is much lower than the amount of plate space current through tube 17. When variable currents are sent through the transformer coil 25, its high ratio produces pulsating current of a value high enough to reverse the bias on the grid of tube 26 as high a positive as the normal negative bias, and the plate space current having been reduced is modulated with great effect. As the grid filament circuits of each tube have one path common to both circuits, namely the filament connections and the connection to battery resistance shunt 19, any variable like change in one circuit will produce like changes in the other. Thus both tubes act as modulators and likewise from their parallel connection in the circuit both act as oscillators.

I have described what I believe to be the simplest adaptations of my improved system; it will be understood, however, that certain modifications may be made without departing from the spirit of my invention; it being also understood that my improved transmitting system is adapted to operate in conjunction with the wires or conducting means of telegraph circuits while said wires or conducting means are in service. For example, one wire may be in quadruplex telegraph service and one wire may be in printer telegraph service; and any suitable number of valves connected in multiple may be employed to function in the manner hereinbefore described; the present application relating to subject matter divided out of my pending application Serial No. 21,486.

What I claim is:

1. In a transmitting system two three element tubes both acting as oscillators and modulators having a common battery source connected through a variable resistance to the filament circuits of said tubes, with a voltage source connected across the plate filament circuits of said tubes in series with an adjustable resistance connected across the filament battery of said tubes and a connection from the negative side of plate battery source to the common side of the grid filament circuits of said tubes, said grid filament circuits being connected in series, one through the secondary of a high ratio transformer coil and high voltage battery to a variable resistance shunted across the filament battery source, the other through an impedance coil shunted by a variable condenser to the same variable resistance connection.

2. In a transmitting system two three element tubes having a common battery source connected through a variable resistance to the filament circuits of said tubes, with a voltage source connected across the plate filament circuits of said tubes in series with an adjustable resistance connected across the filament battery of said tubes and a connection from the negative side of plate battery source to grid filament circuits of said tubes,

one of said grid filament circuits being connected in series through the secondary of a high ratio transformer coil and high voltage battery to filament resistance shunt, the other grid filament circuit being connected in series through an inductance coil to said filament resistance shunt.

JOHN W. COOK.