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POWER SUPPLY SYSTEM

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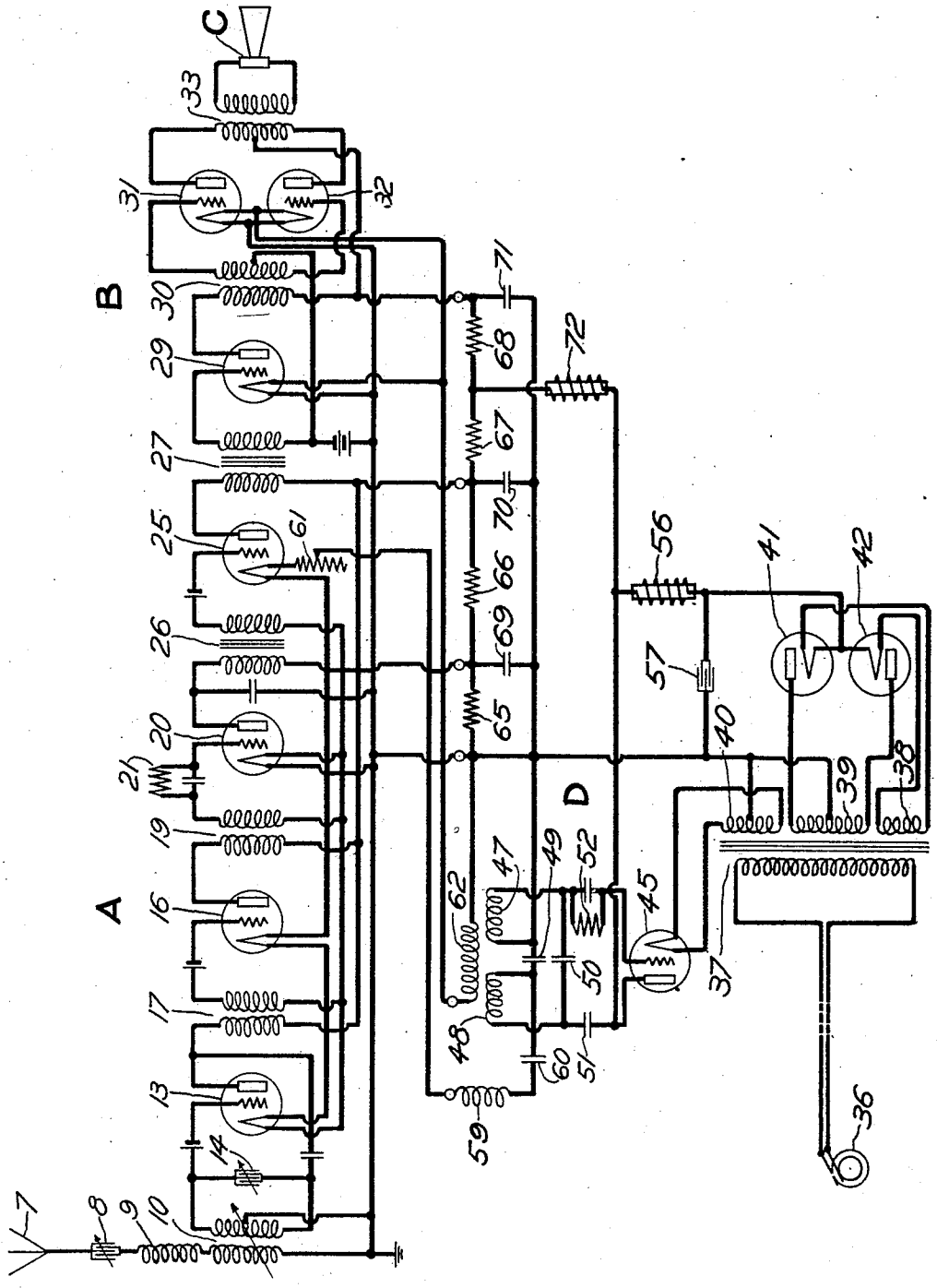

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POWER SUPPLY SYSTEM

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This invention relates to transmission system and more particularly to power systems for radio and amplifying systems, including electron discharge devices of the three-element type.

An object of the invention is to supply the necessary electrical energy for electron discharge devices from standard commercial lighting systems.

Various arrangements have been suggested heretofore for heating the filaments of vacuum tubes by alternating current of the frequencies usually obtainable from commercial power lines. With these arrangements it has been practicable to reduce the audible frequency disturbance to a negligible amount only in amplifiers having one or two stages or where only the last one or two stages of a multi-stage system are provided with alternating current heating. It has also been found impracticable to use low frequency currents to heat the cathodes of vacuum tubes used as detectors of high frequency currents.

In accordance with this invention it is possible to heat the cathodes of electron discharge devices used both for detecting and amplifying purposes by alternating current without introducing objectionable disturbances. They may also be so heated when more than two discharge devices are connected in tandem.

In carrying out the invention an alternating current of a super audible frequency is supplied to the electron discharge devices, which may be used both for radio receiving and amplifying purposes, to heat the cathodes of such devices.

More specifically, the invention contemplates the provision of a vacuum tube oscillation generator which is operated by a current derived from a vacuum tube rectifier set, and which supplies to the respective circuits currents of a super audible frequency for lighting the filaments of the discharge devices of both the receiving and amplifying systems. As shown herein the invention is applied to a radio receiving system, and the filament heating current supplied to the radio frequency portion of the circuit is of a super audible frequency, which is also low enough that it does not combine with the radio frequencies to form audible frequency components.

The potentials for the plate electrodes of the respective electron discharge devices are supplied from the vacuum tube rectifier set through a potentiometer which gives the required potentials to the respective plate electrodes. In order to enable the use of the power system or current supply set by amateurs, suitable means is provided to permit the operation of the vacuum tube rectifier set by currents derived from commercial or residence lighting systems.

Other objects of the invention will be apparent from the following detailed description and claims.

In the single figure of the drawing, one embodiment of the invention is illustrated.

Referring now to the drawing, there is shown a radio receiving system, "A" an amplifying set "B", a loud speaking receiver "C" and a power system or current supply set "D".

The radio receiving system "A" comprises an antenna 7 which is connected to ground through an adjustable condenser 8, an inductance 9, and the primary winding of an adjustable coupling 10. The secondary winding of the adjustable coupling 10 is connected to the input circuit of a vacuum tube 13 which serves as the first stage of radio frequency amplification. Connected in bridge of the input circuit of the vacuum tube 13 is an adjustable condenser 14 for increasing the selectivity of the circuit. Following the vacuum tube 13 is a vacuum tube 16, which is connected to the vacuum tube 13 by means of a radio frequency transformer 17. The vacuum tube 16, like vacuum tube 13, functions as an amplifier of waves of the radio frequency, it being now well-known that better results are obtained through the amplification of the waves prior to their detection. It is, of course, understood that although two stages of radio frequency have been shown, obviously other stages may be added if desired.

Inductively coupled by vacuum tube 16, through transformer 19 is a vacuum tube 20

serving as a detector of the radio signal waves. As shown the detection is of the type in which there is provided in the grid circuit of the vacuum tube 20 a grid leak 21 consisting of a resistance and a condenser. Following the vacuum tube 20 or the detector is a vacuum tube 25 which is connected to the output circuit of the detector 20 by means of a transformer 26, and which serves as an amplifier of the audible frequency waves.

The amplifier set "B" is connected to the output circuit of the vacuum tube 25 by means of a transformer 27. The secondary winding of the transformer 27 is connected to the input circuit of a vacuum tube 29, which has its output circuit connected to the primary winding of a transformer 30. The secondary winding of transformer 30 is connected to the input circuit of a pair of vacuum tubes 31 and 32, which are connected in push-pull relation.

The loud speaking receiver "C" is connected to the output circuits of the vacuum tubes 31 and 32 through a transformer 33.

The current for heating the filaments of the electron discharge devices making up the receiving system A and those in the amplifier set B, and the potentials for the plate electrodes thereof, are supplied from a power system or current supply set D. In the system illustrated the alternating current generator 36 which is shown diagrammatically to illustrate a standard commercial or residence lighting system of 110 volts at a frequency of 60 cycles is connected to the primary winding of a transformer 37 for stepping up the voltage to approximately 1,000 volts. The turns of the secondary winding of the transformer 37 is divided into a number of different sets 38, 39 and 40. The set 38 is connected to the cathodes of a pair of vacuum tube rectifiers 41 and 42 through which the cathodes receive current for heating them to incandescence. The secondary 39 is connected to the plate electrodes of the vacuum tube rectifiers 41 and 42, which serve to rectify the alternating current. The resulting direct current serves to supply the plate circuits of the electron discharge devices of the radio receiving system A, the amplifier set B and the oscillation generator D.

As illustrated the oscillation generator comprises a vacuum tube 45 which has its filament connected to the secondary 40 of the transformer 37 whereby alternating current is supplied to its filament for heating it to incandescence, and which has its grid and plate electrodes connected to inductance coils 47 and 48. The inductance coils 47 and 48 are suitably coupled to coil 62. The plate and filament of the oscillator 45 are connected to the circuit of the vacuum tube rectifiers 41 and 42 between the neutral point on the secondary winding 39 and the filaments of the rectifier tubes. A condenser 49 is connected between the coils 47 and 48 which are bridged by a condenser 50. These elements taken together, constitute the oscillation circuit. The impedance of condenser 49, however, is low as compared with that of condenser 50, and the latter provides most of the condensive reactance for determining this frequency. By selecting the values of these elements the frequency generated by the oscillation generator may be made almost any desired value. In the present case it is desired that the frequency be high, say in the super-audible range. Therefore, the size of the inductances 47 and 48 and the condenser 50 must be small. In order to prevent the flow of direct current to the coil 48 a blocking condenser 51 is connected between the plate electrodes and this coil. Also to prevent the introduction of objectionable disturbances caused by the harmonics of the alternating current generator 36 and the rectifier tubes 41 and 42, a filter consisting of inductance 56 and condenser 57 is connected in the direct current supply circuit. Connected between the coil 47 and the grid electrode of tube 45 is a grid leak 52 comprising a resistance which in combination with a condenser maintains the average grid potential of the oscillating tube 45 at a suitable negative value.

With the arrangement described, when current starts to flow in the plate circuit of tube 45, current is induced from coil 48 to coil 47 thereby changing the charge on the grid electrode. The resultant change produces a change in the current in the plate circuit. When the grid becomes more negative by the current thus produced, the current in the plate circuit decreases, while if the grid is made more positive, the plate current increases. These variations cause an alternating current to flow, the frequency of which is dependent upon the applied potential and the values of the inductances 47 and 48 and condenser 50.

The type of oscillation generator shown in the present case is similar to that of Patent No. 1,472,470 to R. V. L. Hartley, and since the generator itself is not being claimed, a more detailed description thereof is believed unnecessary.

The current for heating the filaments of the electron discharge devices of the receiving system which is made up of devices 13, 16, 20 and 25, is derived from the oscillation generator by taking the potential drop across the condenser 49. It should be noted that one terminal of the condenser 49 is grounded, therefore the filaments of the devices 13, 16, 20 and 25 are at substantially ground potential. Due to the high harmonics of the current generated certain frequencies are produced which approach the frequency of the radio waves and which might introduce objectionable disturbances in the operation of the electron discharge devices as, for example, by beating with the radio frequencies.

Therefore, to prevent the impression of the higher harmonics on the filaments a filter consisting of an air core inductance 59 and a condenser 60 is connected in the circuit extending between the condenser 49 and the filaments of devices 13, 16, 20 and 25. The condenser 49, being of low impedance to the harmonics, serves also to aid in their suppression. There is also connected in this circuit an adjustable resistance 61 to permit of variation in the filament current.

It should be noted that a vacuum tube is employed for detecting purposes and that radio amplification occurs in more than one stage and in spite of the fact that the filaments are lighted by alternating current no appreciable hum or disturbance is produced in the loud speaking receiver C. Such result is due primarily to the fact that high voltages and small current are employed in the primary circuit of the oscillator.

The filter consisting of inductance 56 and condenser 57 as is well known, tends to store or delay the action of the current delivered by the vacuum tube rectifiers 41 and 42 to the oscillation generator. In order that the current delivered by the oscillation generator will be free from modulation, the filter consisting of the condenser 57 and the inductance 56 should be operated at a high flux density of course allowing a reasonable factor of safety. In the case of the inductance 56, it is dependent only on the number of ampere turns, while with regard to the condenser 57, the energy stored is dependent primarily on the voltage. The energy of the condenser may be computed by the use of the following formula:

$$\text{Energy} = \tfrac{1}{2} C E^2$$

where C is the capacity of the condenser and E the voltage applied to the condenser. It is seen from the above formula that by using a high voltage and small current the condenser may function at substantially its maximum flux density, thereby providing a more efficient filter without increasing the capacity. With such an arrangement a current is delivered to the oscillation generator free from ripples and harmonics, therefore it is possible for the oscillation generator to generate an alternating current of a high frequency substantially free from modulation. Since there is no appreciable modulation in the current generated by the oscillation generator, the electron discharge devices may be satisfactorily operated on alternating current without the objectionable hum and disturbances which have been heretofore present in such systems, especially in cases where an attempt has been made to operate the dectector tube on alternating current.

In one example of the arrangement above described, where the output energy required of the oscillator was 20 watts, the oscillator tube was designed to work with a plate voltage of 750 volts, thus giving the high voltage and low current desired for efficient operation of the direct current filter. The filaments of the devices 29, 31 and 32 which make up the amplifier set B are lighted by the current induced in coil 62. The harmonics of the oscillator which, as above stated, are excluded from the circuit A, are included in the heating current for the audio-frequency amplifier. The output efficiency of the oscillator is thus considerably greater than that of the usual type of oscillator which is required to produce a pure sine wave of one frequency.

The potentials of the plate electrode of the respective electron discharge devices are derived from the vacuum tube rectifiers 41 and 42, the gradation of the potentials being obtained by the use of a potentiometer consisting of resistances 65, 66 and 67. In accordance with the established practice the plate electrode of the detector device 20 is supplied with 22½ volts, taken at a point between resistances 65 and 66, and the potential of 45 volts for electrodes of tubes 13, 16 and 25, taken from the point between resistances 66 and 67. Now in the case of the plate electrodes of the electron discharge devices 29, 31 and 32, which require a higher potential, approximately 120 volts the supply is taken from the resistance 67 through another resistance 68. Coupling between various stages of the receiver and amplifier is prevented by the use of condensers 69, 70 and 71.

In order that the rectified current impressed on the plate circuits will be free of disturbances a choke coil 72 is connected in the connection leading from the rectifier tubes 41 and 42 to the potentiometer. Such a choke coil serves to further smooth out the current rectified by the rectifiers. The choke coil 72 also serves to prevent the oscillations of the oscillation generator from being impressed on the plate electrode. The value of the inductance of the choke coil 72 should be such that the condensers 69, 70 and 71 and the inductance will not resonate at the ripple frequency of the rectifier, this frequency being twice the fundamental impressed.

Although the invention has been disclosed and described with reference to a particular circuit arrangement, it is of course obvious that various alterations and modifications may be made without departing from the spirit and scope of the present invention.

The invention claimed is:

1. In combination, a plurality of thermionic discharge devices certain of which operate at low anode potentials, a source of alternating current energy, a thermionic discharge tube oscillation generator for producing ultra-audio oscillations, means for heat-

ing the cathode of said oscillator tube from said source of alternating current energy, said oscillation generator operating at a high anode potential whereby the low frequency fluctuations in the cathode heating current have but slight effect on the amplitude of the generated oscillations and means for employing said generated oscillations to heat the cathodes of said plurality of thermionic discharge devices.

2. The combination as defined in claim 1 and including a device for rectifying alternating current from said source, and means for supplying from the rectified current energy the low anode voltage to said certain of said thermionic discharge devices and the high anode voltage to said oscillation generator tube.

3. The combination defined in claim 1 and in which said plurality of discharge devices operate in tandem in a high-frequency translating system, said oscillation generator having one output circuit for supplying cathode heating current to the initial devices and another circuit for supplying cathode heating current to the final devices of the tandem arrangement, said first circuit including a filter for suppressing harmonics of the generated oscillations.

4. A system for energizing from a single source of alternating current energy a plurality of thermionic discharge tubes connected in tandem, one of which is a detector, comprising a thermionic discharge tube oscillation generator of ultra-audio frequency oscillations having a cathode heated by current from said source, a rectifier for supplying rectified anode potential from said source to the anodes of all of said discharge tubes including said oscillation generator tube, and connections for supplying the ultra-audio frequency oscillations from said generator to the cathodes of said plurality of thermionic devices, the anode potential of said oscillation generator being many times greater than that of said detector.

5. A current supply system for vacuum space discharge devices having cathodes and anodes comprising a low frequency source of alternating current, a vacuum tube rectifier for converting said alternating current to direct current, means for supplying the direct current directly to the anodes of said discharge devices, a vacuum tube oscillator separate from said devices, energized from the output of said rectifier for generating high frequency current, and means to supply said high frequency current to the cathodes of said discharge devices.

6. A current supply system for vacuum space discharge devices having cathodes and anodes, comprising a low frequency source of alternating current, a vacuum tube rectifier for converting said alternating current to direct current connected to said source, a plurality of circuit branches for the output circuit of said rectifier, one of said branches including the anodes and cathodes of said discharge devices and supplying anode potential to said anodes, a vacuum tube oscillator adapted to oscillate at frequencies above the audio range energized from a second of said branches, and connections from said oscillator to the filaments of said devices for supplying superaudible frequency current thereto.

7. In combination, a radio receiver including filament and plate circuits, an oscillation generator for generating currents of ultra audio frequency differing from the received signal frequency, connections for supplying power to said plate circuit and to said generator, and connections for supplying oscillating filament heating current from said generator to said filament circuit.

8. In combination, a radio receiver having plate and filament circuits, an ultra audio frequency oscillation generator for generating currents of ultra audio frequency differing from the received signal frequency, connections for supplying power to said plate circuits and said generator, connections for supplying oscillating filament heating current from said generator to said filament circuits, and means for preventing modulation of the ultra audio frequency output of the oscillation generator.

9. The method of operating a thermionic valve having a cathode and a control electrode which comprises heating the cathode thereof by ultra audio frequency oscillating current and maintaining the control electrode thereof sufficiently negative with respect to the cathode to prevent any substantial flow of current through the control electrode.

In witness whereof, I hereunto subscribe my name this 5th day of December, A. D. 1923.

HUGH M. STOLLER.