

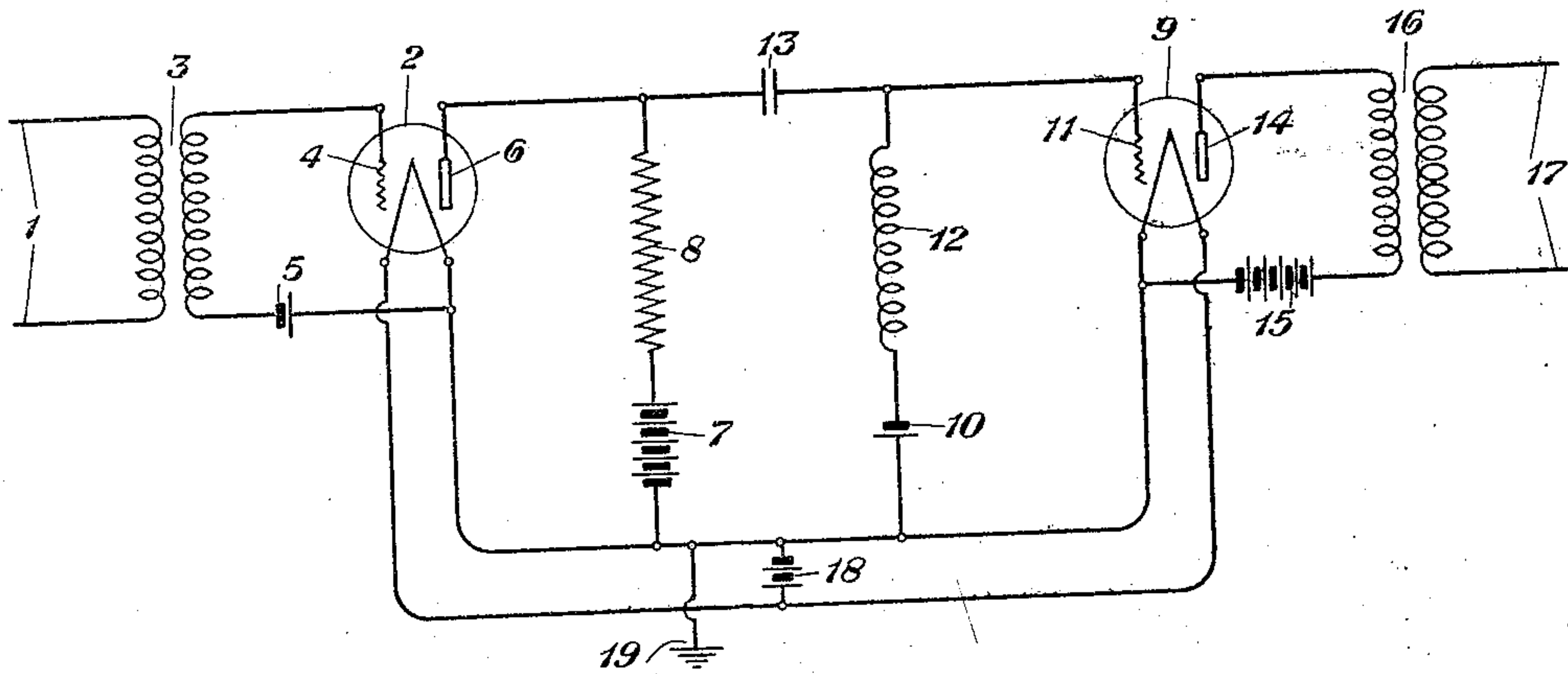
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AMPLIFYING SYSTEM

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AMPLIFYING SYSTEM

Continuation of application Serial No. 49,561, filed August 11, 1925. This application filed April 8, 1931. Serial No. 528,670.

This is a continuation of my application, Serial Number 49,561, filed August 11, 1925.

This invention relates to amplifying systems.

It is an object of this invention to provide means for coupling two or more elements in an amplifying system so that the amplification at a given frequency or in a given frequency band may be large compared with the amplification in another given frequency band which is higher in the frequency spectrum, the amplification of said latter frequency band being practically constant or uniform throughout.

Another object is to provide an amplifying system in which a given frequency or frequency band is effectively amplified while the amplification for frequencies below said given frequency or frequency band decreases rapidly as the frequency decreases.

These objects are accomplished by making use of a vacuum tube amplifier having two or more vacuum tubes coupled in a manner hereinafter described.

It is common in voice frequency telephone amplifying systems to find that the very low frequencies are rapidly attenuated as a result of the use of reactive elements unsuitable for the circuits to which they are connected. According to the present invention it is proposed to so connect two or more vacuum tubes in each of one or more of the amplifiers associated with such a system that the low frequencies which have been attenuated elsewhere in the system will be amplified more than those frequencies which have not been attenuated in order to thereby compensate for the attenuation of the low frequencies.

A condenser is connected between the plate electrode of one tube and the grid electrode of the succeeding tube and an inductance is associated therewith so that at the frequency of resonance greater amplification takes place than at other frequencies, as will appear more fully in the detailed description hereinafter following. The discrimination as to the frequency is also flexible and subject to change, as one condenser and one inductance may easily be substituted for another condenser and another inductance, the size of the con-

denser and the size of the inductance in all cases being chosen with due regard to the range of frequencies to be specially amplified. In order to increase the relative amplification of the frequency band, or the width of the frequency band, or both, a plurality of such vacuum tubes so coupled may be connected in tandem.

A good understanding of the invention may be had from the description hereinafter following when read in connection with the accompanying drawing showing a preferred embodiment of the invention, in which two vacuum tubes are connected in tandem.

Referring to the drawing, a source 1 represents diagrammatically any source for supplying currents having various frequencies, such as a telephone system, only some of which are to be amplified to a greater extent than other frequencies.

The source 1 supplies currents to the amplifier tube 2 which may be of the three-element type, through the transformer 3. The grid 4 of this vacuum tube may be maintained at suitable negative potential by means of the battery 5. The plate 6 is supplied with space current by battery 7 through the impedance 8. Another vacuum tube 9 is connected in tandem with vacuum tube 2.

The battery 10 provides the grid 11, through inductance 12, with suitable negative potential. A condenser 13 has one terminal directly connected with the plate 6 of the vacuum tube 2 and another terminal directly connected with the grid 11 of the vacuum tube 9, and serves, first, to confine the currents from batteries 7 and 10 to their respective circuits, and second to resonate with inductance 12, as will be described hereinafter. The plate 14 of the vacuum tube 9 is supplied with space current from battery 15 through one winding of the transformer 16. Currents in the plate circuit of the vacuum tube 9 are transmitted to the output 17 through the transformer 16. The battery 18 supplies the current necessary to heat the filaments of vacuum tubes 2 and 9, the negative terminal of this battery being grounded at 19.

In a simple series circuit containing inductance and capacity there is a definite value

of the frequency for which the total reactance of the circuit is zero, and the impedance of the circuit is just equal to the resistance of the circuit. This frequency is known as the frequency of resonance, and the circuit is then said to be in a condition of resonance at this frequency. The impedance of the circuit at the frequency of resonance has its smallest value and the current which flows in the circuit has its greatest possible value.

In the simple series circuit in which a current flows having a frequency equal to the frequency of resonance, there are voltages set across the terminals of the inductance and the terminals of the capacity which are much greater than the voltage applied to the circuit, the voltage of the inductance opposing the voltage of the capacity. It is also a fact that at the frequency of resonance the voltage across the inductance has the same value as the voltage across the capacity.

All frequencies coming in from the source 1 are impressed on the input circuit of the vacuum tube 2 through transformer 3. These voltages are amplified in a manner well known in the art and appear in amplified form in the output circuit of the vacuum tube 2, which consists of battery 7, impedance 8, plate 6, and the filament of the vacuum tube 2. These frequencies pass through the condenser 13 and are impressed on the input circuit of the vacuum tube 9. These are further amplified by vacuum tube 9 and appear in the output circuit thereof, which consists of battery 15, one winding of the transformer 16, plate 14 and the filament of the vacuum tube 9. These are then transmitted to the output 17 through the transformer 16.

Condenser 13 and inductance 12 together form a simple series circuit having a characteristic frequency of resonance. Current appearing in the output circuit of the vacuum tube 2 that has a frequency equal to the frequency of resonance of this simple series circuit, is shunted through the condenser 13 and inductance 12 so that a potential is impressed across the terminals of the inductance 12, which is higher than the potential impressed between the plate and filament of the tube 2, provided inductance 12 is of the proper magnitude, as will be referred to later.

Since at the frequency of resonance a potential is impressed on the input circuit of the vacuum tube 9 which is higher than the potential of other frequencies greater amplification occurs at this frequency than at all other frequencies. This arrangement therefore acts like a transformer coupled amplifier in which the transformation ratio varies with the frequency, the transformer acting like a step-up transformer at the frequency of resonance, and like a unity radio transformer at other higher frequencies.

By inserting resistance in series with the

inductance 12 the width of the band to be specially amplified and the magnitude of the voltage at the resonant frequency may be varied. By putting resistance in series with the inductance 12 the width of the resonant band is increased and the magnitude of the voltage at the resonant frequency is decreased. Similarly, by taking out resistance in series with the inductance 12 the width of the resonant band is decreased and the magnitude of the voltage at the resonant frequency is increased. It is to be also understood that the inductance 12 should have an impedance at the resonant frequency which is greater than the plate filament impedance of the vacuum tube 2, the amplification at the resonant frequency increasing as the ratio of the impedance of the inductance 12 to the plate filament impedance of the vacuum tube 2 increases. The arrangement such as is here disclosed may be employed in systems in which it is necessary to equalize the magnitudes of the various low frequencies which have been elsewhere attenuated. In other words, the arrangement may be employed to act like a low frequency equalizer or booster.

Inasmuch as the frequencies below the resonant band are attenuated in a system employing this embodiment of the invention the arrangement may be used in an amplifying system in which a frequency, or a band of frequencies, is to be amplified to a greater extent than other higher frequencies and at the same time to materially reduce the relative amplitudes of currents having frequencies below the frequencies of the resonant band.

A particular application of the invention may be had in connection with loud speakers. Many loud speakers inherently reproduce the low frequencies rather poorly, and therefore by boosting these low frequencies the reproduction by the loud speaker may be considerably improved.

It will be understood that while only two tubes have been shown for amplifying a particular frequency, that a plurality of tubes may be similarly connected, a capacity and an inductance being associated with each so that the voltages of the resonant frequencies of the inductances and capacities may be amplified to a greater extent than other frequencies.

While the invention has been disclosed in one particular embodiment which is deemed desirable, it is to be understood that it is capable of embodiment in other and widely varied organizations without departing from the spirit of the invention and scope of the appended claims.

What is claimed is:

1. A system for amplifying one range or band of audio frequencies to a greater extent than all other higher frequencies, including

two three-element vacuum tubes, the filament electrodes of which are tied together, a condenser connected between the plate electrode of the first vacuum tube and the grid electrode of the second vacuum tube, and an inductance having a very large resistance connected between the grid electrode of the second vacuum tube and the filament electrodes of both vacuum tubes, said condenser and said inductance forming a circuit which is resonant at the band or range of audio frequencies to be specially amplified.

2. A system for specially amplifying a band of low frequencies lying within the limits of audibility to a greater extent than all higher frequencies, including two three-element vacuum tubes, the filament electrodes of which are tied together, a condenser connected between the plate electrode of the first vacuum tube and the grid electrode of the second vacuum tube, a resistance, a high potential battery, said resistance and said battery being connected in series between the plate electrode of the first vacuum tube and the filament electrodes of both vacuum tubes, and an inductance having a large amount of resistance connected between the grid electrode of the second vacuum tube and the filament electrodes of both vacuum tubes.

3. An audio frequency amplification system constituted by a plurality of electron tubes each having input and output circuits, means coupling the output circuit of one electron tube with the input circuit of a succeeding electron tube comprising a circuit including conductively connected inductance and capacity elements cooperatively related for exaggerating the amplitude of particular frequencies and rendering the amplification uniform over another range of frequencies.

4. An audio frequency amplification system constituted by a plurality of electron tubes each having input and output circuits, means coupling the output circuit of one electron tube with the input circuit of a succeeding electron tube comprising a circuit having inductive reactance substantially equal to capacitive reactance over a predetermined frequency range to a predetermined limit and a circuit connected with said aforementioned circuit for effecting uniform transfer of signaling energy at frequencies above said predetermined limit to the input circuit of the next adjacent tube.

In testimony whereof, I have signed my name to this specification this 7th day of April, 1931.

LEE G. BOSTWICK.