

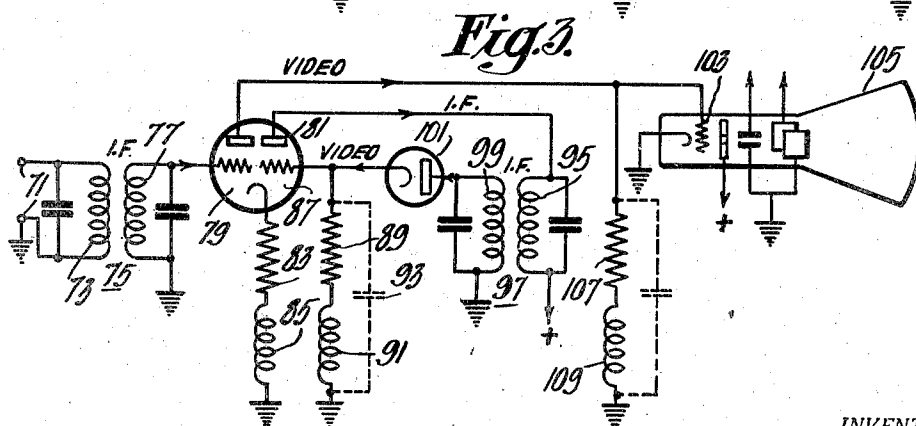
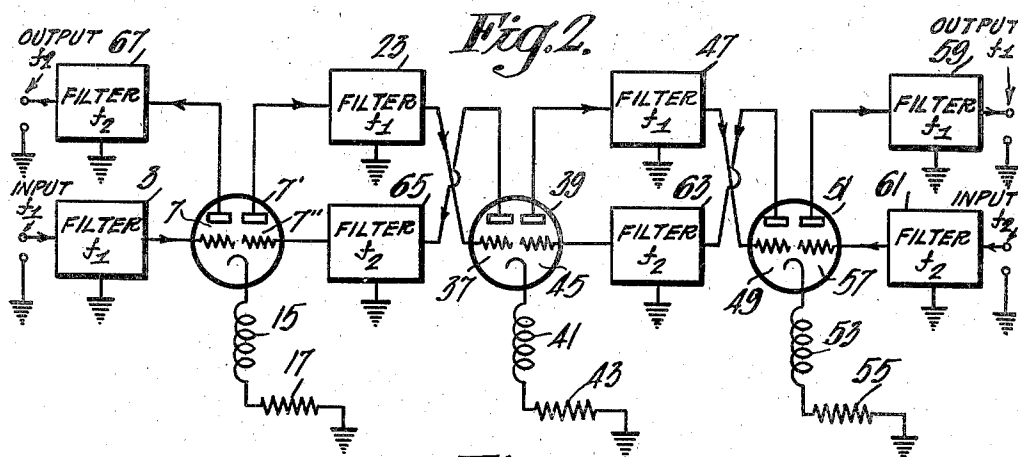
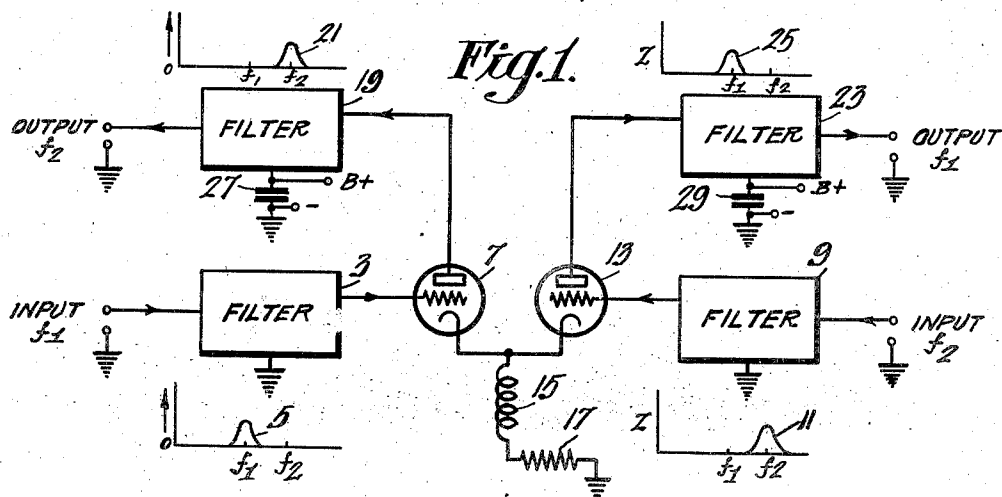
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BIDIRECTIONAL HIGH GAIN AMPLIFIER

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BIDIRECTIONAL HIGH GAIN AMPLIFIER

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This invention relates generally to signal amplifying systems and more particularly to improved bidirectional high gain thermionic tube amplifiers for selective transmission of two different wave bands or frequencies.

Basically, the system employs two triode thermionic tubes which are connected in such a manner that both act separately as cathode followers and grounded grid amplifiers for two applied signal frequencies or frequency bands. The grid and anode circuits of each of the tubes include band-pass filter networks which provide high impedance circuits at one of the applied frequencies and extremely low impedance circuits at the other applied frequencies. The cathode circuits of both tubes are connected to ground through a common reactive or reactive-resistive network. Thus, for each applied frequency, the first tube is a cathode follower, the cathode output voltage of which drives the cathode of the second tube which operates as a grounded grid amplifier. One of the frequencies is applied to the grid electrode of one of the tubes and the second frequency is applied to the grid of the other of the tubes. Amplified currents of the first frequency are derived from the anode of the second of the tubes, and amplified currents of the second frequency are derived from the anode of the first of the tubes.

A second embodiment of the invention employs a plurality of such bidirectional amplifiers in cascade arrangement to provide extremely high gain at both frequencies with great stability of operation.

A third embodiment of the invention employs a similar bidirectional amplifier connected to provide reflex operation for simultaneous amplification of both intermediate frequency and video frequency signals in a television receiving system or similar circuit.

Among the objects of the invention are to provide an improved method of and means for amplifying simultaneously and in opposite directions two different frequency bands or signals through a common amplifying circuit. A further object of the invention is to provide an improved high gain bidirectional amplifying system. An additional object of the invention is to provide an improved high gain bidirectional cascaded amplifier. Another object of the invention is to provide an improved reflex amplifier employing a novel bidirectional high gain amplifier circuit. Still another object of the invention is to provide an improved reflex circuit for simultaneous amplification of intermediate frequency and

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video frequency signals in a television receiving system. An additional object of the invention is to provide a bidirectional high gain amplifier system having great stability of operation and low noise characteristics.

The operation will be described in greater detail by reference to the accompanying drawing of which Figure 1 is a block schematic diagram of one embodiment of the invention, Figure 2 is a block schematic diagram of a second embodiment of the invention providing cascade operation of a plurality of systems as shown in Figure 1, and Figure 3 is a schematic circuit diagram of a bidirectional reflex amplifying system. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figure 1, signals of a first frequency f_1 are applied through a first bandpass filter network 3, having a shunt impedance characteristic as illustrated, for example, in the graph 5, to the grid electrode of a first thermionic triode 7. Similarly, signals of a second frequency f_2 are applied through a second bandpass filter network 9, having a shunt impedance characteristic as illustrated, for example, in graph 11, to the grid electrode of a second triode thermionic tube 13. The cathodes of the first and second triodes 7, 13, are connected together, and are connected to ground through an inductor 15 and a series-connected resistor 17. The first and second bandpass filters 3, 9, also are grounded.

The first bandpass filter 3 is selected to provide a high input shunt impedance for signals of the first frequency f_1 applied to the grid electrode of the first thermionic tube 7, and to have substantially zero shunt impedance between the grid of said tube and ground at the second applied frequency f_2 . Similarly, the second bandpass filter provides high input shunt impedance for the second signal frequency f_2 , while providing substantially zero impedance between the grid of the second tube 13 and ground at the first signal frequency f_1 .

The anode circuit of the first triode 7 includes a third bandpass filter network 19 having similar impedance characteristics to those of the second bandpass filter network 9, as illustrated in the graph 21. The anode circuit of the second triode 13 includes a fourth bandpass filter network 23 having similar impedance characteristics to the first bandpass filter network 3 as indicated in the graph 25. Thus, the first triode anode circuit is at relatively high impedance to ground at the second signal frequency f_2 , while

it is substantially short-circuited to ground at the first signal frequency f_1 . Also, the anode of the second triode 13 is at relatively high impedance with respect to ground at the first signal frequency f_1 , while it is substantially short-circuited to ground at the second signal frequency f_2 .

A source of anode energizing potential is applied across a first bypass capacitor 27 which is connected in series with the ground connection of the third filter network 19 for energizing the anode of the first triode 7. Similarly, anode voltage for the second triode 13 is applied across a second bypass capacitor 29 which is connected in series with the ground connection of the fourth filter network 23.

In operation, signals of the first applied frequency band, or frequency, f_1 are cathode-coupled from the first triode 7 to the cathode of the second triode 13, and the second triode operates as a grounded-grid amplifier to provide output signals of the frequency f_1 at the output terminals of the fourth filter network 23. Simultaneously, signals of the second frequency f_2 , which are amplified in the second triode 13, are cathode-coupled to the cathode of the first triode 7, which operates as a grounded grid amplifier, and the amplified output of which is derived from the output of the third filter network 19.

For simple bandpass networks comprising, for example, two inductively or capacitively coupled parallel tuned circuits, such as are shown in the signal input circuit of Figure 3, the applied signal frequencies preferably should have a frequency ratio of at least 3 to 1 to provide the required selectivity and proper operation of the circuit. For more complex and more highly selective filter networks, the frequency ratio between the applied signals may have a lower value.

Since the first amplifier tube for each of the applied signals is a cathode follower, and since the second amplifier tube in each instance is a grounded grid amplifier, great stability of operation is obtainable with relatively high amplification gain, since the anode currents of the two triodes vary in opposite sense while the input and output signals at each frequency are of the same polarity, and substantially no regeneration is encountered. Also, at each of the applied signal frequencies the input reactance is substantially high, permitting effective amplification of signals of relatively wide band width, while the second tube in either direction employs a grounded grid which acts as a shield between the input and output signals.

Due to the fact that triodes thus may be employed to provide relatively high gain, the stability and signal-to-noise ratio of the amplifier is substantially superior to circuits employing pentodes, and the effects of variations of energizing potentials are minimized.

The series resistor 17 in the common cathode circuit is optional, and may be required only in instances wherein one of the applied signal frequencies is relatively low or includes low frequency or D.-C. components.

In the circuit of Figure 2, the principles of the bidirectional amplifier of Figure 1 are employed to provide a cascaded high gain bidirectional amplifier for two frequency bands f_1 and f_2 . All of the bandpass filters employed in the circuit are tuned to pass either of the applied frequencies f_1 or f_2 , and to provide effective short-circuits

to ground for the other of these frequencies. In effect, the output filter networks from each of the triode sections also are employed as input filter networks for the next succeeding tube section.

A first input filter 3 is similar to that described heretofore with respect to Figure 1 and may have an impedance characteristic as shown, for example, in graph 5 of Figure 1. Input signals of the frequency f_1 are applied to the grid electrode of the first triode section 7, which may comprise, for example, one section of a double triode 7'. The common cathode of the double triode 7' is grounded through the serially-connected inductor 15 and resistor 17. The anode of a second triode section 7'' of the double triode 7' is connected through a second f_1 bandpass filter 23, having an impedance characteristic, for example, as shown in graph 25 of the circuit of Figure 1, to the grid of the first triode section 37 of a second double triode 39. The common cathode of the second double triode 39 is grounded through a second inductor 41 and a serially-connected second resistor 43.

The anode of the second diode section 45, of the second double triode 39, is connected through a similar third f_1 bandpass filter 47 to the grid of the first triode section 49 of a third double triode 51. The common cathode of the double triode 51 is grounded through a third serially-connected inductor 53 and resistor 55. The anode of the second triode section 57 of the third double triode 51 is connected through a similar fourth f_1 bandpass filter 59 to the output terminals for the first applied frequency f_1 .

Similarly, the second input frequency f_2 is applied through a fifth f_2 bandpass filter 61, having a characteristic as illustrated in graph 21 of the circuit of Figure 1, to the grid electrode of the second triode section 57 of the third double triode 51. The anode of the first triode section 49 of the third double triode 51 is connected through a sixth f_2 bandpass filter 63 to the grid of the second triode section 45 of the second double triode 39.

The anode of the first triode section 37 of the second double triode 39 is connected through a seventh f_2 bandpass filter network 65 to the grid of the second triode section of the first double triode 71. The anode of the first triode section 7 of the first double triode 7' is connected through an eighth f_2 bandpass filter 67 to the output terminals for the second applied frequency f_2 . The sixth, seventh and eighth f_2 bandpass filters 63, 65, 67 may have similar impedance characteristics to the fifth f_2 bandpass filter 61, as described heretofore.

Thus, in operation, signals of the frequency f_1 applied to the input terminals of the first f_1 bandpass filter network 3 are successively amplified in the two sections of the first double triode 7'. The amplified signals are then applied through the second f_1 filter network 23 and again amplified through the sections of the second double triode 39. The signals then are passed through the third f_1 filter network 47, amplified further in the third double triode 51 and applied through the fourth f_1 filter 59, to the output terminals for the first frequency f_1 .

Similarly, signals of the frequency f_2 applied through the fifth f_2 filter 61 are amplified by the two sections of the double triode 51, passed through the sixth f_2 filter network 63, amplified by the two sections of the second double triode

33, passed through the seventh f_2 filter 35, amplified by the two sections of the first double triode 77 and thence passed through the eighth f_2 filter network 67 to the output terminals for the second frequency f_2 .

Thus the cascade arrangement of the bidirectional amplifier system provides independent utilization of three double triodes for separate amplification of the two applied frequencies or frequency bands f_1 and f_2 . As described heretofore with respect to the circuit of Figure 1, the filter networks, indicated as resonant to either of the applied frequencies f_1 and f_2 , must be so designed, in accordance with known practice, that the desired selectivity is provided. Since the input and output signals for each frequency from each of the double triodes are in phase, regeneration is minimized, and high gain with great stability and high signal-to-noise ratio are provided without the necessity of employing pentodes with their known disadvantages.

In Figure 3 the principles of the bidirectional amplifier are employed to provide a reflex amplifier for use in television receiving systems. Intermediate frequency signals having the desired video frequency modulation, derived from the first detector of a conventional television receiver, not shown, are applied to the input terminals 71 which are connected across the tuned primary section 73 of a first intermediate frequency transformer 75. The tuned secondary section 77 of the first intermediate frequency transformer 75 is connected across the grid-cathode circuit of a first triode section 79 of a double triode 81. The common cathode of the double triode 81 is grounded through a serially-connected cathode resistor 83 and cathode inductor 85. The grid of the second triode section 87 of the double triode 81 is grounded through a serially-connected grid resistor 89 and grid inductor 91. The distributed capacity across the grid resistor and inductor 89, 91 is indicated by the capacitor 93, shown in dash lines.

The anode of the second triode section 87 is connected to the tuned primary winding 95 of a second intermediate frequency transformer 97. The tuned secondary winding 99 of the second intermediate frequency transformer 97 is connected through a diode 101 to the grid of the second triode section 87 of the double triode 81. The anode of the first triode section 79 is connected to the control electrode 103 of a conventional kinescope television tube 105 to control the intensity of the electron beam applied to the television receiver fluorescent screen. A second grid resistor 107, serially connected through a second grid inductor 109, is interposed between the kinescope grid 103 and ground. The remaining connections to the kinescope 105 may be in accordance with conventional practice.

The video-modulated I. F. signals, applied through the first I. F. transformer 75, are amplified in the two sections of the double triode 81, as explained heretofore in the circuits of Figures 1 and 2, and are then applied through the second I. F. transformer 97 to the diode detector 101. The intermediate frequency signal components derived from the diode detector 101 are bypassed to ground through the grid network 89, 91, 93, while the video signal components are applied to the grid of the second triode section 87 of the double triode 81. The amplified video signal components derived from the anode of the first triode section 79 thence are applied to the control electrode 103 of the kinescope 105. Thus the

double triode 81 provides two-stage amplification of both modulated I. F. and of video signals derived from the diode detector 101 for operation of the kinescope.

It should be understood that the principles of the reflex amplification combined with the bidirectional amplification described heretofore may be employed in combination with others of the known types of radio and communication circuits, and that the embodiment of the invention illustrated in Figure 3 is not limited to its television application.

Thus the invention described comprises an improved method of and means for providing high gain stable amplification of two frequencies by means of a novel bidirectional amplifier system.

I claim as my invention:

1. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including an input circuit and an output circuit and having a common cathode circuit whereby said tubes may be operated as mutual cathode followers, means for applying signal currents of one frequency to the input circuit of said first tube, means for applying signal currents of a different frequency to the input circuit of said second tube, means for deriving from said second tube amplified currents of said one frequency, and means for deriving from said first tube amplified currents of said different frequency.

2. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including an input circuit and an output circuit and having a common cathode circuit whereby said tubes may be operated as mutual cathode followers, means for applying signal currents of one frequency to the input circuit of said first tube, means for applying signal currents of a different frequency to the input circuit of said second tube, means for deriving from said output circuit of said second tube amplified currents of said one frequency, and means for deriving from said output circuit of said first tube amplified currents of said different frequency.

3. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including a grid circuit and an anode circuit and having a common cathode circuit whereby said tubes may be operated as mutual cathode followers, means for applying signal currents of one frequency to the grid circuit of said first tube, means for applying signal currents of a different frequency to the grid circuit of said second tube, means for deriving from said second tube amplified currents of said one frequency, and means for deriving from said first tube amplified currents of said different frequency.

4. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including a grid circuit and an anode circuit and having a common cathode circuit whereby said tubes may be operated as mutual bidirectional cathode followers, means for applying signal currents of one frequency to the grid circuit of said first tube, means for applying signal currents of a different frequency to the grid circuit of said second tube, means for deriving from said anode circuit of said second tube amplified currents of said one frequency, and means for deriving from said anode circuit of said first tube amplified currents of said different frequency.

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5. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including a grid circuit and an anode circuit and having a common cathode circuit whereby said tubes may be operated as mutual bidirectional cathode followers, means tuned to pass currents of one of said frequencies and substantially to short-circuit currents of a different frequency for applying said signal currents of said one frequency to the grid circuit of said first tube and for short-circuiting currents of said different frequency between said grid and cathode circuits of said first tube, means tuned to pass currents of said different frequency and substantially to short-circuit currents of said one frequency for applying said signal currents of said different frequency to the grid circuit of said second tube and for short-circuiting currents of said one frequency between grid and cathode circuits of said second tube, selective means for deriving from said second tube amplified currents of substantially only said one frequency, and additional selective means for deriving from said first tube amplified currents of substantially only said different frequency.

6. A bidirectional amplifier for two frequencies including a pair of thermionic tubes each having at least grid and anode circuits and a common cathode circuit, a first input circuit tuned to pass currents of one of said frequencies and substantially to short-circuit currents of the other of said frequencies, a second input circuit tuned to pass currents of said other of said frequencies and substantially to short-circuit currents of said one of said frequencies, means for applying currents of said one frequency through said first input circuit to the grid-cathode circuit of one of said tubes, means for applying currents of said other frequency through said second input circuit to the grid-cathode circuit of the other of said tubes, a first output circuit tuned similarly to said first input circuit and connected to the anode circuit of said other of said tubes, a second output circuit tuned similarly to said second input circuit and connected to the anode circuit of said one of said tubes, means for deriving amplified currents of substantially only said first frequency from said first output circuit, and means simultaneously for deriving amplified currents of substantially only said second frequency from said second output circuit.

7. A bidirectional amplifier for two frequencies including a pair of thermionic tubes each having at least grid and anode circuits and a common cathode circuit whereby said tubes may be operated as mutual bidirectional cathode followers, a first input circuit connected across the grid-cathode circuit of one of said tubes and tuned to pass currents of one of said frequencies and substantially to short-circuit currents of the other of said frequencies, a second input circuit connected across the grid-cathode circuit of said other of said tubes and tuned to pass currents of said other of said frequencies and substantially to short-circuit currents of said one of said frequencies, means for applying currents of said one frequency through said first input circuit to said grid-cathode circuit of said one of said tubes, means for applying currents of said other frequency through said second input circuit to said grid-cathode circuit of said other of said tubes, a first output circuit tuned similarly to said first input circuit and connected to the anode circuit of said other of said tubes, a second output circuit tuned similarly to said second input circuit

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and connected to the anode circuit of said one of said tubes, means for deriving amplified currents of said first frequency from said first output circuit, and means simultaneously for deriving amplified currents of said second frequency from said second output circuit.

8. A bidirectional amplifier for two frequencies including a pair of thermionic tubes each having at least grid and anode circuits and a common cathode circuit whereby said tubes may be operated as mutual bidirectional cathode followers, a first input circuit connected across the grid-cathode circuit of one of said tubes and tuned to pass currents of one of said frequencies and substantially to short-circuit currents of the other of said frequencies, a second input circuit connected across the grid-cathode circuit of the other of said tubes and tuned to pass currents of said other of said frequencies and substantially to short-circuit currents of said one of said frequencies, means for applying currents of said one frequency through said first input circuit to said grid-cathode circuit of said one of said tubes, means for applying currents of said other frequency through said second input circuit to said grid-cathode circuit of said other of said tubes, a first output circuit tuned similarly to said first input circuit and connected across the anode-cathode circuit of said other of said tubes, a second output circuit tuned similarly to said second input circuit and connected across the anode-cathode circuit of said one of said tubes, means for deriving amplified currents of substantially only said first frequency from said first output circuit, and means simultaneously for deriving amplified currents of substantially only said second frequency from said second output circuit.

9. A cascaded bidirectional amplifier comprising, in combination, a pair of amplifiers as described in claim 1 and including third and fourth amplifying tubes each including grid and anode electrodes and having a common cathode circuit whereby said third and fourth tubes may be operated as mutual bidirectional cathode followers, means for applying amplified currents of said one frequency derived from said second tube of the first of said pair of amplifiers to the grid of said third tube, means for applying amplified currents of said different frequency derived from said first tube of the other of said pair of amplifiers to the grid of said fourth tube, means connecting the anode of said third tube to the input circuit of the second tube of the first of said pair of amplifiers, and means connecting the anode of said fourth tube to the input circuit of the first tube of the other of said pair of amplifiers.

10. A cascaded bidirectional amplifier comprising, in combination, a pair of amplifiers as described in claim 8 and including third and fourth amplifying tubes each including grid and anode electrodes and having a common cathode circuit whereby said third and fourth tubes may be operated as mutual bidirectional cathode followers, means for applying amplified currents of said one frequency derived from said second tube of the first of said pair of amplifiers to the grid of said third tube, means for applying amplified currents of said different frequency derived from said first tube of the other of said pair of amplifiers to the grid of said fourth tube, means connecting the anode of said third tube to the input circuit of the second tube of the first of said pair of amplifiers, and means connecting the anode of said fourth tube to the input circuit of the first tube of the other of said pair of amplifiers.

11. A reflex amplifier for modulated signals including first and second amplifying tube means each including grid and anode circuits and having a common cathode circuit whereby said amplifying tube means may be operated as mutual bidirectional cathode followers, band pass filter means for applying said modulated signal to said amplifying tube means, a signal detector responsive to signals from said amplifying tube means, means for deriving the modulation component of said detected signals, means for applying said modulation signal component to said amplifying tube means in the opposite direction to said modulated signal, and means for utilizing amplified modulation signals derived in said opposite direction from said amplifying tube means.

12. A bidirectional amplifier for signal currents of different frequency including first and second amplifying tubes each including an input circuit and an output circuit and having a common coupling circuit whereby said tubes may be operated as mutual cathode followers, means for applying sig-

nal currents of one frequency to the input circuit of said first tube, means for applying signal currents of a different frequency to the input circuit of said second tube, means for deriving from said second tube amplified currents of said one frequency, and means for deriving from said first tube amplified currents of said different frequency.

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