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BAND-PASS AMPLIFIER

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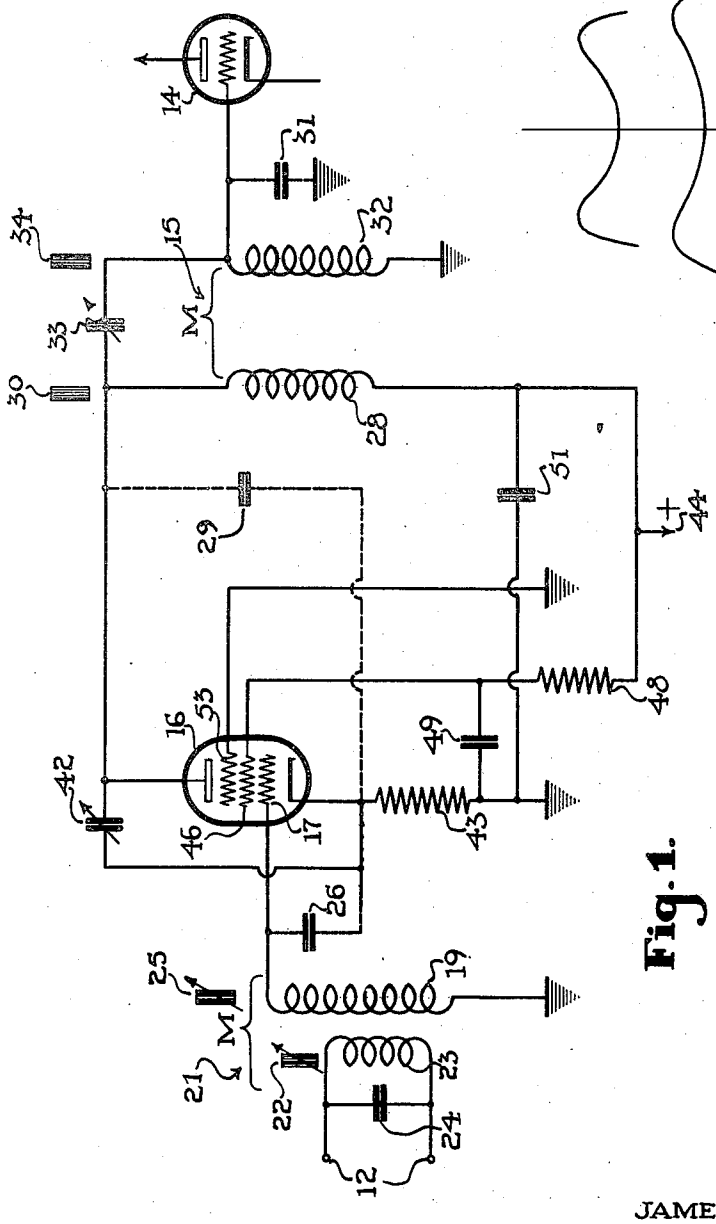


Fig. 1.

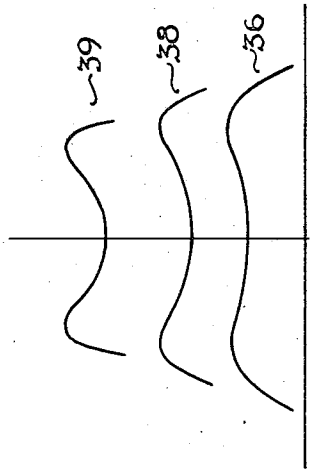


Fig. 2.

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BAND-PASS AMPLIFIER

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The present invention relates to amplifiers, and more particularly to a novel radio frequency band-pass amplifier having a wide pass-band and a relatively high signal-to-noise ratio.

A major object of the present invention is to increase the gain of a band-pass amplifier within controlled amounts and without substantially restricting the band-pass action or decreasing the signal-to-noise ratio.

Another object of the present invention is to increase the gain of a band-pass amplifier in a novel manner by employing regeneration in combination with degeneration.

Still another object of the present invention is to increase the gain of a band-pass amplifier with negligible change of band width and without substantial change in the center frequency of the pass-band.

Other advantages of the present invention will, of course, become apparent and immediately suggest themselves to those skilled in the art to which the invention is directed from a reading of the following specification in connection with the accompanying drawing in which:

Fig. 1 shows a portion of an amplifier embodying the present invention; and

Fig. 2 shows a series of curves used in explaining the operation of the amplifier of Fig. 1.

Referring to Fig. 1 of the drawings, there is shown in detail one stage of an amplifier embodying the invention having input terminals 12 and a succeeding tube 14 which may constitute a following stage of the amplifier or a separate amplifier. Inasmuch as the output circuit of the tube 14 is not concerned with the disclosure of the present invention, it is not shown in detail. The tube 14 is coupled to the preceding stage by a transformer 15. A tube 16 is provided with a control grid 17 which serves as an input electrode by reason of its connection to one terminal of the secondary 19 of a coupling transformer 21. The other end of this secondary is indicated as being connected to ground which, as usual in such apparatus, may be a metallic part of an apparatus support such as an amplifier chassis, or may be connected to a manually or automatically adjusted source of voltage, negative with respect to ground, by means of which the gain of the stage may be controlled under strong signal conditions. Increasing negative bias will also cause the response characteristic to progress from 39 through 38 to 36 (Fig. 2) and beyond.

The transformers 21 and 15 are adjusted for a band-pass characteristic which is obtained, in known manner, by closely coupling the two circuits of which the primary and secondary of each transformer is a part. These circuits in practice are preferably brought into resonance by the use of adjustable cores in the coils. The primary 23 of the transformer 21 is or may be tuned by a core 22 of minutely divided magnetic particles movably mounted so as to be adjustable with respect to the primary. This circuit may, if desired, be tuned by a condenser 24, depending upon the character of the input circuit connected to the terminals 12. The secondary 19 of the transformer 21 is tuned by a core 25, similar to the core 22. The condenser 26 represents the distributed capacity of the tube 16 between its grid and cathode and other capacities which may be present in the input circuit, or if desired, an actual physical condenser may be added at this point. The primary 28 of the transformer 15 is tuned by a core 30 which is similar to the core 22. The condenser 29 represents the plate-to-cathode capacity of the tube 16 and, if desired, an additional physical condenser may be inserted at this point. The secondary 32 of the transformer 15 is tuned by a core 34 which is also similar to the core 22. A condenser 31 represents the grid-to-cathode capacity of the tube 14. The tuning capacities, which, as stated above, may be the inter-electrode capacities, may reduce to the tube plus socket plus wiring capacities for maximum L/C ratio. In addition to the transformer 15, a coupling between the circuits of the tubes 16 and 14 may be obtained by an adjustable condenser 33. If desired, the condenser 33 may contribute to or replace the coupling provided by the mutual inductively coupled primary and secondary of the transformer 15.

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The overall response characteristic of the circuit arrangement of Fig. 1 is shown in Fig. 2. The center frequency of the pass-band is marked 0, and the spacing of the curve peaks indicates approximately the useful width of the pass-band. The lower curve, designated by reference character 36, indicates the amount of gain which is obtained without regeneration. Curves 38 and 39 indicate the beneficial effect of regeneration as it is utilized in the arrangement of Fig. 1. Feedback to produce regeneration is provided by an adjustable condenser 42, while degeneration is provided by an unbypassed cathode resistor 43. A suitable source of direct current plate and screen voltage, indicated at 44, is connected to the screen grid 46 of the tube 16 through a resistor 48 which is bypassed to ground by a condenser 49. The plate supply is bypassed by a condenser 51. The suppressor grid 53 of the tube

is grounded as shown. The tube 16 may be, for example, a type 6AC7.

In operation of the circuit of Fig. 1, the tuned circuits of the transformers 21 and 15 and/or the condenser 33 are adjusted to give a band-pass characteristic. The amount of regeneration to be added will determine the degree of over-coupling for the resultant band-pass width. The condenser 42 may be tapped down on the primary 28 of the transformer 15 to decrease plate detuning and to provide for the use of a larger and less critical condenser for this purpose. The condenser 42 may also be tapped down on cathode resistor 43 to provide for use of a larger and less critical condenser, and also to control the relative proportions of regeneration and degeneration.

Regeneration first tends to insert negative resistance in the grid circuit of the tube 16, equivalently decreasing the input loading. As the circuits, including the primary and secondary of the transformer 21, are over-coupled, decreased loading increases the Q, which increases the degree of over-coupling. Regeneration in limited amounts is stable because it is used with degeneration provided in the illustrative example by the resistor 43. The net effect is to increase the gain up to two or three times with a negligible change of band width, but with a deeper over-coupling valley. The characteristic 39 of Fig. 2 exhibits this last named condition.

The primary 28 of the transformer 15 may require slight readjustment to keep equal peak heights, but the center frequency 0 (Fig. 2) will not shift. The magnitude of this effect depends a great deal on the point of feed for the condenser 33 on the plate side.

With the increase in gain, we may expect a like increase in noise. As long as the change in band width is not appreciable and/or the amount of regeneration is limited to meet these conditions, the signal-to-noise ratio is not predicted to change even though the gain has been increased. Stable increases in gain of two to three times are obtainable.

The above described amplifier is suitable for general use and may be used, if desired, as a radio frequency-amplifier, or an intermediate frequency-amplifier. Since possible uses of the amplifier of this invention will suggest themselves to those skilled in the art, these possible uses will not be enumerated.

Various alterations may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such alterations be considered within the purview of the present invention as defined by the hereinafter appended claims.

Having now described the invention, what is

claimed and desired to be secured by Letters Patent is the following:

1. A band-pass amplifier comprising an input transformer having a tuned primary and a tuned secondary, said primary serving as the input means for the amplifier, a vacuum tube, means for connecting said secondary to the input electrode of said vacuum tube, an output transformer having a tuned primary and a tuned secondary, means for connecting said primary of the output transformer to the output electrode of said vacuum tube, a cathode resistor, means including the cathode resistor for returning said secondary of said input transformer to the cathode of said tube, means including a capacitance for returning said primary of said output transformer to the cathode of said vacuum tube, said cathode resistor providing a degenerative effect, and a regenerative connection including a variable capacitance from said output electrode connection means to the cathode of said tube.

2. A band-pass amplifier comprising an input transformer having a tuned primary and a tuned secondary, said primary serving as the input means for the amplifier, a vacuum tube, means for connecting said secondary to the input electrode of said vacuum tube, an output transformer having a tuned primary and a tuned secondary, means providing an output connection from said secondary of said output transformer, means for connecting said primary of said output transformer to the output electrode of said vacuum tube, a capacitance for providing a coupling between said output electrode connecting means and said output connection from said output transformer secondary, means for providing a degenerative effect when operating in conjunction with said vacuum tube, and a regenerative connection including a variable capacitance from said output electrode connection means to the cathode of said tube.

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