April 29, 1941. J. A. RANKIN 2,239,830

WIDE BAND AMPLIFIER

Filed Oct. 1, 1938

Fig. 1

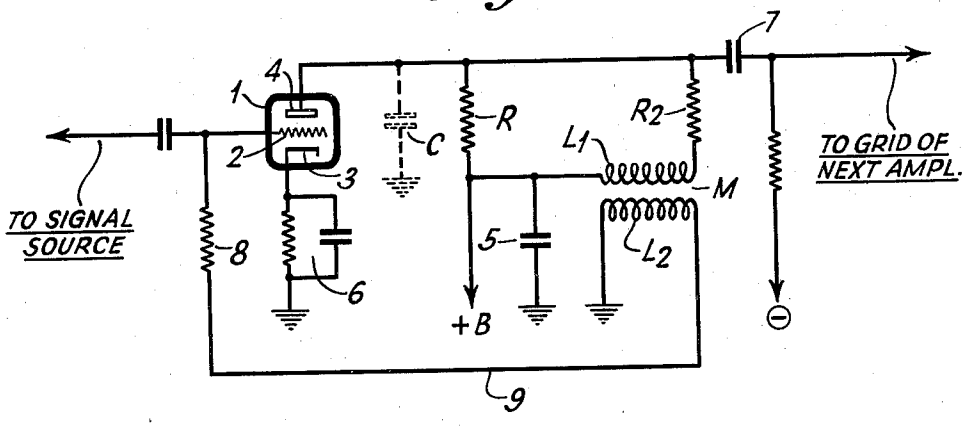
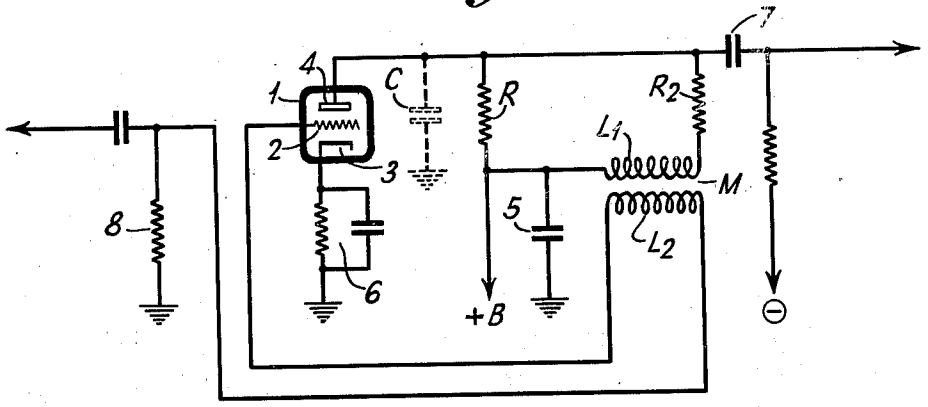



Fig. 2




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## WIDE BAND AMPLIFIER

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2 Claims. (Cl. 179—171)

My present invention relates to wide band amplifiers of the resistance-coupled type, and more particularly to a novel method of, and means for, compensating for the effect of inherent capacity in a resistance-coupled amplifier.

One of the main objects of this invention is to provide wide band amplification in a resistance-coupled amplifier by cancellation of the effect of inherent interstage capacities on the amplifier response curve; the cancellation being effected by feeding back from the output of the amplifier to its input a properly phased alternating voltage developed by the output alternating current across a path including a resistor in series with the primary of a feedback transformer, shunted across the output load; and the mutual inductance between the coils of the transformer imparting the correct phase to the feedback voltage.

Another object of my invention is to derive from the output circuit of a resistance coupled amplifier an alternating voltage which is in phase quadrature with the input signal voltage thereby to reduce the effect of the output capacity on the frequency-response curve of the amplifier.

Still other objects are substantially to improve the efficiency and operation of resistance-coupled amplifiers, and more especially to provide the latter with substantially flat response characteristics.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawing:

Fig. 1 is a circuit embodying the invention,

Fig. 2 shows a modification.

Referring now to the drawing, wherein like reference characters in the two figures indicate similar circuit elements, there is shown an amplifier tube 1 of any desired type between whose input electrodes 2 and 3 is connected a source of signal voltage. The latter may be a prior amplifier stage of a resistance-coupled amplifier; in general, the source of signal voltage may be of any type. Assuming for the present case that the tube 1 is included in a multistage resistance-coupled amplifier, those skilled in the art know that plate 4 is connected to the +B terminal of a direct current voltage source through the load resistor R. The capacity 5 bypasses the currents of signal frequencies to ground. The cathode 3 is connected to ground through the customary grid bias resistor-shunt capacity network 6; grid leak resistor 8 provides the biasing path for grid 2. The reference character C denotes the output shunt capacities, shown in dotted line as a lumped capacity across the load R. It is to be understood that the symbol C represents a lumped capacity made up of the output capacity of tube 1, the input capacity of the next tube and stray circuit capacities.

The signal voltage developed across load R, and in amplified form, is transmitted by coupling capacity 7 to the grid of the following amplifier. The latter may be of the same type as amplifier 1. The construction of resistance-coupled amplifiers of necessity depends on the frequency band which must be covered. In television work, where a wide frequency band is necessary for proper transmission of the radio frequencies, it is difficult to maintain a flat amplitude-frequency characteristic without large reduction in gain per stage. The fundamental cause of a drop in the amplitude response of resistance-coupled amplifiers at high frequencies is the fact that the shunt capacities C are unavoidable. Many arrangements have, therefore, been proposed to boost the response curve at the high frequency end to compensate for the drop in gain due to C.

According to the present invention the current bypassed by the element C is supplied by a feedback path comprising resistor $R_2$ in series with the primary winding $L_1$ of the transformer M. The resistor $R_2$ and transformer M are effectively in series, and are shunted across the load resistor R. The secondary winding $L_2$ of transformer M is connected by lead 9 to the grid circuit of the amplifier 1. There is, in general, developed across resistor $R_2$ an alternating voltage which is fed back across M (negative in polarity sign) and lead 9 to the amplifier input. The effect of this feed back voltage is to cancel out the shunting effect of capacity C. In other words, there is fed back across a —M an alternating voltage in quadrature with the signal input voltage thereby to cancel out C.

It is not believed necessary to complicate this description with a mathematical analysis. It is believed sufficient, for those skilled in the art, to state that flat amplitude-frequency response may be secured for such frequencies where the magnitude of $R_2$ greatly exceeds $(j\omega L)$ so that

the current through $L_1$ is directly proportional to plate volts. By way of illustration the coil $L_1$ may have a value of the order of 30 microhenrys; and the frequency band in megacycles should be of the order of 3 mc. For a type 1851 tube, for example, a gain of 90, for a band width of 3.2 mc., can be secured.

Fig. 2 shows a modified circuit arrangement wherein the coil $L_2$ is included in series between the grid condenser and the grid 2. The grid leak resistor 8 is grounded in this case. In the modified arrangement there has been eliminated from Fig. 1 the effect of the voltage divider action of the grid leak and the output impedance of the prior stage. This circuit arrangement functions, otherwise, in the manner explained in connection with Fig. 1. In both arrangements the improvement in gain over a conventional wide band amplifier, with flat response to the same upper limiting frequency, is of the order of five to one.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In a wide band signal amplifier of the type comprising at least one amplifier tube provided with a resistance coupling element in its output; means for compensating the effect of the inherent output capacities of the tube, said means comprising an inductive element arranged in series with said resistance element, a second inductive element connected between said tube input electrodes, said inductive elements being magnetically coupled to provide a negative mutual inductance, and said resistance element and mutual inductance developing a signal voltage which is applied to said input electrodes in phase quadrature with the signal input voltage thereby to cancel out the effect of said inherent capacities.

2. In a signal amplifier of the resistance-coupled type having unavoidable output capacities which lower the high frequency end of the response curve, said amplifier having input and output circuits, a feedback path between the output and input circuits for boosting said curve end, said path comprising a resistance element across the output circuit, a coil in series with the resistance element, a second coil connected to said input circuit, said two coils being magnetically coupled in such a manner as to provide negative mutual inductance whereby signal voltage developed across the resistance element is fed back to said input circuit in phase quadrature with the signal input voltage.

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