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HUM REDUCING MODULATOR

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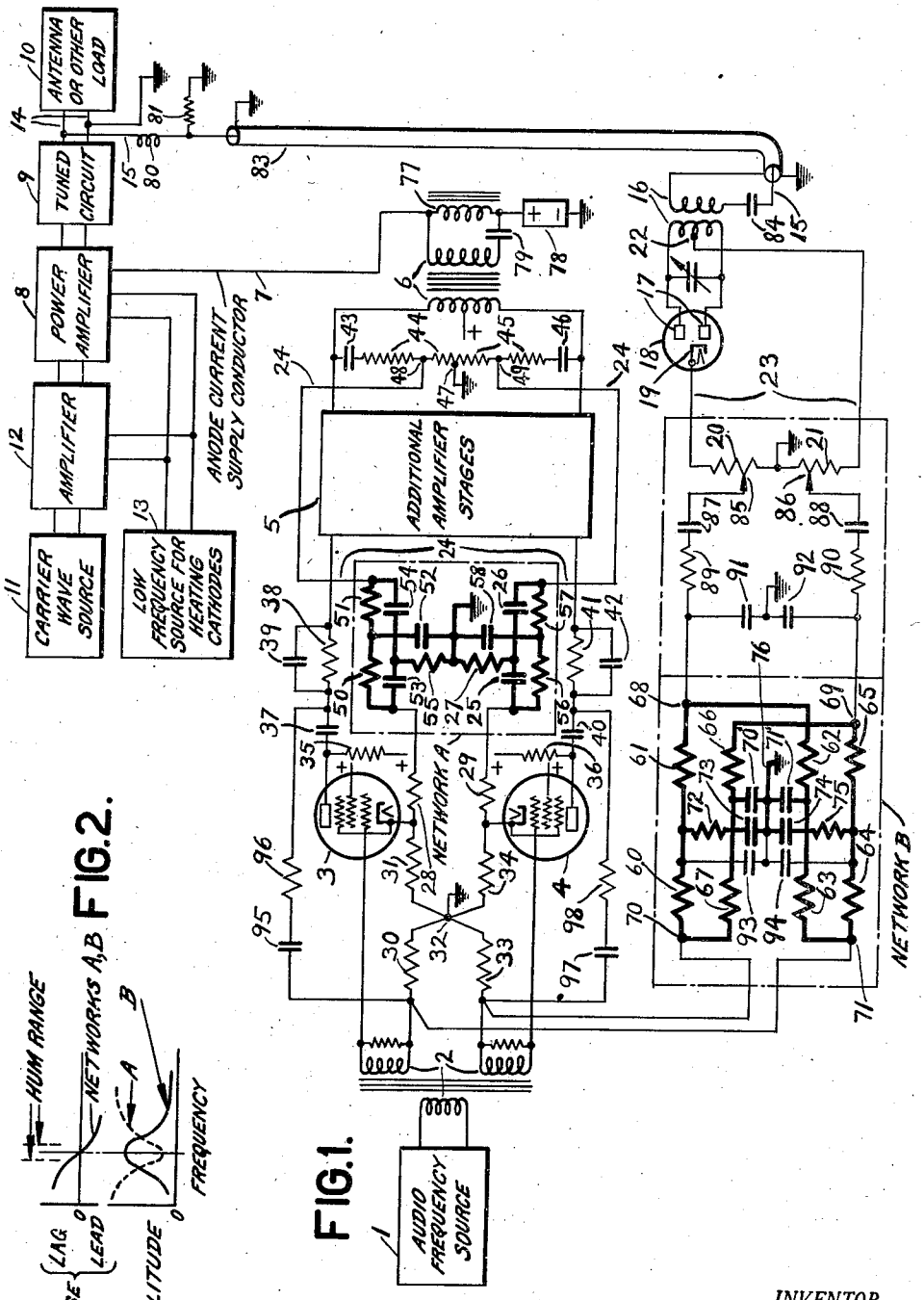


FIG. 1.

FIG. 2.

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HUM REDUCING MODULATOR

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19 Claims. (Cl. 179—171.5)

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This invention relates to wave transmission, and more particularly to the reduction of disturbing interference, hum and distortion tending to appear in the output wave of an amplifying system.

In a carrier wave system utilizing a carrier wave power amplifier at the output of the system and having an audio frequency signal amplifier for supplying amplified audio frequency modulating waves to the anode circuit of the power amplifier, the use of a low frequency alternating current for heating the cathode of the amplifier, especially when the amplifier is of relatively high power, usually tends to cause modulation of the carrier wave at a plurality of hum frequencies corresponding to the fundamental and several harmonics of the cathode heating current. These hum frequencies extend over an appreciable frequency range, such as from 60 cycles to 300 cycles a second or higher, and thus may fall within the same frequency range as the desired signals, and lead to serious complications and difficulties when an attempt is made to reduce them to a negligibly small amplitude.

If an attempt is made to eliminate these hum components by the usual negative feedback methods, many difficulties arise which are not satisfactorily overcome by ordinary expedients. One of the difficulties is to maintain stable operation of the audio frequency amplifying system without regeneration when it is desired to provide a wide band high quality signal transmitting system, as for example in high fidelity radio broadcasting. If the hum is opposed by the usual negative feedback circuit, the signal suffers a corresponding loss of amplitude within the hum frequency range, and at the same time a further serious difficulty arises due to the tendency of the phase-frequency characteristic of the feedback path to produce a positive feedback on account of changes in its relation to the simultaneously changing overall phase-shift within the amplifier, particularly at frequencies remote from the center of the hum frequency band.

An object of the present invention is to provide a stable and high quality wave transmitting system employing amplification and subject to interfering waves near the output of the system, and to reduce the amplitude of the undesired hum or other interfering waves appearing in the output, without sacrificing the quality of the wave transmission.

Another object is to counteract the above difficulties and to provide a wave transmitting system of relatively simple construction and of high efficiency operation over a wide range of signal frequencies.

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Another object is to reduce hum or other interfering components produced in the output of a power amplifier by alternating current employed for heating the cathode of the amplifier.

Another object is to provide a substantially distortionless amplifier system having means for counteracting the effect of unwanted waves tending to be introduced near the output of the system.

Another object is to provide a negative feedback circuit for an audio frequency amplifier, for transmitting to the input of the amplifier one or more undesired components of hum frequency which have been introduced in the amplifier, and to provide means for compensating for the resulting non-uniform frequency transmission of the amplifier, so that the amplifier operates substantially without distortion within the utilized frequency range including the hum frequencies, while effectively counteracting the hum introduced within the amplifier.

In accordance with one aspect of the present invention, a wave translating system, for example a radio broadcast transmitter, having an output amplifier or other portion of the system near the output thereof, subject to interference, is provided with a first frequency selective negative feedback for suppressing interfering components in the output of the system, a second negative feedback being coupled between the input of the amplifier and a part of the system in advance of that subject to interference, the second feedback having a frequency selective characteristic, the effect of which is complementary to that of the first feedback, so that the distorting effect produced on the amplifier by the first feedback is counteracted without destroying the interference reducing effect of the first feedback.

In another aspect, the invention provides an interference or hum reducing negative feedback circuit including a network having frequency-amplitude and frequency-phase characteristics adapted to improve the stability of operation of the amplifier at frequencies outside the interference frequency band, as compared with the operation of an amplifier employing prior forms of negative feedback networks.

From another viewpoint, the invention provides an improved form of network particularly adapted for use in a negative feedback for an amplifier for permitting of stable operation of the amplifier while providing a frequency selective characteristic therefor.

From another viewpoint, the invention provides an amplifier system in which two negative feedback circuits have complementary attenuat-

ing effects with respect to desired signal waves and have non-complementary effects with respect to undesired interfering components, while having similar frequency-phase characteristics adapting the system for stable operation over a wide frequency range.

These and other objects and features of the invention will be understood more clearly in view of the following detailed description and claims and the accompanying drawings in which:

Fig. 1 is a schematic diagram of the circuit of a carrier wave transmitting system, such as a radio broadcast transmitter; and

Fig. 2 shows graphs of the transmission characteristics of networks A and B of Fig. 1.

In Fig. 1 the audio frequency source 1 transmits signal through transformer 2, through the push-pull amplifier stage 3, 4, of the electron tube type, through the additional amplifier stages 5, through the output transformer 6 to the anode current supply conductor 7 of the carrier wave power amplifier 8 of the electronic type within which a carrier wave is modulated in well known manner in accordance with the audio frequency signal wave transmitted to conductor 7, the resulting modulated wave being transmitted to tuned circuit 9, coupled by the line 14 to the antenna or other load 10. The carrier wave source 11 supplies waves to amplifier 12 which in turn excites the power amplifier 8. The low frequency auxiliary source of power 13 is connected in well known manner with the cathodes, not shown, in amplifiers 8 and 12, for supplying heating current thereto.

The low frequency source 13 may be of the usual commercial frequency, such as for example as 60 cycles per second. As is well known, such a low frequency auxiliary current tends undesirably to modulate the carrier wave and produce hum components in the envelope of the modulated carrier wave transmitted from power amplifier 8 to circuits 9, and 10. The hum components have frequencies corresponding respectively with the fundamental of the low frequency source 13 and harmonics thereof as high as the fifth harmonic or higher. Since these hum components represent an interfering frequency within the same frequency range as that of the signal waves from source 1, the usual methods of avoiding interference are not adapted to eliminate the hum, because such methods ordinarily tend to discriminate also against the desired signal frequencies within the hum frequency range, thereby distorting the desired signal wave.

A portion of the carrier wave energy, having an envelope modulated in accordance with the desired signal wave, is transmitted from the output line 14 over the line 15 and ground to the primary of transformer 16, the secondary of which has its terminals connected respectively with the anodes 17 of the rectifier 18. The cathode 19 of rectifier 18 is connected through potentiometer resistances 20 and 21 in series to a mid-tap connection 22 on the secondary coil of transformer 16. Rectifier 18 demodulates the carrier wave from the output of power amplifier 8, to reproduce the signal wave across the negative feedback line 23 which connects through network B with the inputs of amplifier tubes 3 and 4, the network B being of such design as to cause the amplifier 3, 4, 5 to discriminate against waves within the hum frequency range, thus producing discrimination against signal wave components within the same hum frequency range and thereby distorting the signal wave. In order to counteract the distorting effect of network B on the operation of the amplifying system, a negative feedback circuit 24 is connected from the output of amplifier stages 5 with the input of amplifier tubes 3, 4, the input of feedback 24 being connected to the system at a place in advance of the coupling of stages 5 with the power amplifier 8 where the hum or other interfering waves are introduced. The frequency-amplitude characteristic of network A connected in feedback 24, is complementary to that of network B and thus counteracts or compensates for the distorting effect of network B on the desired signal wave.

Since the frequency-phase characteristic of the amplifier 3, 4, 5 with its interstage couplings and input and output connections, varies with the frequency of the wave component being transmitted therethrough, difficulty arises in providing a feedback circuit 23 having such a frequency-phase characterictic as to maintain a proper value of negative feedback to accomplish the desired results throughout the wide range of frequencies to be covered by the signal waves. Furthermore, any shift in the phase angle of network B must be kept within such limits that the feedback circuit 23 can produce no appreciable positive feedback. In order to meet these difficulties, the frequency-phase characteristic of networks A and B are made similar to each other within the range of frequencies in which the amplitude of the feedback wave is sufficient to substantially affect the stability of the amplifier.

Further details of the circuit whereby the above results are obtained will now be described. An input circuit may be traced from the control grid of tube 3 through the upper secondary coil of transformer 2, through resistors 30 and 31 in series to the cathode of the tube, the junction between resistors 30 and 31 being grounded at 32. Similarly an input circuit may be traced from the control grid of tube 4 through the lower secondary coil of transformer 2 and resistors 33 and 34 in series to the cathode of the tube, the junction between resistors 33 and 34 being also grounded at 32.

The output of network B is connected with the ungrounded terminals of resistors 30 and 33, so that the resistors 30 and 33 constitute couplings between the feedback 23 and the input circuits of tubes 3 and 4. The output terminals of network A are connected with the ungrounded terminals of resistors 31 and 34, so that these resistors constitute couplings between the feedback circuit 24 and the input circuit of tubes 3 and 4. By providing separate coupling resistors for the negative feedback circuits 23 and 24, respectively, interaction between these networks is reduced to a minimum and couplings 30 and 33 are relatively independent of couplings 31 and 34.

Current is supplied to the anode of tube 3 through resistor 35 and to the anode of tube 4 through resistor 36. The amplified output wave from tube 3 is transmitted from the anode thereof through the direct current blocking capacitor 37, and through resistor 38 and capacitor 39 in parallel, to the input of the amplifier stages 5. Similarly the amplified output wave from tube 4, is transmitted from the anode of tube 4 through the blocking capacitor 40, and through resistor 41 and capacitor 42 in parallel, to the input of stages 5.

In parallel with the primary of output transformer 6 is connected a circuit including the direct current blocking capacitor 43 the potentiometer 44, potentiometer 45 and the blocking ca-

pacitor 46 all in series, the junction between potentiometers 44 and 45 being grounded at 47 and the reduced voltage tap-off points 48 and 49 being provided respectively on potentiometer 44 and 45, at which points are connected the conductors of the feedback circuit 24.

Network A consists of a double, parallel T-network, that is, of two pairs of T-networks, each pair including two T's in parallel, the upper pair consisting of the resistors 50, 51 in series with each other in one line conductor of feedback circuit 24. The capacitor 52 being connected from ground to the junction of resistors 50, 51. The other T of the same pair includes the capacitors 53 and 54 in series in the line conductor of the feed-back circuit; the resistor 55 being connected in shunt from ground to the junction between the capacitors 53, 54. In the lower half of network A, a similar pair of T's are provided, one T including the series resistors 56, 57 and the shunt capacitor 58 connected between ground and the junction of resistors 56, 57, the other T including capacitors 25, 26 in series, the resistor 27 being connected in shunt from ground to the junction between capacitors 25, 26. The frequency-amplitude characteristic of network A and the frequency-phase characteristic thereof, are shown in Fig. 2 which also shows the complementary frequency-amplitude characteristic of network B, the frequency-phase characteristic thereof being represented by the same curve as that for network A.

Network B includes a lattice network having four impedance arms 60, 61; 62, 63; 64, 65; and 66, 67; connected all in series with each other to form a closed circuit. The two non-adjacent junctions 68 and 69, provide input terminals for the lattice network, while non-adjacent junctions 70 and 71 form output terminals for the lattice network. It will be seen that each arm of the network includes two resistors in series namely 60 and 61 in a first arm; 62, 63 in the second arm; 64 and 65 in the third arm; and 66, 67 in the fourth arm. The lattice network thus constitutes a Wheatstone bridge and the arms of the bridge or lattice are adjusted to balance according to well known practice in Wheatstone bridges, so that when a voltage is applied across input terminals 68, 69, no voltage appears across output terminals 70, 71. In other words, the coupling which normally exists between the input and output terminals by virtue of the arms connected therebetween, is substantially completely neutralized at all frequencies. Under these conditions, if the resistance of arms 60, 61 be called R_1; that of arms 62, 63, R_2; that of arms 64, 65, R_3; and that of arms 66, 67, R_4; the relation of the resistances of the arms when balanced may be represented as follows:

$$R_1/R_2=R_4/R_3$$

The feedback circuit 23 would therefore produce no feedback effect at any frequency, if the balanced elements R_1, R_2, R_3 and R_4 were the only elements coupling terminals 68, 69 with terminals 70, 71. In order to provide a frequency selective path through network B, a frequency selective path is connected between the junction of the two resistors in one arm and a point on some other arm of the lattice where the potential differs from that of the first connection. For this purpose capacitors 70' and 71' are connected in series with each other from the junction of resistors 66, 67 in one arm to the junction of resistors 62, 63 in a non-adjacent arm of the lattice. Similarly a circuit including resistor 72, capacitor 73, capacitor 74 and resistor 75 in series in the order named, is connected from the junction of resistors 60 and 61 in one arm to the junction of resistors 64, 65 in a non-adjacent arm. The junction between capacitors 70' and 71' and the junction between capacitors 73 and 74 are grounded at 76 for the purpose of symmetry and balance of the network B with respect to ground, resistors 60, 67, 63 and 64 being preferably equal to each other, and resistors 61, 66, 62 and 65 being also equal to each other, and resistors 72 and 75 being equal to each other, capacitors 73 and 74 being equal, and capacitors 70' and 71' being equal to each other. The values of capacitors 70', 71', 73 and 74 are so chosen with reference to resistors 72 and 75 as to provide paths in the lattice network having the frequency-amplitude and frequency-phase characteristic represented in Fig. 2. It will be seen that network B may be viewed in a slightly different manner from a Wheatstone bridge, by considering the network to be composed of two pairs of T-networks connecting the input to the output of network B. In one pair of T-networks, one T includes series line resistors 60, 61 having at their junction a shunt connection to ground including resistor 72 in series with capacitor 73. The other T of the pair of T-networks, includes the resistor 67 in series with the resistor 66, having at their junction the shunt connection to ground including the capacitor 70'. The other pair of T-networks includes one T consisting of resistors 64 and 65 in series, having the shunt connection to ground from the junction of said resistors and including resistor 75 and capacitor 74 in series, the other T of the pair of T-networks including resistors 63 and 62 in series and having a shunt connection including capacitor 71' from there junction to ground. The resistors 72 and 75 serve to decrease the phase angle of the shunt path 72, 73, 74, 75.

A high frequency inductive impedance 80 is provided in conductor 15 to reduce the amplitude of the carrier wave transmitted to transformer 16, the resistor 81 being connected from conductor 15 to ground. Conductor 15 is preferably arranged as the inner conductor of the coaxial cable 83, the outer cylindrical conductor of which is grounded and connected with one terminal of the primary coil of transformer 16, the other terminal of the primary coil being connected with conductor 15 through the D. C. blocking capacitor 84.

Sliding contacts 85, 86 are provided respectively on potentiometers 20, 21 for adjusting the amount of voltage transmitted to the input terminals 68, 69 of network B and for adjusting the balance of the feedback circuit with respect to ground. Capacitors 87, 88 are provided in each side of the feedback circuit 23 for blocking the passage of direct current, resistors 89, 90 in series with the line conductors of the feedback circuit 23, serving to isolate or decouple network B from the circuit of rectifier 18. Equal small capacitors 91 and 92 in series and having their junction grounded, provide a path for the high frequency carrier wave component of the wave being rectified in rectifier 18, the grounded junction between the capacitors serving to balance the line conductors with respect to ground. Equal capacitors 93 and 94 of relatively small values compared with capacitors 70', 71', 73 and 74, provide a shunt path for any high frequency

carrier wave component reaching network B from rectifier 18, their reactances being so high as to have a negligible effect on the network. Capacitors 93 and 94 are in series in a circuit connected from the junction of resistors 60, 61 and the junction of resistors 64, 65, the junction of capacitors 93, 94 being grounded.

While network B has been disclosed with a frequency selective impedance path 70', 71'; and a further frequency selective impedance path 72, 73, 74 and 75, it will be understood that in some cases particularly where a relatively small frequency range is covered by the hum frequency components, only one frequency selective path, for example, 70', 71' or 72, 73, 74, 75, may suffice to provide a frequency selective transmission characteristic for the otherwise balanced, non-transmitting network B.

The anode current supply conductor 7 connects from the anode, not shown, of power amplifier 8, through the audio frequency choke coil 77 and the space current supply source 78 to ground, the secondary coil of transformer 6 being connected in shunt with coil 77 and having the blocking capacitor 79 in series therewith to prevent direct current from passing through transformer 6.

A resistor 28 is connected between network A and the cathode of tube 3, and a resistor 29 is connected between network A and the cathode of tube 4 to isolate or decouple the network from the other circuits of the tubes. A negative feedback circuit is connected from the ungrounded terminal of resistor 30 through the capacitive reactance 95 in series with the resistor 96 to the anode or output circuit of tube 3, a similar negative feedback circuit being connected from the ungrounded terminal of resistor 33 through the capacitive reactance 97 in series with the resistor 98 to the anode or output circuit of tube 4, for reducing the gain of the amplifier at the highest signal frequencies and at frequencies above the highest utilized signal frequencies to prevent instability and singing of the amplifier at very high frequencies.

The parallel resistor 38 and capacitor 39 and the parallel resistor 41 and capacitor 42 serve to reduce the amplitude of very low frequencies at the lower end of the signal frequency range to prevent singing at such frequencies in the form of oscillations sometimes referred to in the art as "motor boating."

Resistors 60, 67, 63, 64 serve to decouple the reactances of the frequency selective paths 70', 71'; and 72, 73, 74, 75; from the other feedback paths and circuits of the amplifier tubes 3 and 4.

It has been found that the above described circuits are especially well adapted to provide stable operation of the amplifier while substantially completely suppressing the undesired components of hum frequency introduced in the output of the power amplifier as a result of the cathode heating current acting magnetically or otherwise to modulate the carrier wave current of the amplifier, at the same time the network A serving to restore the characteristic of the amplifier to a substantially flat frequency amplitude characteristic throughout the range of the desired signal frequencies without destroying the hum reducing effect of network B. For example, in a particular case where a broadcast transmitter was adapted to transmit modulating signal frequency waves within a range extending from approximately 30 cycles per second to 10,000 cycles per second, without objectionable departure from a flat transmission characteristic, interfering frequencies representing hum components extending from 60 cycles per second to as high as 720 cycles per second at appreciable amplitudes were substantially completely suppressed by the effect of network B on the amplifier, while network A substantially completely compensated for the distortion introduced into the operation of the amplifier by network B, without disturbing the hum reducing effect of network B.

In the particular case just referred to, in network A, each of the resistors 50, 51, 56 and 57 had a resistance of 1,500 ohms; each of the capacitors 53, 54, 25 and 26 had a capacitance of 0.85 microfarad; and each of the resistors 55 and 27 had a resistance of 600 ohms. In the same case, in network B, each of the resistors 60, 67, 63, 64 had a resistance of 100,000 ohms; each of the resistors 61, 66, 62, 65 had a resistance of 50,000 ohms; each of the resistors 72 and 75 had a resistance of 2,000 ohms; each of the capacitors 70' 71' has a capacitance of 0.05 microfarad; and each of the capacitors 73 and 74 had a capacitance of 0.01 microfarad. In this same case, each of the resistors 30 and 33 had a resistance of 25,000 ohms; each of the resistors 31 and 34 has a resistance of 2,000 ohms; each of the resistors 28, 29 had a resistance of 2,000 ohms; each of the resistors 89 and 90 had a resistance of 50,000 ohms; each of the potentiometers 20 and 21 had a resistance from ground to its respective slider 85 and 86, of approximately 10,000 ohms; each of the capacitors 91, 92, 93, and 94 had a capacitance of about 500 micro-microfarads; and each of the potentiometers 44 and 45 had a resistance from ground to the respective tap thereon of about 200 ohms. It will be understood of course that these values are only examples of a particular case, and that the invention is not limited thereto.

Since the amplitude of the wave transmitted through network B is very small at frequencies remote from the hum frequency range, as shown in Fig. 2, the effect of the phase rotation or shift of phase of the wave in passing through network B is made negligible, so that the desired negative feedback relation may be maintained over a wider frequency range of amplification than in the case where an amplifier is provided with the usual form of frequency selective circuit without any balanced Wheatstone bridge or lattice network that is balanced at all frequencies applied to the network. The network B is therefore particularly well adapted for use in negative feedback circuits in general, apart from the specific combination with which it is used in the above described carrier wave system.

Instead of regarding the network A as a corrective network to compensate for the distortion produced in the amplifier 3, 4, 5 as a result of network B, the network B may be regarded as a corrective element for the distorting effect of network A. From this point of view, network A serves to increase the signal-to-noise ratio of signal components in the hum frequency range or band in the power amplifier 8 relatively to signal components outside the hum range, while network B serves to reduce the amplitude of components in the hum frequency range in amplifier 8 to their normal amplitude relation to components outside the hum range while preserving the improved signal-to-noise ratio.

Various modifications of the above described

circuits and methods will be apparent to those skilled in the art without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a first negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said first feedback means including detecting means for producing an audio frequency current corresponding with the modulations of the high frequency carrier wave in the output of said power amplifier, said first feedback means including a network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier, and second feedback means coupling the output of said audio frequency amplifier with the input thereof and including means for counteracting the distorting effect of said first feedback means on said audio frequency amplifier without destroying the hum reduction produced by said first feedback means.

2. In a wave transmitting system according to claim 1, the combination in which the respective frequency-phase characteristics of said feedback means are substantially equal to each other.

3. In a wave transmitting system according to claim 1, the combination in which the respective frequency-attenuation characteristics of said feedback means are substantially complementary to each other.

4. In a wave transmitting system according to claim 1, the combination in which the respective frequency-attenuation characteristics of said feedback means are substantially complementary to each other and in which the respective frequency-phase characteristics of said feedback means are substantially equal to each other.

5. In a wave transmitting system according to claim 1, the combination in which an anode current supply conductor is provided for said power amplifier and said coupling with the output of said audio frequency signal amplifier includes a coupling with said anode current supply conductor.

6. In a wave transmitting system according to claim 1, the combination in which said first feedback network includes a filter network of the Wheatstone bridge type having four arms in balanced relation with respect to the input and output terminals of the bridge at all frequencies to be applied to the bridge, and a frequency selective impedance connected from an intermediate point in one of said arms to a point on another of said arms having a different potential from said intermediate point in response to an alternating voltage impressed upon the input terminals of the bridge.

7. In a wave transmitting system according to claim 1, the combination in which said first feedback network includes a filter having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each of two of said non-adjacent arms including two resistors joined in series and providing an intermediate tap at their junction, and a frequency selective unit connected between said two taps.

8. In a wave transmitting system according to claim 1, the combination in which said first feedback network includes a filter having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each said arm including two resistors joined in series and providing an intermediate tap at their junction, a first unit having a predetermined frequency selective characteristic connected between the taps of two of said non-adjacent arms, and a second unit having a different predetermined frequency selective characteristic from said first unit connected between the taps of the other two of said non-adjacent arms.

9. In a wave transmitting system according to claim 1, the combination in which said first feedback network includes a filter having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each of two of said non-adjacent arms including two resistors joined in series and providing an intermediate tap at their junction, and a frequency selective unit including two capacitors joined in series and having a ground connection at their junction, said unit being connected between said two taps.

10. In a wave transmitting system according to claim 1, the combination in which said first feedback network includes a filter having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each said arm including two resistors joined in series and providing an intermediate tap at their junction, a first unit having a predetermined capacitance connected between the taps of two of said non-adjacent arms, and a second unit including a predetermined resistance in series with a capacitance connected between the taps of the other two of said non-adjacent arms.

11. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a first negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said first feedback means including detecting means for producing an audio frequency current corresponding with the modulation of the high frequency carrier wave in the output of said power amplifier, said first feedback means including a network for selectively transmitting waves of said hum fre-

quencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier, and second feedback means coupling the output of said audio frequency amplifier with the input thereof and including means for counteracting the distorting effect of said first feedback means on said audio frequency amplifier without destroying the hum reduction produced by said first feedback means, and a third negative feedback means coupling the output of one of the stages of the signal amplifier with the input of one of the stages for reducing the gain of the higher frequencies.

12. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier including at least a first stage, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a first negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said first feedback means including detecting means for producing an audio frequency current corresponding with the modulation of the high frequency carrier wave in the output of said power amplifier, said first feedback means including a network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier, and second feedback means coupling the output of said audio frequency amplifier with the input thereof and including means for counteracting the distorting effect of said first feedback means on said audio frequency amplifier without destroying the hum reduction produced by said first feedback means, and a third negative feedback means coupling the output of the first stage of the signal amplifier with the input.

13. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said feedback means including detecting means for producing an audio frequency current corresponding with the modulation of the high frequency carrier wave in the output of said power amplifier, and said feedback means including a filter network of the Wheatstone bridge type for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier including four arms in balanced relation with respect to the input and output terminals of the bridge at all frequencies to be applied to the bridge and a frequency selective impedance connected from an intermediate point in one of said arms to a point on another of said arms having a different potential from said intermediate point in response to an alternating voltage impressed upon the input terminals of the bridge.

14. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said feedback means including detecting means for producing an audio frequency current corresponding with the modulations of the high frequency carrier wave in the output of said power amplifier, said feedback means including a filter network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter the other two non-adjacent junctions of said arms forming output terminals for said filter, each of two of said non-adjacent arms including two resistors joined in series and providing an intermediate tap at their junction, and a frequency selective unit connected between said two taps.

15. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said feedback means including detecting means for producing an audio frequency current corresponding with the modulations of the high frequency carrier wave in the output of said power amplifier, said feedback means including a filter network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each said arm including two resistors joined in series and providing an intermediate tap at their junction, a first unit having a predetermined frequency selective characteristic connected between the taps of two of said non-adjacent arms, and a second unit having a different predetermined frequency selective characteristic from said first unit connected between the taps of the other two of said non-adjacent arms.

16. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending

to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said feedback means including detecting means for producing an audio frequency current corresponding with the modulations of the high frequency carrier wave in the output of said power amplifier, said feedback means including a filter network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each of two of said non-adjacent arms including two resistors joined in series and providing an intermediate tap at their junction, and a frequency selective unit including two capacitors joined in series and having a ground connection at their junction, said unit being connected between said two taps.

17. In a high frequency carrier wave transmitting system, a carrier wave power amplifier of the electron-discharge type having a low frequency auxiliary power supply circuit tending to produce undesired modulation of said carrier wave in said power amplifier at hum frequencies, an audio frequency signal amplifier, a coupling between the output of said audio frequency signal amplifier and said power amplifier for applying modulating voltages to said power amplifier, a negative feedback means coupling the output of said power amplifier with the input of said audio frequency amplifier, said feedback means including detecting means for producing an audio frequency current corresponding with the modulations of the high frequency carrier wave in the output of said power amplifier, said feedback means including a filter network for selectively transmitting waves of said hum frequencies to the input of said audio frequency amplifier for reducing the effect of said undesired hum modulation in said power amplifier having four resistor arms joined in series with each other to form a closed circuit, two non-adjacent junctions of said arms forming input terminals for said filter, the other two non-adjacent junctions of said arms forming output terminals for said filter, each said arm including two resistors joined in series and providing an intermediate tap at their junction, a first unit having a predetermined capacitance connected between the taps of two of said non-adjacent arms, and a second unit including a predetermined resistance in series with a capacitance connected between the taps of the other two of said non-adjacent arms.

18. In a wave transmitting system, an input circuit and an output circuit, wave amplifying means having means which introduces interference in a limited band of low frequencies, a first negative feedback means coupling said output circuit with said input circuit including a filter network for selectively reducing the gain of said amplifying means in the limited band of low frequencies and thereby producing distortion therein, and a second negative feedback means coupling said input circuit with a part of said amplifying system in advance of said output circuit including a network filter for reducing the effect of the distortion produced by said first feedback means in the limited band of frequencies, and a third negative feedback means coupling said input circuit with a part of said amplifying system in advance of said interference producing means for reducing the gain at the high frequencies.

19. In a wave transmitting system for transmitting carrier frequencies modulated by frequencies within a certain total band, an input circuit and a carrier output circuit, wave amplifying means, a first negative feedback means selectively coupling said output circuit to said input circuit for reducing the gain of said system predominantly within a restricted portion of said total band of frequencies and incidentally introducing both amplitude and phase shift distortion in said system throughout said total band of frequencies, and a second negative feedback means coupling said input circuit with a part of said transmitting system in advance of said output circuit and having attenuation and phase shift characteristics substantially completely compensating for said distortion produced in said system by said first negative feedback means.

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