

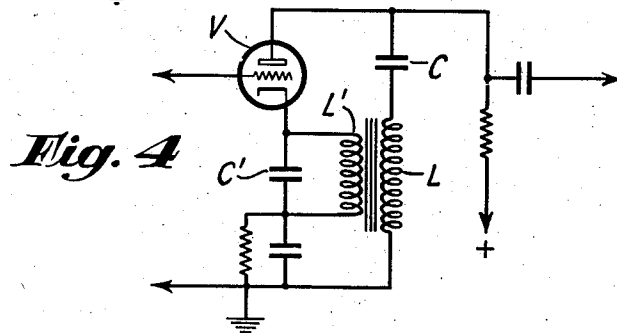
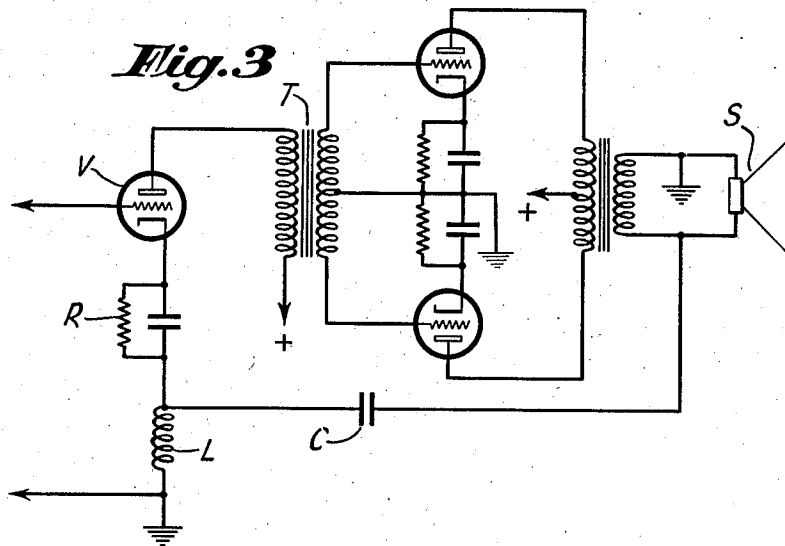
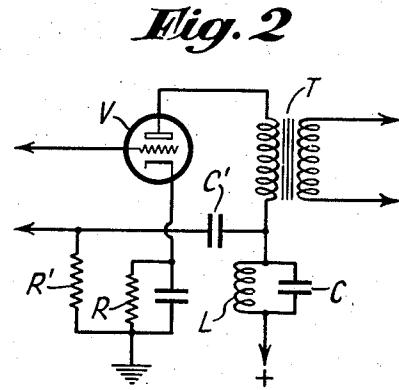
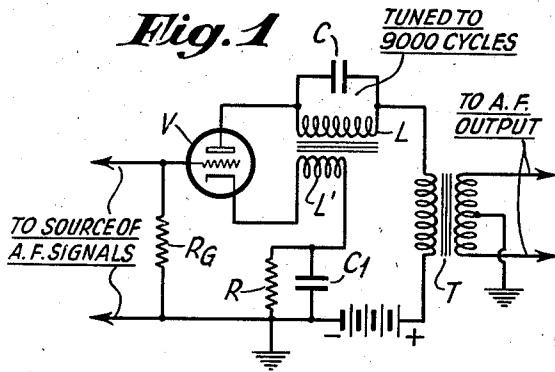
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RECEIVER CIRCUITS

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RECEIVER CIRCUITS

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For the purpose of attenuating, or suppressing, undesirable frequencies or stray frequencies, it is known in the prior art of receivers or amplifiers to include stopper, or filter, circuits in series with the transmission line of the amplifier channel, or in shunt to the same. For instance, in the audio amplifier of a receiver a parallel circuit tuned to 9 k. c., that is the interference frequency of two neighboring transmitter stations, is connected between two consecutive stages.

According to the present invention, the alternating potential which is tapped from one of the reactances of the stopper, or filter, circuit is in reverse, or negative, feedback relationship to a part of the amplifier closer to the input end thereof. While it is known in the prior art to attenuate frequencies that are undesirable by reverse feedback established between the output and the input end, and to insert in such a reverse feedback channel frequency-dependent means or meshes so that undesired frequencies preferably are in negative feedback relation, it will be noted that the present invention insures a far greater attenuation of the undesired frequency band or range by the use of a single tuned circuit, than would be feasible either with a stopper or filter circuit alone, or merely by reverse feedback. According to the invention, on the one hand, one and the same circuit, by virtue of its inclusion in the transmission channel, results in an attenuation of the undesired frequency, while, on the other hand, it insures at the same time a very high degree of reverse feedback which will practically be effective only for this particular frequency.

While it might be conceivable to insert in the amplifier a stopper circuit designed to preclude the disturbing or undesired frequency, and to insure reverse feedback to the input end at the same time from the output of the amplifier by way of a circuit also tuned to the undesired frequency, it will be seen that quite apart from the fact that two circuits would thus be required the reverse feedback would not be particularly effective for the reason that the voltage having the undesired frequency, and serving for the negative regeneration, has been diminished in its amplitude by the action of the stopper circuit provided further below. In the present invention it is just the marked fall of potential occasioned by the disturbing voltage at the stopper circuit that is utilized for negative regeneration. But, above all, it would be impossible to avoid a positive regeneration being produced instead of a negative feedback as a result of the phase ro-

tating, or shifting, action of the two circuits for certain frequencies. As a consequence, the amplifier would thus start to oscillate at one of these frequencies.

Now, these drawbacks are avoided by the present invention in a safe and simple manner. In the drawing, Figs. 1 to 4 show respectively different embodiments of the invention.

Fig. 1 illustrates an embodiment of the invention as applied to the audio amplifier of a receiver. Between the plate of amplifier tube V and the primary winding of the transformer T is a parallel circuit L—C tuned to a frequency of 9000 cycles. In close coupling relationship with coil L is another coil L' which is connected between the cathode of the tube and the cathode resistance R shunted by a condenser C₁. The polarity of the coil L' should be so chosen that negative feedback occurs for a frequency of 9 kilocycles (k. c.). It will be understood that the positions of coil L' and resistance R could be exchanged, so that L' would have one end connected to ground. In case the ohmic resistance is so high that the drop of direct current potential becomes unduly great, or that an undesired high current negative feedback for all frequencies is occasioned, it is of course feasible to connect the coil L' also in the control grid lead of the tube V, in other words, between the lower end of the grid leak resistance R_g associated with one pole of the input alternating voltage and the grounded end of the cathode resistance R. Another way to preclude the chance of current negative feedback is to connect the lower end of the primary winding by way of a condenser with the filament, but with the direct current voltage source of supply by way of an ohmic resistance or a choke-coil.

If the transformer coupling of the stopper circuit, that is to say a distinct coil, is to be avoided, then recourse could also be had to a circuit of the kind shown in Fig. 2. In this arrangement, the stopper circuit L—C lies between the primary winding of the transformer and the positive pole of the voltage source. The stopper circuit by way of condenser C' is in alternating current parallel connection with the resistance R', which is connected in series with the input alternating voltage between cathode and control grid of tube V. The resistance R' in such a scheme must be chosen so high that it will not unduly damp the circuit L—C. Of course, it is also possible in the case of a two-stage amplifier, to insert the circuit L—C for alternating current directly in the cathode lead of the am-

plifier tube connected in series below tube V, for in this instance there results the effect of a negative feedback for 9 k. c.

Another embodiment in which a filter circuit rather than a stopper circuit is used is shown in Fig. 3 as applied to, and incorporated in, a two-stage audio amplifier whose last stage is of the push-pull type. In parallel relationship to a dynamic loudspeaker S, coupled by way of an output transformer with the power stage, is a series path comprising condenser C and coil L which are tuned to 9 k. c. In order that the series circuit for the undesired frequencies which, as is to be remembered are not to be attenuated, may not represent an appreciable load for the power stage it should possess a high inductance and low capacity. Under practical conditions this requirement may be satisfied by making at the same time the ohmic resistance of the coil fairly high. While it is true that in the latter case the filter circuit will not practically alter the load for the desired frequencies, it will insure, for the undesired frequencies, also a comparatively feeble filter effect. The fact that this filter effect is so weak, or that it does not occur appreciably at all, may even be desirable occasionally, for instance, in cases where a triode is used as the input tube, as otherwise, as a result of the low output resistance for a frequency of 9000 cycles (undermatching), distortions would arise, and these would translate themselves in the form of combination frequencies. However, owing to the fact that the coil L is in series with the capacitively bridged cathode resistance R of the input tube V, there arises an additional negative feedback which, in the aggregate, results in a marked attenuation of the disturbing frequency. The effect of the negative feedback, in the present case, is particularly marked because the potential applied to coil L, as a result of resonance emphasis, is substantially higher than the disturbing voltage acting across the aggregate filter circuit, that is, the output. In other words, without any additional amplifier tube, it is possible to make arrangements so that the fraction of the output voltage which is utilized for reverse feedback is essentially higher than unity.

To be sure, the question of correctness of phase deserves special consideration; for in the presence of accurate tuning of the filter circuit to the disturbing frequency, the voltage across the coil L is shifted in its phase in reference to the voltage at the output end an angle of 90 degrees. If the amplifier operated exactly in phase, the result would be that no negative feedback in proper phase relation would be obtainable. However, on the one hand, even in the presence of a reverse phase of 90 degrees phase shift, there still prevails a reduction in the amplitude, while, on the other hand, for each amplifier, especially if of more than one stage, a substantial phase rotation occurs for frequencies of 9 k. c. As a result, it is always feasible to so connect the coil L that essentially the result of properly phased reverse feedback is insured. Finally, a certain correction of the phase is secured by a slight detuning of the series circuit. The decrease in voltage amplitude effective for the reverse feedback occasioned by the detuning may in this instance be very low since a phase rotation of as much as 45 degrees results in the presence of a decrease in amplitude of 30 per cent.

Another scheme would be to include the coil L, in whole or in part, in the control grid lead; that is, between the lower terminal of the input alternating voltage and the ground terminal. The winding of the coil, at all events, is unbroken; in fact, the splitting of the coil into two separate halves would be less satisfactory because of higher damping. If the negative regeneration is to comprise only one stage, then, in the present instance, the coil L may be connected between the primary coil of the input transformer T and the voltage source of supply. The alternating voltage may then be put out at the plate, or anode, of one of the two power tubes rather than at the output transformer.

Fig. 4 shows a further embodiment of the invention comprising a filter circuit and at the same time negative feedback in a single stage amplifier. Between the plate of tube V and ground is included the filter circuit L—C, with transformer coupling relation being established between the coil L of the said filter circuit and the coil L'. The latter is contained in the cathode lead of the tube, and it may be tuned by the aid of parallel capacity C' to the undesired frequency. By the paralleling of the condenser C', on the one hand, additional filtering of the disturbing frequency in the negative feedback channel is insured, while, on the other hand provided the coupling is not unduly close, the undesirable phase shift of 90 degrees (of quadrature relation) is eliminated so that it is here readily feasible to insure negative feedback under the proper phase conditions.

What is claimed is:

1. In an audio amplifier of a radio receiver, said amplifier including at least one tube having input terminals, said input terminals being adapted to have the audio modulation voltage of a broadcast carrier impressed therebetween, a reactive network connected across the output terminals of said amplifier, said reactive network being series tuned to the interference frequency produced by the beating of the said carrier and an adjacent carrier, means for impressing audio voltage of said interference frequency, developed by said reactive network, upon said input terminals in degenerative phase to said modulation voltage, and a reactive element of said tuned network being included in the space current path of said tube.

2. In an audio amplifier comprising an amplifier tube having input terminals and output terminals, means, comprising a push-pull amplifier, coupled to said output terminals, a resonant network, series tuned to a frequency at the upper end of the audio range, connecting between said push-pull amplifier and said input terminals, and means impressing audio voltage of said upper frequency developed by said resonant network upon said input terminals in degenerative phase.

3. In an audio amplifier comprising an amplifier tube having input terminals, a resonant network, series tuned to a frequency at the upper end of the audio range, connected in shunt to the output terminals of said amplifier, and means impressing audio voltage of said upper frequency developed by said resonant network upon said input terminals in degenerative phase and said network having an inductive element connected in the space current path of said tube.

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