

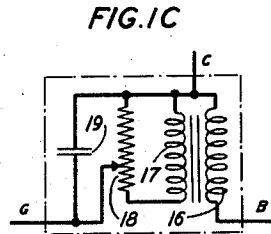
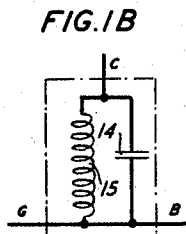
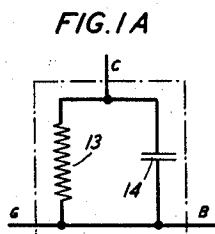
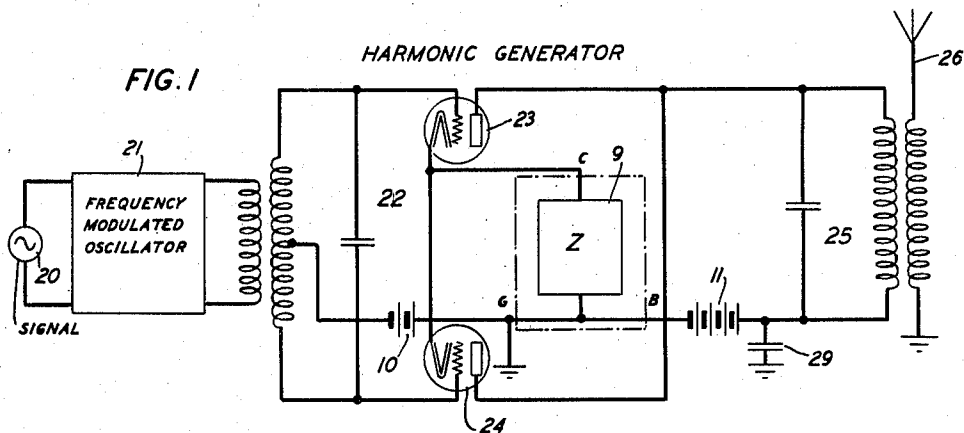
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FREQUENCY MODULATION SYSTEM

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FREQUENCY MODULATION SYSTEM

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2 Claims. (Cl. 250—17)

The present invention relates to electrical wave control for signaling and kindred purposes. More particularly it relates to the suppression of undesired variations in the strength of the waves, such as arise from undesired amplitude modulation, distortion or noise in the system.

In signaling by means of frequency modulated or phase modulated waves, undesired amplitude changes occur from various causes either in the wave generating and modulating part of the system or in parts of the system in which the transmission is not constant as to frequency throughout the entire band of interest. Power variations produce noise, besides which there may be noise from extraneous sources, tube noise, etc., all of which may give rise to amplitude variations.

It is a general object of this invention to suppress undesired amplitude variations with increased effectiveness and in a simplified manner.

It has been proposed heretofore to provide a special pick-up circuit and detector for detecting amplitude variations in a frequency modulated wave and to impress the detected variations on the grid of an amplifier in the main signaling path to vary the amplifying properties of the amplifier in such a way as to compensate for the amplitude variations in the waves passing through the amplifier. One difficulty encountered with this system arises from the fact that there is a certain amount of phase shift around such feedback path, and when the number of meshes included in the feedback loop is at all large, this is likely to result in singing at some frequency.

According to the present invention a simplified arrangement with improved effectiveness is attained by deriving the detected amplitude variations in some circuit device in the system which has detecting properties and using the detected variations to produce compensating modulation in the same device. For example, harmonic generators or frequency changers are commonly present in a frequency modulation transmitting system and are used for shifting the frequencies to a different position in the frequency spectrum. Such devices are efficient detectors and modulators. The present invention comprises the use of a negative feedback coupling from the output to the input of such a device, effective to feed back low frequency waves having the frequency of the undesired amplitude variations but ineffective to feed back the high frequencies. Thus, in its preferred form the invention may comprise an audio frequency impedance con-

nected in the cathode-ground lead and by-passed by a radio frequency condenser. For a fuller disclosure of typical embodiments the detailed description to follow should be consulted.

Referring to the drawing,

Fig. 1 is a schematic circuit diagram of the invention as applied to the harmonic generator portion of a frequency modulated system; and Figs. 1A, 1B, and 1C show modifications that may be made in the circuit of Fig. 1.

Fig. 1 shows the invention applied to a harmonic generator in a frequency modulated wave transmitting system. Harmonic generators have been suggested for use in frequency modulation systems for the double purpose of increasing the carrier frequency and increasing the modulation index so as to preserve a constant percentage of frequency shift. This permits generation of the frequency modulated wave at a relatively low frequency and with small frequency shift. The relatively high frequency wave actually transmitted and the required frequency shift of such high frequency wave may be secured by frequency multiplication in the harmonic generator. In the figure a source of signal waves is indicated at 20 connected to a frequency modulated oscillator 21 of any suitable type for producing a relatively low frequency, frequency modulated wave which is impressed, through a tuned input circuit, on the harmonic generator 22 comprising tubes 23 and 24 whose inputs are in push-pull relation and whose plates are parallel connected to one terminal of tank circuit 25, which is coupled to transmitting antenna 26. The desired harmonic frequency is selected by proper tuning of the tank circuit 25. A by-pass condenser 29 is shown around the plate source 11 which in the case of a system using considerable power would preferably consist of a power rectifier and filtering system as common in the art.

An audio frequency impedance 9, to be described more fully presently, is connected in the cathode lead from the negative pole of source 11 which is preferably grounded. The grids are connected to the ground terminal of impedance 9. A grid bias battery 10 is indicated and may be desirable in some cases.

In the operation of the circuit of Fig. 1, it is assumed that the frequency modulated waves contain some undesired amplitude modulation which is to be eliminated. The harmonic generator 22 has a curved input-output characteristic and has the property of producing a certain amount of amplification together with an efficient degree of distortion for performing the

function of harmonic generation. As a result of the non-linear characteristic of this device the amplitude modulation assumed to be present in the frequency modulated waves is detected and appears as a low frequency detected component flowing in the anode circuit and therefore in series through the low frequency impedance 9. This current develops a voltage across the terminals of the impedance 9 which is applied to the grid circuit in such phase as to oppose the variations of plate current of envelope frequency, resulting in a reduction of the amplitude modulation of the high frequency waves. The action may be regarded as a negative feedback of the envelope frequencies present in the applied wave, resulting in a reduction of the amplitude modulation appearing in the output. The action may also be looked upon as comprising a recovery of the audio frequency modulating component in the plate circuit and remodulation of the radio frequency wave in reverse sense by application of the recovered modulating component to the grid circuit of the frequency changer.

The form which the impedance 9 of Fig. 1 may take may vary widely in practice and illustrative examples are given in Figs. 1A, 1B, and 1C. In Fig. 1A the impedance 9 is shown as comprising a resistance 13 and radio frequency by-pass capacity 14. In this case the resistance 13 serves both for the feedback of the detected modulating component and also for biasing the grid. In case the grid receives an excessive negative bias an opposing battery may be used with its positive pole connected to the grid. The manner in which the substitute network may be connected into the circuit of Fig. 1 is shown by the dotted rectangle and the three terminals passing through it marked respectively G, C and B.

In the form of network shown in Fig. 1B the cathode resistor 13 is replaced by inductance 15. This circuit would permit use of a large degree of feedback over some desired range of frequencies where the impedance of the combination 14, 15 is high, with zero or small feedback for both higher and lower frequencies including direct current where the impedance respectively of condenser 14 or inductance 15 is much lower than that of the combination.

In the form of the network shown in Fig. 1C a transformer consisting of windings 16 and 17 is used for the feedback of the detected modulating component, while avoiding the feedback of direct current voltage. This circuit permits the use of a suitable voltage ratio in the transformer itself. The secondary winding 17 is shown terminated in resistance 18 provided with a slider to which the grid terminal is connected. Any high frequencies appearing on the grid

side of this transformer which are not to be fed back may be shunted out by condenser 19. Obviously each of the circuits shown in Figs. 1A, 1B and 1C contains sufficient elements to enable a certain amount of shaping or control of the amplitude frequency relations of the fed back waves. Also, obviously, other types of cathode networks will appear to those skilled in the art, and the forms that have been disclosed are to be construed as illustrative rather than limiting.

Instead of the one stage of harmonic generation disclosed there may be a plurality of stages in tandem for raising the frequency to the desired frequency level. The cathode impedance for reducing amplitude modulation may be used in one or more of these tandem connected harmonic generators.

The amplitude modulations to be reduced may arise at any point in the system including the tubes in the frequency shifting circuits by which the compensating operation is carried out. For example, such undesired modulation may arise from tube noise, power fluctuations or other local sources, or elsewhere.

Circuits embodying the invention may be modified and varied widely within the scope of the claims, which follow.

What is claimed is:

1. In combination, a source of frequency modulated waves, a harmonic generator comprising a space discharge device having a grid, a cathode and an anode, means to impress waves from said source on said grid and cathode, an outgoing circuit connected to said anode and cathode containing filter means for selectively passing waves of desired harmonic frequencies, and an impedance connected on one side to said cathode and on its other side to said grid and anode, said impedance providing an audio frequency negative feedback path from the output to the input of said device to oppose transmission into the outgoing circuit of amplitude variations of audio envelope frequency in said waves.

2. In combination, a source of frequency modulated high frequency waves, a utilization circuit for waves whose frequencies are harmonics of the frequencies of the waves from said source, and a space discharge amplifying device having an input circuit and an output circuit, and having a non-linear characteristic, connected between said source and said utilization circuit, for stepping up the frequencies to the level of said harmonics, and means for opposing audio frequency amplitude variations in the waves of stepped-up frequency comprising an audio frequency negative feedback impedance common to the input and output circuits of said device.

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