Nov. 18, 1947. D. E. FOSTER 2,430,978

MODULATION LIMITER

Filed July 31, 1943

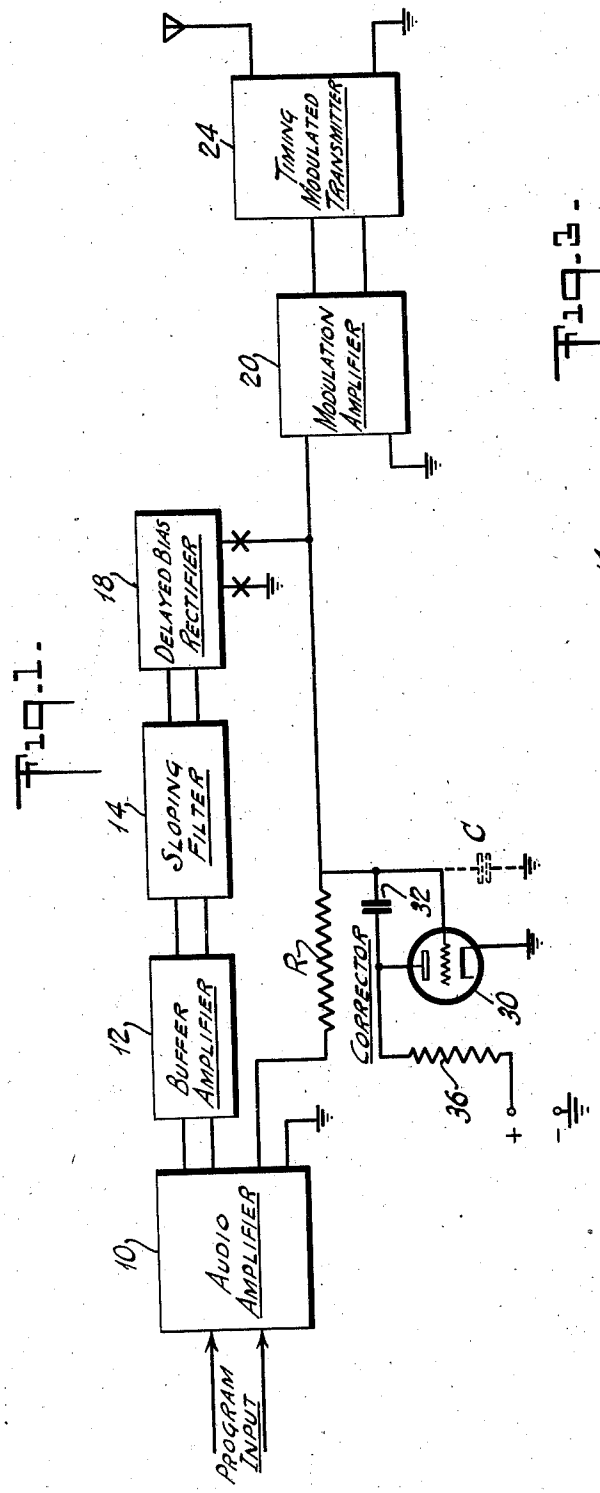



Fig. 1.

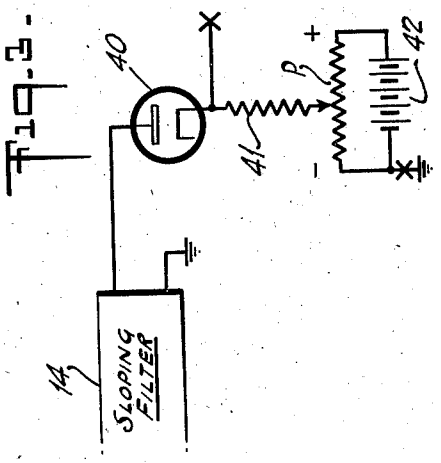



Fig. 3.

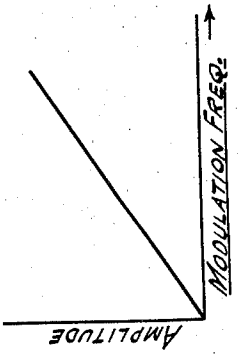



Fig. 2.

INVENTOR
DUDLEY E. FOSTER.
BY H. S. Grover
ATTORNEY

Patented Nov. 18, 1947 2,430,978

# UNITED STATES PATENT OFFICE

2,430,978

## MODULATION LIMITER

Dudley E. Foster, Chicago, Ill., assignor to Radio Corporation of America, a corporation of Delaware

Application July 31, 1943, Serial No. 496,847

5 Claims. (Cl. 179—171.5)

1

This application pertains to timing modulation systems and has for its main general object improvement of timing modulation systems.

In strength and timing modulation systems it is desirable in the sake of efficiency to obtain high percentage modulation. When aiming for high percentage modulation, over-modulation may occur in some instances, thus resulting in distortion of the signal at the receiver.

In amplitude modulation systems to prevent distortion resulting from over-modulation and for other reasons it is frequently desirable to limit the possibility of over-modulation of the carrier automatically. Various means for doing this will be found in the art.

In timing modulation where the frequency of carrier wave energy is deviated in accordance with modulation the equivalent of 100% modulation is governed or fixed by the width of the frequency band wherein transmission is permitted. The frequency band width is established by the FCC and, although I wish to use the entire band, the allowed band width must not be exceeded.

In frequency modulation the modulation energy is in general confined to a band twice the carrier deviation (in accordance with the modulation) plus twice the audio modulating frequency. Thus it can be said that the high modulating frequencies will extend furthest, i. e., the band as defined above is apt to be widest at the high modulating frequencies. This is true even though usually the high frequency modulation components do not have much energy (relative to the energy content of the low frequency modulation components), hence do not deviate the carrier as much as the lower modulation frequencies. However, as stated above, the band width is measured also by the modulation frequency and if the modulation system is arranged to modulate the carrier fully or nearly fully by, for example, lower frequency modulation components, then the permissible band may be exceeded by higher modulation frequencies of relatively large amplitudes.

It is desirable usually to use as much deviation as possible without exceeding the permissible band. If the effect of any unusual or relatively high amplitude high modulation frequencies could be compensated or prevented, wider deviation of the carrier by the modulation throughout the modulation frequency range would be possible.

A more specific object of my invention is to provide an improved modulation system wherein the effect of higher modulation frequencies is reduced so that the frequency spectrum or band can be put more fully to use throughout the modulation range.

The manner in which the objects mentioned above and others, details of which will appear hereinafter are attained, and the advantage gained by attaining such objects will appear from

2

the detailed description which follows. In this description reference will be made to the attached drawings wherein Fig. 1 illustrates schematically a modulation system arranged in accordance with my invention, Fig. 2 illustrates graphically the characteristic of the filter used in the embodiment of Fig. 1, while Fig. 3 illustrates a rectifier satisfactory for use in the embodiment of Fig. 1.

The program which may be of any nature, for example, voice or music, is fed to an audio amplifier in unit 10 and from the audio amplifier in 10 to the buffer amplifier stage in 12. The buffer amplifier stage in 12 amplifies the program and also isolates the following stages from the audio stages in 10 to prevent the same from reacting on the said audio stages in 10. The output from the buffer amplifier in 12 is fed to a filter in unit 14. This filter has a characteristic such that high modulation frequencies provide greater outputs from the filter to the rectifier in unit 18. For example, the filter in 14 may have a sloping characteristic as illustrated by the full line in Fig. 2. In one of its simplest forms a filter having such a characteristic may comprise a series capacity and a shunt impedance in a network through which the audio signal is passed. The series capacity and the shunt impedance attenuate the lower modulation frequencies to an extent greater than the higher modulation frequencies.

The rectifier in unit 18 is a delayed bias rectifier and the output thereof is fed back to control the capacity C in an RC network interposed between the audio amplifier in 10 and the amplifier stages in 20 which supply the modified signal currents to the timing modulated transmitter in 24. The modulation corrector is essentially an RC network for cutting high frequencies if they exceed a certain value set by the delayed bias on the rectifier in 18. Since R is in series in the path between the audio amplifier 10 and the audio amplifier stages in 20 and C is in shunt to this path, in the path the higher frequencies are attenuated. Moreover, the point at which the attenuation begins is in accordance with my invention controlled. The RC network, in the path of the modulation current supplier from 10 to amplifier 20, may be of any type wherein C is controlled in accordance with the output of the rectifier in 18.

In a preferred embodiment the capacity C of the RC network is electronic and may comprise a tube 30 having its control grid coupled to its anode by a capacity 32 with an impedance, say the resistance 36, in its anode circuit. With a tube so connected and with the grid to plate tube capacity supplemented by the external capacity 32 there will be developed a capacity between the grid and cathode, as indicated in dotted lines and represented by C. Moreover, this capacity will vary with variations in bias applied to the grid

of tube 30. In accordance with my invention this grid to cathode capactiy is varied by biasing the control grid of tube 30 in accordance with the output in rectifier 18. The electronic capacity here may be, for example, substantially as illustrated in Fig. 2 of Rothe U. S. Patent #2,088,439, dated July 27, 1937.

The rectifier in 18 may be of any appropriate type, for example, it may be as illustrated in Fig. 3 of the drawings. In Fig. 3 the rectifier tube 40 has its cathode adjustably biased from a source of potential 42 shunted by a potentiometer resistance P. The rectifier anode is coupled to the output of the sloping filter 14 and the drop across the resistance 41 in the cathode circuit is supplied to the control grid of tube 30 for electronic capacity control purposes. By adjusting the bias of tube 40 the rectifier action may be delayed as desired. This bias applies a delay voltage to the rectifier so that this delay voltage must be overcome before rectification takes place. Hence when the output of the sloping filter 14 (consisting mostly of high frequency components) exceeds a certain predetermined value, an output is obtained from 18 which functions to increase the capacity C. The result is a momentary application of tone control which prevents the higher frequency components from over-modulating the system. My improved means therefore minimizes any tendency of high frequency modulation to over-modulate the timing modulated system to thereby deviate the carrier beyond the permissible band limits.

Although I have described my potential modifying circuit in a timing modulation system, it will be understood that the same may be put to other uses wherein it is desired to modify the modulating potentials in accordance with their frequency and amplitude.

I claim:

1. The method of signalling by means of carrier currents and modulation currents which includes these steps, passing a selected band of said modulation currents through a path wherein their amplitudes are decreasingly attenuated as their frequency increases, rectifying the currents so passed which exceed a selected amplitude to dirive control potentials, amplifying the original modulation currents, attenuating the amplitudes of the amplified modulation currents in accordance with their frequency, further attenuating the amplitudes of the modulation currents the frequency of which exceed a selected frequency in accordance with said control potentials, and controlling the timing of the carrier currents in accordance with said amplified modulation currents.

2. In means for relaying wave energy of complex wave form, a wave energy relay circuit having an input and an output, connections for supplying wave energy to be relayed to said input, connections for deriving modified relayed wave energy from said output, a wave form modifying



network including a series resistance and a shunt reactance in said circuit, connections for deriving from said wave energy when the same exceeds a selected frequency a control potential which increases as the frequency of said wave energy increases from said selected frequency and connections for controlling the value of said reactance in accordance with said control potential.

3. In apparatus for relaying wave energy of complex wave form, a relay circuit having an input and an output, connections for supplying wave energy to be relayed to said input, connections for deriving modified relayed wave energy from said output, a wave form modifying network including a series resistance and a shunt reactance in said relay circuit, a frequency discriminating circuit and a rectifier excited by said wave energy for deriving a control potential when components of said wave energy exceed a selected frequency and connections for controlling the value of said reactance in accordance with said control potential.

4. In a wave length modulation system, a source of wave energy the wave length of which is to be modulated, a source of modulating potentials, a network including a resistance and a variable reactance coupling said source of modulating potentials to said source of wave energy to be modulated, connections for deriving control potentials characteristic of selected components of said modulating potentials, and means for controlling the value of said reactance in accordance with the control potentials.

5. In a wave length modulation system, a source of wave energy the wave length of which is to be modulated, a source of modulating potentials, a network including a series resistance and a variable shunt capacity coupling said source of modulating potentials to said source of wave energy to be modulated, a frequency discriminating circuit and a rectifier for deriving control potentials characteristic of components of said modulating potentials which exceed a selected frequency, and means for controlling the value of said capacity in accordance with said control potentials.

DUDLEY E. FOSTER.


REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 1,993,861 | Roberts | Mar. 12, 1935 |
| 2,072,708 | Case | Mar. 2, 1937 |
| 2,279,659 | Crosley | Apr. 14, 1942 |
| 2,085,739 | Crosby | July 6, 1937 |
| 2,017,270 | Yolles | Oct. 15, 1935 |
| 2,034,497 | Travis | Mar. 17, 1936 |
| 2,112,595 | Farnham | Mar. 29, 1938 |
| 2,096,760 | Purington | Oct. 26, 1937 |
| 2,296,919 | Goldstine | Sept. 29, 1942 |