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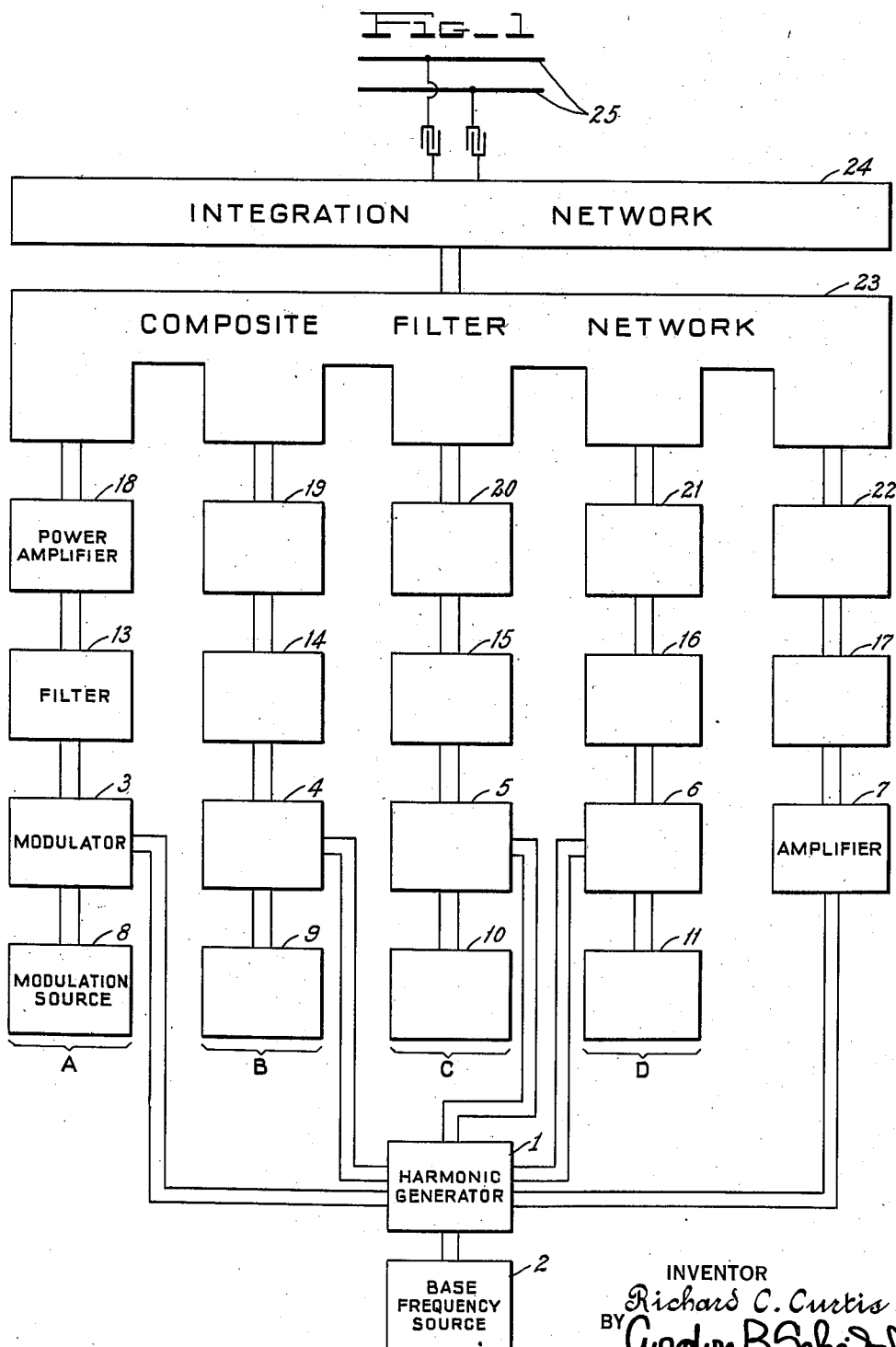
R. C. CURTIS

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CATALYTIC CARRIER SYSTEM

Filed Jan. 14, 1938

2 Sheets-Sheet 1



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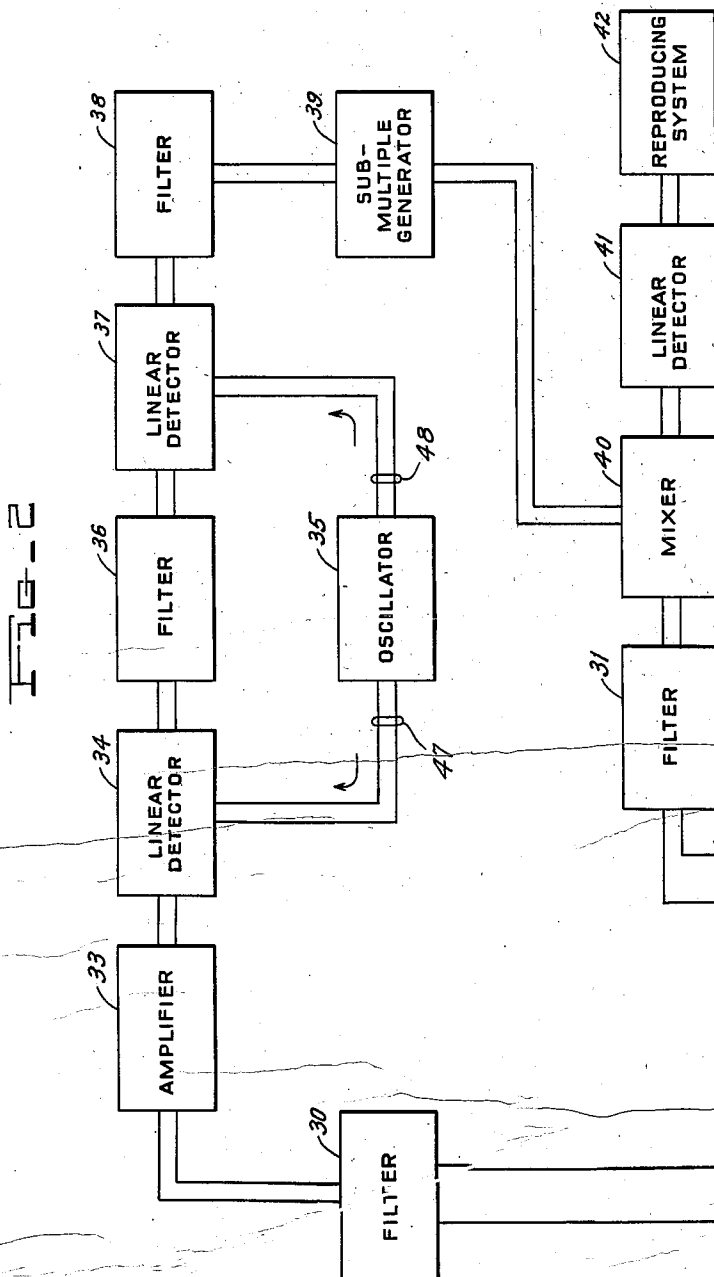
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CATALYTIC CARRIER SYSTEM

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tion of Delaware

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11 Claims. (Cl. 179-1)

This invention pertains in general to signalling systems and specifically relates to signalling systems in which modulated high frequency energy is transmitted to a reception point with the carrier frequency itself substantially eliminated but replaced at the reception point for intelligibly receiving and reproducing the signal.

One object of the invention resides in providing an arrangement for transmitting a replacement carrier frequency over a transmission medium, concomitantly with the transmission of the suppressed carrier signalling energy, the independently transmitted carrier frequency being freed of extraneous modulation and combined with the signalling energy to intelligibly reproduce the signal at the reception point. In this connection, the invention is an enlargement and development of the general field of such systems, as represented by the copending applications of: John C. Walter, Serial No. 84,242, filed June 9, 1936 and issued March 21, 1939 as Patent No. 2,151,454; Robert D. Duncan, Jr., Serial No. 93,908, filed August 1, 1936 and issued January 18, 1938 as Patent No. 2,105,809; and Richard C.

Curtis, Serial No. 180,972, filed December 21, 1937. A further object of the invention comprises providing a suppressed carrier system for the transmission to a reception point of modulated signal high frequency energy with carrier suppressed, together with an independent replacement carrier frequency, with means at the reception point for purifying the individually transmitted carrier frequency so that its recombining quality is enhanced, thereby avoiding distortion, noise and other effects sometimes produced by such transmission methods.

A still further object of the invention comprises providing a system of the type indicated in which a transmitted control frequency and a frequency produced at the reception point are combined to effect a catalytic function whereby any modulation that the control frequency has picked up during transmission is removed, thus providing a clean control frequency for replacement or combining purposes in the reception of signal modulated high frequency energy with carrier suppressed.

Referring to the drawings in detail, a base frequency source 2, such as a crystal controlled electron tube oscillator, produces a sustained electric wave of a base frequency such as 10 kilocycles. This wave, or frequency as it will be called for convenience, is delivered to a harmonic generator 1 which develops from the base frequency a plurality of harmonically related higher

frequencies. These higher frequencies are discretely spaced along the frequency spectrum and are respectively supplied to modulators 3-6 and to an amplifier 7. As an example, the frequency supplied to the modulators 3-6 may be of the order of 30, 50, 60 and 80 kilocycles.

Modulation sources 8-11 provide different signal or program frequencies corresponding to a group of different programs to be transmitted, designated as programs A, B, C and D. These modulation frequencies are fed to the modulators 3-6 respectively, to combine with the carrier frequencies and produce modulated high frequency energy, the carrier frequencies themselves being suppressed before transmission. The outputs of modulators 3-6 are directed respectively through restricting filters 13-16, power amplifiers 18-21 and thence to a composite filter 23 and integration network 24. The output of the integration network 24 is directed through capacitive couplings to a transmission medium 25, which may be a commercial power distribution network such as used in wired radio broadcasting.

The foregoing arrangement of signal transmission is substantially similar to that already disclosed in copending applications of Richard C. Curtis, Serial No. 180,971, filed December 21, 1937 entitled Staggered frequency signal distribution; and Henry R. Butler, Serial No. 161,389, filed August 28, 1937, entitled Wired radio service system, which issued Nov. 14, 1939 as Patent No. 2,179,612.

In the present embodiment of the invention, an amplifier 7 receives from the harmonic generator 1 a high order harmonic frequency such as 150 kilocycles. This frequency is not modulated but is amplified and supplied directly through filter 17 to power amplifier 22 and thence to composite filter 23 and integration network 24, to be transmitted over the transmission medium 25 concomitantly with the transmission of the other frequencies discretely located along the frequency spectrum.

In the operation of the system, receiving equipment, positioned at a reception point, includes a wave filter 30 of the pass range type adapted to receive substantially nothing but the 150 kilocycle frequency transmitted over the medium 25. This transmitted 150 kilocycle wave will be referred to as the primary control frequency to distinguish with respect to a second or catalytic control frequency originated at the reception point. In addition to the filter 30, another filter 31 is provided which may have adjustable parameters for selective reception of any one of the side bands of modulated high fre-

quencies corresponding to the program channels A—D which are transmitted with the carrier frequencies substantially eliminated therefrom.

The output of filter 30 is directed to an amplifier 33 which raises the energy level of the received primary control frequency. The amplification characteristics of the unit 33 are adjustable so that the energy level may be regulated. The regulated output of the amplifier 33 is directed to the input of a linear detector 34. The detector 34 comprises an electron tube and associated circuits for producing sum and difference detection of the input frequencies.

In accordance with the invention, a local oscillator 35 is positioned at the reception point for generating or producing a second control or "catalytic" frequency. The oscillator 35 includes an electron tube and associated circuits for generating a sustained unmodulated high frequency wave. A crystal control arrangement may be used if desired, although in the present embodiment of my invention I prefer to use an oscillator circuit without a crystal, and adjusted to produce a sustained wave of substantially 100 kilocycles. The energy level of the output of the oscillator 35 is controlled by adjustable control means known in the art, and is divided into two circuit paths 47 and 48. The circuit path 47 is directed to the input circuit of the detector 34 so that the frequency of 100 kilocycles from oscillator 35 is combined with the frequency of 150 kilocycles from amplifier 33 by sum and difference detection.

In the course of transmission over lines 25, the 150 kc. control frequency may become modulated by devices connected to said lines between the transmission and reception points. Rectifying devices prove troublesome in this respect by modulating the control frequency at 120 cycles or harmonics thereof. Devices with poor contacts may cause modulation at many audio frequencies. For this reason, the primary control frequency as received through filter 30 becomes a 150 kc. carrier with a small percentage of undesired modulation, for instance at 120 cycles. By the adjustments above mentioned the control frequency input to detector 34 can be made strong relative to the 100 kc. frequency input from oscillator 35 and, inasmuch as detector 34 is linear, the only beat frequencies in the detector output will be as follows:

Input frequencies (kc.)	Sum frequencies (kc.)	Difference frequencies (kc.)
150 (strong)		
150.12 (weak)	300.12	0.12
149.88 (weak)	299.88	0.12
100 (weak)	250	50

Neither the sum nor difference of two weak frequencies appears in the output of a linear detector when a strong frequency also is present, hence the output of detector 34 does not contain frequencies of 250.12 kc. or 249.88 kc. The result is that the beat frequencies of 250 kc. and 50 kc. are not associated with modulation side bands and are spaced sufficiently from the other beat frequencies appearing in the detector output to be easily selected by filtering.

The output of detector 34 is directed to a filter 36 of the pass range type, adjusted to pass substantially nothing but the beat frequency of 250 kc. This pass frequency of the filter 36 is the

sum of the primary control and catalytic frequencies above mentioned. The output of filter 36 is directed to another linear detector 37. The detector 37 operates substantially similarly to the detector 34 and produces sum and difference frequencies. The circuit 48 delivers the relatively weak 100 kilocycle catalytic frequency from the oscillator 35 to the input of detector 37, so as to combine with the 250 kilocycles output of filter 36 in a sum and difference detection operation.

The output of detector 37 is directed to another wave filter 38 of the pass range type. The filter 38 has parameters of values such that the network thereof will pass substantially nothing but a frequency of 150 kilocycles. This frequency, it will be seen, is the difference between the two frequencies delivered to the input of detector 37 and is the same as the primary control frequency but without the modulation which accompanied the control frequency as received over lines 25. The 150 kilocycle frequency passed by filter 38 is directed to a sub-multiple generator 39 which may be a multi-vibrator or other electron tube circuit arrangement for developing from one frequency another frequency of a lower order.

The submultiple generator 39 produces from the frequency 150 kilocycles other frequencies corresponding in cycles per second to the carrier frequencies generated by the generator 1 and which were eliminated from the programs transmitted over the transmission medium 25. The generator 39 includes adjustable circuit parameters for selectively producing a desired one of these frequencies for replacement purposes.

A desired replacement frequency from generator 39 is delivered to a mixer 40 which combines the replacement carrier with the selected side band of modulated high frequency waves delivered from filter 31. The combined frequencies in the output of mixer 40 are delivered to another linear detector 41 and thence to a reproducing system 42 for reproduction of desired modulation as a received selected program.

In the operation of the system it is important that the energy levels of the outputs of amplifier 33 and oscillator 35 be adjusted so that the primary control frequency, from filter 30, has a high energy level as compared with the output of oscillator 35. The catalytic frequency from oscillator 35 in the dual mixing operation in detectors 34 and 37 has been found to produce a material improvement in the quality of the primary control frequency without disturbing its harmonic relation to the base frequency of source 2 at the transmitter. This improvement is so marked that the replacement carrier derived from the primary control frequency may be successfully used to reproduce the program modulation with high fidelity and substantially without hum or noise attendant the transmission of the primary control frequency over a power network such as the medium 25.

The use of the word "catalytic" herein is analogous to the use of the word in the field of chemistry. The catalytic frequency originated at the reception point in accordance with the invention assists in the frequency conversion of the incoming received control frequency to remove extraneous modulation therefrom and yet, like a chemical catalyst, does not appear in the end result.

Although a preferred form of the arrangement for a catalytic carrier system has been shown, it will be recognized that various changes and modifications can be made by those skilled in the art without departing from the intended scope of

the invention. Therefore, no limitation is intended except as pointed out in the appended claims.

What is claimed as new and original to be secured by Letters Patent of the United States is:

1. A system for selectively receiving signals in the form of suppressed carrier side bands transmitted over a wire network together with a control frequency subject to undesired modulation during transmission, said system comprising at a receiving point, means for generating a second control frequency at low energy level compared to the first said control frequency, a linear detector for combining said first and second control frequencies to produce a beat frequency substantially unmodulated, means for selecting said beat frequency in the output of said detector, a second linear detector for combining the second control frequency with the selected beat frequency to reproduce the first control frequency substantially free of said undesired modulation, means connected to the output of the second detector for deriving a replacement carrier from the reproduced first control frequency and means for combining said replacement carrier with a selected one of the received side bands to reproduce its signal.

2. In a receiving system having circuits controlled by a received control frequency which is subject to undesired modulation before reception, means for removing such modulation comprising a source of unmodulated oscillations having a different frequency than the received control frequency, means including a linear detector for combining said oscillations and control frequency, the latter strongly predominating in amplitude, to produce a beat frequency substantially unmodulated, means for selecting said beat frequency in the output of said detector, and a second linear detector for combining relatively weak oscillations from said source with the selected beat frequency to reproduce the control frequency substantially free of the undesired modulation.

3. A system for receiving signal modulated high frequency energy with the carrier frequency itself substantially suppressed but accompanied by a primary control frequency, said system comprising means at a reception point for originating a catalytic control frequency, a selection circuit at said reception point for receiving said primary control frequency, means for adjusting the amplitudes of said primary and catalytic frequencies to make the former strong relative to the latter, a substantially linear detector for combining said primary control frequency and said catalytic frequency, a selection circuit for selecting a resultant frequency from said combined frequencies, a second substantially linear detector for combining said selected resultant frequency with said catalytic frequency, a further selection circuit for selecting the primary control frequency from said second combined frequencies, means for receiving said signal modulated high frequency energy, and means including said selected primary control frequency for replacing the carrier on said received signal modulated high frequency energy.

4. The system in accordance with claim 3 in which said last mentioned means includes a further substantially linear detector for combining said signal modulated high frequency energy with a wave controlled by said selected primary control frequency in a difference detection operation.

5. The system in accordance with claim 3 in which said last mentioned means comprises a sub-

multiple generator for deriving a lower order frequency from said selected primary control frequency, and a substantially linear detector for combining said lower order frequency with said received signal modulated high frequency energy as a replacement carrier for the reproduction of said signal modulation.

6. The system in accordance with claim 3 in which the original carrier frequency of said signal modulated high frequency energy, and said primary control frequency are each multiply related to a base frequency, and in which said selection circuits are all substantially adjusted to the reception of frequencies having substantially multiple relationship with said base frequency.

7. A system for removing modulation from a sustained high frequency primary wave which comprises, means for producing a secondary wave differing in frequency from said primary wave, a selective amplifying circuit for receiving said primary wave and making it strong relative to said secondary wave, a substantially linear detector for combining said primary wave and said secondary wave, a selection circuit for selecting a resultant wave from said combined waves, a second substantially linear detector for combining said selected resultant wave with the relatively weak secondary wave whereby the primary wave is reproduced without modulation, and, a further selection circuit for selecting said reproduced primary wave from said second combined waves.

8. In the art of transmitting and receiving a control frequency over a transmission medium, the method for removing modulation acquired by said frequency during transmission which comprises, amplifying said control frequency as received, combining the same with relatively weak unmodulated oscillations of different frequency and obtaining a beat frequency by linear detection, selecting said beat frequency and recombining it with relatively weak oscillations of said different frequency to obtain by a second linear detection the said control frequency substantially free of modulation.

9. The method for providing a source of unmodulated replacement carriers at a reception point under frequency control of a received control wave subject to modulation during transmission, which method comprises generating unmodulated oscillations differing in frequency from the received control wave, adjusting the relative amplitudes of said oscillations and control wave so that the latter strongly predominates, combining said oscillations and control wave by linear detection to produce a beat frequency substantially free of modulation, recombining said beat frequency with said relatively weak oscillations to obtain the original control wave free of modulation, and using said unmodulated control wave as a source for frequency controlled replacement carriers.

10. A system for removing modulation from a sustained frequency primary wave which comprises, means for producing an unmodulated secondary wave differing in frequency from said primary wave, means for controlling the amplitude of said primary and secondary waves to make the former strong relative to the latter, a substantially linear detector for combining said primary wave and said secondary wave, a selection circuit for selecting a resultant wave from said combined waves, a second substantially linear detector for combining said selected resultant wave with the relatively weak secondary wave whereby the primary wave is reproduced without

modulation, and a further selection circuit for selecting said reproduced primary wave from said second combined waves.

11. The method for eliminating undesired modulation from a primary wave of sustained frequency which comprises mixing said primary wave at a relatively high energy level with unmodulated oscillations of different frequency and

relatively low energy level, obtaining a beat frequency by linear detection, selecting said beat frequency and recombining it with relatively weak oscillations of said different frequency to obtain by a second linear detection said primary wave substantially free of said modulation.

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