Dec. 30, 1947. P. K. CHATTERJEA ET AL 2,433,343

MULTICHANNEL ELECTRICAL COMMUNICATION SYSTEM

Filed Feb. 16, 1943

FIG. 1.

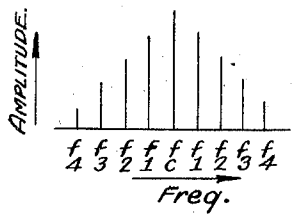



FIG. 2A.

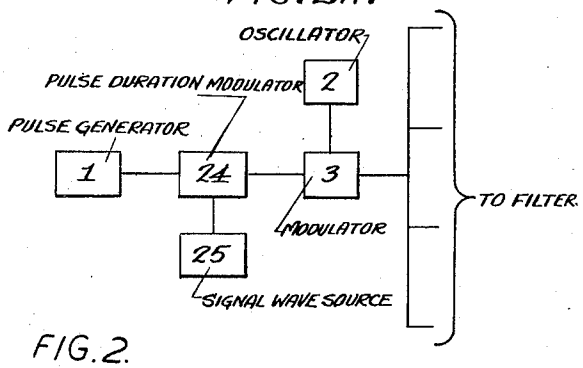



FIG. 2.

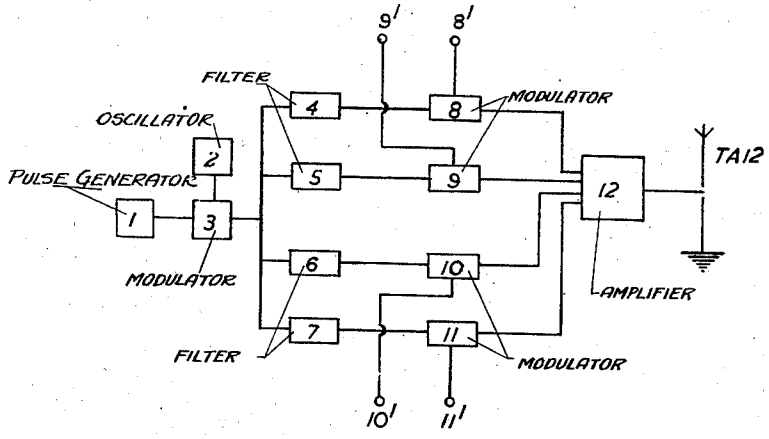
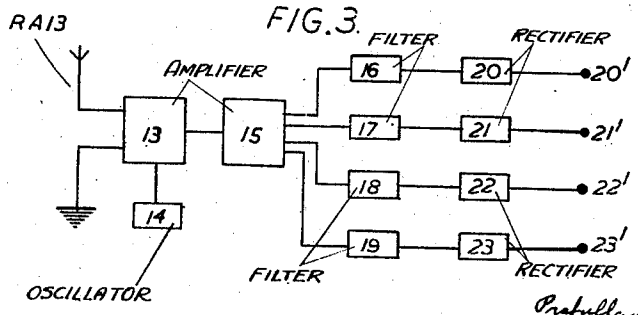



FIG. 3.

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# UNITED STATES PATENT OFFICE

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## MULTICHANNEL ELECTRICAL COMMUNICATION SYSTEM

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1 Claim. (Cl. 179—15)

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The present invention relates to arrangements for producing a series of frequencies equally spaced in the frequency spectrum and its application to the production of carrier frequencies in multi-channel electrical communication systems.

When the necessity arises for the transmission of a plurality of signals contemporaneously, by means of radio, carrier telephony or other like media of communication, there are two chief methods of approach to a solution of such a problem, namely, the multiplication of the carrier frequencies employed, or sub-division of the modulating frequency band applied to one carrier frequency. The first method involves multiplication of transmitting equipment, and difficulty in stabilising each carrier frequency if they are near frequencies, while the second method involves the use of rather cumbersome low frequency filter equipment or like apparatus.

The present invention has for one of its objects the generation of a plurality of carrier frequencies, rigidly separated from each other and to the modulation of each independently, employing a minimum duplication of equipment and to the transmission of the signals from all channels as one transmission.

In an arrangement for the generation of a series of frequencies equally spaced in the frequency spectrum according to the present invention, a wave rich in harmonics of the fundamental frequency thereof modulates a basic frequency thereby producing a series of modulation frequencies separated by a frequency interval equivalent to the fundamental frequency and spreading on either side of said basic frequency.

The invention will be more clearly understood from the following description of its embodiment in a multi-channel communication system given by way of example only and taken in conjunction with the accompanying drawings in which:

Fig. 1 is explanatory;

Fig. 2 shows diagrammatically the transmitting end of a multi-channel communication system embodying the invention;

Fig. 2A shows a modified transmitter system; and

Fig. 3 shows diagrammatically the receiver end of such system.

In the multi-channel electrical communication system an oscillator or other source of carrier frequency is modulated by a train of electrical pulses, preferably of short duration, which result in a series of frequencies, separated by a frequency interval equivalent to the pulse repetition frequency, and spreading on either side of the carrier frequency. These frequencies are in effect the side band frequencies of the pulse train harmonics, and are as shown in Fig. 1 of the drawings where $f_c$ is the carrier frequency, and $f_1$, $f_2$ and $f_3$ etc., are the side-band frequencies due to the pulse train fundamental frequency, second, third etc. harmonics respectively, the difference between any two frequencies, i. e., $f_1$ and $f_2$, or $f_c$ and $f_1$ for example being equal to the pulse train repetition frequency $f_p$. Individual frequencies are then filtered out from this series to function as separate carrier frequencies and are modulated with the signal allotted to a particular carrier frequency or channel after which they are passed through the same amplifier and transmitted as a series of modulated carriers. A receiver of the usual known type if selective enough may select any particular carrier, or signal channel, or a receiver as described hereinafter may be employed.

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In Fig. 2 reference 1 represents a pulse generator and 2 a sinusoidal waveform oscillator, the output from which is fed to unit 3 which consists of a buffer stage and modulator stage for modulating the output of 2 by the output of 1 resulting in a series of frequencies as shown in Fig. 1. The number of such frequencies is governed by the shape of the modulating pulse as well as its duration time, and can readily be made to exceed a hundred or more if desired. One frequency for each required signal channel can readily be obtained by appropriate filtering in known manner, which at the high frequencies normally used can be accomplished by normal tuned circuit technique although in some cases crystal filters may be found necessary. Four channels are shown in Fig. 2, the appropriate carrier frequencies being obtained by filters 4, 5, 6 and 7; the outputs from which are then modulated in units 8, 9, 10 and 11 respectively, the modulating voltages being the signals which it is required to transmit through each channel and are applied at terminals $8^1$, $9^1$, $10^1$ and $11^1$ respectively. The outputs from all of these channels are then combined by unit 12 and amplified before being fed to a radiating system TA12. It is of course essential that the frequency response of unit 12 be sufficient for the frequency spectrum required. If desired, in the case of a large number of channels separate final amplifiers may be employed, and additional radiating systems used. Correction can also be applied to each channel

so that the final signals radiated are all of the same amplitude.

When the carrier frequencies to be radiated are very high frequencies it may be difficult in some cases to separate the individual carrier frequencies by filters 4, 5, 6 and 7 Fig. 2 and it will therefore, be an advantage to carry out the whole of the operation as explained for Fig. 2 at a convenient intermediate frequency; then after combining the individual modulated carriers they may be heterodyned by a local oscillator so as to produce the required high frequencies which may then be radiated after the necessary amplification.

A simple receiver of known type may be used for selecting any particular carrier frequency, and therefore signal channel. In the case where the various carriers are very close to each other however, it is essential to have a band spread system incorporated in the receiver tuning arrangement.

Alternative receivers which may be used where flexibility of channel selection is essential, may include any pre-tuned circuit selection device, or an arrangement as shown schematically in Fig. 3 where the whole band of signals is picked up by aerial system RA13 and amplified by unit 13 which is an amplifier with the requisite wide-band frequency characteristic. The signals are then heterodyned by the local oscillator 14 and the produced I. F. signals are again amplified by unit 15, after which the various channels are separated out by filters, or tuned circuits 16, 17, 18 and 19 and the resulting signals are rectified by the corresponding units 20, 21, 22 and 23 so that the signal transmitted by each channel can be obtained from terminals $20^1$, $21^1$, $22^1$ and $23^1$ respectively.

When it is desired to send the same signal through all the channels, as for example, in the case of an emergency, such signal may be transmitted in each channel by modulating the durations of the initial pulses generated in 1 Fig. 2A in known manner. Energy from a signal source 25 is applied simultaneously with energy from pulse generator 1 to pulse duration modulator 24. As will be well understood by those versed in the art such a modulation is equivalent to an amplitude modulation of the component frequencies making up the pulse and can be received by any of the receivers tuned to one of the carrier frequencies in the outputs of filters 4—7.



Whilst a specific embodiment of the invention has been described by way of example, others which fall within the scope of the appended claim will occur to those skilled in the art.

What is claimed is:

In a multi-channel electrical communication system, means for producing a series of separate carrier frequency waves including a generator of a series of electrical waves each having a form rich in harmonics of the fundamental frequency thereof and comprising a generator of electric pulses of repetition frequency equal to the desired separation of the carrier frequency waves, an oscillation generator producing an electrical sinusoidal wave of a basic frequency, a modulating device to which are fed said wave rich in harmonics and said sinusoidal wave, and means for modulating the durations of said pulses in accordance with the amplitudes of a signal wave, thereby effectively amplitude-modulating the different carrier frequency waves with the same signal wave.

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