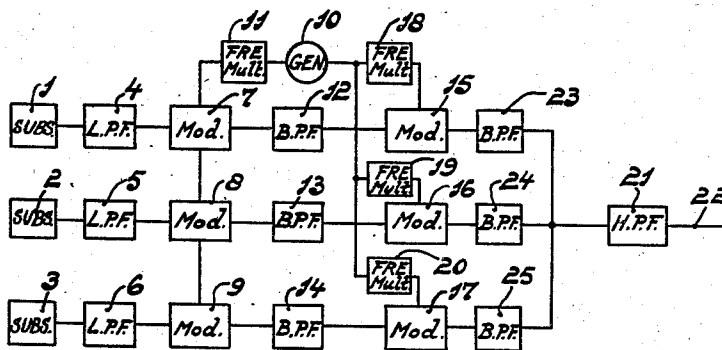Jan. 20, 1942.   T. S. SKILLMAN   2,270,385

MULTICARRIER TRANSMISSION SYSTEM

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This invention relates to a system for multi-channel carrier-wave telephony, in which double modulation is used.

The British Patent #474,021 dated October 25, 1937, describes such a system in which each of the speeches to be transmitted through a common transmission line, which speeches occupy a frequency band of, for instance, 300–2700 cycles, is modulated in the transmitter on an auxiliary carrier wave S which is the same for all speech channels, after which one of the side bands is separated by a filter and modulated on a main carrier-wave in a second modulator. The frequency T of the main carrier wave for each speech to be transmitted is different and the main carriers T_1, T_2–T_n are so selected that the frequency ranges occupied by the side bands to be transmitted are as close together as possible in the total frequency band to be transmitted.

According to the above patent the frequency S of the auxiliary carrier and the frequencies of the main carriers T_1, T_2–T_n are so selected that they are multiples of the same fundamental frequency a, which is determined by and is slightly wider than the width of the speech frequency band to be transmitted, and are in such relation to each other that the sum- and difference-frequencies arising in the second modulation fall in two different frequency ranges. Thus, the sum frequencies $T_1+(S+a)$, $T_2+(S+a)$, ... $T_n+(S+a)$, fall in a frequency range other than the difference frequencies $T_1-(S+a)$, $T_2-(S+a)$ ... $T_n=(S+a)$, whereby it is supposed that after the first modulation in each channel the upper side band $S+a$ is separated and applied to the second modulator. In this patent the two frequency ranges are separated by means of a filter connected between the output circuit of the second modulators of all the channels and the common transmission line so that either the sum frequencies $T_1+(S+a)$, $T_2+(S+a)$ ... $T_n+(S+a)$ or the difference frequencies $T_1-(S+a)$, $T_2-(S+a)$ ... $T_n-(S+a)$ are transmitted to the receiver.

In such systems the output circuits of the second modulators are connected in parallel and this has the disadvantage that a large portion of the output of each of the modulators is lost in the other modulators and as a result only a small portion of the output energy reaches the transmission lines. Consequently, the efficiency of the system is reduced.

The object of my invention is to overcome the above difficulty and to increase the efficiency of such systems and for this purpose I provide a simple band-pass filter in the output circuit of each of the second modulators.

In order that my invention may be clearly understood and readily carried into effect I shall describe the same in more detail with reference to the accompanying drawing in which the single figure is a schematic diagram of a multi-carrier transmission system embodying the invention.

In the drawing the speech currents received from the three subscribers 1, 2 and 3 are fed through three low-pass filters 4, 5 and 6 respectively to three first modulators 7, 8 and 9 respectively. The auxiliary carrier S, which is derived from a generator 10 if necessary through a frequency multiplier 11, is modulated in modulators 7, 8 and 9 by the speech currents. A side band $S+a$ is separated by means of band-pass filters 12, 13 and 14 and is supplied to three second modulators 15, 16 and 17, wherein main carrier waves T_1, T_2 and T_3 are modulated successively by these side bands. The main carrier waves are also derived from the generator 10 and fed to the second modulators 15, 16 and 17 through frequency-multipliers 18, 19 and 20. The output circuits of modulators 15, 16 and 17 are connected in parallel and are connected through a filter 21 to a transmission line 22.

Filter 21, shown as a high-pass filter but which may be a low-pass filter, serves to eliminate the frequency range in which extend either the sum frequencies $T_1+(S+a)$, $T_2+(S+a)$ and $T_3+(S+a)$ or the difference frequencies $T_1-(S+a)$, $T_2-(S+a)$.

In accordance with the invention I provide in the output circuits of the second modulators 15, 16 and 17, band-pass filters 23, 24 and 25 respectively, which transmit one of the side bands arising in the corresponding modulators. The band-pass filter provided in the output circuit of one of the second modulators must produce only a comparatively low damping in the frequency range in which extend the side bands arising from the other two modulators. Thus substantially the entire output energy of each of the second modulators 15, 16 and 17 will be fed to the transmission line 22.

The band-pass filter 23, 24 and 25 may be of very simple construction and need contain only a few elements so that they do not appreciably increase the cost of the system. Thus the cost of the system according to the invention is even maintained considerably lower than that of the other known system, wherein the afore-mentioned relation between the frequencies of the auxiliary and main carriers does not exist and

consequently very sharply cutting-off band-pass filters are required in each of the channels behind the second modulator.

Although I have described my invention with reference to a specific example, I do not wish to be limited thereto because obvious modifications will present themselves to one skilled in the art.

What I claim is:

In a multichannel carrier wave system, a plurality of channels each transmitting a conversation, a first modulator in each channel, means for supplying to each of said first modulators an auxiliary carrier having the same frequency in each of the channels, a first band-pass filter in each channel and separating one of the side bands produced in the first modulator of the channel by the modulation of the auxiliary carrier by the conversation, a second modulator in each channel, means for supplying to said second modulators the side band separated by said first band-pass filter, means for supplying to said second modulators main carriers having frequencies which are different for each of the channels and which are so selected that all the lower side bands and all the upper side bands produced in the second modulators lie in two separate frequency ranges, a common transmission line, and a second band-pass filter in each channel and connected between the second modulator of the channel and said transmission line, all of said second band-pass filters transmitting side bands produced in the corresponding second modulators and lying in the same one of said separate frequency ranges.

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