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RADIO SIGNALING SYSTEM

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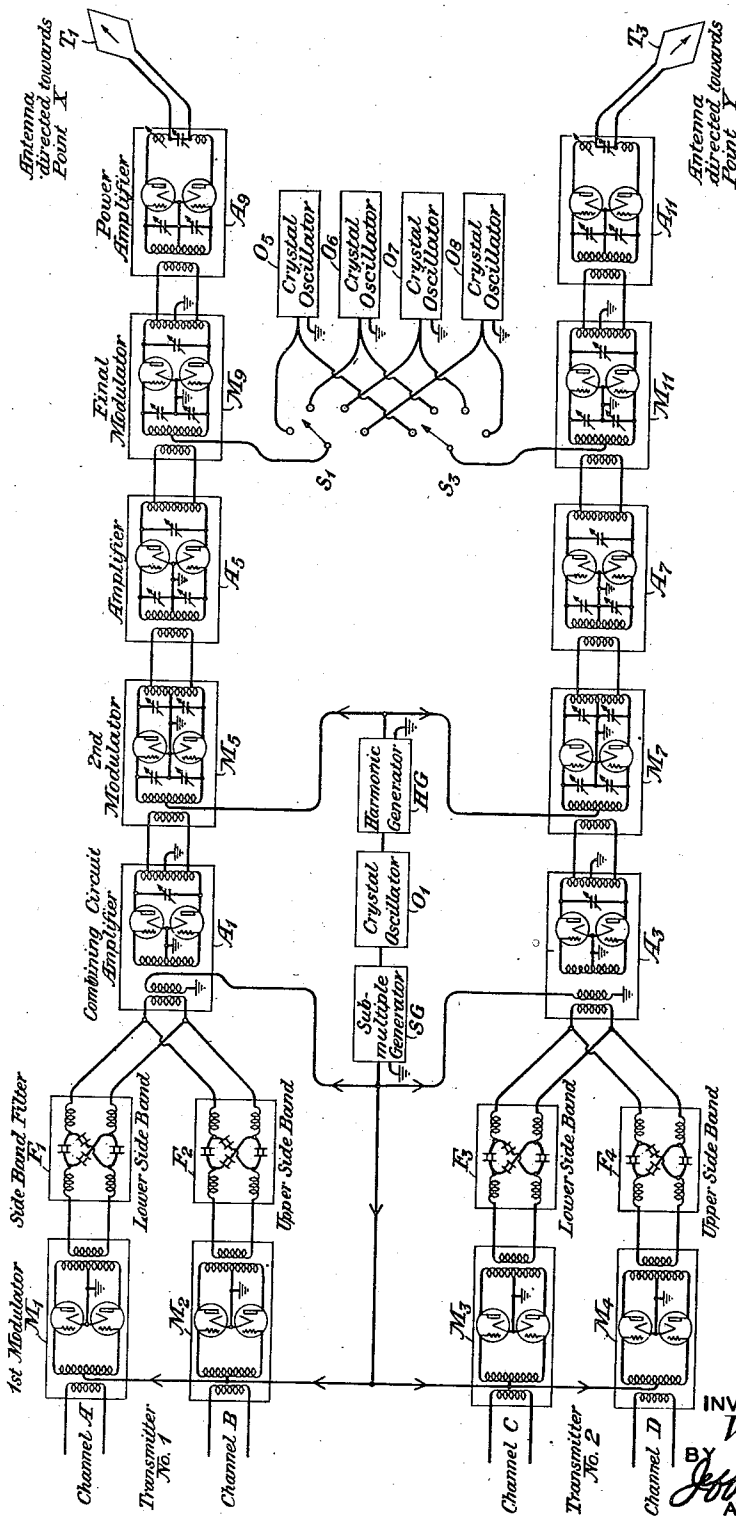


Fig. 1

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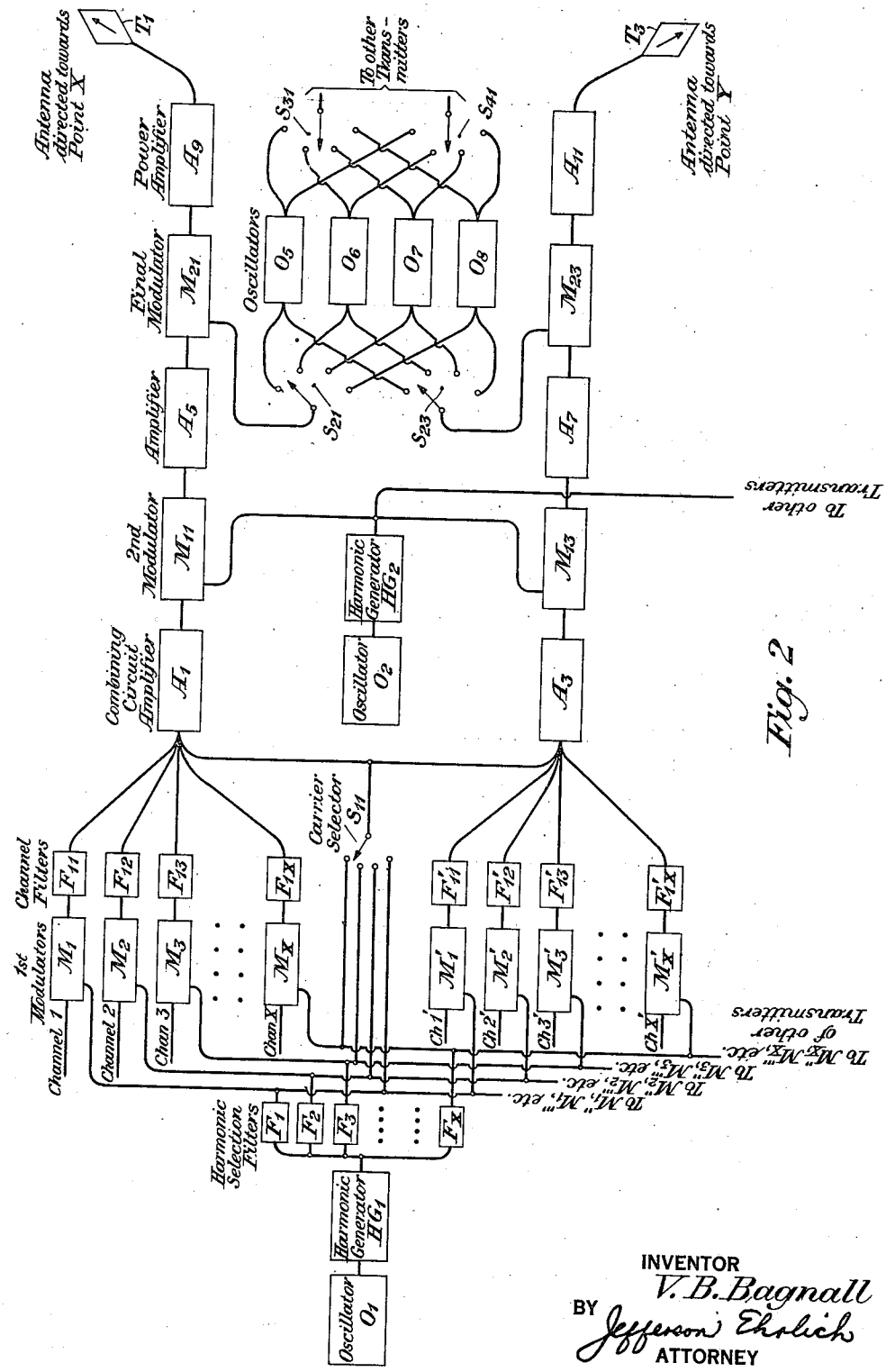


Fig. 2

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RADIO SIGNALING SYSTEM

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5 Claims. (Cl. 250—9)

This invention relates to radio signaling systems. More particularly this invention relates to radio systems for use in transmitting signals to a plurality of different points.

It has heretofore been proposed to transmit two different signaling channels as the upper and lower side bands, respectively, of a single carrier current. With such an arrangement two different sources of signals may be transmitted simultaneously to a distant point or to closely adjacent distant points within the directive characteristics of the antenna used without loss of effectiveness, the different signals being conveyed as single side bands of a common carrier current of radio frequency. This dual or twin channel method of operating single side band radio telephone or telegraph circuits is of some advantage from the standpoint of plant investment, and particularly in the reduction of frequency requirements, inasmuch as the channels may be operated with relatively small frequency separation between channels. With such a multichannel system, the full transmission effectiveness is not obtained unless all channels are operated to the same point of communication, or to points relatively close to each other, as already noted, if directive antenna systems are employed. Where the distant points are relatively close to each other the same frequency must in general be optimum during the periods when the transmission is to take place. Thus a single transmitter and a single directive transmitting antenna system may be employed effectively for operation to both such points. Moreover, such a system may be used for the transmission of more than two signaling channels.

According to the present invention an arrangement is set up for multi-channel operation to two or more points of communication which are not necessarily in the same general direction and which would permit effective operation to all points on the same general band of frequencies simultaneously, or on two separate general frequency bands as may be required by transmission conditions. With the new arrangement two (or more) substantially complete transmitters are required, and separate transmitting antennae may be provided for each point of communication to obtain effective transmission in the directions desired during different transmission conditions. In the new arrangement a carrier frequency control for the two (or more) transmitters may be tied together in such a way as to permit operation of both transmitters on the same carrier frequency assignment simultaneously or, if desired, one of the transmitters may be operated on any one of the various frequency assignments independently of the frequency assignment of the other transmitter. It is clear that the arrangements of this invention will result in considerable economy in frequency assignments which, as is well known, are at a premium.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawings in which Figure 1 shows one embodiment of the invention given merely for the purpose of illustration and Fig. 2 illustrates another modification of the invention.

Referring to the drawings, four different channels of communication designated A, B, C and D may each comprise a single band of signals, such as telephone signals for example, or a plurality of different non-overlapping bands of signals as are used in carrier telephone systems. The channels A and B are connected to one of the transmitters, for example, the upper transmitter, and the channels C and D to the second or lower transmitter. A local oscillator O_1, which may, for example, be crystal-controlled, is connected to a submultiple harmonic generator SG for deriving a submultiple of the frequency of the oscillator O_1. Thus if the oscillator O_1 produces current of a frequency, for example, of 625 kc., the submultiple generator SG may derive current of a frequency of 125 kc. The subharmonic is then transmitted to all of the various first modulators designated M_1, M_2, M_3 and M_4 which are of any well-known type and are shown only schematically. The products of modulation of each of the various modulators are then transmitted to corresponding filters F_1, F_2, F_3 and F_4 as shown, the filter F_1 freely transmitting the lower side band of the submultiple frequency and the filter F_2 the upper side band of that same submultiple frequency, all other products of modulation being substantially suppressed. Similarly the filters F_3 and F_4 will freely transmit the lower and upper side bands, respectively, of the same submultiple frequency corresponding respectively to channels C and D, and all other products of modulation will be substantially suppressed. These filters may be of any well known type as, for example, of the crystal type as illustrated. The lower and upper side bands derived from filters F_1 and F_2, respectively, are then both transmitted to a combining circuit and amplifier A_1, which is part of the upper transmitter and to which the submultiple generator SG is also connected. This combining circuit and am-

plifier amplifies the two received side bands and also introduces the submultiple frequency current at any predetermined level. Similarly the combining circuit and amplifier A_3 combines the lower and upper side bands received from filters F_3 and F_4 with the same current of submultiple frequency at any desired level.

The output of the combining circuit and amplifier A_1 is transmitted to a second modulator M_5 together with a harmonic of the frequency of the oscillator O_1, which is obtained by the harmonic generator HG. The harmonic generator HG may produce, for example, a fourth harmonic of the frequency of the oscillator O_1, or current of 2500 kc. Similarly the same harmonic obtained from the harmonic generator HG is transmitted to the second modulator M_7 along with the currents obtained from the combining circuit and amplifier A_3. The products of the second stage of modulation are then amplified by amplifiers A_5 and A_7, respectively, and the amplified currents are then impressed upon corresponding final modulators M_9 and M_{11}. A switch S_1 is connected to the input side of the modulator M_1, and a corresponding switch S_3 is connected to the input side of the modulator M_{11}. These switches are independently manipulated and are used to connect any one of the various oscillators of high frequency designated O_5, O_6, O_7 and O_8 to the modulators M_9 and M_{11}. The various oscillators O_5 to O_8 are common to the two modulators M_9 and M_{11}. These oscillators produce currents of different frequencies such as 9,000 kc., 12,000 kc., 15,000 kc. and 18,000 kc. After modulation the currents are amplified by corresponding amplifiers A_9 and A_{11}, and the amplified currents are transmitted through space by transmitting antennae T_1 and T_3, which are preferably directive antennae of, for example, the rhombic type. The antenna T_1 may be directed to a point X, or to a pair or group of points closely adjacent to point X. Similarly the antenna T_3 may be directed to a point Y, or to a pair or group of points adjacent to point Y.

In the arrangement shown and described the ultimate carrier frequency for each transmitter is obtained after employing three steps of modulation. In actual practice the number of modulation steps may be increased to any desired extent or reduced to but one or two steps. Moreover, the frequencies noted are given merely for the purpose of explanation of the operation of the invention and other values may be used in practice. Furthermore, while but two transmitters have been shown and described, the invention is, of course, equally applicable to three or more such transmitters all of which may be interconnected in the manner already illustrated. Any number of common oscillators such as O_5 to O_8 may be used to provide any desired flexibility in the system.

The upper transmitter may be used to transmit one signal channel to one point on a single side band basis, and the lower transmitter used to transmit another signal channel to a different point on a similar but opposite single side band basis. In this case a single frequency, such as that provided by oscillator O_5, may be used for both transmitters simultaneously, one transmitter supplying the upper side band and the other the lower side band, and this will be done with substantially no loss in effectiveness. Thus the proposed arrangement permits full flexibility of operation to two points of communication on a twin channel basis. The arrangement will also provide for the operation of two channels to either point of communication, and with the proposed scheme the frequency for most desired transmission under the prevailing conditions may be used for transmission to each point of communication, and this may be done independently of the frequency used to any other point of communication.

It is also apparent that the upper transmitter may be used for the transmission of two signaling channels (or two groups of channels) and the lower transmitter for two similar signaling channels (or groups of channels) in which case one of the oscillators, such as O_5, will be used for the upper transmitter, and another of the oscillators, such as O_6, for the lower transmitter. In this case the oscillators, such as O_5, O_6, etc., supply currents of frequencies which are assignable to the two transmission paths, and the oscillating equipment is common to the two transmitters. This is an important feature of this invention.

The arrangement of this invention is preferably set up so that both transmitters may operate at substantially the same power outputs. This, however, is not absolutely essential. The greater the directivity of the various antennae, the less need the outputs of the two transmitters be made equal to each other. Were the two transmitters of unequal power, then in some cases proper adjustment of the received signals at the distant points would have to be made.

The arrangement shown in the drawings may, therefore, employ a single carrier frequency for two radio transmitters operating simultaneously. This is an important feature of the invention. The single carrier current source is thus connected to both transmitters. When so set up, an important advantage follows from the non-overlapping of the signals of the two channels being transmitted simultaneously. This advantage could not be gained were two separate sources of carrier current used independently for the two transmitters, because due to inherent drifts in the frequencies of the carriers there would necessarily be considerable overlapping and consequent interference between the two channels.

If a frequency is suitable for transmission to two distant points which are in widely different directions from the transmitter then but one transmitter may be employed. In that case the antenna of the transmitter, such as T_1, may be replaced by a non-directive antenna. If desired two directive antennae may be used in place of antenna T_1, these antennae being pointed in the desired directions although connected to the same radio transmitter. When two antennae are so connected to a single transmitter, the transmission to both points may take place on the same carrier frequency, the radiated power being divided between the two transmission paths with resulting lowered effectiveness of the transmission to both points.

Fig. 2 shows a modification of Fig. 1 in which arrangements are shown for superimposing a plurality of channels on a single transmitter, together with further arrangements for transmitting a carrier signal at a frequency which may be above or below the various channels or at a frequency between the various channels. The harmonic generator HG_1, coupled to oscillator O_1, supplies numerous harmonics which are selected by the various filters F_1, F_2, F_3. . . F_x, each filter selecting its individual harmonic. These selected harmonics are supplied to a plurality of corresponding modulators M_1—M_x in

the upper transmitter, for example, as well as to modulators M', M'x of the lower transmitter. These various modulators modulate the different signals supplied thereto over channels 1—x and 1' to x' and one of the side bands of the products of modulation is selected by the corresponding filter of the group F_{11}—F_{1x} of the upper transmitter and by filters of the group F'_{11}—F'_{1x} of the lower transmitter, as shown in the drawings. Thus there are supplied to amplifier A_1, a plurality of modulated non-overlapping signaling bands and to amplifier A_3 a corresponding number of modulated non-overlapping signaling bands.

The switch S_{11} may select any one of the various harmonics obtained by the various filters F_1—F_x. The frequency selected may be located above or below all of the signaling bands just referred to, as will be apparent to those skilled in the art or the selected frequency may be positioned between any two adjacent bands, that is, the selected current may have a frequency positioned between the component frequencies of, for example, filters F_{11} and F_{12}. The current selected by switch S_{11} is transmitted along with all of the signaling channels so that at the receiver it may be employed for control of the gain and for tuning of the receiver.

The rest of the system of Fig. 2 corresponds to that of Fig. 1 except that a second oscillator O_2 and harmonic generator HG_2 are employed. This arrangement permits greater flexibility in that the frequency supplied to the second modulators M_{11} and M_{13} may be independent of and higher than any frequency obtained from the harmonic generator HG_1.

Although Figs. 1 and 2 have been described as embodying two transmitters, additional transmitters may be used. In this case the first modulators may be supplied by currents obtained from filters F_1—F_x, the harmonic generator HG_2 may supply all of the second modulators, as shown in Fig. 2, and moreover, oscillators O_5 to O_8 may supply the high frequencies for the third modulators, as already pointed out.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of two radio transmitters, a carrier generator common to both transmitters, and means for transmitting a band of signals by one of said transmitters as an upper side band of the carrier current supplied by said generator and for simultaneously transmitting another band of different signals by the second transmitter as a lower side band of the same carrier current of said generator, whereby said two radio transmitters will separately transmit the two side bands of said carrier current without interference with each other so that said two side bands may be separately utilized.

2. The combination of two directive antennae pointed in different directions, a source of carrier current, two different sources of signals, means for modulating the signals of one of the sources upon the carrier current of said source of carrier current for transmission through one of said antennae as the upper side band of the carrier current, and means for modulating the signals of the other different source upon the same carrier current of said source of carrier current for transmission through the other antenna as the lower side band of said carrier current whereby said two antennae will separately transmit the two side bands of the carrier current without interference with each other so that said two side bands may be separately received and utilized.

3. The combination of a plurality of separate sources of carrier current, two twin channel radio transmitters to which all of said sources of carrier current are common, the transmitters including directive antennae which are pointed in different directions, and means for utilizing one of said sources of current as the carrier for the operation of one of the radio transmitters and for utilizing a different one of said sources of current as the carrier for the operation of the other of said transmitters, whereby said transmitters will transmit modulated carrier currents corresponding to different bands of signals.

4. A radio signaling system for transmitting a band of signals in one direction without interfering with transmission of a different band of signals in a different direction on the same carrier frequency, comprising a radio transmitter including means for obtaining from one of the bands of signals the upper side band of the carrier current as a signaling channel for transmission in one of said directions, and means for obtaining from the other of the bands of signals the lower side band of the same carrier current as a signaling channel for transmission in the other direction, said carrier currents being obtained from the same source, whereby the transmissions of said upper and lower side bands will not overlap each other and may therefore be separately utilized.

5. The combination of a plurality of multichannel radio transmitters each of which is equipped with a directive antenna, the various antennae being pointed in different directions, a plurality of sources of carrier current of different frequencies which are suitable for the operation of each of the various transmitters, means connecting the various sources of carrier current to said transmitters so that but one of said sources is connected to a single transmitter, and means whereby each transmitter supplies two side bands of the associated carrier current for the transmission of two different bands of signals in a direction different from that of the antennae of the other transmitters.

VERNON BERNARD BAGNALL.