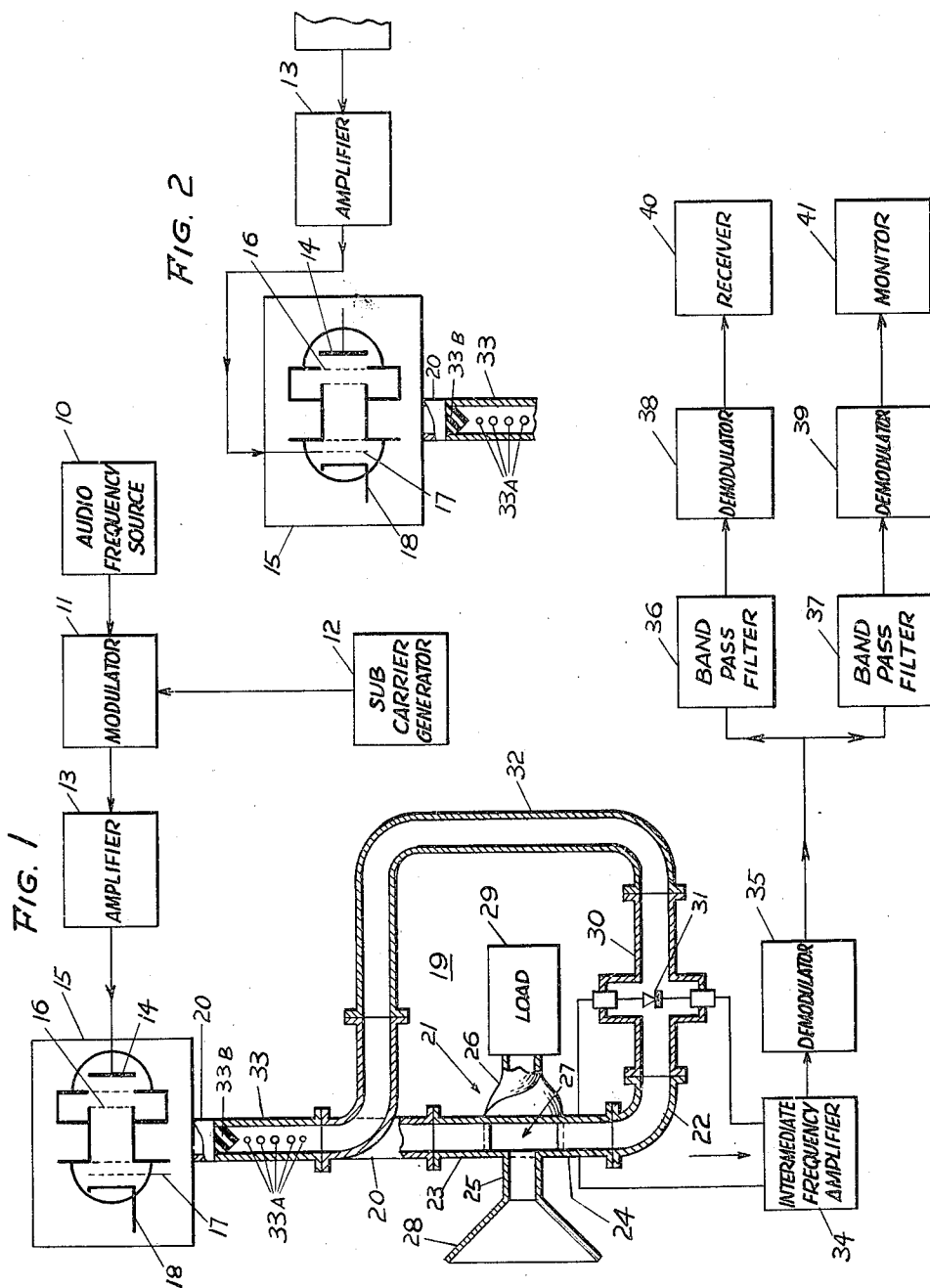


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COMMUNICATION SYSTEM
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COMMUNICATION SYSTEM

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This invention relates to communication systems and more particularly to duplex operation of such systems employing a single carrier wave generator modulated by a subcarrier wave containing any desired intelligence.

An object of the present invention is to provide a system of the type above described which is capable of utilizing a portion of a locally-generated carrier wave and a remotely-generated carrier wave to produce an intermediate frequency wave, substantially lower in frequency than said carrier waves.

Another object is to provide circuit means connected to above described intermediate frequency wave producing means for separating a locally-generated subcarrier wave from a remotely-generated subcarrier wave contained therein together with means for extracting and reproducing any local and remote intelligence therefrom.

The above and other objects will present themselves as the description of the present invention progresses and by reference to the accompanying drawing, in which:

Fig. 1 is a partial block and partial pictorial view of an illustrative embodiment of the present invention; and

Fig. 2 is fragmentary view of another embodiment illustrating an alternative connection to the local carrier wave generator.

Referring now to Fig. 1, the reference numeral 10 represents a source of audio frequency which is connected to a modulator stage 11. A subcarrier generator stage 12 is also connected to said modulator stage 11, and the modulated subcarrier frequency from said modulator stage is applied to an amplifier stage 13. The frequency of said subcarrier generator may be, for example, of the order of 150 kilocycles per second.

The output of said amplifier stage 13, containing the subcarrier frequency and the audio frequency, which may be any local intelligence, is impressed on a reflector electrode 14 of a velocity-modulated electron discharge device 15 of the reflex type. Said discharge device 15 also contains therein a resonator grid 16, a control grid 17 and a cathode 18. The electron discharge device 15 is the source, in this particular embodiment, of a carrier wave whose frequency, for example, may be of the order of 8000 megacycles per second.

The application of the output from said amplifier stage 13 to said electron discharge device 15 serves to frequency modulate said 8000 megacycle carrier wave in accordance with the frequency of said subcarrier wave. This last-named

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modulated carrier wave output is fed, through suitable means, into a waveguide system 19. Said waveguide system includes, by way of illustration, a waveguide section 20 connected to a magic tee 21, which in turn is connected to another waveguide section 22. The so-called magic tee includes a side branch 23, a second side branch 24 collinear with said first side branch, a so-called E arm 25, extending at right angles to said side branches 23—24, and a so-called H arm 26. As shown in the drawing, the H arm 26 recedes from the observer for a short distance from the junction 27, then bends to the right, and is then twisted through an angle of 90 degrees.

15 An electromagnetic horn 28 adapted to directionally radiate the carrier wave output of said electron discharge device 15 is connected to one end of the E arm 25. The horn is also receptive of a remotely-generated carrier wave of a different frequency, for example, one of the order of 8010 megacycles per second. The source of said remotely-generated carrier wave may be a system similar to the one being described and illustrated herein. The remotely-generated carrier wave 25 may be modulated by a subcarrier, for example, one having a frequency of the order of 250 kilocycles per second, together with any remote intelligence that may be transmitted from said remote unit. A matched load 29 which serves to absorb a portion of the carrier wave energy, in a manner known to those versed in the microwave technique, is connected to the other end of the H arm 26. A third waveguide section 30 containing therein a non-linear impedance 31 such as, for example, a crystal, is coupled to the waveguide section 22. A fourth waveguide section 32 is coupled to the opposite side of said section 30, this last-named waveguide section being coupled to a directional coupler 33. In this particular embodiment, the directional coupler, which is supplied with a plurality of apertures 33A, is placed adjacent the waveguide section 20, said waveguide section likewise having a plurality of apertures (not shown) which are in register with the apertures 33A. Also positioned in one end of said directional coupler is an energy absorbing material 33B. Since the directional coupler is a well-known device, discussion of the theory of operation can be found in report P. B. 15,290, dated December 31, 1944, written by R. J. Harrison for the Office of Technical Services, Department of Commerce, and entitled "Design considerations for directional couplers." Said directional coupler is capable of admitting a portion of the carrier wave energy of the device 15 to the waveguide section 32 and thence to the

non-linear device 31, while blocking the passage of any energy of the incoming or remotely-generated carrier wave.

As the carrier wave, generated by the device 15 and modulated by the subcarrier containing any desired intelligence, is fed to the waveguide system, it travels along said waveguide 20 to the junction 27 of the magic tee 21. At said junction, the locally generated carrier wave, whose frequency is 8000 megacycles per second, splits into two like components. One of said components being radiated into space via the E arm 25 and the electromagnetic horn 28, the other component being absorbed by the matched load 29 via the H arm 26.

As the locally-generated carrier wave energy travels through the waveguide section 20, a portion of it is diverted through the apertures 33A of the directional coupler 33 via the waveguide section 32 and appears across the non-linear impedance device 31. Now, when the electromagnetic horn 28 receives any remotely-generated carrier wave, the energy thereof will be conducted via the E arm 25 to the junction 27 where said energy splits into two like components one of which is conducted via the side branch 24 and waveguide section 22 to appear across the non-linear impedance 31. As a result there will now appear across said non-linear impedance, frequencies whose values are the sum of and the difference between said locally and remotely-generated carrier waves. In other words, in accordance with the sample values set forth hereinbefore, said values will be respectively, 16,010 megacycles and 10 megacycles per second. The other component of the remotely-generated carrier, travelling in the direction of the device 15, is lost in said device.

Preferably, the frequency selected, and termed herein as the intermediate frequency, will be the lower one of 10 megacycles. An intermediate frequency amplifier stage 34, receptive of said frequency is coupled to the output of said non-linear impedance 31.

It will be recalled that both of the aforesaid carrier waves were frequency modulated by subcarrier waves containing any desired intelligence, the locally-generated subcarrier having a frequency of 150 kilocycles per second and the remotely-generated subcarrier wave a frequency of 250 kilocycles. A demodulator stage 35, responsive to said subcarrier waves, separates them from the intermediate frequency wave of ten megacycles per second.

The output of said demodulator stage 35 is now fed to a pair of filter network stages 36—37, stage 36 being responsive to the remotely generated subcarrier wave of 250 kilocycles, while stage 37 is responsive to the locally-generated subcarrier wave of 150 kilocycles per second. From these last-named stages, the respective outputs are again demodulated by a pair of stages 38—39. The last-named stages 38—39 may include in the case of frequency-modulation, the usual limiter and discriminator stages. The output of said stages 38—39 will be, respectively, the remote intelligence which is fed to a receiver stage 40 and the local intelligence which is fed to a monitoring stage 41.

Fig. 2 illustrates, in a partial schematic diagram, the use of the system of the present invention for the transmission of amplitude modulated signals. In this particular embodiment the output of the amplifier is applied to the control grid of the electron discharge device 15. In

this application of the present system, the electron stream is controlled by the amplitude of the potential from the amplifier stage 13 and the amplitude of the signal output varied in accordance therewith, the potential on the reflector electrode being supplied from a substantially constant source.

The output of the device 15 is conducted through the waveguide system 19 in the same manner hereinbefore described in connection with Fig. 1, the demodulator stages 38—39 being suitably designed for amplitude modulation operation.

In the operation of the system of the present invention, the subcarrier frequencies of the local and remote stations must be selected to avoid any beat frequencies therebetween to fall into the range of the filters 36 and 37. The selection must also avoid the possibility of higher harmonics, their beat frequencies being within the frequency range of the filter stages 36 and 37.

The system above described provides a point-to-point communication system using different carrier frequencies for transmission in either direction. In such a system the intelligence is usually extracted by beating the incoming modulated carrier wave with an unmodulated carrier wave produced by a local oscillator, and by amplification and demodulation of the intermediate frequency thus obtained. However, in the system of the present invention, the need for such a local oscillator has been eliminated, and a single generator system provided. In a more elaborate scheme sending and receiving of more than one program can be achieved by transmitting each program on a different subcarrier.

Other objects and advantages of the present invention will readily occur to those skilled in the art to which the same relates. Therefore, it should be clearly understood that the present invention is not limited to the details herein shown and described for the purpose of illustration, inasmuch as changes therein may be made without the exercise of invention, and within the true spirit and scope of the claims hereto appended.

What is claimed is:

1. A communication system comprising: means for locally generating a carrier and a subcarrier wave; means for modulating said subcarrier with local intelligence; means for modulating said carrier in accordance with said modulated subcarrier; means for transmitting and receiving, respectively, said locally-generated carrier wave, and a remotely generated carrier wave similarly modulated; means for mixing said transmitted and received carrier waves to produce an intermediate frequency wave; means for demodulating the output of said mixing means to extract said subcarrier waves; means for separating said subcarrier waves; and means for demodulating said subcarrier waves to extract the local and remote intelligence therefrom.

2. A communication system comprising: means for locally generating carrier and subcarrier waves; means adapted to modulate said subcarrier wave in accordance with local intelligence; means for modulating said carrier wave in accordance with said modulated subcarrier wave; means adapted to transmit said locally-generated carrier wave and to receive a remotely-generated carrier wave containing a second subcarrier wave modulated with remote intelligence; means for mixing said locally and

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remotely-generated carrier waves to produce an intermediate frequency wave; means for amplifying the output of said mixing means; means for demodulating the output of said last-named means to extract therefrom said remote and locally-generated subcarrier waves; means connected to said demodulating means for separating said remotely and locally-generated subcarrier waves; and means connected to said last-named means to demodulate, respectively, said remotely and locally-generated subcarrier waves to separately reproduce said local and remote intelligence.

3. A communication system comprising: means for locally generating carrier and subcarrier waves; means adapted to modulate said subcarrier in accordance with local intelligence; means for modulating said carrier wave in accordance with said modulated subcarrier wave; means adapted to transmit said locally-generated carrier wave and receive a remotely-generated carrier wave containing a second subcarrier wave modulated with remote intelligence, said last-named carrier and subcarrier waves differing in frequency from said locally-generated carrier and subcarrier waves; means for mixing said locally and remotely-generated

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carrier waves to produce an intermediate frequency wave; means for amplifying the output of said mixing means; means for demodulating the output of said amplifying means to extract therefrom said remote and locally-generated subcarrier waves; means connected to said demodulating means for separating said remote and locally-generated subcarrier waves; and means connected to said last-named means to demodulate, respectively, said remote and locally-generated subcarrier waves to separately reproduce said local and remote intelligence.

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