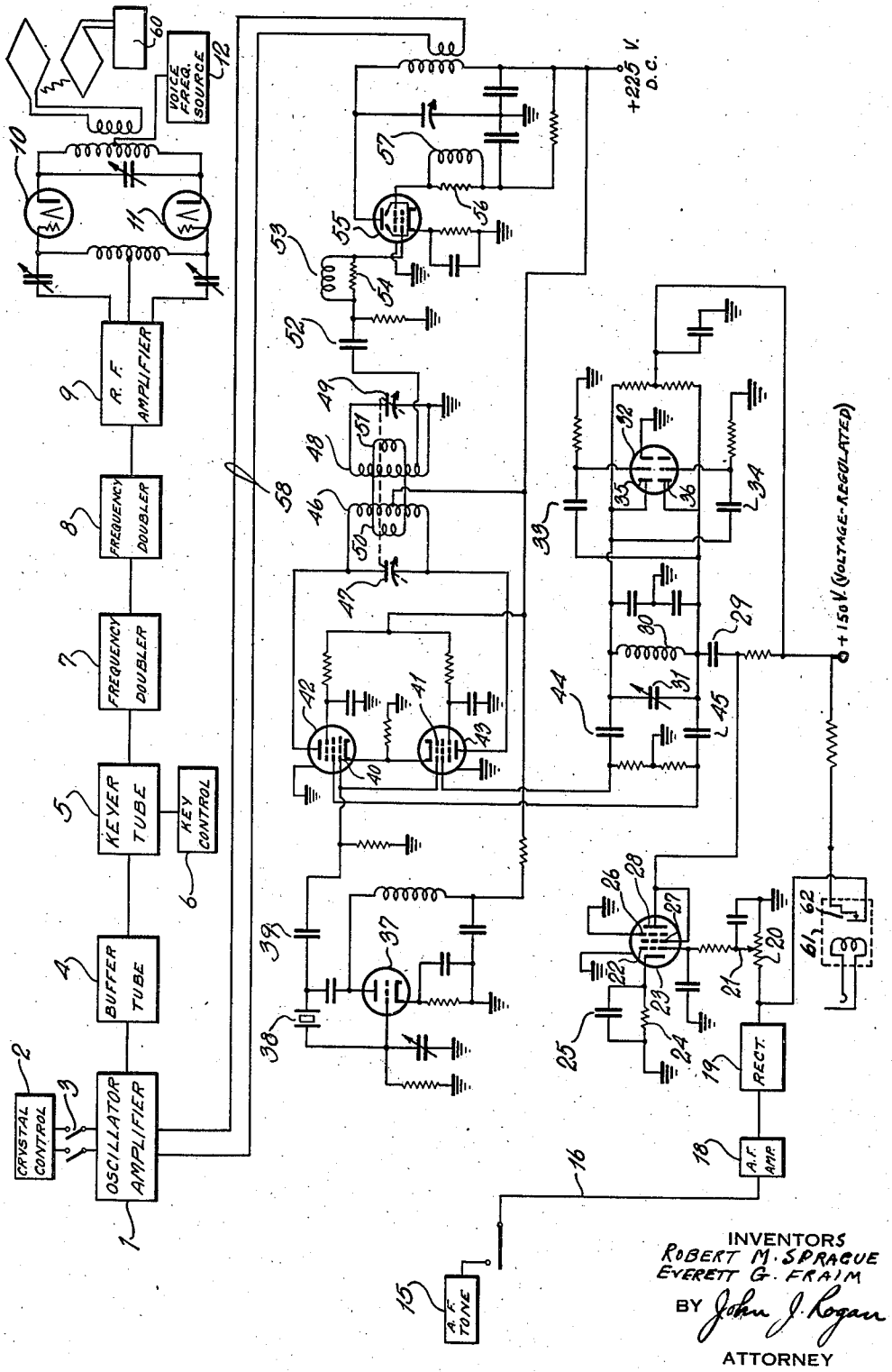
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RADIO TRANSMISSION SYSTEM

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RADIO TRANSMISSION SYSTEM

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1 Claim. (Cl. 250—9)

This invention relates to radio telephone and telegraph systems and more especially to systems in which different messages are sent on the same carrier channel without interference by employing two different kinds of modulation.

The invention is in the nature of an improvement on the system disclosed in application Serial No. 478,854, filed March 12, 1943.

A principal object of the invention is to provide improved circuit arrangements for utilizing a single carrier channel for different classes of communication service by means of simultaneous amplitude and frequency modulation.

A feature of the invention relates to a flexible service radio transmitter whereby the same transmitter can be used for transmission of telegraph or telephone signals by amplitude modulation or keying, and can also be used to transmit simultaneously telephone signals and other signals, e. g., facsimile signals, by two different kinds of modulation.

Another feature relates to an improved circuit arrangement for frequency shifting a carrier by converting telegraph signals or facsimile signals, into frequency modulations of a low frequency oscillator which is sufficiently inherently stable without using control crystals, and converting said frequency modulations into radio frequency signals in the form of a frequency shifted radio frequency carrier using a crystal stabilized oscillator.

A further feature relates to the novel organization, arrangement and relative interconnection of parts which constitute an improved radio transmitter for simultaneously radiating different kinds of intelligence signals.

Other features and advantages not specifically set forth will be apparent after a consideration of the following detailed descriptions and the appended claims.

Referring to the drawing which illustrates one embodiment of the invention, the transmitter comprises a grid-controlled amplifier tube 1 of any well-known type for amplifying radio frequency oscillations, e. g., at from two to four megacycles. If desired, the tube 1 may be connected to a crystal control device 2, by means of a suitable switch 3 when the system is to be used as a straight telegraph or telephone transmitter. The output of tube 1 is fed to a buffer tube 4 and thence to a telegraph keying tube 5 whose conductivity is controlled by any well-known keying device 6. The keyed radio frequency carrier may then be doubled in frequency in device 7, and then redoubled in device 8. The multiplied frequency is then amplified in device 9 and in the balanced or push-pull amplifier-modulators 10, 11, the output of which is applied over suitable feeder lines to a radio antenna. When it is desired to use the transmitter for voice frequency or telephone transmission, a suitable source 12 of voice frequency waves is connected to the plates of tubes 10 and 11 to plate modulate the carrier in the well-known manner.

The foregoing represents well-known radio equipment which can be used either for telegraph or voice transmission, but not for both simultaneously. We have discovered that the system can also be used for simultaneous telegraph or facsimile transmission and for voice by replacing the crystal control device by the improved carrier frequency shifter as shown.

For that purpose, an audio frequency tone line 16 is connected to a telegraph or facsimile signal generator 15. The presence of the audio frequency tone on the line may represent one signal condition e. g., "marking" (or black in the case of facsimile); and the absence of tone may represent another signal condition e. g., "spacing" (or white in the case of facsimile). For a detailed description of one manner of shifting from one to the other signal condition, reference may be had to application Serial No. 424,946, filed December 30, 1941. The audio frequency tone is fed to an audio frequency amplifier 18 and is then rectified in device 19, the rectified voltage (negative) being applied to the voltage divider resistor 20. An adjustable tap 21 connects resistor 20 to the first or control grid 22 of a triple grid or pentode tube 23. The said control grid is normally biased a predetermined amount in the usual way by cathode resistor 24 and its shunt condenser 25. The suppressor grid 26 is grounded in the usual way. However, the shield grid 27 is connected in a D. C. path to the plate 28. By this arrangement, as the voltage on grid 22 is varied under control of rectifier 19, the effective interelectrode capacitance between electrodes 27 and 28 is varied because the shield grid varies in potential, whereas in the usual shield-grid arrangement the shield grid is maintained at a constant potential.

The plate of tube 23 is coupled through a very low capacity condenser 29, e. g., of the order of .00005 mf. to one end of a tuned oscillatory circuit comprising inductance 30 and adjustable shunt tuning condenser 31. Connected to the said tunable circuit is an oscillator generator tube 32 of the double triode type, preferably connected to act as a negative resistance oscillator. For that

purpose the two grids are connected in cross coupled feed back relation through condensers **33**, **34**, to the plates **35**, **36**.

The variations in capacity impedance of tube **23** are reflected through condenser **29**, as a variable capacity across the oscillatory circuit, thus producing variations in the frequency generated by tube **32**. For example, when a signal tone is received over line **16**, the oscillator **32** may have its frequency shifted as much as 0.8 kilocycle above its normal frequency of 199.6 kilocycles. In effect therefore, the carrier from tube **32** shifts between 199.6 and 200.4 kilocycles with a mean frequency of 200 kilocycles.

Associated with tube **32** is another oscillator tube **37** which is controlled by a piezo crystal **38** to generate a high frequency carrier of from 1.8 to 3.8 megacycles, e. g., 2.8 megacycles. The high frequency carrier from tube **37** is fed in like phase through coupling condenser **39** to the first grids **40**, **41**, of a pair of frequency mixer or converter tubes **42**, **43**. The second grids of these mixer tubes are connected in push-pull relation to the coupling condensers **44**, **45**, which are fed from the plates **35**, **36**. The third grids of the mixer tubes are supplied with steady D. C. for example 225 volts from the positive terminal of the D. C. power supply through suitable filter resistors and condensers. The plates or electron collector electrodes of the two mixer tubes are connected in push-pull relation to the output through the push-pull winding **46** which is tuned by shunt condenser **47**. The secondary **48** of the high frequency output coupling transformer is also tuned by a condenser **49**. Preferably also, the primary and secondary circuits of the coupling system are also coupled by respective coils **50**, **51**. The Q of the coupling circuit **46—48**, **50—51**, should be high so that the undesired side-band is rejected, for example the lower side band resulting from the mixing of the crystal frequency of 2.8 megacycles with the 199.6 to 200.4 kilocycle band from oscillator **32**. To a certain extent, the crystal frequency is also suppressed in the coupling. The 200 kilocyclic carrier from tube **32** is mainly suppressed by reason of the fact that the tuned circuit is tuned to some frequency between 2 and 4 megacycles. In other words, there is impressed on the amplifier stage **55** a high frequency carrier having a mean frequency of 3 megacycles. The mean frequency of this carrier is shifted plus 400 cycles to represent one signal condition, and minus 400 cycles to represent another signal condition. In the case of facsimile, "white" shades may be represented by a carrier of 3.0004 megacycles, and "black" shades may be represented by 2.9996 megacycles, with intermediate shades represented by corresponding intervening carrier frequencies. This shiftable high frequency carrier is coupled through condenser **52** and a parasitic suppressor unit comprising high frequency choke **53** and parallel resistor **54**, to the control grid of the amplifier tube **55** which for example may be a type 6V6 whose second grid is supplied with positive D. C. potential through the surge suppressor resistor **56** and parallel high frequency choke **57**. The high frequency output of tube **55** is then applied over line **58** to the input of amplifier **1**. Tube **1** is preferably of a type such as a 6J5 which amplifies the 2.9996–3.0004 megacycle signal which then acts as a carrier for passage through the tubes **4** to **11**. This carrier of signal-controlled shiftable frequency is then capable of simultaneous plate modulation in tubes **10** and **11** under control of the voice frequency source **12**, so that both kinds of intelligence e. g., voice and telegraph or facsimile can be radiated from the same antenna. It will be understood that when the shifted carrier is to be multiplied in frequency, as in multipliers **7** and **8**, this multiplying factor is appropriately taken into account in selecting the frequency of crystal **38**.

At the receiver terminal represented by the block **60**, the signals are demodulated by a respective amplitude-modulation radio receiver and a frequency-modulation radio receiver so that the received demodulated signals can be recorded or reproduced in respective mechanisms. It will be understood that the amplitude-modulation type radio receiver has a response which is substantially flat over the band determined by the amplitude modulation side bands and the stated frequency shift, and is preferably free from beating or heterodyne oscillators in the final detector stage if the receiver is of the superheterodyne type. The frequency-modulation receiver may be of the type which employs a local beating oscillator and should be preferably so adjusted that the local beating oscillator produces at least six times the current in the radio-frequency detector as is produced by the incoming signal so that the heterodyne beat note remains substantially unaffected by amplitude modulations received on the same carrier frequency. For a more detailed description of a suitable receiving terminal corresponding to terminal **60**, reference may be had to application Serial No. 478,854, filed March 12, 1943, which is to be considered as part of the disclosure of the present application. When it is desired to key the transmitter from a D. C. land line, a relay **61** having a normally open set of contacts **62** is provided. Received D. C. keying signals therefore operate relay **61** to apply a positive D. C. keying potential to the control grid of tube **23**. Preferably, the D. C. plate potential for tube **23**, e. g., 150 volts, is supplied from a voltage regulated source e. g., through a type VR–150 voltage regulator tube for example.

What we claim is:

A flexible service radio system comprising, a radio transmitter having an input radio frequency amplifier stage, a keying control stage connected to the amplifier stage, a frequency multiplier stage connected to said keying stage, a modulator stage connected to said multiplier stage, a source of voice frequency signals connected to said modulator stage, a radio frequency oscillator, a subcarrier oscillator, means to shift the frequency of said subcarrier oscillator between predetermined limits in accordance with telegraph signals and the like, means to modulate said radio frequency carrier by said shiftable subcarrier, means to select one side band of the modulated radio frequency carrier, and means to apply said selected side band as a carrier to said input amplifier.

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