May 5, 1942. H. TUNICK 2,282,102

SIGNALING

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Fig. 1

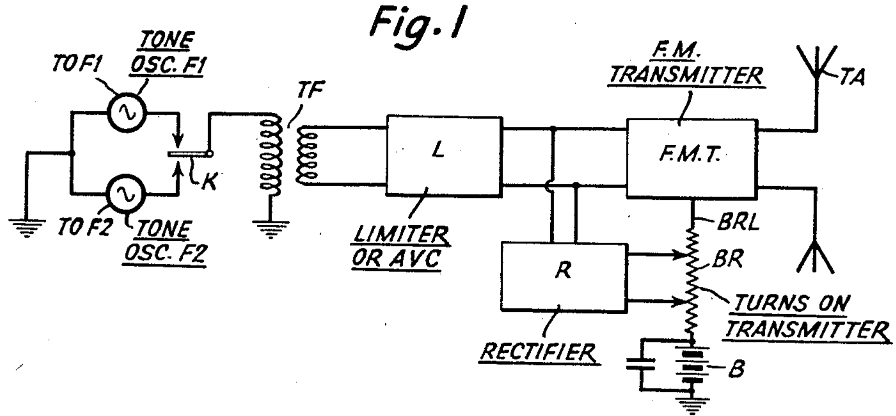

Fig. 2

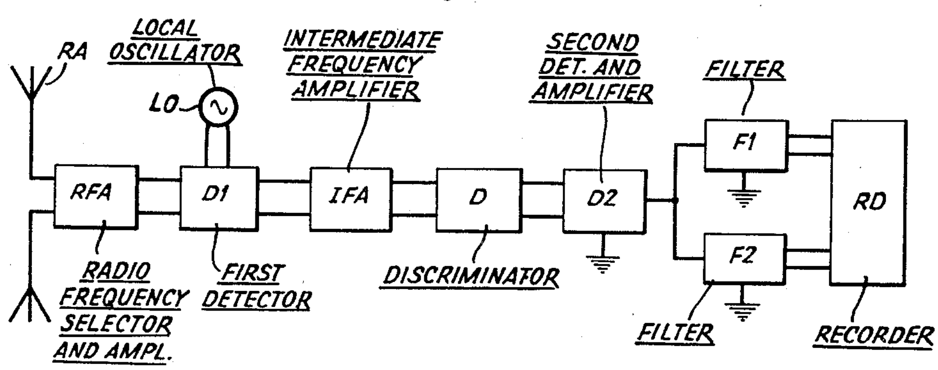

Fig. 3

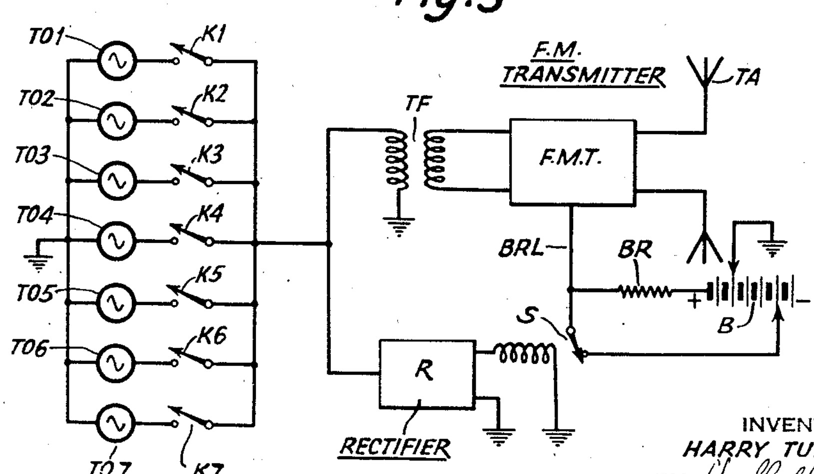

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Fig. 4

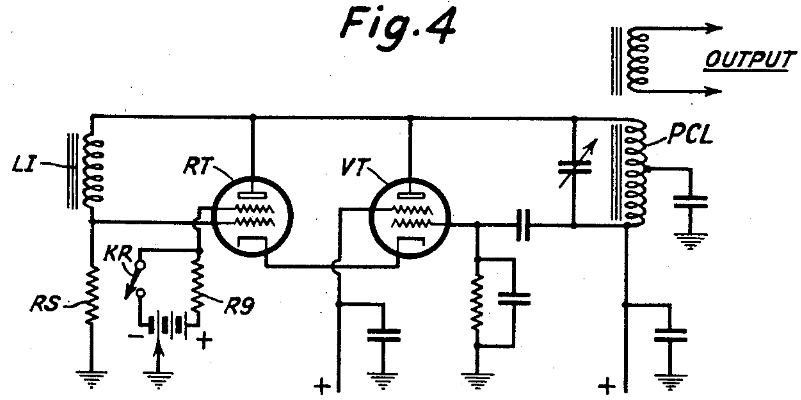

Fig. 5

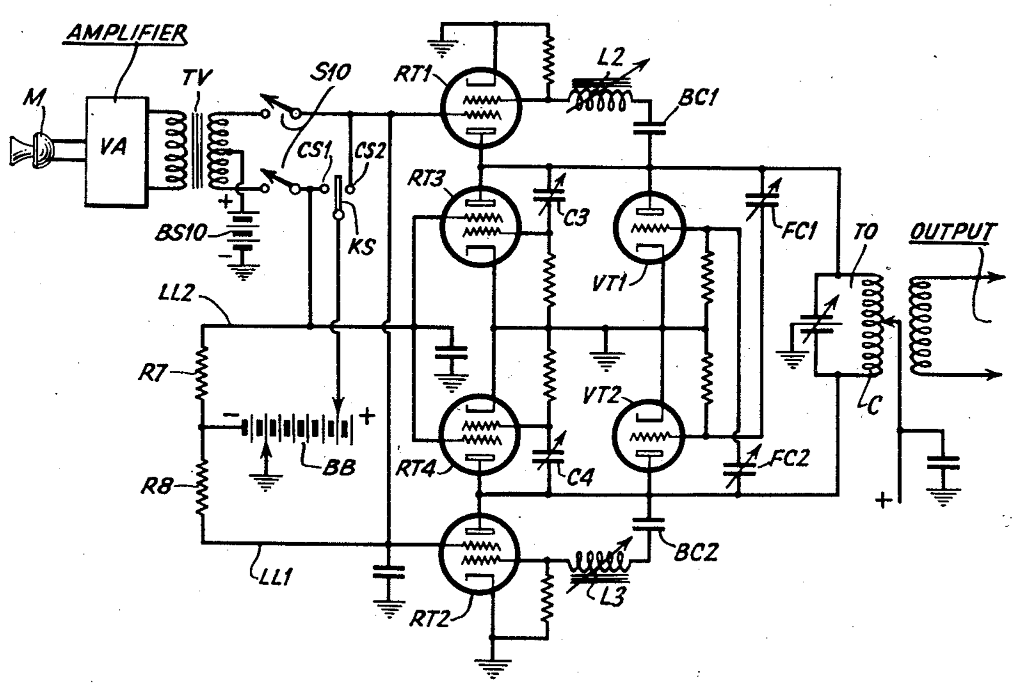

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Fig. 6

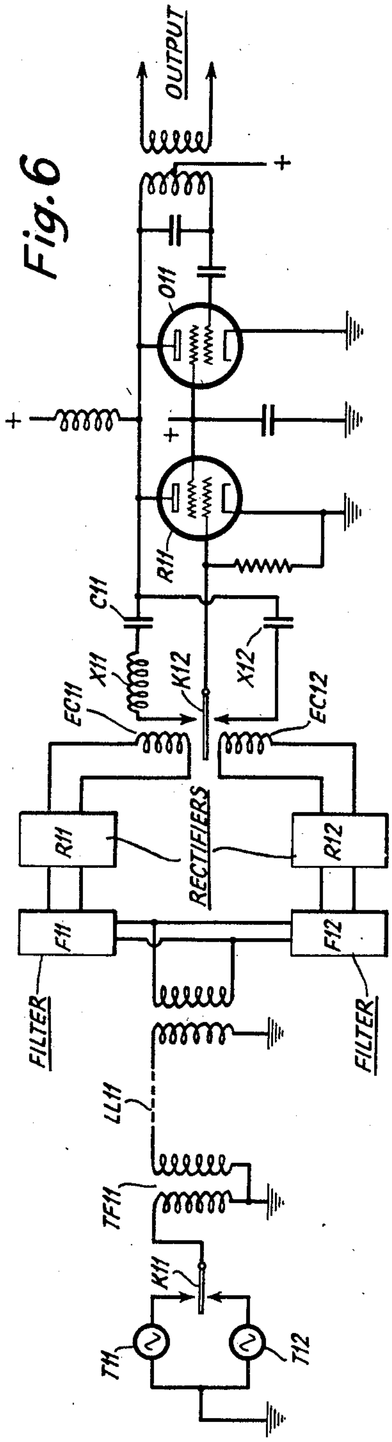
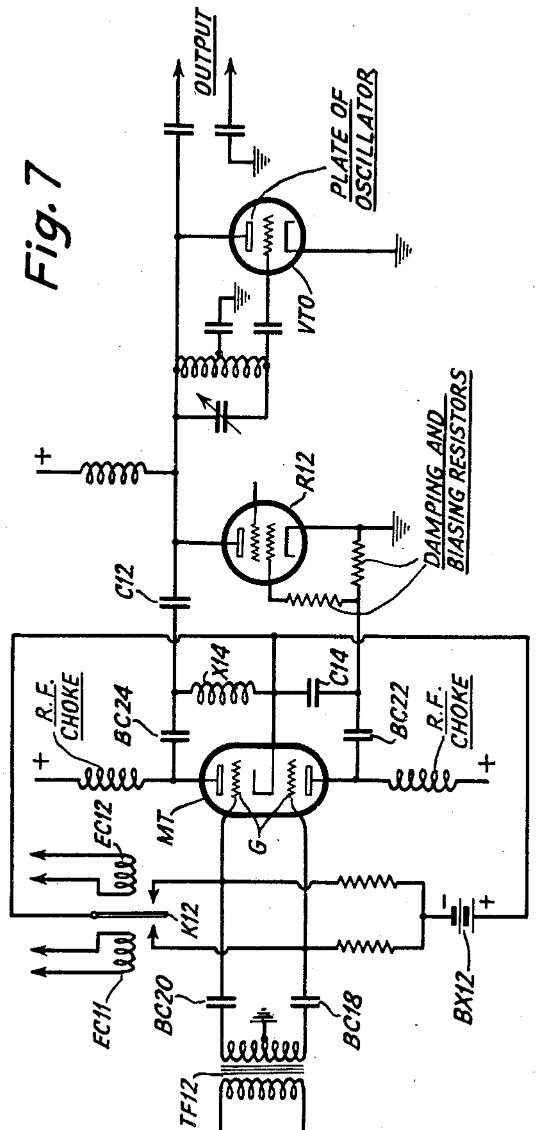


Fig. 7



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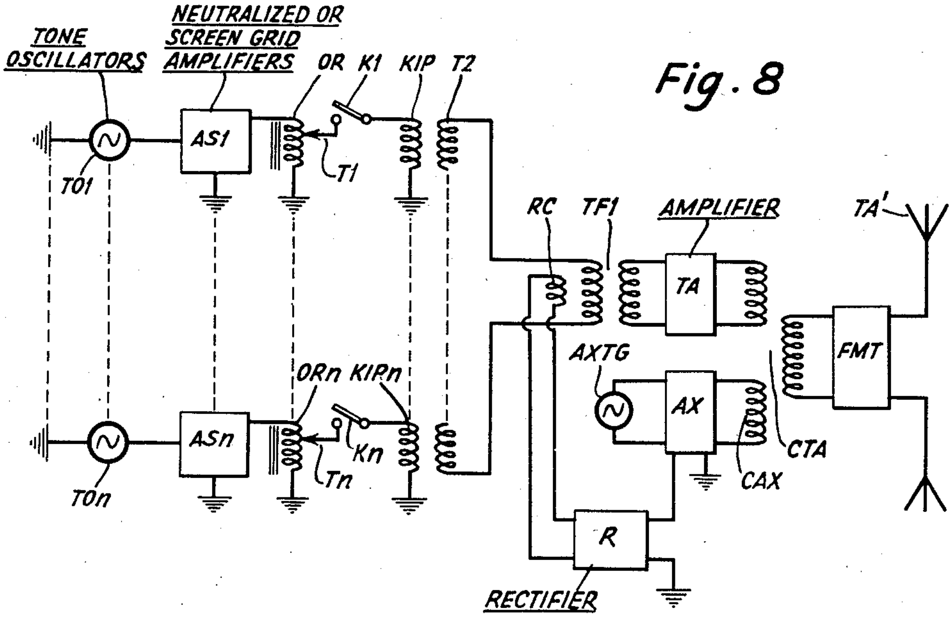

Fig. 8

Fig. 9

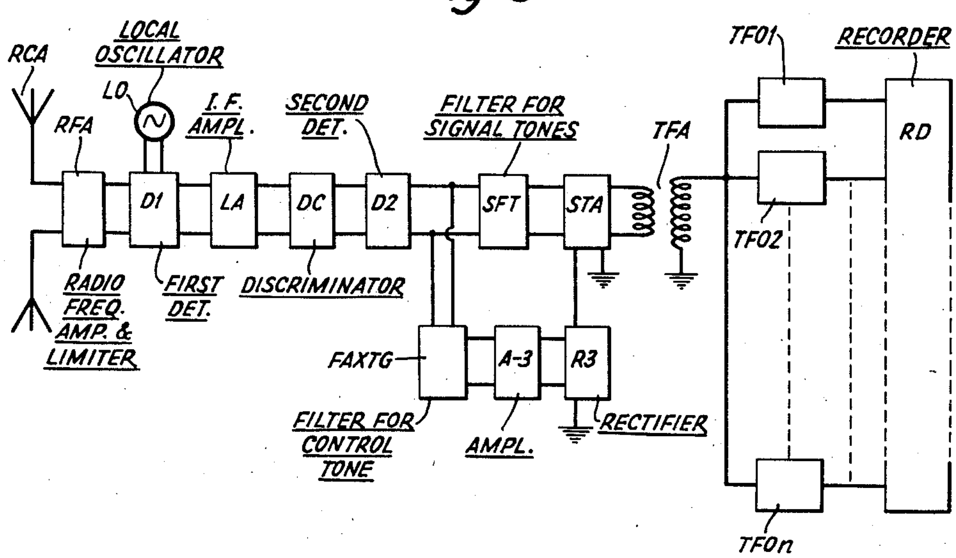

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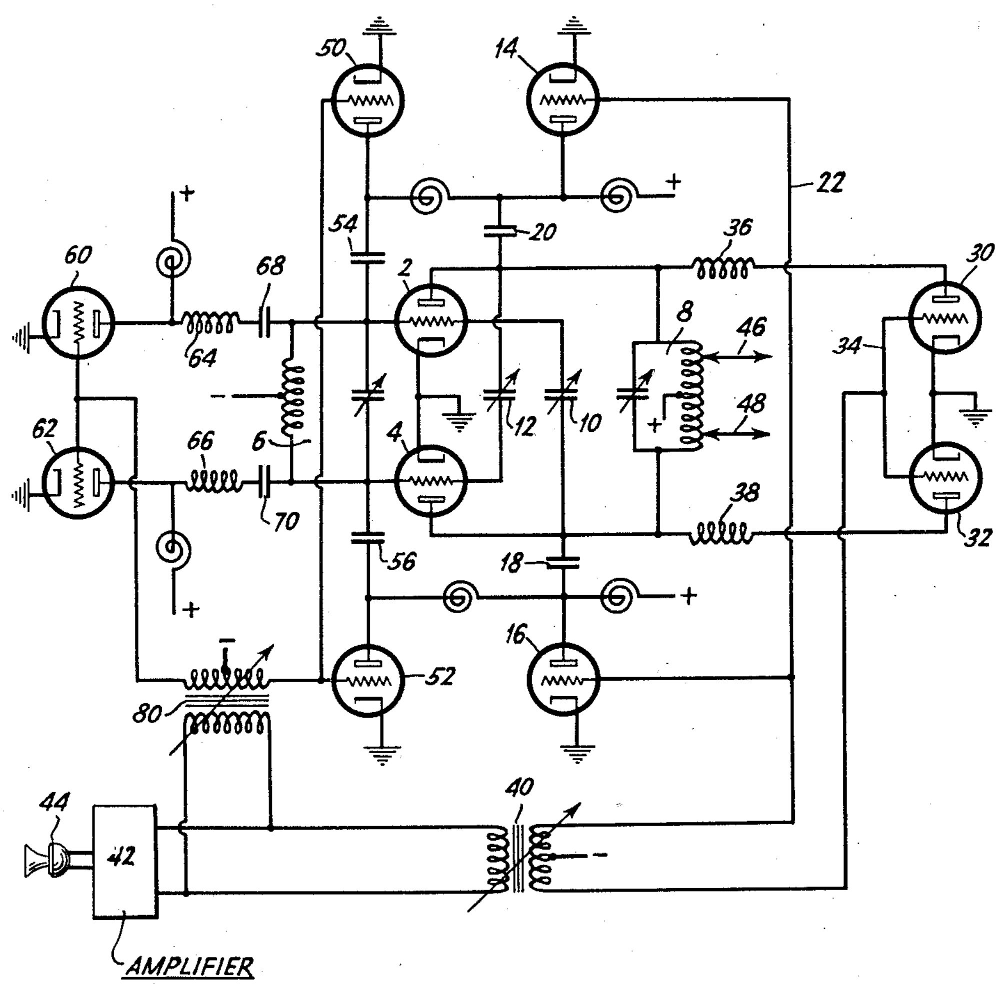
Fig. 10



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Patented May 5, 1942

2,282,102

UNITED STATES PATENT OFFICE

2,282,102

SIGNALING

Harry Tunick, Rye, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application December 12, 1940, Serial No. 369,800

10 Claims. (Cl. 250—8)

My present invention relates to signaling by means of frequency and phase modulated waves. An object of my present invention is to provide an improved system, for signaling by means of phase or frequency modulated waves, especially adapted for simplex, multiplex and printing telegraphy. Other objects, advantages and features of my present invention will be self-evident as the more detailed description thereof proceeds.

In the accompanyiug drawings:

Figure 1 illustrates a transmitting system in which a transmitter is frequency modulated with one of two tones and which is particularly characterized by the provision of means for cutting off carrier energy in the absence of either signaling tone;

Figure 2 is a diagram of a receiver especially adapted for the transmitter of Figure 1;

Figure 3 is a wiring diagram of a transmitter of the multi-unit type which is particularly adapted for printing telegraphy. In this modification, combinations of several different tones are simultaneously transmitted by frequency modulation;

Figure 4 is a circuit diagram of a frequency modulated oscillator which may be used in Figures 1 and 3;

Figure 5 is a wiring diagram of a radio frequency, frequency modulated transmitter which may be used in the systems of Figures 1 and 3;

Figures 6 and 7 are wiring diagrams of other types of frequency modulated transmitters;

Figure 8 illustrates a transmitting system of the type generally illustrated in Figure 3 with means for transmitting an auxiliary tone to indicate intervals between signal transmissions;

Figure 9 is a wiring diagram of a receiver especially adapted for reception of transmissions from the transmitter of Figure 8; and

Figure 10 is a wiring diagram of a modified frequency modulation transmitter which may be used in the systems described herein.

In the system shown in Figure 1 two tone oscillators, of different audio frequencies, TOF1 and TOF2 are provided. These are selectively keyed by means of a key K and fed into a limiter or automatically volume controlled circuit L. The tones are then fed into a frequency modulation transmitter FMT whose carrier frequency is frequency modulated to the same degree, but at different audio rates, dependent upon whether the key K is in its upper or in its lower position. Biasing source B, through the biasing resistor BR, blocks the transmitter FMT so that no carrier is fed to the transmitter antenna TA. However, as soon as the key K is operated, rectifier R, connected to the output of the limiter L, rectifies the tone present and injects a counter-voltage in the biasing resistor BR, overcoming source B and thereby permitting the antenna TA to be fed with frequency modulated waves. Of course, the system may be operated without the rectifier R, biasing battery B and resistor BR, in which event unmodulated radio frequency waves will be transmitted by the transmitting antenna TA in the mid-position of key K when neither of the tone oscillators is connected to the input side of tone transformer TF.

Because of the limiting or leveling action of circuit L, maximum utilization of the radio frequency channel assigned to the transmitter for each signal tone transmitted is secured. In this way, the maximum signal-to-noise ratio is secured for each tone transmitted.

The receiving system for the transmitter of Figure 1 is shown in Figure 2. The waves received upon receiving antenna RA are amplified in a radio frequency amplifier RFA and detected in a first detector D1 also supplied with waves from a local oscillator LO. The resulting intermediate frequency energy is amplified in an intermediate frequency amplifier IFA and fed to a discriminator circuit D which converts the received frequency modulated waves into waves of variable amplitude susceptible of second detector action by second detector D2. The output of the detector D2 is fed through filters F1 and F2, the upper one of which passes waves corresponding in frequency to that of tone oscillator TOF1 of Figure 1. The lower filter F2 passes waves of frequency corresponding in frequency to that of the lower tone oscillator TOF2 of Figure 1. These waves may be fed into a loudspeaker, but, preferably, are fed into a recording device RD.

In Figure 3, seven tone oscillators each of different frequency and preferably of successively higher audio frequencies are provided. These seven tone oscillators are designated by the reference letters TO1–TO7. Seven keys K1–K7 are provided. The keying system K1–K7 is so arranged that different combinations such as pairs of the keys represent different letters to be transmitted. In other words, different combinations of the keys K7 are simultaneously actuated for the transmission of different letters. Preferably, two keys of the series K1–K7 are pressed at a time although three or more keys may be similarly employed, as desired. The tones are fed through the transformer TF to the ultra short wave frequency modulation transmitter FMT which radiates frequency modulated waves over the transmitting antenna TA. In this system, when a multiplicity of tones are used to simultaneously frequency modulate the transmitter, it is to be noted that the limiter L of Figure 1 is omitted.

Referring, again, to Figure 3 a rectifier R is provided which, in the presence of tone, opens the solenoid actuated switch S to remove from biasing source B the negative blocking voltage which is fed to the transmitter around the biasing resistor BR. In the absence of tone in the primary side of the tone transformer TF switch S closes, thereby again impressing added negative bias on the oscillator and/or frequency multipliers and/or amplifiers of the transmitter FMT to cut off unmodulated carrier from the transmitting antenna TA. As in connection with Figure 1, the transmitter of Figure 3 may be operated without the rectifier R, switch S or biasing battery B system, in which event, in the absence of keyed tones, unmodulated carrier frequency energy is radiated by the transmitting antenna TA.

For receiving the signal transmitted by the frequency or, if desired, phase modulation transmitter of Figure 3, the receiving system of Figure 2 may be employed with, however, the provision of additional filters arranged to pass frequencies corresponding to each of the tone frequencies generated by the tone generators TO1–TO7 of Fig. 3. The frequency modulation transmitter in Figures 1 and 3 may be arranged so that the deviation of the radiated carrier frequency is equal to less than, greater than or several times greater than the highest frequency of the tone generators. The receiving circuit should, of course, be made to accept the maximum band of radio frequencies transmitted.

A form of tone generator which may be used in the transmitting systems of Figures 1 or 3 is illustrated in Figure 4. Vacuum tube VT is connected as illustrated to produce audio oscillations, the plate coil PCL being of the powdered iron core type. The reactance tube RT is provided with a phase shifting network consisting of resistor RS and an iron cored phase shifting coil LI. With the key KR open, it will be observed that the oscillator VT of Figure 4 operates at a frequency determined by the tuning of the iron core inductor in the plate circuit as modified by the reactance tube RT. With the switch KR closed, RT is cut off, as a result of which vacuum tube VT oscillates at a different frequency. If desired, coil LI of Figure 9 may be replaced by a condenser and tube VT operated as a high frequency oscillator. In this case, an additional wave of constant frequency should be provided, such as provided by a crystal controlled oscillation generator and the output of the constant frequency crystal oscillator and the keyed output of oscillator BT should then be combined in a detector. By properly choosing the values of frequency of the oscillator BT and the constant high frequency oscillator, the output of the detector may be made an audio frequency tone which varies from one frequency to a second audio frequency dependent upon the position of the key KR.

If desired, in the system of Figure 4, when vacuum tube VT is operated as a high frequency generator, its output may be radiated directly. In this event, two discreet frequencies are successively radiated by operation of key KR. The receiving system of Figure 2 may be used, but in this event a second local oscillator supplying second detector D2 should be employed with its frequency so adjusted that the beat or detected waves are of the desired tone frequencies which are to be passed by the filters F1 and F2.

The transmitting system of Figure 5 consists of the push-pull oscillator tubes VT1 and VT2 provided with a tuned output circuit TO whose coil C may be of the iron core or powdered iron core type. To produce oscillations, feedback condensers FC1 and FC2 are provided. Vacuum tubes VT1 and VT2 may, of course, be of the screen grid or pentode type. The reactance tubes RT1, RT2 are provided with grid circuits consisting of a by-pass condensers BC1 and BC2 phase shifting inductors L2 and L3 which may be provided with adjustable iron or powdered iron cores. The reactance tubes RT3 and RT4 are provided with phase shifting condensers C3 and C4. Hence, it should be apparent that the reactance tubes RT1 and RT2 produce in shunt to the tuned circuit TO a reactance effect of one sign when they are permitted to become conductive, whereas reactance tubes RT3 and RT4 produce in shunt to the output circuit TO a reactance of the opposite sign, thereby changing the frequency of oscillation from one value to another, depending upon which of the pairs of tubes are made conductive. Normally, the reactance tubes RT1, RT2, RT3 and RT4 are biased to cut off by their screen grids which are biased to cut off by battery BB supplying voltage through leads LL1 and LL2. Manipulation of the key KS to the left contact CS1 causes tubes RT3 and RT4 to become conductive, whereas moving the key KS to the other contacts CS2 causes tubes RT1 and RT2 to become conductive while simultaneously causing the blocking of the previously unblocked tubes RT3 and RT4. Short-circuiting of the biasing battery BB during the keying operation is prevented by the action of resistors R7, R8 which act in a way similar to the resistor R9 of Figure 4.

For voice modulation of the transmitting system of Figure 10, switch KS is left in its mid position as shown and switch S10 is closed, enabling voice currents generated by pick-up microphone M and amplified by the voice amplifier VA to be impressed through transformer TV in phase opposition upon the screen grids of the pairs of tubes RT1, RT2 and RT3, RT4. If desired, an additional biasing source BS10 may be provided and connected, as shown, to partially unblock the reactance tubes when the transmitter is used for transmission of speech or other undulatory waves supplied to the transformer TV.

It is to be noted that the transmitter of Figure 5 may be employed as the frequency modulation transmitter FMT of either Figure 1 or Figure 3. In that event, the transformer TF of either Figure 1 or of Figure 3 would be connected at the point referred to as transformer TV of Figure 5. The biasing lead BRL in this case also would be connected to the control grids of the oscillation generator tubes VT1 and VT2 of Figure 5 and, also, if desired, to the control grids of each of the reactance tubes of Figure 5. When the tone oscillators of Figures 1 or 3 are used for transmission over the transmitter of Figure 5, the keyed tones or multiplicity of tones are fed, as before stated, into the primary of transformer TV and switch S10 is closed, but switch KS is left in its open mid-position. The output of the transmitter of Figure 5 may be fed, regardless of the type of modulation (speech or keyed tones) used, to frequency multipliers and amplifiers before radiation over a transmitting antenna.

In Figure 6 manipulation of the key K11 impresses tones from the audio oscillator T11 or from the audio oscillator T12 to transformer TF11 upon land line LL11. Filter F11 passes audio tone T11 of frequency F1 generated by T11 and filter F12 passes the tone of audio frequency F2 generated by T12, respectively, into the rectifiers R11, R12. The rectified tones move key K12 up or down, putting the reactive inductance X11 or X12 effectively into circuit for the electrodes of reactance tube R11.

Oscillator O11 is thereby varied in frequency from one value to another depending upon whether reactive inductance X11 or capacity X12 is connected in the circuits. It will be appreciated that condenser C11 is merely a large by-passing condenser. The other portions of the circuit of Figure 11 are deemed to be self-explanatory to those skilled in the art.

In the system of Figure 7, the reactance tube R12 has its plate interconnected with its grid through the large by-passing condenser C12, inductive reactance X14 and capacitive reactance C14. The multi-element tube MT is provided, the grids G of which are biased to cut-off by means of biasing source BX12. The key K12, as in connection with Figure 6, may be actuated electromagnetically by means of coils EC11 and EC12 connected to rectifiers such as R11, R12 and the system to the left thereof as shown in Figure 6, but which for the sake of simplicity has not been duplicated in Figure 7.

With key K12 of Figure 7 in its left-hand position the lower section of the multi-element tube MT is permitted to draw current and thereby effectively short-circuits condenser C14 and makes the effective feedback path from the plate to the grid of reactance tube R12 through inductance X14. Similarly, when key K12 of Figure 7 is moved to its right extreme position, the upper grid of tube MT causes the upper section of the control tube MT to become conductive, thereby effectively short-circuiting reactance X14 and making the effective feedback path through the capacitive reactance C14. In this way, the effective reactance of tube R12 is changed, thereby changing the frequency of the vacuum tube oscillator VTO to which it is connected, as illustrated. A multiplicity of tones or a complex wave, such as voice, may be used in the system of Figure 7. These complex tones or voice waves with or without amplification are fed through transformer TF12 in phase opposition to the grids GG as shown. When this is done, of course, key K12 is left in its open mid-position as shown. Condensers BC18, BC20, BC22 and BC24 are large by-pass condensers.

In the system of Figure 8, a series of tone oscillators TO1—TOn of different audio frequencies are provided. Each tone oscillator is provided with a neutralized tube amplifying circuit or with an amplifying circuit employing screen grid tubes. The amplifying circuits are designated AS1—ASn. The output of each amplifier AS is provided with an output reactor OR from which output energy is variably tapped by means of taps T1—Tn. Keys K1—Kn are provided and the keyed outputs combined in a transformer secondary T2 to which are coupled the primaries K1P—K1Pn. As before stated, signaling may be carried out by merely keying K1 or by keying several different keys simultaneously, different combinations of keyed tones representing different letters to be transmitted.

The tones as combined in the secondary T2 are fed through transformer TF1 to an amplifier TA. The amplified keyed tones appearing in the output circuit of tone amplifier TA are fed through coupling CTA to the frequency or phase modulation transmitter FMT which radiates over transmitting antenna TA' waves which are frequency or phase modulated by the composite tones fed through transformer CTA.

In the absence of signal tones in the primary of transformer TF1, it is to be noted that the frequency modulation transmitter FMT is modulated with an auxiliary tone from the auxiliary tone generator AXTG. The tone from the auxiliary generator is fed through amplifier AX and coil CAX coupled to the secondary of transformer CTA.

The auxiliary tone from the generator AXTG is of a frequency different than that generated by any of the tone generators TO1—TOn. In the presence of keyed energy from one or more of the tone generators TO1—TOn, rectifier R comes into action, biasing amplifier AX to cut-off so that the auxiliary tone from AXTG is blocked from coil CAX, preventing the auxiliary tone from modulating the waves generated by the phase or frequency modulation transmitter FMT. The rectifier R is supplied with tone energy by means of the pick-up coil RC coupled to the primary of transformer TF1. In this way, waves radiated by antenna TA are either frequency or phase modulated with signal tones from the generators TO1—TOn or in the absence of signal tones are phase or frequency modulated by the auxiliary or spacing tone derived from generator AXTG.

In the receiver of Figure 9, which is especially adapted for use with the transmitter of Figure 8, waves transmitted by the transmitting system of Figure 8 are received upon the receiving antenna RCA and fed to a limiter and radio frequency amplifier RFA. The output of the radio frequency amplifier is heterodyned in a first detector D1 with waves from a local oscillator LO to produce a convenient intermediate or beat frequency. The waves of intermediate frequency are amplified in the limiter and amplifier LA designed for the intermediate frequencies and fed to a suitable discriminator circuit DC which converts the frequency or phase modulated waves of intermediate frequency into waves of varying amplitude. This discriminator circuit may be of the type described in Seeley Patent No. 2,121,103.

The resulting detected signal tones are fed through a filter SFT which passes tones of frequencies corresponding to the tone generated by the generators TO1—TOn of Figure 8. These signal tones are amplified in the signal tone amplifier STA and fed through transformer TF2 to the series of tone filters TFO1—TFOn, in turn connected to, feeding and thereby operating a suitable recording system or device RD. In order that the receiving device is not operated falsely by noise in the intervals between signal transmissions, the auxiliary filter FAXTG is provided and connected as shown. This filter filters out and passes the tone frequency corresponding to the frequency of the tone generator AXTG of Figure 8. This filtered tone is amplified by the amplifier A—3 and rectified by rectifier R—3. The rectified output is used as shown to bias amplifier STA to cut-off in the presence of the auxiliary tone. In this way undesired noise is prevented from reaching the recording device RD in the intervals between tone frequency or signal transmissions. Both rectifiers R of Figure 8 and R—3 of Figure 9 should be provided with circuits having very short time constants so that cutting in and cutting off of the auxiliary tone and its accompanying actions are rapid.

In the transmitter of Figure 10, tubes 2, 4 are provided with tunable high frequency input and output circuits 6 and 8 respectively. Feed-back causing high frequency oscillation generation is accomplished by means of feed-back condensers 10, 12.

Tubes 14 and 16 are connected symmetrically and to opposite sides of the tuned circuit 8 by means of condensers 18 and 20. It will be appreciated, therefore, that as the tubes 14 and 16, which have their grids connected in parallel by means of lead 22, are made more conductive, more and more capacity is effectively connected in shunt to circuit 8, thereby lowering the frequency of oscillation of the oscillation generating tubes 2, 4.

Tubes 30, 32, which have their grids connected in parallel by lead 34, are connected to opposite sides of the plate tuned circuit 8 through inductors 36, 38. Hence, as the tubes 30, 32 are made more and more conductive, more and more inductance is effectively connected in shunt with the coil of the tuned circuit 8 and, hence, this acts to reduce the total inductance in circuit and, hence, raise the frequency of oscillation.

For frequency modulating the push-pull oscillation generator 2, 4 the leads 22, 34 are connected as shown to opposite sides of the secondary of transformer 40. The primary of the latter is fed with amplified voice or tone currents from amplifier 42 in turn supplied by microphone 44 or the secondary of such transformers as TF of Figures 1 and 3 or secondary T2 of Figure 8. By making the amplifier 42 have a rising characteristic for the modulating frequencies fed to its input side, the resulting output of the system taken from leads 46, 48 will be phase modulated.

The tunable grid circuit of the transmitter of Figure 10 may be similarly varied in frequency by means of tubes 50, 52 connected to opposite sides of the tuned circuit 6 through condensers 54 and 56 and by means of tubes 60, 62 also connected to opposite sides of the grid circuit 6 through inductors or coils 64, 66. Large bypassing condensers 68 and 70 are provided to prevent the application of plate voltage applied to the plates of 60 and 62 from the grids of the oscillation generator tubes 2, 4. The grids of tubes 50 and 52 are connected in parallel and to one side of the secondary of modulation frequency transformer 80. Similarly, the grids of tubes 60 and 62 are connected in parallel and to the other side of the secondary of transformer 80. The primary of transformer 80 is connected in shunt to the output of amplifier 42 or in parallel to the primary of transformer 40. Obviously, transformer 40 may be eliminated and the frequency modulation produced by changing only the tuning of the grid circuit or, as shown, both grid and plate circuits may be simultaneously varied.

It is to be noted in Figures 1, 3 and 8 that although frequency modulation transmitters FMT may be employed, the resulting wave radiated by the transmitting antenna TA may be phase modulated provided the deviation produced by each tone or modulating frequency increases in direct proportion to its frequency. In connection with Figure 1, this would require, of course, elimination of the limiter circuit L and adjustment of the amplitudes of the tone oscillators such that the oscillator of higher frequency impresses a wave of greater amplitude upon the frequency modulation transmitter FMT. Similarly, in connection with Figures 3 and 8, to secure phase modulation the amplitudes of the tone waves fed into the transmitter should increase with increasing tone generator frequency.

One of the advantages in the transmitter systems of Figures 1 and 3 for the rectifier apparatus R is that power is saved intermediate signal transmissions. Also, since no tones are generated intermediate signal characters at the receiver, the recorder RD of Figure 2 is substantially cut off from all possible noise and interference. In the system of Figures 8 and 9, the substantial preclusion of noise from the recording system RD is obtained with the simultaneous advantage of being able to tune in the receiver during periods when no signals are being transmitted. Also, when the system of Figure 3 is employed so that two, three or more tones simultaneously transmitted indicate different letters, an advantage follows from the use of phase modulation as described hereinabove, because greater modulation is secured on the higher modulation frequencies which is desirable since greater noise tends to appear at the higher frequencies. In this way, the effective signal-to-noise ratio for each tone channel is maintained constant, insuring greater overall reliability of operation.

Having thus described my invention, what I claim is:

1. In combination, a pair of sources of tone waves, means for selectively keying the tone waves in accordance with signals to be transmitted, means for maintaining said keyed tones at a constant pre-determined level, a frequency modulation transmitter, means for frequency modulating waves from said transmitter in accordance with the leveled keyed tones, means for feeding the frequency modulated waves from the transmitter to a transmitting antenna, and means for cutting off carrier frequency energy from said antenna in the absence of keyed tones.

2. In combination, a phase modulation transmitter, an antenna connected thereto, a pair of sources of tone waves, means to selectively key said sources, a limiter for limiting the amplitudes of the keyed tones from said sources, means for phase modulating waves generated by said transmitter with said limited keyed tone waves, and means for preventing carrier energy from being fed to said transmitting antenna in the absence of keyed signal tones.

3. In combination, a plurality of means for generating a plurality of signal tones of different frequencies, means for simultaneously combining tones from preselected ones of said generating means, means to utilize the combined tones to frequency modulate a high frequency carrier wave, means to generate an auxiliary tone of a frequency different than that of any of said signal tones, and means operative to frequency modulate said carrier wave with said auxiliary tone of different frequency only in the absence of signal frequency tones.

4. In combination, a plurality of signal tone oscillators, means for keying said tone oscilla-

tors, means for combining keyed tones from said keying means and oscillators, means for generating a carrier wave, means for phase modulating the generated carrier wave with said combined keyed signal tones, an auxiliary tone generator of a frequency different than any one of said signal tone generators, and means operating automatically to cause phase modulation of said carrier wave by the auxiliary tone only in the absence of waves from said signal tone generators.

5. In combination, a plurality of signal tone oscillators, means for keying said tone oscillators, means for combining keyed tones from said keying means and oscillators, means for generating a carrier wave, means for frequency modulating the generated carrier wave with said combined keyed signal tones, an auxiliary tone generator of a frequency different than any one of said signal tone generators, and means operating automatically to cause frequency modulation of said carrier wave by the auxiliary tone only in the absence of waves from said signal tone generators.

6. In combination, a signal tone generator, means to key waves from said generator in accordance with a signal to be transmitted, a high frequency generator, means to phase or frequency modulate waves from said high frequency generator with said keyed signal tones, an auxiliary tone generator operating at a frequency different than the frequency of said signal tone generator, means for modulating waves from said high frequency generator with tone from said auxiliary tone generator, a rectifier for rectifying keyed signal tone, and means responsive to the rectified keyed signal tone to prevent waves from said auxiliary tone generator from modulating the high frequency wave generated by said high frequency generator.

7. A signaling system comprising means at the transmitter for transmitting a plurality of signal tones, and means at the transmitter for transmitting an auxiliary tone in the absence of signal tone transmissions, and means for receiving said waves consisting of a plurality of signal tones and an auxiliary tone, means at the receiver for filtering and amplifying the signal tones independently of said auxiliary tone, means for feeding the amplified signal tones to a recorder, and means responsive to the presence of said auxiliary tone for cutting off the tone signal amplifier from the recorder in order to reduce noise response of said recorder in the absence of signal tones.

8. A signaling system comprising means at the transmitting end of the system for generating a plurality of signal tones, means for keying said signal tones, means for combining said keyed tones, means for generating a high frequency carrier wave, means for angular velocity modulating said high frequency carrier wave with the combined keyed tones, means at the transmitter for generating an auxiliary tone of a frequency different from that of any one of the signal tones, means for causing the auxiliary tone to modulate the high frequency carrier, a rectifier for rectifying the keyed tones at the transmitter, means responsive to the rectified tones for preventing modulation of the carrier with the auxiliary tone, and at the receiver means for receiving the high frequency carrier wave and for demodulating the same so as to produce the signal tones and the auxiliary tone, means for amplifying and feeding the signal tones to a recorder, and means responsive to the received auxiliary tone for cutting off wave flow from the tone signal channel into the recorder in order to reduce noise response of said recorder intermediate keyed signal tone transmissions.

9. In combination, a generating system for generating a plurality of signal tones, keying circuits for keying said signal tones, a circuit for combining said keyed tones, a generator for generating a high frequency carrier wave, a modulating circuit for angular velocity modulating said generated high frequency carrier wave with the combined keyed tones, an auxiliary generator for generating an auxiliary tone of a frequency different from that of any one of the signal tones, a modulating circuit for causing the auxiliary tone to modulate the generated high frequency carrier, a rectifier for rectifying the generated signal tones, and apparatus responsive to the rectified tones for preventing modulation of the carrier with the auxiliary tone in the presence of one or more signaling tones.

10. Receiving apparatus for receiving a carrier wave modulated with signal tones, and in the absence of the signal tones with an auxiliary tone, comprising a receiving circuit for receiving the high frequency carrier wave, and for demodulating the same so as to produce the signal tones and the auxiliary tone, an amplifier for amplifying the signal tones, a recorder, a circuit for feeding the amplified tones to the recorder, and apparatus responsive to the received auxiliary tone for cutting off wave flow from the tone signal amplifier into the recorder in order to reduce the response of said recorder intermediate keyed signal tone transmissions.

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