Feb. 19, 1929. 1,702,470

F. B. FALKNOR

RADIO TRANSMITTING SYSTEM

Filed Jan. 29, 1927

Fig.1.

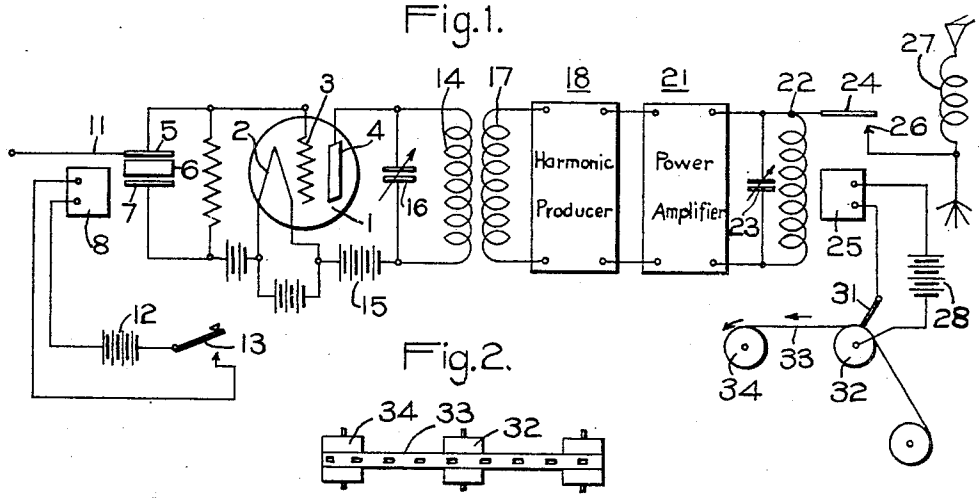


Fig.2.

Fig.3.

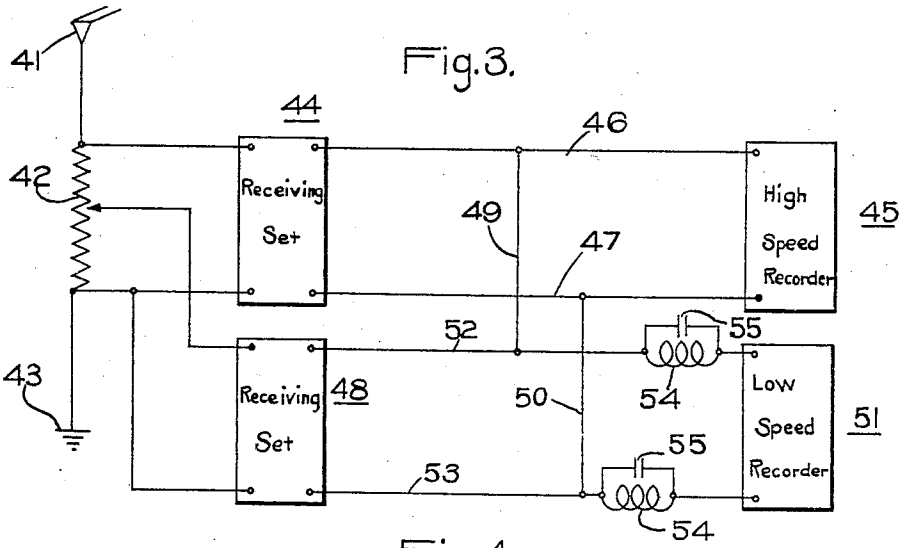


Fig.4.



High Speed Record

Fig.5.



Low Speed Record

WITNESSES:

INVENTOR

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UNITED STATES PATENT OFFICE.

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RADIO TRANSMITTING SYSTEM.

Application filed January 29, 1927. Serial No. 164,467.

My invention relates to radio transmitting systems, and it has particular relation to systems of the type known as "multiplex", in which a plurality of messages are simultaneously transmitted from a single radiating structure.

One object of my invention is to provide a system in which a plurality of materially different signalling frequencies may be superimposed upon the same carrier wave.

Another object of my invention is to provide means for receiving the signals transmitted from a radio station constructed and arranged for multiplex signalling.

It has previously been proposed to accomplish the simultaneous transmission of a plurality of signals over a single carrier wave by modulating the intensity, or amplitude, of said wave at a plurality of frequencies, utilizing each of such frequencies for a different signal. Systems of this type necessitate the use of complicated filter systems, both in transmission and reception, if interference between the various signals is to be completely eliminated.

By the present invention, therefore, instead of modulating the intensity, or amplitude, of a carrier wave at a plurality of frequencies, I propose to maintain the amplitude constant, and to vary the frequency of the wave itself, as well as its continuity, thus obviating the necessity of complicated filter systems both in transmitting and receiving.

I may utilize the frequency-shift for one of the signals, and the interruption of the carrier wave for another, the frequency of the carrier wave interruptions being made so high that visual or audible reception of the signal represented by the frequency-shift is not interfered with.

Among the novel features which are considered characteristic of this invention are those set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description, taken in connection with the accompanying drawing, in which—

Fig. 1 is a diagrammatic view of the circuits and apparatus of a transmitting radio station constructed and arranged according to my invention.

Fig. 2 is a diagrammatic view of a high-speed transmitting device.

Fig. 3 is a diagrammatic view of a receiving station equipped to receive multiplex signals.

Figs. 4 and 5 are views illustrating the forms which visible indications of multiplex signals may take in the event that tape recorders are used.

Referring specifically to Fig. 1, which illustrates a radio transmitting system of the so-called master-oscillator power-amplifier type, a thermionic device 1 comprising a filament 2, a grid 3 and a plate 4, has a movable electrode 5 connected to the grid thereof that is associated with a piezo electric crystal 6. A fixed electrode 7 is conductively connected to the filament 2 and is arranged to support the piezo electric crystal.

The winding of a relay 8 is associated with an armature 11 which carries the movable electrode 5, electric actuating current for the relay 8 being derived from a battery 12 under the control of a telegraph key 13.

An inductor 14 is connected between the plate 4 and the filament 2 through a source of plate potential 15, the inductor being shunted by a tuning condenser 16. The input circuit 17 of a harmonic producer 18 is inductively associated with the output inductor 14, the harmonic producer in turn being arranged to energize the input circuit of a power amplifier 21. The power amplifier has an output circuit comprising an inductor 22 and a tuning condenser 23.

The movable armature 24 of a sensitive relay device 25 is conductively connected to the output inductor 22 of the power amplifier, and is operatively associated with a fixed contact element 26 which is conductively connected to a radiating structure 27.

The relay 25 is arranged to be supplied with actuating current from a source 28, under the control of a movable member 31 so disposed as to normally rest upon a metallic cylinder 32 which is conductively connected to the power source.

A tape 33, of non-conducting material, such as paper, having perforations therein representing signals, is so arranged that it may be passed, at a high speed, between the movable member 31 and the metallic cylinder 32, thus interrupting at signal frequency, the circuit between the source 28

and the relay 25. Motive power for the tape may be obtained from a motor (not shown) connected to a winding reel.

Those portions of the apparatus which comprise the thermionic device 1, the piezo electric crystal 6, the telegraph key 13 and relay 8 and the harmonic producer 18 together co-operate to cause variations in the frequency supplied to the power amplifier, the variations in frequency being determined by the amount of motion given to the movable electrode 5 by the actuating relay 8.

A preferred form of relay and crystal-holding device is disclosed in the copending application of J. B. Coleman, Serial No. 127,725, filed August 7, 1926, and assigned to the Westinghouse Electric & Manufacturing Company (Case 12514).

As explained in the aforesaid application of Coleman, the frequency generated by a crystal-controlled oscillator depends upon the relative spacing of the electrodes associated with the crystal. The apparatus may be so arranged that the spacing of the electrodes is varied between definite limits, one position of the electrodes corresponding to a signal interval and the other position of the electrodes corresponding to a spacing interval. Although the shift in frequency of the crystal-controlled oscillator may be quite small, such shift is magnified by the harmonic producer and gives rise to a shift of any desired number of cycles in the ultimate output of the radio transmitting system.

By arranging the apparatus as illustrated, it is, therefore, possible to accomplish slow-speed signalling by altering the transmitting frequency at a rate corresponding to the manual operation of the telegraph key.

The relay 25 which is arranged to be controlled by the mechanically moved tape 33, causes an interruption in the continuity in the transmitted carrier wave, irrespective of its frequency. During intervals when the movable member 31 is permitted, by the perforations in the tape 33, to make contact with the metallic cylinder 32, the armature 24 is drawn into contact with the fixed contact member 26, and the power amplifier is accordingly conductively connected to the radiating structure 27. During intervals when the movable member 31 is separated from the metallic cylinder 32, the armature is released, thus interrupting the supply of oscillations to the radiating structure. These interruptions in the actual continuity of the carrier wave are, according to my invention, to be made at an extremely high speed for a reason that will later be made apparent.

It is also feasible to reverse the operative relation of the contact 26 to the armature 24, so arranging the apparatus that energization of the relay winding 25 causes a separation of the contact and armature, thus interrupting the continuity of the carrier wave whenever the perforations in the tape 33 permit the movable member 31 to rest upon the cylinder 32.

Referring specifically to Fig. 3, the receiving structure may comprise an antenna 41, a non-inductive reactor 42, preferably a resistor of high value, and a ground connection 43. Receiving apparatus 44, tuned to the frequency transmitted when the movable electrode 5 is at the upper limit of its travel, is connected to the resistor 42. This receiver has an output circuit which is connected to a high-speed tape recorder 45 through conductors 46 and 47.

A receiver 48, tuned to the frequency transmitted when the movable electrode 5 is at the other limit of its travel, is also operatively connected to the resistor 42.

This second receiver has an output circuit conductively connected to a low-speed tape recorder 51 through conductors 52 and 53. The conductor 46 is connected to conductor 52 by means of a conductor 49, and the conductor 47 is connected to the conductor 53 by a conductor 50. A plurality of tuned rejector circuits, comprising an inductor 54 and a condenser 55, are interposed between the receiver and the low-speed recorder. These rejector circuits are tuned to the same frequency as that of the receiver 44, and serve to prevent the high-speed signals from interfering with the operation of the low-speed recorder 51.

Obviously, the low-speed recorder may be replaced by a telephone if the frequency shift at the transmitter is of sufficient magnitude.

In order to explain the operation of a system constructed according to my invention, it is assumed that the normal carrier frequency of the transmitter is of the order of 25,000 cycles per second. The high-speed tape transmitter superimposes a signal on this carrier frequency by interrupting it at a speed of approximately 400 letters per minute, or at even higher speeds.

The movable electrode 5 is arranged to cause the crystal-controlled oscillator to shift in frequency a sufficient amount to change the carrier frequency from 25,000 cycles to 25,700 or 25,300 cycles, or to give the carrier any desired shift. The rate of shift of the signalling frequency should be at a low speed of approximately 100 or 200 letters per minute.

It is thus apparent that two distinct signals may be superimposed upon the carrier wave, one by interrupting its continuity at a high speed and the other by shifting its frequency at a relatively low speed.

In order that both of these signals may be received it is, therefore, necessary that the receiving system incorporate means for recording the high-speed signal, irrespective

of which frequency is being interrupted. To that end, I have provided the connections 49 and 50 between the output circuits of the two tuned receivers, which connections enable the high-speed recorder 45 to give an uninterrupted indication of the signal being received at high speed by either of the said receivers. Inasmuch as the high-speed signal is conveyed by a series of interruptions in the transmitted frequency, it is obviously immaterial which of the two receivers is utilized to control the high-speed recorder.

In so far as the low-speed signals are concerned, the output of the receiver tuned to either of the limits to which the carrier wave is shifted is directly readable by ear, or may be recorded on a tape. The high-speed signal will exist in the low-speed record as a modulation which appears in both signalling and spacing intervals. If the difference between the speed of the interruptions to the carrier frequency and the speed at which the carrier is caused to shift in frequency be made sufficiently great, the modulation caused by the high-speed signal will not be objectionable nor will it interfere with the legibility of the tape recorded low-speed signal.

Referring to Fig. 4, the high-speed record will be made substantially as shown, there being no interruptions to its continuity occasioned by the frequency shift of the carrier wave.

In Fig. 5 is reproduced a typical tape record such as is given by the low-speed recorder, and it will be noted that the high-speed signal appears therein merely as a roughness which in no way interferes with the legibility thereof.

Although I have shown and described a specific embodiment of my invention, I am aware that many modifications will be apparent to those skilled in the art. My invention, therefore, is not to be limited except in so far as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a radio system, means for transmitting a signal by carrier-wave-frequency variations, means for simultaneously transmitting a second signal by interruptions of the carrier wave, and means for receiving and indicating both signals.

2. In a radio system, means for generating and radiating high-frequency oscillations, means for shifting the frequency of said oscillations to impress a signal thereon, means for simultaneously interrupting the continuity of said oscillations to impress another signal thereon, and means for simultaneously receiving and indicating both signals.

3. In a radio system, means including a master-oscillator for generating and radiating high-frequency oscillations, means for altering the frequency of said master-oscillator to impress a signal on said oscillations, means for simultaneously interrupting the continuity of said oscillations for impressing another signal thereon, and means for receiving and indicating both signals.

4. In a radio system, means including a piezo-electric-crystal controlled master-oscillator for generating and radiating high-frequency oscillations, means for altering the oscillation frequency of said crystal to impress a signal on said oscillations, means for interrupting the continuity of said oscillations to impress another signal thereon, and means for simultaneously receiving and indicating both signals.

5. In a radio system, means for generating and radiating high-frequency oscillations, means for shifting the frequency of said oscillations between definite limits to impress a signal thereon, means for simultaneously interrupting the continuity of said oscillations to impress another signal thereon, a plurality of receiving means tuned respectively to said frequency limits, and indicating means under the joint control of said receiving means.

6. In a radio system, means for generating and radiating high-frequency oscillations, means for shifting the frequency of said oscillations between definite limits to impress a relatively low-speed signal thereon, means for interrupting the continuity of said oscillations at a relatively high speed to impress another signal thereon, a plurality of receiving means responsive respectively to said frequency limits, indicating means for said high speed signals under the joint control of said receiving means, and indicating means under the control of a single one of said receiving means for recording said frequency shifts.

7. In a radio system, means for generating and radiating high-frequency oscillations, means for shifting the frequency of said oscillations to impress a signal thereon, and means for simultaneously interrupting the continuity of said oscillations to impress a second signal thereon.

In testimony whereof, I have hereunto subscribed my name this 28th day of January, 1927.

FRANK B. FALKNOR.