March 12, 1929. L. R. SCHMITT 1,705,211

RADIO TELEGRAPH SYSTEM

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Fig. 1.

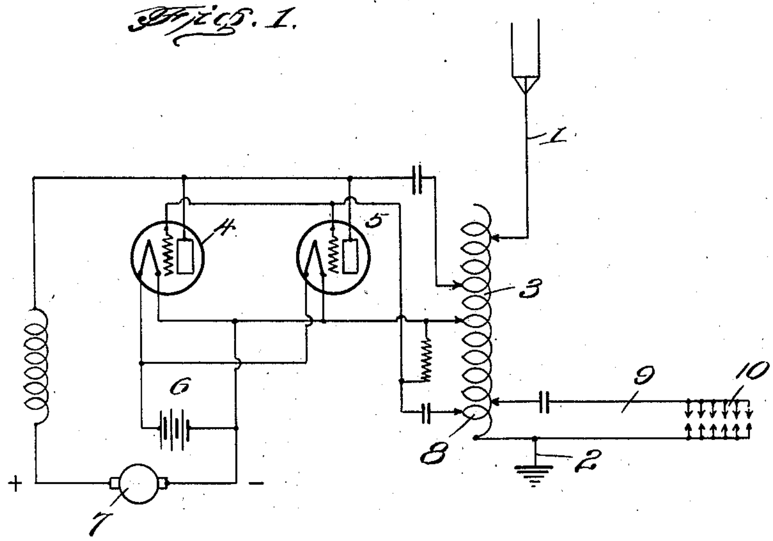

Fig. 2.

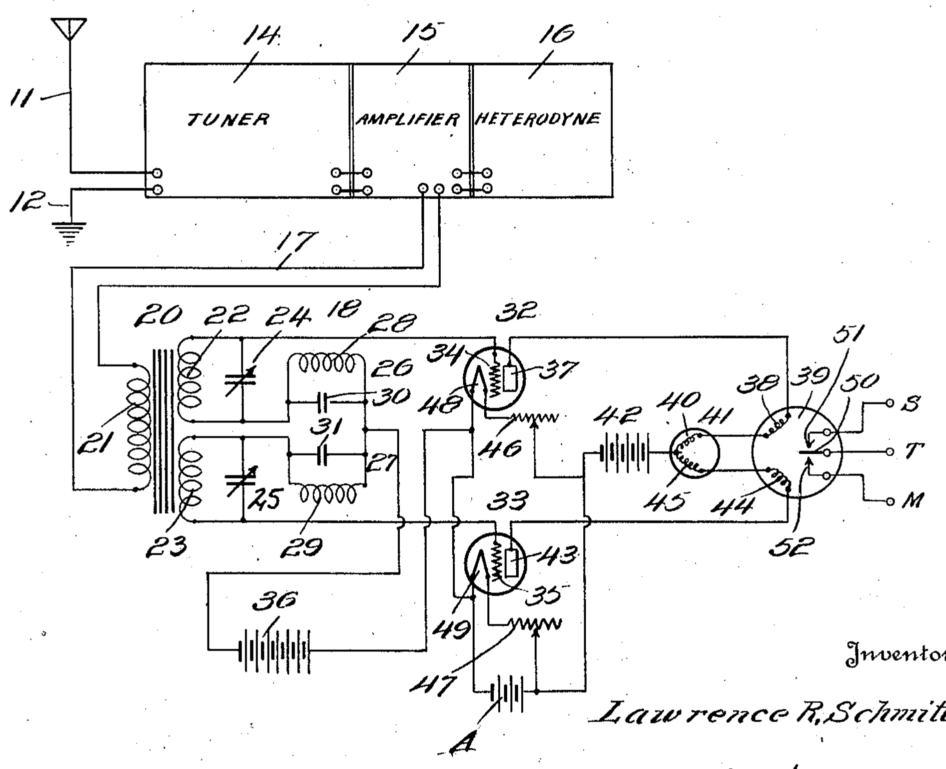

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Fig. 3.

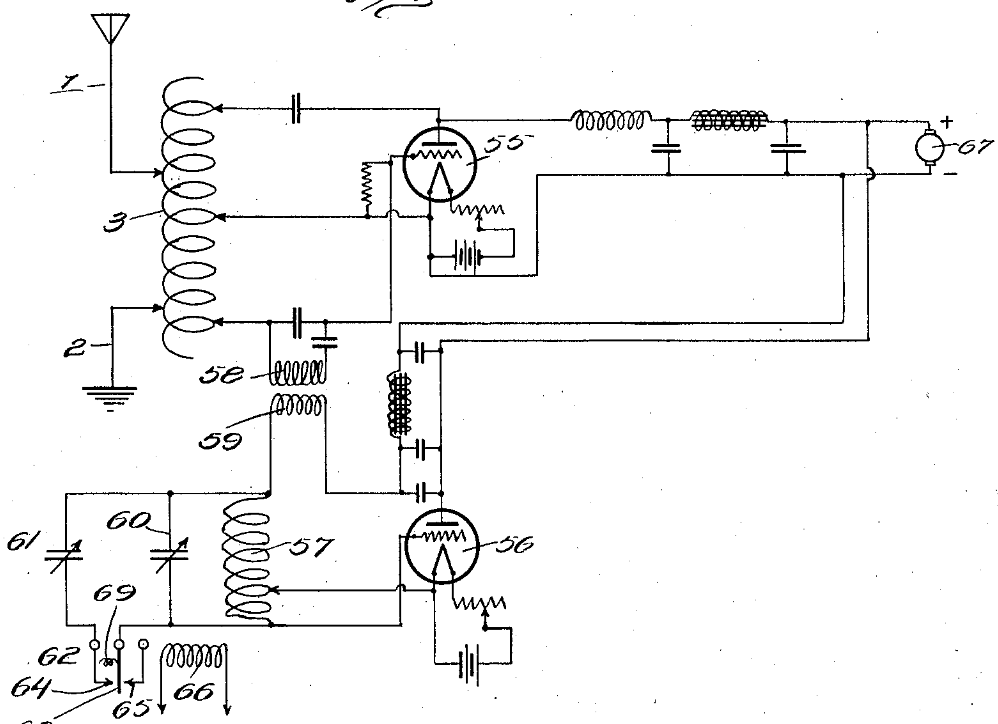
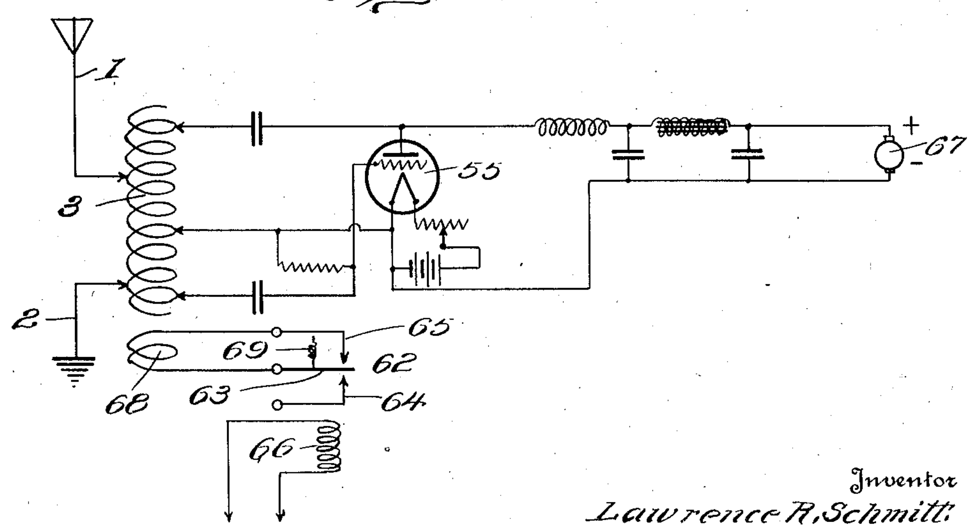


Fig. 4.



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UNITED STATES PATENT OFFICE.

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RADIO TELEGRAPH SYSTEM.

Application filed August 28, 1924. Serial No. 734,664.

My invention relates broadly to radio telegraph systems, and more particularly to a system of telegraphic printing without the use of interconnecting wires between the transmitting and receiving stations.

One of the objects of my invention is to provide a radio telegraph system for the printing of characters where the relay system at the receiving station may be positively actuated both upon the marking and spacing contacts of the relay, eliminating the dependency of the relay system upon spring actuation for either the marking or spacing contact operation.

Another object of my invention is to provide a multi-frequency radio telegraph system where marking and spacing signals may be radiated from a transmitting station to positively actuate a relay system at a receiving station connected with automatic printing apparatus.

Still another object of my invention is to provide a multi-frequency radio printing telegraph system where a pair of slightly separated waves are employed contained within a relatively narrow band of frequencies and adapted to be radiated and received at a receiving station in selectively tuned discriminating circuits where the signals may independently operate a relay system for actuating automatic printing apparatus.

A further object of my invention is to provide a multi-frequency radio telegraph system for printing messages where the wave band employed is relatively narrow but which contains distinct signaling frequencies for marking and spacing signals adapted to be received in the same tuned circuit at a receiving station and separated in tone frequency to a degree necessary to enable the marking and spacing signals to independently actuate a relay system arranged to control an automatic printer.

A still further object of my invention is to provide circuit arrangements at both transmitting and receiving stations whereby the transmission of signals may be automatically controlled by radiating energy through one or more of a definite number of successive time intervals on separated wavelengths for each character transmitted with circuit arrangements at the receiving station for receiving the energy thus transmitted, and selectively discriminating between the energy transmitted at one frequency and the energy transmitted at another frequency comprising a particular character whereby automatic printing apparatus may be positively actuated for printing a character corresponding to the signal energy thus transmitted.

The invention also contemplates the provision of a balanced receiving relay system for the reduction or substantial elimination of static and other interfering signals which normally operate a relay at a radio receiving station and introduce complications in radio printer systems.

My invention will be more clearly understood by reference to the following specification and the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a radio transmitting station showing the electrical connections embodying the principle of my invention; Fig. 2 shows a schematic arrangement of a receiving apparatus and the wiring arrangement of the discriminating circuit of my invention; Fig. 3 is a modified arrangement of a transmitting circuit showing an application of my multi-frequency radio telegraph system to carrier wave systems where the carrier is modulated at separated frequencies for producing the marking and spacing signals; and Fig. 4 shows an arrangement of my multi-frequency radio telegraph system as applied to a continuous wave transmitter with the keying circuit arranged to shift the frequency of the transmitted signal for differentiating the marking and spacing signals transmitted.

My invention makes use of a five-unit code where the signaling energy extends over a given unit of time which is divided into five intervals, during each of which energy may be radiated at one frequency or another to produce different combinations of multi-frequency signals each extending over the same unit of time.

Heretofore in radio telegraph operation of automatic printer systems it has been the practice to transmit a signaling character extending over a given unit of time and divided into five intervals of time, during each of which energy may or may not be transmitted. In this type of system the relay apparatus at the distant receiver must be actuated by either the current or non-current interval and the return of the relay tongue to either the marking or spacing contact has been dependent upon spring action or local electrical bias, with the inherent disadvantages of mechanical inertia of the parts. In a system of this kind I have determined that mechanical inertia offers a serious disadvantage to the operation of relay systems at the high speed necessary to control the circuits of auomatic printing apparatus. With these disadvantages in mind I have developed the invention described herein.

The fundamental principles of this system may be broadly explained by considering a radio transmitter of the continuous wave type adjusted so as to give one wave, say 230.50 kilocycles as a marking wave or signal and another wave separated from the marking wave by two hundred and fifty or more cycles, say 230.25 kilocycles as a spacing wave or signal. At the receiving end of the system a receiving set is provided capable of receiving continuous waves embracing both frequencies as radiated on the marking and spacing waves. A special relay circuit, which will be more fully described hereinafter, is coupled to the receiver and operates to separate this marking signal from the spacing signal whereby one signal pulls the tongue of a polar relay to one side on the marking wave and to the other side on the spacing wave. The relay circuit is adjusted to selectively discriminate between the marking and spacing signals, giving positive operation of the control relay in each of two positions.

I am aware that heretofore in the art it has been proposed to signal by means of a dot and dash code employing a compensation wave. There is a basic difference between this system and such prior methods which use a compensating wave, and that is, my system functions with a very slight difference of frequency, substantially less than a quarter of a kilocycle, and each character signal may be composed of a number of time intervals of differing frequency, whereas dot and dash compensation wave signaling systems have usefully employed only one wave, the other being so objectionable that many methods have been proposed to suppress such additional wave.

My system permits the transmitter to be tuned so that the marking and the spacing waves both will not tune as broadly as the present wave radiated from a radio broadcasting station. Other systems using a compensating wave require the two waves to be fairly well separated to be able to reduce the interference between the two signals at the receiver to enable one to be read. My system accomplishes the results as will be herein described by separating the audio signal notes instead of the radio frequency waves. Only one system of radio frequency tuning is necessary, thus reducing the number of circuits and their electrical losses.

Referring more particularly to the drawings, reference character 1 designates the transmitting antennæ system grounded at 2. The inductance 3 has been shown in electrical connection with an oscillator formed by the parallel connection of electron tubes 4 and 5. The oscillator circuit is formed by linking the input and output circuits of electron tubes 4 and 5 through the transmitting inductance 3. The cathodes of tubes 4 and 5 have been represented as supplied from a suitable source 6 while the plate potential for the oscillator has been represented as supplied from suitable generator 7. It will be understood that the arrangement of the transmitting circuit may be modified to a considerable extent. Connected in shunt with a part 8 of the transmitting inductance 3 I have shown a keying circuit 9. The keying circuit may consist of an automatic transmitter having a plurality of pairs of contacts 10, five sets of the contacts controlling the transmission of signal impulses, while the other pair of contacts forms a start-stop control for the signaling system. It will be understood that the contacts 10 may be controlled from a manual keyboard, or a traveling tape controller may be employed wherein the tape is perforated in accordance with the signal characters to be transmitted and controls the opening and closing of contacts 10 in succession. While contacts 10 are open the entire inductance 3 is placed in the antenna circuit and thereby controls the frequency transmitted. Upon the shunting of contacts 10, or any one of them in succession, the frequency of the transmitted signal is shifted. In this manner the given unit of time over which each signal character extends is divided into successive intervals of either one or another frequency.

The receiving station has been represented in Fig. 2 as comprising an antenna 11 and ground system 12. The tuner has been represented diagrammatically as indicated by reference character 14. The radio frequency tuning system is responsive to both frequencies transmitted by antenna system 1 and 2. The received energy is amplified by the amplifier represented at 15. A local source of energy is established at the receiver as represented diagrammatically by reference character 16 and is connected with the receiving circuit forming means for heterodyning the incoming signaling energy. The output of the receiving apparatus is represented by conductors 17 which lead to the input circuit of the relay system designated generally by reference character 18. The relay system includes an audio frequency iron core input transformer 20 designed for high efficiency over the band of audio notes employed in the marking and spacing signals. Reference character 21 designates the primary winding of the input transformer 20 and numerals 22 and 23 represent secondary windings tuned respectively by variable condensers 24 and 25 to the two transmitted frequencies. Two separate transformers may, however, be used in lieu of the transformer 20. Filter circuits 26 and 27 comprising inductances 28 and 29 and capacities 30 and 31 respectively are inserted in each of the secondary circuits to increase the sharpness of tuning. 32 and 33 designate electron tubes receiving signal impulses on their respective grid electrodes 34 and 35 from circuits 22, 24, 26 and 23, 25, 27. A negative bias is maintained on these grids by a variable C battery designated at 36. The plate circuit of tube 32 connecting with plate electrode 37 goes through one coil 38 of the polar relay indicated at 39 and through one coil 40 of the milli-ammeter 41 to the positive terminal of B battery 42 while the plate circuit of tube 33 connecting with plate electrode 43 goes through the opposite coil 44 of the polar relay 39 and through the winding 45 of milli-ammeter 41 to the positive side of B battery 42. Filament rheostats 46 and 47 are used to control the plate current through the two coils 38 and 44 of the relay 39 by regulation of the temperature of cathodes 48 and 49 respectively. Filament heating current is supplied from any desired source designated "A" in the diagram.

The provision of the split ammeter circuit enables the relay system to be very accurately balanced so that the relay has a neutral bias. The trap circuits 26 and 27 enable the relay system to accurately discriminate between the marking and spacing signals and tend to screen the circuits against operation by interfering signals. The windings 38 and 44 of polar relay 39 operate upon armature 50 which is mounted midway between coils 38 and 44 and is adapted to swing in either of two directions to close contacts at 51 or 52. The marking and spacing circuits are included between terminals T and M and T and S respectively from which connections are taken to the automatic printer control circuits.

In Figs. 3 and 4, I have shown different methods of securing the double frequency signaling characters. In Fig. 3 transmitter tube 55 connected as an oscillator in the antenna system 1, 2 and 3 and radiates a continuous carrier wave. The carrier is modulated by a second oscillator 56 arranged to produce two audio frequency notes at will in accordance with the transmitting impulses. The input and output circuits of tube 56 are shown interlinked through an inductance 57 with the output circuit thereof coupled with the input circuit of the oscillator 55 through coils 58 and 59. The audio frequency note therefore, which is generated by tube 56 may be usefully employed to modulate the carrier frequency produced by tube 55 in the production of a signal. Inductance 57 is normally shunted by capacities 60 and 61 connected in parallel through relay contacts and which may be adjusted to give the desired signaling frequency for transmission of the marking or spacing wave. The second condenser 61 is arranged to be disconnected from the parallel circuit condenser 60 by the operation of relay 62 having tongue 63 and contacts 64 and 65. The tongue 63 is normally drawn over against contact 64 under the action of spring 69. An armature winding 66 is mounted adjacent the swinging armature 63 and is connected in the keying circuits and attracts the armature tongue 63, whereby the signaling intervals may be divided into a plurality of time intervals of either the tone frequency developed by tube 56 having capacity 60 in circuit therewith or the tone frequency developed by tube 56 having both capacities 60 and 61 in circuit therewith. The plate potentials for the several tubes may be secured from a suitable source such as generator 67.

In Fig. 4, I have shown tube 55 connected with antenna ground system 1, 2 and 3 to produce a continuous carrier wave. Inductively related to the antenna inductance 3, I provide a loop 68 which may be shunted in accordance with the succession of time intervals making up the signaling characters for changing the effective signaling frequency. This is accomplished by means of relay 62 having tongue 63 and contact 65 connected with the terminals of loop 68. The relay winding 66 is energized in accordance with the signaling impulses to attract armature 63 against the action of spring 69 breaking the circuit across loop 68 which normally tends to absorb the signaling energy and effectively change the radiated frequency. The control winding 66 is connected as before, in the keying circuit. By the keying circuit it will be understood that I refer to that type of transmitter control embodying the plurality of contacts designated at 10 in Figure 1, wherein the contacts are actuated by suitable mechanism in succession, particularly pairs of contacts remaining either actuated or unactuated in accordance with the particular combination of impulses comprising that signaling character.

I have illustrated but three methods of transmitting signals by double frequency although there are a number of other methods which may be used. For example two different audio notes might be transmitted over the usual broadcasting station transmitter, without the necessity of heterodyning at the receiver. A master oscillator may be employed having its output connected with a power amplifier, the signals being produced by keying the master oscillator. For high power operation alternators may be used at the transmitter and two transmitters installed, tuned to the two waves one sending the marking signal and the other the spacing signal. A high power arc transmitter may be employed and the absorptive method of keying utilized radiating marking and spacing waves at very slightly separated frequencies.

In the operation of my system a signal sent from the transmitting station using a marking wave of say 230.5 kilocycles, although this may be any wave length, and a spacing wave of say 230 25 kilocycles separated from the marking wave by 250 cycles, although this may be more or less. The receiving set is tuned to these waves and the heterodyne is tuned to give a beat note of say 1000 cycles on the marking wave. As the spacing wave is separated from the marking wave by 250 cycles this wave heterodyne will be 1250 cycles or 750 cycles depending on whether the heterodyne is adjusted above or below the marking wave. If filter 27 is designed for 1250 cycles, the spacing wave is heterodyned above the marking wave.

Adjusting the relay, secondary winding 22 and condenser 24 is tuned to resonance on the 1250 cycle note. Filter 27 is adjusted to reject the 1250 cycle note and filter 26 is adjusted to reject the 1000 cycle note. Therefore, the spacing wave of 1250 cycles will pass through to the grid 34 of electron tube 32 causing a current to flow through circuit 37, 38, 40 and 42 and back to filament 48. Filter 27 and the tuned circuit 23 and 25 rejects this current however, and no current flows in circuits 43, 44, 45, 42, and back to filament 49 of tube 33. The marking wave of 1000 cycles, for example will however pass through circuit 23, 25, 27 to the grid 35 of tube 33 causing a current to flow in circuit 43, 44, 45 and 42 and back to filament 49 while this wave is rejected by filter 26 and the tuned circuit 22, 24. This action pulls the relay tongue 50 to one side against contact 52. As the coils 38 and 44 of the polar relay 39 are wound in opposition it can readily be seen that static or other interference will go through both tuned circuits 22—24 and 23—25 and both filter circuits 26 and 27, with equal intensity, if at all, and as the plate circuits 37—38 and 43—44 have been balanced by filament rheostats, 46 and 47, will have substantially no effect on the relay 39.

It will be understood that while I have described my invention in connection with a single printer channel that this multiple frequency telegraph system may be operated as a duplex transmitter for multiplex two-channel transmission by using four transmitted frequencies instead of two as herein described. In practice "A" channel would operate on two separated frequencies after detection and being heterodyned for example at 800 cycles for marking and 100 cycles for the spacing wave while "B" channel would work on 1300 cycles and 1500 cycles for marking and spacing respectively at the transmitter station. These four frequencies may be controlled by two automatic multiplex transmitters and a distributor while at the various receiving stations only regular start stop printers would be used. In this way two-channel transmission can be carried on from one transmitting station with "A" and "B" channel receivers widely separated. It will be understood, that with the system herein described relay operation of a positive character without mechanical or local electrical bias is obtainable and by reason of the sharpness and clear definition of the signaling impulses obtainable, I am enabled to operate the system at relatively high speed with accuracy.

While I have selected certain particular embodiments by which to illustrate my invention, I desire it to be understood that that modification may be made and that no limitations upon the invention are intended other than are imposed by the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is as follows:

1. A radio telegraph system for transmitting and receiving messages in print, comprising in combination means at a transmitting station for radiating one or another frequency in succession within limits of 250 cycles, a common tuned circuit for receiving the several frequencies, and means connected to said common tuned circuit for closing a plurality of circuits corresponding to the number of transmitted frequencies for controlling a circuit to an automatic printer.

2. A radio telegraph system for transmitting and receiving messages in print, comprising in combination at the transmitter a generator of continuous waves, means for radiating energy developed by said generator, means for shifting the frequency of the radiated energy within a limit of 250 cycles through each of a definite number of successive time intervals whereby each signaling character consists of a plurality of frequencies; at the receiving station a common tuned circuit responding to all of the plurality of frequencies comprising each character, a circuit connected to said common tuned circuit for discriminating between said frequencies, and means independ-

ently operated by each of said last mentioned circuits for positively controlling circuits to an automatic printer.

3. A radio telegraph system for receiving messages directly in print, comprising in combination receiving apparatus adapted to respond selectively to a plurality of frequencies within a range of 250 cycles, means connected to said apparatus for discriminating between said frequencies, means independently connected in circuit with said aforemention means and adapted to respond independently to one or another of said frequencies for controlling a circuit to an automatic printer.

LAWRENCE R. SCHMITT.