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3,175,193

TRAFFIC SIGNAL SYNCHRONIZING SYSTEM

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2 Sheets-Sheet 1

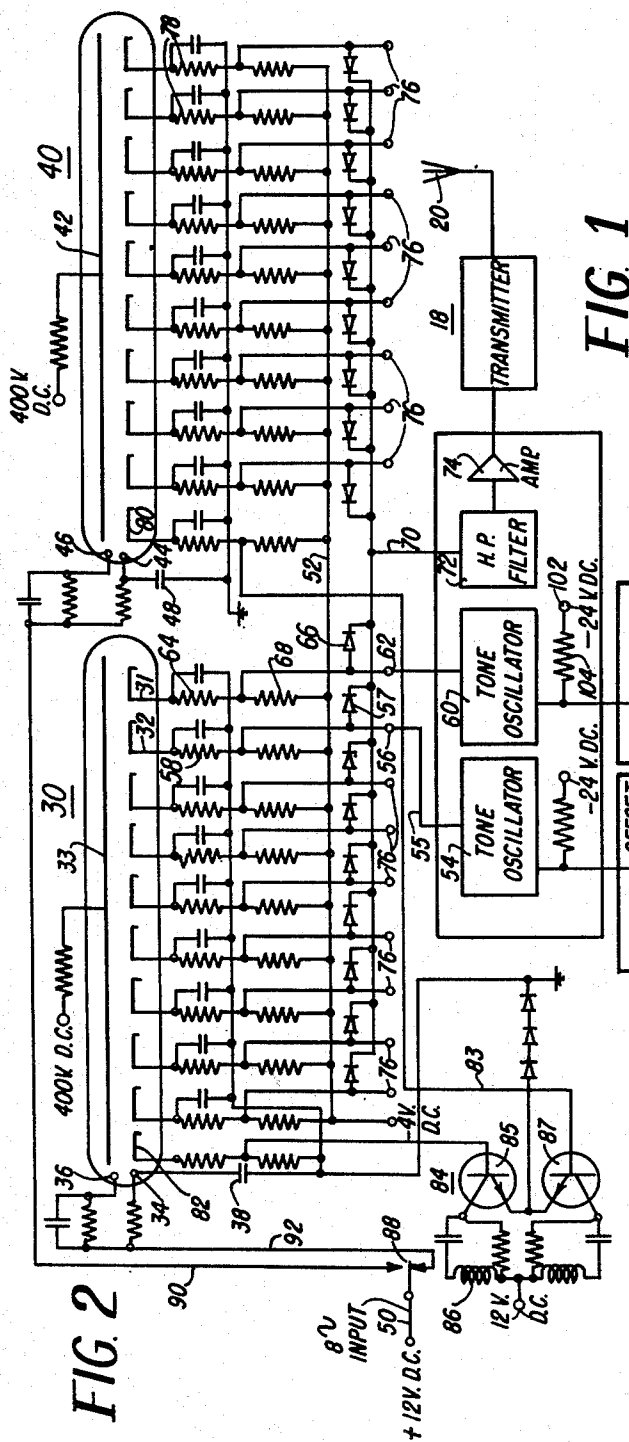
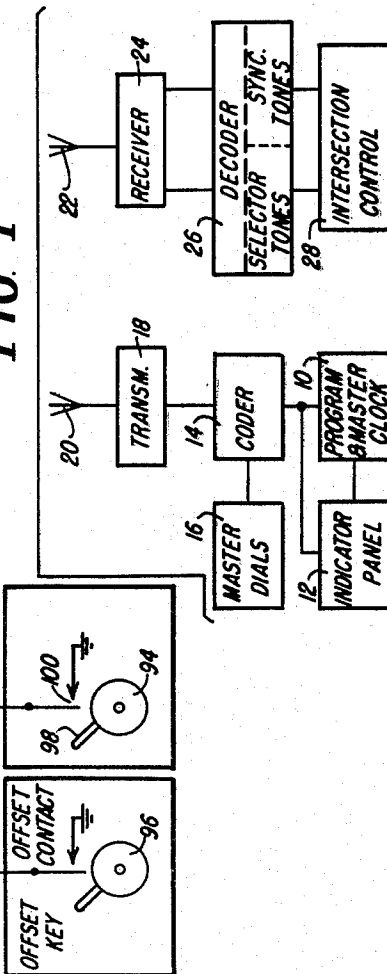


FIG. 1



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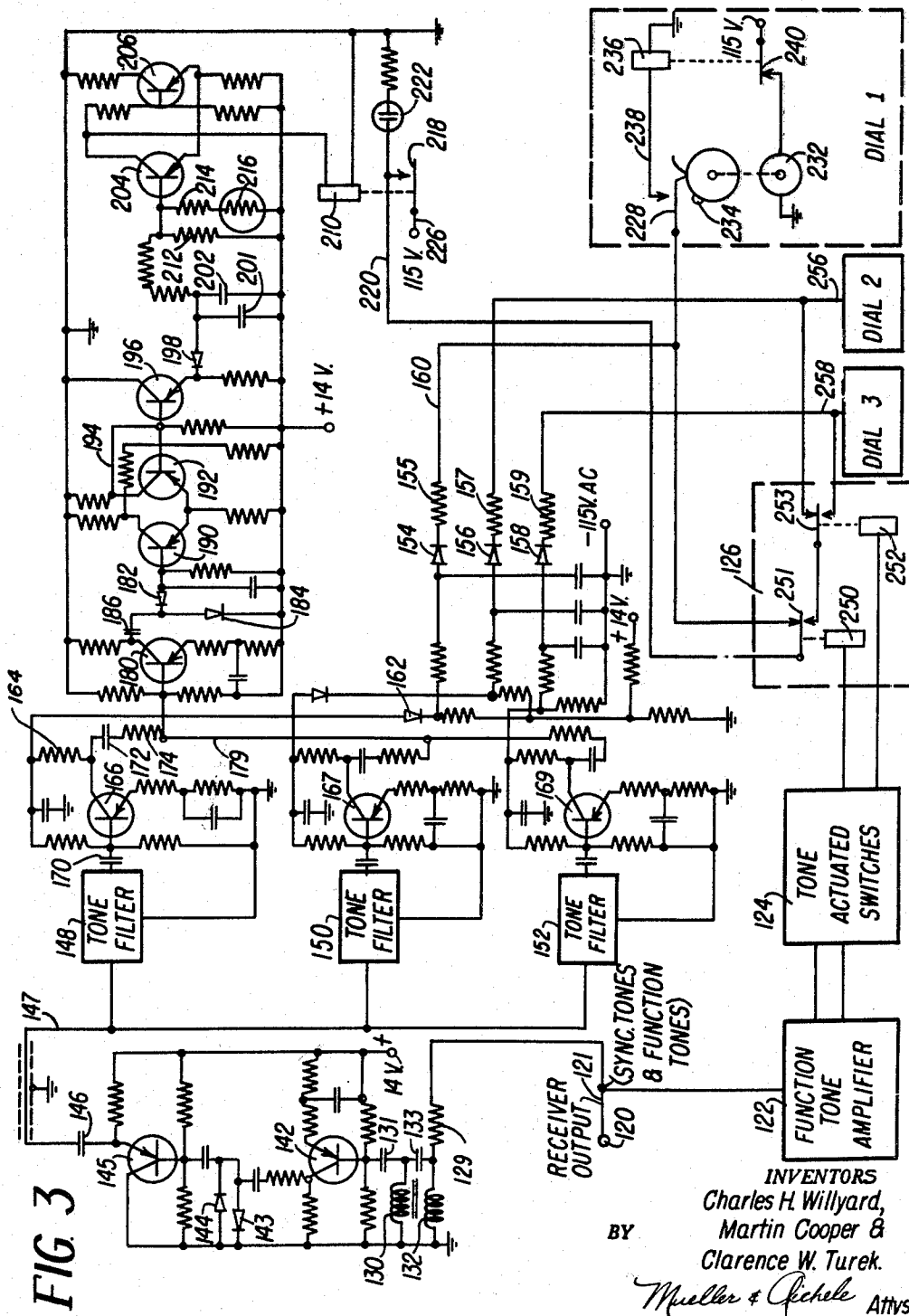
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TRAFFIC SIGNAL SYNCHRONIZING SYSTEM
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11 Claims. (Cl. 340-171)

This invention pertains generally to control systems and in particular to an improved system for synchronizing traffic signals provided at a plurality of intersections.

Traffic signal control systems including those using radio signals for control are known in the art. Such systems generally utilize a central controller having a transmitter which transmits various selected signals to change the function of traffic signal intersection units which are coupled to a radio receiver which receives the transmitted signals. Although the basic systems used in radio control of traffic signals are known, such systems have not been entirely adequate, especially in the synchronization of the intersection unit dials with master dials located at the central controller.

In order to maintain uniform traffic signal control and uniform traffic flow throughout a system, each intersection unit having a specific time cycle must be maintained in synchronism with other units having the same time cycle and with the related master dial at the central control point. The synchronizing signals and the signals which initiate function changes at the intersection units should preferably be transmitted through the same apparatus, thereby minimizing the complexity and cost of the equipment used in the system.

Thus, it is an object of the present invention to provide an improved traffic signal control system for maintaining synchronization of the intersection units with a central controller.

Another object of the present invention is to provide a traffic signal control system which is highly reliable and economical, wherein each intersection unit is controlled by a central controller for both function changes and dial synchronization.

A feature of the invention is the provision of a traffic signal control system utilizing continuous transmission in sequence of a plurality of tone signals having different frequencies to maintain synchronization of the traffic signal intersection units with master central control apparatus.

Another feature of the invention is the provision of a coder apparatus in a radio controlled traffic signal system which utilizes a plurality of cold cathode counter tubes to control the timing of transmission of a plurality of tone signals each having a different frequency for maintaining synchronization of the system. The counter tubes may render semiconductor diodes selectively conductive for gating various tone oscillators which produce signals of different frequencies.

Still another feature of the invention is the provision of a transistorized clipper circuit in the receiver-decoder of a radio controlled traffic signal system wherein the amplitude of signals fed to tone filters in the decoder remains relatively constant, thereby limiting noise signals and normalizing signals of larger amplitude.

Yet another feature of the invention is the provision of a time delay circuit in the receiver-decoder of a radio controlled traffic signal system which provides continuous control from an intermittent synchronizing signal to control an intersection unit dial motor, thereby maintaining an intersection unit dial in synchronism with a corresponding master dial located at the central control point.

In the drawings:

FIG. 1 illustrates in block diagram form a radio con-

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trolled traffic signal system wherein the invention is utilized;

FIG. 2 is a combined schematic and block diagram of a coder which may be used for initiating transmission of synchronizing signals used in a traffic signal control system; and

FIG. 3 is a combined schematic and block diagram of the receiver, decoder, and intersection dials of an intersection traffic unit representative of units which may be used in the traffic signal system.

In practicing the invention there is provided a radio controlled traffic signal system having centrally located master control apparatus which controls a plurality of intersection units to maintain synchronization of the system. A plurality of dials in each intersection unit each have a particular timing cycle which is to be synchronized with master dials at the central control apparatus through transmission of a plurality of tone signals having different frequencies. Each tone signal is gated to represent the rotational speed of a particular master dial and the tone signals are transmitted in sequence and repeated every two and one-half seconds. The tones are provided by a plurality of oscillators and are applied in sequence through rotation of ionization of the cathodes of a plurality of cold cathode counter tubes. The cathodes of such tubes render semiconductor diodes selectively conducting to apply tones from the oscillators to transmission apparatus for sending signals to the individual intersection units. Once during the rotation of each master dial at the central control point the tone signal from the associated oscillator is not transmitted and the absence of the tone is used to control a trigger circuit in the intersection receiver-decoder to maintain synchronization of the intersection unit dials with the master dials as the transmitted signals are received. The decoder also has a clipper circuit which normalizes signals of larger amplitude and suppresses noise. Synchronizing signals of the frequencies associated with the dials in the intersection unit are selected and signals corresponding to a selected dial are applied to a trigger circuit which energizes a relay for controlling a motor coupled to the selected dial in the intersection unit. When a synchronizing signal is not received within a predetermined time period the trigger circuit allows the relay to become deenergized.

Referring now to the drawings, in FIG. 1 there is shown a radio controlled traffic signal system in block diagram. A programmer and master clock 10 are used to select and transmit a particular program. The output of the programmer and clock and the output of the indicator panel 12 are applied to a coder 14. A plurality of master dials 16 provide synchronization signals which are also applied to the coder 14. The output from coder 14 which includes function tones is fed to transmitter 18 and signals are transmitted from antenna 20. The transmitter may be a frequency modulation transmitter as used for two-way communication purposes. The transmitted signals are picked up by receiver antenna 22 and fed to receiver 24. The function tones which perform function changes in the intersection units are applied to one circuit in decoder 26, and the synchronization signals which maintain system synchronization are fed to another circuit in decoder 26. The function tones are in a frequency range of 100 to 1100 cycles per second and the synchronization signals are in a frequency range of 1450 cycles per second to 3150 cycles per second. The outputs from decoder 26 are fed to intersection unit 28 which is coupled to an individual traffic signal or traffic light not shown. More than one intersection control unit may be coupled to the same decoder if desired.

FIG. 2 is a combined schematic and block diagram of part of the synchronizing signal system at the central

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control station. Seventeen master dials at the central controller are continuously rotating, each dial being set for a different rotational speed. The cycle lengths for a complete revolution of each dial vary from 40 to 120 seconds. The rotational speed may vary by 5 second increments such as 40 seconds, 45 seconds, 50 seconds and so on up to 120 seconds per revolution.

A plurality of synchronization oscillators are provided with each being controlled by one of the master dials. A separate oscillator frequency is used for each master dial rotational speed. Thus, each tone frequency corresponds to a specific dial rotational speed. For example, a 1550 cycle per second tone may be controlled by the 40 second master dial. The tone frequency range is from 1450 to 3150 cycles per second.

The synchronization tones applied from the master dials to the intersections throughout the traffic control system from the central station are continuous, while the function tones which perform program changes are transmitted only at a certain time of the day. Two cold cathode counter tubes 30 and 40 are used for controlling the transmission of the synchronizing signals. Anode 33 of tube 30 and anode 42 of tube 40 each have a 400 volt D.C. potential applied thereto.

An eight cycle negative pulse signal is applied through lead 50 to guide pins 34, 36 of tube 30 and to guide pins 44 and 46 of tube 40. Capacitors 38 and 48 act to delay applying of the eight cycle pulse to pins 34 and 44, and therefore pins 36 and 46 ionize first. As shown in FIG. 2, tube 30 has the eight cycle pulse applied thereto through contacts 88 and leads 92. The cathodes of tubes 30 and 40 are negative with respect to the anodes thereof since the potential on lead 52 is a negative four volts D.C. Rotation of ionization of the cathodes occurs in a known manner common to cold cathode counter tubes and a detailed description will be confined to cathodes 31 and 32 of tube 30.

Tone oscillator 54 is connected through lead 55 to point 56 which is connected to the anode of diode 57 and through resistor 58 to cathode 32. Similarly, tone oscillator 60 is connected to point 62 which is connected to the anode of diode 66 and through resistor 64 to cathode 31. Tone oscillators are also connected in the same manner through terminals 76 to the other cathodes of tubes 30 and 40, but for simplicity these are not shown. Diodes 57 and 66 are normally blocked since the anode is negative with respect to the cathode. When cathode 31 of counter tube 30 conducts, the voltage thereon is positive and diode 66 is in a state of conduction, since the current through cathode resistor 68 produces a voltage drop so that there is a positive potential at the junction 62 with respect to the minus four volts on lead 52. With diode 66 in a state of conduction, the audio output of tone oscillator 60 is passed through diode 66 and lead 70 to high pass filter 72, and through line amplifier 74 to the transmitter 18 and antenna 20.

Oscillators 54, 60 and all other oscillators which may be connected to terminals 76, and through resistors 78 to the cathodes of tubes 30 and 40, are operating continuously. However, the diodes coupled to each oscillator prevent passage of the audio tone until the respective cathode conducts. Rotation of ionization within each tube 30 and 40 occurs in response to the pulse signals applied to the guide pins thereof in the usual manner. Counter tube conduction shifts from one cathode to another at the rate of once during each eight cycle per second period. Thus, each tone from the oscillators is coupled to high pass filter 72 for a duration of 125 milliseconds during each two and one-half second period.

The ionization is repeated for each of the twenty cathodes in counter tubes 30 and 40. However, only seventeen of the cathodes control passage of sync tones since only seventeen oscillators are coupled thereto. Of the three cathodes of the tubes 30 and 40 to which oscillators are not connected, one cathode is a spare, and

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cathodes 80 and 82 are used to acutate switching circuit 84 for transferring conduction back and forth between the tubes 30 and 40.

The transfer circuit 84 includes relay 86 having contacts 88 which transfer the 8 cycle per second input signal at 50 between leads 90 and 92 which are connected to the guide pins of tubes 40 and 30 respectively. When the cathodes of tube 30 have ionized in turn and cathode 82 thereof conducts, connection from cathode 82 to transistor 85 causes it to conduct and this releases relay 86 so that contacts 88 thereof move up to apply the pulses to conductor 90 and to tube 40 so that conduction in tube 40 will rotate from one cathode to the next. When the conduction in tube 40 returns to cathode 80, the connection from cathode 80 to transistor 87 through lead 83 causes transistor 87 to conduct to again operate relay 86 and relay contacts 88 to apply the pulses from input 50 to conductor 92 connected to the first counter tube 30.

Each of the 17 oscillators coupled to a cathode of tubes 30 and 40 is also coupled to a master dial similar to master dials 94 and 96 shown in FIG. 2. Each master dial has a different rotational speed and, for example, dial 94 may make one complete rotation in 45 seconds, and dial 96 may make one complete rotation in 40 seconds. Once during the cycle of each master dial, and for purposes of explanation we may refer to dial 94, an offset key 98 mounted on the outside of the cycling drum, closes offset contact 100. The minus 24 volt power source of 102 is grounded between resistor 104 and tone oscillator 60, thereby interrupting the power thereto and the oscillator is cut off. The duration of the period when the oscillator 60 is cut off is such that when the eight cycle input causes cathode 31 to conduct, diode 66 is again forward biased but no audio tone will appear at 62 because oscillator 60 is cut off and therefore the audio tone will not be passed to line 70. Absence of a particular tone during one of the two and a half second periods is the factor that allows the dials at the intersections to be maintained in synchronism with the master dials at the central control points. This will be apparent with the explanation of FIG. 3.

FIG. 3 is a combined block and schematic diagram of the decoder 26 shown in FIG. 1 used at an intersection of the traffic signal control system. The output 120 from the receiver is connected to the sync tone section of the decoder and also to the function tone section of the decoder through lead 121.

In order to understand the circuit operation performed by the sync signals, a brief explanation of the circuit associated with the function signals is necessary. Function tone amplifier 122 selects frequencies which include the various function tones. The selected function tones are then applied to a matrix of tone actuated switches in unit 124. These tone actuated switches have resonant frequencies in the range of 100 to 1100 cycles per second. The switches in unit 124 control relays which in turn control the intersection unit. These provide various controls including selection of particular dials which are rendered effective at desired times. The internal connections of tone actuated switch unit 124 is similar to the arrangement disclosed in application of Charles H. Willyard, Serial No. 795,013, filed on February 24, 1959, now U. S. Patent No. 3,119,093. Relays 250 and 252 of relay system 126 are actuated by tone switches in switch unit 124 to select a desired dial in the intersection unit.

The receiver output 120 is also passed through lead 121 to resistor 129 and through a high pass filter network which includes coils 130 and 132 and capacitors 131 and 133. The filter network allows tones with a frequency above 1200 cycles per second to pass to the base of sync tone preamplifier transistor 142. Diodes 143 and 144 form a clipper circuit whose function is to normalize the amplitude of the signal at this point and to also remove any excessive noise from the signal. The signal is then

applied to the base of transistor 145 in the second stage of the preamplifier. The second stage of the preamplifier is an emitter follower circuit which has a low impedance output from which signals are applied through capacitor 146 and lead 147 to sync tone filters 148, 150 and 152.

These sync tone filters are band pass filters, having a very narrow band pass with each being tuned to one of the seventeen sync tone frequencies transmitted from the central controller. The seventeen sync tones are transmitted in sequence and all will be received in sequence and applied to the filters. Three tone frequencies will be selected by the filters and will be continuously available for synchronizing the intersection unit dials. Signals from only one of the filters will be used at a time depending on which dial in the intersection unit is being used as will be explained.

The tone frequency passed by filter 148 is applied through capacitor 170 to the base of transistor 166, and the output of the collector when transistor 166 is conducting will pass through capacitor 172 and resistor 174 to the base of transistor 180. Similarly, tones from filters 150 and 152 are applied to transistors 167 and 169 respectively. Transistors 166, 167 and 169 are selectively rendered conducting by voltages applied to the collector electrodes thereof by gate voltage rectifiers 154, 156 and 158 connected to resistors 155, 157, and 159 to contacts of relays 250 and 252 in relay unit 126. Thus, if dial 1 is selected, voltage will be applied from lead 160 through resistor 155, diode 154, diode 162, and resistor 164 to the collector of transistor 166 thereby causing it to conduct.

When any one of transistors 166, 167 or 169 conducts, a sync tone of one frequency having a duration of about 125 milliseconds is applied through lead 179 to the base of transistor 180. The usual input to transistor 180 is therefore a tone burst of 125 milliseconds, then nothing for about two and one-half seconds, and then another tone burst of 125 milliseconds.

The output signal at the collector of transistor 180 is rectified by a detector consisting of diodes 182 and 184 connected through capacitor 186 to the collector. The detector rectifies the signal to provide a negative envelope and triggers a Schmitt threshold circuit including transistors 190 and 192. The signal applied through lead 194 to the base of transistor 196 is a negative square wave which is present only while the tone is present. Transistor 196 is connected in an emitter-follower circuit wherein the base becomes negative with respect to the emitter and capacitors 201 and 202 are charged through diode 198 when transistor 196 conducts. When the tone pulse disappears, that is when the pulse voltage goes positive, diode 198 blocks and capacitors 201 and 202 momentarily retain their charge, slowly discharging through resistors 212 and 214 and thermistor 216. The discharge takes about three and one-half seconds.

The voltage on capacitors 201 and 202 is used to control transistors 204 and 206 which are part of a second Schmitt relay trigger circuit. The charge on capacitors 201 and 202 causes sync relay 210 to energize through the second Schmitt trigger circuit. Relay 210 will remain energized as capacitors 201 and 202 slowly discharge and relay 210 will thus remain energized for about three and one-quarter seconds.

At the end of three and one-quarter seconds, if another pulse is not received, relay 210 will deenergize and contacts 218 will open. The time constant of capacitors 201 and 202 and resistors 212 and 214 and thermistor 216 must be very precisely controlled at close to three and one-quarter seconds and thermistor 216 provides thermal compensation for such control. When capacitors 201 and 202 are discharged, if a pulse is not received within the three and one-quarter second period, the base of transistor 204 goes less negative with respect to its emitter until the transistor is cut off and the second Schmitt trigger circuit causes relay 210 to deenergize.

The contacts 218 of relay 210 are in series with 115 volts applied at 226 and with contacts 251 and 253 or relays 250 and 252 respectively in relay system 126. As long as sync tones are received at the proper time intervals, and if relays 250 and 252 are not operated, 115 volts A.C. will be applied through lead 220 and through contacts 251 to offset contacts 228 of dial 1. This voltage is also applied to lead 160 to render transistor 166 conductive as explained previously. As dial motor 232 rotates, offset key 234 makes contact with offset contacts 228 and 115 volts is applied to motor control relay 236 through lead 238. The contacts 240 of relay 236 open the A.C. circuit to dial motor 232 thereby deenergizing it until relay 236 is deenergized. After relay 210 is deenergized when the controlling sync tone is not received during the normal two and one-half second period, relay 236 is deenergized. At this time 115 volts is applied through contacts 240 to energize dial motor 232 and the intersection dial is in step with the master dial.

When relay 250 is energized in relay system 126, potential from lead 220 is applied through contacts 251 of relay 250 and contacts 253 of relay 252 to lead 256 thereby applying energizing potential to dial 2 and to transistor 167. When both relays 250 and 252 are energized, potential from lead 220 is applied through closed contacts 251 and 253 to dial 3 through lead 258 and energizing potential also is applied to transistor 169. Operation of relays 250 and 252 by the function tones thereby control the operation of dials 1, 2 or 3.

The loss of a sync tone forces the offset on the dial motors at the various intersection units to occur at the precise time that the master dial at the central control point begins a new cycle. One important feature of the overall system is that if a malfunction should occur at the central control point, the dials at the intersections will continue to operate until proper system operation is restored.

Neon lamp 222 remains lighted as long as the contacts 218 of relay 210 are closed. If the sync tone is not received, relay 210 deenergizes and neon light 222 goes out thereby giving a visual indication that a loss of the sync tone has occurred for an extended period of time and corrective measures should be taken to restore reception of the sync tone. If there is a failure in the tone transmitting and reception circuitry, relay 210 will remain deenergized and the last selected dial will continue to operate until tone reception is restored.

The present system in which the synchronizing tones are applied in sequence has been found to be preferable to a system in which all of the tones are applied simultaneously and then separated. As previously stated, the equipment may be used with frequency modulation transmitters and receivers, and in such case full deviation by a single tone for a short duration has been found to provide more reliable signal transfer than to apply a plurality of tones simultaneously wherein the frequency deviation is divided between the tones. The receiver system provides continuous action from the recurring pulses of the different tones and in effect stretches out the signals so that the continuous synchronization is effected.

Thus, the invention provides for a traffic signal synchronizing system which is accurate and highly reliable. A central controller used for transmitting sync signals has two cold cathode counter tubes which are used in a selective conduction manner to cause proper sequencing and timing of the sync tones. Through the use of tone signals having higher frequencies than tones used for function changes, and through operation of a control circuit in the decoder, false operation of the system is prevented. The control circuit in the decoder clips the amplitude of the incoming sync signal along with any noise which may accompany it. The dial synchronization method of the invention may be used with existing traffic signal synchronizing systems and offers an improvement

because of its compatibility with such existing systems.

We claim:

1. A radio controlled traffic signal system including in combination, a central controller including a plurality of master dials each having a specific time cycle, a coder device coupled to said master dials, said coder device including means providing in sequence a plurality of synchronizing signals associated respectively with the time cycle of said plurality of master dials, transmitter means coupled to said coder device, a plurality of receivers each including a decoder, and a plurality of intersection units individually associated with said receivers and coupled to said decoders thereof, each of said units having a plurality of synchronizing dials, said transmitter continuously sending synchronizing signals initiated by said coder device in accordance with the cycle time of each of said master dials coupled to said coder, said signal being received by said receivers and applied to said decoder thereof, said decoder responding to one of said synchronizing signals for actuating the corresponding synchronizing dial in said intersection unit for synchronizing said dial with the associated master dial having a corresponding time cycle.

2. A radio controlled traffic signal system including a plurality of master dials each having a different time cycle, a coder device having tone oscillator means for providing different tone frequencies, each of said master dials having one of said tones associated therewith, transmitter means for providing a frequency modulated carrier wave, said coder device including a plurality of cold cathode counter tubes having a plurality of cathodes and gate means coupled to said cathodes, said gate means selectively applying signals from said oscillator means to said transmitter for modulating the carrier wave, conduction of each of said cathodes in sequence for a specific time duration operating said gate means to apply said tones to said transmitter, each of said master dials periodically interrupting the transmission of said associated tone to provide a synchronizing signal for said master dial, and receiver means for receiving the frequency modulated carrier wave, said receiver means including decoder means for responding to said synchronizing signal.

3. A radio traffic signal control system including transmitter means and receiver means, said transmitter means including a coder device having a timing circuit including control voltage input means, a plurality of tone oscillators each having a different frequency, a plurality of cold-cathode counter tubes, each tube having a plurality of cathodes, bias voltage means for applying a bias voltage to each of said cathodes, a plurality of semiconductor diodes each having an anode connected to one of said tone oscillators and a cathode, each of said anodes being coupled to one of said counter tube cathodes, and said transmitter means further including output means coupled to said semiconductor diode cathode, said control voltage input means applying a voltage to said counter tubes to cause selective conduction of said counter tubes through each of said cathodes thereby causing the anode of said diode coupled to the conducting cathode to have a positive potential, whereby said diode conducts and the output of the tone oscillator coupled thereto is passed to said output means.

4. A radio traffic signal control system including transmitter means and receiver means, said transmitter means including a coder device having a plurality of master dials each having a different time cycle, a control circuit including input potential means, a plurality of tone oscillators each having a different frequency, each of said master dials having one of said tones associated therewith, first and second cold cathode counter tubes having a plurality of cathodes each coupled to a tone oscillator, bias voltage means coupled to said cathodes and applying bias potential thereto, a plurality of semiconductor diodes each having an anode and a cathode with the anode of each diode being coupled to one of said coun-

ter tube cathodes, and output means coupled to the cathodes of said semiconductor diodes, said input potential means applying a potential to said counter tubes to cause sequential conduction of said counter tube cathodes thereby permitting said semiconductor diodes to overcome the bias potential on said semiconductor diode cathodes whereby a tone from the tone oscillator coupled to the conducting cathode of said counter tube passes to said output means, each of said master dials periodically interrupting the transmission of said associated tone to provide a synchronizing signal for said master dial, said receiver means receiving said synchronizing signal and responding thereto.

5. A radio controlled traffic signal system for synchronizing dials in remote units from master dials in a central station, said system including in combination, a central controller including a transmitter and a plurality of oscillators, each having a different frequency for producing synchronizing signals, means coupling said oscillators to the master dials respectively so that said oscillators are controlled by the dials, a coder device coupled to said oscillators for applying to said transmitter in sequence synchronizing signals from said plurality of oscillators, a plurality of receivers at the remote units and each including a decoder, said synchronizing signals from said transmitter being received by each receiver and applied to said decoder thereof, said decoder of each unit including means selecting the signals corresponding to the dials of that unit, gating means for passing only the synchronization signal corresponding to the operating dial in the remote unit, and trigger means responsive to the passed signal for synchronizing the operating dial with the master dial having a corresponding time cycle.

6. A radio controlled traffic signal system including a sender unit for transmitting synchronizing signals system, said sender unit including a coder device having tone oscillator means for providing different tone frequencies, transmitter means for providing a frequency modulated carrier wave, said coder device including a plurality of cold cathode tubes each having a plurality of cathodes and gate means including semiconductor diodes normally reversed biased and coupled to said cathodes, said gate means selectively applying signals from said oscillator means through said diodes to said transmitter means for modulating the carrier wave with full frequency deviation for each tone frequency of said oscillator means, conduction of each of said cathodes in sequence for a specific time duration operating said gate means through forward biasing of said diodes to apply said tones to said transmitter and receiver means responsive to said frequency modulated wave, said receiver means including decoder means responsive to said tone frequencies.

7. A radio controlled traffic signal system including transmitter means for transmitting a wave including synchronizing signals, a station for receiving synchronizing signals of various frequencies, said station including a receiver having a decoder, a plurality of intersection units coupled to said decoder with each intersection unit having a plurality of synchronizing dials, said decoder including means for selecting a signal of a particular frequency, a transistor including base, emitter and collector electrodes, means applying the selected signals to said base electrode to cause conduction in said transistors, capacitor means, and a semiconductor diode having an anode and a cathode, said capacitor means being connected in series with said semiconductor diode to said emitter electrode to charge said capacitor means by emitter current, means coupled to said capacitor means forming a discharge circuit therefor, relay means coupled to said capacitor means and operating when a particular voltage is developed across said capacitor means, said capacitor means maintaining said particular voltage for a predetermined time when the selected signal is received thereby operating said relay means to control operation

of a particular synchronizing dial in said intersection units.

8. A radio controlled traffic signal system including transmitter means and receiver means, said transmitter means including a coder device including in combination, a plurality of tone oscillators each providing a signal of a different frequency, first and second counter tubes each having a plurality of cathodes, means providing pulses for causing said tubes to transfer conduction from one cathode to the next, a switching circuit coupled to said counter tubes for selectively applying said pulses thereto, bias voltage means for applying a bias voltage to said cathodes, a plurality of semiconductor diodes each having an anode and a cathode, means coupling said anode of each diode to one of said tone oscillators and to one of said counter tube cathodes, and output means coupled to said cathodes of said semiconductor diodes, each of said cathodes of said counter tubes when conducting assuming a positive potential and bringing the semiconductor anode connected thereto to a positive potential so that the diode which includes the anode conducts to apply the signal from the oscillator coupled thereto to said output means, said switching circuit operating when a particular cathode of said first tube is reached to switch the pulses to said second tube and thereby cause rotation of ionization therein, and operating when a particular cathode of said second tube is reached to switch the pulses back to said first tube and thereby cause rotation of ionization therein.

9. A radio controlled traffic signal system including in combination, a plurality of master dials each having a different time cycle of rotation, a coder device coupled to said master dials and including a plurality of tone oscillators each having a signal of a different frequency, first and second counter tubes each having a plurality of cathodes, means providing pulses for causing said tubes to transfer conduction from one cathode to the next, a switching circuit coupled to said counter tubes for selectively applying said pulses thereto, bias voltage means for applying a bias voltage to said cathodes, a plurality of semiconductor diodes each having an anode and a cathode, means coupling said anode of each diode to one of said tone oscillators and to one of said counter tube cathodes, and output means coupled to said cathodes of said semiconductor diodes, each of said cathodes of said counter tubes when conducting assuming a positive potential and bringing the anode connected thereto to a positive potential so that the diode which includes the anode conducts to apply the signal from the oscillator coupled thereto to said output means thereby sending in sequence synchronizing signals related to the time cycle of each master dial, said switching circuit operating when a particular cathode of said first tube is reached to switch the pulses to said second tube and thereby cause rotation of ionization therein, and operating when a particular cathode of said second tube is reached to switch the pulses back to said first tube and thereby cause rotation of ionization therein, a transmitter coupled to said output means, a plurality of receivers each including a decoder and a plurality of intersection units having a plurality of synchronizing dials coupled to said decoders, said decoders including means for selecting a signal of a particular frequency, a transistor including base, emitter, and collector electrodes, means applying the selected signal to said base electrode to cause conduction in said transistor, capacitor means, a semiconductor diode having an anode and a cathode, said capacitor means being connected in series with said semiconductor diode to said emitter electrode to charge said capacitor means by emitter current, means coupled to said capacitor means forming a discharge circuit therefor, relay means coupled to said capacitor means and operating when a particular voltage is developed across said capacitor means, said capacitor means maintaining said particular voltage a predetermined time when the selected signal is received there-

by operating said relay means to control operation of a particular synchronizing dial in said intersection units, said transmitter continuously sending in sequence synchronizing signals related to each of said master dials, said receivers receiving said signals and applying the same through said decoders to said units to maintain synchronization of said synchronizing dials with said master dials.

10. A radio controlled traffic signal system, including in combination, a transmitter, a central controller including a plurality of master dials each having a specific time cycle, a coder device coupled to said master dials, said coder device including means providing in sequence a plurality of synchronizing signals associated respectively with the time cycle of said plurality of master dials, a function generator providing a plurality of function signals, means coupling said function generator and said coder device to said transmitter means, a plurality of receivers each including a decoder, and an intersection unit individually associated with each receiver and coupled to said decoder thereof, said intersection unit having a plurality of synchronizing dials, said transmitter sending said synchronizing signals and said function signals simultaneously, said signals being received by said receiver and applied to said decoder thereof, said decoder responding to said function signal for selecting a desired synchronizing dial in said intersection unit and to one of said synchronizing signals for synchronizing said synchronizing dial with the associated master dial having a corresponding time cycle.

11. A radio controlled traffic signal system for synchronizing dials in remote units from master dials in a central station, said system including in combination, a central controller including a transmitter and first and second pluralities of oscillators, each of said oscillators having a different frequency, said first plurality of oscillators producing synchronization signals, means coupling said first oscillators to the master dials respectively so that said first oscillators are controlled by said master dials, a coder device coupling said first oscillators to said transmitter for applying in sequence synchronizing signals thereto, means applying at least one of said signals from said second plurality of oscillators to said transmitter simultaneously with said synchronizing signals, a plurality of receivers coupled to the remote units each including a decoder, said synchronizing and function signals from said transmitter being received by each receiver and applied to said decoder thereof, said decoder of each unit including means responsive to said function signals to select a desired synchronizing dial, said decoder of each unit including means to select the synchronizing signal associated with said selected synchronizing dial, and trigger means responsive to the selected synchronizing signal for synchronizing the synchronizing with the master dial having a corresponding time cycle.

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NEIL C. READ, *Primary Examiner.*

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