Jan. 21, 1964 C. H. WILLYARD 3,119,093

TRAFFIC LIGHT CONTROL

Filed Feb. 24, 1959 5 Sheets-Sheet 1

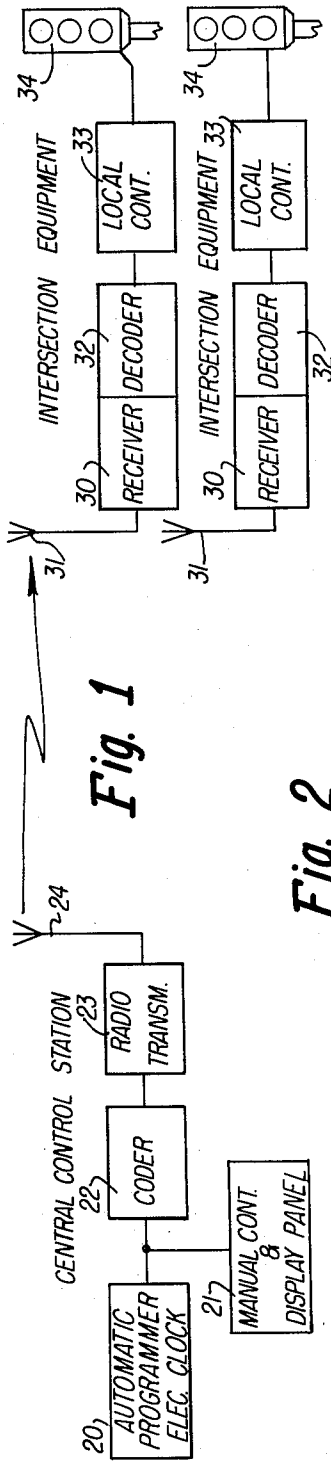


Fig. 1

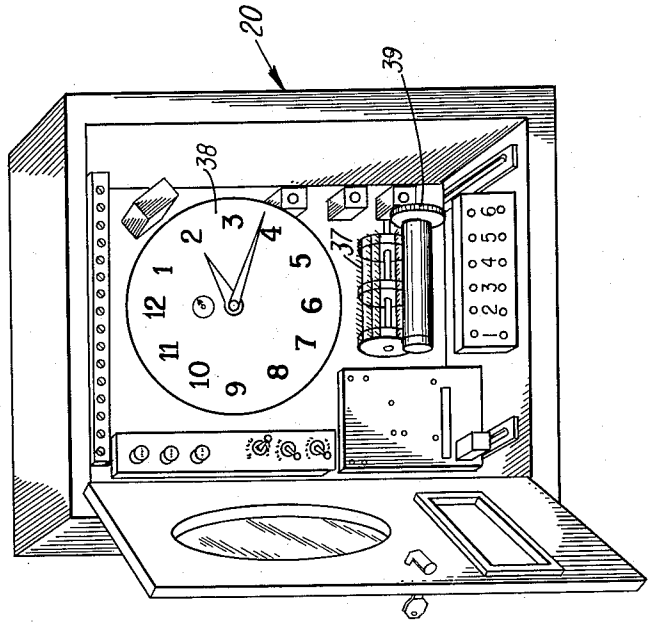


Fig. 2

INVENTOR.
Charles H. Willyard
BY Mueller & Aichele
ATTYS.

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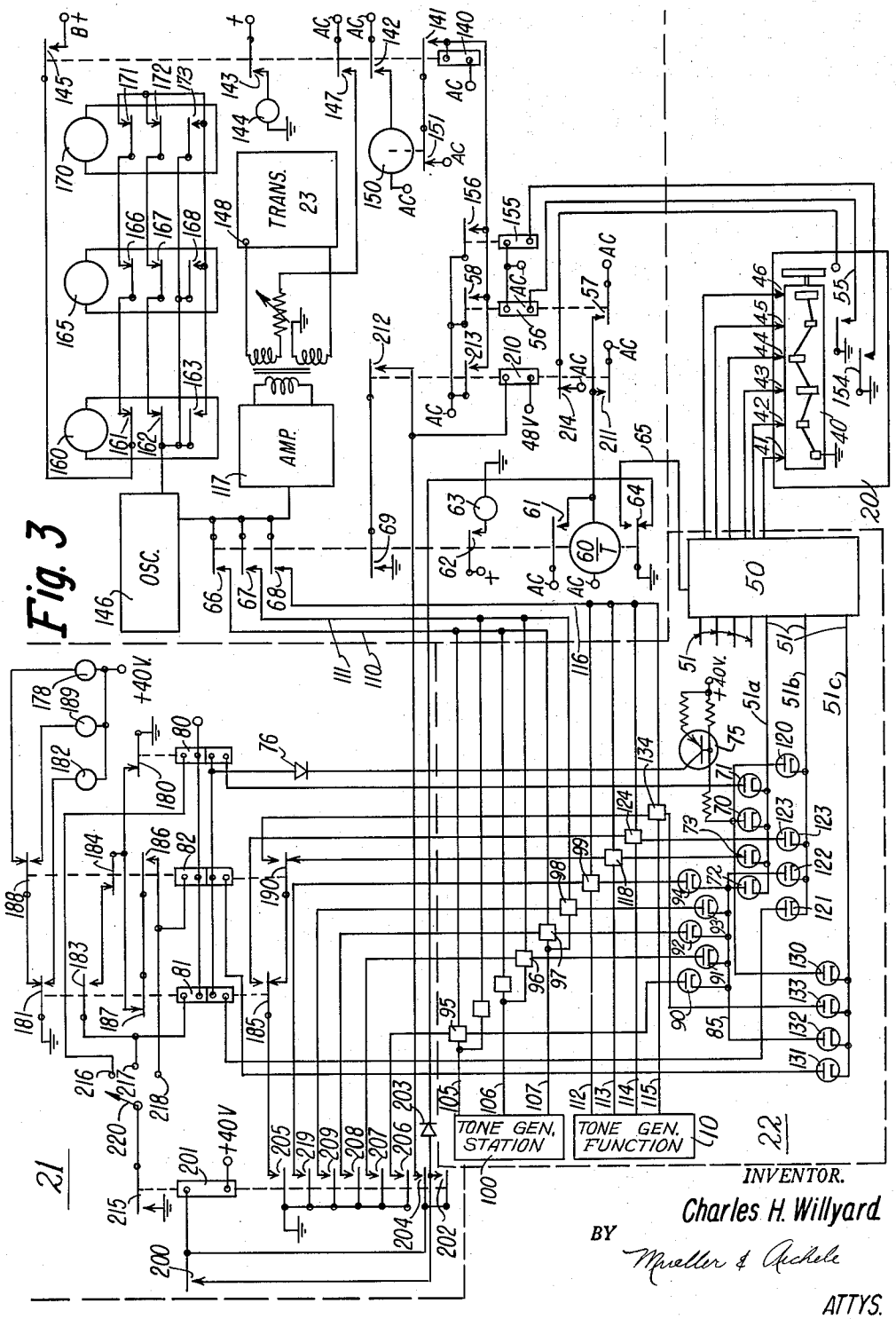


Fig. 3

INVENTOR.
Charles H. Willyard
BY
Mueller & Aichele
ATTYS.

Jan. 21, 1964 C. H. WILLYARD 3,119,093

TRAFFIC LIGHT CONTROL

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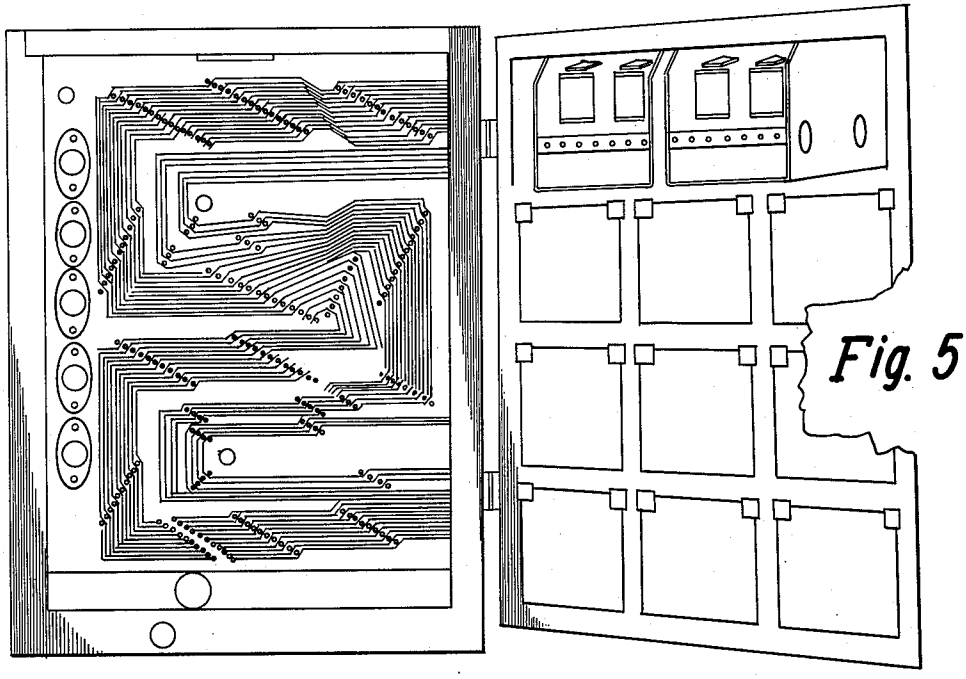


Fig. 5

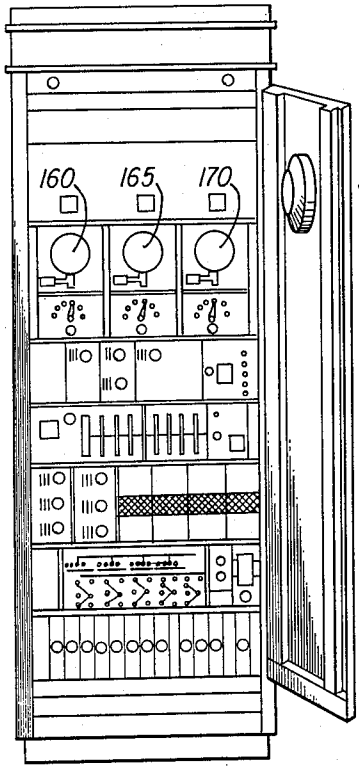
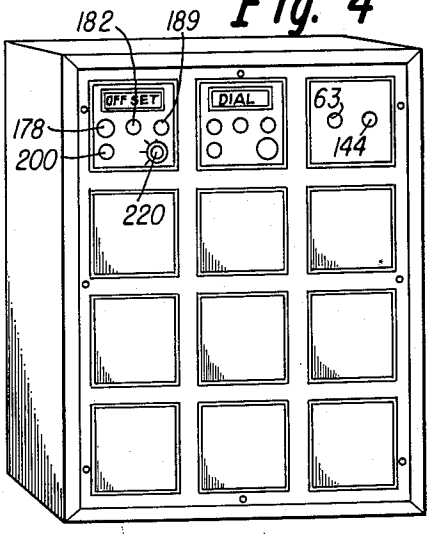


Fig. 6

Fig. 4



INVENTOR.
Charles H. Willyard
BY Mueller & Aichele
ATTYS.

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TRAFFIC LIGHT CONTROL

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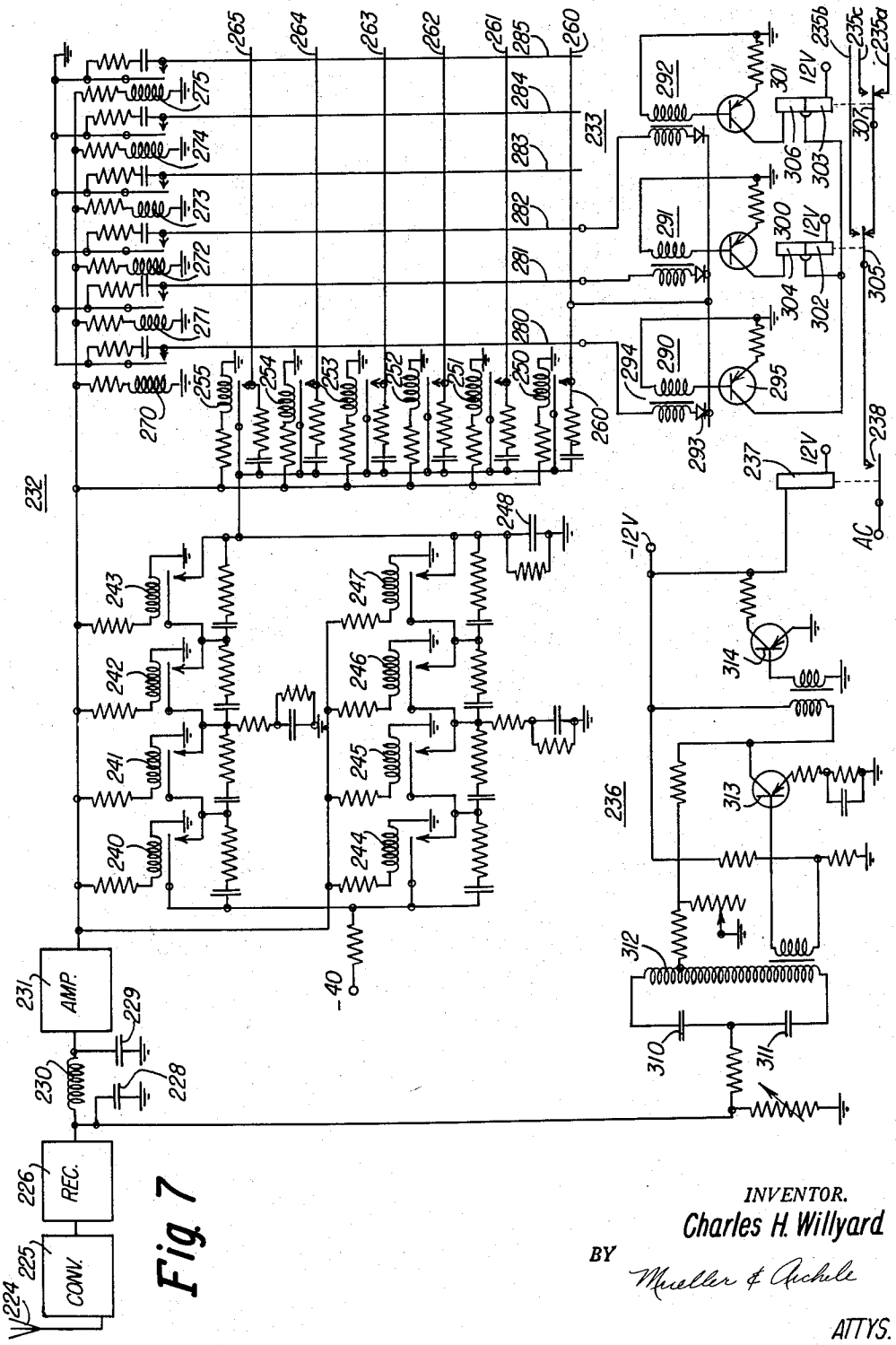


Fig. 7

INVENTOR.
Charles H. Willyard

BY Mueller & Aichele

ATTYS.

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TRAFFIC LIGHT CONTROL

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Fig. 9

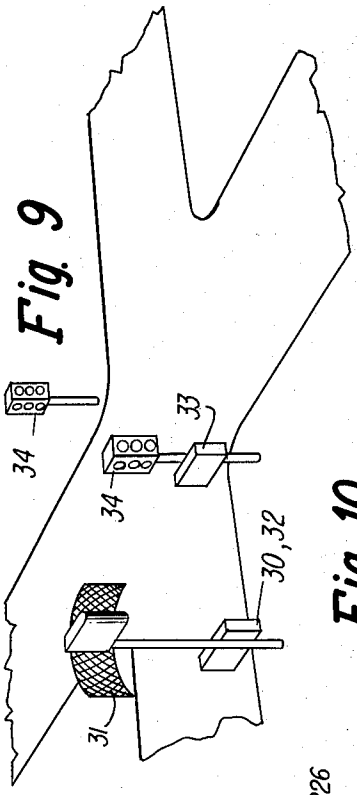


Fig. 10

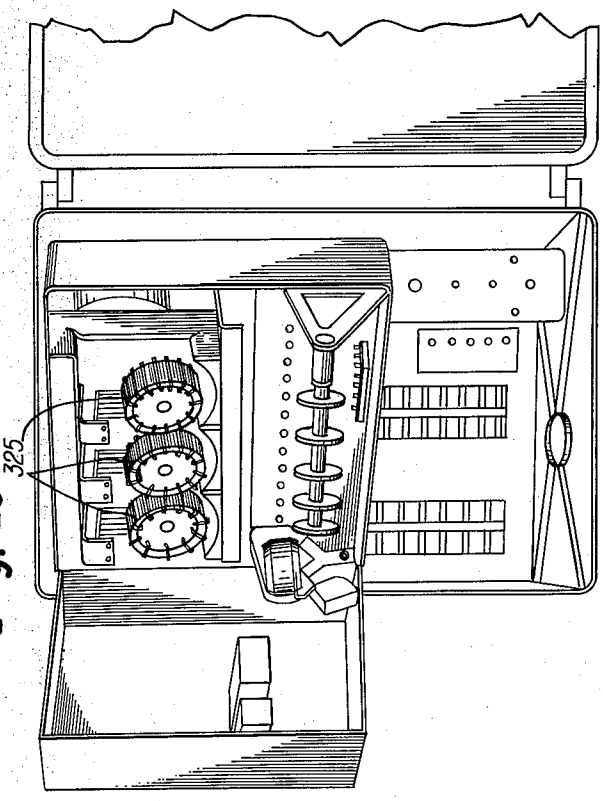
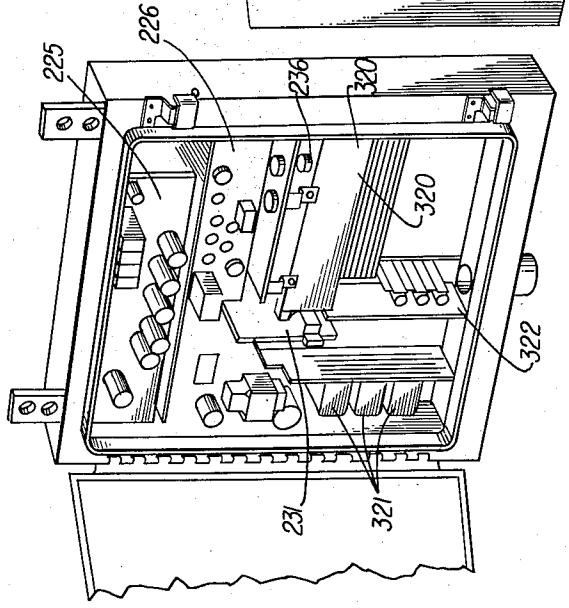


Fig. 8



INVENTOR.
Charles H. Willyard
BY
Mueller & Aichele
ATTYS.

United States Patent Office 3,119,093 Patented Jan. 21, 1964

3,119,093

TRAFFIC LIGHT CONTROL

Charles H. Willyard, Wheaton, Ill., assignor to Motorola, Inc., Chicago, Ill., a corporation of Illinois

Filed Feb. 24, 1959, Ser. No. 795,013
8 Claims. (Cl. 340—40)

This invention relates generally to remote control systems and more particularly to a radio system for controlling traffic lights at a plurality of intersections from a central station.

In order to maintain maximum flow of traffic through busy intersections it is necessary that the traffic lights be set differently at different times. That is, the period of the time that the light permits traffic to move in each direction through the intersection may be changed because of different traffic patterns. Also the timing or offset of the lights along a street with respect to each other should preferably be changed as the movement of the traffic varies. In many systems it is necessary for a patrolman to go to the intersection to change the setting of the traffic light thereat. In some cases control by use of wire lines has been provided but this has been quite expensive since it requires tearing up streets for installing the cables. This is particularly expensive in systems covering long distances.

It is therefore an object of the present invention to provide a relatively simple and inexpensive system for remotely controlling and/or synchronizing traffic lights or other highway signals.

Another object of the invention is to provide a traffic light control system wherein traffic lights at various intersections are continuously synchronized and controlled from a remote station through signals transmitted by radio from the central station.

A further object of the invention is to provide a remote traffic light control system wherein a plurality of lights, which may form groups, may be controlled from the same central station and the same equipment, with either automatic or manual control being provided as desired.

A still further object of the invention is to provide a remote traffic control system wherein equipment at intersections is controlled by radio from a central station, and in which the central station operates automatically and can be easily set up to provide various different control patterns at desired times.

Yet another object of the invention is to provide a traffic light control system wherein different signals provide various desired control patterns, and in which the equipment retains an indication of the signal transmitted to permit repeating the pattern without repetition of the signal.

A feature of the invention is the provision of a radio controlled traffic light system including radio receivers at each controlled intersection and a radio transmitter at the central station, with the transmitter sending code signals and synchronizing signals initiated by automatic program equipment, and each receiver including a device for controlling the traffic light associated therewith in accordance with signals received.

A further feature of the invention is the provision of a system for simultaneously applying pulses for synchronizing at different periods, with pulses being inserted to cause operation to continue without long delay when operation is changed from one period to another.

Another feature of the invention is the provision of a traffic light control system including a single program device which provides signals through a radio communication system to a plurality of intersections or groups of intersections which operate independently of each other. The control may be provided by code signals including components of various frequencies which are provided in different combinations to thereby provide a large number of individual controls.

Another feature of the invention is the provision of a control unit for a traffic light control system, which control unit includes holding circuits for retaining a controlling condition, and apparatus for causing the signal corresponding to the retained conditions to be transmitted to repeat the control signal last applied.

Still another feature of the invention is the provision of a traffic light control system having equipment at the intersection for selectively providing circuit connections to the traffic light controller thereat for selecting different dials and different offsets and for synchronizing the different operations, and which permits a large number of different controls which may in addition control signs indicating the condition of the highway or the light.

The invention is illustrated in the attached drawings in which:

FIG. 1 is a block diagram of the traffic light control system in accordance with the invention;

FIG. 2 is a view illustrating the automatic program machine;

FIG. 3 is a circuit diagram of the manual control, display panel, and coder of FIG. 1;

FIG. 4 is a plan view of the display panel;

FIG. 5 is a schematic diagram of the wiring of the display panel;

FIG. 6 is a plan view of the control unit;

FIG. 7 is a schematic diagram of the receiver and the decoder;

FIG. 8 illustrates the structure of the remote station equipment;

FIG. 9 shows a typical intersection installation with the receiver and the antenna therefor, the controller and traffic signals; and

FIG. 10 illustrates the traffic signal controller.

In practicing the invention there is provide a traffic light control system wherein a master clock and automatic programmer at a central station controls a plurality of local controllers individually associated with traffic lights. Signals from the automatic programmer as well as manual controls are applied to a coder which provides signals for transmission over a radio communication system. These signals include code signals for controlling the operation of traffic signals which may be normal stop and go signals or any other type of signals such as signals indicating highway conditions. The coder also applies synchronizing signals which hold the lights at the intersection in synchronism during operation on cycles of various durations and with various offsets between adjacent signals. At each control intersection a receiver is provided with an antenna for intercepting radio signals. The receiver supplies signals to a decoder which in turn provides circuit connections for operating a local controller for traffic signals which may be of a standard construction. Signals may be provided from the decoder for operating other equipment if desired.

Referring now to the drawings, in FIG. 1 there is illustrated in block diagram form a complete system in accordance with the invention. The equipment at the central station includes an automatic programmer 20 which has a master clock for controlling the system to provide different control programs or patterns at various times. A manual control and display panel 21 is provided which makes it possible to manually control the system and which shows the control pattern last applied to the system. The automatic programmer and the manual control are connected to each other and to the coder 22. The coder applies signals to the radio transmitter 23 which signals are radiated by antenna 24. The radio

transmitter may be a frequency modulated transmitter or may use modulation of any desired type. A transmitter operating at a very high frequency may be used.

A plurality of remote stations are shown in FIG. 1 and these stations may be provided at various intersections to be controlled. Alternately a single remote station may control traffic lights at a plurality of intersections through the use of wire lines. Each remote station includes a radio receiver 30 connected to an antenna 31. The receiver applies signals to decoder 32 which converts the signals to circuit closures for controlling the local controller 33, which in turn controls the traffic signal 34. The local controller may be of any one of a plurality of different available standard units. These may be used in existing systems so that the remote control may be added without requiring a different controller for the traffic signals.

In traffic control systems it may be desired to control the cycle used at a traffic signal, that is the time from one complete operation through the green or go signal, the yellow or caution signal, and the red or stop signal, back to the green signal. It may also be desired to change the split of the signals, that is the time during which traffic is permitted to move in one direction with respect to the time during which traffic is permitted to move in the cross direction. The offset of the various traffic signals in a system must also be changed to accommodate various speeds of traffic movement. That is, the time at which one signal turns green with respect to the time at which the next signal down the street turns green should be coordinated with the speed of movement of traffic in order to permit the maximum traffic flow.

The system in accordance with the invention is described mainly in connection with transmission of signals from a program unit which provides the selection of different dials and different offsets for traffic signals to a remote station having equipment which provides signals for the local controller which controls the dials and offsets therein to control the operation of the traffic signals. It is to be pointed out however that the system may be used in providing remote control of various different equipment. The system may derive signals from program units of different constructions such as a unit wherein the signals have been recorded on tape. Similarly the system may apply signals to various controller devices which operate any desired equipment.

In FIG. 2 there is illustrated an automatic program unit suitable for use as the item 20 in the system of FIG. 1. This includes a master clock 38 which controls a program unit 39. The program unit may be a standard item such as Program Machine type 803 manufactured by International Business Machines Corporation, New York, New York. This machine includes a drum mechanism driven by the clock and having a plurality of bars 37 with fingers which may be arranged in different manners. A first set of fingers responds to the clock mechanism to move a bar in operative position at a particular time. A second set of fingers on the bar controls switch means to selectively ground circuits connected to six terminals provided in the unit. These six terminals which are selectively grounded in different combination provide up to 63 different program combinations. The program machine may also provide controls when a different bar is moved in operative position, and at predetermined time intervals as will be further set forth.

FIG. 3 illustrates schematically the circuits and interconnections of the automatic program unit 20, the manual control and display panel 21 and the coder 22 of the system of FIG. 1. The automatic program unit 20 is shown schematically with the drum 40 having grounded connections thereon which selectively ground the contacts identified as 41, 42, 43, 44, 45 and 46. These contacts are connected to a relay device 50 which is effective to ground any one of a plurality of lines 51 extending therefrom in accordance with the various combination of the contacts 41 to 46 which are grounded. Such a unit is generally referred to as a relay tree and is known in the art. As previously stated 63 different lines can be provided by the device 50, which are each selectively grounded when a particular combination of contacts 41 to 46 are grounded. In FIG. 3, for purposes of simplicity, only three of the lines 51 are connected to the control unit to provide control operations.

The automatic programmer 20 also operates to ground conductor 55 whenever a different program bar is moved into place to indicate that a new program is to be provided. Conductor 55 is connected to relay 56 and energizes the relay to close its contacts 57 and 58. Contact 57 energizes timer 60 which closes its own holding contact 61. Contact 62 of timer 60 energizes the "wait" pilot light 63, and contact 64 thereof moves to its upper position to apply ground to conductor 65. Conductor 65 is connected to the relay device 50 and functions to render this device operative. As previously stated the relay device 50 when operated applies a ground connection to one of the lines 51 depending upon which of the contacts 41 to 46 have been grounded.

The lines 51 are connected to the coder 22 to provide a different signal in response to grounding of each line. Considering that the line 51*a* is grounded, this functions to ground diodes 70, 71, 72 and 73 connected thereto. A circuit is completed through the diode 70 to the transistor switch 75 which is connected through diode 76 to the relays 80, 81 and 82. The diode 71 also establishes a connection to the relay 80. The diode 72 provides a ground on line 85 which is connected to the diodes 90, 91, 92, 93 and 94. These diodes are connected respectively to gates 95, 96, 97, 98 and 99 which provides a closed circuit when the ground is established to the gate. These gates may be provided by various known devices such as relays which are energized when a ground is applied thereto to close contacts which will complete a circuit.

The tone gates apply various low frequently tones to provide codes for transmission to identify various stations and particular programs which are being applied from the central station to the remote stations. The tones may be produced by tone generators 100 and 101 which may be of any known construction. The tone generators 100 and 101 may be generally the same except that it may be desired to have these generators provide tones in different frequency ranges. The various tones produced by the generator 100 are applied on lines 105, 106 and 107. It will be noted that the line 105 is connected to the tone gate 95, and when the gate closes the tone on line 105 will be applied to conductor 110. The tone on line 107 is connected to tone gates 97 and 98 with the gate 97 applying the tone on line 107 to the conductor 110 and the gate 98 applying the tone on line 107 to conductor 111. Line 106 is connected to the tone gate 96 which applies the tone on this line to the conductor 111. Additional tone lines from the generators and additional gates may be provided so that various tones may be selectively applied to the conductors 110 and 111. The same tone may be applied to both conductors 110 and 111, the tone from line 107 being applied to both in the example given above. The conductors 112, 113, 114 and 115 from the tone generator 101 similarly provide various different output frequencies. The frequency on line 112 is applied to tone gate 99 which when operated applies this tone to conductor 116.

The diode 73 which is grounded through the line 51*a* is connected to a tone gate 118 which operates to apply the tone on line 113 to the conductor 116. This is the last diode connected in the circuit of line 51*a*. It will be apparent that the grounding of this line causes actions produced through the diodes described to apply first and second pairs of tones from generator 100 to conductors 110 and 111, and a pair of tones from generator 101 to line 116. These three pairs of tones form the code which

is applied from the central station to the remote stations to control the equipment thereat.

Grounding of conductor 51*b* operates to ground diodes 120, 121, 122 and 123. These diodes function generally the same as diodes 70, 71, 72 and 73 connected to line 51*a*. The diode 120 energizes the transistor switch 75 as previously described. Diode 121 provides a ground to relay 81. Diode 122 grounds the line 85 which in turn grounds diodes 90, 91, 92 93 and 94 which operate as previously described. Diode 123 provides a ground to gate 124 which applies the tone on line 114 to conductor 116. It is therefore seen that grounding line 51*b* provides exactly the same operations as grounding line 51*a* except that the individual control is applied to relay 81 instead of relay 80, and the tone from line 114 instead of the tone from 113 is applied to line 116. The grounding of line 51*b* will therefore provide two tones to each of the lines 110, 111 and 116 to provide a different code which will be transmitted and used to control the remote stations.

Grounding of line 51*c* will provide ground to the diodes 130, 121, 132 and 133 which operate similarly to the diodes 70, 71, 72 and 73. The diode 130 again energizes the transistor switch 75. The diode 131 provides a ground to the relay 82. The diode 132 grounds the line 85 and the diodes 90, 91, 92, 93, and 94 to operate the gates which select the tones from the tone generator. The diode 133 operates gate 134 which connects line 115 to conductor 116. Here again grounding of line 51*c* provides the same operation as grounding of line 51*a* except that relay 82 is energized instead of relay 80 and the tone on line 115 instead of the tone of line 113 is applied to conductor 116.

The timer 60, which is started when a new program is to be transmitted, includes contacts 66, 67 and 68 which connect the lines 110, 111 and 116 to the amplifier 117. The contacts 66, 67 and 68 operate in sequence so that first the tones on the line 110 are applied to the amplifier 117, then the tones on line 111, and finally the tones on line 116. The amplifier 117 applies the tones to the transmitter 23.

The relay 56 which is energized when a new program is initiated operates through contacts 58 to energize relay 140. Relay 140 closes contacts 141 which hold this relay energized through the contacts 151 of timer 150. Relay 140 also includes contacts 142 for energizing the timer 150. Contacts 143 energize the "transmit" pilot light 144 and contacts 145 provide a circuit to energize oscillator 146 which provides synchronization signals. The oscillator may operate at a higher frequency than that of the low frequency tones, such as 1500 cycles per second for example. Contacts 147 apply energizing current to terminal 148 connected to the radio transmitter 23 so that the transmitter is conditioned to transmit signals applied thereto. The delay 140 will remain energized until contacts 151 of the timer 150 are opened, and this is controlled by the setting of the timer 150. The timers 60 and 150 are therefore started at the same time with timer 60 acting to send out the control tones in sequence and timer 150 energizing the transmitter and applying the synchronization signals thereto for a predetermined time duration.

The program unit 20 also includes a contact 154 which is grounded every hour and this is connected to the relay 155. Operation of this relay energizes contacts 156 which energize the relay 140. The relay 140 then operates to start timer 150 and this closes contacts 140 to energize the synchronization oscillator 146. Accordingly the synchronization signal information is transmitted every hour whether or not there is a change in program at such an interval.

The circuit for energizing the synchronizing oscillator 146 is controlled by three master dials which are continuously operating. The dials interrupt this supply of potential to the oscillator to gate the same to provide pulses of the synchronization oscillator. The dial 160 is set for a sixty second cycle period, the dial 165 for a seventy second period and the dial 170 for an eighty second period. These periods are given merely as examples and the dials are arranged to be set up for any desired periods from thirty to one hundred twenty seconds. Since keying is provided at different intervals, various traffic light controllers in the system may be set for different periods, or may be changed from one period to another, and may be synchronized by the same synchronization signal which is gated by the three master dials. The circuit shown also inserts pulses to prevent long periods of traffic light lockups at intersections because of failure of synchronization when changing from one period to another.

Considering now the operation of the dials, the primary contacts 161, 166 and 171 of dials 160, 165, and 170 respectively open for a period which may be about two seconds long at the beginning of the period of the respective dial. These contacts are in series and any one will interrupt the potential supply to oscillator 146 to provide a primary pulse. When the dial is changed and synchronization is desired at a different period, it will be apparent that there may be an interval of 60 seconds after one period before the next pulse, and the dial at a traffic signal may stop for this period. The contacts 162, 163, 167, 168, 172 and 173 are arranged to insert a pulse if a primary pulse is not produced by operation of the primary contacts 161, 166 and 171 for a predetermined interval. If it is desired to limit the interval to 24 seconds, the contacts 162, 167, 172 may be arranged to operate for a period of 2 seconds at an interval of 24 seconds after the beginning of the periods of the respective dials. To prevent the insertion of a pulse if a primary pulse has been produced within the interval, the contacts 163, 168 and 173 are each bridged across the series circuit including the contacts 162, 167 and 172. The contacts 163, 168 and 173 are each closed for a period of 23 seconds at the beginning of the periods of the respective dials. These contacts therefore short or disable the series circuit including contacts 162, 167 and 172 until after there has been an interval of 23 seconds after any primary pulse. Then the dial producing the last primary pulse will insert a pulse at an interval of 24 seconds.

Referring now to the manual control and display panel 21, the diode 70 when grounded renders the transistor 75 conductive and this operates the relay 80. The diode 70 grounds the base of the transistor 75 and as the emitter is connected to a positive potential the transistor conducts to apply the positive voltage to the collector thereof. This is applied through diode 76 to the relay 80, and diode 71 provides a ground connection to the relay so that the relay operates. The relays 80, 81 and 82 each have two energizing windings, one energized through transistor 75 and a second energized by circuits to be described. Relay 80 includes contacts 180 which open to break the hold circuit for relays 81 and 82.

When a ground is provided on line 51*b* the relay 81 is operated by action of diodes 120 and 121. This pulls down contact 181 to deenergize pilot light 178 and to energize pilot light 182. Contacts 183 are closed to establish a holding circuit for the second winding of relay 81 through contacts 184 of relay 82 and contacts 180 of relay 80. Contact 185 is pulled up to provide a circuit to the gate 124 which will be further described. Movement of contact 185 will break the connection to the tone gate 118. The application of ground to line 51*c* causes the relay 82 to be energized through action of the diodes 130 and 131. This will open contacts 184 to remove the holding circuit for relay 81. Relay 82 will be held energized through its contacts 186 and contacts 187 of relay 81. Contact 188 will be pulled down to energize pilot light 189. Contact 190 will similarly be pulled up to provide a connection to the tone gate 134. This will break the connection to tone gate 124.

It will therefore be seen that the relays 81 and 82 will

be operated when lines 51*b* and 51*c* are grounded respectively, and each will be held operated until the other is grounded, or the line 51*a* is grounded to operate relay 80. Grounding of line 51*a* will operate relay 80 but this has no function other than to open the holding circuit to release relay 81 or 82 which might be energized. When relays 81 and 82 are not energized, whether or not relay 80 is energized, the pilot light 178 will be energized and a connection will be provided to the tone gate 118. Accordingly the relays 80, 81 and 82 act to retain or provide a memory of the operation of the system, and the pilot lights 182, 189 and 178 will indicate this condition.

Considering now manual operation of the system, the switch 200 is provided to initiate manual operation. This energizes relay 201 which includes contacts 202 to hold the same operated. The energizing circuit is completed through diode 203 and the released contact 64 which provides a ground connection to relay 201. It will be noted that when the timer 60 is operating and the contact 64 is pulled up the manual circuit is disabled. The relay 201 includes contact 204 which provides a ground to relay 210 to energize the same to start the system for manual operation. Contacts 211 of relay 210 close to start the timer 60, and contacts 212 establish a holding circuit for the relay 210. Contacts 213 are closed to energize the timer 150 which energizes the transmitter and applies the synchronization pulses thereto as previously described. Contacts 214 of relay 210 open to remove energizing current from the program unit 20 so that when manual operation is started automatic operation cannot be initiated.

Relay 201 also includes contacts 205 which provide a ground to one of the tone gates 118, 124 or 134 depending upon the condition of operation of relays 80, 81 and 82 to establish connections through contacts 185 and 190 to these tone gates as previously described. Contacts 206, 207, 208, 209 and 219 operate to apply a ground to the tone gates 95, 96, 97, 98 and 99 to cause operation thereof. Accordingly the six tones which provide a code are provided with one tone being different in each case so that different codes are provided.

Contact 215 of relay 201 is connected to a multiposition switch having a control arm 220 which may be manually set to provide a connection to contacts 216, 217 and 218 selectively. Contact 216 is connected to the auxiliary winding of relay 80, contact 217 to relay 81 and contact 218 to relay 82. Accordingly, when it is desired to manually select a particular control, the control arm 220 may be moved to provide the desired control. Switch 200 is then operated so that the control corresponding to the position of the arm 220 will be transmitted. When automatic control is desired, the contact 220 should be placed in the position shown so that the relays 80, 81 and 82 are controlled only through the diode circuit. The manual control switch 200 may be used to repeat the automatic control last provided, which is retained by operation of the relays 80, 81 and 82.

FIG. 4 shows the indicator panel with two modules in place. Each module will show the operation of three separate controls such as the three controls previously described. The indicator lights 178, 182 and 189 are the same shown in FIG. 3 as are the manual start button 200 and the selection control 220. A plurality of different indicator modules may be provided in the indicator panel to indicate the condition of various different controls. As illustrated in FIG. 4, the module at the upper left may be used to provide three different offsets in the traffic light control system. The module in the center may be used to provide control of various dials and indication of the controls. The module on the left includes the "wait" pilot light 63 and the "transmit" pilot light 144 (FIG. 3). In a traffic system it might be desired to operate various different groups of traffic signals in different ways and this would be provided through different control signals. These signals could be connected to different indicator modules provided in the indicator panels.

FIG. 5 shows the wiring of the indicator modules which are arranged so that each module can be connected through removable pin connectors to conductors provided on a panel. Accordingly, any module can be connected to any tone gate and can therefore be used to provide any desired control.

FIG. 6 illustrates the control unit and shows the master dials for gating the synchronization signals. The various relays for controlling the operations as shown in FIG. 3 are also included in the cabinet shown in FIG. 6.

FIG. 7 illustrates the equipment at the remote stations for receiving the signal, decoding it and applying the signals to the local controller. The signal is picked up by an antenna 224, shown more fully in FIG. 9, and applied to converter 225. The converter is used to reduce the frequency of the received wave because the radio frequency wave used is at a higher frequency than that of a commercially available receiver suitable for this purpose. The reduced frequency is applied to receiver 226 which may be a frequency modulation receiver to receive the signal from the frequency modulation transmitter. The output of the receiver is applied through a low pass filter including condensers 228 and 229 and coil 230 to an amplifier 231. The amplifier increases the level of the signals so that they are adequate to drive the frequency selective reed units utilized in the decoder 232. The decoder applies signals to the relay control system 233 which includes output lines 235 adapted to be coupled to the local controller and selectively energized to operate the controller. The synchronizing signal at the output of the receiver is derived by the frequency selective amplifier 236 and operates relay 237 to selectively apply alternating current power to the local controller through the lines 235.

Considering the tone decoder 232 more specifically, the various low frequency tones selected and transmitted at the central station are received and applied through resistors to the coils of selective reed devices. The reed devices include frequency responsive needs which close contacts when a particular frequency is applied to the coil thereof and may be in accordance with Holzinger Patent No. 2,688,059. The coils of all reed devices are connected in parallel. The devices including coils 240, 241, 242 and 243 respond to the first two pairs of tones of the code signal to render a particular remote station operative. By use of different combinations of tones, the various stations in the system may be individually selected. It may be desired to render a plurality of stations operative at the same time and reed units 244, 245, 246 and 247 are provided which may be the same in a plurality of different remote stations so that the various stations will all operate in response to a single code signal. The operation of the selective unit is in accordance with Noble Patent No. 2,547,025 and operates to provide a voltage across condenser 248 in response to the code signal.

In order to provide a particular function at a selected station the tones of the third pair are arranged to energize a matrix. The voltage across condenser 248 is applied to the contacts of the reed units which include coils 250, 251, 252, 253, 254 and 255. When a reed unit responds to the tones applied to its coil, the contacts will close to connect a horizontal conductor to capacitor 248 to apply the voltage thereto. This selectively energizes the horizontal conductors 260, 261, 262, 263, 264, and 265. Similarly the reed units 270, 271, 272, 273, 274 and 275 are selectively operated when the tones to which they respond are applied and close their contacts to connect the vertical conductors of the matrix to ground. That is, the conductors 280, 281, 282, 283, 284 and 285 are selectively connected to ground when particular tones are applied to the reed units connected to the vertical conductors of the matrix.

A plurality of amplifiers are connected to various points on the matrix for controlling relays to energize circuits in

accordance with the energization of the matrix. The amplifier 290, for example is connected between conductors 260 and 280, the amplifier 291 is connected between conductors 260 and 281, and the amplifier 292 is connected between conductor 260 and conductor 282. The voltage applied to the amplifier from the matrix is a pulsating direct current which is applied through the diode 293 to the transformer 294 and is converted in the transformer to an alternating current. This alternating current applied between the base and emitter of the transistor 295 produces current flow through the collector so that current flows through the reset coils 302 and 303 of the relay 300 and 301 respectively. This insures that both relays are deenergized and provides the contact arrangements shown. Accordingly the alternating current line from relay contacts 238 is connected to conductor 235*a*.

When the amplifier 291 is energized so that its transistor conducts, the current will split between the reset coils 302, and 303 and will all flow through the operate coil 304 of relay 300. Accordingly the operate coil of relay 300 will have a greater current than the reset coil, and this relay will operate. This will pull up the contact 305 of the relay so that the alternating current line is connected to the conductor 235*b*. If the matrix is energized in such a way that voltage is applied to amplifier 292, the transistor of this amplifier will be energized to cause cause current flow through reset coils 302 and 303 and through the operate coil 306 of relay 301. Since there is no current in the operate coil 304 of relay 300 the current through the reset coil 302 will release this relay. The current in the operate coil 306 of relay 301 is greater than that through its reset coil 303 so that the relay 301 will energize to pull up contact 307. This will connect the line to conductor 235*c*.

The selective tone amplifier 236 which responds to the synchronizing signal includes a tuned circuit formed by capacitors 310 and 311 and coil 312. This is coupled to the transistor 313 in such a way that an output is provided only when the signal received has a predetermined frequency. As previously stated a frequency of 1500 cycles per second may be used as the synchronizing tone, and the synchronizing tone is gated by the master dials, so that the output will be an intermittent signal. This signal is amplified by transistor 314 and applied to the relay 237. The relay 237 has contacts 238 connected in series with the relay contacts 305 and 307 so that the alternating current applied through lines 235 to the remote controller is intermittent. In addition to selecting the offset of the controller in accordance with the line through which the current is applied, this current also serves to synchronize the controller. As previously pointed out the synchronizing signal may be applied when there is no change in the program, and alternating current so applied to the remote controller will be gated by action of contact 238 to provide the required synchronization of the traffic signals.

Although the above equipment has been described as providing current for the traffic signal controller to select the offset provided thereby, it will be apparent that this system or a similar system may be used for other purposes. For example, to control the various dials in the traffic controller, amplifiers are connected to the matrix and operated when particular points on the matrix are energized. These amplifiers may be the same as the amplifier 290 disclosed. A plurality of amplifiers may be connected through relays to energize different lines to the controller to select one of a plurality of different dials. The controller illustrated has three dials, and three amplifiers which may operate through two relays as in FIG. 7 will selectively energize lines for controlling the dial selection in the controller.

It may be desired to use synchronizing tones of different frequencies in some systems. For example, different tone frequencies may be used for different dials. In such case a plurality of oscillators 146 are required at the central station, and a plurality of selective units 236 at the remote stations.

FIG. 8 shows the radio receiving and decoding equipment at the remote station provided in a housing. This is a weatherproof housing suitable for mounting on a pole of some type at the intersection. The converter 225 is provided at the top of the housing and the receiver proper 226 immediately below. The tone selector and amplifier 236 is provided below the receiver. To the left is the amplifier 231 for amplifying the control tones, and the reed units are provided in the housing 320. The magnetic latching relays are shown at 321 and may include relays for controlling offset, dials and any other desired function. An interconnecting board 322 is provided which controls all of the basic interconnections so that different controlling operations may be had by changing the interconnecting board with all of the other connections remaining the same. Suitable power supplies are also provided in the waterproof housing.

FIG. 9 shows the antenna 31 used at the remote station and shows this mounted on a pole which also supports the receiver and decoder unit 30, 32. This may be located close to the traffic signal which has the local controller 33 mounted on the same upright which supports the traffic signal.

The local controller is shown in FIG. 10 and as previously stated the lines which are energized by the decoder are connected thereto for controlling the operation thereof. The traffic light controller is a standard item and that shown in FIG. 10 is the NE17 controller manufactured by the Eagle Signal Corporation, Moline, Illinois. The controller shown includes three dials which are selected by lines connected thereto which are energized by amplifiers controlled from the matrix. These dials are indicated by reference number 325. The controllers also include means for providing the desired offset which as previously stated is the time interval in between a reference time signal and the beginning of the main street green signal indication. As previously stated three separate offset arrangements are provided by this controller.

In addition to providing amplifiers coupled to the matrix for controlling the dials and offsets of traffic signals, amplifiers may be provided for various other controls. For example, a flashing red or a flashing yellow signal might be provided by the traffic signals. Other signals such as indication of the condition of the street, signals designating fire lanes etc. may be controlled in the same manner by the remote control system. The same radio equipment, in addition to applying signals to the controller for traffic signals, may also apply signals to other controllers, so that the equipment is quite flexible.

I claim:

1. Apparatus for controlling signal devices provided at a plurality of local stations from a central station including in combination, a radio transmitter at the central station, a plurality of radio receivers associated with the local stations, means associated with said transmitter for simultaneously applying thereto synchronizing signals and code signals, said code signals each having components of a plurality of different frequencies to provide a distinctive code signal, decoder means coupled to each receiver and responsive to signals therefrom, said decoder means separating said code signals from said synchronizing signals, and controller means coupled to said decoder means and to the associated local station signal devices, said decoder means applying said separated signal devices to said controller means for controlling the operation of the local station signal devices in predetermined timed relation by the selected synchronizing signals and for controlling the mode of operation of selected local station signal devices in accordance with the distinctive code signal.

2. Apparatus for controlling traffic signal devices provided at a plurality of intersections from a central sta-

tion which is remote from at least part of the intersections, said apparatus including in combination, a radio transmitter at the central station, a plurality of radio receivers associated with the traffic signals, coding means associated with said transmtiter for simultaneously applying thereto synchronizing signals of a given characteristic and code signals of a differing characteristic, said coding means producing code signals having first components of predetermined frequencies and second components of different frequencies, and control means coupled to each receiver and responsive to signals therefrom, said control means including first means responding to said first components of said code signal to select traffic signal devices at particular intersections, and second means responding to said second components to control the mode of operation of the selected traffic signal devices, said control means including further means responding to said synchronizing signals to provide operation of the traffic signal devices in a predetermined timed relation.

3. Apparatus for controlling traffic signal devices provided at a plurality of intersections from a central station including in combination, a radio transmitter at the central station, a plurality of radio receivers associated with the traffic signal devices, automatic coding means coupled to said transmitter for continuously applying thereto synchronizing signals and for periodically applying to said transmitter code signals of various frequencies simultaneously with said synchronizing signals, and control means coupled to each receiver and responsive to signals therefrom, said control means being coupled to the traffic signal devices associated with the receiver and controlling the mode of operation thereof, said control means including means responsive to said periodic code signals of predetermined frequencies and selectively controlling operation of the traffic signal devices in accordance therewith and in predetermined timed relation to said continuous synchronizing signals.

4. Apparatus for controlling traffic signal devices provided at a plurality of intersections from a central station including in combination, a radio transmitter at the central station, a plurality of radio receivers associated with the traffic signal devices, automatic coding means associated with said transmitter and applying thereto at predetermined times code signals having first components in a first frequency range and second components in a second different frequency range, and control means including first and second selective means coupled to each receiver and responsive to signals therefrom, said first selective means responding to said first components in said first frequency range for selecting traffic signal devices at particular intersections, said control means including a controller unit for operating the traffic signal devices, and said second selective means responding to said second components in said second different frequency range to control the mode of operation of said controller unit and thereby controlling the selected traffic signal devices.

5. Apparatus for controlling traffic signal devices provided at a plurality of intersections from a central station, and wherein the traffic signal devices are adjustable to provide different dial and offset settings, said apparatus including in combination, a radio transmitter at the central station, a plurality of radio receivers associated with the traffic signal devices, automatic coding means coupled to said transmitter for simultaneously applying thereto synchronizing signals of a given characteristic and code signals of a differing characteristic and having first components for selecting traffic signal devices at particular locations and having second components for selecting particular dial and offset settings, and means coupled to each receiver and responsive to signals therefrom for controlling a traffic signal device associated therewith, said last named means controlling the operation of the traffic signal device in predetermined timed relation to the received synchronizing signals and controlling the dial and offset of the traffic signal device in accordance with said second components of the received code signal.

6. Apparatus for controlling traffic signal devices provided at a plurality of intersections from a central station including in combination, a radio transmitter at the central station, oscillator means for providing a high frequency continuous signal, means for gating the continuous signal to provide a synchronizing signal, means for producing a plurality of low frequency signals, means for selecting a group of said low frequency signals to provide a code signal, with signals of various frequencies being selected to identify traffic signals at particular intersections and to provide particular dial and offset settings thereof, automatic coding means for simultaneously applying said synchronizing signal and said selected code signals to said transmitter, a pluraltiy of radio receivers associated with the traffic signal devices, and control means coupled to each receiver and responsive to signals therefrom for controlling the traffic signal devices associated therewith, said control means including a plurality of circuits for connection to the traffic signal devices and which are selectively established to provide different dial and offset settings, said control means including first and second selective means, said first selective means being responsive to said low frequency code signals to selectively establish said circuits and thereby control the operation of the associated traffic signal devices, and said second selective means being responsive to said synchronizing signal to interrupt an established circuit in accordance with the gating of said synchronizing signal to thereby synchronize the connected traffic signal device.

7. In a traffic signal system including traffic signal devices provided at a plurality of intersections and a local controller at each intersection for controlling the devices thereat, apparatus for operating the controllers from a central station including in combination, a radio transmitter at the central station, a plurality of radio receivers individually associated with the local controllers for receiving signals from said radio transmitter, means associated with said transmitter for simultaneously applying thereto synchronizing signals and code signals, said code signals each having components of a plurality of different frequencies to provide a distinctive code signal, decoder means coupled to each receiver and responsive to signals therefrom, said decoder means separating said code signals from said synchronizing signals, and control means coupled to said decoder means, said decoder means applying said separated code signals and synchronizing signals to said control means, said control means including means for connection to the local controllers for operating the same to control the traffic signal devices in predetermined timed relation with the synchronizing signals and for controlling the mode of operation of selected traffic signal devices in accordance with the distinctive code signals.

8. In a traffic signal system including traffic signal devices provided at a plurality of intersections and a local controller at each intersection for controlling the devices thereat, and wherein said local controller includes a plurality of dial means and a plurality of circuits for rendering the same operative, apparatus for operating the local controllers from a central station including in combination, a radio transmitter at the central station, a plurality of radio receivers individually associated with the local controllers for receiving signals from said transmitter, automatic coding means coupled to said transmitter for continuously applying thereto synchronizing signals and for periodically applying to said transmitter code signals of various frequencies simultaneously with said synchronizing signals, and control means coupled to each receiver and responsive to signals therefrom, said control means including means for selecting and separating received code signals and synchronizing signals, said control means including a plurality of control circuits for connection to

the circuits of the local controller associated with the receiver and controlling the operation thereof, said control means including means responsive to said periodic code signals of predetermined frequencies and selectively energizing said control circuits to control operation of the dial means of the local controller in accordance with said code signals and means responsive to received synchronizing signals to hold the local controller in predetermined timed relation to said continuous synchronizing signals, whereby the traffic signal devices are operated in accordance with said periodic code signals and are held in predetermined timed relation to said continuous synchronizing signals.

References Cited in the file of this patent

UNITED STATES PATENTS

1,383,750	Parker	July 5, 1921
1,814,956	Ohl	July 14, 1931
2,203,871	Koch	June 11, 1940
2,276,154	Byrne	Mar. 10, 1942
2,355,607	Shepherd	Aug. 15, 1944
2,429,607	Capen	Oct. 28, 1947
2,665,417	Alles	Jan. 5, 1954
2,832,060	Hendricks	Apr. 22, 1958
3,015,802	Newsom	Jan. 2, 1962