

March 23, 1965

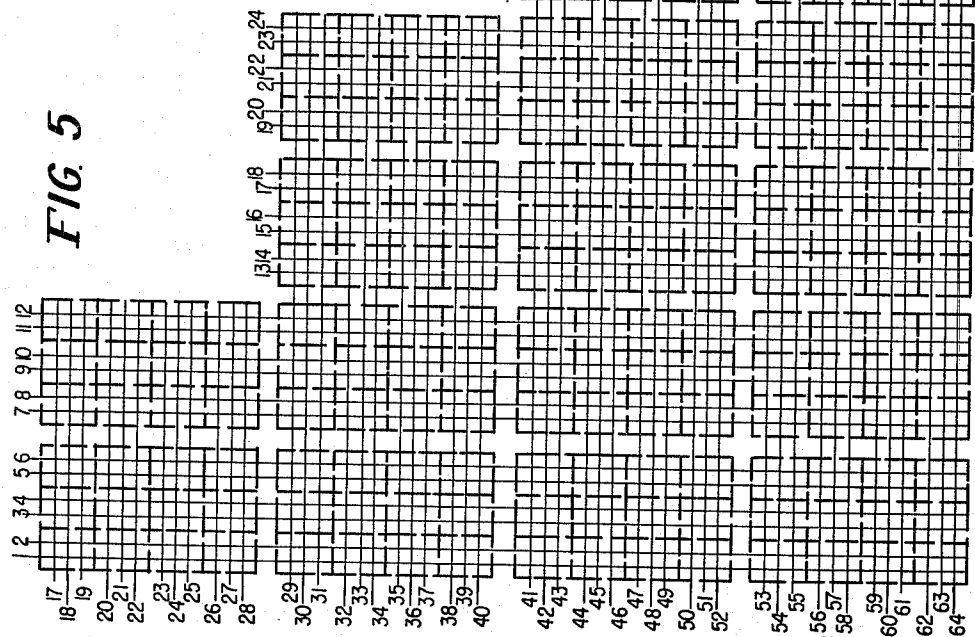
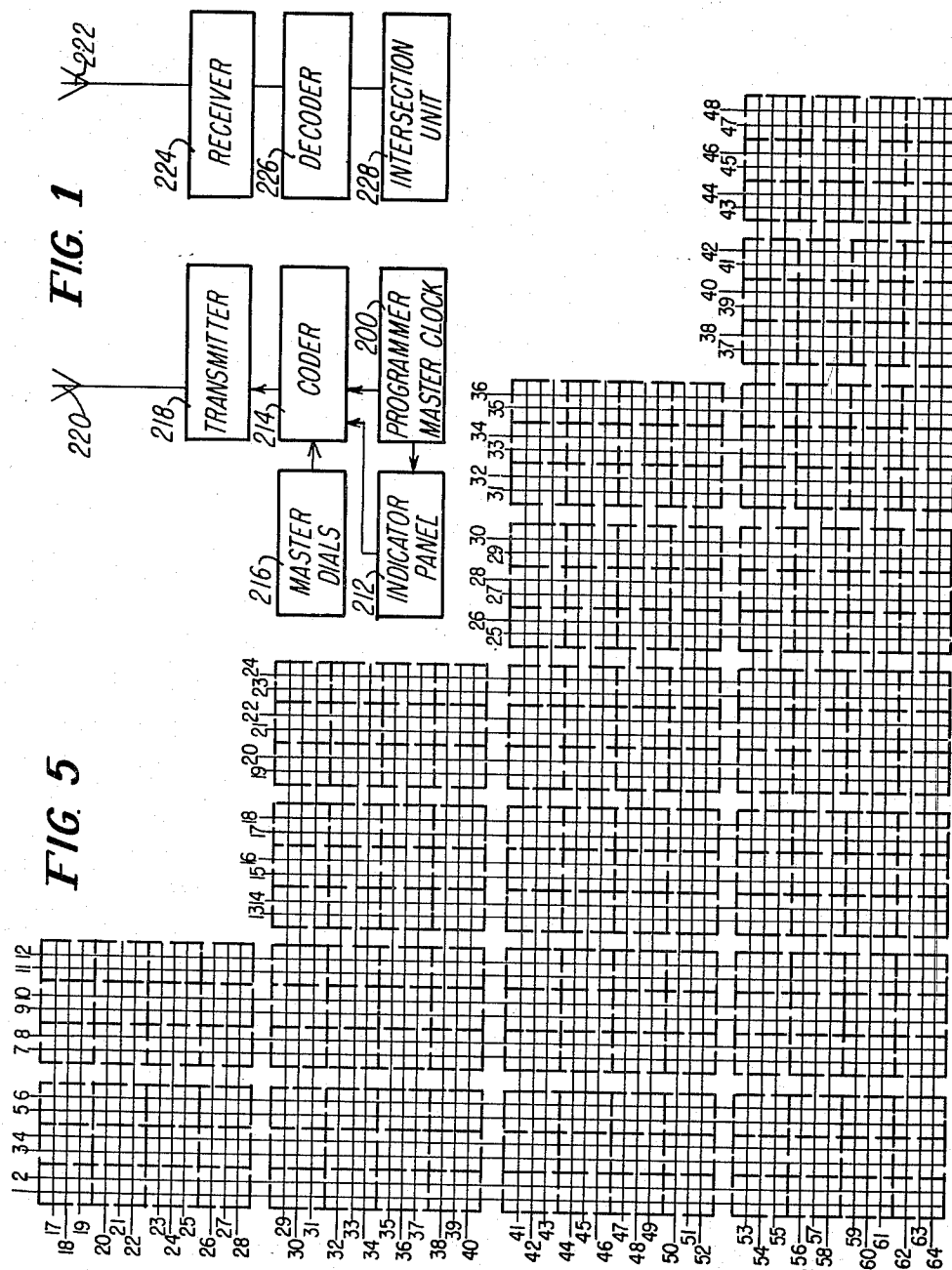
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3,175,183

TRAFFIC SIGNAL CONTROL SYSTEM

Filed Aug. 1, 1960

3 Sheets-Sheet 1



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TRAFFIC SIGNAL CONTROL SYSTEM

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3 Sheets-Sheet 2

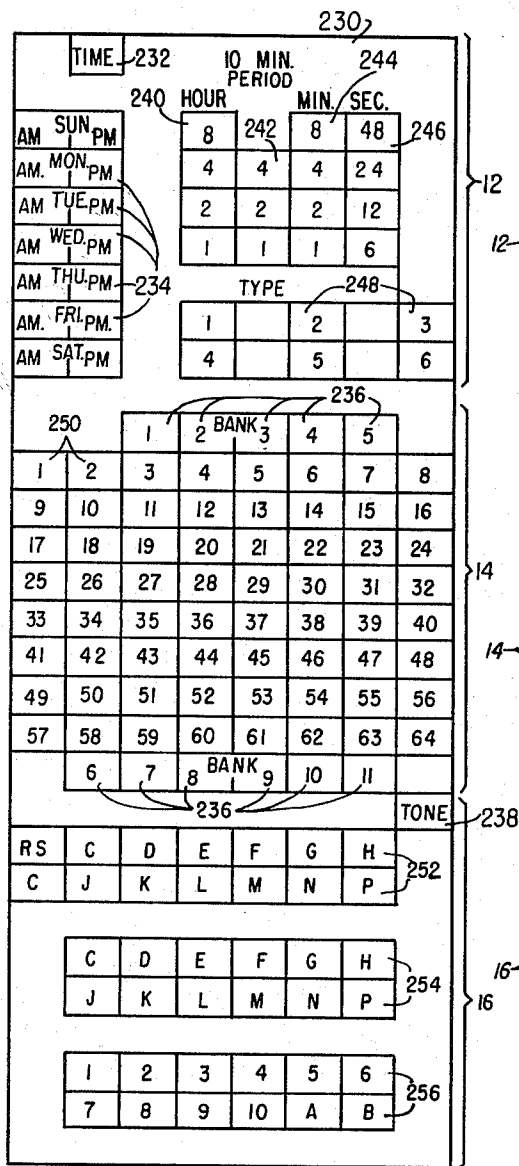


FIG 2

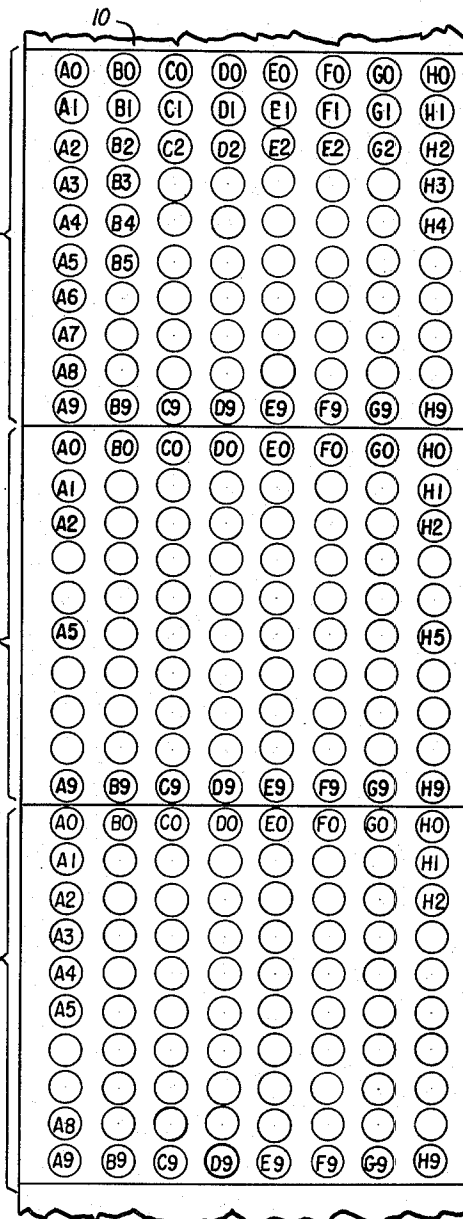


FIG 3

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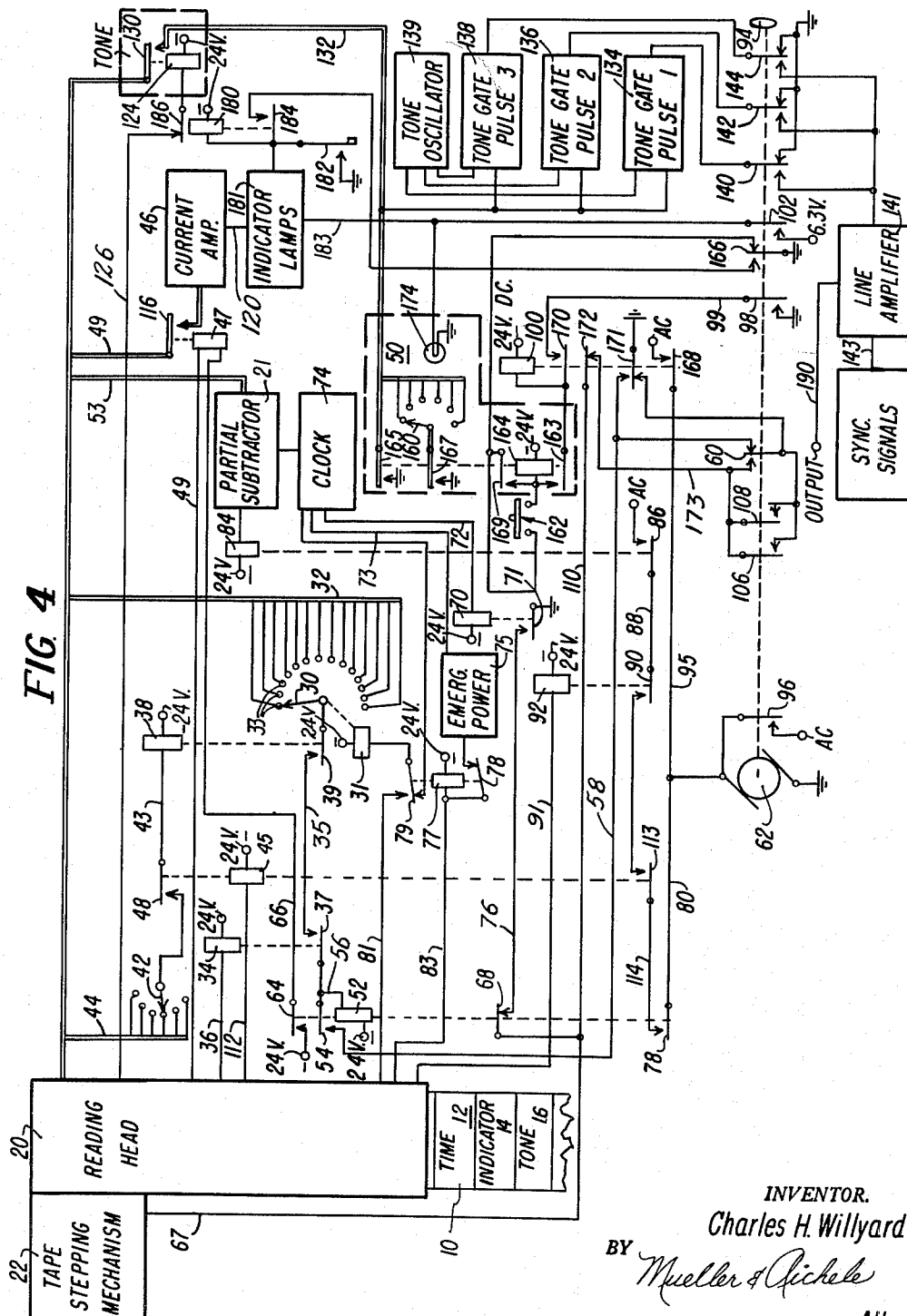
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TRAFFIC SIGNAL CONTROL SYSTEM

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3 Sheets-Sheet 3



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3,175,183

TRAFFIC SIGNAL CONTROL SYSTEM

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Filed Aug. 1, 1960, Ser. No. 46,798

11 Claims. (Cl. 340-41)

This invention relates generally to control apparatus and in particular to a central controller used in a traffic signal system controlled by radio.

Controllers of various kinds have long been used to perform many functions. In traffic signal control systems controllers have been used at a central location for selectively operating traffic signals at various street and highway intersections. The central controller may be used for controlling the transmission of particular program signals to the intersection traffic signals and for maintaining synchronization of the intersection traffic signals with the central controller. Most of the central controllers for traffic signal systems, therefore, have been quite complex and in many instances unreliable. Also, when only one central controller is used to control the traffic signals in a large city, the method and manner in which particular program changes are made has resulted in complex storing and feeding of coded program media which may be in the form of punched tape or cards. Many methods of feeding and sensing the coded program media in the central controllers have not been completely satisfactory. Although complete mechanization and automation of controllers is desirable in many instances, certain problems may also exist when, for example, the normal power supply to the controller is interrupted thereby disrupting program transmission.

Optimum design requirements for controllers used in traffic signal systems demand that the traffic signal system be capable of expansion or modification without major changes to the central controller. Although many traffic signal control systems are connected by wire from the central controller to the various intersection control units, increasing use has been made of radio controlled traffic signal systems and an optimum traffic signal controller should be equally compatible with traffic signal systems using wire, radio, or other communication channels.

Therefore, an object of the present invention is to provide a traffic signal central controller which is relatively simple but highly reliable.

Another object of the present invention is to provide a traffic signal central controller which may be used with various communication channels to control traffic signal lights at a plurality of remote locations.

Still another object of the present invention is to provide a traffic signal central controller which is not disabled completely because of a power outage and which will transmit the programs which were scheduled for transmission during such outage after the normal power supply is restored.

Yet another object of the present invention is to provide a traffic signal central controller which transmits program signals in response to sensing or reading of coded media such as a continuous tape which has various programs coded thereon.

A feature of the invention is the provision of a controller having a plurality of relays which are selectively responsive to sensing means which sense or read a plurality of program frames which are on coded media such as continuous tape.

Another feature of the invention is the provision of a central controller utilizing a program tape which has three separate frames or sections which are used to transmit a particular program.

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Yet another feature of the invention is the provision of a central controller for a traffic signal system wherein signals which perform function changes at selected intersection control units are applied to a line simultaneously with synchronizing signals which maintain synchronization of the traffic signal system.

A still further feature of the invention is the provision of a traffic signal system central controller which transmits function change signals which control selected intersection control units, such function change signals being transmitted at a particular time represented by a master clock in the controller.

In the drawings:

FIG. 1 shows a block diagram of a radio controlled traffic signal system wherein the invention is utilized;

FIG. 2 shows a program coding form of the type which may be utilized in the invention;

FIG. 3 shows a representative program on a continuous tape;

FIG. 4 is a combined schematic and block diagram of a central controller which incorporates the invention; and

FIG. 5 shows the connections to the modules of the indicator.

In practicing the invention, there is provided a central controller used in a traffic signal control system wherein a continuous tape coded with program information is used. Information for each individual program is provided in three frames or sections on the tape and these frames may be called a time frame, an indicator frame, and a tone frame. The central controller reading head senses the holes or perforations in the tape which provides a ground connection through each hole. These ground connections actuate certain circuits and equipment within the controller in accordance with a selected code used while the tape is being programmed. The central controller utilizes a master clock whose time is compared by a partial subtractor or logic circuit with the program timer coded on the time frame of the tape. When clock time is ahead of or coincident with program time, certain relays in the controller are actuated sequentially and the tape is moved or stepped under the reading head to the second frame which is the indicator frame. Information coded on the indicator frame allows selection of an indicator module and an indicator lamp within a particular module thereby allowing visual monitoring of the type of program being transmitted from the controller. The indicator module also provides manual selection of a particular program for transmission and a program on the tape which is ready to be transmitted may also be blocked from transmission by the indicator module. The tape stepping mechanism within the controller then moves the third frame which is the tone or control frame under the reading head where it is sensed. The tone frame has coded thereon information for selecting six tones for transmission which select particular intersection units and case function changes therein to control the traffic signals connected to such intersection units. Simultaneously with the transmission of the function change signals synchronizing signals also are transmitted.

Referring now to the drawings, in FIG. 1 there is shown in block diagram form a traffic signal control system wherein the invention is incorporated. A programmer and master clock 200 are connected to an indicator panel 212 and a coder 214. The indicator panel 212 is also connected to the coder 214 along with master dials 216. Coder 214 is connected to transmitter 218 which is connected to transmitter antenna 220. A receiver antenna 222 receives the transmitted signals and they are applied through receiver 224 to decoder 226. The output of decoder 226 may be connected to a plurality of intersection units similar to unit 228.

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FIG. 2 represents a program coding form 230 which may be utilized in programming a continuous tape used in the controller. The blocks on program coding form 230 correspond to positions of holes which will be punched on the program tape 10 shown in FIG. 3. A program consists of three sections or frames shown in FIGS. 2 and 3. The first frame is the time frame 12, the second frame is the indicator frame 14, and the third frame is the tone or control frame 16. The next program follows on the continuous tape which may include all the programs for the different days of a week. The tape has eighty positions in each frame provided by ten rows along the length of the tape and eight spaces in each row across the width of the tape. Openings in the tape are sensed by a reader head having eighty contacts which provide ground connections through openings in the tape. The same ground connections are used in different circuits when the three different frames for each program are being read.

With reference to FIG. 2, the program coding form may be marked with "x" marks in the blocks corresponding to positions which are to be punched on program tape 10 shown in FIG. 3. As the same positions are used to transmit different information in the three frames for each program, it is necessary to identify the frames by the tape itself. The block 232 in the top row of the frame is punched to designate the time frame. This is the position B0 in the tape of FIG. 3. One of blocks 236 in the top or bottom row of the frame is punched to designate the indicator frame. These are positions C0 to G0 and B9 to G9 in the tape shown on FIG. 3. Block 238 in the top row of the frame is punched to designate the tone frame. This is position H0 on the tape of FIG. 3.

Considering first the time frame, we may assume for purposes of explanation that a program is to be set up which will be transmitted on each weekday at 5:37 in the afternoon. Thus, the time block 232 would be marked and the AM-PM blocks 234 will be marked in the PM blocks for Monday, Tuesday, Wednesday, Thursday and Friday. The hour blocks 240 of the program form will have block number 4 and block number 1 marked to give a total of five hours. The series of blocks 242 to the right of the hour blocks correspond to ten minute periods and blocks 2 and 1 would be marked thereby giving a total of thirty minutes. The next series of blocks 244 correspond to minutes and blocks 4, 2, and 1 would be marked to give a total of seven minutes. The next series of blocks 246 correspond to seconds and for this particular program no blocks need to be marked.

The lower series of blocks 248 of the time frames correspond to the type of program to be transmitted. This is to permit a selection of several different programs at a given time in accordance with different conditions which may be encountered. In this particular instance we may assume that the program being set up is type 4 and, therefore, the block corresponding to number 4 would be marked.

The indicator frame 14 includes, in addition to the blocks 236 which represent the various banks of the indicator, sixty-four blocks 250, two of which may be selectively punched to designate a particular indicator light on a module in the selected bank. These are positions A1 to H8 of the tape and include all the spaces in the second to ninth rows inclusive. Various combinations of two of the sixty-four blocks may be used to selectively energize the indicator lamps of up to two hundred forty modules of a selected bank.

The tone or control frame 16, in addition to including block 238 which identifies this as the tone frame, has two groups of blocks 252 and 254 each of which will be marked to designate a pair of tones, and the two pair of tones from the two blocks form the address portion of the tone code. The group of blocks designated 256 form the function code, and two of the twelve blocks will be selected to provide one of a group of functions. When

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the time frame corresponds to the master clock time so that a program is to be transmitted, and the tape is then stepped to the indicator frame and to the tone frame, two pair of tones will be transmitted in sequence to indicate the address of a particular intersection of the traffic system, and the function tones will then be sent to perform the desired operation at the selected intersection.

After the program coding form has been marked, perforations or holes are made in the corresponding spaces on continuous tape 10. The program coding form 230 shown in FIG. 2 may be placed over tape 10 to provide a pattern for punching the holes therein.

In FIG. 4 there is shown in combined schematic and block diagram form the basic components utilized in the central controller. The controller has been successfully used in conjunction with a traffic signal control system and will be explained in accordance with such system, but the controller may be used in other systems.

Reading head 20 senses all of the frames on tape 10, and the dimensions of the tape and the location of the perforations on the tape are determined by the type of reading head used. A reading head which has been successfully utilized is Model 171A Tape-Ard reader, manufactured by California Technical Industries, 1421 Old County Road, Belmont, California. The perforations in tape are sensed by 80 individual sets of contacts which become grounded when a hole in the punched tape passes between the contact and a grounding plate. Tape reader 20 also contains a tape stepping mechanism 22 which causes the tape to move or step one frame at a time. Each frame of the tape is sensed by the 80 contacts and the various connections from reading head 20 are indicated in FIG. 4.

As previously stated, each program consists of a time frame 12, an indicator frame 14, and a tone or control frame 16, and the different programs are placed on tape 10 in chronological order according to time of transmission. The programs may be intermixed as to program type but all programs which are to be transmitted at a particular time of a certain day are placed in consecutive order on tape 10. The entire length of continuous tape 10 passes through the reading head 20 once during each twenty-four hour period. Thus, the time frame of all of the programs on the tape are sensed by tape reader 20, but only the desired programs will be transmitted. Prior to transmission of a particular program, certain conditions in the controller must be met and in the proper sequence before a particular program is transmitted and certain of these conditions are determined by the first or time frame.

When time frame 12 of tape 10 is under reading head 20, time relay 45 becomes energized through lead 112 from reading head 20. This lead is connected to the contact in reader head which is grounded through the perforation at the position B0 on tape 10 (FIG. 3) which corresponds to block 232 of the form of FIG. 2. This position is not used in any other frame so lead 112 is not connected to any other circuit. Contacts 48 on relay 45 are used to complete a ground path from the program type selector 42 to energize type responder relay 38 through lead 43.

The type of program may be manually selected through switch 42, or this may be accomplished remotely through program type relays. If the program selection corresponds to the program type coded on time frame 12 (FIG. 2) a ground will be obtained through switch 42 and the selected one of the six leads in cable 44 from tape reader 20. The program type may be selected periodically but such selection is usually made at the beginning of each day by the traffic engineer or other personnel depending upon particular conditions to be encountered on that day.

As previously stated, six different types of programs are used. Program type 1 may be a normal program used daily at a specific time and the five remaining types of programs may be used for special applications such as

holidays or Sundays. It should be remembered, however, that the programs are still placed on the tape chronologically according to time for transmission. When a program selection is made only that type of program will be transmitted while other program types will be passed.

Relay 34, called the error relay, if energized will prevent a particular program from being transmitted. In each frame on tape 10, as shown in FIG. 3, error position A9 is punched when an error has been made in punching the tape. In this way, a complete new tape will not have to be used if a punching error occurs. If no known error has been made in punching the tape, position A9 in FIG. 3 is not punched and there is no ground path through lead 36 connected to the reading head 20. Consequently, error relay 34 will not be energized.

A frame check is also provided in the system to prevent operation of the system if the frame is not properly positioned in the reader head. Position H9 of each frame is the frame check position and this is always punched. A ground is provided through the contact at position H9 in the reader head and applied through lead 91 to relay 92. This closes contacts 90 when the frame is in the proper position.

Switch 30 is the twelve hour switch and it is moved to a new contact every twelve hours. The selected contact on switch 30 must correspond to the day, and either AM or PM as recorded on time frame 12 to complete the circuit. Switch 30 has fourteen contacts 33 which correspond to the fourteen half days in each week. When switch 30 is in the position corresponding to the time programmed on time frame 12, a ground is obtained from tape reader 20 through one of the fourteen conductors in line 32. Thus, when the conditions just enumerated have been fulfilled, a ground path may be traced from the tape reader 20 through one lead of cable 32 to the engaged contact of switch 30, through lead 35 and contacts 37 of relay 34, and through contacts 39 of relay 38 and lead 56 to energize the coil of relay 52.

Relay 52 has contacts which perform several operations. Contacts 54 are in a holding circuit for relay 52 and maintain a ground through lead 58 and contacts 60 of the switch controlled by timer motor 62 and through contacts 171 of relay 100. Contacts 64 of relay 52 apply -24 volts through lead 66 to indicator relay 47. However, relay 47 will remain de-energized until a ground is obtained through lead 49 from reader head 20 after indicator frame 14 of tape 10 is under the reader head. Contacts 68 of relay 52 disable the action of relay 70, the one-second relay.

Relay 70 is energized by the binary commutator on the second wheel of master clock 74 through lead 72. Relay 70 will close contacts 71 once each second, and when contacts 68 are closed, this will operate through lead 67 to cause the tape stepping mechanism 22 in the reader to step the tape one frame each second until relay 52 becomes energized thereby breaking the circuit to the tape stepping mechanism.

Partial subtractor circuit 21 is used to initiate transmission of a program when a particular program time of the selected half day equals or is behind master clock time. Fifteen conductors in cable 53 extend from contacts in the reading head 20 to the partial subtractor circuit 21. The selective grounding of these leads indicate a particular time as described in connection with FIG. 2, and this time is compared with the time on the master clock by the subtractor circuit. The subtractor circuit may be in accordance with the disclosure of application of Charles H. Willyard and John C. Reis, Serial No. 36,504, filed June 16, 1960.

If the time on the time frame is ahead of the clock time, but the program corresponds to the type program selected, the relay 52 will operate to stop movement of the tape but the program will not be transmitted until the clock time catches up to the time on the time frame. However, when a condition exists where clock time is ahead of tape time,

or both clock time and program time are coincident, then the partial subtractor 21 will energize relay 84, the A.C. control relay. There is now an alternating current path through contacts 86 of A.C. control relay 84, through contacts 90 of frame check relay 92, through contacts 113 of time relay 45, through lead 114 and contacts 78 of relay 52 and through lead 80 to energize timer motor 62. As motor 62 rotates, camshaft 94 rotates and the cams on the camshaft open and close various contacts. One complete revolution of camshaft 94 takes approximately five seconds and during this period all of the contacts are activated and perform various functions.

Contact 96 maintains alternating current voltage on motor 62 during one complete revolution of camshaft 94. Contact 98 holds manual start relay 100 closed for one complete revolution of camshaft 94, in the event the manual start relay 100 is energized. Contacts 102 energize lamp 174 within an indicator module to indicate that a program is being transmitted. Contacts 60, 108 and 106 apply a ground from contacts 171 of relay 100 through contacts 172 of relay 100 and through lead 110 to tape stepping mechanism 22 in tape reader 20. Contacts 60, 108 and 106 on camshaft 94 are sequenced in such a manner as to close one at a time, thereby actuating tape stepping mechanism 22 which advances the tape 10 one frame at a time.

When the first ground is applied through contacts 60 while the time frame is under the reader 20, indicator frame 14 of tape 10 is moved under reader head 20 by the tape stepping mechanism 22. Time relay 45 is de-energized because no ground is applied through lead 112 since a time frame no longer is under the reader head and position B0 shown in FIG. 3 will not be punched on the indicator frame. The A.C. voltage which was applied through lead 114 from contacts 113 of relay 45 to timer motor 62 is removed. However, alternating current potential is still applied to timer motor 62 through contact 96 of camshaft 94 for a full five second duration which corresponds to one full rotation of the camshaft 94.

After the tape is stepped, one bank of indicator frame 14 is sensed by reading head 20 and a ground is applied through lead 49 to energize relay 47. Although only one relay 47 is shown, if the indicator includes more than one bank (up to 11) there will be a relay corresponding to 47 for each bank. The punching of the indicator frame 14 on the tape is used to select a bank and a particular point in a module of the indicator. The positions C0 to G0 and B9 to G9 on tape 10 in FIG. 3 which select the banks of the indicator by energizing the indicator relay 47 are not used for the time or tone frames of the program. Sixty-four positions in the tape, which form the second to ninth rows, are used to select a particular module. As these positions are also used in the time and tone frames, the connections from the contacts in reader head 20 for these positions provided by cable 49, are switched by contacts 116 of relay 47 to the sixty-four current amplifiers in unit 46. In the event that more than one bank is provided, the relay for each bank will connect the contacts in reader head 20 to current amplifiers for that bank. Two of these positions are punched for each program and the two amplifiers energized thereby will conduct and apply control voltages through leads 120 to specific indicator modules which are associated with the function being performed. In turn, specific indicator lamps within the modules will be turned on or off to indicate which control functions are in operation or which control functions have been selected.

FIG. 5 shows the indicator modules for one bank of the indicator, and shows the connections from the current amplifiers to the controlled elements in the modules. The connections form a matrix with the intersection identifying a particular light in a module. The lines extending down from the top vertically through the mod-

ules are from current amplifiers No. 1 through 48 inclusive. These connections provide a ground in the modules through which they extend, and the current amplifiers provide a path to ground which can handle substantial current. The horizontal lines coming in from the left of the figure are from current amplifiers Nos. 17 to 64 inclusive. When grounds are provided by both the vertical line and the horizontal line at a junction, this point is selected to turn on or off an indicator light. It will be noted that lines from amplifiers 17 through 48 inclusive are provided both in the vertical and horizontal directions through matrix, but horizontal and vertical lines from the same current amplifier do not extend to any one module. Accordingly by selective energization of two of the sixty-four amplifiers the various points in the matrix are selected. The matrix may operate in various different manners to turn on or off lights as particular conductors are grounded.

Meanwhile, timer motor 62 is still causing camshaft 94 to rotate and tape stepping mechanism 22 is activated by contacts 108 to bring the third program frame or tone frame 16 under reading head 20. Position H0 in FIG. 3 is used to actuate tone relay 124 through lead 126 and normally closed contacts 186 of relay 180. The tone frame 16 has information coded thereon for selecting six program tones. There are four address tones and two function tones for a particular program. Two tones are applied as a pulse so that six tones are transmitted as three pulses. Relay 124 has thirty-six contacts which make connections from contacts in the tape reader associated with positions shown by the blocks 252, 254 and 256 of FIG. 2. Six grounds are applied from the tape reader for each program to operate six selector tone gates. For simplicity this operation is represented by contact 130 of relay 124, lead 132, and tone gates 134, 136 and 138 corresponding respectively to pulses 1, 2 and 3. The tone oscillators which supply the various tones are shown in block 139 which is connected to the various tone gates 134, 136 and 138. Only the specific tone gates will be actuated that have been programmed on tone frame 16 of tape 10 as shown in FIG. 3.

Timer motor 62, it will be remembered, is still rotating and the three pulses of two tones in each pulse are applied through contacts 140, 142 and 144 to line amplifier 141. Each pulse from the tone gates has a duration of one second and contacts 140, 142 and 144 on camshaft 94 are sequenced so that the four address tones in pulses 1 and 2 represented by blocks 134 and 136 precede the function tones in pulse 3 represented by block 138. The pulses are passed from line amplifier 141 to output 190. Output 190 may be connected to a radio transmitter or other apparatus which couples the central controller apparatus to remote intersection traffic signal controllers.

Also connected to line amplifier 141 from lead 143 is apparatus for applying synchronizing signals. The operation of the sync signals is explained in the application of Charles H. Willyard, Martin Cooper and Clarence W. Turk, Serial No. 39,675, filed June 29, 1960. The signals from tone gates 134, 136 and 138 and the synchronizing signals are passed simultaneously to output 190.

Timer motor 62 completes its last function through contact 106 again causing the tape stepping mechanism 22 to step the tape and thus remove tone frame 16 from under reading head 20. A time frame should be the next frame on tape 10 but if it is not a time frame, possibly a blank frame, or is a time frame of a program of a different type, relay 52 will become deenergized through type responder relay 38. Relay 38 cannot be energized unless relay 45 is energized as the circuit for relay 38 extends through contacts 48 and selector 42. The one-second relay 70 will then cause the tape stepping mechanism 22 to step the tape 10 through contacts 68 of

relay 52, and lead 67. One frame of tape 10 is stepped each second until a time frame of the proper program type and having a program time ahead or equal to the time on master clock 74 comes under reader head 20. When the half day indicated on the tape and the program type is the one to be used, relay 52 is again energized and the tape stepping action of one-second relay 70 is disabled through the opening of contacts 68 of relays 52 which connect through lead 76 to contacts 71 of relay 70. When program time on the time frame is ahead of, or coincident with master clock time, relay 34 is energized to start timer 62 and a program will be transmitted as explained previously.

The central controller also provides a feature for preventing complete disabling if the normal power supply of 115 volts is interrupted or if the voltage drops to 100 volts or less. It is imperative that a voltage be maintained which is adequate to insure proper operation of master clock 74. The alternating current power line which is connected to the master clock motor is monitored by a microammeter having a pair of contacts set at a position equivalent to approximately 100 volts A.C. If the line voltage to the master clock 74 decreases to approximately 100 volts, the contacts in the microammeter will close. Emergency power circuit 75 is used for maintaining limited control over the central control apparatus through several battery cells in power supply 75. The direct current voltage of the battery cells is changed to 60 cycle alternating current voltage which is applied through lead 73 to master clock 74 thereby keeping clock 74 in operative condition.

Under normal operating conditions, contacts 79 of twelve-hour relay 77 receive a ground from the hour commutator of master clock 74 to energize motor 31 and step switch 30 to the next position. However, energizing voltage for relay 77 is interlocked through the emergency power supply 75 and whenever the input voltage drops to 100 volts or less, relay 77 will be deenergized. Relay 77 will then not pass the ground obtained from clock 74 through contact 79 to motor 31. Relay 77 remains deenergized even after the normal power supply is restored as contacts 78 thereof are open, thereby insuring that motor 31 does not move switch 30 to a new position until all of the programs on the tape are transmitted which were scheduled for transmission during time when relay 77 was deenergized. A special program called the 12-hour program is programmed on tape 10 and transmitted at noon and midnight of each day to reset relay 77 if it is deenergized. The resetting is accomplished through a ground from a contact on time frame 12 through lead 81 and contacts 79 (now closed in the upper position) to motor 31 to thereby cause switch 30 to move to its next position. A ground will then be obtained from tone frame 16 of the special 12-hour program and the ground will be applied through lead 83 to energize relay 77. This will close contacts 78 so the relay will remain energized. Thus, all of the programs which follow the special 12-hour program will be in agreement with the contact position of switch 30 and the programs will be transmitted in proper sequence.

The operation of the indicator modules will now be explained in conjunction with module 50 which is representative of all modules. Each indicator module accomplishes three operations, the first of which is to visually indicate the program being transmitted. When a program change is initiated a light within a chosen module is turned on or off through the matrix illustrated on FIG. 5 to indicate the particular function changes of the program being transmitted.

A second operation of the indicator module allows program selection and transmission to be achieved manually, without advancing tape 10 through tape reader 20. Selector switch 150 in module 50 is set to one of the program selection positions available for this module. When the start button 162 is manually closed, relay 164

is energized through contact 166 on cam shaft 94 which is closed no program is being transmitted. Contacts 169 of relay 164 complete a holding circuit therefor. When relay 164 is energized, manual start relay 100 is energized through closed contacts 163 of relay 164. Contact 168 of relay 100 applies alternating current voltage to time motor 62 through lead 95 thereby causing rotation of camshaft 94. Contact 98 on camshaft 94 applies a ground through contact 170 of relay 100 thereby keeping relay 100 energized. Contact 172 of relay 100 opens lead 110 to tape stepping mechanism 22 thereby preventing the tape from being stepped by the camshaft 94 through lead 173.

Relay 164 in indicator module 50 applies six grounds to six selector tone gates through representative contacts 165 and 167. The tone gating is similar to the operation described for normal program transmission. The selector tones are passed to line amplifier 141 after having been pulsed by the contacts 140, 142 and 144 of the camshaft 94 in a manner similar to conventional program transmission.

Contacts 102 of camshaft 94 complete an A.C. path of 6.3 volts to wait lamp 174 in module 50. The indicator lamps in block 181 are similar to lamp 174 and are associated with modules which are related to a particular function. Lead 183 connects lamps 181 to camshaft contact 102. Lamp 174 remains lighted as long as timer camshaft 94 is rotating thereby indicating that a program is being transmitted. When lamp 174 is lighted, the operator will be warned not to attempt to transmit another program until the program being transmitted has been completed.

After camshaft 94 has completed its cycle of one rotation, contact 166 opens the ground path to the coil of relay 164 deenergizing the same. Contact 98 on camshaft 94 is also opened and relay 100 is deenergized through opening of contacts 170 connected to the coil of relay 100. Timer motor 62 is deenergized as contact 168 of deenergized relay 100 opens. Wait lamp 174 is also extinguished by the opening of contacts 102 on camshaft 94 when time motor 62 is deenergized. Thus, manual operation of indicator module 50 through selection of a program type and energization of relay 164 allows individual programs to be transmitted without stepping the program type 10 and in this manner, the program sequence is not disrupted.

The third function which may be accomplished through the indicator modules is the blocking of transmission of a program on the tape and this is accomplished through block relay 180. When blocking switch 182 is closed manually a ground is provided to energize relay 180. Relay 180 remains energized through contact 184 and contact 166 of camshaft 94 if motor 62 is energized. Contact 186 of relay 180 is in series with the coil of tone relay 124 and when relay 180 is energized, contact 186 is opened thereby preventing energizing of tone relay 124 through a ground from the reading head 20. Consequently, as tone frame 16 appears under the reading head 20, no tones will be passed since relay 124 is deenergized and contacts 130 remain open. Thus a ground will not be applied through tone relay 124 to the tone gates. However, the remainder of the circuit in the central controller continues to operate as though a complete program had just been transmitted with camshaft 94 advancing the tape as in normal program transmission and another program will be transmitted in accordance with the previous description of operation.

Thus, the invention provides for a traffic signal central controller which transmits simultaneously synchronization and function change signals. The function change signals to be transmitted are selected from a program tape which has three frames for each program, each frame actuating specific circuitry within the controller preparatory to transmission of function change signals which are selected by coded information on the third frame

of the program tape. The frames are sensed by a single reader head and connections therefrom are applied to different circuits for the three different frames. The central controller also includes an indicator having modules which provide for visual indication of the various programs being transmitted. Manual transmission of a particular program, and blocking of a program scheduled for transmission can be accomplished through the indicator without complete disruption of normal controller operation. The central controller is reliable, relatively simple, and additional intersection traffic signal controllers may be added to the traffic signal system with a minimum amount of additional equipment at the central control point.

I claim:

1. A central controller for a traffic signal system, including in combination, tape reader means for operation with a continuous tape having a plurality of particular programs coded thereon, each having a time frame, an indicator frame, and a control frame, and each of said frames including at least one position peculiar thereto and not used in the other frames, said reader means including sensing means for responding to the coded program information on each frame of the tape, time comparing means, indicator means, and signal transmission means, and control means causing operation of said tape reader means to sense a time frame of the tape, said sensing means applying information derived from said time frame to said control means and said time comparing means, said control means responding to the sensing of a position peculiar to the time frame to cause operation of said time comparing means, said time comparing means responding when the time indicated on the time frame corresponds to or is ahead of actual time to operate said control means to cause said reader to sense in turn the indicator and control frames for the same program, said control means responding to the sensing of a position peculiar to the indicator frame to apply signals from said sensing means produced by the indicator frame to said indicator means for controlling the same, said control means responding to the sensing of a position peculiar to the control frame to apply signals from said sensing means derived from the control frame to said signal transmission means for transmitting signals to provide the traffic signal changes programmed on said tape.

2. In a signal system, a central controller for operation by a continuous tape having a plurality of programs coded thereon, and with each of the programs having a time frame, an indicator frame, and a tone frame, said controller including tape reader means for positioning and sensing the tape, control means coupled to said reader means and responsive to signals therefrom, clock means, relay means coupled to said control means, indicator means for designating the program coded on the tape, oscillator means for generating a plurality of low frequency tone signals, output means, gate means coupling said oscillator means to said output means, said reader means applying signals derived from the time frame to said control means to cause operation of said relay means when the time frame is sensed by said reader means, said relay means applying signals from said reader means to said clock means to compare the time representation on said time frame with the time representation of said clock means, said clock means operating when the time representations have a predetermined relation to actuate said control means, said control means causing said tape reader means to step the tape to the indicator frame thereof, said reader means applying signals derived from the indicator frame of the tape to said indicating means to provide an indication of the program on the tape, and said control means then causing said reader means to step the tape to the tone frame thereof, said reader means applying signals derived from the tone frame of the tape to said gate means for applying combinations of particular tones from said oscillator means to said output means to form

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a composite output signal having an address portion and a control function portion.

3. A traffic signal control system including a central controller for controlling a plurality of traffic signal control units located at intersections remote from said central controller, said system including in combination sensing means responsive to continuous program media having coded program representations thereon, each of said program representations having a plurality of frames, timer means coupled to said sensing means, output means, function signal means, synchronizing signal means, first circuit means including said timer means for selectively coupling said function signal means to said output means, second circuit means coupling said synchronizing signal means to said output means, said sensing means decoding the frames representing a particular program on the program media in sequential order and controlling said timer means to selectively apply particular function signals from said function signal means through said first circuit means to said output means according to the particular program on the program media, said synchronizing signal means continuously applying synchronizing signals through said second circuit means to said output means simultaneously with said function signals applied thereto for transmission to said plurality of traffic signal controllers.

4. Central control apparatus for a traffic signal system, said apparatus including tape reader means for operation by a continuous coded program tape including a time frame, subtractor circuit means including a clock, signal means, output means, said tape reader means sensing the time frame of said tape and applying time signals from said tape to said subtractor circuit for comparison therein with the time on said clock, relay means coupled to said subtractor circuit means and operated thereby when the clock time is ahead of or coincident to the time indicated on said tape, timer means coupled to said relay means and actuated thereby, said timer means coupling said signal means to said output means and selectively applying signals from said signal means to said output means.

5. A central controller for a traffic signal system, said controller including tape sensing means for receiving a continuous tape coded with a plurality of particular programs each having a time frame, an indicator frame and a tone frame, time control means, indicator means, and signal transmission means, said sensing means reading each of said frames in sequential order, said sensing means applying the derived information from said time frame to said time control means to determine that a particular program will be transmitted at the proper time, said sensing means applying the derived information from said indicator frame to said indicator means to actuate the same, and said sensing means applying information from said tone frame to said signal transmission means to control the transmission of signals in accordance with the desired traffic signal changes.

6. A central controller responsive to a continuous tape coded with a plurality of particular programs each having a time frame, an indicator frame and a tone frame, said controller including tape sensing means for receiving the tape, time comparison and control means, indicator means, and signal transmission means, said sensing means reading said frames of each of said programs in sequential order, said sensing means first applying the derived information from said time frame to said time comparison and control means for determining that each of said programs will be transmitted at the proper time, said sensing means secondly applying the derived information from said indicator frame to said indicator means for actuating the same, said sensing means thirdly applying the derived information from said tone frame to said signal transmission means for transmitting signals in accordance with the program coded on the tape.

7. A controller responsive to a continuous tape coded with a plurality of particular programs each having a

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time frame, an indicator frame and a tone frame, said controller including tape sensing means for receiving the tape and deriving information therefrom, time comparison and control means, indicator means, and signal transmission means, said sensing means reading said frames of each of said programs in sequential order, said sensing means first applying signals derived from said time frame to said time control means for determining that a particular program will be transmitted at the proper time, said sensing means secondly applying signals derived from said indicator frame to said indicator means for actuating the same, said sensing means thirdly applying signals derived from said tone frame to said signal transmission means for transmitting signals in accordance with the program coded on the tape, said indicator means including control means coupled to said signal transmission means and for operating the same to transmit signals to provide desired programs.

8. A controller responsive to a continuous tape coded with a plurality of programs each having a time frame, an indicator frame and a tone frame, said controller including tape sensing means for and reading the tape, time control means, indicator means, and signal transmission means, said sensing means reading each of said program frames in sequential order, said sensing means and applying information derived from said time frame to said time control means for determining that a particular program will be transmitted at the proper time, said sensing means applying information derived from said indicator frame to said indicator means for actuating the same, said sensing means applying information derived from said tone frame to said signal transmission means for transmitting tone signals in accordance with the program coded on the tape, said signal transmission means including gate means for selecting the particular tone signals to be transmitted, said indicator means including means coupled to said gate means of said signal transmission means for operating the same to select the particular tone signals to be transmitted to provide desired programs.

9. In a signal system, a central controller for operation by a continuous tape having a plurality of programs coded thereon, and with each of the programs having a time frame, an indicator frame, and a tone frame, each of the frames having a position for indicating an error in the coded information contained therein, said controller including tape reader means for positioning and sensing the tape, control means coupled to said reader means and responsive to signals therefrom, clock means, relay means coupled to said control means, indicator means for designating the program coded on the tape, oscillator means for generating a plurality of low frequency tone signals, output means, gate means coupling said oscillator means to said output means, said reader means providing signals derived from the time frame to said control means, said control means including means responsive to a signal derived from the error position on the frame to cause the tape to be stepped to the next program, said control means causing operation of said relay means in the absence of an error signal when the time frame is sensed by said reader means, said relay means applying signals from said reader means to said clock means to compare the time representation on the time frame with the time representation of said clock means, said clock means operating when the time representations have a predetermined relation to actuate said control means, said control means causing said tape reader means to step the tape to the indicator frame, said reader means applying signals derived from the indicator frame of the tape to said indicating means to provide an indication of the program on the tape, and said control means then causing said reader means to step the tape to the tone frame, said reader means applying signals derived from the tone frame of the tape to said gate means for applying combinations of particular tones from said oscillator means to said output

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means to form a composite output signal having an address portion and a control portion.

10. In a signal system, a central controller for operation by a continuous tape having a plurality of programs coded thereon, and with each of the programs having a time frame, an indicator frame, and a tone frame, each of the frames having a reference position, said controller including tape reader means for positioning and sensing the tape, control means coupled to said reader means and responsive to signals therefrom, clock means, relay means coupled to said control means, indicator means for designating the program coded on the tape, oscillator means for generating a plurality of low frequency tone signals, output means, gate means coupling said oscillator means to said output means, said reader means providing signals derived from the time frame to said control means, said control means including means responsive to a signal from said reader means when the reference position on the frame is properly positioned in said reader means to cause operation of said relay means, said relay means applying signals from said reader means in response to the time frame to said clock means to compare the time representation on the time frame with the time representation of said clock means, said clock means operating when the time representations have a predetermined relation to actuate said control means, said control means causing said tape reader means to step the tape to the indicator frame, said reader means applying signals derived from the indicator frame of the tape to said indicating means to provide an indication of the program on the tape, and said control means then causing said reader means to step the tape to the tone frame, said reader means applying signals derived from the tone frame of the tape to said gate means for applying combinations of particular tones from said oscillator means to said output means to form a composite output signal having an address portion and a control portion.

11. A control system including a central controller for

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controlling a plurality of remote units, said controller including sensing means for receiving program storage means coded with a plurality of particular programs each having a time frame, an indicator frame and a tone frame, time control means, indicator means, and signal transmission means, said sensing means reading each of said frames in sequential order, said sensing means applying the derived information from said time frame to said time control means to determine that a particular program will be transmitted at the proper time, said sensing means applying the derived information from said indicator frame to said indicator means to actuate the same, and said sensing means applying information from said tone frame to said signal transmission means to control the transmission of signals to said remote units in accordance with programs coded on the storage means.

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NEIL C. READ, *Primary Examiner*.

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