United States Patent

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[54] CENTRAL TRAFFIC SIGNAL CONTROL

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[52] **U.S. Cl.** **340/40**

[51] **Int. Cl.** **G08g 1/07**

[58] **Field of Search** 340/40–42, 160, 340/163, 172

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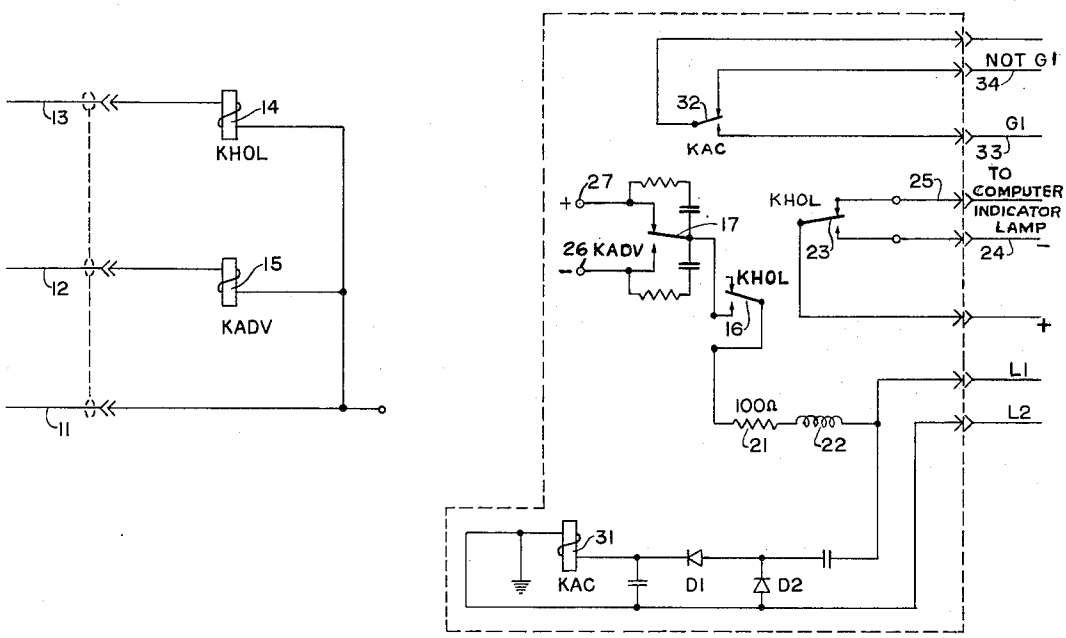
[57] **ABSTRACT**

Two lines interconnect a central traffic signal control station with a local control station. The two lines carry signals from the central station to the local station that determines whether the local station is under local or central control. When on central control, the two lines carry signals that cause the traffic signal at the local station to advance to the next condition. In addition, the two lines carry signals from the local station to the central station indicative of a predetermined condition, such as the main thoroughfare signal being green so that s shift from local control to central control may be effected without interrupting the smooth flow of traffic during the changeover.

16 Claims, 4 Drawing Figures



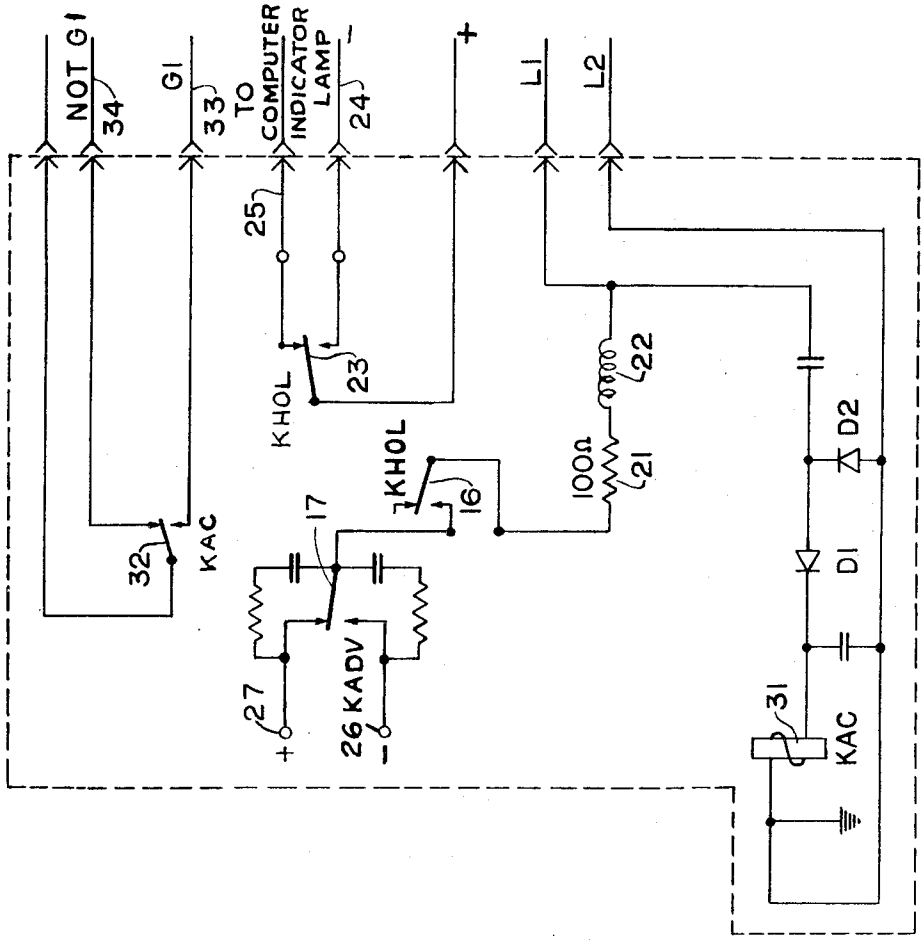
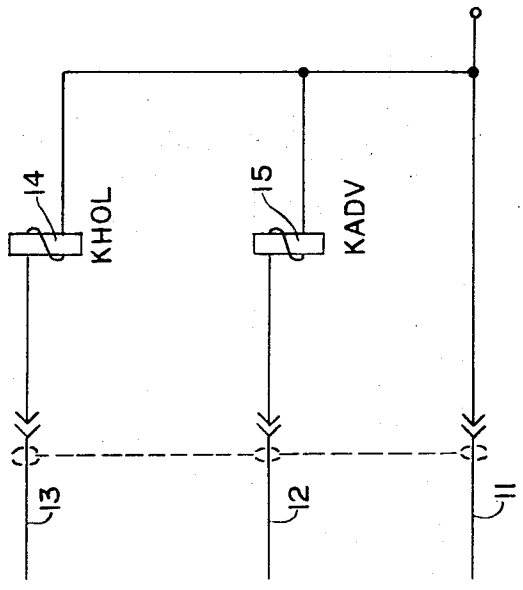


FIG. 1



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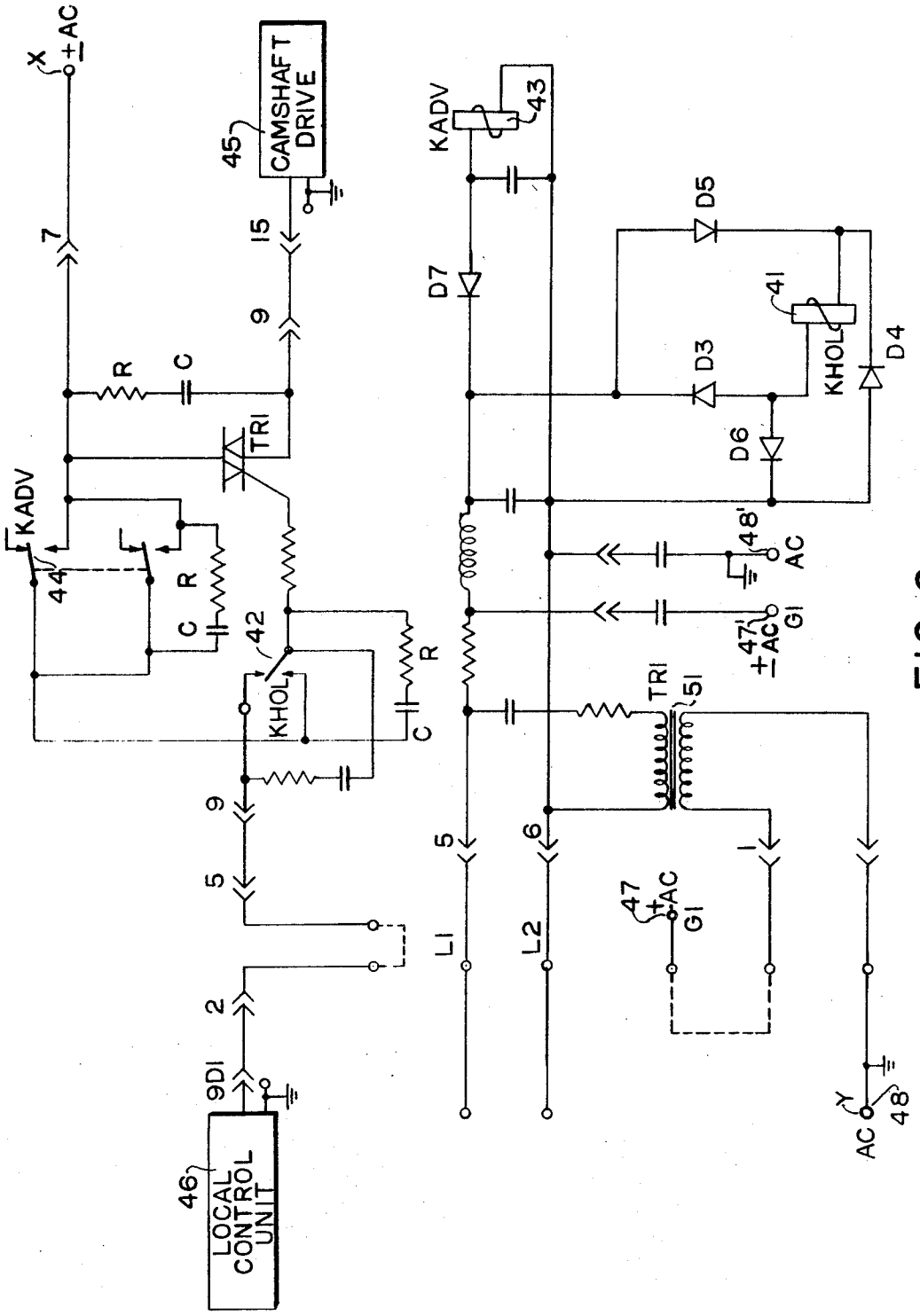

FIG. 2

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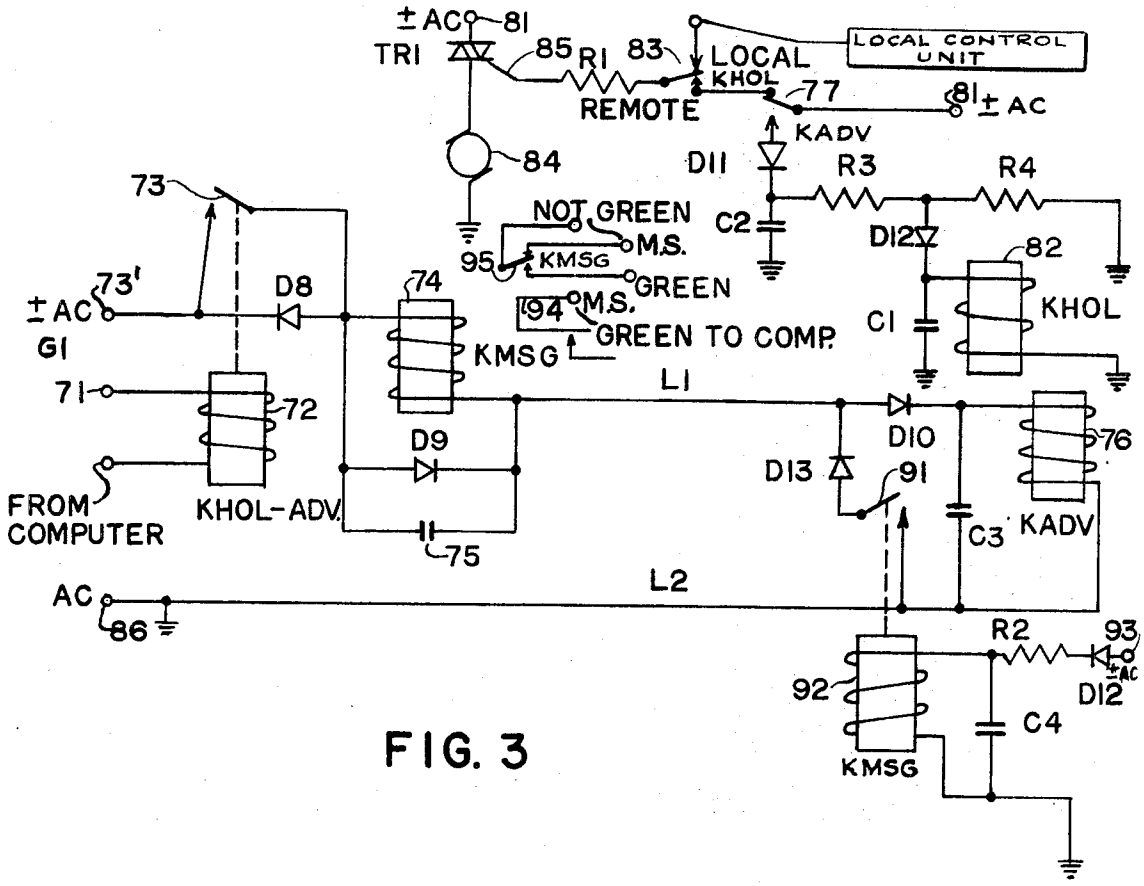

FIG. 3

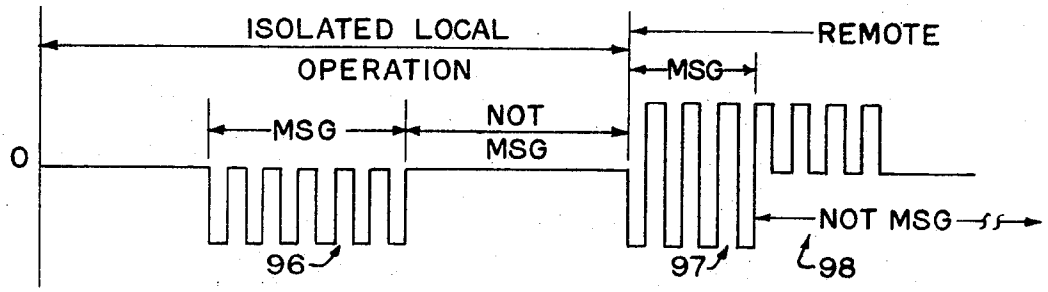

FIG. 4

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CENTRAL TRAFFIC SIGNAL CONTROL

BACKGROUND OF THE INVENTION

The present invention relates in general to the control of local traffic signals from a central location and more particularly concerns a novel system for effecting such control over but two ordinary telephone wires that convey information directing changeover between central and local control, advancing to the next traffic signal condition upon direction from central control and information from the local station to the central station on the occurrence of a predetermined condition, such as the main thoroughfare signal being green. These features are embodied in reliably operating apparatus that is relatively inexpensive.

It has long been recognized that the flow of traffic may be improved by logically coordinating the traffic control conditions along a network of thoroughfares. An old approach involved synchronization with power lines to change the traffic signals along a thoroughfare so that a vehicle traveling at a predetermined constant speed need never stop. The fundamental difficulty with this system is that it is difficult for the vehicles to maintain this speed under condition of heavy traffic flow when coordination of traffic signals along a network of thoroughfares is most desirable. Accordingly, a more recent approach involves central control of a number of local traffic signals at intersections of the network of thoroughfares. Typically, central control is exercised by a computer that determines what the condition at each controlled intersection should be to maintain optimum traffic flow at a given time. Yet, during periods of low traffic or when computer control fails, it is desirable to allow the traffic signals to function under local control. Typically, such control is accomplished over more than two-wire lines or if two-wire lines are used, the flow of information is in one direction only and may involve the use of relatively costly transmission lines.

Accordingly, it is an important object of this invention to provide methods and means for establishing communication and control between central and local control stations of a traffic signal system over two-wire lines.

It is another object of the invention to achieve the preceding object reliably over relatively poor quality lines.

It is a further object of the invention to achieve the preceding objects with equipment that is relatively low in cost.

SUMMARY OF THE INVENTION

According to the invention, there is a two-wire transmission line intercoupling a central control station and a local traffic signal control station. Polarized signals transmitted from the central to the local station select local or central control and initiate a change in signal condition at the local control station when under control of the central station. The two wires also may carry information from the local station representative of a predetermined condition, such as the main thoroughfare signal having turned green.

Preferably information is transmitted by controlling the polarity. A feature of the invention resides in using a signal of the same polarity to both select control from central and to advance the local signal to the next selected condition. This result is accomplished by memory means at the local station, such as a delay relay, for maintaining the local station in condition to receive control signals from the central station designating a change in the signalled condition for a predetermined time interval longer than the occurrence of changes in such conditions.

Another feature of the invention resides in control means comprising a triac for controlling a traffic signal control cam.

Numerous other features, objects and advantages of the invention will become apparent from the following specification when read in connection with the accompanying drawing in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a combined block-schematic circuit diagram of a typical central station control system according to one embodiment of the invention;

FIG. 2 is a combined block-schematic circuit diagram of a typical local station according to the invention for association with the central station of FIG. 1;

FIG. 3 is a combined block-schematic circuit diagram of another embodiment of the invention showing both central and local stations; and

FIG. 4 illustrates ths signal waveforms between lines L1 and L2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference now to the drawing and more particularly FIG. 1 thereof, there is shown a combined block-schematic circuit diagram of a typical central station control according to the invention. There is a common line **11**, an advance line **12** for receiving advancing signals and a hold line **13** for receiving signals to select remote control. Lines **11**, **12**, and **13** may be connected to a computer or manually controlled system at the central station. The particular computer or other means for providing the various control signals is not a part of this invention and is not discussed.

Energization of hold line **13** operates hold relay KHOL **14** to provide appropriate signals carried by lines L1 and L2, an ordinary telephone pair, informing the local station of selection of central control. Lines L1 and L2 also carry appropriate signals from the local station indicative of a condition at the local station useful in exercising control of the local station from the central station. A signal on advance line **12** operates advance relay KADV **15** to provide appropriate signals on lines L1 and L2 for advancing the local controller.

When hold relay **14** is energized, its normally open contacts **16** close, thereby connecting advance contact arm **17** to line L1 through resistor **21** and AC blocking choke **22** while moving arm **23** to provide an energizing potential on remote line **24** that lights an appropriate map light at central control to indicate that the designated local station has switched from local to remote as the local line **25** is de-energized. The signals on lines **24** and **25** might also go to a central computer to signal the central computer that the select remote command had been executed.

When relay **14** is energized, advance relay **15**, when energized, selects the negative potential from terminal **26** for transmission over line L1 while when de-energized, it selects the positive potential from terminal **27**. Thus, the presence of a positive or negative DC potential on line L1 signifies selection of remote operation. Each time it is desired to cause a change in the indication at the local station, advance relay **15** is energized with the signal on advance line **12**.

Telephone lines L1 and L2 also transmit information from the local station to the remote station. Thus, ordinarily it is desired to shift between local and remote operation smoothly, such as with the occurrence predetermined condition of green on the main thoroughfare. The occurrence of this condition at the local station may be signified by transmitting a low frequency AC signal on lines L1 and L2 that is blocked by blocking inductor **22** but rectified to operate the AC relay KAC **31**, diodes D1 and D2 comprising a voltage doubler circuit. Energization of relay **31** switches arm **32** of the relay contacts to indicate a signal on line **33** that the main thoroughfare is green. This indication is typically indicated as G1. Arm **32** delivers a potential on line **34** indicating not G1 at other times. These indications may control map lights in the manner described above and/or signal the central station computer that the time may be appropriate for switching.

Referring to FIG. 2, there is a combined block-schematic circuit diagram of a typical local station according to the invention for association with the central station of FIG. 1. Whenever there is a DC potential on line L1 the local hold

relay 41 remains energized regardless of the polarity, diodes D3 and D4 passing the negative potential while diodes D4 and D6 transmit the positive potential. With holding relay 41 energized, its arm 42 is moved to the remote position so that advancing signals will occur upon each actuation of local advance relay KADV 43. Diode D7 passes each negative advance signal to pulse KADV advance relay 43 and intermittently close normally open contacts 44 so that triac TR1 may transmit energy to local camshaft drive 45 to cause a change in the indicated traffic flow condition. Arm 42 of the local holding relay KHOL 41 is connected to the local position as indicated when relay 41 is de-energized. Then local control unit 46 transmits control signals to determine when local camshaft drive 45 changes an indicated traffic condition. Since traffic signal sequencing controls are well known in the art, they will not be described in detail here.

The use of a triac comprising means for controlling local camshaft drive 45 is advantageous. Such a device is reliable, relatively economical and responds to a relatively low level control signal for delivering and interrupting higher power driving currents.

G1 terminal 47 provides AC+ signal when the main thoroughfare signal is green. Transformer 51 then receives an AC signal that is applied across lines L1 and L2 that activates KAC relay 31 (FIG. 1) in the manner described above. Alternately, the G1 signal may be capacitively coupled across lines L1 and L2 as indicated in the coupling arrangement from a G1 terminal 47′ and an AC terminal 48′. It is convenient to refer to the normally ungrounded AC terminal as ± AC and the other AC terminal as the grounded terminal.

Referring to FIG. 3, there is shown a combined block-schematic circuit diagram of still another embodiment of the invention. In this embodiment of the invention the central station selects remote operation by applying a signal to terminal 71 that performs both the selection of remote and the advance function. That is to say, the KHOL–ADV central hold and advance relay 72 performs the functions of both relays 14 and 15 in FIG. 1. When relay 72 is de-energized, the 15 Hz signal on AC terminal 73′ provides a signal that is rectified by diode D8 to produce negative pulses that are passed by diode D9. When relay 72 is energized to select remote operation, normally open contacts 73 are closed to short diode D8 and pass AC energy. Positive pulses bypass KMSG relay 74 through diode D9 , relay 74 being operated only to indicate that the main street is green in a manner to be described below when contacts 91 are closed. With diode D8 bypassed the positive pulses of the AC energy between lines L1 and L2 is rectified by diode D10 to operate the local KADV relay 76, but open contacts 91 block the flow of negative pulses. With local advance relay 76 energized arm 77 couples AC energy from AC± terminal 81 through diode D11 and diode D12 to operate the local hold relay KHOL 82. Relay 82 has the property of coming on fast but turning off slowly after a predetermined number of seconds T_D for reasons to be discussed below in explaining how the relay 72 may function both for selecting remote operation and signifying an advance. When local holding relay 82 operates, it draws its arm 83 from the local contact to the remote contact so that local drum drive 84 may be operated upon actuation of triac TR1. It will be recalled that arm 77 is in such a position as to open the path between AC± terminal 81 and the gate electrode 85 of triac TR1. If, however, local advance relay 76 is de-energized for a period less than the interval T_D, arm 77 may transmit AC energy to gate 85 of triac TR1 to actuate a change in the local condition while local holding relay 82 will remain in the operate position keeping arm 83 connected to the remote contact.

We turn now to a consideration of how this short de-energization of local advance relay 76 occurs. When it is desired to advance the traffic condition at the local station, the holding signal on terminal 71 at the central station is removed for an interval less than the period T_D, thereby opening contacts 73 and allowing diode D8 to rectify the AC from terminal 73 so as to provide only negative pulses that are blocked by diode D10 so that relay 76 is de-energized for this short time interval less than T_D to allow arm 77 to move to the position indicated and transmit energy from terminal 81 to gate 85 of triac TR1 as indicated above. Relay 74 will not operate because the path to AC terminal 86, to which L2 is connected, is blocked by diode D10 and by the open contacts 91 of de-energized relay KMSG 92, operated only when the main street is green. Then a potential on terminal 93 is rectified by diode D13 to operate relay contact 91 and allow negative current pulses to flow through relay 74 and operate it to close computer contacts 94 and map light contacts 95, thereby indicating to the computer that that local main street is now green and providing a visual indication on a map light at the central location. Thus, only two lines carry both control information from the central station to the local station and information on the condition at the local station back to the central station.

Referring to FIG. 4, there is shown signal waveforms between lines L1 and L2 as a function of time helpful in understanding system operation. During the period in which there is isolated local operation, there is no signal between lines L1 and L2 except when the main street is green. Then, the negative going half-cycles 96 occur. When it is desired to shift from local to remote, the central station responds to an indication that the main street is green by causing a signal to appear on terminal 71 that operates relay 72 to provide the bipolar waveform 97 for the remainder of that interval and thereafter providing the positive half-cycles 98 that keep relay 76 operated until the next advance is desired.

There have been described embodiments of the invention which facilitate using but one pair of low grade telephone wires between a central location and each local control station that both transmits control information to the local station from the central station and transmits condition indicating information from the local station to the central station. The systems are reliable, relatively inexpensive to fabricate and especially convenient for use with computer controlled traffic signal systems. It is evident that those skilled in the art may now make numerous uses and modifications of and departures from the specific embodiments described herein without departing from the inventive concepts. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of features present in or possessed by the apparatus and techniques herein disclosed and limited solely by the spirit and scope of the appended claims.

What is claimed is:

1. Traffic signal control apparatus comprising,

means defining a local control station,

said local control station having local traffic signal control means for establishing a predetermined sequence of traffic flow, means for providing a predetermined condition signal representative of a predetermined traffic flow condition and means responsive to select signals from a central location for selectively establishing said local traffic signal control means under local control at said local control station or under central control from said central location in response to advance signals from said central location, and first and second input terminals for receiving therebetween said select signals and said advance signals and for transmitting said predetermined condition signal and having only two relays for responding to said advance and select signals,

one of said two relays being a hold relay and the other being an advance relay,

whereby a two-wire transmission line may be connected to said first and second input terminals and exchange said advance signals, said predetermined condition signal, and said select signals between said local control station and said central location and control operation of said hold relay to establish said local and central control and control operation of said advance relay in response to each advance signal,

said local control station having means for coupling said predetermined condition signal to said first and second

input terminals and means for coupling said select and advance signals from said first and second input terminals.

2. Traffic signal control apparatus in accordance with claim 1 wherein said local control station further comprises a full-wave rectifier coupled to said first and second input terminals and said hold relay for keeping said hold relay energized in response to a potential between said first and second input terminals independently of polarity.

3. Traffic signal control apparatus in accordance with claim 2 and further comprising,

means defining a central control station at said central location having means for providing said select signals and said advance signals, means responsive to said initial condition signal, and first and second input terminals for receiving therebetween said predetermined condition signal and for transmitting said select signals and said advance signals,

a two-wire transmission line intercoupling the central control station first and second input terminals with the local control station first and second input terminals,

sources of positive and negative DC potentials at said central control station,

means including a choke for coupling said DC potentials across said input terminals as a select central location control signal,

and means for selectively reversing the polarity across said first and second input terminals to provide said advance signals.

4. Traffic signal control apparatus in accordance with claim 1 and further comprising means responsive to operation of said advance relay for operating said hold relay for maintaining said local traffic signal control means under said central control and responsive to release of said advance relay for longer than a predetermined time interval for releasing said hold relay and shifting said local traffic signal control means to local traffic signal control upon the expiration of said predetermined time interval.

5. Traffic signal control apparatus in accordance with claim 1 wherein said local traffic signal control means comprises a triac having a gate electrode, and means for coupling said advance signals to said gate electrode.

6. Traffic signal control apparatus in accordance with claim 1 and further comprising,

means defining a central control station at said central location having means comprising only one relay for providing both said select signal and said advance signals, means responsive to said predetermined condition signal, and first and second input terminals for receiving therebetween said predetermined condition signal and for transmitting said select signals and said advance signals,

and a two-wire transmission line intercoupling the central control station first and second input terminals with the local control station first and second input terminals.

7. Traffic signal control apparatus in accordance with claim 6 wherein said local control station further comprises polarity responsive means coupled to said first and second input terminals for transmitting a signal of only a first polarity to operate said advance relay.

8. Traffic signal control apparatus in accordance with claim 6 where the energy of said predetermined condition signal is provided by said central control station.

9. Traffic signal control apparatus in accordance with claim 7 and further comprising means responsive to operation of said advance relay for operating said hold relay for maintaining said local traffic signal control means under said central control and responsive to release of said advance relay for longer than a predetermined time interval for releasing said hold relay and shifting said local traffic signal control means to local traffic signal control upon the expiration of said predetermined time interval.

10. Traffic signal control apparatus in accordance with claim 7 wherein said local traffic signal control means comprises a triac having a gate electrode, and means for coupling said advance signals to said gate electrode.

11. Traffic signal control apparatus in accordance with claim 8 wherein said means for providing said initial condition signal comprises a source of bipolar signals at said central location and means for selectively connecting a unilaterally conducting device between said first and second local station input terminals.

12. Traffic signal control apparatus in accordance with claim 1 and further comprising,

means defining a central control station at said central location and having means for providing said select signals and said advance signals, means responsive to said predetermined condition signal, first and second input terminals for receiving therebetween said predetermined condition signal and for transmitting said select signals and said advance signals, and first and second AC terminals for receiving AC energy,

means including unilaterally conducting devices at both said central control station and said local control station for selectively rectifying the AC energy received on said first and second AC terminals and comprising means for providing said advance signals, said select signals and said predetermined condition signals,

and a two-wire transmission line intercoupling the central control station first and second input terminals with the local control station first and second input terminals.

13. Traffic signal control apparatus in accordance with claim 12 wherein said central control station includes a predetermined initial condition relay coil serially connected with a first unilaterally conducting device between said first a-c terminal and said first input terminal and shunted by a second unilaterally conducting device poled oppositely to said first unilaterally conducting device,

means for interconnecting said second AC and signal terminals,

a third unilaterally conducting device at said local control station,

and means at said local control station for selectively connecting said third unilaterally conducting device across said first and second input terminals poled in the same sense as said first unilaterally conducting device.

14. Traffic signal control apparatus in accordance with claim 13 wherein said central station comprises only one relay for providing both said select signals and said advance signals and having contacts for selectively bypassing said first unilaterally conducting device.

15. Traffic signal control apparatus in accordance with claim 14 wherein said advance relay has a coil connected in series with a fourth unilaterally conducting device between said first and second input terminals poled oppositely to said first unilaterally conducting device.

16. Traffic signal control apparatus in accordance with claim 15 wherein said local control station includes a source of energy and said hold relay includes a coil for receiving operating energy from the latter source through means including the contacts of said advance relay.

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