United States Patent

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[54] **TRAFFIC RESPONSIVE CONTROL SYSTEM**
12 Claims, 8 Drawing Figs.

[52] U.S. Cl. 340/37, 340/38
[51] Int. Cl. G08g 1/01, G08g 1/02
[50] Field of Search 340/37, 38

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ABSTRACT: In order to provide efficient and safe traffic control at a signal intersection, a system is shown for operating the signal sequence according to detection of the approach, presence and passage of vehicles relative to the intersection. Each approach lane to the intersection is provided with traffic detector, such as an induction loop detector for sensing the presence of an automobile within a circumscribed area. Utilizing this detection feature to its fullest extent, logic circuitry is described responsive to the information generated by the loop detectors and operating the signals, for providing directional traffic flow primarily in accordance with the instantaneous, clear space available within the intersection and protection against conflicting signal indications. Additionally, the circuitry in its preferred form is modulized to provide a separate control unit for each direction of traffic, which units may be conveniently interconnected for providing a wide variety of intersection control functions.

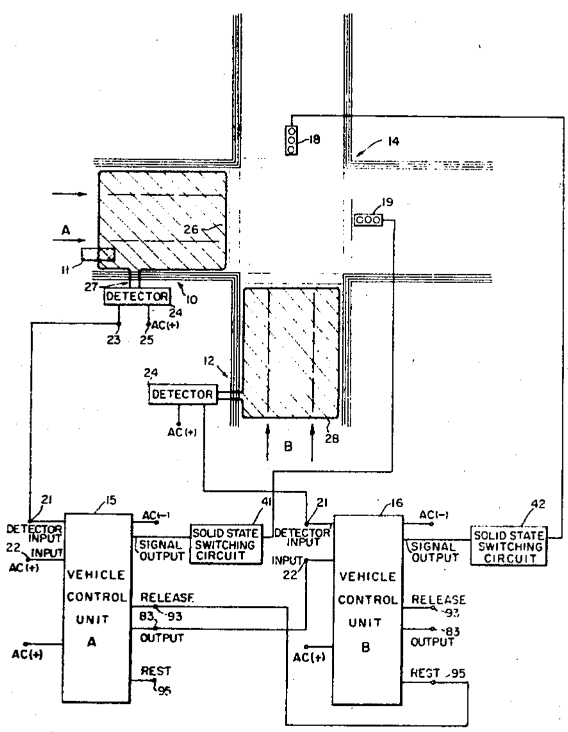
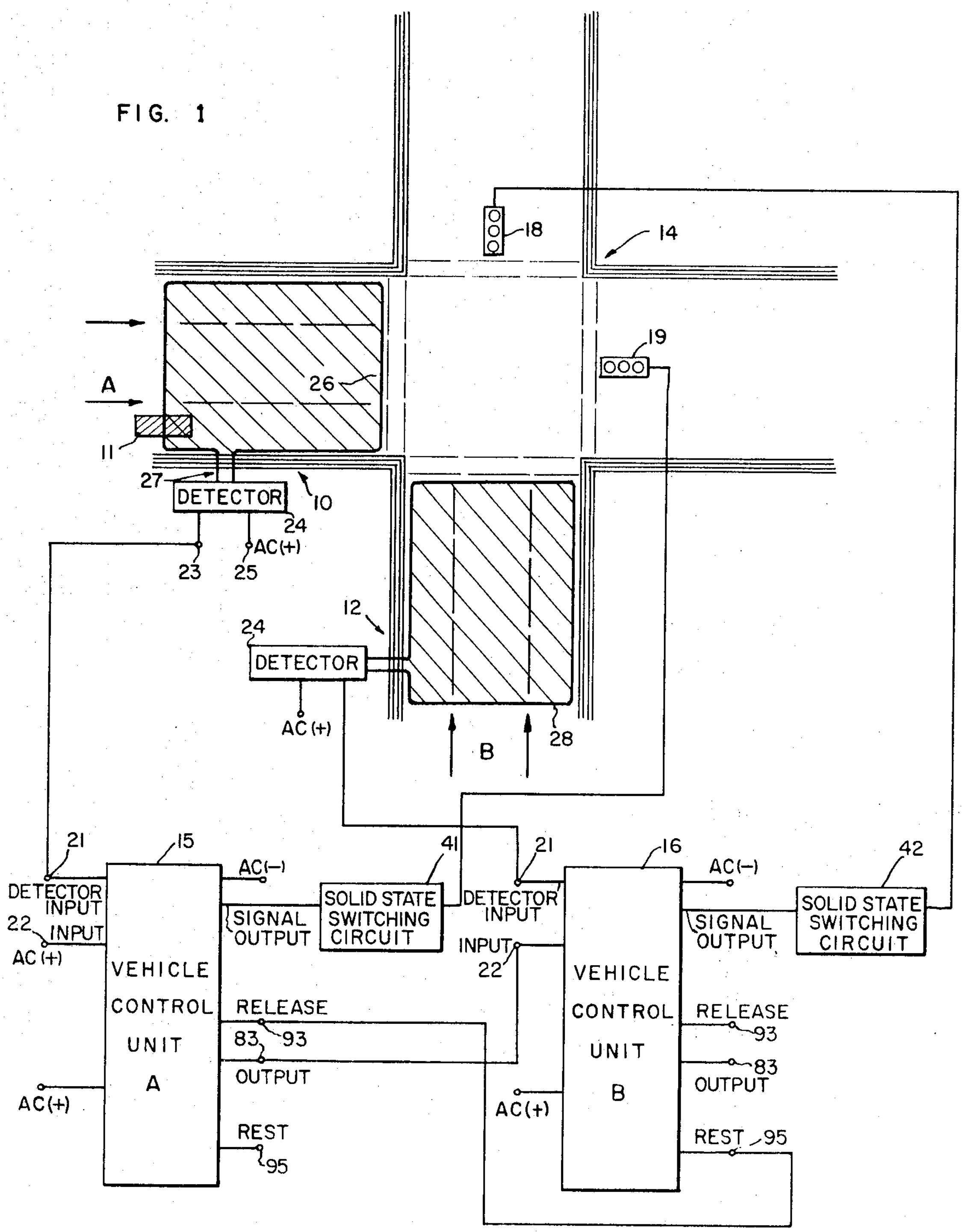


FIG. 1



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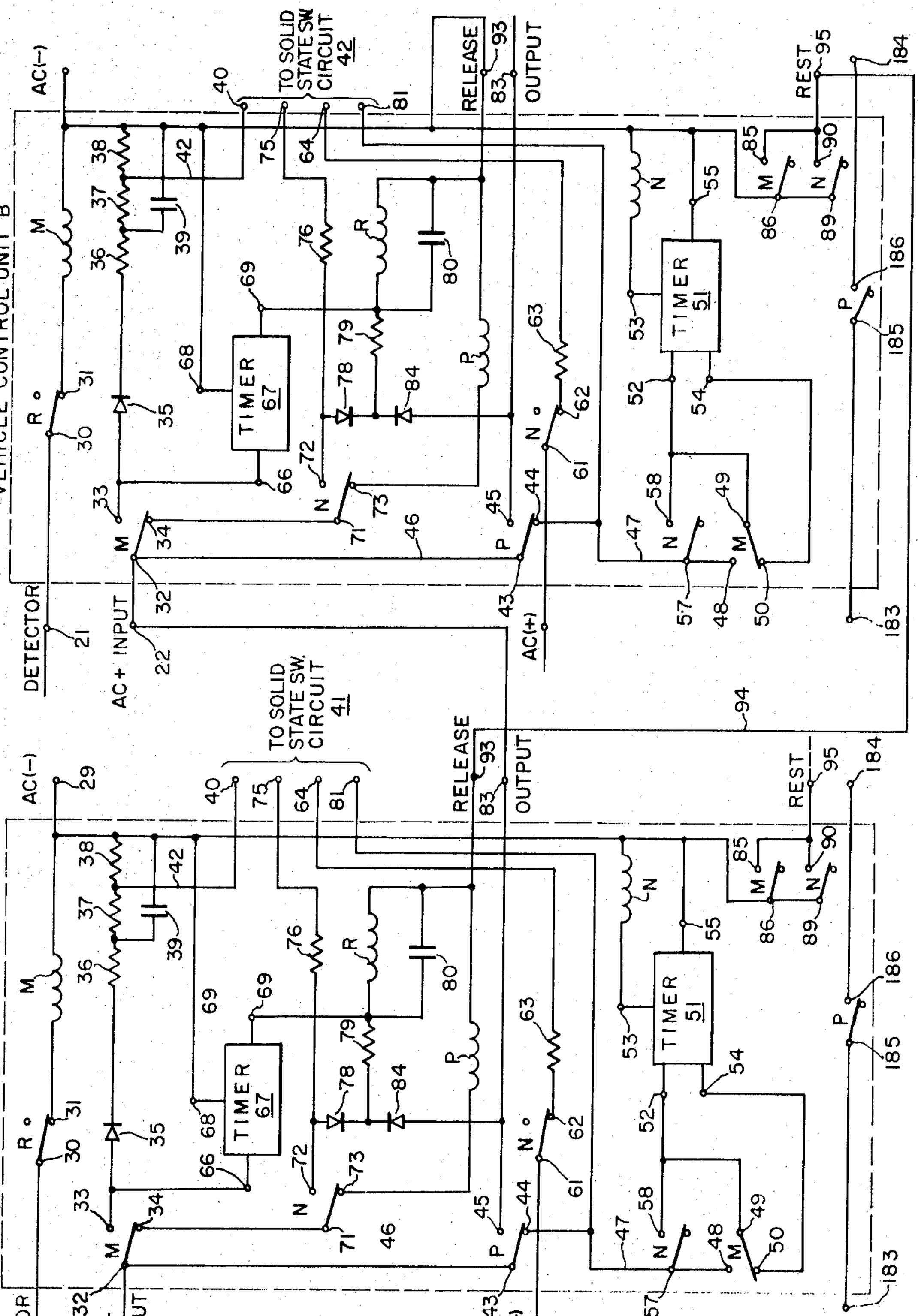

FIG. 2

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FIG. 3

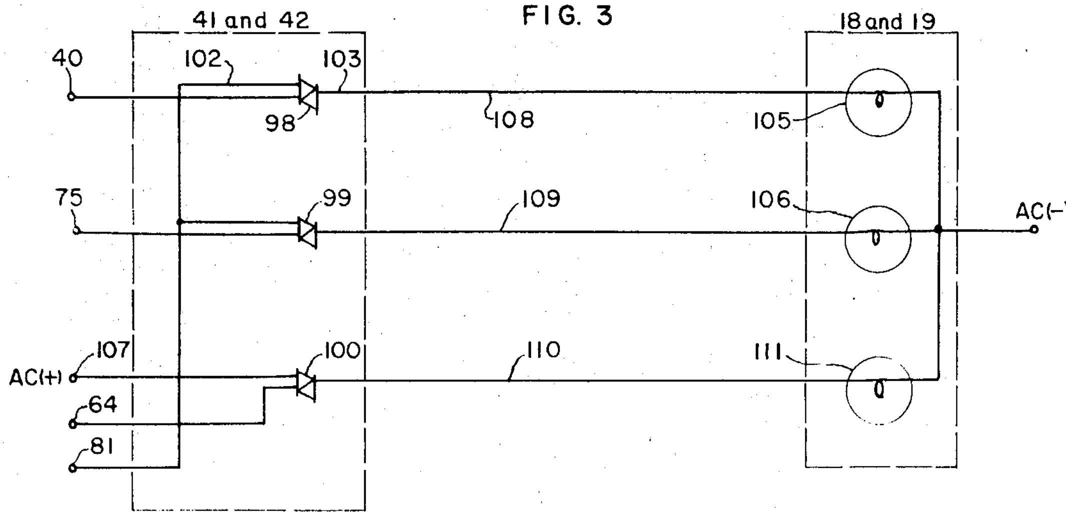

FIG. 4

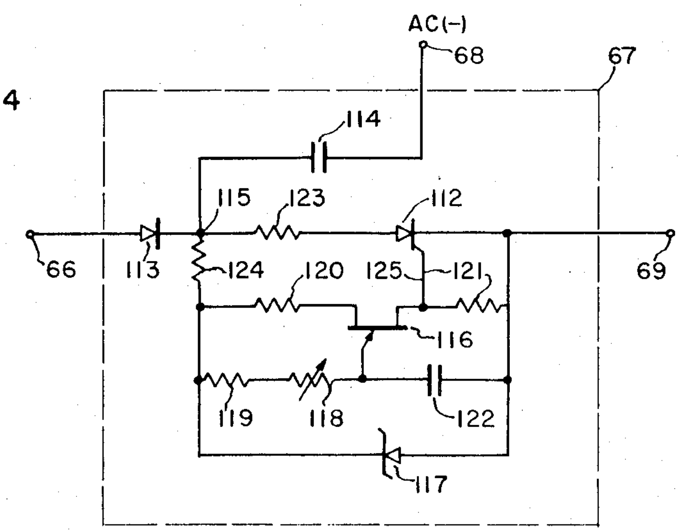

FIG. 5

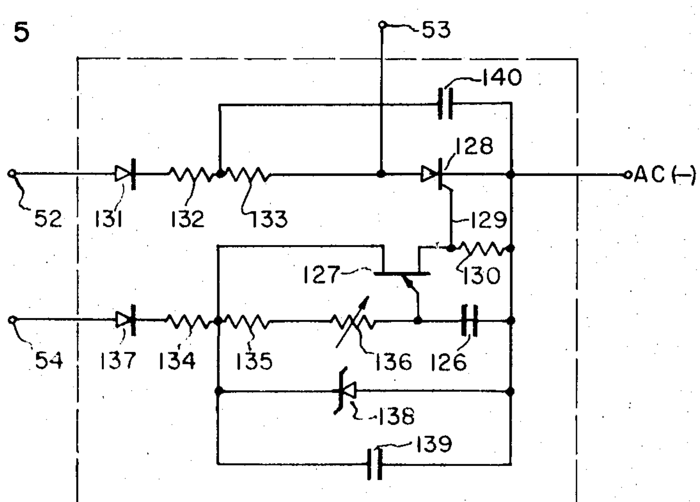

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FIG. 6

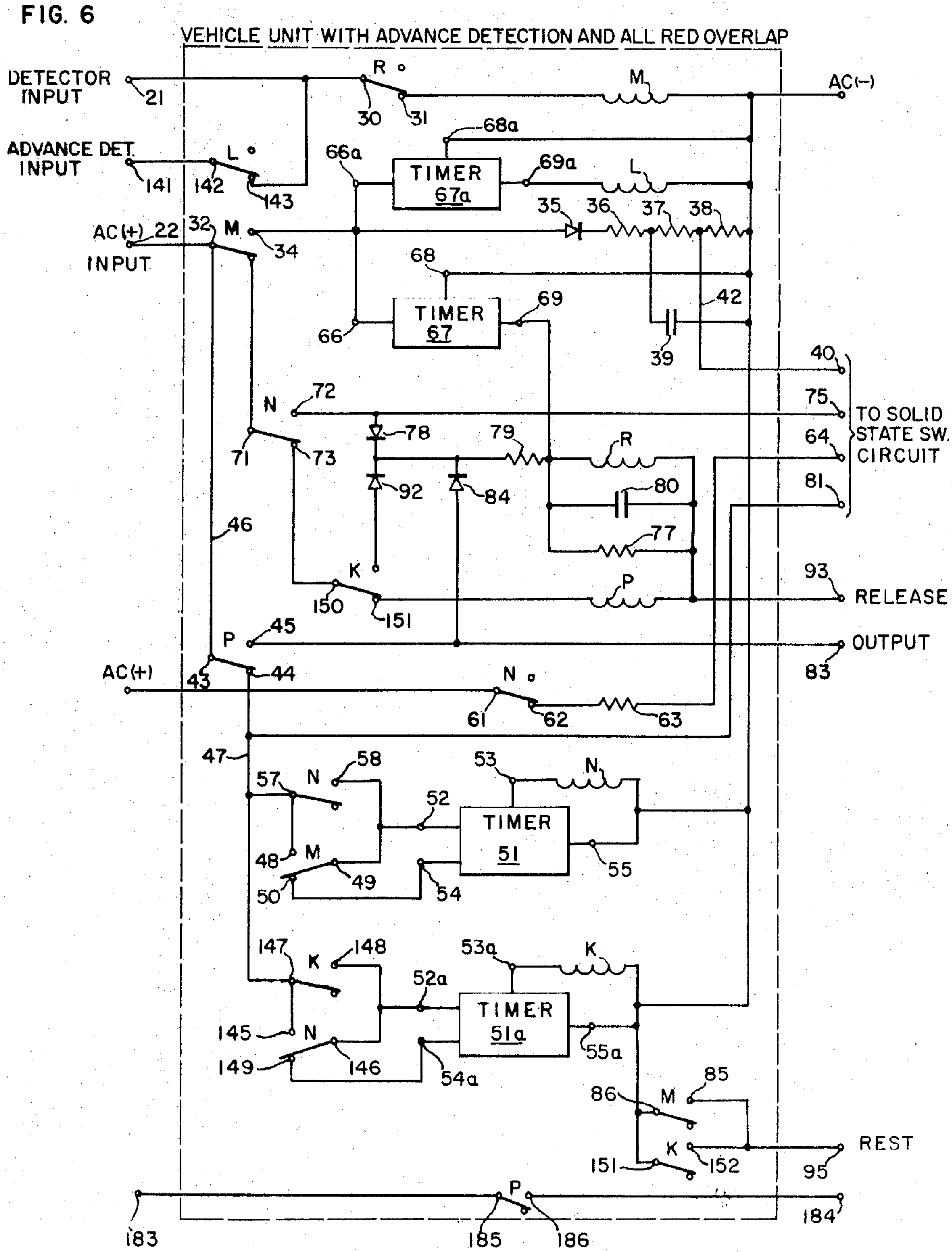

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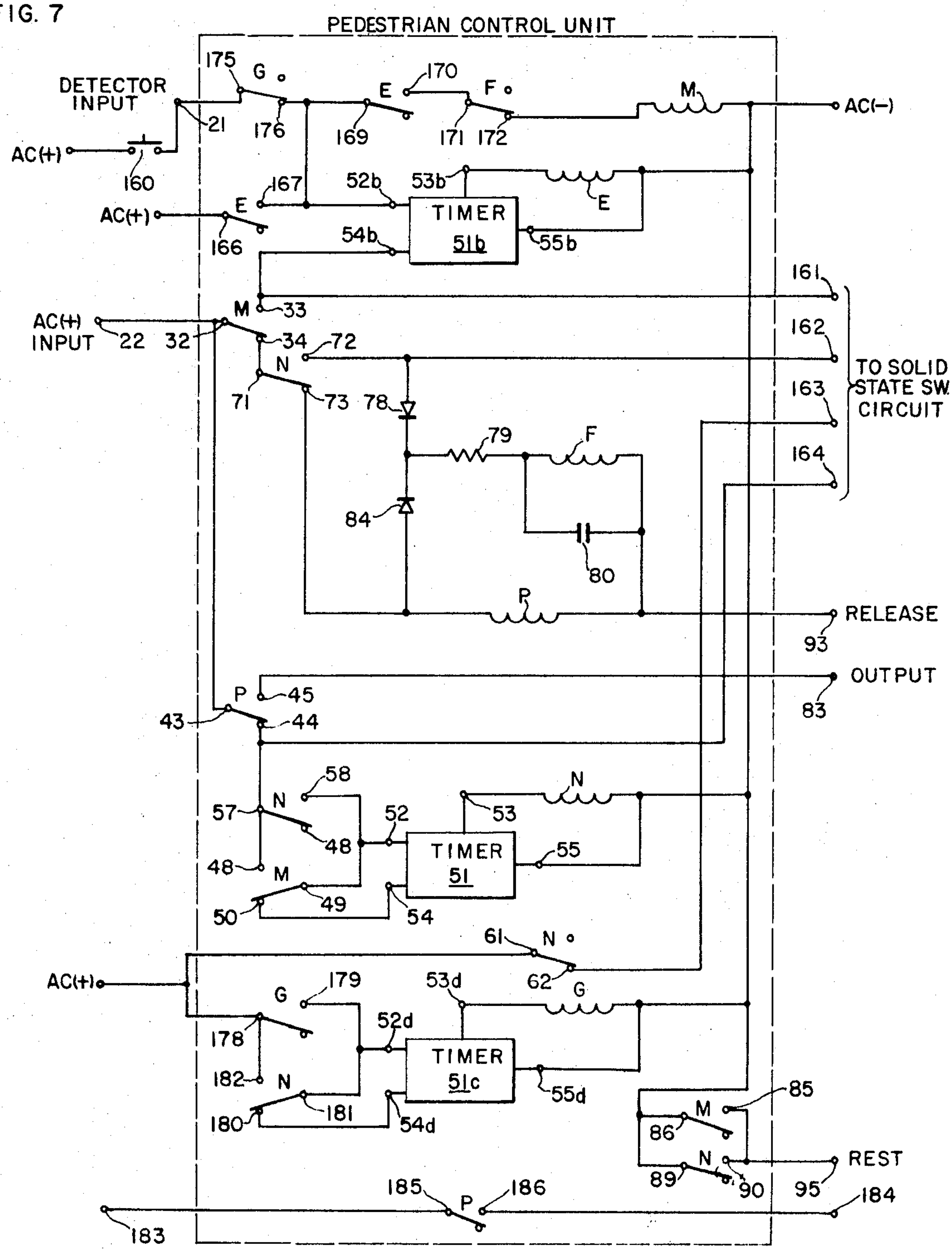
FIG. 7



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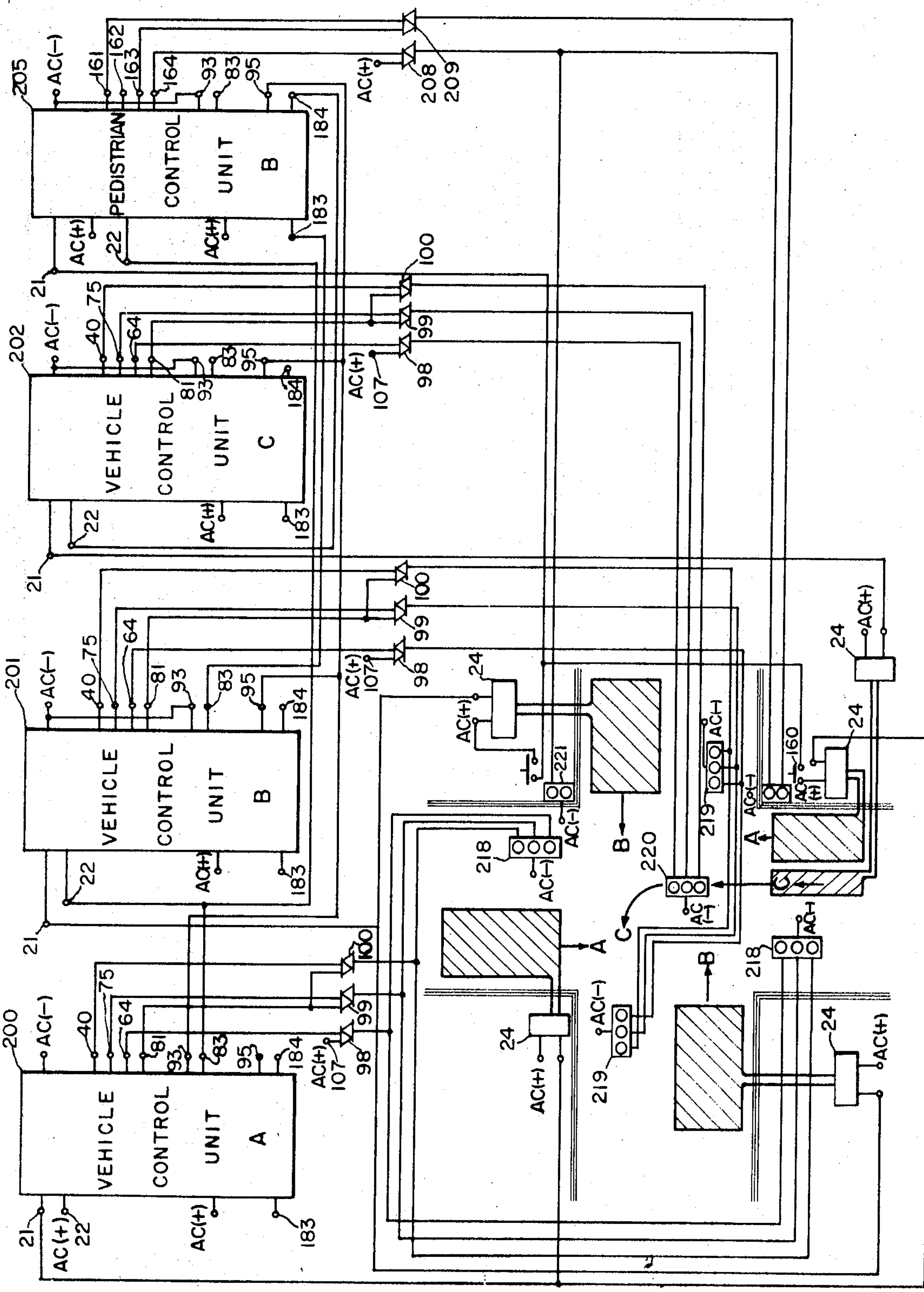

FIG. 8

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TRAFFIC RESPONSIVE CONTROL SYSTEM

The present invention relates to traffic control systems and more particularly to an improved traffic control system which operates on a principle of space allocation rather than conventional time allocation.

To provide a background for appreciating the contribution made by the present invention to the art, several widely used traffic control techniques will be considered. The most common type of controller is the fixed time device, wherein traffic lights are set according to a semipermanent time cycle. That is, the time sequence may be adjusted during the day at the signal station to compensate for variable traffic conditions. In locations where highly varying traffic conditions exist, this is the most inefficient of all the devices.

Another type of system is the semitraffic actuated controller wherein, approaching cross-street traffic is sensed by a vehicle detector, such as a pressure detector. In the absence of cross street traffic, the main street is provided with a continuous green light. Upon detection of an approaching cross-street vehicle by the detector, which commonly is placed about 80 feet from the intersection, the main street green light is changed through yellow to red and the cross-street signal receives a green indication. The green proceed indication is maintained for at least a preselected initial fixed interval sufficient to allow the maximum possible number of cars waiting between the intersection and the vehicle detector, e.g. 80 feet, to pass through the intersection regardless of the actual number of cars waiting, and for a longer time interval if vehicles continue to approach and pass over the detector in close order. This second, vehicle responsive time interval will terminate upon occurrence of a sufficient gap in the flow of cars, in this instance 80 feet, or otherwise upon elapse of a preset maximum time interval. After such termination, the main street traffic will obtain a green signal, for an assured preset duration independent of traffic requirements.

Additionally, there is in use a system characterized as a volume density controller, modifying the above semitraffic actuated controller, in which both the initial time interval and the vehicle responsive interval are varied by the density of traffic flow. That is, the controller counts cars approaching the intersection during a stop indication and attempts to provide an average initial green interval of sufficient duration to allow the average number of waiting cars to pass through the intersection. Subsequently arriving vehicles in close order extend the green light into the vehicle responsive interval as above, however, in the volume density system the permissible gaps between cars decreases with time according to detected and computed average traffic density, again independently of the instant traffic needs. For example, at first substantial gaps between cars may occur without inducing a red indication, however, as time elapses the permissible gap distance decreases rapidly when a large number of cars are waiting in the other approaches to the intersection and more slowly when the heavier traffic is in the moving stream.

It will be apparent that all of the above described traffic actuated systems attempt to construct a time model of the average traffic at the intersection and control the signal lights according to the model conditions. Accordingly, such systems, while offering some improvement over entirely fixed time devices, neglect the instantaneous traffic requirements and make signal control decisions which are to a large degree arbitrary and inefficient. Moreover, and with particular reference to the volume density system, complex and expensive circuitry is required to achieve the described control functions, wherein the incurred substantial cost of construction and maintenance prohibits widespread applications of the system.

Accordingly, it is an object of the present invention to provide a traffic responsive control apparatus which is to a large degree more efficient, more reliable and safer in regulating the movement of traffic through an intersection.

It is a still further object of the present invention to provide a versatile traffic control system for performing allocation of available intersection space, and which is capable of handling a plurality of traffic phases, i.e. lanes of traffic flow through an intersection allowing non conflicting concurrent moves safely and efficiently.

A feature and advantage of the instant invention is that pedestrian traffic control may be achieved in combination with vehicle control utilizing the same basic circuit for both traffic components.

A further feature and advantage of the instant invention is that pedestrian travel may occur during a slack in the vehicle traffic so as to avoid pedestrian dominance of the intersection.

A still further feature and advantage of the invention is that the system may be arranged for concurrent movement of several nonconflicting lanes of traffic. In this same regard, the system may be conveniently adapted to provide for movement of one lane of traffic during separate movements of several other traffic lanes, that is, allowing for overlapping signal controls. Additionally, the system is particularly adaptable for providing preempter operations, desirable in emergency traffic situations such as preempting normal traffic flow to allow fire vehicles and the like, clear passage.

The present invention possesses other objects, features and advantages, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of this specification. It is to be understood, however, that variations in the drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to the d4awings:

FIG. **1** depicts, in block diagram form, the traffic control system operating in conjunction with the basic two-way intersection.

FIG. **2** shows a schematic diagram of the control circuitry indicated in FIG. **1**.

FIG. **3** is a schematic diagram of a solid-state signal light switching circuit utilized in the invention.

FIGS. **4** and **5** are detailed schematic diagrams of electronic timers used in the various circuits of the invention.

FIG. **6** shows a schematic diagram of a more sophisticated control unit including the features of advanced vehicle detection and mandatory timed stop intervals between each conflicting traffic movement.

FIG. **7** is a further schematic diagram illustrating a pedestrian signal control unit of the present invention.

FIG. **8** shows a typical intersection situation utilizing the system of the present invention.

The control system of the present invention to allocate available space within an intersection to approaching traffic. Pursuant to this end, the control apparatus, for most purposes, is solely responsive to vehicle or pedestrian traffic.

Referring to FIG. **1**, the invention here includes at least two detectors **10** and **12** arranged within a preselected area of the approach lanes to an intersection, in this case intersection **14** of two one-way street approaches, A and B. Detectors **10** and **12**, in this instance, are of the type which provide for opening and closing of a switch in response to the presence of a vehicle within the areas bounded by each of the respective loops. Connected to each of detectors **10** and **12** are vehicle control units A and B, **15** and **16**, having letters corresponding to approaches A and B, which are in turn interconnected with one another to insure mutually exclusive operation of green or proceed traffic directory conditions for the intersecting traffic. Signal lights **18** and **19**, each having red (stop), yellow (caution), and green (proceed) indicator lights, are connected respectively to control units **16** and **15** for supervising vehicle traffic along the respective directions of B and A approaches.

In practice, when both of area detectors **10** and **12** are free of vehicles, indicating no traffic in either the A or B approaches, both of signal lights **18** and **19** are in the red or stop condition. Now, as a car enters the area of one of the detectors, for example, car **11** shown entering the area of detector **10**, the corresponding vehicle control unit, in this instance, unit **15**, receives an impetus from the detector which causes the associated signal, signal light **19**, to switch from the red to the green condition. As car **11** passes into the intersection proper thus leaving the boundaries of area detector **10**, control unit **15**, receives another impetus which responsively causes signal light **19** to cycle through a yellow indication to a red indication. Should a vehicle enter area detector **12**, approaching the intersection in direction B, during the time period in which car **11** is receiving a green signal, vehicle control unit **16**, is prevented from switching light **18** to the green condition until car **11** has left the boundaries of detector **11** and entered the intersection. That is, control unit **16** is disabled during the actuation of control unit **15**. Of course, as soon as car **11** leaves the area of detector **10**, which eventually changes signal light **19** to a red or stop indication, then unit **16**, is again operative such that the detection of a car by area detector **12**, causes signal light **18** to switch from its normally red or stop indication to the green or proceed indication.

Additionally, several advantageous and preferred features may be added to this basic operation as discussed more fully hereinafter. Among such features are a means for detecting a vehicle approach in advance of area detectors **11** and **12**, wherein additional similar detectors are disposed upstreet from area detectors **10** and **12** to allow early switching of the signal lights to the proceed condition, during light traffic, so that approaching cars need not slow down.

Furthermore, circuitry is shown for providing a pedestrian control unit which operates in conjunction with the vehicle control unit such as those shown in FIG. **1**, to permit pedestrian traffic to pass during periods of nonconflicting vehicular movement.

Referring now to both FIGS. **1** and **2**, wherein FIG. **2** schematically illustrates the control circuitry for vehicle control units **15** and **16**, and the interconnections therebetween as partially shown in FIG. **1**. Each of the control units **15** and **16** are of like circuitry such that any number of such units may be cascaded for controlling a corresponding number of traffic approaches or phases. This is to be considered an important advantage of the invention due to the present day usage of multiple traffic lanes at busy intersections, e.g. right- and left-hand turn lanes. Only the circuitry of vehicle control unit **16**, will be described in detail due to such universalness between the units and reference will be made to unit **16** only to describe the interconnection and cooperation between the circuits.

Unit **15** is provided with inputs of detector input **21** and alternating current (AC+) power input **22**. Detector input **22** also shown in FIG. **1**, is connected to terminal **23** of detector switch **24** of area detector **10**. Connected to the remaining terminal, terminal **25** of switch **24** is an alternating current source (AC+) which for the present purposes will be denoted as the (+) side of such source.

Detectors **10** and **12** are means which detect the presence of a vehicle in a defined area. In the instant case, induction loop detectors are utilized for detectors **10** and **12** which operate on a radiant electromagnetic field principle, wherein a loop conductor **26** connected to switch **24** is supplied with a given frequency of alternating electrical energy. As a vehicle enters the area defined by loop conductor **26**, the electromagnetic field is altered by the Ferromagnetic or magnetizable mass of the vehicle, thereby changing the frequency of the field and of the alternating electrical signal appearing on conductors **27** connected to switch **24**. Switch **24**, responds thereto and closes a contact connected between terminals **23** and **25**. Accordingly, terminals **23** and **25** in a rest or open condition are insulated From one another, in the absence of vehicles within loop conductor **26** while the same terminals are in an activated or closed condition, shorted together when an automobile is present within the detector area.

Thus, detectors **10** and **12** provide a means for detecting the presence of traffic within the approaches proximate the controlled intersection, and provide information for operating the switching circuitry of the instant invention. If desired, other types of detection means may be utilized, however, it has been found that the type of induction detectors described herein are very reliable and best suited for use in the present invention.

Considering now the operation of area detectors **10** and **12** with control units **15** and **16**, as a car for example, car **11**, enters induction loop **26**, switch **24** shorts terminals **23** and **25** and applies AC(+) to detector input **21** of control unit **15**. Now as best shown in FIG. **2**, AC current flowing between terminal **25** of detector switch **24**, see FIG. **1**, and terminal **29** connected to AC(−), see FIG. **2**, activates an M relay coil through normally closed contacts **30** and **31** of an R relay. The M relay and its associated contacts thus provide a detector controlled switching means operating between first and second modes in response to the presence or absence of traffic in the associated approach. In its second or in this cast activated mode AC(+) applied to input **22** passes through normally open contacts **32** and **33** (now closed) of the M relay, energizing a delay network comprising diode **35**, resistors **36**, **37** and **38**, and capacitor **39**. After a preselected delay, which may typically vary between 10 and 20 milliseconds, the green light of signal lights **19** is turned on by means of a solid-state switching circuit **41**, see FIGS. **1** and **3**, in response to a signal appearing at terminal **40**. The operation of this delay network is provided by the rectification of the AC current by diode **35** and the eventual charging of capacitor **39** through resistor **36** providing a unidirectional voltage across resistors **37** and **38** a portion of which is applied to terminal **40** via line **42**. The purpose and advantage of this delay is to permit contacts **43** and **44** (previously opened) of a P relay to close securing firm electrical connection therebetween such that AC power may be supplied to signal light switching circuits **41** through terminal **81** and the above-mentioned contacts **43** and **44**. It will be noted that the P relay coil is in an energized state during the operation of vehicle control unit **16**. This is, the normally open contacts of the P relay, for example, contacts **43** and **45** are closed during time periods in which unit **16** was in operation passing traffic appearing in the B approach through the intersection.

During the operation discussed above, as the M relay coil is energized, M relay normally closed contact **32** and **34** are open preventing energization of the P relay coil and thereby disabling unit **16** as discussed more fully hereinafter.

Upon the activation of the M relay in response to vehicle detection, power is supplied to the coil of an N relay from power input **22**, through line **46**, normally closed P relay contacts **43** and **44**, line **47**, normally opened M relay contacts **48** and **49**, and terminals **52** and **53** of primer **51**, and through the end relay coil to AC(−). As the N relay is energized, normally open contacts **57** and **58** thereof close, latching the N relay in its energized state and normally closed contacts **61** and **62** thereof open interrupting AC power applied to terminal **64** through contacts **61** and **62** and resistor **63** and thereby extinguishing the red or stop light of signal lights **19** controlled by solid-state switching circuit **41**.

As soon as car **11**, shown in FIG. **1**, passes over and leaves loop conductor **26** of detector **10**, terminals **23** and **25** of detector switch **24** open and consequently removes power from the coil of the M relay. As soon as this occurs, and the M relay is deenergized, the normally open contacts **32** and **33** thereof open and thereby terminate the proceed or green light of signal light **19**. Additionally, normally closed contacts **32** and **34** of the M relay close at this point applying AC power through normally open contacts **71** and **72** (now closed) of the N relay through resistor **76** to terminal **75** actuating the caution or yellow light indication of signal lights **19**. It will be appreciated that the N relay is still in its energized state due to the latching thereof on its own normally open contacts **57** and **58**, and thereby remains energized even though the M relay has deenergized.

At the same time that the caution indication is given at signal lights **19**, the coil of an R relay is energized through diode **78** and resistor **79** which causes normally closed R relay contacts **30** and **31** to open thereby preventing actuation of the M relay by detector **10** during clearance of the intersection, that is during the caution light signal. The R relay coil is operated by a rectified and filtered AC signal provided respectively by diode **78** and shunt capacitor **80** and thus provides a prevent switching means disabling operation the M relay upon actuation thereof.

Concurrently with the caution indication, as the M relay is deenergized, normally closed contacts **49** and **50** thereof close supplying AC(+) power from input **22** through terminal **54** of timer **51** through line **46**, normally closed P relay contacts **43** and **44**, line **47**, normally open N relay contacts **57** and **58**, and M relay contacts **49** and **50**. This connection, starts timer **51** which after a preselected interval deenergizes the N relay coil by shorting terminal **53** to terminal **55** as discussed herein. Terminal **55** of timer **51** is connected to AC(−).

As the N relay is deenergized, normally open contacts **71** and **72** thereof are opened removing the signal to terminal **75** and thereby extinguishing the yellow or caution light of signal lights **19**. In effect the N relay and timer **51** operate as a caution timer switching means for activating the caution condition of signal lights **19** for a preselected interval after the M relay resumes its first or nonactuated mode.

Additionally, normally closed contacts **61** and **62** of the N relay again close and thereby actuate the red or stop light signal at signal lights **19**.

In summary of the forgoing, a system is provided for controlling traffic flow along approaches to a region of conflicting movement, including detector means for detecting the presence of traffic in each of a number of approaches, means for signalling stop and proceed conditions for each of the several approaches, a switching means (M relays) for responding to such detection of traffic and switching the signal means from a normal stop condition to a proceed condition for each approach in which traffic is detected and means for preventing the signals from displaying a proceed indication for one approach during a proceed indication for the other approach. Particularly, vehicle control unit **15**, responds to an approaching vehicle by means of detector **10** and switches signal lights **19** from a red to a green condition. As the vehicle passes into the intersection, thus leaving the boundaries of area detector **10**, unit **15** causes signal lights **19** to cycle from a proceed indication through a timed interval of the caution indication and finally back to the normally stop indication.

Similarly, vehicle control unit **16**, operates in response to detection of the presence or approach of a vehicle in approach B by means of area detector **12** and causes a green or proceed signal to appear at lights **18** which eventually cycles through caution to a stop indication as the vehicle proceeds through the intersection.

As an important aspect of the present invention, control unit **15** and **16** are connected together as shown in FIGS. **1** and **2** to provide for instantaneous sharing of the intersection proper according to the immediate traffic demands. In other words, the particular cooperation of control units **15** and **16** permits allocation of nonconflicting intersection space in response to approaching or awaiting vehicles. Specifically, as illustrated in FIGS. 1 and 2, an output terminal **83** of control unit **15** is connected to an input terminal **22** of unit **16** while a release terminal **93** of unit **15** is connected to a rest terminal **95** of unit **16**. As most clearly shown in FIG. 2, connection between terminals **83** and **22** supplies AC power to unit **16** only when the P relay of control unit A is energized and contacts **43** and **45** thereof are closed. Furthermore, connecting line **94** joining unit **15** release terminal **93** with unit **16** rest terminal **95** provides power to energize the P relay coil of unit **15** only when the M or N relays of unit **16** are in an energized state. In other words, the P relay coil of unit **15** will be energized through input **22**, normally closed contacts **32** and **34** of the M relay of unit **15**, normally closed contacts **71** and **73** of the N relay of unit **15**, through the P relay coil of unit **15** to release terminal **93** thereof and through line **94** to unit **16** rest terminal **95** and through either the unit **16** M or N relay contacts **68—65** or **89—90** to AC(−).

The cooperation between units **15** and **16** will be described by means of several examples. First, consider the case where approach A is absent of vehicles and approach B by means of detector **12** senses an oncoming car. Vehicle control unit **16** responds thereto causing the M relay thereof to close, thus closing normally open M relay contacts **86** and **85**. This connection places rest terminal **95** of unit **16** at AC(−) and thereby energizes P relay of unit **15**. Normally open P relay contacts **43** and **45** of unit **15** accordingly close connecting AC(+) power from input terminal **22** of unit **15** to input terminal **22** of unit **16**. Unit **16** is now in condition to switch signal lights **18** from a red to a green state and accordingly does so in the manner described in reference to unit **15** above. It will be noted that the P relay of unit **15** remains energized through release terminal **93** of unit **15** and rest terminal **95** of unit **16** throughout the green and yellow light condition of signal lights **18** and the P relay of unit **15** opens only after unit **16** has cycled signal lights **18** back to the stop or red condition.

Now consider a second situation where a steady stream of cars traveling over detector **10** in approach A is operating control unit **15** providing a continuous green or proceed indication of signal lights **19**. In this state, unit **15**, M and N relays are energized connecting normally open M relay contacts **32** and **33** are accordingly applying AC(+) power to terminal **155** of timer **67**. Now at this point with a green light indication on signal lights **19**, a car enters loop conductor **28** of detector **12** and thereby closes the M relay of unit **16**. The P relay coil of unit **15** cannot close due to open M relay contacts **32** and **34** and accordingly power cannot be supplied to unit **16** rendering this unit disabled for operation so long as unit **15** remains in operation passing approach A traffic. However, with AC(+) applied to terminal **66** of timer **67** and AC(−) applied to terminal **69** of timer **67** to the R relay coil and release terminal **73** and timer through the R relay coil and release terminal **73** timer **67** is actuated. After a preselected interval, timer **67** connects terminal **66** with terminal **69** thereof and thereby energizes the R relay. Normally closed R relay contacts **30** and **31** accordingly open deenergizing the M relay, which in turn closes normally closed M relay contacts **32** and **34** and starts timer **51** for cycling through the yellow light interval. Upon termination of the yellow light interval, the N relay is deenergized closing normally closed N relay contacts **71** and **73**, supplying power through the P relay coil which in response thereto closes normally open P relay contacts **43** and **45** delivering AC power to input **22** of unit **16**.

Additionally, upon closure of normally open P relay contacts **43** and **45** a rectified alternating current signal is applied through diode **84** of unit **15** to the R relay coil thereby maintaining the R relay in an energized state such that R relay contacts **30** and **31** are maintained open preventing unit **15** from being actuated during operation of control unit **16**.

Since AC power is now supplied to unit **16**, its operation may proceed as normal, switching signal light **18** from a red to a green state and eventually back through yellow to red again. This immediately above described sequence allows vehicles waiting in the B approach to interrupt a steady stream of traffic flowing in the A approach after a given substantial time period, fixed by a timer **67** of unit **15**.

Now consider the reverse of the above situation, wherein approach B is undergoing a steady stream of traffic with a green light indication on signal light **18** and a car approaches the intersection from Direction A. At variance with the connections for unit **15**, unit **16** release terminal **93** is connected directly to AC(−). Accordingly, with B unit in a green light condition, timer **67** thereof starts immediately without waiting for a response from unit **15**, and fixes the maximum time duration at which unit **16** will remain in the green light state.

As an example of the versatility of the present system, unit **15** may be easily modified to operate as a preempter control unit. Particularly, by removing the connection of the R relay coil of unit **15** to release terminal **93** of the same unit the M relay of unit **16** will be conditioned to response to detector **10** even during continuous traffic in approach B. Upon such an occurrence the M relay of unit A will immediately return the P relay of unit A to its unactivated state, disabling unit **16**. Such an arrangement is desirable in the case of emergency traffic such as fire equipment, where detector **10** would be arranged to respond only to the emergency vehicles for immediately returning a proceed condition therefor.

Also, it will be appreciated that from the foregoing described operation, that any number of control units such as **15** and **16** may be cascaded to provide allocation of available intersection space for a multiplicity of approach lanes. Additionally, while the embodiment of the invention described in FIGS. **1** and **2** provides for maximum time intervals for which any one approach lane can receive a green light condition, it has been found in practical applications that substantial gaps between vehicles, even in heavy traffic, occur such that awaiting vehicles on a cross street approach may efficiently share the available intersection space without inducing the operation of timers **67** of units **15** and **16**. Also, in view of this fact, it has been possible to extend the portion of loop conducters **26** and **28** distal the intersection, back as far as 100 feet from the intersection to provide for early green light indication and thus reducing traffic slow down to a minimum.

To enhance the multilane traffic control capabilities of the instant system, a pair of auxiliary terminals **183** and **184** are provided for each unit **15** and **16**, to be shorted by normally open contacts **185** and **186** of the P relays. Terminals **183** and **184** may then be connected as shown in FIG. **8**, to control AC power supplied to another unit, in a manner similar to normally closed P relay contacts **43** and **44**.

Up to this point, the actual switching of signal lights **18** and **19** has not been discussed. For this purpose a pair of solid-state switching circuits **41** and **42** shown in FIG. **1** are employed to respond to the control signals provided by control units A and B and in accordance therewith switch the light lamps of signals lights **18** and **19**. While circuits **41** and **42** are shown separately in this instance, it will be appreciated that they form a portion of each control units and may if desired be incorporated in the circuitry thereof. Particularly, FIG. **3** shows the schematic diagram for solid-state switching circuits **41** and **42**, each of which include a set of three solid-state switching devices **98, 99** and **100**, known in the art as triacs, a set of input terminals **40, 75, 64, 81** and **107**, and a set of output lines **108, 109** and **110** connected to the signal lights **18** and **19**. Each set of the input terminals to circuit **41** and **42** are connected to the output terminals of like reference numerals of units **15** and **16**. Briefly, the operation of each of switching devices **98, 99** and **100** provide for example, connection of AC power between input **102** and output **103** of device **98** in response to a gating signal applied to gate terminal **104** of device **98**. Accordingly, as power is supplied to the input of devices **98** and **99** through terminal **81** from vehicle control unit **15**, each such device will allow power to flow into green lamp **105** and yellow lamp **106** in response solely to the presence of separate gating signals at terminals **40** and **75**, respectively.

Somewhat at variance with the operation of devices **98** and **99**, a permanently connected AC(+) supply is provided to terminal **107** and thus to the input of device **100**, for energizing red lamp **111** solely in response to the presence of a gating signal at terminal **64**. The purpose of supplying power to devices **98** and **99** through terminal **81** which is controlled by normally closed P relay contacts **43** and **44** of units **15** and **16** is to prevent spurious and erroneous green or yellow light indications for one approach during a green or yellow light indication in the remaining direction thereby to a large degree eliminating the possibility of conflicting traffic movement. On the other hand, red lamp **111** is normally lit in the absence of approaching traffic in either direction and, therefore, receives a permanent supply of power controlled only by a red gating signal appearing at terminal **64** of units **15** and **16**. Thus circuits **41** and **42** cooperate with the P relays of the control units to provide supervisory circuit means to insure consistent operation of the approach signal lights **18** and **19**.

The combination of solid-state switching devices for controlling the power supply to the lamp loads together with electromagnetic relays for performing various logical functions, takes advantage of the most useful characteristics of each class of device. Particularly, relay contacts tend to disintegrate after periods of constant high current load switching, yet operate very efficiently for switching low current such as found in the logic circuit. The solid-state switching devices, particularly triacs, on the other hand perform most advantageously under high current load switching conditions such as in the case of incandescent lamp loads.

Timers **67** and timer **51** of unit **15** and **16** are shown in detail by FIGS. **4** and **5**. Timer **67** having terminal **66, 69** and **68** corresponding with like reference numerals in FIGS. **2, 6** and **7** provide for allowing a rectified alternating current signal to pass through resistors **124, 119** and **118** charging capacitor **122** upon application of AC across terminals **66** and **69**. Diode **113** together with capacitor **114**, the latter of which is connected to AC(−) at terminal **68** provides rectification and filtering of the AC source such as to present a relatively unidirectional voltage at junction **115** with respect to terminal **69**. In the presence of such voltage capacitor **122** begins to charge through resistor **119** and variable resistor **118** and upon reaching a preselected voltage value switches unijunction transistor **116** to a low impedance state. Upon reaching such a low impedance state, the potential at control electrode **125** of silicon controlled rectifier (SCR) **112** changes rapidly and thereby switches SCR **112** to a low impedance mode. Zener diode **117** maintains a constant charging voltage across capacitor **122** to insure uniformity of timing. Resistors **124, 123, 120** and **121** are biasing resistors which maintain SCR **112** and unijunction transistor **116** in a quiescent condition suitable for switching thereof. Accordingly, timer **67** provides for the passage of generally unidirectional current between terminals **66** and **67** after a preselected time interval, which may be adjusted by variable resistor **118**, of AC power connected across terminal **66** and **69**. Thus, timer **67** provides a means for energizing the R relay coil shown in FIG. **2** so as to provide a maximum time interval during which a single approach may dominate the intersection.

Timer **51** illustrated in detail in FIG. **5**, includes terminals **52, 53, 54** and **55** corresponding to like reference terminal numbers in FIG. **2**. Timer **51** is particularly advantageous, in that it operates with a relatively high power current sufficient for directly energizing and deenergizing a relay coil. That is, most timers are low power devices, which are not capable of supplying sufficient current to operate a relay coil directly and must use intermediate switching means connected between the timer and the relay coil for supplying operational current thereto. On the other hand, a timer **51** operating on an AC power source, is capable of directly energizing and deenergizing the N relay coil as in FIG. **2** thereby eliminating an additional switching component. Specifically, referring to FIG. **2** and **5**, upon application of AC to terminal **52**, timer **51** operates to energize the N relay coil through terminal **53** and AC(−). This condition of the timer will continue until AC(+) is applied to terminal **54** which in combination with AC(−) connected to terminal **55** initiates charging of capacitor **126**. After a preselected interval determined by the rate of charging capacitor **126**, which may be controlled by variable resistor **136**, unijunction transistor **127** is switched to a low impedance state, which in turn rapidly changes the voltage applied to gate **129** of silicon controlled rectifier **128**. In response thereto, SCR **128** switches to a low impedance state thereby effectively shorting terminals **53** and **55** together deenergizing the N relay coil. Diode **131** together with resistors **132** and **133** and capacitor **140** provide for rectifying and filtering the AC signal applied across terminals **52** and **53** and as mentioned above, provide for passing current energizing the N relay coil. Diode **137** together with resistors **134** and **135** and variable resistor **126** provide for introducing current for charging capacitor **126** upon application of AC across terminals **54** and **55**. Zener diode **138** and capacitor **139** stabilize the charging current for capacitor **126** thereby insuring uniformity of timing intervals. Resistor **130** provides for biasing transistor **127** and SCR **129**.

Referring now to FIG. 6, a schematic diagram is shown of a vehicle control unit similar to that of units 15 and 16, shown in FIG. 2, but further including the features of advancing called detection and all red overlap. The operation of this unit is the same as the basic control unit, units 15 and 16, with the exception that provision is made for advance detection of vehicles approaching the intersection. The purpose of the advance calling detection feature is to permit an on-coming vehicle to obtain a green light signal at a greater distance from the intersection during light traffic for efficient flow thereof. Additionally, the control unit shown in FIG. 6 allows for greater gaps to occur between the approaching vehicles during the first part of the green interval without inducing a reversion of the signal light to its red condition.

For this purpose, an additional or advance detector would be attached to advance detector input 41, which in turn connected to detector input 21 through normally closed L relay contacts 142 and 143. In this configuration, the M relay coil can be energized by a signal from either detector. The advanced calling detector would be an area type detector similar to those described in FIG. 1 arranged proximate the principal detector upstreet from the intersection. As a car proceeds toward the intersection, the advance detector input 141 would first respond, energizing the M relay through the normally closed contacts of the L and R relays, respectively 142 and 143 and 30—31. With M relay energized, timer 67*a* starts timing a preselected interval due to the application of AC(+) power to terminal 66*a* through normally open M relay contacts 32 and 34 (now closed). Upon termination of the timing sequence, the L relay coil is energized via a connection may be timer 67*a* between terminals 66*a* and 69*a* thereof. At this point normally closed L relay contacts 142 and 143 open thereby leaving only the principal detector connected to detector input 21 to respond to vehicle movement or presence. In effect, the L relay and timer 67*a* functions as an advance timing means for conditioning the M relay to respond to the advance detector only for a preselected time interval if the M relay is thereafter continuously maintained in its activated condition. Subsequent action of the vehicle control unit illustrated in FIG. 6 is the same as described above, in reference to FIG. 2 except for the all-red overlap feature.

The all-red overlap provides for separating otherwise adjacent yellow light and green light indications by a preselected red light time interval. For this feature, relay K and timer 51*a* are included in the circuit of FIG. 6. Particularly when M relay energizes, normally open contacts 48 and 49 close, energizing the N relay coil through timer 51. In response thereto, N normally open relay contacts 145 and 146 energizes the K relay coil through timer 51*a* through terminals 52*a* and 53*a*, thereupon the K relay locks on its own normally open contacts 147 and 148. Therefore, relays M, N and K are all energized during the green light condition. As discussed in reference to FIG. 2, a yellow light condition is timed by timer 51. Additionally by means of closing of normally closed N relay contacts 149 and 146 and opening of the normally open N relay contacts 145 and 146 a timing sequence at timer 51*a* is initiated. Also, normally closed N relay contacts 61 and 62 close completing the circuit to the red light gate, terminal 64. When timer 51*a* times out, the K relay coil is deenergized and closes normally closed K relay contacts 150 and 151 completing normally closed K relay contacts 150 and 151 completing the circuit to the P relay coil so as to allow other cascaded vehicle control units to respond to a vehicle demand. The K relay when energized additionally provides power, through normally open contacts 151 and 152 thereof, to the R relay coil via diodes 92 and resistor 79 so as to maintain the R relay energized during the red light overlap period. Also, it is noted that K relay contacts 153 and 154 provide for connecting rest terminal 95 to AC(−) during this period. The result of this arrangement is to disable other cascaded control units for a certain time period determined by timer 51*a* immediately after the control unit reverts to its red light condition. The advantage gained is to allow additional time for the intersection to clear before vehicles are permitted to proceed from the remaining approaches.

The circuit of FIG. 6 may be connected in cascade with a like or similar unit in the manner as described in conjunction with FIGS. 1 and 2 for vehicle control units 15 and 16.

Up to this point in the description, no provision has been made for controlling pedestrian traffic. However, the method and apparatus of the present invention is readily adapted for such purpose. Specifically, FIG. 7 illustrates a schematic diagram of a pedestrian control unit especially adapted for cooperating with vehicle control units such as those shown in FIG. 2 and FIG. 6. Pursuant to the invention, the principle or basic operation of the pedestrian control unit is the same as that of the vehicular control units. Exceptions are a provision for limiting the maximum "walk" interval (corresponding to green light or proceed interval) and a provision for delaying the "walk" indications independently of reoccurring demands until a certain time interval has elapsed. This latter feature is particularly advantageous in cooperation with the vehicular control unit for the following reason. If the vehicular movement is light in both directions of travel, the green light intervals presented in response thereto are very short, in the range of 2 seconds allowing efficient use of the intersection. However, minimum pedestrian "walk" intervals are much longer, on the order of 15 seconds. If pedestrians are permitted to move each time a vehicle is given a green indication, pedestrian traffic will accordingly determine the timing of the intersection, greatly reducing the efficiency of vehicular control. For this reason, the features of the present invention provide for collecting of pedestrians for selected time intervals, typically in the range of 30 seconds. After such collection, the pedestrians are allowed to cross the street with the next nonconflicting vehicular interval. In the meantime, several cycles of vehicular intersection transversals, in both directions, may take place.

Referring now to FIG. 7, a pedestrian calling detector, pushbutton switch 160, is serially arranged between an AC(+) power source and detector input 21 and substitutes for the function of vehicle detectors 10 and 12 shown in FIG. 1. Output terminals 161 for a walk signal; terminal 162, for a flashing "don't walk" signal; 163, for a constant "don't walk" signal and 164 for AC power corresponding to output terminals 40, 75, 64 and 81 in FIG. 2 provide for the control of the pedestrian signal lights.

As in the case of the embodiment described in FIGS. 1, 2 and 3, it is preferred that outputs at terminals 161—165 operate the corresponding lamp loads through a solid-state switching circuit so as to avoid deterioration of the relay contacts with the control unit itself. Output terminals 93, 83, and 95, are respectively the release output and rest terminals of control unit A shown in FIG. 2. Similarly, AC(+) power input 22 of FIG. 6 corresponds to inputs 22 in FIG. 2.

In operation, as pushbutton switch 160 is momentarily depressed in response to a pedestrian call, a circuit is completed from AC(+) through switch 160, through normally closed G relay contacts 175 and 176, through terminals 52 and 53 of timer 51 completing the circuit through the E relay coil and locking the E relay on normally open E relay contacts 166 and 167. Timers 61*b* and 51*c* are of the same type of timer as illustrated in FIG. 4. As the E relay closes, power supplied to the M relay coil through normally open E relay contacts 169 and 170, and normally close F relay contacts 171 and 172. Particularly, the E relay and timer 51*b* function as a pedestrian timer switching means for controlling the mode of the M relay in response to actuation of the pedestrian calling detector.

When AC power is applied to input 22 from another cascaded control unit, for example vehicular control units 15 or 16 of FIG. 2, a walk indication is given in response to AC power being applied to "walk" terminal 161 through now closed M relay contacts 32 and 33. At the same time, AC power will be delivered 54*b* of timer 51*b* commencing its timing operation. Upon termination of this timing operation, relay E will deenergize opening the circuit to the M relay by opening E relay contacts 169 and 170. As the M relay drops out, the "walk" light indicating signal is extinguished and the flashing "don't walk" signal is actuated at terminal **162** through previously closed N relay contacts **71** and **72**.

The remainder of the operating characteristics of this pedestrian control unit are the same as that of the above described vehicular unit A except for the provision of lock out timer, timer **51*d***. The purpose of timer **51*d*** is to prevent the immediate reoccurrence of a "walk" light indication after a previous pedestrian crossing. As mentioned above, this feature avoids pedestrian domination of the signal controlled intersection. In operation, relays N and M energize at the same time in the normal manner. Relay N contacts **181** and **182** close energizing the G relay coil through terminals **52*d*** and **53*d*** of timer **51*d*** whereupon the G relay locks upon its own normally open contacts **178** and **179**.

Upon termination of the flashing "don't walk" interval (which correspond to the yellow or caution signal in the vehicle control units) the N relay deenergizes and the normally closed contacts **180** and **181** thereof close the circuit to terminal **54*d*** of timer **51*d*** thus initiating its timing cycle. On the terminal of this cycle, the G relay is deenergized by the shorting of timer terminals **53*d*** and **55*d***. The object of this action is to disable switch **160** from activating the E relay, after an immediately proceeding pedestrian crossing by means of the open G relay contacts **175** and **176** until timer **51*d*** marks off a preselected interval thus the G relay together with timer **51*c*** provide a prevent timer switching means so as to avoid pedestrian dominance of the intersection. As discussed above, this timed interval which may be in the range of 30 seconds, allows efficient vehicular traffic movement while pedestrians are collected for eventual crossing.

It is noted that in the pedestrian control unit shown in FIG. **6**, the F relay provides a similar prevent function to that of the R relay described in previous embodiments of the invention. Particularly, normally closed F relay contacts **171** and **172** open the circuit to the M relay coil in response to energization of the relay coil which occurs upon demand by another control unit through release terminal **93**. At variance with the circuits shown in FIGS. **3** and **6**, however, the actuation of the F relay is not delayed through a timer but occurs promptly upon demand, opening contacts **171** and **172** so as to prevent further pedestrian control of the M relay.

It will be apparent that each of the circuits shown in FIGS. **2**, **6** and **7** have a common basis of operation, this is evidenced by the reoccurrence of the M relay which is responsive to the vehicle or pedestrian traffic and provides for displaying proceed indications in accordance therewith, and the reoccurrence of the P relay in each of the units, which provides with switching circuits **41** and **42** for disabling the operation of one of the units during conflicting operation of the other and insuring against erroneous conflicting signal indications. It is this common basis of operation which provides for the extreme versatility and flexibility of the invention. For example, as shown in FIG. **8** a three-phase vehicular and pedestrian control system is readily assembled through the use of three vehicle control units **200**, **201** and **203**, each identical to control unit **15** shown in FIG. **2** and a pedestrian control unit **205** identical to the pedestrian control unit shown in FIG. **7**. In a manner similar to that described in conjunction with FIG. **1**, control unit **200** provides for switching signal lights **219** for A approaches, unit **201** provides for switching signal lights **218** for B approaches, unit **202** switches signal lights **220** for a left-hand turn approach C and pedestrian control unit **205** operates signal lights **221** for controlling pedestrian traffic along the B direction. Only the output terminals of the control units are shown for convenience, each having a reference numeral corresponding to the terminal numbers shown and described in detail hereinabove. For example, unit A has a detector input terminal **21** connected to detector switches **24** for the A approaches, control unit **201** has a detector input **21** connected to detector switches **24** for the B vehicle approaches, control unit **202** similarly has a detector input **21** connected to detector switch **24** for the left-hand turn C approach while pedestrian control unit **205** has a detector input **21** connected to pedestrian detector switches **160** for the B direction.

Each of control units **200**—**202** have signal control output terminals **40**, **75**, **64** and **81** connected to solid-state switching devices **98**, **99** and **100** in the manner described for switching each of signal lights **219**, **218** and **222**. Pedestrian control unit, **205**, similarly has output terminals **161**, **162** **163** and **164**, a pair of solid-state switching devices **208** and **209** for switching pedestrian signal lights between "walk" and "don't walk" indications. It is noted in this regard, that terminal **162** of pedestrian control unit **205** which provides for the "don't walk" signal indication is not used in this instance.

Now in regard to the connections of each of the units for providing the sequential operation thereof in accordance with instantaneous traffic demands, vehicle control unit **200** has released terminal **93** thereof connected to rest terminals **95** for each of control units **201**, **202** and **205** for preventing operation of unit **200** during proceed and walk indications and caution indications for units **201**, **202** and **205**. Additionally, vehicle control unit **200** has power output terminal **83** connected to AC power input terminals **22** of vehicle control unit **201** and pedestrian control unit **205** for preventing operation of these latter two units during a proceed or caution operation of unit **200** for the A approaches.

Control unit **202**, providing for left-hand turns from the C approach receives power to input terminal **22** thereof, from output **83** of control unit **200** through auxiliary terminals **183** and **184** of pedestrian control unit **205**, so as to disable control unit **202** for the C approach not only when control unit **200** is operating to pass traffic from the A approaches but also during passage of pedestrians in the C direction. That is, during operation of unit **200** passing vehicles in the A direction, power is interrupted at output terminal **83** of unit **200** preventing power from reaching input terminal **22** via unit **201** and **205**. During operation of unit **201**, power is interrupted at output terminal **83** thereof again preventing unit **202** from receiving power at input terminal **22** thereof through pedestrian unit **205**. During operation of pedestrian control unit **205**, power is interrupted at auxiliary terminal **184** again preventing operation of unit **202**.

Additionally, in this example, each of release terminals **93** for units **101**, **102** and **105** are connected to AC(−) so as to provide a maximum time out interval during which each of control units **101**, **102** and **105** may maintain a proceed indication. At variance with this operation, unit **200** having release terminal **93** connected to the rest terminals **95** of each of units **201**, **202** and **205** providing such a maximum time out interval for unit **200** only in the event vehicle or pedestrian traffic is waiting in the B approaches or if vehicle traffic is waiting in the left hand turn C approach. Accordingly, in the instant case, it is anticipated that the A approaches are oriented along the direction of the main street traffic, so as to allow a continuous stream of traffic therealong to maintain a continuous proceed indication until the traffic approaches the intersection along one of the other directions.

It is noted that several of the terminals for each of the control units remain unconnected, for example rest terminal **95** of unit **200**. As indicated above, due to the universal characteristics of each of the units, allowing for mass production and modular assembly, it is not always necessary or desirable to utilize each and every function of the units. However, by providing identical and universal units which may be sold separately and assembled into a system according to the requirements of a particular intersection or traffic control problem, extreme versatility is obtained together with economy in manufacturing the circuits.

As an example of this versatility, it will be appreciated that concurrent movements of traffic may be provided if desired for certain intersections, such as concurrent left-hand turns from the C approach together with nonconflicting movement of traffic from the right-hand side A approach. Additionally, overlapping movements may be provided for, wherein a first approach to an intersection is allowed to proceed concurrently with adjacent but separate movements of traffic from two or more approaches. That is, movement in the first direction overlaps the movement in the remaining several directions. Further still, preemptor traffic operations are readily adapted to the instant system as discussed above, allowing for emergency traffic situations at intersections for example near a fire station. In this situation, separate detection of the emergency traffic by a separate control unit, would immediately interrupt operation of each of the remaining control units so as to allow preemption thereof.

We claim:

1. A system for controlling traffic through an intersection having at least first and second approaches thereto, wherein the traffic in said first approach is characterized by vehicles exhibiting a substantial magnetizable mass, comprising in combination:

first detector means associated with the first approach characterized by an electromagnetic sensor productive of an electromagnetic field within a region of the first approach proximate the intersection and being responsive to such vehicles within said field to assume its actuated condition, and having a rest condition and an actuated condition and being responsive to the presence of traffic in the first approach to assume its actuated condition;

second detector means associated with the second approach characterized by having a rest condition and an actuated condition and being responsive to the presence of traffic in the second approach to assume its actuated condition;

first detector controlled switching means operatively connected to said first detector means and having first and second modes, said first switching means being responsive to said first detector means in its rest condition to assume its first mode and being responsive to said first detector means in its actuated condition to assume its second mode;

second detector controlled switching means operatively connected to said second detector means and having first and second modes, said second switching means being responsive to said second detector means in its rest condition to assume its first mode and being responsive to said second detector means in its actuated condition to assume its second mode;

supervisory circuit means operatively connected to said first and second switching means and having first and second states, said supervisory circuit means being responsive to said first switching means in its second mode to assume its first state and being responsive to said second switching means in its second mode and said first switching means in its first mode to assume its second state;

first traffic signal means characterized by having mutually exclusive stop and proceed traffic directory conditions and positioned to indicate its condition to traffic in the first approach, said first signal means operatively connected to said supervisory circuit means together with said first switching means and being responsive to said supervisory switching means in its first state and said first switching means in its second mode to assume its proceed condition and responsive to said supervisory circuit means in its second state to assume its stop condition;

second traffic signal means characterized by having mutually exclusive stop and proceed traffic directory conditions and positioned to indicate its condition to traffic in the second approach, said second signal means operatively connected to said supervisory circuit means together with said second switching means and being responsive to said supervisory circuit means in its second state and said second switching means in its second mode to assume its proceed condition and responsive to said supervisory circuit means in its first state to assume its stop condition;

first prevent switching means operatively connected to said first and second switching means and said supervisory circuit means and having a normal mode and a disabling mode, said first switching means responsive to said prevent switching means in its disabling mode to assume and remain in its first mode, said prevent switching means being responsive to said supervisory circuit means in its second state and said second switching means in its second mode to assume its disabling mode;

first time out switching means operatively connected to said first and prevent switching means, said time out switching means responsive to said first switching means in its second mode to actuate said prevent switching means to its disabling mode after a preselected time interval with said supervisory circuit means in its first state and said second switching means in its second mode;

second prevent switching means and second time out switching means operatively connected to said second switching means and said supervisory circuit means, said second prevent switching means having a normal mode and a disabling mode, said second switching means responsive to said second prevent switching means in its disabling mode to assume and remain in its first mode, said second prevent switching means responsive to said second time out switching means to assume its disabling mode after a preselected time interval with said supervisory circuit means in its second state and said second switching means in its second mode;

advance detector means having a rest condition and an actuated condition and being characterized by an electromagnetic sensor productive of an electromagnetic field and responsive to the presence of such vehicles within said field to assume its actuated condition, said advance detector means positioned to arrange its field within said approach adjacent the field of said first detector on the side thereof opposite the intersection to respond to such vehicles approaching the intersection prior to the response of said first detector means; and

advance timer switching means operatively connected to aforesaid first switching means and said advance detector means and having a normal state and a disabling state, said first switching means being responsive to said advance detector means in its actuated condition and said advance timer switching means in its normal state to assume its second mode, said advance timer switching means being responsive to said first switching means in its first mode to assume its normal state and responsive to said first switching means being in its second mode for a preselected time interval to assume its disabling state.

2. A system for controlling traffic through an intersection having at least first and second approaches thereto, wherein the traffic in the second approach is composed of pedestrians, comprising in combination:

first detector means associated with the first approach characterized by having a rest condition and an actuated condition and being responsive to the presence of traffic in the first approach to assume its actuated condition;

second detector means associated with the second approach characterized by a manually operated switch disposed for operation by the pedestrians and responsive to such operation to momentarily assume its activated condition and having a rest condition and an actuated condition and being responsive to the presence of traffic in the second approach to assume its actuated condition;

first detector controlled switching means operatively connected to said first detector means hand having first and second modes, said first switching means being responsive to said first detector means in its rest condition to assume its first mode and being responsive to said first detector means in its actuated condition to assume its second mode;

second detector controlled switching means operatively connected to said second detector means and having first and second modes, said second switching means being responsive to said second detector means in its rest condition to assume its first mode and being responsive to said second detector means in its actuated condition to assume its second mode;

supervisory circuit means operatively connected to said first and second switching means and having first and second states, said supervisory circuit means being responsive to said first switching means in its second mode to assume its first state and being responsive to said second switching means in its second mode and said first switching means in its first mode to assume its second state;

first traffic signal means characterized by having mutually exclusive stop and proceed traffic directory conditions and positioned to indicate its condition to traffic in the first approach, said first signal means operatively connected to said supervisory circuit means together with said first switching means and being responsive to said supervisory switching means in its first state and said first switching means in its second mode to assume its proceed condition and responsive to said supervisory circuit means in its second state to assume its stop condition;

second traffic signal means characterized by having mutually exclusive stop and proceed traffic directory conditions and positioned to indicate its condition to traffic in the second approach, said second signal means operatively connected to said supervisory circuit means together with said second switching means and being responsive to said supervisory circuit means in its second state and said second switching means in its second mode to assume its proceed condition and responsive to said supervisory circuit means in its first state to assume its stop condition;

first prevent switching means operatively connected to said first and second switching means and said supervisory circuit means and having a normal mode and a disabling mode, said first switching means responsive to said prevent switching means in its disabling mode to assume and remain in its first mode, said prevent switching means being responsive to said supervisory circuit means in its second state and said second switching means in its second mode to assume its disabling mode;

first time out switching means operatively connected to said first and prevent switching means, said time out switching means responsive to said first switching means in its second mode to actuate said prevent switching means to its disabling mode after a preselected time interval with said supervisory circuit means in its first state and said second switching means in its second mode; and

a pedestrian timer switching means operatively connected between said second detector means and second switching means and having a normal state and an actuated state, said pedestrian timer switching means operative in its normal state to maintain said second switching means in its first mode and operative in its timing state to activate said second switching means to its second mode for a preselected time interval, said pedestrian timer switching means responsive to said second detector means being momentarily in its activated condition to assume its timing state until termination of said interval.

3. A system as defined in claim 2, further comprising prevent timer switching means operatively connected between said second detector means and said pedestrian timer switching means and having a normal mode and a disabling mode, said prevent timer switching means operative in said normal mode to permit said pedestrian timer switching means to assume its normal and timing states in aforesaid response to said second detector means and operative in its disabling mode to render said pedestrian timer switching means nonresponsive to said second detector means.

4. A control unit for use in a traffic control system having a traffic detector associated with one approach to an intersection and productive of an electrical signal in response to traffic therein and an electrically operated traffic signal having separate proceed, caution and stop conditions also associated with such approach and electrical control means for regulating traffic associated with another approach to the intersection productive of an electrical signal indicating its instant mode of operation and reception of a source of operating power, wherein the control unit comprises;

a detector input adapted to be connected to the detector for receiving the electrical signal therefrom,

a first electrical power input adapted to receive a controlled source of electrical power;

a second electrical power input adapted to receive a continuous source of electrical power;

a release input adapted to be connected to the control means for receiving the electrical signal indicative of the instant operational mode thereof;

an electrical power output adapted to be connected to the control means unit for providing the controlled source of power therefor;

traffic signal proceed, caution and stop outputs adapted to be connected to the traffic signals for providing electrical signals separately actuating its proceed, caution and stop conditions;

detector controlled switching means having first and second modes and being connected to said detector input, and said first power input, said detector controlled switching means being responsive to said detector input to assume its first or second modes in response to the electrical signal appearing thereat;

supervisory circuit means having first and second states and being connected to said detector controlled switching means, said first electrical power input, said release input, said electrical power output and said traffic signal proceed and caution outputs, said supervisory circuit means being responsive to said detector controlled switching means in its second mode to assume its first state and being responsive to said detector controlled switching means in its first mode and the controlled source of power appearing at said first power input and the electrical signal appearing at said release input to assume its second state, said electrical power output being responsive to said supervisory circuit means in its second mode and the controlled source of power appearing at said first power input to provide the controlled source of power for the control means, said traffic signal proceed output being responsive to said supervisory circuit means in its first state and said detector controlled switching means in its second mode, and the controlled source of power appearing at the said first power input to provide the electrical signal for actuating the traffic signal to its proceed condition; and

caution timer switching means having a normal and an actuated state and being connected to said supervisory circuit means, said detector controlled switching means, said second power input, said traffic signal caution output and stop output, said caution timer switching means being responsive to said supervisory circuit means in its first state and said detector controlled switching means in its second mode and the controlled source of power appearing at said first power input to assume its actuated state being responsive to said detector controlled switching means resuming its first mode to assume its normal state after a preselected interval, said traffic signal caution output being responsive to said caution timer switching means in its normal state to provide the electrical signal for actuating the traffic signal to its stop condition.

5. In a system as defined in claim 4, wherein the control means is receptive to an electrical signal indicating the instant operational mode of the control unit and the control unit further comprises;

a rest output adapted to be connected to the control means, said rest output being connected to said detector controlled switching means and said caution timer switching means and being responsive to said detector controlled switching means in its second mode or said caution timer switching means in its actuated state to provide the electrical signal at said rest output indicating the mode of the control unit.

6. In a system as defined in claim 4, the control unit further comprising;

a prevent switching means connected to said detector controlled switching means, said supervisory circuit means and said release input and having a normal mode and a disabling mode, said detector controlled switching means being responsive to said prevent switching means in its disabling mode to assume and remain in its first mode, said prevent switching means responsive to said supervisory circuit means in its second state and the electrical signal appearing at said release input to assume its actuated mode.

7. In a system as defined in claim 4, the control unit further comprising;

time out switching means connected to said detector controlled switching means and said prevent switching means, said prevent switching means being responsive to said time out switching means and said detector controlled switching means in its second mode and said supervisory circuit means in its first state and the presence of the electrical signal at said release input for a preselected time interval to assume its disabling mode.

8. In a system as defined in claim 4, wherein said supervisory circuit means is responsive to said caution time switching means being in its actuated state to remain in its first state.

9. In a system as defined in claim 6, the control unit as defined, wherein said prevent switching means is responsive to said caution timer switching means in its actuated state and said detector controlled switching means in its first mode to assume its disabling mode.

10. In a system as defined in claim 4, further characterized by an additional traffic detector associated with the first named approach and productive of an electrical signal indicative of traffic conditions therein in advance of the first named detector, and the control unit further comprising;

an advance detector input adapted to be connected to the addition detector for receiving the electrical signal therefrom; and

advance timer switching means having a normal state and a disabling state and being connected to said advance detector input and said detector controlled switching means, said detector controlled switching means being responsive to the electrical signal appearing at said advance detector input when said advance timer switching means is in its normal state to assume its first and second modes, said advance timer switching means being responsive to said detector controlled switching means being in its second mode for a preselected time interval to assume its disabling state and being responsive to said detector controlled switching means in its first mode to assume its normal state.

11. In a system as defined in claim 5, further characterized by the traffic in the first named approach being composed of pedestrians and the detector being a manually operated switch providing the electrical signal therefor,

pedestrian timer switching means connected to said detector input and said detector controlled switching means and having a normal state and an actuated state, said detector controlled switching means being responsive to said pedestrian timer switching means in its actuated state to assume its second mode for a preselected time interval, said pedestrian timer switching means being responsive to the electrical signal appearing at said detector input and the source of power at said second power input to assume and remain in its actuated state and being responsive to said supervisory circuit means being in its first state and said detector controlled switching means being in its second mode for said interval to assume its normal state.

12. In a system as defined in claim 11, the control unit further comprising;

prevent timer switching means connected between said detector input and said pedestrian timer switching means and having a normal mode and a disabling mode, said pedestrian timer switching means being responsive to said detector input, said prevent timer switching means further being connected to said second power input and said caution timer switching means and being responsive to said second power input and said caution timer switching means in its actuated state to assume its disabling mode for a preselected interval.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,582,876 Dated June 1, 1971

Inventor(s) Howard Carmack et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 2, "non conflicting" should read -- non-conflicting --; line 30, "d4awings" should read -- drawings --. Column 3, line 66, "From" should read -- from --. Column 6, line 26, "155" should read -- 66 --; lines 35 and 36, cancel "to the R relay coil and release terminal 73 and timer". Column 10, line 72, after "delivered" insert -- to terminal --. Column 16, line 62, after "switching means" insert -- in its actuated state and said detector controlled switching means in its first mode to provide the electrical signal for actuating the traffic signal to its caution condition, said traffic signal stop output being responsive to said caution timer switching means --.

Signed and sealed this 18th day of January 1972.

(SEAL)
Attest

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents