

April 4, 1967

A. BROTHMAN ET AL
TRAFFIC LOOP DETECTOR

3,312,935

Filed April 21, 1964

2 Sheets-Sheet 1

FIG. 1a.

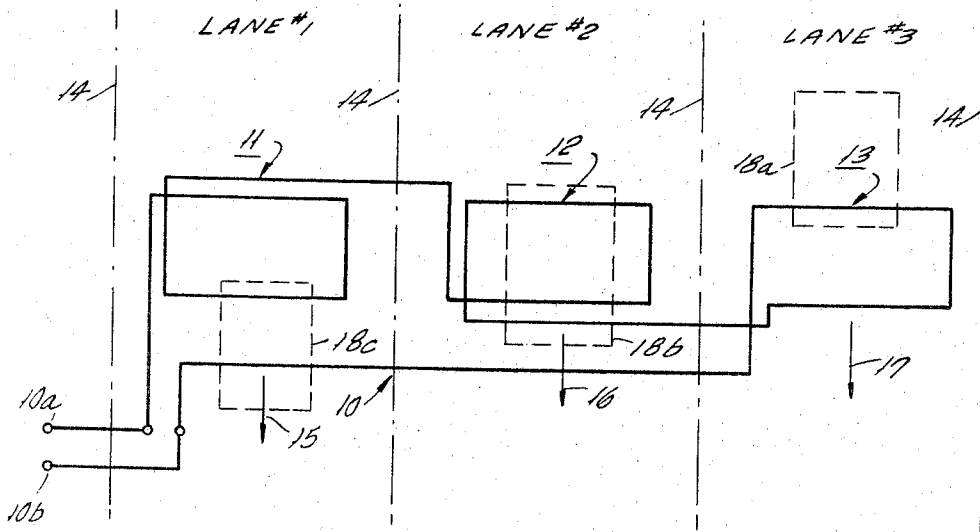
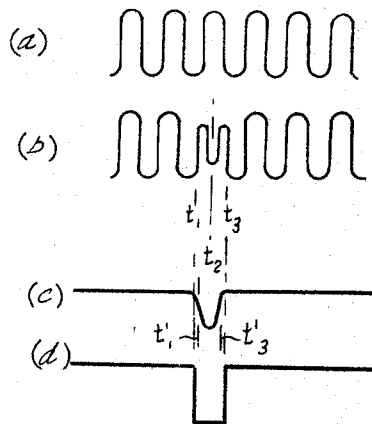


FIG. 2.



INVENTORS
ABRAHAM BROTHMAN
RICHARD D. REISER
BY MICHAEL GOMERY
BRUCE A. CUDDEBACK
OSTROLENK, FABER, GERB & SOFFEN
ATTORNEYS

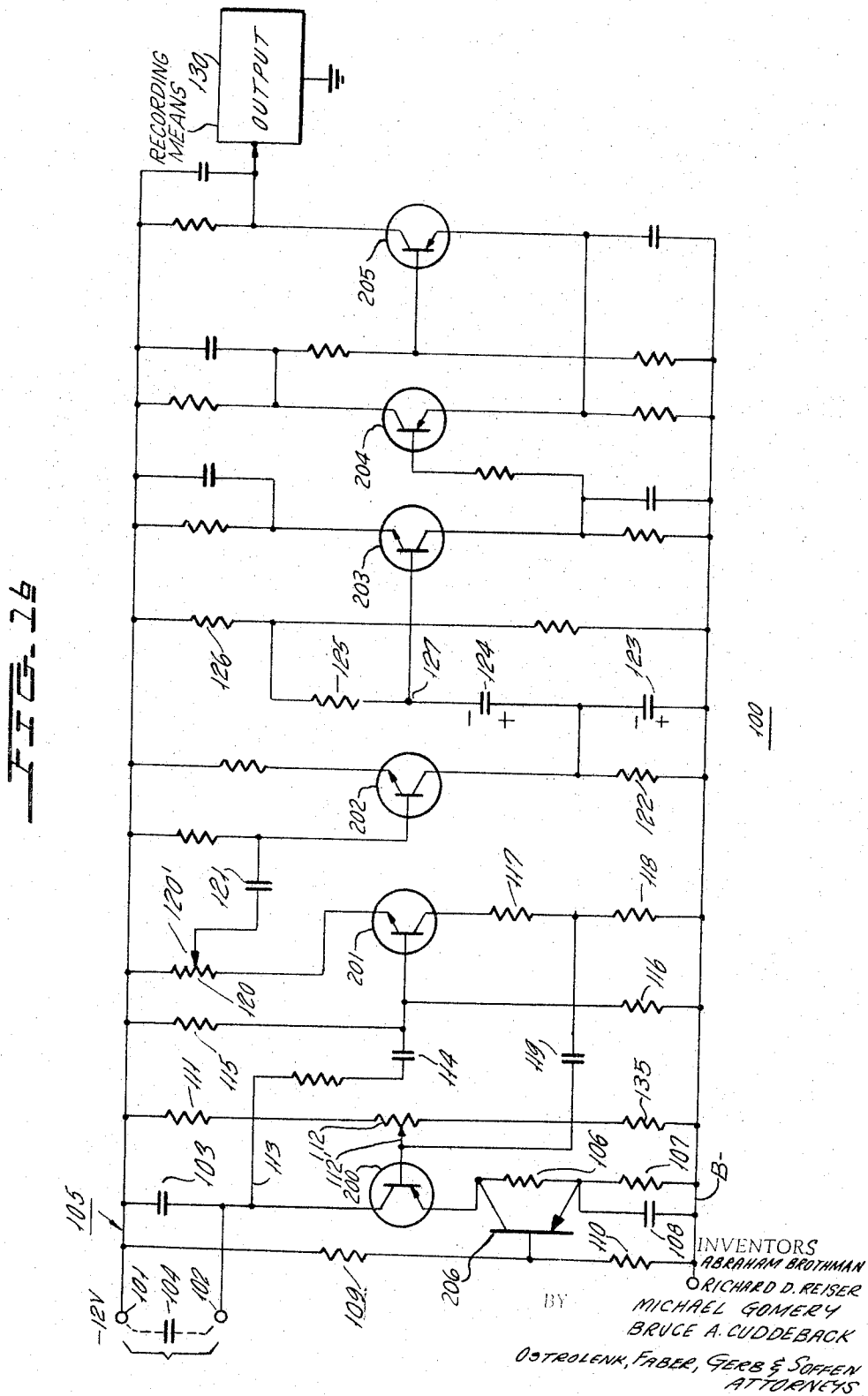
April 4, 1967

A. BROTHMAN ETAL
TRAFFIC LOOP DETECTOR

3,312,935

Filed April 21, 1964

2 Sheets-Sheet 2



1

2

3,312,935

TRAFFIC LOOP DETECTOR

Abraham Brothman, Dumont, Richard D. Reiser, Waldwick, Michael Gomery, Saddle River, and Bruce A. Cuddeback, Waldwick, N.J., assignors, by mesne assignments, to Sangamo Electric Company, Springfield, Ill., a corporation of Delaware

Filed Apr. 21, 1964, Ser. No. 361,339

5 Claims. (Cl. 340—38)

The instant invention relates to sensing means and more particularly to novel electronic sensing or detection means providing an output signal which is highly suitable as a means for counting moving vehicles for traffic control purposes and the like.

In order to both simplify and aid the duties of highway planning commissions and street and highway maintenance departments throughout the world, it is quite frequent that traffic counting devices be employed. Such counting devices accurately determine traffic volume for periods of days, weeks, months, years and so forth, which information is highly useful in scheduling road and highway maintenance as well as in the determination of such traffic counting means and also have been designed with the capabilities of determining the speed of vehicles along the highway which the counting device is set up to monitor, thereby increasing the versatility of such devices.

Typically, traffic detectors or counters of this type are electromechanical in nature and are comprised of a resilient rubber hose which is positioned upon the highway surface in a direction transverse to the flow of traffic with a pneumatic linkage being established between the rubber hose and the mechanical counting means. Since the elongated rubber hose makes direct physical contact with the wheels of the passing vehicles, it is exposed to a high degree of wear, thus requiring frequent repair and/or replacement of the components. In addition thereto, such traffic detectors are exposed to the atmospheric and climatic conditions such as rain, snow, heat and humidity which act to still further aid in the wearing out, or destruction, of the rubber hose.

The instant invention provides electronic traffic detection means which are substantially low in cost relative to present day traffic detectors and which in providing inductive linkage with the moving vehicles thereby completely avoids the occurrence of any physical contact between the detector means and the moving vehicle so as to insure an extremely long, useful, operating life for the detector means.

The detector means of the instant invention is comprised of wire loop means which is preferably imbedded into the surface of the highway street or road in which it is to be used. The loop means is coupled into a suitable tank circuit which preferably, but not necessarily, as a low Q (as it is commonly called) which is a measure of the quality of the tuned circuit. The Q of a circuit is normally inversely proportional to the amount of resistance contained in the tank circuit. That is, a low Q is present in the face of a large resistance.

The low grade or quality tank circuit is connected into a self sustaining electronic oscillating circuit having feedback means for sustaining the output of the circuit at a given frequency. The output of the oscillating means is suitably demodulated and amplified by electronic demodulation and amplification circuits to produce an output signal which represents the envelope of the alternating frequency signal generated by the oscillating means.

The operation of the circuit is such that when a vehicle passes over the loop imbedded in the road or highway, this action tends to degrade the quality of the tank circuit due to a removal of energy from the circuit by the passing vehicle. This causes the oscillating means to tend toward

increasing its output in order to sustain the tank circuit operation at its prior energy level. Current limiting means are provided within the oscillating means, which act to prevent the oscillating means to increase its over-all energy output, causing the oscillating means to react in such a manner as to significantly diminish the amplitude of the output signal. The result is such that the traffic loop detector circuit generates a very well defined pulse having a front porch representing the entrance of the vehicle upon the inductive loop; a back porch representing the departure of the vehicle from the inductive loop and a pulse width or pulse duration representing the time taken to pass over the inductive loop by the vehicle. This very well defined and hence easily distinguishable output pulse is then used to drive any form of recording means, such as a mechanical or electromechanical chart recorder, or an electronic counting circuit, for example. The cumulative count may then be utilized as input information to an automatic traffic control center or for any of the other applications previously mentioned.

The advantages of the instant invention are many. Since the inductive loop which forms a part of the traffic loop detector is buried into the road or highway, no physical contact exists between the loop detector system and the moving traffic being measured so that neither the physical elements nor the traffic have any appreciable effect upon the operating life of the system. Since the circuit is deliberately, or at least preferably, designed to have a low quality or Q, any suitable wire may be employed. Since the type of wire employed and the coupling between the wire loop and the moving vehicles is not critical, the wire may be imbedded in an extremely shallow groove provided within the street or road surface, it being experimentally shown that a one or two inch cut in the road surface is more than adequate for this purpose. The configuration of the wire loop is in no way critical, thus greatly facilitating the installation thereof, making it a simple and very straightforward operation. The circuit requires effectively no adjustment whatsoever. Since the Q of the circuit is so low, wire having the highest resistivity per thousand feet may be used, thereby greatly diminishing the cost of such wire. In applications where it is desired to detect vehicular traffic on multilane highway or road surfaces, a single traffic detector may be used, simply by providing at least one loop for each lane of traffic to be monitored.

Since the frequency of the output signal generated by the oscillating means employed in the traffic detector system is in no way critical, nor is it employed for the detection purpose, there is no necessity for controlling or attempting to maintain the operating frequency of the circuit. In addition, it is quite normal to find a good deal of metal structure imbedded in or near a road surface, which metal structure appreciably affects the inductive value of the circuit, thereby affecting the resonant frequency. All of these outside influences can vary markedly from location to location. By providing a system which is effectively insensitive to and is not dependent upon frequency changes for successful counting operation thereof, no consideration whatever need be given to the manner of installation of the instant invention nor need any consideration be given to the proximity of other metallic objects and their lack of homogeneity (i.e. non-continuous) distribution within the operating region of the traffic detector inductive loop.

Since the circuit is effectively insensitive to the outside influences of metallic elements, the significant output of the traffic detector circuit is its output envelope as opposed to the frequency of the output signal generated. The easily distinguishable changes in shape of the wave envelope lend itself readily to usage as a traffic loop de-

3

tor which is far superior in its ruggedness, design and operation to present day traffic detectors.

It is therefore one object of the instant invention to provide novel electronic detector means for detecting and counting vehicular traffic and the like.

Still another object of the instant invention is to provide novel electronic traffic detector means for detecting vehicular traffic and the like wherein no physical contact need take place between the vehicular traffic and the detector means for a successful operation thereof.

Still another object of the instant invention is to provide novel loop detector means for detecting and counting vehicular traffic and the like comprising oscillator means having a tank circuit with at least one inductive element positioned in close proximity to the vehicular traffic to be measured.

Still another object of the instant invention is to provide novel loop detector means for detecting and counting vehicular traffic and the like comprising oscillator means having a tank circuit with at least one inductive element positioned in close proximity to the vehicular traffic to be measured wherein said tank circuit has a substantially low Q.

Another object of the instant invention is to provide novel electronic traffic detector means for detecting and counting vehicular traffic and the like comprising oscillator means having a tank circuit of a low Q and current limiting means in said tank circuit for controlling the energy fed into the tank circuit.

Another object of the instant invention is to provide novel electronic traffic detector means for detecting and counting vehicular traffic and the like comprising oscillator means having a tank circuit of a low Q and current limiting means in said tank circuit for controlling the energy fed into the tank circuit and further having demodulation means for extracting only the envelope from said oscillator means output signal.

These and other objects of the instant invention will become apparent when considering the accompanying description and drawings in which:

FIGURE 1a is a schematic view showing the traffic loops employed in the traffic detector of the instant invention.

FIGURE 1b is a schematic diagram of the traffic loop detector circuit which combines with the inductive loops of FIGURE 1a to form the traffic loop detector designed in accordance with the principles of the instant invention.

FIGURE 2 shows a plurality of waveforms employed for describing the invention.

Referring now to the drawings, FIGURE 1a shows the induction means 10 which may be employed in the instant invention and which is comprised of terminals 10' and 10''. The induction means 10 is further provided with three independent loops 11, 12 and 13 which are connected in series fashion in the general loop arrangement 10. Each of the loops 11-13 are preferably substantially coplanar and are imbedded into the surface of the road or highway on which traffic is to be monitored. In the embodiment of FIGURE 1a, it is assumed that traffic detection is required for half of a six-lane highway with the loops 11, 12 and 13 being positioned in each of the three lanes of the highway, which lanes are defined by the phantom lines 14. Let it further be assumed that the direction of flow of traffic in each lane is represented by the arrows 15-17. Thus, the connecting terminals 10' and 10'' of the general loop means 10 are positioned along the left-hand edge of the arrangement of FIGURE 1a. While the configuration of each of the loops 11-13 is not critical, it is preferable that each loop be comprised of three turns (with only one turn for each loop being shown in FIGURE 1a for the purpose of simplicity) and such that the dimensions of each loop are six feet in width by three feet in length. Since the operating frequency of the traffic detector circuitry, which will

4

be more fully described, is not a critical selection, no great concern need be given about the accuracy of the dimensions of each loop, the number of turns provided in each loop 11-13, nor need any degree of concern be given to the diameter of the wire employed or the resistivity per thousand feet of the wire which is ultimately selected. This makes the cost and installation procedures greatly simplified.

FIGURE 1b shows the loop detector solid state circuitry 100, having input terminals 101 and 102 to which the loop terminals 10' and 10'', respectively, are connected. Such connection establishes a tank circuit arrangement by virtue of the parallel connection of loop means 10 with capacitor 103. Capacitor 104, shown in dotted fashion, and further shown connected across terminals 101 and 102, represents the distributed capacitance due to electronic connections and any capacitance that exists within the loop means 10 itself. Thus, these three elements which have been shown as the circuit parameters 10, 103 and 104, establish the resonant frequency of the tank circuit 105. The tank circuit 105 is connected between a voltage source -12 v. and the collector electrode of a transistor 200, the emitter electrode of which is series connected through resistors 106 and 107 to the ground potential level B minus. Capacitor 108, connected in parallel with resistor 107, acts to establish the self-bias for transistor 200.

The collector and emitter electrodes, respectively, of a transistor 206 are connected across the terminals of resistor 106. The base of transistor 206 is connected to the common point between resistors 109 and 110, which form a potential divider to establish the bias voltage for the operation of transistor 206. The transistor 206, being connected in the manner shown in FIGURE 1b, controls the current flow in the circuit of transistor 200, in a manner to be more fully described.

Second potential divider means is comprised of resistors 111, 135 and adjustable resistor 112, which are connected between minus 12 volts and ground potential. Adjustable resistor 112 is provided with a contact arm 112' connected to the base electrode of transistor 200 to establish its bias level.

With the resonant frequency of the tuned circuit 105 of transistor 200 being established by the elements 10, 103 and 104, this alternating frequency signal constitutes the output of transistor circuit 200 and is connected via conductor 113 and capacitor 114 to the base electrode of transistor 201. A potential divider comprised of resistors 115 and 116 have their common terminal connected to the base electrode of transistor 201 and their opposite terminals connected between minus 12 volts and ground potential level B minus. The signal developed in the collector circuit of transistor 201 appears at the common terminal between resistors 117 and 118 such that a portion of this signal is fed back through capacitance 119 to the base of transistor 200. The 180° phase shift which takes place between base and collector electrodes of transistor 201 acts to sustain operation of transistor 200 at the resonant frequency established by tank circuit 105.

The emitter electrode of transistor 201 is connected to the minus 12 volt level by adjustable resistance means 120, having movable arm 120' connected through capacitor 121 to the base transistor 202. This signal appearing at the emitter electrode of transistor 201 constitutes the output waveform from tank circuit 105, which operating waveform is impressed upon the base electrode of transistor 202 which comprises a demodulation stage. The collector electrode of transistor 202 is connected through the parallel connected resistor and capacitor elements 122 and 123, respectively, to the ground potential level B minus. The parallel coupled elements 122 and 123 are further connected in the series path comprised of capacitor 124 and resistors 125 and 126, which total series path is connected between B minus and minus 12 volts. The

common terminal between resistor 125 and capacitor 124 is connected to the base electrode of transistor 203. The alternating frequency wave impressed upon the base of transistor 202 undergoes demodulation by the transistor circuit 202 so that the wave envelope appears at the output terminal 127, which envelope is impressed upon the base of transistor 203. The transistor circuit 203 acts as an A.C. gain stage amplifying the output of the demodulation stage comprised of transistor 202. The output of the A.C. gain circuit comprised of transistor 203 is impressed upon the base of transistor 204 from the collector of transistor 203. The stage comprised of transistor 204 acts as a D.C. gain stage. The second D.C. gain stage is comprised of transistor 205, the base electrode of which is connected to the collector electrode of transistor 204. The output of the last D.C. gain stage appears at the collector electrode of transistor 205 and is impressed upon suitable output utilization means 130. The output means 130 may be an electronic counter, a mechanical or electromechanical recording means, such as a chart recorder, or a data processing system, any of which may be designed to count the pulses developed by the traffic detector circuit 100.

The operation of the traffic loop detector is as follows:

Considering both FIGURES 1a and 1b, let it be assumed that a vehicle is progressing along the highway or road surface being monitored by the loop detector 100. While the development provided herein will utilize all three lanes shown in FIGURE 1a, this is done only for purposes of clarity and it should be understood that the positions shown in the figure are progressive positions all of which would occur in each lane as a vehicle passes the monitoring location of the loop detector. Let it be assumed that a vehicle is progressing along the road surface and is moving in the direction shown by arrow 17 in lane 3. As the vehicle, represented by the dotted line box 18, progresses in the direction 17, its forward end moves above one side of loop 13. Immediately prior to this time and assuming that no other vehicle is near any of the loops 11-13, the oscillator stage of the detector 100, comprised of transistors 200 and 201, generates an output waveform of constant amplitude and frequency as shown by the waveform *a* of FIGURE 2.

At the time t_1 at which the forward end of vehicle 18a is positioned above loop 13, the metal of the vehicle in position 18 extracts energy generated by the loop 13, thereby removing energy from the tank circuit 105.

The entry of the vehicle 18 into the loop simultaneously extracts energy generated by the loop and degrades the loop Q, thereby causing the loop means 10 and hence the tank circuit 105 to dissipate energy at a greater rate.

Due to the feedback loop established between transistor circuits 200 and 201, the oscillator wants to maintain operation with the same constant amplitude at which it was operating previous to the entry of the motorized vehicle into the loop region 13. However, instantaneously, due to the greater energy dissipation rate of the tank circuit 105, the current in the 200 emitter and collector circuits experiences an initial drop. This drop in current establishes a decreased voltage drop across the resistor 106, hence establishing new voltage conditions across the emitter and collector electrodes of transistor 206. The basic function of the transistor 206 is that of enhancing the effect of the degraded tank circuit in order to provide a clear distinction between normal operation and operation which occurs due to the entry of a vehicle into the loop means 10. Thus, it is the basic function of the 206 circuit to provide a significant difference in output amplitude of the tank circuit generated signal upon the passage of a motorized vehicle through the region of the loop means 10.

When the voltage drop across resistor 106 drops instantaneously, this causes the conductivity of transistor 206 to decrease significantly and hence causing its resistivity (which is the inverse of conductivity) to increase at the

same rate. This, thereby establishes a larger resultant resistance across the terminals of the parallel connected elements 106 and 206. This resultant, or total resistance automatically acts to limit the amount of current which may flow through the emitter circuit of transistor 200. Thus, even though the output taken from the collector circuit of transistor 201 attempts to provide regenerative feedback into the base of transistor 200, this feedback signal is nevertheless insufficient to enable transistor 200 to regain the operating state which it occupied previous to the entry of vehicle 18a into the loop 13.

Thus, considering waveform B of FIGURE 2, at the time t_1 at which the forward end of vehicle 18 enters the loop 13, the amplitude of the tank circuit signal decreases markedly. Maximum degradation in the Q of the tank circuit occurs when the vehicle is in the position 18', which is shown in the lane 2, purely for purposes of simplicity. This maximum degradation occurs at the time t_2 , as shown in waveform B of FIGURE 2. At time t_3 , the vehicle is in the position 18'', shown in lane 1 and, with the vehicle almost completely removed from the region of the loop, the Q of the circuit becomes upgraded, the tank circuit 105 dissipates energy at a lower rate and the current requirement for the 200 transistor circuit becomes diminished so that the amplitude level of the output signal returns to normalcy at the time t_3 as shown in waveform B. It should be understood that the time duration t_3 minus t_1 is very small and the waveform B of FIGURE 2 shows the time scale greatly expanded for purposes of simplicity only. For example, in the case of a vehicle traveling at 60 miles per hour, or 88 feet per second, through the loop 13 of the dimensions given therein, the time duration t_3 minus t_1 is approximately 34 milliseconds; for a vehicle traveling at 40 miles per hour or 58.7 feet per second the time duration t_3 minus t_1 is equal to approximately 51 milliseconds.

The demodulation circuit which is comprised of the transistor 202 generates merely the wave envelope of the original waveform from the tank circuit. This is shown by waveform C of FIGURE 2, with the negative tick being formed during the time period t_2-t_3 . The output of the demodulator circuit is first amplified by an A.C. gain stage comprised of transistor 203 which then feeds the signal upon the input or base electrode of transistor 204 which together with transistor 205 forms a Schmitt trigger circuit, which circuits are well known in the art. Basically, it is sufficient to understand that the Schmitt trigger circuit is normally disabled until a signal which surpasses the threshold level of the transistor 204 base electrode is impressed upon this electrode so as to trigger the circuit into operation forming a pulse as shown by the waveform D of FIGURE 2. The threshold, for example, may be surpassed at a time t_1' just slightly after time t_1 while the reversal of the waveform C may occur at a time t_3' just slightly before the time t_3 , providing a pulse having a time duration t_3' minus t_1' , which pulse appears at the collector of transistor 205 and is then impressed upon an output utilization means 130 which may, for example, be a chart recorder, an electronic counting circuit, an electromechanical counting circuit, data processing means or an automatic traffic control center.

The circuit described herein requires no adjustment whatsoever as far as its operating frequency is concerned since the measurement to which the circuit is responsive is that of amplitude and not frequency. The circuit is operative over an extremely wide range, for example, a typical oscillator output is 20 volts peak-to-peak. The circuit, however, will provide very satisfactory operation in the range from 5-17 volts peak-to-peak, with no adjustments whatsoever being necessary. The adjustable resistor means 120 is provided so as to prevent transistor 202 from being driven into saturation. While the embodiment of FIGURES 1a and 1b is designed for monitoring three lanes of a highway, it should be understood that the circuit is readily adaptable for highways having a

greater or lesser number of lanes. For a single lane, for example, the loop means 10 of FIGURE 1a need be designed with only one loop having the dimensions of one of the loops 11, 12 or 13, shown therein. Another loop dimension which has proven to yield satisfactory results is that of providing a substantially rectangular loop having three turns with the dimensions of the rectangle being 4' x 9' with the wire being used having a total series resistance of approximately 40 ohms. The circuit of the type shown in FIGURE 1 employing a loop of this type has proven to yield extremely good results and have a high degree of sensitivity over a voltage range from 6-16 volts D.C. variance in the power supply for the detector circuit.

While a preferred embodiment has been described herein in numerous modifications and variations will be apparent to those skilled in the art. For example, the pulse output as shown by waveform C of FIGURE 2 may be immediately employed without going to the use of a Schmitt trigger circuit. Also, a differentiation circuit might be substituted for the Schmitt trigger circuit, to name just a few modifications, therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

What is claimed is:

1. Means for detecting the movement of vehicles and the like comprising first means arranged for inductive association with moving vehicle; second means for forming a resonant electrical circuit with said first means; third transistor means for supplying energy to said first and second means; feedback means coupled to said third means for sustaining the operation of said first, second, and third means at the resonant frequency; fourth means for demodulating the output of the resonant circuit to produce the wave envelope of said frequency signal; the rate of dissipation of energy by said resonant circuit being increased due to the passage of a vehicle; variable impedance means connected in series with said third transistor means to reduce the output of said third means when its energy dissipation rate increases; said variable impedance means comprising fifth transistor means having base, emitter and collector electrodes;

sixth means for maintaining said base electrode at a reference voltage level;

resistance means coupled in parallel across said emitter and collector electrodes; one terminal of said resistance means being connected to said third transistor amplifier means, and the other terminal of said resistance means being coupled to ground potential.

2. Means for detecting the movement of vehicles and the like at a selected location comprising; resonant circuit means having at least one inductive element at said selected location; transistor amplifier means for supplying energy to said resonant circuit means; feedback means connected to said transistor amplifier means for sustaining operation of said resonant circuit means at a constant amplitude and frequency; demodulation means connected to said resonant circuit for detecting the wave envelope of said resonant circuit means output; said transistor amplifier means having variable impedance means for controlling the energy supplied to said resonant circuit means by said amplifier means; the Q of said resonant circuit means being degraded due to the passage of a vehicle in the region of said inductive element; said variable impedance means controlling the increasing of its impedance when the Q of said resonant circuit means is degraded to reduce the amplitude of the output signal from said resonant circuit means; said variable impedance means comprising transistor means having base, emitter and collector electrodes;

means for maintaining said base electrode at a reference voltage level;

resistance means coupled in parallel across said emitter and collector electrodes; one terminal of said resistance means being connected to said transistor ampli-

fier means, and the other terminal of said resistance means being coupled to ground potential.

3. Means for detecting the movement of vehicles and the like at a selected location comprising; resonant circuit means having at least one inductive element at said selected location; transistor amplifier means for supplying energy to said resonant circuit means; feedback means connected to said amplifier means for sustaining operation of said resonant circuit means at a constant amplitude and frequency; demodulation means connected to said resonant circuit means for detecting the wave envelope of said resonant circuit means output; said amplifier means having variable impedance means for controlling the energy supplied to said resonant circuit means by said amplifier means; the Q of said resonant circuit means being degraded due to the passage of a vehicle in the region of said inductive element; said variable impedance means controlling the increasing of its impedance when the Q of said resonant circuit is degraded to reduce the amplitude of the output signal from said resonant circuit means; said variable impedance means comprising fifth transistor means having base, emitter and collector electrodes;

sixth means for maintaining said base electrode at a reference voltage level;

resistance means coupled in parallel across said emitter and collector electrodes; one terminal of said resistance means being connected to said third transistor amplifier means, and the other terminal of said resistance means being coupled to ground potential;

said inductive element being a substantially square loop of wire of at least one turn capable of being buried in a road surface for vehicle detection.

4. Means for detecting the movement of vehicles and the like at a selected location comprising; resonant circuit means having at least one inductive element at said selected location; transistor amplifier means for supplying energy to said resonant circuit means; feedback means connected to said amplifier means for sustaining operation of said resonant circuit means at a constant amplitude and frequency; demodulation means connected to said resonant circuit means for detecting the wave envelope of said resonant circuit means output; said amplifier means having variable impedance means for controlling the energy supplied to said resonant circuit means by said amplifier means; the Q of said resonant circuit means being degraded due to the passage of a vehicle in the region of said inductive element; said variable impedance means controlling the increase of its impedance when the Q of said resonant circuit is degraded to reduce the amplitude of the output signal from said resonant circuit means; said variable impedance means comprising a resistor, second transistor means having its collector and emitter electrodes connected in parallel across the terminals of said resistor; bias means maintaining a reference bias at the base of said second transistor means; said resistor transistor parallel circuit being said amplifier means and ground potential.

5. Means for detecting the movement of vehicles and the like at a selected location along a thoroughfare comprising:

resonant circuit means including at least one inductive element positioned at said selected location to enable vehicles to pass over said element;

a first transistor amplifier circuit having base, emitter and collector electrodes;

said collector being coupled to said resonant circuit;

second transistor means having base, emitter and collector electrodes;

the base and collector electrodes of said second transistor being coupled respectively to the collector and base electrodes of said first transistor amplifier circuit to sustain oscillation;

variable impedance means being coupled in series with

9

said first transistor amplifier circuit to prevent increased current flow to said first transistor amplifier circuit when the Q of the resonant circuit means is degraded due to passage of a vehicle over said inductive element;

said variable impedance means including:

a resistor coupled between the emitter electrode of said first transistor amplifier circuit and ground potential;

a third transistor having base, emitter and collector electrodes;

said resistor being coupled across said third transistor emitter and collector electrodes and having one terminal thereof connected to the emitter of said first transistor amplifying circuit;

fourth means for maintaining a reference voltage level at the base electrode of said third transistor;

5

10

15

10

fifth means for demodulating the output signal appearing at the output of the collector electrode of said second transistor means;

recording means for recording the pulses generated by said fifth means as a result of the degrading of the resonant circuit means accompanying the passage of a vehicle over said inductive element.

References Cited by the Examiner

UNITED STATES PATENTS

2,917,732	12/1959	Chase	-----	340—38
3,205,352	9/1965	Prucha	-----	340—38
3,233,234	2/1966	Stelmach	-----	340—38

NEIL C. READ, *Primary Examiner*.

THOMAS B. HABECKER, *Examiner*.