

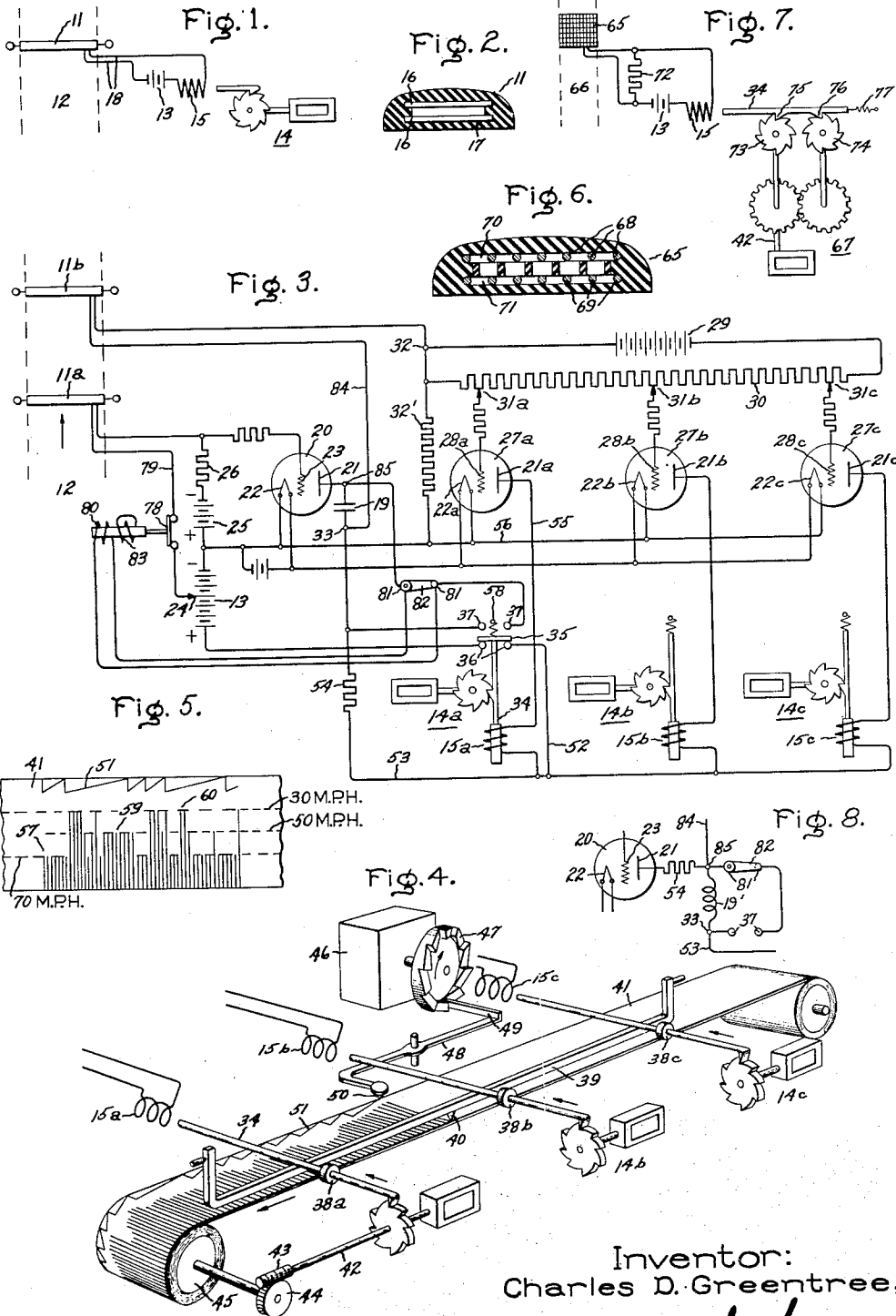
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TRAFFIC ANALYZER

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TRAFFIC ANALYZER

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My invention relates to traffic counters and analyzers and concerns particularly recorders and registers for selectively showing traffic density according to speeds of vehicles and according to time of day.

It is an object of my invention to provide relatively light and compact but accurate apparatus adapted to be carried about and set up temporarily at various positions on the highways for making traffic surveys.

It is also an object of my invention to provide apparatus for selectively counting moving objects in general and for counting pedestrian traffic.

Other and further objects and advantages of my invention will become apparent as the description proceeds.

In carrying out my invention in its preferred form, a pair of road contact strips are stretched across a lane or road in which it is desired to count or analyze traffic. These contact strips are so combined with a condenser, a source of current, and electric valves that charging of the condenser starts when a vehicle, or a unit of traffic to be counted, crosses the first contact strip and charging of the condenser stops when the vehicle crosses the second contact strip. A group of counters is arranged to respond selectively according to the voltage acquired by the condenser in order to count separately the vehicles traveling at speeds below each of several different maximum speeds, and the arrangement is such that the condenser is discharged after the passage of each vehicle. A recorder tape mechanism is also provided which has a marker operated simultaneously with the counters in order to produce a record of the passage of each vehicle distinguishable according to its speed.

The invention will be understood more readily from the following detailed description when considered in connection with the accompanying drawing and those features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. In the drawing, Fig. 1 is a schematic diagram of a simple traffic-counting arrangement; Fig. 2 is a view partly in cross section of a road contact strip used in the arrangement of Fig. 1; Fig. 3 is an electric circuit diagram of a modification of the arrangement of Fig. 1 for counting vehicles selectively according to speed; Fig. 4 is a schematic diagram in perspective of part of the apparatus of Fig. 3, the diagram being drawn to show particularly the arrangement for producing tape records of traffic classified according to speed

and time of day, and the electrical circuits and circuit elements being omitted; Fig. 5 is a representation of a portion of a record which might be produced by the apparatus of Fig. 4; Fig. 6 is a sectional view of a contact mat particularly useful for counting pedestrian traffic; Fig. 7 is a schematic diagram of an arrangement intended primarily for counting pedestrian traffic; and Fig. 8 is a fragmentary representation of a partial modification in Fig. 3. Like reference characters are utilized in the drawing to designate like parts throughout.

Referring now more in detail to the drawing, in the elementary form of the apparatus shown in Fig. 1, a road contact strip 11 is stretched across a roadway 12 or across a traffic lane in an unobtrusive manner in order that automobilists will be unaware of the strip 11 and will drive their cars over the strip 11 without change in speed. A source of current 13 and a counting register 14 with an operating winding 15 are provided. The contact strip 11, the current source 13, and the winding 15 are connected together in a series circuit adapted to be completed momentarily by the passage of a vehicle wheel over the contact 11. In order to have the traffic count in terms of four-wheel or two-axle vehicles, the register 14 may have dials which advance one digit with two operations of the mechanism by the winding 15. Trucks with semitrailers thus count as three axles or one and one-half ordinary vehicles. A modified arrangement for producing only one operation upon the passage of a two or three-axle vehicle will also be described hereinafter (page 4, column 1, line 37 et seq.)

In order to make the contact strip 11 light and portable for use at different locations and still unobtrusive, it may be constructed as shown in Fig. 2 of two flexible metallic plates 16 embedded in a hollow tape of flexible insulating material, such as rubber, normally spacing the plates 16 but permitting them to come in contact under the weight of a vehicle when a wheel passes over the contact strip. Preferably, the rubber or compound 17 is of the same color as the pavement across which the contact strip is stretched or the outside of the strip is suitably painted to blend with the roadway and avoid the attention of vehicle drivers. If it is desired to count only those vehicles traveling in a particular lane of a wide roadway or if it is desired to count only the vehicles traveling in one direction on a two-way road, the contact strips 11 are arranged to have one or both of the metallic plates 16 removed from the portion of the strip 11 covering the

traffic lanes in which no traffic is to be counted or, if desired, the portion of one or both the metallic plates 16 covering such traffic lanes are cut separate from the portions of the plates 16 covering the part of the roadway in which traffic is to be counted. Suitable leads 18 are, of course, brought out from the contact plates 16 or the used portion thereof for connection to the remainder of the apparatus.

In the arrangement of Fig. 3, there are one or more counting registers, such as 14a, 14b, and 14c, each responsive only to vehicles traveling below a predetermined maximum speed, different for each register or counter. This selectivity is obtained by providing a condenser 19 and two road contact strips 11a and 11b with suitable relay means for starting the charging of the condenser 19 when a vehicle crosses the contacts 11a and for discharging the condenser 19 after the vehicle crosses the contacts 11b, the direction of travel of the vehicle being as shown by the arrow from 11a toward 11b. There is interposed in the charging circuit of the condenser 19 an electric valve 20 having an anode 21, a cathode 22, and a control electrode 23. For firing the electric valve 20 and starting the condenser charging when a vehicle crosses the strip 11a, the contacts of the strip are connected between the control electrode 23 and an intermediate positive potential tap 24 of the charging current source 13. A negative bias voltage source 25 in series with a current-limiting resistor 26 may be connected between the cathode 22 and the control electrode 23 for maintaining the valve 20 normally non-conductive.

Electric valves 27a, 27b, and 27c are connected in series with the operating windings 15a, 15b, and 15c, respectively, of the registers 14a, 14b, and 14c in parallel circuits energized by the current source 13. The valves 27a, 27b, and 27c include anodes 21a, 21b, and 21c, cathodes 22a, 22b, and 22c, and control electrodes or control grids 28a, 28b, and 28c, respectively, and a grid bias arrangement is provided consisting of a current source 29 and a potentiometer 30 connected thereto with adjustable taps 31a, 31b, and 31c connected to the control grids 28a, 28b, and 28c, respectively. The contacts of the road strip 11b are connected between the positive terminal 32 of the potentiometer 30 and the positive terminal 33 of the condenser 19 in order that passage of a vehicle across the strip 11b will raise the grid potentials of valves 27a, 27b, and 27c the amount corresponding to the charge acquired by the condenser 19 during the passage of a vehicle between the strips 11a and 11b. For stabilizing the tubes 27a, 27b, and 27c, a resistor 32' of high resistance, e. g., two or three megohms is connected between the cathode and grid of the tube 27a.

The positions of the potentiometer taps 31a, 31b, and 31c are so chosen that the grid biases are such that the valves trip only if the vehicle speed is below the predetermined values corresponding to the voltages for which the taps are set. For example, if the counter 14a is intended to count all vehicles traveling below seventy miles per hour, the tap 31a is set sufficiently close to the positive terminal 32 of the potentiometer that the charge acquired by the condenser 19 during the passage of the vehicle between strips 11a and 11b will raise the potential of grid 28a enough to fire the valve 27a and cause current to flow through the winding 15a, operating the register 14a when a wheel of the vehicle to be

counted crosses the strip 11b and closes its contacts.

The faster a vehicle is traveling, the shorter the charging time of the condenser 19 and vice versa. Accordingly, if the registers 14b and 14c are to count only vehicles traveling below fifty miles per hour and below thirty miles per hour, respectively, for example, the taps 31b and 31c will be set at correspondingly more negative points in the potentiometer 30 in order that greater condenser charges will be necessary to fire the valves 27b and 27c for operating the registers 14b and 14c, respectively.

Preferably, the valves 20, 27a, 27b, and 27c are of the gas or vapor filled or ionic discharge type in which a discharge, once started by a positive voltage on the control electrode, continues regardless of control electrode voltage as long as sufficient voltage of the right polarity exists between the anode and cathode.

A relay is provided for breaking the charging circuit to the valve 20, for opening the anode circuits of the valves 27a, 27b, and 27c, and for discharging the condenser 19 when the vehicle has passed the second contact strip 11b. The relay has its operating winding connected in series with the valve 27a controlling the high-speed register. Such a relay and the high-speed register 14a may have the operating winding 15a in common, as well as the armature 34. The movable armature 34 carries a movable contact 35, and there are provided a pair of normally closed stationary contacts 36 and a pair of normally open stationary contacts 37 adapted to cooperate with the movable contact 35. The contacts 37 are connected across the condenser 19, and the contacts 36 are interposed in series with the current source 13 and the condenser 19 in the anode circuit of the valve 20.

The armatures of the register-operating windings 15a, 15b, and 15c also carry suitable projections or striking members, such as collars 38a, 38b, and 38c, (shown in Fig. 4) for operating a rocker arm 39 carrying a suitable marking element, such as a pen 40, cooperating with a record tape 41 for producing records of the passage of the vehicles. The collars 38a, 38b, and 38c are in different relative positions with respect to the armatures. The spindle 42 of the high-speed register 14a carries a worm wheel 43 driving a gear 44 attached to the spool 45 on to which the record tape is wound.

For producing a record on the tape 41 of the passage of time, a suitable time-marking mechanism is provided. Such a mechanism may comprise a clockwork 46, a ratchet 47 driven thereby, and a lever 48 having a spur or lateral arm 49 and carrying a marking device, such as a pen 50, cooperating with the record tape 41. The teeth of the ratchet 47 engage the spur 49 to oscillate the lever 48, thereby producing a serrated line 51 in which each serration represents a given interval of time, for example, an hour.

The apparatus operates in the following manner:

When a vehicle approaches the contact strips 11a and 11b, the front wheels first cross the strip 11a and close its contacts, impressing a positive voltage on the control grid 23 of the valve 20, causing this valve to become conductive, and a charge begins to flow into the condenser 19. The charging circuit is from the positive terminal of the current source 13, through the contacts 35 and 36, the conductors 52 and 53, the resistor 54, the condenser 19, and the

valve 20, back to the negative terminal of the source 13. After a given interval, depending upon the speed of the vehicle, the front wheels cross the strip 11b and close its contacts, impressing the voltage acquired by the condenser 19 upon the terminal 32 of the potentiometer 30, thus raising the potentials of the control grids 28a, 28b, and 28c a corresponding amount. If the speed of the vehicle is under seventy miles per hour, the valve 27a is caused to become conductive. The other valves 27b and 27c may also be caused to become conductive if the speed of the vehicle is sufficiently low. When the valve 27a becomes conductive, a circuit is formed from the positive terminal of the source 13 through the contacts 36 and 35, the conductor 52, the relay and counter winding 15a, the conductor 55, the valve 27a, and the conductor 56, back to the negative terminal of the source 13. In a similar manner, when the valves 27b and 27c become conductive, circuits are formed through the winding 15b and 15c, respectively.

When the valve 27a becomes conductive, the winding 15a, picking up the armature 34, advances the mechanism 14a an amount corresponding to one-half digit. At the same time, the collar 38a (Fig. 4) strikes the rocker arm 39 and causes a short line 57 to be produced upon the record tape 41, as illustrated at the left-hand end of the sample shown in Fig. 5. Likewise, register spindle 42 rotates and advances the record tape 41 a short distance, for example, $\frac{1}{100}$ of an inch, so that on the next operation a second line may be produced close to the first line 57. When the armature 34 picks up, it also breaks the condenser-charging circuit at the contacts 36 and it short-circuits the condenser through the contacts 37. Although the closing of the contacts 37 is only momentary, the time of closure is of sufficient duration to discharge the condenser 19 and prepare for a second charging cycle when the contacts 11a are again closed. A compression spring 58 biases the movable contact 35 to the position shown, closing the contacts 36. Similar compression springs return the armatures 15b and 15c to their downward positions. When the contacts 36 are opened by the relay 34 the discharge through the valve 20 is terminated and this valve remains non-conducting until the contact strips 11a are closed again.

When the rear wheels of the vehicle cross the contact strips 11a and 11b, the operation just described is repeated and the register 14a is advanced another one-half digit so that both axles of the vehicle advance the register 14a a whole digit. In case the speed of the vehicle falls within the proper range, one or more of the remaining registers, such as registers 14b and 14c, are also advanced.

For the sake of clarity, the dimensions along the direction of vehicle travel and the spacing of the road contact strips 11a and 11b are exaggerated in the drawing in relation to the width of the roadway 12. In order to count the axles of vehicles separately, the strips 11a and 11b are preferably spaced about four feet or close enough for the front wheels to cross both contact strips and produce a complete operation of the apparatus before the rear wheels reach the first strip 11a and far enough apart to obtain an adequate time interval between contact closings of strips 11a and 11b for the fastest vehicle.

Referring to Fig. 5, since the serrations of the line 51 each represent a time interval of one hour, one may observe how many vehicles pass within

a given hour by measuring the length of the serration corresponding to that hour. It will be understood that the time at which the apparatus is placed in operation is to be written on the record tape 41 in order that the time of day represented by any portion of the tape 41 may be ascertained by counting the serrations that occur thereon from the end of the tape.

For the sake of explanation, it is assumed that all the vehicles are passing at a speed of seventy miles per hour or less so that all vehicles will be counted by the register 14a and a pair of vertical lines will be produced for each two-axle vehicle. The collar 38b operated by the winding 15b is mounted closer to the rocker arm 39 than the collar 38a so that, when a vehicle passes at less than fifty miles an hour and the winding 15b is energized, the rocker arm 39 moves further and produces a longer line, as shown at 59 in Fig. 5, representing the passage of a vehicle travelling at less than fifty miles an hour and more than thirty miles an hour. Similarly, the collar 38c is mounted still closer to the rocker arm 39 so that a still longer line is produced on the record tape, as shown at 60 in Fig. 5, representing passage of vehicles at 30 miles an hour or less. In the case of vehicles traveling at lower speeds, the collars on higher-speed armatures have no effect. The passage of each axle produces only one line on the record tape 41 but the speeds of the vehicles may be distinguished by the lengths of the lines produced. It will be apparent that, by examination of the record tape, one can readily ascertain not only how many vehicles have passed during a given time interval but also at what speeds the vehicles passed and how many passed at each speed. The apparatus is thus responsive to the rate of passage of vehicles measured either in miles per hour or vehicles per hour and responds selectively to the rate of passage of vehicles measured in miles per hour.

For cases where several vehicles might run abreast on a wide road and for counting pedestrian traffic, I prefer to employ an arrangement such as that shown in Fig. 7 in which a contact grid or mat 65 is laid across the roadway or sidewalk 66 and a polarizing register 67 is employed. The construction of the mat 65 is shown in detail in the cross-sectional view of Fig. 6 in which the vertical dimension is exaggerated for the sake of clarity.

The resistance mat 65 consists of two separate groups of resistance wires 68 and 69 which may be formed into grids by being joined by cross wires 70 and 71, respectively. The upper group of wires 68 is normally out of contact with the lower group of wires 69 so that, when a vehicle or a pedestrian treads upon the mat 65, some of the wires come in contact and a resistance of a predetermined value is shunted across a resistor 72 to produce a resultant resistance in series with the current source 13 and the counter operating winding 15, which draws a current sufficient to cause the winding 15 to attract the armature 34. The register 67 is provided with two ratchet wheels 73 and 74 geared together and mechanically connected to the register spindle 42. The armature 34 is provided with oppositely pointing detents 75 and 76 and the ratchet wheels 73 and 74 have their teeth arranged in opposite manner so as to cooperate with the detents 75 and 76, respectively. The dials of register 67 are so arranged that, when a pedestrian steps upon the mat 65 and decreases the resistance in the circuit of the winding 15 a predetermined amount,

the armature 34 is moved a predetermined distance against the force of the tension spring 77 and the dials are moved one-half digit. When the pedestrian steps off the mat again, the winding 15 releases the armature 34, which is drawn back by the spring 77, and the detent 76 engages the ratchet wheel 74 to cause the dial of the register 67 to move another one-half digit.

On the other hand, if a second pedestrian steps upon the mat 65 before the first pedestrian steps off, a second contact is made between the upper and lower sets of wires 68 and 69 and resistance in the circuit of the winding 15 is reduced still further so as to move the armature 34 an additional step and to cause further rotation of the dials of the register 67. As the pedestrians step off the mat 65, the resistance thereof again increases in steps and the armature 34 is released to complete the registration of the register 67. In a similar manner, if a great number of pedestrians step upon the mat at the same time, the armature moves still further and an appropriate registration is obtained, the spindle 42 being rotated an amount corresponding to one-half digit each time the resistance in the circuit of the winding 15 is increased or decreased. Although the same principle may be employed for counting either wheeled vehicles or pedestrians, it will be understood that it may be desirable to vary the strength and size of the mat 65 according to the type of service intended. The verb "tread" is utilized in the description and claims to refer either to the action of persons and animals in stepping on the mat 65 or of wheeled vehicles in rolling on to the mat 65.

It may, in some cases, be desirable to reduce the wear and tear in the mechanism of Figs. 3 and 4 by reducing the number of impulses and counter operations to one for each vehicle passing instead of one for each axle. This may be accomplished, for example, by interposing a normally-closed switch 78 in one of the leads 79 to the contact strip 11a, and inserting the operating winding 80 of the switch 78 in the discharge circuit of the condenser 19. The winding 80 is connected to the terminals 81 of a switch 82, which is kept open when it is desired to operate the apparatus with only one impulse for each vehicle.

The switch 78 is of the quick-opening slow-closing type well known in the art. Various types of such switches or relays are known but, in the type illustrated, there is a short-circuited portion in the winding or a separate secondary coil 83 tending to hold the switch open and delaying its closing. The switch 78 is so adjusted that it does not reclose until the passing vehicle has crossed the strip 11a and, consequently, the rear axle of the vehicle has no effect on the apparatus. A consideration of the circuit will make it evident that the time delay of closing of the switch 78 adjusts itself automatically to the speed of the vehicle. In case the vehicle passes slowly and a large charge is collected in the condenser 19, there is a large current impulse in the winding 80 when the contacts 37 close to discharge the condenser 19 through the winding 80 in response to operation of the road strips 11b. The large current impulse in the winding 80 induces a large current in the short-circuited coil 83 and holds the switch 78 open for a relatively long period. On the other hand, if the vehicle passes quickly, only a small charge is accumu-

lated and the contacts 78 are held open only a relatively short time.

For the sake of illustration, I have referred particularly to the use of a condenser 19 to perform the timing function and to produce a voltage variation depending on the time required for a traffic unit to traverse the distance between the contact strips 11a and 11b. It will be understood, however, that my invention is not limited to the exact arrangement and includes the use of any electric circuit element offering an opposition to the flow of current, which opposition varies with the flow of current during the continuance thereof so as to produce a varying voltage in the element. For example, an inductance 19' may be substituted for the condenser 19 as illustrated in the fragmentary diagram of Fig. 8. Since, however, the characteristics of inductance are the converse of those of capacitance or, to use an optical metaphor, an inductance is the mirror image of a capacitance, I connect the lead 84 from the contact strip 11b to the negative side instead of the positive side of the inductance 19', i. e., to the terminal 85 instead of the terminal 33 in the particular circuit illustrated in the drawing. Likewise, I place the current-limiting resistor 54 on the negative side of the inductance 19' as illustrated in Fig. 8.

The operation will then be as follows:

When a traffic unit crosses the strip 11a and fires the tube 20, current starts flowing in the inductance 19'. The inductance opposes the current flow and sets up a back voltage, tending to hold down the potential of the terminal 85. As time passes, the current increases and its rate of change decreases so that the back voltage of the inductance 19' diminishes, permitting the potential of the terminal 85 to rise progressively. When the traffic unit crosses the contact strip 11b, the terminals 85 and 32 are connected together and, of course, the potentials impressed upon the grids 28a, 28b, and 28c depend upon the speed of the traffic unit which has passed. Operation of the counters and recording mechanism accordingly takes place in the manner already described.

The time relay feature, including the switch 78 for preventing the rear axles of vehicles from affecting the apparatus, may also be employed when the inductance 19' is substituted for the condenser 19. When the inductance 19' is employed, the arrangement of the contacts 36 and 37 is preferably such that the contacts 37 begin to close before the contacts 36 have opened in order to avoid arcing at the contacts 36, which breaking current in an inductive circuit would tend to cause. The inductance 19' tends to maintain the current flow and produces a flow of current through the shunt circuit including the contacts 37, the switch terminals 81, and the winding 80. The current is greater the greater the time required for the vehicle to transverse the distance between the contact strips 11a and 11b and, accordingly, the time delay with which the switch 78 recloses varies with the slowness of the vehicle which has passed.

I have herein shown and particularly described certain embodiments of my invention and certain methods of operation embraced therein for the purpose of explaining its principle and showing its application but it will be obvious to those skilled in the art that many modifications and variations are possible and I aim, therefore, to cover all such modifications and variations as fall

within the scope of my invention which is defined in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

5 1. A traffic analyzer comprising in combination, a first circuit closer adapted to operate when a traffic unit crosses a given point, a second circuit closer adapted to operate when the traffic unit crosses a second more advanced point,
10 a condenser, a source of charging current, an electric valve of the ionic discharge type with an anode, a cathode, and a control electrode, said condenser and said anode and cathode being connected in series to said current source to form an
15 anode circuit, said first circuit closer being connected in a grid circuit to said cathode and said control electrode, a second electric valve with an anode, a cathode and a control electrode, a relay with normally open contacts, normally closed
20 contacts, and an operating winding, said winding being connected in series with said normally closed contacts and the anode and cathode of said second electric valve to said current source, said normally open contacts being across said
25 condenser, a source of biasing voltage connected in series with said second circuit closer, said condenser and said first valve between the cathode and control electrode of said second electric valve, and a counter connected in responsive
30 relation to said relay.

2. A traffic analyzer comprising in combination, a first circuit closer adapted to operate when a traffic unit crosses a given point, a second circuit closer adapted to operate when a
35 traffic unit crosses a second point, a condenser, a source of condenser-charging current, an electric valve with an anode, a cathode, and a control electrode, said condenser and said anode and cathode being connected in series to said current
40 source to form an anode circuit, said first circuit closer being connected in a control electrode circuit to said cathode and said control electrode, voltage-responsive means, and relay means, the latter having normally closed contacts inter-
45 posed in said anode circuit, normally open contacts across said condenser, and a control winding adapted to be energized by said voltage-responsive means, said second circuit closer having
50 contacts in series with said condenser and said voltage-responsive means.

3. A traffic analyzer comprising in combination, a condenser, a source of charging current, means for starting charging of said condenser when a traffic unit crosses a predetermined point,
55 an electric valve having a control grid circuit with a predetermined negative bias, a counter, normally inoperative means for applying the accumulated voltage of said condenser in said con-

trol grid circuit when the traffic unit crosses a second more advanced point, and means interposed in series with said electric valve and said current source for operating said counter and disconnecting said condenser from the charging
5 source in response to a discharge through the electric valve.

4. A traffic analyzer comprising in combination, an electric circuit element offering an opposition to the flow of electric current, which op-
10 position varies with the flow of current during the continuance thereof so as to produce a varying voltage in said element, a source of current, means for starting flow of current from said source into said electric circuit element when a
15 traffic unit crosses a predetermined point, an electric valve having a control-grid circuit with a predetermined negative bias, normally inoperative means for subjecting said control-grid circuit to the variation in voltage in said electric
20 circuit element when the traffic unit crosses a second more advanced point, and current responsive means interposed in series with said electric valve and said current source for disconnecting said condenser from the charging source
25 in response to a discharge through the electric valve.

5. A traffic analyzer comprising in combination, a condenser, a source of charging current, means for starting charging of said condenser
30 when a traffic unit crosses a given point, a plurality of electric valves with control grids and cathodes, a grid-biasing potentiometer with points at different relative potentials to which said control grids are connected, means for connect-
35 ing said condenser between the cathodes of said electric valves and a terminal of said potentiometer when the traffic unit crosses a second more advanced point, and a plurality of counters with operating windings, each in series
40 with one of said electric valves and said current source.

6. A traffic analyzer comprising in combination, a condenser, a source of charging current, means for starting charging of said condenser
45 when a traffic unit crosses a given point, a biasing potentiometer, a plurality of electric valves with control electrodes and cathodes, each of said control electrodes being connected to a different point on said potentiometer, means for connect-
50 ing said condenser between the cathodes of said valves and a point on said potentiometer when a traffic unit crosses a second given point, and a plurality of current-responsive devices each in series with one of said electric valves and said
55 current source.

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