

May 21, 1940.

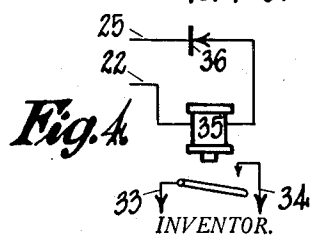
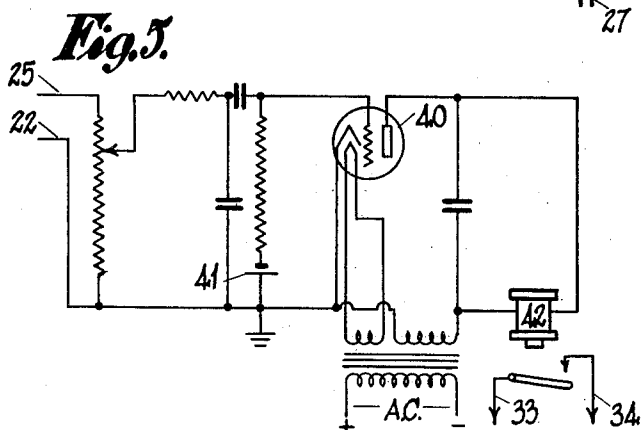
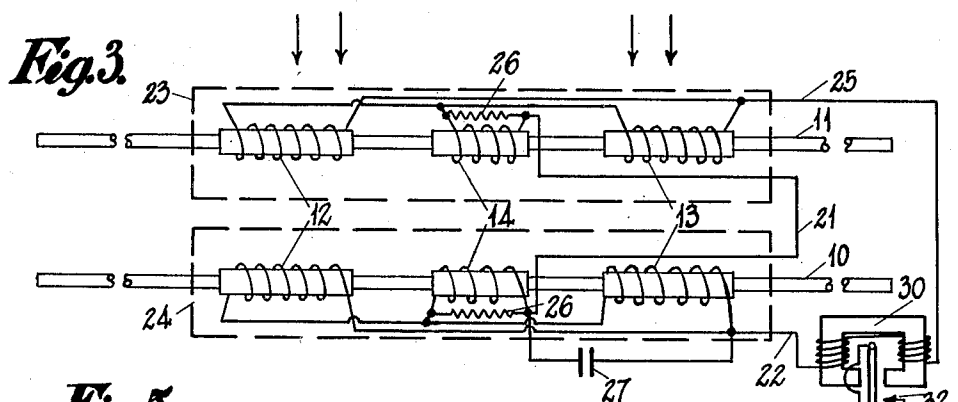
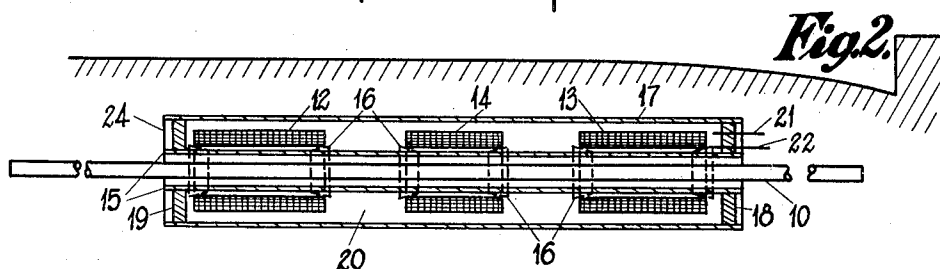
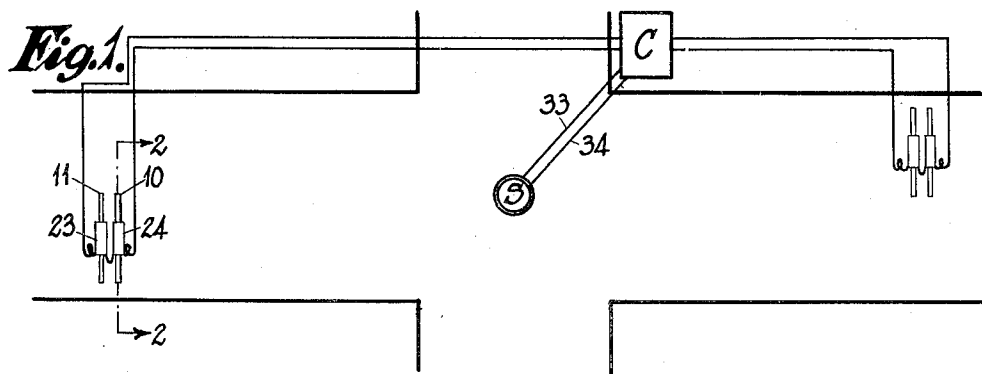
J. L. BARKER

2,201,146

TRAFFIC DETECTOR

Filed Aug. 14, 1937

2 Sheets-Sheet 1



INVENTOR.
JOHN L. BARKER
BY Edward H. Cames
ATTORNEY

May 21, 1940.

J. L. BARKER

2,201,146

TRAFFIC DETECTOR

Filed Aug. 14, 1937

2 Sheets-Sheet 2

Fig. 6.

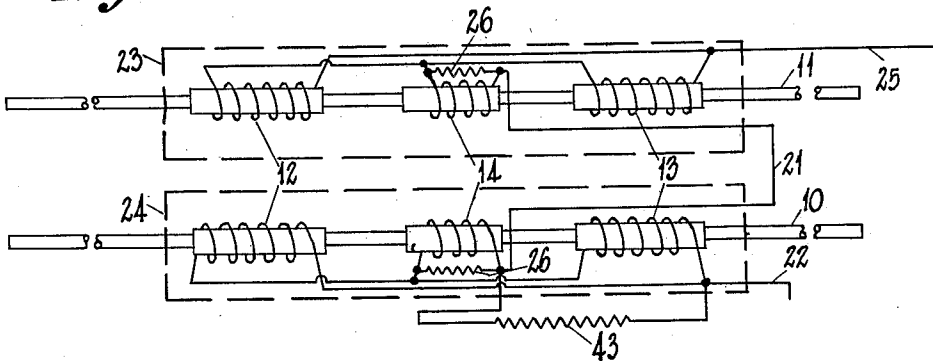
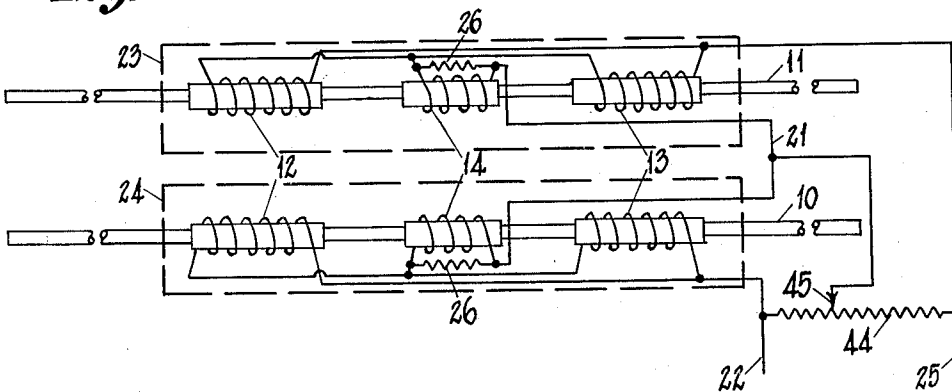


Fig. 7.



INVENTOR.

JOHN L. BARKER

BY *Edward H. Ames*
ATTORNEY

UNITED STATES PATENT OFFICE

2,201,146

TRAFFIC DETECTOR

John L. Barker, Norwalk, Conn., assignor to Automatic Signal Corporation, New York, N. Y., a corporation of Delaware

Application August 14, 1937, Serial No. 159,059

24 Claims. (Cl. 171-209)

This invention relates to traffic detectors and more particularly to detectors of a magnetic type for detecting the passage of vehicles in streets, roadways, driveways, doorways, tunnels and the like as well as articles passing along conveyors or chutes, and other forms of traffic in these or other traffic paths, where such traffic contains magnetic material, and the terms traffic, vehicle, and traffic path and the like used in the specification and claims of this application will be understood to include broadly all items and forms of traffic and paths of travel of the same. In accordance with the invention the magnetic detector unit itself will provide on passage of traffic a distinctive electrical impulse which may actuate a relay or amplifier unit, or other responsive device. This invention is primarily concerned with the provision of an improved detector of this type which will be very substantially non-responsive to traffic units outside the range of the detector or to magnetic or other electrical disturbances outside such range, or it may be responsive only to traffic units proceeding in a predetermined direction.

It is well known that a body of magnetic material when passed through a magnetic field will induce in a coil surrounding or adjacent to the field an electromotive force or voltage impulse. The passage of the magnetic body through the field momentarily provides a better path than air for the magnetic field and accordingly the field is strengthened and an induced electromotive force generated in the coil. Many arrangements utilizing the principle have been used for detecting the passage of vehicles in a roadway, as by locating a coil and magnet adjacent to or under the pavement in the roadway. The impulse produced in a unit of this type may be used for governing operation of a warning signal or bell, traffic signal, traffic actuated signal controller, garage door opening device or a counter for vehicles or other articles generally, for example.

Many different types of impulse responsive devices may be employed in connection with a magnet and coil unit of this type to control operation of the desired signal-operating device. For example, the impulse responsive device may comprise a polarized relay, or highly sensitive relay in series with a rectifier, or amplifier operating a relay, or other arrangement. A selective electrical network may be used in cooperation with the amplifier to give reliable operation of the relay upon the passage of vehicles and to make the detector vary substantially non-responsive to extraneous electrical and magnetic disturbances associated with nearby street railway or power lines.

The present invention contemplates a novel type of magnet and coil unit for location in the traffic path for use with an impulse-responsive device. The novel magnet and coil assembly is inherently directional; that is, it produces upon the passage of vehicles across the unit in a predetermined direction one type of impulse while for vehicles traversing the unit in the opposite direction it produces a distinctly different type of impulse. It is generally desirable however, to add circuit arrangements shunting one of the coils to make the unit reliably responsive for uni-directional detection of high speed traffic. Also, by virtue of its design, the unit is inherently compensated to be substantially non-responsive to extraneous magnetic disturbances at any considerable distance from the detector or affecting the coils equally. The unit is additionally designed so that the effect of vehicles passing over any portion of the unit in the direction selected for controlling the signalling is substantially uniform. Certain features of the design disclosed herein render the unit particularly reliable in detecting vehicles passing only within a sharply defined area in the selected direction at from very low to even the highest encounterable speeds. Yet it is substantially non-responsive to all other vehicles. This detector may be adapted to be very substantially non-responsive to extraneous electric and magnetic disturbances when not used as a uni-directional detector, and even when used as a uni-directional detector retains to a considerable degree its non-responsiveness to such disturbances.

As the relay in the responsive unit is operated only by impulses produced by vehicles travelling in the selected direction, the relay operations are a highly accurate measure of the passage of vehicles in the predetermined direction through the sharply-defined range of the detector. As subsequently appear, the time duration of each such relay operation is roughly proportional inversely to the speed of the actuating vehicle.

It is an object of this invention to provide a detector of the magnetic type which will be responsive to units of traffic passing in a single predetermined direction.

It is also an object of the invention to provide a traffic detector dependably responsive to the passage of traffic, and very substantially non-responsive to extraneous magnetic or electrical disturbances.

It is another object to provide a detector which will produce an impulse substantially uniform over the range of the detector transverse to the

traffic path for all vehicles passing over various parts of the detector in one direction and not responsive to vehicles outside its range or to those passing over the detector in the opposite direction.

Another object of the invention is the provision of a traffic detector of the magnetic type which will produce in a signalling circuit an impulse roughly proportional inversely to the speed of vehicles traversing the detector in only a predetermined direction.

It is an additional object to provide a magnet and coil assembly which upon the passage of traffic in one direction will produce a type of voltage wave adaptable to operate a signalling circuit and which upon passage of traffic in the opposite direction will produce a voltage wave of different type or no wave at all so that traffic proceeding in the latter direction will be ineffective to operate the signalling circuit.

Still another object of the invention is the provision of a magnet and coil arrangement of this type for location in or adjacent to a traffic lane and including means for preventing false impulses upon passage at high speeds of vehicles proceeding in the wrong direction for detection.

Other objects will appear subsequently.

The invention will be described and its operation explained in connection with the accompanying drawings illustrating a practical embodiment, and in which drawings Figure 1 represents a preferred form of the magnet and coil assembly, located in a roadway, together with a signal and a control for same for operating the signal upon passage of vehicles proceeding across the detector toward the signal;

Figure 2 is a vertical cross-sectional view along the line 2—2 of Figure 1 and showing the roadway and detector unit located beneath the pavement;

Figure 3 is diagrammatic top view of the detector unit showing the wiring connections for the coils and the external connection to a polarized relay which serves as an illustrative type of impulse-responsive unit;

Figure 4 shows another embodiment of impulse-responsive unit including a relay and rectifier combination;

Figure 5 shows still another embodiment of impulse-responsive unit comprising an amplifier operating a relay; and

Figures 6 and 7 show alternative arrangements to that shown in Figure 3.

Referring now to Figure 1, there is shown a roadway in which the detector magnet and coil unit is located. The construction of a preferred form of the unit will more readily be apparent from Figures 2 and 3 which represent respectively a cross-sectional view of the roadway and magnetic unit and a view from directly above the unit looking down on it.

This roadway unit consists of a pair of magnetized iron bars 10, 11 or bundles of iron rods having their axes spaced apart a short distance, for instance, about six or ten inches, each such bar or bundle being encircled for part of its length by a coil assembly. The bars may have been given a permanent magnetism or may be maintained magnetized by supplementary magnetizing means. The coil assembly on each bar is the same and consists for each bar of two coils 12, 13 encircling the bar and spaced apart at equal distances on either side of the mechanical center of the bar. These two coils 12, 13 are preferably connected in parallel with each other and

both are in series opposition with a third coil 14 located with its electrical center at the mechanical center of the bar as shown. This centrally located coil 14 is a bucking coil whose purpose will be explained below.

In practice it has been found expedient to assemble these three coils into a separate unit. Accordingly as shown in Figure 2, the coils have been placed on a cylindrical tube 15 of non-magnetic material having an outside diameter slightly less than the inside diameter of the coils, and an inside diameter great enough for the tube to slide freely on to the bar or bundle of magnetized rods. Cylindrical shaped wedges 16 are provided to hold the coils in proper relation with one another on the tube. A second cylindrical tube 17 is arranged to cover the entire assembly and at the ends of the unit the space between the tubes is closed with washers 18, 19 and the space 20 surrounding the coils between the inner and outer tubes is filled with any suitable sealing compound of insulating material. Any other suitable type of covering for the coils may be used in lieu of the present arrangement to protect them from dampness or drainage water. The two leads 21, 22 from the assembly of coils are brought out through suitable holes in washer 18.

The two magnetized bars with their encircling coil assembly units mounted on them are located transversely of the vehicle lane or roadway with like poles of the two magnets at the same end of the unit. As will be apparent from Figure 3 the two coil units 23, 24 are connected in series opposition by lead 21, the lead 22 from one coil unit and the corresponding lead 25 from the other coil assembly being connected to the impulse-responsive unit. The bars may be held rigidly in place and the coil assemblies protected from damage by casting in concrete or other non-magnetic material as an additional precaution against damage by moisture or abrasion.

As indicated in Figure 2, the magnetic unit may preferably be buried a short distance below the road surface and the passage of a vehicle across the detector will cause a considerable increase in the strength of the field of the magnets, since the iron of the vehicle provides a better magnetic path than air, through which the magnetic field circuit of each magnet was completed prior to the arrival of the vehicle.

By well-known electrical law, in a simple coil linking a magnetic field the flux change or change in intensity of the magnetic field induces a voltage in the coil, this voltage being proportional to the rate of change of flux linking the coil. The voltage generated is of one polarity while the flux linking the coil is increasing; it is of the opposite polarity while this flux is decreasing, and when there is no change in the flux linkages of the coil there is no generated voltage. For example, as a vehicle enters the detector field thus increasing the flux linking the coils, the voltage in any single coil increases in one direction, during the brief instant the vehicle is momentarily over the detector the voltage falls off to zero, and as the vehicle is leaving the detector field decreasing the flux linking the coil, the generated voltage in the coil rises in the opposite direction.

As the voltage is proportional to the rate of change of the flux linking the coil and as this latter rate of change is dependent naturally on the speed of the vehicle the voltages induced in the coil will be roughly proportional in amount to the speed of actuating vehicles.

Not only will the voltage wave produced have a greater peak value with greater speed but it will reach this peak value in less time and thus the wave form for higher speeds of actuation will be characterized by a wave front of greater steepness and frequency (if it were considered to be repeated as a periodic oscillation instead of being transitory for a single vehicle).

In the detector unit of the present invention the coil assembly on each magnet bar acts as a single coil. The use of two parallel-connected coils spaced apart from the center on each bar permits of greater uniformity of voltage impulses by vehicles traversing any portion of the unit. If for instance, a vehicle passes over one coil the field strength of this coil alone is increased and a voltage wave generated in this coil. If the vehicle passes centrally over the unit and causes an induced voltage to be generated in both coils the parallel connection of the coils tends to make the peak voltage very nearly the same as in the case of a vehicle passing at the same speed over only one coil. However, in order further to insure that the induced voltage not be greater for a vehicle passing over the central portion of the detector than one passing near one end, the third coil 14 centrally located on the bar is connected in series opposition with the two parallel coils. Thus the voltage induced in coil 14 opposes the voltage induced in coils 12, 13 and cuts down the height of the latter voltage without changing its wave form. The number of turns on this bucking coil is determined in accordance with the length of magnet bars and the amount of shielding provided by any magnetic portions of the housing of the detector structure to reduce the direct pickup of this coil thus attaining the desired uniformity of response over the entire length of the unit.

By loading the bucking coil 14 with a resistance 26 connected across its terminals, it has been found that the direct pickup of this coil is further reduced. The bucking coil can thus be considered to act as a shading ring for flux trying to pass through the center point of the magnet bar, and serves to reduce the flux in the magnet linking both coils and thus to flatten the curve of induced voltage for vehicles traversing any portion of the detector. For a long slender magnet the field pattern shows that all the magnetic field concentrated in the center of the bar does not continue entirely to the end of the bar, a great portion of the flux leaving the sides of the magnet near the ends. Consequently, there is very little fanning out of the flux more than a short distance beyond the ends of the magnet and the area through which vehicles passing will actuate the detector accordingly has sharply defined limits.

In order to obtain detection of vehicles passing over the detector in a single predetermined direction, two magnets 10, 11 and their associated coil assemblies, 23, 24 are arranged side by side with the magnet bars a short distance apart so that the magnetic fields overlap. A spacing of from six to ten inches between the axes of the bars has been found practicable in the present embodiment; however, with magnets of different shape or with different coil arrangements other spacing may be desirable. The unit coils 23 and 24 are connected in series opposition as described and a condenser 27 is connected in shunt across the unit coil on the side from which it is desired not to detect approaching vehicles, that is the

coil nearer the intersection, as coil 24 in the present embodiment.

For vehicles travelling in the proper direction to be detected, as in the direction indicated by the arrows in Figure 3, the induced voltage wave in each coil as hereinabove pointed out is first a voltage of one polarity which rises to a peak and falls to zero, then rises to a peak in the opposite polarity and falls to zero. The wave induced in the second coil 24 will be slightly displaced from the wave of the first coil 23 in respect to time. Since in the present case, the second coil is in series opposition with the first, then accordingly the shape of the voltage wave across leads 22, 25 produced by a mass of iron moving in the proper direction for detection will be the difference between the impulse waves in the two coils. Careful examination has shown this wave to consist of a small peak of one (minus) polarity, then a large peak of the second or opposite (plus) polarity followed by another small peak of the first (minus) polarity. In the absence of condenser 27, a vehicle proceeding in the opposite direction would produce a voltage wave having first a small peak of plus polarity then a large minus peak and a small plus peak. It is on the large peak of the second (plus) polarity, produced by a vehicle travelling in the proper direction for detection that the impulse responsive unit is arranged to operate the relay for signalling purposes.

Due to the fact that the magnetic field of the detector induces eddy currents in the axles and similar magnetic portions of the vehicle passing over the detector, there is a slight time factor to be considered before the strengthening of the magnetic field of the detector and accompanying impulse wave is truly the result of the substitution, in the magnetic field of the magnet, of the vehicle's magnetic material for the air through which this field was previously completed. The presence of a condenser 27 or a resistance across the second coil 24 of the unit substantially retards the terminal voltage across this coil from building up due to the effect of such eddy currents or to the effect of the residual magnetism in portions of the vehicle. High speed vehicles which may move across the detector in the wrong direction for detecting without having been exposed to the magnetic field of the bars long enough to reverse their own magnetism, if their magnetism had previously been in the direction opposite to that in the bars, are thus prevented from causing false voltages in the coils. By suitably choosing the size of condenser 27 it is possible to make the voltage impulse of vehicles travelling in the wrong direction for detection very small, at least for a certain average band of speeds, and to reduce the impulses for all other vehicles travelling in such direction. A resistance may be substituted for the condenser 27 to provide similar satisfactory uni-directional detection. The use of a resistance is particularly advantageous where the average band of speeds encountered is very low, since with low speeds and accompanying low frequencies of induced currents the condenser required would be of high capacitance to produce any effect in delaying building up of the voltage. Furthermore, with the same value of capacitance the condenser would act as a direct short circuit by-pass to the higher frequency associated with a higher speed vehicle traversing the unit.

Values and space relations for the various parts which have been found suitable in one practical

embodiment of the complete magnetic detector roadway unit illustrated in Figs. 2 and 3 are as follows. The bars 10 and 11 may each be six feet long and about two inches in diameter for example, made of permanent magnet iron and magnetized for a field strength some fifteen to twenty times the earth's magnetic field in a horizontal plane about two feet over the bar, the latter distance being about in the middle of its working range. The spacing of the two bars may be about seven inches between centers for example.

The end coils 12 and 13 may for example be about three inches long and about four inches in outside diameter and wound with some 14,000 turns of wire to have a resistance of some 2500 ohms. The middle bucking coil may for example be about four inches in outside diameter and about two inches long, and wound with some 3750 turns of wire to have a resistance of some 300 ohms. The loading resistance 26 may be 1000 to 2000 ohms.

The end coils 12 and 13 may be placed about two and one half feet from the nearest end of the bar and the middle coil about in the center. The condenser 27 may be about ten microfarads, and the resistance of Fig. 6 may be about three thousand ohms for example.

In general the complete magnetic unit may be placed in the roadway as shown in Figs. 1, 2 and 3 with the centers of the bars at a level about nine to ten inches below the road surface. The output leads 22 and 25 of the magnetic unit may be suitably connected with a multi-stage electronic amplifier of five thousand average gain and high impedance input. If a unit of eight foot length is employed for example instead of the six foot length the coil spacing from the center on each bar is increased with the end coils again about two and one-half feet from the ends of the bar.

It will be appreciated that the values, size and spacing described are largely exemplary, and that they can be suitably proportioned by those skilled in the art to cooperate with various types of impulse responsive devices. The spacing between the magnetized bars 10 and 11 is the primary factor in obtaining uni-directional operation by providing the overlapped magnetic fields, so long as the magnetic field of the bars is several times stronger than the earth's natural magnetic field in the working range above the unit. The condenser 27 is also a factor in the directional operation as described earlier in the specification. The spacing of the individual coils along each bar is concerned primarily with the uniformity of impulses obtained whether a vehicle passes over one end of the bar only or over the middle, and is significant whether the two bar and coil assemblies are used in a directional or compensated (against extraneous disturbances) magnetic unit or one assembly is used individually as a simpler form of magnetic detector where the directional and compensation features are not required.

The electrical values of the coils are related principally to the strength and type of output impulse of the magnetic detector roadway unit, however. Higher voltage output is obtained by increasing the number of turns and such output is adapted primarily to the electronic amplifier as an impulse responsive device, while a smaller number of turns with lower resistance is adapted primarily to the polarized or galvanometer type relay.

The present type of unit is substantially non-responsive to extraneous electrical or magnetic disturbances due to the novel arrangement of the two magnets 10 and 11 and their associated coil assemblies 23, 24. The coil units 23 and 24 lie side by side as noted, spaced apart a short distance and connected in series opposition. A disturbance occurring midway between the bars and coil units, that is, at any point on the center line between the bars and parallel to them, will affect the magnetic field associated with each bar equally and a voltage of equal magnitude will simultaneously be induced in each coil. The series opposition connection of the coils, however, if the effect of any impedance shunting one of the coil assemblies to unbalance their current build-up characteristics is disregarded, will balance the voltages against each other so that such disturbance will cause no impulse or response in output leads 22, 25.

Considering similar disturbances located at points not on the above-mentioned center-line and at a distance from the detector, it will be obvious that the distance of any of these disturbances from the magnetic field linking each coil assembly partially determines the magnitude of the induced voltage in the coil produced by the disturbance. For disturbances occurring at any point off either end or side of the detector more than a very short distance from the detector the distance to both coils will be approximately equal, the induced voltages in the coils will be substantially the same, and the effect of such extraneous disturbance on the terminal output of the detector across leads 22, 25 will therefore be substantially zero.

The presence of an impedance such as a condenser 27, or a resistance 43 as shown in Fig. 6, across one of the coils in order to obtain improved and reliable uni-directional detection will to a certain extent, depending upon the amount of unbalance of the coil units by such impedance, cut down the non-responsiveness of the detector to extraneous magnetic conditions. Accordingly, it is generally desirable to determine in making an installation of this type whether the unit is to be highly compensated against all extraneous magnetic disturbances, in which case the coils are not shunted by impedances or are shunted by equal impedances, or whether if vehicles travelling in either direction pass directly over the unit, the unit must be made uni-directional. In this latter case the coil on the side from which it is desired not to detect vehicles is shunted with a condenser 27 or a suitable sized resistance. However, even in such latter case experience indicates that about 75 per cent of the compensating effect of the detector against extraneous disturbances is retained when the coils are unbalanced to aid directional detection.

In practice a potentiometer 44 across output leads 22, 25 has been found convenient for producing varying degrees of unbalance between the coils. The moveable arm 45 of the potentiometer is connected to common lead 21 between the two coils. With such an arrangement complete variation of the amount of resistance shunting each coil in respect to the other is obtained by suitably adjusting the position of moveable arm 45. For example, if it is desired to detect only vehicles approaching the coil 23 side of the detector the arm 45 is moved to a point on potentiometer 44 near the lead 22 end, so that a small resistance is placed across coil unit 24 and a high resistance coil unit 23. The high resistance has little or no

effect on the voltage induced by the vehicle in coil unit 23 but the low resistance shunt across coil unit 24 prevents the building up in this coil of impulses by vehicles approaching in the wrong direction for detection. It will be appreciated that the form of the voltage impulse wave produced by the detector with the resistances across the coils, as shown in Figure 7, differs from that described above, and instead of comprising a small impulse followed by a large impulse in the opposite direction and then a small impulse in the first direction it now appears to lose one of the small impulses, probably the trailing one, and increases the magnitude of the first two. Any of the impulse responsive devices of Figures 3, 4 or 5, or others, may be used with the forms of the invention shown in Figures 3, 6 and 7.

The impulse responsive device for use with the magnetic unit may take any of a number of forms. For example, a polarized relay of sufficient sensitivity to be actuated by voltages of this order of magnitude may be used, as shown in Figure 3. In such a case the coil of relay 30 is simply connected directly across output leads 22, 25. Armature 31 is arranged to close against contact 32 when a voltage of plus polarity which is of sufficient size, as caused by the passage of a vehicle in the proper direction for detection, is applied to the polarized relay. The threshold value of impulse necessary to actuate the armature is in excess of the small voltages mentioned so that closure of armature 31 against contact 32 occurs only on the desired peak voltages of plus polarity. A circuit completed through wires 33 and 34 by the contacts of the polarized relay may be arranged to operate a signal S of Figure 1 directly or to energize an additional relay (not shown) with sufficient contact capacity for controlling the signal S, or other mechanism to be operated.

In lieu of a polarized relay a sensitive relay 35 in series with a rectifier as shown in Figure 4 may be used. The rectifier 36 is inserted in the circuit so as to prevent voltages of the minus polarity from actuating the relay.

Ordinarily, however, with a magnetic detector of this general type it has been found desirable in order to facilitate use of a relay of sturdier construction, more reliable operating characteristics and greater contact capacity, to amplify the voltage impulse from the detector. A simple type of thermionic amplifier arrangement for this purpose is shown diagrammatically in Figure 5 for purpose of illustration. The impulse in output leads 22, 25 is impressed across the grid of tube 40 so as to reduce, upon the passage of a vehicle across the street unit in the proper direction for detection, the negative grid bias normally supplied from source 41. The reduction in grid bias permits a greater flow of current in the plate-filament circuit to operate relay 42.

Vehicles passing in the wrong direction for detection do not actuate the relay since the tube is supplied with a grid bias near the cut-off point of the plate current-grid voltage curve and small impulses of plus polarity from the magnetic unit only slightly reduce the grid bias. The negative portion of the impulses increases the grid bias of the tube and of course reduces the current flowing in the plate circuit. Other arrangements may be provided which include a selective electrical network and one or more amplifiers of one or more stages, the selective network being adapted to reduce substantially or eliminate the extraneous impulses produced by trolley car lines, power

wires and the like since the latter impulses lie generally in a frequency range apart from the traffic-produced detector impulses.

When two or more detector units as shown in Figure 1 are used to operate the same relay, the output leads 22, 25 from each detector may be connected together in parallel or series, care being taken that they be connected in such a way to actuate the relay only upon the passage of traffic across each detector in the proper direction for detection.

The magnets in the detector unit need not necessarily be slender bar magnets as shown, but may be made in many other shapes. It is also to be appreciated that when the bar magnets are used the coils need not encircle the bars but may be located anywhere where each could be linked by a substantial portion of its associated magnetic field.

Thus it will be seen that the present invention provides a novel arrangement for detecting the passage of vehicles in a predetermined direction in a roadway by generating an impulse of unique character for such vehicles which will cause suitable impulse responsive means to operate a relay or other means for controlling signalling circuits. From the foregoing description it will also be apparent that by virtue of the novel magnet and coil arrangement the detector may be adapted to be substantially non-responsive to extraneous electrical and magnetic disturbances; that the net period of closure of the output relay contacts will be generally inversely proportional to the speed of the actuating vehicle; that the detector has a sharply-defined area of sensitivity and that the response of the unit to vehicles passing through any portion of this area in the proper direction for detection is substantially uniform, varying only with the speed and magnetic characteristics of the vehicle; that compensating means form a part of the detector unit to reduce greatly the intensity of the impulses of traffic in the opposite or wrong direction for detection; and that when used with a preferred form of responsive device the effect of extraneous impulses arising from stray disturbances as street car lines and power wires, is minimized or eliminated.

It will be seen that the objects above enumerated and others, are attained by applicant's device. The form of the invention described and illustrated herein is to be considered as but one embodiment, and it will be appreciated that many changes may be made in the construction of the unit or alterations in the design thereof or rearrangement of the parts, as the relative size, shape or location of the several coils, or other changes, without departing from the spirit of the invention as defined by the claims.

I claim:

1. A traffic detector adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path, including in combination, means for producing two magnetic fields interlinking such path with the axes of magnetic polarity of such fields parallel and extending transversely to such path and spaced apart along the direction of such path, coils located in such fields so as to have electromotive forces generated in themselves upon the passage of any unit of traffic containing magnetic material in such path, and circuit means connecting the said coils in series opposition and providing terminal leads for external connection whereby substantially all magnetic disturbances occurring at any appreciable distance from the coils will

produce substantially equal and opposite impulses of electromotive force in the coils and will produce substantially no effect in said terminal leads but magnetic disturbances resulting from the passage of such unit of traffic containing magnetic material along such path so as to effect the coils sequentially will produce such opposing impulses sequentially so that separate impulses across said terminal leads will indicate passage of traffic.

2. A traffic detector adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path, including in combination, means for producing two magnetic fields interlinking such path with axes of magnetic polarity of such fields parallel and extending transversely to such path and spaced apart along the direction of such path, coils located in such fields so as to have electromotive forces generated in themselves upon the passage of any unit of traffic containing magnetic material in such path, and circuit means connecting the said coils in series opposition and providing terminal leads for external connection, the coils and magnetic fields being arranged at such close spacing along the path of traffic that the electromotive force generated in one of said coils will partially overlap and add to the electromotive force generated in the other coil during the time while a unit of traffic is passing over both coils, whereby a relatively large impulse of electromotive force of one polarity will be given by traffic proceeding in one direction over the coils and a similar large impulse of electromotive force of the opposite polarity will be given by traffic proceeding in the opposite direction over the coils.

3. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in said path including in combination, a pair of bars of magnetic material placed parallel to each other adjacent to and transverse to the path of traffic and magnetized in the same direction to provide magnetic fields interlinking said path, said bars being spaced relatively closely to each other along said path, coils encircling the respective bars, and means connecting said coils in series opposition with each other and providing leads for external connection from the end of each coil whereby a unit of traffic containing magnetic material in traversing said traffic path will first induce a voltage in one coil in one direction to produce a small voltage impulse of one polarity across said leads and second, will induce voltages in said one coil in the opposite direction and in the other coil in said one direction and the voltages will be added together by the series opposition connection of the coils to produce a large voltage impulse of opposite polarity to the first impulse across the said leads, and then will induce a voltage in said other coil to produce another small voltage impulse of the same polarity as the first impulse.

4. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in said path including in combination a pair of magnetized bars arranged parallel to each other adjacent to the path of traffic and extending transverse to such path with their magnetic polarity in the same direction, said bars being spaced along such path relatively closely to each other as compared with the length of the bars, a coil encircling each bar, and circuit means connecting the two coils in series opposition to each other and providing leads for external connection from one end of each coil,

the spacing of the coils and the connection of the coils being such that a relatively strong impulse of the electromotive force of one polarity will be generated across said leads by the passage of a unit of traffic in one direction along such path and a similar strong impulse of opposite polarity will be generated by passage of a unit of traffic in the opposite direction.

5. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in said path including in combination a pair of magnetized bars arranged parallel to each other adjacent to the path of traffic and extending transverse to such path with their magnetic polarity in the same direction, said bars being spaced along such path relatively closely to each other as compared with the length of the bars, a pair of coils connected in parallel in the same direction on each bar, the two coils on each bar being placed relatively near the ends of the bar, and circuit means connecting in series opposition the two pairs of parallel connected coils and providing leads for external connection from one end of the coils on one bar and the opposite end of the coils on the other bar.

6. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in said path including in combination, a pair of magnetized bars placed parallel to each other adjacent and transverse to such path with each bar having north and south magnetic poles and the two bars having their north magnetic poles in the same direction and said bars being spaced relatively closely to each other along the path of traffic, a pair of coils encircling each bar with the coils spaced near the opposite ends of the bar and said coils being wound in the same direction on said bar, circuits connecting the south ends of the coils on one bar together and the north ends of the coils on said one bar together, and other circuits correspondingly connecting the south ends of the coils together and the north ends of the coils together on the other bar, another circuit connecting the south ends circuit of the coils on the first bar to the south ends circuit of the coils on the second bar, and leads for external connection extending from the respective north ends circuits of the coils of the respective bars.

7. A traffic detector adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path and including in combination a bar of magnetic material placed in and transverse to the path of traffic and to provide a magnetic field interlinking said path, and a plurality of coils of wire encircling said bar and including one coil located near each end of said bar, said coils being connected in parallel in the same direction electrically and having leads to permit external connection to the parallel connected coils, whereby said coils will provide an electrical impulse across said leads in response to a passage of a unit of traffic containing magnetic material along said path which impulse will have a substantially uniform value irrespective of the position of said traffic unit transverse to said path with respect to said bar as long as a portion of said traffic unit passes over a part of said bar.

8. A traffic detector adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path and including in combination a bar of magnetic material placed in and transverse to the path of traffic and mag-

netized to provide a magnetic field interlinking said path, and a plurality of coils of wire encircling said bar and including one coil located near each end of said bar, and a third smaller coil located substantially at the middle of said bar, and means connecting the end coils together in electrical parallel connection and also connecting said third coil in series opposition to the pair of parallel connected coils, and leads from the free end of the parallel connected coils and the opposite free end of the third coil for external connection of the entire coil assembly whereby a substantially uniform electrical impulse will be produced across said leads in response to the passage of a unit of traffic containing magnetic material along said path irrespective of whether such unit of traffic passes over either end or the middle of said bar.

9. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in one direction only along said path, including in combination, a pair of bars of magnetic material placed parallel to each other adjacent to and transverse to such path and magnetized in the same direction to provide magnetic fields interlinking said path and said bars being spaced relatively closely to each other along such path, coils encircling the respective bars, means connecting said coils on the two bars in series opposition with each other and providing leads for external connections from the free end of each coil and an impedance connected in shunt with the coil on the second bar to be passed by traffic proceeding in said one direction.

10. A traffic detector of the character described in claim 9 in which said impedance comprises a condenser.

11. A traffic detector of the character described in claim 9 in which such impedance comprises a resistance.

12. A magnetic type of traffic detector to be located adjacent to a path of traffic for detecting the passage of traffic in one direction only along said path, including in combination, a pair of bars of magnetic material placed parallel to each other adjacent to and transverse to such path and magnetized in the same direction to provide magnetic fields interlinking said path and said bars being spaced relatively closely to each other along such path, coils encircling the respective bars, means connecting said coils on the two bars in series opposition with each other and providing leads for external connection from the free end of each coil, a resistance connected across said leads, and a tapped connection extending from a point in the series connection between said coils to a variable point on said resistance.

13. In a traffic detector of the magnetic type adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path in one direction only, the combination of means for providing two closely adjacent magnetic fields interlinking said path transversely, coils located in respect to each of said magnetic fields so as to have generated in each coil a wave of electromotive force upon the passage of any unit of traffic in said path, means connecting said coils in series opposition and including a lead from each coil for external connection, and means including an impedance shunting the second one of said coils which is passed by a unit of traffic proceeding in said one direction to delay the generation of such electromotive force in the latter coil whereby different types of waves of electro-

motive force will be generated across said external leads by different units of traffic passing said coils along said path in opposite directions.

14. In a traffic detector of the magnetic type adapted to be located adjacent to a path of traffic for detecting the passage of traffic in such path in one direction only, the combination of means for providing two closely adjacent magnetic fields interlinking said path transversely, coils located in respect to each of said magnetic fields so as to have generated in each coil a wave of electromotive force upon the passage of any unit of traffic in said path, means connecting said coils in series opposition and including a lead from each coil for external connection, such coils and magnetic fields being located at such spacing along the path of traffic that the waves of electromotive force in the respective coils will partially overlap each other and the series connection of the coils being such that such partially overlapped waves will be added together in their overlapped portion to provide an increased voltage across said leads, and means including an impedance shunting the second one of said coils to be passed by traffic proceeding in said one direction along said path to delay the generation of the voltage wave in such second coil to increase such overlap and addition of the voltage of the electromotive forces in said one direction and to reduce such overlap and addition of voltage resulting from traffic proceeding in the opposite direction.

15. In a traffic detector of the magnetic type for detecting the passage of traffic in a traffic path, the combination of means for providing a pair of closely adjacent magnetic fields interlinking said path transversely, a coil placed in each of said fields for generating a voltage wave upon the passage of a unit of traffic containing magnetic material through such field, each of said coils having one end adapted for external connection and the other ends of the coils being connected together, means including an impedance connected in shunt across one of the coils to retard the generation of a voltage wave in said one coil whereby a unit of traffic passing the detector in one direction will produce one type of voltage wave across the external connection and a unit of traffic passing in the other direction will produce a different type of voltage wave.

16. In a device of the class described for use in the detection of a paramagnetic mass in substantially unidirectional linear motion, in combination, a pair of substantially identical electromagnetic generators sequentially spaced in the direction of movement of the mass and each generator including two termini, a conductor differentially serially connecting said generators to one another by attachment to two selected termini, a capacitor connected across the termini of said generator which is last influenced by the said movement of the paramagnetic mass, the termini not connected by said conductor serving as means for connection of said generators to a circuit.

17. In a device for detection of a paramagnetic mass in substantially unidirectional motion, in combination, a pair of substantially identical electromagnetic generators, spaced sequentially in the direction of movement of the mass and each adapted to produce an impulse of electromotive force responsive to the passage of such mass, each generator including two termini and a conductor differentially serially connecting said generators to one another by two selected termini,

the remaining termini serving as a means for connection of said generators to an external circuit, said generators being so closely spaced that the impulses of electromotive force in the two generators partially overlap at said remaining termini as the mass passes the first generator and approaches the second generator and the electromotive force produced in said first generator will add to the electromotive force produced in said second generator.

18. In a device for detection of a magnetized body in substantially unidirectional motion along a traffic path, in combination, a pair of substantially identical coils closely spaced sequentially along said path, conducting means interconnecting said coils in series opposition and providing a lead from each coil for external connection, and a capacitor connected in shunt with the coil last passed by said body in the direction of said motion.

19. In a device for detection of road vehicles containing paramagnetic material in substantially unidirectional movement along a roadway in a magnetic field, the combination of a pair of coils closely spaced sequentially along said roadway in the direction of such movement, conductor means interconnecting said coils in series opposition and providing free ends for external connection, a paramagnetic core within each of said coils, and a capacitor connected in shunt with the coil last passed by such vehicle in said movement.

20. In a traffic detector of the magnetic type adapted to be located adjacent to a path of traffic for directionally detecting the passage of a magnetized unit of traffic in such path, the combination of two coils spaced sequentially along said path so as to have electromotive force generated in each coil upon the passage of such traffic unit, conducting means interconnecting said coils in series opposition and including a conductor from each coil for external connection, said coils being so closely spaced that the electromotive force generated in one coil as the traffic unit passes said one coil and approaches the second coil will add to the electromotive force generated in said second coil as traffic so approaches the second coil so as to provide at the external connection an increased impulse of electromotive force distinctive of the direction of passage of such traffic unit.

21. In a traffic detector of the magnetic type adapted to be located adjacent to a path of traffic for directionally detecting the passage of a magnetized unit of traffic in such path, the combination of two coils spaced sequentially along said path so as to have electromotive force generated in each coil upon the passage of such traffic unit, conducting means interconnecting said coils in series opposition and including a conductor from each coil for external connection, and a paramagnetic core within each of said coils, said coils being so closely spaced that the electromotive force generated in one coil as the traffic unit

passes said one coil and approaches the second coil will add to the electromotive force generated in said second coil as traffic so approaches the second coil so as to provide at the external connection an increased impulse of electromotive force distinctive of the direction of passage of such traffic unit.

22. A traffic detector adapted to be placed close to a path of traffic for detecting the passage of a traffic unit containing magnetic material along said path, comprising magnetic field generating means, a pair of coils disposed one behind the other along said path and linking the magnetic field so as to produce impulses of electromotive force in the respective coils responsive to passage of such traffic unit, conducting means interconnecting said coils in series opposition and providing free ends from said coils for external connection, said coils being disposed so close to one another along said path that the opposing impulses of electromotive force in the coils so connected with overlap to produce across the external connection an impulse of relatively large value of one polarity by passage of such traffic unit in one direction and an impulse of relatively large value of opposite polarity by passage of such traffic unit in the opposite direction.

23. A traffic detector adapted to be placed close to a path of traffic for detecting the passage of a traffic unit containing magnetic material along said path, comprising means for producing a magnetic field in transverse direction to the traffic path, at least two coils linking the magnetic field and spaced one from the other in said transverse direction, conducting means connecting said coils in parallel in the same electromagnetic direction, and providing free ends for external connection, whereby the impulse of electromotive force produced at the free ends of the coils by passage of such traffic unit is approximately uniform irrespective of the position of such traffic unit in said transverse direction.

24. A traffic detector adapted to be placed close to a path of traffic for detecting the passage of a traffic unit containing magnetic material along said path, comprising magnetic field generating means, a pair of coils disposed one behind the other along said path and linking the magnetic field so as to produce impulses of electromotive force in the respective coils responsive to passage of such traffic unit, conducting means interconnecting said coils in opposition and providing free ends from said coils for external connection, said coils being disposed so close to one another along said path that the opposing impulses of electromotive force in the coils so connected will overlap to produce across the external connection an impulse of relatively large value of one polarity by passage of such traffic unit in one direction and an impulse of relatively large value of opposite polarity by passage of such traffic unit in the opposite direction.

JOHN L. BARKER.