

Jan. 9, 1940.

W. O. HAMPTON ET AL

2,186,922

COUNTING CONTROL SYSTEM

Filed July 23, 1934

2 Sheets-Sheet 1

Fig. 1

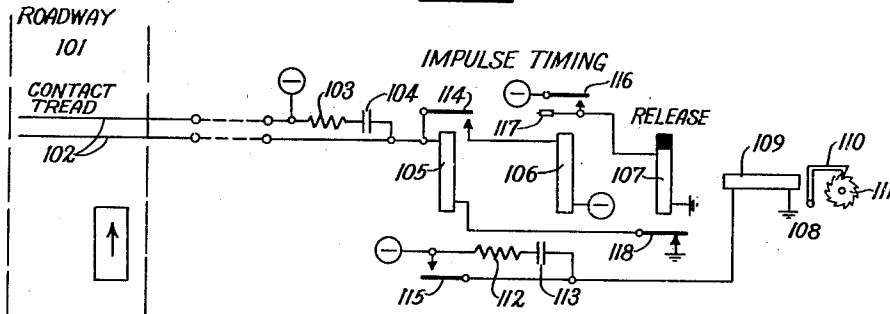
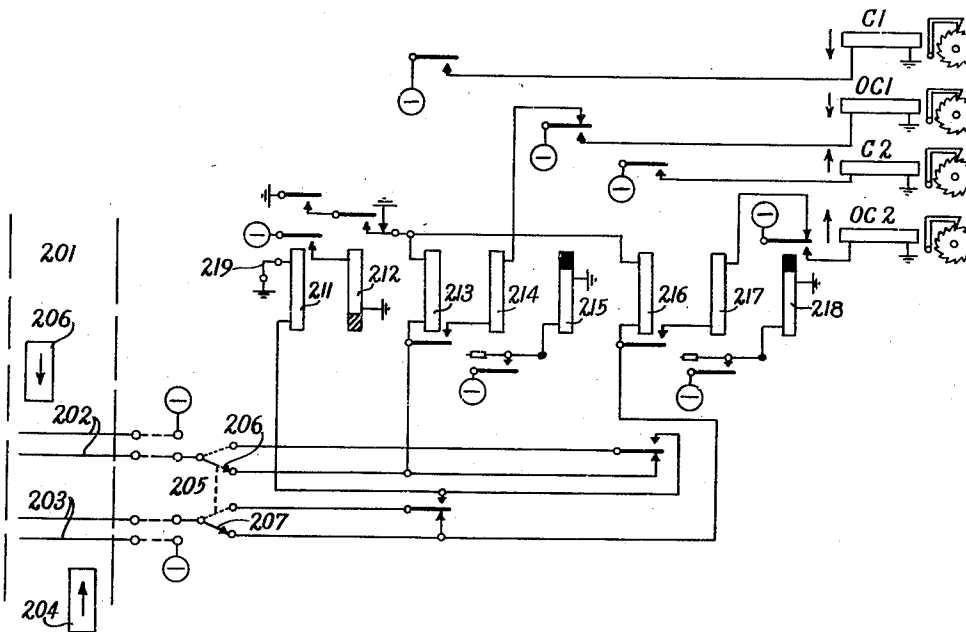


Fig. 2



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2 Sheets-Sheet 2

Fig. 3

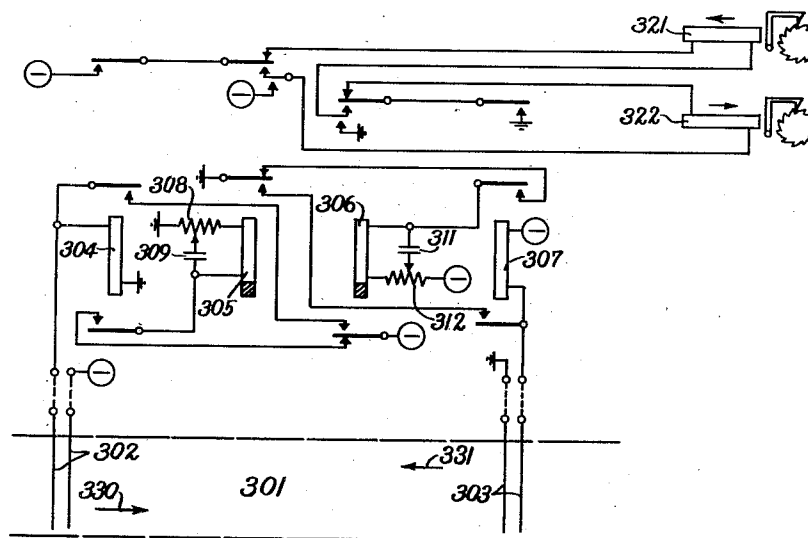


Fig. 4

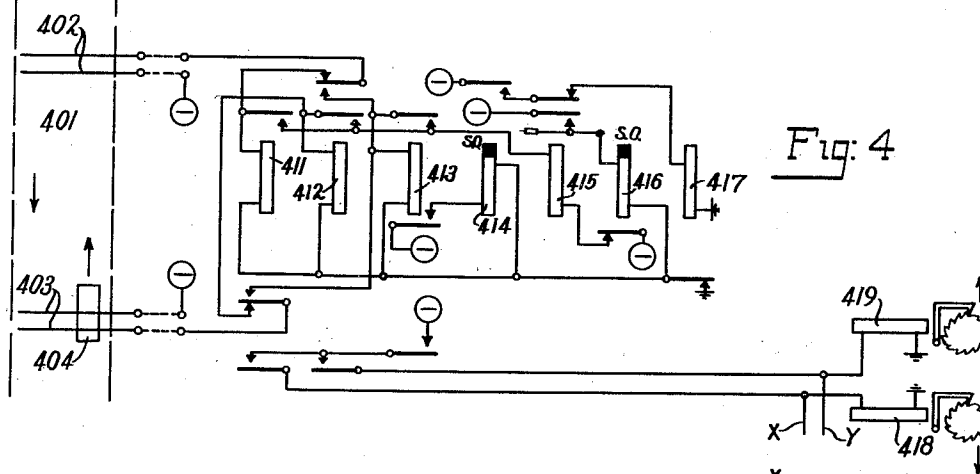
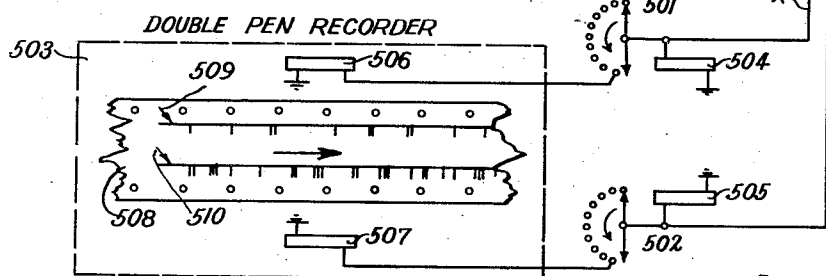


Fig. 5



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2,186,922

COUNTING CONTROL SYSTEM

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Application July 23, 1934, Serial No. 736,466

19 Claims. (Cl. 235—92)

Our invention relates to control systems in general but is more particularly concerned with integrating control systems which are suitable for controlling, registering and otherwise signalling or indicating predetermined occurrences or events, such, for example, as the passing of objects at predetermined points of observation or control.

Some of the features of our invention may be applied either separately or conjointly in numerous fields; however, the preferred embodiments and applications of our invention may be found in the field of traffic control and the like. Accordingly, the invention will be described herein in conjunction with traffic control systems broadly, and more specifically in conjunction with traffic counting systems, that is, with systems having novel and improved means for automatically registering and counting the number of vehicles passing predetermined observation points.

Suggestions for counting traffic have been made and numerous systems are known and in practical use. For example, prior investigators have suggested the use of the photo-electric cell and the like. However, the corresponding systems due to the peculiarities of the photo-electric cell do not furnish accurate counts under the varying conditions of traffic. They require optical shielding and impose restrictions as to placement which cannot be observed without sacrificing certain advantages and narrowing the requirements. It should be noted that the broad designations "traffic control" or "traffic system" or equivalent language as used herein comprehend control in the sense of signalling as well as in the sense of registering or counting or otherwise observing the volume of vehicular and other road traffic. Therefore, any system that is to be successfully applied must include means for discriminating between various principal groups of traffic, e. g., vehicular traffic as distinguished from other traffic. The use of light-sensitive apparatus has met with difficulties because of the necessity of distinguishing or discriminating between the categories of the objects passing a given point. Of the other known systems we may mention for the sake of reference appliances designed primarily for the control or counting of vehicular traffic, including contact means disposed in excavations in the pavement. A passing vehicle upon rolling over a contact tread causes the production of an impulse or impulses for the operation of certain control mechanisms housed in suitable boxes or containers at the side of the roadway or street. The systems in this group are usually termed "vehicle actuated" or "vehicle controlled" sys-

tems. The mechanisms of the latter types of systems include timing and impulse storing means, for example, condensers for electrostatically storing the impulses received from the corresponding contact tread. The necessity of excavating for the placement of the contact treads produces difficulties and the impulse receiving and operating mechanisms of these systems are rather complicated and consequently expensive.

The lack of a practical, easily installed and easily and cheaply operated and maintained system of this character which furnishes accurate results within practically useful limits is responsible for the fact that wherever accurate traffic counts are required they are usually made by individual observers equipped with manually operable counters and tally sheets on which the empirically observed traffic figures are entered.

The principal object of our invention resides in the production of new and improved means for automatically counting traffic, for example, passing vehicles in such a manner as to overcome the drawbacks of existing systems and to furnish practically useful and substantially accurate results with simple and readily installed as well as simply and economically maintained apparatus.

A specific object is to provide economical and reliable electrically controlled counting means which respond to electric impulses produced by the action of wheels or passing vehicles on a contact tread device of suitable construction disposed in or on a roadway or traffic lane.

Another object relates to the production of a counting system which will function properly while the vehicles are proceeding in the customary manner and at the usual speeds so that no special control of the traffic is necessary in order to carry out the counting operations.

A further object is to provide suitable means for differentiating between traffic passing in the two directions of a common traffic artery or roadway so that a separate integration may be had for the volume of traffic and the components thereof in each direction.

Still another object is realized by the provision of means for recording varying traffic density and for showing for any given time period how much traffic passed the observation point and in which direction.

Other objects and features of the invention will appear from the detailed description which is to follow with reference to the accompanying drawings, Figs. 1 to 5, inclusive. In these drawings,

Fig. 1 shows the invention in a simple form applied to an integrating counting system, espe-

cially suitable for taking a total count of all traffic passing a given point in both directions;

Fig. 2 illustrates an integrating counting system which is convertible by means of a double-throw switch, from a total traffic integration system to a system for separately counting the traffic units passing in two directions, respectively;

Fig. 3 indicates a directionally selective dual counting system wherein a single count is registered for each vehicle, a timing device consisting of a condenser-shunted relay being used to hold the system against a second count until the vehicle has completely passed;

Fig. 4 shows a particularly desirable system in which the vehicle passes over one contact tread to prepare the circuit arrangement for a directionally selective count and passes over the next tread to effect the counting operation and to restore the system for performance in the registering or counting of the successive vehicle. A timing clearing arrangement is provided to function in case, for example, one set of wheels of a vehicle jumps over a contact tread without actuating it; and

Fig. 5 shows an auxiliary arrangement for recording traffic counts on a moving tape or record so that periods of varying traffic density and the values thereof may be noted. A feature of this arrangement is that several traffic counts are stored and then placed on the tape or record as one, thereby condensing the desired information and permitting the use of a slower running tape.

Referring now particularly to Fig. 1, a roadway 101 is indicated across which the two poles 102 of a contact tread of suitable structure extend. Since the construction of contact treads forms no part of this invention, we have indicated it only diagrammatically. The tread may be of such a structure as to permit its placement on the pavement or it may be secured temporarily or permanently on the pavement as the case may be. We have shown in conjunction with the systems as illustrated in the drawings contact treads to be operated by the wheels of vehicles. It should be noted, however, that it is not necessary to employ a structure for operation directly by the weight of passing vehicles. Other provisions may be used, in fact, any suitable contact making or impulse producing means responsive to the passing of an object, such as a vehicle may be employed. It will be understood, therefore, that certain features of our invention are applicable in recording or counting systems generally, aside from the specific use in traffic counting systems as described herein.

Numerals 105, 106 and 107 represent impulse, timing and release relays, respectively, while numeral 108 indicates an electrically actuated counter of suitable construction including an actuating magnet 109 adapted to operate an armature 110. This armature 110 may carry a pawl which serves for advancing the unit wheel 111 one step each time armature 110 is attracted by the magnet 109. Relays 105-107 (shown diagrammatically) may be of a type widely used in signalling systems and telephone systems and the like, such as shown, for example, in the book by A. B. Smith, "Telephony", published by F. J. Drake & Company, Chicago, 1924, page 375. Each of the contact springs such as 114-118 is actuated by the armature (not shown) of the corresponding relay, upon energization of the associated electro-magnet. These springs are termed "armature springs" but for convenience in circuit description

are usually called "armatures". The contact associated with armature spring, or "armature" 116 has a weight 117 attached so as to cause the contact to vibrate for a period of time after being struck by the armature spring, thereby delaying the operation of the release relay 107 for the length of time required for the making of a steady contact. A relay of a type having such a vibrating contact is disclosed in the patent to Erickson, No. 1,641,256, issued September 16, 1927. Relay 107, as is indicated by the solid black upper portion of the core thereof, has a copper collar placed around the armature end of the magnetic core to delay its operation.

Resistance element 103 and condenser 104 are bridged across the poles of contact tread 102 to minimize sparking; the resistance element 112 and condenser 113 associated with armature 115 have a similar function.

Throughout the drawings, a small circle with a minus sign or dash therein is used to indicate a point at which the negative pole of a current source is to be connected. Similarly, the conventional ground designation is used in the drawings to denote each point of connection of the positive pole of the current source in accordance with customary practice in circuit representation.

The various features incorporated in the system in Fig. 1 will appear from the following explanations.

When the front wheels of a vehicle pass over the contact tread of Fig. 1, poles 102 are brought into momentary electrical engagement extending the negative pole of the current source to the upper left terminal of the impulse relay 105. Since its lower right terminal is connected to the positive pole of the current source through armature 118 and associated resting contact of relay 107, relay 105 now operates and locks itself in a holding circuit at armature 114 in series with the timing relay 106. Relay 106, however, is shunted by the initial circuit closed to relay 105 by way of the contact elements 102 and therefore remains momentarily inactive. But when contact elements 102 separate due to the cessation of the wheel pressure of the passing vehicle, relay 106 operates in series with relay 105 which latter relay remains operated.

At armature 116 timing relay 106 closes a circuit through the associated weighted contact 117 for the energization of the release relay 107. The weight 117 carried at the end of the contact spring of relay 106, as indicated, causes vibration of the contact spring and thus prevents the closure of a steady circuit for relay 107 for an interval of sufficient duration to permit the rear wheels of the vehicle to reach the contact tread before permitting relay 107 to operate in a steady circuit. Accordingly, the release relay 107 will not operate during the interval of time which elapses from the moment the front wheels of a vehicle leave the tread to the moment when the rear wheels reach the tread. This interval varies with the speed of the vehicles. However, any variations which will occur in normal traffic can be easily taken care of by providing for such a delayed operation of the relay 107 as will substantially correspond to the percentage variations in the speeds which are to be normally encountered. The speed of vehicles rarely varies within limits exceeding 25%. In terms of mileage, this means that where a speed of 40 M. P. H. is lawfully admitted occasionally a vehicle will travel at a speed of 50 M. P. H. and some vehicles will travel at a speed of 30 M. P. H. It is in any case a matter of milli-

seconds from the moment when the front wheels of the vehicle leave the tread to the moment when the rear wheels encounter the tread and, inasmuch as the operative energization of relays of the type used in our system is measured in milliseconds, it will be readily seen that the operation of the release relay 107 has to be delayed only for so many milliseconds as will take care of the known speed percentage variations to be expected at any given observation point. This maximum delay can be determined by varying the weight on the contact spring 117 or by using a more or less resilient spring or by varying the length of the spring carrying the weight or, finally, by varying the distance of the weight on the spring relative to the point where the spring is mounted. In other words, the vibrating period of the contact spring on relay 106 is adjustable by adjusting one or more of the variables that determine its vibration. The vibrating period can therefore be adjusted to take care of any maximum requirements of speed percentage variations that might occur, with such a safety factor that even conditions appreciably exceeding these maximum requirements are taken care of.

It is to be noted that relay 105 at armature 115 closes an operating circuit for the magnet 109 to actuate the counter 108 in order to register the passage of the vehicle.

When the rear wheels of the passing vehicle strike the contact tread, the initial circuit of impulse relay 105 is again established and timing relay 106 is shunted. If the vehicle is moving relatively slowly, timing relay 106 is shunted or short-circuited long enough to permit its restoration, which may not be the case when the vehicle is moving at a relatively high rate of speed. However, in case relay 106 restores, it immediately operates when the rear wheels leave the contact tread, thereby starting a new timing operation which is useful to prevent immediate circuit restoration in case a slow moving vehicle is followed by a trailer. At any rate, when the vehicle has finally passed over the contact tread 102, relay 107 operates responsive to the steady current flow in its energization circuit after cessation of the vibrations of the weight 117 and, upon operating, relay 107 opens the circuit of relays 105 and 106 at armature 118 whereupon relays 105 and 106 restore to normal position. Relay 105 opens the counting circuit at armature 115; while relay 106 opens the circuit of release relay 107 at armature 116, permitting relay 107 to restore and to prepare a circuit at armature 118 for relay 105 so that the latter may become effective upon the arrival of the next impulse caused by a subsequently passing vehicle.

It will be seen, therefore, that our invention, as explained above, is concerned with a counting system wherein relay means respond to signalling impulses released by a passing object for effecting the registration, regardless of the direction of the object, together with a timing means including a relay employing a vibrating contact for governing the operation of the system, regardless of the specific type of passing object, in this case, regardless of the size of the vehicle, its speed or the number of its axles. The system is of utmost simplicity, is reliable in operation, and is well suited for use under light traffic conditions, where vehicles do not follow each other too closely.

In addition to being of utility in counting two-way traffic over an entire roadway, the system shown in Fig. 1 is also useful in counting vehicular traffic in a single lane of a multi-lane major

highway, in which case the associated contact tread may be confined to a single lane and all traffic passing over the tread during a given interval will likely be in the same direction. This latter arrangement contemplates a separate contact tread and a separate counter for each traffic lane.

In the system illustrated diagrammatically in Fig. 2, two contact treads 202 and 203 are indicated disposed across the roadway 201. Both of these treads are indicated as lying across the entire roadway, and the invention may be carried out in this manner if desired. However, it will be understood that the contact treads shown may be disposed each in a separate traffic lane, for example, tread 203 in the lane for the traffic indicated by the arrow in conjunction with the vehicle 204 and contact tread 202 in the lane for the traffic in opposite direction as indicated by the arrow in conjunction with the vehicle 206. The operation will be explained presently for both cases of operation.

A switch 205 having double-throw blades 206 and 207, is provided to permit the system to operate non-selectively for counting the total traffic in both directions or to operate selectively for counting traffic units separately for the two directions, regardless of whether the treads are placed in separate lanes or not. Two counters C1 and C2, associated with treads 202 and 203, respectively, are provided while over-counters OC1 and OC2 are associated with counters C1 and C2 for a purpose to be brought out subsequently.

Relays 213—215, associated with tread 202, correspond in general structure and function to relays 105—107, shown in Fig. 1, while the similar relays 216—218 are associated with tread 203. Relays 211 and 212 have a special switching and release function to be presently explained.

The operation of the system non-selectively or non-directionally relative to the direction or flow of the traffic, with the switch 205, in the position shown, will be described first.

Assuming now that the front wheels of the vehicle indicated at 204 and proceeding in the direction indicated by the arrow pass over the tread 203, the two poles of this tread will be brought into engagement and the impulse relay 216 will be operated from ground through the resting contact of relay 212 to battery at the tread contacts 203, as shown. At its upper armature relay 216 operates counter C2, while at its inner lower armature it locks itself in a series circuit with the timing relay 217 and contacts of release relay 218 to battery. The arrows shown at the left of the counter C1—OC1 and C2—OC2, respectively, indicate the traffic direction corresponding to the arrows shown in conjunction with the diagrammatically indicated vehicles 206 and 204, respectively. As a result of the operation noted above, the armature of relay 217 shown below this relay is brought against its weighted contact to start the contact into vibrations and to delay the operative response of release relay 218 as previously described with reference to this function in connection with the description of Fig. 1.

When the rear wheels of the vehicle 204 strike the tread 203, the initial circuit of relay 216 is reestablished and relay 217 is shunted by the battery at the contact tread. This relay will restore for a new timing operation if the assumed vehicle is moving sufficiently slow and premature operation of the release relay 218 will be prevented. The weighted armature of relay 217 will otherwise continue to vibrate and will thus delay the

operative actuation of the release relay 218. However, when the vibrating contact of relay 217 comes to rest in actuated position, relay 218 operates and opens the locking circuit of relays 216 and 217, to restore these relays, at the same time energizing the over-counter OC2 which in this instance serves merely as a check of the accuracy of the operation of counter C2. When relays 216 and 217 restore, relay 217 opens the circuit of release relay 218, permitting relay 218 to de-energize and to prepare the locking circuit again, at the same time de-actuating over-counter OC2.

Assuming now that each of the treads is disposed across the entire roadway so that vehicles travelling in either direction will strike both contact treads, responsive to the wheels of vehicle 204 passing over tread 202, relays 213—215 operate as described for relays 216—218 to bring about the actuation of counters C1 and OC1. It will be understood, of course, that each of the treads 202 and 203 together with their respective associated equipment operates independently of the other in the example described.

When a vehicle proceeding in opposite direction closes the contact treads, the operation is the same as described except, of course, that the equipment associated with tread 202 operates first.

In the assumed case of applying the invention, with the contact treads extending over the entire roadway, the separate counting or registering of each passing vehicle according to the front and rear wheels or axles, respectively, on the counters and over-counters provides an effective check of one counter against the other. Errors which might occur in a great number of counts will be compensated. Each vehicle will thus be registered twice, taking into consideration merely the counters C1 and C2, and one count will provide a check against the other.

However, if the invention is applied with each of the contact treads 202 and 203 in a separate traffic lane, counters C2 and OC2 will register only the traffic in the lane for vehicles such as 204 travelling in the direction indicated by the arrow, while counters C1 and OC1 will register only the total traffic travelling in the corresponding lane of vehicle 206.

Assuming now that directionally selective counting is desired, and further assuming that both treads are again placed across the roadway, the blades 206 and 207 of switch 205 are thrown into their alternate positions, indicated by the dotted lines. When the system is to be used in this manner and for this purpose, the treads 202 and 203 should be preferably placed close together so that the front wheels of a vehicle pass over both treads before the rear wheels pass over either. It may be remarked at this point that the contact treads 202 and 203 may be separate structures or, if desired, a structure may be used containing a plurality of sets of contacts, such as 202 and 203.

Now, with the switch 205 in alternate position, when the front wheels of a vehicle, for example, the wheels of vehicle 204 pass over the tread 203 in a direction indicated by the arrow, a circuit will be closed by way of grounded resting contact of relay 212 to operate relay 216, as previously described, except that the circuit extends over the resting contact and lower armature at relay 213 and the switch blade 207 in alternate position shown in dotted lines and then to battery at the tread contacts. In addition to operating the corresponding counter C2 and closing a locking cir-

cuit through relay 217, relay 216 at its lower armature disconnects contact tread 202 from its associated impulse relay 213 and transfers it to relay 211 of the special switching and release means including this relay and also relay 212. It will be remembered that the operation now being considered is directionally selective relative to the flow of traffic, and, therefore, only specific counting means are to be actuated responsive to specific directional operation of the contact treads. The disconnection of tread 202 from its associated control equipment prevents the actuation of counters C1—OC1. Only the equipment provided for one specific direction, namely the direction indicated by the arrow within the vehicle 204 must be effected, since it was assumed that this vehicle crosses the observation point.

When the wheels of the vehicle strike contact tread 202, the prepared circuit for relay 211 through the arm 206 of the switch 205 in upper position and the now operated lower armature of relay 216 is completed. Upon operating, relay 211 prepares a new locking circuit for relays 216 and 217 at its upper armature, at the same time operating the slow release relay 212 at its inner armature. Relay 212 completes the new holding circuit for relays 216 and 217 through contacts of relay 211, at the same time opening their initial series circuit. Therefore, when relay 211 restores, responsive to the wheels of the vehicle leaving the tread 202, it opens the circuit of relays 216 and 217 at its upper armature so that these relays are restored and relay 216 opens the locking circuit at another point at its inner lower armature. A moment later, the slow release relay 212 restores and the circuit elements are again in normal condition.

It should be noted that the counter provided for the corresponding direction is actuated to count the passage of the vehicle but the counter for the opposite direction is not operated because, in this instance, relays 213—215 have been disconnected by the actuation of relays 216.

The operation will be repeated by the action of the rear wheels. Thus, when the rear wheels of the vehicle pass successively over the treads 203 and 202, relays 216, 217, 211 and 212 are again operated in the manner described and the counter C2 is again actuated. This double actuation of counter C2 necessitates computing the actual total count by taking half of the total count as the number of vehicles that passed in the corresponding direction. There is one objection that could be raised to the double count in case of slowly moving vehicles, namely, that vehicles with trailers or more than the usual number of axles will cause a larger reading. It should be considered, however, that the categories of traffic passing over a certain route are known prior to taking a count. Thus, it is known in advance that freight traffic predominates on a certain road while fast moving traffic predominates on another road. This prior knowledge will not only determine the use of a certain counting system but will also determine the interpretation of the count. If a large percentage of multi-axle vehicles are included in the traffic to be counted, the count may be considered merely as an axle count which, in some respects, gives a truer picture of traffic conditions than a vehicle count.

It is to be particularly noted that the circuit equipment above described is cleared, or returned to normal condition, positively responsive to actuation of the second tread and without waiting for the operation of the release relay 218

under the control of timing relay 217. Since relay 218 is not operated, overcounter OC₂ is not operated. However, in the event that the vehicle fails to actuate the second tread, or in the event that one tread only is operated, for example, when a fast moving vehicle bounces over a tread the positive clear-out described does not occur, and the concerned over-counters (OC₁ or OC₂) operate to indicate that a short count has been registered on the corresponding counter. Therefore, the true count is the sum of the counts registered on a counter and the corresponding over-counter.

When a vehicle proceeding in the opposite direction, for example, vehicle 206, crosses treads 202 and 203, relays 213 and 214 operate (as described for relays 216 and 217) responsive to the actuation of tread 202. Relay 213 operates the corresponding direction counter C₁, at the same time disconnecting tread 203 from the impulse relay 216 and transferring it to relay 211. Relays 211 and 212 therefore operate in the same manner described to clear the circuit when the front wheels of the vehicle pass over tread 203. The count is repeated when the rear axle passes over the treads, depending on the relative speed of the vehicle.

With the above described arrangement a minimum of a number of counts are lost because of cars travelling abreast or passing over the treads in opposite direction at nearly the same time, since the circuit is positively cleared for further selective counting as soon as an axle (front or rear) passes the second tread in either direction.

In the event that an "axle" count is described is not desired but a straight vehicle count is preferred, possibly at some slight sacrifice of accuracy, when cars are passing each other or travelling nearly abreast, it suffices to remove the current source connection from the upper terminal of relay 211 by removing jumper wire 219, rendering relays 211 and 212 ineffective. Under this condition, the circuit is not cleared until the concerned one of the release relays 215 or 218 operates, as previously described.

Alternatively, the "axle" count may be avoided in an additional way as will now be described:

The foregoing description of the selective operation of Fig. 2 is based on the assumption that the release time of the slow release relay 212 is adjusted so that the relay restores in a minimum time interval, allowing only time for relays 216 and 217 to restore. In the event that a vehicle count, as distinct from the described axle count, is especially desired perhaps at some slight sacrifice of accuracy when traffic is heavy in both directions, the release relay 212 is given a slower releasing adjustment. As is well known in the art, this may be done by properly adjusting the tension or pressure of the armature springs. Under this condition, release relay 212 is ordinarily still operated when the rear wheels strike the treads, effectively preventing a second actuation of the relays 216 and 217 or 213 and 214. Of course, an especially slowly moving vehicle will cause two counts, as it entails too much loss of accuracy to give relay 212 an adjustment slow enough to prevent all double counts. The count taken by direct reading will indicate the number of vehicles under the assumption of the customary rates of speed in the corresponding direction. However, since this assumption will not cover all cases, the records obtained will be an accurate indication only of such traffic as moves faster than a predetermined rate, with respect to axle

spacing. It will be understood, of course, that those in charge of the equipment will be conversant of the traffic conditions, and will be able to interpret the readings accordingly.

The device in Fig. 2 may also be operated with a relatively wide spacing of the tread contacts, for example two or more wheel-base distances apart, say twenty-five feet apart, switch 205 being in its dotted line position. With such a spacing of the treads, when the front wheels strike the first tread, tread 202 for example, relay 213 operates, followed by the operation of relay 214, when the wheels leave the tread. Counter C₁ is operated by relay 213 to register the passage of the vehicle.

When the rear wheels subsequently strike the tread 202, relay 214 is momentarily shunted by the direct circuit established at tread 202 for relay 213. Relay 214 restores and reoperates, again starting a timing operation involving its weighted contact and release relay 215.

Now, when the front wheels strike the distant tread 203, release control relay 211 is momentarily operated through switch arm 206 in upper position and the operated armature of relay 213. Relay 212 operates as before described responsive to the operation of relay 211, with the result that relays 213 and 214 restore responsive to the restoration of relay 211, when the front wheels leave the distant tread 203.

For the usage now being described, release relay 212 is preferably given a sufficiently slow release adjustment that the rear wheels of the vehicle ordinarily strike the distant tread while the slow acting relay 212 is still operated, in which case relays 213 and 216 are both disconnected from ground potential, and the tread actuation is ineffective.

Shortly, relay 212 restores, and the circuit is again receptive.

In case the vehicle is moving so slowly that relay 212 has time to restore before the rear wheels strike the distant tread 203, relay 216 is operated to count in the opposite direction on counter C₂ which count may be carried through the usual sequence of operations in case a vehicle is at the same time approaching the treads from the opposite direction. Otherwise, the operation of the vibrating-contact relay 217 results in the eventual operation of relay 218 to restore the circuit and to operate over-counter OC₂ to neutralize the specious operation of counter C₂. In the system just described the reading of the over-counter OC₂ is subtracted from counter C₂ to obtain the true traffic count in the corresponding direction.

The operation of the system shown in Fig. 2 has been described for two cases of application, namely, for the case of directional straight counting with the contact treads disposed in separate traffic lanes, and for straight counting and differential counting, respectively, with each tread extending over the roadway regardless of traffic lane divisions. In the case of modern roads with several well defined traffic lanes and well regulated traffic, particularly in the case of roads of considerable width, each lane may be provided with a special tread. However, most of the existing roads and highways are relatively narrow and the traffic is neither well defined as to lanes nor is it well regulated or even capable of strict regulation at all points. Our invention will be particularly serviceable for such conditions.

In the directionally selective counting system

according to Fig. 3 contact treads 302 and 303 may be placed across the roadway about an average wheel base distance apart. Impulse and timing relays 304 and 305 are associated with tread 302 while impulse and timing relays 307 and 306 are associated with tread 303. Condenser 309 which should preferably be of relatively high capacity and variable resistor 308 are associated with relay 305 in the manner shown so that the condenser 309 is charged when relay 305 receives current, and then discharges through the relay, holding the relay operated for a desired interval, for example, from one tenth of a second to two seconds. The holding time of relay 305 is determined within desired limits by the adjustment of variable resistor 308. A similar arrangement is provided for the relay 306 as designated by the numerals 311 and 312.

For the purpose of explaining the operation of this system, it will be assumed that a vehicle travelling from left to right in the direction indicated by the arrow 330 crosses the treads 302 and 303. When the tread 302 is actuated by the front wheels of the vehicle, the impulse relay 304 will respond and will operate its three armature springs shown in the drawing. The upper two armatures are ineffective at this time. At the lower armature relay 304 closes a circuit for relay 305, including the resistor element 308 in addition to the lower contacts of timing relay 306. At its inner armature relay 305 opens a point in the operating circuit of timing relay 306 and prepares a locking circuit for impulse relay 307 while at its upper armature it opens a point in the circuit of the counter 321, provided for counting vehicles travelling in the opposite direction, and extends negative potential to the counter 322 through the two working contacts indicated at this armature. It should be noted that the arrows 330 and 331 shown in conjunction with roadway 301 indicate the respective travel directions. Corresponding arrows are shown above the counters 321 and 322.

Condenser 309 takes a charge responsive to the closure of the circuit of relay 305 upon actuation of relay 304 so that it may discharge through relay 305 and maintain it operated until the rear wheels of the vehicle strike the tread 302. The slow release characteristic of the condenser-shunted relay 305 is augmented by a copper collar placed around the heel end of the core, as is indicated by the shaded lower portion of the relay.

Impulse relay 307 will be energized when the front wheels strike tread 303 which may or may not occur about the same time when the rear wheels strike tread 302. Relay 307 closes a locking circuit for its own winding at its lower armature to the front contact of the inner armature of the operated timing relay 305. Relay 307, therefore, will remain operated until relay 305 restores. It should be noted that relay 306 does not respond at this time because relay 305 is actuated and its inner armature is in operated position.

At its upper armature relay 307 closes a circuit for the actuation of the traffic counter 322 from ground to battery at the two working contacts now held in engagement by the upper armature of relay 305. The counter 322 provided for counting the traffic in the travel direction indicated by the arrow is in this way actuated but the counter 321 provided for the opposite travel direction remains unoperated.

When the rear wheels of the vehicle strike

the tread 302, relay 304 is again actuated, again fully energizing relay 305 and charging the condenser 309. This operation is repeated again, one or more times, in case the vehicle is provided with a trailer or the like. However, no further operation of relay 307 can take place because relay 307 is locked in a holding circuit under control of relay 305 as previously explained.

After the last set of wheels has passed over tread 302 and caused the last impulse to be delivered to timing relay 305 and has then passed beyond tread 303, relay 305 restores responsive to the discharge current from the condenser 309 falling below holding value, whereupon the counter 322 and the impulse relay 307 restore. The circuit equipment is now again in normal position, in readiness to respond selectively to a vehicle proceeding in either direction.

When a vehicle proceeding in the opposite direction as indicated by arrow 331 passes over the treads 303—302, the relays 307 and 306 operate first, followed by the operation of relay 304 to lock up under control of relay 306 and to operate the corresponding counter 321. The apparatus is then cleared by the deenergization of relay 306 after the vehicle has finally passed both treads. The treads 302 and 303 are preferably placed together as close as possible without being so close that a swiftly moving vehicle may strike the second tread before the concerned one of the timing relays 305 or 306 has had time to operate responsive to the impulse delivered to the first tread. The closer together the treads are placed, the less will be likelihood of loss of counts. It should be mentioned again that the treads may be combined in a single physical structure or may be constructed individually and placed on the road as desired or required by any given conditions.

In the system disclosed in Fig. 4, the contact treads 402 and 403 are placed across the roadway 401 preferably slightly farther apart than the distance between front and rearmost wheels of the longest vehicle likely to pass over the roadway during the count. The counters provided for registering the passage of vehicles in the respective travel directions are operated under control of relays 411—417 in a manner now to be pointed out. It should be observed first that the circuit is directionally prepared for counting by the passing of wheels (front and rear) over the first tread encountered while the selected directional counting is effected and the circuit is positively cleared when the wheels of the vehicle pass over the second tread.

Assuming now that a vehicle 404 passes over the treads in the direction indicated by the arrow, it will be seen that when the tread 403 is actuated by the front wheels, the associated impulse relay 412 will be energized through the lower contacts of relays 411 and 417. At its inner armature relay 412 locks itself in series with weighted contact timing relay 415; at its upper armature it disconnects tread 402 from its normally associated impulse relay 411 and transfers it to the common impulse or counting relay 413; and at its lower armature it prepares an actuating circuit for the corresponding counter 419. Relay 415 responds operatively as soon as the tread impulse ceases removing the shunt from its winding and opens a point in the circuit of the clearing relay 417 at its upper armature, while at its inner armature it sets the weighted contact into vibration preparatory to the operation (about two seconds later) of the release re-

lay 416 in case the circuit does not clear in its normal operation. When the rear wheels strike the tread 403, the stiffly adjusted relay 415 being again shunted restores momentarily and then reoperates to start the timing operation anew. This is repeated one or more additional times in case the vehicle is equipped with a trailer.

When the front wheels strike the second tread 402, relay 413 will be actuated through the operated upper armature of relay 412. Upon energizing relay 413 locks itself in parallel with relay 412 and in series with relay 415 at its upper armature whereupon relay 415 restores momentarily until the wheels have cleared the tread. At its lower armature relay 413 closes the circuit of the corresponding counter 419 through the previously actuated armature of relay 412. Counter 419 registers the passage of the vehicle but counter 418 remains unaffected because its circuit depends on relay 411 which has not operated.

At its lower middle armature relay 413 closes a circuit for relay 414. The latter operates but not before relay 415 has had time to reoperate, since relay 414 is slow in operating, as indicated in the drawings. This prepares the actuation of the switching functions for clearing the system as discussed below.

When the rear wheels of the vehicle strike the tread 402, the timing relay 415 being again shunted restores, at this time closing a circuit at its upper contact through the upper contact of the now operated relay 414 for the clearing relay 417. The latter relay disconnects positive potential from each of the relays 411—414 and 416, restoring relays 412—414. Relays 412 and 413 open their previously established locking circuits through relay 415. Relay 414 on restoring de-energizes relay 417 but not until the tread has been cleared since relay 414 is slightly slow in restoring as well as in operating.

The counter 419 provided for registering vehicles travelling in the direction of the arrow of vehicle 404 has been actuated and the relays of the circuit are in normal condition and in readiness for effecting further counting in either traffic direction.

The circuit was cleared as explained, responsive to the operation of the tread 402 by the rear wheels of the passing vehicle after it had responded to the front wheels for effecting the count. Now, in the event that the vehicle is trailer equipped, one or more additional axles will pass over tread 402 after the apparatus is cleared. This will operate relays 411 and 415 but will not cause a further count since the count requires that the two treads be actuated in succession. In this case, the vibrating contact of timing relay 415 will come to rest and the release relay 416 will operate to release relays 415 and 411 and then restores.

When a vehicle proceeding in opposite direction crosses the treads, the operation is similar to that described except that tread 402 is encountered first and relay 411 is operated instead of relay 412 causing the operation of the corresponding counter 418 in response to the operation of relay 413 which energizes responsive to front wheel actuation of the tread 403.

It will be understood that the major part of the vehicles counted will ordinarily be passenger cars and trucks without trailers and will, therefore, have the usual two axles each. Accordingly, in most cases, the circuit is left in a cleared condition, reached as described responsive to the rear wheels of a vehicle making contact with the

second tread, and is in immediate readiness for further use.

In view of the foregoing description of Fig. 4, it will be seen that the system is especially adapted to counting both cars when two cars pass the observation point in opposite directions at nearly the same time. For example, if the front wheels of a vehicle such as 404 strike tread 403 and set the circuit for a corresponding direction count as described, and the front wheels of a car travelling in opposite direction almost immediately strike the tread 402, the passage of the first vehicle is counted, and the rear wheels of vehicle 404 then clear the circuit, so that the rear wheels of the other vehicle on striking the tread 402 prepare the circuit for the opposite direction count which will be completed when the front wheels of the corresponding vehicle strike the tread 403.

It is to be noted that a contact at either tread clears out the circuit following a count, as relay 415 is shunted in either case to restore and operate relay 417 through contacts of the operated relay 414.

Referring now to Fig. 5, which shows a system for recording traffic counts on a moving tape or record to permit observation of the traffic density for different periods of the day, the two incoming conductors X and Y may be connected to the corresponding conductors X and Y of Fig. 4. Each of the storing switches 501 and 502 may be of the familiar double-wiper construction, one wiper point passing off the contact bank when the other wiper point engages the contact bank. When a ten point switch is used, the wiper will reach any given point once in ten steps. Switch 501 is driven one step in a clockwise direction each time the armature (not shown) of driving magnet 504 retracts following the receipt of an impulse. Switch 502 operates similarly under the control of magnet 505.

The tape or record 508 of the double-pen register 503 may be moved to the right under the pens or recording elements 509 and 510 by means of a suitable tape-driving mechanism (not shown). Each pen is adapted to make a normal straight line as indicated. In addition it may make a short ink line perpendicularly to the straight line each time its associated control magnet, 506 and 507 respectively, receives an impulse. Several impulse lines are indicated in the drawings. In operation, each time the counter 418 shown in Fig. 4 receives an actuating impulse, an impulse passes also over conductor X to magnet 504. When this magnet operates and subsequently restores, the associated wiper 501 is advanced one step in the direction indicated by the arrow. When the tenth impulse arrives, the wiper is standing on the tenth contact to which is connected the pen-control magnet 506. This magnet, therefore, receives this tenth impulse and causes the pen 509 to produce a line indicating on the tape the passage of ten vehicles during the current time period determined by the motion of the tape. The spacing between the side lines or impulse marks indicates the average density of the traffic in this direction.

Similarly, magnet 505 receives impulses over conductor Y in parallel with counter 419 causing the stepping switch 502 to be operated and to deliver every tenth impulse to magnet 507 for the control of the recording pen 510. The latter, therefore, makes the impulse marks on the moving tape to indicate the density of the traffic in the corresponding direction.

It may be pointed out that the selection of a ten-point switch is arbitrary and that a stepping switch of a greater or lesser number of points may prove advantageous according to any given condition or according to the result which is desired.

If desired, magnets 506 and 507 may be connected directly to conductors X and Y in which case it will, generally speaking, be necessary to operate the tape 508 at a higher rate of speed to avoid blurring or illegibility of the record because of overlapping impulse marks. The recording equipment shown in Fig. 5 may also be employed in conjunction with the other embodiments of our invention if desired. Likewise, certain features of one embodiment may be used in another.

Changes may be made within the scope and spirit of the following claims in which we have defined what we believe to be new and desire to have protected by Letters Patent.

What we claim as our invention is:

1. In a vehicle counting system, impulse means arranged to be actuated responsive to the passage of a vehicle, a switching relay and circuit means therefor arranged to cause the energization thereof responsive to the actuation of said impulse means, counting means operatively responsive upon energization of said switching relay, a locking circuit for said switching relay, a control relay disposed in said locking circuit and arranged to energize responsive to the closure thereof, and a release relay operatively responsive to the actuation of said control relay for restoring said switching and said control relays.

2. In a traffic counting system, a roadway contactor operable by the front and rear wheels of passing vehicles, a counter, means for operating said counter responsive to actuation of said contactor by the front wheels of a passing vehicle, and means including a timer started into operation by the said operation of said contactor for preventing further operation of said counter for a predetermined time notwithstanding that the rear wheels of said vehicle pass over said contactor during that time.

3. In a traffic counting system, two counters for counting traffic in two directions, respectively, two circuit closing devices for operating said counters, respectively, circuit arrangements whereby the first of said devices operated by a passing vehicle is effective to operate its corresponding counter and including means dependent on the speed of the vehicle for preventing the second device from operating its corresponding counter, a third counter, and means for operating said third counter in the event the vehicle is traveling so slowly that said preventing means is ineffective.

4. In a traffic supervisory system, a contact device, a counter, a relay responsive to actuation of said device by a passing vehicle for operating said counter, means for locking said relay in operated position, a second contact device operated by said vehicle for unlocking said relay, and timing means for unlocking said relay if said vehicle fails to operate said second contact device.

5. In a traffic counting system, a counter, contact devices adapted to be controlled by passing vehicles, means responsive to said devices for controlling said counter to register the passage of vehicles, the proper operation of said means being dependent upon the speed of said vehicles, a second counter, and means for operating said second counter to register the number of times said first means fails to operate the first counter due to abnormal speed of passing vehicles.

6. In a system for counting vehicular traffic, a contact device adapted to be operated by passing vehicles, a relay, a circuit including said contact device for operating said relay, a locking circuit for holding said relay operated, means for opening said locking circuit a predetermined time after the same is closed, and means for counting the number of times said relay is operated.

7. In a system for counting vehicular traffic, a relay, means including a vehicle controlled contact device for energizing said relay, a locking circuit for said relay, timing means set in operation by the energization of said relay and cooperating with said locking circuit to keep the relay energized for a predetermined time after each actuation, and counting means controlled by said relay to register the number of actuations thereof.

8. In a system for supervising vehicle traffic, a circuit closing device adapted to be operated by a passing vehicle, a relay responsive to operation of said device by a vehicle, a second relay responsive to release of said device as the vehicle moves along, a locking circuit for said relays, and slow-acting means set in operation by the second relay for opening said circuit in a predetermined time.

9. In a traffic counting system, two spaced contact devices adapted to be operated by passing vehicles, a relay responsive to the operation of the first contact device, a slow-releasing device operated by said relay, a relay responsive to the operation of the second contact device, a locking circuit for said second relay controlled by said slow-releasing device, and a counter controlled by said second relay.

10. A traffic counting system as set forth in claim 9, characterized by the provision of a circuit for the counter controlled jointly by the first and second relays.

11. In a two-way traffic counting system, two contact devices, two relays responsive to operation of said contact devices, respectively, a locking circuit for each relay, circuit arrangements whereby each relay has its locking circuit closed or not contingent on whether the corresponding contact device is the last or first operated by a passing vehicle, two counters associated with said relays, respectively, and means whereby each relay operates its associated counter only at a time when its locking circuit is closed.

12. In a traffic counting system, two spaced contact devices adapted to be operated by passing vehicles, a counter, a relay energized responsive to operation of the first operated contact device to prepare a circuit for said counter, and a relay energized responsive to operation of the second operated contact device to close said prepared circuit and thereby operate said counter.

13. In a two-way traffic counting system, two spaced circuit control devices adapted to be operated by passing vehicles, two relays individual to said devices, respectively, a common relay, circuit arrangements causing each individual relay to respond to operation of the corresponding device if such device is operated before the other, means whereby each relay upon operating switches the device associated with the other relay into association with said common relay, and two counters adapted for selection by said individual relays, respectively, and for operation by said common relay.

14. In a two-way traffic counting system, two counting devices for counting traffic in two di-

rections, respectively, a common traffic controlled relay for operating both counters, circuit means whereby one counter or the other is operated responsive to each operation of said common relay, and other relays controlled in accordance with the direction of traffic for determining which counter is operated by said common relay each time an item of traffic passes.

15. In a traffic observation system, two vehicle counters, means including a relay responsive to the passage of a vehicle for actuating the first counter, a locking circuit for said relay, a second relay for opening said locking circuit, means controlled over said locking circuit and effective after a predetermined time interval for operating said second relay, and a circuit for said second counter controlled by said second relay.

16. In a traffic counting system, two contact devices disposed in the path of traffic, two counters associated with said devices, respectively, two relays normally connected with said contact devices, respectively, for operating said counters, a locking circuit for each relay, means associated with each relay for opening its locking circuit after a predetermined time interval, a common means for opening said locking circuits, and switching means cooperating with contacts on either one of said relays for disconnecting the contact device normally connected to the other relay from such relay and for connecting it instead to said common means.

17. In a two-way traffic counting system, two spaced contact devices disposed in the path of traffic, two relays associated with said devices, respectively, two counters controlled by said relays, respectively, a circuit for each relay including its associated contact device, whereby the contact

device first actuated by a passing vehicle will energize its associated relay, and contacts on each relay effective when such relay is energized to open the circuit of the other relay, whereby the last operated contact device is prevented from energizing its associated relay.

18. In a two-way traffic counting system, two spaced contact devices disposed in the path of traffic, two relays associated with said devices, respectively, two counters controlled by said relays, respectively, a circuit for each relay including its associated contact device, means whereby each relay on energizing responsive to actuation of its associated contact device opens the circuit of the other relay, means for holding the energized relay, and means controlled by the contact device associated with the other relay for deenergizing the energized relay.

19. In a two-way traffic counting system, two spaced contact devices disposed in the path of traffic, two relays associated with said devices, respectively, two counters controlled by said relays, respectively, a circuit for each relay including its associated contact device, means for holding either relay when energized by actuation of its associated contact device, means controlled by each relay for rendering the contact device associated with the other relay ineffective to energize such other relay, a common relay controlling said holding means, and means whereby each of said first mentioned relays on energizing responsive to actuation of its associated contact device places the said common relay under control of the other contact device.

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