dices. Sections 5 and 6 do not appear to present any particular problem from a traffic service standpoint Sections 1, 2 and 3 are of three lane concrete pavement, 27 ft. in width. Section 4 is an 18-ft concrete pavement as are sections 5 and 6 It is obvious from a scrutiny of the congestion indices for this route that three of the first four sections have reached a point of intolerable traffic congestion and will require corrective measures within a reasonably short time. Sections 5 and 6, while not indicating severe congestion, must be rebuilt within a reasonable period of time due to physical obsolescence

*Application of Congestion Index to Design*—It appears reasonable to conclude that a highway section which does not presently or will not, through normal traffic increase, reach a congestion index of 1.0 is adequate to serve present and future traffic from a design standpoint. If improvement is indicated it is dictated rather by conditions of physical obsolescence or high maintenance costs. The existing geometric design with respect to general roadway alignment and width appears adequate to serve traffic The significance of the low congestion index lies in the fact that it may be of material value in assisting to prevent over-design.

In those instances where highway sections show a present congestion index of 1.0 or will reach that point within a reasonable time, given normal traffic increase, reference to the congestion index should serve as a guide to a design section in determining whether a planned improvement is adequate to serve present and probable future traffic needs.

### CONCLUSION

This discussion of preliminary conclusions has been necessarily rather broad. The congestion index should not yet be accepted at its face value. It is our opinion that a great deal more work should be done. There may be weaknesses in the methods set forth here which further study will reveal so that the general idea, which prompted the development of the congestion index, will eventually result in a useful tool for the highway administrator in meeting his ever present problem of highway improvements.

# A SEGMENTED ELECTRICAL ELEMENT FOR DETECTING VEHICULAR TRAFFIC

J. H Mathewson, R Brenner, and R J Reiss, *Institute of Transportation and Traffic Engineering, University of California, Los Angeles*

## SYNOPSIS

Most vehicle detecting mechanisms or systems in use today have a serious limitation in that they cannot accurately determine the transverse location of a vehicle. This deficiency is serious inasmuch as many important traffic problems cannot be properly studied or satisfactorily solved to the exclusion of data on lane traffic patterns and transverse placement. To facilitate the study of such problems, the Institute of Transportation and Traffic Engineering of the University of California initiated a research program to develop a more universally applicable detecting unit In addition to sensitivity to transverse placement, other important design criteria included inexpensive manufacture, inexpensive installation and maintenance, portability, rugged construction for field use, reliability of operation, concealment from the driver, and weather resistant qualities. The detecting unit which was designed is believed to embody the various qualities specified.

The detector is of the so-called metallic contact type in which two metallic elements, normally held open by some form of a spacer, are closed by a wheel passing over them In this design, the bottom contact extends throughout the entire length of the unit and serves as a common contact for all the circuits The top contact is made up of one-foot metal segments which, together with the common bottom contact, constitute the elements for the individual circuits Lead wires are attached to each segment so that, with appropriate jumper connections, any desired segment width can be readily obtained The entire unit is attached to the road surface by means of a quick drying rubber cement and a covering of industrial adhesive tape The tape also serves to protect the unit from abrasive tire action.

In order to evaluate the design a test program was set up wherein the detecting unit would be subjected to both severe and ordinary driving conditions as well as to a series of controlled conditions involving rapid acceleration, deceleration and skidding The results of these tests indicate that the design is basically sound and also practical.

An integral part of almost all traffic instrumentation systems is a detecting medium which impresses the presence of a vehicle at a specific point on the road into the system. The system, in turn, utilizes this information to determine the particular traffic variable being measured, such as speed, volume, density or transverse placement. In the past, the detecting function has been performed in a number of ways which can be conveniently grouped in three categories, namely; visual, photographic and vehicle-actuated.

In visual detecting systems, the position of a vehicle relative to a fixed landmark is determined by an observer watching the road. An example would be an observer counting the vehicles that went past him. Telescopes and various surveying instruments have been used as a refinement for sighting the vehicle from a distance, but the general principle is the same.

In the photographic method, motion pictures are taken of a given landmark and show each vehicle approaching and reaching the landmark. Since the camera is usually operated at a constant speed, the time-location of the vehicle is given by the particular frame in which the vehicle is shown as having reached the predetermined position (*5*).

The vehicle-actuated system, which has been the most widely used method of the three, operates on the principle of automatically giving a signal at the instant a vehicle moves across a fixed line on the road. A vehicle actuated system which does not operate on this principle is the Electro-matic Speed Meter (*1*)[1] which indicates the instantaneous speed of a moving vehicle on the basis of the change in frequency of a radio wave reflected from the moving vehicle. This principle of operation is quite different from the other, but since there is only the one system based upon it, it will not be considered in this paper.

[1] Italicized figures in parentheses refer to the list of references at the end of the paper.

Probably the most commonly used vehicle- or wheel-actuated detecting device, other than the permanently installed treadle-type detector used in traffic control systems, is the pneumatic detector in which a length of rubber tube is placed across the road perpendicular to the direction of vehicular travel and is secured in place by clamps spiked to the road. The tire rolling over the tube sets up an air pulse which actuates some form of switch or counter which is attached to one end of the tube (*3*).

Another vehicle-actuated detecting system utilizes photo-electric tube circuits. Here, a light beam is directed across a roadway into either a phototube or photoelectric cell. When the beam is interrupted by a passing vehicle, an electrical circuit is either energized, or de-generized (*4*) (*7*). In another class of vehicle-actuated detecting systems, metallic contacts, normally held open, are pressed together as the wheels pass over them, thereby closing an electrical circuit. These are usually referred to as the direct contact type of detectors.

Each of these three systems has some very desirable characteristics. The pneumatic detector is portable, relatively easy to install, inexpensive, and stands up well under field conditions. The photoelectric systems subject no parts to traffic wear, can be used on all types of roads and can be effectively camouflaged so that the driver does not know that the road is instrumented. In the metallic contact detector, the operation is the most positive and, at the same time, simple. At the present stage of development all of these detectors are so limited in application that transverse placement cannot be measured, although some phototube systems can differentiate direction. The seriousness of this limitation will be evident if consideration is given to the many important problems in which lane traffic patterns and transverse position are significant

To overcome the deficiency, the Institute of

Transportation and Traffic Engineering of the University of California initiated a program for the development of an appropriate type of vehicle-actuated detector. Design criteria were established with the aim that the final design would embody, in addition to the transverse placement measuring quality, the most desirable characteristics of the other vehicle-actuated detecting systems to the greatest extent feasible Desired characteristics included:

1. Sensitivity to transverse placement
2. Inexpensive manufacture
3. Inexpensive installation and maintenance
4. Portability
5. No impedance to traffic

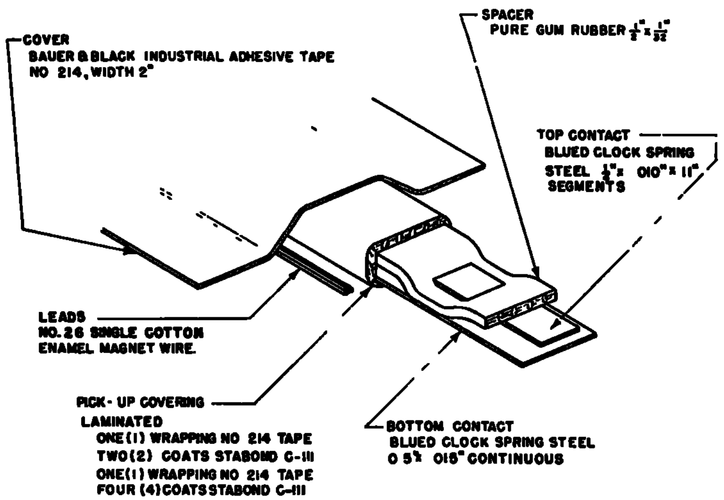


**Figure 1. Design Details of the Segmented Traffic Tape**

6. Rugged construction for field use
7. Reliability of performance
8. Not readily distinguishable by the driver
9. Weather resistant

The most practical approach appeared to center around the use of some form of the direct contact system since neither the pneumatic detector nor the photoelectric system was considered to be adaptable to the transverse placement measuring requirement. Moreover, direct contact systems had been successfully used in previous transverse location studies (*6*). Through the cooperation of Mr. O. K. Normann, Chief, Section of Traffic Operations, U. S. Bureau of Public Roads and Chairman, Committee on Highway Capacity, Highway Research Board, a sample of such a traffic pick-up element known as a "Transverse Placement Detector," was made available for study.

This unit had several of the desired characteristics, including sensitivity to transverse placement, rugged construction and direct electrical contacts. However, on the basis of examination of the sample, it was believed that the unit was not sufficiently portable, that it would be expensive to manufacture, and that it would be readily distinguished by a driver. Notwithstanding these apparent drawbacks, the design served as an excellent guide and materially facilitated the subsequent development program.

## DESIGN DETAILS

The design details of the unit which was developed are shown in Figure 1. Segments of blued clock spring steel ½-in. wide, 0.01-in. thick and 11-in. long are laced through a continuous spacer of pure gum rubber- ½in. wide, $\frac{1}{32}$-in. thick. The lacing is placed against a continuous strip of blued clock spring steel, ½-in. wide, .015-in. thick. A separate electrical lead is attached to each steel segment and one lead is attached to the continuous bottom segment. The bottom steel strip serves as a common contact for all of the circuits, while the separate top segments are the other contacts for the individual circuits. The gum rubber serves as the spacer separating the contacts until pressure on the top forces them together.

The lacing, made up of the top contacts and the spacer, and the continuous bottom contact are bound together by a laminated covering made up of three wrappings of industrial adhesive tape[2] and six coats of rubber cement[3] Terminal lugs, which are soldered to the steel segments, extend outside the wrapping thus providing a means for connecting the lead wires. The wrapped assembly is referred to as the pick-up element, while the wires attached to the lugs are referred to as the harness. The whole is referred to as the detecting unit. This unit is secured in place on the roadway by a cover of industrial adhesive tape which also serves to protect the unit from the abrasive wearing action of traffic. To ensure a strong bond between the cover tape and the roadway, a strip of the latter is brush coated with rubber cement immediately preceding the placing of the detecting unit The protective cover and harness are considered expendable, but the pick-up element is not. However, the cost of fabricating the pick-up element, as will be demonstrated later, is so low that possibly it too could be considered expendable.

When installed on the roadway, the complete detecting unit measures 2 in. in width and varies in thickness from .010 in at the edges to a maximum of $\frac{1}{16}$ in. at the center. Accordingly, on a concrete pavement, the driver cannot easily distinguish it from an asphaltic-type expansion joint.

### TEST PROGRAM—FIRST PHASE

In order to evaluate the design, a test program was devised whereby the detecting element would be subjected to both severe and ordinary driving conditions.

The objective of the first phase of the test program was to determine how long an installation would operate under traffic conditions without any major malfunction A detecting unit 10 ft long was installed 75 ft. ahead of a traffic signal, this location being selected so that the unit would be subjected to accelerating and decelerating vehicle movements in addition to movements at higher speeds at night when the signal was not operating. An electromechanical counter was connected to the unit to indicate the total number of wheels which passed over the detecting unit. No attempt was made to evaluate other characteristics of the traffic flow at this point. Relative to determining if the unit picked up all vehicles passing over it, the assumption was made that if the unit was operating satisfactorily at a given time, it had been operating satisfactorily up to that time Actually this assumption can be criticized although repeated observations indicated that all vehicles were being recorded.

The unit operated satisfactorily for a continuous period of 47 days during which time there was a total rainfall of 0.13 in., the maximum for one 24 hour period being 0 08 in. A total of 555,973 wheels were registered which could have represented anywhere from 138,000 to 276,000 vehicles since there would be four wheel counts for some vehicles and two for others depending upon the transverse placement of the vehicle. There were four broken lead connections at the lugs, but there were no signs of wear or deterioration in the pick-up element which was cut open for study at the end of the test period.

### TEST PROGRAM—SECOND PHASE

There were three objectives in the second phase of the testing program, namely;

1. Observation of the performance of the complete segmented element and assembly under severe driving conditions.
2. Determination of the effectiveness of the unit as a pick-up element when actuated by a vehicle traveling at high speeds.
3. Determination of any possible hazard in the event of physical failure of the unit.

The site selected for these tests was at the City of Santa Monica (California) Municipal Airport. A non-traffic situation was selected because it was desired to conduct the tests under controlled conditions which could not be achieved on a public thoroughfare without hazard to the test drivers, other drivers, or pedestrians

A ten-segment unit was installed on the test course, part of the surface of which was very soft asphalt and the remainder bituminous concrete Each segment was electrically connected to a separate light bulb so that when a wheel passed over the segment the specific circuit would be closed and that bulb would

[2] Industrial Adhesive Tape: Bauer and Black No. 214, 2 in width

[3] Rubber Cement· "Stabond C-111", The Latex Company, Los Angeles, California

light. This, of course, served only to indicate that the circuit had been closed.

The first tests made were high, but constant, speed tests in which a test car was driven over the detecting unit at a speed of 60 mi per hr. as indicated by the speedometer of the vehicle The initial test run was made immediately after the installation was completed, that is, without allowing the rubber cement to set Successive passes were made until each segment had been actuated at least four times. The detecting unit operated satisfactorily on every trial, and there were no signs of wear or displacement of the tape

The second series of tests were conducted with the test car being driven over the unit under various accelerating and decelerating conditions which roughly simulated actual driving conditions. Acceleration and deceleration rates were not measured inasmuch as it was believed that these data, although interesting, would not contribute enough to the performance evaluation of the detecting unit to justify the work involved in making such measurements Procedures for the various acceleration and deceleration tests were specified in order to insure that each segment of the detecting unit would be subjected to approximately the same wear. This was done so that in the event of a single failure, the segment at which the failure occurred could be compared with the other segments for possible delineation of desirable as well as undesirable characteristics of the design The conditions of the various tests along with the number of actuations of each segment under those conditions are as follows

*Acceleration from Stop Test* (20 actuations of each segment)—The test car, at complete rest 1 ft. from the detecting unit, is fully accelerated in first gear.

*Low Acceleration Test* (20 actuations of each segment)—The test car, in second gear, approaches at a speed of 25 mi. per hr. The accelerator is fully depressed when the vehicle reaches a point 15 ft. in front of the detecting unit.

*High Acceleration Test* (6 actuations of each segment)—The test car, in second gear approaches at a speed of 15 mi per hr The accelerator is fully depressed when the vehicle reaches a point 10 ft in front of the detecting unit

*Deceleration Tests* (6 actuations of each segment)—The test car approaches the detecting unit at a speed of 40 mi. per hr. The brakes are firmly applied, but not locked, just as the front wheels reach the unit.

As was the case in the high, but constant, speed tests the detecting unit operated satisfactorily on every accelerating and decelerating trial and there were no signs of wear.

The third series of tests were designed to subject the detecting unit to the grinding action of a wheel slipping on the road surface.

In these tests, the test car was at rest with the rear wheels almost touching the tape. With the engine of the car "racing," the clutch was quickly engaged causing the wheels to spin while passing over the detecting unit. Each segment was actuated four times under these conditions. The detecting unit operated satis-

**Figure 2. The Effect of a Grinding Action of a Tire on the Protective Covering**

factorily on each trial, but the protective adhesive tape covering was torn where it was attached to the soft asphalt surface as shown in Figure 2, or was pushed back where it was attached to the bituminous concrete. There was no apparent damage to either the harness or the pick-up element.

The final series of tests in this phase of the testing program were the locked-wheel braking tests in which the test car approached the detecting unit at speeds varying from 30 to 35 mi. per hr. The brakes of the vehicle were locked when it was about 10 ft. in front of the unit, all wheels accordingly skidding over the detecting unit In order to eliminate side thrust during skidding, the brakes of the test car had been carefully adjusted beforehand. Each segment was actuated an average of five times in this manner, the operation and appearance of the unit being carefully observed after each trial. After the first skidding trial, abrasions were noted on the adhesive tape covering and after repeated skids the covering was split along the aft edge. This was the entire extent of the damage. There were no electrical malfunctions and the harness and pick-up element showed no apparent damage. This was verified by high-speed tests which were repeated (two actuations of each segment) at the conclusion of the skidding tests and during which all circuits operated satisfactorily. The slide marks at the conclusion of the skidding tests are shown in Figure 3.

At the conclusion of the tests, the pick-up element, harness, and almost all of the adhesive tape covering were still firmly fixed in place on both the asphalt and bituminous concrete surfaces. Although there were no apparent indications that the bond with the pavement was breaking down, the possibility

**Figure 3. Slide Marks at the Conclusion of the Skidding Tests**
**(Arrow indicates direction of travel)**

of its breaking at a later time could not, of course, be eliminated entirely. However, in the light of the severity of the tests, it appeared that the bond would be maintained under normal traffic conditions almost indefinitely. This was interpreted as a desirable safety factor in that little hazard can be associated with an installation that remains firmly secured to the road.

### TEST PROGRAM—THIRD PHASE

There were four primary objectives in the third phase of the test program including:

1. Observation of the performance of the detecting unit under heavy traffic conditions.
2. Determination of the effect of repeated installations of the unit upon its performance.
3. Observation of the performance of the unit under traffic conditions in rainy weather (simulated).
4. Development of techniques for repairing the unit without removing it from its installed position on the roadway.

The site selected for these tests was on the south side of Sunset Boulevard adjacent to the University Nursery School, Los Angeles, California.

Two detecting units were installed on the test course, the first being made up of a new adhesive covering along with the pick-up element and harness which had been subjected to the previously described severe driving tests of the second phase of the test program. This will be referred to as the "A" unit. The other unit was completely new and will be referred to as the "B" unit. In order to roughly quantify the speed characteristics of the vehicles involved, the units were used as the detecting elements for the Vehicle Speed Distribution Recorder which was developed by the Institute of Transportation and Traffic Engineering and reported at the 28th Annual Meeting of the Highway Research Board in December 1948 (*2*).

Fourteen installations of the "A" unit were made, each being maintained for approximately three hours either in the morning or afternoon. These installations were made at one of three adjacent locations so that there was no more than one installation on any one location within any 24-hr. period. This was done to minimize any positive effects of previous installations on the adhesive properties of the later installations. The "B" unit served as the control for the "A" unit with respect to the effect of repeated installations. Although the "B" unit should have been installed only once, it actually was removed and reinstalled a second time to facilitate the making of several changes in the electrical circuits. However, this additional installation was not considered to have invalidated its use as this control.

The tests extended over an 11-day period with measurements being taken on 9 days. On seven of these days the road was dry. During the last 2 days of measurements, rainy conditions were simulated by directing a stream of water from a garden hose on both units. The entire area extending approximately 30 ft. in front of the units was also kept wet with the garden hose.

During the test period, 11,789 vehicles were registered and an additional 3000 vehicles are estimated as having passed over the detecting units while the counting equipment was not operating. Therefore, a total of approximately 15,000 vehicles passed over the two units.

The mean speed of the vehicles counted was 34.9 mi. per hr., with the distribution of the speeds as shown in Figure 4. Segment counts were simultaneously maintained on the "A" unit to establish the effectiveness of the design in measuring transverse placement while serving also as a detecting element in speed measurement. The operation was entirely sat-

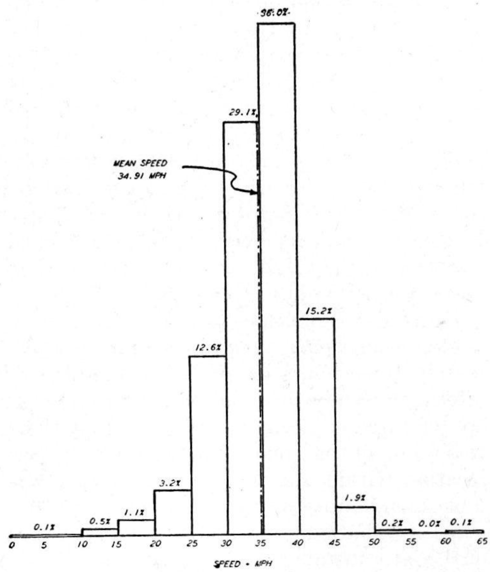


**Figure 4. Percent of Eastbound Vehicles vs. Speed—Weekday Forenoon and Afternoon Traffic—Third Phase of Test Program**

**Dates of Test: August 3rd to 11th, 1949**
**Test Site: Sunset Blvd., 250 yards East of Westwood Blvd.**
**Total Vehicles Represented: 11,789**

isfactory, although quantitative results were not obtained since the road was 35 ft. wide and only a 10-ft. length of the detecting unit was used.

During the simulated rainy weather tests, both units operated satisfactorily for 45 min. For approximately one-half of this period both units were completely submerged. Short circuits between different segments and the ground lead began to occur intermittently during the next hour, but persisted only for a few minutes. After 2 hr. of wetting all segments were shorted.

The units were left on the site for 16 hr. (overnight) during which time no water was applied. All segments except one were again operating satisfactorily the next morning although short circuit resistances ranging from 10,000 to 500,000 ohms existed. The units were subjected to an additional 5 hr. of wetting during which the operation became progressively worse. At the end of this period, four of the ten segments of unit "A" were still operating satisfactorily. Unit "B" was inoperative. Both units were still firmly attached to the road which demonstrated the adequacy of the bond (Figure 5). Since no attempt was made to control the amount of water, setting up analogies as to rates of rainfall to which the units had been subjected was impossible.

**Figure 5. Taking Up a Detecting Unit After the Simulated Rainy Weather Tests**

At the conclusion of the tests, the pick-up elements of both units were split open for examination. A very small amount of rust was found inside each. This indicated that the elements could have continued to "recover," that is, dry out and continue to operate satisfactorily. The fact that there was no appreciable difference in the amount of rust in the two elements was believed to be significant. Assuming that the amount of rust present at a specific point in the pick-up element is an indication of the amount of moisture which was present at that point, it follows that the amount of moisture which seeped into the pick-up elements was approximately the same in both units. The "A" unit, however, had been installed and re-installed 15 times as compared to two for the "B". The "A" unit had also been subjected to the severe grinding and skidding tests while unit "B" was new. It can be inferred, therefore, that the severe grinding and skidding tests, as well as the repeated installations of the "A" unit, apparently did not affect the moisture resistant properties of this pick-up element. It is assumed that the "A" and "B" pick-up elements were identical when new, which was the case as nearly as could be determined. If the moisture resistant properties can be extrapolated to be an indication of wear, then the grinding, skidding, and repeated installations did not noticeably affect the wearing properties of the element

During the entire test period there were a total of three breaks among the eleven leads which made up the harness of the "A" unit. Each of these breaks was repaired without taking the unit up by a technique in which the protective adhesive cover was cut open at the location of the break. After the break was spliced, the cover was flattened back over the pick-up element and harness assembly, and a patch of new tape placed over the old tape at that point. The maximum time required for a complete repair was ten minutes.

### DISCUSSION OF THE DESIGN

The following interesting design features are worthy of note. First, the unit is completely portable weighing approximately 0.1 lb. per lin. ft. of pick-up element and harness for a 40-segment unit. The adhesive tape covering is supplied in compact 60-yd. rolls. The pick-up element and harness assembly can be easily coiled without harmful effects. The coil shown in Figure 6 is 40 ft. long and is segmented at 1-ft. intervals.

Another very desirable characteristic of the design is the general nature of the transverse placement problems which can be readily instrumented. The lugs are spaced at 1-ft intervals and by connecting any number of lugs together in any desired arrangement a wide range of placement problems can be efficiently attacked. For example, suppose total counts in each of two adjacent 10-ft lanes were desired, the five center segments in each lane would be jumpered together which would leave an inactive length of 2 5 ft. on each side of the active portion of the detecting unit. The two adjacent inactive sections together would be 5 ft. long and would minimize the double counting of lane straddling vehicles In the event that counts of the number of lane "straddlers" were desired, the appropriate connection could also be made. The detecting unit can be made sensitive to transverse placement from 1-ft. intervals up to full lane widths over a multi-lane highway merely by connecting the appropriate harness to the same pick-up element Actually, one harness can be used for the same variety of applications by making the necessary jumper connections at the instrument end. However, it is desirable to have a minimum number of wires stretched across the road even though they are relatively well protected by the adhesive tape covering.

The water resistant properties of the unit tested were not up to the standard desired, although there were indications that under actual weather conditions the performance might be better. The covering of the pick-up element which was tested was laminated of adhesive tape and rubber cement Since the time of that test, a dipped rubber cover over the pick-up element in place of the laminated wrapping has been developed A specimen pick-up element of this type was soaked in a barrel of water for two weeks at the end of which high resistance short circuits, 15,000 ohms minimum, had developed. These were not considered excessive since the element was still completely operative It is believed that the weather resistant properties will be bettered.

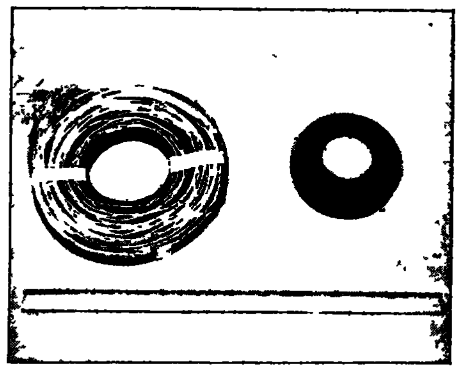

**Figure 6. Forty Foot Length of Pick-up Element and Harness Segmented at One Foot Intervals and a Sixty Yard Roll of the Protective Adhesive Tape Covering**

An important consideration in the design of any instrumentation is the cost involved in

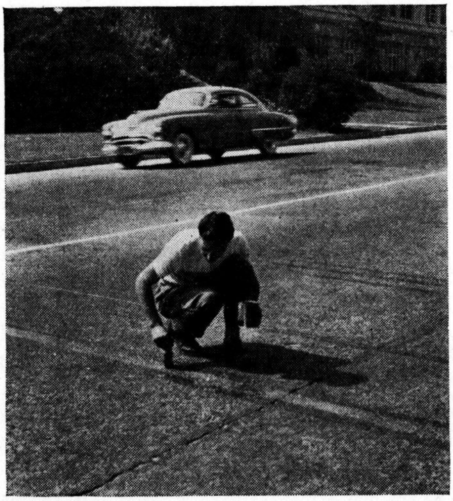

**Figure 7. Installation Procedure: Applying Rubber Cement to Roadway Immediately Preceding the Placing of the Detecting Unit**

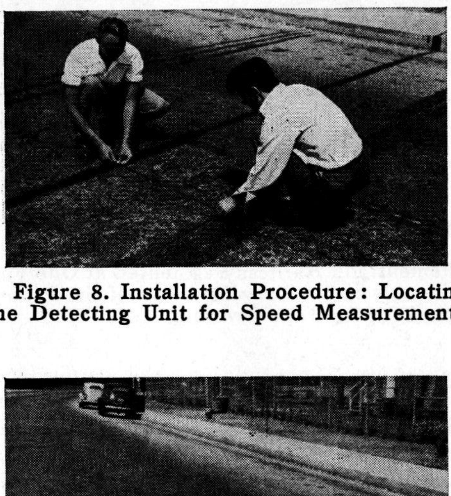

**Figure 8. Installation Procedure: Locating the Detecting Unit for Speed Measurements**

**Figure 9. Installation Procedure: Applying the Protective Adhesive Tape Covering Over the Detecting Unit**

both manufacture and use. Designs can be directed toward precision and top quality materials in order to lengthen the effective life or they can be directed toward low cost and complete expendability. The design under discussion was developed with the latter objective in mind, namely toward inexpensive manufacture and expendability. However, as demonstrated in the testing program, the inexpensive materials used were entirely satisfactory so that in all probability very little would have been gained by using more costly materials. The following breakdown is an estimate of the unit cost of a 1-ft. length including labor and material:

| | |
|---|---|
| *Detecting Unit* | |
| Pick-up element | \$.52 |
| Harness | .04 |
| *Protective Cover* | .02 |
| *Installation* | .02 |
| | \$.60 |

The above estimates are believed to be conservative inasmuch as the design lends itself to mass production techniques, while the cost picture set forth is based on the manufacture of a single 40-ft. length.

One of the factors in the design of a detecting unit with which the traffic engineer is concerned is the time required to complete an installation under traffic conditions. The time must be a minimum, not only to minimize traffic delay but, of even greater importance, to minimize the exposure to danger of personnel making the installation. Repeated measurements indicated that a 35-ft. unit could be installed by one man in 7 min. and that traffic could move over the unit immediately after the installation was completed. It is believed that this time compares favorably with the time required for installing any detecting unit which is attached to the road. Installation procedures are shown in Figures 7, 8, 9.

## CONCLUSIONS

This new type of segmented element is an effective, practical device for detecting vehicular traffic. It is entirely portable, positive in action and can be inexpensively manufactured. It is particularly well adapted to a wide variety of transverse placement studies in addition to usual speed, volume and other traffic studies which require comprehensive data on vehicular movements. It is not necessarily the solution for all vehicle detecting problems since there are situations where such a unit should not be used. For example, there would certainly be little point in using such a unit to perform functions which could just as easily be performed by a pneumatic tape. On the other hand, the unit could hardly be considered as more than a temporary substitute for any permanent installation, although the basic principle of operation could be used for the design of a permanent installation. Each of the various detecting systems has specific uses for which it is best suited and it is the responsibility of the traffic engineer to select the system most appropriate for the particular measurement involved.

ACKNOWLEDGMENTS

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The writers also wish to express their appreciation to Mr. O. K. Normann, Chief, Section of Traffic Operations, Bureau of Public Roads, and Chairman, Committee on Highway Capacity, Highway Research Board, who criticized the detecting unit at an early point in its development and suggested several of the test procedures, and to Mr. Ralph T. Dorsey, Principal Street Traffic Engineer, Department of Traffic Engineering, City of Los Angeles, with whose cooperation the third phase of the testing program was performed.

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