

FAILURE OF CENTER-MOUNT DELINEATORS  
A Summary of Research Laboratory Observations

Research Laboratory Division  
Office of Testing and Research  
Research Project 51 G-54(4)  
Research Report No. R-627

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State of Michigan  
Department of State Highways  
Lansing, May 1967

## INFORMATION RETRIEVAL DATA

REFERENCE: Janson, M. H. et al. Failure of Center-Mount Delineators: A Summary of Research Laboratory Observations. Michigan Department of State Highways Research Report No. R-627. May 1967. Research Project 51 G-54(4).

ABSTRACT: Observations between 1962 and 1965 are summarized, with reference to the causes of failure of center-mount delineators in Michigan. Failure is attributed to damage from snowplows, use of improper fasteners, incorrect hole diameter in delineator posts, tensile stresses in delineators, and mounting by inexperienced installers. District Maintenance Engineers have surveyed the percentage of delineators cracked or broken during installation in 10 Districts.

KEYWORDS: damage, delineator/traffic, failure, hole size, posts, reflector buttons, reflectors, riveting, rivets, snow and ice control, snowplows.

## FAILURE OF CENTER-MOUNT DELINEATORS

During the winter of 1962-63, it was discovered that a considerable number of center-mount delineators on I 96 and I 196 in the Grand Rapids area had cracked or were badly damaged by snowplowing operations. The problem was assigned to the Research Laboratory in March 1963, through correspondence between H. H. Cooper and W. W. McLaughlin. The following report chronologically summarizes the findings from a series of subsequent field and laboratory studies. It is now understood from the Office of Maintenance that the problem is no longer serious and consequently the research project will be closed with this summary of the Research Laboratory's observations.

- I. March 16, 1962. G. R. Cudney made the following statements concerning Research Project 54 G-73:
  - A. "A recent spot check of 100 consecutive center-mount delineators on eastbound I 96 west of Portland showed 48 percent of the delineators cracked as a result of the riveting operation. Of 88 similar delineators on westbound I 96 west of Portland 22 percent were cracked.
  - B. "Perhaps some additional thought should be given to this method and technique of fastening."
- II. March 20, 1963. An office memorandum from H. H. Cooper, Director Traffic Division, to W. W. McLaughlin, Testing and Research Engineer, stated the following:
  - A. "On I 96 and I 196 a considerable number of center-mount delineators have cracked during the recent cold months.
  - B. "Please check into this problem and determine the cause of cracking."
- III. March 25, 1963. W. W. McLaughlin notified H. H. Cooper that the problem of cracked delineators was being called to the attention of E. A. Finney, Director, Research Laboratory Division. A study of the problem was to begin as soon as possible.

IV. June 19, 1963. H. C. Brunke, Civil Engineer, Structures Unit, reported to L. T. Oehler, Supervisor, Physical Research Section:

A. G. M. Smith and M. H. Janson went to Kent County and acquired the damaged delineators referred to by Mr. Cooper.

B. E. A. Finney requested a verbal report on approximately May 27, 1963.

V. August 9, 1963. Richard Harvey, Foreman, Grand Rapids Sign Shop, reported the following to E. A. Finney:

A. The majority of damage to delineators is caused by snow plows:

1. Delineators behind guard rails and on ramps are not damaged like the ones on straightaways.
2. All delineators are broken exactly the same way.
3. Single-mount delineators in Ottawa County, erected by a contractor, have a nick on the side of the housing.
4. The percentage of breakage of delineators diminished after crossing the Kent County line on I 96.

B. Some opinions suggest that the pressure of snow hitting the delineators is causing the problem.

VI. September 30, 1963. H. C. Brunke reported to E. A. Finney as follows:

A. Based on results of a laboratory test where delineators were fastened to posts, according to Departmental standards, riveting did not cause any cracks in the 35 delineators tested (Figs. 1 and 2).

B. 17 delineators riveted to posts were subjected to a heat shock test with no evidence of cracking, warping, or water inclusion (Fig. 3).

C. "I concur with Mr. Harvey that most failures of center-mount delineators should be attributed to direct blading damage by snow removal equipment, rather than the riveting operation. However, another direct factor, in my opinion, is impact resulting from flying ice, snow, and frozen shoulder material" (Fig. 4).

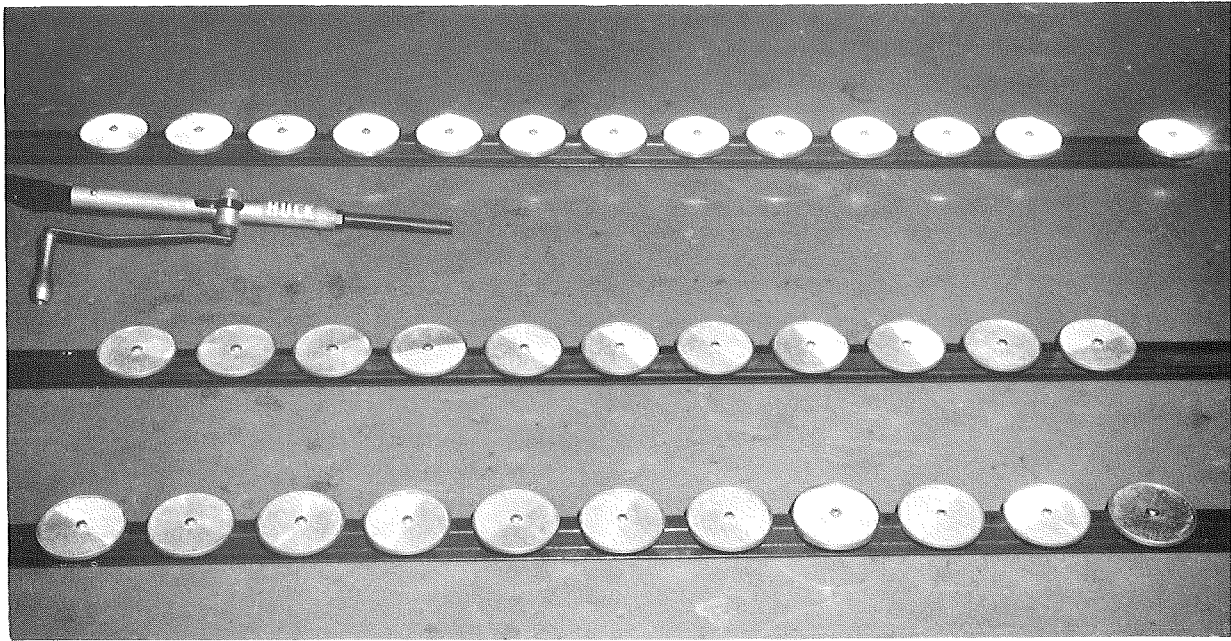


Figure 1. Typical delineators mounted on posts with the necessary riveting gun.

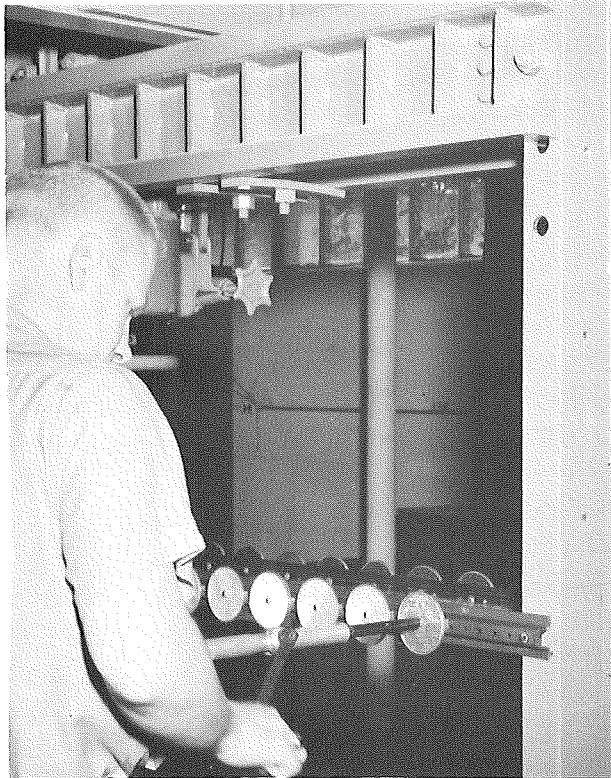


Figure 2. Riveting operation.

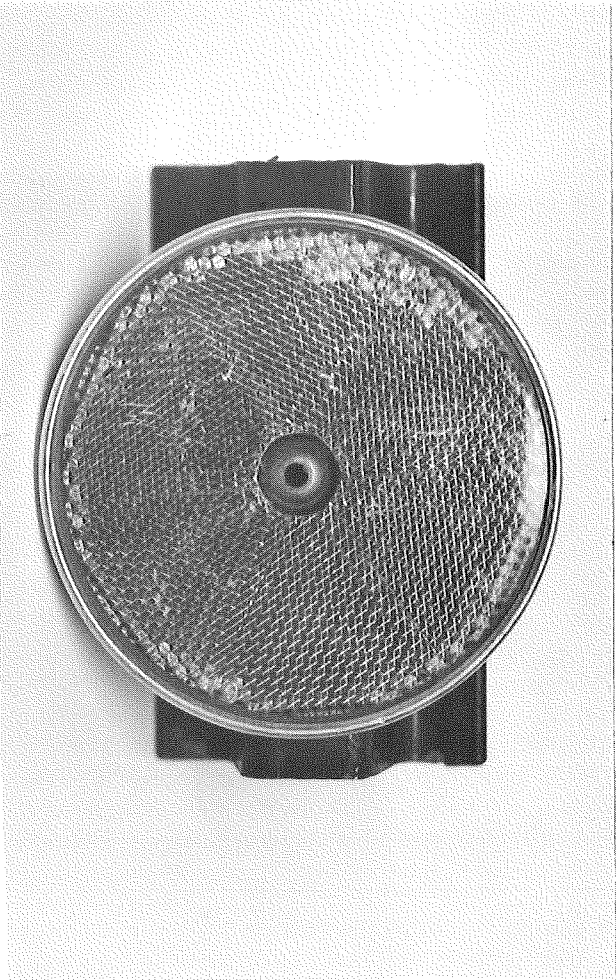


Figure 3 (right). Reflector button after completion of specified heat shock test.

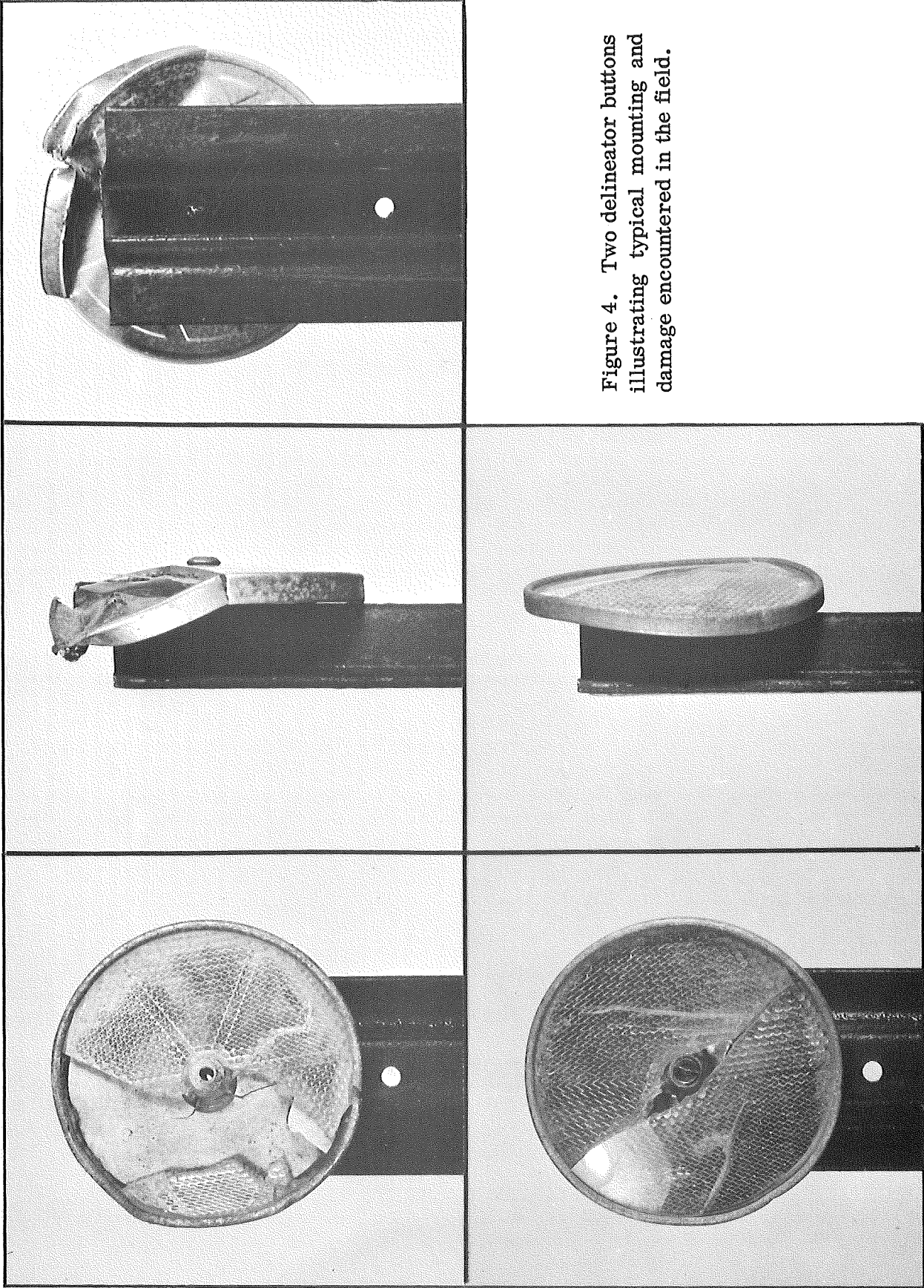


Figure 4. Two delineator buttons illustrating typical mounting and damage encountered in the field.

VII. November, 1963. M. H. Janson presented the following progress report for Research Project 51 G-54(4) to E. A. Finney:

A. October 10, 1963. M. H. Janson and P. J. Chamberlain inspected center-mount delineators located on US 27 between Alward Lake Road and Townsend Road:

1. Inspection results are recorded in Table 1 and samples shown in Figures 5 and 6:
  - a. All delineators were mounted on the narrow side of the post.
  - b. Approximately 54 percent of the delineators inspected were damaged.
2. All new delineators, used to replace the sampled ones, cracked curing replacement riveting. A laboratory examination of the riveting process (Fig. 7) revealed:
  - a. Huck rivets are 0.187-in. diam before riveting but expand up to 0.255-in. diam during fastening.
  - b. Diameter of the hole in the plastic delineator is 0.240 in. Maximum inside diameter of the grommet mounting hole is 0.220 in.
  - c. The examination shows the rivet can expand to a diameter 0.035-in. greater than can be accepted by the delineator.

B. The Huck Manufacturing Co. of Detroit was contacted concerning types of fasteners available:

1. A two-piece fastener was used successfully, but had little tolerance for accommodating various thicknesses of material and was considerably more expensive.
2. A plugging-type rivet was used, but greater pressure was created on the delineator during fastening than by the pull-through rivet.
3. A truss-head fastener cracked a sample during riveting.
4. Previous work on the problem indicated the Department had accepted the pull-through rivet although it was not completely satisfactory. The Huck Manufacturing Co. recommended the use of aluminum rivets instead of steel rivets purchased by the Department. Aluminum rivets are less expensive.

C. October 25, 1963. Delineators were removed and inspected between Alward and Pratt Roads on southbound US 27 and Jason and Pratt Roads on southbound US 27:

1. Truss-head rivets could not be used because of the short working length of the rivet.

TABLE 1  
 SUMMARY OF DELINEATOR BUTTON PERFORMANCE SURVEY  
 (Sample Nos. refer to Figs. 5 and 6)

Post No.	Alward to Pratt	Jason to Price	Parks to Townsend	Centerline to Price
1	cracked (Sample 6)	no damage	(Sample 6)	no damage
2	new; no damage	cracked (Sample 2)	destroyed	(Sample 10)
3	cracked (Sample 21)	destroyed	cracked (Sample 2)	new; no damage
4	cracked (Sample 8)	new; no damage	cracked (Sample 2)	no damage
5	cracked (Sample 6)	no damage	(Sample 7)	cracked (Sample 9)
6	cracked (Sample 9)	new; no damage	no damage	no damage
7	no damage	(Sample 3)	cracked (Sample 3)	new; no damage
8	no damage	no damage	no damage	new; no damage
9	cracked (Sample 8)	no damage	cracked	(Sample 11)
10	new; no damage	cracked (Sample 9)	(Sample 8)	cracked (Sample 9)
11	cracked (Sample 21)	no damage	cracked (Sample 6)	cracked (Sample 12)
12	cracked	(Sample 4)	cracked (Sample 9)	cracked (Sample 12)
13	no damage	cracked (Sample 3)	no damage	no damage
14	no damage	no damage	no damage	no damage
15	cracked (Sample 9)	cracked (Sample 7)	new; no damage	new; cracked (Sample 9)
16	no damage	cracked (Sample 9)	no damage	cracked (Sample 7)
17	cracked (Sample 21)	(Sample 5)	(Sample 9)	no damage
18	no damage	no damage	no damage	no damage
19	cracked (Sample 21)	new; no damage	cracked (Sample 3)	(Sample 12)
20	cracked (Sample 11)	no damage	no damage	no damage



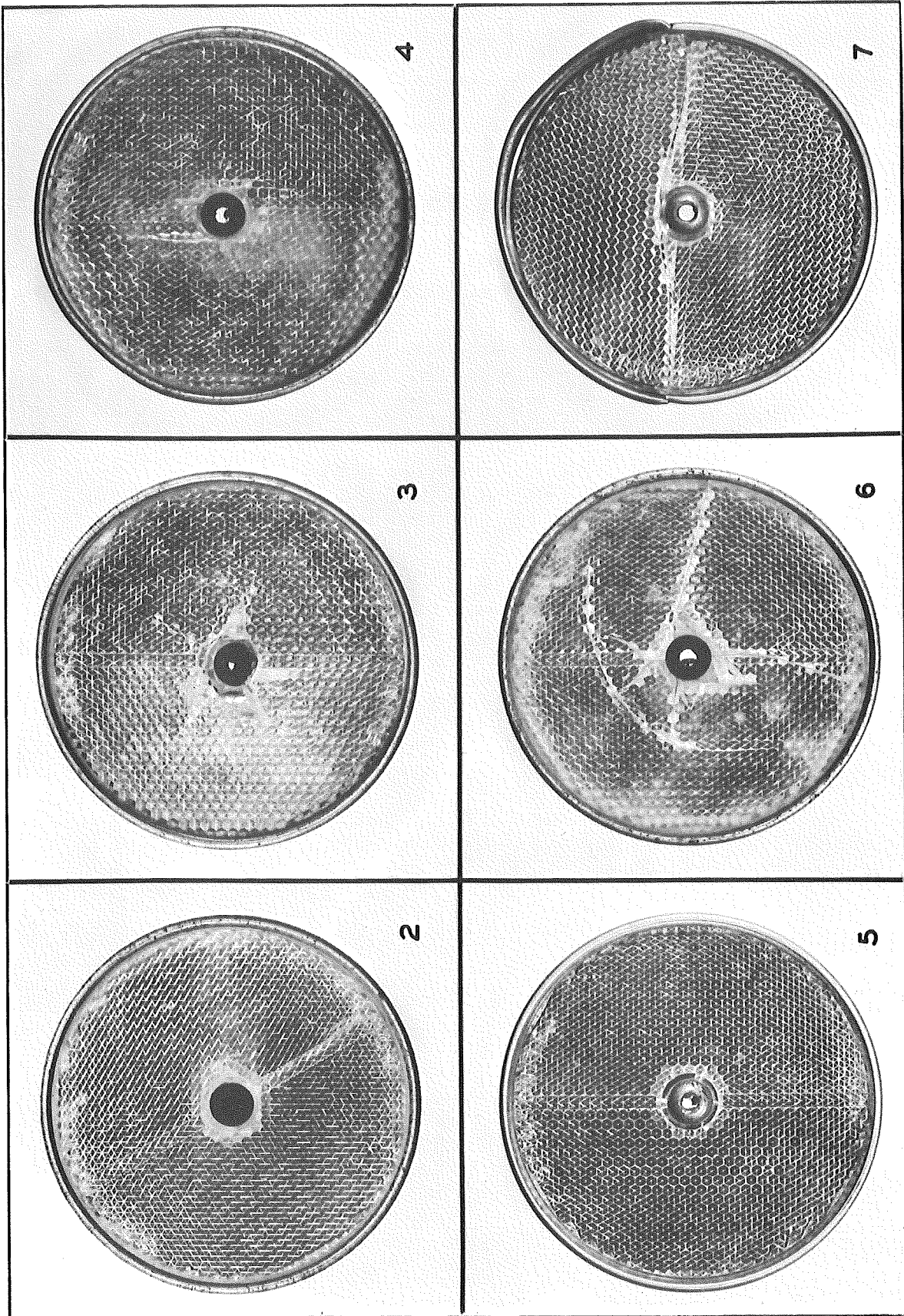


Figure 5. US 27 button samples.

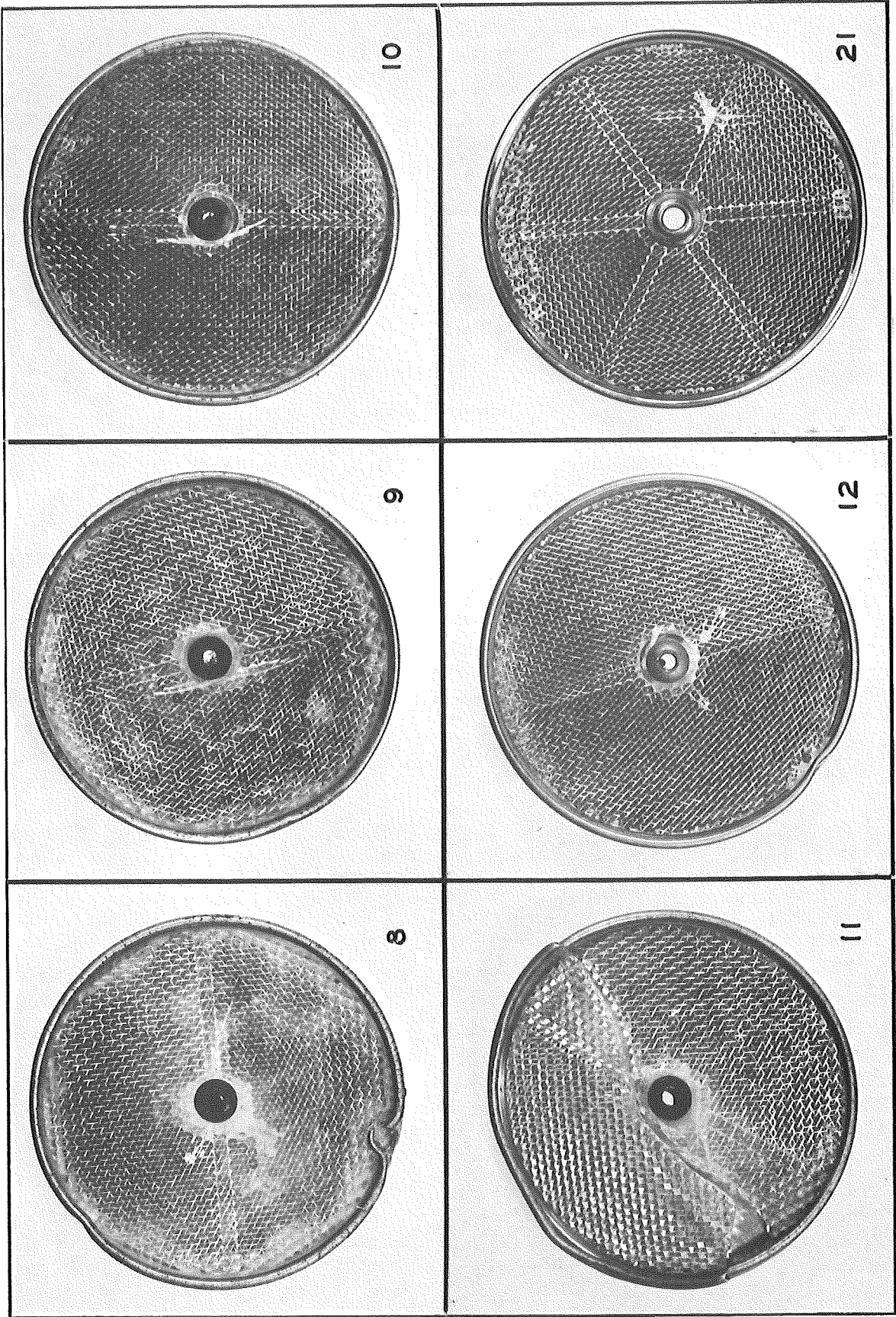
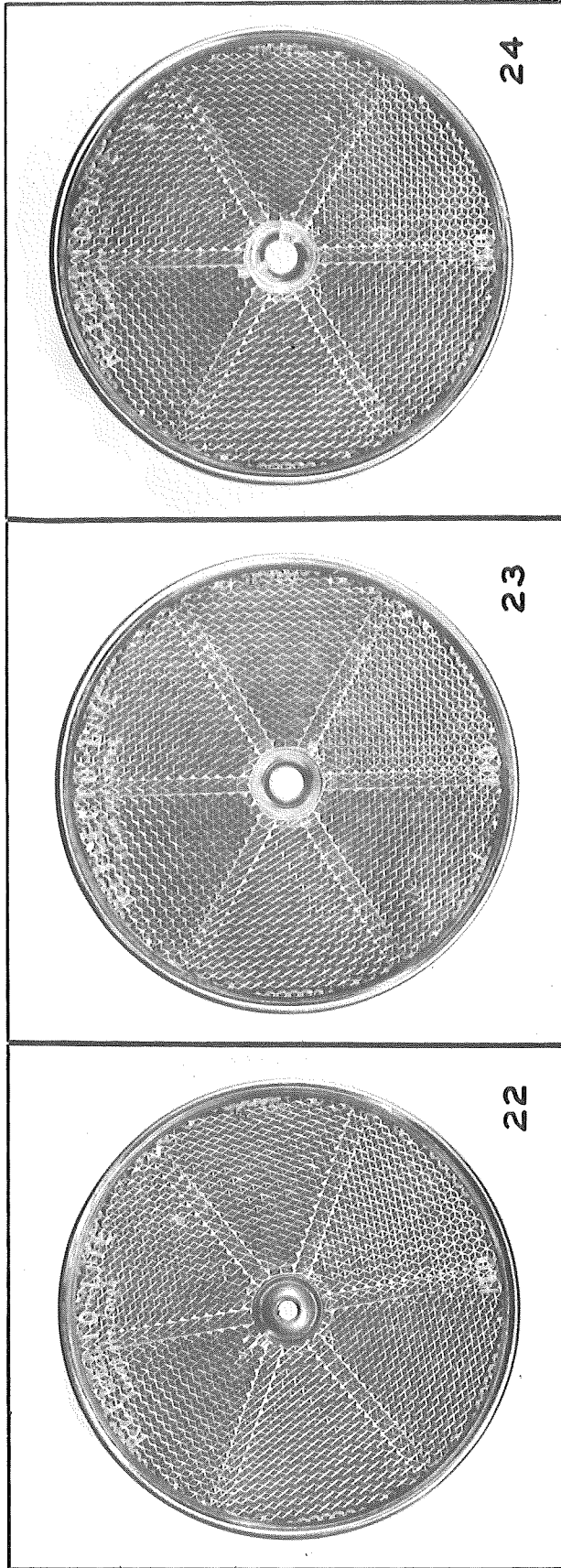


Figure 6. US 27 button samples.



Delineator cracked at center, with rivet in place.

Normal delineator with grommet removed.

Delineator cracked at center, with rivet and grommet removed.

Figure 7. Condition of new delineators after laboratory riveting.

2. Plugging rivets were not entirely satisfactory. Four of the twelve rivets used cracked the delineators during installation.
3. Delineators satisfactorily fastened with pull-through rivets were free to rotate on the rivet.

D. Recommendations and observations resulting from the inspections:

1. Two controllable factors responsible for cracking delineators are the fastening device and the mounting.
2. It is recommended that pull-through rivets be discontinued as fasteners for center-mount delineators.
3. It is recommended that the Physical Research Section investigate the use of other fasteners and revise present specifications to agree with investigation results.
4. The plugging-type rivet is considered more satisfactory and is recommended for use during the investigation.
5. The use of backing-plates or a more satisfactory method of providing support for the delineators is also recommended (Fig. 8).

VIII. December 30, 1963. G. R. Cudney reported the following to L. T. Oehler:

A. Based on laboratory tests with the Huck rivet gun currently being used, "...the cracking of the plastic reflector depended on the diameter of the punched hole in the delineator post";

1. Traffic Division Plan SF-48 calls for 7/32-in. diam punched holes in posts. Standard tolerances allow a hole diameter variation from 0.2187 to 0.2312 in.
2. Larger diameter holes allow expansion of the rivet shell, exerting an internal pressure on the grommet causing radical cracking of the plastic.
3. A recent installation of 50 delineators using an aluminum alloy break stem blind (Pop) rivet fastener indicated only one had cracked. A laboratory demonstration and observed field results indicate the fastener should be satisfactory for posts with 7/32-in. diam holes.

B. Other possible solutions to the problem and corresponding specification changes required are outlined for consideration as follows:

1. Use the steel Huck pull-through rivet, with two No. 10 steel washers:
  - a. Washer measurements are 1/2-in. outside diameter, 7/32-in. hole diameter, and 1/16-in. thick.
  - b. Washers would prevent expansion of the rivet shell that results in cracked plastic.



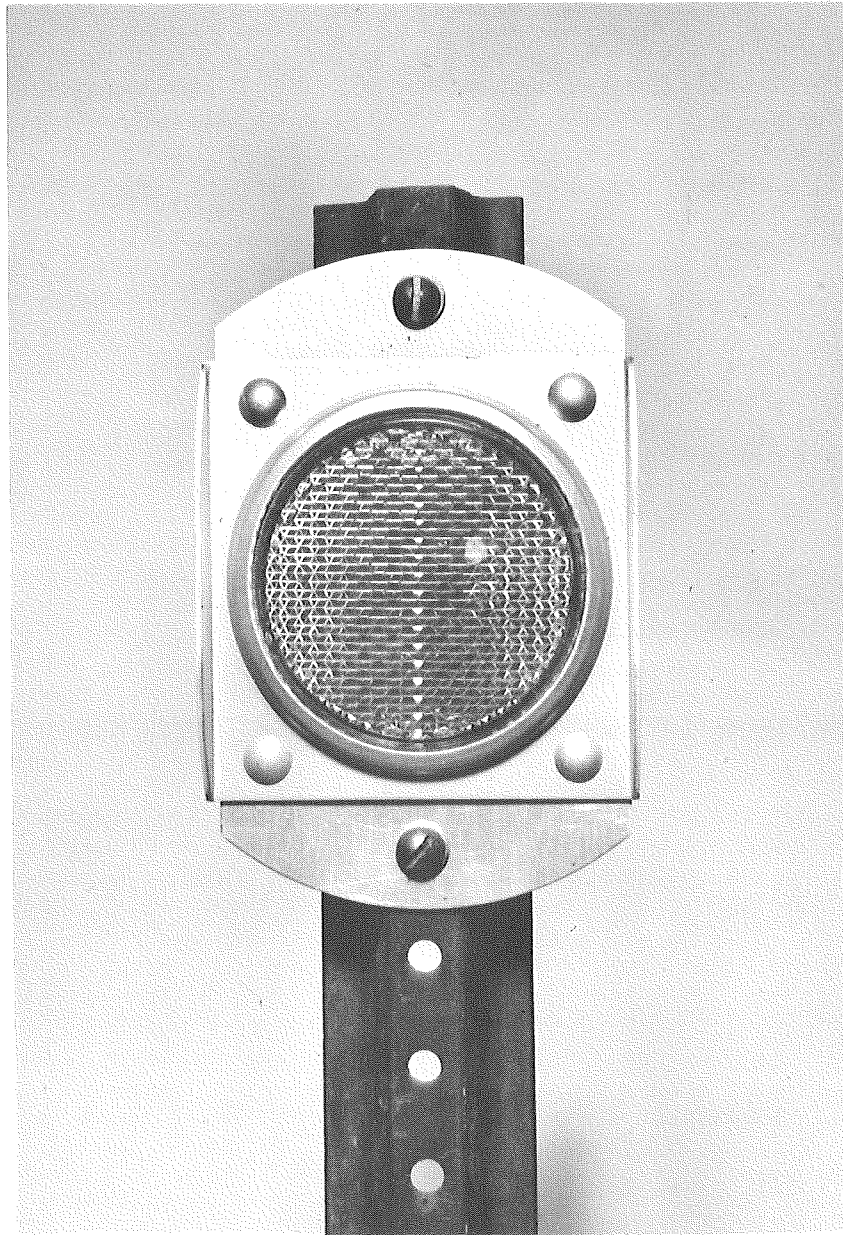


Figure 8. Delineator type used on short length of road-  
way in Ottawa County.

- c. A change in Article 7.26.03-d-4 would prescribe two No. 10 steel washers, steel rivet material, and increased rivet grip to 5/8 in.
- 2. Use the Pop break stem rivet with changes in Article 7.26.03-d-4. Rivet material must be changed to agree with manufacturer. Rivet grip should be 5/8 in.
- 3. Specify punched holes in delineator posts be  $7/32 \pm 0.005$  in. and use the steel Huck-pull through blind rivet:
  - a. Requires change in rivet material and additional tolerance dimensions.
  - b. Close tolerance on hole diameter might be offset by distortional changes involved in the galvanizing operation.

C. Irrespective of these mentioned specification changes, the following two corrections should be made:

- 1. Under Article 7.26.03-d-4 strike out the words "... Type 1 and ... " in the first sentence. The blind rivet fastener is intended for use only with the Type 2 delineator.
- 2. Under Article 7.26.03-g-1 change the dimension 3/16 to 7/32 in the last sentence.

IX. June 10, 1964. J. T. Ellis, Chemist, Spectroscopy and Photometry Section reported to M. H. Janson on the "Stresses in Reflector Buttons." Dr. Pindera, M.S.U. Applied Mechanics Department, made the following study:

- A. Samples of reflectors before and after riveting were observed with a polariscope. Tensile stresses were present before riveting but riveting magnified stresses.
- B. Stresses in the reflectors before riveting probably originated during cooling after casting. The heavy center section cools slower than the outside and causes shrinking and tensile stresses.
- C. Tensile stresses can be reduced if the casting is changed so that cooling would take place from the center outward. This would create compressive stresses which would offset expansion due to riveting.
- D. Another possible solution is to assemble the reflector buttons with a steel washer on the center post to reduce expansion due to riveting and consequently reduce further tensile stresses.

X. June 12, 1964. M. H. Janson advised E. A. Finney of the results of Dr. Pindera's study, explaining that the findings might be sufficient to reopen Project 51 G-54(4) for further investigation.

- XI. January 11, 1965. S. F. Cryderman, Assistant Maintenance Operations Engineer, requested that District Maintenance Engineers for Districts 2, 3, 4, 5, 6, 7, 8, 9, and 10 survey the percentage of delineators cracked or broken during installation:
- A. District 2. Very few delineators are broken or cracked during installation if the men installing them have experience with the Huck riveter.
  - B. District 3. Relatively few delineators are broken during installation. Consensus of opinion is that the greatest amount of delineator button breakage occurs when the posts are struck by plows. Breakage also occurs from vandalism near larger municipalities.
  - C. District 4. Crawford, Emmet, Otsego, and Roscommon County Road Commissions reported no installation damage. Cheboygan reported 3- or 4-percent damage. Otsego reported some breakage after installation with guns, by cars running off roads, and by snow thrown from snow plows.
  - D. District 5. No damage of any type regarding cracked or broken delineator buttons at time of installation.
  - E. District 6. Very few delineators are cracked or broken during installation. Experience with the Huck rivet gun prevents cracking during installation:
    - 1. Cold weather may be a factor because more break during cold weather than during warm weather.
    - 2. Many cracked and broken reflector buttons are the result of snow plowing and persons trying to remove buttons from posts.
  - F. District 7. Report indicates the following damage resulting from contractor installation: Area 1--15 percent, Area 2--5 percent, Area 3--20 percent, Area 4--10 percent. Sign Shop or direct installation is reported at less than 2 percent.
  - G. District 8. Approximately 1-percent breakage of delineators is caused by installation.
  - H. District 9. Macomb, Oakland, and St. Clair Counties report breakage so slight it is insignificant. Oakland and St. Clair Counties use a hand-type rivet gun, while Macomb County uses bolts, peening the ends.
  - I. District 10. No breakage of delineator buttons during installation but a great deal of breakage after installation due to vandalism.
- XII. February 11, 1965. R. L. Greenman transmitted the results of S. F. Cryderman's survey to E. A. Finney.