KRALASTIC PLASTIC FOR NON-REFLECTORIZED SIGNS

MICHIGAN HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

KRALASTIC PLASTIC FOR NON-REFLECTORIZED SIGNS

J. T. Ellis

Research Laboratory Section
Testing and Research Division
Research Project 68 NM-220
Research Report No. R-819

Michigan State Highway Commission
E. V. Erickson, Chairman; Charles H. Hewitt,
Vice-Chairman, Claude J. Tobin, Peter B. Fletcher
Lansing, March 1973

INTRODUCTION

The evaluation of Uniroyal "Kralastic" as material for small signs was requested by H. H. Cooper in a letter to R. L. Greenman dated December 10, 1968. R. L. Greenman authorized the study in a December 17, 1968 letter to G. R. Cudney. Mr. Cooper requested in his letter that the Kralastic evaluation be similar to the study previously requested for Borg-Warner's "Cycolac" so that the two materials might be compared to provide a competitive bid should the evaluation be favorable.

The three-phase outline previously proposed for Cycolac evaluation by L. T. Oehler in his July 11, 1968 memorandum to R. L. Greenman follows:

A. Cost

No evaluation was performed specifically for Kralastic signs because Kralastic and Cycolac are similar materials and it was assumed that their total cost per sign would be nearly identical.

B. Performance Evaluation (Kralastic signs)

1. Three newly fabricated Kralastic signs were obtained from the MDSH Sign Shop and color and gloss were measured on each sign.

2. A test installation of 25 Kralastic signs was installed in the Lansing area.

3. The test installation was inspected twice at approximately yearly intervals.

4. Representative signs were returned to the laboratory for color and gloss measurements following each inspection.

C. Control Sign Evaluation (aluminum)

1. Five newly fabricated aluminum signs were obtained from the MDSH Sign Shop and color and gloss were measured on each sign.

2. The area adjacent to the Kralastic test installation was signed with new aluminum signs.

3. The aluminum signs were inspected twice and at the same time as the Kralastic signs.

4. Representative aluminum signs were returned to the laboratory for color and gloss measurements following each inspection.

COST

Previous contacts with Michigan State Industries, Traffic and Safety Division, and Sign Shop personnel provided information on the service life of aluminum signs and the total cost (material, processing, and installation) per sign for both aluminum and Borg-Warner's Cycolac signs. From this information it was estimated that the service life of aluminum was 5 years (60 mo.) and the total cost per sign was $8.04 for aluminum and $7.83 for Cycolac. A Cycolac sign would thus need a service life of 7.83/8.04 x 60 months or 58 months to be competitive with aluminum. Since Cycolac and Kralastic are similar materials and the installation cost would be the same for both, it was assumed that their total cost per sign would be identical and the cost relationship between aluminum and Cycolac would also be true for aluminum and Kralastic. Thus, a Kralastic sign would need a service life of 58 months to be competitive with aluminum.

PERFORMANCE AND CONTROL SIGN EVALUATION

Three 12 in. by 18-in. Kralastic signs with the legend "No Parking At Any Time" were obtained by the Research Laboratory from the highway Sign Shop in April, 1970. The signs had been newly fabricated by Michigan State Industries using normal production procedures. Five new aluminum signs of the same size with the same legend were obtained from the highway Sign Shop. Color measurements were performed on the white background and the red legend of both types of signs. Gloss of the background was also measured. These measurements were performed to show a comparison between new signs and weathered signs after one to two years service. Test Installations of twenty-five Kralastic "No Parking At Any Time" signs on M 43 from Theo St west to Stoneridge Dr in Eaton County was completed in September, 1969. The test signs were installed consecutively in the test area. Test signs at each location were placed on both sides of the street so that directional weathering effects could be examined. The areas adjacent to the test Kralastic signs were signed with aluminum signs at approximately the same time.

VISUAL INSPECTION

Two inspections of the test installation were performed, Inspection 1 was completed in July, 1970 and Inspection 2 in October, 1971. It was found that several Kralastic signs were missing or had been replaced with aluminum signs. No information was available as to the reason for the missing or replaced signs. It was learned that both District Maintenance personnel and Sign Shop personnel in a roving sign truck install and replace signs. Each of the signs remaining in service was visually examined in detail for general appearance and for such defects as:

1. Discoloration (a change from the initial white color).

2. Dirtiness (soiled with removable dust, dirt, road grime, etc.).

3. Crazing (fine cracks at or under the surface). Figure 1.

4. Chalking (a dry chalk-like powdery deposit on the surface). Figure 2.

5. Cracking (fractures).

6. Breakage (broken or shattered into more than one piece).

7. Scratches (surface gouges or marks).

8. Warping (bent from it's normal plane).

9. Vandalism (deliberate malicious damage).

Also considered in the visual inspection was:

1) Direction of the sign face (north and south).

2) Sign environment (shade, open, roadside, shopping center, etc.).

Following each visual inspection, 10 Kralastic signs from each test area and 5 aluminum signs from each of the adjacent areas were returned to the laboratory for color and gloss measurements. The measurements were first performed in the field condition (dirty) and again after the signs had been cleaned employing a standard scrub cycle (Appendix). A standard scrub cycle was used to ensure that all signs had precisely the same amount of cleaning before remeasuring the color and gloss. When the measure-

ments were completed the signs were returned to their respective test field locations for further service. The findings of the two visual inspections are reported below.

Inspection 1

Kralastic - 22 remaining signs of 25 installed

1. All signs were slightly dirty.
2. All signs showed chalking.
3. Twenty-one signs were warped or bent from the vertical up to about 3/4-in. (Most signs were bent less than 1/2-in.)
4. Two signs were cracked.
5. Two signs were scratched or gouged.
6. Two signs showed crazing.

Aluminum - 5 signs

1. All signs were quite dirty.
2. One sign was scratched.
3. One sign was bent
4. Four signs had chipped paint.

Inspection 2

Kralastic - 18 remaining signs of 25 installed

1. All signs were slightly dirty.
2. All signs showed chalking.
3. Sixteen signs were warped or bent from the vertical up to about 3/4-in. (Most signs were bent less than 1/2-in.)
4. Two signs were cracked.
5. One sign was scratched.
6. Eleven signs showed crazing.
7. One sign was broken.

Aluminum - 5 signs

1. All signs were quite dirty.
2. Three signs were scratched.
3. Two signs were bent.
4. Four signs had chipped paint.

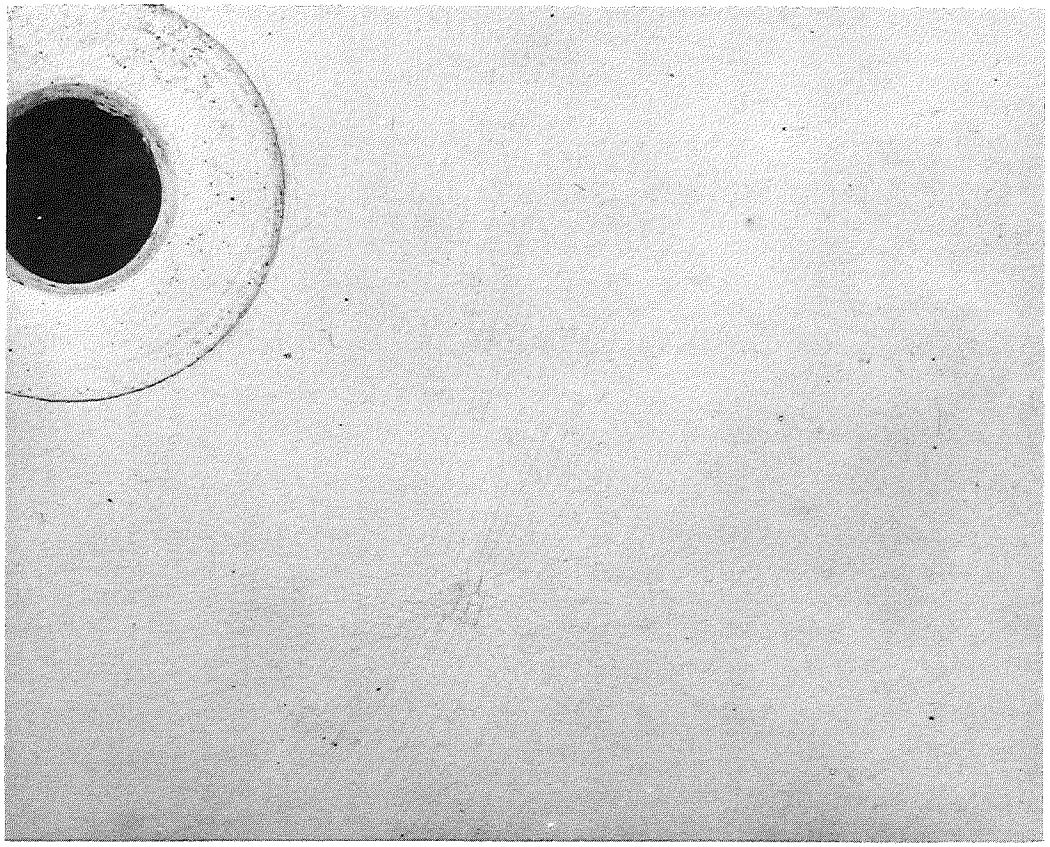

Figure 1. Crazing on Kralastic sign.

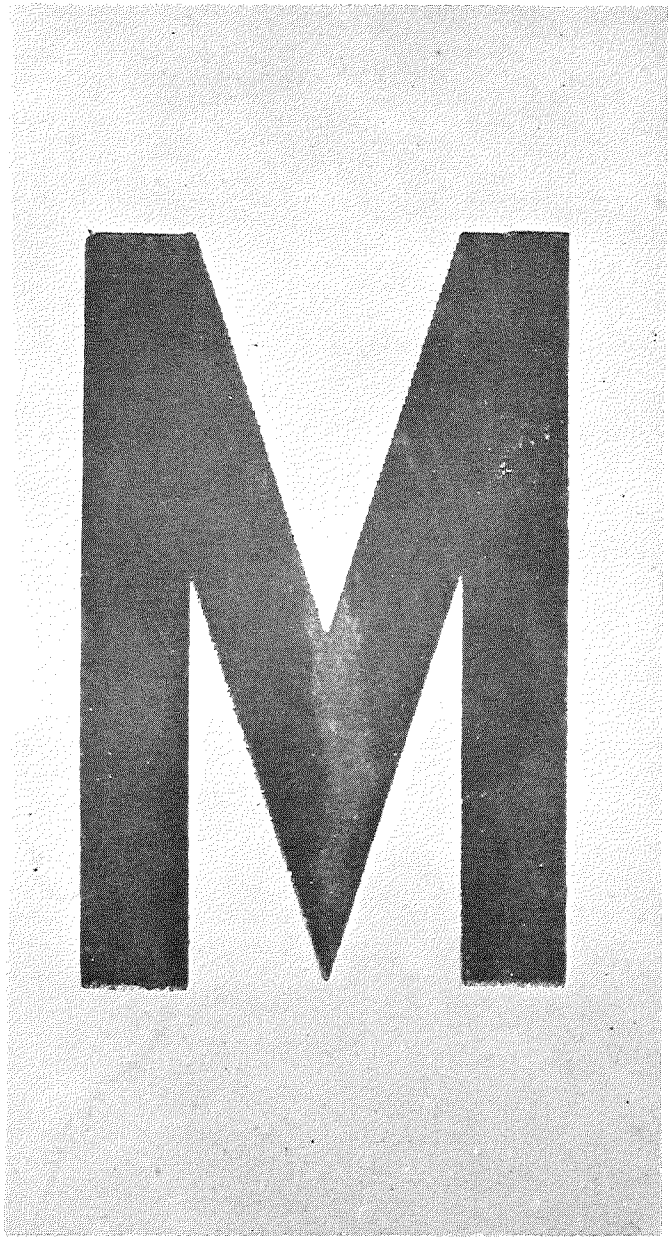

Figure 2. Chalking on Kralastic sign.

Discussion - Visual Inspection

Kralastic

Some of the test signs had multiple minor defects such as dirtiness, discoloration, crazing, scratches, and cracks so in the tabulations are counted more than once. The dirt on the signs was usually just dust, mud, and road grime, etc., and was easily removed by washing with a detergent solution. The chalking noted on all signs probably resulted from white pigment leaching out from the sign's surface and running down over the legend (Fig. 2). The chalking condition did not seriously detract from the signs legibility and was easily removed by washing with a detergent solution. The warping or bending condition observed on many signs is not readily explained. No hole spacing differences were noted between aluminum and Kralastic signs and only in one instance was their a significant hole spacing difference between the sign and its post. This warping condition, while unsightly, does not affect the signs legibility or function. The crazing or surface cracking probably resulted from the almost constant flexing from the wind and/or backwash from fast moving traffic. This crazing condition did not significantly reduce the legibility or impair the function of the sign. No definite explanation can be offered for most of the scratched, cracked, broken, or missing signs. One of the missing signs had apparently been struck by a vehicle since the post was bent and broken off about 4 ft above the ground.

Of the original 25 test signs, 18 signs, or 72 percent were still functioning in legibile-serviceable condition at the time of Inspection 2.

Aluminum

The chipped paint reported on most of the signs usually occurred on the sign edges and in areas surrounding the bolts. One sign was bent slightly around its post and in the bend area considerable paint was chipped off. Aside from the chipped paint, the dirty condition of most signs, and a few scratches, the aluminum signs do not appear to have been significantly affected by weathering (service in the field) and are generally in good condition.

Color and Gloss Measurement

Experimental

The measurements were performed with a Photovolt colorimeter and a Multi-Angle Glossmeter. Four areas were measured for color on the white background and two areas measured for color on the red legend. Four

60-degree gloss measurements were performed on the white background of each sign. The measurements were first performed in the field condition (dirty) then again after being cleaned in a standardized scrub cycle (Appendix). The color measurements on the white background were converted into CIE chromaticity or color coordinates x and y, in daylight and into reflectivity (R_S) values. A Yellowness Index YI = 100 (A-B/G) was also calculated in accordance with ASTM E 313-67. YI values are numbers which correlate with visual ratings of yellowness and whiteness of certain white and near-white surfaces. The measurements on the red legend were also converted into CIE color values.

Discussion of Color and Gloss

Table 1 shows YI, R_S, and gloss values for the white background of both aluminum and Kralastic test signs for the two inspections and YI, R_S, and gloss values for the new signs of each type. Table 1 also shows the range of values obtained and the final average values.

Examination of the average data in Table 1 shows the following.

1. The Kralastic signs became slightly more yellow and lost a small amount of reflectivity and gloss up to the time of Inspection 1. Between Inspection 1 and Inspection 2 no further significant change occurred.

2. Comparison of YI, R_S and gloss values of new aluminum signs and clean (after washing) aluminum signs after both inspections shows only minor changes.

3. No significant differences in YI, R_S and gloss values are noted between dirty (before washing) and clean (after washing) Kralastic signs.

4. The aluminum signs had considerably higher YI values, considerably lower gloss, and slightly lower reflectivity when dirty (before washing) than when clean (after washing).

Examination of the color data on the red legends of the test signs showed no measurable changes upon weathering in the field for either type of sign (Kralastic and aluminum) during the test period.

OTHER INFORMATION

In addition to the economic and performance evaluation reported above literature references were checked for recent developments in ABS plastic technology and several people knowledgeable in traffic control and signing

TABLE 1
COLOR DATA ON KRALASTIC & ALUMINUM SIGNS

	New Signs			M 43											
				Inspection No. 1						Inspection No. 2					
				Before Washing			After Washing			Before Washing			After Washing		
	YI	R_s	60 gloss	YI	R_s	60 gloss	YI	R_s	60 gloss	YI	R_s	60 gloss	YI	R_s	60 gloss
KRALASTIC	-8.2	81.0	11.7	4.7	77.0	2.0	6.1	80.0	2.1	6.1	74.1	2.1	6.4	79.4	2.0
	-8.7	82.0	11.2	4.7	78.4	2.1	4.6	80.9	2.2	5.3	75.6	2.1	5.3	81.2	2.1
	-8.7	81.6	12.0	5.8	77.3	2.0	5.8	79.8	2.0	3.0	78.8	2.6	4.3	82.0	2.2
				4.8	79.2	2.0	4.0	80.3	2.1	6.6	75.4	2.4	5.4	80.9	2.0
				5.1	78.3	2.0	2.3	79.5	2.3	7.0	74.5	2.4	6.6	80.1	2.1
				4.5	80.0	2.3	5.7	80.8	2.2	0.9	81.3	2.5	2.5	82.4	2.8
				5.8	77.2	2.8	5.1	79.9	2.5	1.5	80.8	2.7	2.7	82.6	2.7
				5.2	76.3	2.0	4.7	79.5	2.2	0.9	80.9	2.8	1.8	82.2	2.7
				1.5	79.5	2.0	2.2	80.7	2.3	0.7	81.7	3.0	1.3	82.8	2.6
				1.2	78.2	2.1	4.1	79.8	2.3	3.1	78.6	2.6	4.4	81.4	2.5
Range High	-8.2	82.0	12.0	5.8	80.0	2.8	6.1	80.9	2.5	7.0	81.7	3.0	6.6	82.8	2.8
Range Low	-8.7	81.0	11.2	1.2	76.3	2.0	2.2	79.5	2.0	0.7	74.1	2.1	1.3	79.4	2.0
Average	-8.5	81.5	11.6	4.3	78.1	2.1	4.5	80.1	2.2	3.5	78.2	2.5	4.1	81.5	2.4
ALUMINUM	-1.6	88.1	97.9	4.9	75.8	42.3	-1.4	84.5	95.0	5.4	79.1	53.8	-2.0	86.1	95.9
	1.3	88.7	99.0	6.2	72.8	19.0	-3.8	83.7	46.5	4.9	74.2	23.5	-3.1	84.5	43.4
	1.4	88.1	98.0	14.6	63.5	9.8	-3.0	82.5	69.3	3.8	71.9	18.6	-1.4	83.9	68.6
	2.9	88.6	98.0	12.8	54.9	5.0	-3.1	83.9	77.5	10.5	65.8	11.1	-2.5	85.4	71.1
	0.2	88.7	98.2	1.8	74.0	32.5	-6.1	82.3	86.0	2.3	83.7	45.3	-3.8	84.8	81.4
Range High	2.9	88.7	99.0	14.6	75.8	42.3	-1.4	84.5	95.0	10.5	83.7	53.8	-1.4	86.1	95.9
Range Low	-1.6	88.1	97.9	1.8	54.9	5.0	-6.1	82.5	46.5	2.3	65.8	11.1	-3.8	83.9	43.4
Average	0.8	88.4	98.2	8.1	68.2	21.7	-3.5	83.4	74.3	5.4	74.9	30.1	-2.4	84.9	72.1

were contacted for information on the performance of small aluminum and plastic signs. The following summarizes the findings:

Literature References

Since the inception of this study almost five years ago, developments in plastics technology have produced significant improvements in several physical properties of ABS. Table 2 shows that some properties such as the low temperature impact strength of high impact molding grade ABS has been increased up to 60 percent.

TABLE 2

Physical Property	1967[1]		1972[2]	
	Extrusion Grade	High Impact Molding Grade	Extrusion Grade	High Impact Molding Grade
Tensile Strength psi	4000-6000	5000-6000	4000-7000	4500-7500
Flexual Yield Strength psi	5000-8000	7500-9800	6000-14000	6000-11000
Low Temperature Impact Strength, ft lb/in. of Notch	2.5-3.4	1.5-2.5	0.6-4.0	1.5-4.0

[1]1967 Modern Plastics Encyclopedia, p. 30.
[2]1972-73 Modern Plastic Encyclopedia, p. 142.

Technology for enhancing the weatherability of ABS has also been developed by laminating with a thin layer of more ultra-violet resistant materials. With these advances in ABS plastic technology we expect the present Kralastic to be a better sign material than the material used for the study.

Comments of Traffic Control and Signing Personnel

1. The red legend on aluminum signs often fades seriously sometimes requiring replacement in three to five years.

2. The estimated maximum service life of aluminum signs is about five years.

3. Two 36-in. plastic test construction warning signs (men working) are being used in District 7. The legibility of the signs is considered satisfactory but one of the signs has developed a crack for unknown reasons.

4. The City of Saginaw is using small 12 in. by 18-in. ABS plastic parking restriction signs quite extensively. Saginaw Traffic Engineer Mr. G. Meredith stated that they have had 2,000 to 3,000 plastic signs in service since 1968 and are very favorably impressed with their performance. Mr. Meredith said they particularly like the plastic signs because: 1) the plastic sign blanks are slightly cheaper than aluminum, 2) the holes are prepunched, 3) the backing does not require painting (legend is painted directly on the backing), 4) the plastic signs are easier to recycle than aluminum signs since they can be reversed and the legend repainted on the back, 5) they have experienced only a few minor problems with the plastic signs (a small number of cracked and broken signs, but no noticeable yellowing, crazing, or chalking).

SUMMARY

The following statements summarize the findings of this study:

1. Kralastic has approximately a $0.21 per sign cost advantage over aluminum.

2. A slight tendency for Kralastic signs to warp, chalk, and craze with service life was noted; however, these defects are considered minor and do not seriously impair the signs legibility or function.

3. Neither the sign environment (shade, open, roadside, driveway, etc.) nor the direction of sign face, had any significant effect on the condition of either type of sign.

4. Only minor changes in YI, R_S and gloss were apparent between new and weathered Kralastic signs. The same was true for new and weathered aluminum signs.

5. The white background paint on aluminum signs tends to chip, particularly at the edges and around bolt holes.

6. Recent developments in plastic technology have improved the physical properties of some ABS plastics.

7. Reports from the field (Districts) indicate that the red legend on aluminum signs fades seriously, often limiting the service life to three to five years.

8. Plastic signs apparently perform satisfactorily on many city streets as indicated by their successful performance over a three-year period in the City of Saginaw.

RECOMMENDATION

In consideration of the above findings it is recommended that Kralastic be considered a suitable alternate material to aluminum for small signs.

APPENDIX

Standard Scrub Cycle

1. Position the sign on the scrub machine sign holder (Fig. 3) and apply a 500 gm weight to the sponge scrubber.

2. Wet the sponge scrubber with water and place several drops of a 2 percent liquid detergent solution to the sign in the path of the scrubber.

3. Turn on the scrub machine and scrub the sign 100 times at the rate of 40 cycles per minute.

4. Remove the sign from the scrub machine sign holder, rinse with distilled water and air dry.

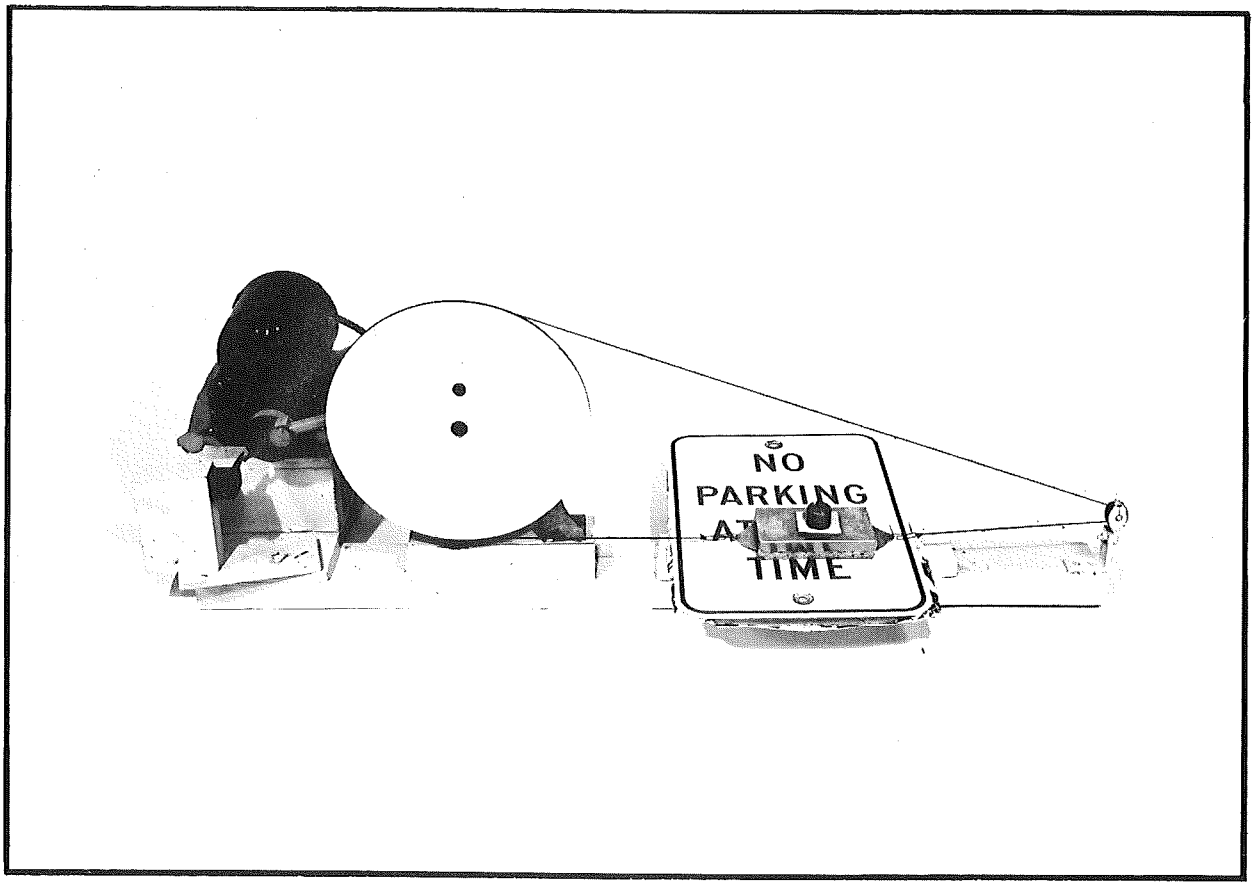

Figure 3. Sign Scrubber.