

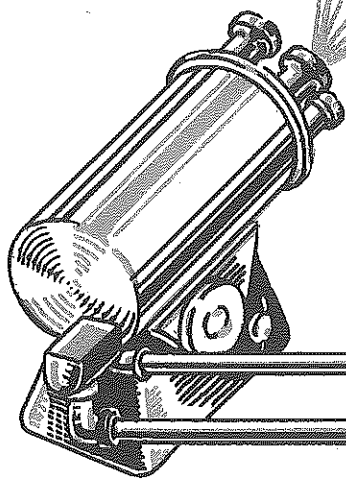
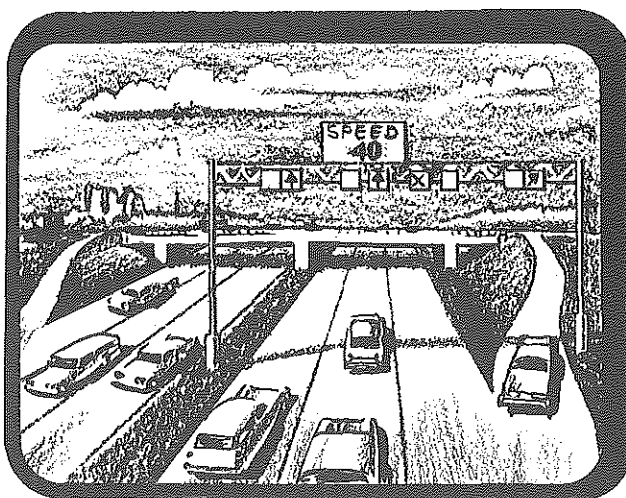
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JOHN C. LODGE FREEWAY TRAFFIC SURVEILLANCE

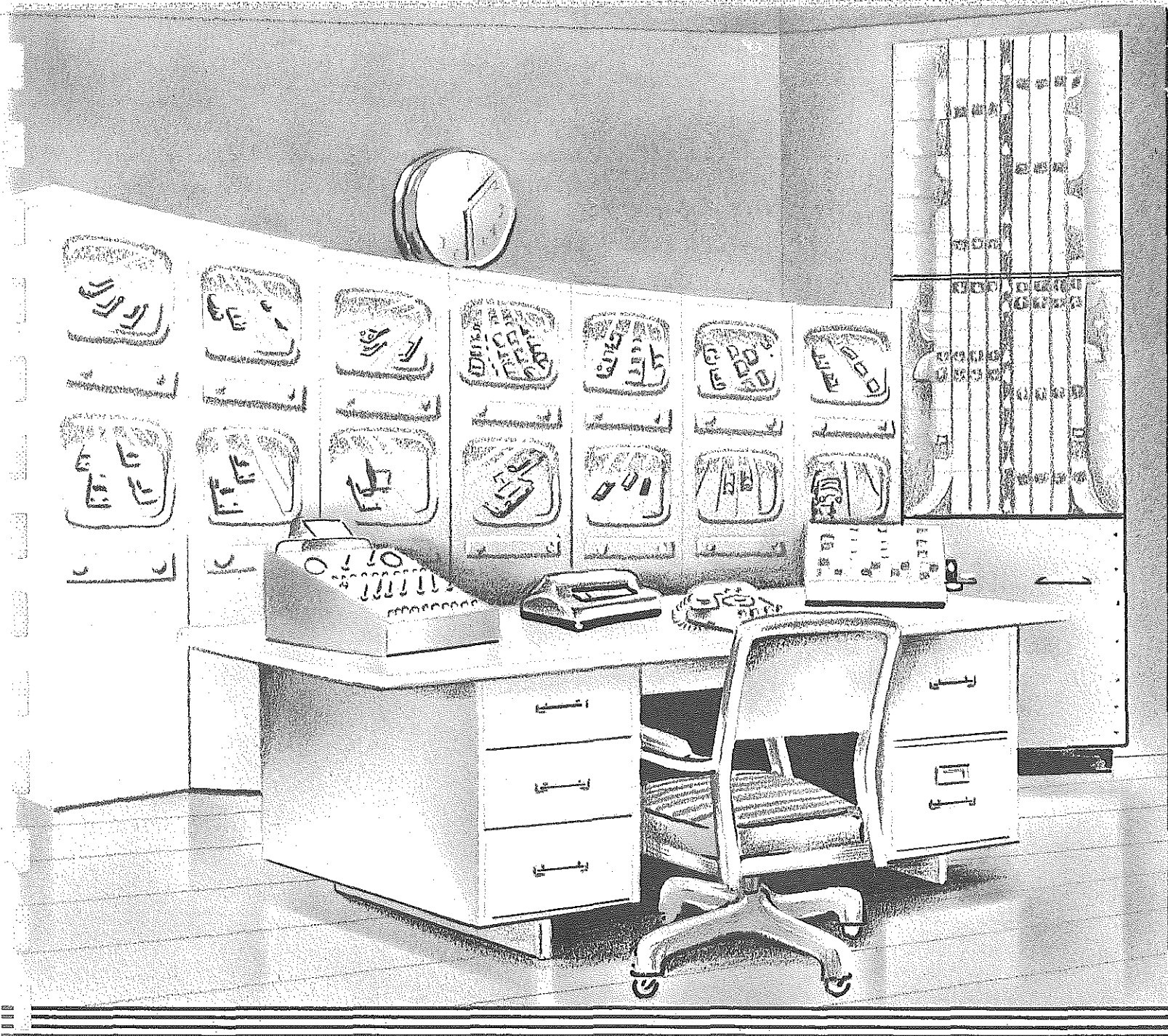
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CONTROL RESEARCH PROJECT



BLANKOUT SIGNALS FOR FREEWAY TRAFFIC CONTROL

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TRAFFIC SURVEILLANCE AND CONTROL RESEARCH PROJECT

A Project of the
Michigan State Highway Department
Jointly With The
Wayne County Road Commission
City of Detroit, Department of Streets and Traffic
In Cooperation With The
U. S. Bureau of Public Roads

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THE DEVELOPMENT OF BLANKOUT SIGNALS
FOR FREEWAY TRAFFIC CONTROL

A report of the
Project Technical Committee

By

Keith Bushnell and Charles Richard
Michigan State Highway Department

August 1963

JOHN C. LODGE FREEWAY
TRAFFIC SURVEILLANCE AND CONTROL RESEARCH PROJECT

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This Project consists of the establishment of a comprehensive system of surveillance and control on an urban freeway. The purposes of the Project are to evaluate the use of surveillance, traffic control and sensing equipment; to investigate the characteristics of the freeway traffic flow which may be determined and treated by such equipment; to improve freeway traffic operation and safety by these means, as well as to conduct basic research into freeway operations by making use of this specialized equipment. For the first time, it has become possible to assemble the specialized equipment required to carry on a project of this scope.

The Project is sponsored jointly by the Michigan State Highway Department, Wayne County Road Commission, and City of Detroit, Department of Streets and Traffic, in cooperation with the United States Bureau of Public Roads. The following report pertains to one of a number of individual studies to be performed. Each of the studies will be reported separately as it is completed and each will contribute to the overall objective of this study.

ACKNOWLEDGEMENT

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Holden LeRoy

of the
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City of Detroit

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PREFACE

Blankout legend signals have been used successfully for several years as pedestrian "Walk/Dont Walk" signals. In spite of experience with this application, it was impossible to foresee the design problems which would be encountered in developing a blankout signal for freeway traffic control. This discussion will cover the development and use of "blankout" signals for lane control, speed control, and ramp control.

THE DEVELOPMENT OF BLANKOUT SIGNALS
FOR FREEWAY TRAFFIC CONTROL

Lane Control Signals

Mackinac Bridge Signals

The first successful blankout lane control signals used in the State of Michigan were installed on the Mackinac Bridge in July 1958. This installation (Figures 1 and 2) allowed an operator to close a lane, reverse the flow of traffic, or change the normal 45 mph speed limit to 30 mph or 15 mph. A patterned plexiglas face is backlit by a grid of neon tubing, using neon gas to produce the red "X"* and mercury vapor with argon gas for the green arrow.

Although the Mackinac Bridge installation is reasonably successful, several problems occurred which were difficult to solve.

Engineers were not satisfied with the "punch," or readability, delivered by the signals on the bridge. It was impossible to obtain the proper light intensity to produce a message with enough "punch" during bright sunlight periods.

The second major problem was to develop an effective blankout process. With the sun shining directly upon the non-illuminated signal face, the reflected image

* See Appendix

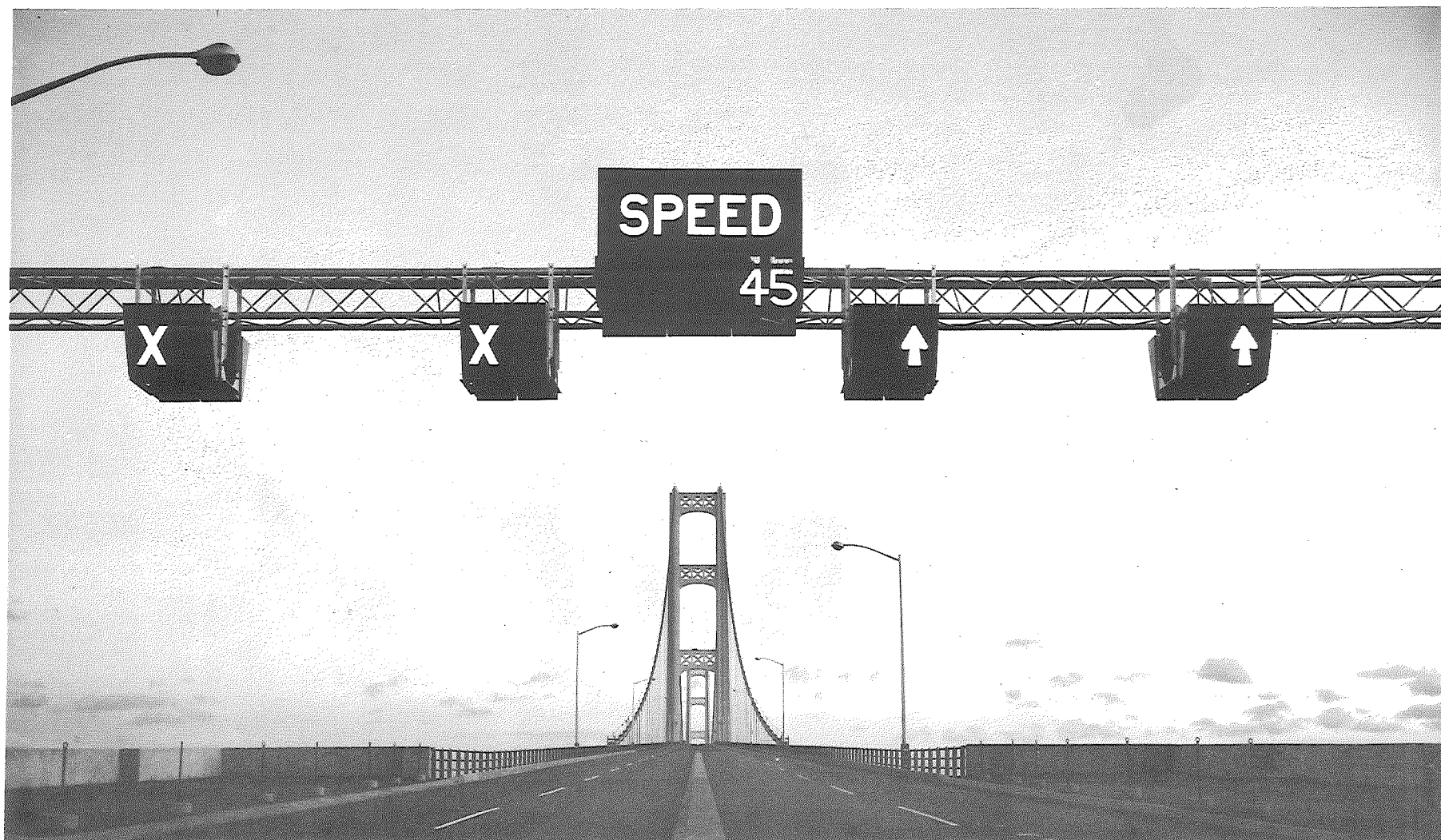


FIGURE #1

Illuminated Lane and Speed Control Signals on Mackinac Bridge. This group of signals provides an "X" and an arrow over each lane of traffic and the speeds--15, 30, and 45 m.p.h.



FIGURE #2

Night view of traffic control signals on Mackinac Bridge. The word "Speed" is back-illuminated by fluorescent lamps.

provided a dim, unwanted display of the message--called "sun phantom."

Various colored paints were applied to the back of the plastic faces, in an effort to reflect the same amount of light from the legend areas as from the message background areas, when the signal was not illuminated. This method was only partially effective.

Large visors corrected the sun problems except when the signals had to be installed in such a position that the setting sun could shine directly on the face.

Cold weather produced another problem. Since the green arrow message uses vaporized mercury, a temperature drop reduces the output considerably. The addition of a thermostat controlled 500-watt heater in the green arrow signal solved this problem, although it is a costly solution.

Surveillance Project Development

New designs of lane signals started in earnest in the fall of 1959 when an agreement was reached between the Bureau of Public Roads, the Michigan State Highway Department, the City of Detroit, and the Wayne County Road Commission on a combined research project involving the use of closed circuit television and control signals on the John C. Lodge Freeway in the City of Detroit. Engineers were convinced that the existing 12-inch lane signals available were inadequate for freeway conditions. They

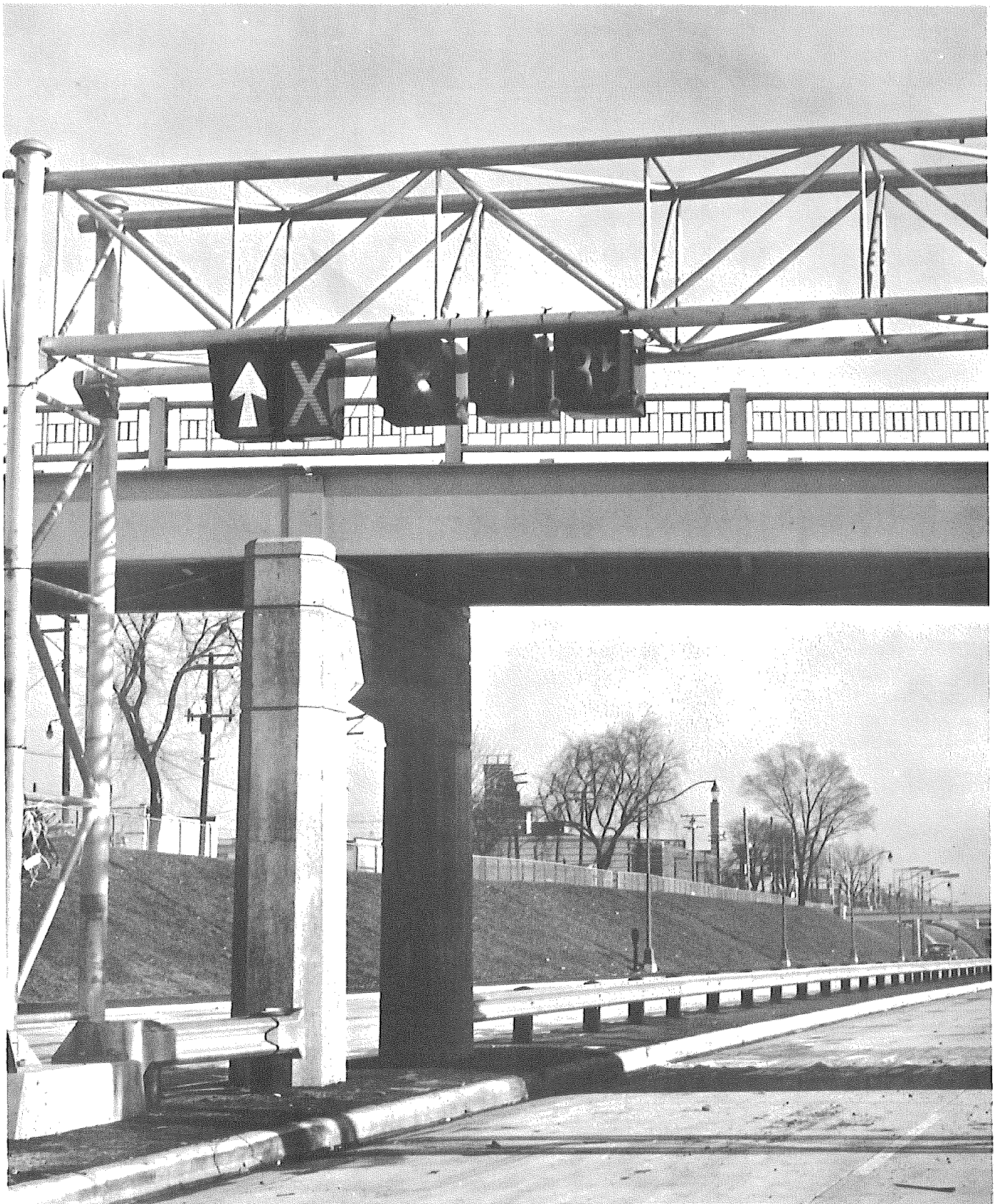


FIGURE #3

Signal test on unopened section of freeway.
Neon signals with 18" legend are to the left.
Incandescent signals with 16" legend on right.

realized that the type of signals installed on the Mackinac Bridge required improvement if they were to be used. Several signal companies, in conjunction with Highway Department engineers, developed and submitted new lane signals. The models varied from standard 12-inch square signals, already in production, to large 30-inch units, including single and multi-lamp sources. From this information, an 18" legend size was set as the minimum needed for freeway usage.

In December 1959, the first full-scale evaluation of lane signals was performed on a section of unopened urban freeway which had typical freeway lighting (Figure 3). This study tested the latest in neon and incandescent signals, which were installed directly over the freeway to give actual freeway conditions. The neon "X" and arrow performed fairly well and the incandescent "X" was very good. The green incandescent arrow still had the same problems encountered with all incandescent arrows. Any arrow design which would give a satisfactory daytime signal would be too hot at night or, if the signal was designed for a night-time signal, it had no punch during the day.

Considerable time was spent to vary the size and the stroke of the incandescent arrow and to determine whether different types of lamps might produce a better signal. Improvements were observed but still did not produce a green arrow which was good for both daytime and night-time operation. Improvement in legibility could be obtained if the

voltage was dropped for night-time operation, but the single lamp source created an unwanted hot spot. A lamp company succeeded in producing a 150-watt lamp with a coating on the front envelope which transmitted 50% of the light and reflected the rest. This lamp provided better uniform light distribution and eliminated part of the objectionable hot spot, producing an acceptable incandescent signal.

The development of ballasts and 24-inch 800-milliamp fluorescent lamps opened a whole new avenue of design for lane signals. Prototypes were constructed and installed in conjunction with the neon and incandescent signals on the Michigan State Highway Department test site.

In August of 1960, a second full-scale performance test was conducted at the Michigan State Highway test site, using fluorescent, neon, single lamp, and multi-lamp incandescent signals (Figure 4). Observers made a total of 30 observations during the daytime and 27 observations during the hours of darkness. The intention of this study was to choose one of the three types to be used on the TV Surveillance Project.

While there was a general preference for the fluorescent signal, all three types seemed to be within an acceptable level of visibility. Besides legibility, a signal to be installed on the freeway must have several other qualifications. The signal must be easily installed,



FIGURE #4

Lane Signal experiment at Michigan State Highway Department test site. From left to right, in pairs: (1) single source incandescent, (2) multi-source incandescent, (3) fluorescent source, (4) single source incandescent, (5) formed neon source.

require the lowest possible maintenance, and insure the utmost reliability. A simple change of lamps can be done only during off-peak periods of the day and a complete relamping has to be done on an early Sunday morning.

In view of the many factors involved in any one of the signals to be used, it was finally determined that all three types of signals would be used on the project for research purposes. Signals of only one type were used on any single structure but successive structures used different types of signals. This allowed a good comparison from the standpoint of obedience and also of maintenance (Figure 5).

After ten months operation, the following advantages and disadvantages can be listed for each type of signal:

Fluorescent Source Lane Signal (Figures 6 and 7)

Advantages:

1. Provides a very good wide angle legend,
2. Can be constructed in various sizes (no limit to size),
3. Provides a good signal for both day and night operation without lowering the voltage at night,
4. Uses two ballasts, each wired alternately to four lamps. Provides continuous operation even if one circuit fails.



FIGURE #5

Typical lane and speed signal installation on John Lodge Surveillance Project. Signals are capable of providing "X" and arrow over each lane and displaying the speeds 25, 40, and 55 m.p.h.

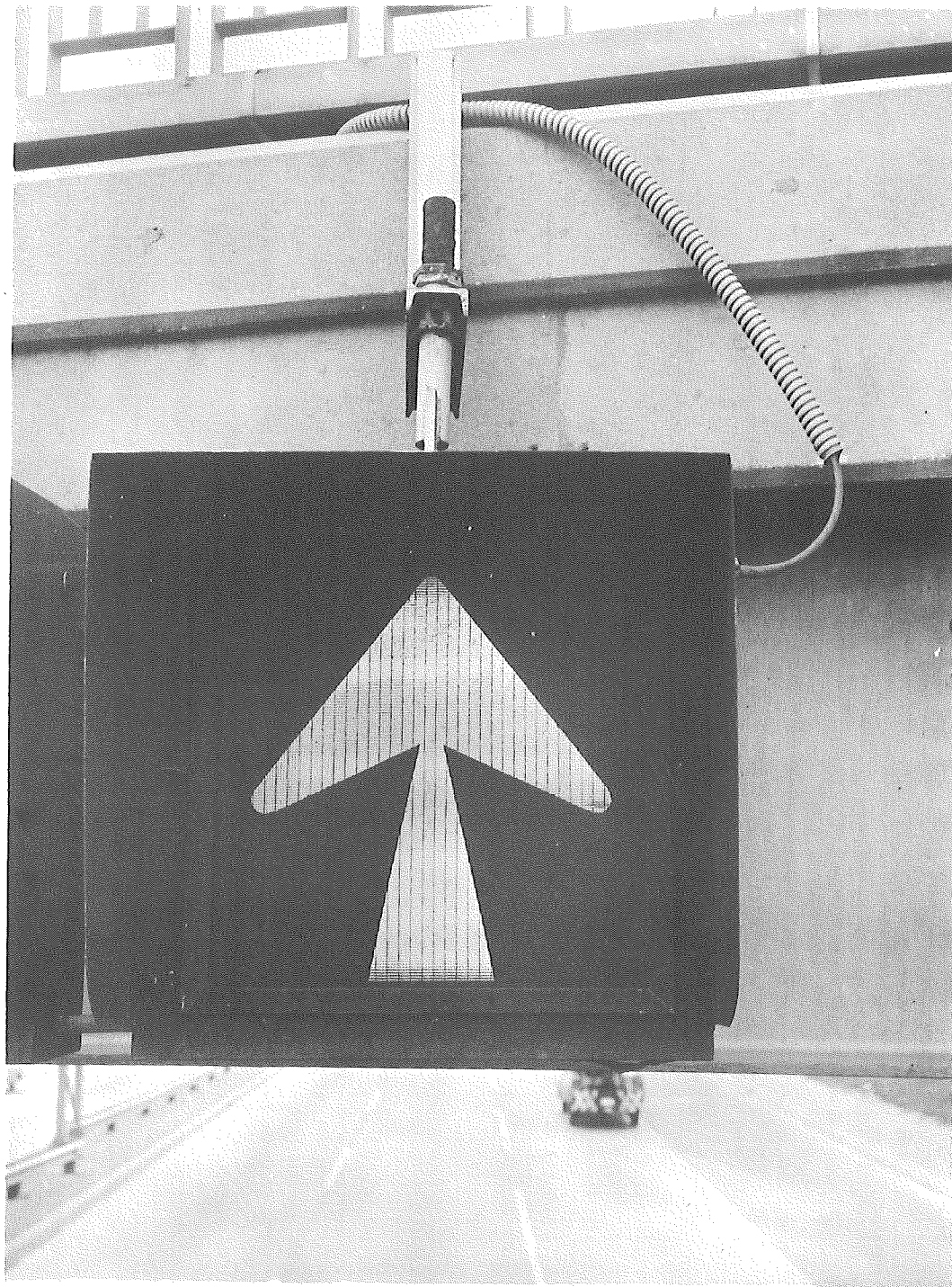


FIGURE #6

Internally illuminated fluorescent lane signal with arrow illuminated, mounted on overpass bridge.

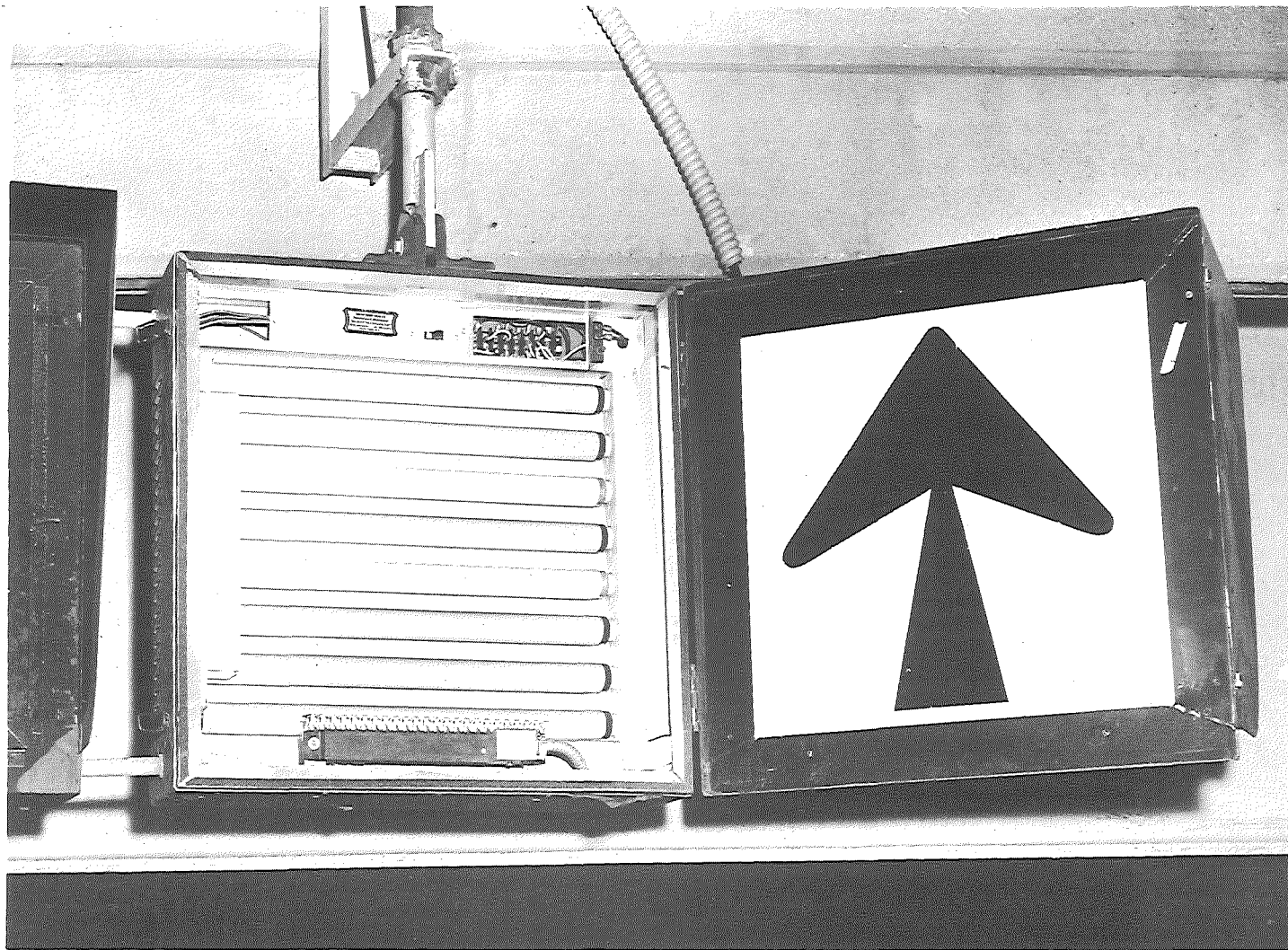


FIGURE # 7

View of Inside of Fluorescent Lane Signal.

Disadvantages:

1. Has the largest power requirements,
2. Eight fluorescent lamps require more time to change than incandescent lamps,
3. Requires thermostat-controlled, 500-watt heater in red "X" to insure proper punch in cold weather.

Neon Source Lane Signal (Figures 8 and 9)

Advantages:

1. Provides a good wide angle legend,
2. Can be constructed in most sizes or shapes,
3. Grid can be constructed to provide unlimited punch. Present signs use tubing formed only in legend area,
4. Provides a good signal for both day and night operation,
5. Can use two transformers and interlaced tubing to provide operation even if one circuit fails.

Disadvantages:

1. Has high power requirements,
2. Delicate tubing grid requires most change time and is highly susceptible to breakage,
3. Tubing must be made by local sign shops and consistent high quality is practically unavailable,

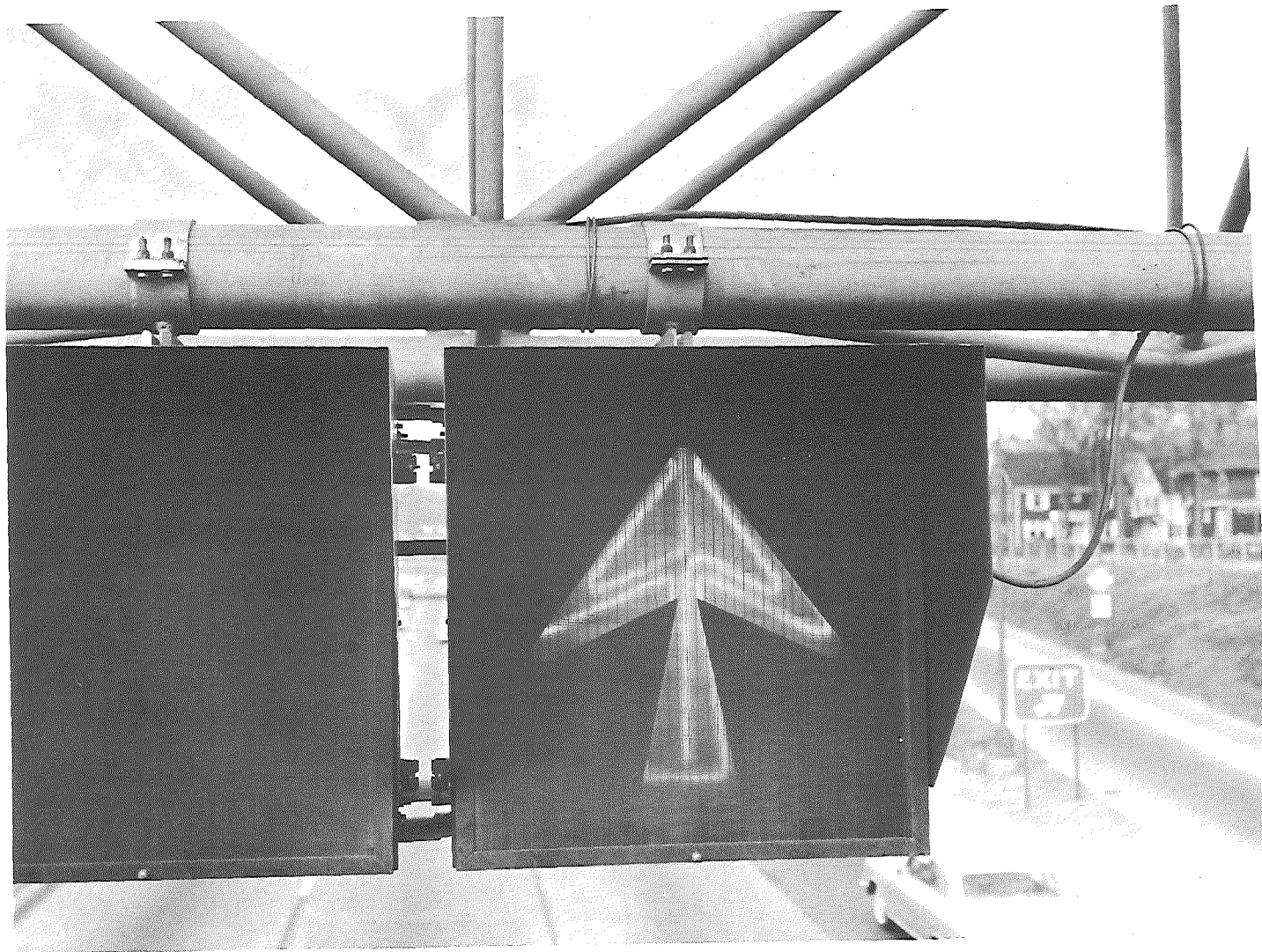


FIGURE #8

Neon lane signal with arrow illuminated on overhead sign truss.

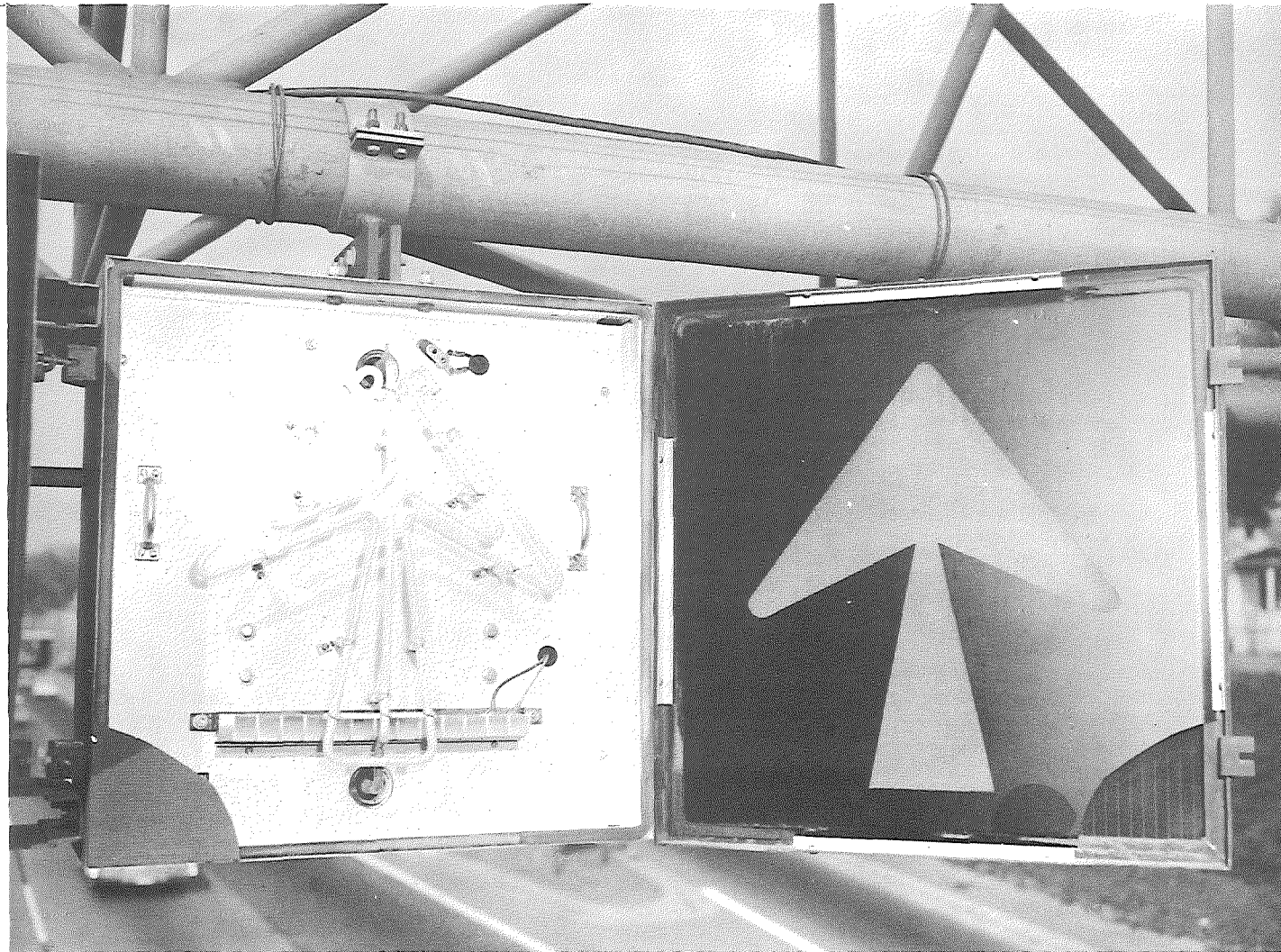


FIGURE #9

View of inside of neon signal, showing formed
arrow message.

4. Requires 500-watt heater in green arrow for cold weather operation.

Incandescent Source Lane Signal (Figures 10 and 11)

Advantages:

1. Lightest and simplest to install,
2. Does not require heat for proper operation,
3. Lamps can be simply and rapidly changed,
4. Uses lowest amount of power--single lamp sources.

Disadvantages:

1. Has only one light source and does not provide standby circuit in case of failure,
2. Does not provide a wide angle legend,
3. Has poorest light distribution over signal face,
4. Focusing of lamp is critical,
5. Sizes are presently limited to 18 inches (16-inch legend) because of lamp sources available,
6. Requires auxiliary voltage reducing equipment for night viewing,
7. Difficult to produce satisfactory day-night message with the same arrow design.

Variable Speed Control Signal

In the summer of 1961, engineers from General Motors Technical Center desired to perfect a multi-speed message

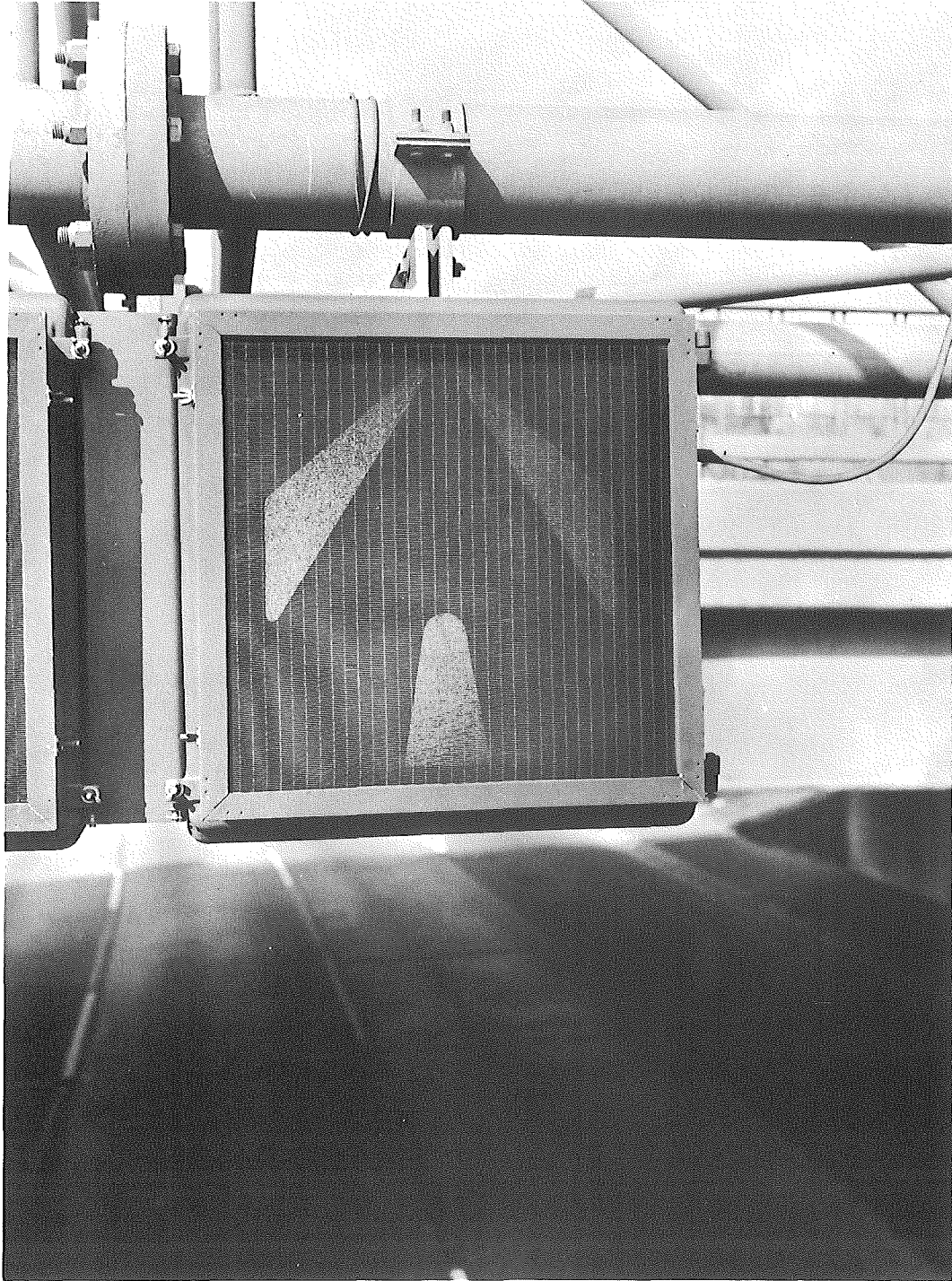


FIGURE #10

Internally illuminated single source incandescent signal, with arrow illuminated.

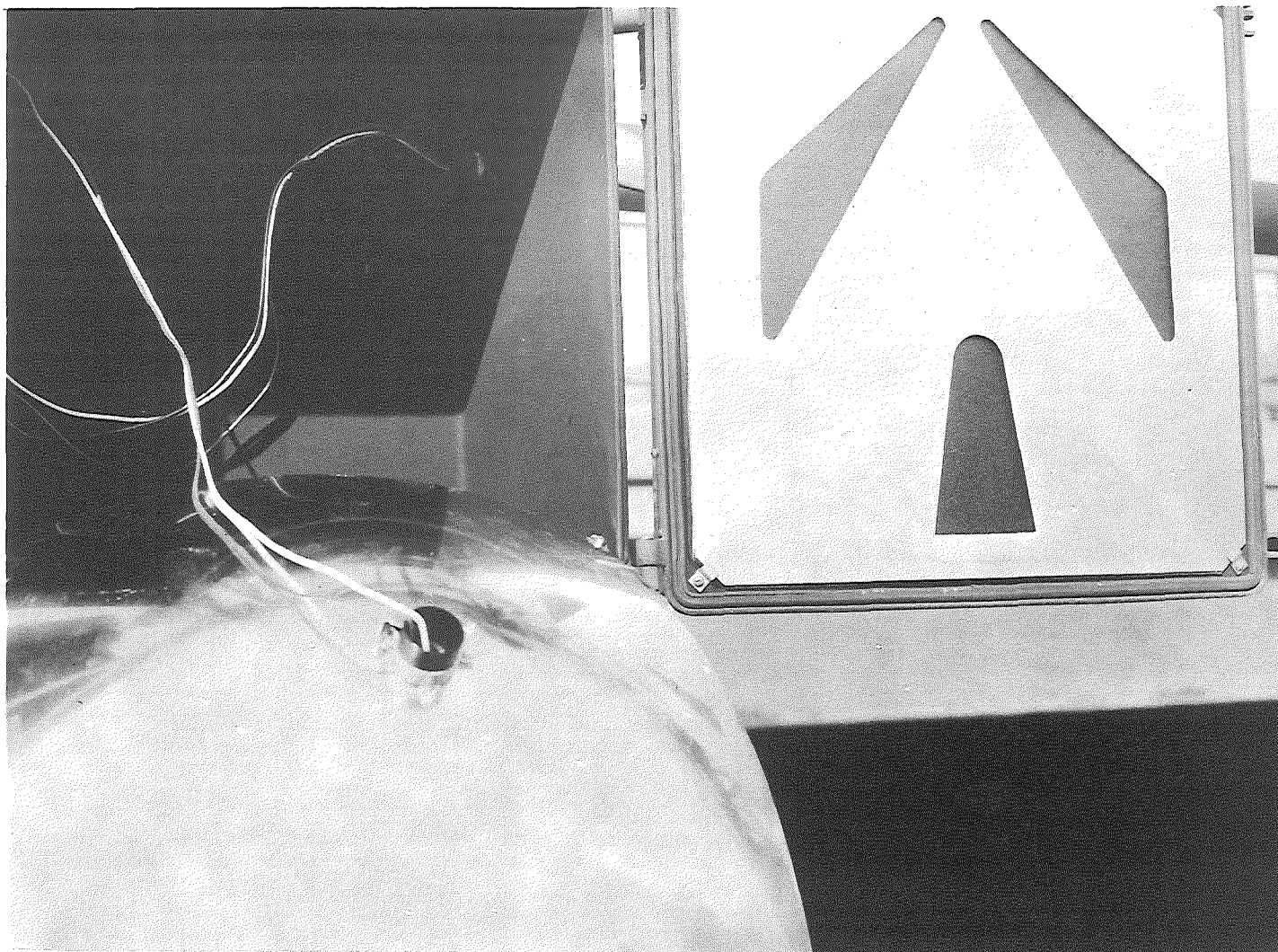


FIGURE #11

View of inside of incandescent signal, showing
exposed reflector.

signal capable of informing motorists the speed they could drive to reach a traffic signal in the green phase. This was known as the Traffic Pacer Research Study. Engineers from the John Lodge Traffic Surveillance Research Project worked with the General Motors engineers in the development of a speed matrix signal which was finally used on Mound Road where the Pacer Study was conducted.

This matrix design used a simplified lamp arrangement which displayed easily-read speed messages with a minimum of misinterpreted readouts in case of lamp burnouts.

(Figure 12)

The design of this signal solved the sun phantom problem by providing a louvered screen which prevented the sun rays from reaching the surface of the lamps and also absorbed the light rays which reached the surface of the screen. This type of screen was highly effective and was incorporated into all blackout signals, including the three-lane signals mentioned earlier.

The problem of changing a group of lamps was overcome by designing plug-in panels to allow the replacement of an entire matrix of lamps without tools.

Several tests were held to determine the proper size and type of incandescent lamps to be used and the size of the individual speed message numeral which could be obtained. Three matrix sizes were tested: a 14 by 9 inch matrix,

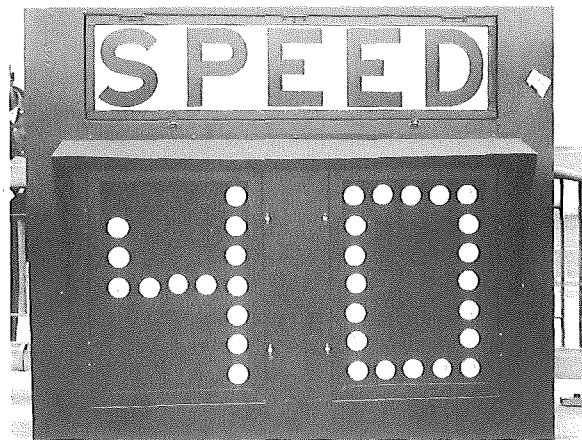
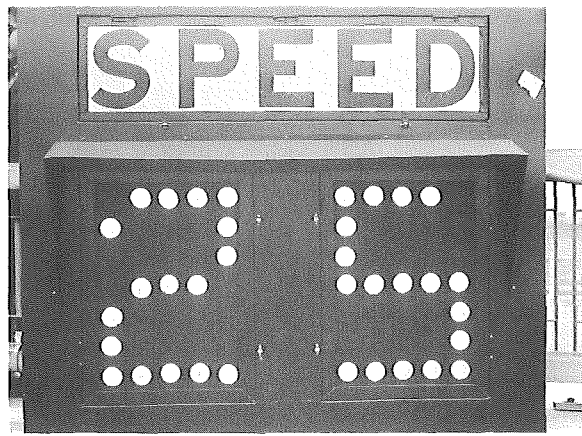


FIGURE #12

Variable speed signal, showing three of the possible speed messages capable of being displayed.

which is the size used in the General Motors Pacer System; a medium matrix of 15 by 21 inches; and a large matrix of 28 by 28 inches. The matrix size chosen is 15 inches wide by 21 inches high and the numerals are 12 inches apart with a 9-inch border.

All types and sizes of incandescent lamps were investigated and tested. It was proven that the smaller wattage lamps did not provide a satisfactory contrast in bright sunlight. The 30-watt reflector lamps were assumed to be the minimum size for freeway speed signs, and the 50-watt reflector lamps were selected, with the intention of operating at reduced voltages to increase lamp life. The 75-watt lamps delivered more punch but were not used because they required a much larger signal.

Once the 50-watt lamps were chosen, two problems remained. The lamps had to be colored and made weatherproof. One lamp company developed a new 5000-hour reflector lamp with a special plastic coating to protect the lamp from moisture. This lamp can be obtained in any color and can be used without any weather shield except the louvered screen. A yellow lamp is used which does not affect night viewing but gives an excellent contrast during the daytime and does not attract insects.

The illuminated panel over the speed matrix which signifies the word "speed" is internally illuminated with 425 Ma. fluorescent tubes. Some consideration was given

to the possible omission of this illuminated sign or the substitution of a reflective sign, but the sign is mounted over twenty feet above the roadway and does not receive enough light from headlights or street lighting to be an effective message.

After 10 months of operation, these signals have proven to be very effective. The speed sign produces a legible speed message, which, without a doubt, delivers the best message of all signals on the Project. Maintenance problems have been at a very minimum and in no case have lamp failures occurred because of moisture coming into contact with the lamp.

Multi-Lamp Lane Signal

With the successful development of the variable speed message, a multi-lamp "X" and arrow lane signal was the next step. (Figures 13 and 14)

The design was patterned after the speed sign, using multi-lamp messages on a quick-change panel, and providing the blackout effect by using KoolShade screen. The signal case is of extruded aluminum and welded construction. Two messages are combined in a single, compact unit.

Here again, the same lamp company developed red and green weatherproof colors and coatings for the 50-watt reflector lamps. Even with the improvement in readability

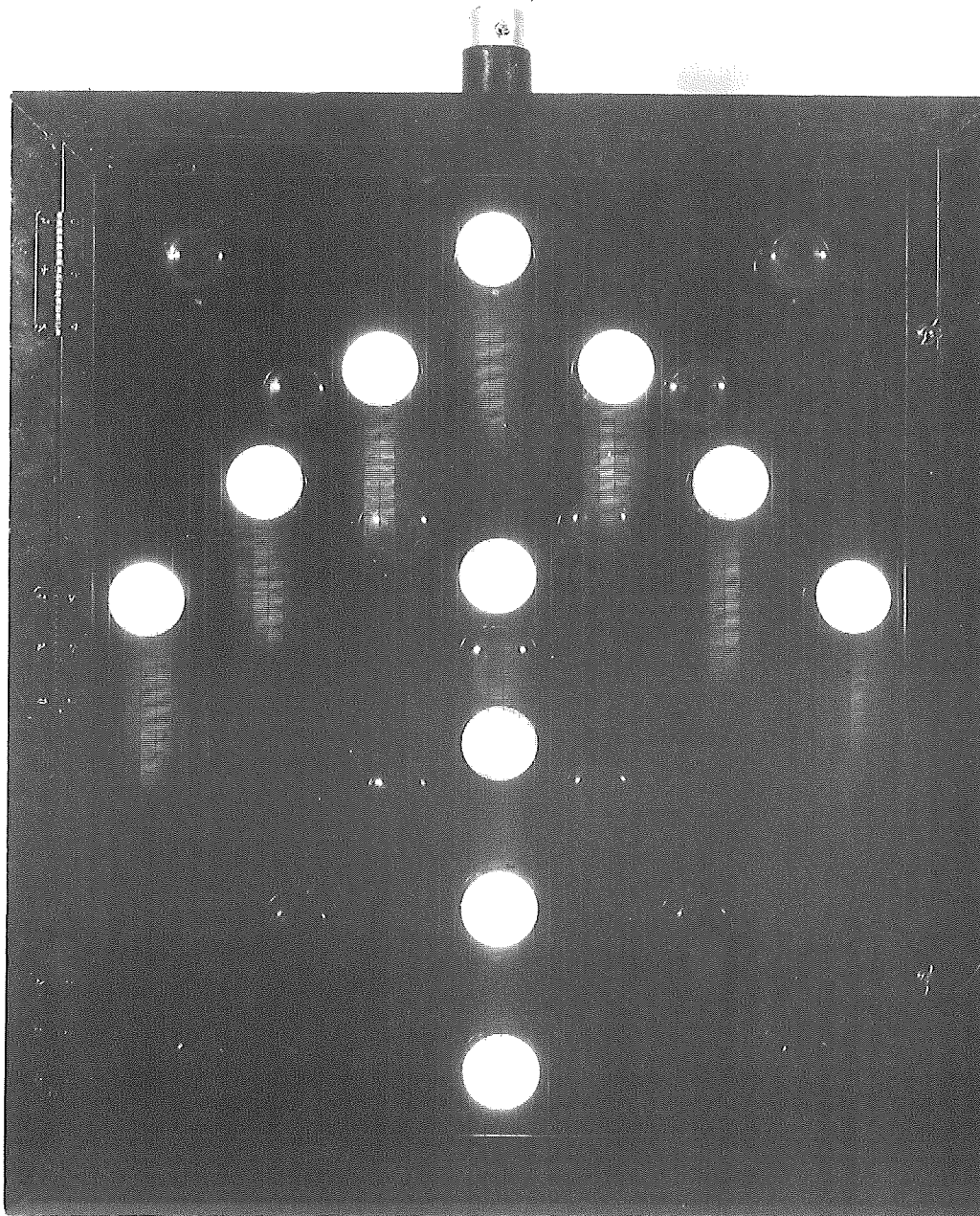


FIGURE #13

New multi-lamp lane signal, displaying the arrow message, using eleven green incandescent lamps.

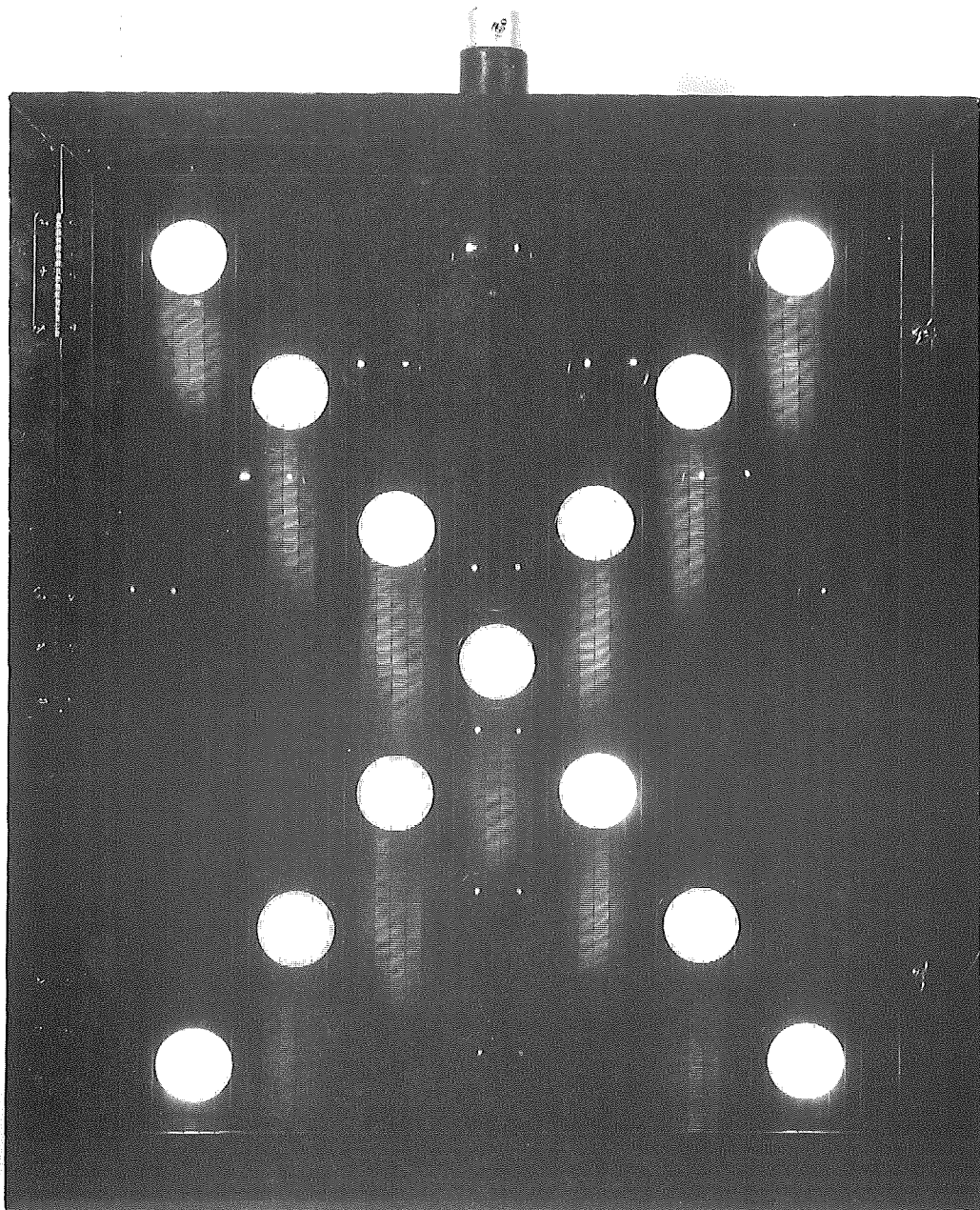


FIGURE #14

Same multi-lamp lane signal as Figure #13, displaying the "X" message, using thirteen red incandescent lamps.

of the signal, designers are trying 60 and 75 watt lamps to deliver greater punch for daytime messages.

From preliminary tests of the multi-lamp lane signal "X" and arrow, the following advantages and disadvantages have been noted:

Advantages:

1. Provides readable wide-angle legend,
2. No limits to size,
3. Requires only one signal to produce both the "X" and arrow message,
4. Produces legible message even with several lamps burned out,
5. Plug-in panel makes relamping quick and simple,
6. Requires no heater in cold weather,
7. Has no plastic face to clean,
8. Light weight.

Disadvantages:

1. Medium power requirements,
2. Single lamp burnout and confirmation difficult to accomplish,
3. Requires dimming of lamps at night.

This type of signal will soon be put in operation on the John C. Lodge Freeway Traffic Surveillance Project and, in the future, may be substituted for all other types of

lane signals now in use when replacement is required. Following a period of field experience, an evaluation of this signal will be performed.

Ramp Control Signals

Blankout ramp control signals have been developed and are in operation on the Project (Figure 15). The blankout portion contains the legend "Dont Enter" and has the message "Ramp" in reflective legend attached to the blankout signal case. This signal makes use of all of the features learned to date. The ramp signals have extruded cases, welded construction, and extruded door frames for ease of fabrication and maintenance. An extrusion is designed to allow the easy placement of the louvered screen assembly and also to hold the plexiglas in the door. A new type of lamp socket is being used which snaps into position and can be moved or put into position with no tools required. The signal is designed to allow a single case to be hung by itself or to allow the placement of two units back to back for two-way signals. The unit uses eight 800-milliamp 36-inch fluoresecent lamps with two ballasts each wired into an alternate arrangement of lamps so that, in case of lamp failure or ballast failure, at least half of the lamps will still operate.

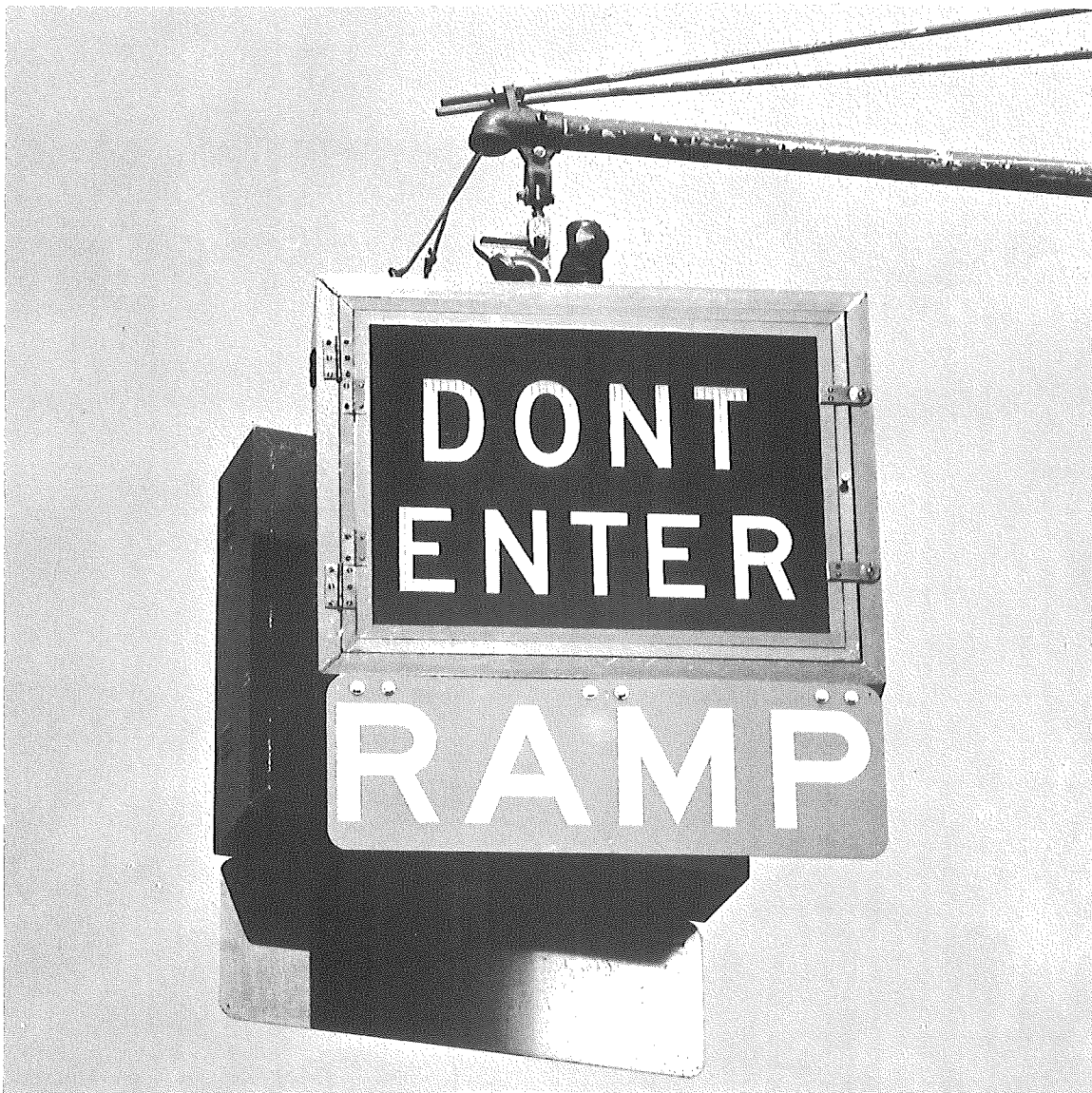


FIGURE #15

Ramp signals to control traffic entering freeway.
"Dont Enter" is a blankout legend.

Maintenance of Freeway Control Signals

Probably the greatest unsolved problem remaining lies in the access to these control devices for maintenance. Traffic on the John C. Lodge is too heavy to permit closing of any lane during rush hours for routine maintenance. Even a prolonged closure between the hours of 10:00 a.m. and 2:30 p.m. will cause traffic backups. Night-time maintenance has proven too hazardous because of visibility and even the relative light volumes during Sunday a.m. have produced accidents. Specially designed boom trucks, which will reach over the roadway from the shoulder, may be possible but they would be costly and extremely heavy. Observation also has shown that any unusual activity reduces capacity and causes accidents due to rubbernecking.

A more favorable solution may lie in the design of the signal truss. If the box truss were clear of structural members on the inside, maintenance men could enter the truss from the end, walk on a mesh floor, and service the signals from the back. The signals would conceal the maintenance personnel from the view of passing motorists, thus eliminating any source of distraction to the motoring public.

Closing Remarks

Certainly the prime consideration of any device to be used over urban freeway traffic will be its ease of installation and maintenance. Signals must be of the highest possible reliability and any maintenance to be performed must be possible with a minimum of effort or time. Dual circuitry should be mandatory to insure operation until maintenance personnel can service the unit. Confirmation control systems should be specified to insure reliability. Routine maintenance should be performed without the necessity of handling small parts or tools and quick-disconnect assemblies should allow rapid replacement for major rework.

The use of internally-illuminated blankout signals for freeway operation is just beginning. Advanced developments in this field will produce many types of blankout signals for traffic control.

APPENDIX

In conjunction with the Mackinac Bridge lane signal installation, a study of the effectiveness of symbols for lane control signals was made by Dr. T. W. Forbes and Dr. T. Allen of Michigan State University and Mr. E. F. Gervais of the Michigan State Highway Department, with participation of the Bureau of Public Roads. This study showed a consistent advantage of the red "X" over other indications such as a slash arrow, a red arrow, a standard red bulls-eye, etc. The "X" produced the desired reaction of "Do Not Drive in This Lane" and showed the least tendency to create the undesired "Stop" reaction. This report was presented to the Highway Research Board in January 1959 and copies are available upon request to the Michigan State Highway Department.
