NBSIR 73-253 (R)

Description and Performance Characteristics of Engineering Models of Visual Alerting Devices

J. Richard Lepkowski

Technical Analysis Division
Institute for Applied Technology

and

William F. Mullis

Heat Division
Institute for Basic Standards
National Bureau of Standards

September 1973

Phase II Report
(FRA AR 20033)

Prepared for
Federal Railroad Administration
U.S. Department of Transportation
Washington, D. C. 20590

NBSIR 73-253

DESCRIPTION AND PERFORMANCE CHARACTERISTICS OF ENGINEERING MODELS OF VISUAL ALERTING DEVICES

J. Richard Lepkowski

Technical Analysis Division
Institute for Applied Technology

and

William F. Mullis

Heat Division
Institute for Basic Standards
National Bureau of Standards

September 1973

Phase II Report
(FRA-AR 20033)

Prepared for
Federal Railroad Administration
U.S. Department of Transportation
Washington, D. C. 20590

U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

This report describes the construction and performance characteristics of a Visual Alerting System (VAS) designed for railroad locomotives, particularly of the diesel-electric type. The VAS consists of four different types of electrically powered signals. One is mounted on the cab roof and emits alternating rays of white and red lights covering 360° of azimuth. There are 115 white and 115 red rays in all. The light does not rotate, but as an observer passes from ray to ray it will appear to be a flashing red and white light. The other units consist of roof-mounted dual-colored (red-white) flashtubes (for use when approaching a highway-railroad grade crossing), lighted side panels with integral flash-tubes, and rear panel light.

Intensity distributions for the steady burning signals and effective intensity distributions for the flashtubes are presented in both narrative and graphical form. The goniometer plots of the intensities of these roof-mounted units permitted the determination, to a specified intensity level, of the vertical beam spreads of the flashtube units and the bi-colored radial beacon (all of which give 360° azimuthal coverage), as well as the horizontal intensity distribution of the side and rear panel lights.

The electrical characteristics of all the signals are discussed in detail including power requirements and flash rates of the flashtubes. Photographs of all the lights are included as well as one for the Lighting Control Panel. A description and use of the latter unit is also given.

Engineering models of each type were subjected to high temperature (130°F), low temperature (-30°F) and vibration testing.

One appendix shows the detailed production drawings for the Visual Alerting System (except for the flashtube units, which are off-the-shelf items). Another appendix presents the instructions for installing the VAS on a GP 40 locomotive.

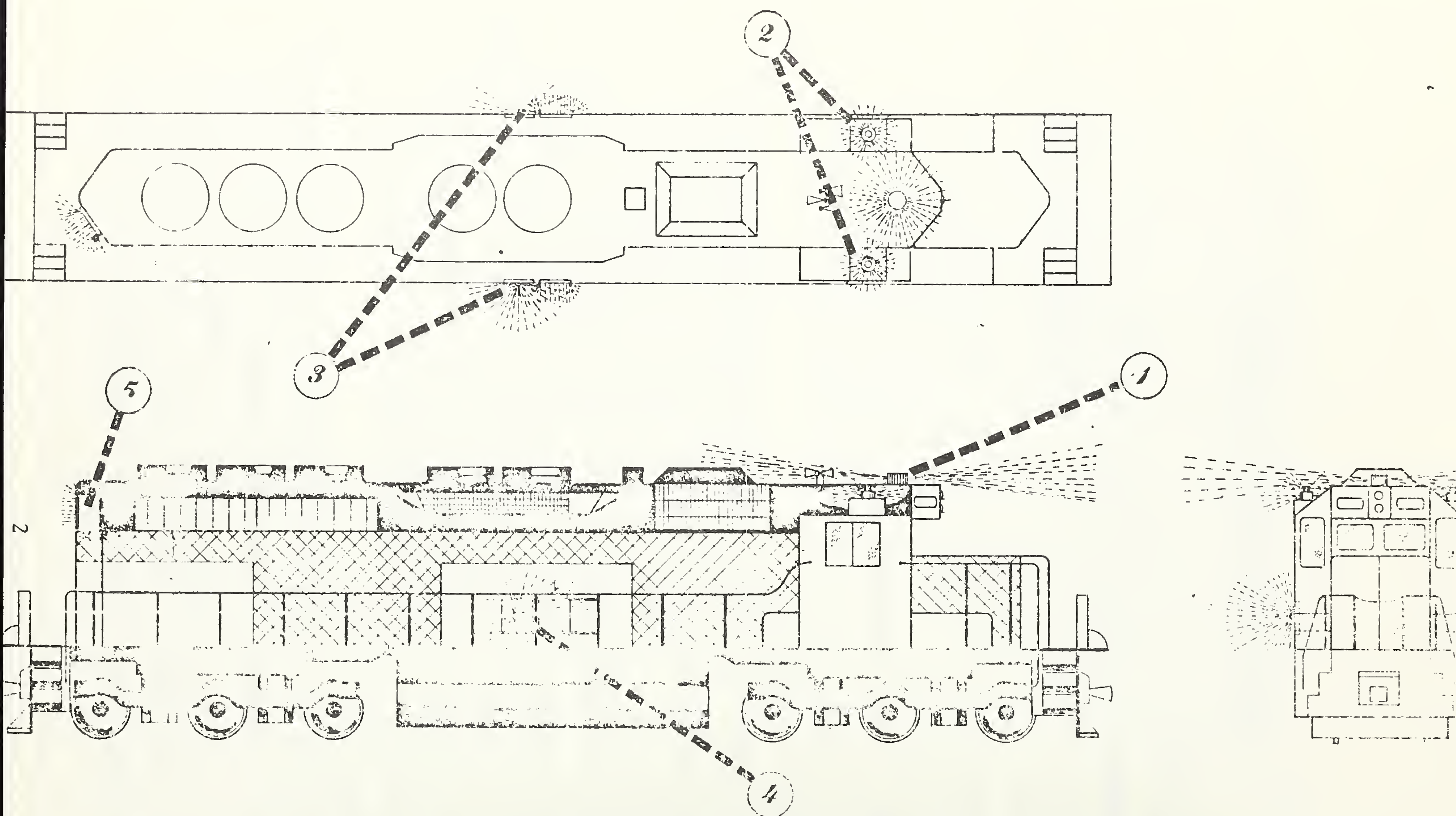
DESCRIPTION AND PERFORMANCE CHARACTERISTICS OF ENGINEERING MODELS OF VISUAL ALERTING DEVICES (PHASE II)

1.0 Introduction

This document is a supplemental report on the Phase II effort of a series of phases with the ultimate goal of improving the conspicuity of railroad trains. The first phase was concerned with the study of laboratory models of visual alerting devices designed primarily for mounting on locomotives. The results of Phase I are reported in "Development of Visual Alerting Devices for Railroad Locomotives" (July 1972) prepared for the Federal Railroad Administration by the National Bureau of Standards.

Phase II entailed the detailed design and construction of engineering models comprising the Visual Alerting System (VAS). Six complete sets of this system were constructed. One system has been installed on a locomotive for evaluation at the U.S. Naval Ammunition Depot, Crane, Ind. This particular evaluation is being done by personnel from Crane Laboratory's Behavioral Sciences Division under contract to the Transportation Systems Center (DOT), Cambridge, Mass. One or more sets are planned to be mounted on power equipment of at least one cooperating railroad company in the Washington, D.C. vicinity.

A third phase will include the evaluation of VAS in terms of train crew acceptance and engineering factors such as compatability with the railroad environment, maintainability, and location of each device on the locomotive for maximum effectiveness. It will be decided at a later time whether to conduct additional tests. If the results of the Phase III study indicate



Legend

1. Bi-color Radial Beacon
2. Flashtube
3. Side Panel Light
4. Side Panel Light, one panel with Flashtube
5. Rear Panel Light

FIGURE 1 - Locomotive roof, side and rear lights.

that one or more of the devices merit a more wide-spread evaluation, then the performance specifications will be defined for production models in larger numbers.

Phase IV will cover a large-scale longitudinal operational demonstration involving up to 200 locomotives. But before details of such a demonstration can be specified, a thorough study and analysis needs to be accomplished. The study should define a specific geographical area and identify within that area such items as the number and kinds of grade-crossings, accident history and detailed railroad operations.

A fifth phase which ran in parallel with Phase II deals with visual alerting devices for enhancing the conspicuity of railroad rolling stock. The Phase V report is Supplement 2 to the first report.

2.0 Devices Comprising the Visual Alerting System (VAS)

The VAS consists of several devices: a Bi-color Radial Beacon (BRB); two combination red and white roof flashtubes; two pairs of lighted side panels; and a lighted rear panel. The general locations for the devices on a GP40 locomotive are shown in Figure 1. The following paragraphs in this section give a general physical description of the devices as well as performance characteristics and an account of the limited environmental testing done.

Copies of the detailed drawings for the VAS can be found in Appendix A.

2.1 Bi-color Radial Beacon (BRB)

2.1.1 Physical Description

The BRB is a beacon-type light that was designed for mounting on the locomotive cab roof. In this position it cannot be seen directly by anyone in the cab. This device consists of a powerful incandescent lamp having a small diameter filament (about 1/8") in a straight,vertical alignment. A cylindrical, glass Freznel lens, 7 1/2" in diameter and about 7 1/2" high, surrounds the lamp. The lens collects and concentrates the luminous flux into a relatively narrow, horizontal beam. Surrounding the lens is a transparent red acrylic cylinder 11 1/2" in diameter. The red cylinder has vertical slots cut through the plastic to permit alternate red and white beams of luminous flux to emanate in a series of rays in a complete horizontal circle. In all, there are 115 red and 115 white rays. A clear acrylic cylinder, 12" in diameter, encircles the red cylinder. The purpose of the clear cylinder is primarily to keep out dust, rain, snow and the like. Figure 2 shows an assembled and unassembled BRB.

A small electric powered fan in the base of the unit supplies air for cooling. Holes in the base plate and the top plate (under the cover) permit the free flow of air for heat removal.

It was originally planned to position the BRB in the approximate geometric center of the cab roof. In this position the top of the BRB would extend

Figure 2. Two Bi-color Radial Beacons. One assembled (upper left) and the other unassembled to show components.

about 9 1/2" up from the roof[1/]. It would also permit the use of protected air from the cab for cooling the BRB and make periodic re-lamping of the unit from inside the cab and estimated 3 to 4 minute operation. However, this position would have entailed cutting about a 4" diameter hole through the roof and inside insulation. Officials of the railroad cooperating in the study had second thoughts about cutting a hole in that location and requested that an alternative position be found. Another site was selected -- between the air horns on top of the 'number box cavity'. In order to clear the horns a mount for raising the BRB was designed. The mount is welded over a hole in the cavity roof, cut to permit running wires through to the lamp and cooling air to get to the fan which is located in the mount. (Appendix B contains a copy of the mount drawings). The air for cooling is protected air from the cavity but relamping must be done from the outside and will take an estimated 12-15 minutes. For study purposes this relamping should pose no particular difficulties but for wide-spread operational use a faster method should be devised.

Use of the mount raises the BRB another 7 or 8 inches (depending on the particular installation). This height exceeds 'Plate C' limits by

---

[1/] The top of this light would then be about 2 1/2" below the specified limit of 15' 6" called for in "Equipment Diagram Standard (Plate C) for Limited Interchange Service."

about 5 or 6 inches, but is still well below the overhead restrictions found on the right-of-way of the cooperating railroad.

The BRB and cooling fan are controlled simultaneously from one switch on the Lighting Control Panel located in the locomotive cab.

2.1.2 Performance Characteristics of the BRB

2.1.2.1 Electrical Parameters

The BRB is equipped with a 500 watt (nominal), 20 ampere, medium bi-post, incandescent lamp, designated as 20/T-24/3 and a 4-inch "muffin" type cooling fan, designated as part number M845HS. The lamp is manufactured by the General Electric Company* and the fan is manufactured by Rotron Engineering, Inc.* These devices require auxiliary components to adapt them to the 74 VDC system of the locomotive. A large "ballast" or voltage dropping resistor is used in the lamp and fan circuits for this purpose. A small DC to AC inverter is also used in the fan circuit. The circuit is shown in Drawing 1, Appendix B. Both the lamp and cooling fans are activated by a relay which in turn is operated by a single switch in the Lighting Control Panel. Consequently, the total electrical load for the BRB circuit consists of the power dissipated in the lamp, ballast resistor, fan and inverter, and the control relay. A breakdown of the approximate operating voltage and power dissipated in each device is as follows:

* Identification of equipment by trade name is in the interest of precision in reporting procedures and does not constitute indorsement by NBS or the Department of Transportation.

Component	Volts or IR Drop		Power (Watts)
Lamp	23		446
Ballast Resistor	51	.	970
Fan & Inverter	74		15
		Total Power	1,431

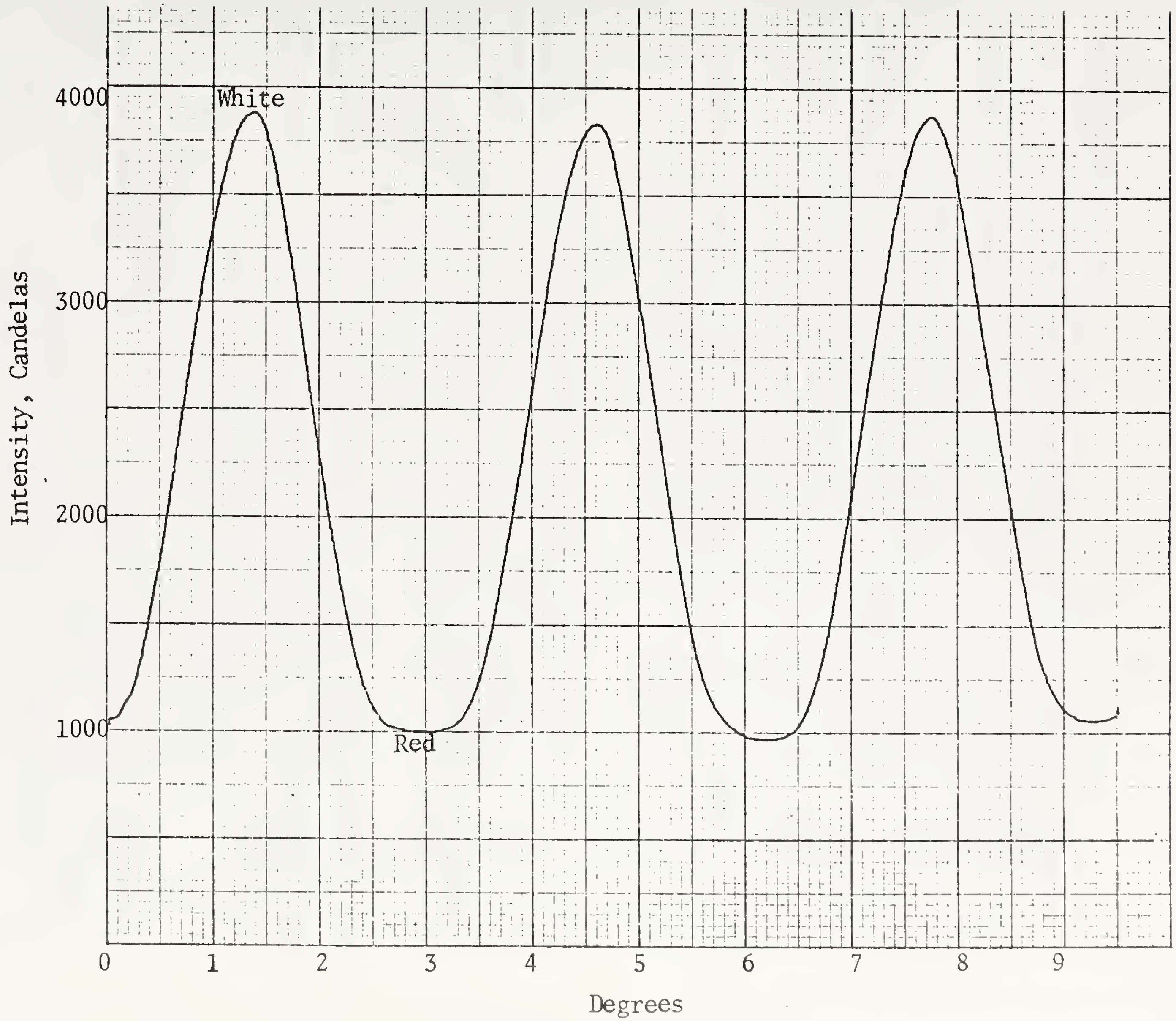
As will be noted the lamp is operated at 446 watts or well below its nominal rating of 500 watts. At the reduced power level, life of the lamp is computed to be approximately 400 hours.

2.1.2.2 Intensity Distributions

Horizontal and vertical intensity distributions for the BRB is given in Figures 3 and 4, respectively. The horizontal distribution shows the intensities of the alternating projected beams of red and white lights. This curve spans about 9 1/2° although the same pattern is presented throughout 360° of azimuth. An analysis of the curves indicates that the spread of the white beam is about 1.5° at the 50% intensity point and the spread of the red beam is 1.66° at this same intensity level. Visually, the two beams appear to be the same width due to intensity of the white light overcoming the chromaticity of the red at the interface between the filters. Peak intensities for the white and red beams are about 3,800 and 1000 candelas, respectively, when the lamp is operating at rated voltage (25V). With the lamp operating at 23 volts (as planned, to extend the life of the lamp) the peak intensities for the two beams are about 3,000 and 750 candelas, respectively.

Figure 4 gives the intensity distribution in the vertical plane of the BRB with the lamp operating at the indicated voltages. Curves are presented for both the red and white beams. Due to the Freznel lens the beam spread

Figure 3. Intensity Distribution in the Horizontal Plane for the Bi-color Radial Beacon. (Lamp operating at 25 vdc). Note: Only 9 degrees of rotation are shown. A similar pattern would be obtained through 360°.



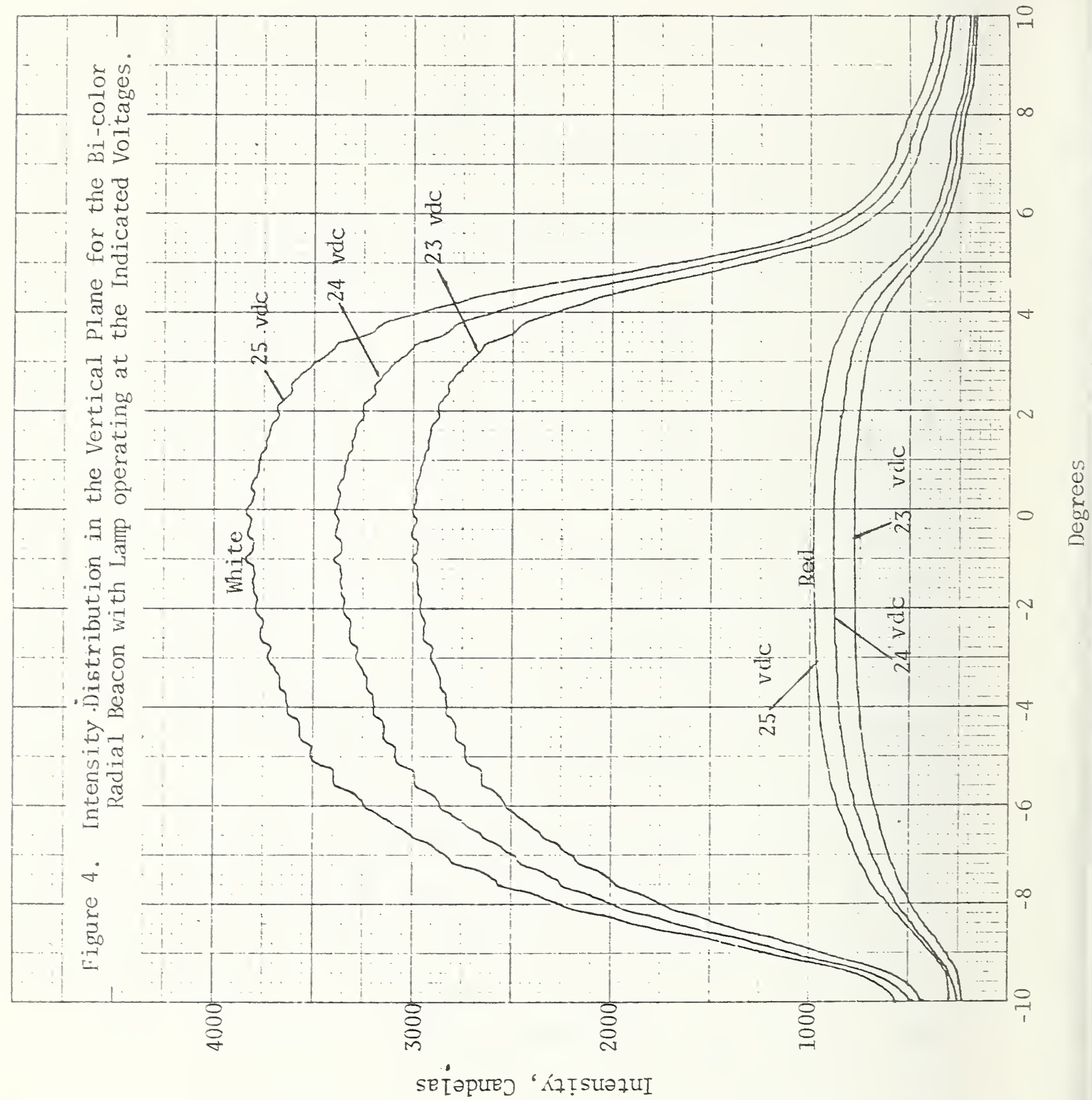


Figure 4. Intensity Distribution in the Vertical Plane for the Bi-color Radial Beacon with Lamp operating at the Indicated Voltages.

is on the order of 13^{o} at the 50% intensity point and more than 20^{o} at the 10% intensity level.

2.1.3 Environmental Testing

The Bi-Color Radial Beacon was tested in a High Temperature Chamber. Ambient temperature measurements in the chamber were made with a mercury thermometer; temperature measurements inside the BRB next to the red plastic filter were made with a thermocouple detector. Figure 5 shows the rise in ambient temperature and rise in temperature in the BRB over a 47 minute period. As was expected, with the BRB turned on, the internal temperature led the rise over the chamber ambient. The point of most significance is that the internal temperature was raised to $154^{o}F$ without any apparent detrimental effects.

The chamber ambient was maintained at $131\text{-}133^{o}F$ for one hour. During this period the internal temperature of the BRB remained between $145\text{-}147^{o}F$. It is not expected that temperatures as high as these will be encountered during the Pilot Study (Phase III).

To check on the performance of the cooling fan at reduced ambient temperatures, the BRB was tested in a Low Temperature Chamber. The ambient temperature was stabilized at $-38^{o}F$ for approximately one hour. Fan functioning appeared to be normal during this period.

Vibration tests were conducted on the basis of vibration parameters obtained from the Vibration Engineer of the manufacturer of GP40 (EMD-GM, La Grange, Ill.)*. It was reported that vibration amplitudes obtained with

---

* See footnote on page 7.

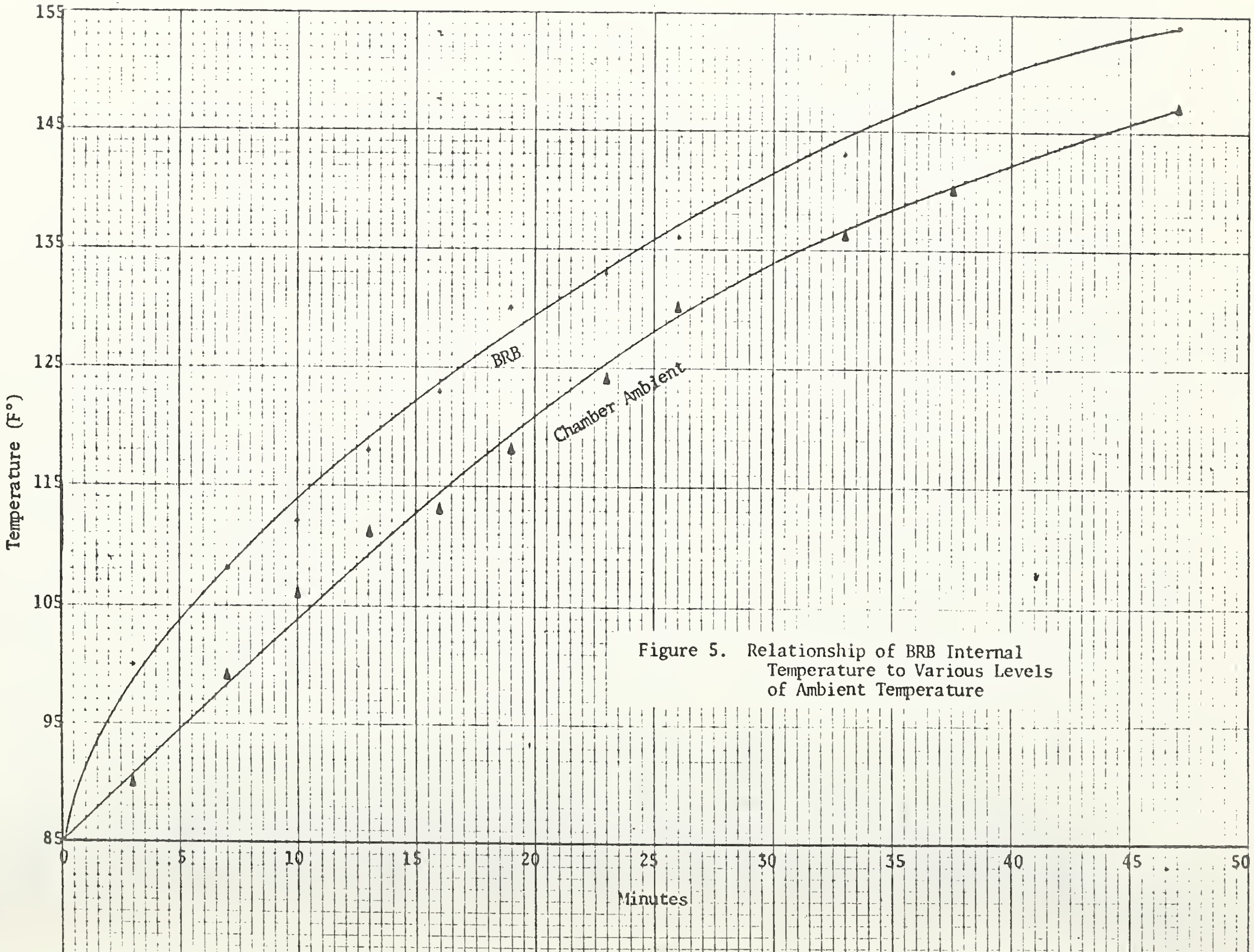


Figure 5. Relationship of BRB Internal Temperature to Various Levels of Ambient Temperature

diesels running and the locomotive standing still are not exceeded when the train is moving. With the engine throttle speed set at 900 rpm (full speed) the dominant frequency is measured at 15 cps and the second dominant frequency at 60 cps. The displacements that occur are between .005-.010". Forces on the order of .2 g's are usually found.

The BRB was lashed to the Vibration Table in three different positions in order to test the device in the lateral, horizontal and vertical planes. The first and second dominant frequencies were used (15 cps and 60 cps) as well as an additional harmonic (75 cps). With the BRB turned on, each of the three positions and at each of the three frequencies were tested for 20 minutes each. In each condition the appropriate displacement was used to produce a .2g force. No adverse affects to the BRB were noted during or after this test.

2.2 Roof Flashtubes

2.2.1 Physical Description

The roof flashtubes are located on the hip portions of the cab roof--one unit on each side (see Figure 1). They are about 7-2/3" high and 4" in diameter. The units are positioned so as not be seen directly by anyone in the cab. Each unit contains two flashtubes, one atop the other. The lower flashtube is surrounded by a clear filter and the upper one by a red filter. The former (white) is for daytime use and the latter (red) is for nighttime use. The selection of either color to be used as well as the OFF condition is made through one switch on the Lighting Control Panel in the cab. The actual activation of the selected pair of colors occurs through a micro-switch which works in conjunction with the Bell Switch. The Bell Switch is activated primarily on approaches to grade-crossings. Figure 6 shows 2 roof flashtube units and their mounts.

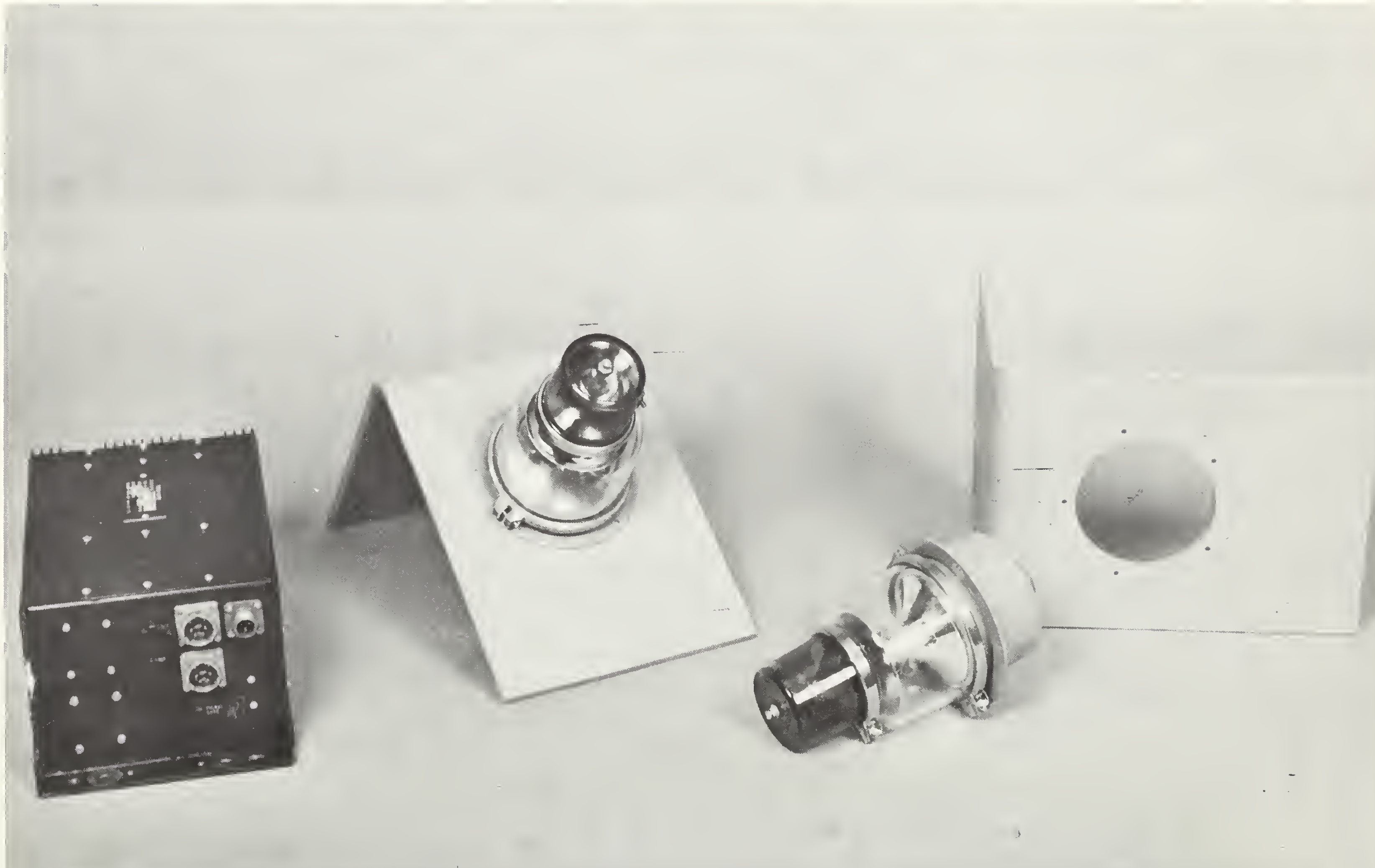


Figure 6. Two Roof Flashtubes (Dual Color) and their Mounts. The Power Supply for operating these units is shown on the left.

2.2.2 Performance Characteristics of the Roof Flashtubes

2.2.2.1 Electrical Parameters

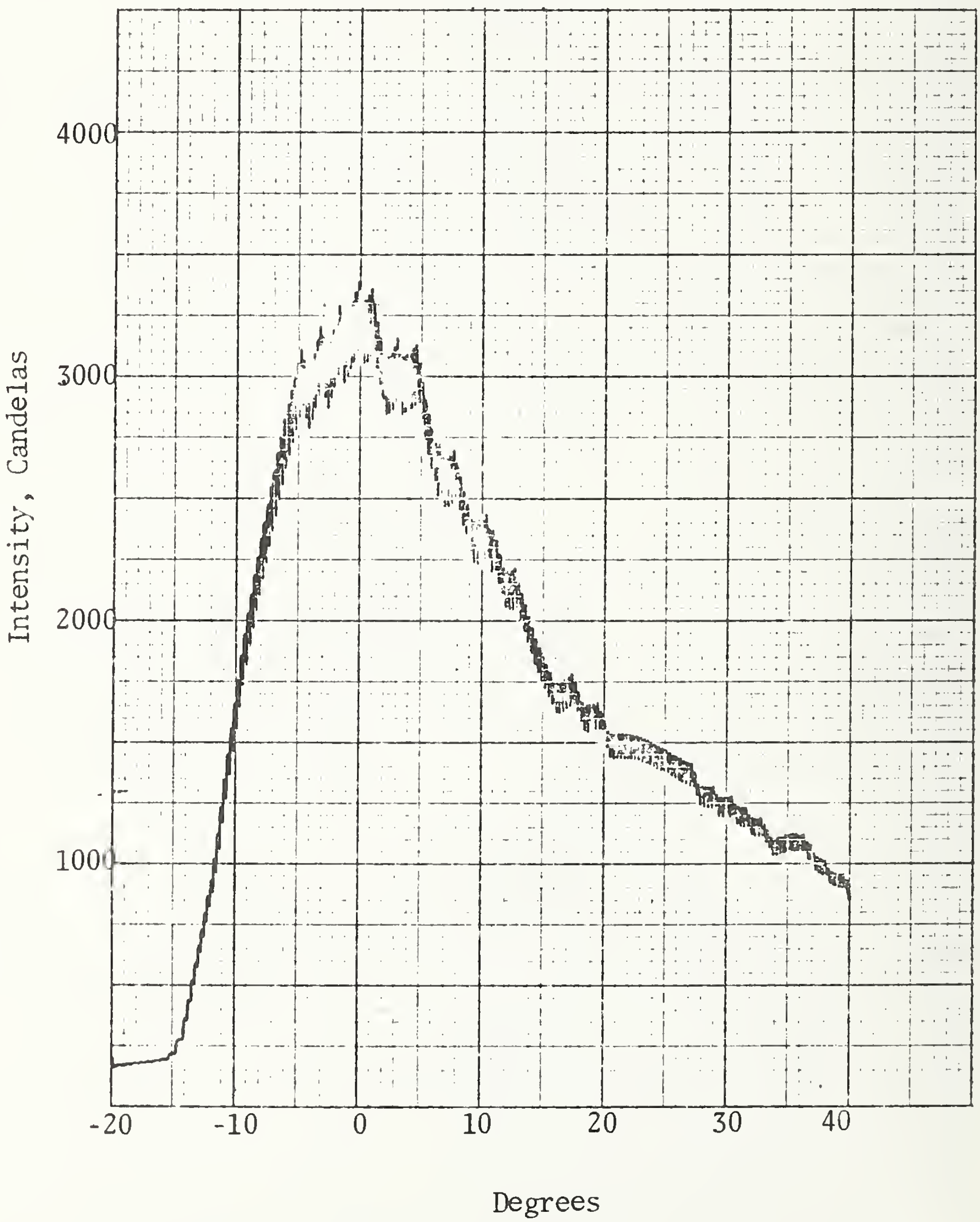
The two roof flashtubes assemblies are powered through an auxilliary inverter type power supply operating from the 74 VDC electrical bus of the locomotive. The system is manufactured by the Grimes Mfg. Company, * Urbana, Ohio, and bears their part numbers 85-0250-1 and 85-0245-1 for the flashtube assembly and power supply, respectively. The circuit provides one flashing sequence for the white or "daylight" flashtubes and a different sequence for the red or "nighttime" flashtubes. Both sequences give an effective flash rate of 60 flashes per minute (FPM) when both lights are in view. The sequences differ in that the two red units flash simulta-eously, whereas, the two white units alternate at 30 FPM each. To increase the intensity for daylight use, twice as much power per flash is expended in the clear (white) units. This time sharing arrangement of the inverter reduces the cost of the equipment. Average input current to the inverter is 1.5 amperes at 74 VDC or a total of 111 watts. Power delivered to each red flashtube is approximately 30 Joules and power delivered to each clear flashtubes is about 60 Joules.

2.2.2.2 Effective Intensity

The effective intensity distribution for the flashtube assemblies are given in Figures 7 and 8. Only vertical distributions are presented since both units give complete 360° coverage in the horizontal plane. The distribution for the unit with the clear filter is given in Figure 7. Similarly, the distribution for the unit with the red filter is given in Figure 8. Beam spread to the 50% intensity level is about 28° and

*See footnote on page 7.

Figure 7. Effective Intensity Distribution in the Vertical Plane for the Clear Filter Portion of Roof Flashtube Assembly



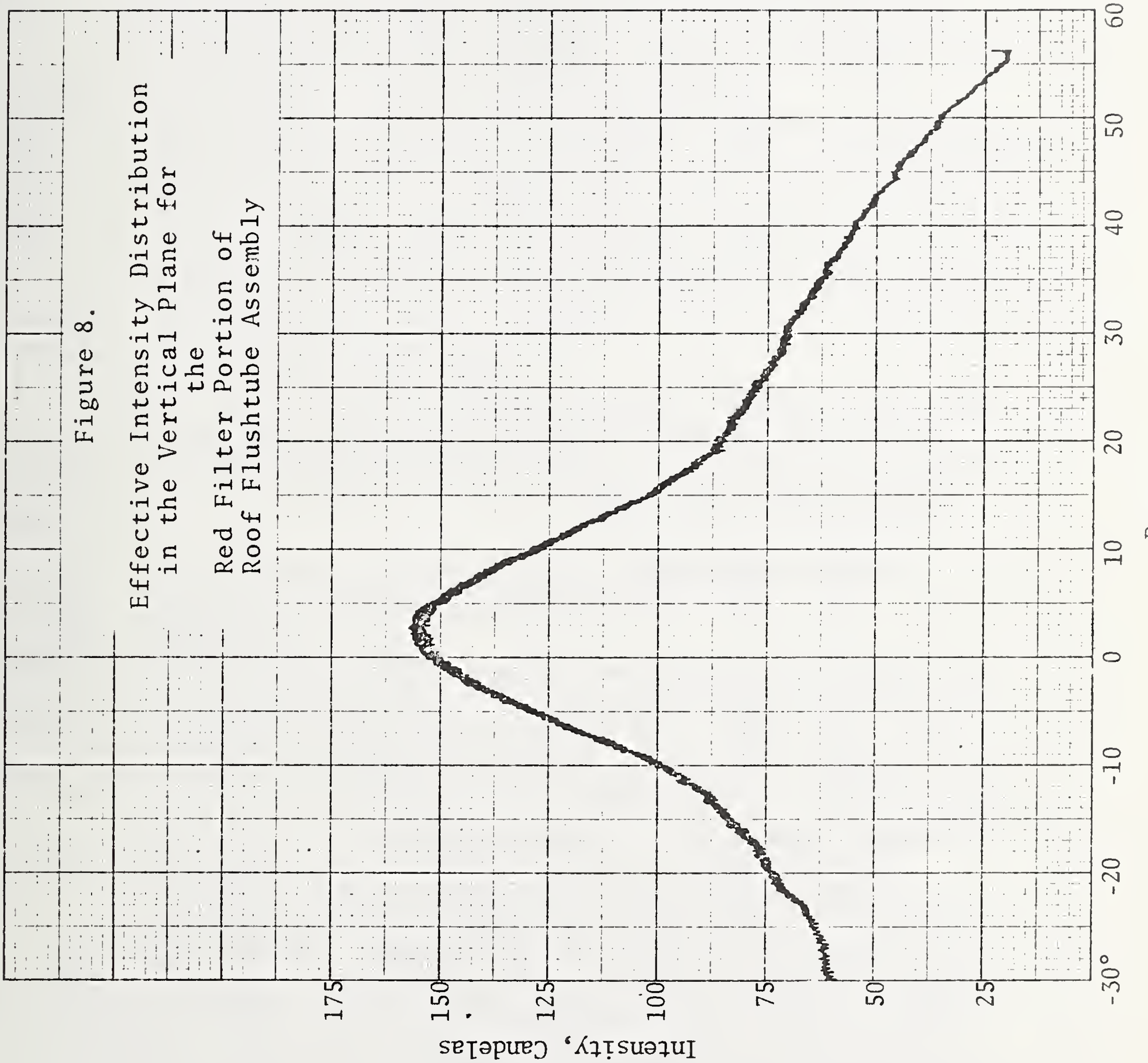


Figure 8.

Effective Intensity Distribution in the Vertical Plane for the Red Filter Portion of Roof Flushtube Assembly

37^{o} for the clear unit and red unit, respectively. Peak intensity of the clear unit is about 3,300 candelas and the peak intensity for the red unit is about 150 candelas.

2.2.3 Environmental Testing

The roof flashtube units were not subjected to any environmental tests during Phase II since these lights are off-the-shelf items and have been used on aircraft for years. It was noted, however, that moisture could get into the unit. This would be a problem only if enough moisture accumulated to short-circuit the electrical components in the base. The manufacturer of the lights was notified of this possibility and a representative was sent to modify the units purchased for this effort. The modifications entailed improving the seals between the housing components and providing a small drain hole in the base of each unit.

2.3 Side and Rear Panel Lights

2.3.1 Physical Description

The Panel Lights of VAS are 24 inches square and 3" thick. Light from two U-shaped fluorescent lamps is transmitted through a white, diffusing filter in each panel. The size of the area through which the light comes is 22" x 22" due to the 1" wide filter retaining bezel bolted to the light box. Each panel contains its own ballast-inverter.

Five panel installations are planned for each locomotive. One panel is to be mounted on the right rear body housing. This rear panel is for use primarily in yard switching operations to provide supplemental conspicuity to the usual rear headlights used in backing maneuvers. A switch in the Lighting Control Panel is provided for turning the Rear Panel Light on and off.

On each side of the locomotive, about half-way back (see Figure 1) a pair of panels are to be mounted on the cat-walk handrail. Each pair will be bolted, side by side, to their own brackets which in turn are bolted to the railing supports. In this manner when the railings are removed to permit easy access to the locomotive's power mechanisms, the side Panel Lights will also be removed with no more extra trouble than disconnecting the power lines at a near-by junction box.

Within one panel of each pair of Side Panel Lights is a flashtube unit for added conspicuity. The flourescent lamps in the four Side Panels are turned on and off from a switch in the Lighting Control Panel. A separate switch in the panel controls the operation of the two side flashtubes independently of the fluorescent lamps.

Figure 9 shows a pair of Side Panel Lights. The disassembled unit shows the arrangement of the fluorescent lamps as well as the location of the flashtube.

2.3.2 Performance Characteristics of the Panel Lights

2.3.2.1 Electrical-.

The two fluorescent lamps within each panel operate from a special inverter-type ballast also installed within the panel. The lamps are "U" shaped, rated at 40 watts each and are manufactured by the Westinghouse Corporation. They bear the manufacturers part number FB40CW/6.

The inverter ballast is manufactured by TRANS-LITE, INC.,* Milford, Connecticut and bears their part number A.S.2357-1. One such inverter is required per panel. The unit is designed to operate from the 74vdc electrical system of the locomotive at an input current of approximately

* See footnote on page 7.

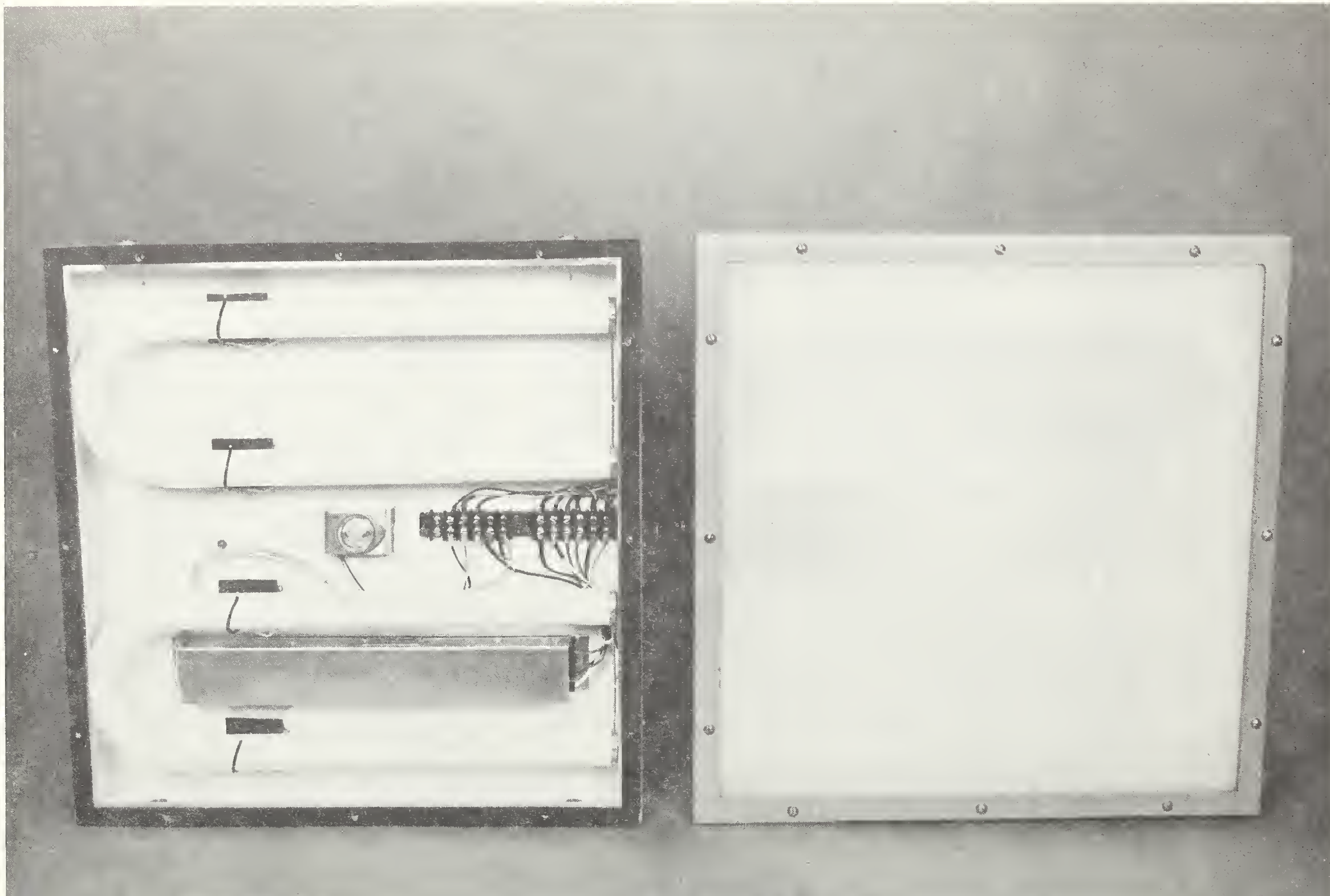


Figure 9. Two Side Panel Lights. The Panel on the left has the diffusing cover removed to show the internal arrangement of parts. The flashtube is in the center.

1.3 amperes. The current delivered to the lamps is on the order of 0.5 amperes at a frequency of about 20,000 Hz.

The flashtube within the panel as well as its power supply is manufactured by the Grimes Mfg., Co.,* Urbana, Ohio.

The flashtube assembly bears the manufacturer's part number 85-0246-1 and the power supply bears the part number 85-0247-1. The power supply operates from the 74 vdc system of the locomotive and is designed to flash the two lamps (one of the panels on each side of the locomotive) alternately at a flash rate of 30 flashes per minute each. Average input current to the power supply is 1.5 amperes while the power delivered to the lamps is 25 Joules per flash.

2.3.2.2 Intensity Distribution

Representative curves of the intensity distribution for the side panels are presented in Figures 10 and 11. Figure 10 gives the distribution with only the two fluorescent lamps operating while Figure 11 gives the effective intensity distribution for the panel with only the flashtube operating. As related earlier, the flashes from the flashtube are superimposed onto the steady background illaminating from the fluorescent lamps. The distributions are for a single panel and two such panels are used (only one with a flashtube) on each side of the locomotive. The curves show only 1/2 of the total distribution, 0° - 90°, since both sides of the distribution are symetrical.

As indicated then, with two such panels on each side of the locomotive, peak steady-state intensity from the panels is on the order of 1900 candelas. The flashtube in one of the panels then provides an additional peak effective intensity of about 900 candelor.

* See footnote on page 7.

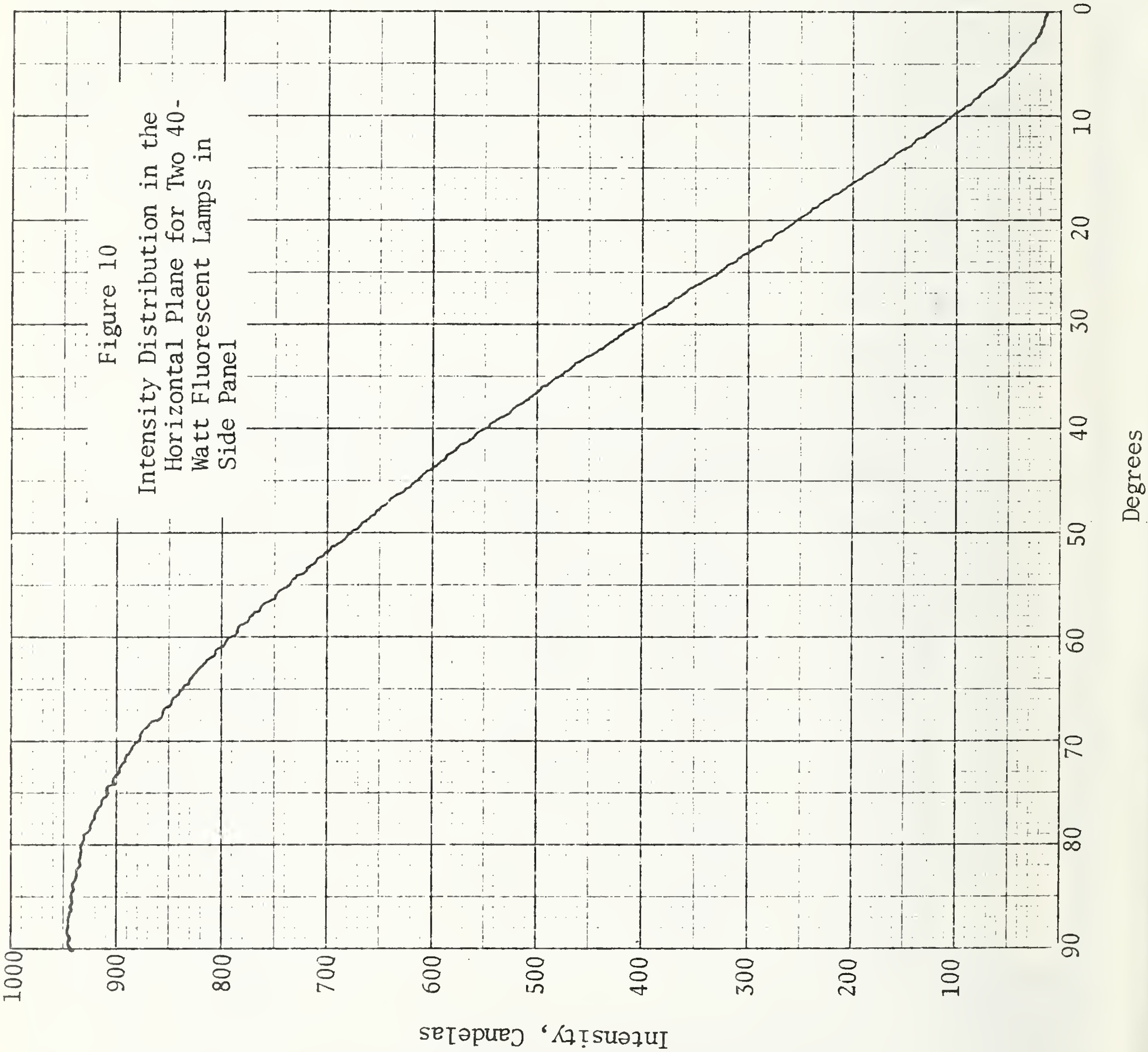


Figure 10

Intensity Distribution in the Horizontal Plane for Two 40-Watt Fluorescent Lamps in Side Panel

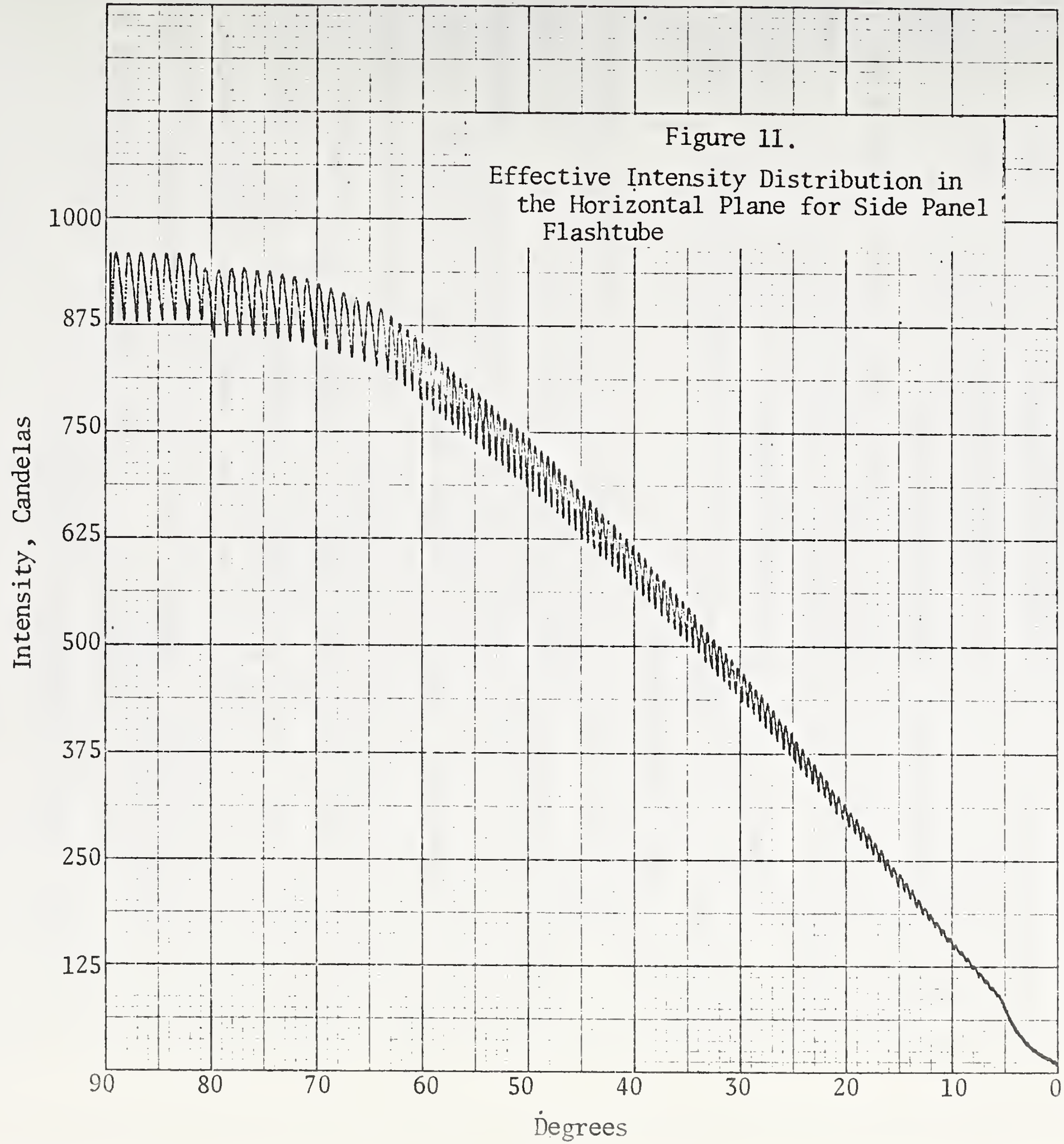


Figure 11.
Effective Intensity Distribution in the Horizontal Plane for Side Panel Flashtube

2.3.3 Environmental Testing

Since the internal capacity of the available High Temperature Chamber was not large enough to accommodate a complete panel, only the electrical components were subjected to high temperature testing. Two U-shaped fluorescent lamps were mounted on a board and together with an inverter-ballast were placed in the chamber. The inverter-ballast was operated at 74 vdc input. A thermocouple detector was placed through a hollow rivet hole at the approximate mid-point of the ballast. (A previous check showed the middle area of the ballast to be hotter than the ends). The ambient temperature in the chamber was raised to 131°F and maintained at this level for approximately 2 1/2 hours. The temperature of the ballast stabilized at 158°F and the base of the lamps at 140°F. No adverse effects were noted at this ambient temperature.

Fluorescent lamps of this type have a maximum luminous output at an ambient temperature surrounding the lamp itself of about 75 - 90°F. Since there is about a 28°F difference between the inside and outside temperatures when the panel lamps are on, the maximum light output occurs with an outside temperature of about 60°F. It is characteristic of this particular type of fluorescent lamp for the light output to decrease as ambient temperatures go above or below the temperature range of maximum luminous flux. Figure 12 shows the change in relative intensities as ambient temperature changes. If panel lights such as these are to be used in low temperatures, then special lamps designed for this purpose can be used or heaters can be installed to raise the internal temperature of the panel.

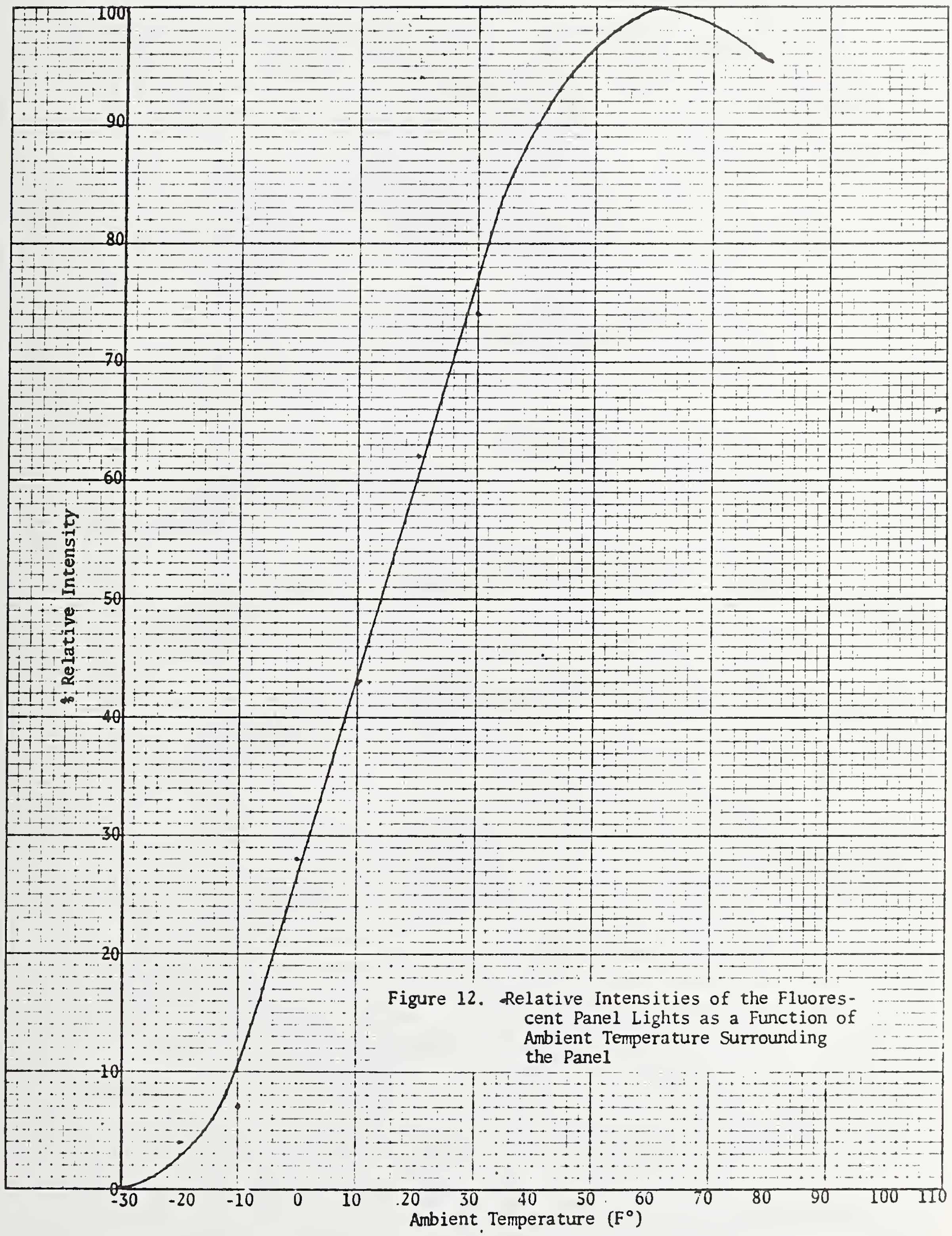


Figure 12. Relative Intensities of the Fluorescent Panel Lights as a Function of Ambient Temperature Surrounding the Panel

2.4 Lighting Control Panel

The Lighting Control Panel is a module 7" long, 2" deep and 2 1/2" high. It has a beveled face bearing the legends which identify each of five switches. The identification and use of each switch were discussed in the preceding sections. A list of the switches are as follows:

Switch	Positions
Rear Panel	ON-OFF
Side Panel Flashers	ON-OFF
Side Panel	ON-OFF
Roof Flashtubes	Night(R)-OFF-Day(W)
Roof Beacon	ON-OFF

The Lighting Control Panel is located on top of the Engineers Control Console within easy reach. A connector in the back of the unit accepts a wiring harness from the control console for connecting the switches into the system. Figure 13 shows a picture of the Lighting Control Panel.

In normal operational usage, the switches are to be turned on at the beginning of a run and turned off at the end of a run. If for any reason any of the lights need to be turned off, such as annoying flashtube reflections from ground fog, for example, the engineer can quickly de-select the appropriate devices and reinstate them when conditions are more favorable.

3.0 Some Comments on the Installation of VAS on a GP40 Locomotive

As was mentioned before, Figure 1 shows the general locations of the various devices as applied to a GP40 locomotive. The precise location for each is not rigidly inviolate. Some shifts fore and aft or up and down can be tolerated as long as the new location maintains a minimum, or preferably, no annoyance to the train crew and a maximum of attention-getting quality with respect to observers not on the train. This flexibility should be

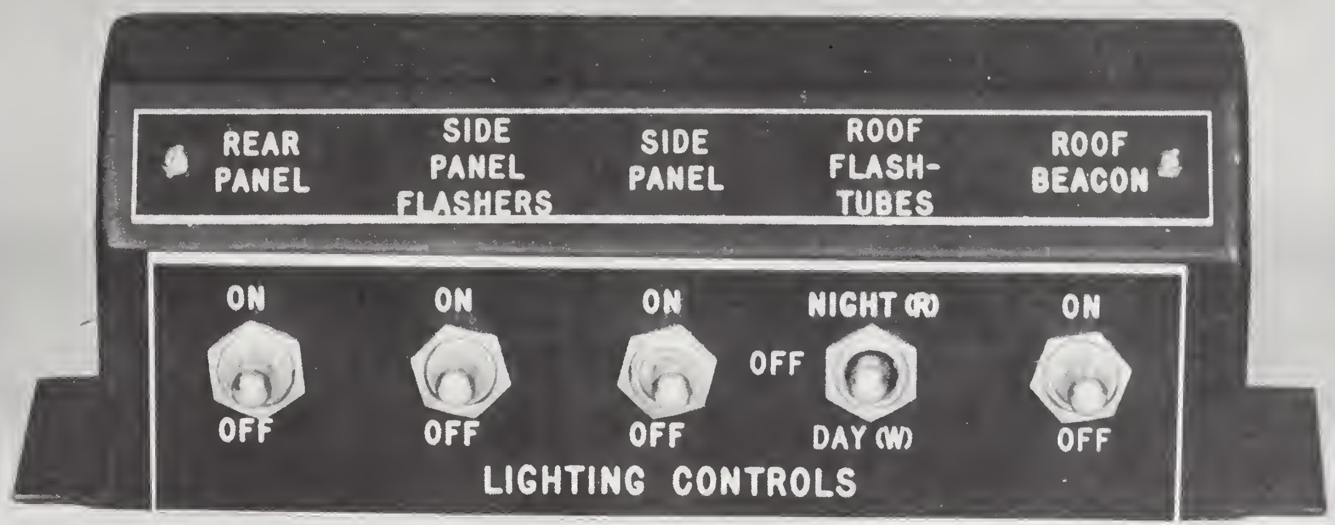


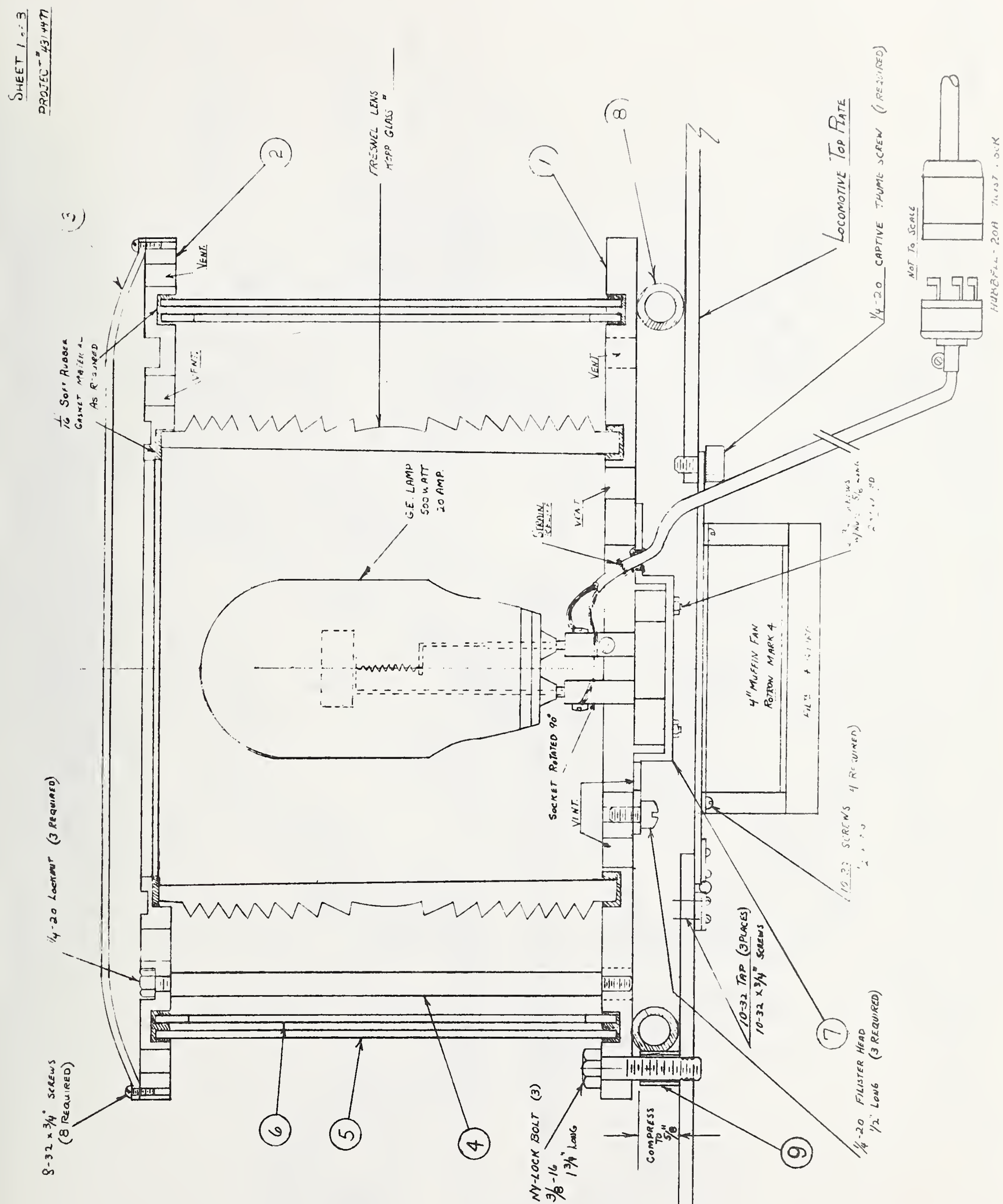
Figure 13. Lighting Control Panel.

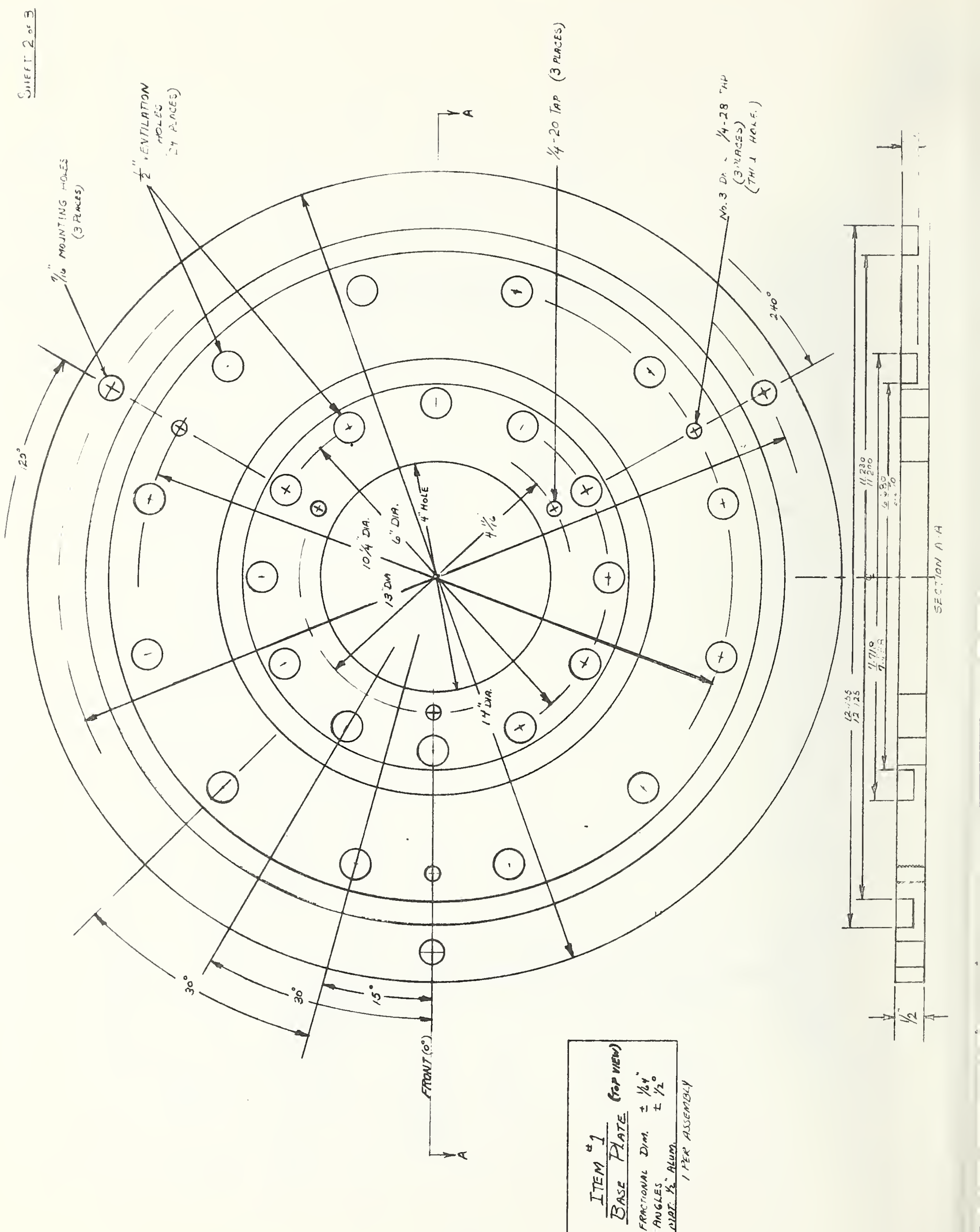
maintained, since, of the several GP40's inspected early in the study, it was noted that no two were exactly alike. This was especially true at the engineer's station in the cab. Although, for example, a location for mounting the Lighting Control Panel could be found on each of the GP40's inspected, the exact position on each was different.

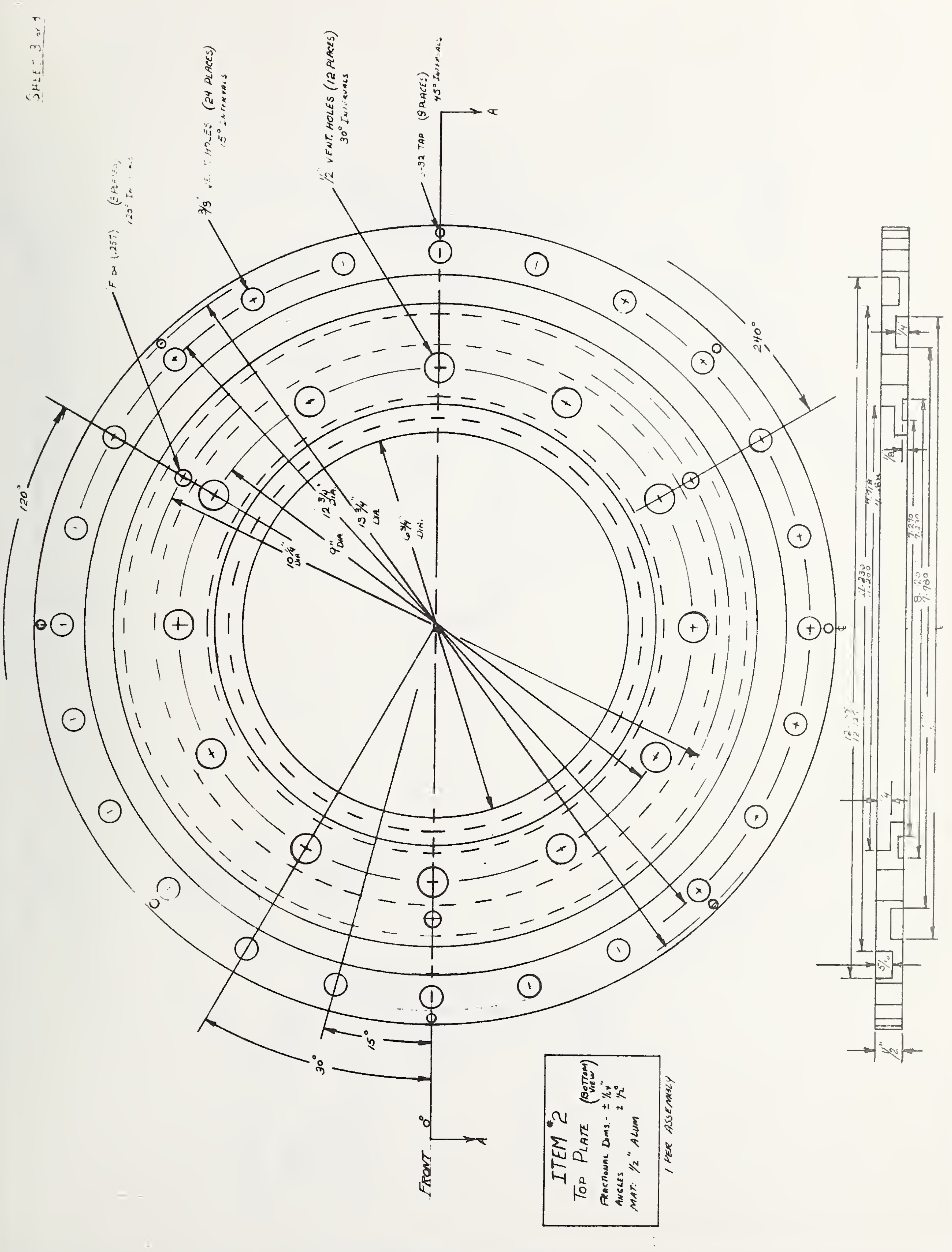
The instructions for the installation of the components making up the Visual Alerting System are given in Appendix B. Included with the instructions are the schematic wiring diagram, conduit diagram as well as the details for the various junction boxes and wiring harnesses. These instructions, as an adjunct to a detailed briefing, were sufficient to permit the installation of the VAS on the locomotive at Crane, Indiana mentioned in the Introduction. In addition, knowledgeable personnel at NBS are available for consultation should unexpected installation and/or operational problems arise.

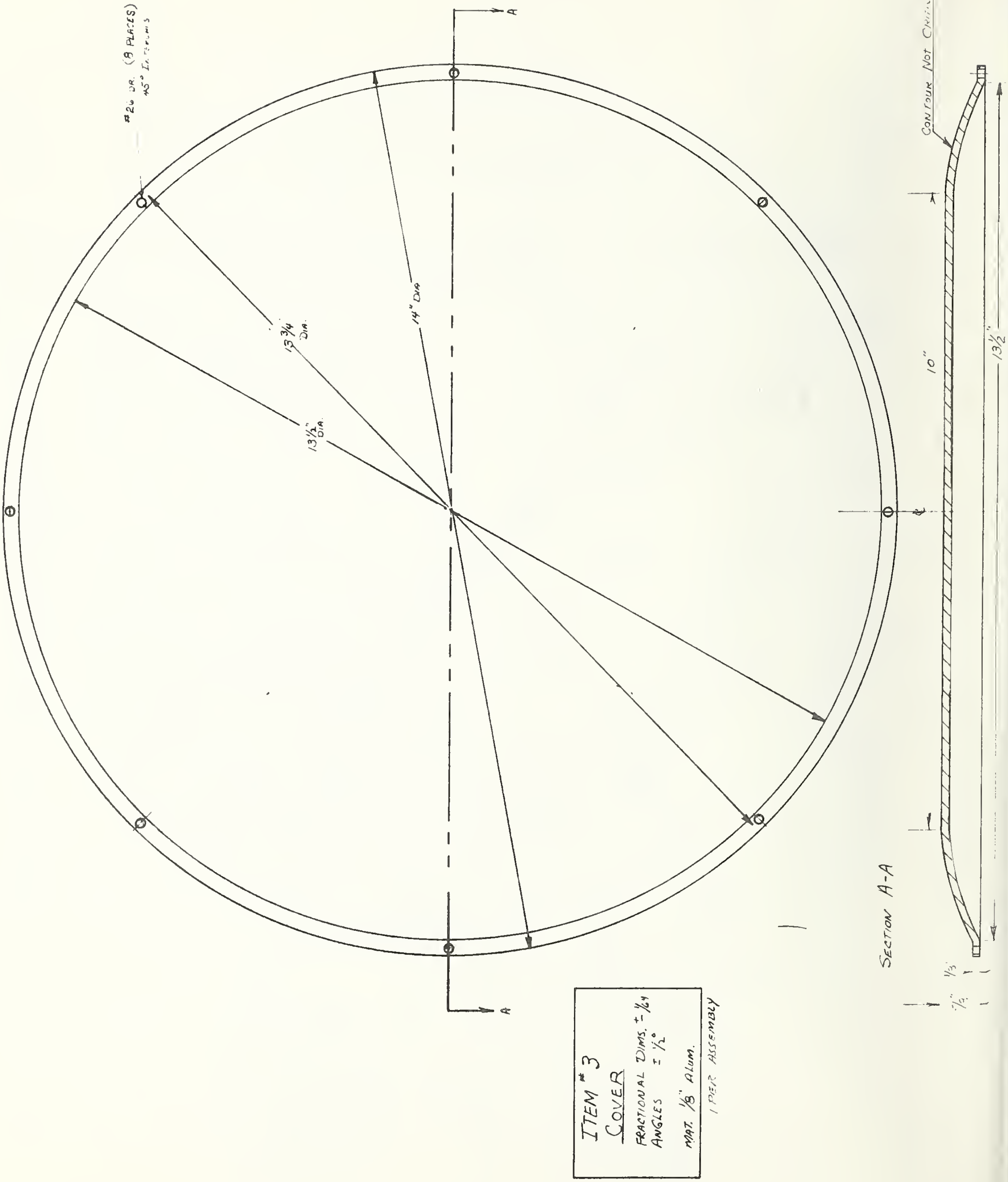
APPENDIX A

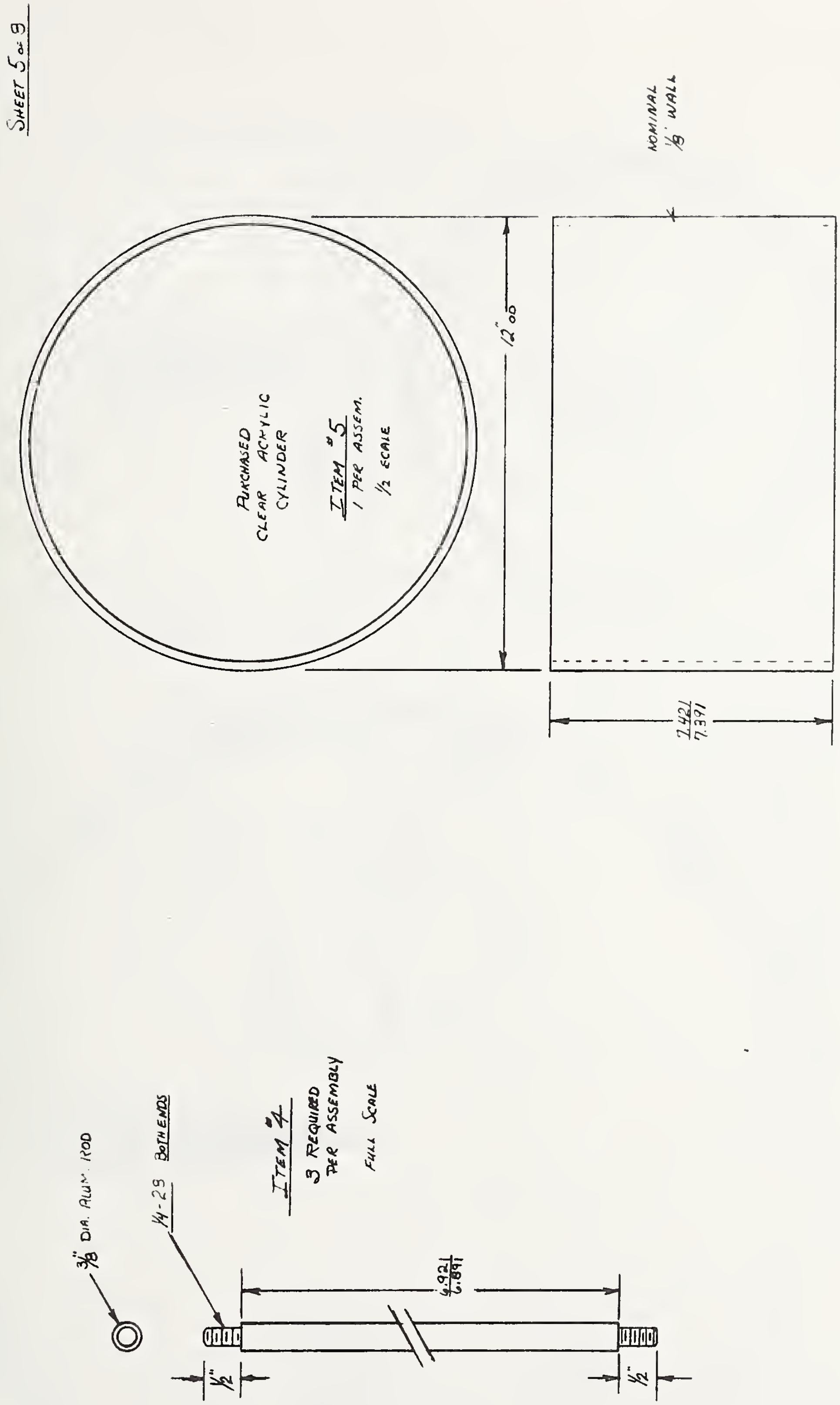
Detailed Drawings for the Visual Alerting System


SHEET 1 OF 3
FRESNEL LENS
LOCOMOTIVE TOP PLATE
1/4-20 CAPTIVE THUMB SCREW (1 REQUIRED)
NOT TO SCALE
1/16 SOFT RUBBER GASKET MATERIAL AS REQUIRED
VENT
G.E. LAMP 500 WATT 20 AMP.
SOCKET ROTATED 90°
4" MUFFIN FAN ROTRON MARK 4
10-32 SCREWS 4 REQUIRED
10-32 TAP (3 PLACES) 10-32 x 3/4" SCREWS
1/4-20 FILLISTER HEAD 1/2" LONG (3 REQUIRED)
1/4-20 LOCKNUT (3 REQUIRED)
8-32 x 3/4" SCREWS (8 REQUIRED)
NY-LOCK BOLT (3) 3/8-16 1 3/4" LONG
COMPRESS TO 5/8"
1
2
4
5
6
7
8
9

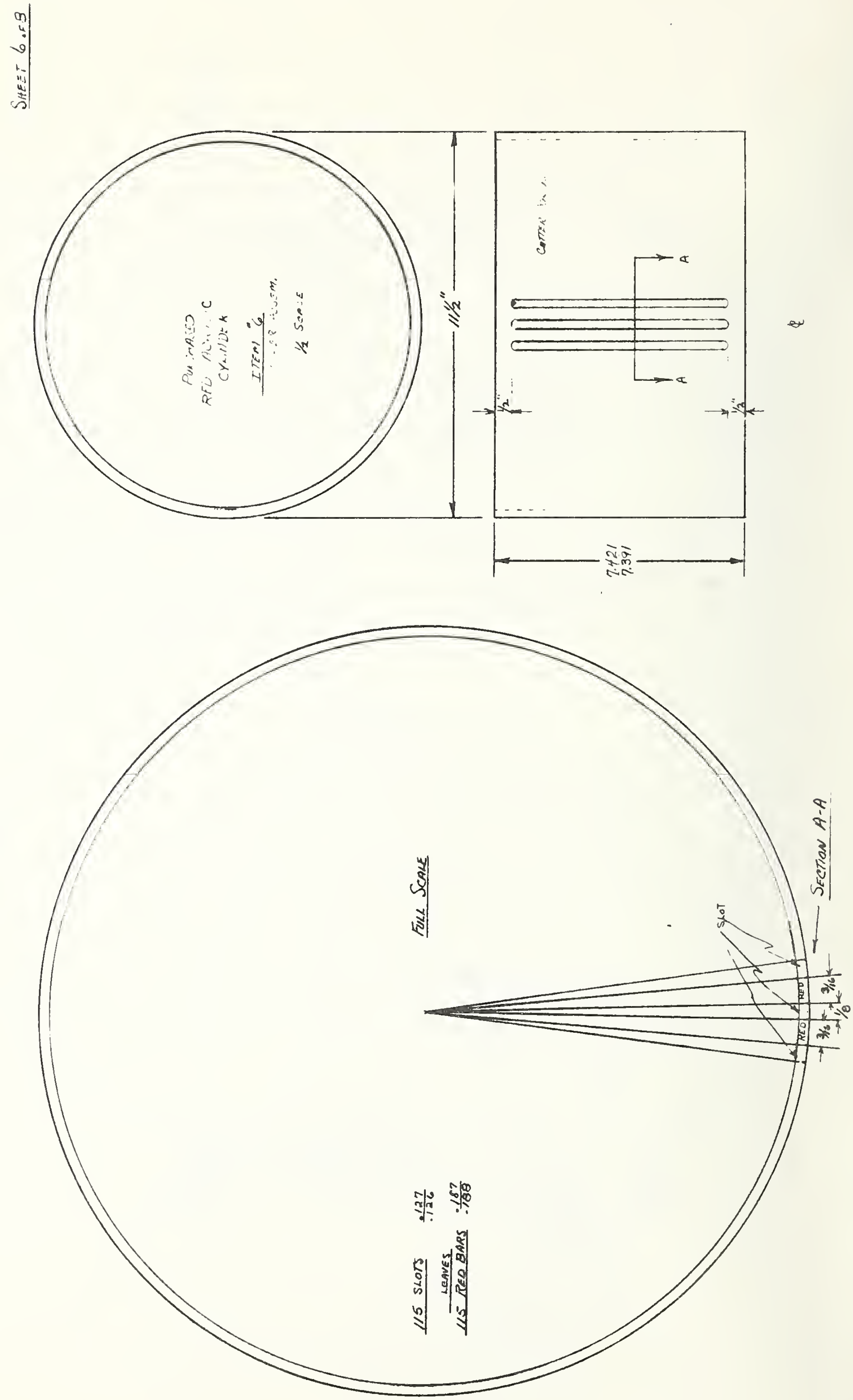

SHEET 2 of 3
ITEM #1
BASE PLATE (TOP VIEW)
FRACTIONAL DIM. ± 1/64"
ANGLES ± 1/2°
MAT: 1/2" ALUM.
1 PER ASSEMBLY
FRONT (0°)
7/16" MOUNTING HOLES (3 PLACES)
1/2" VENTILATION HOLES (24 PLACES)
1/4-20 TAP (3 PLACES)
No. 3 DR. - 1/4-28 TAP (3 PLACES) (THRU HOLE)
120°
240°
30°
30°
15°
10 1/4" DIA.
6" DIA.
4" HOLE
4 1/16
13" DIA.
14" DIA.
SECTION A-A
1/2"


ITEM #2
TOP PLATE (BOTTOM VIEW)
FRACTIONAL DIMS. - ± 1/64"
ANGLES ± 1/2°
MAT: 1/2" ALUM
1 PER ASSEMBLY
FRONT
0°
A
A
15°
30°
120°
240°
1/2" VENT. HOLES (12 PLACES)
30° INTERVALS
10 1/4" DIA
9" DIA
12 3/4" DIA
13 3/4" DIA
6 3/4" DIA
1/4
1/8
5/16
1/2"

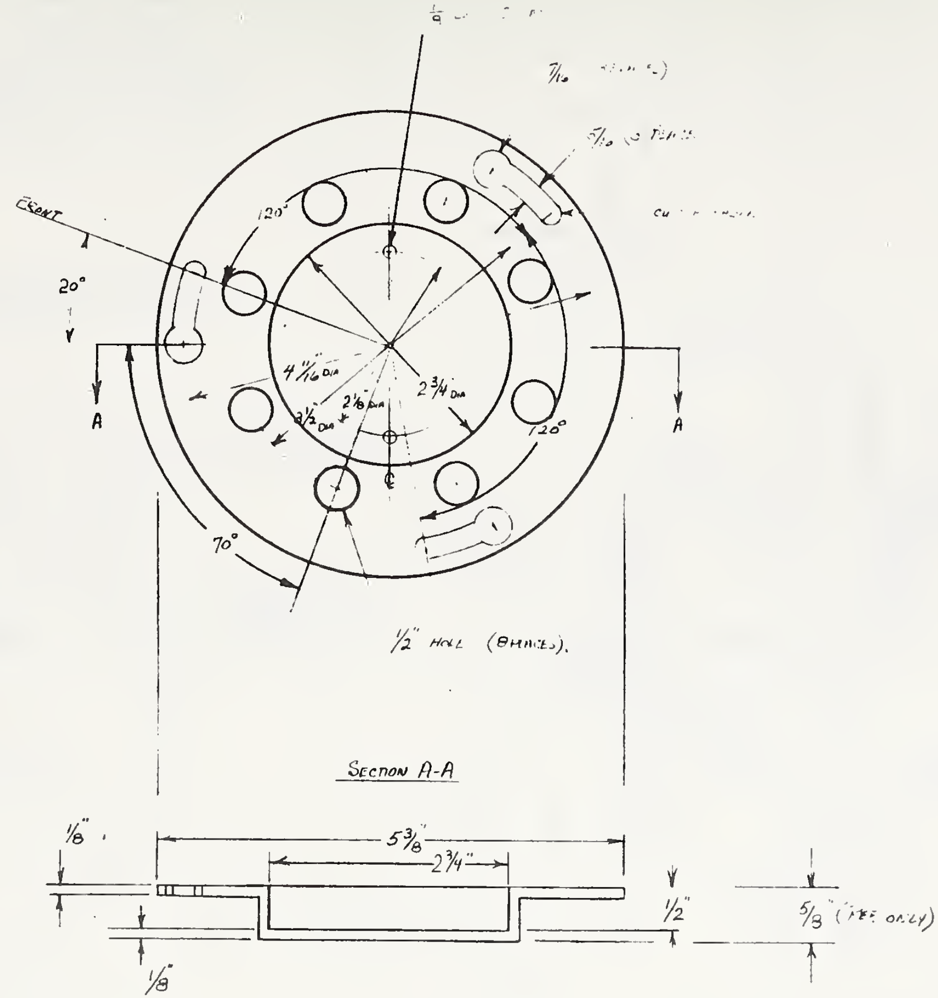

#26 DR. (8 PLACES) 45° INTERVALS
14" DIA
13 3/4" DIA
13 1/2" DIA
A
A
CONTOUR NOT CRITICAL
10"
13 1/2"
SECTION A-A
ITEM # 3
COVER
FRACTIONAL DIMS. ± 1/64
ANGLES ± 1/2°
MAT. 1/8" ALUM.
1 PER ASSEMBLY



SHEET 5 OF 9
NOMINAL 1/8" WALL
12.00"
PURCHASED CLEAR ACRYLIC CYLINDER
ITEM #5
1 PER ASSEM.
1/2 SCALE
7.421 / 7.391
3/8" DIA. ALUM. ROD
1/4-29 BOTH ENDS
ITEM #4
3 REQUIRED PER ASSEMBLY
FULL SCALE
6.921 / 6.891
1/2"
1/2"



SHEET 6 OF 8
PURCHASED RED ACRYLIC CYLINDER
ITEM 6
1/2 SCALE
11 1/2"
1/2"
7.421
7.391
A
A
FULL SCALE
SECTION A-A
SLOT
RED
3/16
1/8
115 SLOTS .127/.126
LEAVES
115 RED BARS .187/.188

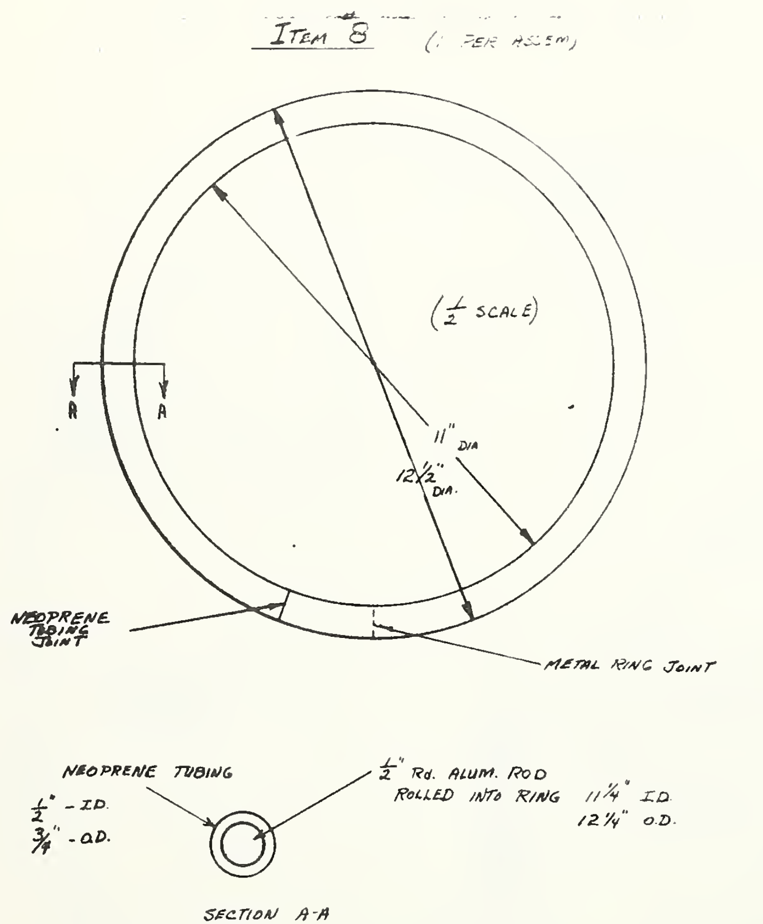


ITEM # 7 1 PER ASSEM.

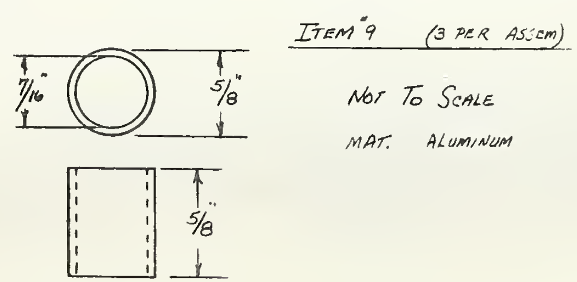
FRACTIONAL DIM. $\pm \frac{1}{64}$

ANGLES $\pm \frac{1}{2}°$

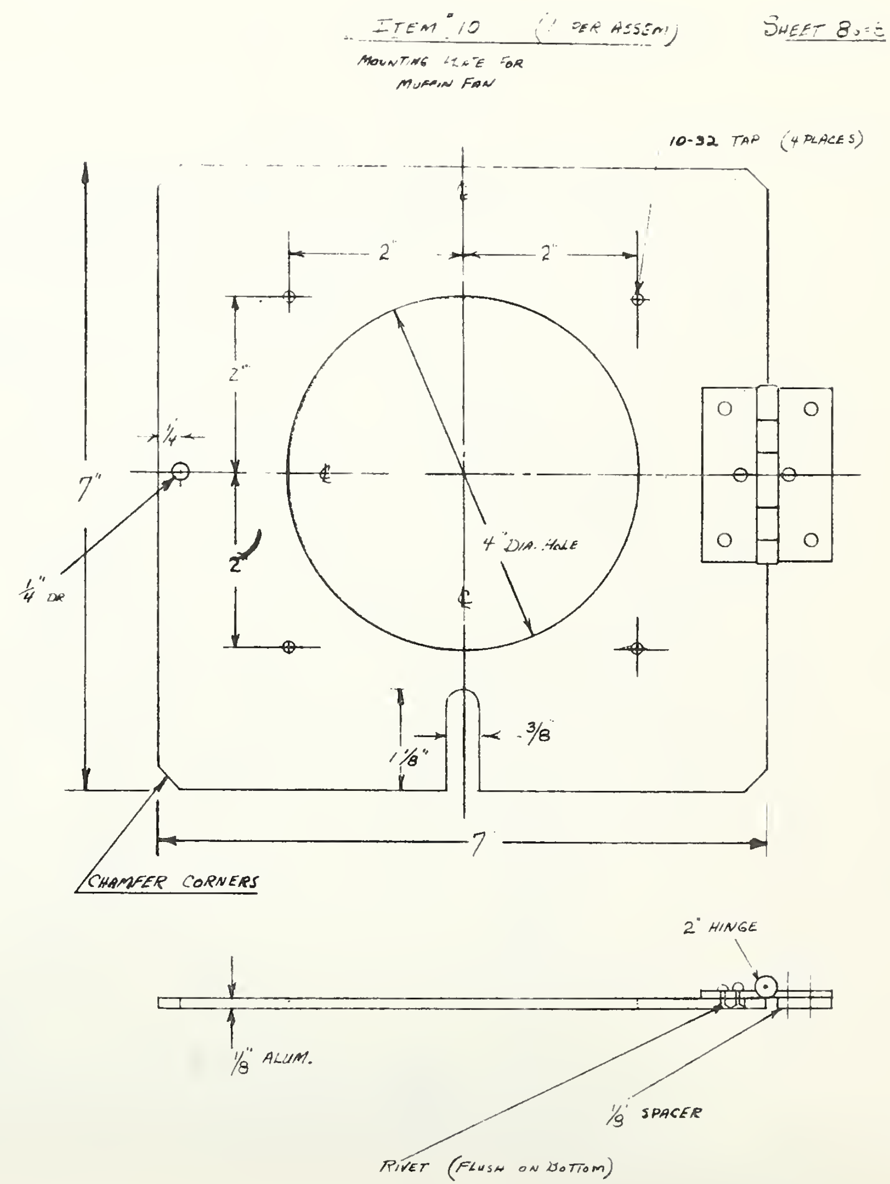
MAT. ALUM.



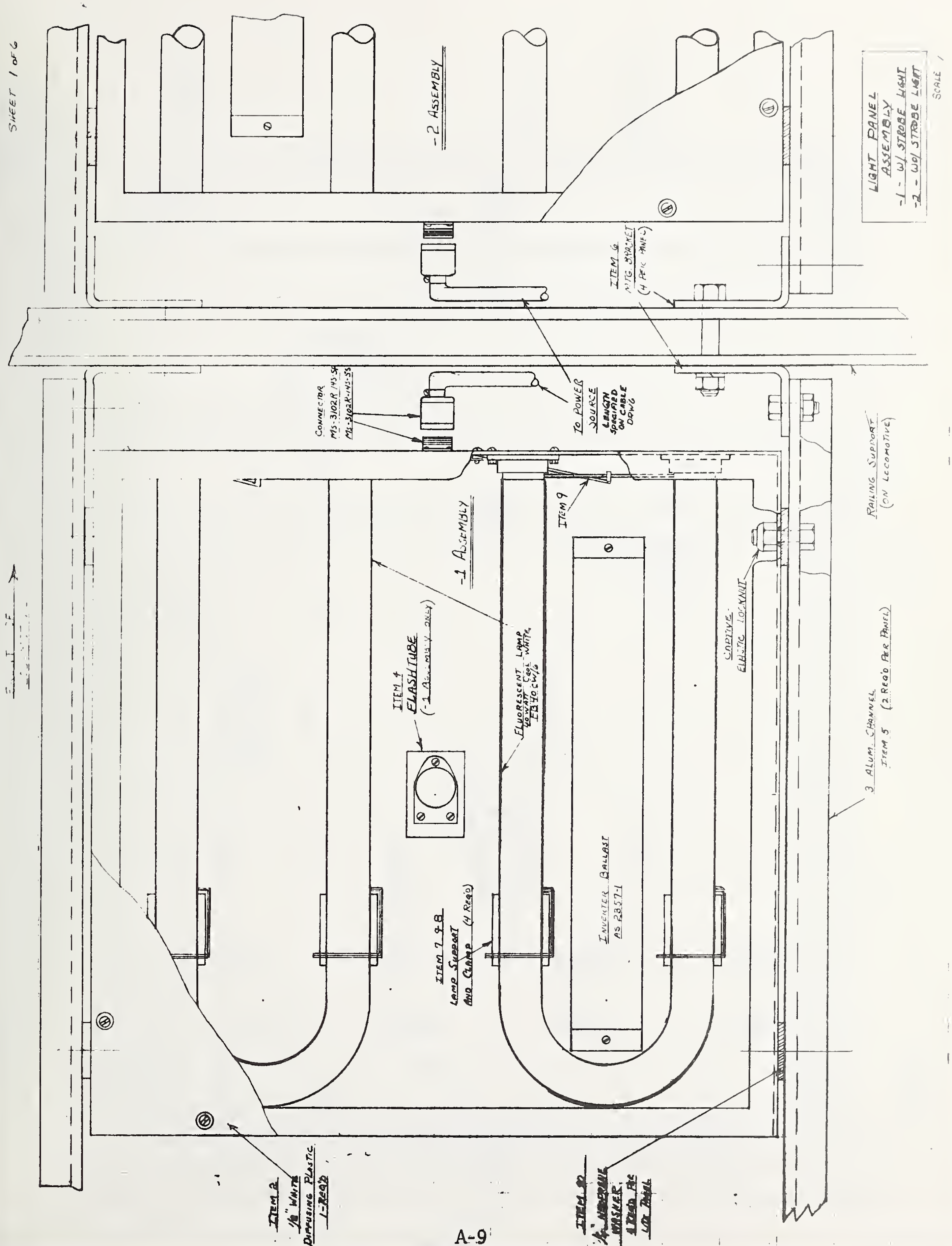
ITEM 8 (1 PER ASSEM)
(1/2 SCALE)
11" DIA
12 1/2" DIA.
A
A
NEOPRENE TUBING JOINT
METAL RING JOINT
NEOPRENE TUBING
1/2" - I.D.
3/4" - O.D.
1/2" Rd. ALUM. ROD ROLLED INTO RING
11 1/4" I.D.
12 1/4" O.D.
SECTION A-A



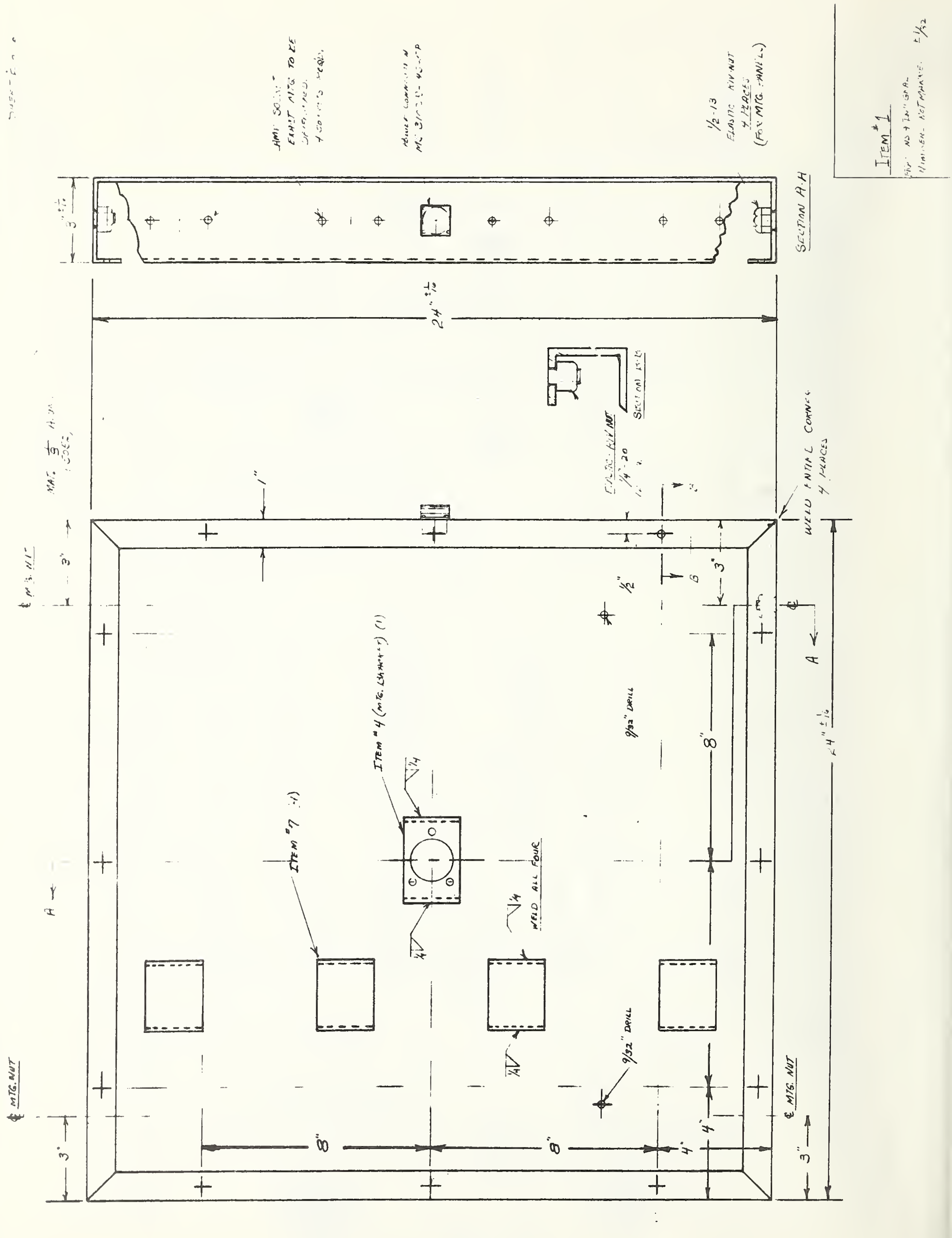
ITEM 9 (3 PER ASSEM)
NOT TO SCALE
MAT. ALUMINUM
7/16"
5/8"
5/8"

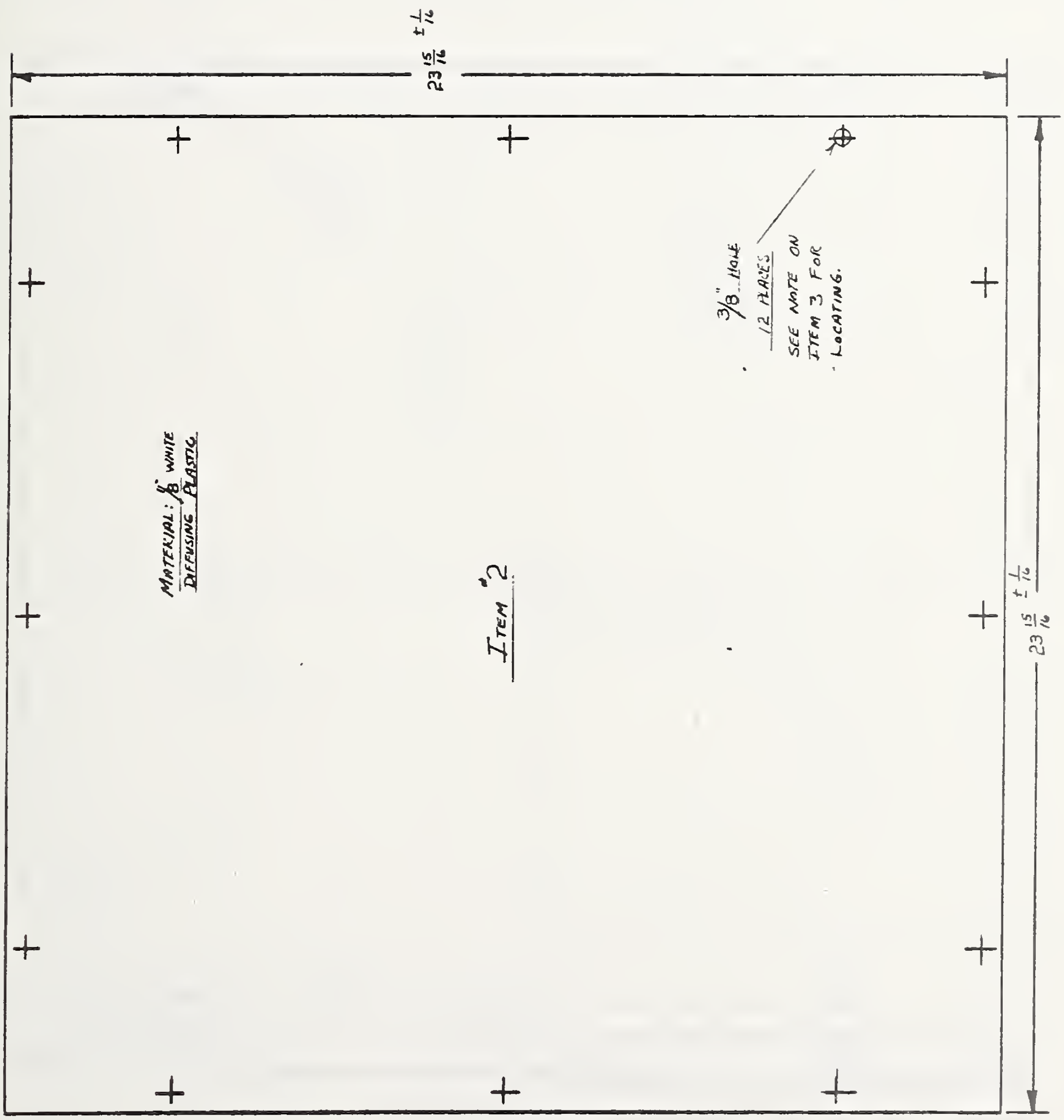


ITEM 10 (1 PER ASSEM)
SHEET 8
MOUNTING PLATE FOR MUFFIN FAN
10-32 TAP (4 PLACES)
2"
2"
2"
2"
7"
7"
1/4
1/4" DR
4" DIA. HOLE
3/8
1 1/8"
CHAMFER CORNERS
2" HINGE
1/8" ALUM.
1/8" SPACER
RIVET (FLUSH ON BOTTOM)

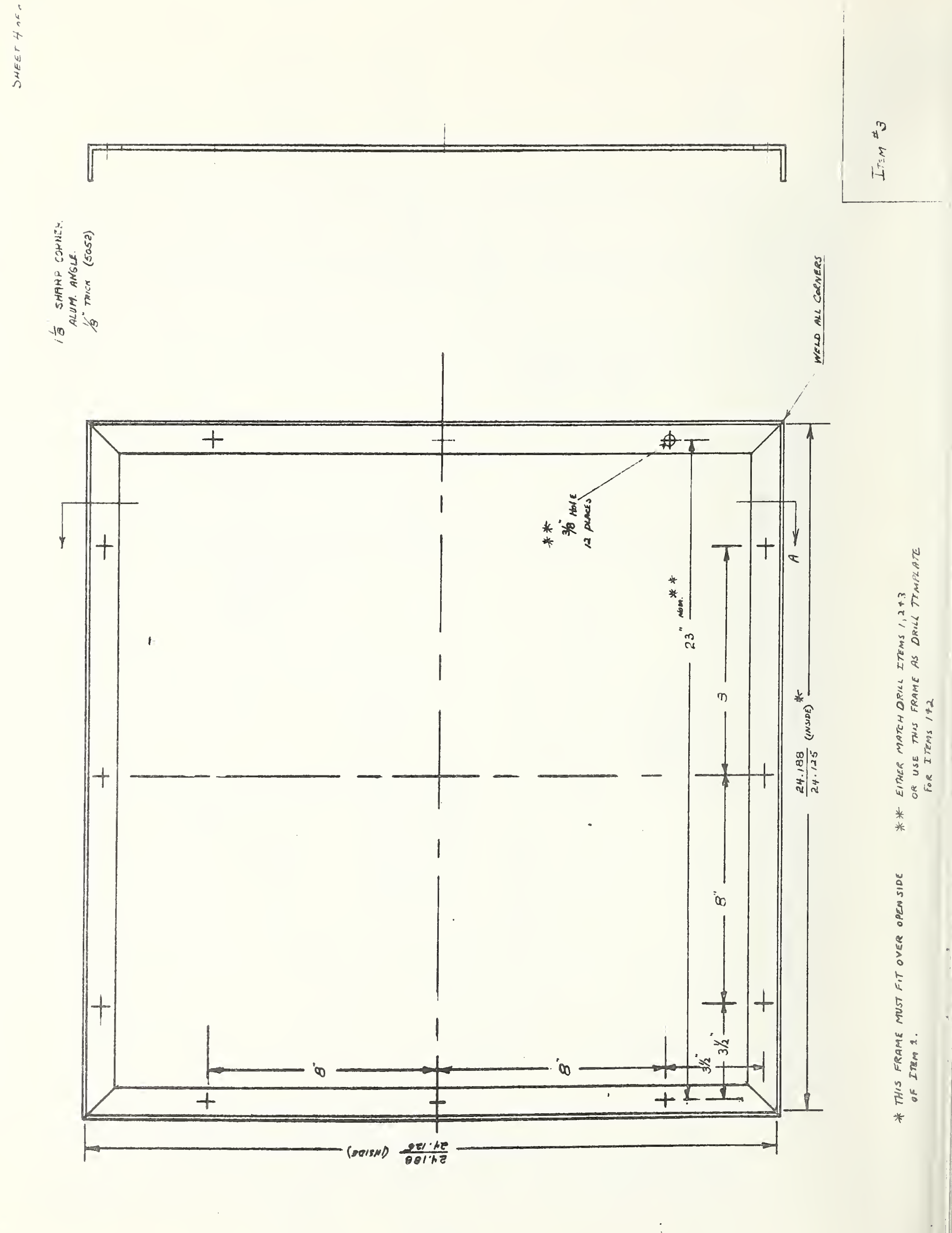


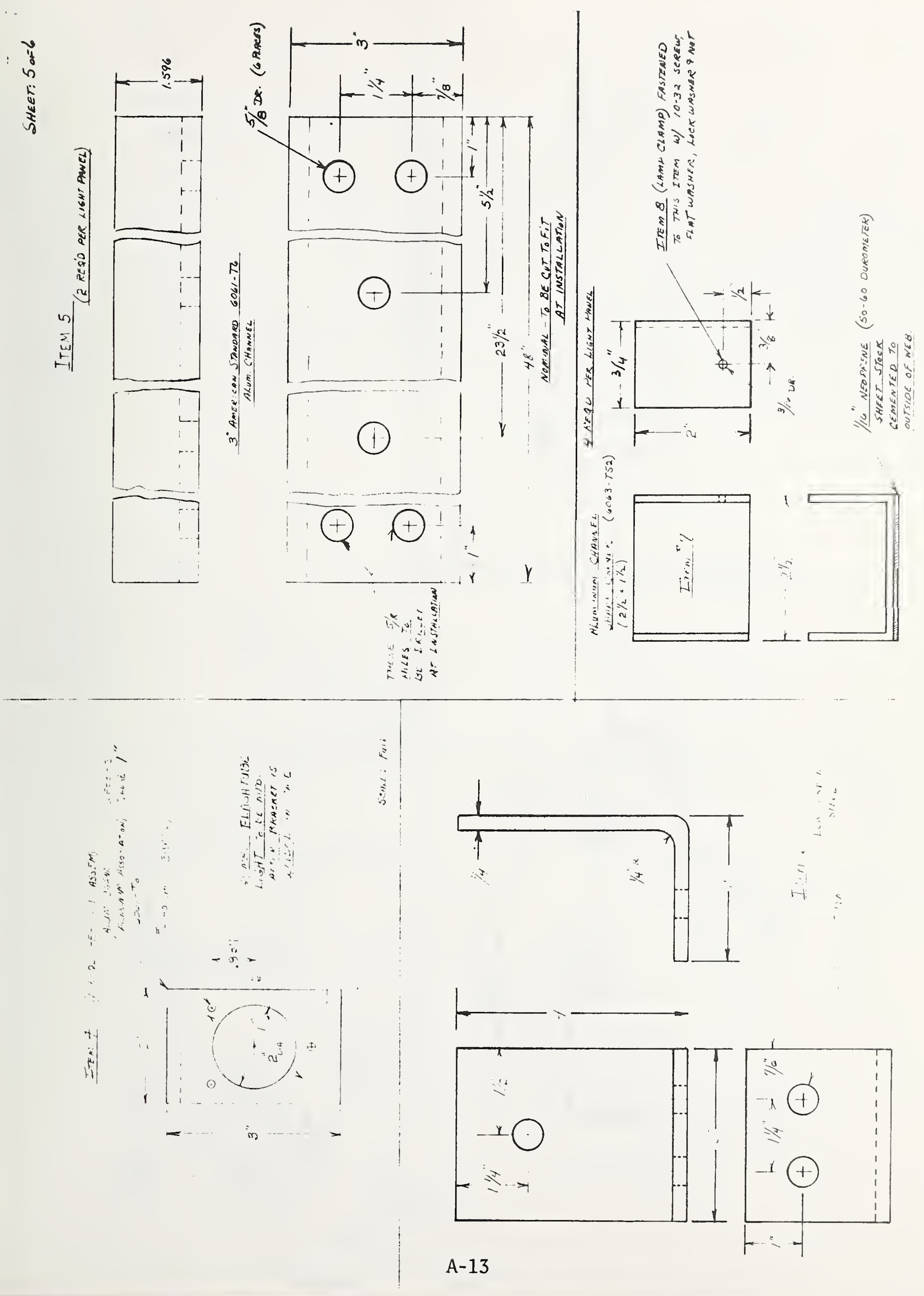
SHEET 1 OF 6
-2 ASSEMBLY
LIGHT PANEL ASSEMBLY
-1 - W/ STROBE LIGHT
-2 - W/O STROBE LIGHT
SCALE 1
ITEM 6 MTG. BRACKET (4 PER PANEL)
CONNECTOR MS-3102R 14S-5P MS-3102R-14S-5S
TO POWER SOURCE LENGTH SPECIFIED ON CABLE DRWG
RAILING SUPPORT (ON LOCOMOTIVE)
ITEM 9
-1 ASSEMBLY
ITEM 4 FLASHTUBE (-1 ASSEMBLY ONLY)
FLUORESCENT LAMP 40 WATT COOL WHITE F40CW/6
CAPTIVE ELASTIC LOCKNUT
3 ALUM. CHANNEL ITEM 5 (2 REQ'D PER PANEL)
INVERTER BALLAST AS 2357-1
ITEM 7 & 8 LAMP SUPPORT AND CLAMP (4 REQ'D)
ITEM 2 1/8" WHITE DIFFUSING PLASTIC 1-REQ'D
ITEM 10
WASHER


ITEM #1
SECTION A-A
24" ±1/16
24" ±1/16
1/2-13
ELASTIC RIV-NUT
4 PLACES
(FOR MTG. PANEL)
WELD INITIAL CORNERS
4 PLACES
ITEM #4 (MTG. BRACKET) (1)
ITEM #7 (4)
WELD ALL FOUR
9/32" DRILL
9/32" DRILL
¢ MTG. NUT
¢ MTG. NUT
8"
8"
8"
4"
4"
3"
3"
3"
1/2"
1"
A
A
B



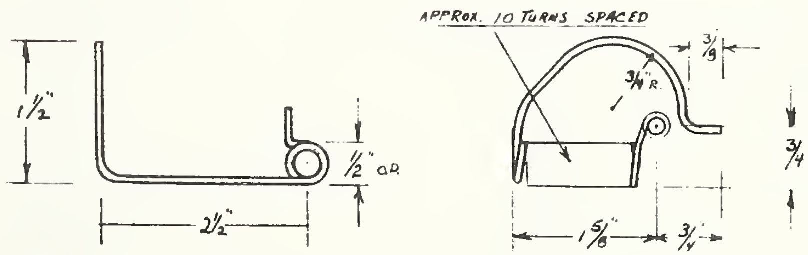
23 15/16 ± 1/16
MATERIAL: 1/8" WHITE DIFFUSING PLASTIC
ITEM #2
3/8" HOLE
12 PLACES
SEE NOTE ON ITEM 3 FOR LOCATING.
23 15/16 ± 1/16


SHEET 4 OF
ITEM #3
1 1/8 SHARP CORNER ALUM. ANGLE 1/8" THICK (5052)
WELD ALL CORNERS
** 3/8" HOLE 12 PLACES
23" NOM. **
3
8"
3½"
A
24.188 / 24.125 (INSIDE) *
* THIS FRAME MUST FIT OVER OPEN SIDE OF ITEM 1.
** EITHER MATCH DRILL ITEMS 1, 2 + 3 OR USE THIS FRAME AS DRILL TEMPLATE FOR ITEMS 1 + 2



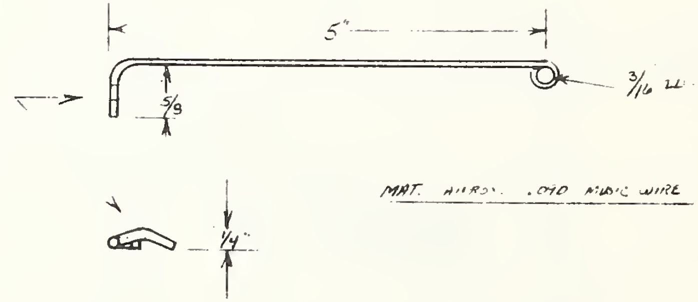
SHEET: 5 of 6
ITEM 5
(2 REQ'D PER LIGHT PANEL)
1.596
3" AMERICAN STANDARD 6061-T6
ALUM. CHANNEL
5/8" DR. (6 PLACES)
3"
1 1/4"
7/8"
1"
5 1/2
23 1/2"
48"
NOMINAL - TO BE CUT TO FIT
AT INSTALLATION
ITEM 8 (LAMP CLAMP) FASTENED
TO THIS ITEM W/ 10-32 SCREW
FLAT WASHER, LOCK WASHER & NUT
4 REQ'D PER LIGHT PANEL
3/4"
2"
1/2
3/16 DR.
1/16" NEOPRENE (50-60 DUROMETER)
SHEET STOCK
CEMENTED TO
OUTSIDE OF WEB.
(6063-T52)
(2 1/2 x 1 1/2)
2 1/2
3"
SCALE: FULL
1/4
1/4 R
1 1/4"
1/2
7/16
1"

ITEM # 8



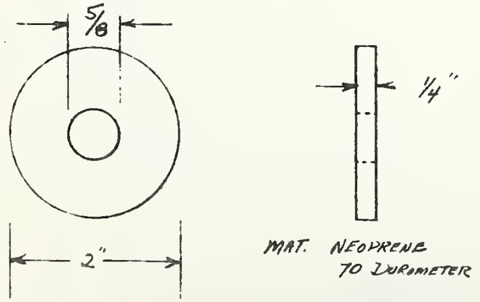
MAT: .062 MUSIC WIRE
(APPROX)

ITEM # 9

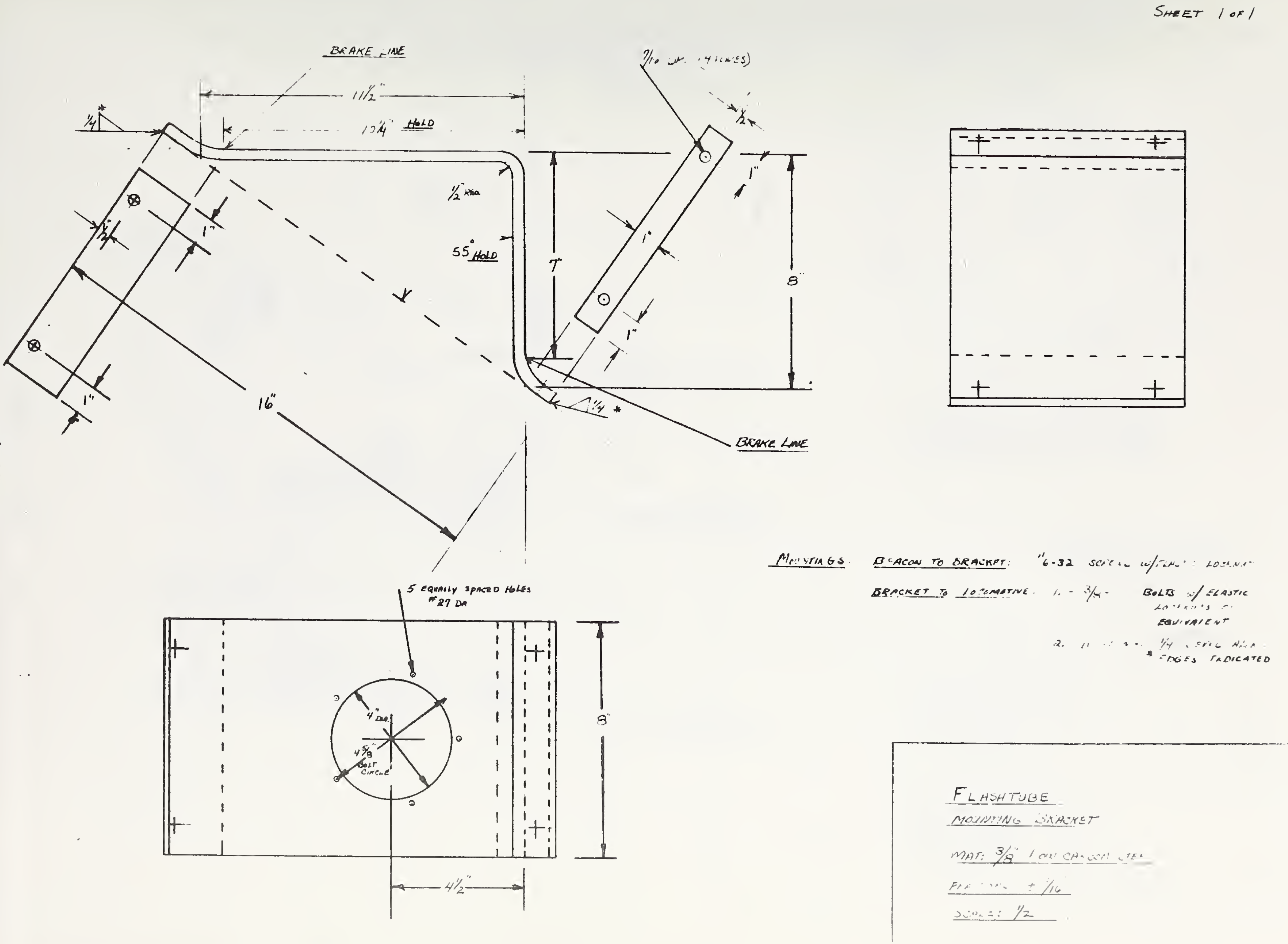


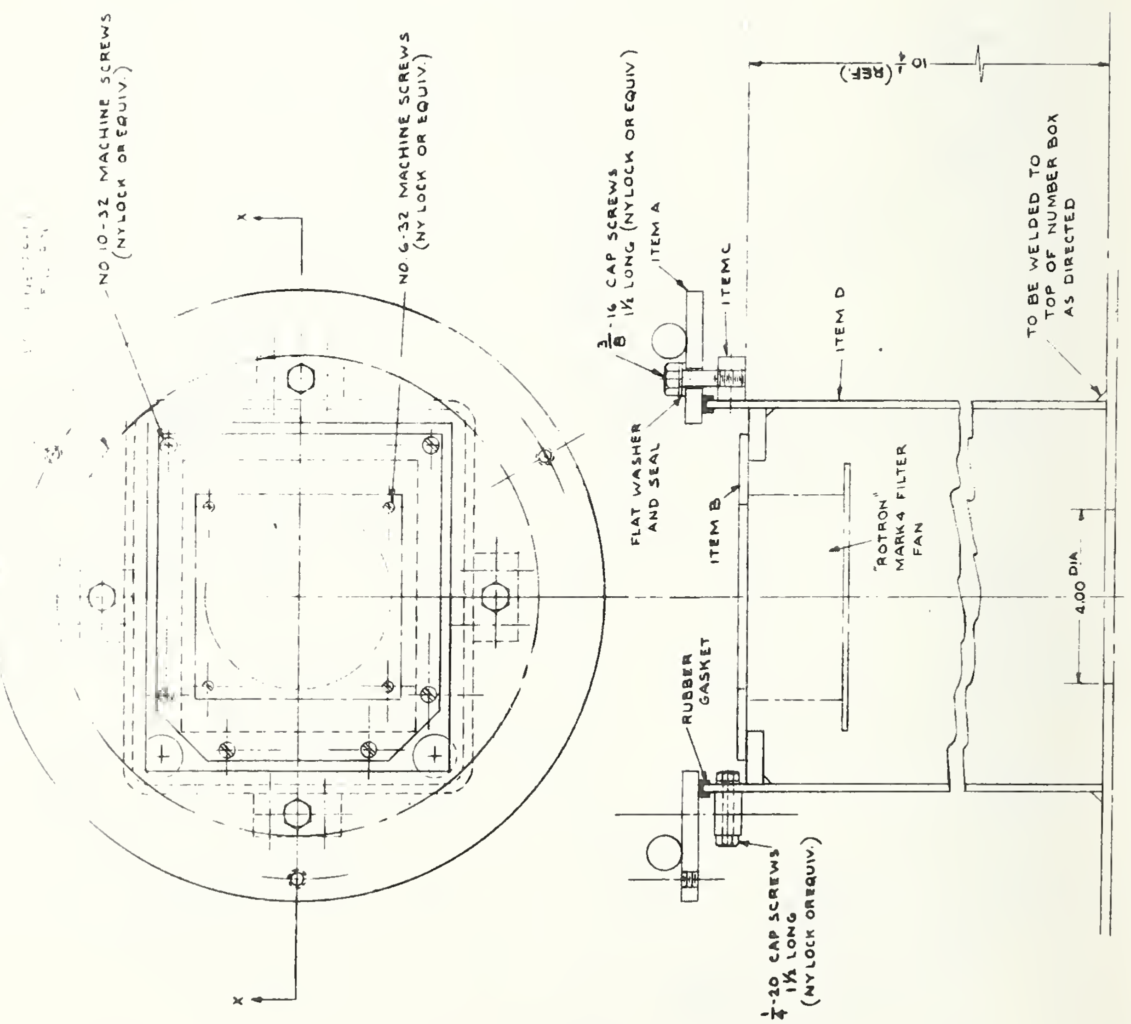
MAT. APPROX. .040 MUSIC WIRE

ITEM # 10



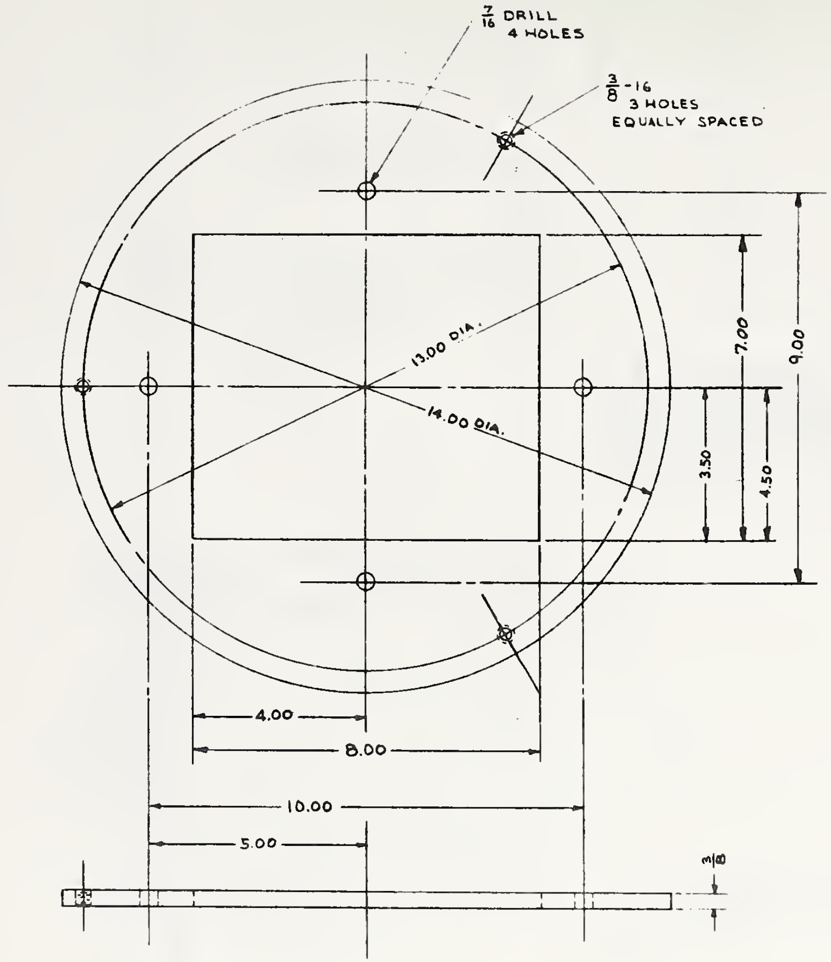
MAT. NEOPRENE
70 DUROMETER


SHEET 1 of 1
BRAKE LINE
11½"
10¼" HOLD
¼
½" RAD.
55° HOLD
7"
8"
1"
½"
16"
Y
BRAKE LINE
¼
5 EQUALLY SPACED HOLES #27 DR
4" DIA.
4⅝" BOLT CIRCLE
8"
4½"
MOUNTINGS
BEACON TO BRACKET:
6-32 SCREWS
BRACKET TO LOCOMOTIVE
1. - ⅜ - BOLTS w/ ELASTIC
EQUIVALENT
2.
¼
EDGES INDICATED
FLASHTUBE
MOUNTING BRACKET
MAT: ⅜"
± 1/16
½

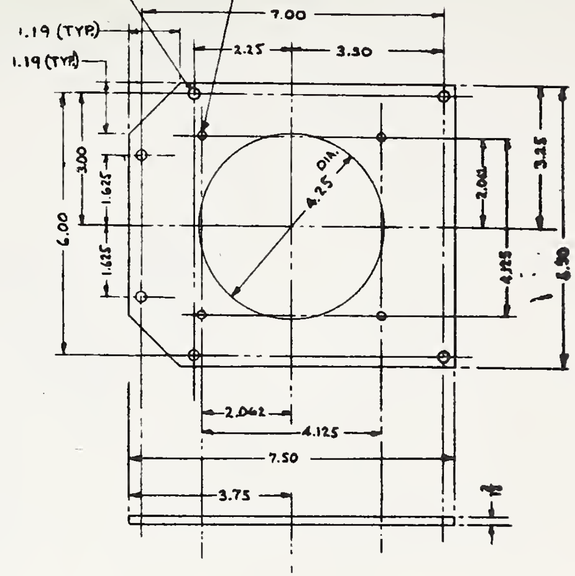


LAMP MOUNT
SCALE: 1/2

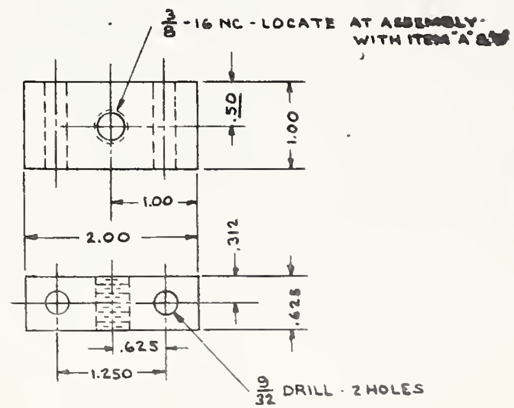
Item A (1 PER ASSEMBLY)
H.R. STEEL (PICKLED & OILED)
SCALE: 1/2

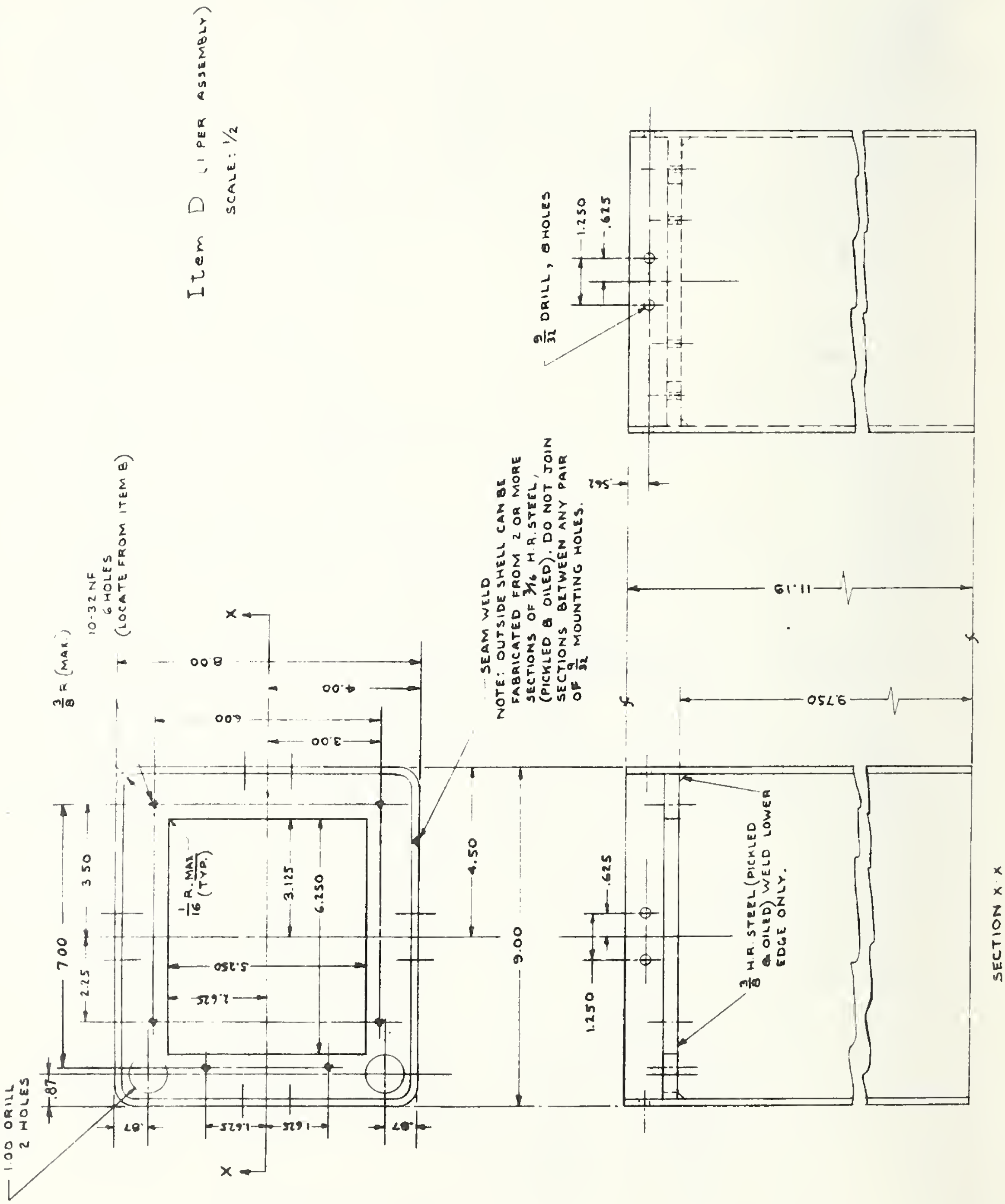


Item B (1 PER ASSEMBLY)
C.R. STEEL
SCALE:



Item C (4 PER ASSEMBLY)
C.R. STEEL
SCALE: 1/1





Item D (1 PER ASSEMBLY)
SCALE: 1/2
3/8 R (MAX)
10-32 NF
6 HOLES
(LOCATE FROM ITEM B)
SEAM WELD
NOTE: OUTSIDE SHELL CAN BE FABRICATED FROM 2 OR MORE SECTIONS OF 3/16 H.R. STEEL, (PICKLED & OILED). DO NOT JOIN SECTIONS BETWEEN ANY PAIR OF 9/32 MOUNTING HOLES.
9/32 DRILL, 8 HOLES
1.00 DRILL
2 HOLES
1/16 R. MAX (TYP.)
3/8 H.R. STEEL (PICKLED & OILED) WELD LOWER EDGE ONLY.
SECTION X-X

APPENDIX B

Instructions for Installation of Visual Alerting Devices on a GP40 Locomotive

INSTRUCTIONS FOR INSTALLATION OF VISUAL ALERTING DEVICES ON A GP40 LOCOMOTIVE

1.0 General Description

1. The visual alerting lighting fixtures for one locomotive consist of:

   - Five fluorescent panels (two of which have integral flashtubes)
   - Two dual (red and white) roof flashtube units
   - One Bi-color Radial Beacon (BRB).

   Figure 1 shows the general locations of these lighting fixtures on a GP40.

   (a) One plain fluorescent panel (without flashtube) will be mounted on the rear of the locomotive. Two panels, one of which contains a flashtube, will be mounted on each side of the power unit.

   (b) The BRB will be mounted on top of the front numbers compartment between the horns.

   (c) The roof flashers will be mounted on either side of the cab roof toward the front of the cab. Mounts have been constructed which are to be welded to the slanted portion of the roof to receive the flashtubes.

2. A lighting control panel will be mounted on top of the engineers control chassis. This panel contains five toggle switches. A bell operated-switch will be mounted by means of a bracket within the engineer's control chassis so as to be actuated by the bell

plunger. These six switches control all the lights in the system (except the headlights).

3. The BRB contains a 24 VDC bulb which operates on approximately twenty amperes. This makes it necessary to provide a ballast resistor to drop the excess voltage supplied by the power system. The ballast resistors and the relay to actuate the BRB will be mounted in the engine compartment near the existing resistors for the headlights.

4. There are two inverters for the operation of the flashtube lights. These will be mounted on the forward wall of the compartment in front of the cab.

5. All electrical leads will be routed through either rigid conduit or flexible conduit. Terminations will be made in junction boxes.

2.0 Hardware Installation

The following is the procedure for installing the system:

1. Cut a 4 inch diameter hole in the top center of the front numbers box between the horns. Weld the BRB mount to the top of the box in the location shown in the attached drawing (Figure 2). Be sure that the mount is centered on the 4 inch hole before welding.
2. Weld the two flashtube mounts to the slanted portion of the cab roof. (The precise location for these mounts has yet to be determined).

3. Weld tubular brackets to handrail stanchions to support the stringers on which the side panels are to be mounted. On either side of the locomotive both side panels should be attached to the same removable section of handrail.
4. Weld the brackets for the fluorescent rear panel to the rear wall of the train above the numbers and to the right of the headlights. Drill a 3/8" diameter hole in the train wall adjacent to the panel for entrance of the power leads.
5. Mount the Lighting Control Panel on the top right of the engineer's control chassis. A hole will need to be drilled in the back of the control chassis to accommodate the wires from this control panel. Feed the wires from the control panel into the control chassis.
6. Bolt the mounting bracket for the bell operated switch to the support brace adjacent to the bell plunger inside the control chassis. Provision has been made in this bracket for adjusting the position of the switch. See Figure 3.
7. Mount the two inverters for the roof and side panel flashtubes to the front wall of the forward compartment.
8. Mount the ballast resistors and the relay for the BRB to the forward wall of the engine compartment.
9. Install one 15 amp and one 30 amp circuit breaker in Circuit Breaker Cabinet. (After installation of all wiring, connect circuit breakers to power source.)
10. Mount Terminal Strip 11 (TS11) in engineer's control chassis.

3.0 Conduit and Wiring

Drawing 1 shows the schematic wiring diagram for the visual alerting system and Drawing 2 shows the conduit diagram. Reference to these documents will assist in understanding the following detailed instructions:

1. Install flexible conduit containing Wiring Harness 1 (WH1), Figure 4. WH1 runs from the circuit breakers (CB) to Junction Box 1 (JB1) located under the floor directly below the CB cabinet. WH1a runs from JB1 and terminates in JB1a connecting to the ballast resistors (through the relay contact) and relay coil. WH1b runs under the floor and connects JB1 with positions 0 and 5 on the Terminal Strip 11 (TS11) in the engineer's control chassis. WH1c runs under the floor to the front wall of the cab and goes up into the numbers box along side of existing wires for the headlights where it terminates in JB1b. Run leads (#10AWG) without conduit from JB1b through the hole provided in the numbers box roof for the BRB. Run leads (#16 AWG) from JB1b to the Fan Inverter mounted on the side of JB1b. Attach wires from the fan to Fan Inverter output.
2. Install flexible conduit containing WH2 which runs from TS11, positions 2, 3, 4 and 6 to JB2 (Figure 5). JB2 is located beneath the control chassis. In accordance with Figure 5, run wire pair B and triplets A, C, and D through flexible conduit from JB2 to JB2a adjacent to Power Supplies 1 and 2 located

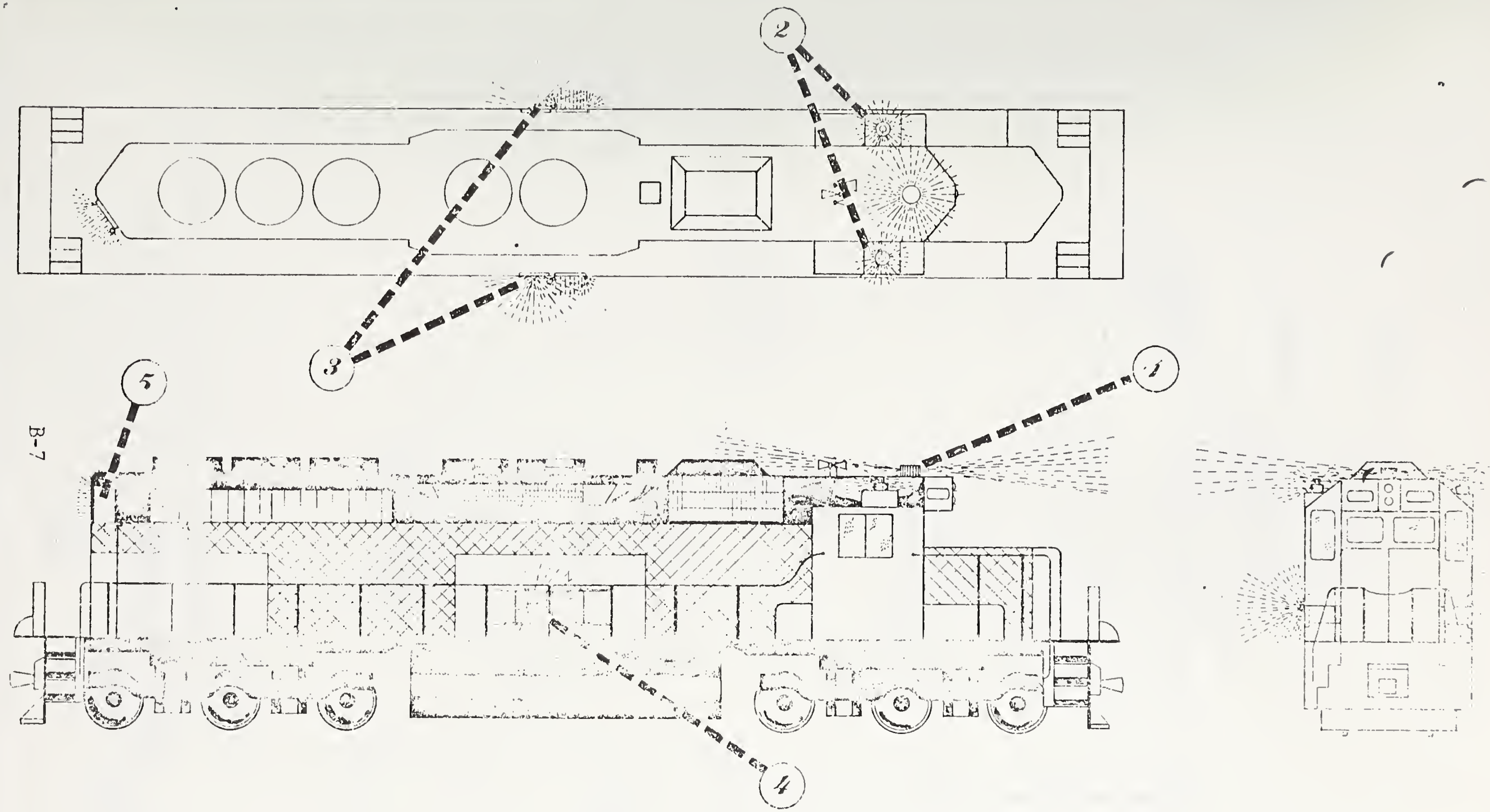
on the forward wall of the front compartment. Route wire triplets C and D and pair E from JB2 through rigid conduit to JB2b. The conduit should run from JB2 under the cab floor, exiting at a point below the walkway on the right side of the locomotive. From this point extend the conduit below the walkway to JB2b which is positioned on the underside of the walkway below the right side panels. Route wire pair E and triplet C from JB2b without conduit (but plastic jacketed as one cable) to the right side panels. Run separate wire pair E (plastic jacketed) to right side panels. Route wire pair E and triplet D through rigid conduit to JB2c. JB2c is mounted on the underside of the left walkway below the left side panels. Route wire pair E and triplet D from JB2c without conduit (but plastic jacketed as one cable) to the left side panels. Run separate wire pair E (plastic jacketed) to left side panels.

3. Connect wire triplet A (see Figure 6) from JB2a to Power Supply 1 (PS1) using plastic jacketed leads and connect wire pentads K and P (groups of 5) from PS1 to JB2a. Similarly, connect wire pair B from JB2a to PS2 using plastic jacketed leads and connect wire triplets C and D from PS2 to JB2a.
4. Install flexible conduit containing WH3 which runs from JB2a through the roof of the numbers box to JB3 which is located on roof (see Figure 7). WH3 consists of wire pentads K and P.

Route wire pentad K through rigid conduit to JB3a which is attached to the left roof flashtube mount. Similarly, route wire pentad P through rigid conduit to JB3b which is attached to the right roof flashtube mount. Attach the pigtail cabling assembly from each flashtube unit to the respective junction boxes.

5. Terminal Board 23 (TB23) and TB52 are presently installed in the GP40 (refer to GP40 locomotive wiring diagram). TB23 is located about half way down the right side of the locomotive within the engine compartment. TB23 has spare leads which connect to TB52 located inside the engineer's control chassis. Run 2 wires from TS11, position 1, to TB52 and connect to spare wires running to TB23. Install WH4 (Figure 8) through flexible cable from TB23 along the floor of the engine compartment to a point on the rear wall adjacent to the hole drilled for the power lead to the rear panel. Install JB4 for terminating the leads. Run cable from rear panel, through hole to JB4.

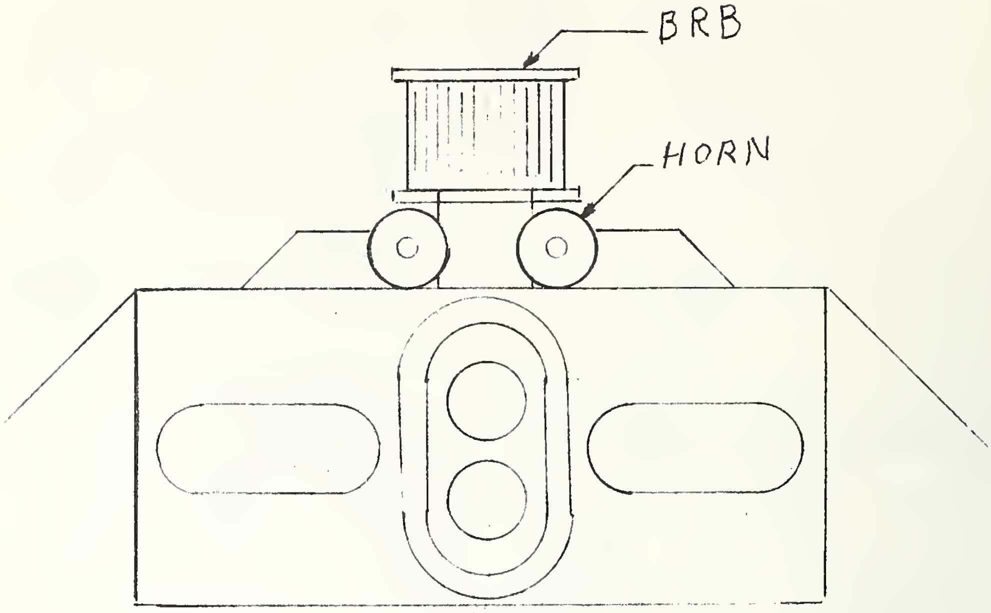
6. Attach leads from Lighting Control Panel switches to appropriate positions on TS11 as shown in Drawing 1.



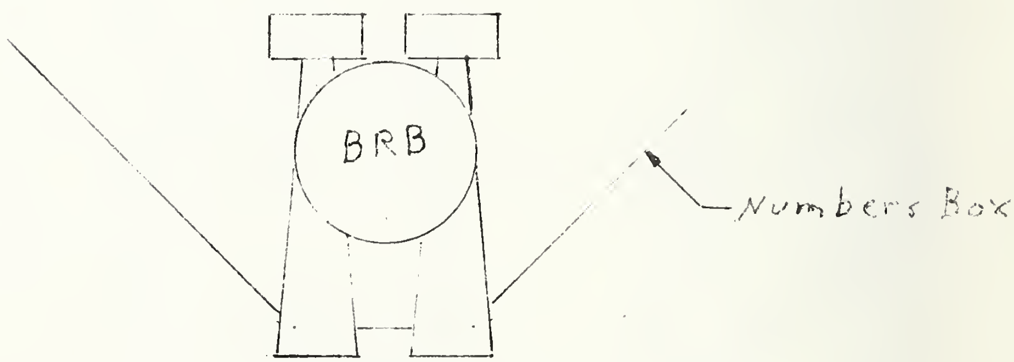
Legend

1. Bi-color Radial Beacon
2. Flashtube
3. Side Panel Light
4. Side Panel Light, one panel with Flashtube
5. Rear Panel Light

FIGURE 1 - Locomotive roof, side and rear lights.



FRONT VIEW



TOP VIEW

Figure 2. Location Drawing for the BRB

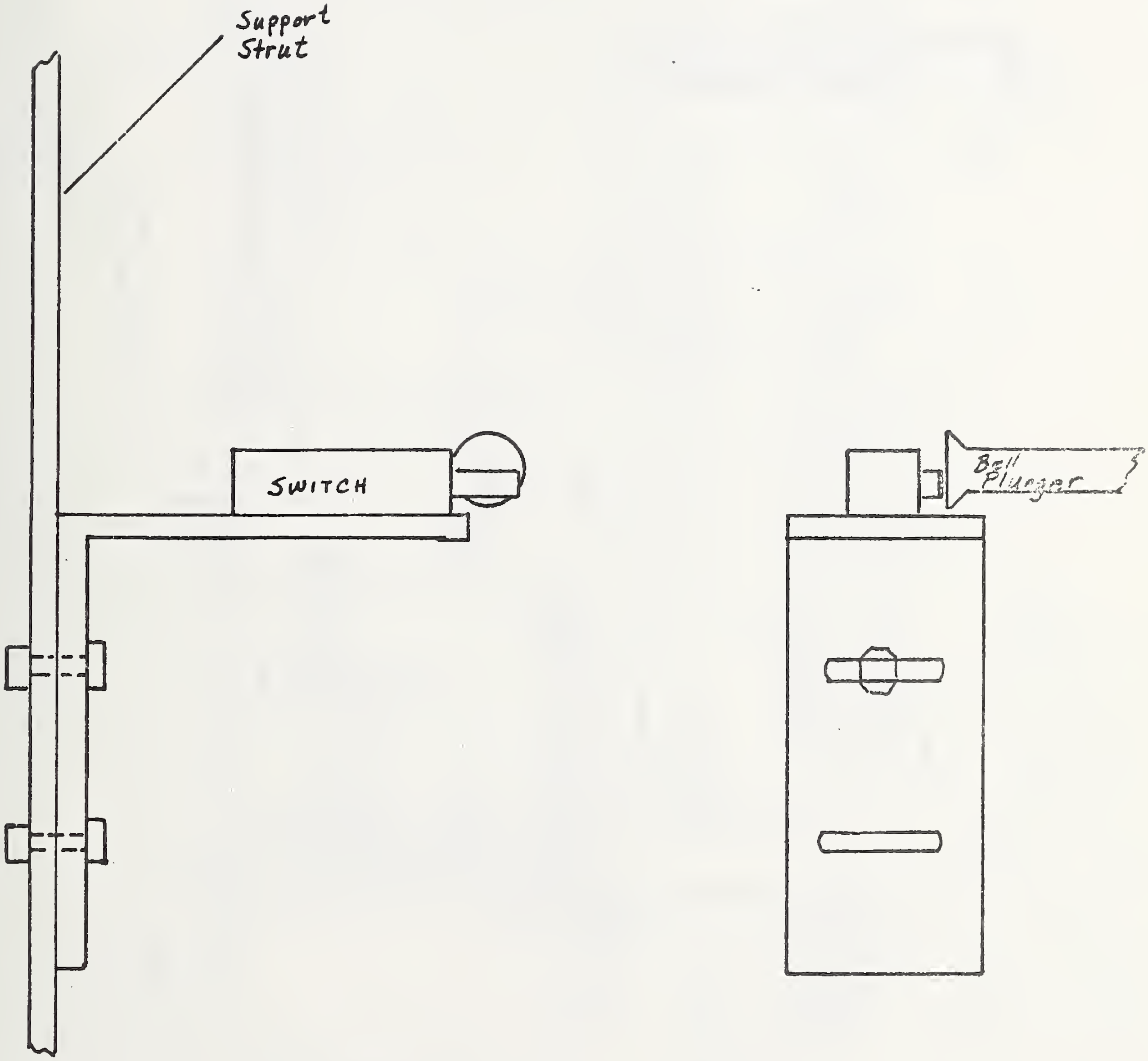
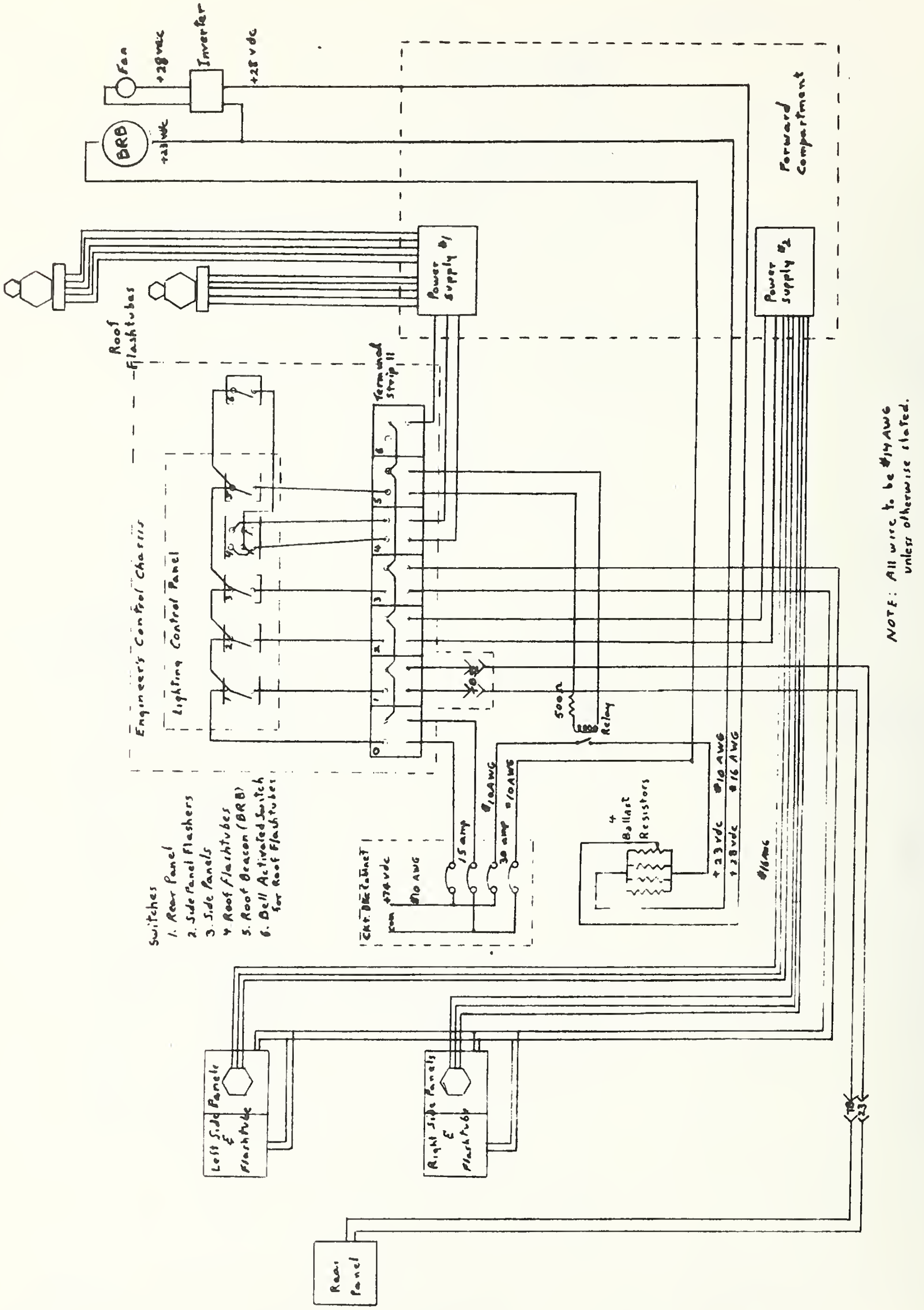
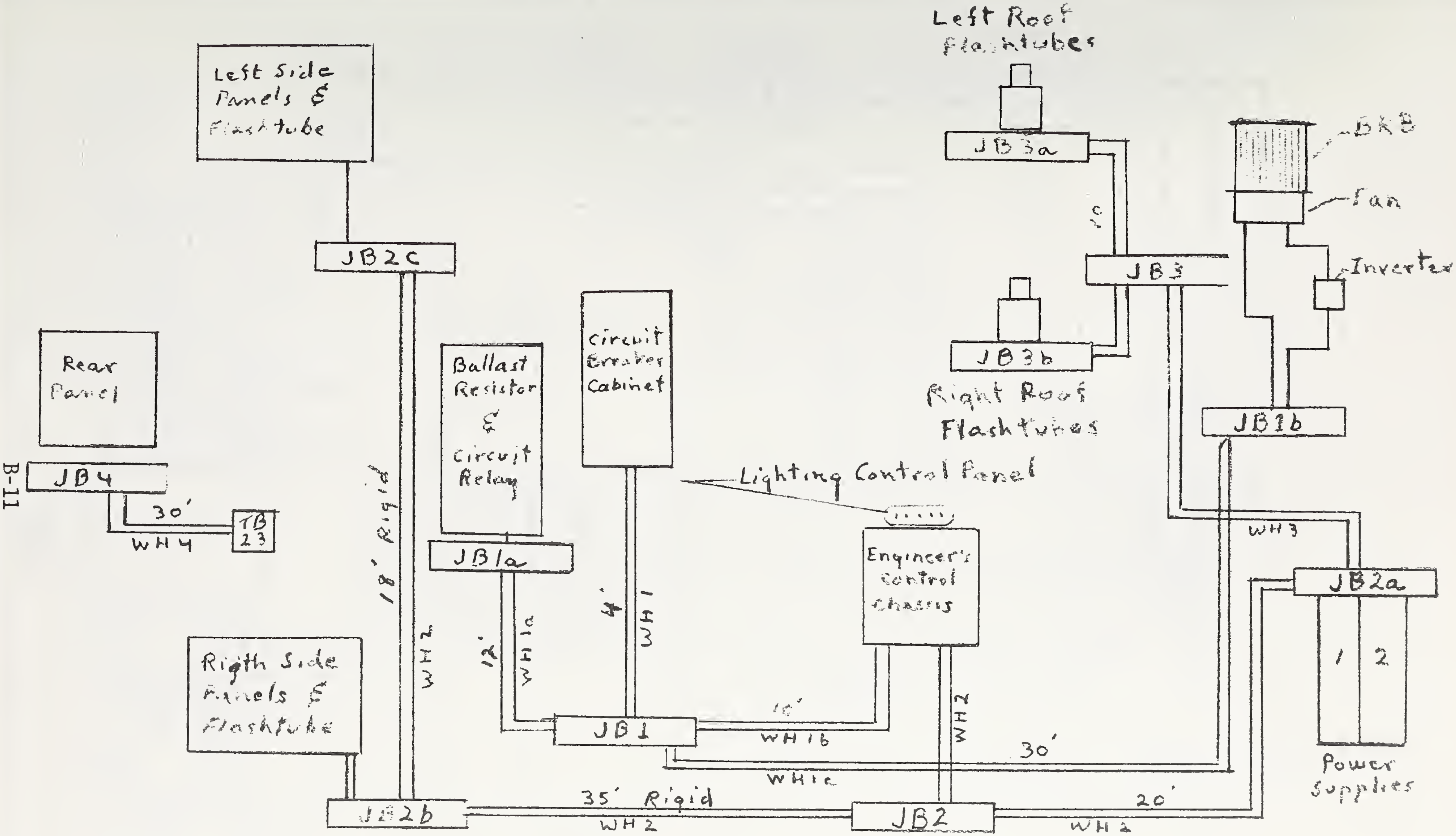


Figure 3. Switch Installation
VISUAL ALERTING SYSTEM



Drawing 1. Schematic Wiring Diagram for GP-40 Visual Alerting System



NOTES: 1 All conduit will be 1/2" o.d. flexible unless otherwise stated.

2 All conduit lengths are approximate; conduit should be tailored to fit.

3. Watertight adapters should be used where wire feeds from the junction boxes to the panels.

Drawing 2. Conduit Diagram

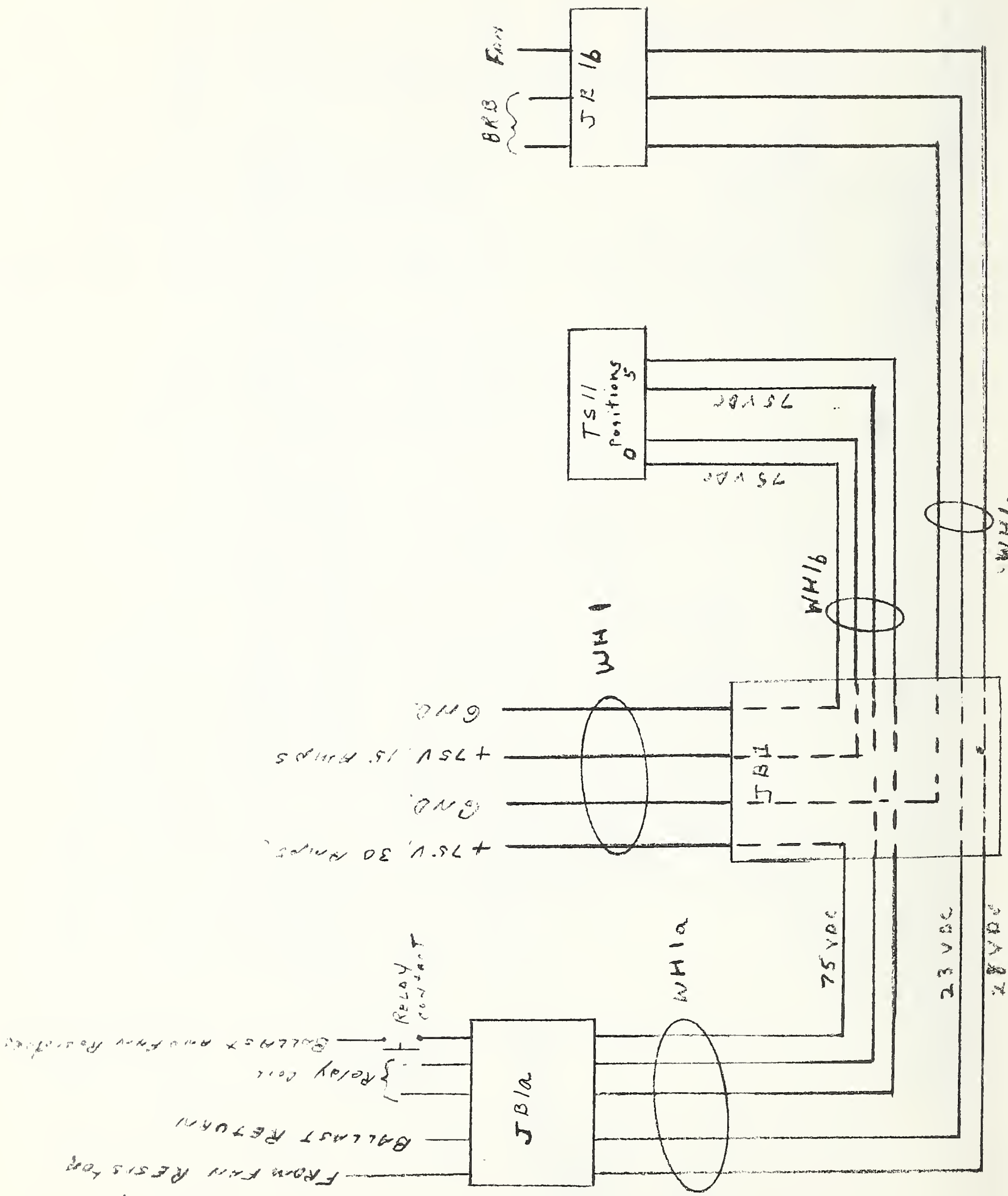


Figure 4. Wiring Harness 1

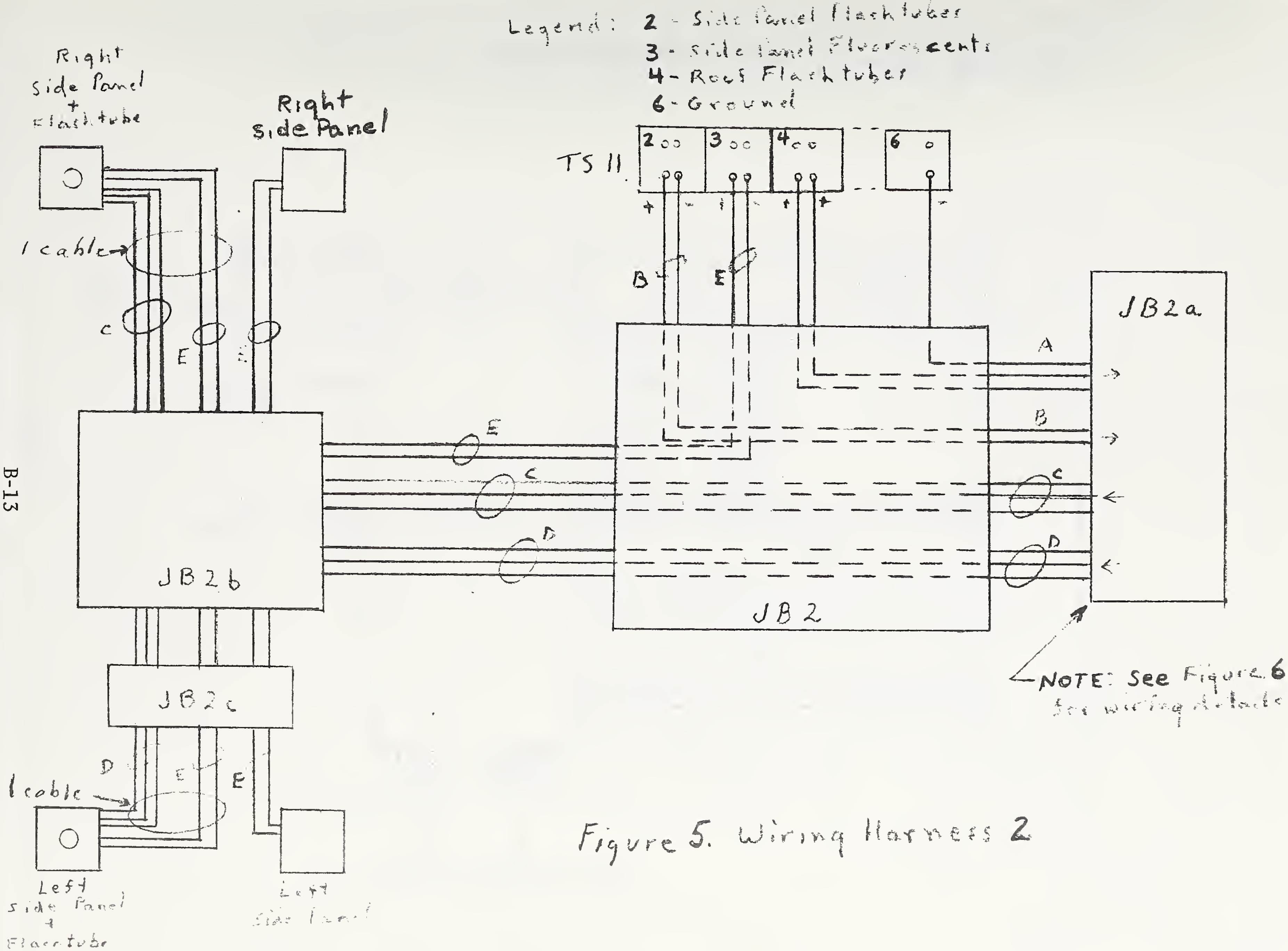


Figure 5. Wiring Harness 2

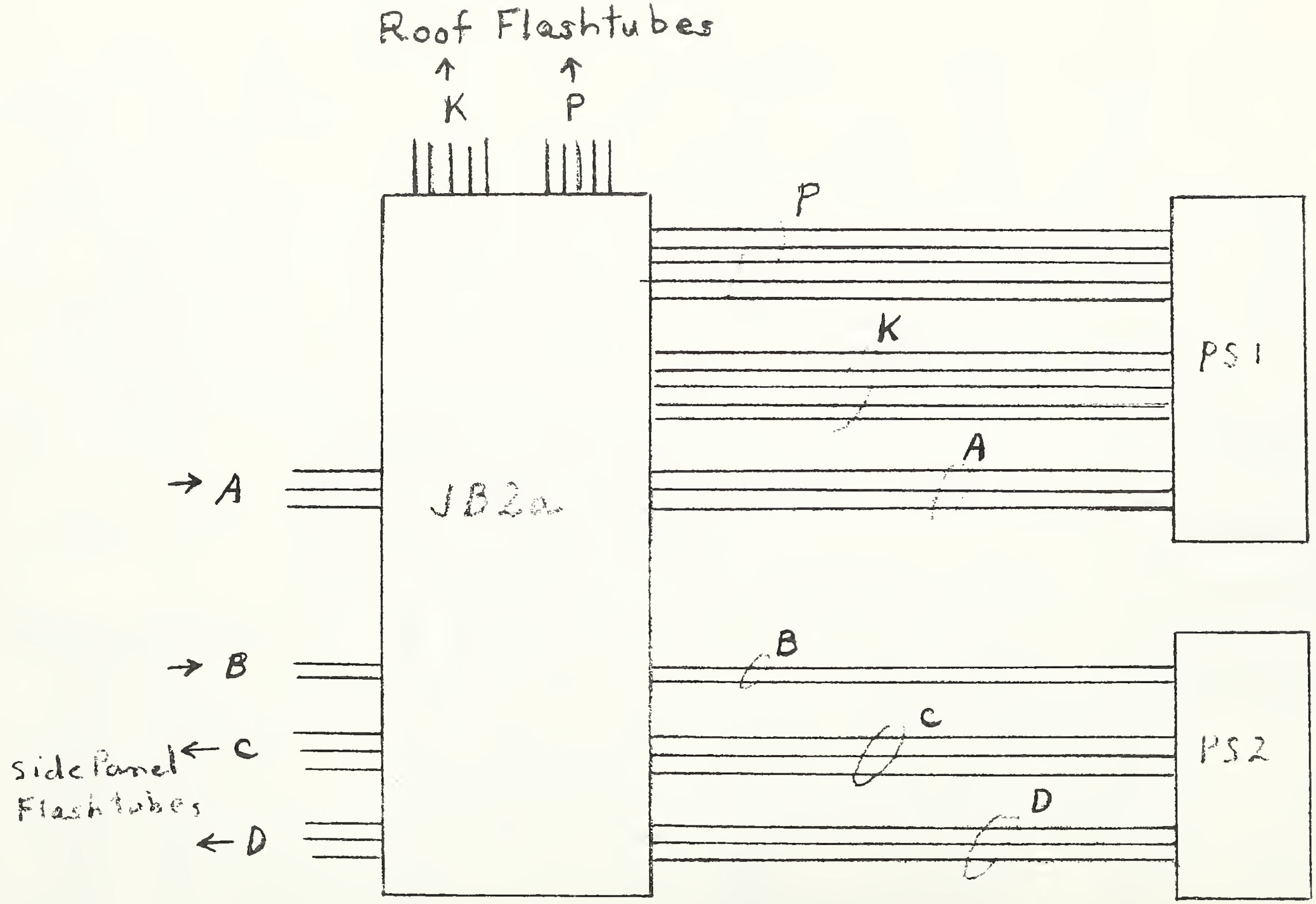


Figure 6 Wiring Details for Junction Box 2a

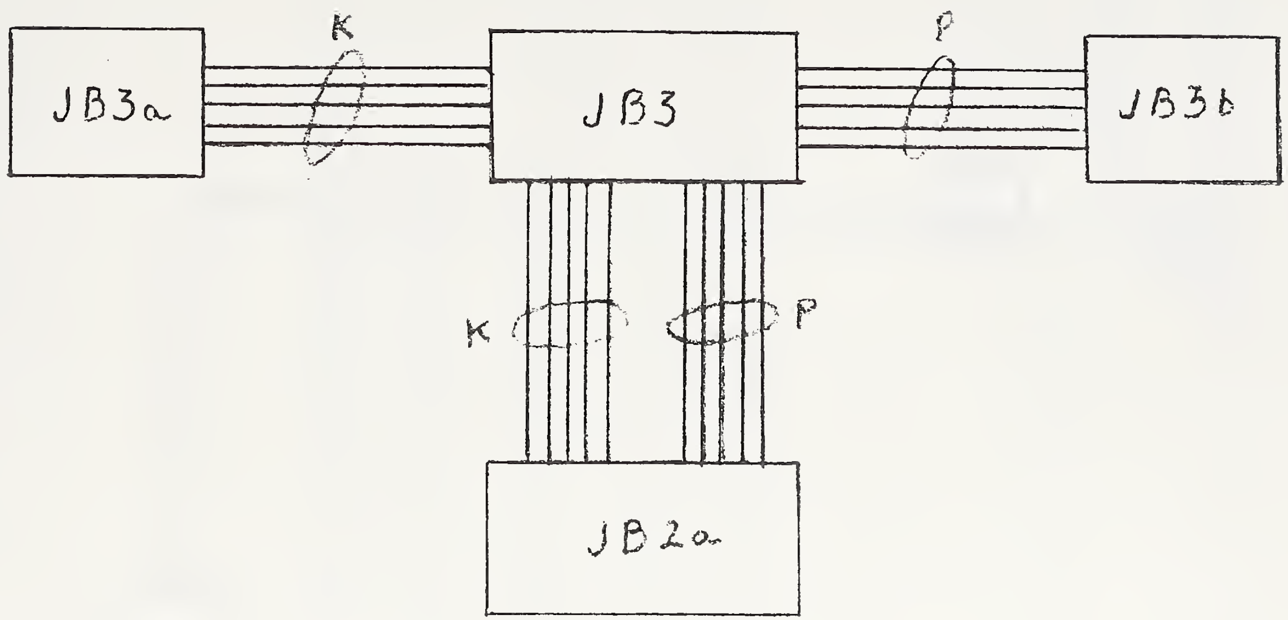


Figure 7. Wiring Harness 3

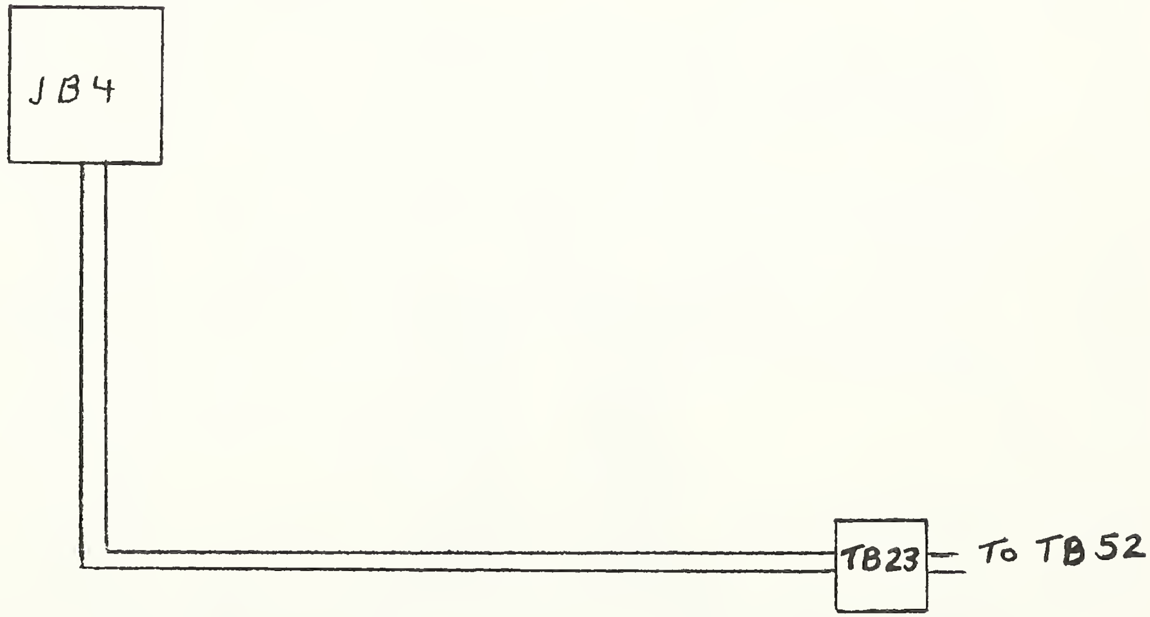


Figure 8. Wiring Harness 4

FORM NBS-114A (1-71)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBSIR 73-253	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE Description and Performance Characteristics of Engineering Models of Visual Alerting Devices			5. Publication Date July 1973 6. Performing Organization Code --
7. AUTHOR(S) J.R. Lepkowski and W.F. Mullis			8. Performing Organization NBSIR 73-253
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234			10. Project/Task/Work Unit No. 4314477 11. Contract/Grant No. FRA-AR 20033
12. Sponsoring Organization Name and Address Federal Railroad Administration U.S. Department of Transportation Washington, D.C.			13. Type of Report & Period Covered Final Inter-agency, 7/1/72-6/30/73 14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

Physical descriptions and performance characteristics of a Visual Alerting System for railroad locomotives are given. The system consists of:

1. Bi-color Radial Beacon: This device projects alternating red and white rays of light from the cab roof.

2. Side Panels: Two 2 x 2 foot lighted panels are mounted on each side of the locomotive. Within one of each pair of panels is a flashtube for increased conspicuity.

3. Roof Flashers: A dual red-white flashtube unit is mounted on either side of the cab roof. White for daytime and red for nighttime use.

4. Rear Panel: A 2 x 2 foot lighted panel mounted on the rear of the locomotive. It is primarily intended for yard switching operations.

17. KEY WORDS (Alphabetical order, separated by semicolons)

Beacon; flashtube; panel light; visual alerting device

18. AVAILABILITY STATEMENT	19. SECURITY CLASS (THIS REPORT)	21. NO. OF PAGES
☐ UNLIMITED.	UNCLASSIFIED	72
☒ FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NTIS.	20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price