SERVICE MANUAL 5958

Description, Installation, and Maintenance

GRADE CROSSING WARNING SYSTEMS

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UNION SWITCH & SIGNAL

REVISION INDEX

This service manual supercedes all previously issued SM5958 manuals. Destroy all previously issued manuals. Future revisions to this manual will be handled by and addendum where as revised pages will be provided only.

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Figure 1-1. Typical Grade Crossing Warning System

SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides a complete overview of Union Switch & Signal's Grade Crossing Warning Systems (Figure 1-1). The information contained in this manual, although general in nature, can be used as a valuable guide in the installation, operation, and maintenance of the US&S supplied equipment. Specific application information, if required, is presented in separate supplements to this manual.

Grade Crossing Warning equipment (Figure 1-2) is offered in many different configurations to satisfy various site requirements. Systems can be provided with flashing lights only or with flashing lights and gates. Flashing lights can be arranged for normal highway applications, converging highways, or for use with cantilevers. The lights can be either one-way or two-way (back to back).

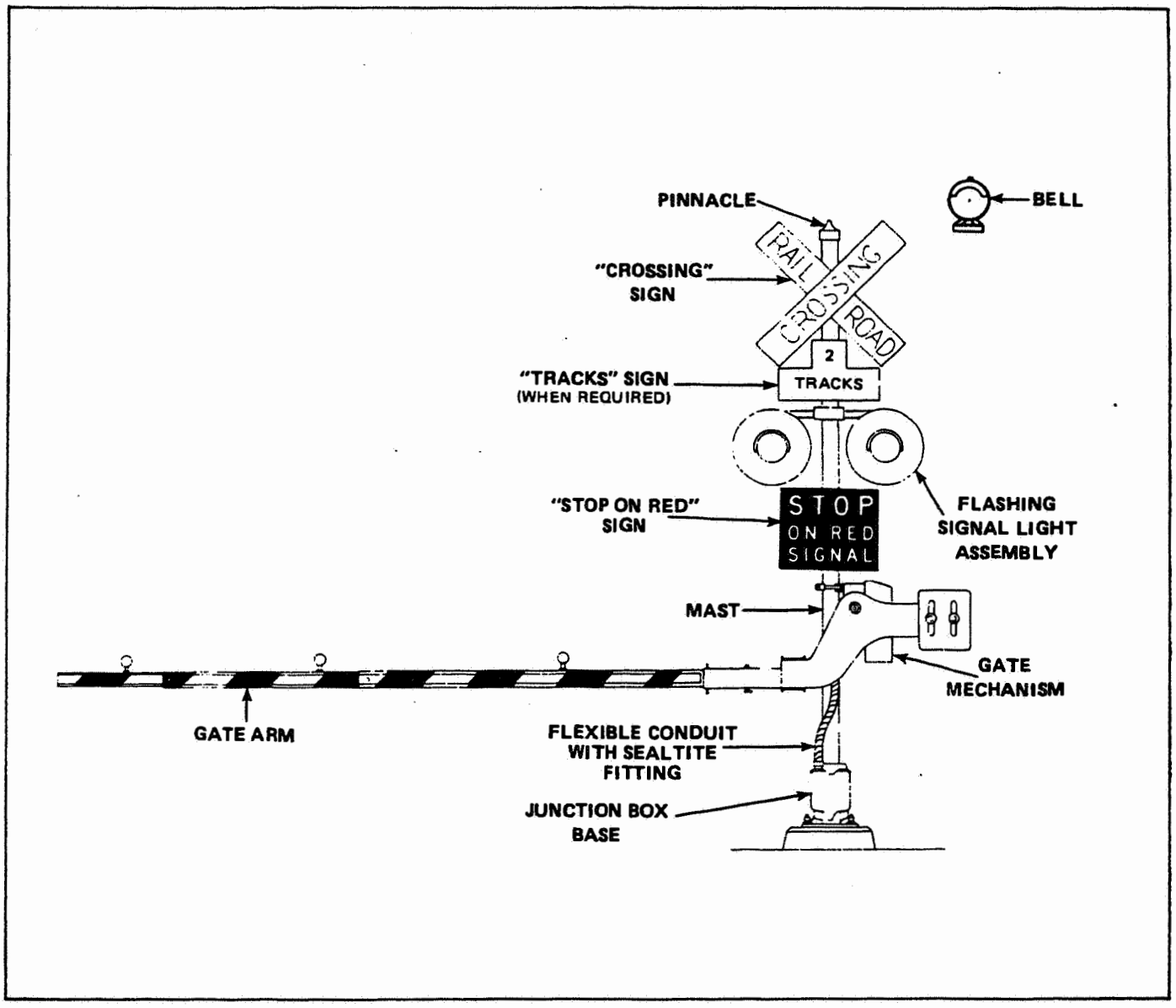


Figure 1-2. Grade Crossing Warning Assembly with Gate

Different control schemes are also available. These range from the very basic for use at industrial sidings, such as our AW-10 Area Directional Warning System, to our very sophisticated MM-25 Motion Monitor equipment.

1.2 EQUIPMENT DESCRIPTION

1.2.1 Flashing Light Assembly (Figure 1-3)

Flashing light assemblies consists of a XA-120 Junction Box Crossarm on which are mounted the flashing light units. The flashing light units are either the standard HC-100 (8-3/8" lens) or for increased light output the HC-120A (12" lens). Assemblies are available for 1-way and 2-way (back-to-back) applications and for use with crossing assemblies equipped with fiberglass, aluminum or wood gate arms, and for cantilever installations. The light units are equipped with a hood and either the standard 20" background or the 24" background (HC-120A Unit Only).

1.2.1.1 HC-120A Flashing Light Unit (Figure 1-3)

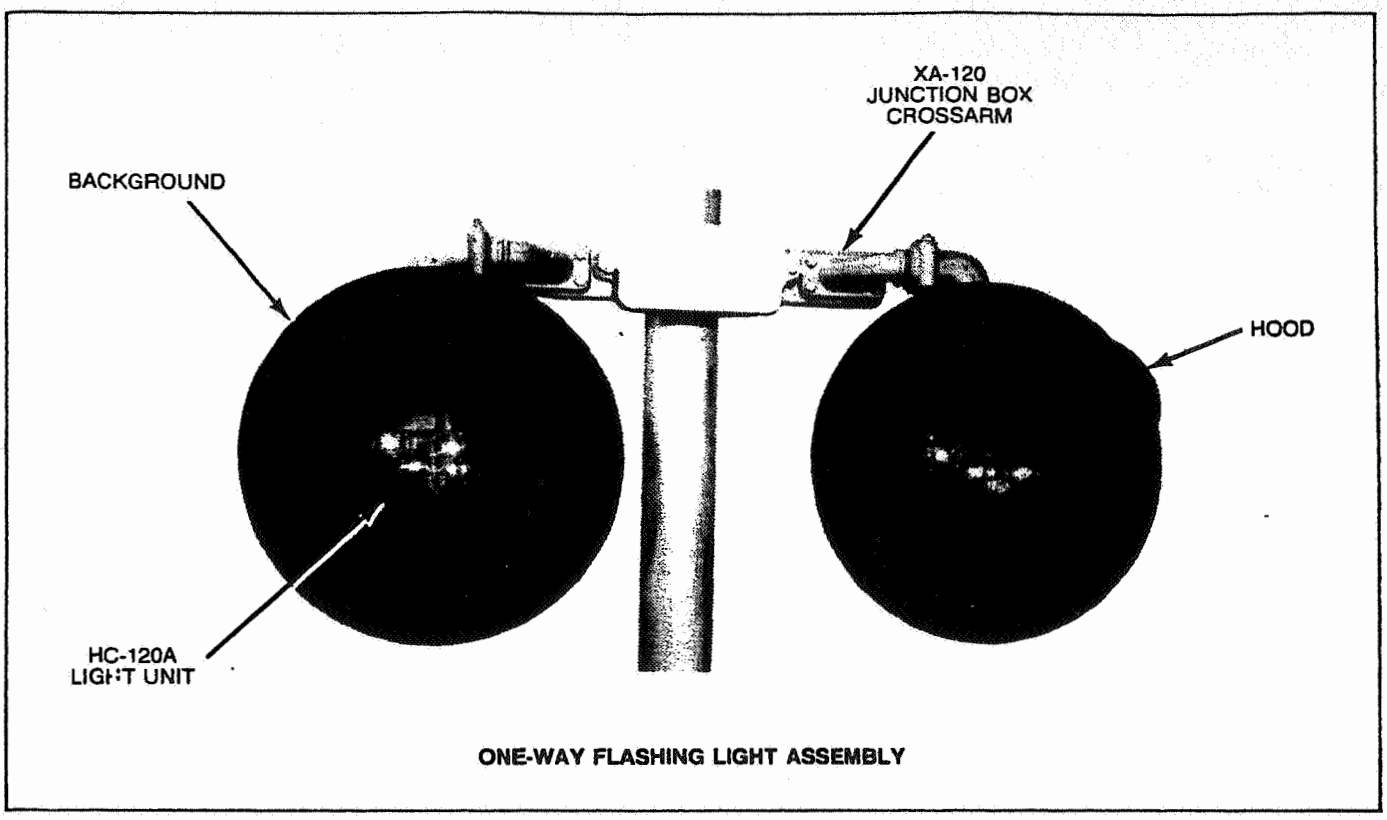
The HC-120A Light Unit is constructed of aluminum with stainless steel hardware, and utilizes a 12" deep dish paabolic refelector with a 12" red Lexan ^{R} roundel. The reflector is center mounted for easy replacement. The roundels come in different beam spread and deflection combinations. Therefore, when replacing a roundel in the field, it is important that it is replaced with one of the same kind. The cover, which is secured by a bolt that accepts the AAR terminal wrench, swings open to provide easy access to the interior for changing the lamp, interior cleaning, or other maintenance.

The lamp socket is brass plated and its mounting allows for X, Y, Z axis lamp location adjustment. The socket accepts 10 or 25-watt, 10-volt S-11 lamps; 25-watt 110-volt G-16-1/2 lamps; or 10-volt 16 or 36-watt Quartz-Iodide lamps. Voltage reading can be taken at the bulb for battery adjustments.

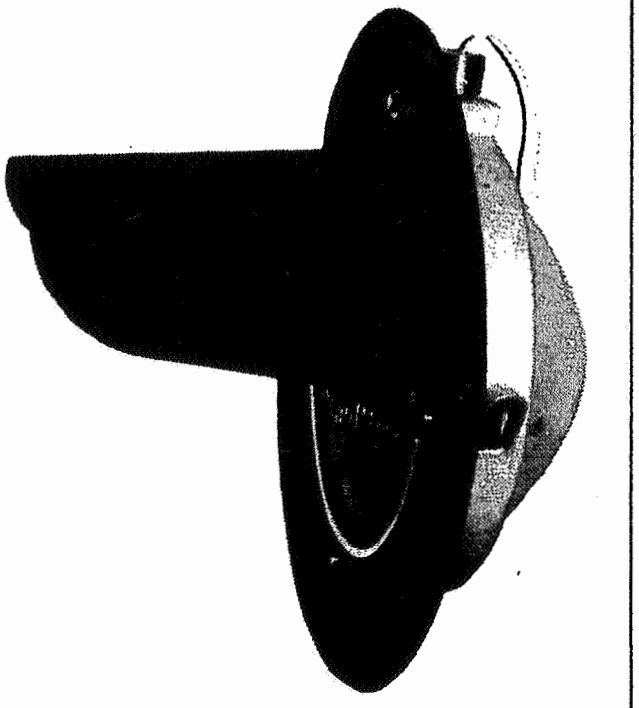
The light unit has a standard 1-1/4" straight pipe thread suitable for mounting the unit to all type crossarms.

1.2.1.2 HC-100 Light Unit (Figure 1-3)

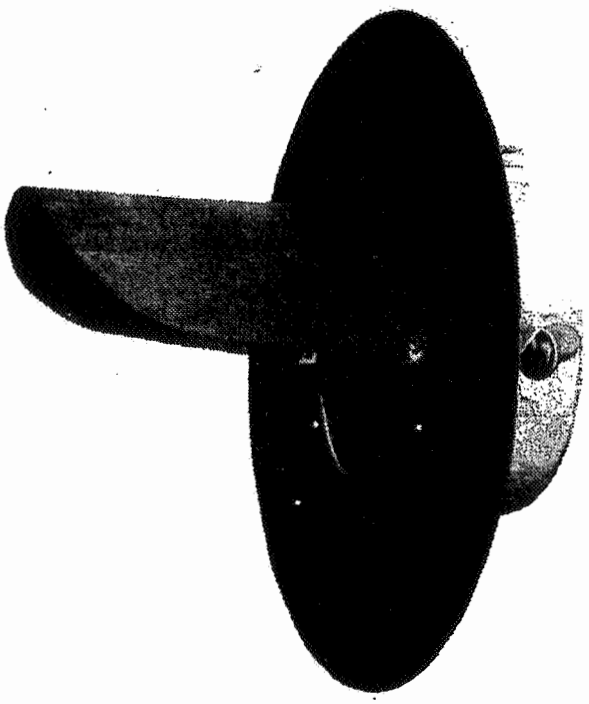
The HC-100 Light Unit is constructed of aluminum for long service life and easy maintenance. It is equipped with a standard reflector and 8-3/8" roundel. The roundels are available in red Lexan ^{R} or red plexiglass, and yellow glass for special applications. Roundels come in different beam and spread combinations. Therefore, when replacing a roundel in the field, it is important that it is replaced with one of the same kind. The cover swings open for easy access to the interior for lamp replacement and other maintenance. The lamp holder is also 3-axis (X, Y, and Z) adjustable and uses the same lamps as the HC-120A Light Unit described in paragraph 1.2.1.1.



ONE-WAY FLASHING LIGHT ASSEMBLY



HC-120 LIGHT UNIT



HC-100 LIGHT UNIT

Figure 1-3. Flashing Light Assembly

1.2.1.3 XA-120 Junction Box Crossarm (Figure 1-3)

Junction Box Crossarms are available in different configurations to provide a wide range of applications. The crossarms are constructed of aluminum for long service life, minimum maintenance, and ease of installation. The junction box, used for interconnecting the wiring, contains standard AAR terminals complete with terminal nuts and washers. Removable end plates are provided on the arms for easier access to the wires for stringing. Threaded elbows allow for independent horizontal (azmiuth) and vertical (range) adjustments of each signal. Attaching hardware consists of a U-bolt clamp and nuts. The nuts are located in the junction box.

1.2.2 Model 75 Crossing Gate Assembly (Figure 1-4)

The Model 75 Crossing Gate Assembly consists of the Model 75 Gate Mechanism and either aluminum, fiberglass, or wood gate arms. The automatic crossing gate is completely adjustable and is adaptable to 2 wire or 3 wire circuitry.

1.2.2.1 Model 75 Gate Mechanism (Figure 1-4)

The gate mechanism is mounted on a steel chassis, and is housed in an aluminum enclosure. The mechanism comes either with the DN-22A relay for 2 wire control circuitry or without for 3 wire control circuitry. The Gate is locked into the clear position by an electromagnetic brake. If the power fails, the gate arm drops to the horizontal.

The mechanism consists of the following: a permanent magnet dc electric motor, which requires a nominal 12-volt power supply, driving through a 115:1 gear reduction train; a hold clear unit (sometimes called electric brake) which is located on the motor armature shaft; and a circuit controller assembly, which has four contacts operated by a cam. Two circuit controller contacts are wired for mechanism control and two contacts are available for controlling external circuits, such as the bell and the clear position repeater relay. Contacts 1B-1C and 2B-2C are adjustable from 70 to 93 degrees.

Rubber bumpers are provided at 0- and 90-degree positions of the mechanism. A stop bolt is used in the top bumper to adjust the gate arm position when the arm is horizontal.

The splined ends of the main shaft extend out both sides of the mechanism for mounting the cast aluminum arm supporting members. The counterweights are attached to these supporting members and the support bracket for fiberglass, aluminum, or wooden arms. The total weight of the operating mechanism alone is approximately 225 pounds.

To facilitate maintenance, torque readings can be taken directly off the main shaft, and the gate arm can be manually cranked up or down. Also provided is a power cut-out link which cuts internal power to the mechanism without affecting power to the bell, arm lights, or signal flashers.

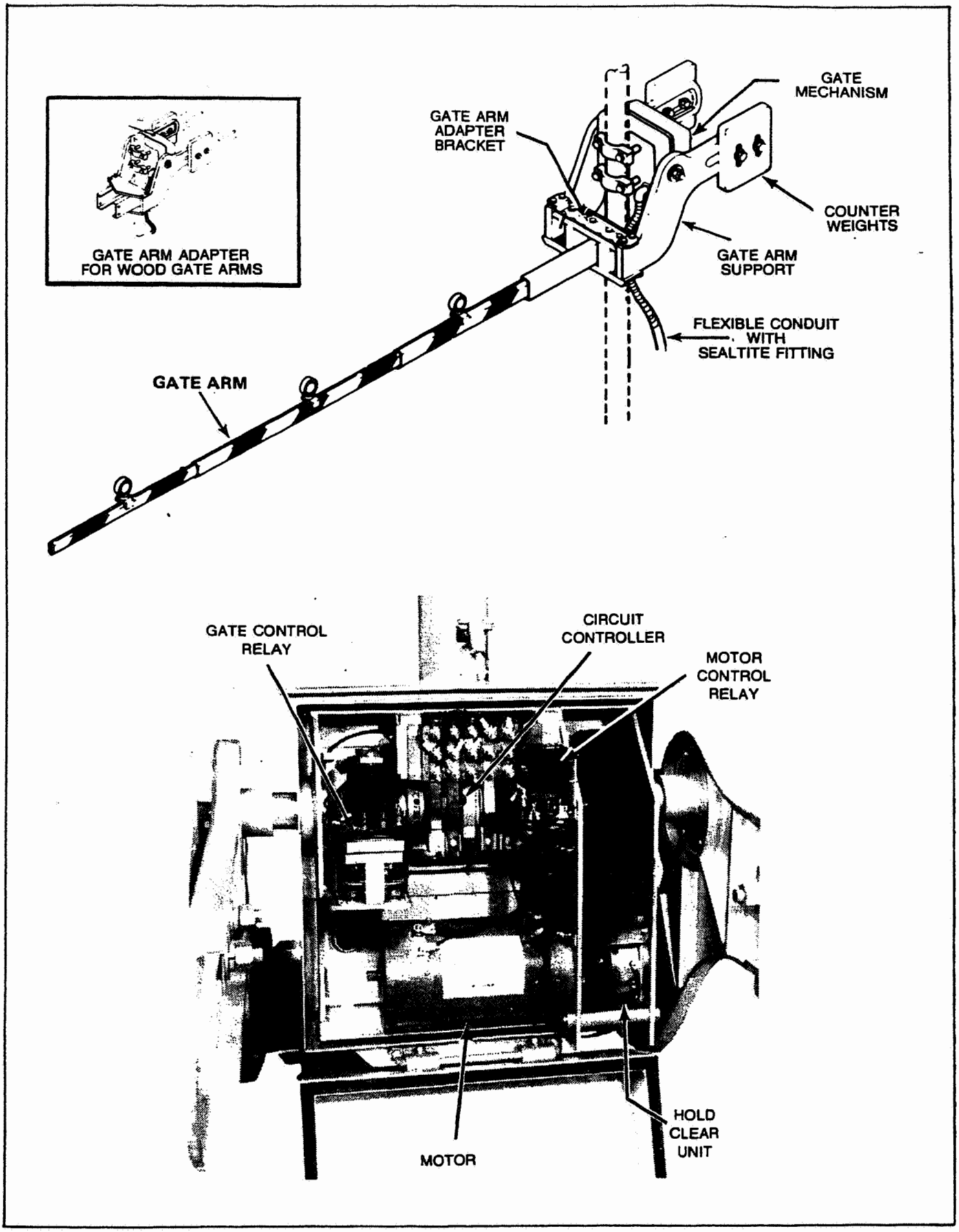


Figure 1-4. Model 75 Crossing Gate Assembly

1.2.2.2 Gate Arms (Figure 1-4)

Gate arms are either wood or telescoping aluminum or fiberglass. US&S does not provide wood gate arms. The telescoping aluminum gate arm consists of three sections of extruded aluminum. The telescoping fiberglass gate arm consists of the first section of extruded aluminum, and the second and third sections of pultruded glass reinfored polyester thermoset (fiberglass). Both come in adjustable lengths from 17 to 40 feet.

To warn on-coming vehicular traffic, three 10-volt weatherproof bi-directional 4" or 7" lights are mounted on the arm. Each is plug connected to the main harness. A plug connector is provided in the wiring harness between the first and second arm sections to facilitate arm replacement. Another plug connector is located between the gate arm and the mechanism. Additional warning is provided by the alternate Scotchlite reflective red and reflective white sheeting on the arms.

The gate arm is linked to the support assembly by a shear pin which helps to prevent mechanism damage if the arm is struck.

1.2.2.3 Counterweights (Figure 1-4)

Counterweights are supplied to suit each corresponding length of the gate arm. The weights are approximately the same for both fiberglass and aluminum arms. The weights are secured to the gate support arm supports with bolts and nuts. This allows for moving the counterweights forward or backward for proper gate arm balance and operation.

1.2.3 Bell Unit (Figure 1-5)

The bell unit is a Model BA-10 with a 12-inch steel gong mounted on a cast aluminum housing with a rain hood. A hinged aluminum cover is provided for easy access to the operating mechanism. The operating mechanism is a rotary solenoid driving a clapper. The solenoid is sealed against dirt and foreign material and requires no lubrication. Operating voltage is 10 Vdc, producing a sound level of 105 - 113 dbA at 180 - 190 strokes per minute.

1.2.4 Masts (Figure 1-2)

Masts for grade crossing warning assemblies come in two lengths; 13'6" and 15'3". The 13'6" mast is used in standard installations, while the 15'3" mast is used for converging highway applications. On the 15'3" mast, an additional hole is drilled at the appropriate degree from center to accommodate the additional crossarm.

Masts are constructed of aluminum for easy handling, long life, and minimum maintenance. Both 4" and 5" diameter masts are available. In general, the 5" diameter mast is used when the grade crossing warning assembly is equipped with automatic gates. Refer to Section VI for additional data, including ordering information.

1.2.5 Junction Box Base (Figure 1-2)

Aluminum Junction Box Bases are available for both the 4" and 5" diameter mast. They are used to support the mast and for terminating underground cable and for making circuit connnections. Bases come with either 12 or 24 AAR terminals, depending on application. A plain clamp base is also available for the 4" diameter mast. Refer to Section VI for additional data, including ordering information.

1.2.6 Signs (Figure 1-2)

Grade crossing warning signs are made of aluminum and include all hardware necessary for mounting. Signs are provided either in engineering grade Scotch-Lite ^{R} or Hi-intensity reflex-reflection, and conform to AAR requirements. The signs are: Railroad Crossing, Tracks, and Stop on Red Signal. Refer to Section VI for additional data, including ordering information.

1.2.7 Equipment Cases (Figure 1-6)

Equipment cases, located at wayside are provided in different sizes to accommodate the control equipment and ancillary items. They include the train detection equipment, plug-in relays, batteries, power supply components, and miscellaneous. These cases, constructed from Cor-Ten Steel, are provided with front and rear full size locking doors. Provisions are made for shelves and backboard.

1.3 CONTROL CIRCUITS

Standard DC, AC/DC, AFO (Audio Frequency Overlay), High Frequency and Motion Monitor track circuits are used to provide train detection for grade crossing warning control systems. To properly maintain the system, it is important to know what type of track circuit is used. For information on the different control circuits, refer to Section IV.

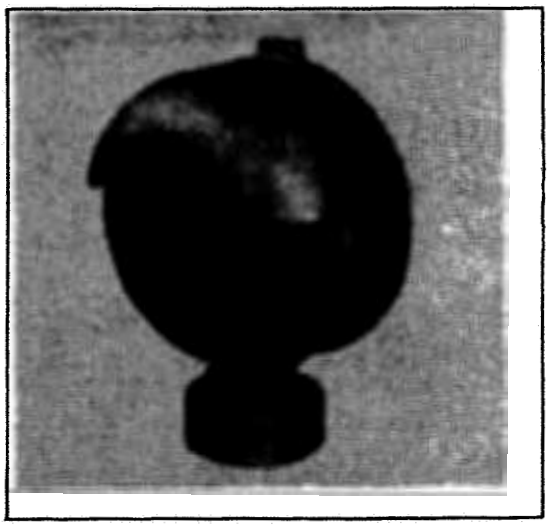


Figure 1-5. Crossing Bell

1.4 SUPPORTING PUBLICATIONS

For complete information on the components comprising a grade crossing warning system including maintenance and parts list, refer to Table I for a listing of all applicable service manuals.

Table I. List of Service Manuals

Model 75 Crossing Gate	SM6043
Flashing Light Unit w/Junction Box Crossarm	SM6326
BA-10 DC Aluminum Bell	SM6094
AFO-IIC Audio Frequency Overlay Track Circuit	SM6134
ATT-20 Audio Track Tranceiver	SM6299
AW-10 Directional Area Warning Device	SM6133
MM-25 Motion Monitor	SM6252
Type C Track Circuit	SM6120

1.5 MATERIAL, TOOLS AND EQUIPMENT

Normal cleaning materials consisting of clean lint free cloths, soft bristle brush, compressed air in aerosol can and a commercial detergent and solvent. Other than the tools required for the gate mechanism (refer to SM6043), no special tools are required to install and maintain the equipment, and the only test equipment required would be a good multimeter. Grease for the gate mechanism, called for in paragraph 5.2.3, should be made available.

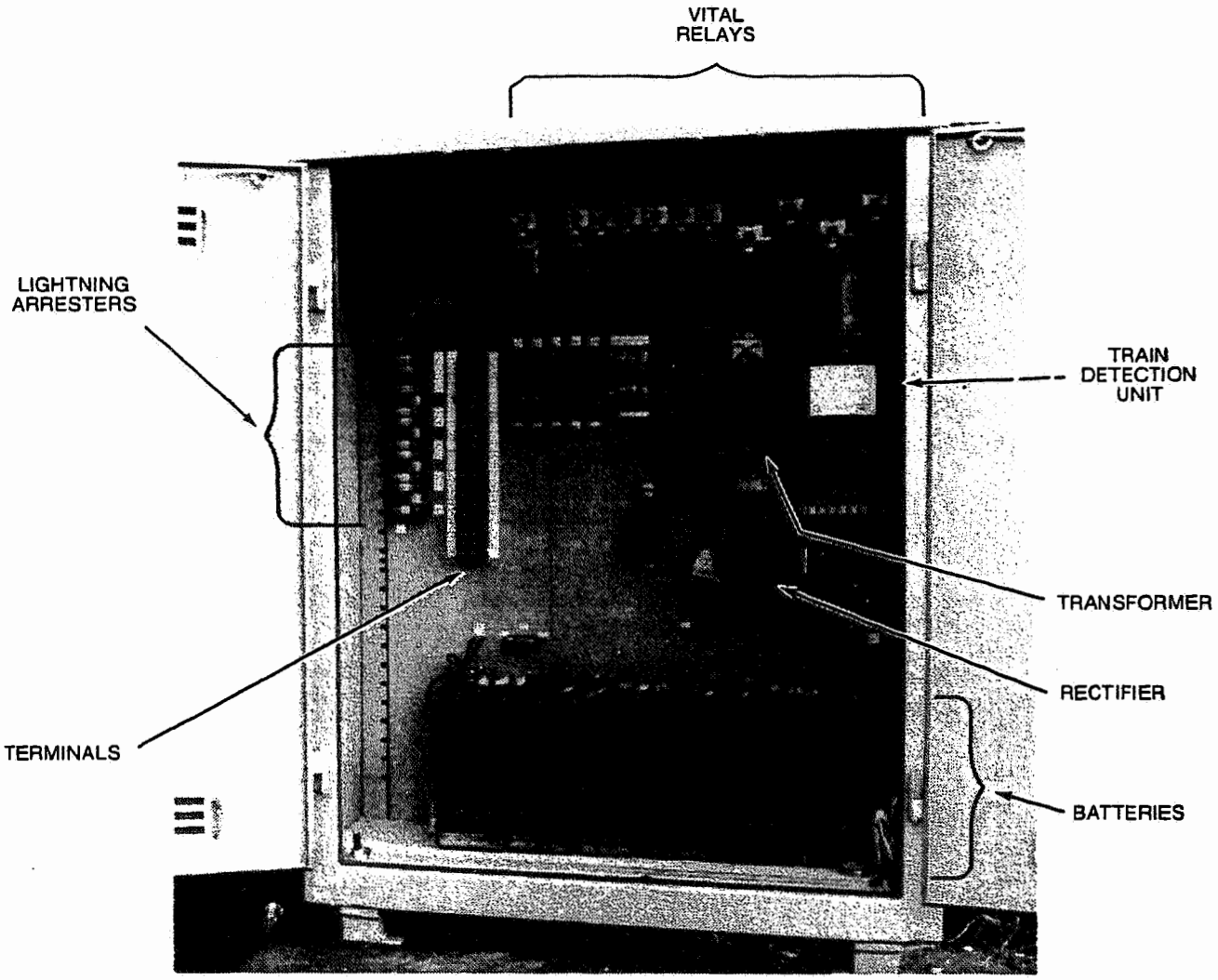


Figure 1-6. Typical Grade Crossing Control Equipment Case

SECTION II
APPLICATIONS

2.1 GENERAL

Grade Crossing Warning Systems can be applied anywhere a highway crosses a railroad. The type of equipment installed, and the type of control used is dependent upon many factors. For example; because of the terrain a cantilever may be required, or warning lights for converging highways may have to be installed. In certain areas, warning gates may also be required. When planning a grade crossing warning system all factors must be considered.

The train detection track circuit and control circuits must also be determined. For example: in coded track circuit territory, AFO equipment should be used. Where train traffic involves frequent stop, restart and reverse movements, motion monitor control is recommended. Section IV provides a brief description of the different controls available. For detail information, refer to the applicable service manual listed in Table I.

Because of the many variables, it is not practical to cover all the applications possible in this manual. For the equipment and controls that apply to a specific location, refer to the applicable layout drawings and circuit diagrams.

SECTION III
INSTALLATION

3.1 GENERAL

The plans and circuit diagrams developed for the specific location must be followed when installing a Grade Crossing Warning System. The following data are provided to guide in the proper planning and installation of the equipment. All equipment must be installed in accordance with rules and regulations imposed by municipal, state, and federal government agencies.

3.2 PRE-PLANNING

Because of the many variables involved, a site survey is recommended to determine the specific system to be installed. Table II is a typical site survey check list that can be adopted to suit particular needs. Upon completion of the survey, a plan should be made to show the location of all components and the sources of power. Based on this plan, a cabling diagram can be developed showing the length of cable runs between components and track, and the number of wires required for each cable. Information to be considered in a survey is covered in paragraphs 3.2.1 and 3.2.2.

3.2.1 Cable and Wire Requirements

Recommended cable and wire requirements are as follows:

a. No. 8 AWG in lengths of less than 50 feet.

b. No. 6 AWG in lengths of 50 feet to 120 feet.

c. Wire size would be proportional for longer lengths.

d. For track circuit connectors use 1-conductor No. 8 AWG underground cable, non-metallic sheath.

e. For connections to signals use 5-conductor No. 9 AWG underground cable, non-metallic sheath or single conductor No. 10 AWG underground.

f. For wiring signal units use 1-conductor No. 14 AWG flexible wire, 3/64-inch wall insulation, neoprene compound sheath, or equivalent.

g. For bonding track circuits use the Cadweld rail head type (or equivalent).

h. Track circuit bootleg connections and track rectifier connections are Tigerweld 1S-1 bond wires with 3/8-inch terminal on one end, other end tinned, 36-or 42-inch in length (or equivalent).

i. Ground wire is No. 6 AWG.

Table II. Site Survey Check List

The following is not meant to portray a complete site survey questionnaire but is typical of some of the information that will be found on a site survey that will aid in installation planning.

Customer _____

Location of Installation _____

Date _____

1. No. of Tracks — Single ☐ Double ☐ Other ☐

2. Type of Operation: — Automatic ☐ Manual ☐
   If Automatic: — Area Warning ☐ Directional Control ☐

3. Type of Highway Traffic: — One Way ☐ Two Way ☐

4. Maximum speed of fastest train in mph _____

5. Train switching or stopping in approach zones: — Yes ☐ No ☐

6. No. of train movements per day over crossing _____

7. Within the control limits: — Switches T or F ☐ Train Signals ☐ Track bonded ☐ Metal guage rods ☐

8. Rail Section _____
   4 hole joints ☐ 6 hole joints ☐

9. Ties — Wood ☐ Steel ☐ Concrete ☐ Other ☐

10. Power available at crossing: — DC ☐ AC ☐
    Voltage _____
    Frequency _____

11. Standby power required: — Yes ☐ No ☐
    A. Battery: — Yes ☐ No ☐

12. Track Ballast Condition: — 2 ohm ☐ 5 ohm ☐ Sand ☐ Other ☐

13. Highway at crossing: Width _____ ft.
    Angle _____

14. Crossing Signals located at: — Sides of street ☐ Center of street ☐ Other ☐

15. Signals/Gates:
    Signal with 2 units ☐
    Signal with 4 units ☐
    Cantilevers ☐
    Lights on main masts ☐
    Gates (Length) ☐
    "No Turn" Light ☐

16. Bells required: — Yes ☐ No ☐
    No. required _____

17. Signs required: — Crossbuck ☐ SORS ☐ Tracks ☐

18. Track circuits: — DC ☐ AFO ☐ Type 'C' ☐ Motion Monitor ☐

19. Cases factory wired: — Yes ☐ No ☐

3.2.2 Standards/Equipment Location Data

Following is a general list of standards and location data that should be observed in developing a layout plan for the site. Figure 3-1 and 3-2 illustrate typical location plans.

a. Width and surface of roadway at grade crossing should correspond to that of the adjoining highway and have the same number and width of traffic lanes as the adjoining highway without extra lanes at the crossing.

b. The center of the foundations should be six feet from the edge of the curb or roadway, and no closer than 12 feet from the center of the closest track. (See Figures 3-1 and 3-2.)

c. Foundations shall be placed so that the signal assembly is square with the highway, regardless of the angle of the crossing. (See Figure 3-2.)

d. The top of all highway crossing signal foundations shall be 6 inches above the crown of the highway (see Figure 3-3).

e. Location of control cases and far end approach cases should be determined by accessibility of AC power and circuit design of the installation.

f. The location of bootlegs and other track connections are usually determined by the particular standards of each individual railroad.

3.3 SITE PREPARATION

3.3.1 Excavation

Excavation is required for foundations and underground cable trenches. Foundation requirements are covered in the following paragraphs. Cable trenches and holes for pedestal mounted junction boxes and bootlegs are dictated by local conditions and individual railroad standards. Follow normal installation procedures.

3.3.2 Signal Mast Foundations

Figures 3-4 and 3-5 provide details of poured concrete foundation for grade crossing masts. Figure 3-4 is for aluminum signal masts proposed for grade crossing warning systems with gate installations which have 11-11/16" x 11-11/16" bolt spacing at the base. Figure 3-5 is for aluminum signal masts which have 9-1/2" x 9-1/2" bolt spacing at the base. Precast foundations may be used in place of the poured foundation provided the correct bolt spacing is available. Information for precast foundations is shown in Figures 3-6.

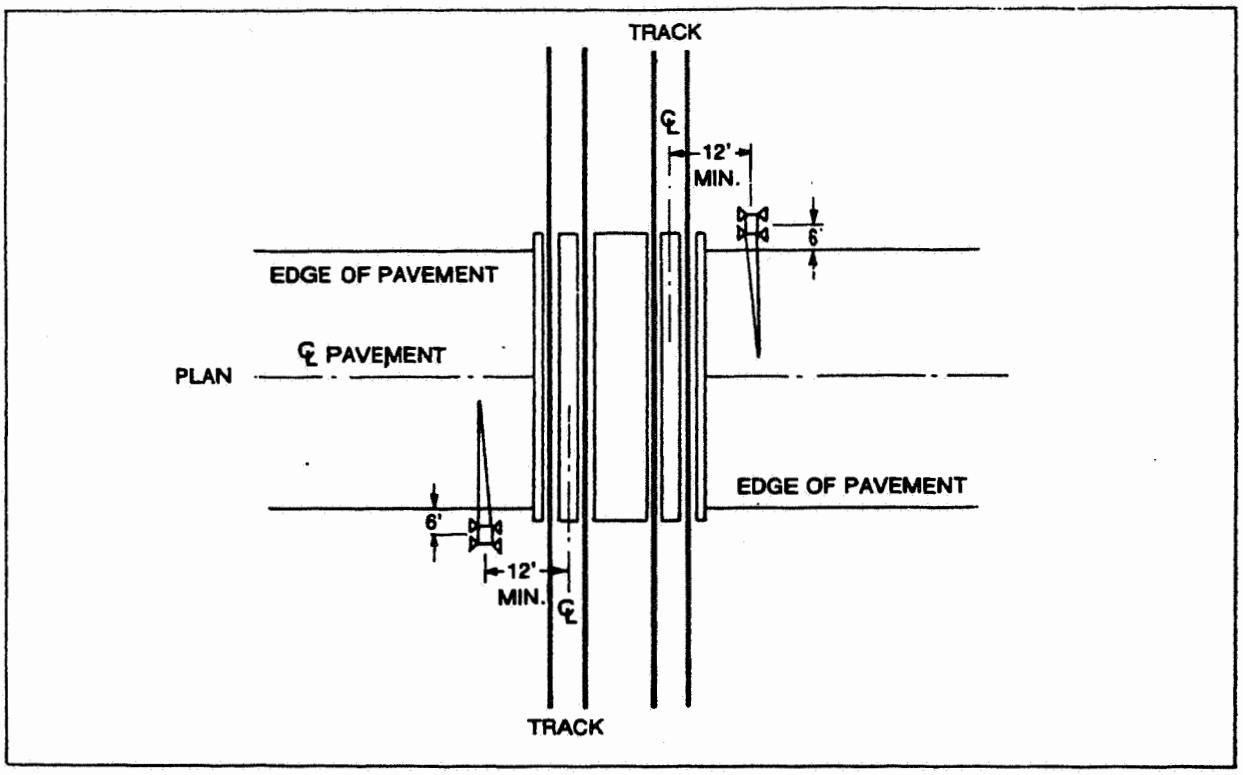


Figure 3-1. Typical Location Plan for Highway Crossing Signals With or Without Gates for Two-way Highway Traffic (Right Angle)

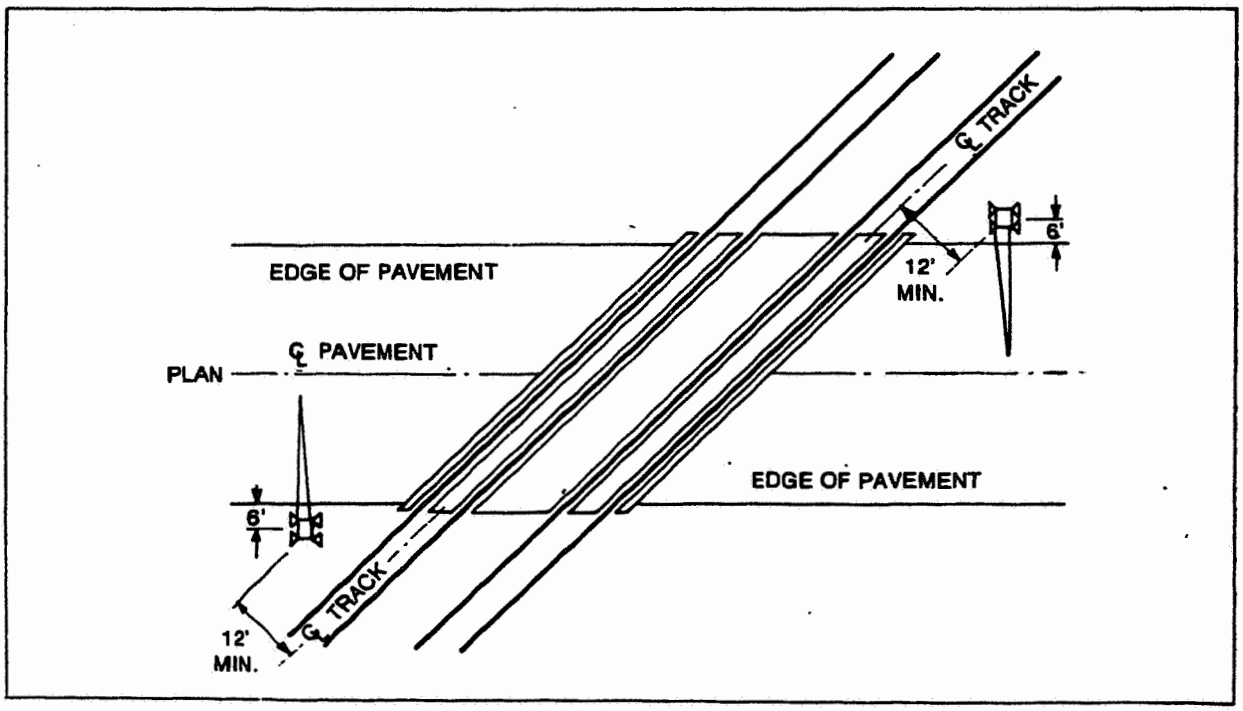


Figure 3-2. Typical Location Plan for Highway Crossing Signals With or Without Gates for Two-way Highway Traffic (Acute Angle)

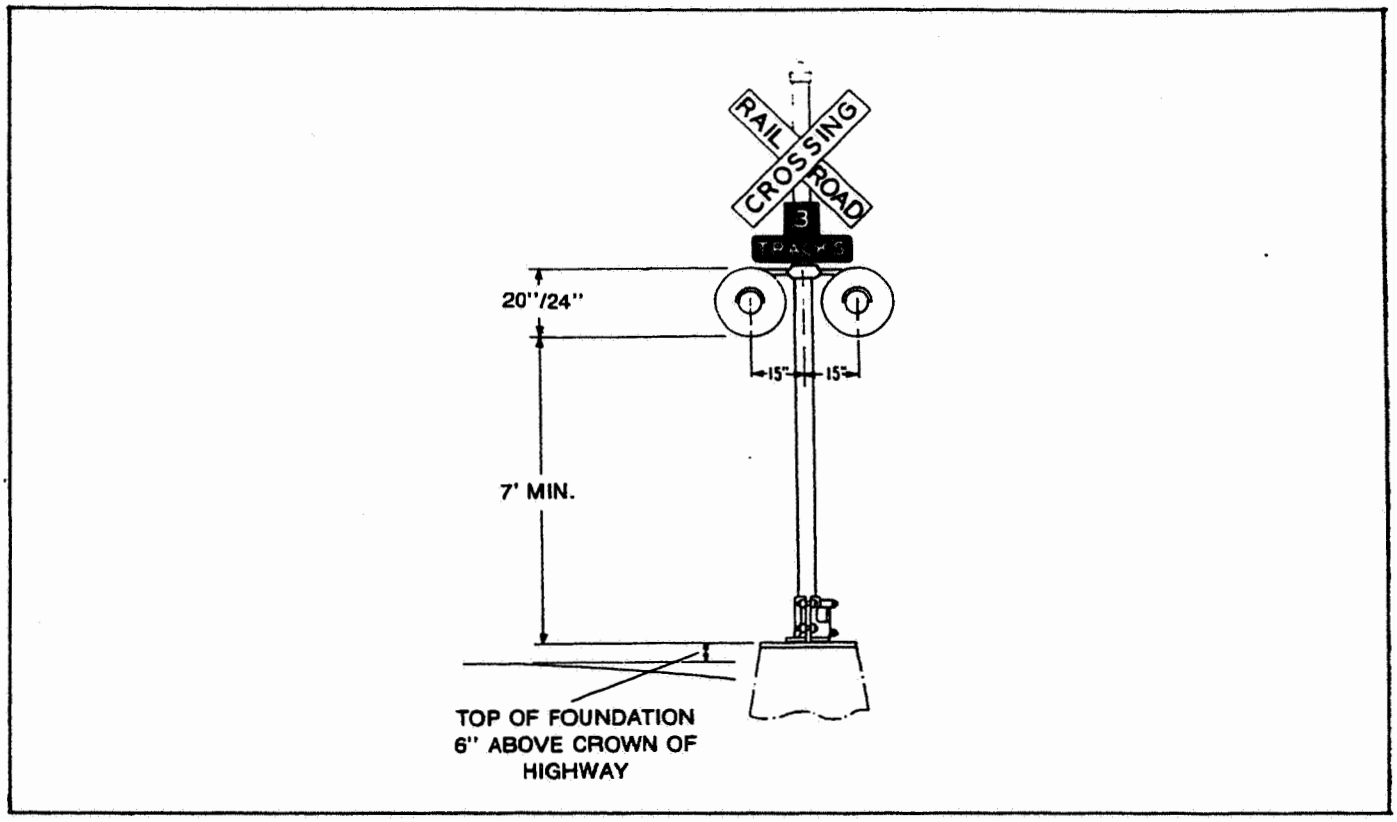


Figure 3-3. Foundation Height

3.3.3 Cantilever Foundations

Details of concrete foundations for cantilevers depends on the type cantilever used. This information will be detailed on the applicable plans.

3.3.4 Control Case Foundations

Cast iron piers are generally used with cases, but precast foundations can also be used. Some amount of excavation is required for both types.

3.3.5 Trenching for Cables

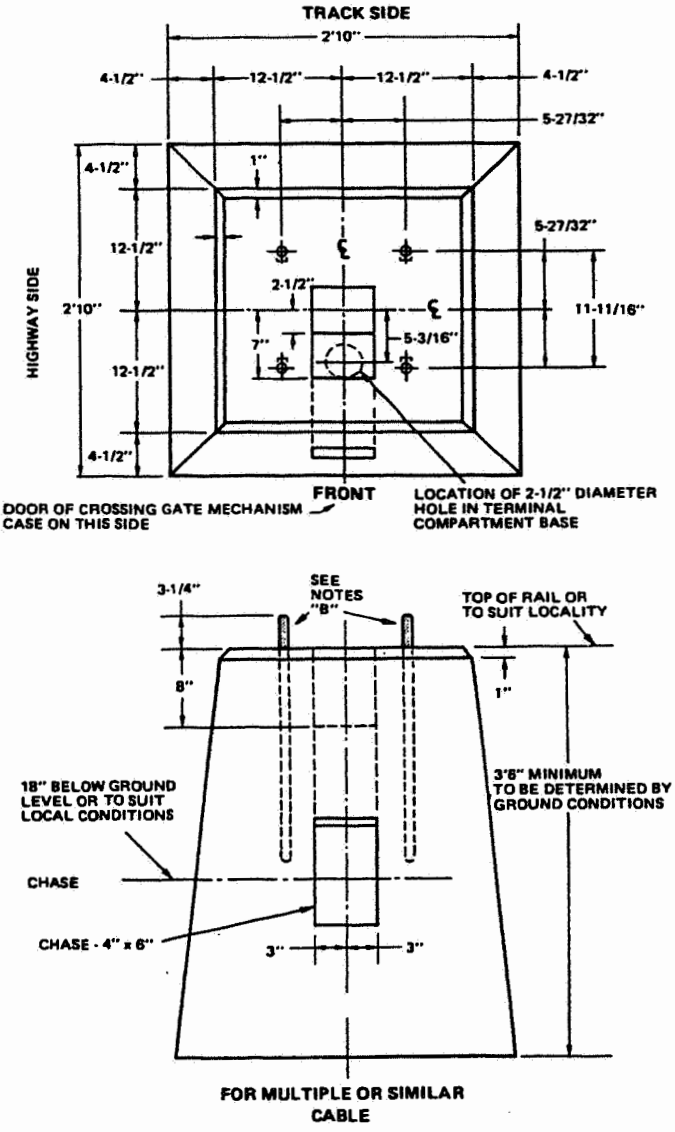
a. Use of a trencher or backhoe is recommended for a more uniform depth and direction.

b. Cables should be laid at a depth of 30 inches unless conditions or local regulations mandate otherwise.

c. Cables, in most instances, can be fed under roadways by using a "driving pipe".

d. If this is impractical, the roadway must either be torn up, or cables strung overhead.

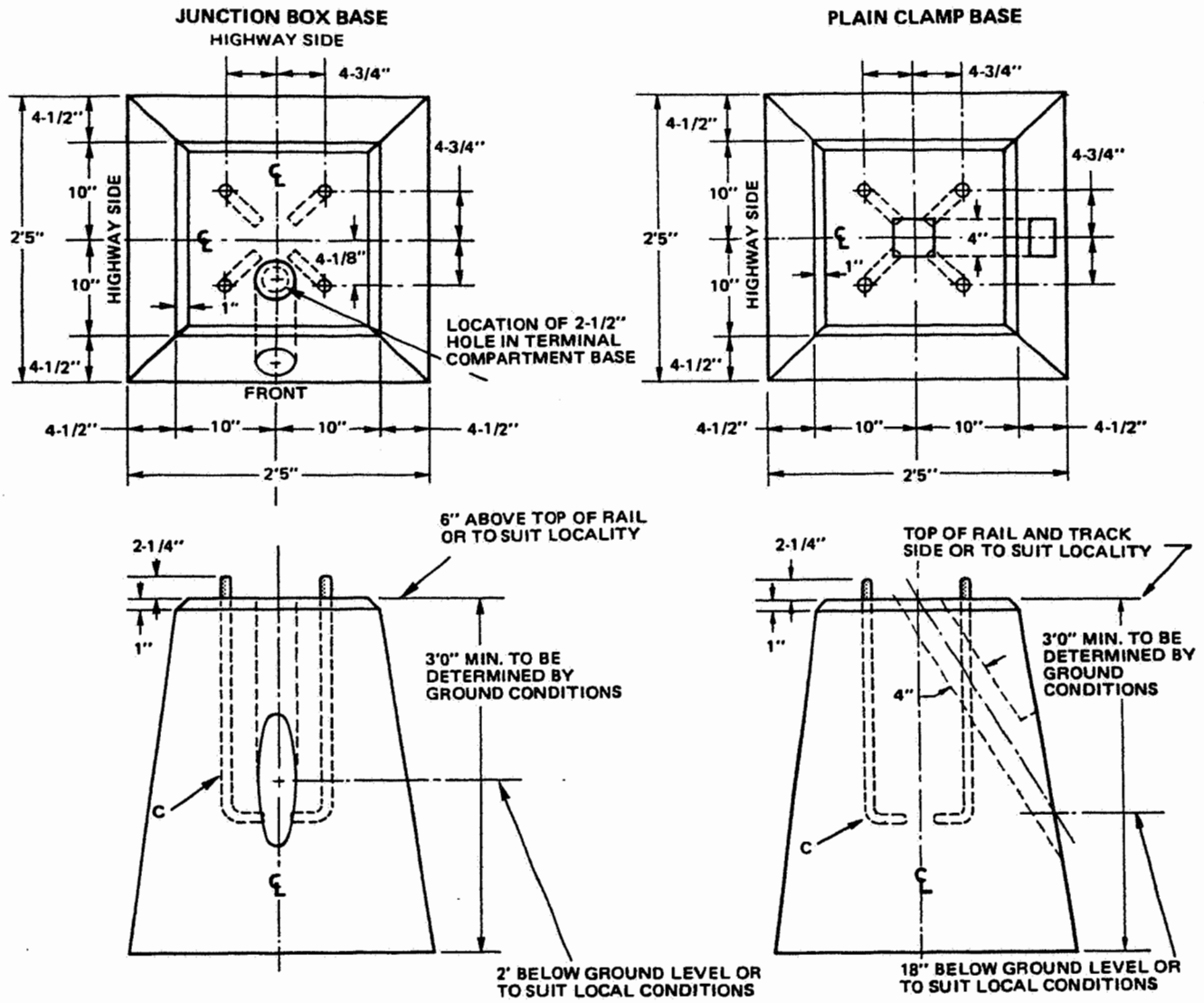
A suggested poured concrete foundation for junction box bases with 11-11/16" x 11-11/16" bolt spacing is shown below.



MATERIAL	NOTES
18 - Cu. Ft. Stone 9 - Cu. Ft. Sand 4.5 - Bags Cement Concrete Mixture 1-2-4 4 - Foundation Bolts with Hex Nuts and Washers.	A - Dimensions of chase may be varied to suit number of electrical conductors. Fibre or steel conduit of suitable diameter may be substituted for chase. B - Refer to ordering reference for foundation bolt size and part number.

Figure 3-4. Poured Concrete Foundations For Flasher Signals With Automatic Gates

Suggested concrete foundations for clamp bases or junction box bases with 9-1/2" x 9-1/2" bolt spacing are shown below.



FOR MULTIPLE OR SIMILAR CABLE ARRANGEMENT WITH TERMINAL BOX LOCATED OPPOSITE SIDE FROM TRACK

FOR MULTIPLE OR SIMILAR CABLE

MATERIAL	NOTES
12.5 - Cu. Ft. Stone 6.25 - Cu. Ft. Sand 3.12 - Bags Cement Concrete Mixture 1-2-4 4 - Foundation Bolts 1" x 24" with Hex Nut and Washer. Conduit as required. See Note A.	A - Dimensions of chase may be varied to suit number of electrical conductors. Fibre or steel conduit of suitable diameter may be substituted for chase. B - Foundation to be placed square with the highway regardless of the angle of the crossing. C - Refer to ordering reference for foundation bolt size and part number.

Figure 3-5. Poured Concrete Foundations For Flasher Signals

PRECAST CONCRETE FOUNDATIONS FOR FLASHER SIGNALS AND FLASHER SIGNALS WITH AUTOMATIC GATES BY SECTIONAL FOUNDATIONS, INC.

Order by Model No., height, bolt length and total weight.

FOUNDATION MODEL NO.	BOLT CENTERS	HEIGHT	BOLT LENGTH	BASE 3-1/2" THICK	TOTAL WEIGHT
		FLASHER ONLY FOUNDATIONS			
SF-1	9-1/2" x 9-1/2"	2'6"	32-1/4"	30" x 30"	544 lb.
SF-1	9-1/2" x 9-1/2"	3'6"	44-1/4"	30" x 30"	702 lb.
SF-1	9-1/2" x 9-1/2"	4'6"	56-1/4"	30" x 30"	806 lb.
SF-1	9-1/2" x 9-1/2"	5'6"	68-1/4"	30" x 30"	910 lb.
SF-1X	9-1/2" x 9-1/2"	4'7-1/2"	58-1/4"	30" x 30"	860 lb.
		FLASHER AND GATE FOUNDATIONS			
SF-2	11-11/16" x 11-11/16"	3'6"	44-1/4"	30" x 30"	1096 lb.
SF-2	11-11/16" x 11-11/16"	4'6"	56-1/4"	30" x 30"	1293 lb.
SF-2	11-11/16" x 11-11/16"	5'6"	68-1/4"	30" x 30"	1490 lb.
SF-2	11-11/16" x 11-11/16"	6'6"	80-1/4"	30" x 30"	1686 lb.
SF-2	11-11/16" x 11-11/16"	7'6"	92-1/4"	30" x 30"	1882 lb.
SF-2	11-11/16" x 11-11/16"	8'6"	104-1/4"	30" x 30"	2078 lb.
SF-2X	11-11/16" x 11-11/16"	3'6-1/2"	44-1/4"	30" x 30"	996 lb.
SF-2X	11-11/16" x 11-11/16"	5'7-1/2"	69-1/4"	30" x 30"	1368 lb.

PRECAST CONCRETE FOUNDATIONS FOR FLASHER SIGNALS AND FLASHER SIGNALS WITH AUTOMATIC GATES BY PERMACRETE PRODUCTS CORP.

Order by Model No., height, bolt length and total weight.

FOUNDATION MODEL NO.	BOLT CENTERS	HEIGHT	BOLT LENGTH	BASE 3-1/2" THICK	TOTAL WEIGHT
		FLASHER ONLY FOUNDATIONS			
S-1	9-1/2" x 9-1/2"	2'6"	32-1/4"	30" x 30"	544 lb.
S-1	9-1/2" x 9-1/2"	3'6"	44-1/4"	30" x 30"	702 lb.
S-1	9-1/2" x 9-1/2"	4'6"	56-1/4"	30" x 30"	806 lb.
S-1	9-1/2" x 9-1/2"	5'6"	68-1/4"	30" x 30"	910 lb.
		FLASHER AND GATE FOUNDATIONS			
S-2	11-11/16" x 11-11/16"	3'6"	44-1/4"	30" x 30"	1096 lb.
S-2	11-11/16" x 77-11/16"	4'6"	56-1/4"	30" x 30"	1293 lb.
S-2	11-11/16" x 11-11/16"	5'6"	68-1/4"	30" x 30"	1490 lb.
S-2	11-11/16" x 11-11/16"	6'6"	80-1/4"	30" x 30"	1686 lb.
S-2	11-11/16" x 11-11/16"	7'6"	92-1/4"	30" x 30"	1882 lb.
S-2	11-11/16" x 11-11/16"	8'6"	104-1/4"	30" x 30"	2078 lb.

Figure 3-6. Precast Foundations

3.3.6 Backfilling and Grading

a. Backfill of trenches should not be done until a "megger" has been used on the cables to ascertain there is proper continuity and no crossed or exposed wires.

b. "Pull" concrete forms.

c. Fill and grade level.

d. Tamp fill thoroughly, especially around signals equipped with gates and cantilevers.

3.4 INSTALLATION PROCEDURES

This section describes the general procedures for installing the components of a Highway Grade Crossing Warning System. If more detailed information is required, consult the individual service manuals which are provided with each major component (refer to Table I).

NOTE

If preferred, with the exception of the gate mechanism and gate arm, the equipment may be assembled and mounted on the mast while on the ground and raised into its final position on the foundation. Make sure that all components are properly aligned to the road, etc. before raising in place.

3.4.1 Installation of Plain Clamp Base and Mast

NOTE

Mast and base are usually received as an assembly.

a. Feed the cables from the chase through the center of the base, up the mast and out the pre-drilled crossarm hole. Position the base on the foundation bolts. Check that the pre-drilled hole for the crossarm is correctly oriented.

b. Install nuts on foundation bolts and hand tighten.

c. Use a level and check all sides of the mast to ascertain that the mast is plum. (If not, shimming is required.)

d. Securely tighten all foundation bolt nuts.

3.4.2 Installation of Junction Box Base and Mast

a. Open the access cover at the junction box base and feed the cable from the chase through the junction box opening. Position the junction box base and mast on the foundation bolts. Check that the pre-drilled hole for the crossarm is correctly oriented.

b. Install nuts on foundation bolts and hand tighten.

c. On the mast, feed a cable through the pre-drilled hole for the crossarm to the junction box base.

d. Use a level and check all sides of the mast to ascertain that the mast is plum. (If not, shimming is required.)

e. Securely tighten all foundation bolt nuts.

3.4.3 Installation of Junction Box Crossarm

NOTE

The light units may be fastened to the junction box crossarms and pre-wired when received. If not, they may be mounted to the junction box crossarm before installing the junction box crossarm, or installed after the junction box crossarm is mounted (refer to paragraph 3.4.4.).

a. Open the junction box cover on the crossarm by loosening the two bolts and swinging the cover open.

b. Remove the U-bolts and temporarily place them aside.

c. Lift the crossarm into position and feed the cable protruding from the mast into the junction box outlet. Position the crossarm on the mast with the back of the junction box aligning with the pre-drilled hole in the mast.

d. Install U-bolt, nuts, and tighten securely. Torque U-bolts to 70-90 ft. lbs.

e. Connect the cable to the terminals as shown in Figure 3-7.

f. Close and secure the junction box cover.

3.4.4 Installation of Light Units

Both the HC-100 and HC-120A Light Units are installed in the same manner.

3.4.4.1 Installation Procedure

a. Open the junction box cover on the crossarm by loosening the two bolts and swinging the cover open.

b. Remove the elbow from the crossarm bracket and fasten to the light unit.

c. Carefully feed the pigtail from the light unit through the bracket and through the arm to the junction box. End plates on the arms may be removed to facilitate stringing the wires. A fish tape may also be helpful.

NOTE

If extension arms need to be attached, signal light brackets must be removed from junction box assembly. Remove the four screw nuts and washers that secure the signal light brackets to junction box assembly. Brackets can now be removed. Align the four holes in the extension arm cover plate with the holes in the junction box assembly, making sure that the gasket is between these two pieces. Install the four screws.

Slide gasket and signal light bracket or an extension arm (whichever is required) onto the screws. Install the four washers and nuts.

Remaining brackets must now be installed. Align the four holes in the cover plate of signal light bracket with the holes in extension arm cover plate. Make sure gasket is between these two pieces and install screws, washers, and nuts.

At this point, it is best to have arranged a fish wire or fish string through the crossarm and any extensions there might be so that the signal unit with elbow attached can be assembled to the remaining part of the crossarm unit as the fish wire is tied to the lamp pigtail and pulled through to the junction box.

d. Secure the light unit to the bracket. Loosen the set screws on the elbow and position light unit to its approximate final position. Repeat for all other light units.

e. Complete wiring by attaching leads to terminals in accordance with Figure 3-7.

f. Secure junction box cover.

g. If crossarm end plates were removed, replace and secure with attaching hardware.

h. Align the signal light units in accordance with paragraph 3.4.4.2 following.

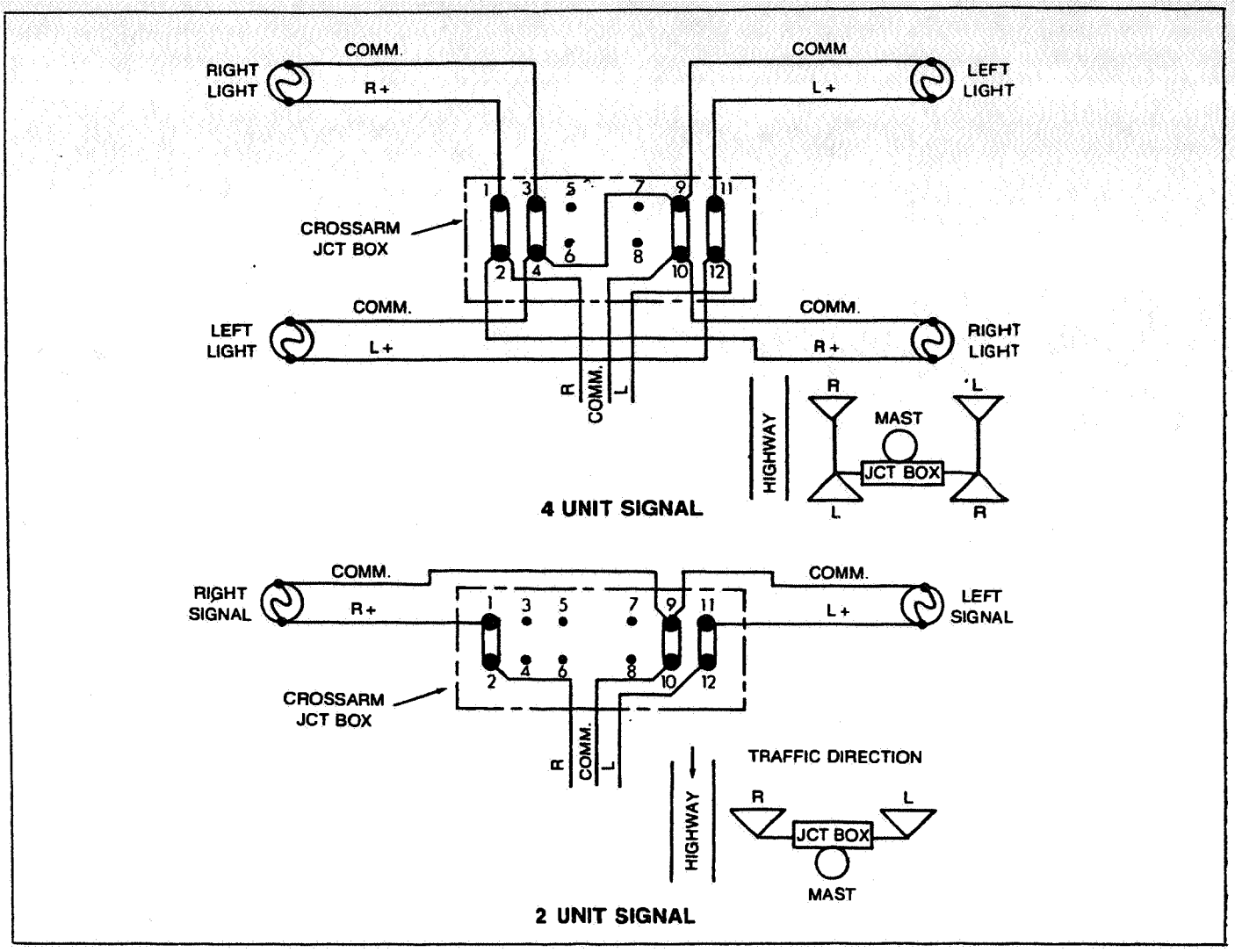


Figure 3-7. Signal Lamp Wiring Diagrams

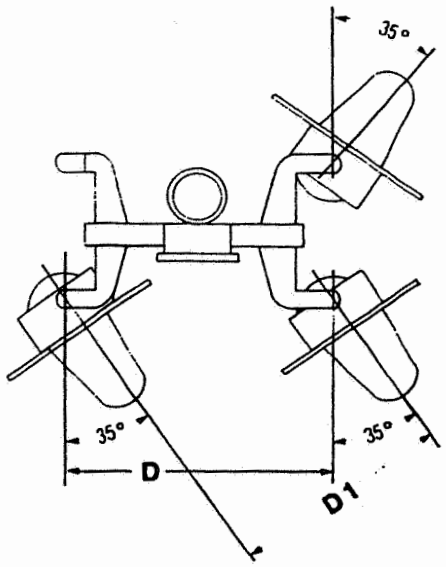
3.4.4.2 Light Units Alignment (see Figure 3-8)

Vertical adjustment should be made first with the horizontal adjustment tightly clamped so that unit wiggling does not cause a bad vertical adjustment. A sighting tube (N170622) can be used to aid in the initial adjustment. The final adjustment should be checked by an observer on the road, safely .

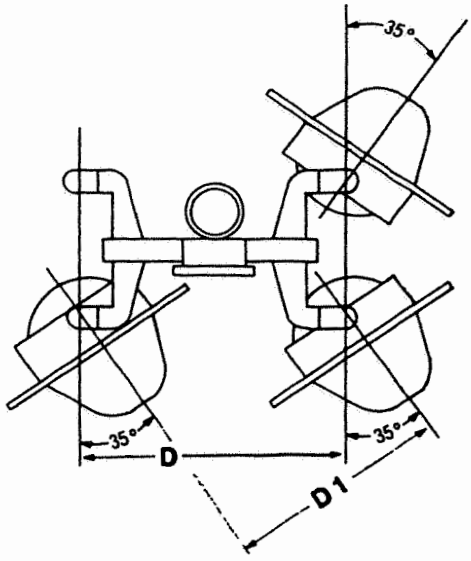
AAR Signal Manual Part 268, 1972 Revision is repeated herein as a Guide to Signal Unit Alignment. Some sentences of manual Part 268 are omitted for simplicity sake.

ALIGNING HIGHWAY CROSSING SIGNAL REFLECTOR TYPE LIGHT UNITS
(REVISED SIGNAL MANUAL PART 268)

a. The aligning of electric light units in accordance with these instructions must not be started until proper protection has been afforded for highway and pedestrian traffic. When aligning, care must be exercised that no unsafe conditions are set up.

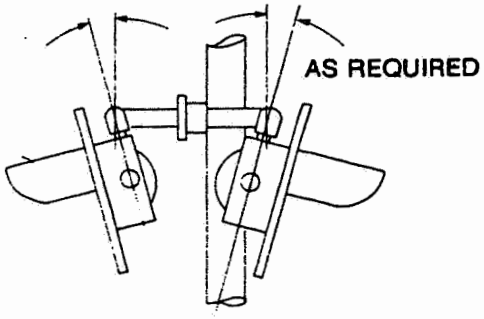


HC-100

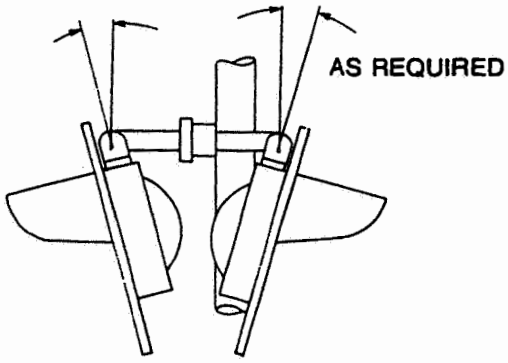


HC-120

Azimuth (Horizontal) Alignment



HC-100



HC-120

Range (Vertical) Alignment

Figure 3-8. Light Unit Alignment

(1) The lamp receptacles are positioned and sealed by the manufacturer, using 1/64 inch precision based lamps. To obtain the range and efficiency intended, signal precision lamps must always be used in the light units.

(2) When aligning of light units has been completed, tests must be made immediately to determine that the equipment functions as intended.

b. Procedure is as follows:

(1) Front Light Units

(a) Continuously light one lamp.
(b) Open door wide so clear beam is displayed.
(c) Adjust light unit vertically to align axis of beam five feet six inches above pavement at selected alignment distance. Both lamps should be aligned to same point.
(d) Adjust light unit horizontally to align axis of beam to center of approach lane in approach to signal at selected alignment distance, maintaining vertical alignment.
(e) Tighten clamps and close door.
(f) Repeat instructions for other front light units.

(2) Back Light Units Where Used

(a) Continuously light one lamp.
(b) Open door wide so clear beam is displayed.
(c) Adjust light unit vertically to align axis of beam five feet six inches above pavement at a point 50 ft. in approach to the signal on opposite side of track.
(d) Adjust light unit horizontally to align axis of beam to a point 50 feet with symmetric patterned roundels, 150 feet with non-symmetrical roundels in approach to the signal on opposite side of track and in center of approach lane, maintaining vertical alignment as in Instruction (2)(c).
(e) Tighten clamps and close door.
(f) Repeat Instructions for other back light units.

(3) After units have been aligned, clamps tightened and doors closed, they must be checked with lights flashing and lamps burning at recommended voltage to make certain a flashing light aspect is visible within a range of 1,000 feet.

NOTE

Torque on 3/8" U-bolt nuts of the crossarm elbows should be 15-20 ft.-lbs. Torque on 3/8" bolt which holds junction box door should be 8-13 ft.-lbs.

c. Assemble background and hood on each signal unit. Torque #10-32 screws which hold background and hood in place to 1-2 ft.-lbs.

3.4.5 Installation of Bell or Pinnacle

NOTE

The bell or pinnacle slides over the top of the mast and is secured by tightening one setscrew.

a. String wires from crossarm junction box through the mast and out the top.

b. Position bell with face of gong parallel to the highway. Open back of bell and feed wire to terminals. Attach wires to bell terminals and position on top of mast.

c. Tighten setscrew.

3.4.6 Installation of Signs

a. Position the signs on the mast as shown in Figure 1-2 (or Section VI), and secure with the hardware provided.

3.4.7 Installation of Equipment Cases

a. Remove control case from shipping skid.

b. Cut banding wire that secures ground pipe to bottom of case.

c. Set control case in position on foundation, aligning parkway cable with knockout in bottom of case. Secure to foundation with appropriate hardware.

d. Attach the "flower pot" or ground pipe coupler. Tighten the setscrews.

e. Feed all cables (or wires) through ground pipe into the case.

f. Pack oakum into the pipe to seal it, and top with Johns-Manville "Dux Seal", or equivalent.

3.4.8 Installation of Relays

Shelf-mounted relays are shipped already installed in the case. For installations using plug-in relays, the relays are shipped separately. These relays should be carefully unpacked and plugged into their respective locations. Keyed index plates prevent plugging the wrong relay in the wrong location.

3.4.9 Installation of Crossing Gate Mechanism

Complete instructions for installing the Model 75 Gate Mechanism, crossing gate arms, and counterweights are covered in Service Manual 6043. Refer to this manual for detail instructions.

3.5 CONNECTING EQUIPMENT

Prior to installing the equipment, it should have been ascertained that all cabling and wiring was completed. To connect the various components of the system, refer to the applicable installation diagrams.

3.5.1 Ringout Circuits and Cables

Ringing out a circuit simply means applying a "buzzer" or ohmmeter to the open ends of the wire to check continuity. Each line should be checked prior to hookup; then re-checked as units when they have been terminated.

3.6 ALIGNMENT AND ADJUSTMENT PROCEDURES

Generally, the alignment and adjustment to be accomplished upon completion of installation include signal light units, grade crossing gate mechanism, track circuits, and the lamp intensity. Alignment procedures for the light units are covered in paragraph 3.4.4.2. Complete alignment and adjustment procedures for the other items are contained in their respective service manuals. Refer to these manuals (Table I) for these procedures.

3.7 FIELD INSTALLATION RECORD

A permanent record of the installation adjustments, values, etc. for each site should be made. An example of a form that can be used for this purpose is shown in Figure 3-9. When properly filled out, this form will be a valuable aid in future servicing the equipment.

3.8 INSPECTION AND TESTING

3.8.1 Operational Test

To perform this test, track sections must be shunted at the battery or feed end and at the relay end. A satisfactory shunt arrangement should be of 0.06 ohms resistance. A fifteen (15) foot length of 16 gauge insulated wire, with ends soldered to files, provides an adequate shunt. While shunting, the files can be scraped on the rail to assure good contact.

a. Check all track circuits to see that the proper relay is being controlled from its respective section. Shunting of the track assures this, and in addition, it verifies that proper direction is being selected.

UNION SWITCH & SIGNAL DIVISION
Swissvale Post Office, Pittsburgh, Pa. 15218

UNION SWITCH & SIGNAL

RECORD OF FIELD INSTALLATION OPERATING TESTS

CUSTOMER _____ PROJECT _____

GO _____ LOCATION _____

TRK. PLAN DWG. #_____ RTE. SHEET DWG. #_____ CKT. DWG. #_____.

TEST: HIGHWAY CROSSING WARNING SYSTEM: To verify proper operation of systems being placed in service.

TRACK NO.	CONDITION	TRAINS/DAY	TIME BETWEEN TRAINS	A.C. LINE
_____	BALLAST _____ JOINTS _____	_____	Min._____Hr. Median _____ Hr.	____ V.A.C.

TYPE CONTROL	BATTERY FULLY CHARGED		BATTERY CHARGER	TRACK RELAYS
	LOCAL	TRACK		
	____V.	E(N)___ V. Isl.___V. W(s)___V.	____ V.D.C. ____ A.	E(N)____ MA. Isl.____ MA. W(S)____ MA.

TRANSF. SECOND. TAPS	CROSSING INACTIVE	CROSSING ACTIVATED	SENSITIVITY ADJUSTME (AFO, MM-10)
____ Second V.	_____ V.D.C. _____ A.	___V.D.C.__ V.A.C. ___A.D.C.___ A.A.C.	E(N) W(S) (Mark Slot Positior

VOLTS AT SIGNALS	APPROACH CONTROL	RECEDING CONTROL (Crossing Clears after Train clears Road)	TOTAL SIGNALS Operate Time/Trai
"A" _____ V. "B" _____ V.	From E(N)___ Sec. From W(S)___ Sec. Train Speed___ MPH	Train Speed MPH ____ sec., _____Ft.	_____ sec.

GATES TIME	TIMING RELAY SET.	GATE OPERATION
UP: "A"___ sec., "B"___ sec. DOWN: "A"___ sec., "B"___ sec.	_____ sec.	Down___ sec. after signals start

REMARKS:

ATTESTED:

US&S REPRESENTATIVE _____ DATE _____

CUSTOMER REPRESENTATIVE _____ DATE _____

Figure 3-9. Record of Field Installation Operational Check

b. Simulate the movement of a train by first applying a shunt in the approach section. This will start the bell ringing, the lights flashing, and after 3-5 seconds flashing; cause the gate arm to descend.

c. With the first section still shunted, shunt the island circuit. There should be no change.

d. Shunt leaving section.

e. Remove the first shunt. No change should take place. Remove the island shunt. When the island shunt is removed, the gate arm should assume its vertical position, the lights should stop flashing, and the bell cease ringing.

f. Leaving section is still shunted but no warning stick relay is bridging track circuit down.

g. When leaving section is clear, system should return to normal and is ready for next move.

h. Repeat this procedure, beginning at the opposite end of the circuit and observe the functions as before.

3.8.2 Final Checkout

The final checkout of the system should include these points.

a. Re-check the focus and alignment of the signal units.

b. Measure the voltage of the lamp. Voltage should be at least 85% of the lamp rated voltage.

c. Check of the gate mechanism for proper operation.

d. Check the discharge of the batteries with an ammeter and set the rectifier for proper charging rate. This information is included with the installation plans. Keep storage battery between 1215 and 1220 specific gravity (or as specified for the batteries used).

e. External resistance in the battery circuits should be adjusted to provide at the track terminals of the track relay the recommended working voltage of the relay.

f. Make one last check of the site for items such as wire, which could result in shorts.

g. After all checks and adjustments have been made, turn on the entire system and observe that all track relays are energized, the gate arm is in the vertical position, and the lights and bell are not functioning.

SECTION IV
CONTROL CIRCUITS AND FUNCTIONAL OPERATION

4.1 GENERAL

For most system applications, all control equipment required to initiate highway grade crossing warning is located at the crossing. Control packages designed for Audio Frequency Overlay (AFO) track circuit application require additional equipment at the approach end. AFO track circuits and motion monitoring track circuits can be superimposed on existing direct current (dc) track circuits or applied separately in various combinations. The motion monitoring track circuit is highly recommended in switching areas where frequent stop, restart and reverse movements are made to minimize crossing down time. All controls for the Motion Monitor are located at the crossing. The Type "C" track circuit scheme, because of its high shunting sensitivity, is recommended for application at difficult shunting areas. It is intended for use in non-signalled territory. The type "C" track circuit is not suitable for overlay track circuit application; therefore, it should not be used in a similar manner as AFO and motion detection track circuits. Conventional direct current (dc) track circuit schemes are also incorporated with various control packages as well as high frequency track circuits.

4.2 TRAIN DETECTION TRACK CIRCUITS

Train detection track circuits are used to determine track occupancy when a train approaches the grade crossing. When a track circuit is occupied, a control circuit is activated and the warning signals start to flash and the gates, if provided, will drop. Anyone of the following basic track circuits are most practical for non-electrified railroad applications. Most track layouts can be adapted to one of these basic schemes. Equipment arrangement and circuitry can be modified to suit special applications when required. The track circuits which will be described are the basic Type "C" track circuit, motion monitoring track circuit, audio frequency overlay (AFO), direct current (dc) and high frequency track circuits. For detailed information on the specific track circuits used, refer to the applicable service manual listed in Table I of this manual.

4.2.1 Type "C" Track Circuit (Figure 4-1)

The Type "C" track circuit is an ac-dc track circuit designed to detect the presence of a train. A dc relay is connected across an ac power source (inverter) which is connected to the rails. A track rectifier is also connected across the rails at the opposite end of the track circuit providing a halfwave shunt across the relay coil.

This rectified ac signal energizes the relay. A train on the track circuit shunts the rectifier and reduces the rail potential resulting in a low power ac wave being presented to the dc relay. This combination of events causes the track relay to become deenergized, thus initiating grade crossing warning.

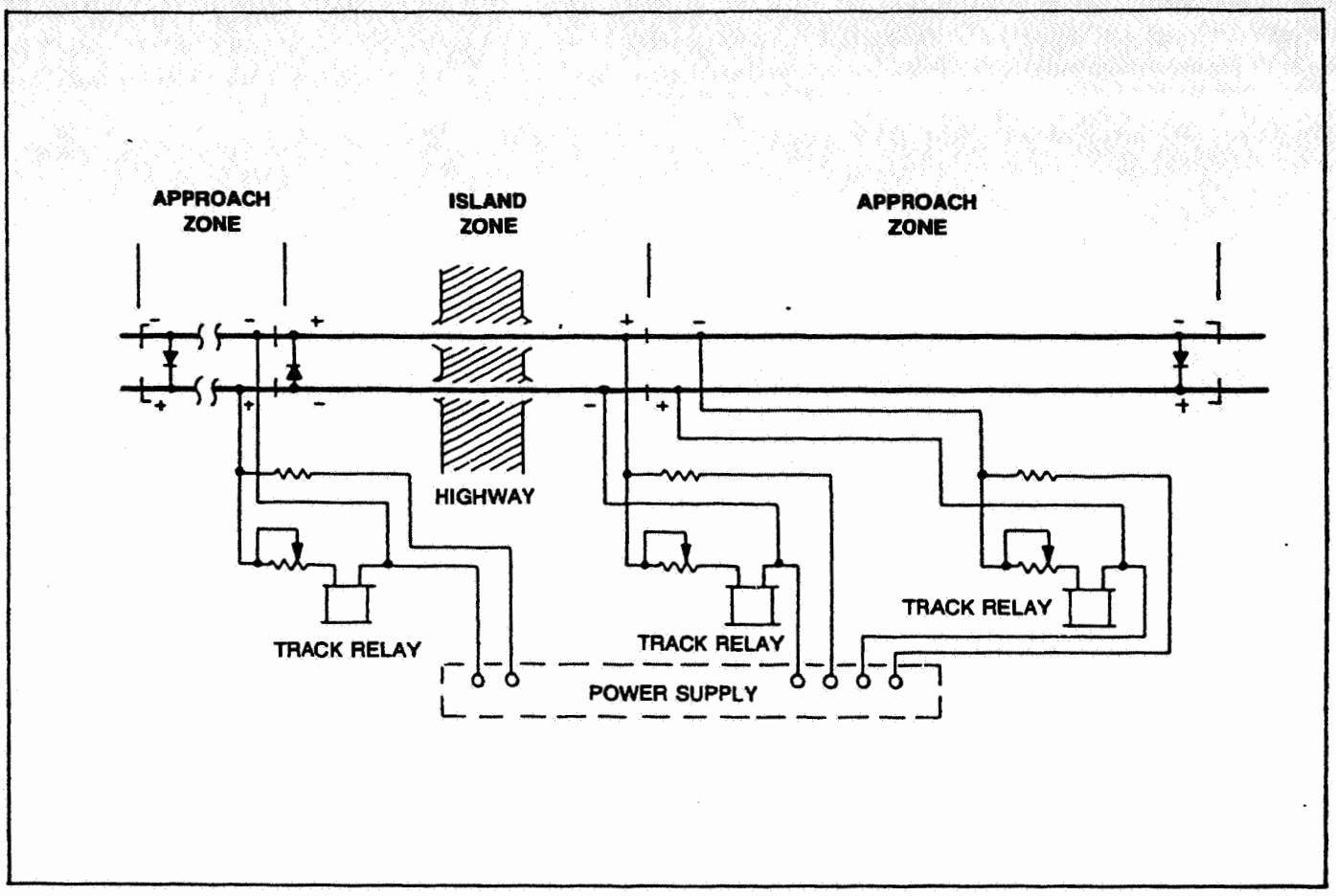


Figure 4-1. Type "C" Track Circuit Scheme

Type "C" track circuits must be isolated with insulated rail joints and all rail ends within the track circuit must be bonded to ensure proper electrical continuity. This type of track circuit is economical and provides good shunting characteristics where rails tend to be rusty. All power supply equipment is located at the crossing.

4.2.2 Motion Monitoring Track Circuit (Figure 4-2)

The Motion Monitor train detection device is designed for application without insulated rail joints, except for special applications. This device detects train motion by continuously measuring track circuit characteristics. A constant current signal is fed into the rails adjacent to the highway grade crossing. This signal develops a rail to rail voltage proportional to the track circuit impedance. As a train proceeds toward the crossing, the moving shunt effect of the train causes the impedance of the track circuit and the rail voltage to decrease at the feed point. The rate at which the impedance decreases is related to train speed, position of train within the warning zone length, rail impedance and ballast resistance. The detection device includes the island zone (grade crossing area). A self-contained receiver, which is connected to the rails on the opposite side of the highway from the track feed, continuously monitors the rail to rail voltage at that point. If a train shunt

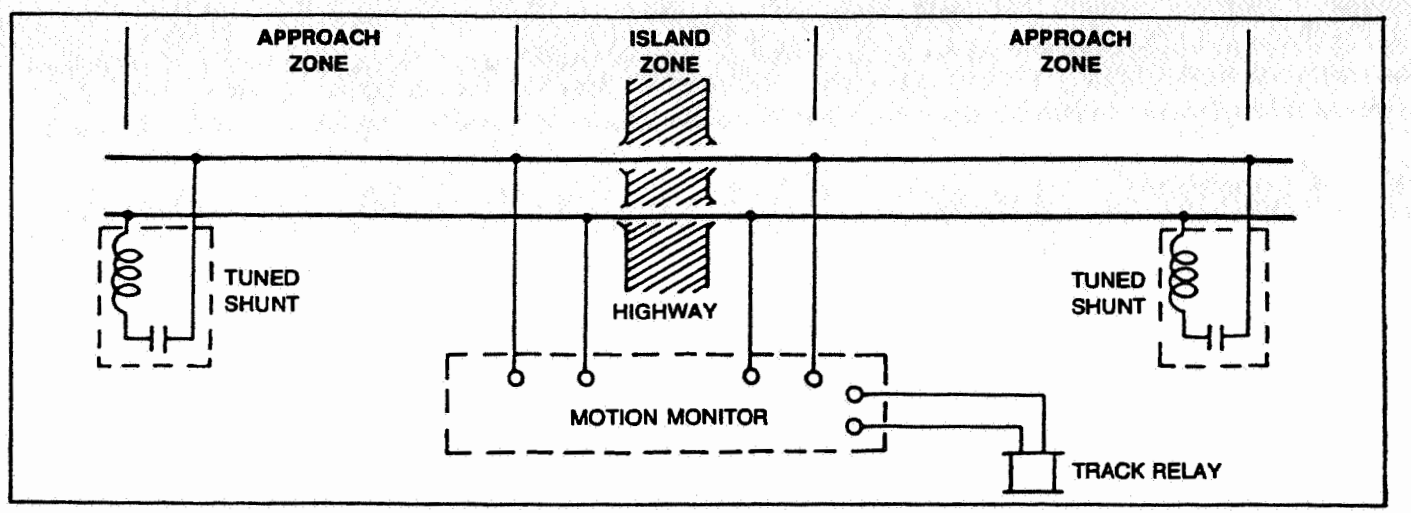


Figure 4-2. Motion Monitoring Detection Track Circuit
For Signalled Territory
(Use hard wire shunt in place of tuned shunt in non-signalled territory)

occurs within the island zone (between rail connections), the receiver input voltage will fall below the island receiver's threshold, thus detecting the presence of a train.

A motion monitoring detection circuit may be applied as a sole means of train detection where maximum train speeds are less than 20 mph. It is recommended, where train speeds exceed 20 mph, that AFO wrap-around be installed to detect high resistance rail breaks or faulty connections. A motion monitoring detection circuit can be superimposed on existing dc or AFO track circuits, which then serve as the wrap-around; however a motion monitoring track circuit cannot be superimposed on a Type "C" track circuit. Track coupling units must be used to pass the current signal around insulated joints. A tuned shunt (or hard-wired shunt in non-signaled territory and where wrap-around is not used) is connected across the rails at the approach ends of the track to terminate the detection circuit.

All rail ends within the warning zone area must be bonded to ensure proper electrical continuity. Double bonding is recommended for additional protection.

4.2.3 Audio Frequency Overlay (AFO) Track Circuit (Figure 4-3)

The AFO track circuit is designed for use without insulated rail joints. This is particularly useful when insulated rail joints would be a problem or where continuous welded rail is employed. AFO circuits can also be superimposed on existing dc track circuits. Depending upon distance required, a low-power transmitter is used for track circuits up to approximately 3500 feet or a high-power transmitter may be used for lengths over 3500 feet. Frequencies vary from 885 Hz to 6180 Hz for single track operation, and 930 Hz to 6330 Hz for the second track in double track applications.

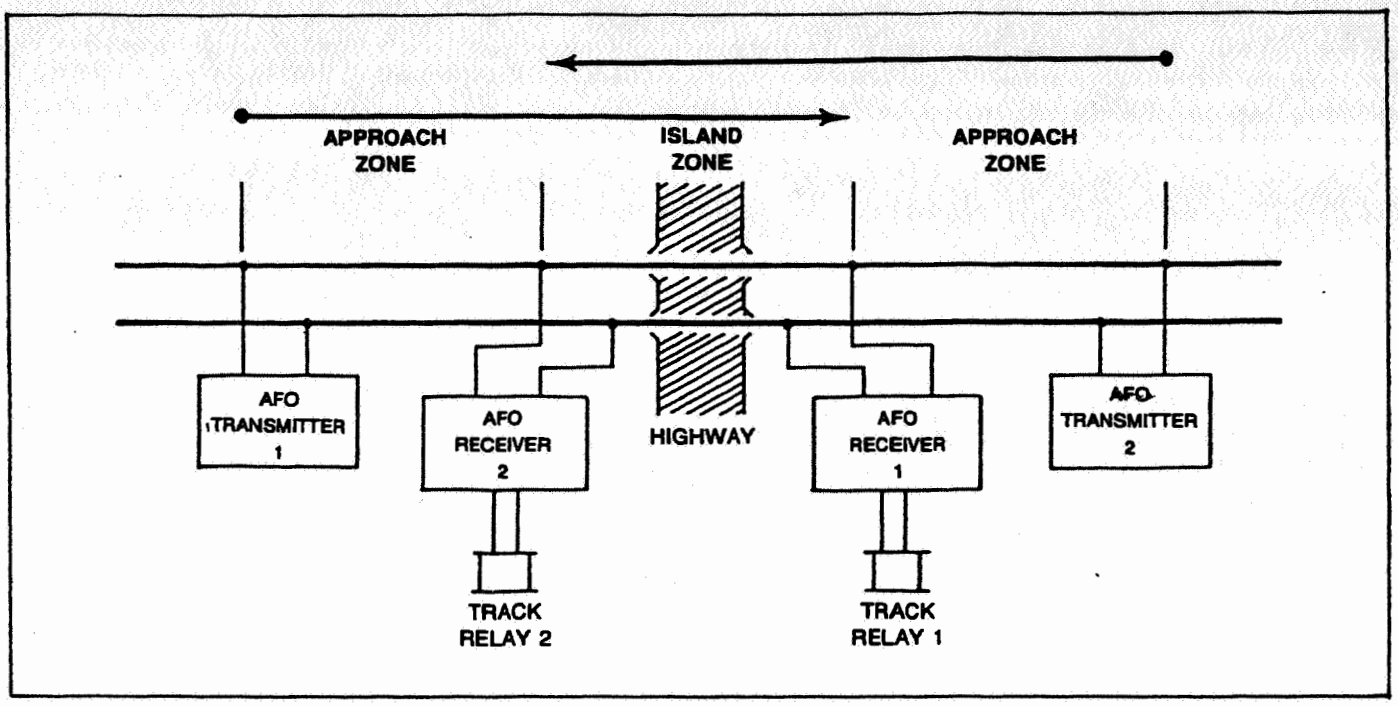


Figure 4-3. Audio Frequency Overlay (AFO) Track Circuit with Overlapping Track Circuits

The AFO system provides 16 different frequencies divided into two groups of eight each: class 1 is recommended for single track and class 2 is recommended for the second track.

The AFO circuit introduces an audio frequency signal from a solid state oscillator into the track at the transmitter approach end. This signal is detected by a receiver located at a second position adjacent to the crossing. In the receiver, the signal is amplified and rectified into a dc control voltage which then energizes a relay. The relay remains energized while the signal is being received and is deenergized by the train shunt. This type of track circuit can be used for either signalled or non-signalled applications. Two AFO track circuits are required for crossing warning. The overlap at the crossing provides an equivalent island circuit.

4.2.4 Direct Current (DC) Track Circuit (Figure 4-4)

The dc type track circuit employs a constant energy flow to detect the approach of a train. At the battery end of the track circuits, current is fed into both rails to energize a relay located at the opposite end of the circuit. A train shunt reduces the rail potential below the drop-away value of the relay and de-energizes the relay which activates the control circuit.

DC track circuits must be isolated from adjacent track circuits with insulated rail joints. Rail ends within the track circuit must be bonded to ensure proper electrical continuity.

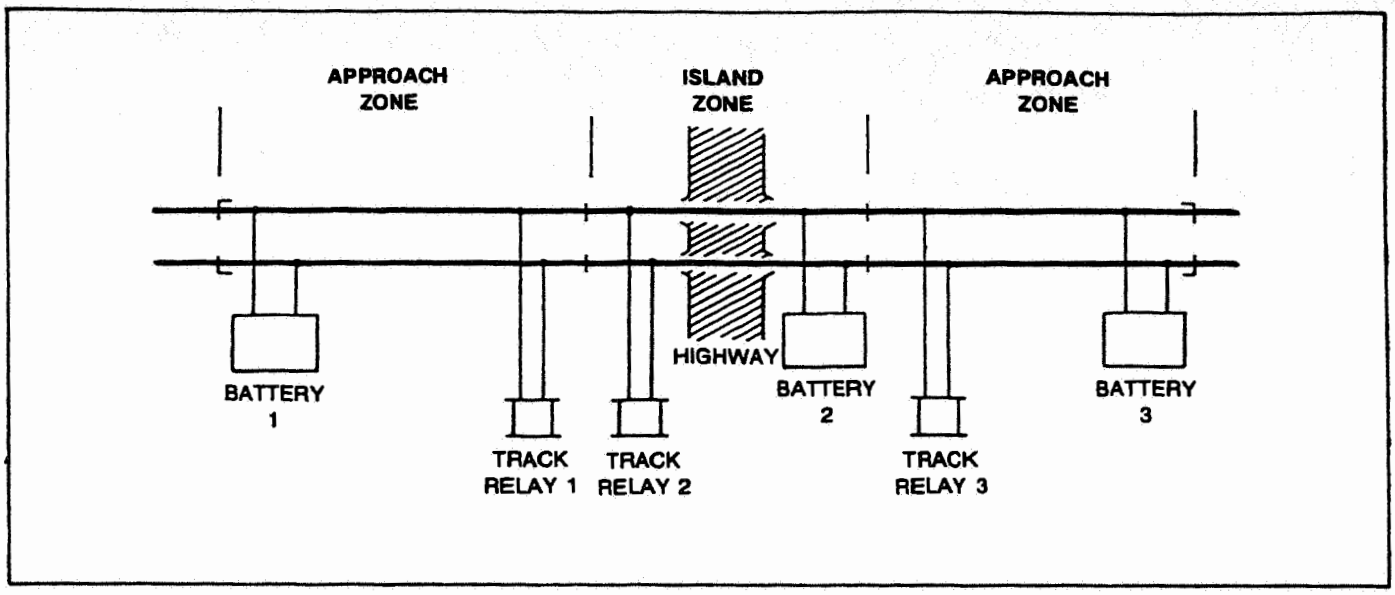


Figure 4-4. Direct Current (DC) Track Circuit

4.2.5 High Frequency Track Circuit (Figure 4-5)

The high frequency AW-10 device is a short-range train detection system suitable for applications involving restricted train speeds and limited approach distances. A typical application provides a 20-second warning time for 10 mph traffic at highway crossing applications having a minimum approach length of 300 feet; and may be operated in either a directional or non-directional mode.

The device consists of a transceiver unit and two separate transponder units. The transceiver unit contains a transmitter and two receivers; each receiver is tuned to a dedicated transponder frequency.

The transceiver, housed at the crossing, transmits a 24 kHz signal through the rails to each of the transponder units which can be buried beneath the rails at each of the approaches. This signal is used as a source of power for each of the transponder units which reply with respective 37.5 kHz and 42 kHz signals to the receiver portion of the transceiver which consists of independent channels. In the respective receiver channel, the appropriate transponder signal frequency is detected and produces a negative dc drive voltage which energizes a corresponding vital output relay that interfaces with the highway warning apparatus. If train traffic is not within the 300-foot approach boundaries, the input signal to the respective receiver channel is of sufficient strength to pick the corresponding track relay. When train traffic approaches within 300 feet of the crossing, signal energy from the respective transponder is shunted away from the associated receiver channel input. When this occurs, the receiver output drive signal becomes insufficient to maintain the vital output relay in a picked (energized) condition, and the relay armature drops, thereby enabling the highway crossing warning apparatus. The high frequency signals used in the AW-10 provide for excellent track circuit definitions that permit less than 15 feet spillover or ringby. Furthermore, the unit can provide a shunting sensitivity of up to 0.6 ohm to permit effective system operation in industrial areas with a potential of rusted rails.

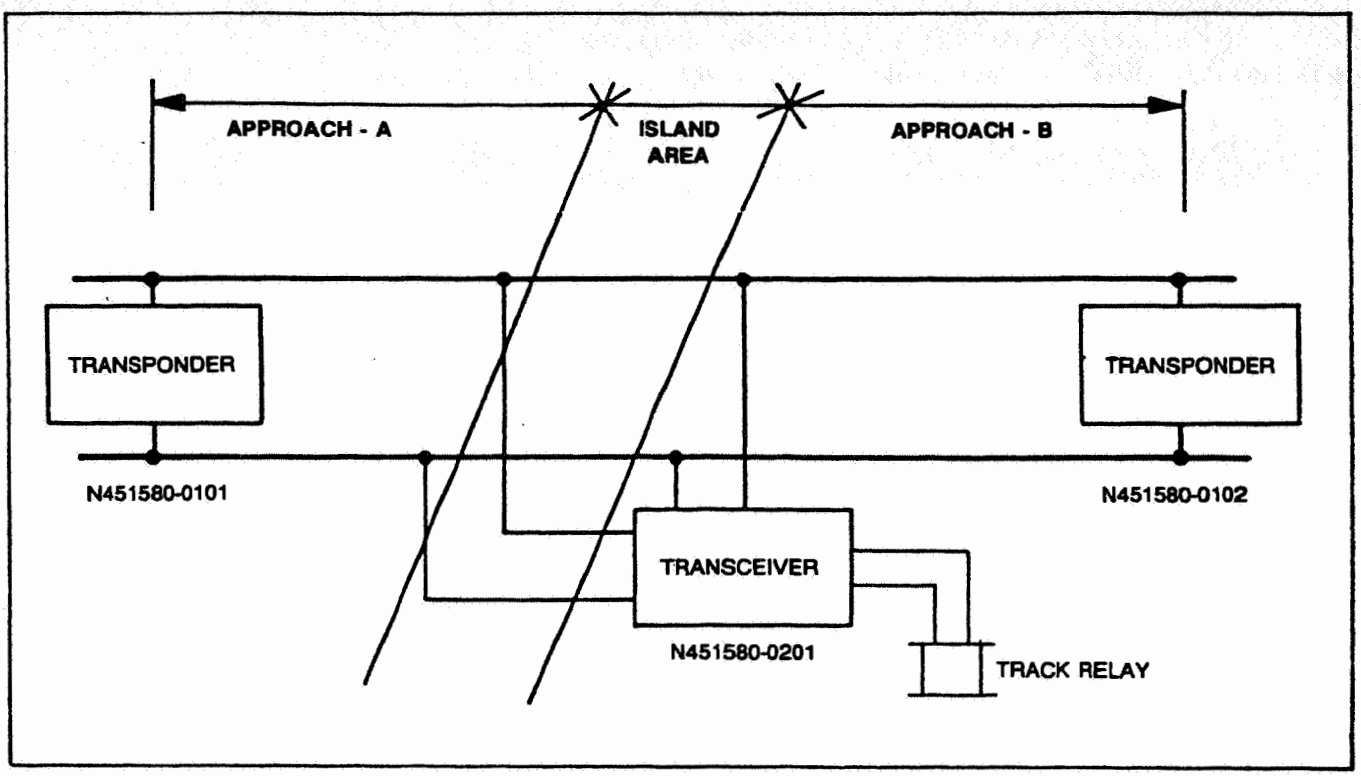


Figure 4-5. High Frequency Track Circuit

4.3 ACTIVATION CONTROL CIRCUITS

The types of control circuits used to activate the grade crossing warning devices depend upon the specific application. Control circuits can be designed for the very basic grade crossing, or for the very complex; for example, overlapping track circuits. Because the control circuits are designed for specific applications, it is not practical to cover them in this manual. A typical grade crossing control circuit is shown in Figures 4-6. For specific control circuits, refer to the circuit diagrams for the particular installation.

4.4 POWER REQUIREMENTS

When two sources of power are provided in a local control case and approach end case, storage battery capacity is maintained at all times with a 4.5 ampere automatic battery charger operated by commercial power. If commercial power fails, the battery charge is suspended and the entire system is operated from standby battery until power is restored. AFO approach end cases are also designed for operation with primary batteries where commercial ac power is not available.

Type "C" track circuits are operated with low voltage ac output from an inverter. The inverter will also invert dc to ac in conjunction with a power off transfer relay and standby battery during power outage.

Control equipment normally operates from a 10 Vdc or 12 Vdc power supply. dc "area warning" and "island" track circuits use separate power supplies.

4.5 FUNCTIONAL OPERATION

Although there are many different control schemes possible, the principles of operation are basically the same. The description that follows cover a typical control scheme using Audio Frequency Overlay equipment. This functional description can be applied to systems using other types of train detection equipment; the differences primarily being in the train detection equipment itself.

Simply put, operation of a grade crossing warning system is basically controlled by the train detection and the warning activation circuits. The train detection circuit indicates the presence of a train in the controlled area. The warning activation circuits initiate the operation of the warning devices (flashing lights, gates, bells). When the train leaves the controlled area, the warning circuits are deactivated.

A typical audio frequency overlay (AFO-IIC) track circuit is shown in Figure 4-6. In this example, audio frequency overlay (AFO-IIC) track circuits are used for approaches in either a southbound or northbound direction for each track in the normal direction of traffic. They are designated SOT and NOT (southbound and northbound overlay track), and each have an assigned frequency with a separate transmitter and receiver. Island circuits at grade crossing intersections designated SXOT and NXOT (southbound and northbound crossing overlay track) utilize an ATT-20 transceiver with an assigned frequency.

The block diagram shown in Figure 4-6 illustrates circuit interaction for a typical grade crossing location containing a gate mechanism with gate lights, flashing mast-mounted signal lights and warning bell. Each block represents a functional circuit. The arrow-tipped lines between blocks are transfers of information from one circuit to another. These transfers are accomplished via relay contact openings and closures. The designated relay coils are contained in the circuit originating the transfer. For example, the Warning Activation Circuit conditions the status of the Crossing Relay (XR). Contacts of the normally energized XR relay are then used in the various warning circuits. Therefore, the warning activation/deactivation sequence is controlled by the status of the (XR) relay. For example, as long as there is no occupancy of track circuits in the southbound or northbound approach (SOT and NOT track relays energized), and no occupancy of island track circuits (SXOT and NXOT track relays energized), the XR relay is kept in its energized state preventing warnings from activating.

Typical designations and functions of the relays used are given in Table III. The designations are those found in AAR specifications on signaling. A typical track circuit diagram with a list of components is shown in Figure 4-7.

4.5.1 Audio Frequency Overlay (AFO) Train Detection

Each Grade Crossing Warning System location provides the capability to automatically initiate warning (gate driven to horizontal position, bell and flashing lights activated) with the presence of a train in one or more of the location's approach track circuits.

Table III. Relay Functional Designations

Designation	Function
SXOTR	Southbound Crossing Overlay Track Relay
SOTR	Southbound Overlay Track Relay
NXOTR	Northbound Crossing Overlay Track Relay
NOTR	Northbound Overlay Track Relay
XR	Crossing Relay
SGP	Crossing Gate Repeater Relay
XP	Crossing Repeater
EO	Element On Relay (Flasher)

AFO-IIC track circuits designated with an assigned frequency and having separate transmitter and receiver are used for approaches in a northbound or southbound direction. Island track circuits at grade crossing intersections utilize an ATT-20 transceiver, and are also designated with an assigned frequency.

Regardless of type, each track circuit, when unoccupied, energizes an associated track relay. When a train enters the track circuit, signal strength is shunted away from the associated track circuit receiver, resulting in the deenergization of the track relay. Each track relay utilized for grade crossing warning approach circuits can be identified by its assigned transmission/reception frequency, i.e. OTR for AFO-IIC track circuits and XOTR for ATT-20 track circuits.

4.5.2 Warning Activation

The Warning Activation Circuit provides for automatic or manual activation and deactivation of grade crossing warnings. When under automatic control, occupancy of approach and island track circuits determines the status of the Warning Activation (XR) Relay. When warnings are deactivated (gate in vertical position, lights and bell off), the XR relay is energized via contacts of energized approach (OTR) and island track relays (XOTR). Upon occupancy of an approach track circuit, the XR deenergizes, initiating warnings, and remains deenergized until the originating approach track circuit and the island track circuit are unoccupied.

4.5.2.1 Flashing Warning Lights

Flashing warning lights commence upon deenergization of the XR relay, and in turn, the Crossing Gate Repeater (XGP) Relay. When this occurs, ac power is applied via contacts of an energized Element On (EO) Relay, (flasher relay) to alternately flash gate lights, and mast- or cantilever-mounted signal lights. The signal lights continue to flash until the island track circuit has been passed by the train, and the gate is driven to its deactivated vertical position.

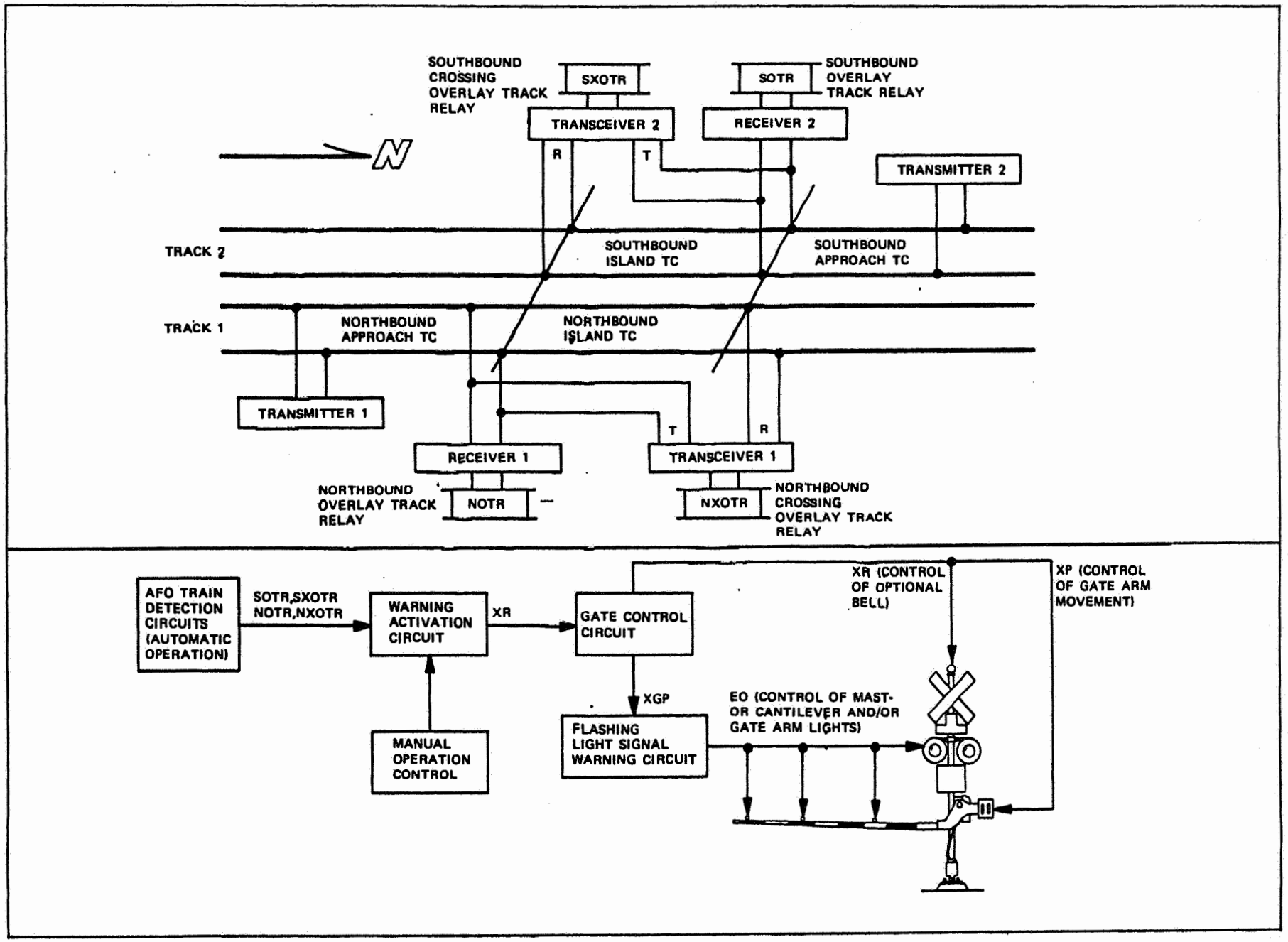


Figure 4-6. Typical Grade Crossing Warning Control Scheme Using Non-Overlapping AFO Track Circuits (Normal Direction Running)

4.5.2.2 Gate Activation

Deenergization of the XR, and in turn, the Crossing Repeater (XP) Relay causes the internal gate mechanism circuits to drive the gate to a horizontal position. Deactivation (XR relay reenergizes) initiates gate drive up to the vertical 90 degree position once the island track circuit has been passed by the train.

4.5.2.3 Warning Bell

Deenergization of the XR causes the crossing warning bell to activate. Bell shutoff is controlled by the movement of the gate arm during drive down via an adjustable cam controlled contact of the gate mechanism's circuit controller.

4.5.3 Warning Activation by Manual Operation Control

Each grade crossing location can contain a provision in the control circuits to effect activation without occupancy of approach or island track circuits. A normally closed pushbutton circuit in series with the coil energizing path to the XR relay can be utilized for this function (as shown in Figure 4-6).

4.5.4 Optional Control and Timing Applications

When required, control circuits can be modified to satisfy design criteria within a grade crossing subsystem or system. The following paragraphs describe some of these applications.

4.5.4.1 Signaling System Tie-In

Track circuits ordinarily used for train detection within interlocking and/or automatic block signaling subsystems can be used in conjunction with grade crossing warning track circuits, and provide an additional means of initiating warning activation and/or deactivation. Line control circuits between crossing locations containing contacts of grade crossing and signaling system track relays can provide varying warning times (elapsed time between warning activation and occupancy of the island track circuit), and protection against AFO (or similar type) track circuit failure. In the event of warning activation upon grade crossing warning track relay failure, timing circuits can be configured to deactivate warnings after a predetermined time delay to allow the gate to rise and flashing signal lights to go dark and avoid unnecessary vehicular or pedestrian traffic buildup.

4.5.4.2 Reverse Traffic Direction Warning Activation

Circuits can also be configured to accommodate reverse as well as normal traffic direction approaches to a grade crossing warning location. If this were the case, warning activation would commence upon occupancy of the approach track circuit for a normal direction running track, and upon occupancy of the island track circuit (slowed or stopped train) or an additional approach track circuit for a reverse direction running track. Warning deactivation would commence upon vacancy of the island track circuit for either direction of traffic.

SECTION V
MAINTENANCE

5.1 GENERAL

The maintenance procedure provided in this manual are limited to field maintenance. Maintenance procedures beyond the scope of this manual, and shop maintenance, are covered in the applicable equipment manuals. Procedures covered in this section include preventive maintenance, troubleshooting, and corrective maintenance.

5.2 PREVENTIVE MAINTENANCE

Preventive maintenance consists of routine cleaning, inspection, and operational tests. Proper preventive maintenance will help to assure continued uninterrupted operation of the Grade Crossing Warning System. The procedures and intervals are those recommended by Union Switch & Signal. Actual procedures and intervals depend on the customers own operation and past experience.

Table IV lists the maintenance actions to be performed and recommended frequency. Ideally, perform all procedures that are due at the same time. For example, if cleaning and inspection fall at six month intervals, these procedures should be performed together.

5.2.1 Cleaning

Cleaning consists of the removal of dust and dirt from the control equipment (located in the instrument case), dirt and grime from the flashing light units, and internal cleaning of the gate mechanism.

5.2.1.1 Equipment/Materials Required

a. Lint-free cloths
b. Soft bristle brush
c. Compressed air in aerosol can
d. Cleaning solvent
e. Commercial cleaning detergent

5.2.1.2 General Cleaning Procedures

WARNING

HAZARDOUS VOLTAGES AND CURRENT MAY BE PRESENT. EXERCISE EXTREME CARE WHEN WORKING AROUND EXPOSED TERMINALS. NEVER USE WET CLOTHES NEAR EXPOSED ELECTRICAL TERMINALS.

a. Remove dust and dirt from the surface of the components mounted in the equipment case and inside the gate mechanism housing with a soft bristle brush. Blow out dust and dirt from hard to reach areas with compressed air in aerosol can.

Table IV. Maintenance Action

Frequency	Action
Every 30 days	Perform a systems operation test per paragraph 5.3.
Every 6 months	Clean and inspect all grade crossing equipment per paragraphs 5.2.1 and 5.2.2.
	Lubricate gate mechanism per paragraph 5.2.3.
Every 12 months	Vital flasher relays performance test per applicable service manual.
Every 24 months	All vital track and control relays performance test per applicable service manuals.

b. Remove accumulation of heavy dirt and grime with a lint-free cloth dampened in a detergent solution. Dry with clean cloth.

c. With a cloth dampened in an approved solvent, wipe clean the gate mechanism circuit control, motor control relay contacts, and hold clear amature of any oil, and dirt that may have accumulated during operational service.

d. Flashing Light Units

1) Clean glass roundels and glass reflectors with a clean cloth moistened with a detergent solution. Wipe dry. Use an approved solvent for hard to remove dirt or grease.

2) Clean plastic roundels by flushing with clean water, using a chamois or soft cloth. Use a detergent for hard to remove dirt.

CAUTION

Do not use any solvents on plastic roundels.

3) Remove dirt from hoods and background with a damp cloth moistened in a detergent solution.

5.2.2 Inspection

Inspect the equipment for damaged parts, etc. in accordance with the following paragraphs. Any parts found to be damaged during inspection should immediately be repaired or replaced. Refer to Section VII, Corrective Maintenance.

5.2.2.1 Grade Crossing Equipment

a. Broken or cracked light unit roundel and/or reflector.

b. Broken light unit case, door, or other parts. Damaged lamp receptacle.

c. Faulty or damaged door gasket which would result in water leaking into the case.

d. Burned out or broken light unit or gate arm lamps.

e. Broken or cracked lens on gate arm lights.

f. Broken or cracked gate arms.

g. Damaged mast and/or signs, or other equipment.

h. Exterior damage to gate mechanism signs of vanadalism.

i. Interior of gate mechanism for the following:

1) All wiring connections are tight; wiring is free from cuts, nicks, and fraying.

2) Damage to gears, motor, cams and contacts.

3) Secure mounting of components.

4) Contacts for proper opening (refer to SM6043).

5) Slide contacts on resistors are clean and are bearing on the resistor windings with firm pressure. Lockscrew securing the slide contact should be tight.

5.2.2.2 Control Equipment

a. Check control case exterior for any signs of physical damage or of vandalism (such as bullet holes). Check for water leaks inside the case.

b. Check batteries for fluid and specific gravity. Remove all corrosion to assure proper voltage and battery charging.

c. Check for loose or damaged electrical connections.

d. Check for loose or damaged components.

e. Check for wiring for burned, frayed, or damaged insulation.

f. Check track circuit cabling for secure connections to track and damage such as kinks, cuts, etc.

g. Check for insulated joints (if applicable) for damage or deterioration.

h. Check relays for:

1) Cracked or broken cover; broken seals.

2) Pitted or damaged contacts; contact misalignment.

3) Corrosion or other contamination of relay components; loose parts inside cover.

5.2.3 Lubrication

The only equipment requiring lubrication is the gate mechanism. Every six months, or more frequently depending on operating conditions, apply a light brush coat of lubricant to the gear teeth and circuit controller cam. Texaco Regal Starfax #2 (MIL-G-3278) VA4830 grease, or equivalent is recommended. The mechanism gear shaft and main shaft bearings are pre-lubricated and double sealed at the factory and requires no lubrication in the field.

5.3 SYSTEM OPERATIONAL TEST

NOTE

More frequent operating tests should be made in areas where the system is seldom or only periodically used. Where the system is in use daily, a visual observation of the system should suffice until normal periodic testing.

Keep test records for handy referral so that proper checks are made at regular intervals.

Every 30 days perform the operational test covered in paragraph 3.8.2. Observe the operation for any signs of malfunctioning or faulty operation. Initiate corrective action if any faults are observed.

5.4 TROUBLESHOOTING

5.4.1 Table V covers the more common problems encountered in system operation. Faulty operation generally will occur in three major areas:

1) Train detection circuits,

2) Activation control circuits, and

3) Gate mechanism.

Table V. Troubleshooting

Problem	Cause	Remedy
1. Erratic or malfunctioning gate arm operation; warning system operating properly.	Improper gate mechanism adjustments.	Refer to gate mechanism SM6043.
2. Gate arm remains down when track is unoccupied.	Open motor-up circuit.	Refer to gate mechanism SM6043.
3. Gate in horizontal position with other warnings not activated.	Loss of primary ac and dc power (common source)	Check distribution of primary ac power to signal lighting transformer and dc rectifier. Check transformer and rectifier.
	Open gate fuse	Check fuse for continuity. If required, replace with identical fuse.
4. Gate in horizontal position with steady lit gate and signal lights.	Loss of dc power	Check distribution of dc power to control relays. Check power supply or rectifier.
	Malfunctioning flashing signal lighting circuit.	Check operation of flashing signal lighting circuit (specifically, the flasher relay and distribution of ac to signal lighting lamps).
5. Control system activated; gate and signal lights malfunctioning (not flashing, one side not lit, etc.)	Malfunctioning flashing signal lighting circuit.	Check operation of flashing signal lighting circuit (specifically, the flasher relay). Check lamps.

Table V. Troubleshooting (Cont'd.)

Problem	Cause	Remedy
6. Activation of warnings with no occupancy; flashing lights on gate down.	Train detection equipment failure (one or more track relays deenergize resulting in warning control relay deenergizing).	Refer to applicable train detection manual. Check relays.
	Open in energizing path to warning control relay resulting in deenergization.	Check continuity of energizing path to warning control relay.
	Open in manual activation circuit.	Check operation of manual activation circuit.
	Malfunction relay in activation circuit.	Check relays.
7. System remains activated after train leaves control areas; flashing lights on, gate remains down.	Malfunctioning detection equipment.	Troubleshoot detection circuit/equipment and correct. Check relays. Replace if faulty.
	Malfunctioning activation equipment.	Troubleshoot activation circuits/equipment and correct. Check relays. Replace if faulty.
8. Gate goes up; flashing lights remain on with no occupancy.	Malfunctioning lighting control circuits.	Troubleshoot control circuit/equipment and correct. Check relays. Replace if faulty.
9. Flashing lights go dark; gate remains down with no occupancy.	Malfunctioning gate control circuit.	Troubleshoot control circuit/equipment and correct. Check relays. Replace if faulty.

5.5 CORRECTIVE MAINTENANCE

Corrective maintenance consists of repairing or replacing damaged or faulty components or equipment. In general, most items can be replaced in the field to restore the system to full operation. This would include control equipment such as relays, rectifiers, transformers, and detection equipment. Minor repairs can also be done in the field such as replacing roundels, lamps, damaged signs, broken gate arms, etc. Items requiring major repair should be returned to the shop such as:

a. Gate mechanism for damage to gears, contacts, cams, motor, clutch, etc.

b. Relays for broken covers, damaged or misaligned contacts.

c. Light units for broken reflector, lamp receptacle, case and case door.

d. Train detection unit if it does not meet minimum performance standards and cannot be brought into specification through normal adjustments.

SECTION VI
REPLACEMENT PARTS

6.1 GENERAL

For detail parts of the major components, refer to the applicable service manual listed in Table I. For parts and equipment associated with a specific installation, refer to the applicable drawings (see Figure 4-7 for an example). Miscellaneous parts information for signs, bases, etc. are covered in the following catalog sections included in this section:

Grade Crossing Masts	RSE-10B1
Junction Box Bases	RSE-10B2
Grade Crossing Signs	RSE-10B3

6.2 REPLACEMENT LAMPS

For convenience, replacement lamps for the flashing light units and the gate arm lights are listed below:

a. Flashing Light Units and Gate Arm Lights

10 Volt - 18W	S.C.B.C. Base	J071463
10 Volt - 25W	S.C.B.C. Base	J071574
110 Volt - 25W	S.C.B.C. Base	J714054

a. Flashing Light Units Only

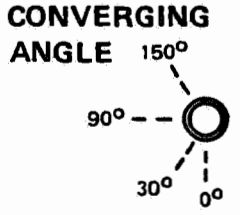
10 Volt - 16W	Quartz Iodide	J714283
10 Volt - 36W	Quartz Iodide	J714284

GRADE CROSSING MASTS

U S & S masts are constructed of aluminum for easy handling, long life, and minimum maintenance. The 13' 6" mast is used for mounting grade crossing signals, signals with gate assemblies, or gate assemblies, only. A 6' 9" stub mast is available for mounting U S & S's gate mechansim with gate arm. The 15' 3" mast is designed for converging highway applications. An additional hole is drilled at appropriate angle from the center to accommodate additional crossarms.

4 AND 5-INCH GRADE CROSSING ALUMINUM SIGNAL MASTS

(FOR USE WITH 17" HIGH JUNCTION BOX BASES WITH 11-11/16" BOLT SPACING)



ORDERING INFORMATION

PART NO.	MAST DIA.	MAST HEIGHT	J.B. BASE HOLE	J.B. CROSSARM HOLE	CONVERGING CROSSARM HOLE	NOTES
M451394-4301	4"	6'9"	0°	–	–	
M451394-4201	5"	6'9"	0°	–	–	
M451394-4401	4"	13'6"	0°	0°	–	
M451394-3902	5"	13'6"	0°	0°	–	
M451394-4101	4"	15'3"	0°	0°	–	
M451394-4001	5"	15'3"	0°	0°	–	
M451394-4102	4"	15'3"	0°	0°	30°	
M451394-4002	5"	15'3"	0°	0°	30°	
M451394-4103	4"	15'3"	0°	0°	90°	
M451394-4003	5"	15'3"	0°	0°	90°	
M451394-4104	4"	15'3"	0°	0°	150°	
M451394-4004	5"	15'3"	0°	0°	150°	

4-INCH GRADE CROSSING ALUMINUM SIGNAL MASTS

(FOR USE WITH 12" HIGH JUNCTION BOX BASE WITH 9-1/2" BOLT SPACING)

ORDERING INFORMATION

PART NO.	MAST DIA.	MAST HEIGHT	J.B. BASE HOLE	J.B. CROSSARM HOLE	CONVERGING CROSSARM HOLE	NOTES
M451394-5101	4"	13'6"	0°	0°	–	
M451394-5102	4"	15'3"	0°	0°	90°	

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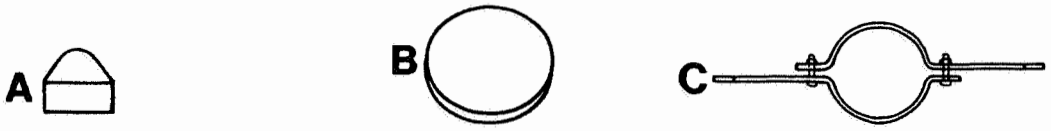
UNION SWITCH & SIGNAL DIVISION
AMERICAN STANDARD INC. / SWISSVALE, PA 15218

RSE-10B1
8/79

PINNACLE AND APPLICATION HARDWARE

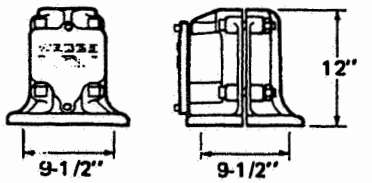


ORDERING INFORMATION

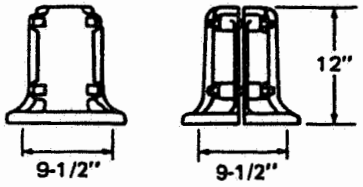
REF.	PART NO.	DESCRIPTION	NOTES
A	J026104	PINNACLE for 4" diameter mast	
A1	J026111	PINNACLE for 5" diameter mast	
B	M451195-3601	RODENT COVER PLATE for 4" diameter mast	
B1	M451195-3602	RODENT COVER PLATE for 5" diameter mast	
C	N199590	STEP, GALVANIZED, includes mounting hardware	

JUNCTION BOX BASES FOR 4-AND 5-INCH MASTS

U S & S junction box bases are constructed of aluminum for easy handling, long life, and minimum maintenance. They provide for terminating leads at the mast base. These junction box bases facilitate installation and maintenance.



A



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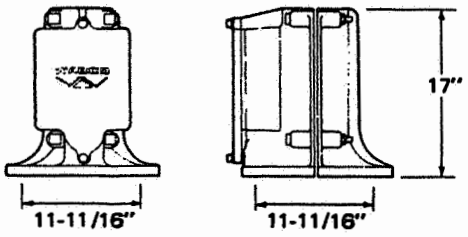
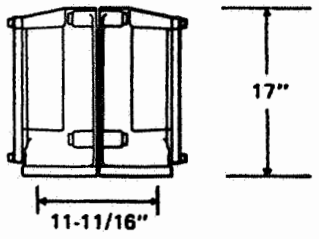


C/C1



C2

REF.	PART NO.	MAST DIA.	FDN. BOLT SPACING	BASE HEIGHT	NO. TERM.	NOTES
A	J705049-0201	4"	9-1/2 "	12"	12	Not For Use With Gates
B	J705049-0203	4"	9-1/2"	12"	None	Plain Clamp Base
C	J705049-0602	4"	11-11/16"	17"	24	
C1	J705049-0801	5"	11-11/16"	17"	24	
C2	J705049-0901	5"	11-11/16"	17"	48	

For FOUNDATION BOLTS see RSE-10F1.

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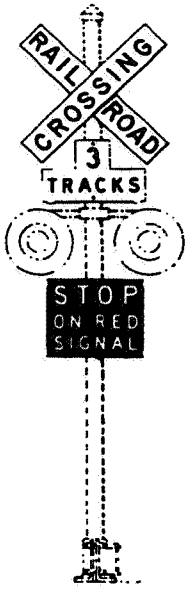
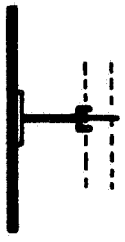
GRADE CROSSING SIGNS

U S & S grade crossing warning signs are made of aluminum and include all hardware necessary for mounting. Signs can be ordered in engineering grade Scotch-Lite® or Hi-Intensity reflex-reflection. U S & S signs conform to AAR requirements.



"RAILROAD CROSSING" SIGN

All aluminum construction with black lettering and includes mounting hardware.



STANDARD

PART NO.	MAST SIZE	BACKGROUND
X392931-001	4"	Engineering Grade
X392931-007	4"	Hi-Intensity
X392931-002	5"	Engineering Grade
X392931-008	5"	Hi-Intensity
X392931-005	10" (Pipe Mast)	Engineering Grade
X392931-009	10" (Pipe Mast)	Hi-Intensity
X451506-0711	10/11" (Tapered Mast)	Engineering Grade
X451506-0712	10/11" (Tapered Mast)	Hi-Intensity

WITH STAND-OFF for Wooden Gate Arms

PART NO.	MAST SIZE	BACKGROUND
X438002-002	4"/5"	Engineering Grade
X438002-003	4"/5"	Hi-Intensity

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"TRACKS" SIGN

Specify number required. All aluminum construction with black lettering and includes mounting hardware.

STANDARD

PART NO.	MAST SIZE	BACKGROUND
X392929-001	4"	Engineering Grade
X392929-005	4"	Hi-Intensity
X392929-002	5"	Engineering Grade
X392929-006	5"	Hi-Intensity
X392929-004	10" (Pipe Mast)	Engineering Grade
X392929-007	10" (Pipe Mast)	Hi-Intensity
X451506-0714	10/11" (Tapered Mast)	Engineering Grade
X451506-0715	10/11" (Tapered Mast)	Hi-Intensity

WITH STAND-OFF for Wooden Gate Arms

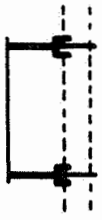
PART NO.	MAST SIZE	BACKGROUND
X437997	4"/5"	Engineering Grade
X437997-001	4"/5"	Hi-Intensity

"STOP ON RED SIGNAL" SIGN

All aluminum construction with black background. Includes mounting hardware.

STANDARD

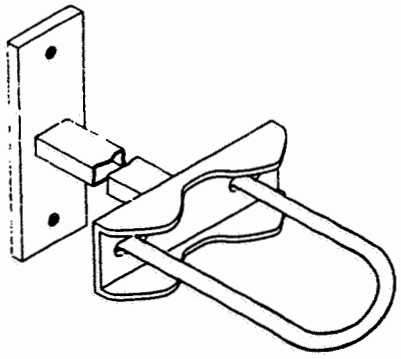
PART NO.	MAST SIZE	LETTERING
X392930-001	4"	Engineering Grade
X392930-005	4"	Hi-Intensity
X392930-002	5"	Engineering Grade
X392930-006	5"	Hi-Intensity
X392930-004	10" (Pipe Mast)	Engineering Grade
X392930-007	10" (Pipe Mast)	Hi-Intensity
X451506-0720	10/11" (Tapered Mast)	Engineering Grade
X451506-0721	10/11" (Tapered Mast)	Hi-Intensity



WITH STAND-OFF for Wooden Gate Arms

PART NO.	MAST SIZE	LETTERING
X438077	4"/5"	Engineering Grade
X438007-001	4"/5"	Hi-Intensity

STAND-OFF BRACKETS (Includes hardware.)



4"/5" MAST

PART NO.	SIGN
N438004-001	"Railroad Crossing"
N437999	"Tracks"
N438078	"Stop On Red Signal"

10"/11" MAST

PART NO.	SIGN
X451506-0710	"Railroad Crossing"
X451506-0713	"Tracks"
X451506-0719	"Stop On Red Signal"