MAINTENANCE INSTRUCTION
M.I. 1602
Revision C

Service Department
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
October, 2001

RADIAL DYNAMIC BRAKE GRID RESISTORS

SAFETY PRECAUTIONS

Please refer to the EMD Safety Precautions in appendix to the Locomotive Service Manual whenever routine service or maintenance work is to be performed on any AC traction equipped locomotive.

The maintenance procedures as outlined in this instruction are specific to the radial style dynamic brake grid resistors and are offered for planning purposes only. As written, this document reflects current EMD product design and service experience for this design. The content of this M.I. reflects maintenance requirements based on time from delivery or miles in service. This recommendation is consistent with present fleet performance and remains within the EMD experience envelope.

This Maintenance Instruction is intended to serve as a guide when establishing maintenance procedures to meet the particular requirements of individual operations and planned economic life of the radial type dynamic brake grid resistors. It provides average recommendations, which should ensure satisfactory locomotive operation, and economical maintenance costs where average load factors and climatic conditions are encountered.

The scheduled inspection and maintenance items defined herein are specific to these designs. Component renewal provisions are consistent with traditional overhaul procedures.

Prepared by International Technical Services – London, Ontario, Canada

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1.0 INTRODUCTION

A properly maintained dynamic brake grid system will provide a grid life equal to the life of the motive power equipment. Associated equipment directly affects the grid resistor. Therefore, proper functioning of cooling fans, regulators, and cabling is essential. This instruction provides procedures necessary to perform maintenance on the dynamic brake hatch when the locomotive is equipped with radial grids.

2.0 DESCRIPTION

The radial resistor grids are four 90^{o} or six 60^{o} pie-shaped, 670, 700, 760, 906, or 945 ampere resistor sections, Figure 1, each with a ribbon grid designed to convert electrical energy into heat. The ribbon assembly has a consistent preset thermal expansion gap, and is firmly held in place by retention pins.

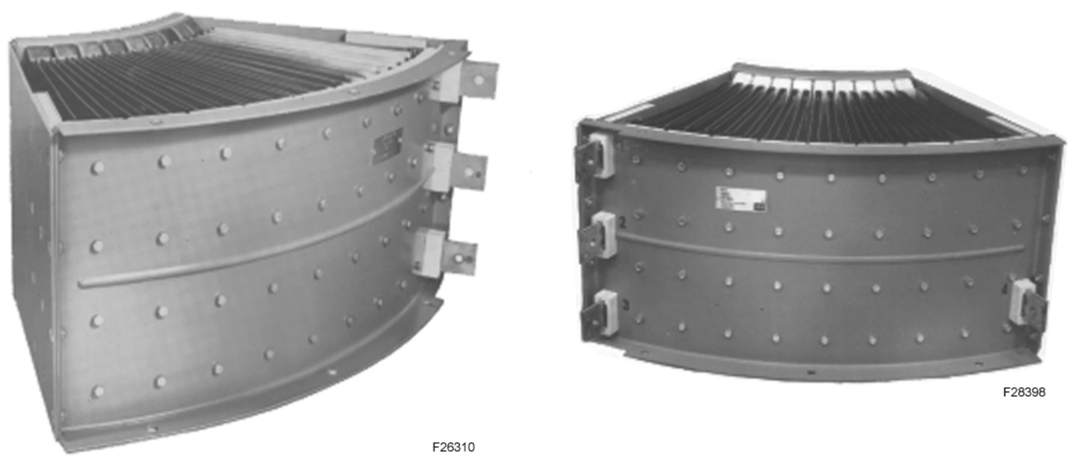


Figure 1 Typical Radial Dynamic Brake Grid Resistor Sections

Since the grid assembly consists of individual basic sections, replacing the defective section can easily and economically repair partially failed grids.

Several dynamic brake resistors with associated cooling fan and motor are usually grouped in a sub-assembly, Figure 2, which in turn is mounted in the superstructure of the locomotive; Figure 3, Figure 4, and Figure 5.

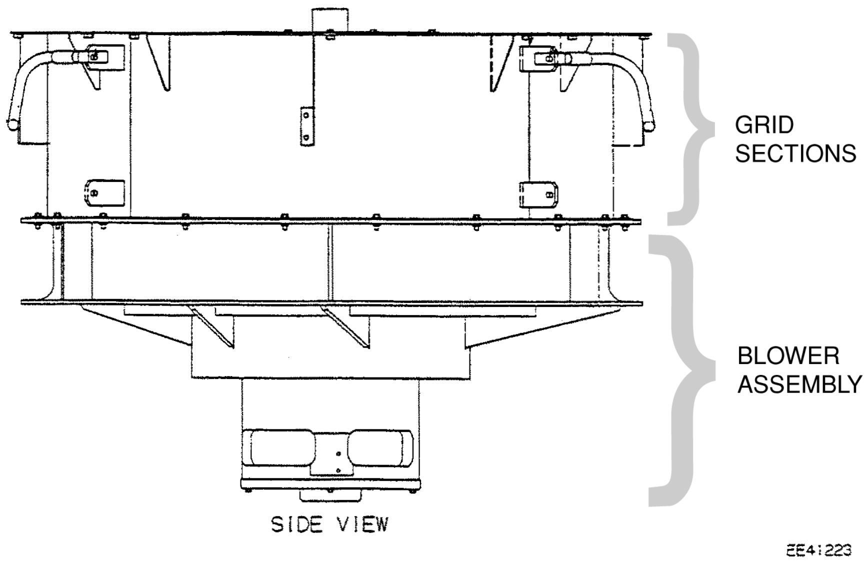


Figure 2 Typical Radial Dynamic Grid and Blower Assembly

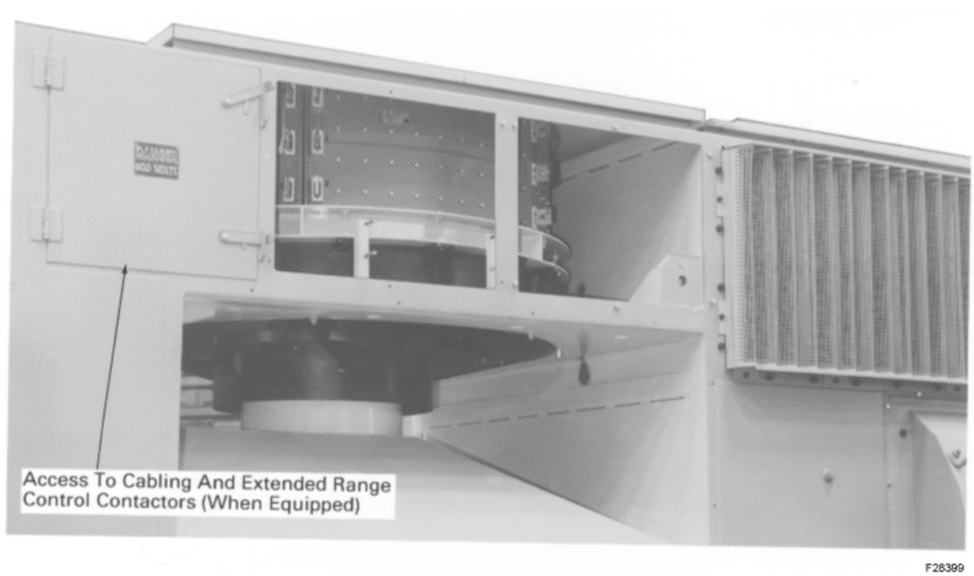


Figure 3 Typical Dynamic Brake Resistors, Fan, And Motor Application in 50, 60, and 70 Series Locomotive Superstructure

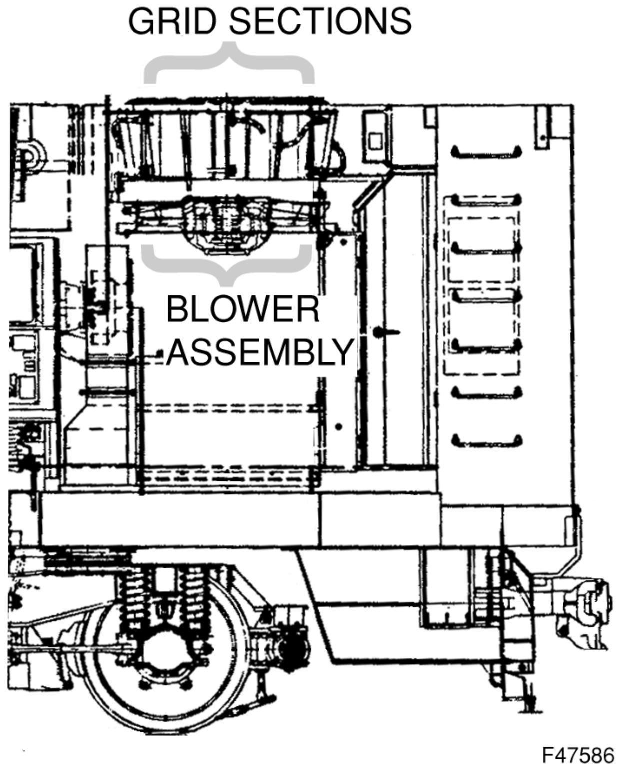


Figure 4 DE/DM 30AC Dynamic Brake Resistors, Fan, And Motor Application in Locomotive Superstructure

Figure 5 Typical Dynamic Brake Resistors, Fan, And Motor Application in 80, and 90 Series Locomotive Superstructure

Each section is individually removable through the top of the hatch. In addition, the entire hatch, including the cooling fan, screen, and grid, is easily removable as an assembly from the dynamic brake compartment.

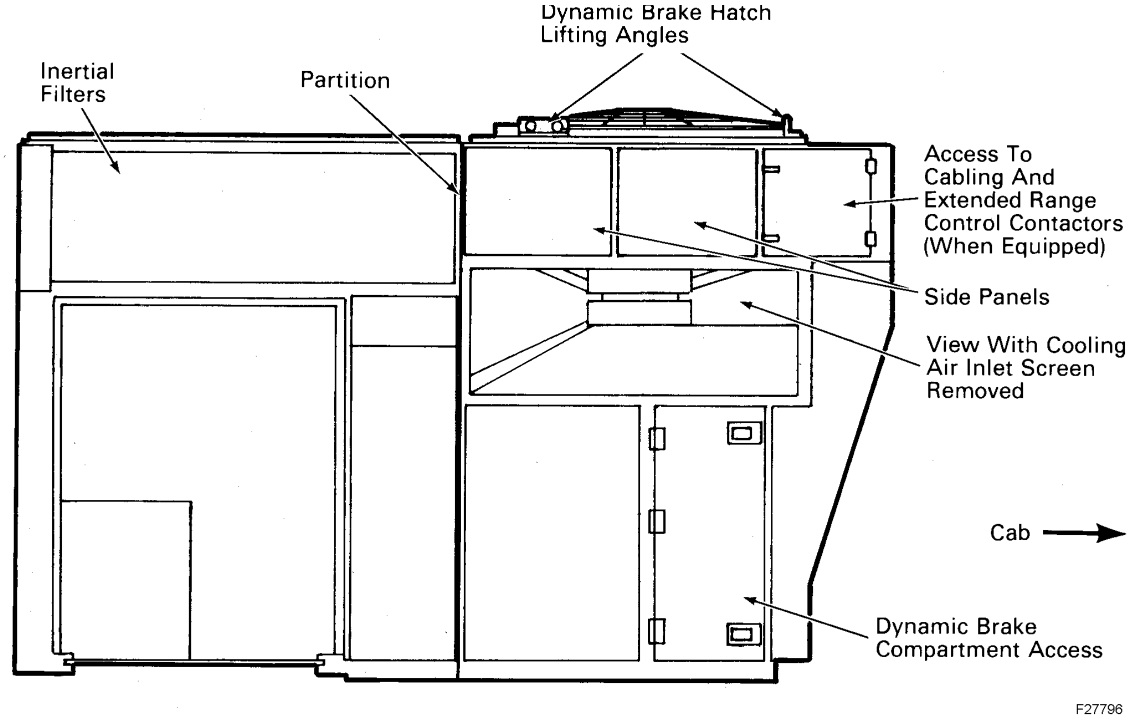


Figure 6 Dynamic Brake And Inertial Filter Compartment (50/60/70 Series)

Extended range control contactors, when equipped, are easily accessible through maintenance door provided at the dynamic brake hatch. Fan motor brush maintenance is accomplished through a carbody side door leading into the dynamic brake compartment. Note that the AC blower used on the DE/DM 30AC locomotives requires no brush maintenance.

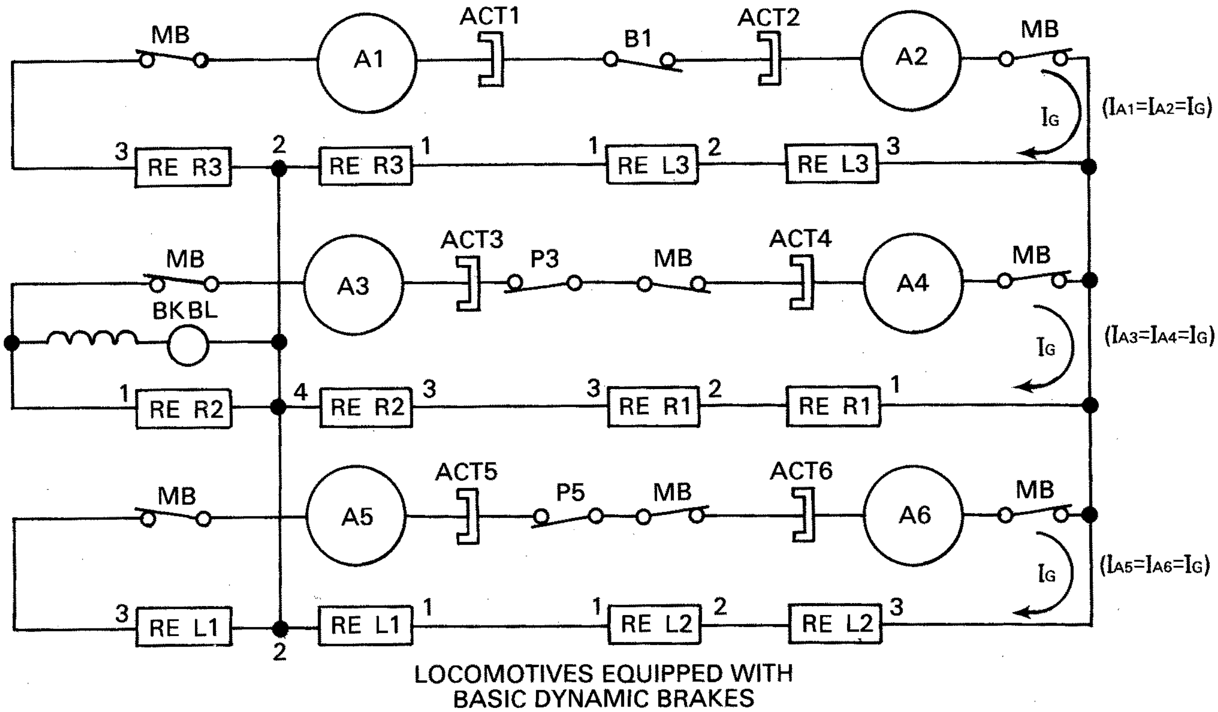
2.1 OPERATION

Dynamic braking is a system used to retard speed through conversion of kinetic energy into electrical energy. During dynamic braking, power developed by the traction motors acting as separately excited generators is dissipated through the dynamic brake grid resistors in the form of heat.

The following schematics represent typical configurations of the dynamic brake grids to the locomotive tractive power circuits when configured for dynamic brake operation. While these reflect normal design principles, always refer to the correct schematic for the locomotive being worked on.

NOTE

- Figure 7 covers both basic and extended range dynamic brake systems when equipped with 700 or 760 ampere grids.
- Figure 8 provides information for the 945 extended range dynamic brake system only.
- Figure 9 illustrates the four 90° grid application for certain orders of SD70MAC locomotives.
- Figure 10 illustrates the six 60° grid application used on various SD70MAC locomotives.
- Figure 11 illustrates the circuit configuration used on SD80MAC and early SD90MAC locomotives.
- Figure 12 illustrates the circuit configuration used on late models of SD90MAC locomotives equipped with grid shorting.
- Figure 13 illustrates the truck inverter / HEP inverter/ grid circuit configuration used on the DE and DM30AC locomotives.



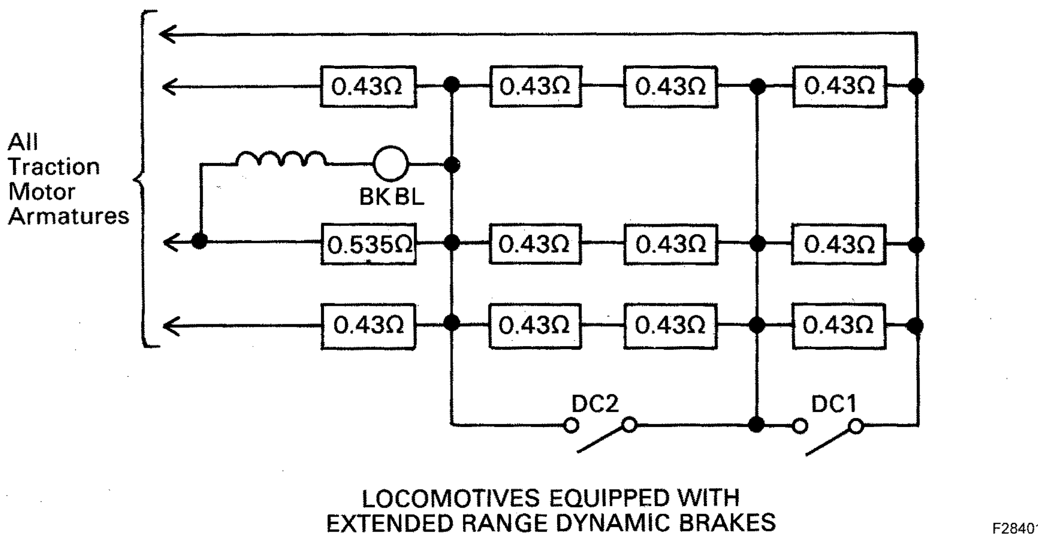


Figure 7 Traction Motor Armature Connections During Dynamic Braking – 700 And 760 Ampere Resistors

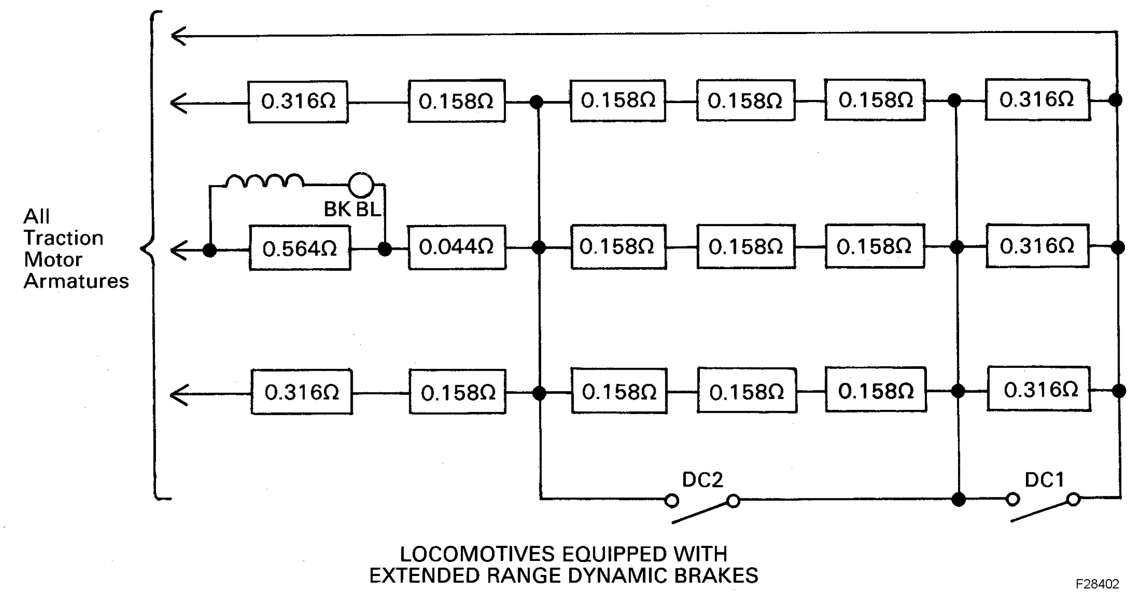


Figure 8 Traction Motor Armature Connections During Dynamic Braking – 945 Ampere Resistors

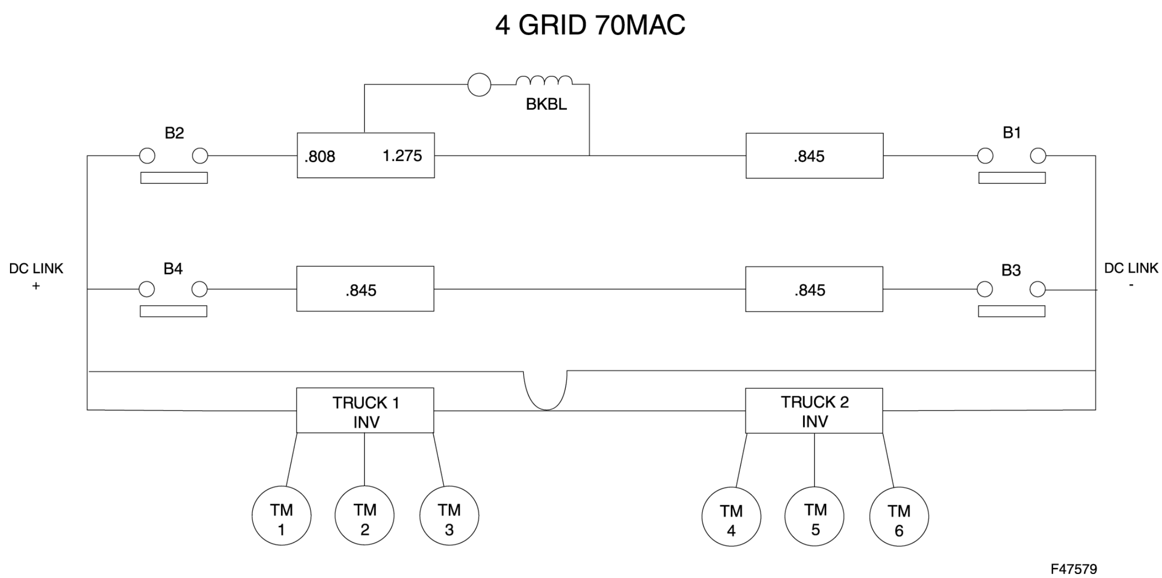


Figure 9 Traction Inverter / Grid Connections During Dynamic Braking – four 90° grid application SD70MAC

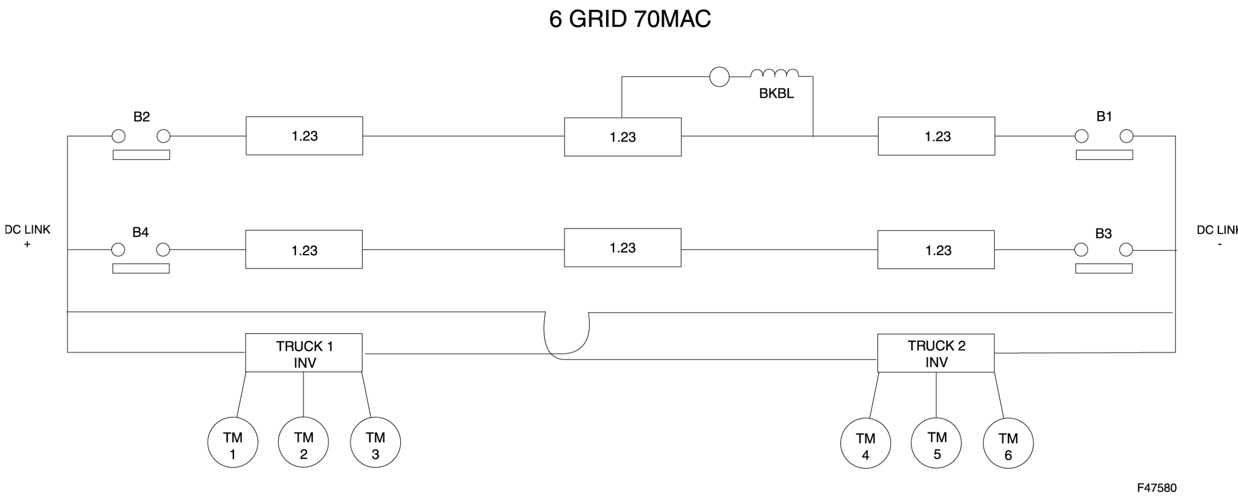


Figure 10 Traction Inverter / Grid Connections During Dynamic Braking – six 60° grid application SD70MAC

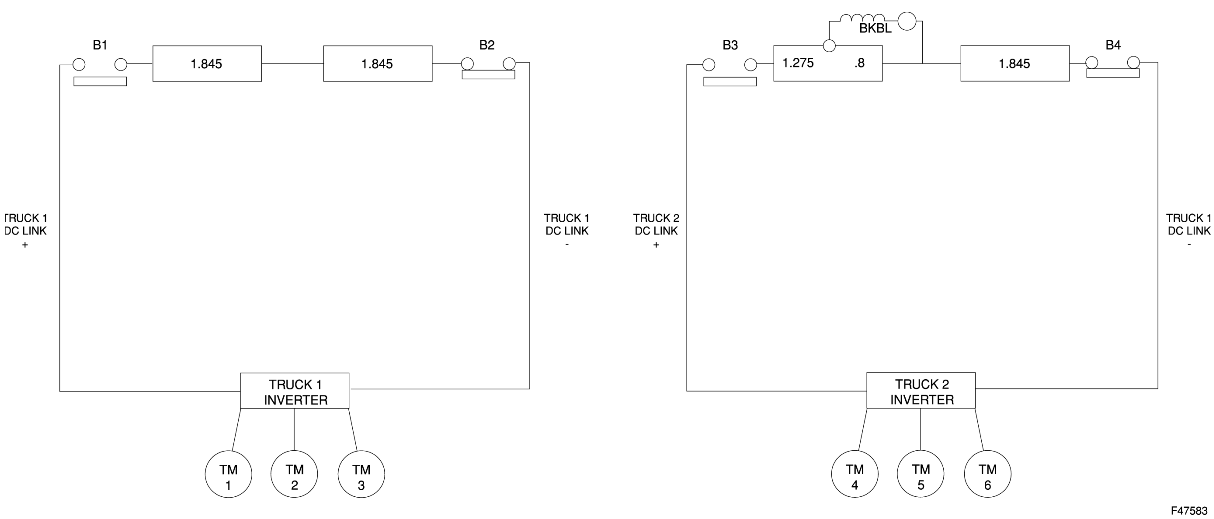


Figure 11 Traction Inverter / Grid Connections During Dynamic Braking – SD80/SD90 applications

90 MAC W/GRID SHORTING

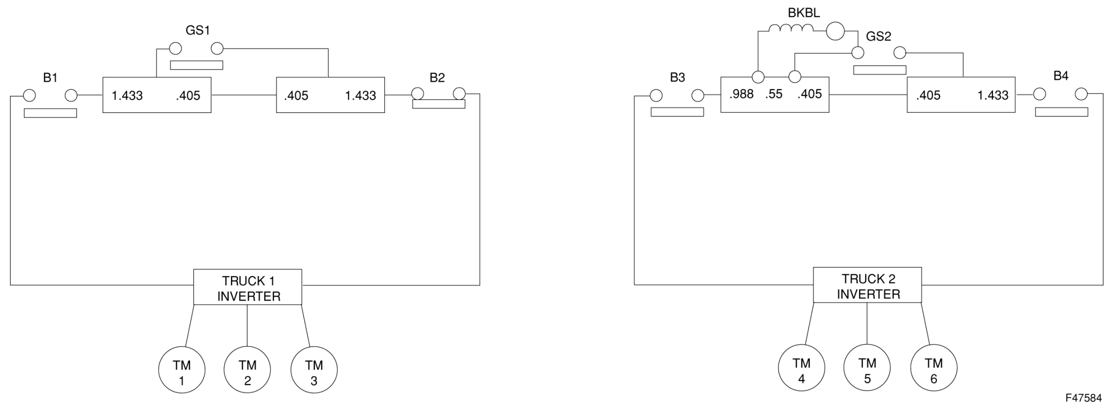


Figure 12 Traction Inverter / Grid Connections During Dynamic Braking – SD90 application equipped with grid shorting

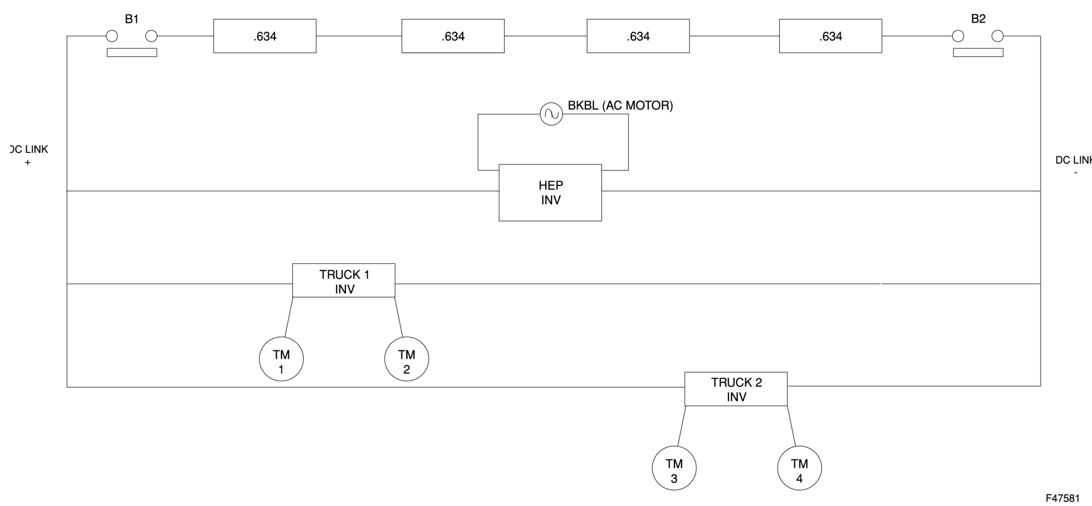


Figure 13 Traction Inverter / HEP Inverter / Grid Connections During Dynamic Braking – DE and DM30AC applications

The amount of kinetic energy that is converted into electrical energy is proportional to I^2R where I is braking grid current and R is the effective resistance of the braking grids. Grid current increases to its maximum value at the speed where maximum braking effort is attained and is regulated to the maximum value at all higher speeds.

2.2 RATING FACTORS

Radial grid ventilation is by discharge air from the fan. This is a drastic change from ventilation of the earlier, box-type grids, which were cooled by suction. It is more difficult to achieve uniform cooling with the new configuration, but it saves space on the locomotive and facilitates installation and maintenance of the brake grids.

Many factors influence the effectiveness of the cooling air:

- Presence of air deflectors.
- Fan motor size.
- Fan size.
- Location of motor tap on motor tap grid.

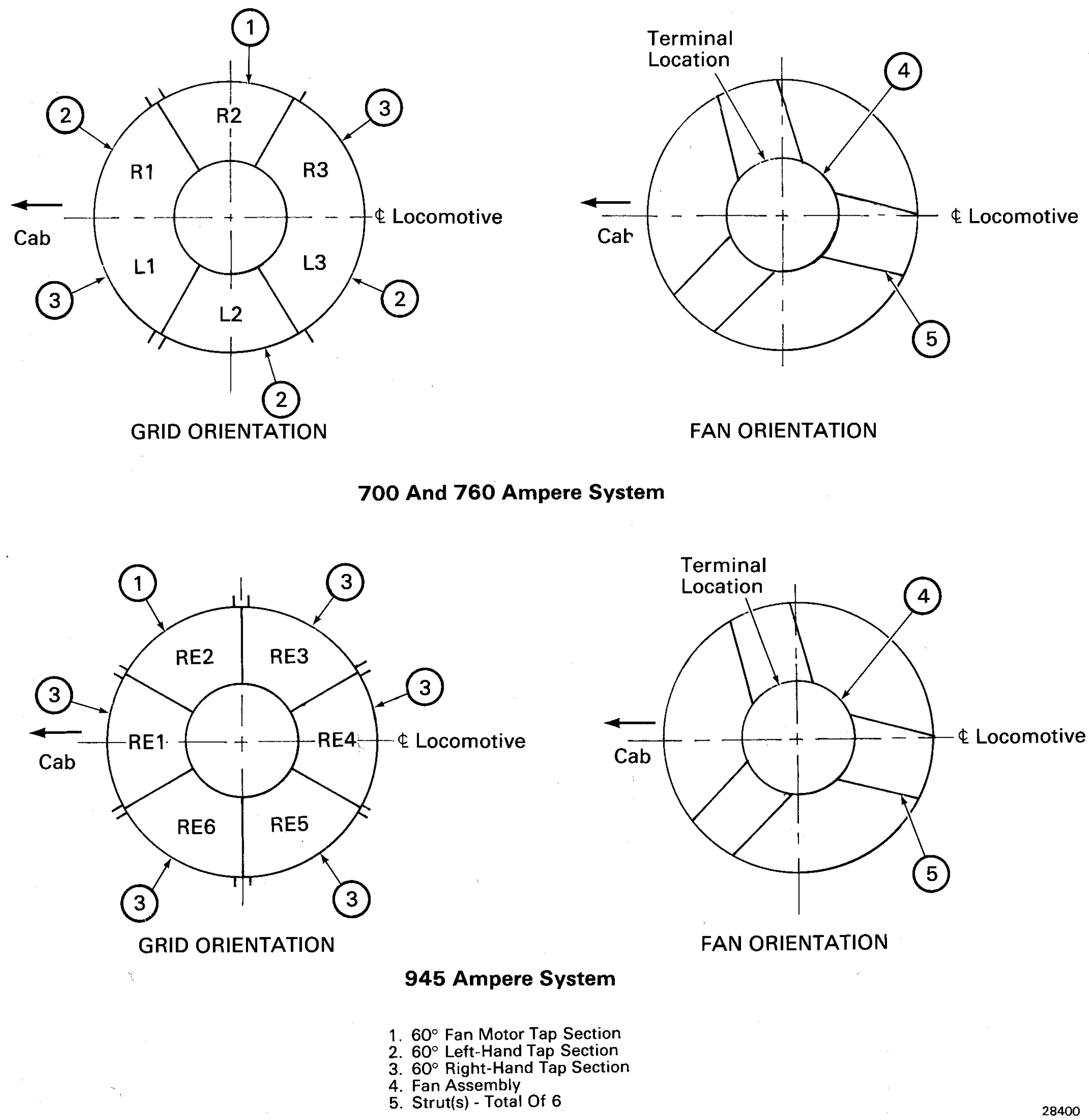


Figure 14 Typical Grid and Fan Orientation

The four ribbons making up each grid section are “skewed” that is, they are placed in an alternating fashion, Figure 15, at an angle to the vertical airflow entering the grids from the fan. This creates a vertical zigzag ribbon structure, causing greater air turbulence and thereby more effective cooling.

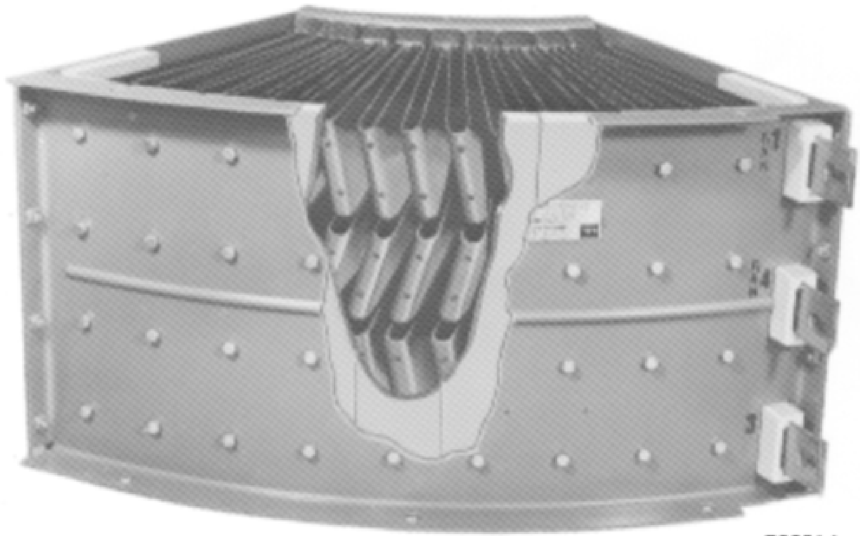


Figure 15 Resistor Ribbon “Skewing”

Ampere rating of the grid in a specified hatch and location is established to provide an adequate safety margin for wind direction, ambient temperature, and variations, which occur in other areas directly affecting the grid cooling power.

The rating of the radial grids is determined by a combination of two factors: (1) the braking horsepower required for typical locomotive application, and (2) the maximum permissible temperature on the grid ribbon and insulation.

2.3 RESISTOR TYPES

In all configurations of resistors, except for the DE/DM 30AC locomotives, there is at least one resistor with a special tap for the blower motor, Figure 16. This resistor has a different resistance value from the companion resistors and may have extra tap.

NOTE

On the DE/DM 30AC locomotive application, the conventional DC grid blower powered off the grid tap has been replaced by an AC blower fed from the AC traction system. For information on this blower, refer to M.I. 4105

Figure 16 Dynamic Brake Grid Resistor With Control Tap

The motor tap is positioned to provide a desired fan speed at a given value of current, and the total value of the grid resistance is such that the total power consumed by the motor tap grid and the cooling fan motor is the same as that consumed by one of the untapped grids in the same configuration when a given current flows through them.

The companion resistors are also provided with center taps, Figure 1. These taps are used for control purposes or for series-parallel arrangement when loading the engine.

2.4 VENTILATION

All resistors require a large amount of ventilating air when operated at rated current value. The proper amount of air is furnished by the dynamic brake grid blower (fan) which is tapped across a section of one of the resistors.

NOTE

A particularly integral relationship exists between the grid fan and grid resistor. Proper maintenance of the cooling fan motor components (including bearing, brushes, cabling, and alignment procedures) is stressed. (Refer to M.I. 4104 or 4105.)

2.5 INSULATION

In operation, the entire resistor is "above ground" electrically. As a component of a new or rebuilt unit, the resistors are expected to withstand a 3200 VAC 60 Hz high potential test for 1 minute. During operation, the resistors are usually electrically isolated by disconnecting the ground connection of the power circuit.

2.5.1 ON AC APPLICATIONS

A potential of up to 3000 volts can exist on the DC link during dynamic braking. It is common practice to place two or three grid sections (depending on four or six grid configuration) in series across the DC link, so each section can see up to 1500 V.

2.5.2 ON DC APPLICATIONS

A potential of 500-600 volts exists between the terminals of the resistor, and it is common practice to put two resistors in series with the armature outputs of two traction generators. Therefore, 1200 volts-to-ground may exist during operation. If insulation is damaged, a portion of a resistor may short out either directly or by a "double-ground."

2.6 TERMINALS

Since the current carrying capacity of the grids is measured in hundreds of amperes, the cable carrying current to the grids is of necessity, bulky and stiff. The grid terminals are ruggedly constructed to withstand severe pulling or twisting at the cable lugs.

NOTE

The contact surfaces of the cable lugs and terminals must be kept free from corrosion.

3.0 RESISTOR GRID DISASSEMBLY

WARNING

Please refer to the EMD Safety Precautions in appendix to the Locomotive Service Manual whenever routine service or maintenance work is to be performed on any AC traction equipped locomotive.

NOTE

Although the location of the grid assembly varies between locomotive models, the general procedures for removal of the components and assembly are similar.

3.1 GRID SECTION REMOVAL

Depending on locomotive model, the grid assembly is made up of four 90^{o} or six 60^{o} pie-shaped resistor sections arranged as shown in Figure 17.

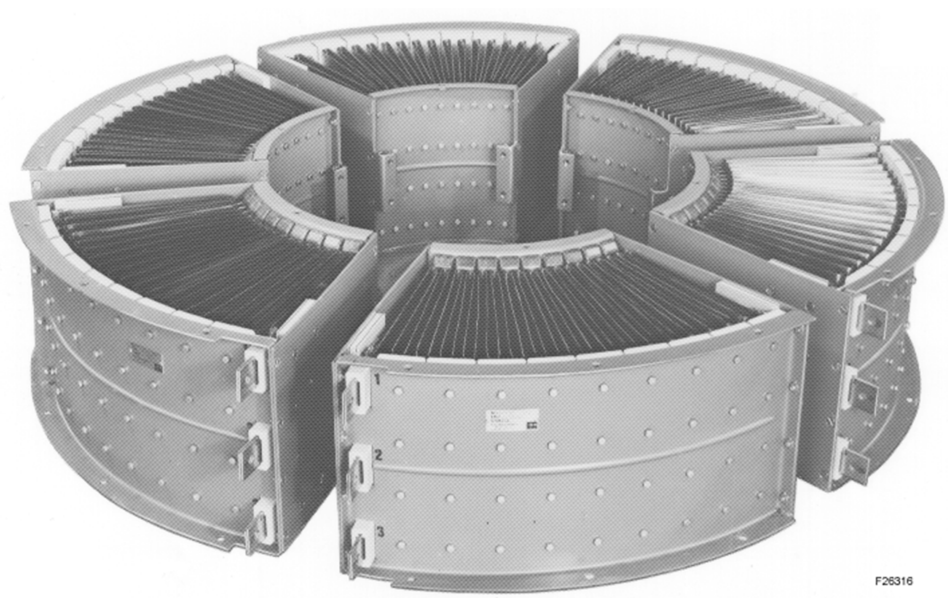


Figure 17 Exploded View of Dynamic Brake Grid Assembly six 60^{o} grids

1. The following procedure provides the information necessary to remove a single or group of grid sections, without removing the dynamic brake hatch from the locomotive.

2. Remove hatch roof mounting bolts. Utilizing the three lifting angles, remove hatch roof and grid guard assembly, Figure 18.

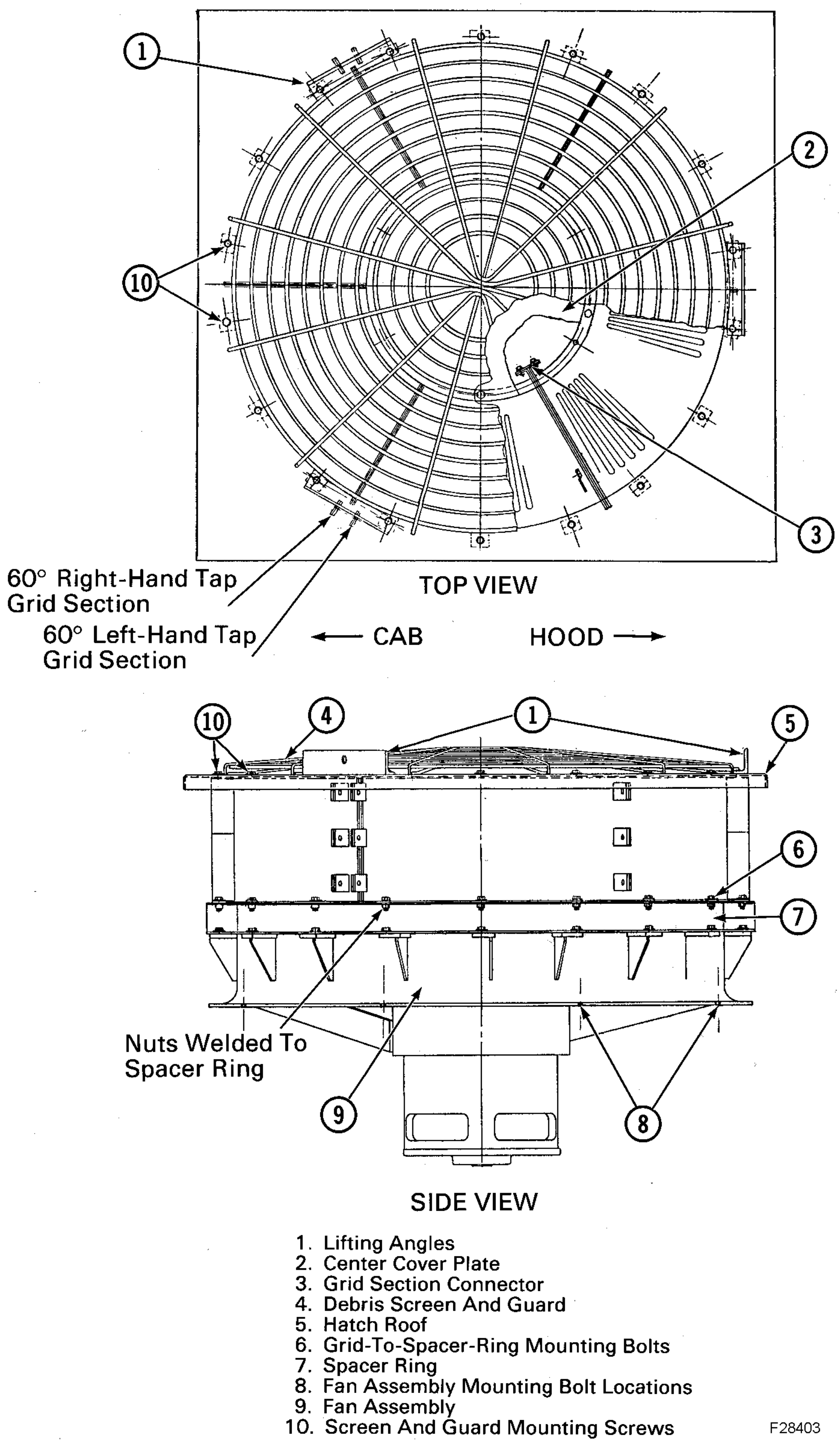


Figure 18 Typical Dynamic Brake Hatch Assembly

3. Remove center cover plate.

4. Disconnect electrical cables from terminals of grid section to be removed.

5. Attach 3/8" eyebolts to the first grid section to be removed. Attach a suitable lifting device to these eyebolts.

6. Remove grid section connectors from grid section to be removed. Remove the three grid-to-spacer-ring mounting bolts and washers from each grid section to be removed (nuts are welded to the spacer ring).

7. Carefully raise the grid section from locomotive.

8. Repeat procedure for any other grid sections to be removed.

3.2 GRID ASSEMBLY REMOVAL

To remove the entire assembly of six grid sections, use the following procedure:

1. Remove side panels, as required.

2. Disconnect electrical cables from each of the grid terminals.

3. Remove the bolts and washers (3 per grid) connecting the grids to the spacer ring.

4. Attach a suitable lifting device to the three lifting angles provided on the hatch roof. Lift grid assembly straight up until it clears the dynamic brake compartment.

3.3 DYNAMIC BRAKE HATCH REMOVAL

To remove the pre-cabled dynamic brake hatch as an assembly including the grid and fan, perform the following procedure:

1. Remove side panels and air inlet screens as required.

2. Disconnect electrical cables from each of the grid terminals, and disconnect grid blower motor wiring at the motor terminals.

3. Remove hatch mounting bolts, Figure 19

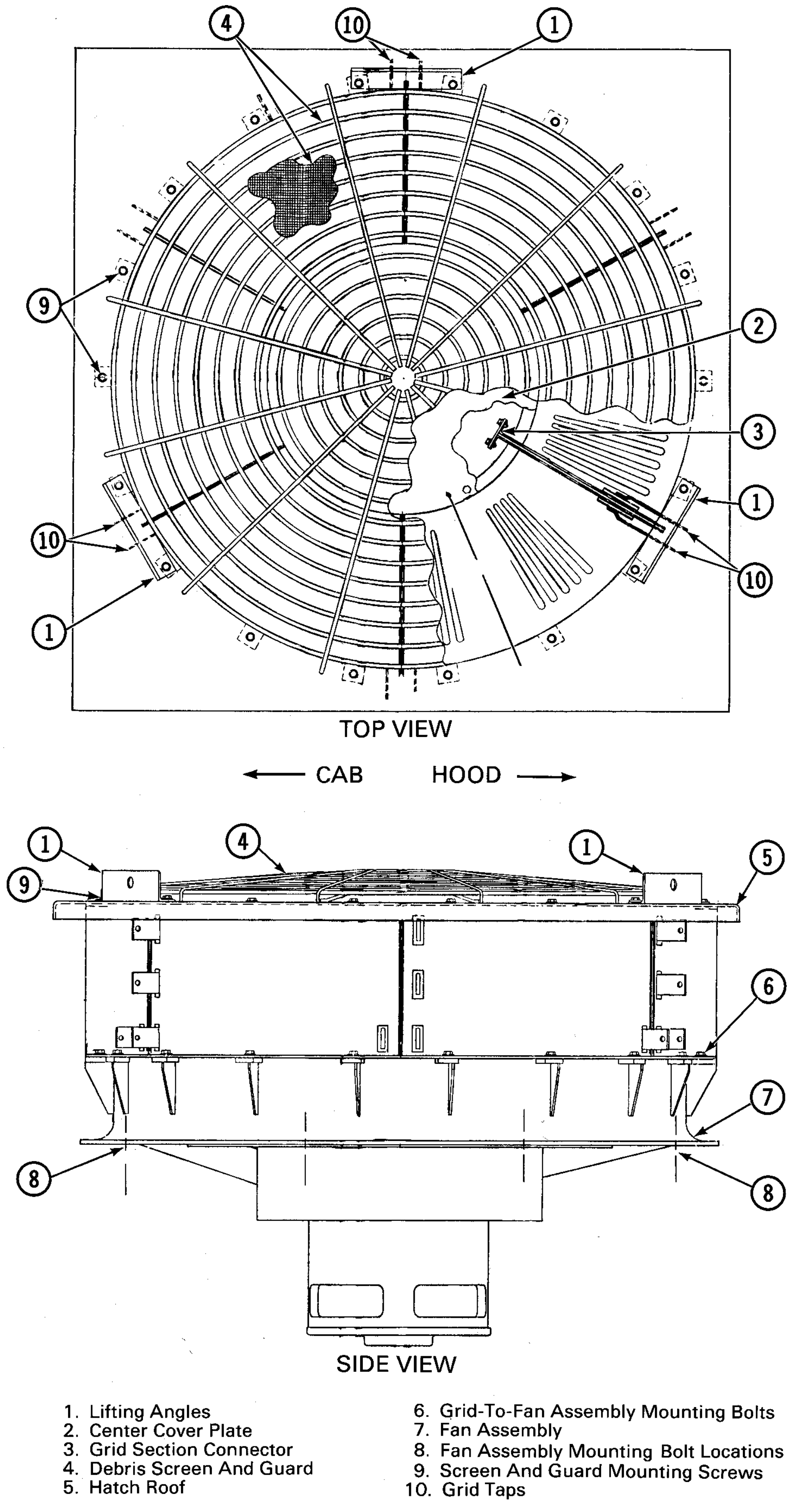


Figure 19 Typical Dynamic Brake Hatch Assembly

4. Attach a suitable lifting device to the three lifting angles provided on the hatch roof. Lift the hatch assembly straight up until it clears the dynamic brake compartment.

3.4 INSPECTION

Visually inspect the grid(s) and remove all foreign material which has been lodged in the resistor. This can be accomplished by blowing compressed air through the ribbons. Inspect the section assemblies for warped or burned ribbon by looking through the ribbon assemblies. If warped or burned ribbon is found, replace the ribbon assembly with the proper replacement part number. (Refer to the appropriate Parts Catalogue and Service manual.)

4.0 RESISTOR GRID INSTALLATION

NOTE

Although the location of the grid assembly varies between locomotive models, the general procedures for installation of the components and assembly are similar.

CAUTION

Each grid system provides for fan operation at a specific speed, for example:

- 700 Ampere grids – 1650 RPM
- 760 Ampere grids – 1850 RPM
- 945 Ampere grids – 2000 RPM

Use only the fan assembly and grids listed in the correct Replacement Parts Catalogue and Service Manual for replacement components.

4.1 GRID SECTION INSTALLATION

1. Carefully lower grid section into position.

2. Before disconnecting lifting device, install three grid-to-spacer-ring mounting bolts and washers, or grid-to-fan mounting bolts and washers as applicable, at each grid section being installed, refer to Figure 18 or Figure 19.

3. Install grid section connectors. Reconnect electrical cables, as appropriate, to grid section terminals. A list of cable codes is provided in the Service Data section of this bulletin.

4. Mount center cover plate.

5. Place hatch roof and grid debris screen and guard assembly into position. Install hatch roof mounting bolts.

6. Recheck all mounting hardware and part alignment.

7. Hi-Pot completed assembly. (See Hi-Pot Test section.)

4.2 DYNAMIC BRAKE HATCH INSTALLATION

1. Attach a suitable lifting device to the lifting angles provided on the hatch roof. Lower hatch into dynamic brake compartment. Refer to the appropriate application drawings, wiring schematics, and service manuals for correct wire routing.

2. Install eight (four each side) hatch mounting bolts and nuts.

3. Connect electrical cables to grid terminals and verify with wiring schematic.

4. Install side panels and air inlet screens as required.

5. Recheck all mounting hardware and part alignment.

6. Hi-Pot completed assembly. (See Hi-Pot Test section.)

5.0 HI-POT TEST PROCEDURE

The preferable time to perform high potential tests is soon after a locomotive has completed a run. In such instances, the equipment is warm and dry, thus eliminating the possibility of moisture being present in units that have been shut down for an extended period of time.

Prior to making a high potential test, the circuit insulation resistance should be checked with a suitable megohmmeter. Readings of less than one megohm should be viewed with suspicion. A high potential test in such instances may cause a breakdown of the insulation. To reduce the risk of this possibility, the cause of low megohmmeter readings should be determined and corrected. This may be done by reducing the complete circuit concerned into individual circuits, which are then isolated and checked separately. In this way, the circuit portion or equipment causing the low reading can be found. Correction may often be made through cleaning and drying of the affected areas.

6.0 TROUBLESHOOTING

As indicated previously, improper maintenance or malfunction of a fan motor and related equipment is the major cause of dynamic brake grid failure. Therefore, the following check list is offered as a handy inspection guide to ensure against practices and conditions which may contribute to, or result in, dynamic brake fan or grid failure. If inspection reveals the existence of an adverse condition, proper repair or maintenance procedures should be initiated.

NOTE

The recommended procedure for repairing partially failed grids is section replacement. (Refer to the appropriate Parts Catalogue.) Replacement parts are available through Electro-Motive Parts Center.

6.1 CHECK LIST

6.1.1 FAN MOTOR

1. Overly tight rotation?
2. Bearings noisy?
3. Grease leaks?
4. Flash damage? (DC Blowers only)

5. Brushes short? (DC Blowers only)

6. Shunts frayed or burned? (DC Blowers only)

7. Brush holder studs loose? (DC Blowers only)

8. Stator insulation damaged?

9. Leads chafed or shorted?

10. Lead supports loose?

11. Armature wire bands loose? (DC Blowers only)

12. Fan: Rubbing on I.D. of frame? Blades cracked?

13. Check condition of fan motor enclosure.

6.1.2 GRID(S)

1. Terminal support bolts loose?

2. Lack of ventilation?

3. Terminal support insulators broken?

4. Impact damage to ribbons or terminals?

5. Ribbons misaligned due to warp, hot spots, or welds?

6. Improper "hoisting" practices causing frame malformation?

7. Foreign material present (nuts, bolts, tape, paper, or lading such as iron ore or coal)?

6.1.3 GENERAL

Ensure electrical controls, wiring, and brake-regulating equipment is intact and connected correctly. (Refer to applicable Locomotive Service Manual and Wiring Diagram.)

7.0 SERVICE DATA

7.1 REFERENCES

DC Grid Blower Motor ....M.I. 4104
AC Grid Blower Motor ....M.I. 4105

7.2 RESISTANCE MEASUREMENTS

Refer to the Appropriate Service Manual
Resistance measurements +/- 3% at 25 °C (77 ° F).

Hi-Pot: 3200 VAC, 60 Hz for 1 minute.

7.3 WIRE AND CABLE LEGEND

Symbol	AWG/CM	Strand	Diameters		Insulation
			Outside	Bare	
I E #	12 AWG	37/.0133	.180	.085	Exane
IV E	50,500	125/24	.395	.285	Exane
XIV E	313,100	775/24	.930	.720	Exane

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Electro-Motive Division of General Motors Corporation
La Grange, Illinois 60525 USA
Telephone: 708-387-6000
WebSite: www.gmemd.com