ELECTRO-MOTIVE

M.I. 9648

MAINTENANCE INSTRUCTION

MODERNIZATION RECOMMENDATION
RETROFIT OF TWO-SPEED DYNAMIC BRAKE

PURPOSE: The following article provides the necessary material and instructions to replace the present single-speed dynamic brake system with a two-speed system; the purpose being to reduce fuel consumption.

APPLICATION: All Dash-2 locomotives equipped with DR13 module regulation. This includes locomotives with extended range or non-extended range control, field current or grid current trainline control, and .86 ohm or .66 ohm grids.

DISCUSSION: In recent years, energy conservation has become a major issue and many design changes, both electrically and mechanically, have been made by Electro-Motive to help railroads reduce annual fuel consumption. As a part of our continuing efforts, a new DR20 module has been designed to reduce engine speed from the normal throttle four or throttle five, to idle when operating in dynamic brake with traction motor currents below specified levels. Tests performed during revenue service have shown that this modification can result in fuel savings of up to 1.1% annually.

The DR20 module replaces the DR13 module for brake current regulation, the two modules are equivalent. The DR20 module has the additional function of controlling engine speed. When traction motor armature current is below 575A and traction motor field current is below 800A, engine speed is regulated at idle by the DR20 module. If armature current rises above 575A or field current rises above 800A, a signal from the DR20 module to the governor will raise engine speed to throttle four (or in some cases throttle five) to provide adequate cooling air to the traction motors.

The DR20 module is physically interchangeable with the DR13 module, but wiring modifications to the high voltage cabinet are necessary. The unit to be modified should have the CRDB rectifier assembly applied, refer to Figs. 1 and 2 to confirm application of this assembly. Units equipped with extended range dynamic brake delivered after August 1977 have the CRDB applied. Units with standard dynamic brake delivered after December 1978 have the CRDB applied.

In addition to CRDB, the locomotive must have RE46 and CR68 applied as shown in Figs. 1 and 2. Units delivered after October 1979 have RE46 and CR68 applied. These modifications are described in Section 1.

NEW MATERIAL REQUIRED: Kit 9524245 has been issued and contains the following material:

QUANTITY	PART NUMBER	DESCRIPTION
1	9338033	Module, DR20
1	9510430	Resistor, RE7
1	9512761	Panel, CADB
1	9505835	Resistor, RE46
2	8421017	Rectifier, CR67, CR68
1	9514171	Nameplate, DR20
1	8411515	Contact Pin Assembly

Additional miscellaneous material required:

QUANTITY	PART NUMBER	DESCRIPTION
A.R.	8472022	Cable, No. 14 (500 ft)
A.R.	8250906	Faston Terminal
A.R.	8468611	Cable, No. XE (500 ft)

COST OF MATERIAL: Approximate material cost for this modification is $1150. This cost is for job estimating purposes only. Material will be billed at the prices in effect at the time of shipment.

PROCEDURE

SECTION I

Refer to Section II if modifications to add CRDB, RE46, and CR68 have already been applied; Figs. 1 and 2 indicate modified circuits. Units which have not been modified will require additional material and circuit changes as indicated in this section.

MATERIAL REQUIRED:

QUANTITY	PART NUMBER	DESCRIPTION
1	8413373	CRDB-Rectifier Assembly
2	9419643	Screw, Self Tap No. 8-32 x 1/2"
6	9419644	Screw, Self Tap No. 10-24 x 1/2"
A.R.	8250906	Faston Terminal
30 ft	8472022	Cable No. 14 (500 ft)
A.R.	8194927	Wire Markers, Letters
A.R.	8194928	Wire Markers, Numerals
1	8363014	RE90 5 k ohm Resistor (on units with standard dynamic brake only)

ADDITION OF CRDB

All Dash-2 GP Locomotives With Extended Range Dynamic Brake

1. Mount new diode assembly 8413373, label as CRDB. Label the three sections as A, B, and C.

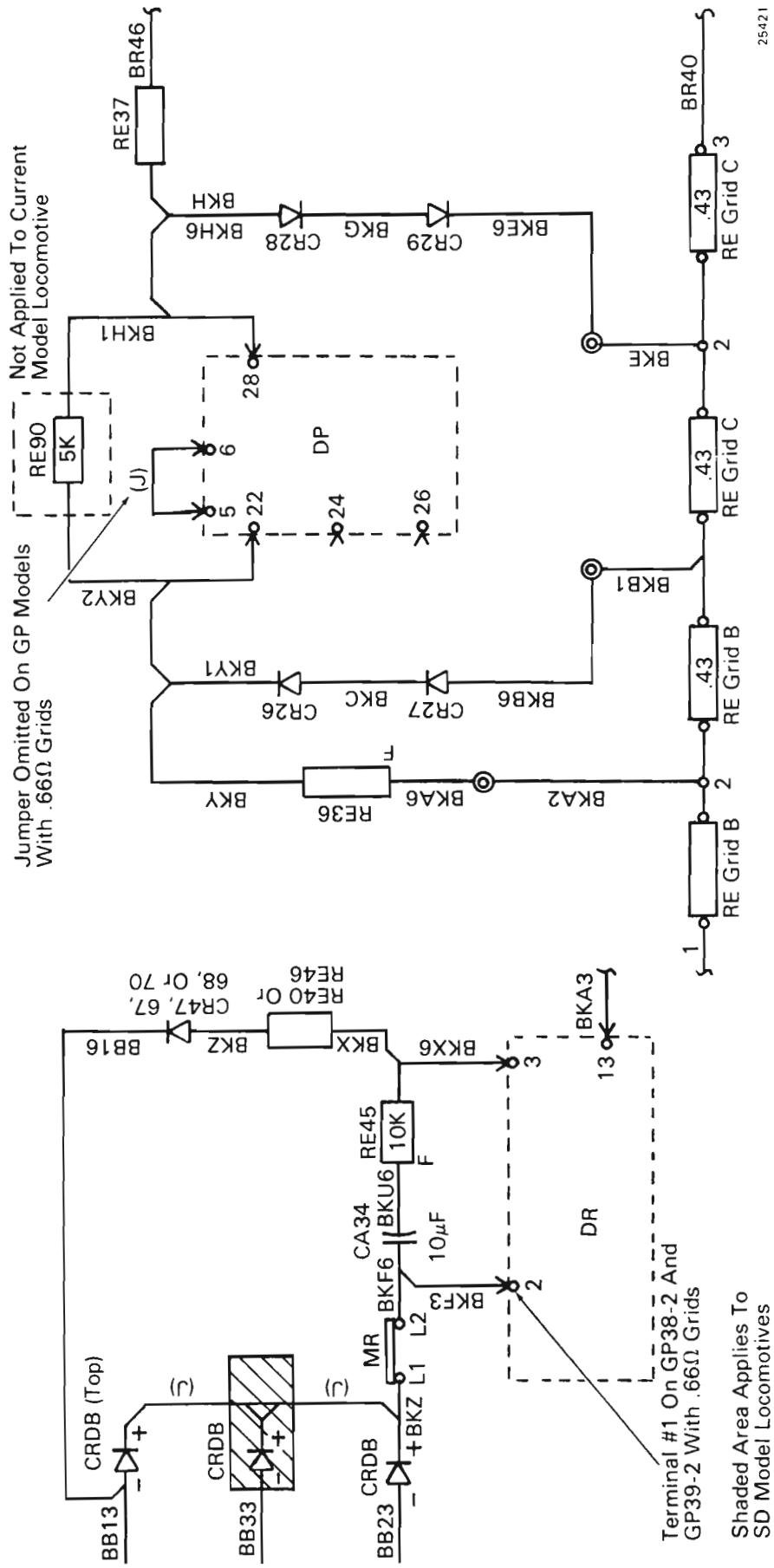
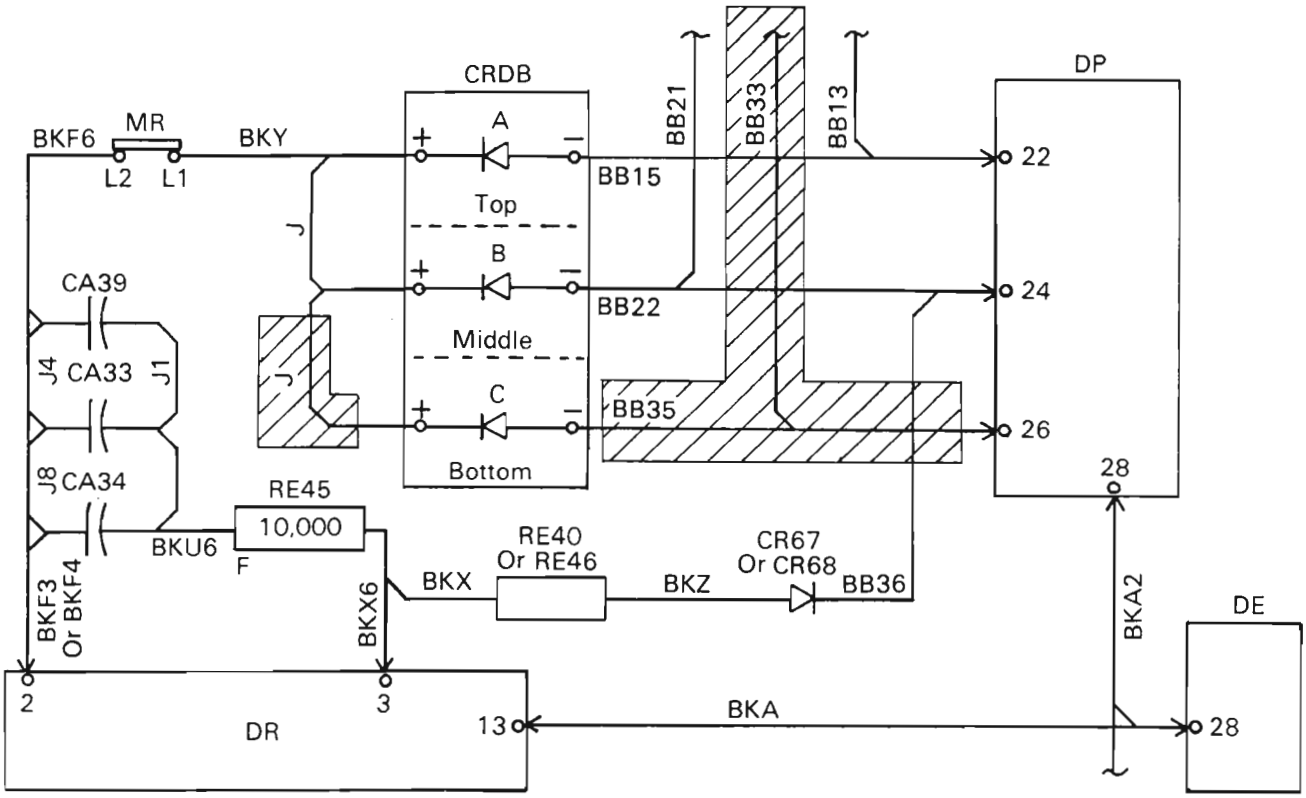


Fig.1 - Original High Voltage Circuit With CRDB, RE46 And CR68 Applied to Locomotives With Standard Dynamic Brake



Shaded area applies to SD model locomotives.

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Fig.2 - Original High Voltage Circuit With CRDB, RE46 And CRDB Applied To Locomotives With Extended Range Dynamic Brake

2. Make the following wire changes.

WIRE	REMARKS	FROM	TO
BB21	Move	MR-L1	CRDB-B (-)
BB22	Move	MR-L1	CRDB-B (-)
BB15	Add	DP-22	CRDB-A (-)
BKY	Add	CRDB-A (+)	MR-L1
J	Add	CRDB-B (+)	CRDB-A (+)

All Dash-2 SD Locomotives With Extended Range Dynamic Brake

1. Mount new diode assembly 8413373, label as CRDB. Label the three sections as A, B, and C.

2. Make the following wire changes.

WIRE	REMARKS	FROM	TO
BB21	Move	MR-L1	CRDB-B (-)
BB22	Move	MR-L1	CRDB-B (-)
BB15	Add	DP-22	CRDB-A (-)
BB35	Add	DP-26	CRDB-C (-)
BKY	Add	CRDB-A (+)	MR-L1
J	Add	CRDB-C (+)	CRDB-B (+)
J	Add	CRDB-B (+)	CRDB-A (+)

All Dash-2 SD Locomotives With Standard Dynamic Brake

1. Mount new control rectifier assembly 8413373 and label as CRDB.
2. Mount new resistor (5 k ohm, stud mount) 8363014 and label as RE90.
3. Make the following wire changes.

WIRE	REMARKS	FROM	TO
BB13	Move and splice	DP-22	CRDB-top (-)
BB23	Move and splice	DP-24	CRDB-mid (-)
BB33	Move and splice	DP-25	CRDB-bot (-)
(J)	Add	CRDB-top (+)	CRDB-mid (+)
(J)	Add	CRDB-mid (+)	CRDB-bot (+)
BKZ	Add	CRDB-bot (+)	MR-L1
BKA3	Move and splice (if req'd.)	DP-28	DR-13
BKY1	Move and splice	MR-L1	DP-22
BKY2	Add	DP-22	RE90-Front
BKH1	Add	DP-28	RE90-Rear
BKH6	Move and splice (if req'd.)	DR-13	DP-28

All Dash-2 Locomotives With Standard Dynamic Brake

1. Mount new control rectifier assembly 8413373 and label as CRDB.
2. Mount the new resistor (5 k ohm, stud mount) 8363014 and label as RE90.
3. Make the following wire changes.

WIRE	REMARKS	FROM	TO
BB13	Move and splice	DP-22	CRDB-top (-)
BB23	Move and splice	DP-24	CRDB-bot (-)
(J)	Add	CRDB-top (+)	CRDB-bot (+)
BKZ	Add	CRDB-bot (+)	MR-L1
BKA3	Move and splice (if req'd.)	DP-28	DR-13
BKY1	Move and splice	MR-L1	DP-22
BKY2	Add	DP-22	RE90-Front
BKH1	Add	DP-28	RE90-Rear
BKH6	Move and splice (if req'd.)	DR-13	DP-28

ADDITION OF RE46 AND CR68 TO ALL DASH-2 LOCOMOTIVES

1. Mount resistor RE46 8472380 in a vacant location adjacent to the stud mount resistors on the main control panel. (High voltage cabinet zone 36.)
2. Mount rectifier CR68 8421017 in a vacant location in the control rectifier section of the main control panel. (High voltage cabinet zone 36.) Mount with two screws 9419643.

Add New Wiring As Follows. Use No. 14 Exane Wire 8468611 (500 ft)

1. Wire BKZ from RE46 - Front to CR68 - Black.
2. Wire BB16 from CR68 - Red to CRDB-A (-).
3. Wire BKX from RE46 - Back to RE45 - Back.

SECTION II

TWO-SPEED DYNAMIC BRAKE MODIFICATION GP38-2DE, SD38-2DE, GP40-2DE, GP39-2DE, SD45-2DE

1. Refer to Fig. 2 and remove the following wires.

WIRE	FROM	TO
BKX6	DR-3	RE45-BK
BKA	DE-28	DR-13
BKA3 or BKA33 or BKA66	TB47-R12 or Splice or TB36-D16	DR-13
BKX	RE45-BK	RE40-BK or RE46-BK
BKF3 or BKF4	CA34-Red	DR2 (DR-1 with .66 ohm grids)
BKF6	CA34-Red	MR-L2
BKU6	CA34-Blk	RE45-FR

2. Refer to Fig. 3 and remove the following wires.

WIRE	FROM	TO
24H	DE-5	DR-5
24F	DE-3	DR-6
24F6	DR-6	BR2-G2
24C6	BR2-G1	RC-4
NM39 or NM36 (Except SD38-2DE)	DP-14	DR-14
J1 or NM38 (Except SD38-2DE)	DR14	TR14 or WO14
J1 or NM38 (SD38-2DE only)	DR-14	FS-14
ETF6	MR-G2	RC-9
J	RC-11	RC-12

3. On units equipped with field current trainline control, remove wires according to Step a. On units equipped with grid current trainline control, remove wires according to Step b. Refer to Fig. 3 in both cases.

a.

WIRE	FROM	TO
24K6	DE-4	DP1A-1NO
24J6	DR-4	DP1A-C
ETF	BR1-K1	MR-G2
ETE6 or ETE3	BR1-K2	RC-11
24S*	DP1A-2NO	RE44-FR
24R*	BR2-H2	DP1A-2C
24P6*	RC-8	RE44-BK
J*	BR2-G1	BR2-H1

*These steps will apply to most units. Omit these steps on models which do not have a circuit containing DP1A and RE44 circuitry between BR2-H2 and RC-8.

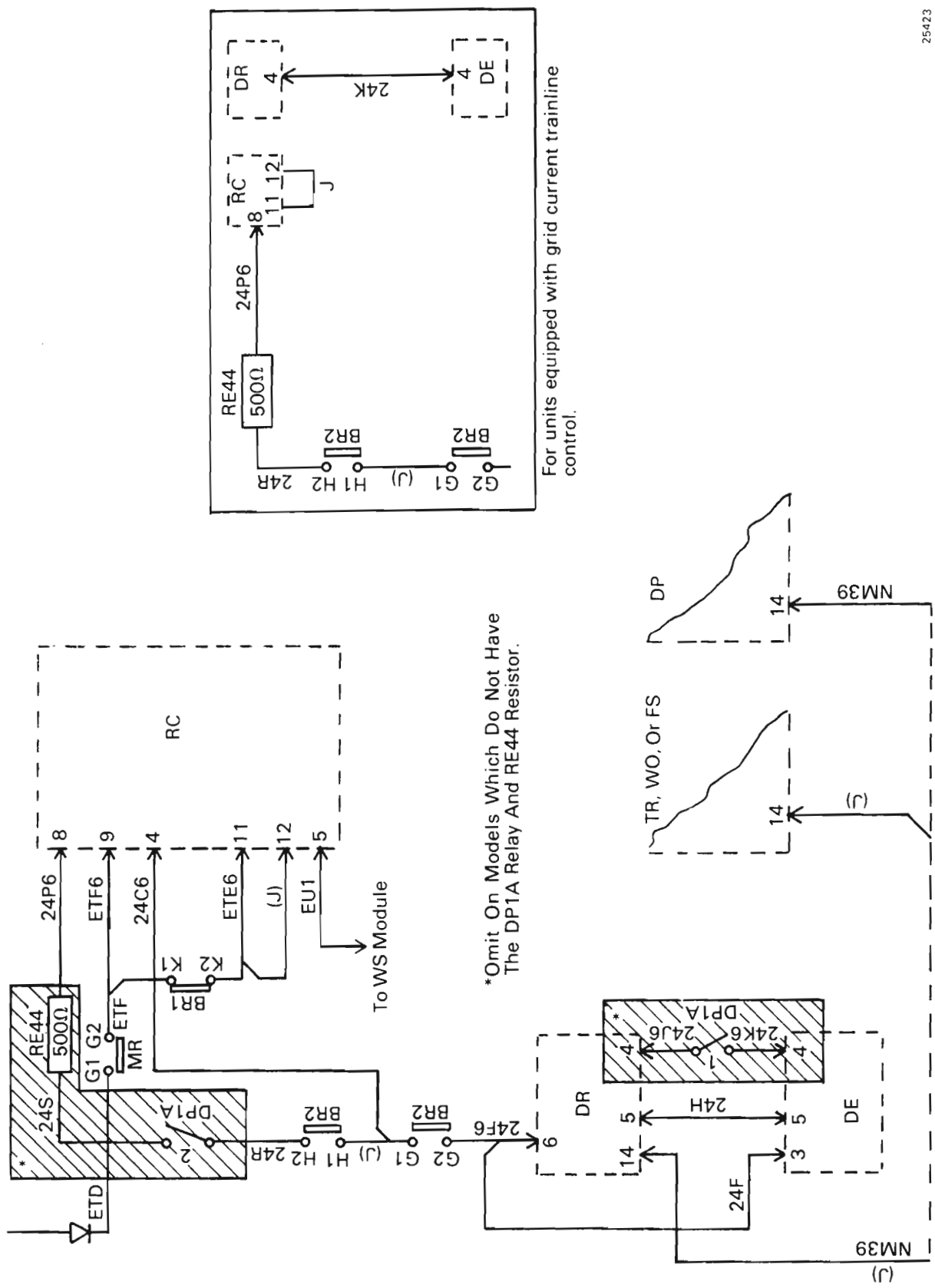


Fig.3 – Original Control Circuit Locomotives With Extended Range Dynamic Brake

b.

WIRE	FROM	TO
24R	BR2-H2	RE44-FR
24P6	RE44-BK	RC-8
24K	DE-4	DR-4
J	BR-G1	BR2-H1
J1	RC-9	RC-11

4. On units equipped with throttle four engine speed in dynamic brake, remove wires according to Step a. On units equipped with throttle five engine speed, remove wires according to Step b. or c. Refer to Fig. 4 in both cases.

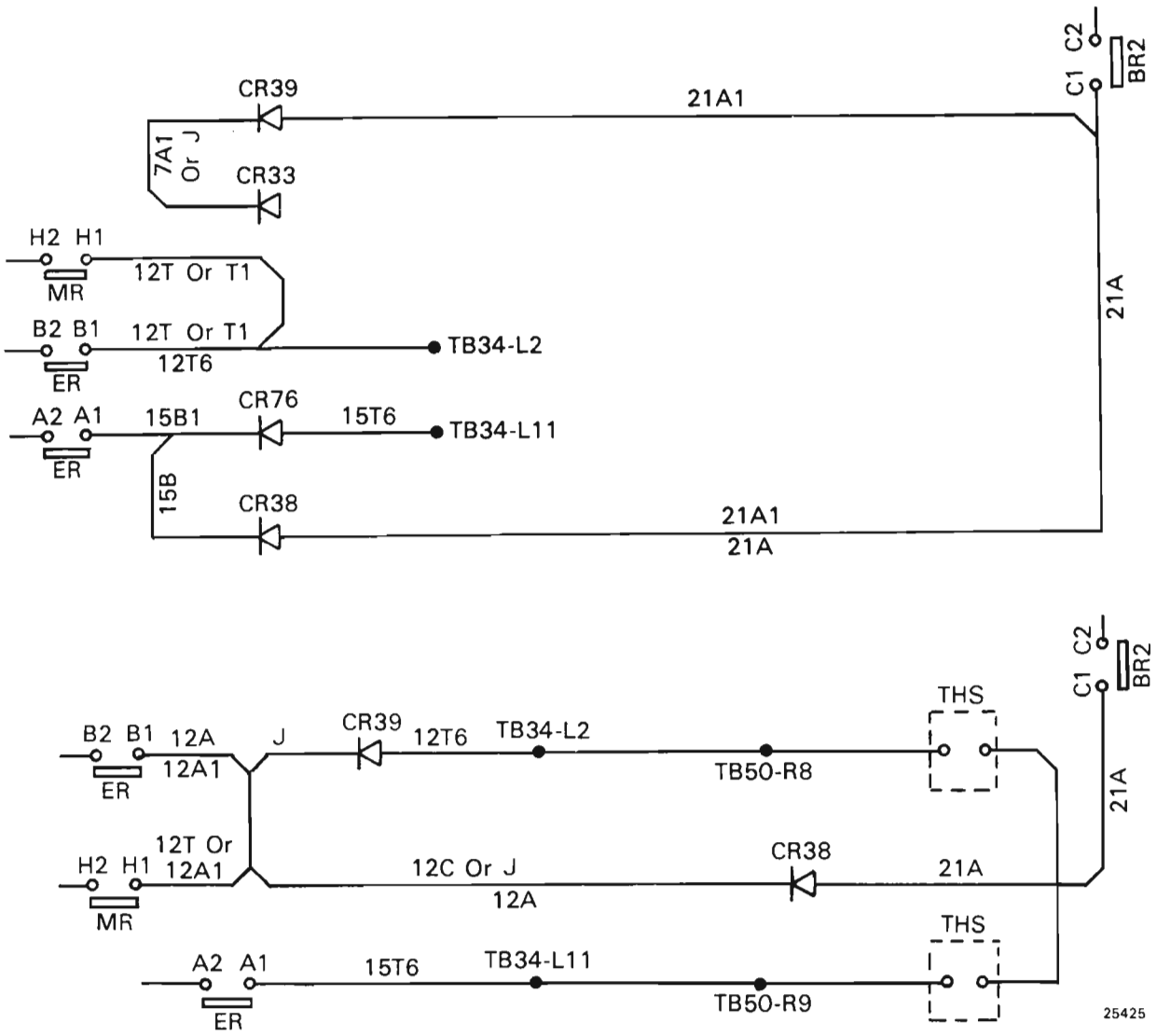


Fig.4 – Original Trainline Control Circuit
All Model Locomotives

a.

WIRE	FROM	TO
12T6	ER-B1	TB34-L2
12T or 12T1	MR-H1	ER-B1
21A1	CR39-Blk	CR38-Blk
7A1 or J	CR39-Red	CR33-Red
15B1	ER-A1	CR40-Red or CR76-Red
15B	CR38-Red	CR40-Red or CR76-Red
15T6	TB34-L11 or TB31A12	CR40-Blk or CR76-Blk
21A	BR2-C1	CR38-Blk

b.

WIRE	FROM	TO
12T6	CR39-Blk	TB34-L2
12C or J	CR39-Red	CR38-Red
12A	ER-B1	CR38-Red
12A1 or 12T	ER-B1	MR-H1
15T6	CR43-Blk	TB34-L11 or TB31-A12
21A	CR38-Blk	BR2-C1

c.

WIRE	FROM	TO
12T6	CR39-Blk	TB34-L2 or TB31A10
12T	MR-H1	CR39-Blk
J or 12C	CR39-Red	CR38-Red
12C1	CR39-Red	ER-B1
21A	CR38-Blk	BR2-C1
15T6	ER-A1	TB34-L11 or TB31A12

5. Refer to Fig. 5 and remove the following wires on all model locomotives.

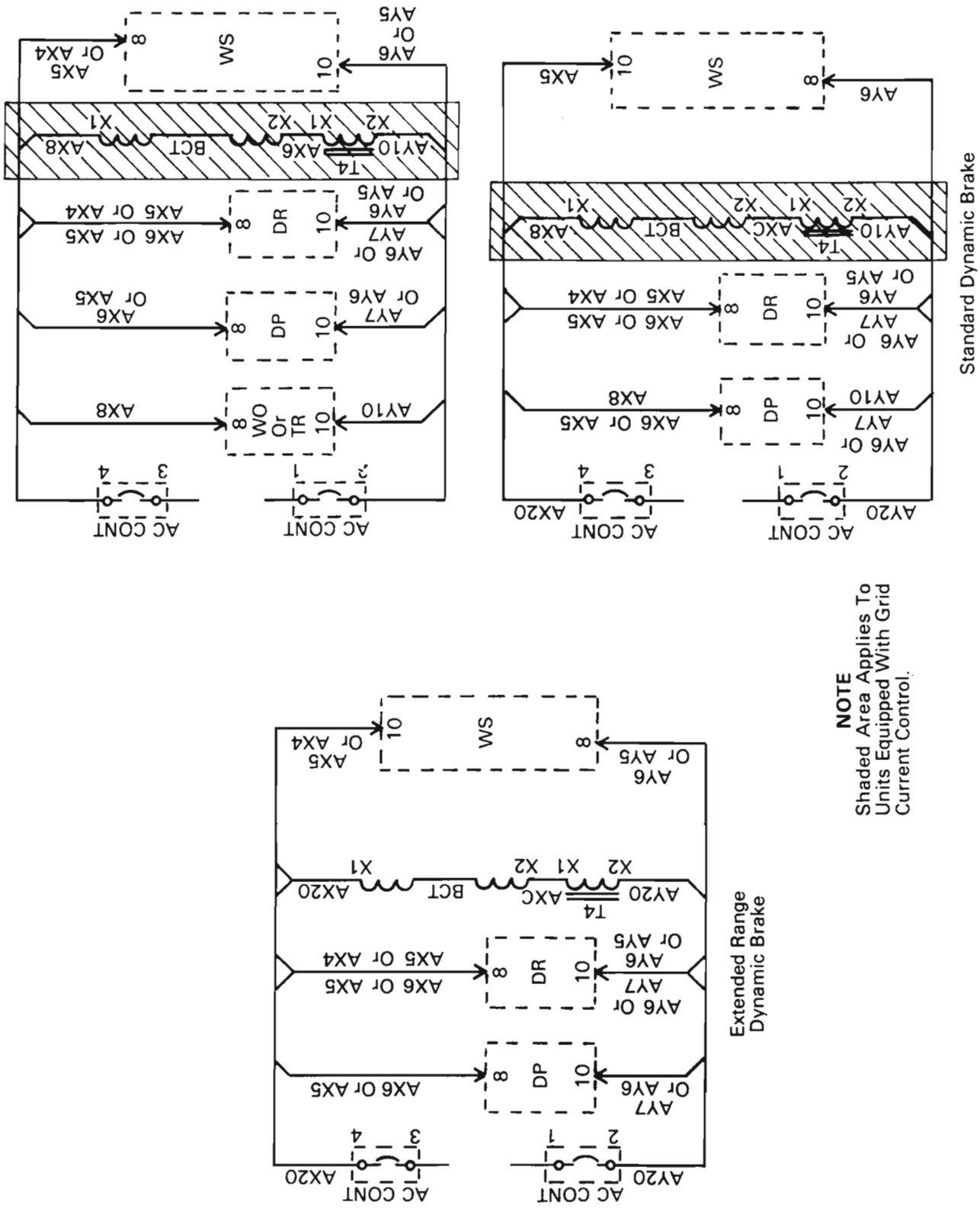
WIRE	FROM	TO
AX5 or AX4	DR-8	WS-10
AX6 or AX5	DP-8	DR-8
AY5 or AY6	DR-10	WS-8
AY7 or AY6	DP-10	DR-10

6. Remove the following devices.

ITEM	DESCRIPTION	P/N
RE45	10 k ohm Resistor	8472380
RE44	500 ohm Resistor	8252712
CA34	10 microfarad capacitor	8130632
DR-13	Module	8460734

7. Add the following devices at a convenient location in the electrical cabinet.

ITEM	DESCRIPTION	P/N
CADB	Capacitor Assy.	9512761
RE7	40.3 k ohm Resistor	9510430
CR68	Rectifier	8421017
DR20	Module	9338033



NOTE
Shaded Area Applies To Units Equipped With Grid Current Control.

Fig.5 - Original AC Circuit All Model Locomotives

8. Add the following XE cable. Refer to Fig 6.

WIRE	FROM	TO
BKB6	CADB-5	RE46-BK
BKA80	CR68-Blk	RE7-L
BKF6	MR-L2	RE7-L
BKA8	DE-28	RE7-R
BKC8	DR-5	RE7-R/Mid
BKC80	CADB-6	RE7-R/Mid
BKA33	DE-28	TB47-R12 or TB36-D16

9. Add the necessary XE cable according to anticipation desired.

TAG	FROM	TO
	For 10 sec. .86 ohm grids	
BKX	DR-7	CR68-Red
BKX3	CADB-2	DR-7
BKB8	DR-6	RE7-L/Mid
BKB80	CADB-1	RE7-L/Mid
J	CADB-1	CADB-5
	For 10 sec. .66 ohm grids	
BKB8	DR-7	RE7-L/Mid
BKX3	CADB-2	DR-6
BKX	CADB-2	CR68-Red
BKB80	CADB-1	RE7-L/Mid
J	CADB-1	CADB-5
	For 16 Sec. .86 ohm grids	
BKB80	CADB-3	RE7-L/Mid
J	CADB-3	CADB-5
BKB8	DR-6	RE7-L/Mid
BKX3	CADB-4	DR-7
BKX	CADB-4	CR68-Red
	For 16 sec. .66 ohm grids	
BKB80	CADB-3	RE-7-L/Mid
J	CADB-3	CADB-5
BDB	DR-7	RE7-L/Mid
BKX3	CADB-4	DR-6
BKX	CADB-4	CR68-Red

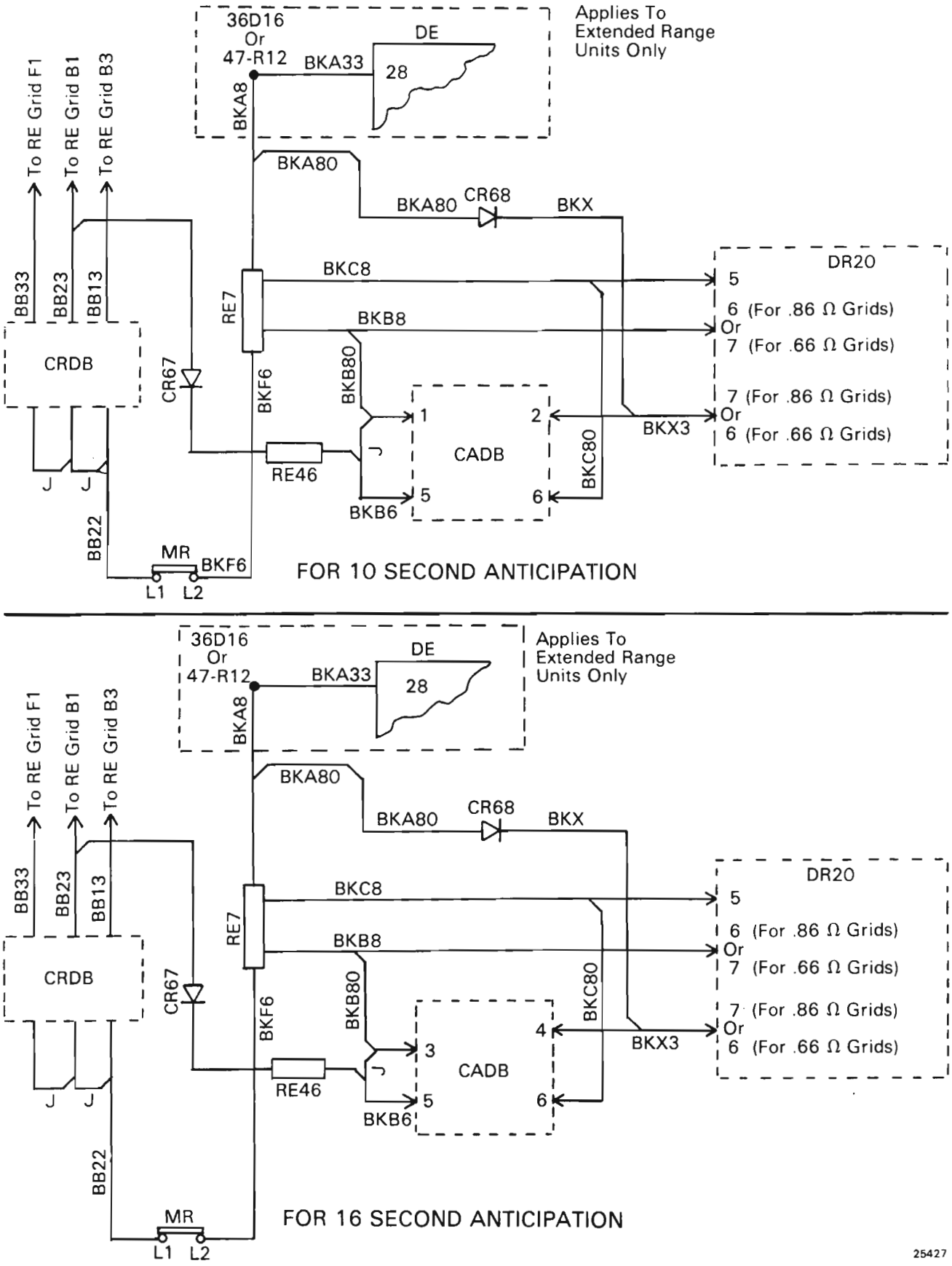


Fig.6 – Modified High Voltage Circuitry
All Model Locomotives

10. Add the following No. 14 wires. Refer to Fig. 7.

WIRE	FROM	TO
24P6	BR2-H2	RC-8
24F6	BR2-G2	DR-10
24F	DE-3	DR-10
24B	DR-12	RC-2
24R6	BR2-H1	DR-8
EM1	DR-4	RC-13
EZ3	DR-9	WS-4
13T36	DR-1	TB60-R3
J	RC-9	RC-11
NM39	DR-11	DP14
N33	DR-14	GFC-Coil/L
J1	DR-11	WO-14 or TR-14 or FS-14
AX5	DP-8	WS-10
AY6	DP-10	WS-8

11. On units previously equipped with field current control, follow Step a. On units previously equipped with grid current control, follow Step b. Refer to Fig. 7.

a.

WIRE	FROM	TO
13T37	DP1A-1C	DR-1
13BX6	DP1A-1NC	DR-13

b.

J	DR-1	DR-13

12. Railroads which have sustained high speed, maximum dynamic brake operation, require throttle five engine speed to provide sufficient cooling for the traction motors. The operation characteristic which will require throttle five engine speed is maximum dynamic brake above 65 mph for a continuous period of 1-1/2 hours. Any railroad whose dynamic brake operation is less demanding, add wires according to Step a., which will result in throttle four engine speed. For throttle five engine speed, add wires according to Step b. Refer to Fig. 8 for both parts.

a.

WIRE	FROM	TO
7A1	CR39-Red	CR33-Red
12E	CR39-Blk	CR38-Blk
12E6	DR-2	CR38-Blk
21A	DR-3	BR2-C1
15B	CR76-Red	CR38-Red
15B1	ER-A1	CR76-Red
15T6	CR76-Blk	TB34L11
12T6	ER-B1	TB34-L2 or TB31A10
12T	ER-B1	MR-H1

b.

21A	BR2-C1	DR-3
12E6	DR-2	CR38-Blk
12C	CR38-Red	CR39-Red
12C1	CR39-Red	ER-B1
12T6	CR39-Blk	TB34L2 or TB31A10
12T	CR39-Blk	MR-H1
15T6	ER-A1	TB34-L11 or TN31A12

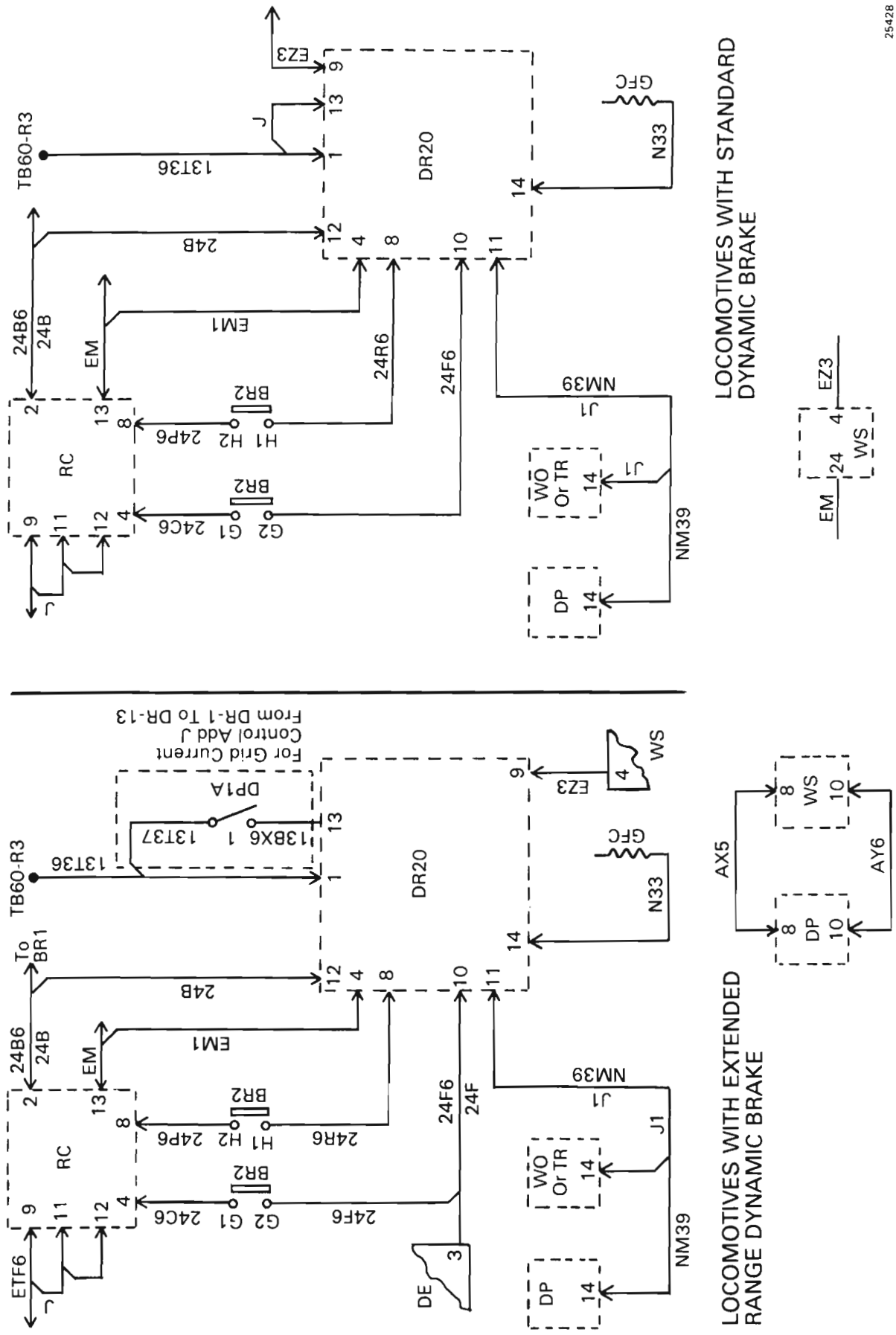


Fig.7 - Modified Control Circuitry Extended Range Dynamic Brake - Standard Dynamic Brake

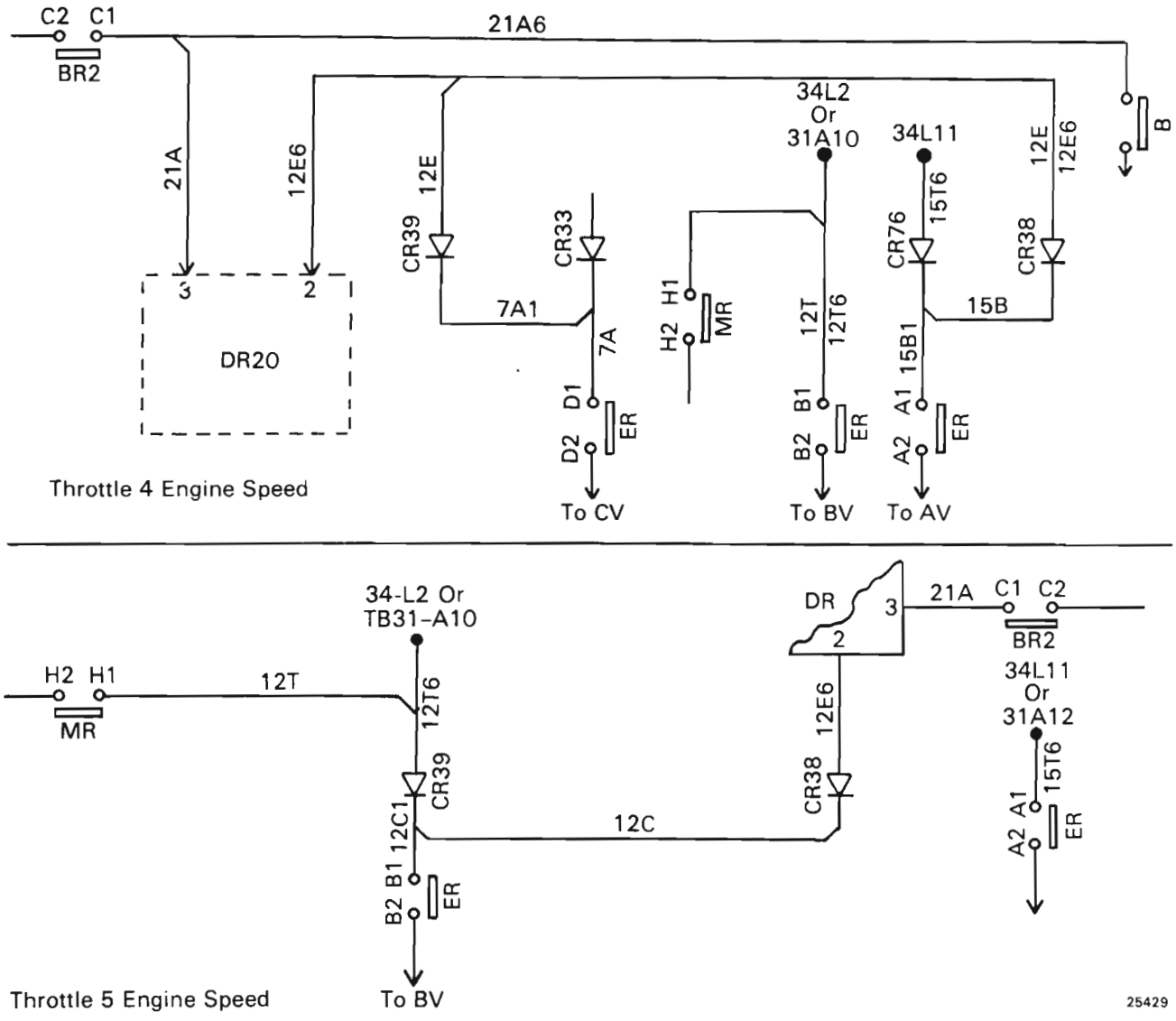


Fig.8 – Modified Control Circuitry
All Model Locomotives

TWO-SPEED DYNAMIC BRAKE MODIFICATION GP38-2D, GP39-2D, GP40-2D, SD38-2D, SD39-2D, SD40-2D, SD45-2D

1. Refer to Fig. 1 and remove the following wires.

WIRE	FROM	TO
BKX	RE45-BK	RE40-BK or RE46-BK
BKX6	RE45-BK	DR-3
BKU6	RE45-FR	CA34-BLK
BKF6	CA34-RED	MR-L2
BKF3 or BKF4	CA34-RED	DR-1
BKA3 or BKA33 or BKA66	DR-13	TB47-R12 or TB36-D16 or splice

2. Refer to Fig. 9 and remove the following wires. Use Step a. for units equipped with field current control, and Step b. for grid current control.

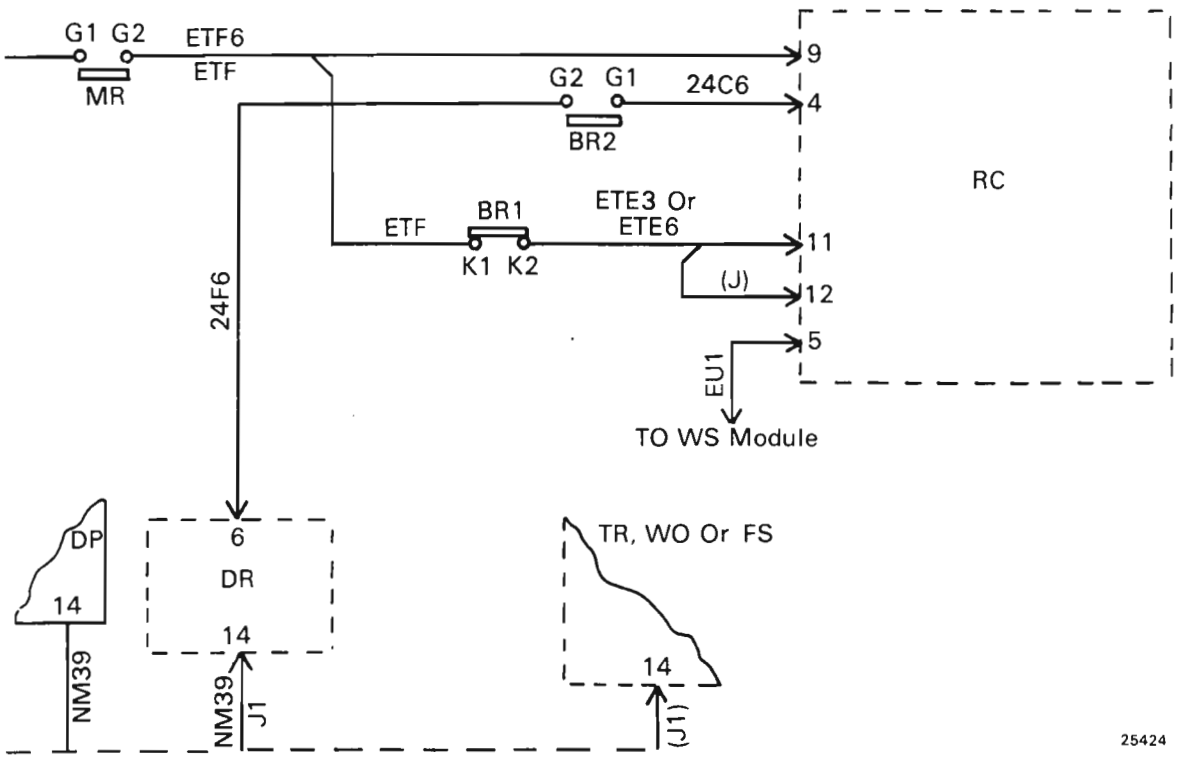


Fig.9 - Original Control Circuit Locomotives With Standard Dynamic Brake

a.

WIRE	FROM	TO
24C6	BR2-G1	RC-4
24F6	DR-6	BR2-G2
ETF	BR1-K1	MR-G2
ETE6 or ETE3	BR1-K2	RC-11
J	RC-11	RC-12
NM39	DR-14	DP-14
J1	DR-14	TR-14 or WO-14

b.

WIRE	FROM	TO
24C6	BR2-G1	RC-4
24F6	BR2-G2	DR-6
J	BR2-G1	BR2-H1
24R	BR2-H2	RE44-FR
24P6	RE44-BK	RC-8
ETF6	MR-G2	RC-9
24Z6	DR-7	BR1-B2
J	BR1-B1	BR1-A1
ETR	DR-9	T4-H1
ETQ	DR-11	T4-H4
NM38	DR-14	TR-14 or WO-14
NM39	DR-14	DP-14

3. On units equipped with throttle four engine speed in dynamic brake, remove wires according to Step a. On units equipped with throttle five engine speed, remove wires according to Step b. or Step c. Refer to Fig. 4 in both cases.

a.

WIRE	FROM	TO
12T6	ER-B1	TB34-L2
12T or 12T1	MR-H1	ER-B1
21A1 or J	CR39-Blk	CR38-Blk
7A1	CR39-Red	CR33-Red
15B1	ER-A1	CR40-Red or CR76-Red
15B	CR38-Red	CR40-Red or CR76-Red
15T7	TB34-L11 or TB31A12	CR40-Blk or CR76-Blk
21A	BR2-C1	CR38-Blk

b.

WIRE	FROM	TO
12T6	CR39-Blk	TB34-L2
12C or J	CR39-Red	R38-Red
12A	ER-B1	CR38-Red
12A1 or 12T	ER-B1	MR-H1
15T6	CR43-Blk	TB34-L11 or TB31-A12
21A	CR38-Blk	BR2-C1

c.

WIRE	FROM	TO
12T6	CR39-Blk	TB34-L2 or TB31A10
12T	MR-H1	CR39-Blk
J or 12C	CR39-Red	CR38-Red
12C1	CR39-Red	ER-B1
21A	CR39-Blk	BR2-C1
15T6	ER-A1	TB34-C11 or TB31A12

4. Refer to Fig. 5 and remove the following wires on all model locomotives.

WIRE	FROM	TO
AX5 or AX4	DR-8	WS-10
AX6 or AX5	DP-8	DR-8
AY5 or AY6	DR-10	WS-8
AY7 or AY6	DP-10	DR-10

5. Refer to Fig. 5 and remove the following wires on units equipped with grid current trainline control. Follow Step a. on older units and Step b. on units equipped with a TR12 or WO14 module.

a.

WIRE	FROM	TO
AX8	BCT-X1	TR-8 or WO-8
AY10	T4-X2	TR-10 or WO-10
AXC	T4-X1	BCT-X2

b.

AX8	BCT-X1	DP-8
AY10	T4-X2	DP-10
AXC	T4-X1	BCT-X2

6. Remove the following devices.

ITEM	DESCRIPTION	P/N
RE45	10 k ohm Resistor	8472380
RE44	500 ohm Resistor	8252712
CA34	10 microfarad Capacitor	8130632
BCT (if applicable)	Transducer	8422753
T4 (if applicable)	Transformer	8234831
DR-13	Module	8460734

7. Mount and label the following devices at a convenient location in the electrical cabinet.

ITEM	QTY	DESCRIPTION	P/N
CADB	1	Capacitor Assy.	9512761
RE7	1	40.3 k ohm Resistor	9510430
CR68	1	Rectifier	8421017
DR20	1	Module	9338033

On units previously equipped with throttle five engine speed in dynamic brake, it will be necessary to add two more rectifiers, 8421017, CR33 and CR76 to drop to throttle four engine speed.

8. Add the following XE cable. Refer to Fig.6 .

WIRE	FROM	TO
BKB6	CADB-5	RE46-BK
BKA80	CR68-Blk	RE7-R
BKF6	MR-L2	RE7-L
BKA8	TB47-R12	RE7-R
BKC8	DR-5	RE7-R/Mid
BKC80	CADB-6	RE7-R/Mid

9. Add the necessary XE cable according to anticipation desired.

TAG	FROM	TO
	For 10 sec. .86 ohm grids	
BKX	DR-7	CR68-Red
BKX3	CADB-2	DR-7
BKB8	DR-6	RE7-L/Mid
BKB80	CADB-1	RE7-L/Mid
J	CABD-1	CADB-5
	For 10 sec. .66 ohm grids	
BKB8	DR-7	RE7-L/Mid
BKX3	CADB-2	DR-6
BKX	CADB-2	CR68-Red
BKB80	CADB-1	RE7-L/Mid
J	CADB-1	CADB-5

10. For 16 sec. .86 ohm grids

BKB80	CADB-3	RE7-L/Mid
J	CADB-3	CADB-5
BKB8	DR-6	RE7-L/Mid
BKX3	CADB-4	DR-7
BKX	CADB-4	CR68-Red

For 16 sec. .66 ohm grids

BKB80	CADB-3	RE-7-L/Mid
J	CADB-3	CADB-5
BDB	DR-7	RE7-L/Mid
BKX3	CADB-4	DR-6
BKX	CADB-4	CR68-Red

11. Refer to Fig. 7 and add the following No. 14 wires.

WIRE	FROM	TO
24P6	BR2-H2	RC-8
24F6	BR2-G2	DR-10
24B	DR-12	RC-2
24R6	BR2-H1	DR-8
EM1	DR-4	RC-13
EZ3	DR-9	WS-4
13T	DR-1	TB60-R3
J	RC-9	RC-11
NM39	DR-11	DP14
N33	DR-14	GFC-Coil /L
J1	DR-11	WO-14 or TR-14 or FS-14
AX5	DP-8	WS-10
AY6	DP-10	WS-8

12. On units previously equipped with field current control, add a jumper (J) from DR-1 to DR-13. It is not necessary to do anything on units previously equipped with grid current control.

13. Railroads which have sustained high speed, maximum dynamic brake operation, require throttle five engine speed to provide sufficient cooling for the traction motors. The operating characteristic which will require throttle five engine speed is maximum dynamic brake above 65 mph for a continuous period of 1-1/2 hours. Any railroad whose dynamic brake operation is less demanding, add wires according to Step a., which will result in throttle four engine speed. For throttle five engine speed, add wire according to Step b. Refer to Fig. 8 for both parts.

a.

WIRE	FROM	TO
7A1	CR39-Red	CR33-Red
12E	CR39-Blk	CR38-Blk
12E6	DR-2	CR38-Blk
21A	DR-3	BR2-C1
15B	CR76-Red	CR38-Red
15B1	ER-A1	CR76-Red
15T6	CR76-Blk	TB34-L11
12T6	ER-B1	TB34-L2 or TB31A10
12T	ER-B1	MR-H1

b.

WIRE	FROM	TO
21A	BR2-C1	DR-3
12E6	DR-2	CR38-Blk
12C	CR38-Red	CR39-Red
12C1	CR39-Red	ER-B1
12T6	CR39-Blk	TB34-L2 or TB31A10
12T	CR39-Blk	MR-H1
15T6	ER-A1	TB34-L11 or TB31A12