



MAINTENANCE INSTRUCTION

C-4327

LOCOMOTIVE CONTROLLER - MINI MECHANICAL ROLLER SWITCH TYPE

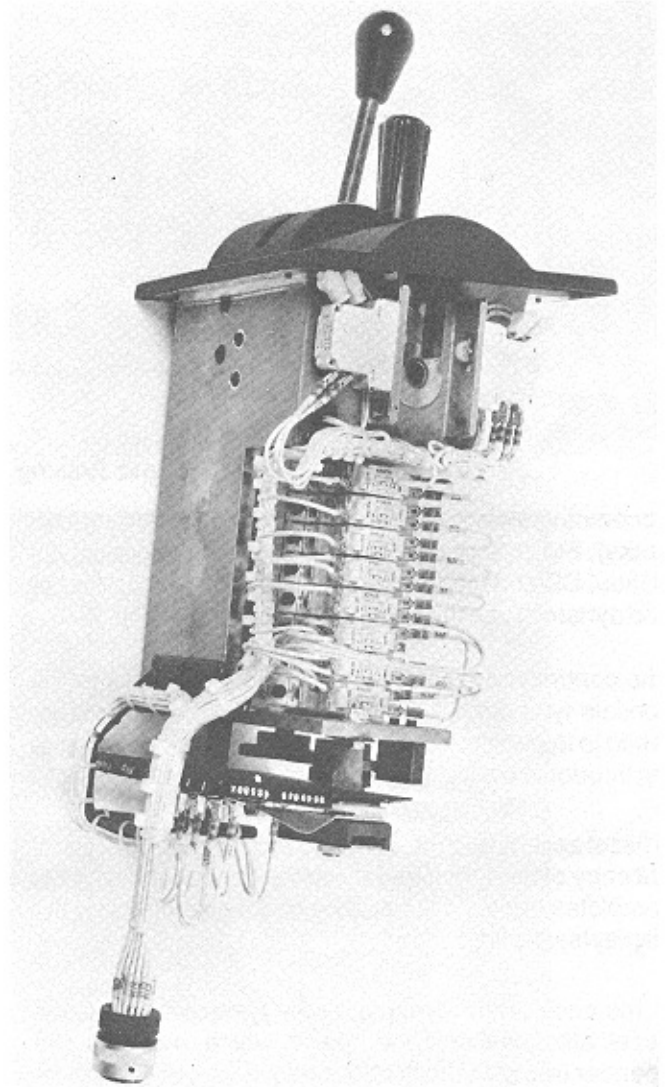
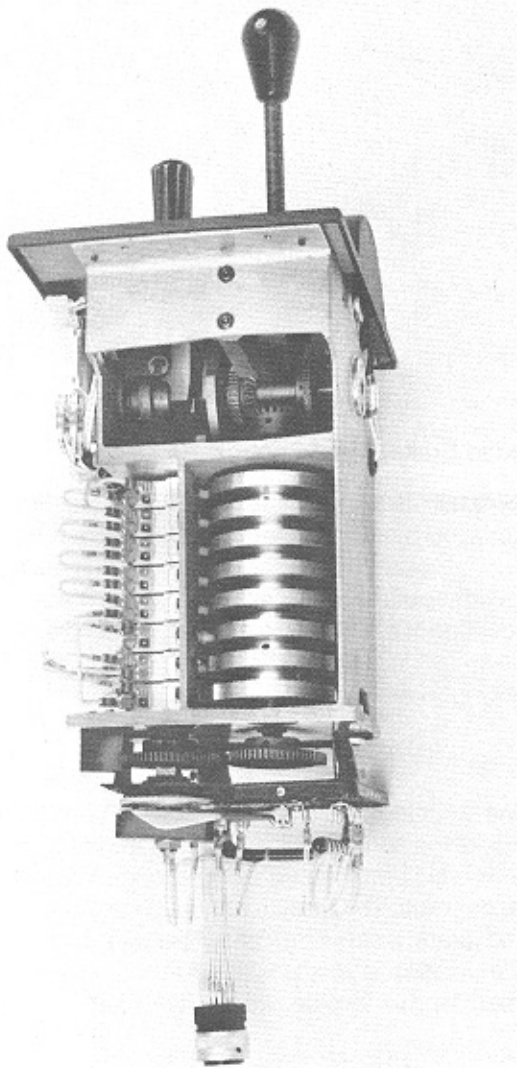


Fig. 1 - Manual Dynamic Braking Type Controller

DESCRIPTION

The roller switch type of controller, Figures 1 and 2, is a compact mechanism designed to energize the locomotive electrical control circuits through cam actuated roller switches.

Two basic models of controllers are used. The two controllers differ only in the dynamic brake control mechanism, interlock mechanism, and the location, number, and type of roller switches used to provide the desired control.

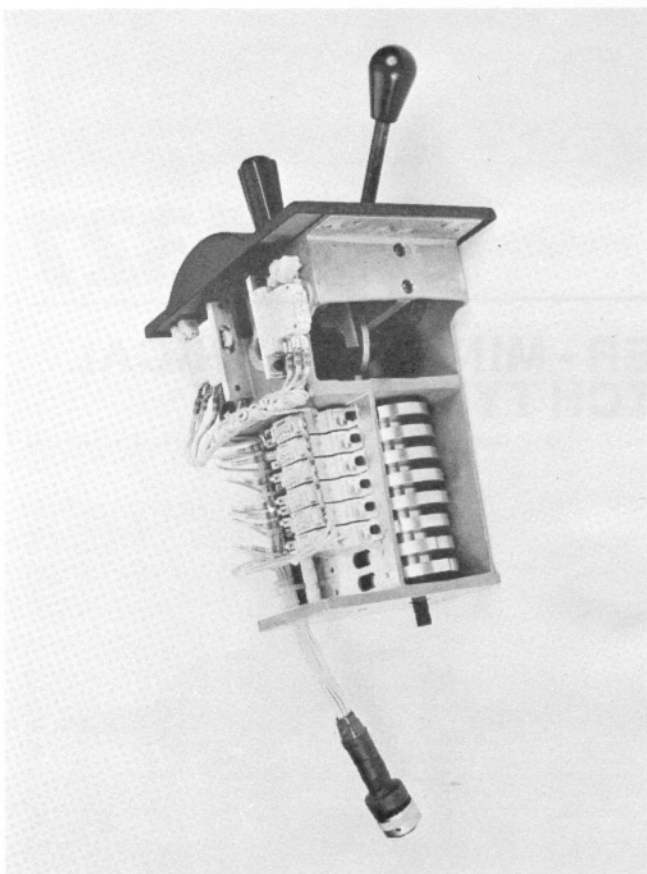


Fig. 2 - Non Dynamic Braking (Blended Brake) Type Controller

Locomotives with manual controlled DB (dynamic brake), Fig. 1, use the DB type controller, locomotives without DB and those equipped with Blended Brake (air and dynamic) use the Non DB type controller, Fig. 2.

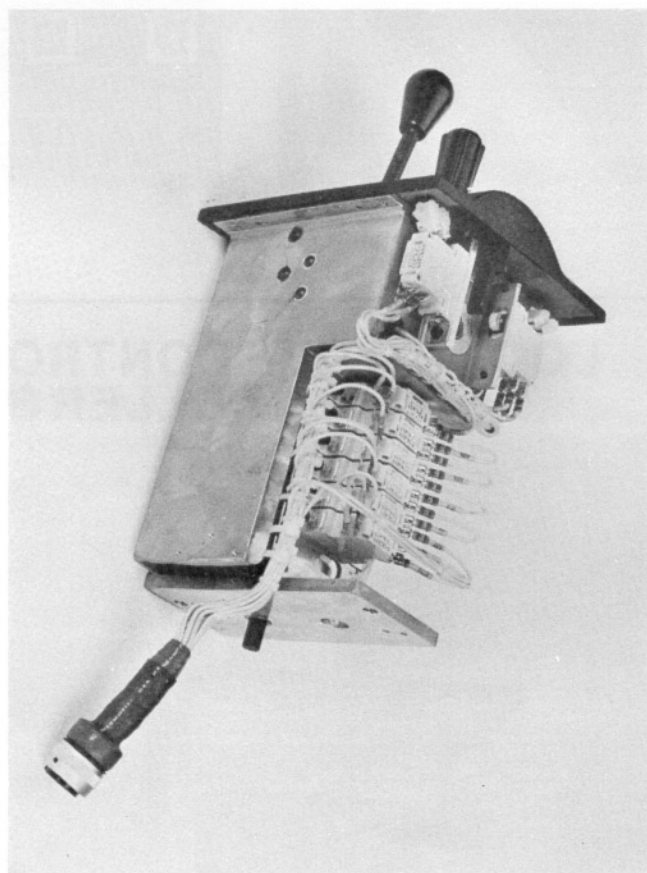
The controller assemblies are designed for use in the console type control stand, figs. 3 and 4, and are fastened to the control stand top surface by four bolts passing through the mounting flange of the controller.

A bezel assembly containing two sliding seals to prevent the entry of foreign material into the controller assembly completes the installation. The bezel also contains the display(s) and light.

In the case of the dynamic brake type controllers, the bezel also contains the "gate" which prevents the operator from moving the throttle/dynamic brake handle directly from the Power section of the quadrant through IDLE to the DYNAMIC BRAKING section, fig. 6.

The bezel assembly for the non-dynamic brake type controller, fig. 5, has a throttle quadrant that extends from the idle position to position "8" only.

The mini-mechanical controller uses only two handles whether of the DB design or non DB design. The



Dynamic Brake Handle in the DB version has been replaced by a combined DB/Throttle handle and this is used to control both the power as well as the braking functions of the locomotives. The following is a brief description of each handle and its associated mechanism.

THROTTLE HANDLE (non dynamic brake or blended brake type controller) Fig. 5

The throttle handle which is located on the right hand side of the controller, has (9) detented or "notched" positions which are placed along a longitudinal arc of about 60 degrees. The throttle handle controls, through shafts and gears, a cam drum and roller switches. The notched idle position is in a position furthest removed from the operator, full throttle (#8 position) is located closest to him.

Each of the positions is shown in the illuminated indicator window to the right of the throttle handle, Fig. 5.

THROTTLE/DB HANDLE (dynamic brake type controller) Fig. 6

The combined throttle/DB handle is located on the right hand side of the controller and operates, through gears



Fig. 3 - Manual Dynamic Braking Equipped Control Console

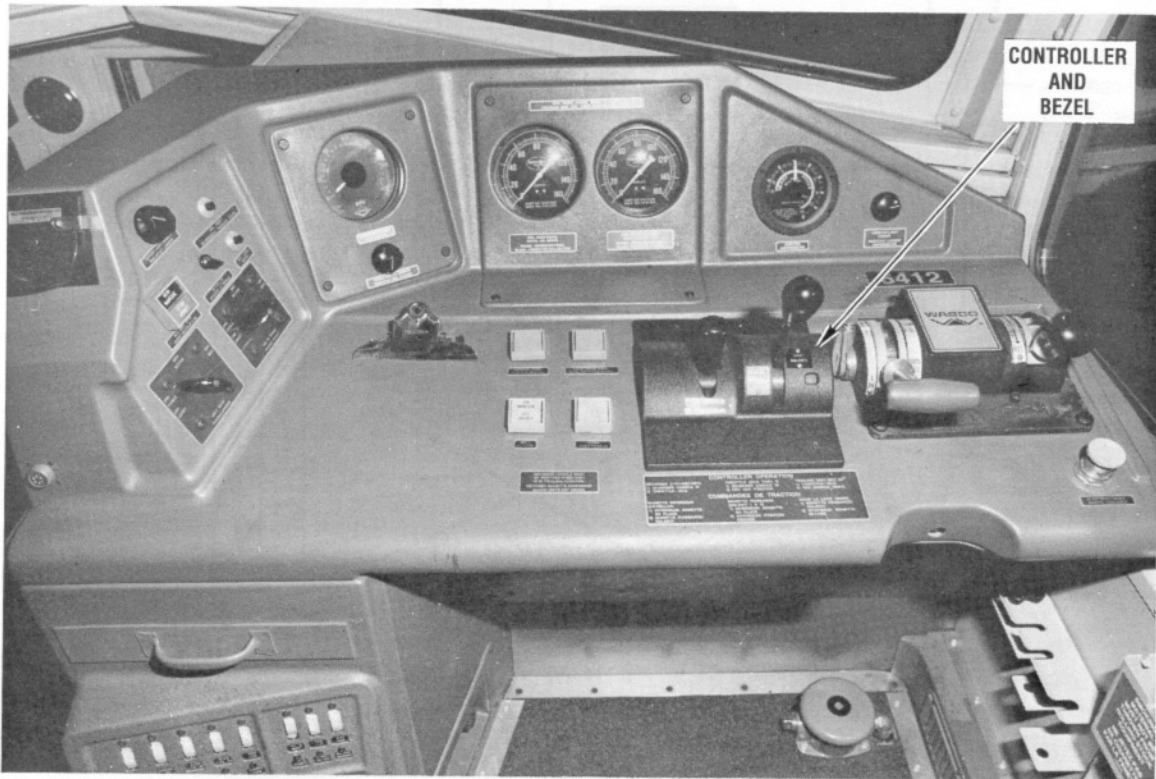


Fig. 4 - Non Dynamic Braking (Blended Brake) Equipped Control Console

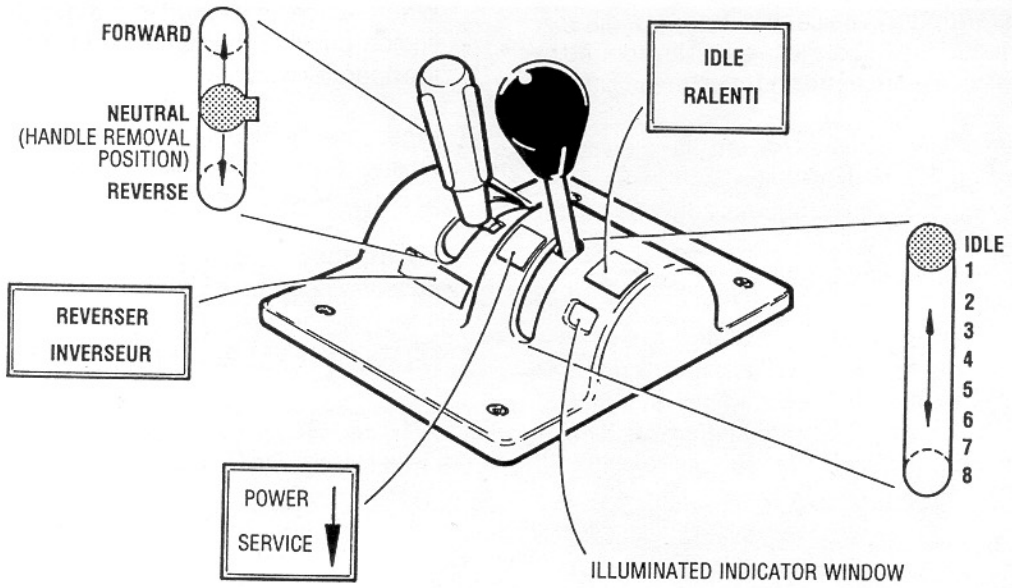


Fig. 5 - Bezel - Non Dynamic Brake Type

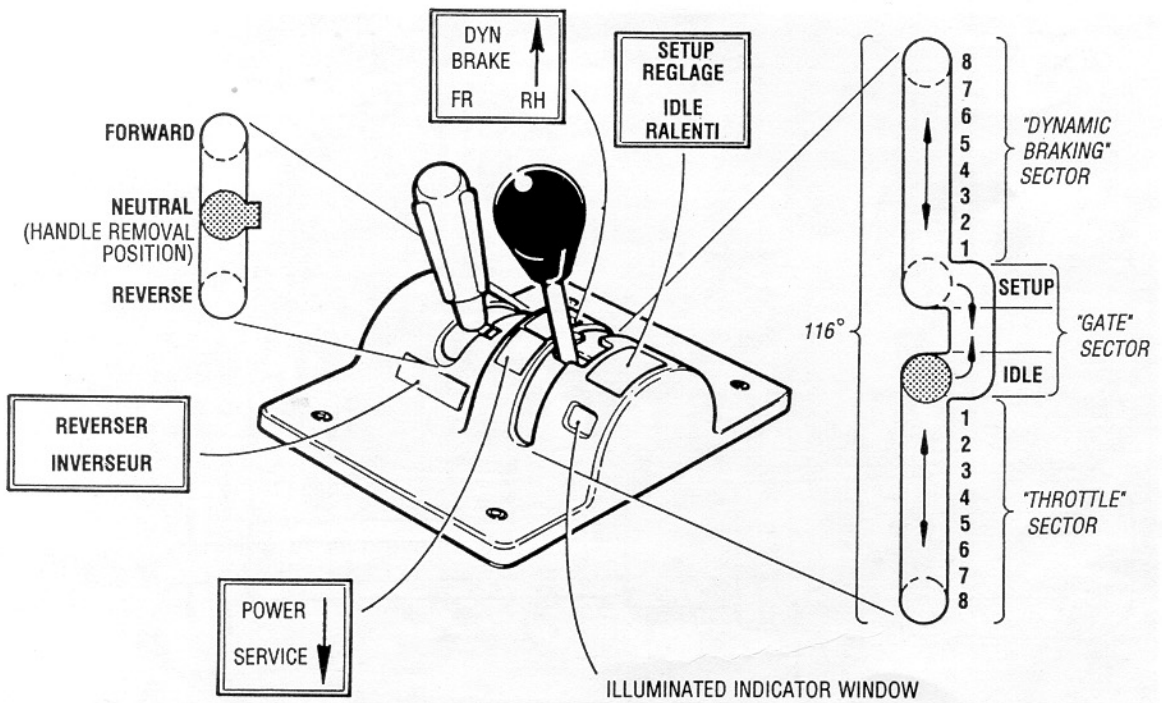


Fig. 6 - Bezel - Dynamic Brake type

and shafts, a cam drum and roller switches as it moves along a total longitudinal arc of 116 degrees. The 116-degree arc is interrupted in its central area by a gate. A distinct movement of the handle to the right is required to overcome a light spring pressure and to enter the gate.

Entering the gate only, without forward handle movement does not affect locomotive control logic in any way. Handle movement forward, within the confines of the gate will reach a detented position marked SET-UP and cause the dynamic brake system to be set up.

Continued movement forward after exiting the gate area by moving the handle to the left will control DB retardation from position 1 through 8, by rotating an infinitely variable rheostat on the bottom of the controller. These positions, 1 through 8, are *not* detented.

NOTE

When handle is located in the dynamic brake arc sector, pushing the handle forward or away from the operator will *increase dynamic braking*.

When handle is located in the throttle arc sector, pulling the handle backwards or toward the operator will *increase locomotive power*.

Each of the positions is shown in the illuminated indicator window to the right of the handle.

DIRECTIONAL HANDLE, Fig. 7

The directional handle is located on the left side of both DB and Non DB controller and controls the direction in

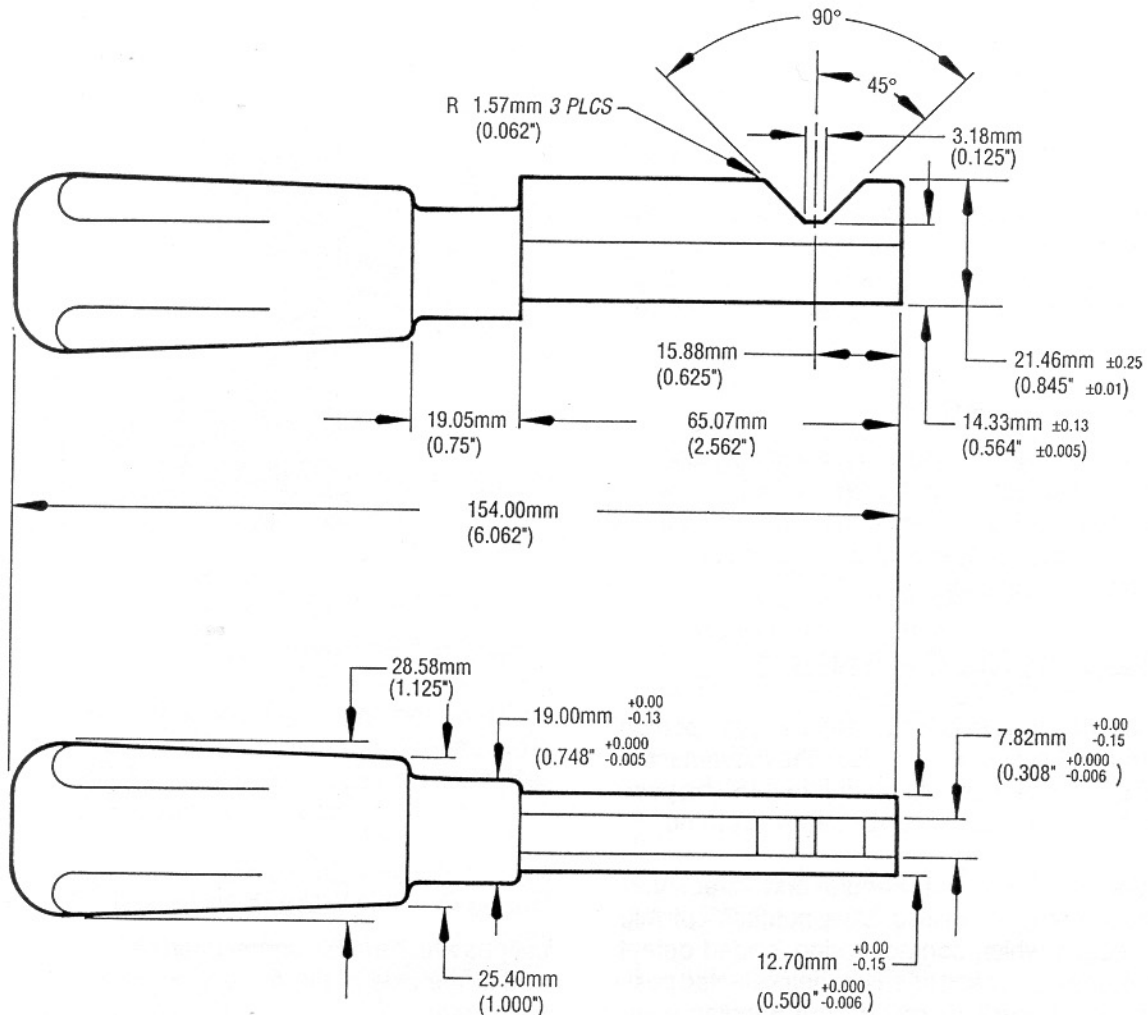


Fig. 7 - Reverser Handle A.A.R. Specifications

which the locomotive moves. The handle has three positions: forward of center, center position, and aft of center. The locomotive will move in the direction in which the handle is positioned. With the handle in the center position, no tractive effort will be developed if the throttle is opened. The directional handle should be moved only when the locomotive is not in motion.

The directional handle on a locomotive controller also functions as a key to lock the mechanism when the handle is removed and to unlock it when the handle is inserted. The directional handle can be removed from the controller only when the handle is in the center position, the throttle is in IDLE, and the dynamic brake is in OFF.

WARNING

ALTERATION OF A DIRECTIONAL HANDLE TO MAKE THE HANDLE EASIER TO INSERT OR REMOVE IS A HIGHLY DANGEROUS PRACTICE. SUCH ALTERATION CAN AFFECT THE ABILITY OF THE HANDLE TO ENGAGE THE LOCKING MECHANISM OF THE CONTROLLER.

For proper and safe operation, the directional handle must conform to specifications. Fig. 7 shows the correct dimensions of the directional handle as specific by the Association of American Railroads. Handles conforming to these specifications, even though well worn through many years of normal service, continue to function properly.

NOTE

The design of the directional handle and controller is such that lubrication of the slot into which the handle is inserted is not necessary. Lubricant in this area can collect dust and dirt and cause the controller to malfunction.

INTERLOCK MECHANISM

The interlock mechanism is located in the upper portion of the controller. This interlock inhibits the movement of an operating handle unless the other handle is in a position where the subject handle can be safely operated.

The throttle/dynamic brake handle and directional handle carrier cam plates also have notches cut into their outer edges which contact spring loaded detent rollers to hold the carrier and shafts in their selected positions. A moderate push or pull on the handles overcomes the detent pressure allowing movement to the next notch. Interlocking of the dynamic brake/throttle handle and directional handle is provided in OPERATION section.

THROTTLE CAM DRUM

The cam drum is made of aluminum. Care should be taken to avoid damage to the cam drum surface.

The contours on the face of the drum are arranged to actuate the proper roller switches as dictated by the movement of the throttle/DB handle. When the lobes of a cam are in contact with the roller switch, the switch plunger is fully depressed. When the cam depressions are in alignment with the switch, the switch roller drops into the depression and the switch plunger moves to the free position (switch contacts transfer). No switch contact adjustment is necessary or provided.

CONTROLLER HOUSING

The controller housing is a box shaped structure of aluminum. The housing and the center partition plate contain bushings for the throttle and dynamic brake handle shafts and for the interlock mechanism. The roller switches are mounted in the bottom of the housing at lo-



Fig. 8 - Dynamic Brake Rheostat With Wiring Harness connections which enable proper interface with the cam drum and at the side of the housing to interface with the reverse cam.

SWITCHES

Each roller switch consists of a two piece housing which

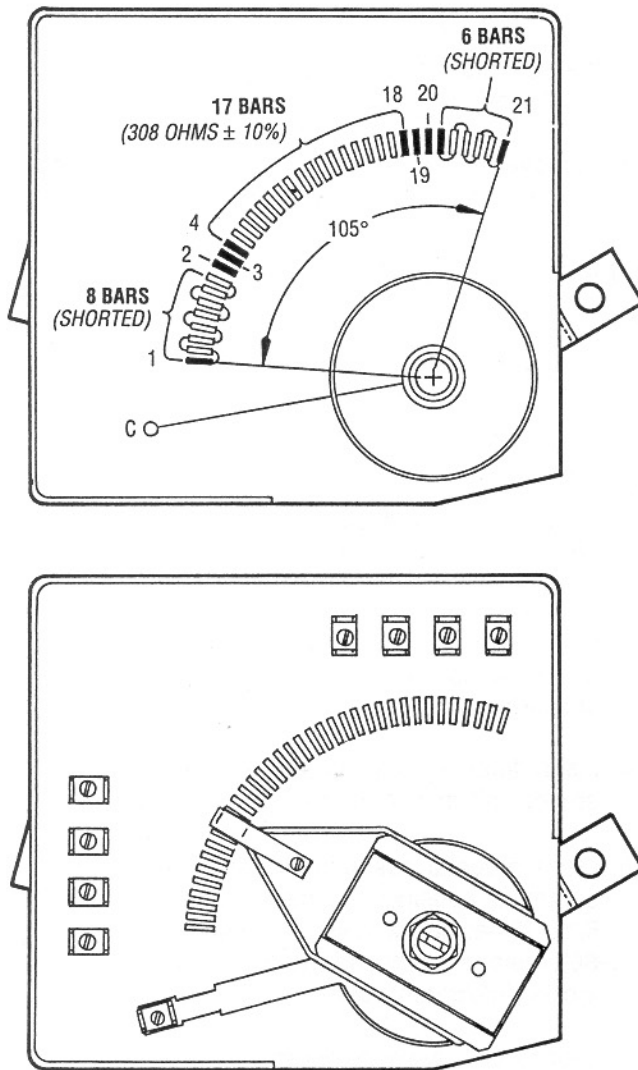


Fig. 9 - Dynamic Brake Rheostat Configuration

encloses either one or two sets of contacts. A snap action mechanism provides positive making and breaking of switch contacts.

DYNAMIC BRAKE RHEOSTAT

(used on manual dynamic brake type controllers only)

A plate type rheostat is mounted on the bottom of the controller housing. The rheostat brush arm is attached to the cam drum shaft through sector gears and rotates through an angle of 90 degrees, Fig. 8.

The rheostat, Fig. 9, has 21 individual steps consisting of 35 contact bars. The first step consists of eight contact bars shorted together and the last step consists of eight contact bars shorted together. Steps four through eighteen contain an internal resistance of $308 \pm 10\%$ ohms. The remaining steps contain no internal resistance but are connected to externally mounted resistors.

Faston terminals are located on the base plate, and ter-

minal identification is shown on the side of the plate. The brush is made of silver graphite and must make contact with each bar. With brush removed, brush drive pin should touch all contact segments to ensure that adequate wiper arm tension exists.

OPERATION

Due to mechanization differences between dynamic and non-dynamic controllers, two separate lists of handle operation and interlocking are provided.

MANUAL DYNAMIC BRAKE

CONTROLLERS, Refer to Table Fig. 24A

1. Directional handle removed.
 - a. Throttle/DB handle locked in "IDLE".
2. Directional handle installed and centered.
 - a. Throttle/dynamic brake handle can be moved to any position, in the power or "THROTTLE" range only.
 - b. "DYNAMIC BRAKE" section of quadrant not accessible.
3. Directional handle installed and in either "FORWARD" or "REVERSE".
 - a. The throttle/dynamic brake handle can be moved to any position on the 116° quadrant. The design of the controller is such, however, that *only "THROTTLE" or "DYNAMIC BRAKE" can be engaged at one time.*
 - b. Throttle/dynamic brake handle in "DYNAMIC BRAKE" section, reverser handles is locked in either forward or reverse.
 - c. Throttle/dynamic brake handle in "THROTTLE" sector, reverser handle is locked in either "FORWARD" or "REVERSE".
 - d. Throttle/dynamic brake handle in IDLE position.
 - i) Directional handle can be moved to forward or reverse.
 - ii) Directional handle can be removed, locking throttle/DB handle in IDLE.

NON-DYNAMIC OR BLENDED BRAKE CONTROLLERS

Refer to Table Fig. 21A

1. Directional handle removed.
 - Throttle locked in "IDLE".
2. Directional handle installed and in either "FORWARD", "CENTER" or "REVERSE".
 - Throttle can be moved to any position.

3. Throttle in "IDLE".
 - Directional handle can be moved to any position.
4. Throttle in any position from 1 to 8.
 - Directional handle locked in either "FORWARD," "CENTER" or "REVERSE".

MAINTENANCE

Under extremely dusty or humid conditions, occasional inspection is advisable to determine if all components are functioning properly and efficiently. If sluggishness, tightness, or a gritty feeling is experienced, the controller should be cleaned with a petroleum solvent and blown with dry air, and lubricated. After assembly, the controller should be thoroughly checked to qualify it for service. This work would be more conveniently performed on a bench. The removal of the controller consists of removing the handle(s), bezel, four screws and disconnecting the quick disconnect plug.

INDICATOR LAMP, Fig. 12

To replace a burned out indicator lamp, remove the handles and bezel only. See Service Data for lamp part number.

SWITCHES

The switches are mounted on the side of the controller housing and are made accessible by removing the controller. See Service Data for specifications on switches.

DYNAMIC BRAKE RHEOSTAT

(Manual D.B. Controller Only) Fig. 8

Dynamic brake rheostat should be inspected, cleaned, and serviced at intervals stated in the applicable Scheduled Maintenance Program.

INSPECTION AND CLEANING

1. Remove controller from console and place on its side on a suitable bench.
2. Blow rheostat clean with dry air.
3. Inspect contact brush for chips or excessive wear and replace if brush height is less than 5.5 mm (7/32").

REMOVAL OF RHEOSTAT, Fig. 10

1. With controller on a bench, remove wiring from the rheostat assembly.
2. Remove the two 5/16-18 hex cap screws, nuts and washers (64, 65 & 66) that attach rheostat assembly

(59) to bottom of controller. Rheostat is now free to be lifted off.

3. Remove two Allan socket head cap screws (61) that attach rheostat sector gear to rheostat adapter.

INSTALLATION OF RHEOSTAT, Fig. 10

1. Install (sector) gear on rheostat adapter using two socket head cap screws (61). The (sector) gear (60) orientation relative to the rheostat brush arm is critical and the following must be observed:
 2. With rheostat assembly held vertical fig. 10, and the wiper arm on bar #1, place the flat side of the sector gear on the rheostat adapter.
 3. Locate the "blank" section of the (sector) gear (60) so it is located between the 10:00 and 1:00 o'clock position while facing the brush arm, then install two socket head screws (51) and tighten.
 4. Insert detent spring (68) and ball (69) into detent assembly (67) and hold in place temporarily.
 5. Place rheostat assembly in position on bottom of controller housing and fasten into place with two 5/16-18 hex cap screws, nuts and washers (64, 65 & 66), release detent and check for free movement and locking into detent notch.

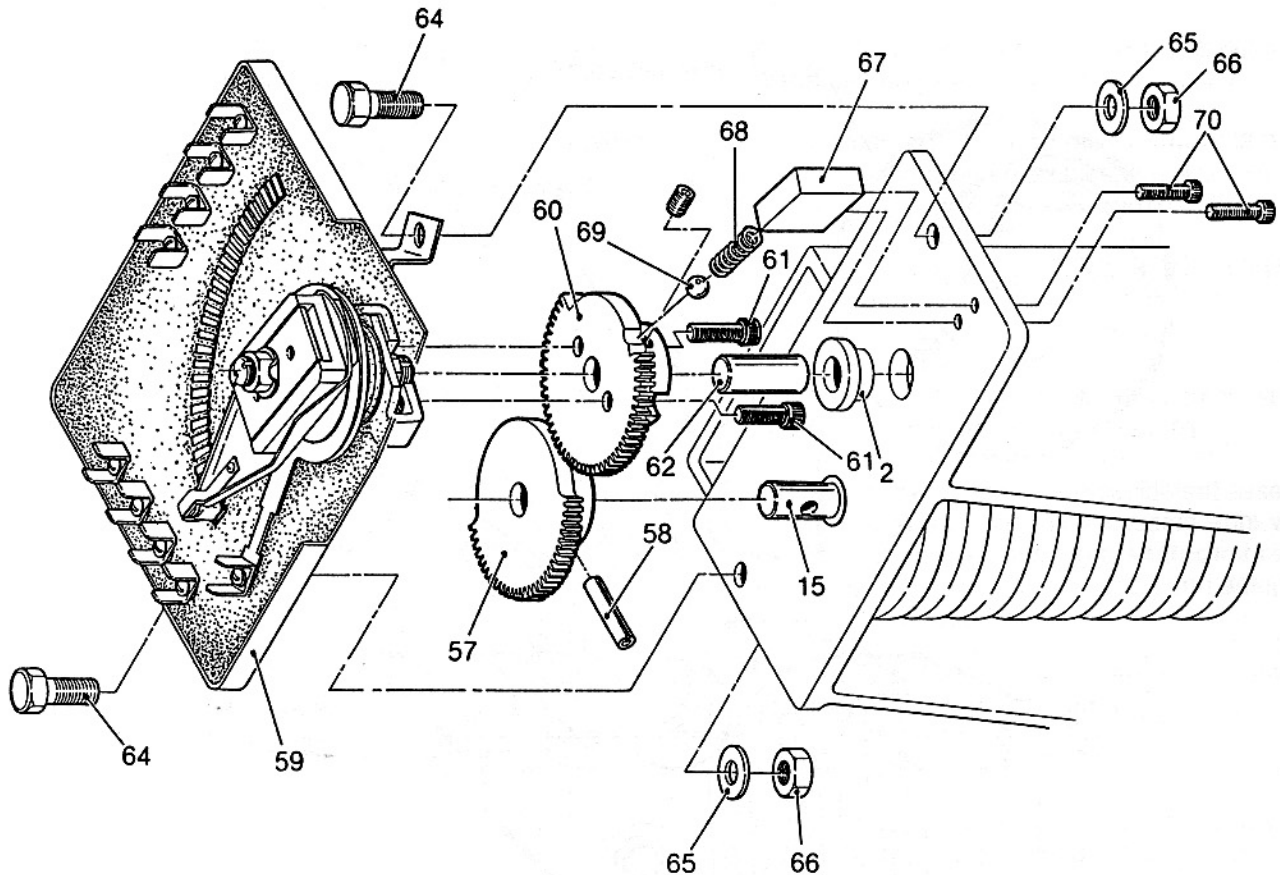
NOTE

With rheostat installed properly, throttle/DB handle in SET-UP, rheostat (sector) gear detent in the appropriate detent notch and brush arm on #1 bar, sector gears (items 57 & 60) should be just *out of engagement*.

6. Move throttle/DB handle to BRAKE RANGE; (sector) gears (57 & 60) should now have *initial tooth contact*.
7. Move throttle/DB handle through DB range, (sector) gears should now be fully engaged and rheostat should rotate through its entire range (any of the first eight bars in OFF position and any of the last six bars in the FULL 8 position, fig. 9).
8. Move throttle/DB handle into IDLE position, rheostat sector gear should disengage and detent should "trap" rheostat in position at or near bar #1.

CAUTION

PERFORM CONTINUITY TEST FROM RHEOSTAT TERMINALS TO HARNESS PLUG BEFORE INSTALLING INTO LOCOMOTIVE.



NO.	DESCRIPTION
2	BEARING
57	GEAR (SECTOR) - CAM SHAFT
58	SPRING PIN - 4.8mm DIA. x 34.9mm LG. (3/16" x 1 3/8)
59	RHEOSTAT ASSEMBLY
60	GEAR (SECTOR) - RHEOSTAT SHAFT
61	SCREW SOCKET HEAD CAP - No. 8 - 32 x 3/8"
62	SHAFT RHEOSTAT
64	SCREW CAP - 5/16" - 18 x 7/8"
65	WASHER FLAT - 5/16"
66	NUT - 5/16" - 18
67	PLUNGER (DETENT)
68	SPRING
69	BALL
70	SCREW SOCKET HEAD CAP - NO. 8 - 32 x 5/8"

Fig. 10 - Dynamic Brake Rheostat Application

INSPECTION AND CLEANING OF CAM, GEARS, AND SHAFTS, BUSHINGS, SPRINGS, INTERLOCKING AND DETENT MECHANISMS

Blow out any foreign material with dry air, check for binding and/or excessive looseness. Replace worn parts that affect the smooth and efficient operation of the controller mechanism. By ensuring that the proper switches are activated, rheostat positions are reached at the appropriate throttle and DB handle positions and that proper interlocking is achieved, qualifies the essential operational functions of an efficient controller.

Use "Lubriplate" or equivalent on all gears and bushings, the throttle detent mechanism, slide assembly and "V" groove in the reverser-gear assembly (use the appropriate parts list for proper identification of these items).

CONTROLLER REMOVAL (DB and non DB type)

1. Remove #3 - 48 set screw from throttle or throttle/DB knob.
2. Unscrew throttle or throttle/DB knob from shaft.
3. Remove four bezel assembly hold down screws and remove bezel assembly. Reverser and throttle handle seals can become dislodged from bezel assembly, and care should be taken to ensure seals are oriented correctly when reinserted.
4. Controller flange hold down screws are now accessible and must be removed before the controller can be lifted clear of the console.
5. Lift controller assembly carefully until cable quick

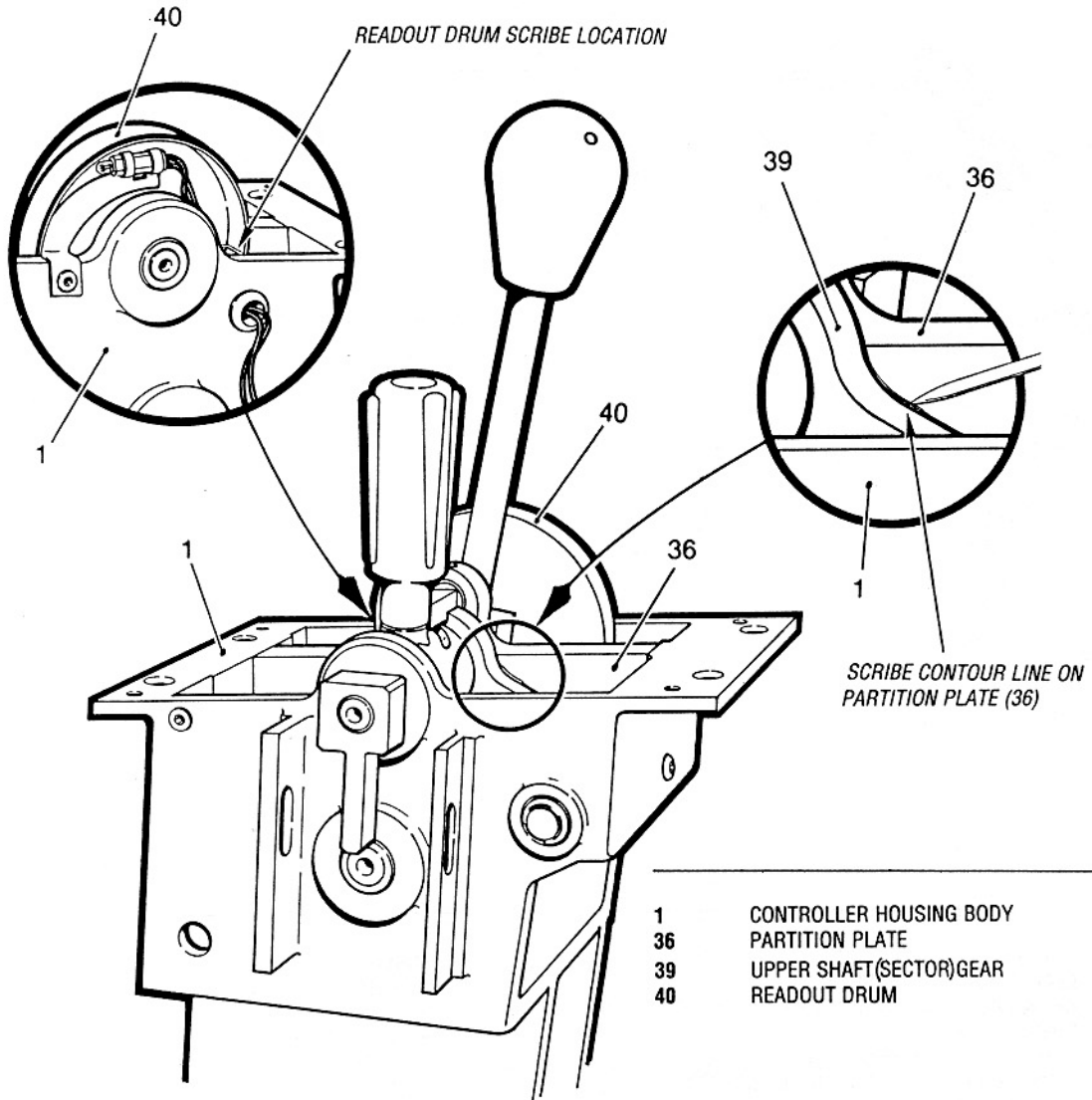


Fig. 11 - Scribe Line marking - Prior to Disassembly

disconnect is accessible. Disconnect plug and cable assembly. Controller can now be removed completely. Place on bench or suitable work area.

DISASSEMBLY (DB type controllers), fig. 12 and 13. For non DB controllers, see page (14) and refer to figs. 12 and 19

This procedure describes the complete disassembly of the manual dynamic brake type controller. If controller needs only partial disassembly, use only the steps required to complete that portion of disassembly.

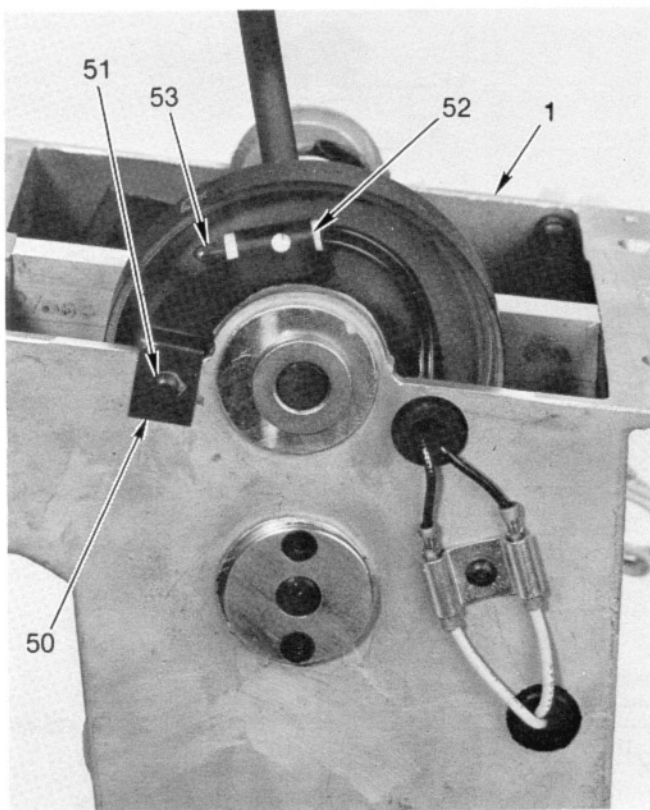
CAUTION

PROPER DISPLAY OF THROTTLE HANDLE (OR THROTTLE/DB HANDLE) POSITION ON THE READOUT DRUM IS DEPENDENT ON AC-

CURATE INDEXING OF UPPER SHAFT (SECTOR) GEAR (39) LOWER SHAFT DETENT ASSEMBLY (9), LOWER SHAFT GEAR (11) AND UPPER SHAFT GEAR (42).

PRIOR TO TEARDOWN, TO FACILITATE EASY REASSEMBLY, WITH DIRECTIONAL HANDLE IN CENTER POSITION AND THROTTLE/DB HANDLE IN IDLE POSITION, SCRIBE OUTLINE OF UPPER SHAFT (SECTOR) GEAR (39) ON PARTITION (36) AND MARK WITH PENCIL, THE READOUT DRUM (40) IN LINE WITH THE EDGE OF THE CONTROLLER BODY (1). REFER TO FIG. 11.

1. Ref. Fig. 13. Identify wiring, if not already marked, and remove wiring from roller switches. Remove roller switches (76, 77 & 78) and identify location. To



1	CONTROLLER HOUSING BODY	52	SOCKET
50	SOCKET CLAMP	53	BULB
51	SCREW - #8 - 32		

Fig. 12 - Controller Indicator Lamp
(D.B. and Non D.B. Types)

avoid possible damage to the indicator bulb and socket, remove #8-32 screw (51) and tape back the socket clamp (50), socket (52) and bulb (53) assembly against the side of the controller body (1). Refer to fig. 12.

2. Remove slide assembly (37) by removing the set screw (89) from the top of the partition assembly, Fig. 13.
3. Remove the Throttle/DB handle retaining rings (49), pivot pin (47), and handle assembly (46).
4. Rotate throttle/DB shaft sufficiently to line up spring pin (12) of the upper shaft (sector) gear (39) and carefully drive out pin. Using snap ring pliers, release tension from retaining ring (86). Remove throttle/DB shaft (45) and (sector) gear (39) by sliding shaft through the readout drum (item 40) and out of the end bearing. Carefully retrieve all parts such as shims (79) and avoid damage to readout drum (40) as it clears the shaft.
5. Line up and drive out spring pin (18) from reverser gear assembly (30) and remove forward and reverse switch cam (35) and upper shaft assembly (29) as a unit.

6. Remove four partition plate screws (38) and partition plate assembly (36).
7. The reverser lock (31) and reverser gear (30) sub-assembly cannot be withdrawn from the controller until the lower shaft (8) is first removed.
8. Line up and drive out spring pins, (10 & 12) from the lower shaft gear (121) and lower shaft detent assembly (9).
9. Remove three lower shaft end bearing screws (27) and bearing (13) from controller housing.
10. Slide lower shaft (8) and reverser detent assembly (9) towards side of controller housing from which bearing has been removed until shaft clears opposite end bearing (2). Remove shaft and detent assembly from controller body (1).
11. Remove spring pin (18) from bevel gear (17), and two roll spring (22) from switch cam (16).

NOTE

Ref. fig. 14. Thrust bearings (20) and thrust washers (19) located at the top and bottom of the cam, along with shims (21) (82) (84) located at the bottom, will be released upon the removal of the shaft (15) from the controller assembly. To ensure correct reassembly, identify the quantity and location of these parts. The shims are required to establish the proper bevel gear backlash (Refer to Service Data section for backlash tolerance).

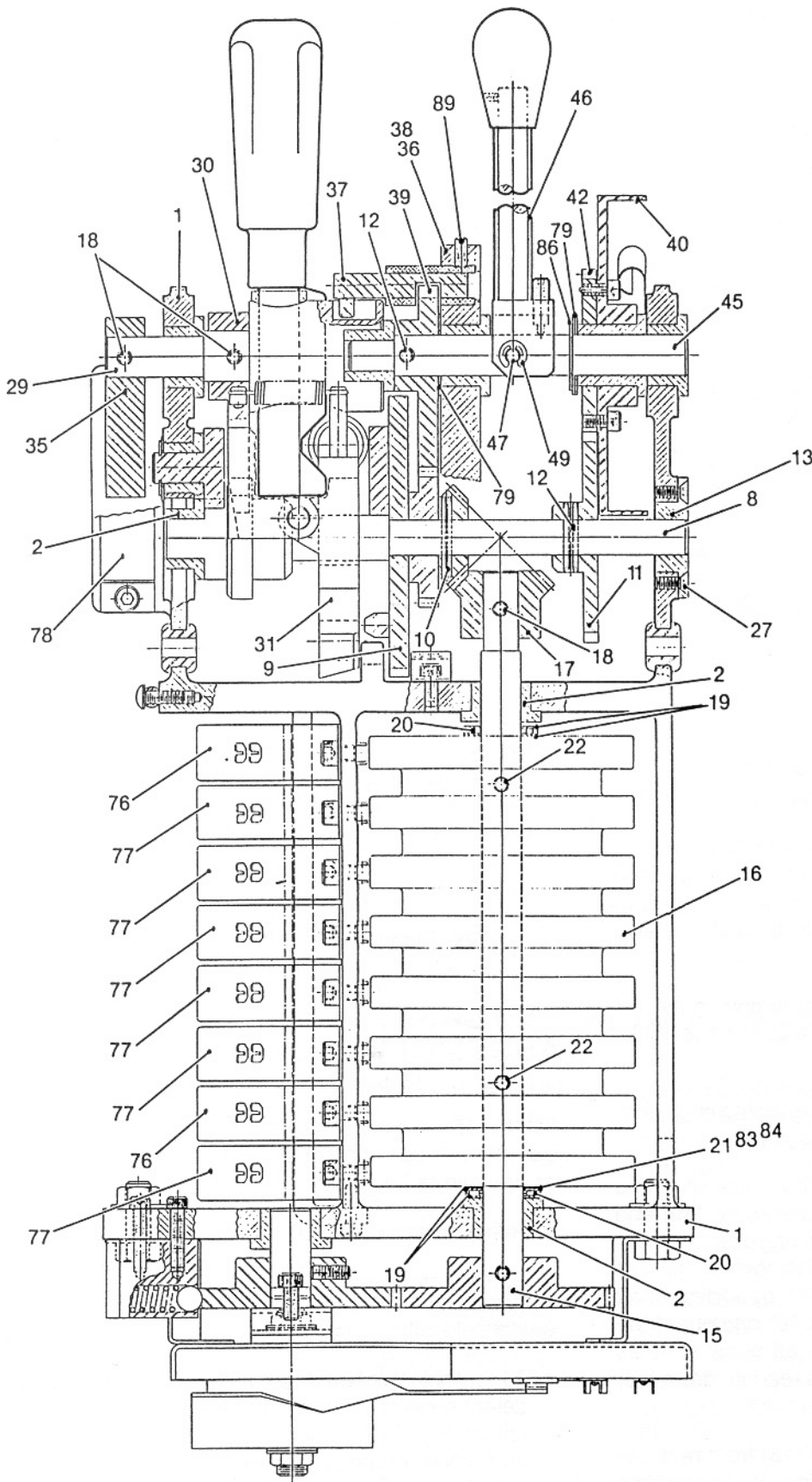
12. Remove bevel gear (17) shaft (15) and cam (16) from controller body (1).

REVERSER LOCK AND DETENT ASSEMBLIES (DB and non DB type controllers) Figs. 15, 16 and 17

Ref. fig. 15. To disassemble the reverser gear (30) and lock (31) sub-assembly once removed from the controller, proceed as follows.

1. Remove retaining rings (33), two per swivel pin (32).
2. Remove two swivel pins (32).
3. Unhook both springs (34).
4. To remove reverser detent arm assembly (23) and detent spring (28) from controller body, remove retaining RING (25) and thrust washer (24) and unhook spring at spring retainer (26). Refer to fig. 16.

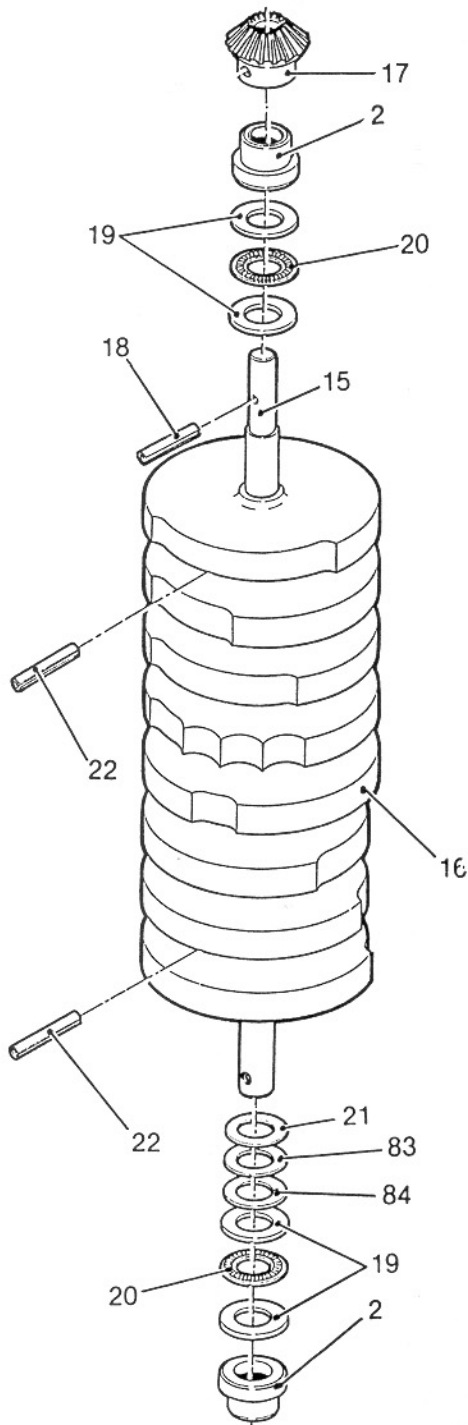
To reassemble the reverser lock and detent arm assembly, reverse the above procedure.



NO. DESCRIPTION

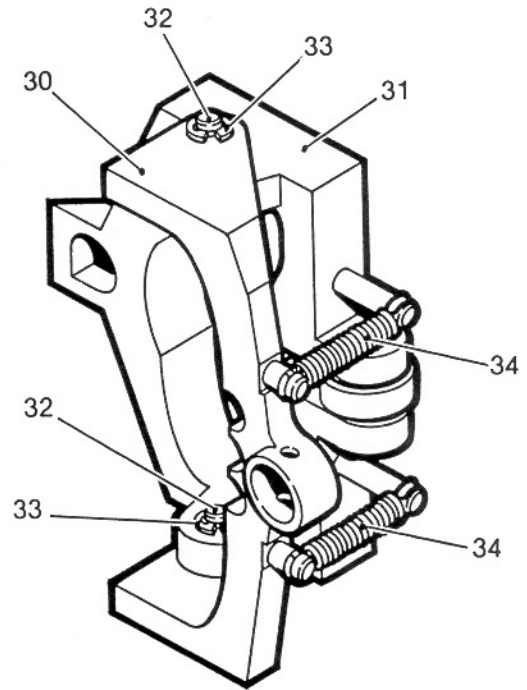
- 1 CONTROLLER HOUSING BODY
- 2 BEARING
- 8 LOWER SHAFT
- 9 LOWER SHAFT DETENT ASSEMBLY
- 10 SPRING PIN - 3.2mm DIA. x 25.4mm LG. (1/8" x 1")
- 11 LOWER SHAFT GEAR
- 12 SPRING PIN - 4.8mm DIA. x 22.2mm LG. (3/16" x 7/8")
- 13 BEARING
- 15 CAM SHAFT
- 16 SWITCH CAM
- 17 BEVEL GEAR
- 18 SPRING PIN - 4.8mm DIA. x 25.4mm LG. (3/16" x 1")
- 19 THRUST WASHER
- 20 ROLLER THRUST BEARING
- 21 SHIM - 0.18mm (0.007") THICK
- 22 SPRING PIN - 4.8mm DIA. x 38mm LG. (3/16" x 1 1/2")
- 27 SCREW - NO. 8 - 32 x 1/2"
- 29 UPPER SHAFT ASSEMBLY
- 30 REVERSER GEAR ASSEMBLY
- 31 REVERSER LOCK ASSEMBLY
- 35 CAM - FORWARD AND REVERSE
- 36 PARTITION PLATE ASSEMBLY
- 37 SLIDE ASSEMBLY
- 38 SCREW - PARTITION 1/4" - 20 x 3/4"
- 39 UPPER SHAFT (SECTOR) GEAR
- 40 READOUT DRUM
- 42 UPPER SHAFT GEAR
- 45 THROTTLE/DB SHAFT
- 46 THROTTLE/DB HANDLE ASSEMBLY
- 47 HANDLE PIVOT PIN
- 49 RETAINING RING
- 76 SWITCH
- 77 SWITCH
- 78 SWITCH
- 79 SHIM - 0.51mm (0.020") THICK
- 83 SHIM - 0.08mm (0.003") THICK
- 84 SHIM - 0.13mm (0.005") THICK
- 86 RETAINING RING
- 89 SET SCREW NO. 8 - 32 x 3/8"

Fig. 13 - Dynamic Braking Controller - Section



NO.	DESCRIPTION
2	BEARING - (CONTROLLER BODY)
15	CAM SHAFT
16	CAM
17	BEVEL GEAR
18	SPRING PIN - 4.8mm DIA. x 25.4mm LG (3/16" x 1")
19	THRUST WASHER
20	ROLLER THRUST BEARING
21	SHIM - 0.18mm (0.007") THICK
22	SPRING PIN - 4.8mm DIA x 38mm LG. (3/16" x 1.5")
83	SHIM - 0.08mm (0.003") THICK
84	SHIM - 0.13mm (0.005") THICK

Fig. 14 - Switch Cam and Shaft Bearing and Shims Application



30	REVERSER GEAR ASSEMBLY
31	REVERSER LOCK ASSEMBLY
32	SWIVEL PIN
33	RETAINER RING
34	SPRING

Fig. 15 - Reverser Gear and Lock Assembly (D.B. and Non D.B. Types)

THROTTLE HANDLE (OR THROTTLE/DB HANDLE) DETENT PLUNGER ASSEMBLY

(DB and non DB type controllers) Figs. 17 and 18

Ref. fig. 18. As with the reverser detent mechanism, the throttle or throttle/DB handle detent system also consists of two sections, lower shaft detent assembly item (9) and detent plunger assembly (5, 6 & 7). The detent plunger assembly may be removed at any time without the removal of the lower shaft detent assembly as follows:

1. Remove the two #10 - 24 Pan Head screws (44), attaching the plunger housing (5), to the controller body (1).
2. Apply pressure to plunger assembly (7), to release roller from lower shaft detent assembly (item 6).
3. Slide detent plunger assembly sideways and carefully release plunger assembly spring pressure, then remove plunger, spring and housing from the controller, as a unit.

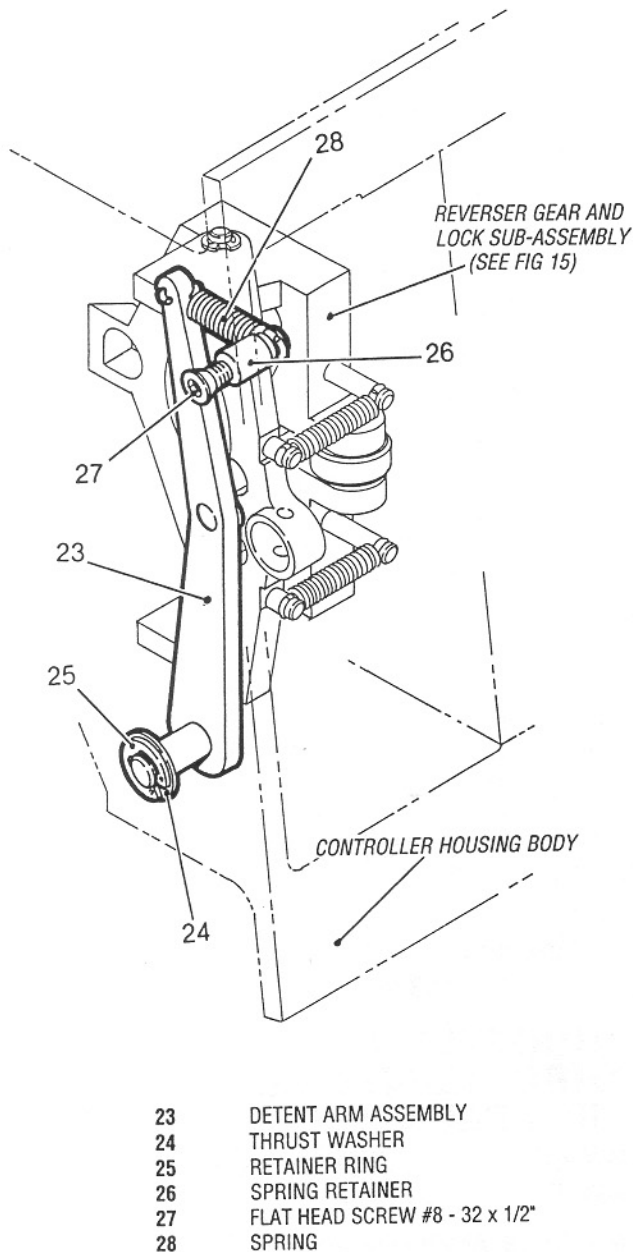


Fig. 16 - Reverser Detent Arm Removal (D.B. and Non D.B. Types)

NOTE

In the event that the throttle/DB handle detent assembly (9) has already been removed from the controller assembly, the plunger assembly (7) and spring (6) can be readily removed without removing the plunger housing.

Reassembly of the detent plunger and housing assembly can be performed by following the above procedure in reverse.

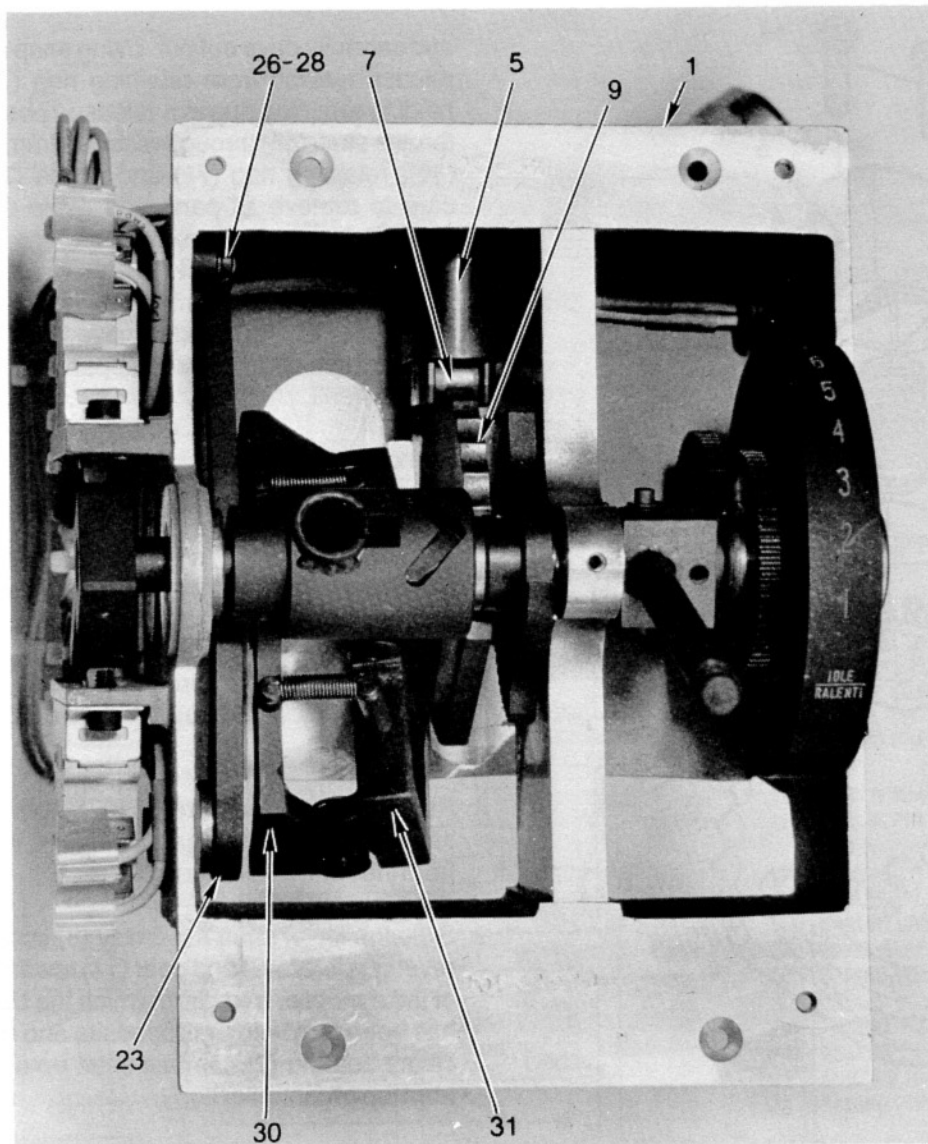
CONTROLLER REASSEMBLY (DB and non DB type controllers)

1. Follow disassembly procedure in reverse.
2. Shim the camshaft by inserting the proper number of thrust washers between the cam assembly and the bottom thrust bearing (Refer to Service Data Section) to obtain .03 mm to .10 mm (.001 to .004") backlash between the cam and lower shaft bevel gears.
3. Where dissimilar metals are permanently assembled as in the case of switch cam (16) and switch camshaft (15), for instance, use a sealant to create an effective interface between the contact surfaces, inhibiting galvanic cell action.
4. Readout drum to indicator window alignment may require fine adjustment if new parts have been installed; refer to Service Data Section for proper procedure.
5.
 - a) Proper display of throttle handle (or throttle/DB handle) position on the readout drum is dependent on accurate indexing of upper shaft (sector) gear (39) lower shaft detent assembly (9), lower shaft gear (11) and upper shaft gear (42).
 - b) *Prior to teardown*, to facilitate easy reassembly, with directional handle in center position and throttle/DB handle in idle position, scribe outline of upper shaft (sector) gear (39) on partition (36) and mark, with pencil, the readout drum (40) in line with the edge of the controller body (1). Refer to Fig. 11.
 - c) *On reassembly*, line up scribe marks to ensure proper handle/indicator drum alignment.
6. Refer to Section "Installation of Rheostat" for DB type controllers.
7. After assembly and mechanical check-out, confirm that electrical connections are as per diagram both at the individual switches *and* at the harness plug.

DISASSEMBLY (Non DB Type Controllers)

Figs. 12 and 19

This procedure describes the complete disassembly of the non dynamic type controller. If controller needs only partial disassembly, use only the steps required to complete that portion of disassembly.



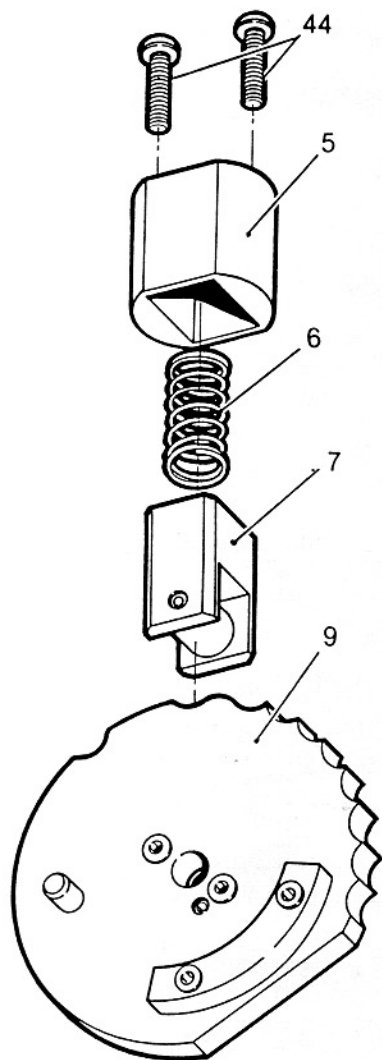
NO.	DESCRIPTION		
1	CONTROLLER BODY	26	SPRING RETAINER
5	PLUNGER HOUSING	28	SPRING
7	PLUNGER ASSEMBLY	30	REVERSER GEAR ASSEMBLY
9	LOWER SHAFT DETENT ASSEMBLY	31	REVERSER LOCK ASSEMBLY
23	REVERSER DETENT ARM ASSEMBLY		

Fig. 17 - Throttle and Reverser Detent Mechanisms Installed
(D.B. and Non D.B. Types)

CAUTION

PROPER DISPLAY OF THROTTLE HANDLE (OR THROTTLE/DB HANDLE) POSITION ON THE READOUT DRUM IS DEPENDENT ON ACCURATE INDEXING OF UPPER SHAFT (SECTOR) GEAR (39) LOWER SHAFT DETENT ASSEMBLY (9), LOWER SHAFT GEAR (11) AND UPPER SHAFT GEAR (42).

PRIOR TO TEARDOWN, TO FACILITATE EASY REASSEMBLY, WITH DIRECTIONAL HANDLE IN CENTER POSITION AND THROTTLE/DB HANDLE IN IDLE POSITION, SCRIBE OUTLINE OF UPPER SHAFT (SECTOR) GEAR (39) ON PARTITION (36) AND MARK WITH PENCIL, THE READOUT DRUM (40) IN LINE WITH THE EDGE OF THE CONTROLLER BODY (1). REFER TO FIG. 11.



5	PLUNGER HOUSING
6	SPRING
7	PLUNGER ASSEMBLY
9	LOWER SHAFT DETENT ASSEMBLY
44	PAN HEAD SCREW #10 - 24 x 5/8"

Fig. 18 - Throttle Detent Mechanism
(D.B. and Non D.B. Types)

1. Identify wiring, if not already marked, and remove wiring from roller switches. Remove roller switches (63, 64 & 65) and identify original location. Refer to Fig. 19. To avoid possible damage to the indicator bulb and socket, remove #8-32 screw (51) and tape back the socket clamp (50), socket (52) and bulb (53) assembly against the side of the controller body (1). Refer to Fig. 12.
2. Remove the throttle handle retaining ring(s) (49) and pivot pin (47) and handle assembly (46).
3. Rotate throttle shaft (45) sufficiently to line up spring pin (12) of the upper shaft (sector) gear (39)

and carefully drive out pin. Using snap ring pliers, release tension from retaining ring (72). While holding retaining ring in a released position, slide throttle shaft (45) through readout drum assembly (40), retaining ring (72) and shims (70), taking care to retrieve all parts and avoid damage to readout drum as it clears the shaft.

4. Line up and drive out spring pin (18) from reverser gear assembly (30) and remove forward and reverse switch cam (35) and upper shaft assembly (29) as a unit.
5. Remove four partition plate screws (38) and partition plate (36).
6. The reverse lock (31) and reverser gear (30) sub-assembly cannot be withdrawn from the controller until the lower shaft (8) is first removed.
7. Line up and drive out spring pins (10 & 12) from the lower shaft gear (11) and the lower shaft detent assembly (9).
8. Remove the three screws (27) from the lower shaft end bearing (13) and remove the bearing from the controller body (1).
9. Slide the lower shaft assembly (8) complete with reverser detent (9) and gear (11) towards the side of the controller body from which the bearing (13) has been removed until opposite end of the shaft clears bearing (2), then tilt shaft up and remove from top of controller body.
10. Remove spring pin (18) from bevel gear (17) and both spring pins (22) from switch cam (16).

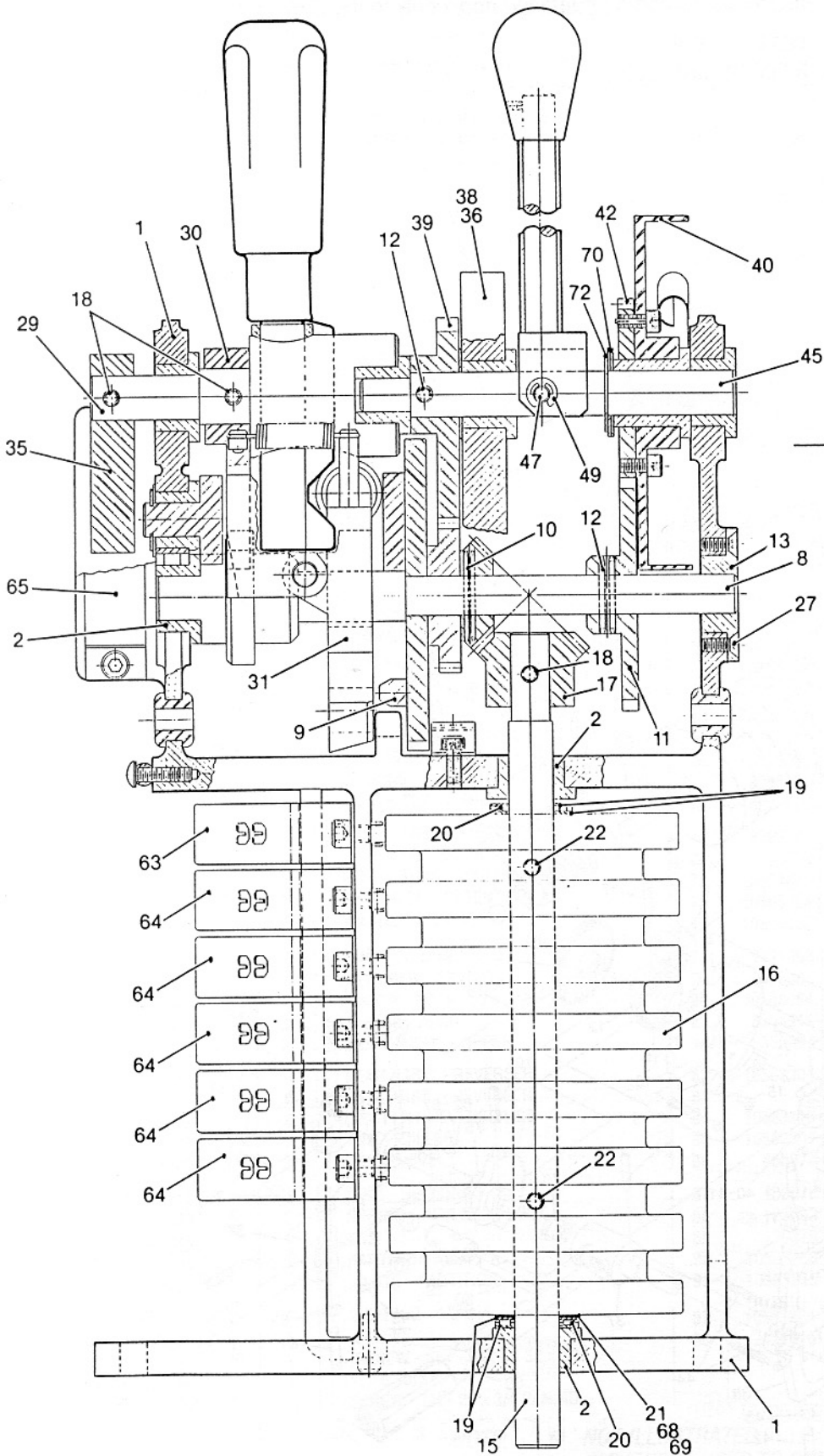
NOTE

Ref. Fig. 14. Thrust bearings (20) and thrust washers (19) located at the top and bottom of the cam, along with shims (21) (68) (69), located at the bottom, will be released upon the removal of the shaft (15) from the controller assembly. To ensure correct reassembly, identify the quantity and location of these parts. The shims are required to establish the proper bevel gear backlash (refer to Service Data section for backlash tolerance).

11. Remove bevel gear (17) shaft (15) and cam (16) from controller body (1).

CONTROLLER REASSEMBLY

See page 14, items 1 through 7.



NO.	DESCRIPTION
1	CONTROLLER BODY
2	BEARING
8	LOWER SHAFT
9	LOWER SHAFT DETENT ASSEMBLY
10	SPRING PIN - 3.2mm DIA. x 25.4mm LG. (1/8" x 1")
11	LOWER SHAFT GEAR
12	SPRING PIN - 4.8mm DIA. x 22.2mm LG. (3/16" x 7/8")
13	BEARING
15	CAM SHAFT
16	SWITCH CAM
17	BEVEL GEAR
18	SPRING PIN - 4.8mm DIA. x 25.4mm LG. (3/16"x1")
19	THRUST WASHER
20	ROLLER THRUST BEARING
21	SHIM - 0.18mm (0.007") THICK
22	SPRING PIN - 4.8mm DIA. x 38mm LG. (3/16" x 1 1/2")
27	SCREW - NO. 8 - 32 x 1/2"
29	UPPER SHAFT ASSEMBLY
30	REVERSER GEAR ASSEMBLY
31	REVERSER LOCK ASSEMBLY
35	CAM - FORWARD AND REVERSE
36	PARTITION PLATE
38	SCREW - PARTITION 1/4" - 20 x 3/4"
39	UPPER SHAFT (SECTOR) GEAR
40	READOUT DRUM
42	UPPER SHAFT GEAR
45	THROTTLE SHAFT
46	THROTTLE HANDLE ASSEMBLY
47	HANDLE PIVOT PIN
49	RETAINING RING
63	SWITCH
64	SWITCH
65	SWITCH
68	SHIM - 0.08mm (0.003") THICK
69	SHIM - 0.13mm (0.005") THICK
70	SHIM - 0.51mm (0.020") THICK
72	RETAINING RING

Fig. 19 - Non Dynamic Braking Controller - Section

Note: Reference numbers underlined> apply only to the D.B. type Controller

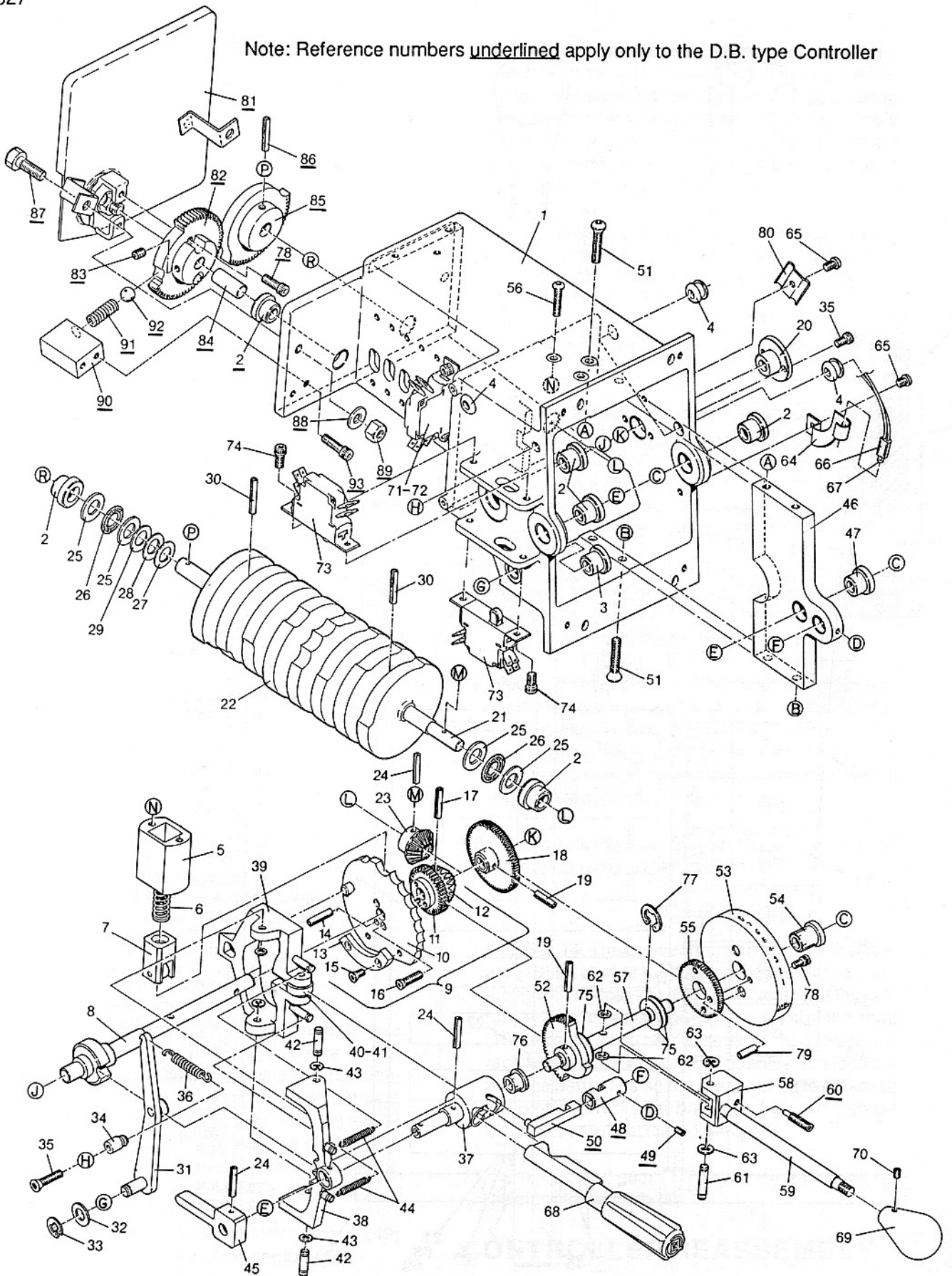


Fig. 20 - Controller Assembly (D.B. and Non D.B. Types)

NOTE	REF. NO.	PART NUMBER	A QTY.	B QTY.	DESCRIPTION	NOTE	REF. NO.	PART NUMBER	A QTY.	B QTY.	DESCRIPTION
		10561914	1	-	CONTROLLER ASSY. - NON DB		52	10563308	1	1	.GEAR - SECTOR - UPPER SHAFT
		10562791	-	1	CONTROLLER ASSY. - DB		53	10563320	1	1	.DRUM - READOUT
1		10562868	1	1	.BODY - CONTROLLER		54	10574188	1	1	.BEARING - 1/2 DIA.
2		10563314	5	6	.BEARING - 1/2 DIA.		55	10563305	1	1	.GEAR - UPPER SHAFT
3		10563387	1	1	.BEARING - 3/8 DIA.		56	10563603	2	2	.SCREW - NO. 10 - 24 x 5/8 PAN HD.
4		10568052	3	3	.GROMMET - RUBBER		57	10563311	1	1	.SHAFT - THROTTLE
5		10563272	1	1	.HOUSING - PLUNGER		58	10564109	1	-	.HANDLE ASSY. - THROTTLE
6		10563273	1	1	.SPRING		58	10563279	-	1	.HANDLE ASSY. - THROTTLE
7		10563270	1	1	.PLUNGER ASSY.		59	10563628	1	1	.SLEEVE - NYLATRON
8		10563312	1	1	.SHAFT - LOWER		60	10563629	-	1	.PLUNGER
9		10563237	1	1	.DETENT ASSY. - LOWER SHAFT		61	10563355	1	1	.PIN - HANDLE
10		10563350	1	1	.WHEEL ASSY. - DETENT		62	10563356	2	2	.WASHER - THRUST
11		10563239	1	1	.GEAR - LOWER SHAFT		63	274611	2	2	.RING - RETAINING
12		10563240	1	1	.GEAR - BEVEL		64	10563354	1	1	.CLAMP - SOCKET
13		10563241	1	1	.RING - STOP		65	10574299	2	2	.SCREW - NO. 8 - 32 x 3/8 BUTTON HD.
14		456652	1	1	.PIN - SPRING - 3/16 DIA. x 7/8 LG.		66	10563353	1	1	.SOCKET - BULB
15		10563376	2	2	.SCREW - NO. 8 - 32 x 1/2 FLAT HD.		67	10563352	1	1	.BULB
16		10563375	2	2	.SCREW - NO. 4 - 40 x 7/8 FLAT HD.		68	10563802	1	1	.HANDLE - DIRECTIONAL
17		453676	1	1	.PIN - SPRING - 1/8 DIA. x 1 LG.		69	10563591	1	1	.KNOB - HANDLE
18		10563309	1	1	.GEAR - LOWER SHAFT		70	10563605	1	1	.SCREW - SET - NO. 3 - 48 x 3/16
19		456652	2	2	.PIN - SPRING - 3 1/16 DIA. x 7/8 LG.		NI	10563581	1	1	.ROD-TIE (CABLE ASSY.)
20		10563317	1	1	.BEARING - 7/16 DIA.		NI	10563582	1	1	.ROD - TIE (CABLE ASSY.)
NI		8203428	1	1	.CLAMP - INSULATOR		NI	10563580	-	1	.ROD - TIE (CABLE ASSY.)
21		10563313	1	1	.SHAFT - CAM	A	NI	10574300	2	2	.SCREW - NO. 8 - 32 X 1/2 BUTTON HD.
22		10563319	1	1	.CAM - SWITCH	A	NI	9421696	1	1	.SCREW - NO. 6 - 32 x 1/2 SOC. HD.
23		10563299	1	1	.GEAR - BEVEL		NI	10564242	1	-	.PLUG AND CABLE ASSY.
24		455481	3	3	.PIN - SPRING - 3/16 DIA. x 1 LG.		NI	10564243	-	1	.PLUG AND CABLE ASSY.
25		10563587	4	4	.WASHER - THRUST		NI	8428099	4	4	.TIE - CABLE
26		10563588	2	2	.BEARING - THRUST		71	8298178	5	6	.SWITCH ASSY.
27		10563589	2	2	.SHIM - .007 IN. THICK		72	8296750	1	2	.SWITCH ASSY.
28		10564776	1	1	.SHIM - .003 IN. THICK		73	8299162	2	2	.SWITCH ASSY.
29		10564777	1	1	.SHIM - .005 IN. THICK		74	191209	16	20	.SCREW - NO. 10 - 24 x 3/8 SOC. HD.
30		457008	2	2	.PIN - SPRING - 3/16 DIA. x 1 1/2 LG.		75	10564833	3	3	.SHIM - .020 IN. THICK
31		10563274	1	1	.ARM ASSY. - DETENT		76	10563284	1	1	.BEARING - 3/8 DIA.
32		10565469	1	1	.WASHER - THRUST		77	10568053	1	1	.RING - RETAINING
33		9413182	1	1	.RING - RETAINING		78	9421698	4	8	.SCREW - NO. 8 - 32 x 3/8 SOC. HD.
34		10563302	1	1	.RETAINER - SPRING		79	9420389	1	1	.PIN - SPRING - 1/16 DIA. x 3/8 IN. LG.
35		10563376	3	3	.SCREW - NO. 8 - 32 x 1/2 FLAT HD.		80	10568054	1	1	.CLAMP - TUBE
36		10563303	1	1	.SPRING - ARM		81	8354311	-	1	.RHEOSTAT ASSY. - DYN. BRAKE
37		10563282	1	1	.SHAFT ASSY. - UPPER		NI	8355907	-	1	.BRUSH - SILVER GRAPHITE
38		10563287	1	1	.GEAR ASSY. - REVERSER		82	10563306	-	1	.GEAR - SECTOR - RHEOSTAT
39		10563286	1	1	.LOCK ASSY. - REVERSER		83	-	-	1	.SCREW - SET
40		10563293	1	1	.ROLLER - REVERSER		84	10563310	-	1	.SHAFT - RHEOSTAT
41		10563292	1	1	.PIN - ROLLER		85	10563307	-	1	.GEAR - SECTOR - CAM SHAFT
42		10563288	2	2	.PIN - SWIVEL		86	455972	-	1	.PIN - SPRING - 3/16 DIA. x 1 3/8 IN. LG.
43		274612	4	4	.RING - RETAINING		87	180078	-	2	.BOLT - 5/16 - 18x 7/8
44		10563289	2	2	.SPRING - REVERSER LOCK		88	120393	-	2	.WASHER - FLAT - 5/16
45		10563318	1	1	.CAM		89	120376	-	2	.NUT - 5/16 - 18
		10563590	-	1	.PARTITION ASSY.		90	10563263	-	1	.PLUNGER - RHEOSTAT GEAR
46		10563321	1	1	.PLATE - PARTITION		91	10563265	-	1	.SPRING - PLUNGER
47		10563315	1	1	.BEARING - 1/2 DIA.		92	10563264	-	1	.BALL - 3/8 DIA.
48		10563269	-	1	.SLEEVE		93	9421616	-	2	.SCREW - NO. 8 - 32 x 5/8 SOC. HD.
49		9423223	-	1	.SCREW - SET - NO. 8 - 32 x 3/8						
50		10563266	-	1	.SLIDE ASSY.						
51		10563602	4	4	.SCREW - 1/4 - 20 x 3/4 PAN HD.						

NOTE: NI NOT ILLUSTRATED
A FASTENERS USED TO CLAMP CABLE TIE RODS TO CONTROLLER BODY.

HANDLE	POSITIONS	THROTTLE		REVERSER	REMOVABLE
		IDLE	1-8		
THROTTLE	IDLE			◆	
	THROTTLE 1 THRU 8			◇	
REVERSER	CENTERED	◆	◆		◆
	FORWARD	◆	◆		◇
	REVERSE	◆	◆		◇
	REMOVED	◇		◇	

◆ MOVABLE ◇ NOT MOVABLE

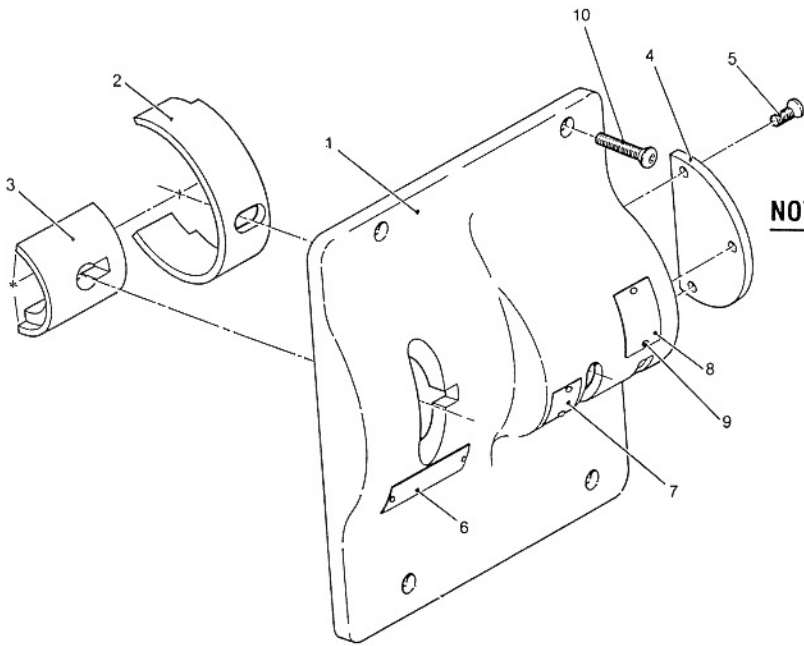
A- NON DYNAMIC BRAKING CONTROLLER: MECHANICAL INTERLOCKING

SWITCH LABEL	CONTACT LABEL	THROTTLE								REVERSER			
		IDLE	1	2	3	4	5	6	7	8	FORW	OFF	REV
THS 1-8	A-B	◆											
	C-D		◆	◆	◆	◆	◆	◆	◆	◆			
THS 5-8	A-B						◆	◆	◆	◆			
	C-D						◆	◆	◆	◆			
THS 3-8	A-B				◆	◆	◆	◆	◆	◆			
	C-D				◆	◆	◆	◆	◆	◆			
THS 2,4,6&8	A-B		◆			◆		◆		◆			
	C-D		◆			◆		◆		◆			
THS 5,6	A-B						◆	◆					
	C-D						◆	◆					
IDLE	A-B	◆											
	C-D	◆											
RHS R	A-B											◆	
	C-D											◆	
RHS F	A-B									◆			
	C-D									◆			

◆ CLOSED CONTACT

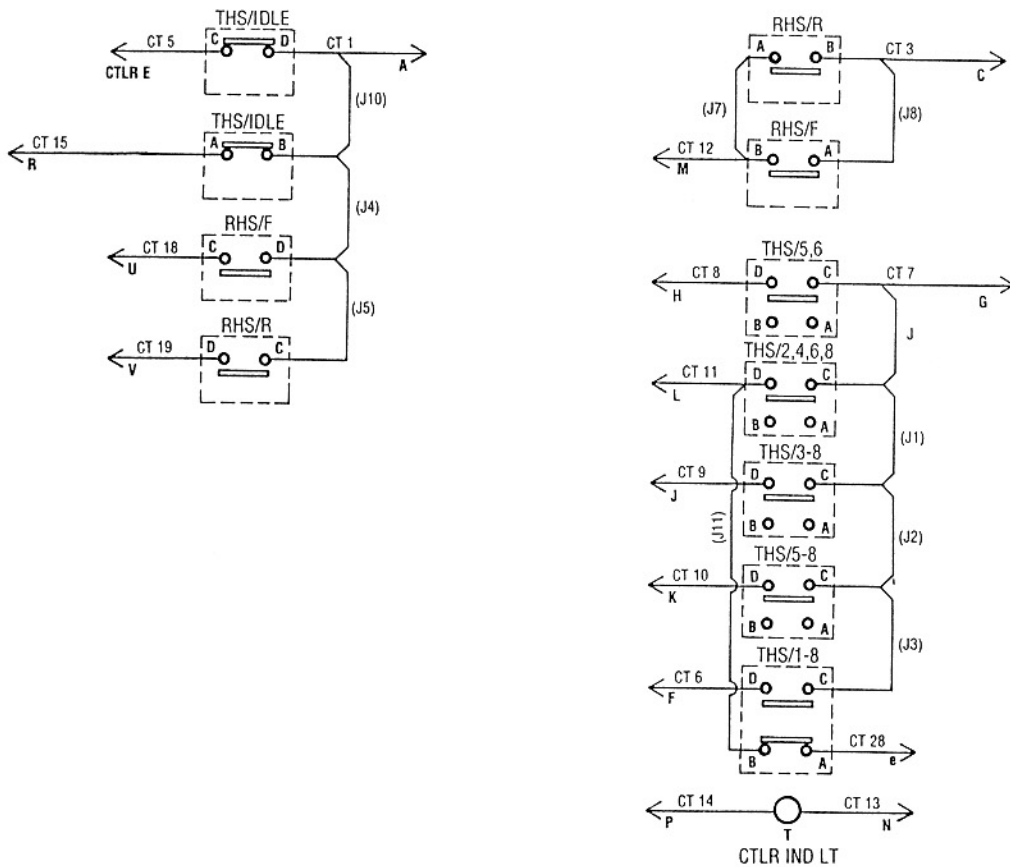
B- NON DYNAMIC BRAKING CONTROLLER: ELECTRICAL SWITCH CONTACT LOGIC

Fig. 21 - Non Dynamic Braking Controller Data



REF. NOTE	PART NO.	NUMBER	QTY.	DESCRIPTION
		10563171	1	BEZEL ASSY.
1			1	.BEZEL
2	10563219		1	.WIPER - THROTTLE
3	10563220		1	.WIPER - REVERSER
4	10563221		1	.CAP - BEZEL
5	155886		3	.SCREW - NO. 8 - 32 x 1/2
6	10563755		1	.NAMEPLATE - (REVERSER)
7	10563756		1	.NAMEPLATE - (POWER)
8	10565316		1	.NAMEPLATE - (IDLE)
9	145372		6	.SCREW - DRIVE - NO. 4
10	10563191		4	.SCREW - NO. 10 - 24 x 1/2 (BEZEL TO CONTROLLER MTG.)

Fig. 22 - Bezel Assembly - Non D.B. Controller



WIRING SCHEMATIC DIAGRAM SHOWS REVERSER HANDLE IN NEUTRAL (OFF) POSITION AND THROTTLE/BRAKE HANDLE IN IDLE POSITION

NON DYNAMIC BRAKING CONTROLLER WIRING SCHEMATIC

Fig. 23 - Wiring Schematic for Non Dynamic Braking Controller

HANDLE	POSITIONS	THROTTLE		BRAKE		REVERSER	REMOVABLE
		IDLE	1-8	SETUP	1-8		
THROTTLE/BRAKE	IDLE					◆	
	THROTTLE 1 THRU 8					◇	
	SETUP					◇	
	BRAKE 1 THRU 8					◇	
REVERSER	CENTERED	◆	◆	◇			◆
	FORWARD	◆	◆	◆	◆		◇
	REVERSE	◆	◆	◆	◆		◇
	REMOVED	◇				◇	

◆ MOVABLE ◇ NOT-MOVABLE

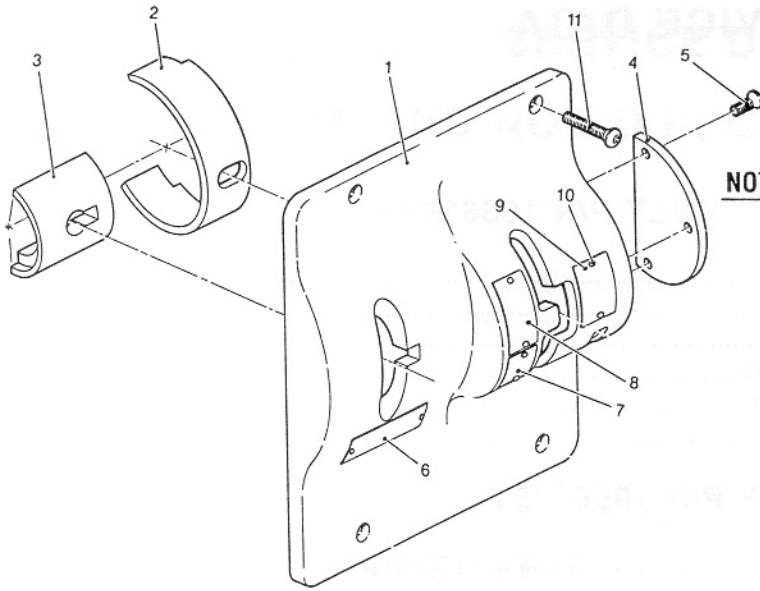
A- DYNAMIC BRAKING CONTROLLER: MECHANICAL INTERLOCKING LOGIC

SWITCH LABEL	CONTACT LABEL	BRAKE		THROTTLE								REVERSER			
		1-8	SETUP	IDLE	1	2	3	4	5	6	7	8	FORW	OFF	REV
THS 1-8	A-B	◆	◆	◆											
	C-D				◆	◆	◆	◆	◆	◆	◆	◆	◆		
THS 5-8	A-B								◆	◆	◆	◆			
	C-D								◆	◆	◆	◆			
THS 3-8	A-B					◆	◆	◆	◆	◆	◆	◆			
	C-D					◆	◆	◆	◆	◆	◆	◆			
THS 2,4,6,8	A-B				◆			◆		◆		◆			
	C-D				◆			◆		◆		◆			
THS 5,6	A-B							◆	◆						
	C-D							◆	◆						
IDLE	A-B	◆	◆	◆											
	C-D	◆	◆	◆											
BKS-B	A-B			◆	◆	◆	◆	◆	◆	◆	◆	◆			
	C-D	◆	◆												
BKS-BG	A-B	◆													
	C-D	◆													
RHS R	A-B													◆	
	C-D													◆	
RHS F	A-B											◆			
	C-D											◆			

◆ CLOSED CONTACT

B- DYNAMIC BRAKING CONTROLLER: ELECTRICAL SWITCH CONTACT LOGIC

Fig. 24 - Dynamic Braking Controller Data



NOTE	REF NO.	PART NUMBER	QTY.	DESCRIPTION
		10563206	1	BEZEL ASSY.
	1		1	.BEZEL
	2	10563219	1	.WIPER - THROTTLE
	3	10563220	1	.WIPER - REVERSER
	4	10563221	1	.CAP - BEZEL
	5	155886	3	.SCREW - NO. 8 - 32 x 1/2
	6	10563755	1	.NAMEPLATE - (REVERSER)
	7	10563756	1	.NAMEPLATE - (POWER)
	8	10563757	1	.NAMEPLATE - (DYN BRAKE)
	9	10563758	1	.NAMEPLATE - (SETUP IDLE)
	10	145372	8	.SCREW - DRIVE - NO. 4
	11	10563191	4	SCREW - NO. 10 - 24x 12 (BEZEL TO CONTROLLER MTG.)

Fig. 25 - Bezel Assembly - D.B. Controller

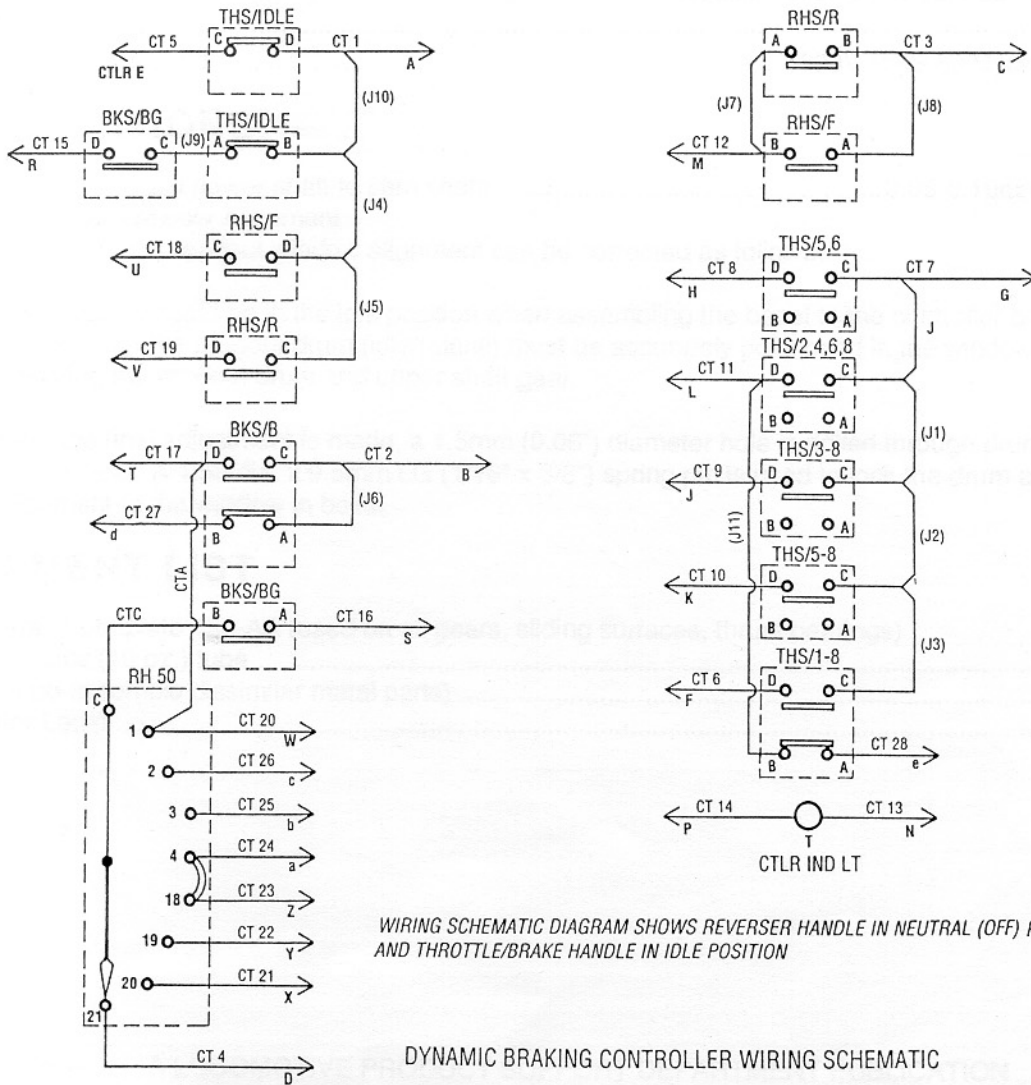


Fig. 26 - Wiring Schematic for Dynamic Braking Controller

SERVICE DATA

REFERENCES

NON D.B. TYPE CONTROLLER ASSEMBLY P/N 10561914

Parts Identification	Fig. 20
Controller Mechanical Interlocking Chart.....	Fig. 21-A
Throttle Handle Position vs. Throttle Switch Logic	Fig. 21-B
Reverser Handle Position vs. Reverser Switch Logic	Fig. 21-B
Bezel Assembly p/n 10563171 - Parts Identification.....	Fig. 22
Wiring Schematic	Fig. 23

DB TYPE CONTROLLER ASSEMBLY P/N 10562791

Parts Identification	Fig. 20
Controller Mechanical Interlocking Chart.....	Fig. 24-A
Throttle Handle Position vs. Throttle Switch Logic	Fig. 24-B
Reverser Handle Position vs. Reverser Switch Logic	Fig. 24-B
Bezel Assembly p/n 10563206 - Parts Identification.....	Fig. 25
Wiring Schematic	Fig. 26

SERVICE DATA

D.B. AND NON D.B. CONTROLLERS

SWITCH ASSEMBLIES

2 Contacts - N.O. - I.N.C.....	8296750
2 Contacts - N.C.	8298178
2 Contacts - N.O.	8299162

Hi-Pot

Terminals to Ground	1500V RMS 60 Cycles AC for one min.
Contact Current	10 Amps @ 120V DC Inductive
Contact Resistance	0.020 Ohms Max. @ 10A DC

DYNAMIC BRAKE RHEOSTAT

Contact Bars	35
Backlash	2.5° Max.
Brush/Silver Graphite	8355907
Hi-Pot	
Terminals to Ground	600V RMS 60 Cycles AC for one min.

SPECIFICATIONS

Bevel Gear Backlash (lower shaft to cam shaft)	0.03-0.10mm (0.001" - 0.004")
Bezel Indicator Window Alignment	

Readout drum to readout window alignment can be corrected as follows:

1. The throttle should be in the idle position when assembling the bezel to the controller body. The initials inscribed on the readout drum (idle/ralenti) must be accurately positioned in the window of the bezel, by adjusting the readout drum and upper shaft gear.
2. After the final adjustment is made, a 1.5mm (0.06") diameter hole is drilled through drum from a locating hole in gear. A 1.58 dia. x 9.5mm LG (1/16" x 3/8") spring pin is used to lock the drum and gear in alignment to the window in bezel.

EQUIPMENT LIST

Lubricant - Lubriplate 130-AA (used on all gears, sliding surfaces, thrust bearings)	
283 grams (10 oz.) tube	10576140
Sealant (to assemble dissimilar metal parts)	10504745
Indicator Lamp	10563352

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