ELECTRO-MOTIVE DIVISION • GENERAL MOTORS CORPORATION
SERVICE DEPARTMENT

MAINTENANCE INSTRUCTION

LOCOMOTIVE CONTROLLERS — ROLLER SWITCH TYPE

DESCRIPTION

The roller switch type of controller, illustrated in Fig. 1, is a compact mechanism designed to energize the locomotive control circuits through cam operated roller switches. The various models, of this type of controller, differ only in interlock mechanism, and the location, number, and type of roller actuated switches to provide the desired control. Since basic construction and operation is common to all models no attempt will be made here to list them all.

CONTROLLER PANEL AND LEVERS

Either two or three levers protrude from the face of the controller depending upon the locomotive application.

Throttle Lever

The function of the throttle lever is to regulate engine speed. Movement of this lever from right to left progressively increases diesel engine speed from idle to No. 8, full speed, by rotating a phenolic cam drum which actuates roller switches to complete circuits to the governor solenoids.

The engine speed at each throttle position is given in the operating manuals for the various locomotive models.

Reverse Lever

A directional or reverse lever, is included on all models to control the direction of locomotive movement. NEUTRAL is the center position of this lever, FORWARD is to the right of center, and REVERSE is to the left of center. This lever can be removed by pulling outward when it is in the center or NEUTRAL position and when the throttle lever is in IDLE and the selector lever, if used, is in the OFF position. Removing the reverse lever sets up a mechanical lock on the throttle and selector levers so they cannot be moved.

Selector Lever

The following locomotive functions require the addition of a selector lever to the controller.

1. Dynamic Brakes
2. Switching Service
3. Manual Transition
4. Electric Operation (Model FL9)

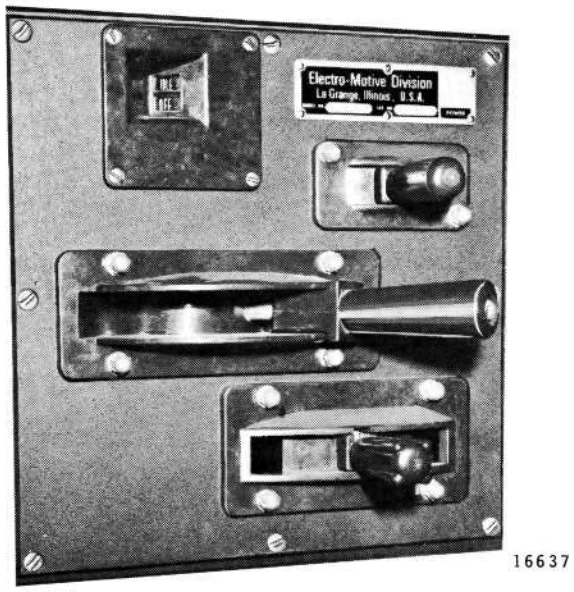


Fig. 1 — Controller Assembly

In dynamic braking, the selector lever positions are "B" braking, OFF, and 1 (Power).

When the selector is put in the braking, "B", position, a mechanical arrangement lifts the throttle cam drum vertically to disengage the power switches and engage the braking switches. In this position the throttle handle moves freely without "notching" to control a braking rheostat.

When a provision for manual transition is applied to a locomotive, the selector lever will have five positions: OFF and POWER, 1, 2, 3, and 4. If dynamic brakes are also provided on the locomotive, a sixth or "B" position is added.

The position of the selector lever is indicated by the lower indicating band illuminated through the opening at the upper left corner of the controller front panel. Movement of this lever all the way in one direction will index the selector cam one notch in that direction. The lever is spring loaded and must be allowed to return to center position before indexing again in either direction.

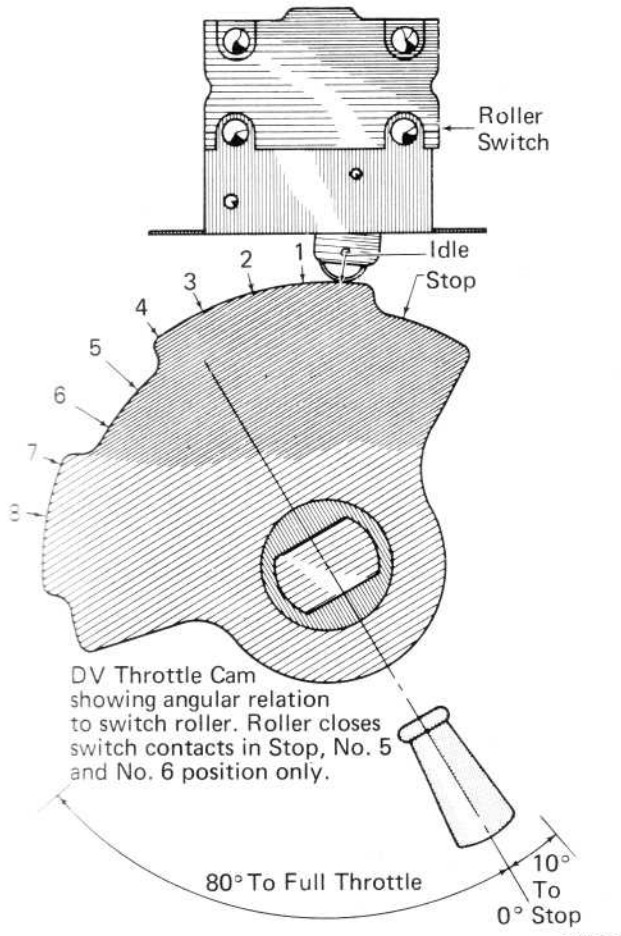


Fig. 3 – Angular Relation Throttle Cam

SWITCH CHASSIS

The switch chassis, Fig. 4, is a box shaped cast aluminum frame machined to close tolerances. The roller switches are mounted on the back face and on the left side. Bushings for the throttle and selector axles are set in the top. The chassis is bolted to the top plate of the interlock assembly and positioned by three locating pins which assure the correct relation between the roller switches and the cam drums.

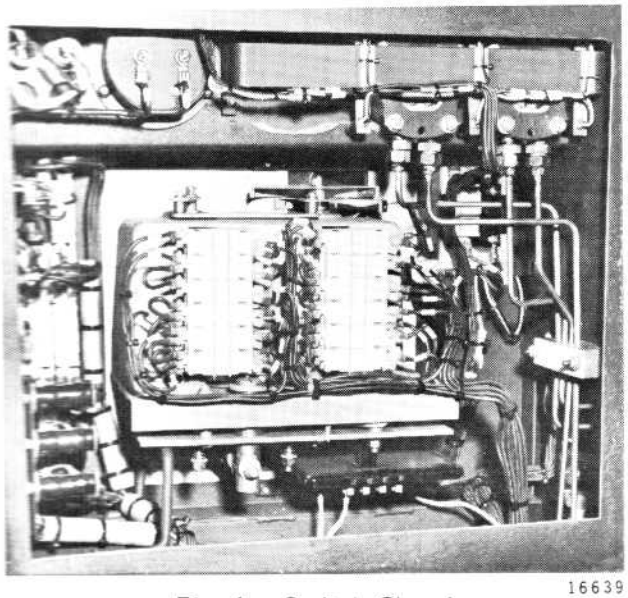


Fig. 4 – Switch Chassis

SWITCHES

Each roller switch consists of a two piece bakelite switch housing which encloses one or two sets of contacts rated for 10 amperes. The movable bridge contacts are carried by a bakelite stem called the contact carrier. The carrier projects through the housing and is spring lifted to its fully extended position. The stationary contacts are positioned in slots in the housing halves. Contact arrangement is such that with the contact carrier fully depressed, the contacts are open .060". Total travel of the carrier is .090" which gives a .030" overtravel or contact lift when the contact carrier is in normal position.

The housing halves are riveted together to form a dust tight switch housing surmounted by a brass housing support which carries the roller operating arm. An approximate 4 to 3 ratio between the roller and contact carrier provides for the full 0.090" movement of the carrier with 0.120" corresponding movement at the roller. Spring loading of the roller arm provides a safety margin where accumulation of permissable manufacturing tolerances results in roller movement above 0.120", but not more than 0.150". With roller movement less than 0.120" the contacts will not be fully opened and the minimum movement, therefore, should be held close to this figure. The amount the roller moves depends on the position of the switches and the height of the operating cam lobes, plus the distance that the roller extends out from the switch mounting surface with the roller arm against the carrier.

DYNAMIC BRAKE RHEOSTAT

A plate type rheostat is mounted on the bottom mounting plate of the controller mechanism. The rheostat brush arm is attached to the throttle axle and moves through a rotation of 90°. The resistance of the rheostat as measured between terminals 4 and 18 is 308 ohms ±10%.

OPERATION

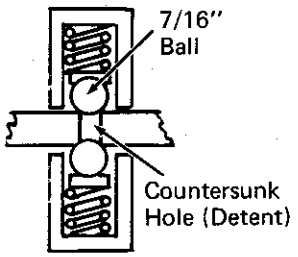
The reverse lever can be removed from the controller when it is in NEUTRAL, the throttle lever is in IDLE, and the selector lever is in OFF. This will lock the controller. With the reverse lever installed, all three controller levers can be maneuvered to rotate the cam drums and produce the various combinations of switch operation as follows:

To shut down the engine the throttle handle must be pulled toward the operator and moved all the way to the right. This allows the throttle handle to get past the offset in the throttle escutcheon, which normally stops the handle in idle, and move into the stop position.

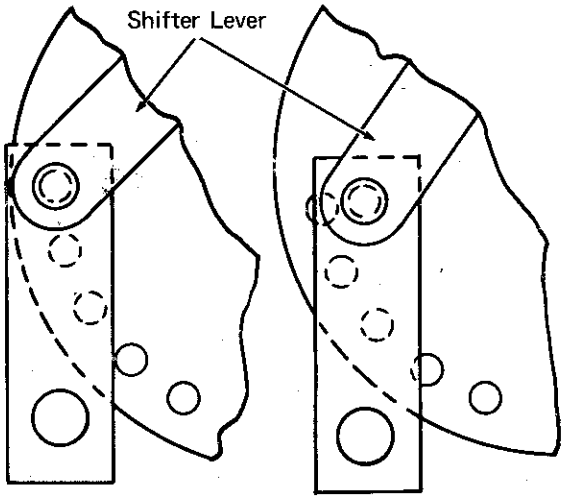
INTERLOCK MECHANISM

The interlock mechanism is located in the lower portion of the controller. This assembly consists of an interlocking and notching detent apparatus positioned between two mounting plates. The throttle and selector axles extend upward from the top of this assembly and are positioned by bushings in the bottom and top plates. The bushings are brass, and the axles are zinc or cadmium plated. Close tolerances between bushings and axles provide positive alignment and easy turning.

Attached to each axle is a metal cam plate, the lobes and notches of which interact with pivoted rollers and the directional indexing plate to provide the necessary mechanical interlocking. This interlocking prevents the movement of an operating lever unless the other levers are in a position where the subject lever can be safely operated. The throttle cam plate has equally spaced detents located on the same radius on the top and bottom of the plate, Fig. 2. These detents are paired directly opposite each other and are engaged by spring loaded steel balls. These detent assemblies hold the axles in the selected "notches" and a moderate pull on the handle overcomes the detent for movement to the next "notch." Throttle escapement (imposed stopping at each notch) is not employed, consequently the throttle may be moved through all throttle positions without hesitation.



Detent balls in engagement with cam plate detent.



Ball detent assembly positioned for throttle action.

Ball detent assembly positioned for dynamic brake action.

8358

Fig. 2 — Detent Assembly

When the selector lever is moved into position for dynamic braking, it actuates a shift lever to disengage the throttle detent arrangement as shown in Fig. 2. Since the throttle is used to control dynamic braking, it can now be moved smoothly without the previous "notching" action. This shifter lever is omitted in nondynamic controllers and the detent assembly is pinned in the throttle position.

The directional cam plate is positioned by a single fixed detent assembly which engages holes in the cam plate from the top only.

Total number of degrees of handle movement is established by the stop pins which contact lobes on the cam plates at each end of the travel.

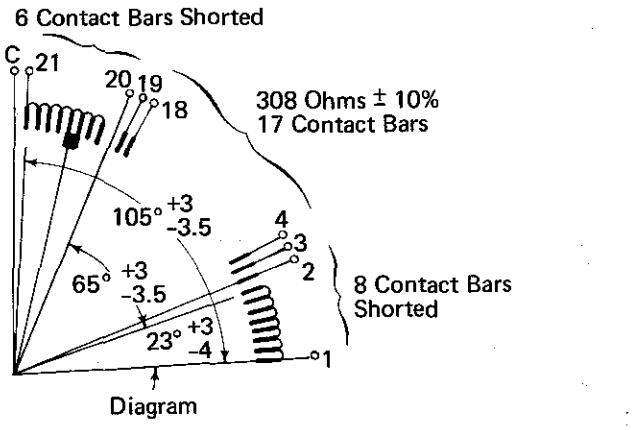
CAM DRUM ASSEMBLIES

Each controller has two or three cam drum assemblies, depending on the type of controller, which are molded of a durable and stable phenolic. These are identified as the throttle, direction (or reversing) and selector drums.

Each drum face has contours corresponding to the angular position of the attached operating lever. When the lobes of a cam are in contact with the switch roller, Fig. 3, the switch plunger is fully depressed and the contacts are open. When the cam depressions are in alignment, the switch roller drops into the depression and the switch contacts close.

The surface of the phenolic cam drum is sealed during molding to provide a moistureproof coating and prevent swelling due to moisture absorption. Care should be taken, therefore, to avoid scuffing or scratching the surface.

The throttle and directional cam drum is molded in one piece. The selector drum is assembled from separate pieces since two steel ratchet wheels are included in the assembly. The contour of the outer surface of the cam drum assembly is based on the angular displacement from the 0° line which is the centerline of the throttle handle, Fig. 3.



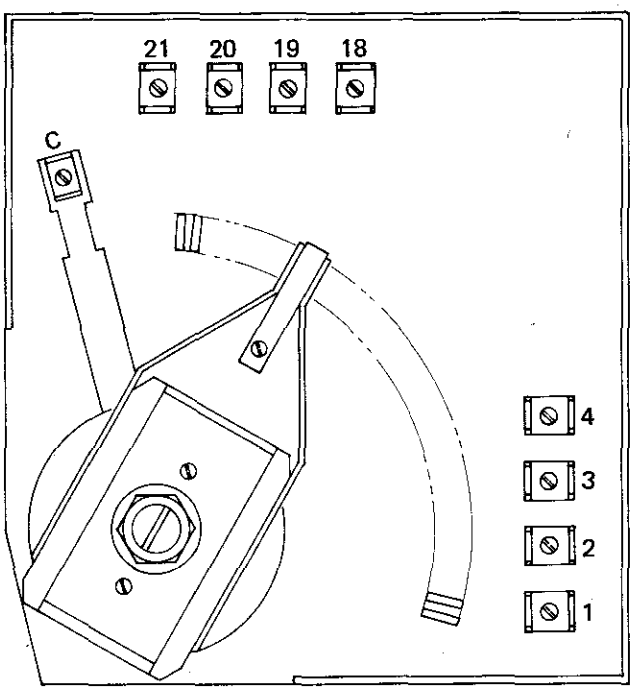


Fig. 5 – Dynamic Brake Rheostat

1. Reverse lever in NEUTRAL.
   a. Throttle may be moved to any position.
   b. Selector may be moved between OFF and 1 (or the 1-4 range if used.)
2. Reverse lever in FORWARD or REVERSE.
   a. Throttle may be moved to any position.
   b. Selector may be moved to any position.
3. Throttle in IDLE or STOP.
   a. Reverse lever may be moved to any position.
   b. Selector may be moved to any position.
4. Throttle above IDLE.
   a. Reverse lever position cannot be changed.
   b. Selector is locked in either B or 1 (or the 1-4 range if used).
5. Selector in OFF.
   a. Reverse lever may be moved to any position.
   b. Throttle may be moved to IDLE and STOP.
6. Selector in 1 (also 2, 3 and 4 when used).
   a. Reverse lever may be moved to any position.
   b. Throttle may be moved to any position.
7. Selector in "B."
   a. Reverse lever cannot be moved.
   b. Throttle may be moved to any position.

Where positions 2, 3 and 4 for manual transition are incorporated in the selector, this lever may be moved from 1 to these positions if the reverse lever is in FORWARD or REVERSE, and with the throttle in any position. Permissible movement of the throttle and reverse levers with the selector in 2, 3 or 4 is the same as with the selector in 1.

The locomotive wiring diagram covering any unit and controller in question will show the physical location of the switches and their designation. A sequence chart for the various positions of the operating levers is also included on these drawings and should be referred to for complete understanding of a particular controller operation. Sequence charts for controller 8238232 are shown in Fig. 6 as an example.

The various locomotive controller options are listed in Fig. 7.

MAINTENANCE

This contoller has been carefully designed and manufactured to provide excellent service for many years without maintenance or attention.

Although periodic lubrication of the moving parts is unnecessary, the reverser cam drum assembly should be checked to determine if there is lubrication on the large bushing. If the bushing and shaft are dry, but the cam moves freely, lubricate at this point with a few drops of graphite oil commonly used for locks and tumblers. If there is binding or tightness, the controller mechanism should be disassembled to the point where the cam drums can be removed and any roughness on the shaft or bushing smoothed out.

Maintenance of the controller is, therefore, limited to replacement of parts that have become worn after extended service. After such replacements, the controller should be thoroughly checked to

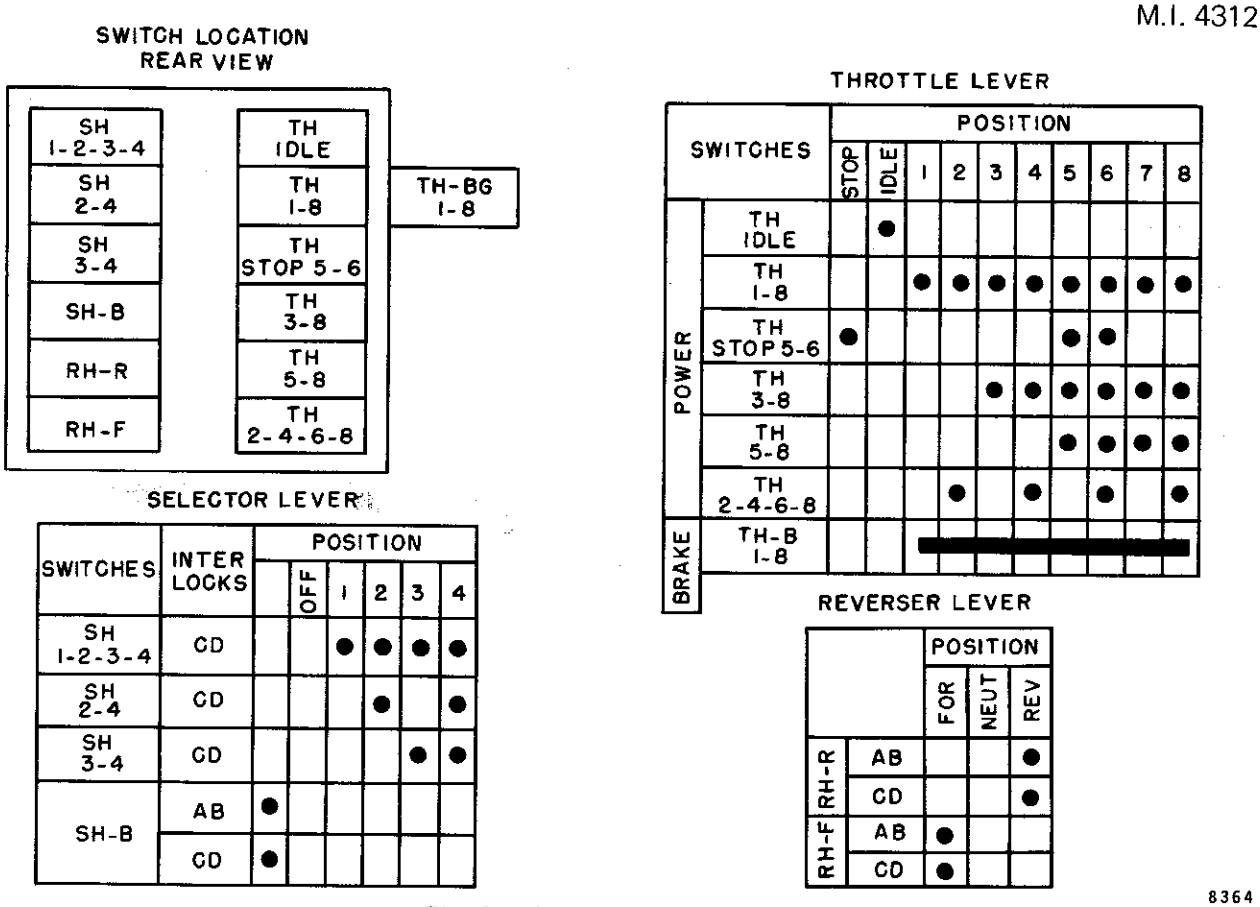


Fig. 6 — Sequence Charts

DATA SHEET FOR LOCOMOTIVE CONTROLLERS

PART NUMBER	TYPE OF BRAKES	TRANSITION CONTROL	ALERTNESS CONTROL	ROAD LOCOMOTIVE	SWITCHER LOCOMOTIVE
8286554 8403345 8226959	DYNAMIC	AUTOMATIC		X	
8405234 8238232	DYNAMIC	AUTOMATIC-MANUAL		X	
8368599	NON-DYNAMIC	AUTOMATIC	ALERTOR	X	
8227211	NON-DYNAMIC	AUTOMATIC		X	
8349556	NON-DYNAMIC	AUTOMATIC-MANUAL	ALERTOR	X	
8238268	NON-DYNAMIC	AUTOMATIC-MANUAL		X	
8345834	DYNAMIC	AUTOMATIC	ALERTOR	X	
8351326	DYNAMIC	AUTOMATIC-MANUAL	ALERTOR	X	
8227211 8261598 8368599 8381465					X

Fig. 7 — Data Sheet For Locomotive Controllers

qualify it for service. When repairs or attention are necessary, other than for replacement of a dial lamp or individual switches, the entire controller should be removed from the engineer's control stand and the work performed on a bench.

Dial Lamp

To replace a burned out dial lamp, remove the four screws holding the indicator escutcheon plate. The lamp socket is on the back of this plate.

Switches

Although designed for long life, after extended service the switches may need to be replaced. The switches are easily accessible by merely removing the back cover plate from the engineer's control stand in which the controller is housed.

Dynamic Brake Rheostat

Early model dynamic brake controllers have a set screw to maintain the relationship between the throttle axle and the rheostat shaft. If the set screw loosens, it should be removed and the cup point end ground flat. Reinstall the screw, tighten snugly against the rheostat shaft, and stake the edges of the hole in the throttle axle. It will then be possible to remove the rheostat for service without disturbing the set screw.

Later model controllers have a roll pin through the throttle axle to prevent a change in position during operation. The pin does not interfere with replacement of the rheostat.

Current model controllers have a bolted adapter bracket to ensure that the brush arm position will not change in relation to the throttle axle.

Electrical Inspection

In order to ensure proper electrical operation of the controller or to validate repairs which have been made, the following checks should be made:

1. Operate the controller levers through all possible combinations. For each position of the selector lever, put the reverse lever in FORWARD and check all throttle positions. Refer to switch sequence charts on the controller drawing and note that proper switches are engergized for each position.

2. Shake the lever in each position. This should not affect the established circuits as indicated by no change in switch energization. The shaking of the throttle lever should not be strong enough to start a definite motion to the next throttle position. Defective switches should be replaced as a unit.

3. On dynamic brake equipped controllers, check the operation of the dynamic brake rheostat. The rheostat brush should be adjusted so that it does not leave the No. 1 terminal until the BG throttle switch is closed. Also, the brush should reach terminal No. 21 in the maximum brake position.

4. Check voltage on the indicating dial lamp. It should be 6-8 volts with 74 volts applied to the series circuit of the lamp and resistor.

Mechanical Inspection

After any maintenance work the following mechanical checks should be made to qualify the controller for complete trouble-free operation. Sluggish mechanical action should be remedied by replacement of parts so smooth controller and, consequently, locomotive operation will result.

1. Check to see that the levers are tight on their respective axles or shafts and that they move freely enough so the spring loaded detent action on the respective axle segment plates can "center" each position as follows:

   a. Reverse lever

      As the lever approaches either the forward or reverse position a slight pull aiding the movement to the final position should be experienced. This is due to spring action of the directional cam interlocking clevis.

   b. Selector lever

      Lever can be moved either clockwise (CW) or counterclockwise (CCW) from the center position unless the selector cam is in either its extreme CW or CCW position which locks it from further movement in that direction. As the lever approaches the extreme position in either direction, the ball detent action on the selector axle plate should automatically "pull" the selector drum and indicator into the next position. The selector lever may then be released and should automatically return to center from which it can next be operated to again move the selector cam either CW or CCW unless, as previously mentioned, it is in either extreme position.

   c. Throttle lever

      Free play in each throttle position should not exceed 1/2". Full movement of the throttle lever from one "notch" to the next is 10° with one-half this movement being required to get out ot the previous "notch." The effort required to shift the ball detents between "notches" should not

exceed 7 lbs. measured at the end of the lever. The throttle lever should automatically "fall" into the next position as the ball detent passes over the hump between positions. No "hanging up" should be noticed between positions. On dynamic brake controllers note that the throttle lever (with selector in B) shifts from a "notching" lever to a free sliding lever with only a slight "notching" feel at the very beginning of the movement.

2. Check the indicating drums to see that:

   a. The proper position is indicated from each throttle and selector position.

   b. The numbers or designations are lined up in the center of the opening.

Disassembly Procedure

Should it become necessary to disassemble the controller for repair or possible lubrication, the following procedure is recommended:

A. Removing Controller

1. Disconnect electrical connection leads at the controller.

2. Remove the eight screws securing the controller assembly to the control stand.

3. Remove the controller and place controller assembly on bench using stand to support assembly as shown in Fig. 4.

If it is only necessary to remove the cam drums and lever bar, proceed as follows:

B. Controller Disassembly

1. Remove the handles and escutcheons and lift off the front plate.

NOTE: To remove the selector handle it will be necessary to use a 3/32" Allen wrench. Insert the wrench into the small hole in the selector guide, turn the Allen screw in until the handle can be pulled off the spindle.

For partial disassembly of dynamic controller, follow Steps 2 through 9 below; for nondynamic controller, follow Step 10.

2. Remove the nuts securing the throttle and selector indicator assembly and connecting bars to the throttle and indicator shafts. Remove parts from the shafts.

3. Remove the switches from the switch chassis.

4. Remove the mounting nuts and bolts from the base of the switch chassis, loosen and remove the nut from the eccentric adjusting pin located on the back of the switch chassis.

NOTE: The pin will have to be supported from the inside with a screw driver while loosening the external nut.

5. Remove the eccentric pin from the inside of the switch chassis.

6. Remove the top and bottom latch bars located above and below the selector handle assembly.

7. The switch chassis can now be removed. Note the position of the bar assembly located between the throttle drum and selector drum. After the chassis is removed, keep in mind its position for reassembly.

8. The throttle drum and selector drum assembly can not be lifted off their respective shafts. Note that the selector handle arm assembly is removed along with the selector drum on dynamic brake equipped controllers. The small springs on the handle assembly may have to be released to disengage the ratchet latch. Note position of springs before releasing.

9. With the selector drum removed, the reversing drum can be removed from the shaft.

10. The same general procedure is used to remove the cam drums on nondynamic controllers which do not have a selector drum, except that it is necessary to remove a snap ring on the stub shaft above the reversing cam to free it from the shaft.

To reassemble the controller, apply parts in the reverse order of their removal, making certain all parts replaced operate freely on the mating parts. It is also necessary to apply a film of grease 8196886 to the shafts, to the bushings in the cam drums, and to the pin which fits into the small bushing of the reverser drum. When assembling, make certain this pin is vertically aligned with the small bushing and does not cause any binding when the drum is operated.

When assembling the eccentric pin to the switch chassis, a 5/16" plain washer and lock washer should be installed under the lock nut. Adjust the eccentric by turning it until the throttle cam drum just rests lightly on the phenolic segment of the throttle handle when the selector handle is in OFF or No. 1 position. Tighten eccentric nut securely to hold proper setting of lever bar.

Litho In U.S.A.