THE PENNSYLVANIA RAILROAD

Locomotive Maintenance Instructions No. L-39-A

ISSUED PHILADELPHIA, PA.
May 12, 1938

Instructions for Operating and Repairing Alco Power Reverse Gear, Types E, G and G-P.R.R.

(Superseding Locomotive Maintenance Instructions No. L-39, Dated April 6, 1927)

1. **General:** These rules apply to steam locomotives equipped with Alco Power Reverse Gears, Type "E", "G" and "G-P.R.R.". Where tracings are referred to, the latest issue of same is intended unless otherwise specified. For application and details of parts see standard tracings.

DESCRIPTION

2. These gears are designed for air operation and consist of a cylinder, piston, piston rod, crosshead, guides, reverse cylinder valve, check valves, piping, levers and connections. In most cases the gears now have reversing valve assemblies containing built-in check valves, either in the valve body cap or valve body.

3. The air for operating the gear is obtained from the main reservoir pipe leading from the dust collector by means of a ½" pipe connected to the main reservoir pipe at a point back of the dust collector and extending to pipe connection in side of reverse cylinder valve housing. The air pressure is turned into gear by means of a cut-out cock in the ½" pipe line. A check valve prevents the return of air for operating the gear when the pressure is reduced for any reason.

4. The gear is operated by a reverse lever in the cab connected by a reach rod to the floating lever mounted on the gear. This floating lever is connected to the reverse cylinder valve and automatically maintains a cut-off position of the locomotive valve motion corresponding to the position indicated by the reverse lever.

5. Both sides of the piston are constantly under air pressure when gear is at rest. To reverse the locomotive or change the cut-off, the reverse lever is moved in the required direction. This movement opens the valve thereby exhausting a portion, or all of the air from one end of the cylinder and admitting air to the opposite end of the cylinder. The crosshead will then move to the desired position. This movement of the crosshead when the reverse lever is at rest, causes the valve, by means of the floating lever and floating lever rod, to return to its central position, thereby closing the exhaust and bringing the crosshead to rest.

6. It will be seen that for any position of the reverse lever there is a corresponding position of the crosshead. Any slight movement of the crosshead due to the pull of the valve motion of the locomotive while working will be corrected promptly by the automatic opening and closing of the reverse cylinder valve through the floating lever.

7. The reverse cylinder valve has an exhaust lap of not less than 3/64" or more than 1/16", which prevents escape of air from cylinder, except when the valve is moved by the reverse lever, or automatically by the crosshead. The reverse cylinder valve has an admission lead of 1/32" on each side.

8. The parts of the type "E", "G" and "G-P.R.R." gears differ slightly (see standard tracings for details of parts) but the operation of the gears is the same.

DAILY TESTS AND CARE

9. With air pressure in gear open drain cocks in bottom of cylinder and bottom of reverse cylinder valve housing and blow out accumulation of oil and water. If air for any reason has been cut off from gear, care must be taken to slowly re-open the air supply cock in order to avoid damage to operating lever latch.

10. The reverse gear should be tested with air for lost motion. If found to be excessive it must be corrected so gear will respond to movement of two notches or less of reverse lever on quadrant, in either direction

11. Lost motion may be due to worn pins and bushings in gear, reverse lever reach rod support, between reverse lever and reverse gear (on locomotives so equipped), also loose quadrant support, quadrant bracket on fire box, crosshead arm to crosshead, reverse lever latch guide, reverse cylinder valve arm on reverse lever valve stem and reverse cylinder valve stem bushing.

12. (a) Note and correct leakage from cylinder exhaust port, piston rod stuffiing box, cylinder heads, reverse cylinder valve ports, pipe plugs, drain cocks and piping. If reverse cylinder valve has a constant blow at the exhaust port after the reverse cylinder valve has come to rest, refer to paragraph No. 50 for explanation of cause. If valve is defective it must be renewed.

(b) Test for leakage at piston rod stuffing box, also at cylinder heads by slowly moving the reverse lever from full ahead to full back position. If necessary to renew piston rod packing do not blow out old packing with air as this may result in damage to stop lugs on valve body.

(c) If reverse lever operates hard and stiff, cause will be found to be due to parts rubbing or interfering, reverse cylinder valve stem dry, connecting pins and bushings dry or operating levers or rods out of line due to being bent or twisted. Defects must be located and corrected.

13. Lubricate all connections, guides and piston rod with No. 2 Coach-Engine oil, particular care being taken to see that all pins and bushings are well lubricated and that they work freely without lost motion. Clean out hole in oil plug in operating valve housing over valve stem and lubricate valve stem. Move reverse gear to full forward and full back position to insure oil flowing to bearings. Apply a few drops of oil daily in oil plug in valve housing to keep valve stem free. Refer to paragraph No. 28 for kind of light oil to be used for lubricating gears during winter months.

MONTHLY INSPECTION AND TESTS

14. With air pressure drained from reverse gear it should be determined that the minimum amount of lost motion exists in pins and bushings, arms, reverse lever and reverse gear brackets and support. Particular attention should be given to fit of reverse lever valve arm on reverse valve stem, the ½" bolt must be drawn tight and castellated nut properly secured with cotter key. For renewals, all pins and bushings must be case hardened and ground to fit. The supports and brackets attached to running board must be tight and rigid.

15. After lost motion has been eliminated, charge the gear with compressed air from the shop air line. The charging line to be equipped with a connection for application of a test gauge. Care must be taken to open supply cock slowly to avoid damage to reverse lever latch.

16. Test piston rod stuffing box for air leakage by slowly moving reverse lever in cab from full ahead to full back position. If necessary to renew the packing do not blow out old packing with air as this may result in damage to stop lugs on reverse cylinder valve body.

17. Test for reverse cylinder valve leakage. Place a pressure gauge in drain cock opening at either end of the cylinder. Charge the power reverse gear system with air at 100 lbs. Place the crosshead in its central travel position by means of the reverse lever and the reverse cylinder valve. Shut off the air supply to the main operating valve and immediately check the reading of the pressure gauge. If the gauge shows a drop of 5 lbs. in the first minute after closing off the air supply, it indicates that the valve or seat are leaking excessively, in which case the valve assembly must be removed and forwarded to central shop for repairs, a new or repaired valve assembly being taken from stock to replace it. In forwarding the

assembly the operating arm should not be removed. A slight leakage at valve may be caused by scale or foreign matter under valve seat which may be removed by the application of light oil.

18. Test for packing cups or piston head and stud leakage. Test back packing cup and follower studs for leakage by first applying a 7/8" bolt through reinforced oil hole in top guide then move reverse lever ahead until crosshead rests against bolt and the reverse valve arm is against stop. With test gauge attached to back cylinder drain cock opening move reverse lever to admit pressure to one end of cylinder, charge cylinder to 100 lbs., close cut-out cock in supply pipe to gear and note drop on test gauge for the first minute. If the drop exceeds the operating valve leakage by more than 5 lbs., separate operating valve pressure from cylinder pressure by applying blind gasket to air passage between operating valve and both ends of cylinder, charge the cylinder to 100 lbs. through cylinder drain cock opening, close cock in supply line and note drop in pressure on test gauge. If the drop is more than 5 lbs. for the first minute, the piston must be withdrawn and the packing cup studs and cylinder given the necessary attention and cup tested. Test the other cup by reversing the operation.

19. Check travel of reverse gear crosshead with stops on quadrant to insure proper movement necessary for engine valve travel. If crosshead overtravels and the cause is known not to be due to leaking piston packing cups and the over-travel causes blow at exhaust port when reverse lever is in the corner, disconnect and place floating lever, reverse cylinder valve arm and reverse lever in a vertical position when locomotive is hot. If the connecting rods are then found too long or too short, they must be changed as necessary to connect them properly so that valve arm, floating lever and reverse lever are in a vertical position when the reverse gear crosshead is in the center of its proper travel and the link blocks are in the center of the links. When this condition has been obtained, the quadrant stops should be altered as necessary to provide proper valve travel. If change in connecting rods is not necessary then the stop should be changed.

20. Test and correct leakage if any from all piping, connections, cylinder heads, reverse cylinder valve housing joints, pipe plugs and drain cocks.

21. Reverse gear must respond to movement of two notches or less of reverse lever in either direction on the quadrant. If it fails to do so, correct defects as outlined in paragraph No. 11.

22. If lost motion between crosshead and guides is in excess of 1/16", the crosshead must be remetaled, care being taken that the crosshead guide is lined so that the piston travels on the center line of the stuffing box.

23. Inspect crosshead for cracks. Inspect reverse lever quadrant, latch and spring to insure proper contact of latch and quadrant. The quadrant teeth must be cleaned by means of a wire brush. Renew parts found to be defective.

24. To adjust the locomotive counterbalance spring, relieve all tension on the spring, disconnect reach rod and eccentric rods. Tighten up counterbalance spring until it has sufficient tension to hold the block at center of the link. In this operation, after the eccentric rods are disconnected, the link should be plumb so it will stand vertically.

25. At regular six months air brake test, the main operating valve and assembly should be removed and forwarded to Central shop for cleaning and lubrication, if and when tests indicate these parts are in need of repairs and replaced with an assembly from stock. Also, cylinder heads should be taken down and cylinder examined for cutting, or corrosion.

26. The Engineman's Work Report must be given proper consideration at all times in regard to operation of these gears. While the daily tests are specified as well as tests to be made at monthly certificate dates, it is to be understood that where Engineman's Work Reports demand it, the full monthly certificate test may have to be carried out irrespective of monthly certificate dates.

27. Lubricate reverse cylinder valve assembly and cylinder. With air pressure released and with piston full stroke ahead or back remove the 3/4" pipe plug from top of valve head cap and pour in 1/2 pint

of No. 2 Coach-Engine oil (except for cold weather see Par. No. 28 for kind of lighter oil) slightly warm to insure free flowing. Replace plug, cut in air slowly and move reverse gear slowly forward and back to insure proper distribution of lubricant. The ¾" pipe plug in some cases where reverse cylinder valve head is not so equipped, is located in tee connection on the ½" air line adjacent to valve housing. Clean out oil hole in valve stem oil plug and fill with oil to lubricate stem and bearing; also properly lubricate all connections, crosshead guides and piston rod, care being taken to see that they work freely without lost motion.

28. It is desirable that a lighter oil be prepared as a lubricant for the gears in cold weather during the months of December to March inclusive, as the Coach-Engine oil, which is now prescribed congeals in cold weather. The recommended lighter oil can be made by adding one part of 150 degree oil to three parts of winter Coach-Engine oil. The 150 degree oil is a standard stock oil at most oil houses, the same as now used in hand lanterns. The mixture of these two oils, both of which are now standard stock items will make a suitable lubricant and should be used during cold weather.

ATTENTION TO ALCO GEARS WHEN LOCOMOTIVES ARE IN SHOP

29. When locomotives are in shop for class repairs, or when necessary to remove the reverse gear to perform other items of work, the entire power reverse gear should be cleaned, inspected, tested and necessary repairs made to place it in first-class condition as follows:

30. The cylinder, valve and crosshead assembled should be placed in a cleaning vat, after which all internal parts of the reverse cylinder valve should be cleaned with turpentine substitute and blown out with compressed air. Note that the valve stem is a snug fit in the valve. The valve should then be lubricated with No. 1 Cylinder Oil, or a suitable valve grease, and tested on a rack as shown on standard tracing E-81464. If it fails to pass the prescribed test, it must receive attention as outlined under the heading of SHOP REPAIRS.

31. The cylinder and piston should be cleaned with turpentine substitute and all particles of dirt removed by use of compressed air, and the cylinder lubricated with brake cylinder graphite grease, in the same manner as outlined for brake cylinders.

32. All lost motion must be eliminated from pins and bushings. All pins and bushings must be case hardened and ground to fit. The reverse lever valve arm must be tight on the reverse cylinder valve stem, being secured with a dowel key and by drawing tight the bolt in the bottom of valve arm. This ½" bolt must be drilled for a cotter key and a castellated nut applied. All lost motion must be taken up between valve stem and valve, the fit of the valve stem to be as tight as possible without causing the parts to bind. Lost motion between crosshead and guides must be corrected. If in excess of 1/16", repair these parts as outlined in paragraph No. 22.

33. Test the piston rod packing by slowly moving the reverse piston from full ahead to full back position under pressure.

34. Test all joints and pipe connections by use of soap suds. Apply a test gauge in the shop air supply line between the cut-out cock and operating valve connection, block the crosshead in both front and back position and test the packing cups and studs for leakage, as outlined in paragraph under heading of "MONTHLY INSPECTION AND TESTS", except with operating valve in forward position and test gauge showing 100 lbs. With supply cock closed, a drop in pressure in excess of 5 lbs. in one minute indicates the back packing cup or studs are defective; or with the operating valve in back position and test repeated, a drop in pressure in excess of 5 lbs. in one minute indicates the front packing cup or studs are leaking.

35. After gear has been placed on locomotives, if it does not respond to one notch on quadrant in either direction, lost motion exists between operating valve and reverse lever, which must be corrected.

SHOP REPAIRS

36. In order to establish a uniform practice in repairing Alco reverse gears at Central Shops the following instructions should be followed:

37. When cylinder is scored or worn out of round, or taper .015″ or when the packing cup does not make a good joint, the cylinder should be trued up. Care to be exercised so that no more metal is removed than is absolutely necessary to obtain a true surface. If the cylinder cannot be trued up to 10 1/16″, remove only sufficient metal to true up cylinder not to exceed 10 1/8″. The standard packing cup which is 10″ must be used only on cylinders up to 10 1/16″. If cylinders are larger than 10 1/16″ the oversize packing cup which is 10 1/8″ must be used. When truing up cylinders the nominal diameter must not be exceeded by more than 1/8″.

38. When the piston rod is out of round or taper .010″ it must be trued up and when rod is 1/16″ below standard size it must be renewed.

39. To eliminate wear of piston and leakage at stuffiing box, the crosshead and guide must be lined up so that the piston rod will ride in center of stuffing box. Pennsylvania Railroad Style No. 10, or any other approved suitable packing must be used in stuffing box. If necessary to renew packing, do not blow out old packing with air, as this may result in damage to stop lugs on valve body.

40. When lost motion between reverse cylinder valve and valve stem exceeds .003″, the tongue on the key should be brought back to standard by being tinned, or built up with bronze or by sweating a thin steel shim on the key, or the valve fitted with a stem having an oversize tongue as shown on standard tracing C-401293. The air inlets and exhaust ports on repaired valve and repaired valve body must be checked with a standard gauge to insure the proper air inlet dimensions, lap and proper exhaust lap to insure proper operation.

41. When repairs are necessary, the reverse cylinder valve seat as well as the valve must be machine lapped and each separately spotted to a surface plate, and then spotted to each other, then the reverse cylinder valve follower must be ground to a true seat on the reverse cylinder valve to eliminate leakage by the reverse lever valve stem. Care should be exercised to see that there is no lost motion between valve stem and valve. Valve arm should be located so as to allow the minimum clearance between the valve arm and valve body.

42. When the reverse cylinder valve housing used with type "E" gears is worn out of round more than .005″, it should be re-bored and brass bushings applied as shown on tracings C-401291 and C-401293 (Repairs) and when the bushings in the types "E" and "G" gears are worn out of round more than .005″ they should be rebored and fitted with an oversize stem. When the bushings cannot be trued up to fit the maximum oversize stem they must be renewed. When applying new bushings the internal diameter of the hole in bushing should be 1/32″ smaller than its nominal diameter and worn stems turned to fit this smaller size bushing. When fitting stems to bushings the maximum clearance between the stem and bushing must not exceed .005″ or be less than .001″.

43. If necessary to heat the reverse lever quadrant for any reason, it should be case hardened again before being placed in service.

44. When reverse cylinder valve bodies are found with a 1/2″ opening instead of a 3/4″ where air supply pipe is connected, they should be tapped out for a 3/4″ pipe thread, if the boss is 1 3/4″ in diameter so the valves are interchangeable without a change in size of supply pipe. Also continue the 1″ cored hole through the top reverse gear guide at re-inforced oil cup if a 1/4″ hole is now in guide. This is for the application of bolt to block the crosshead when making packing cup leakage tests.

45. On gears with checks integral with reversing valves, after gear has been repaired at the bench, it should be operated from both sides of the valve with compressed air to insure that the checks are holding and that the gear operated properly. On locomotives receiving running repairs on which the gear has not been removed from locomotive, the gear should be operated from each side of the reversing valve by attaching the air line to insure that the checks are holding and that the gear operates properly. On gears without integral checks and using a 1/2″ check in the air line, cut the 1/2″ union back of check and apply air to the opposite side of reversing valve; if check is not holding, air will leak at this union.

46. When applying gear to locomotive, have floating lever and valve arm vertical. This will bring the crosshead and piston in center of their travel. Then apply reach rod of necessary length, between valve motion lift shaft arm and reverse gear crosshead. Next place reverse lever vertical when locomotive is hot (if locomotive is not hot make allowance for expansion) then connect reverse lever to floating lever with 1" extra heavy pipe and fittings of required length. Reach rod should be as straight as possible, avoiding sharp bends. It is important that this rod be supported at one or more places by close fitting guides to prevent vibration and care taken to see that this rod is in proper alignment. Care must also be taken to avoid stepping on the reach rod, since these rods are made of pipe and are easily distorted.

47. After setting locomotive valves, locate stops on reverse lever quadrant in order to limit movement of reverse lever and crosshead to the amount necessary to provide for engine valve travel.

48. Usually the stop on the reach rod from the reverse lever to floating lever must be changed when gear is removed from one locomotive and applied to another.

49. When crosshead over-travels, causing valve to blow when reverse lever is in corner, place floating lever, valve arm and reverse lever vertical when engine is hot. Then change stop to suit. In some cases it will not be necessary to change stop as the adjustment of rod between reverse lever and floating lever will have corrected the trouble.

50. If reverse cylinder has a constant blow at the exhaust it is caused by one of the following:

(a) Blow at exhaust when reverse lever is in either full forward or backward position and can be stopped by moving reverse lever a notch or two, is due to improper length of stops on quadrant, or improper lengths of rod between floating lever and reverse lever.

(b) When blow at exhaust occurs with reverse lever in any position and stops when the reverse lever is shaken, there is lost motion in pins at the reverse lever quadrant, reach rod, reverse gear or between the rotary valve and valve stem.

(c) When blow at exhaust is constant with reverse cylinder valve arm in vertical position the reverse cylinder valve seat is damaged and should be repaired.

51. When using reverse lever, make sure that latch is clear of quadrant so that there will be the least possible wear on teeth of latch and quadrant.

52. When locomotives are out of service both ends of cylinder must be thoroughly drained to avoid damage by freezing in cold weather.

53. If reversing valve does not work for any reason, it should be removed and returned to Central Repair Shop.

54. When locomotives are out of service, both ends of the power reverse gear cylinder must be thoroughly drained to avoid freezing in cold weather. Locomotives in storage or awaiting shop should, if possible, have the inner surface of the reverse gear cylinder walls lubricated and the polished surface of piston rod, guides, and crosshead covered with slushing oil.

F. W. HANKINS,
Assistant Vice President—
Chief of Motive Power.

THE PENNSYLVANIA RAILROAD

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-39-A

INSTRUCTIONS FOR OPERATING AND REPAIRING ALCO POWER REVERSE GEAR, TYPES E, G AND G-P.R.R.

Philadelphia, Pa.
April 20, 1945

The following paragraphs Nos. 16-(a) and 28-(a) should be added to the present issue of the Circular:

16-(a) When testing leakage on power reverse gears of locomotives equipped with auxiliary reservoirs, the allowable leakage must not be over 3 pounds in the first minute.

28-(a) When all tests have been completed at either monthly, running or class repairs and before releasing locomotives equipped with power reverse gear auxiliary reservoirs and with 100 pounds main reservoir pressure, the gear must be moved to full forward position and the main reservoir supply cock to the reverse gear closed off. The reverse gear will then be operated using the auxiliary reservoir supply. This supply must be able to operate the gear from full forward to full reverse and back to full forward position. Before making the above test, the brakes must be applied, the snifting valves and cylinder cocks opened.

H. W. Jones.
Chief of Motive Power.

L-39-A
Addition of Paragraphs Nos. 16-a and 28-a

THE PENNSYLVANIA RAILROAD

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REVISION OF PARAGRAPH 27

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-39-A

Instructions For Operating And Repairing ALCO Power Reverse Gear, Types E G And G-P,R.R.

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Philadelphia, Pa.
April 15, 1946.

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The following shall be substituted for paragraph 27 in the present issue of this Circular:

27. Lubricate reverse cylinder valve assembly and cylinder. With air pressure released and with piston full stroke ahead or back remove the 3/4" pipe plug from top of valve head cap and pour in 1/2 pint of No. 2 Coach-Engine oil (except for cold weather see Par. No. 28 for kind of lighter oil) slightly warm to insure free flowing. Replace plug, cut in air slowly and move reverse gear slowly forward and back to insure proper distribution of lubricant. The 3/4" pipe plug in some cases where reverse cylinder valve head is not so equipped, is located in tee connection on the 1/2" air line adjacent to valve housing. Clean out oil hole in valve stem oil plug and fill with oil to lubricate stem andbearing; also properly lubricate all connections, crosshead guides and piston rod, care being taken to see that they work freely without lost motion. Locomotives equipped with Auxiliary Reservoirs will have power reverse gear lubricated in accordance with instructions shown on tracing D-434198-B.

H. T. COVER
Chief of Motive Power