QD8 Quik-Drive Voltage Regulator Tap-Changer installation and maintenance instructions

Powering Business Worldwide

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Contents

Safety for life

Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment, and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.2

Product information

Introduction

Eaton combines more than 50 years of tap-changer experience with the latest technology providing the most advanced and reliable voltage regulator tap changer with its Cooper Power™ series QD8 Quik-Drive™ tap changer. Advanced thermal-set material utilized in the QD5 tap changer has now been utilized in the QD8 tap changer. The material provides a marked advantage over the Phenolic material used by other tap-changer manufacturers. The flexibility of the material provides for improved contact alignment and life. Increased contact board surface area also provides for improved insulating characteristics. The QD8 tap changer incorporates the Eaton's exclusive holding switch circuit, which has set the standard for tap-changer tracking reliability.

Eaton's QD8 Quik-Drive tap changer offers many advanced features when integrated with Eaton's Cooper Power series voltage regulator controls. Applications such as Preventative Maintenances Tapping (PMT™), Duty Cycle Monitor (DCM), and Time-ON-TAP™ features enables the unique capability to monitoring factors that affect tap-changer life.

Read this manual first

These instructions apply to distribution voltage regulators equipped with the polymer model of the QD8 tap changer. Read these instructions carefully before attempting maintenance on the voltage regulator.

The equipment covered by these instructions should be operated and serviced only by competent personnel familiar with good safety practices. These instructions are written for such personnel and are not intended as a substitute for adequate training and experience in safe procedures for this type of equipment.

The text of this instruction includes information concerning hazards to safety, which are common to all regulators. This safety hazard information is offered for guidance when installing and operating the descriptive matter to aid in preventing damage to the equipment and to advise of possible hazards to personnel. When reading this text, the meaning and content of these statements should be understood and followed carefully.

Quality standards

ISO 9001 Certified Quality Management System

General

Service Information MN225011EN covers operating, maintenance and component replacement instructions for the QD8 Quik-Drive tap changer in Eaton's VR-32 voltage regulators. The Phenolic version of the QD8 tap changer was introduced in 1999 for applications up to 875 A and 200 kV BIL. In 2015, the original Phenolic contact board design of the QD8 was replace by thermal-set material.

⚠ CAUTION

Do not operate the motor in air for excessive periods of time or overheating and failure may result.

Figure 1. Motor

Motor

The motor for the QD8 Quik-Drive tap changer is a permanent split capacitor type suitable for operation in both directions of rotation at 120 Vac, single-phase, 50 or 60 Hz. All components are compatible with hot transformer oil and windings are oil cooled. The motor will carry locked-rotor current for at least 3000 hours.

Motor resistance

To measure the motor resistance of each motor directional winding, see the following:

Motor Ground *White Lead* to *Blue Lead* Raise = 7.2 ohms

Motor Ground *White Lead* to *Red Lead* Lower = 7.2 ohms

Raise *Blue Lead* to Lower *Red Lead* = 13.9 ohms

Motor capacitor

The QD8 tap-changer motor uses a motor capacitor rated for 50 µF, 440 Vac, 50 or 60 Hz and 100°C. The motor capacitor is not part of the tap-changer assembly; it will be located in the control box.

Figure 2. Motor capacitor

Table 1. Motor capacitor
Size Rating
50 µF, 440 Vac, 50 or 60 Hz, 100°C

It is recommended that a replacement capacitor be of the same size and rating as was originally supplied with the unit. Incorrectly sized motor capacitors can cause the motor to labor and not run properly or all; premature motor failure will result. Tap position tracking of the voltage regulator control will also be adversely affected by improperly sized motor capacitors.

Holding switch

All Eaton's Cooper Power series tap changers are equipped with a holding switch to assure that a tap-changer operation is completed. This switch also provides a repetitive and accurate opening action causing the motor to stop the drive components with correct alignment. A signal from the holding switch activates the operations counter and prevents time delay reset during a tap change. The holding switch is operated by a pinion cam causing the holding switch lever to close in on either the raise or lower micro switch.

If there is a problem with one of the micro switches on the holding switch, the individual micro switch should not be replaced. Instead, the complete holding-switch assembly must be replaced. Replacement of an individual micro switch can cause alignment problems which will affect the operation of the tap changer. Special fixtures are used to assemble the holding-switch assembly to ensure that alignment gap setting requirements are met.

For information on holding switch replacement see the document MN225009EN, ***Quik-Drive tap-changer holding switch assembly replacement instructions***. The kit number for the replacement holding switch is 5740794B04.

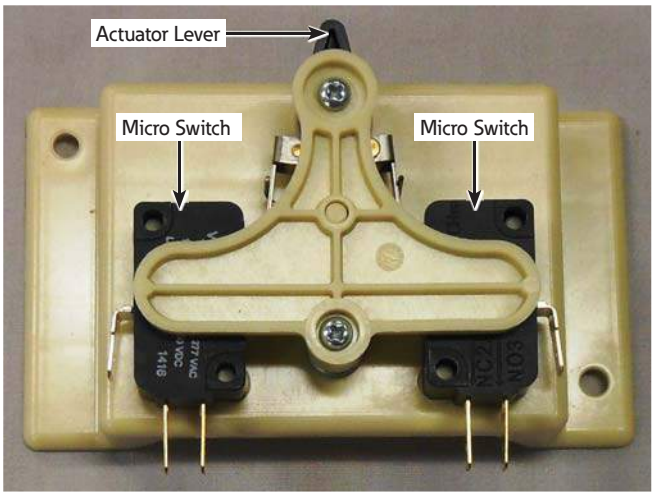

Figure 3. Holding switch assembly

Contacts

All movable and main stationary contacts employ copper-tungsten alloy tips at points subjected to arcing duty. Contact points not subjected to arcing employ a combination of EPT copper to provide a high conductivity current path. Movable contacts are split to make contact on both sides of mating parts and resist separation during high current surges. Contact pressure is maintained by steel compression springs.

Main stationary contacts

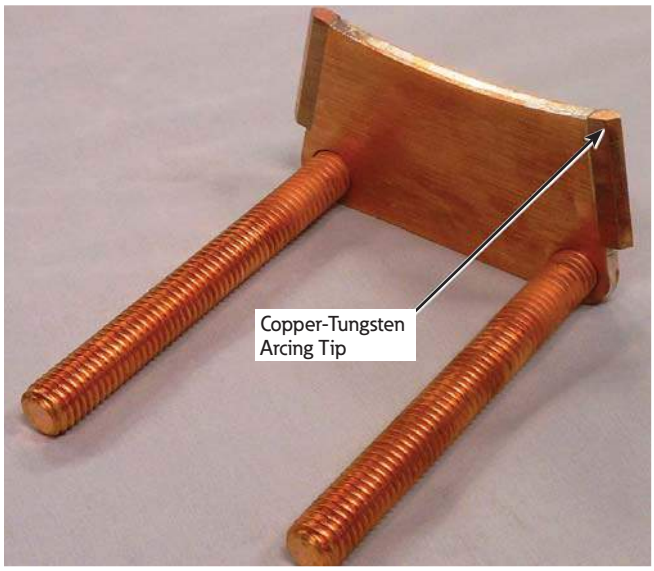

Figure 4. Main stationary contact

The main stationary contact is used for stationary tap contacts and the neutral contact.

Main movable contacts

Figure 5. Main movable contact assembly

The main movable contact assembly is made up of a set of two individual contact assemblies and a thermal set material insulating arm. Each of the main movable contacts makes contact with the main stationary contacts as the tap changer rotates through each tap position. At least one of the main movable contacts remains in contact with a stationary contact at all times. The main stationary contacts bolt to collector rings. The collector rings insert between a set of button contacts that are able to hold a continuous current path through all 32 steps of the tap changer and while in neutral. The movable contact assemblies are identical and can be used for either the right or left hand contacts.

Reversing switch stationary contacts

Figure 6. Reversing switch stationary contact. This contact is used for the neutral, VL, and VR reversing switch stationary contacts.

The set of reversing switch stationary contacts on the QD8 tap changer consist of three individual stationary contacts: a VL-Reversing Stationary, a Reversing Neutral Stationary, and a VR-Reversing Raise Stationary contact. All three contacts are identical and interchangeable. The reversing switch stationary contacts see less operating duty than the main stationary contacts and therefore do not utilize the copper-tungsten alloy arcing tips.

Main reversing movable contacts

Figure 7. Reversing movable contact assembly

The reversing switch changes the polarity of the tapped winding. When the QD8 Quik-Drive tap changer is in neutral position, the reversing switch is located on the "VN" Reversing Neutral Stationary Contact. In the open position the reversing switch is not in the load current circuit.

The reversing switch motion on the QD8 tap changer occurs as the main movable contacts enter or leave the neutral position. The QD8 tap-changer reversing switch movable contacts interact with the three reversing stationary contacts during the buck and boost operation of the tap changer.

The first tap step in either direction rotates the Reversing Segment actuator causing the Reversing Segment Actuator arms to rotate the reversing switch and engage the appropriate reversing stationary contact. When the tap changer receives a signal for raise and the reversing switch contact is in neutral, the reversing movable contacts will move clockwise on to the VR stationary bridging the VR and VN stationary contacts. In the lower direction from neutral the reversing movable will move counter clockwise on to the VL stationary contact. The reversing movable will be bridging the VL and VN when moving in the lower direction.

Micro switches

Micro switches are use for the holding switch, reversing logic, neutral indication and taping limit logic switches.

Two sets of normally closed switches are use to provide a safety switch circuit to prevent the tap changer from tapping beyond 16R and 16L acting as a fail-safe to the mechanical stop. The switches enable the tap changer to step back from the mechanical stop when the holding switch is closed.

The micro switches used are rated for -40°C to 130°C, 5 Amp 125/250 Vac rating. The switches are designed to exceed one million operations at QD8 tap-changer current.

QD8 tap-changer operating sequence

When the tap changer is in the neutral position and the control calls for a tap change, the following events occur:

1. Motor will start and drive the chain sprocket.
2. Rotation of the chain sprocket rotates the drive pinion.
3. The drive pinion cam engages and closes in the holding switch.
4. Drive pinion roller engages the position indicator drive gear advancing the position indicator pointer.
5. The sprocket drive roller engages the Geneva gear rotating the Geneva gear.
6. As the sprocket rotates and the holding switch is actuated, the sprocket cam dis-engages and releases the brake.
7. The rotation of the Geneva gear causes the reversing segment actuator to operate which moves the reversing switch movable contacts, via the linkage tying the reversing segment actuator to the reversing switch from neutral to VR or VL.
8. Rotation of the Geneva gear relocates the movable contacts on the stationary contacts.
9. Drive pinion cam returns to the open area opening the holding switch.
10. Tap change is completed.

Maintenance, service, and troubleshooting

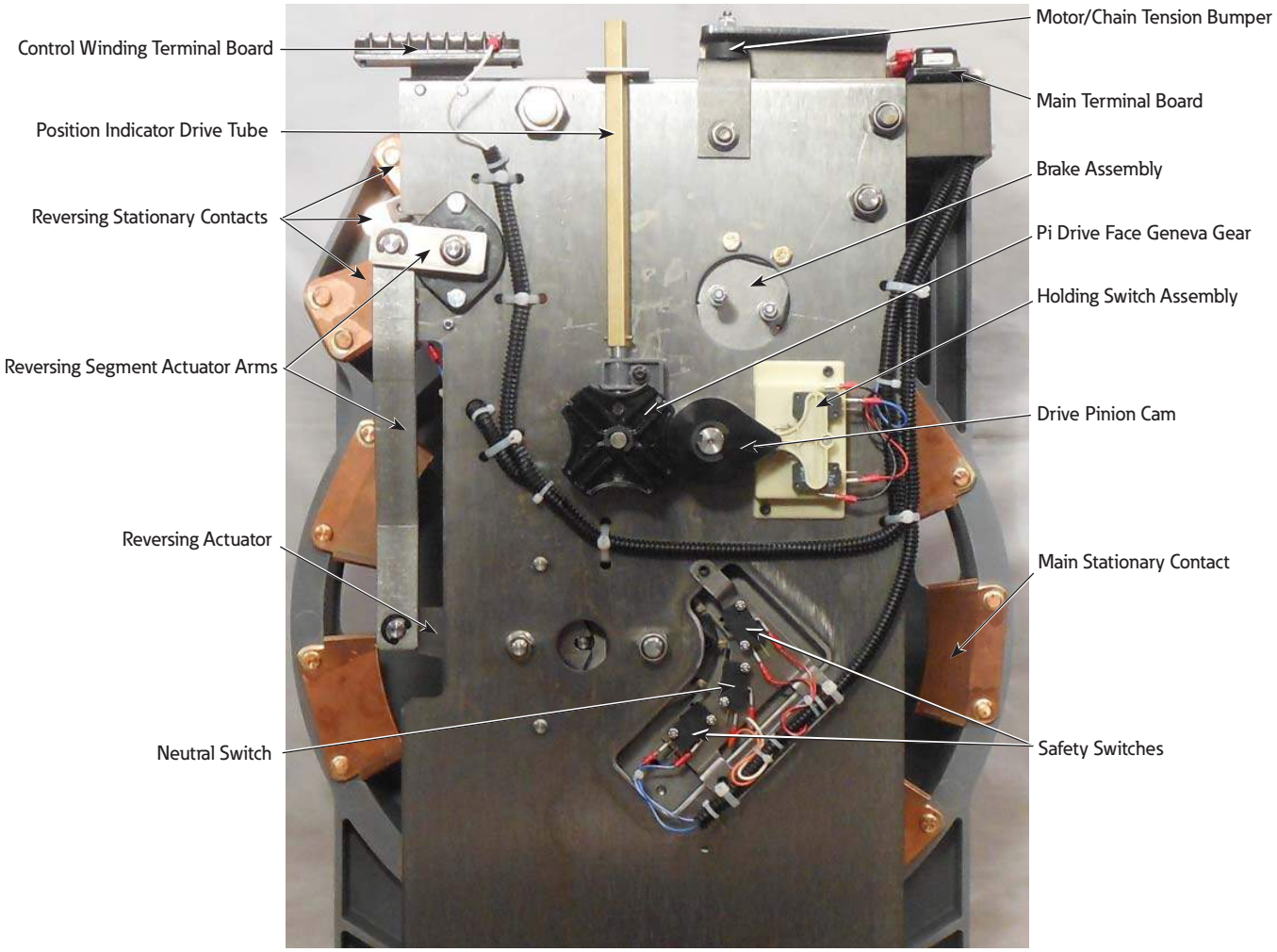

Figure 8. Tap-changer front view

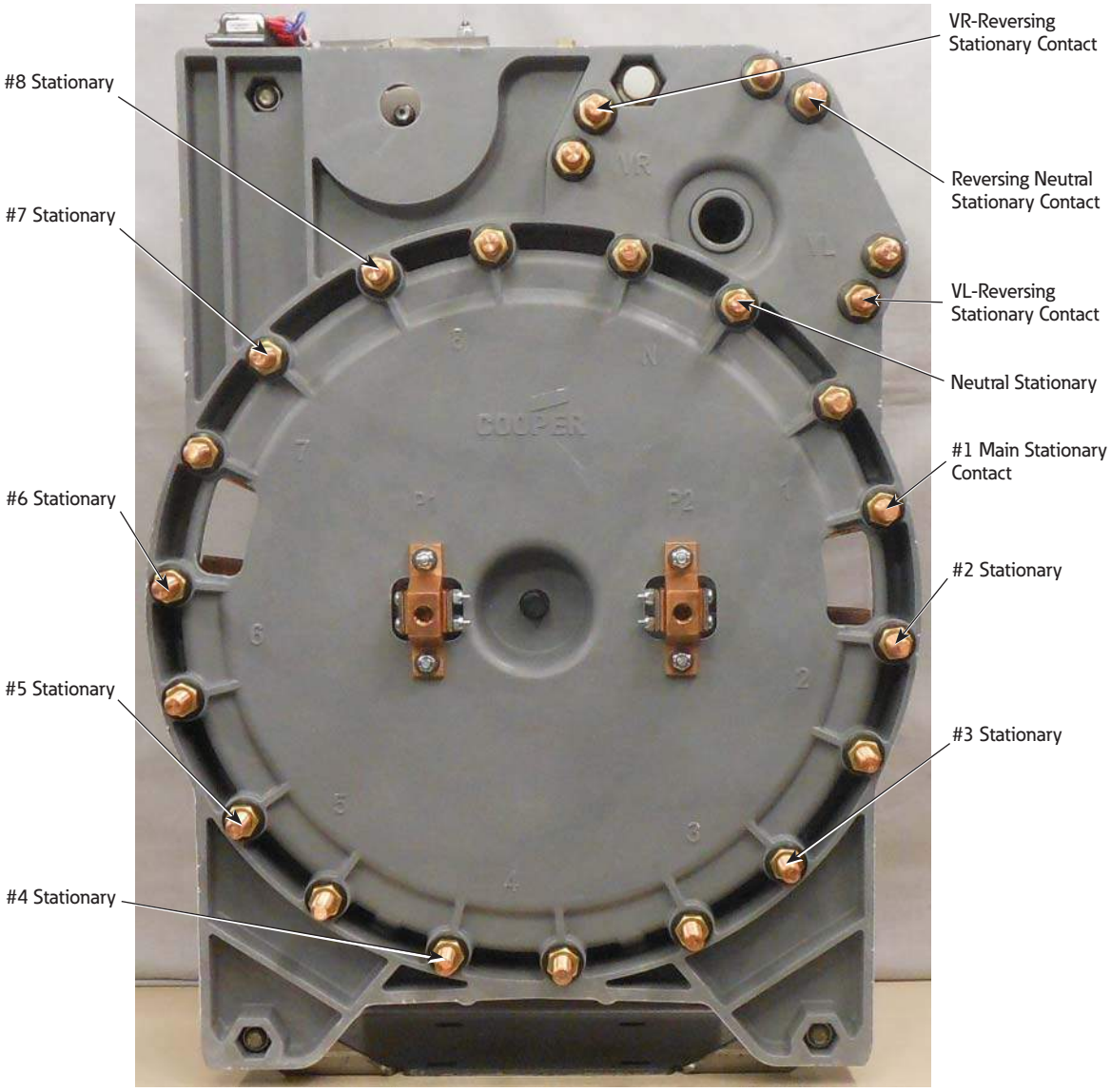

Figure 9. Rear view of QD8 tap changer

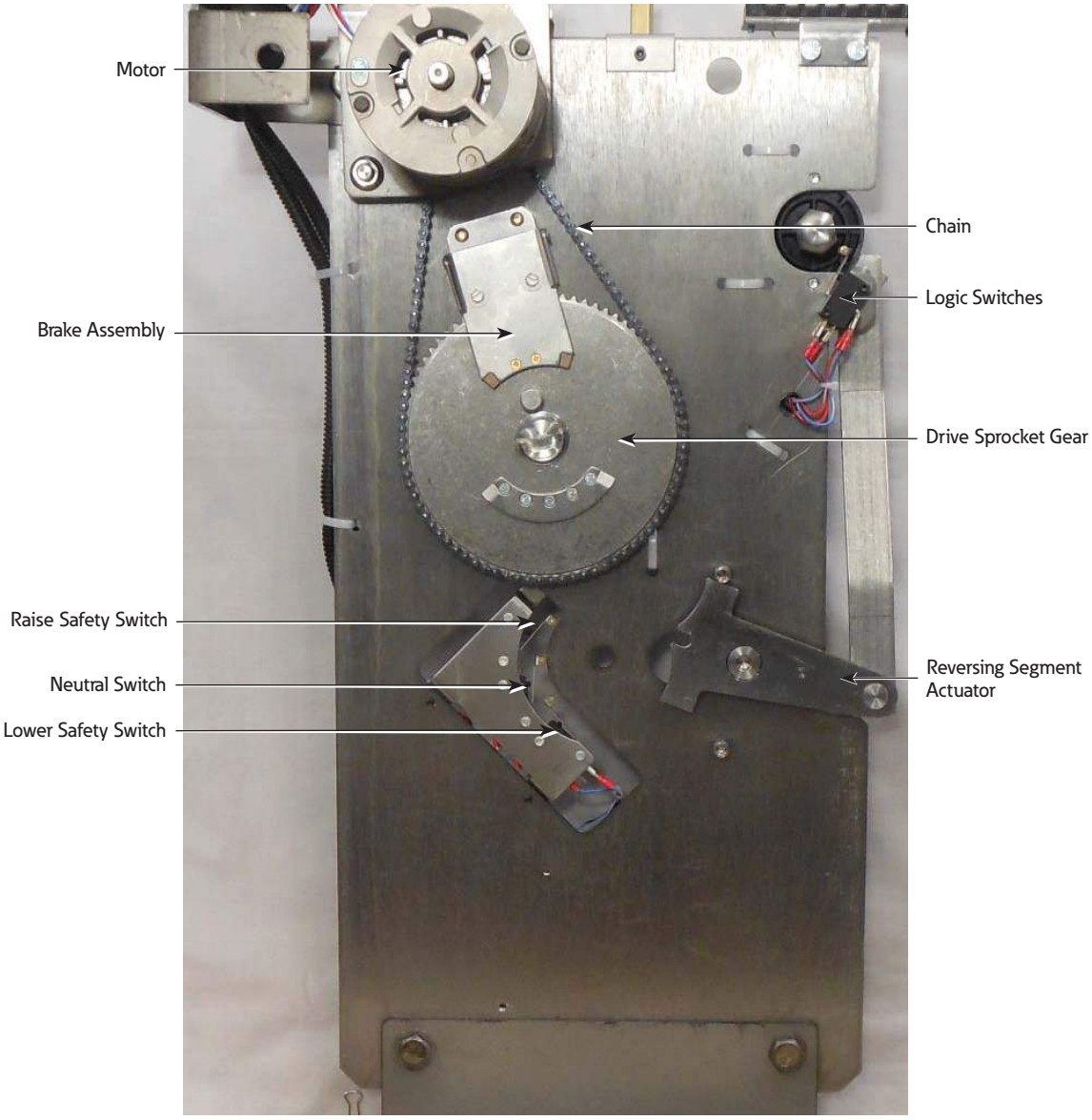

Figure 10. Inside drive frame

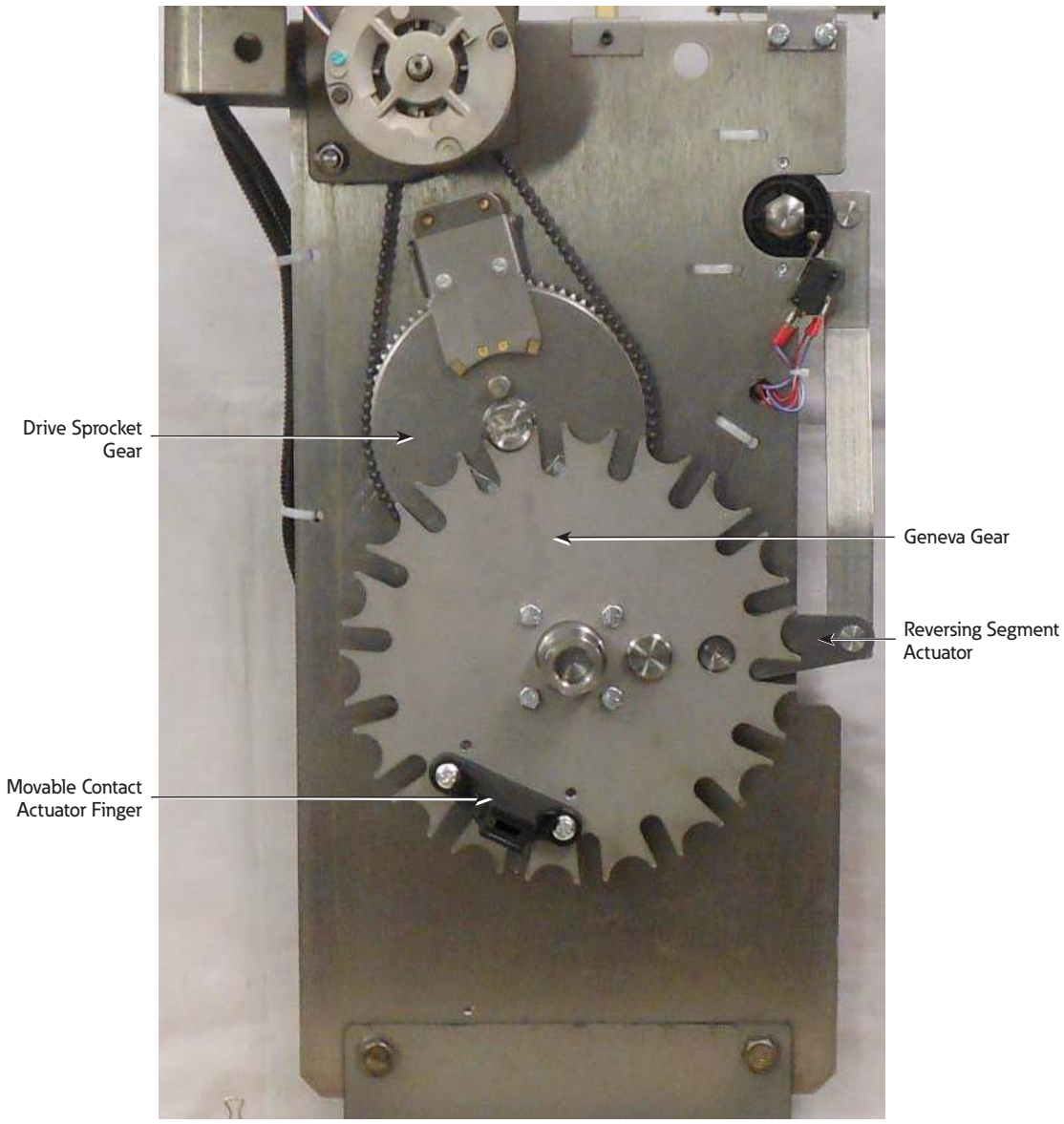

Figure 11. Drive frame with Geneva gear

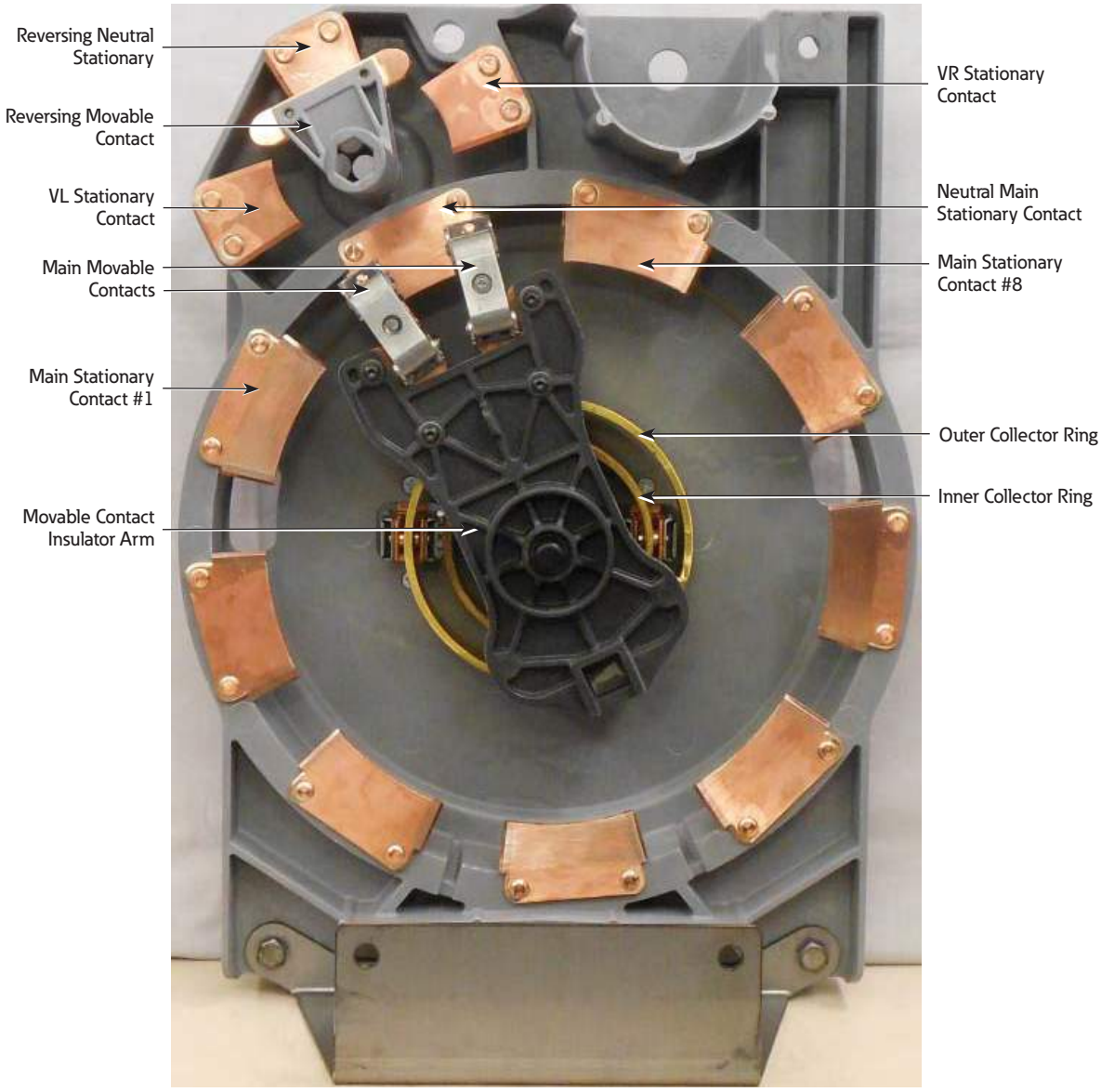

Figure 12. Inside contact assembly

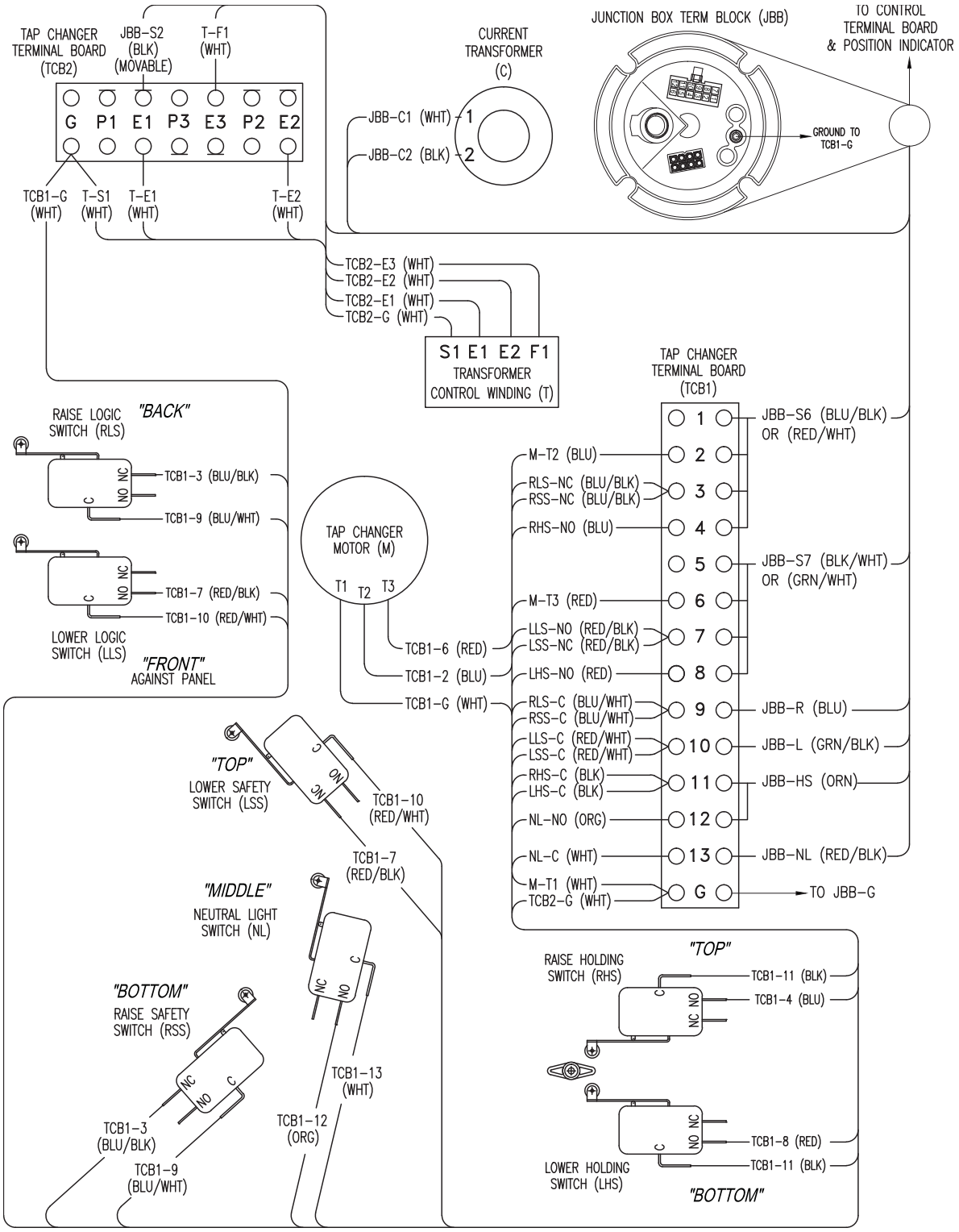

Figure 13. QD8 wiring schematic

Contact erosion patterns

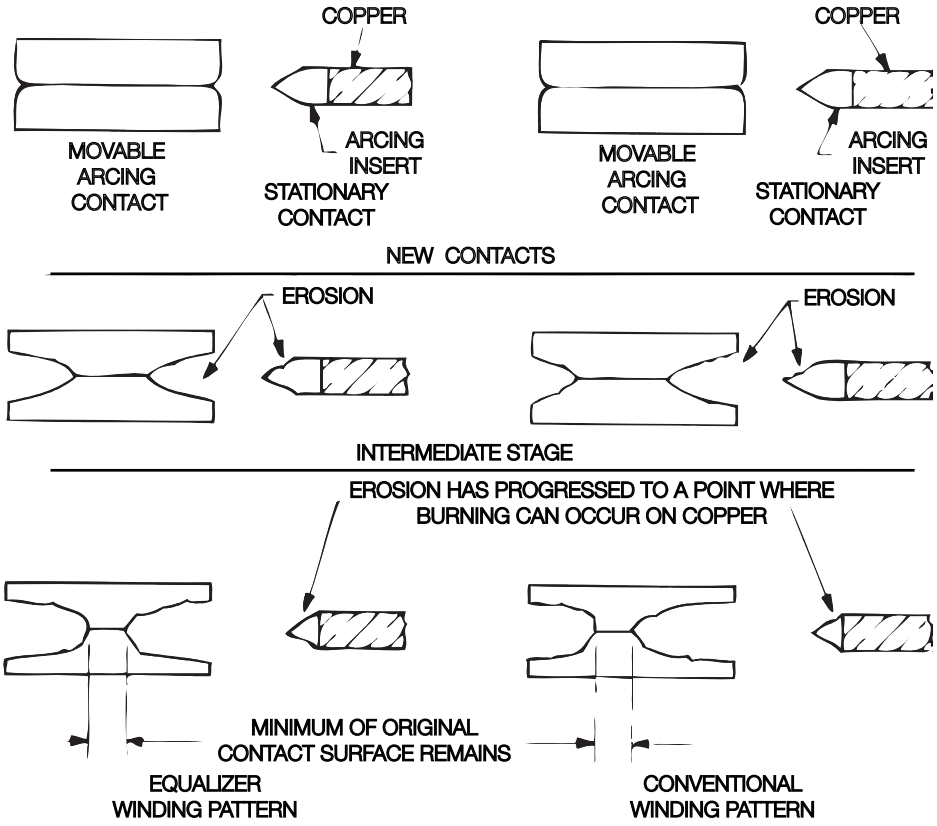

Figure 14. Contact life stages

Contact inspection

Tap-changer contacts are exposed to combination of electrical, mechanical and thermal conditions that result in deterioration. Erosion at the points subjected to arcing duty is the most visible indication of wear. Figures 17 and 18 illustrate typical contact erosion patterns resulting from normal service. Contacts at the end of life stage shown in Figures 19 and 20 must be replaced. The figures show actual contacts after various stages of contact erosion.

Figure 15. New QD8 tap-changer movable contact

Figure 16. New QD8 tap-changer stationary contact

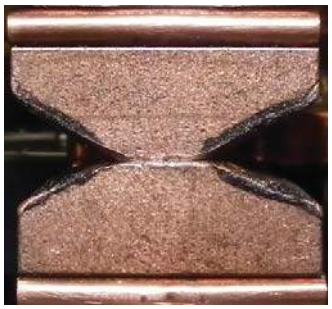

Figure 17. Intermediate life stage QD8 tap-changer movable contact

Figure 18. Intermediate life stage QD8 tap-changer stationary contact

Figure 19. End of life stage QD8 tap-changer movable contact

Figure 20. End of life stage QD8 tap-changer stationary contact

QD8 tap-changer torque requirements

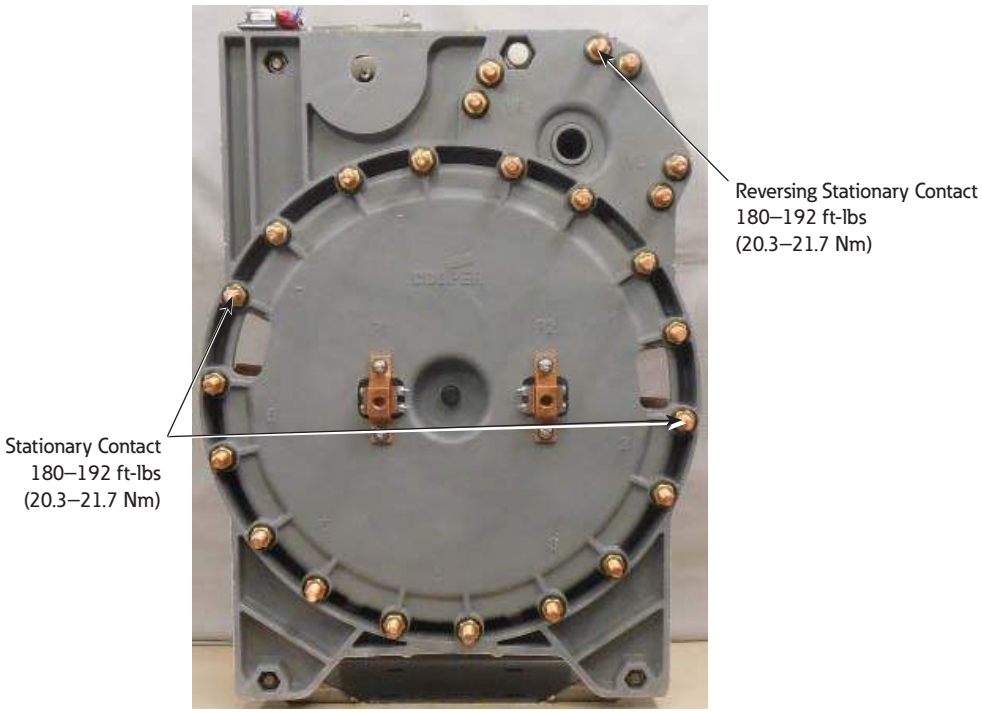

Figure 21. Stationary contact torque requirements

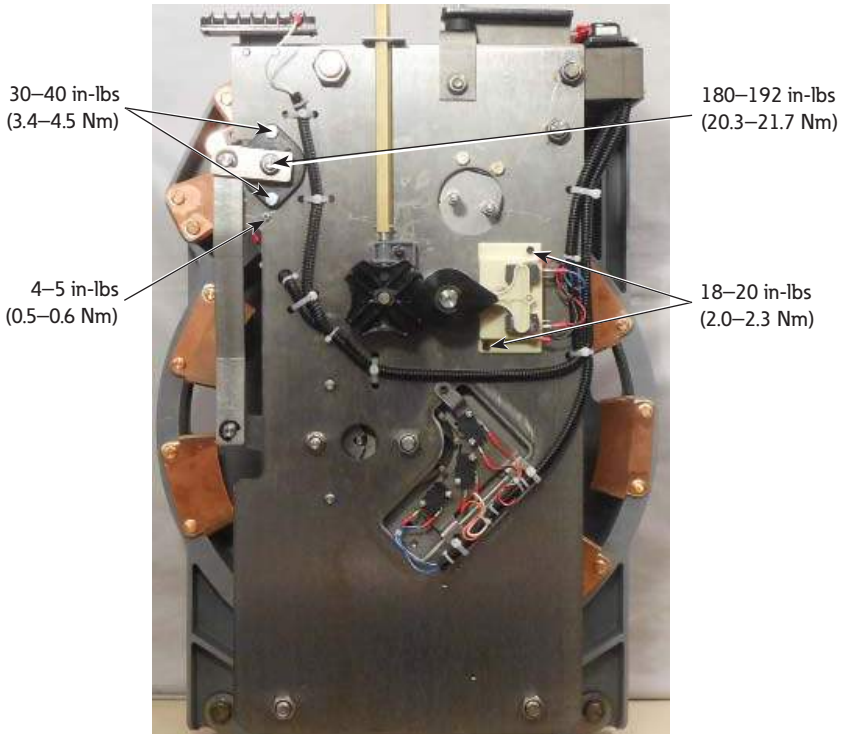

Figure 22. Front drive torque requirements

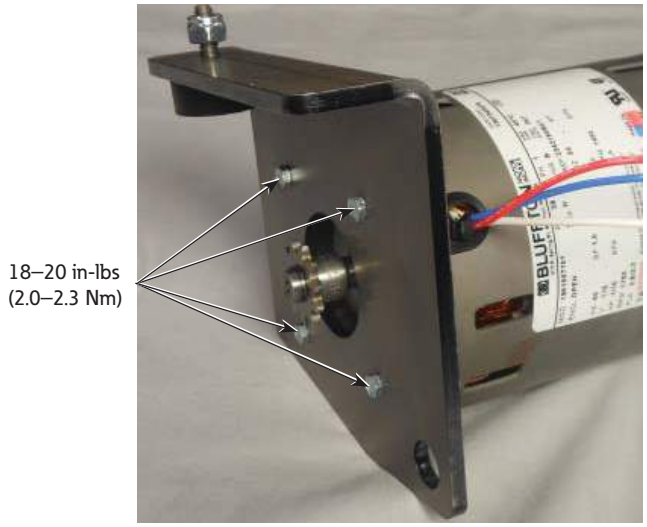

Figure 23. Motor-to-mounting bracket torque requirements

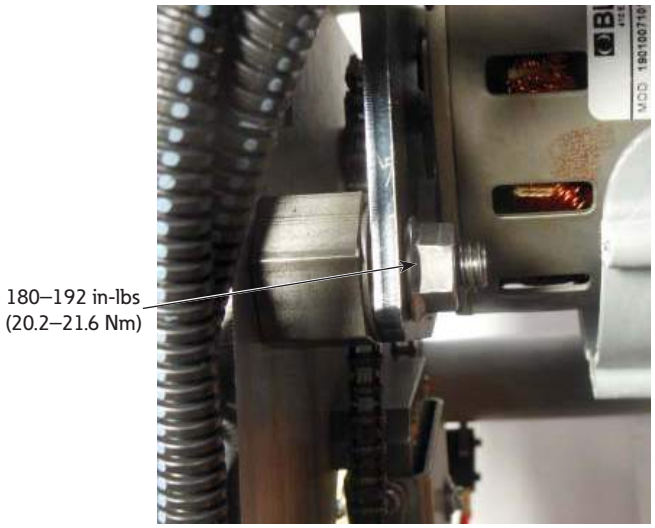

Figure 24. Motor pivot stud and locknut torque requirements

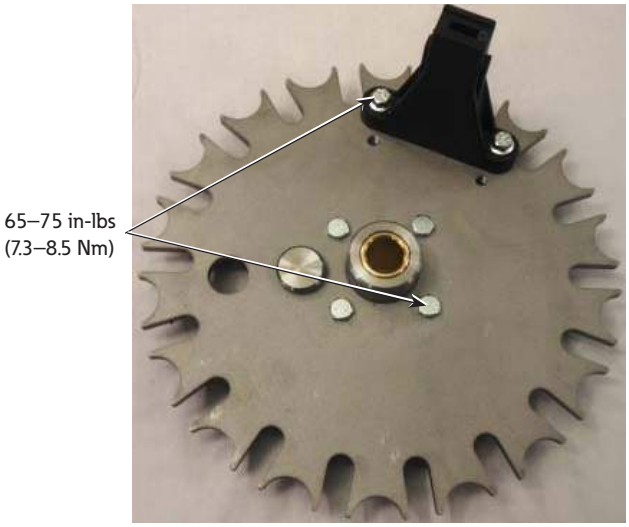

Figure 25. Geneva gear torque requirements

Reversing switch movable contact assembly kit number 5740785B13

Reversing switch neutral stationary contact kit number 5791646A48

(Refer to Service Information MN225035EN.)

General

This procedure provides instructions for removal and replacement of the reversing switch movable contact assembly and reversing switch neutral stationary contact for the QD8 Quik-Drive tap changer.

Parts supplied

Table 2. Reversing switch movable contact assembly kit number 5740785B13

Item	Part Number	Description	Qty
1	0740785B13	Reversing Switch Movable Contact Assembly	1

Table 3. Reversing switch neutral stationary contact kit number 5791646A48

Item	Part Number	Description	Qty
1	0791646A48	Reversing Switch Neutral Stationary Contact	1
2	0800005001Z	Jam Nut	2
3	0892568A02	Belleville Washer	2

Tools required

- 3/8 inch drive ratchet wrench
- 3/8 inch drive ratchet extension
- 1/4 inch socket
- 7/16 inch socket
- 9/16 inch socket
- 3/4 inch deep-well socket
- 3/32 inch Allen wrench
- Standard 8-inch long flat-blade screwdriver
- Torque wrench for in-lbs
- Loctite® 243™ Threadlocker

Figure 26. Reversing movable contact kit

Figure 27. Reversing neutral stationary contact kit

Installation procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.

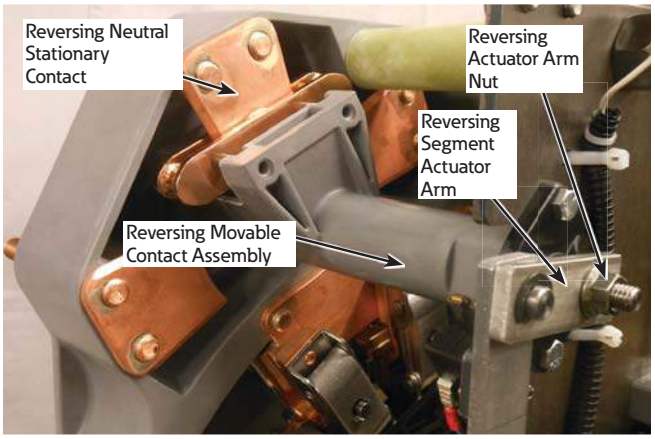

Figure 28. Reversing switch and hardware

2. Using a 9/16" wrench loosen and remove the reversing actuator arm nut. See Figure 28.
3. Lift outward on the reversing actuator arm and remove it from the reversing movable contact bushing. The reversing actuator shaft may be tapped in to allow clearance to remove the arm. See Figure 29 and Figure 30.

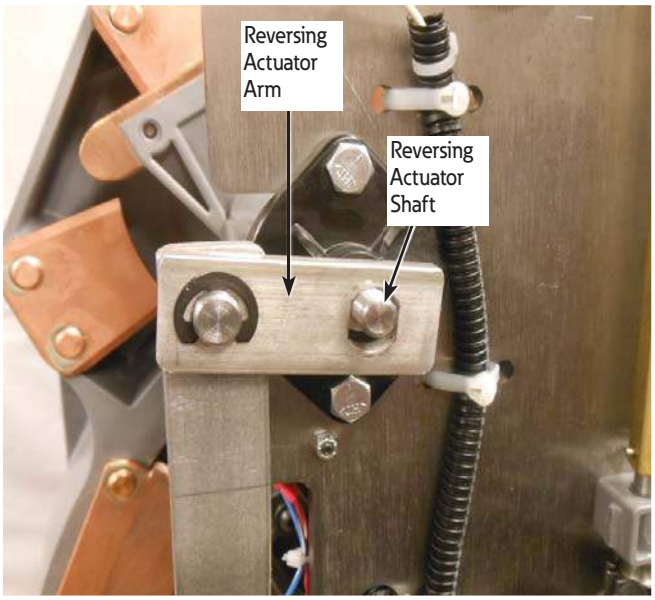

Figure 29. Removal of actuator arm

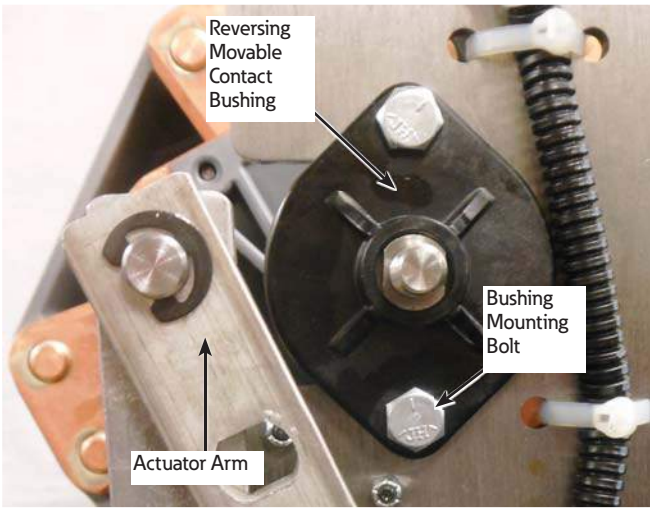

Figure 30. Bushing

4. Using a 7/16" socket wrench, loosen and remove both bushing-mounting bolts. See Figure 30.
5. Remove the bushing from the reversing movable contact shaft. See Figure 31.

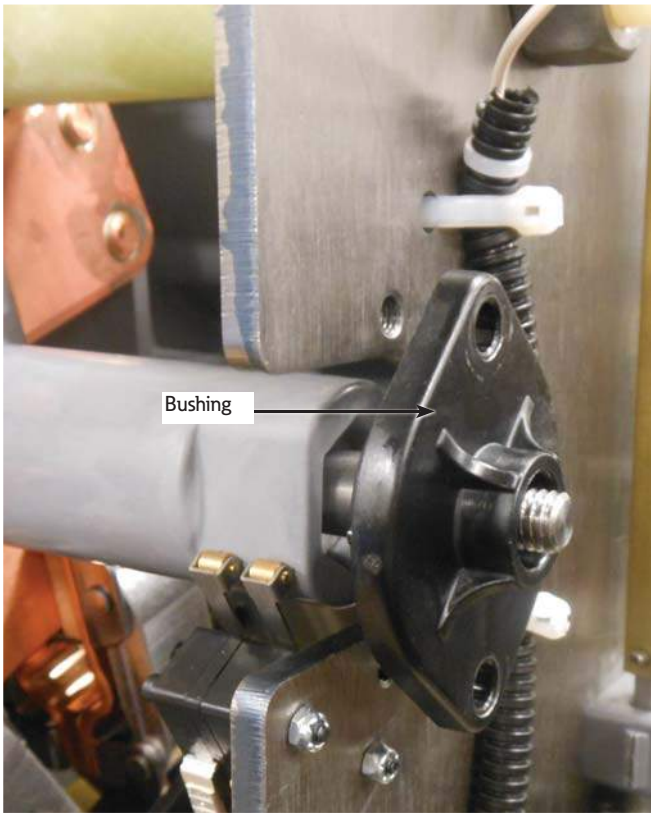

Figure 31. Removal of bushing

6. Use a 3/32" Allen wrench and a 1/4" socket wrench to loosen and remove the self-locking nuts and logic switch mounting screws. See Figure 32 and Figure 33.

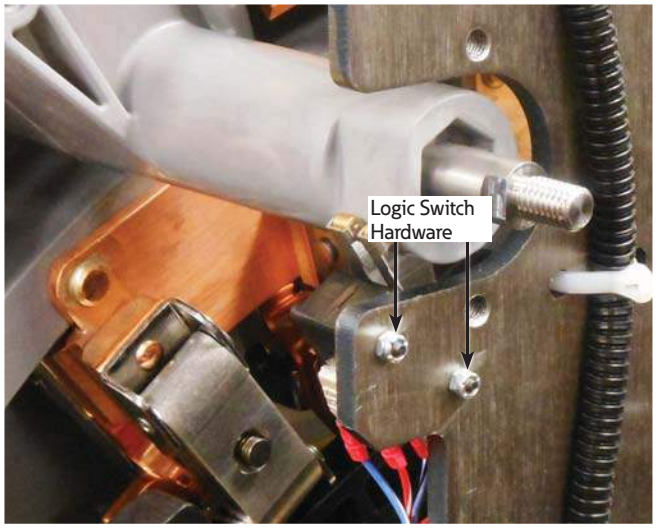

Figure 32. Reversing logic hardware

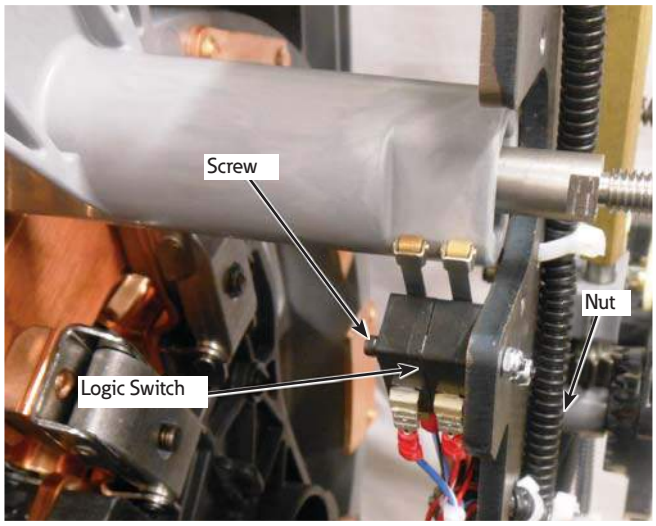

Figure 33. Removal of logic switch

7. After removing the logic switch mounting screws the switches will drop away from the reversing switch movable contact tube and hang by the wires.
8. On the back side of the tap-changer contact board, carefully mark the reversing switch leads; photos can be helpful to assist in remembering the arrangement of the connections. See Figure 34.

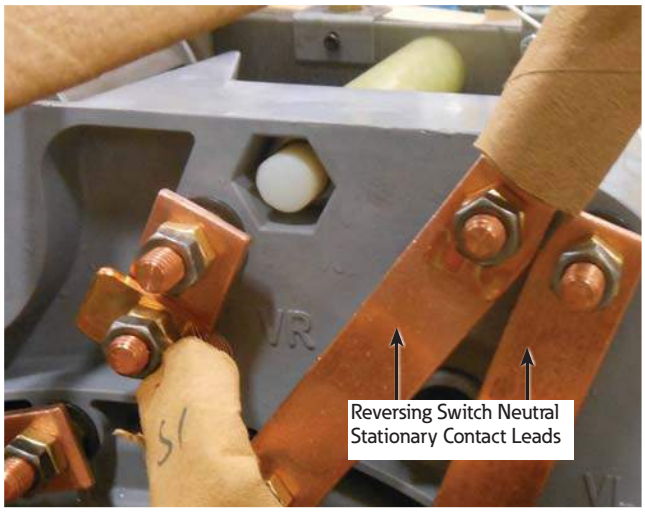

Figure 34. Loose logic switches

9. Using a 3/4" wrench, remove the nuts and jam nuts holding the leads and copper bars connected to the reversing switch neutral stationary contact and remove the connections. See Figure 34.
10. Use a 3/4" wrench to loosen and remove the nuts and flat washers from both of the reversing neutral stationary contacts on the back of the tap-changer contact panel. See Figure 35.

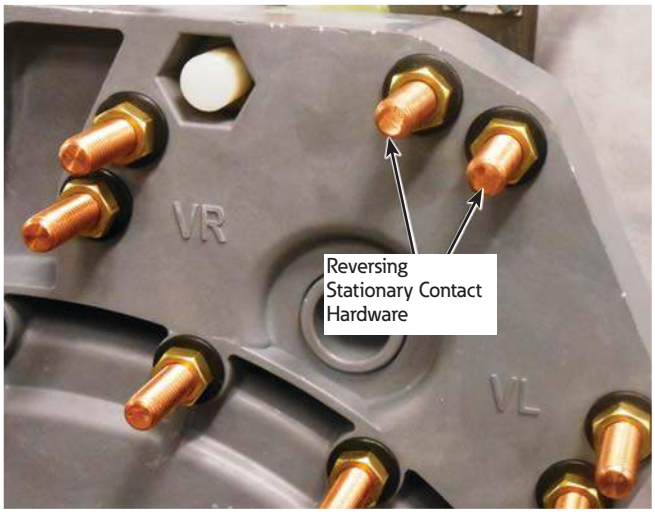

Figure 35. Reversing neutral stationary contact

11. Pull the reversing movable contact assembly and the reversing neutral stationary contact forward toward the steel front panel as shown in Figure 36.

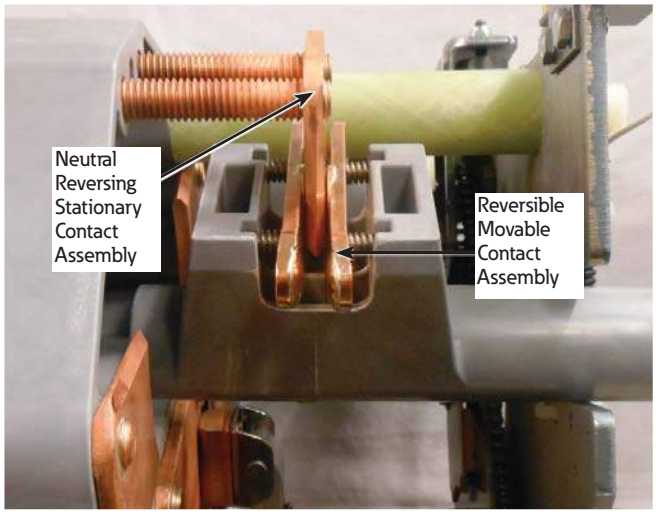

Figure 36. Reversing movable and stationary contacts

12. Rotate the reversing movable contact counter clockwise until the movable contact assembly disengages from the reversing neutral stationary contact and remove it from the tap changer. See Figure 37.
13. Remove the reversing neutral stationary contact from the tap-changer contact panel.

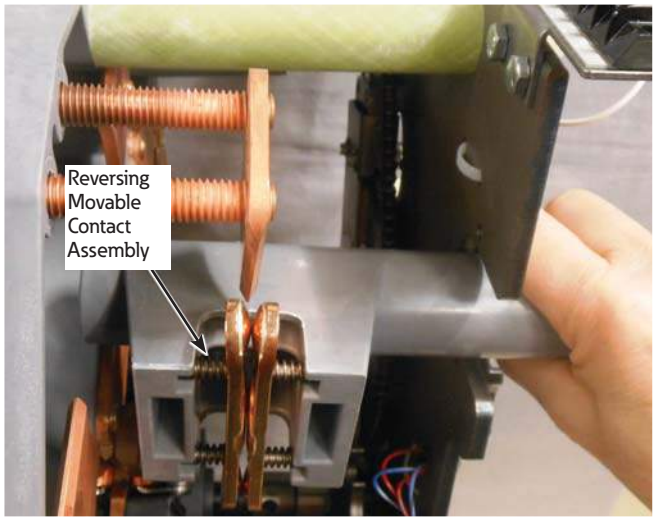

Figure 37. Rotating the reversing movable contact

14. Remove the reversing actuator shaft from the reversing movable contact assembly and retain for use in the new contact assembly. See Figure 38.

Figure 38. The actuator shaft removed from the reversing movable contact assembly

15. Insert the reversing actuator shaft into the new reversing movable contact assembly. See Figure 38.
16. Partially install the reversing neutral stationary contact into the mounting holes as shown in Figure 39.
17. Place the new reversing movable contact into the mounting slot in the tap-changer front panel, aligning the movable contact assembly with the reversing neutral stationary contact. See Figure 39.

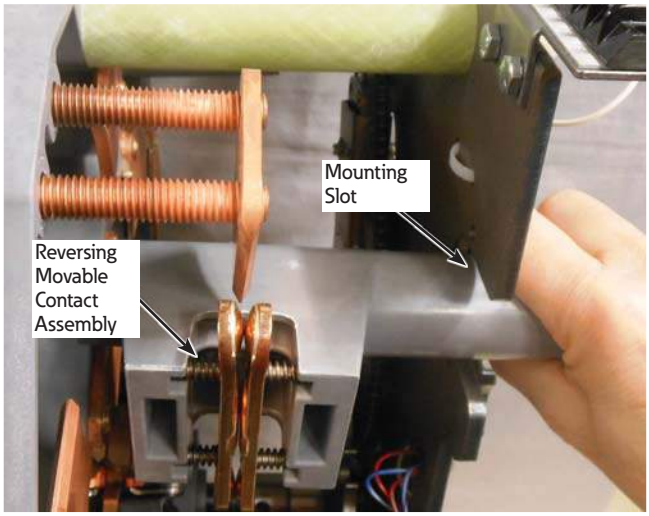

Figure 39. Reinstalling reversing movable contact

18. Insert a standard flat-blade screwdriver between the middle and top button contacts on the reversing movable contact assembly and twist to separate. Line up the movable and stationary contacts and rotate the movable contact assembly clockwise over the reversing stationary contact. See Figure 40.

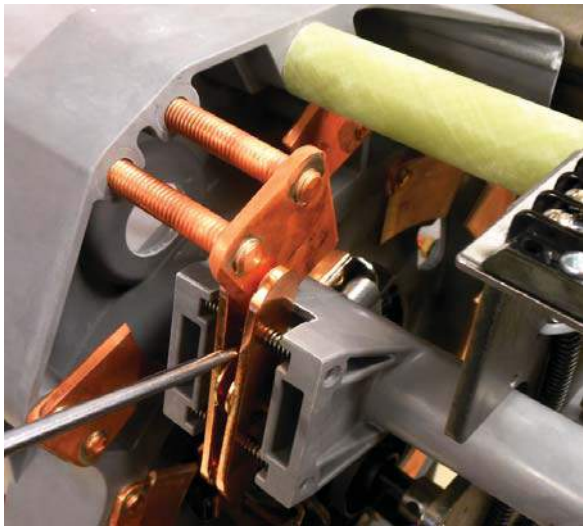

Figure 40. Positioning reversing movable contacts

19. Continue to reposition the screwdriver, separate the button contacts and rotate the reversing movable contact assembly until the middle button contact is fully engaged in the center of the reversing stationary contact blade. See Figure 41.

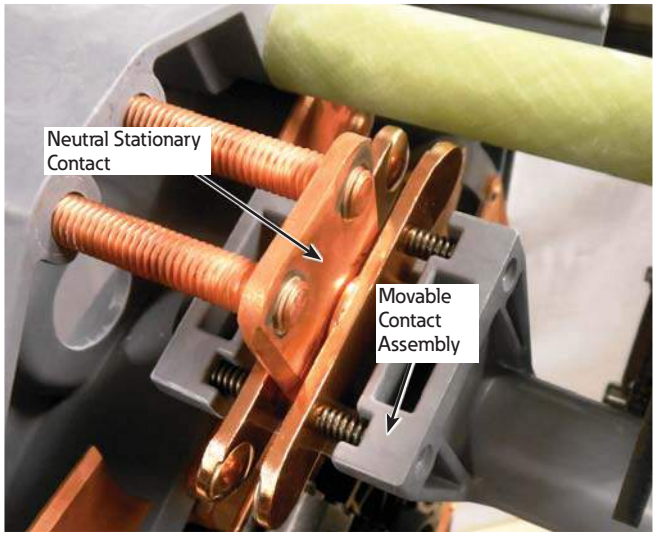

Figure 41. Engaging contacts

20. Slide the stationary and movable contact assembly toward the contact panel. Align the movable contact assembly so that the reversing movable tube aligns with and goes through the hole in the contact panel. At this point the stationary contact and movable contact should be fully engaged with the contact panel. See Figure 42.

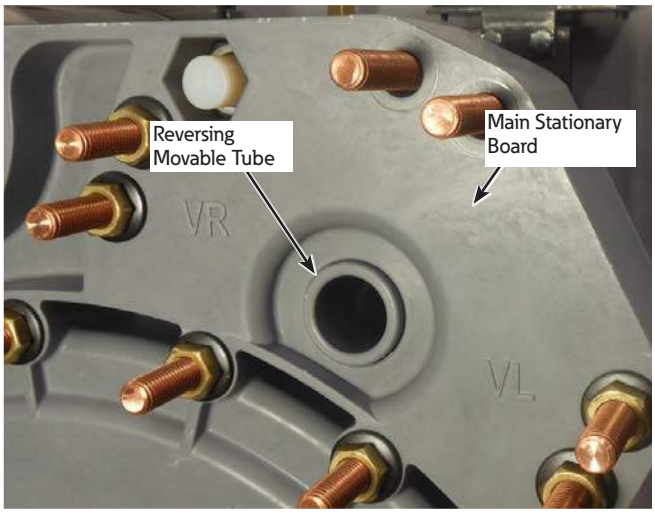

Figure 42. Aligning with main contact board

21. Place a Belleville washer and nut over each of the reversing neutral stationary contact studs. The cupped side of the washer must face in toward the contact board. Tighten to a torque of 180–192 in-lbs (20.3–21.7 Nm). See Figure 43.

Figure 43. Reinstalling neutral stationary and hardware

22. Reinstall the copper bars and leads to the positions noted in step 7 and secure with the hardware removed earlier. Tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm).

23. Place the mounting hardware onto the reversing logic switches and fasten to the tap-changer front plate. Use a 3/32" Allen wrench and 1/4" socket wrench to tighten the nuts to a torque of 4–5 in-lbs (0.5–0.6 Nm). See Figure 44.

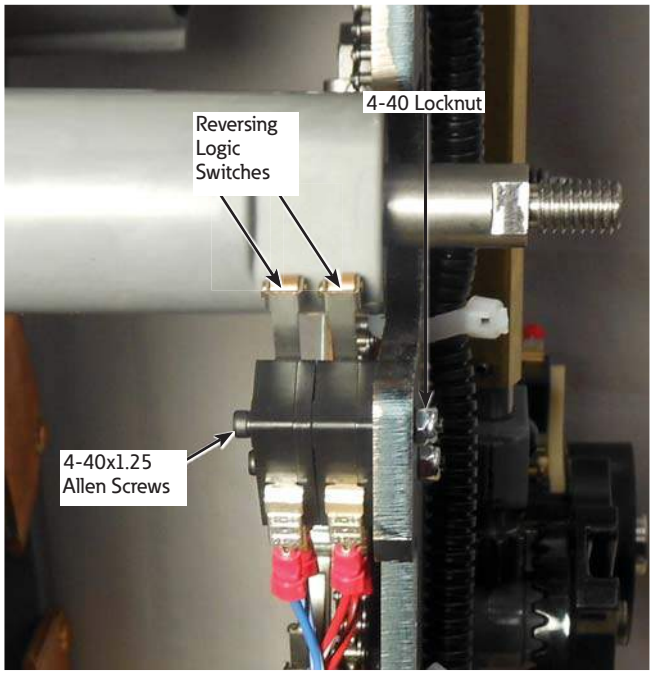

Figure 44. Reinstalling logic switches

24. Apply Loctite® 243™ Threadlocker to the two 1/4-28 bolts. Using the bolts and a 7/16" wrench, fasten the reversing movable bushing to the front of the tap changer. Tighten the bolts to a torque of 30–40 in-lbs (3.4–4.5 Nm). See Figure 45.

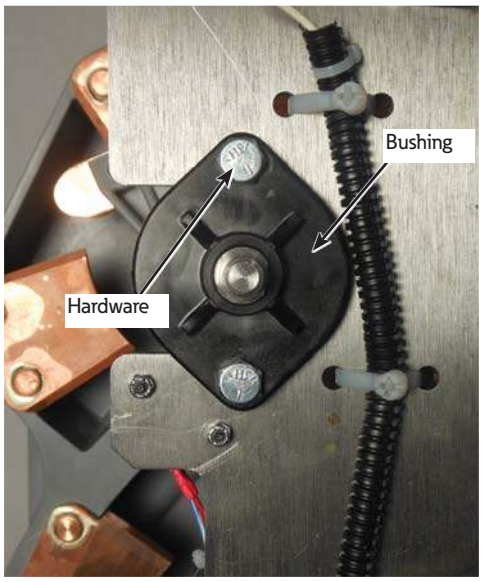

Figure 45. Reinstalling bushing

25. Place the reversing segment arm onto the reversing actuator shaft. Align the square portion of the shaft with the square hole in the arm. If needed, place a screwdriver through the movable contact tube and push the shaft forward while seating the arm over the shaft. It may be necessary to rotate the movable contact assembly slightly to align the shaft and hole. See Figure 46 and Figure 47.

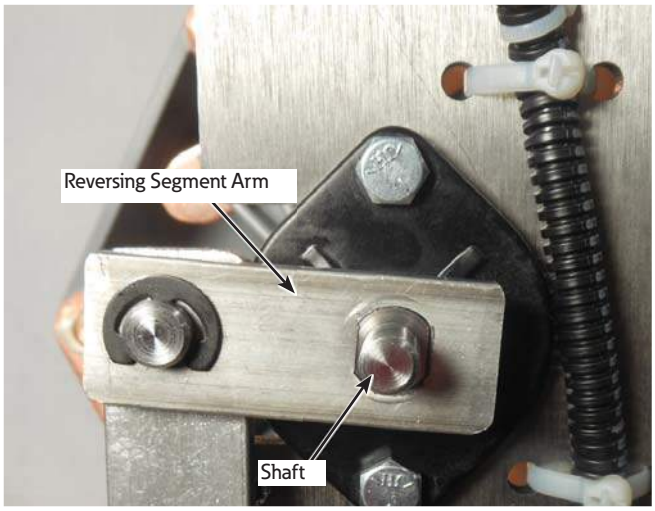

Figure 46. Installing reversing segment arm

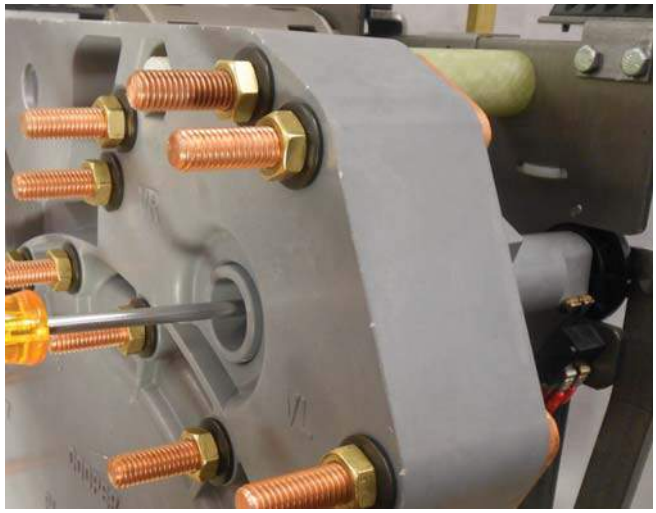

Figure 47. Positioning the reversing movable with the bushing

26. Place the self-locking nut onto the reversing segment shaft and tighten with a 9/16" wrench. The nut should be tightened to a torque of 180 to 192 in-lbs (20.3 to 21.7 Nm). See Figure 48.

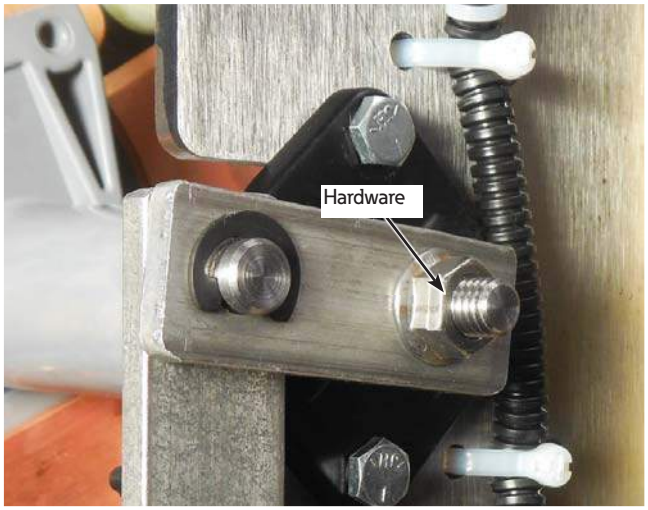

Figure 48. Fastening reversing segment

27. Once the work has been completed place the tap changer in the neutral position. See **Placing tap changer into neutral**.

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 49.

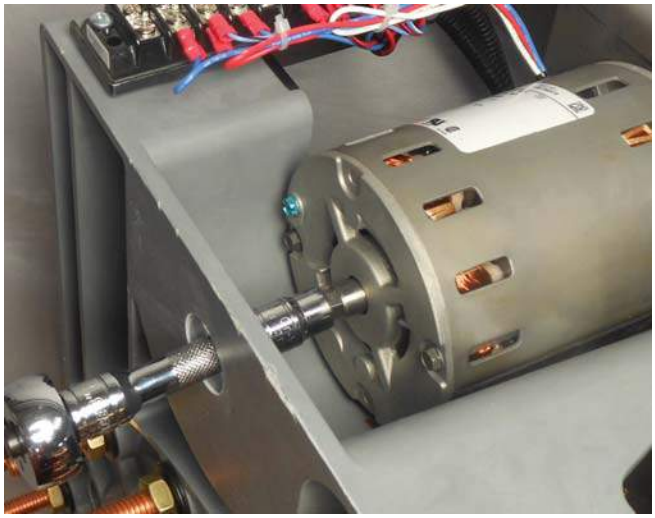

Figure 49. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:
   A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 50.

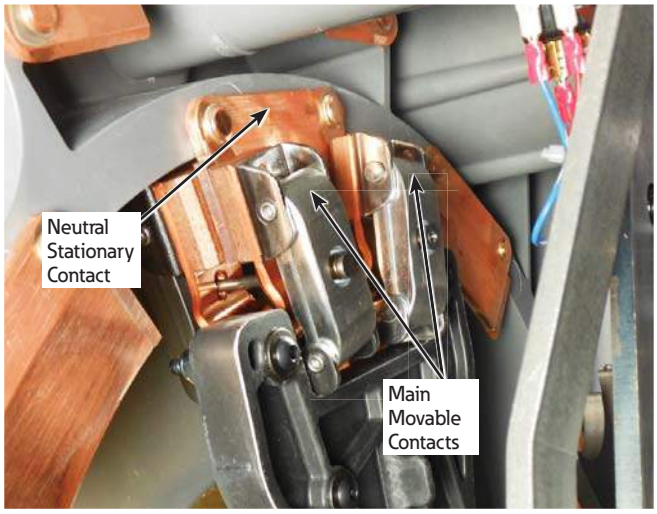

Figure 50. Neutral stationary contact position for main movable contacts

B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 51.

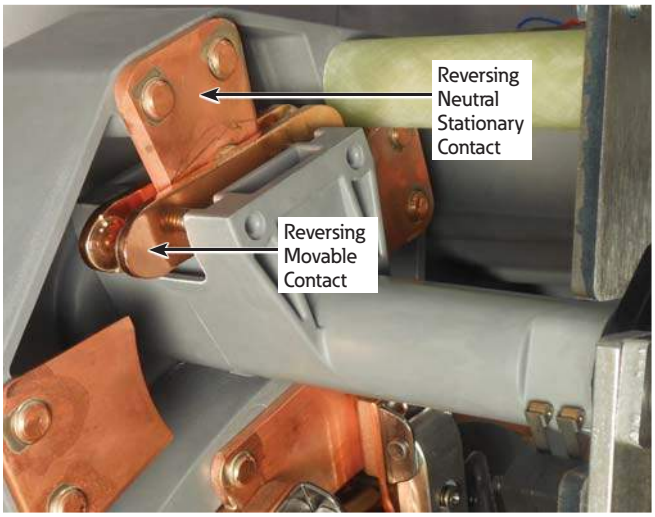

Figure 51. Neutral position for reversing movable contact

C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 52.

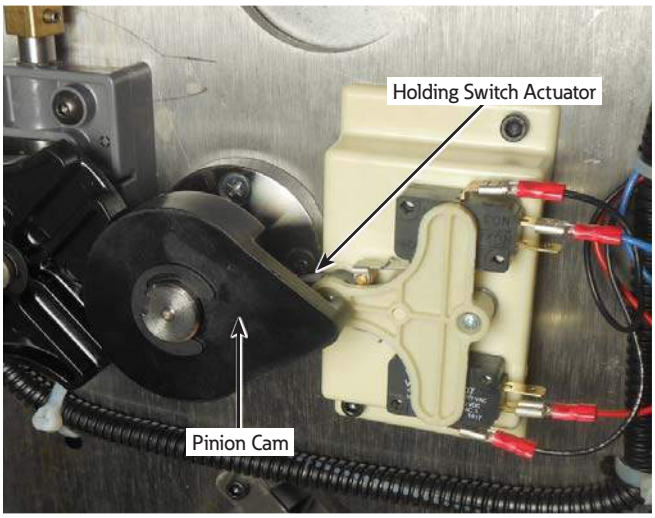

Figure 52. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 53.

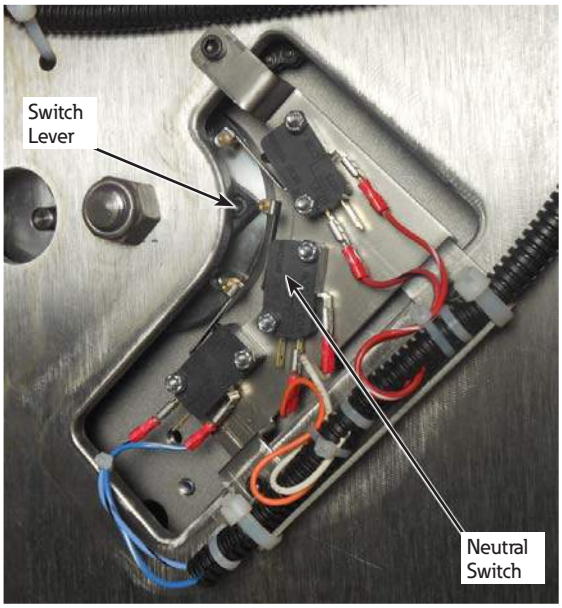

Figure 53. Neutral switch is depressed

Main stationary contact kit number 5791646A10

(Refer to Service Information MN225036EN.)

General

The purpose of this replacement kit is to provide the parts and installation instructions for replacing the main stationary contacts on the polymer version of the QD8 Quik-Drive tap changer. Each QD8 tap changer has nine main stationary contacts. Of these, eight are tap contacts and one is the neutral stationary contact.

Parts supplied

Table 4. Main stationary contact kit number 5791646A10

Item	Part Number	Description	Qty
1	0791646A48	Main Stationary Contact	1
2	0800005001Z	Jam Nut	2
3	0892568A02	Belleville Washer	2

Tools required

- 3/8 inch drive ratchet wrench
- 3/8 inch drive extension
- 3/8 inch Socket
- 3/4 inch deep-well socket
- Torque wrench for in-lbs

Figure 54. Main stationary contact kit

Installation procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.

Note: A sheet wrapped around and below the tap changer can be used to catch dropped hardware before it falls into the tank.

2. Carefully mark the series winding leads before any disassembly. Photos can be helpful to assist in remembering the arrangement of the connections. See Figure 55.

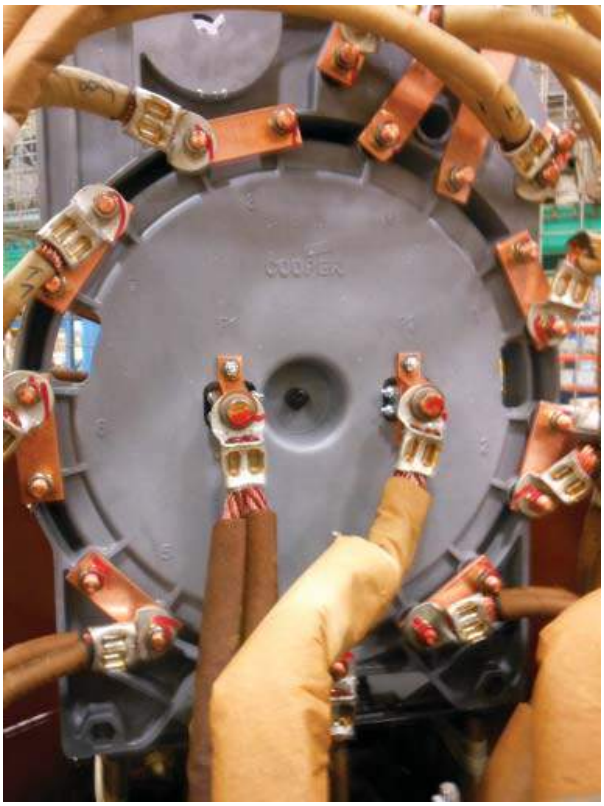

Figure 55. Leads and bars connected to tap changer

3. Using a 3/4" wrench, remove the nuts and jam nuts holding the leads and copper bars from the contacts to be replaced and then remove the connections.

4. If the main movable contacts are over the stationary contact to be replaced (Figure 56), rotate the motor using a 3/8" socket and extension on the rear motor shaft until the stationary contact is clear (Figure 57).

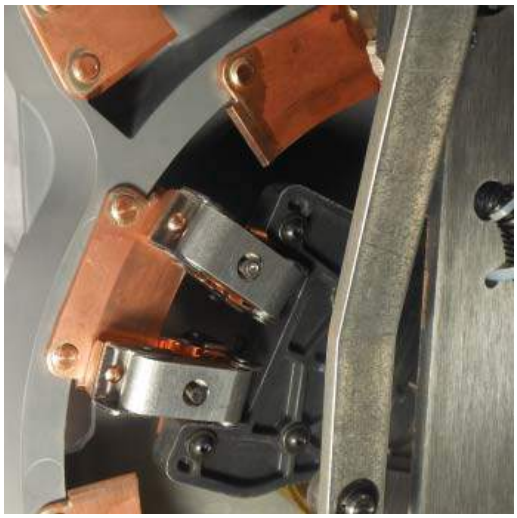

Figure 56. The main movable contacts over the number 1 stationary contact

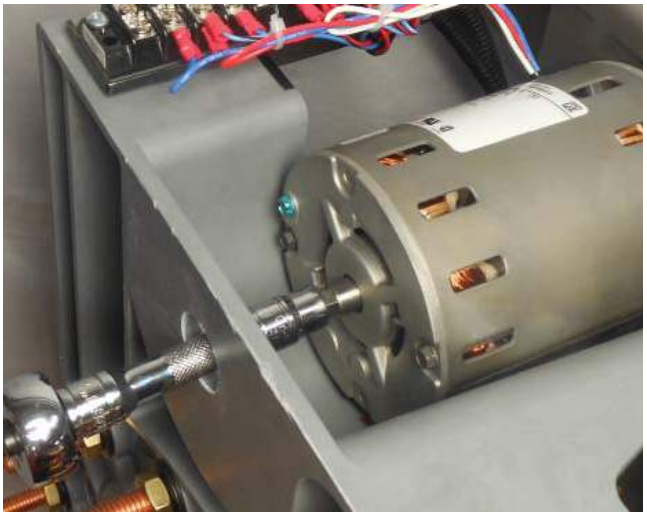

Figure 57. Rotating the motor shaft to clear the main movable contacts from the main stationary contacts

5. Use a 3/4" deep-well socket and ratchet to loosen and remove the nuts and washers from each stationary contact stud. See Figure 58.

Figure 58. Main stationary contact hardware

6. Remove the stationary contact from the contact assembly panel. See Figure 59.
7. Install the new stationary contact into the mounting holes in the contact assembly board. See Figure 59.

Figure 59. Stationary contact removal and installation

8. Place a new Belleville washer and nut on each stud. The cupped side of the Belleville washer must face in toward the contact board. Use a 3/4" deep-well socket and ratchet to tighten the nuts. Using a torque wrench, tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm). See Figure 60.

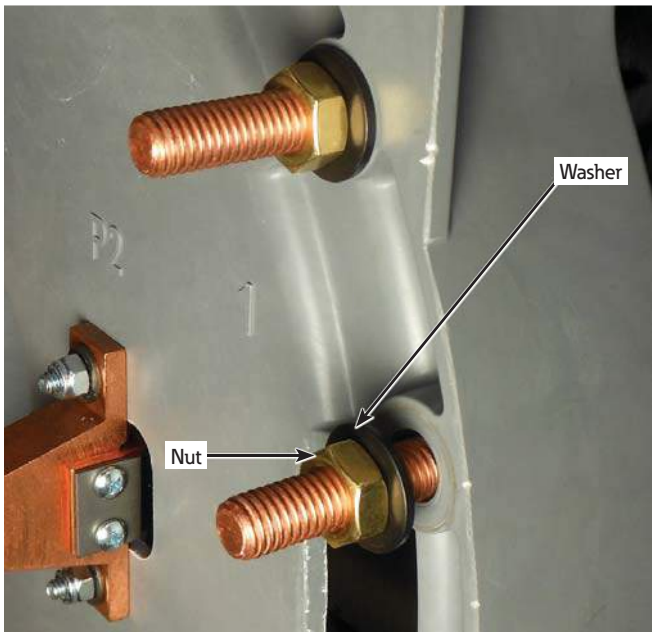

Figure 60. Contact hardware installation

9. Repeat steps 4 through 8 for each stationary contact to be replaced.
10. Reinstall the copper bars and leads to the positions noted in step 2 and secure with the hardware removed earlier. Tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm).
11. Once the work has been completed, place the tap changer in the neutral position. See **Placing tap changer into neutral**.

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 61.

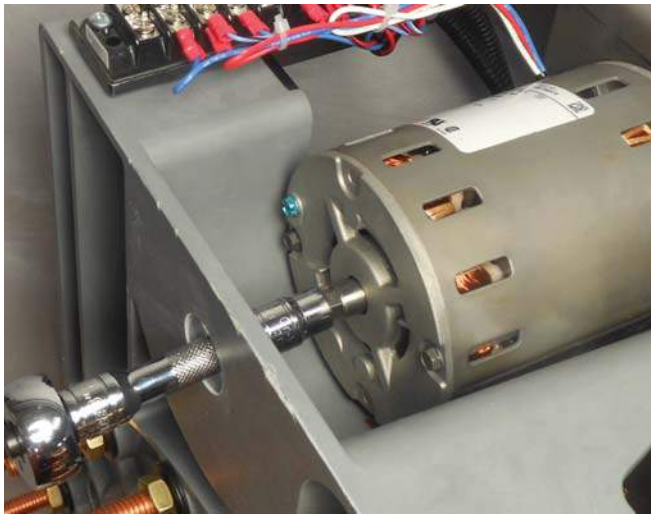

Figure 61. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:
   A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 62.

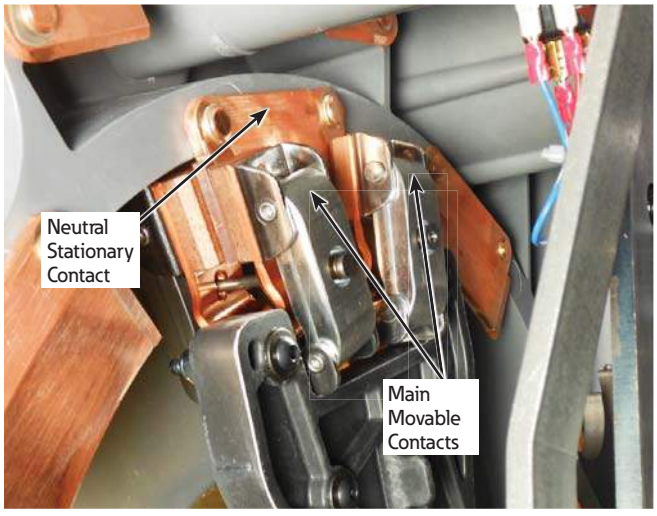

Figure 62. Neutral stationary contact position for main movable contacts

B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 63.

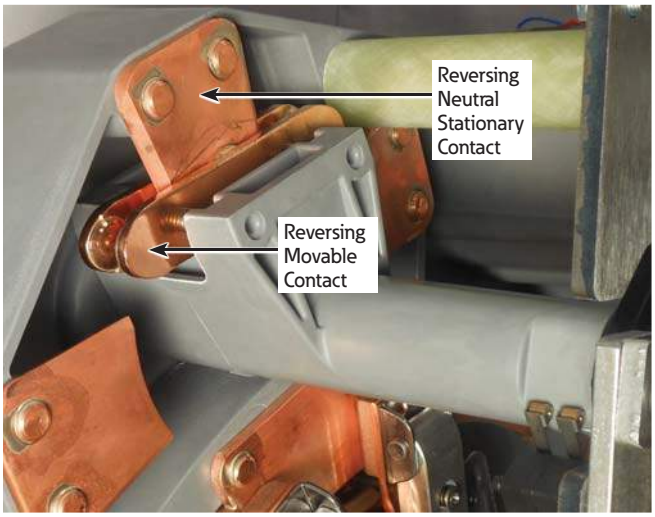

Figure 63. Neutral position for reversing movable contact

C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 64.

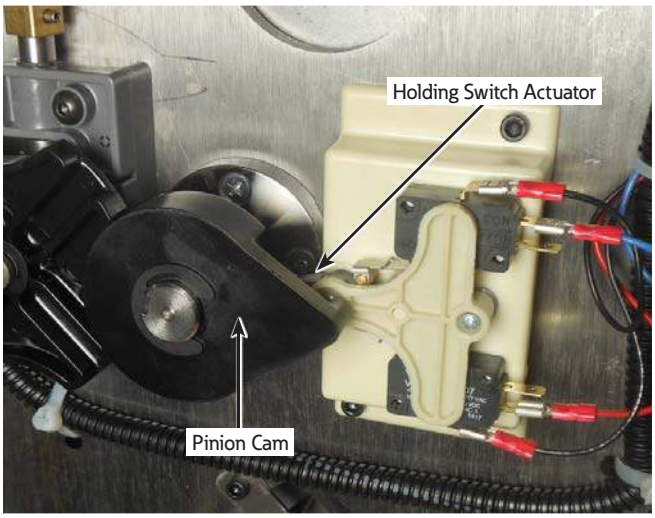

Figure 64. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 65.

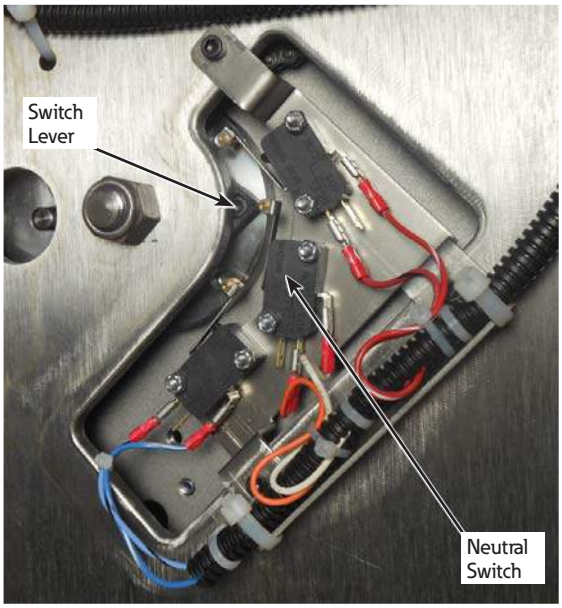

Figure 65. Neutral switch is depressed

Main movable contact assembly kit number 5740785B16

(Refer to Service Information MN225039EN.)

General

The purpose of this replacement kit is to provide the parts and installation instructions for replacing the main movable contacts on the polymer version of the QD8 Quik-Drive tap changer.

Parts supplied

Table 5. Main movable contact assembly kit number 5740785B16

Item	Part Number	Description	Qty
1	0740785B16	Main Movable Contact Assembly	2
2	0800073753Z	Screw, 1/4-20 X 1.7	4
3	0800070894Z	Flat Washer	8
4	0803935A18	Belleville Washer	4
5	0891663A10	Teflon Washer	1
6	0800073777Z	Locknut 1/4-2	4

Tools required

- 3/8 inch ratchet wrench
- 3/8 inch ratchet extension
- 3/8 inch socket
- 3/4 inch deep-well socket
- 9/64 inch Allen wrench
- 5/32 inch Allen wrench
- Torque wrench for in-lbs
- Phillips-head screwdriver
- Loctite® 243 Threadlocker

Figure 66. Main movable contact kit

Installation procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.
2. It is recommended to start this procedure with the tap changer in the neutral position. See the section **Placing tap changer into neutral** located after the installation procedure.
3. Using a 3/4" wrench, remove the nuts and jam nuts holding the lead and copper bar from the number 1 contact and then remove the connections. See Figure 67.

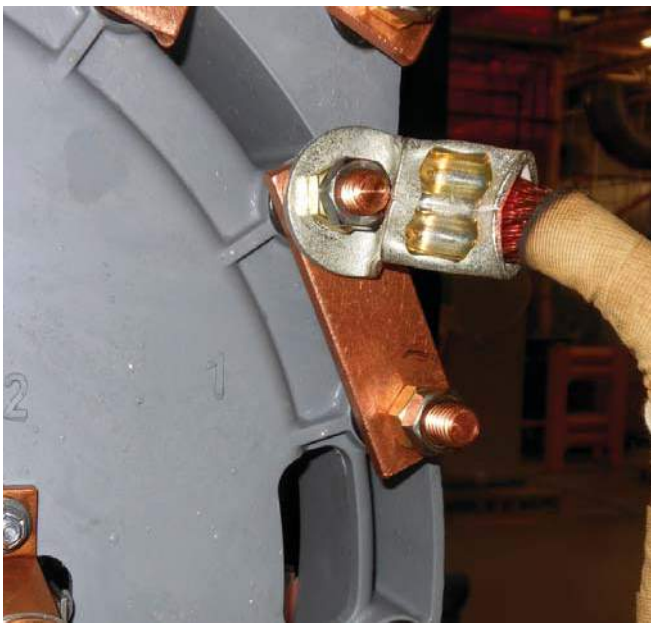

Figure 67. Removal of connections to number 1 stationary contact

4. Remove the number 1 stationary contact from the polymer contact board using a 3/4" deep-well socket. See Figure 68.

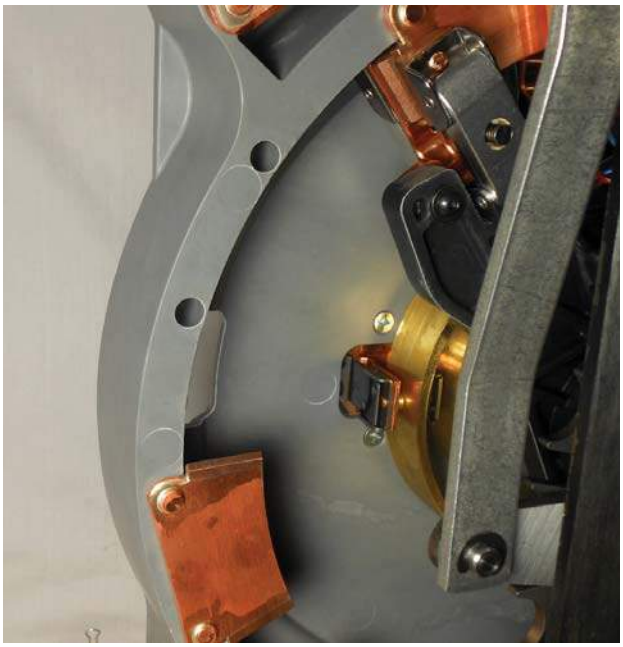

Figure 68. Removal of number 1 stationary contact

5. Loosen, but do not remove the two screws and nuts on the P1 and P2 terminals on the back of the contact board using a Phillips-head screwdriver and 3/8" wrench. This will loosen the P1 and P2 button contact springs. See Figure 69.

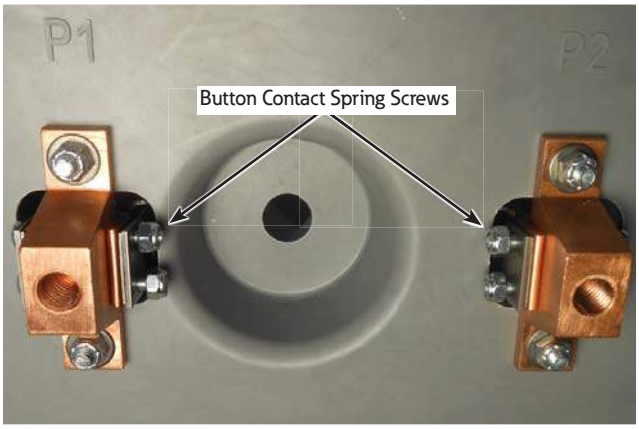

Figure 69. Loosening the button contact springs

6. Remove the two bolts that mount the actuator finger using a 3/8" wrench and then remove the actuator by tilting it up. See Figure 70.

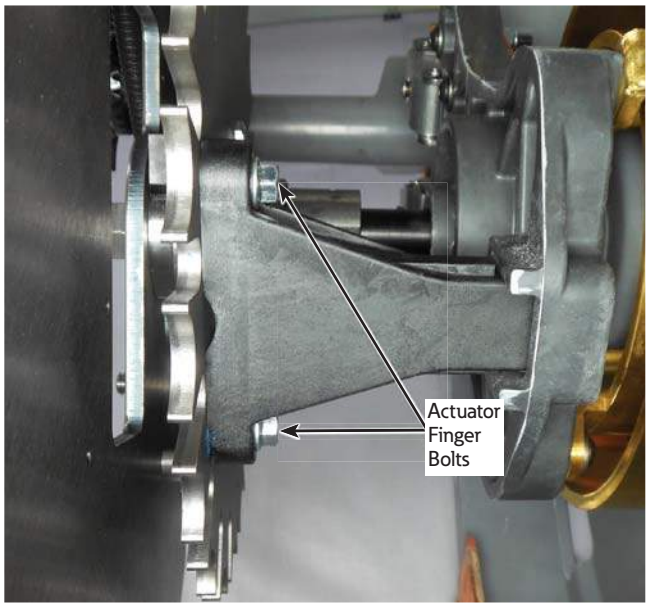

Figure 70. Actuator finger removal

7. Using a 9/64" Allen wrench, remove the screw holding together the two sections of the main shaft. See Figure 71.

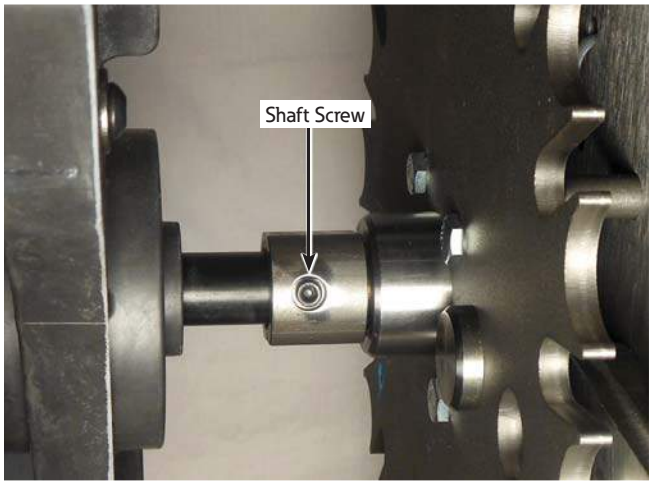

Figure 71. Remove screw from main shaft

8. Pull the black polymer portion of the main shaft from the rear and remove it. See Figure 72.

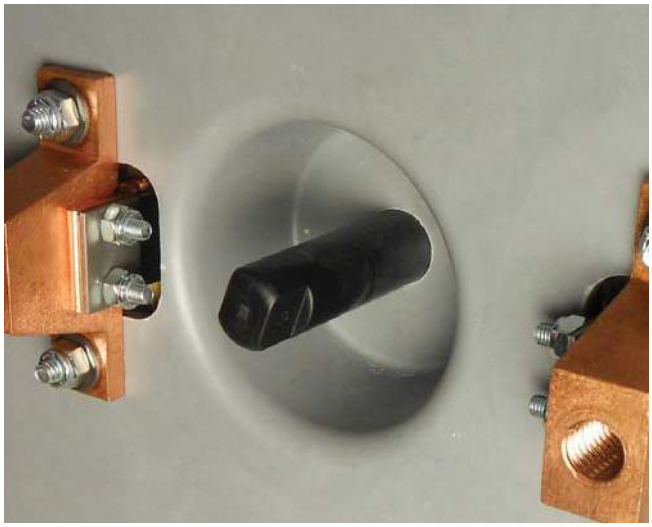

Figure 72. Removal of the polymer portion of main shaft

9. Rotate the main movable contact panel toward the space created when the number 1 stationary contact was removed (Figure 73) and then pull the movable contact board to free it from the collector rings. Carefully remove the assembly from inside the tap changer.

Figure 73. Rotating and removing the movable contact panel assembly

10. Remove the two screws, nuts, washers, and Belleville washers that secure each contact to the movable contact panel using a 5/32" Allen wrench and a 7/16" socket. See Figure 74 and Figure 75.

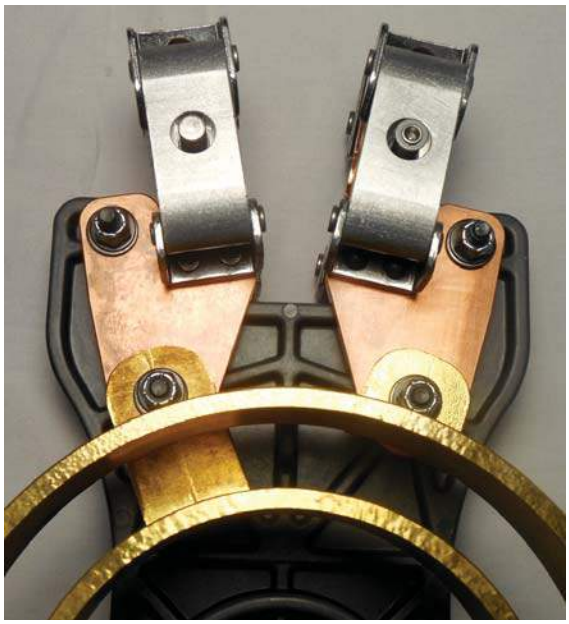

Figure 74. Movable contact removal from contact panel and collector rings

Figure 75. Use 5/32" Allen wrench for screw removal

11. The two movable contact assemblies are identical and can be installed in either position on the movable contact panel. Position one of the replacement movable contact assemblies between the contact ring and the movable contact panel and align the holes. Insert a screw with flat washer through each hole from the contact panel side (Figure 75). Place a flat washer, Belleville washer (cupped side down) and nylon locknut onto each screw (Figure 76). Tighten the nuts to 65–75 in-lbs (7.3–8.5 Nm) using a 7/16" deep well socket while holding the screw in place with the 5/32" Allen wrench. Repeat this procedure for the second movable contact assembly. The assembly should look like Figure 75 and Figure 76 when completed.

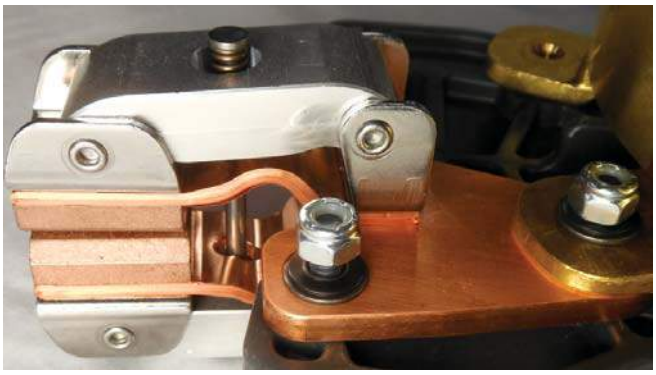

Figure 76. Installing the hardware to attach the movable contacts to the contact panel

12. Place the new Teflon washer in the recess on the back of the movable contact panel as shown in Figure 77.

Figure 77. Teflon washer placed in contact panel recess

13. Position and center the movable contact panel assembly in the molded panel cavity with the contact rings facing the molded panel locating the movable contacts in the area of the removed number 1 stationary contact as shown in Figure 78. Take care that the Teflon washer does not fall out of place. The collector rings will slip between the P1 and P2 button contacts.

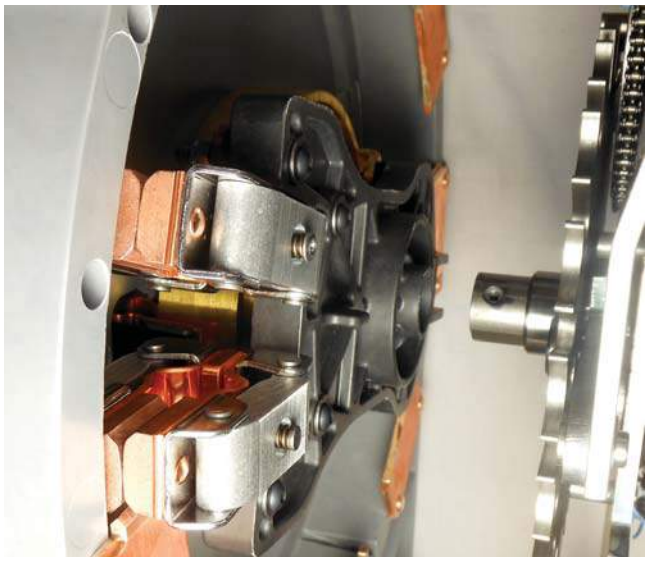

Figure 78. Movable contacts in tap-changer cavity

14. Rotate the movable contacts over the neutral stationary contact (Figure 79).

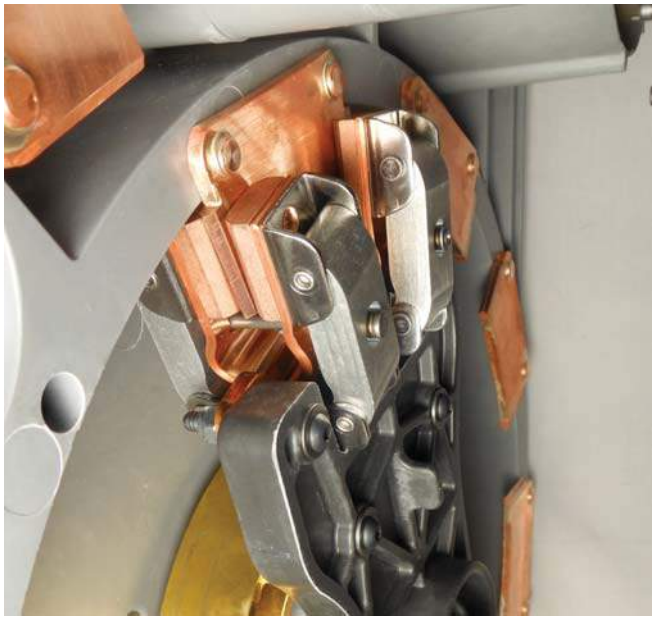

Figure 79. Movable contacts rotates over the neutral stationary contact

15. Insert the polymer portion of the main shaft through the back of the contact board (Figure 80). Push it all the way through until it inserts into the metal portion of the main shaft. Rotate the polymer shaft to line up the holes in both parts of the shaft (Figure 81).

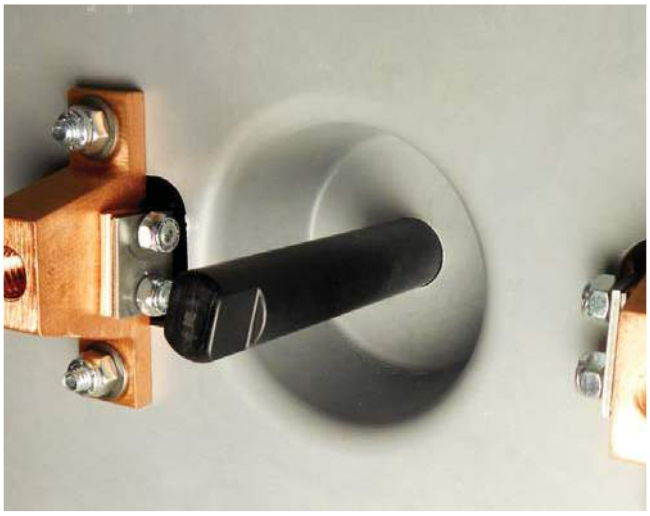

Figure 80. Inserting the polymer shaft into the contact board

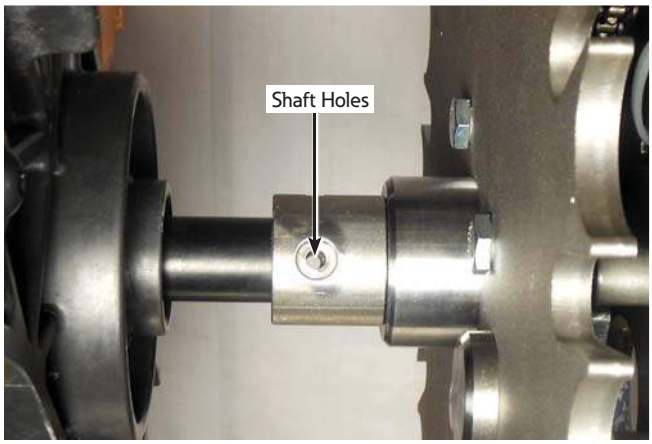

Figure 81. The holes in the two shafts line up

16. Install the screw to attached the two parts of the main shaft and tighten to a torque of 10–15 in-lbs (1.3–1.7 Nm). See Figure 82.

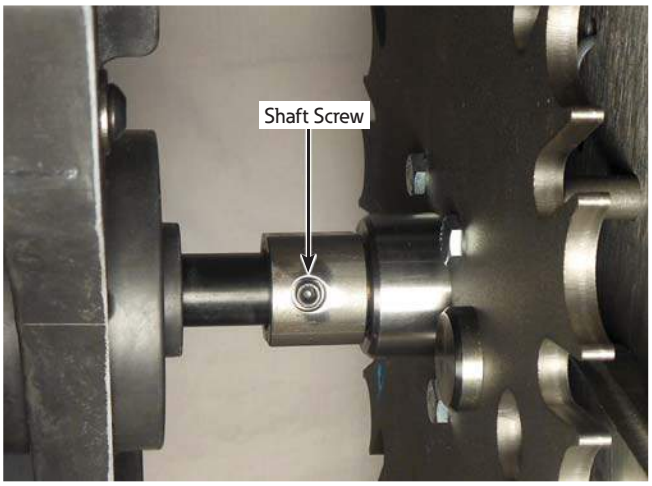

Figure 82. Screw installed to attached two sections of the main shaft

17. Use a 3/8" wrench and Phillips-head screwdriver to tighten the screws and nuts on the rear of the P1 and P2 contacts to a torque of 45–55 in-lbs (5.0–6.2 Nm). See Figure 83.

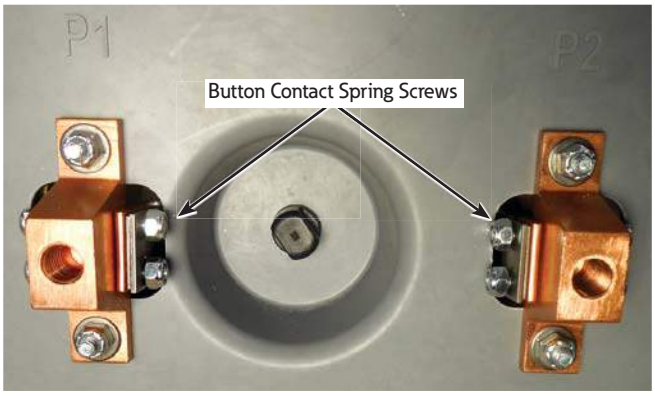

Figure 83. Tighten the screws on the P1 and P2 terminals

18. Apply Loctite® 243 Threadlocker to the two actuator finger bolts (Figure 84).

Figure 84. Actuator finger bolts with Loctite® Threadlocker

19. Install the actuator finger and bolts. Tighten the bolts using a 7/16" socket to a torque of 65–75 in-lbs (7.3–8.5 Nm). It may be necessary to reposition the movable contact panel slightly if the bolt holes in the finger and Geneva gear do not quite line up. See Figure 85.

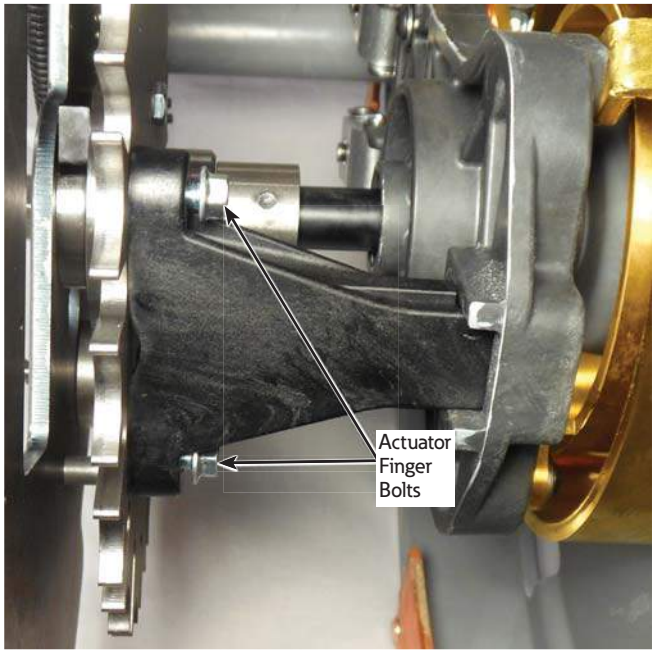

Figure 85. Positioning the actuator finger and tightening the bolts

20. Ensure that the tap changer has remained in the neutral position. See **Placing tap changer into neutral**.
21. Reinstall the number 1 stationary contact. Place a Belleville washer with the cupped face in and a nut onto each contact stud and tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm).
22. Reinstall the copper bar and lead to the number 1 stationary contact to reverse the process from step 3. These nuts should also be tightened to a torque of 180–192 in-lbs (20.3–21.7 Nm).

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 86.

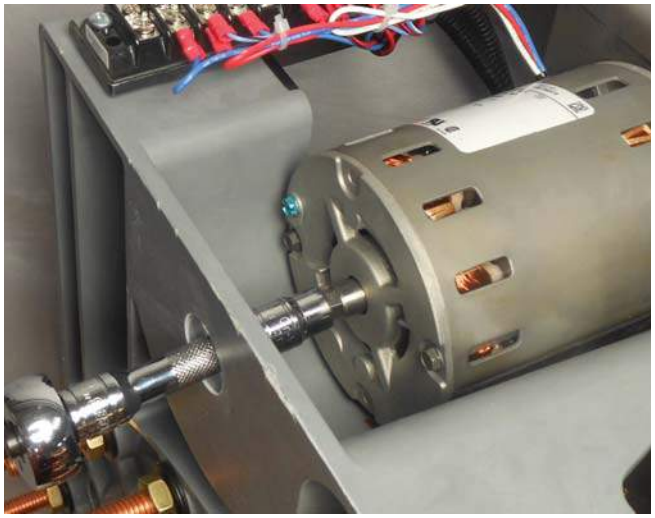

Figure 86. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:
   A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 87.

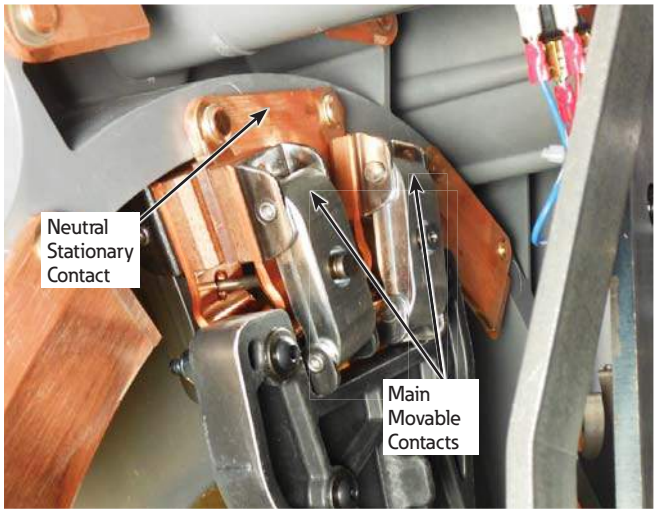

Figure 87. Neutral stationary contact position for main movable contacts

B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 88.

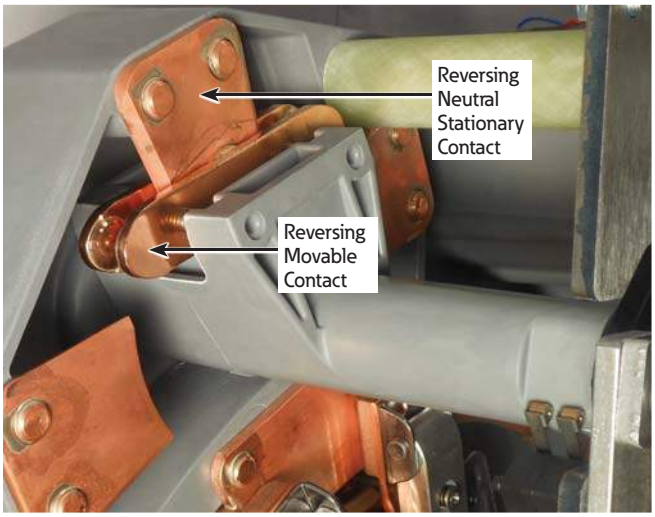

Figure 88. Neutral position for reversing movable contact

C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 89.

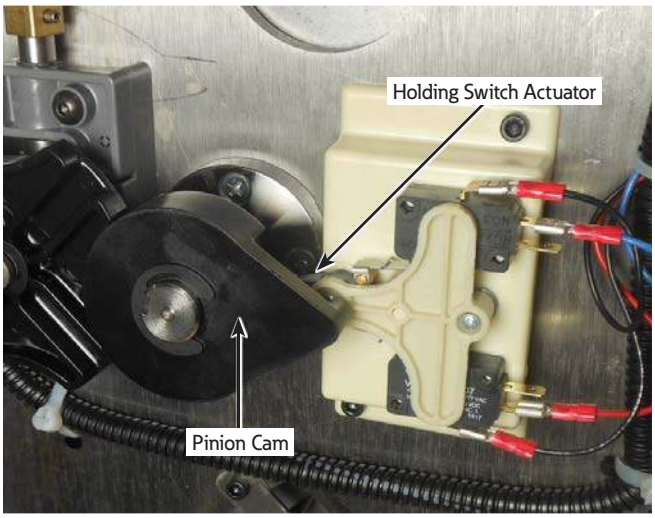

Figure 89. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 90.

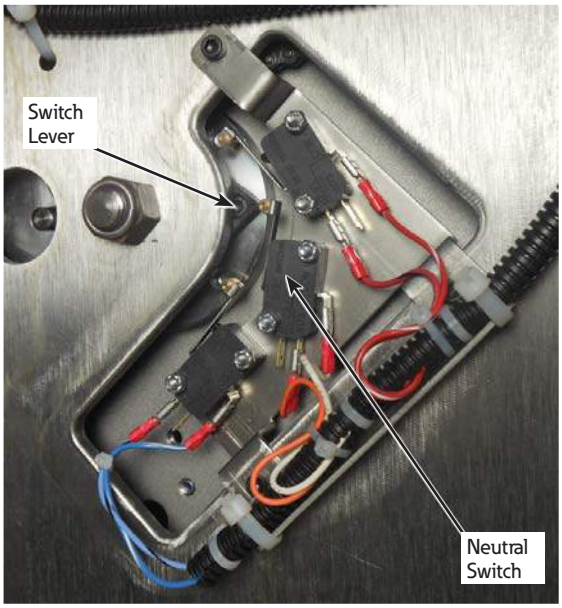

Figure 90. Neutral switch is depressed

VR or VL reversing switch stationary contact assembly kit number 5791646A48

(Refer to Service Information MN225037EN.)

General

The purpose of this replacement kit is to provide the parts and installation instructions for replacement of the VR and VL reversing switch stationary contacts on the polymer version of the QD8 Quik-Drive tap changer. Each tap changer has one VR and one VL reversing switch stationary contact.

Parts supplied

Table 6. VL or VR reversing switch stationary contact kit number 5791646A48

Item	Part Number	Description	Qty
1	0791646A48	VR or VL Reversing Switch Stationary Contact	1
2	08000050001Z	Belleville Washer	2
3	0892568A02	Jam Nut	2

Tools required

- 3/8 inch drive ratchet wrench
- 3/8 inch drive extension
- 3/8 inch Socket
- 3/4 inch deep-well socket
- Torque wrench for in-lbs

Figure 91. VL or VR reversing stationary contact kit

Installation procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.

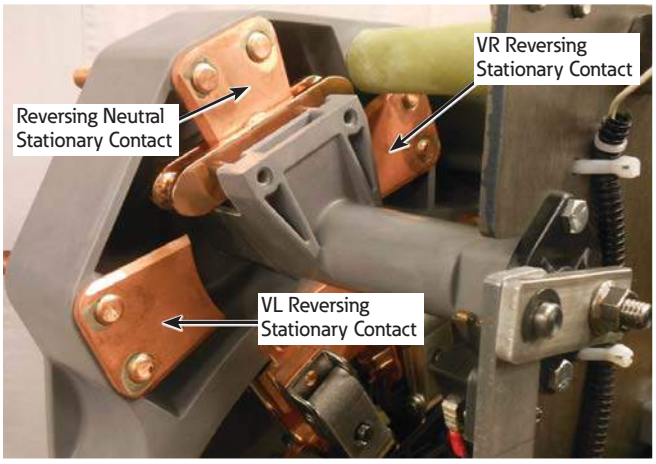

Figure 92. VR and VL reversing switch stationary contact locations

Note: A sheet wrapped around and below the tap changer can be used to catch dropped hardware before it falls into the tank.

2. Carefully mark the leads before any disassembly. Photos can be helpful to assist in remembering the arrangement of the connections. See Figure 93.
3. Using a 3/4" wrench, remove the nuts and jam nuts holding the leads and copper bars from the contacts to be replaced and then remove the connections.

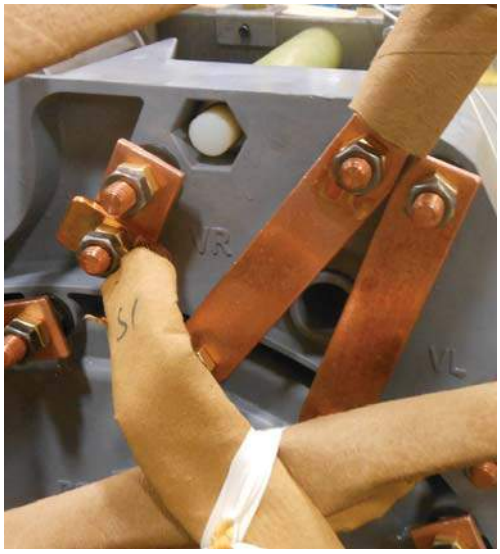

Figure 93. Take note of connections before disassembly

4. If the reversing movable contacts are setting on the VR or VL reversing switch stationary contact, place a 3/8" socket onto the rear shaft of the motor. See Figure 94. Using a ratchet, rotate the motor shaft to move the reversing movable contacts off of the reversing switch stationary contacts. It may be necessary to rotate the tap changer through several positions before the movable reversing contact will begin to move.

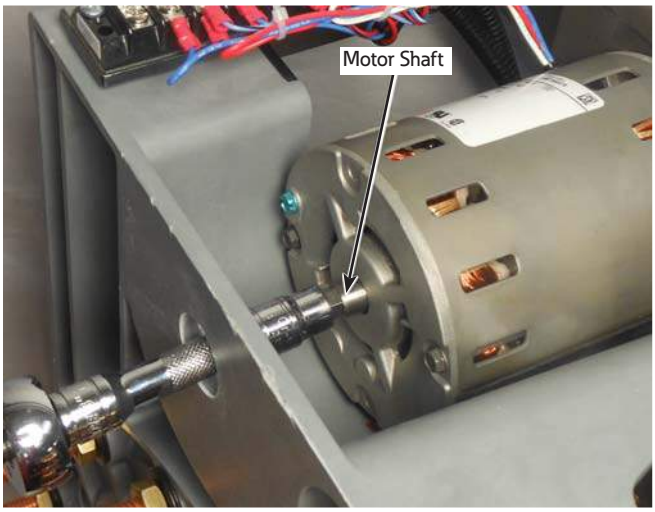

Figure 94. Motor and reversing movable contact rotation

5. Use a 3/4" socket and ratchet to loosen and remove the nuts and flat washers from each of the contact studs to be removed. See Figure 95.

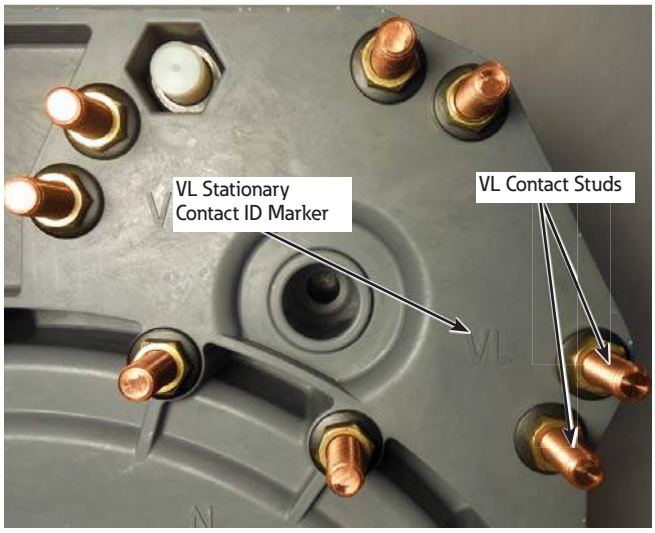

Figure 95. VR and VL reversing switch stationary identification and hardware

6. Remove the VR and/or VL reversing switch stationary contact from the contact assembly panel. See Figure 96.

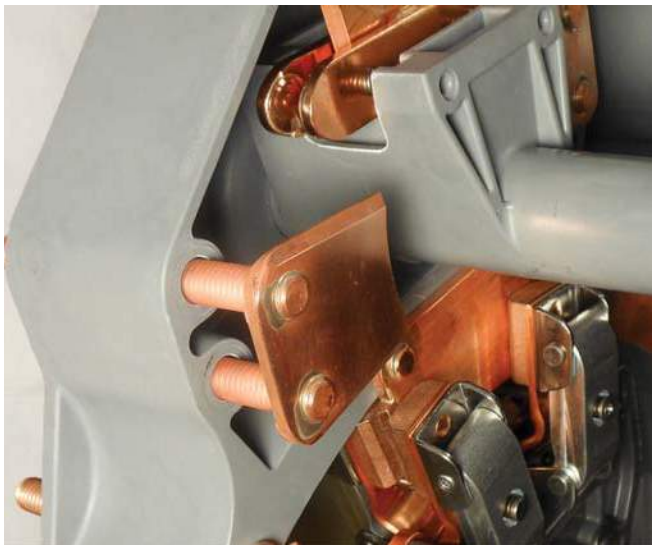

Figure 96. VL reversing switch stationary contact removal

7. Install the new VR and/or VL reversing switch stationary contact into the mounting holes in the contact assembly board. The VR and VL contacts are identical and interchangeable.

8. Place a new Belleville washer and nut on each stud. The cupped side of the Belleville washer must face in toward the contact board. Use a 3/4" socket and ratchet to tighten the nuts on each contact stud. Using a torque wrench tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm). See Figure 97.

Figure 97. VL reversing stationary hardware

9. Reinstall the copper bars and leads to the positions noted in step 2 on page 35 and secure with the hardware removed earlier. Tighten the nuts to a torque of 180–192 in-lbs (20.3–21.7 Nm).

10. Once the work has been completed, place the tap changer in the neutral position. See **Placing tap changer into neutral**.

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 98.

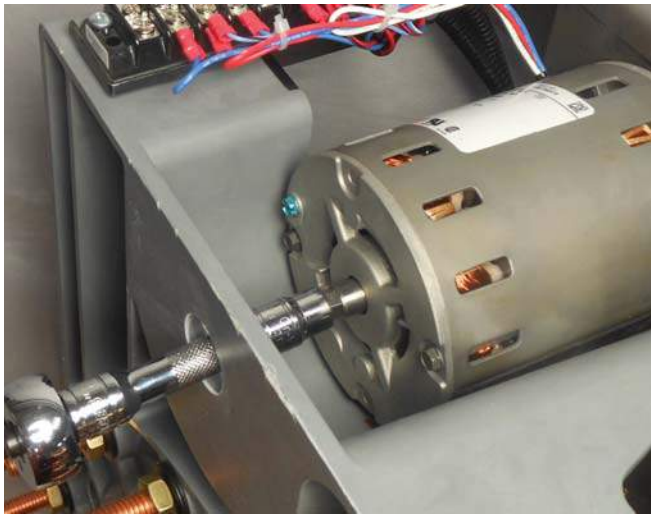

Figure 98. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:

   A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 99.

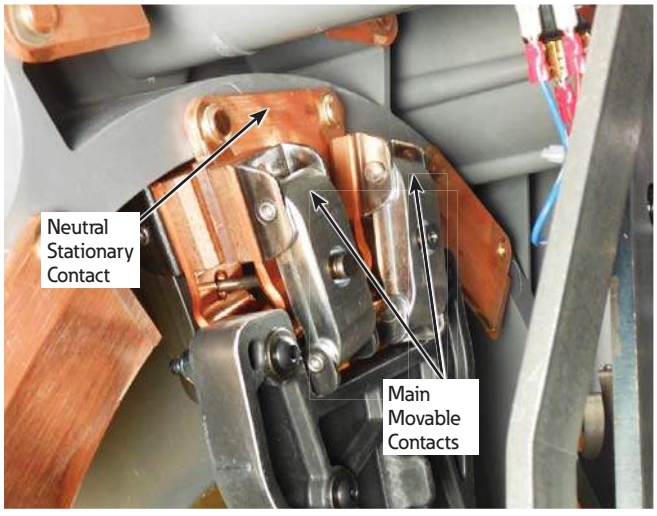

Figure 99. Neutral stationary contact position for main movable contacts

B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 100.

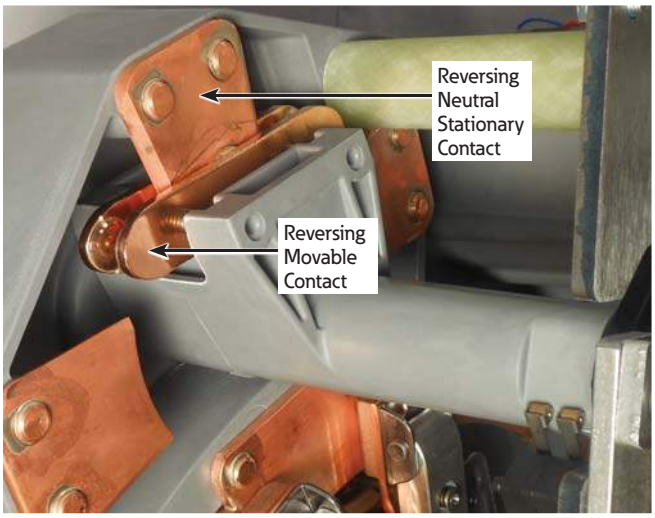

Figure 100. Neutral position for reversing movable contact

C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 101.

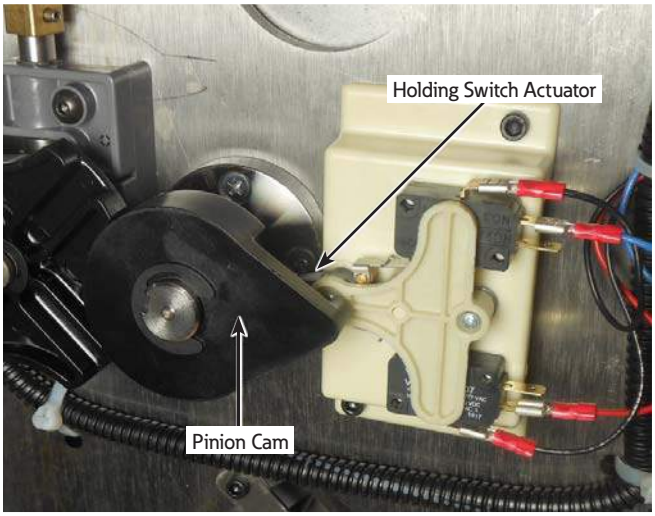

Figure 101. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 102.

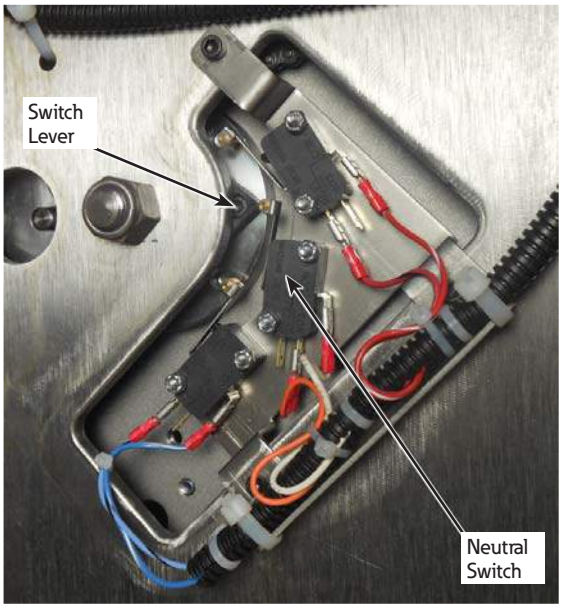

Figure 102. Neutral switch is depressed

Motor assembly kit number 57A63675100A

(Refer to Service Information MN225038EN.)

General

The purpose of this replacement kit is to provide the parts and installation instructions for replacing the motor on the polymer version of the QD8 Quik-Drive tap changer.

Parts supplied

Table 7. Motor assembly kit number 57A63675100a

Item	Part Number	Description	Qty
1	2242190B01	Motor Assembly	1
2	TAA114651003	Ring Terminal	3
3	0800011079Z	Wire Tie	3
4	2240787B34	Sprocket, 12-tooth (black)	1
5	2291647A34	Woodruff Key	1
6	0800073173Z	Retaining Ring	2
7	0800073190Z	Machine Screw, 8-32X0.5	4
8	2240787B44	Sprocket, 11-tooth (silver)	1

Tools required

- 3/8 inch drive ratchet wrench
- 3/8 inch drive ratchet extension
- 1/4 inch socket
- 3/8 inch socket
- 7/16 inch socket
- 9/16 inch ratcheting box end wrench
- Phillips-head screwdriver #2
- Standard blade screwdriver
- Diagonal cutters
- External snap ring pliers
- Torque wrench for in-lbs
- Crimping tool
- Pliers

Figure 103. Motor assembly kit

Removal and disassembly procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.
2. It is recommended to start this procedure with the tap changer in the neutral position. See the section **Placing tap changer into neutral** located after the installation procedure.
3. Use diagonal cutters to cut the wire ties from the motor wires. See Figure 104.

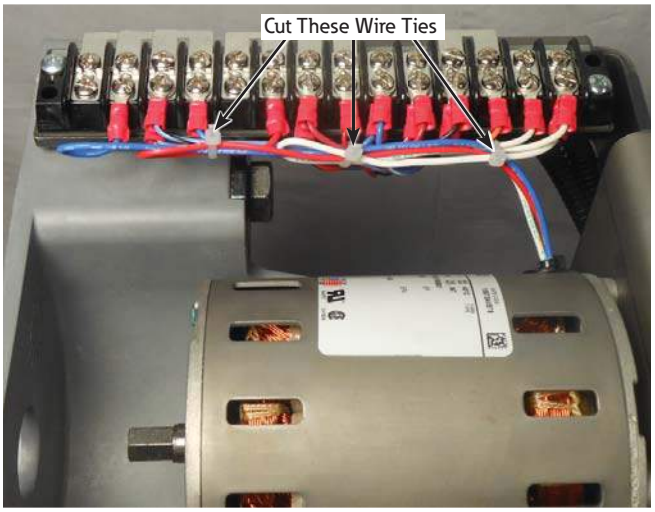

Figure 104. Removal of wire ties

4. Use a Phillips-head screwdriver to disconnect the white motor wire located on terminal "G," the red motor wire located on terminal #6 and the blue motor wire located on terminal #2. See Figure 105.

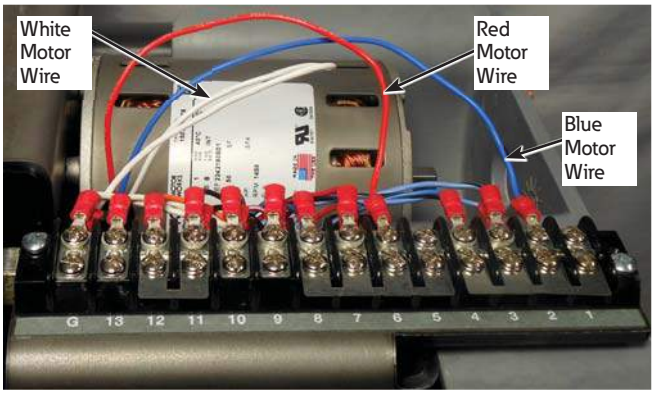

Figure 105. Disconnection of wires

5. Loosen the locknut on the chain tension screw with a 7/16" wrench. Loosen the chain tension screw with a screwdriver until the rubber bumper is against the motor mounting bracket. See Figure 106.

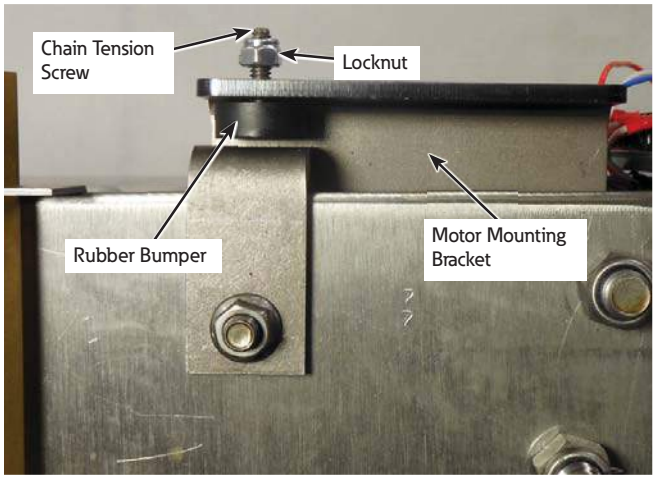

Figure 106. Loosening the chain tension

6. Remove the motor pivot stud locknut with a 9/16" ratcheting wrench. Pull the motor off of the motor pivot stud; make sure the Belleville washer stays on the motor pivot stud and does not fall into the tank. Set the motor in the motor relief area of the molded back panel. See Figure 107 and Figure 108.

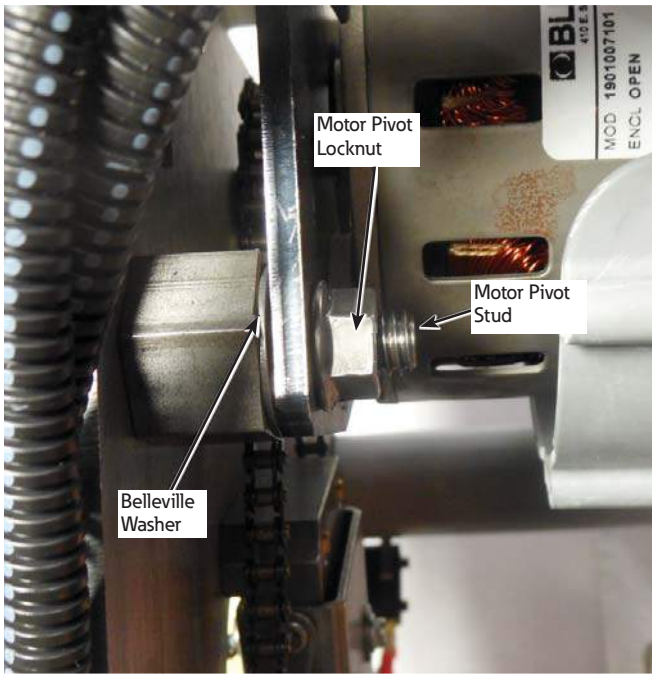

Figure 107. Motor pivot stud

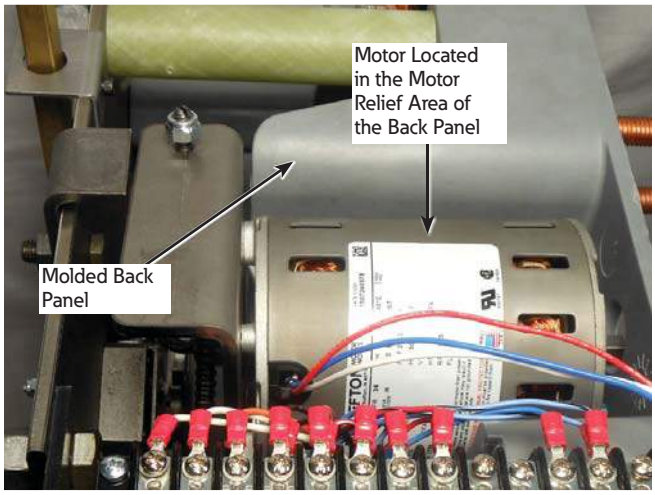

Figure 108. Removal of the motor

7. Remove the chain from the motor sprocket and set it on the brake assembly as shown in Figure 109. Lift the motor out of the relief area.

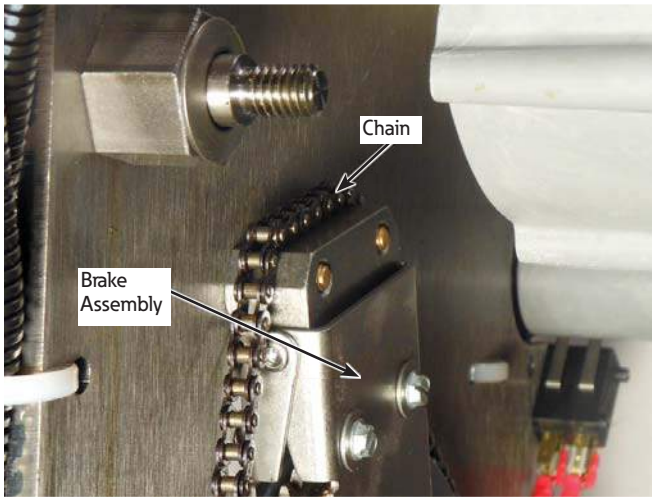

Figure 109. Removal of the chain

8. Remove the four screws securing the motor to the motor mounting plate using a 1/4" socket on a ratchet. Remove the motor mounting plate from the old motor. See Figure 110.

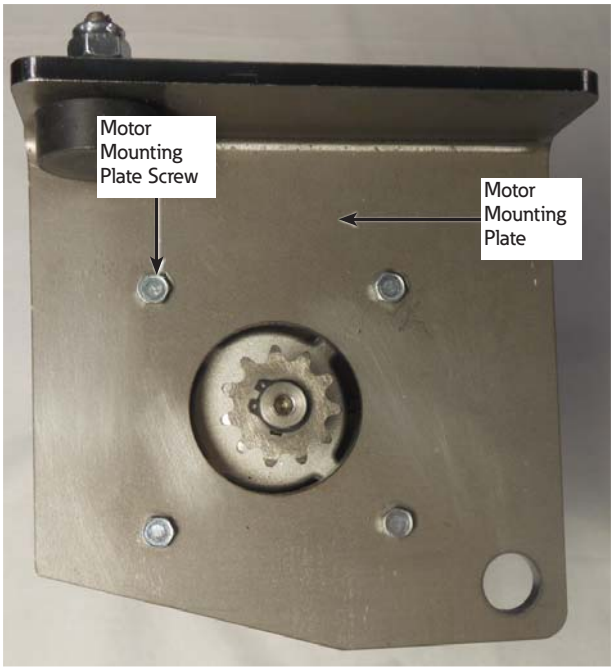

Figure 110. Removal of the motor plate

Reassembly and installation procedure

9. The new motor kit has a 12-tooth sprocket (black) for the phenolic QD8 tap changer and an 11-tooth sprocket (silver) for the polymer QD8 tap changer. The motor shaft has two snap ring grooves and a Woodruff keyway. Install a snap ring with a snap ring pliers into the inner snap ring groove behind the Woodruff keyway. Using a pliers, squeeze the Woodruff key into the keyway with the Woodruff key tilted slightly down towards the end of the motor shaft. See Figure 111.

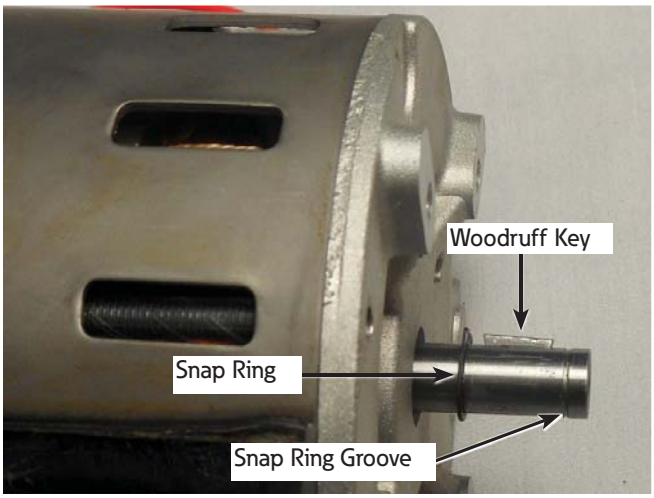

Figure 111. Woodruff key placement

10. Align the sprocket keyway with the Woodruff key on the motor shaft. Slide the sprocket onto the motor shaft with the sprocket hub end towards the motor. Install the second snap ring into the outer snap ring groove using a snap ring pliers. See Figure 112.

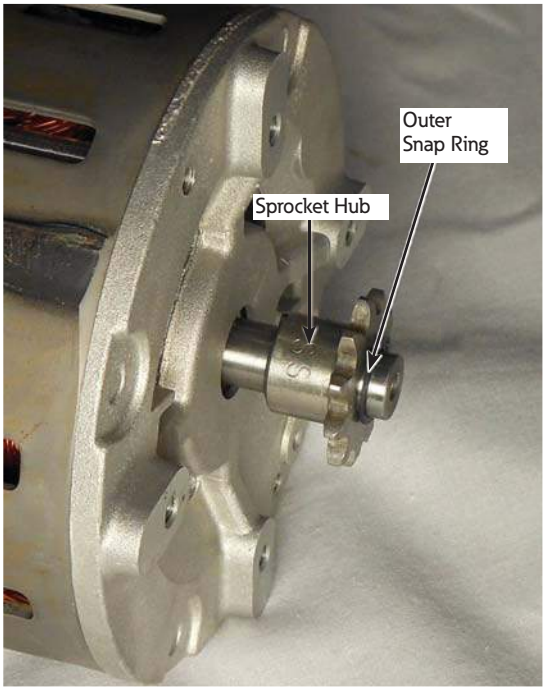

Figure 112. Placement of the sprocket

11. Use a 1/4" socket on a ratchet attach the motor mounting plate to the new motor using the new motor mounting plate screws provided in the motor replacement kit. Do not fully tighten. Make sure the motor wires are extending out of the top right of the motor when looking at the motor from the sprocket end. See Figure 113. Using a torque wrench, tighten the motor plate mounting screws to 18–20 in-lbs (2.0–2.2 Nm).

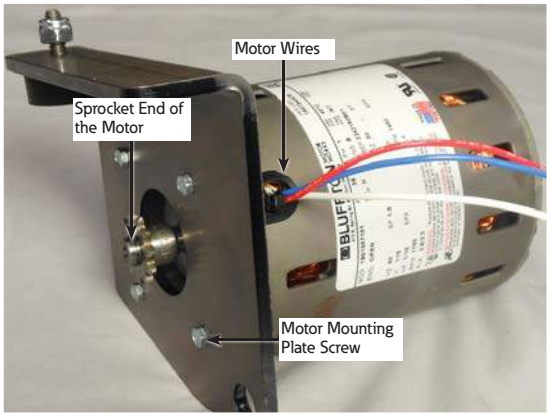

Figure 113. Motor mounting plate

12. Place the motor into the motor relief area of the molded back panel. Pull the chain under the drive sprocket gear insuring that the chain fully engages the sprocket teeth. Pull the chain up and onto the motor sprocket teeth. If there are any loose links around the bottom of the drive sprocket gear, the motor will not fit properly. See Figure 114.

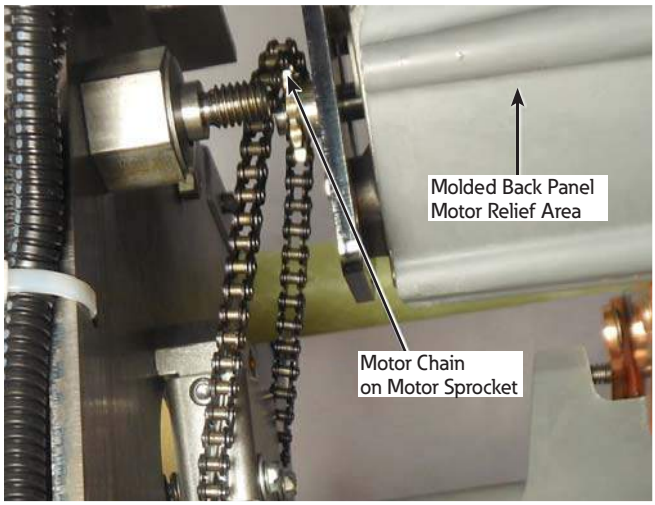

Figure 114. Locating motor

13. Ensure that the Belleville washer is installed over the motor-mount stud with the cupped side facing in. See Figure 115.

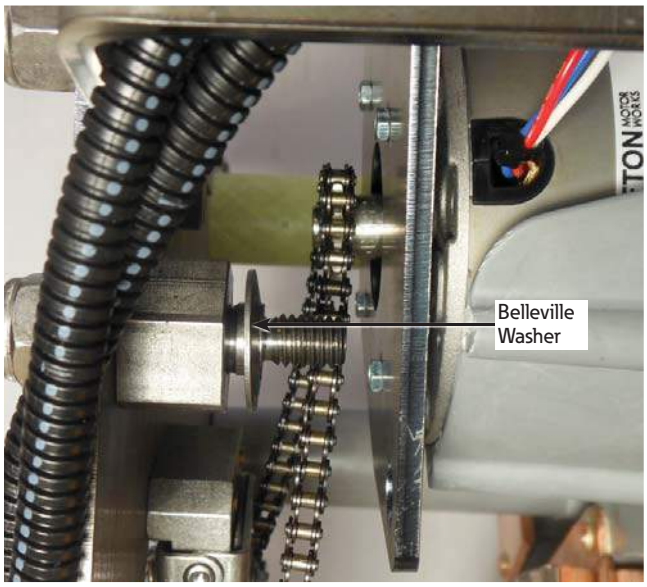

Figure 115. Belleville washer on the motor mounting stud

IMPORTANT

Make sure that the mounting hole in the motor mounting bracket is fully seated on the shoulder of the mounting stud. If it is not fully seated, the chain may bind and fall off. See Figure 116 and Figure 117.

14. Move the motor assembly into position with the motor chain adjustment screw bumper located on top of the adjustment bracket and the motor pivot stud inserted through the mounting hole in the motor mounting plate. Secure the motor mounting plate to the motor pivot stud with the locknut removed in step 6. See Figure 116 and Figure 117. Tighten the nut snugly, but not tightly.

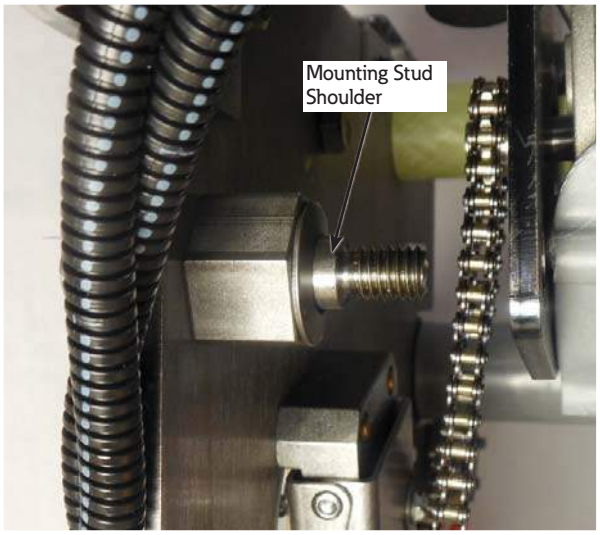

Figure 116. Belleville washer on the motor mounting stud

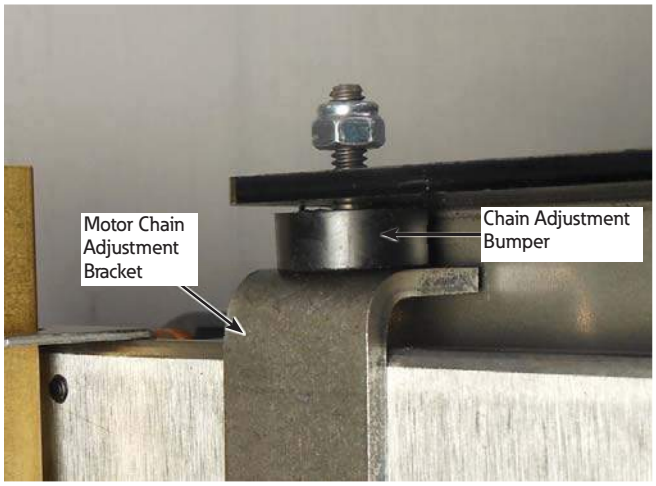

Figure 117. Motor positioning

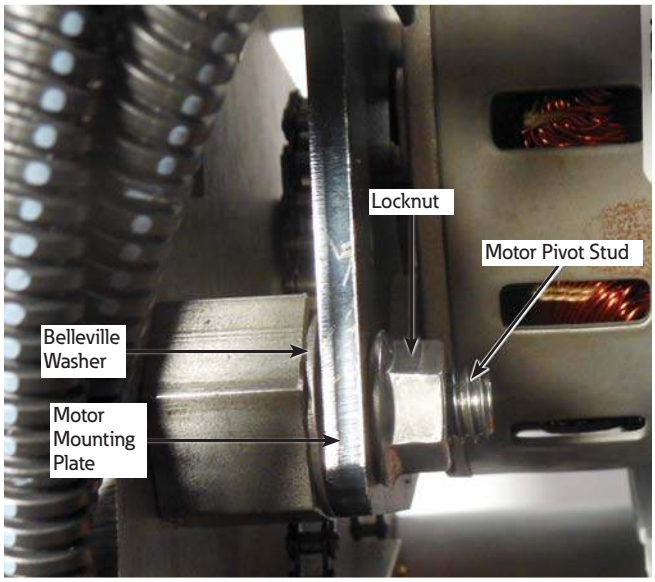

Figure 118. Motor mounting plate properly seated on the mounting stud shoulder. Notice that there is no gap between the motor mounting plate and Belleville washer.

15. Adjust the chain tension by turning the motor bumper screw with a blade screw driver. Adjust the motor mount bumper screw until 1/4" deflection exists when exerting pressure on the chain. Secure the motor mount bumper screw in place with the locknut using a 7/16" wrench. See Figure 119.

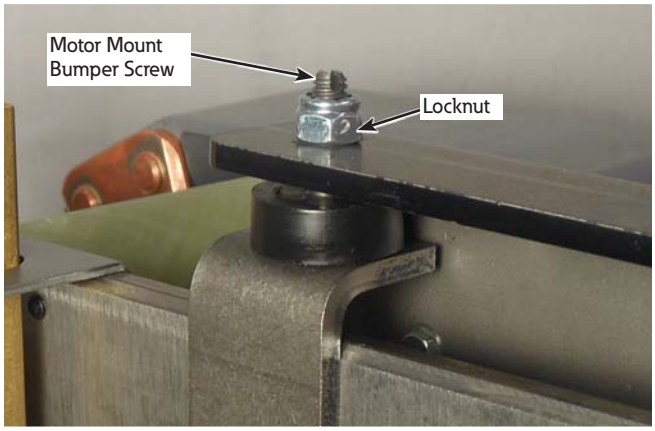

Figure 119. Chain tension

16. Using a torque wrench tighten the pivot motor stud locknut to 180–192 in-lbs (20.0–21.1 Nm). See Figure 118.
17. Trim the motor wires with a diagonal cutter to a length of 8 inches. Crimp one of the supplied ring tongue connectors to the end of each wire.

18. Attach the terminals to the motor connection points on the terminal board as follows:
    - White wire connects to terminal G
    - Red wire connects to terminal #6
    - Blue wire connects to terminal #2

    See Figure 120.

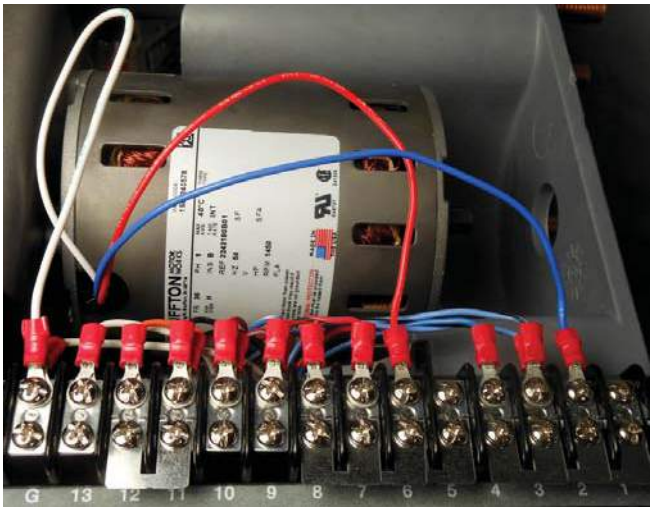

Figure 120. Wiring connections

19. Use the wire ties provided in the motor replacement kit to bundle all the wires near the terminal board. Trim the excess length of the wire ties. See Figure 121.

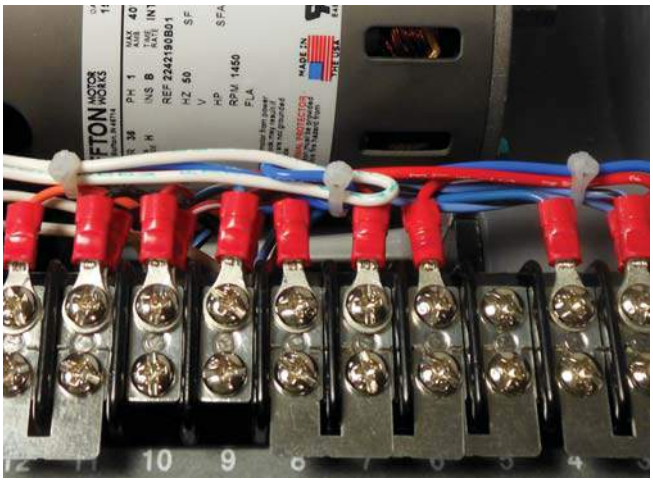

Figure 121. Wire fastening

20. Ensure that the tap changer is in the neutral position when the work is completed. See **Placing tap changer into neutral**.

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 122.

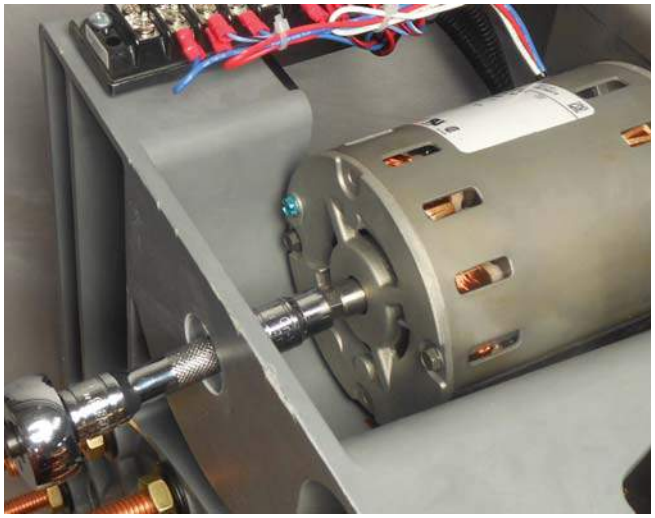

Figure 122. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:
    A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 123.

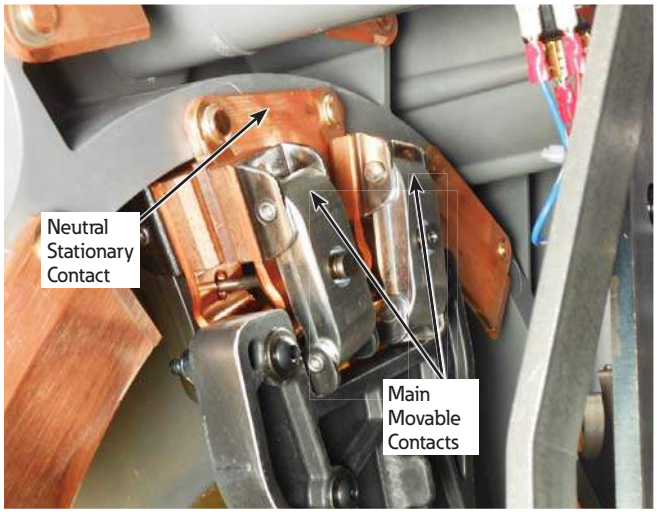

Figure 123. Neutral stationary contact position for main movable contacts

B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 124.

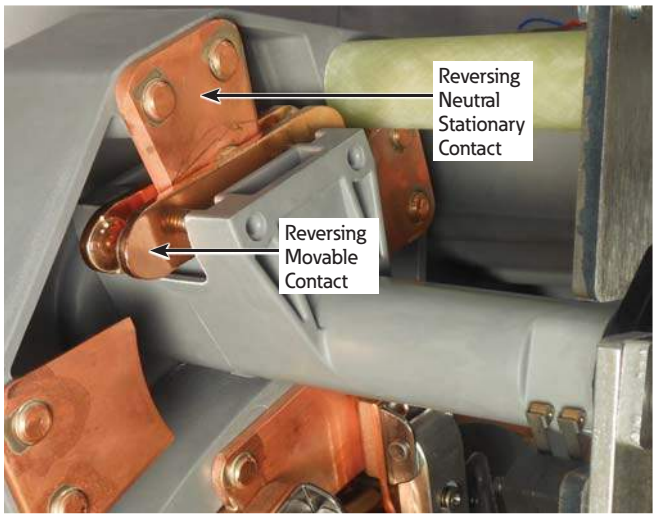

Figure 124. Neutral position for reversing movable contact

C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 125.

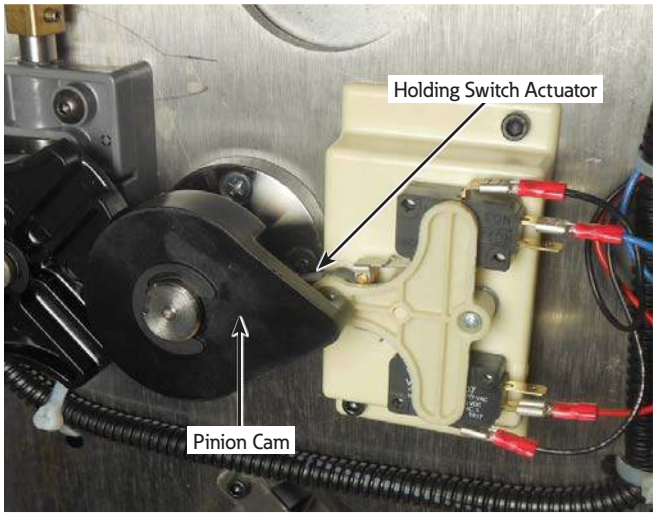

Figure 125. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 126.

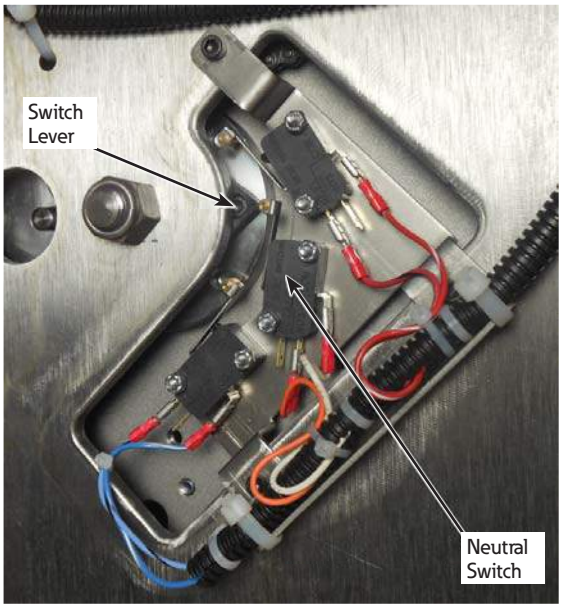

Figure 126. Neutral switch is depressed

Micro-switch kit number 5740794B05

(Refer to Service Information MN225040EN)

General

The purpose of procedure is to provide the installation instructions for replacing of the micro-switches on the polymer version of the QD8 Quik-Drive tap changer. There are seven micro-switches found on the QD8 tap changer—a neutral switch, two logic switches, two safety (limit) switches, and two holding switches (see Service Information MN225009EN for holding switch replacement instructions).

Parts supplied

Table 8. Micro-switch kit number 5740785B16

Item	Part Number	Description	Qty
1	2291660A01	Micro-switch	1

Tools required

- 5/32 inch Allen wrench
- 9/64 inch Allen wrench
- 1/4 inch combination wrench
- 3/16 inch nut driver
- Needle-nose pliers
- Torque wrench
- Loctite® 243 Threadlocker

Figure 127. Micro-switch kit

Installation procedure

1. This procedure may be completed without removal of the tap changer from the voltage regulator. Carefully follow the procedures for partially untanking a voltage regulator in Service Information MN225008EN, *VR-32 voltage regulator with Quik-Drive tap-changer installation, operation, and maintenance instructions*.

Neutral and safety switches

2. Identify the switches to be replaced and the position of these switches on the tap changer. See Figure 128 for neutral and safety switch replacement and Figure 131 for logic switch replacement.

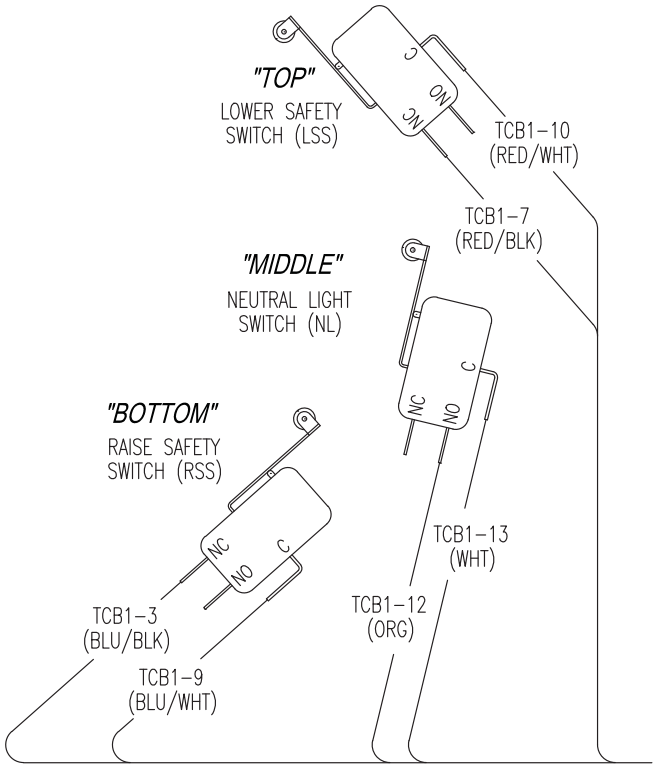

Figure 128. QD8 neutral and safety micro-switches placement and connections

3. Using a 9/64" Allen wrench, remove the three screws holding the switch bracket to the front of the tap changer. See Figure 129.

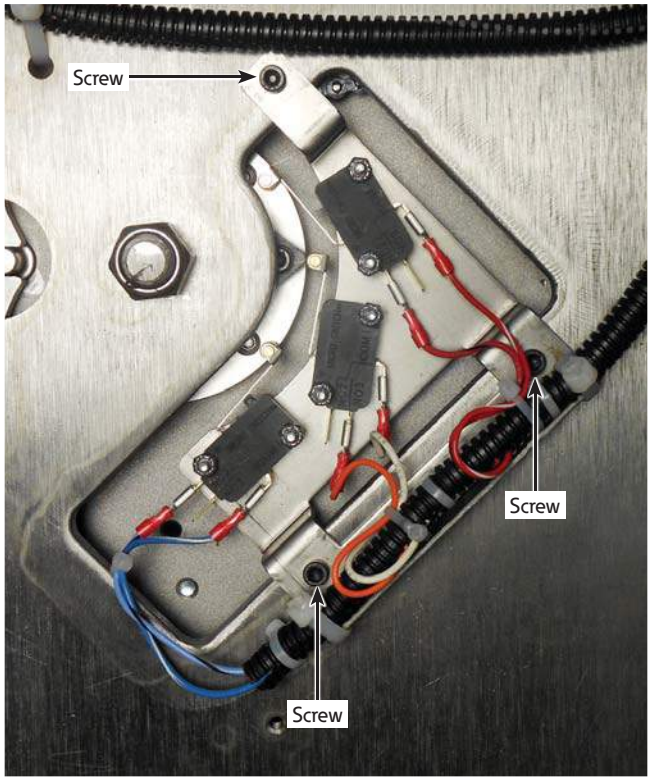

Figure 129. Remove screws holding the bracket

4. Remove the two screws attaching the switch to the bracket using 3/16" nut driver and 1/4" wrench.
5. Disconnect the wires, using a needle-nose pliers by pulling the connectors from the blade terminals on the removed switch.
6. Connect the wires to the new switch by sliding the connectors onto the bladed terminals. Make sure the wires are connected to the correct terminals. View Figure 128 as a guide for the wire connections.
7. Install the new switch on the bracket using the screws removed in step 4, the 3/16" nut driver, and 1/4" wrench. Make sure the switches are oriented correctly. Tighten the screws and nuts to a torque of 4–5 in-lbs (0.5–0.6 Nm).
8. Repeat steps 4–7 for each switch being replaced.
9. Apply a small amount of Loctite® 243 Threadlocker on each of the bracket screws removed in step 3.

IMPORTANT

Take care when installing the switch assembly to avoid damaging the switch actuator arm.

10. Position the switch bracket in place while depressing any switch that may come in contact with the switch lever. If the tap changer is in the neutral position, it will be the neutral switch that must be depressed so that it is not damaged. See Figure 130.

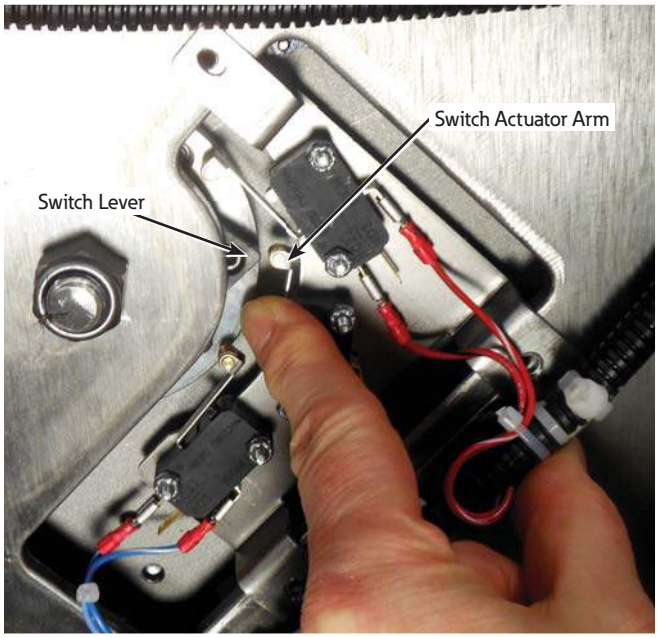

Figure 130. Depressing the neutral switch actuator arm so that it is not damaged by the switch lever

11. Install the three screws to attach the switch bracket and tighten them to a torque of 18–20 in-lbs (2.0–2.3 Nm).
12. Ensure that the tap changer is in the neutral position after completing the installation. See the section **Placing tap changer into neutral** located after the installation procedures.

Logic switches

13. Identify the switches to be replaced and the position of these switches on the tap changer. See Figure 131.

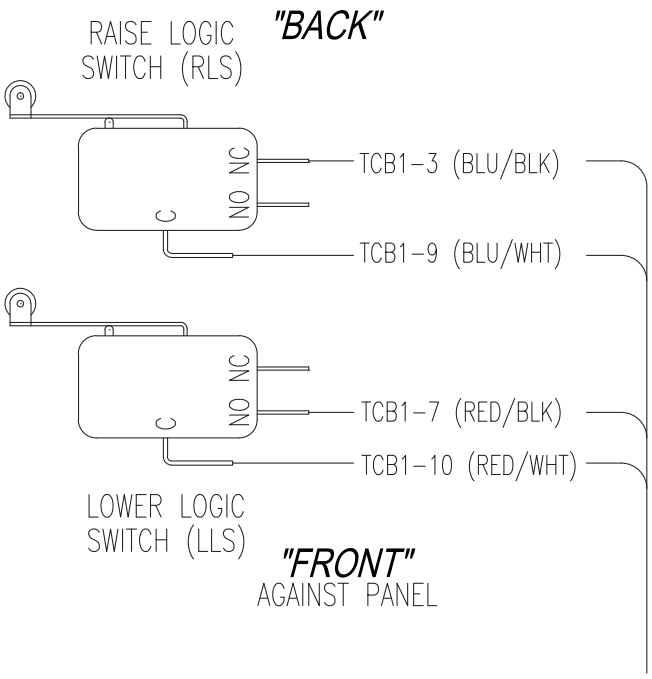

Figure 131. QD8 logic micro-switches placement connections

14. Using a 5/32" Allen wrench and 1/4" wrench, remove the screw attaching the switches to the tap changer. See Figure 132 and Figure 133. Take care to avoid dropping hardware into the tank.

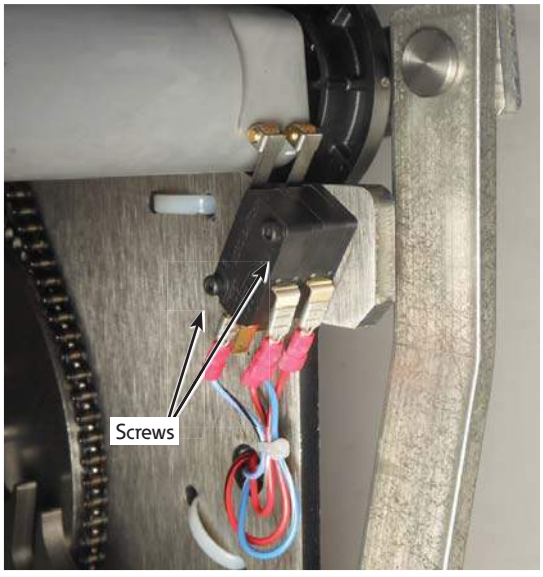

Figure 132. QD8 logic micro-switch screws

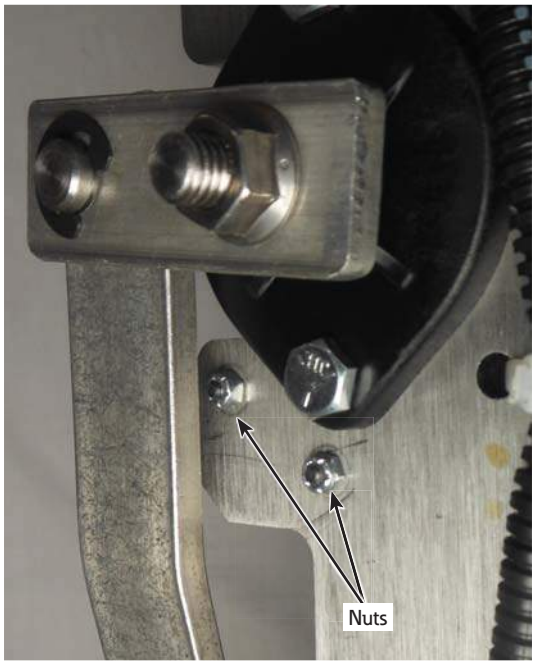

Figure 133. QD8 logic micro-switch nuts

15. Disconnect the wires using a needle-nose pliers by pulling the connectors from the blade terminals on the removed switch. Repeat for each switch being replaced.
16. Connect the wires to the new switch by sliding the connectors onto the bladed terminals. Make sure the wires are connected to the correct terminals. View Figure 131 as a guide for the wire connections. Repeat for each switch being replaced.
17. Insert the screws through the pair of switches and then through the holes in the steel tap-changer plate.
18. Reinstall the nuts onto the ends of the screws. It may be necessary to hold the nut behind the reversing segment actuator arm with a needle-nose pliers to get it started. Take care to avoid dropping hardware into the tank.
19. Tighten the screws and nuts to a torque of 4–5 in-lbs (0.5–0.6 Nm).
20. Ensure that the tap changer is in the neutral position when finished with the installation. See **Placing tap changer into neutral**.

Placing tap changer into neutral

1. Place a 3/8" socket with extension and ratchet on the output shaft of the motor; rotate the motor until the contacts and other components are aligned in the neutral position. See Figure 134.

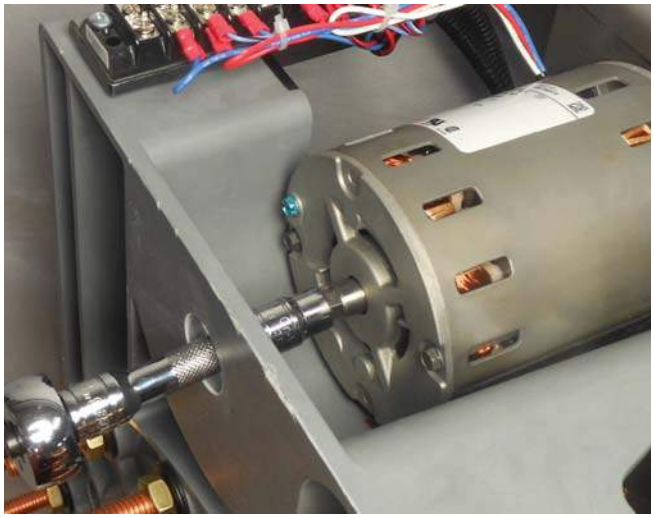

Figure 134. Rotating the motor shaft

2. Confirm that the regulator is in the neutral position:
   A. Main movable contacts are located on the neutral stationary contact, which is located at the 11 o'clock position. See Figure 135.

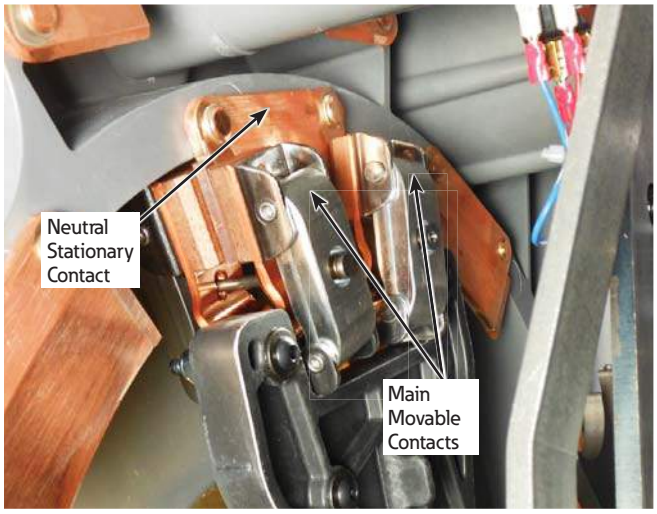

Figure 135. Neutral stationary contact position for main movable contacts

   B. The reversing movable contact is located on the reversing neutral stationary contact. See Figure 136.

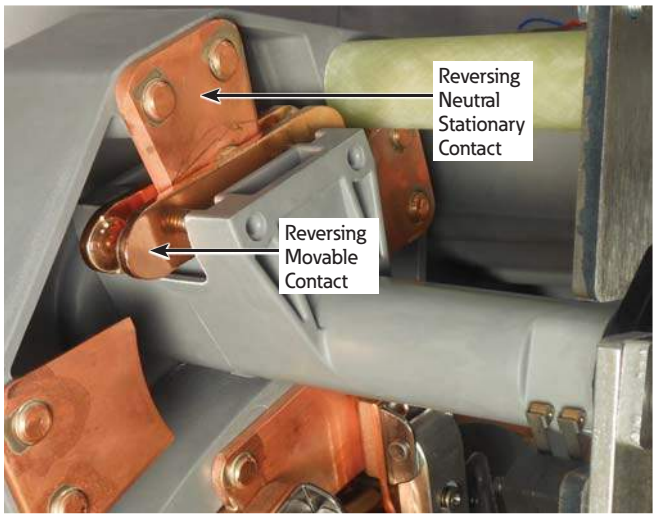

Figure 136. Neutral position for reversing movable contact

   C. The pinion cam is pointing to the right over the holding switch actuator. See Figure 137.

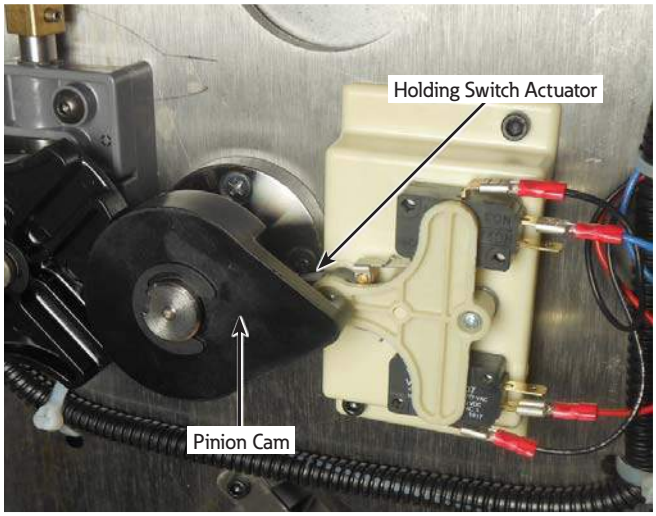

Figure 137. Neutral position for position indicator pinion cam and holding switch

D. The neutral switch will be depressed with the switch lever. See Figure 138.

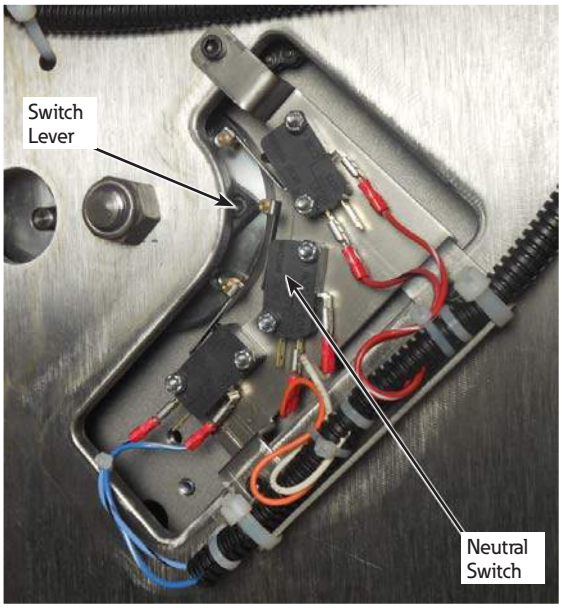

Figure 138. Neutral switch is depressed

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