01.4IB.50100 Power/Vac®
ML-17 Mechanism

For use with all Power/Vac® Electrical Ground and Test Devices

Powered by Safety®
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Signal Words

As stated in ANSI Z535.4-2007, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are “Danger”, “Warning”, “Caution” and “Notice”. These words are defined as:

![DANGER]

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

![WARNING]

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

![CAUTION]

**CAUTION**, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

![CAUTION]

**CAUTION**, used without the safety alert symbol, is used to address practices not related to personal injury.

![NOTICE]

**NOTICE** is used to address practices not related to personal injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

1. trained and authorized to energize, deenergize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
2. trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
3. trained in rendering first aid if necessary.
## Contents

### Ch 1 General Information

- **A. SCOPE** ................................................................. 2
- **B. PURPOSE** ............................................................... 2
- **C. INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY** ............................................................. 3

### Ch 2 Safety

- **A. SAFE WORK CONDITION** .................................................... 4
- **B. SAFETY GUIDELINES** ....................................................... 4
- **C. GENERAL** .................................................................. 5
- **D. SPECIFIC** .................................................................. 5
- **E. SAFETY LABELS** .......................................................... 5

### Ch 3 Equipment Description

- **A. GENERAL** ................................................................. 6
- **B. ML-17H GENERAL DESCRIPTION (63kA ONLY)** ............................................................. 6
- **C. OPERATION** ............................................................. 7
  1. Close Spring Charging .................................................. 7
  2. Closing Operation ............................................... 8
  3. Opening Operation ............................................... 8
  4. Trip Free Operation ................................................ 12
- **D. INTERLOCKS** .......................................................... 12
  1. Closing Spring Discharge Interlock ................................ 12
  2. Negative Trip Interlock ............................................. 12
  3. Positive Interlock .................................................... 12
  4. Closing Spring Gag Interlock ...................................... 12

### Ch 4 Installation

- **A. RECEIVING** ............................................................ 13
- **B. HANDLING** ............................................................ 13
- **C. STORAGE** .............................................................. 13
- **D. SHIPPING POSITION** ............................................... 14

### Ch 5 Mechanical Checks and Adjustments

- **A. GENERAL** ............................................................ 15
- **B. SLOW CLOSING OPERATION** ........................................ 15
- **C. PULL ROD ADJUSTMENT** ............................................. 17
- **D. TRIP LATCH CLEARANCE** ........................................... 17
- **E. OVERTRAVEL ADJUSTING BOLTS** .................................. 18
- **F. WIPE AND GAP ADJUSTMENT** ..................................... 18
  1. General .......................................................... 18
  2. Checking ........................................................ 19
  3. Adjustment ................................................... 20
- **G. PRIMARY CONTACT EROSION INDICATION** ............................................................. 21

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Contents

Ch 6  Electrical Checks ........................................................................................................... 22
   A. HIGH POTENTIAL TEST ................................................................................................. 22
      1) Primary Circuit ............................................................................................................. 22
      2) Secondary Circuit ......................................................................................................... 22
      3) Primary Circuit Resistance ......................................................................................... 22
      4) Vacuum Interrupter Integrity Test .............................................................................. 23

Ch 7  Maintenance .................................................................................................................. 25
   A. RECOMMENDED MAINTENANCE ............................................................................... 25
   B. LUBRICATION .................................................................................................................. 25

Ch 8  Recommended Renewal Parts and Replacement Procedures ................................... 26
   A. ORDERING INSTRUCTIONS ......................................................................................... 26
Figures

Figure 1  Typical Schematic for ML-17 Mechanism, Models -4 ........................................9
Figure 2  Typical Schematic for ML-17 Mechanism, Models -4 (continued) ..............10
Figure 3  Toggle Linkage Positions of ML-17 Mechanism View from Rear ..............11
Figure 4  Lifting Holes for Overhead Crane .................................................................13
Figure 5  Closing Spring Gag Lock .............................................................................16
Figure 6  Slow Close Pin on Flywheel .......................................................................16
Figure 7  Primary Contact Gap and Erosion Indication .............................................18
Figure 8  Wipe Gauge ...............................................................................................19

Tables

Table A Wipe and Gap Measurements .........................................................................19
Ch 1 General Information

⚠️ WARNING

The equipment described in this document may contain high voltages and currents which can cause serious injury or death.

The equipment is designed for use, installation, and maintenance by qualified users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Powell immediately at 1.800.480.7273.

⚠️ WARNING

Before any adjustment, servicing, part replacement, or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, the power supply must be disconnected. Failure to follow this warning may result in injury or death.

NOTICE

The information in this instruction bulletin is not intended to explain all details or variations of the Powell equipment, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems, which are not presented sufficiently for the user’s purposes, contact Powell at 1.800.480.7273.

NOTICE

Powell reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.
A. **Scope**

The information in this instruction bulletin describes the following Power/Vac® Electrical Ground and Test Devices:

- 50kA and below, using the 49A or 69A vacuum bottle, equipped with Revision 1 ML-17 operating mechanism
- 63kA using the 68A vacuum bottle, equipped with Revision 1 ML-17 operating mechanism

The “Revision 1” mechanism can be identified by the “1” in the 8th position of the catalog number as shown on the nameplate, i.e., GEPVEGT1xxxxxxxxx.

ML-17/49A and ML-17/69A devices include:

- GMV 1050
- GMV 1051
- GMV 1052
- GMV 1053
- GMV 1054
- GMV 1055
- GMV 1060
- GMV 1061

ML-17H/68A devices include:

- EGT-63-A
- EGT-63-B

B. **Purpose**

The information in this instruction bulletin is intended to provide information required to properly operate and maintain the ground and test device described in **Ch 1 General Information, A. Scope**.

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the ground and test device
3. Instructions for installation and placing the ground and test device into service
4. Instructions for part replacement
5. Information for ordering renewal parts
6. Procedure for critical adjustments
7. Illustrations, photographs, and description of the ground and test device

The illustrations contained in this document may not represent the exact construction details of each particular type of ground and test device. The illustrations in this document are provided as general information to aid in showing component locations only.

*All illustrations and photos are shown using deenergized equipment.*

**WARNING**

*Be sure to follow the appropriate safety precaution while handling any of the equipment. Failure to do so may result in serious injury or death.*

To the extent required, the products described herein meet the applicable ANSI, IEEE, and NEMA Standards; however, no such assurance is given with respect to local codes and ordinances which may vary greatly.
C. **INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY**

**NOTICE**

Changes to the instruction bulletin may be implemented at any time and without notice. Go to www.powellind.com to ensure use of the current instruction bulletin for the Powell equipment.

For more information visit www.powellind.com. To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email info@powellservice.com.

For specific questions or comments pertaining to this instruction bulletin email documents@powellind.com with the IB number in the subject line.
Ch 2  Safety

A. Safe Work Condition

The information in Section A is quoted from NFPA 70E 2012 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.

120.1 Process of Achieving an Electrically Safe Work Condition

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2. After properly interrupting the load current, OPEN the disconnecting device(s) for each source.

3. Wherever possible, visually verify that all blades of the disconnecting devices are fully OPEN or that drawout type circuit breakers are withdrawn to the fully disconnected position.

4. Apply lockout/tagout devices in accordance with a documented and established policy.

5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

6. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

B. Safety Guidelines

Study this instruction bulletin and all other associated documentation before uncrating the ground and test device.

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures. Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

It is mandatory that the following rules be observed to ensure the safety of personnel associated with usage, installation, operation, and maintenance of these ground and test devices.

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to Power/Vac® Electrical Ground and Test Device.
C. General

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the ground and test device shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, any supplements, and service advisories be studied, understood, and followed.

2. Maintenance programs must be consistent with both customer experience and manufacturer's recommendations, including service advisories and instruction bulletin(s). A well planned and executed routine maintenance program is essential for ground and test device's reliability and safety.

3. Service conditions and applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

D. Specific

When operating the ground and test device safety precautions must be observed. Improper use can result in death, serious personal injury, or damage to the equipment. It is important for the user to develop specific and safe operating procedures to be observed when using the ground and test device.

The following specific safety precautions must be observed:

1. Do not attempt to ground an energized circuit. The circuit to be grounded should always be treated as energized until proven otherwise.

2. Do not attempt to service the device while it is installed in a switchgear compartment or on a lift truck. For service, the device must be located either on the floor or on a sturdy, level work bench, and blocked from rolling.

3. Store the electrically operated ground and test device in a clean, dry area free from dust, dirt, moisture, caustic atmosphere, and vermin.

4. Keep all insulating surfaces, which include primary support insulation and insulation barriers, clean and dry.

5. Check all primary circuit connections to make certain that they are clean and tight.

6. Take extreme care while using this device to avoid contacting “live” or “hot” (energized) terminals.

E. Safety Labels

The equipment described in this document has DANGER, WARNING, CAUTION, and instruction labels attached to various locations. All equipment DANGER, WARNING, CAUTION, and instruction labels shall be observed when the ground and test device is handled, operated, or maintained.

**NOTICE**

Warning and Caution labels are located in various places in and on the switchgear and on the circuit breaker removable element. Always observe these warnings and caution labels. Do NOT remove or deface any of these warning/caution labels.
Ch 3  Equipment Description

A. General

The Power/Vac® Electrical Ground and Test Device uses sealed vacuum ground switches to make or break contact between the primary stud and the equipment ground. Primary connections to the associated metal-clad switchgear are made by horizontal bars and disconnect fingers, electrically and mechanically connected to the vacuum interrupters. Molded interrupter supports, one per phase on a three phase ground and test device, provide mountings for the primary bars, interrupters, current transfer fingers, and heat dissipation fins (where used). The operating mechanism provides vertical motion at each phase location in order to move the lower contact of the vacuum interrupters from an open position to a spring loaded closed position and then back to the open position on command.

The ML-17 mechanism is of the stored energy type and uses a gear motor to charge a closing spring. During a closing operation, the energy stored in the closing spring is used to close the vacuum interrupter contacts, compress the wipe springs which load the contacts, charge the opening springs, and overcome bearing and other friction forces. The energy then stored in the wipe springs and opening springs will open the contacts during an opening operation.

Closing and opening operations are controlled electrically by a remote control cable attached to the front of the ground and test device. For maintenance and checkout, the closing spring may be manually charged, and a method for slow-closing the ground switch is available.

B. ML-17H General Description (63kA Only)

The ML-17H mechanism is a very high energy unit used in 63kA applications. It has much stiffer wipe springs to achieve the required high closing and latching forces. It also has a double close spring to overcome the forces of the opening and wipe springs. Special runbacks and primary fingers are incorporated to withstand higher peak currents. The use of #271 Loctite® and jam nuts on many bolts and hardware make a more durable mechanism. Also, note that wipe and gap measurements are different for ML-17H ground and test devices than for standard ML-17 ground and test devices. Refer to Table A Wipe and Gap Measurements for wipe and gap parameters.
C. Operation

1) Close Spring Charging

Figures 1 & 2 show the mechanism expanded schematically with the primary contacts open and the closing spring nearly charged. When the closing spring is discharged, the flywheel eccentric (Figure 2, AA) will be about 180 degrees from where it is shown with respect to center pivot (Figure 2, CC). The transfer crank (Figure 1, #14) will be rotated counterclockwise, the slotted link (Figure 1, #17) will be holding the close toggle (Figure 1, #20 & Figure 2, #21) against the frame through link (Figure 1, #19), and the trip latch (Figure 1, #18) will be held out of engagement clockwise by the trip toggle roller (Figure 2, #52). The toggle linkage will appear as shown in Figure 3 (d). When the closing spring is discharged, switch operator (Figure 2, #44), operates the motor limit switch (Figure 2, #43). If the close latch checking switch (Figure 2, #47) closes.

As the close spring is compressed, the slotted link (Figure 1, #17) rises, and the close toggle (Figure 1, #20 & Figure 2, #21) forms a more acute angle until the closing spring goes over center and the trip latch (Figure 1, #18) is spring biased into place under the trip roller. When the trip latch is in place, the latch checking switch (Figure 2, #47) closes.

With the close spring charged and the ground and test device open, the toggle linkage is as shown in Figure 3 (a).

If control power is lost, or manual operation desired, the close spring may be manually charged by using a 5/8” hex socket ratchet type wrench to rotate the manual charging wind shaft in the direction indicated by the arrow until the yellow indicator shows “CHARGED”.

flywheel and attempts to discharge, the close roller (Figure 1, #3) is blocked by the close latch (Figure 1, #4) and held until a closing operation is required. Additionally, as the close spring goes over center, the switch operator (Figure 2, #44) is spring biased into a notch on the front flywheel (Figure 1, #2). The spring charge indicator arm (Figure 2, #40) moves clockwise which, through the action of the rod (Figure 2, #41) causes a flag (Figure 2, #42) to indicate “CHARGED”. A cam (Figure 1, #12) engages the wind pawl (Figure 1, #9) moving it from contact with the hub (Figure 1, #11) notch, thereby allowing the gear motor to coast to a stop when power is removed by the limit switch (Figure 2, #43).
2) **Closing Operation**

By either energizing the close solenoid or depressing the manual close button, the close latch (Figure 1, #4) is rotated counterclockwise and releases the close roller (Figure 1, #3) permitting the flywheel (Figure 1, #1 & #2) to rotate counterclockwise by the force of the close spring. This action, transmitted to the slotted link (Figure 1, #17) by means of the pull rod (Figure 1, #13) transfer crank (Figure 1, #14 & #16), pulls the close toggle through the center against link (Figure 1, #19) which is tied to the frame. This action rotates the output crank (Figure 2, #22) counterclockwise. The Pole 1 bellcranks (Figure 2, #23), on the same shaft as the output crank, also rotate counterclockwise, and by means of the horizontal connecting bar (Figure 2, #28) rotate Pole 2 and 3 bellcranks. This rotation compresses the opening spring (Figure 2, #29), closes the vacuum interrupters connected with each operating rod (Figure 2, #25), and compresses the wipe spring (Figure 2, #26) on each pole when the trunnion (Figure 2, #24) continues moving after the operating rod (Figure 2, #25) stops. Rotation of an arm (Figure 2, #34) coupled to the output shaft (Figure 2, DD) changes the auxiliary switch (Figure 2, #37) position, and the position flag (Figure 2, #38) indicates “CLOSED”. The lever (Figure 2, #44) is moved out of the notch in the flywheel (Figure 1, #2) and with the close latch (Figure 1, #4) in position to catch the close roller, the limit switch (Figure 2, #43) energizes the gear motor as described under **Ch 3 Equipment Description, C. Operation, 1) Close Spring Charging**. With the ground and test device closed, closing spring discharged, the toggle linkage appears as shown in Figure 3 (b). With the ground and test device in the closed position, the links (Figure 1, #17) can move up past the close toggle without disturbing it as they are slotted to accommodate a close spring charged, ground and test device closed, the toggle linkage appears as shown in Figure 3 (c).

3) **Opening Operation**

By either energizing the trip solenoid or depressing the manual trip button, the trip latch (Figure 1, #18) is rotated clockwise permitting the trip toggle (Figure 1, #19 & #20) to collapse and the vacuum interrupter contacts to open under the force of the wipe springs (Figure 2, #26) and opening spring (Figure 2, #29). At the end of the opening stroke, a stop block (Figure 2, #30) on the bottom of the trunnion (Figure 2, #24) strikes set screws in the horizontal connecting bar (Figure 2, #28) which limits the over travel. At the same time an opening stop is provided by a plate and buffer assembly (Figure 2, #50). An opening dashpot (Figure 2, #31) controls opening velocity and prevents excessive rebound of the interrupter contacts. Rotation of the output shaft (Figure 2, DD) from a closed to an open position operates the auxiliary switch (Figure 2, #37) as described in **Ch 3 Equipment Description, C. Operation, 2) Closing Operation** and interrupts the trip coil circuit. If the closing spring is charged, the close toggle can raise to the top of the slotted link (Figure 1, #17) thereby permitting the trip toggle to reset and the trip latch to fall in place under its roller preparatory to a closing operation. If the closing spring is not charged, the trip latch is held, rotated clockwise until the close spring is compressed as described in **Ch 3 Equipment Description, C. Operation, 1) Close Spring Charging**. Electrically initiated closing is blocked by the latch checking switch (Figure 2, #47) when the trip latch is not reset.
Figure 1  Typical Schematic for ML-17 Mechanism, Models -4

1. Rear Flywheel Section  
2. Front Flywheel Section  
3. Close Roller  
4. Close Latch  
5. Close Latch Monitor Switch  
6. Closing Spring Assembly  
7. Blocking Pin in Closing Spring Assembly  
8. Hex Shaft with Connection Blocks on Flywheel  
9. Wind Pawl  
10. Slow Close Pawl  
11. Wind Hub  
12. Pawl Disengagement Cam Surface - On Frame  
13. Pull Rod  
14. Adjustable Throw Transfer Crank  
15. Adjustment Link (Factory Adjustment Only)  
16. Short Transfer Crank  
17. Slotted Link  
18. Trip Latch  
19. Link - Trip Toggle to Frame  
20. Link from Close Toggle to Trip Toggle
Figure 2  Typical Schematic for ML-17 Mechanism, Models -4 (continued)

21. Link from Output Crank to Close Toggle
22. Output Crank
23. Pole 1 Bell Cranks
24. Wipe Spring Trunnion Block
25. Interrupter Operating Rod Connection
26. Wipe Spring
27. Overtravel Stop Adjustment - On Each Pole
28. Horizontal Connecting Bar
29. Opening Spring Assembly
30. Opening Stop Block
31. Dashpot
32. Brake (on ML-17H Mechanism Only)
33. Closing Latch Shaft
34. Auxiliary Switch Drive Arm
35. Idler Link
36. Switch Drive Arm
37. Auxiliary Switch
38. Position Indicator Flag
39. Operation Counter
40. Spring Charge Indicator Arm
41. Rod
42. Spring Charge-Discharge Indicator Flag
43. Gear Motor Limit Switch
44. Gear Motor Limit Switch Operator
45. Gear Motor
46. Gear Motor Housing
47. Trip Latch Checking Switch
48. Slow Close Pin
49. Retaining Clamp
50. Opening Stop
51. Toggle Pin
52. Trip Roller
53. Horizontal Bar Stop Locking Nut
54. Trip Shaft
AA Eccentric Shaft Connecting Flywheel Halves
BB Hex Shaft Connecting Transfer Cranks
CC Flywheel Rotation Axis
DD Hex Shaft Connecting Output Cranks
Figure 3  Toggle Linkage Positions of ML-17 Mechanism View from Rear

1. Output Crank
2. Link-Output Crank to Close Toggle
3. Link-Close Toggle to Trip Toggle
4. Link Trip Toggle to Frame
5. Trip Latch

6. Slotted Link
7. Transfer Crank
8. Trip Roller
9. Linkage Return Spring
10. Toggle Pin
4) **Trip Free Operation**

The linkage (Figure 1, #19 & 20 & Figure 2, #21) is mechanically trip free in any location on the closing stroke. This means that energization of the trip coil while closing after the auxiliary switch contacts change position will rotate the trip latch (Figure 1, #18) clockwise and permit the ground and test device to open. The linkage will reset as a normal open operation, the flywheel will complete its rotation, and the closing spring will recharge as described under SPRING CHARGING.

D. **INTERLOCKS**

1) **Closing Spring Discharge Interlock**

The function of the closing spring discharge interlock is to prevent racking into or out of metal-clad switchgear a ground and test device with the closing spring charged. This is accomplished by a roller on the right hand side of the mechanism which contacts the racking mechanism and discharges the closing spring except if the ground and test device is in the “Disconnect/Test” position or the “Connect” position in the metal-clad switchgear. This interlock also opens the CL/MS switch in the motor charging circuit to prevent charging the closing springs when the ground and test device is between the “Disconnect/Test” or “Connect” position in the metal-clad switchgear.

2) **Negative Trip Interlock**

The function of the negative trip interlock is to disengage the trip latch from the trip latch roller thereby preventing a closing operation. The interlock also opens the latch checking switch (52LCS) in the closing circuit thereby removing the close circuit power. The negative interlock is in operation while the ground and test device is moving between the “Disconnect/Test” position and the “Connect” position. A redundant negative trip interlock is a backup to the negative trip interlock and provides the same function except it operates only near the connect position.

3) **Positive Interlock**

The positive interlock operates to prevent the racking of a ground and test device that is closed. A linkage connected to the horizontal connecting bar extends a detent bar out from the side of the mechanism frame when it is in the closed position. If the closed ground and test device is in the “Connect” or “Disconnect/Test” position in the metal-clad switchgear the detent bar locks into the racking mechanism to prevent access to the hex section of the jack screw. The positive interlock also prevents the lift truck from picking up a closed ground and test device.

4) **Closing Spring Gag Interlock**

The closing spring gag interlock (Figure 5) is provided on the ground and test device to prevent a ground and test device that has a gagged closing spring from entering the metal-clad switchgear unit. This is accomplished by projecting a lever out of the left side of the mechanism when the closing spring is gagged.
Ch 4 Installation

A. Receiving

When the ground and test device is received check for any sign of damage. If damage is found or suspected, file all claims immediately with the transportation company and notify the nearest Powell representative.

The ground and test device is enclosed in a carton used for shipment. The carton is attached to the shipping pallet by two metal bands. Remove the bands and lift the carton from the pallet so that the ground and test device is visible. Remove all shipping hardware, members, or brackets that attaches the device to the pallet. When these are removed the ground and test device may be removed from the shipping pallet. Refer to Ch 4 Installation, B. Handling, for more information.

B. Handling

After the ground and test device has been removed from its shipping pallet it may be rolled on its own wheels on a level surface. This is the preferred way of handling the ground and test device. When rolling the ground and test device it should be pushed and steered by the steel frame or the front cover.

Do not handle or move the ground and test device by the primary disconnecting devices, as damage may occur.

If necessary, the ground and test device can be moved by a fork lift truck or an overhead crane. When using a fork lift truck take care to avoid components located under the ground and test device floor pan. The device can also be lifted by an overhead crane using the four lifting points which have been provided for hooks at the bottom of the ground and test device mechanism housing (Figure 4).

Figure 4 Lifting Holes for Overhead Crane

C. Storage

Shipping and storage of electrical equipment requires measures to prevent the deterioration of the apparatus over a long unused period. The mechanical and dielectric integrity must be protected. Electrical equipment is designed for use in a variety of environments. When the equipment is in transit and storage, these design considerations are not fully functional. In general, the following measures must be considered.
1. Equipment designed for indoor installation must be stored indoors in a climate controlled environment to prevent condensation of moisture. Exposure to rain and the elements, even for a short period, can permanently damage the equipment. Space heaters within the equipment should be energized, if so equipped. Humidity controlling desiccant materials should be utilized when space heaters are not provided or cannot be energized. The temperature should be kept above 33°F/1°C and below 140°F/60°C. The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure operational integrity.

2. Equipment designed for outdoor exposure may be stored either in indoor or outdoor storage locations. The equipment must be protected from airborne external contaminates if stored outdoors. Outdoor storage will also require additional care to maintain temporary covers over the openings and shipping splits. The equipment must be provided with control power to facilitate the energization of space heaters, as well as other temperature and humidity controlling equipment. The temperature should be kept above freezing (>33°F/1°C) and below (<140°F/60°C). The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure its integrity.

D. Shipping Position

The ground and test device has been shipped in an open and discharged position. To make sure close and open springs are in their discharged position, press the manual close button followed by pressing the manual trip button.
A. GENERAL

Checking the mechanical adjustments may be performed in any order. However, the adjustments associated with the stroke of the mechanism must be performed in the prescribed order since they are related in such a way that the adjustment of one affects the next in the series. These adjustments and the prescribed order are:

1. Pull rod adjustment
2. Trip latch clearance
3. Overtravel stops
4. Wipe and Gap setting

For example, if the pull rod is adjusted, then the trip latch clearance must be checked and adjusted followed by resetting the overtravel stops and then checking and adjusting the wipe and gap setting. However, if only the wipe and gap setting is adjusted, it is not necessary to perform the adjustments preceding it.

When adjusting the pull rod or the trip latch clearance, the overtravel stops should be backed out of the horizontal connecting bar two turns to assure that they do not interfere with the mechanism stroke during the adjustment.

B. SLOW CLOSING OPERATION

Slow closing the ground and test device allows observation of the motion of the mechanism while manually cranking it from the open to the closed position. The slow closing operation is required when performing adjustments on the ground and test device such as setting the pull rod adjustment and when setting the wipe and gap.

1. Manually charge the ground and test device closing spring using a 5/8 inch hex socket-ratchet-type wrench for safety, and turn in the direction of the arrow as indicated on the end of the manual wind shaft. Several rotations with no apparent load are necessary until the winding mechanism engages the spring-charging pawl.

As the manual charging shaft is rotated the trip latch will reset first with a small “click”. Continued rotation will fully charge the closing spring and a louder sound will be heard. At this time the charge/discharge indicator will change from “Discharged” to “Charged”. Stop cranking when this occurs.
2. Insert the close spring blocking pin (Figure 5, b) by carefully removing it from its storage hole, rotating the interlock lever and inserting it in the blocking hole.

3. Press the manual close button to partially discharge the closing spring against the blocking pin.

4. Pull the slow close pin on the flywheel (Figure 6, b) and resume ratchet wrench operation of the manual wind shaft. After several rotations at no apparent load, the winding mechanism will engage the slow close pawl and begin the closing operation of the mechanism.

Continue rotating the manual wind shaft. Be sure the close toggle pin (Figure 2, #51) goes over-center and the spacers on the ends of the pin rest against the frame. After the one-half flywheel rotation necessary for closing, the slow close pawl is automatically disengaged.
C. **Pull Rod Adjustment**

The pull rod (Figure 1, #13) is a turnbuckle, with a right-hand thread at the crank and a left-hand thread at the flywheel connection. Slow close the mechanism as described in *Ch 5 Mechanical Checks and Adjustments*, B. Slow Closing Operation. As the flywheel rotates the slotted link pulls the closing toggle pin over-center so that the spacers on the end of the pin are resting on the mechanism frame. In this position, the slotted link should be in contact with the closing toggle pin.

If the spacers are not against the frame, the toggle links must be tapped firmly downward so that they rest against the frame.

**Note:** Before making adjustments to the pull rod the overtravel stop bolts (Figure 2, #27) should be backed out of the horizontal connecting bar two turns.

Increase the rod length by backing off about 1/4 turn so that the slotted links are just free of the pin and can move slightly from side to side.

In this position the slotted links (Figure 1, #17) should have no apparent clearance to the pin in the close toggle (Figure 2, #51) but should be capable of being moved axially along the pin by firm finger pressure. Tighten the pull rod lock nuts to 30-35 ft-lbs. of torque.

**If the pull rod is too short, i.e., slotted link is too tight against the pin in the closed toggle, the pin may be bent and require replacement.**

D. **Trip Latch Clearance**

Refer to items 5 & 8 in Figure 3 (a). Charge and gag the close spring as described in steps 1 & 2 of *Ch 5 Mechanical Checks and Adjustments*, B. Slow Closing Operation. With the ground and test device open, determine the trip latch clearance by depressing the trip roller against the latch face from its spring-reset position. If no apparent motion exists, depress the manual trip push button and see if the trip roller rotates.

The latch clearance should be set between .005 and .040 inch. The trip roller must not rotate when the latch is moved by the manual push button. The clearance may be estimated by pressing the roller down against the latch.

To adjust, loosen the locking nut (Figure 2, #53) holding the stop bolt to the horizontal connecting bar, and then unscrew the stop bolt to decrease latch clearance while pushing the manual trip push button in and out until the trip roller just starts to turn.

**Note:** Before making adjustments to the trip latch clearance the overtravel adjustable bolts (Figure 7, l) should be backed out of the horizontal connecting bar two turns.

Screw in the adjusting bolt until the roller no longer turns. Torque the lock nut to 55 ft-lbs. while holding the adjusting screw. This sets latch clearance at a minimum and any mechanism wear will tend to increase the clearance. When 0.060 inch clearance is reached readjustment will be required.
E. **OVERTRAVEL ADJUSTING BOLTS**

Six adjustable bolts (Figure 7, l) are threaded into the horizontal connecting bar to provide stops for each pole to prevent overstroking the Power/Vac® interrupters. Each of these bolts should be backed out of the horizontal connecting bar two turns prior to performing adjustments to the pull rod or to the trip latch setting. To adjust the overtravel stop bolts, back off locking nut (Figure 7, n) and turn each of the six bolts (Figure 7, l) in toward the opening stop block (Figure 7, k) until the bolt touches the stop ring (ground and test device is open for this adjustment). Back off ¼ to ½ turn and tighten the locking nuts (Figure 7, n) to 20 to 25 ft-lbs.

F. **WIPE AND GAP ADJUSTMENT**

1) **General**

Wipe is the additional compression of the preloaded wipe spring (Figure 7, i) which is used to apply force to the closed vacuum interrupter contacts. Proper adjustment of the wipe springs is necessary to assure that the vacuum interrupter contact will stay closed against the forces which tend to open them due to fault currents and to supply the propelling energy required to attain the correct opening speed needed for a clean interruption of the current.

Gap is the distance between the two vacuum interrupter contacts when the ground and test device is open. Correct adjustment of the gap assures that the minimum required distance for current interruption is achieved and that the distance is not so great that mechanical damage to the vacuum interrupter occurs.

Wipe and gap are related in such a way that decreasing the wipe increases the gap and increasing the wipe decreases the gap. Therefore, these two adjustments must be coordinated to bring both to within required settings simultaneously.
2) Checking

a. Close the ground and test device and block the trip latch against the frame to prevent accidental opening. Use a 3/8-16 (with 2 5/8 inch minimum thread length) bolt in the trip latch blocking hole. Screw the bolt in until it just contacts the trip latch.

b. Insert gauge 0282A2459G001 (Figure 8) over the orange erosion disc and align the screw with the top of the wipe indicator. Turn the screw until it just touches the wipe indicator. Carefully hold the screw in position while removing the gauge. Measure the extension of the screw below the gauge plate bottom using a dial caliper and record this reading. Perform this measurement on all three phases.

c. Measure the position of the operating rod (Figure 7, d) relative to the ground and test device frame. Measure all three phases. (SUGGESTION: place a piece of masking tape vertically on the operating rod. Using a block (approximately 2" high) that spans the ground and test device mechanism frame, draw a line on the tape to indicate the position when the ground and test device is closed. Leave the tape in place. Then in step f draw another line on the tape when the ground and test device is opened. The distance between these lines is the gap for that phase.

d. Remove the trip latch blocking bolt installed in step a and open the ground and test device by pushing the manual trip push button.

e. Repeat step b to measure the position of the wipe indicator with the ground and test device open. Subtract the two measurements of the screw length to obtain the wipe of each phase.

f. Repeat step c to measure the position of operating rod with the ground and test device in the open position. Subtract the two measurements to obtain the vacuum interrupter contact gap for each phase. (If the suggestion in step c was followed, remove the tape from the operating rod, place it on a flat surface and measure the gaps directly as the distance between the two lines on the tape).

g. Compare the wipes and gap measured with the Table A Wipe and Gap Measurements.

<table>
<thead>
<tr>
<th>Interrupter</th>
<th>Wipe (inches)</th>
<th>Gap (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>49A &amp; 69A (50kA and below)</td>
<td>.156 minimum</td>
<td>.375 to .425</td>
</tr>
<tr>
<td>68A (63kA)</td>
<td>.155 minimum</td>
<td>.450 to .550</td>
</tr>
</tbody>
</table>
3) **Adjustment**

If wipe and gap adjustments are deemed to be necessary in the field for breakers using 45A, 46A, 47A, 48A & 49A interrupters, the following parameters should be used:

- **Wipe**: .156 inches minimum
- **Gap**: .375-.425 inches

If the wipe is less than .109, adjustment is required.

If wipe and gap adjustments are deemed to be necessary in the field for breakers using 68A interrupters, the following parameters should be used:

- **Wipe**: .155 inches minimum
- **Gap**: .450-.550 inches

If the wipe is less than .100, adjustment is required.

a. Determine the amount of adjustment required to bring both the wipe and gap within requirements.

b. Close the ground and test device and block the trip latch against the frame using the 3/8-16 bolt in the trip latch blocking hole.

c. Loosen but do not remove the 1/4” socket head cap screws (Figure 7, c) holding the coupling clamp (Figure 7, b). Be sure that the clamp can be rotated freely by hand.

d. Hold the hexagon projection at the bottom of the operating rod (1 1/8” wrench) and loosen the adjacent lock nut (Figure 7, h) (15/16” wrench).

e. Decrease the wipe (and increase the gap a like amount by turning the operating rod down (clockwise looking from the top) or increase the wipe (while decreasing the gap) by turning the operating rod up (counterclockwise looking from the top).

**Note:** The operating rod has 11 threads per inch so that 1/6 turn (one flat) of the operating rod hex will result in approximately .015” change in wipe and gap.

f. After completing the adjustment, torque the operating rod locknut (Figure 7, h), to 40-50 ft-lbs while preventing the Operating Rod from turning. Tighten the coupling clamp screws to 10-12 ft-lbs.

g. Remove the trip latch blocking bolt and trip the ground and test device open. Recheck the wipe and gap and readjust if necessary.

h. If both wipe and gap cannot be brought into the required settings, check the pull rod adjustment and the trip latch clearance. Increase the trip latch clearance to decrease the sum of the wipe and gap or decrease the trip latch clearance to increase the sum of the wipe and gap.

**Note:** Do not exceed the specified range of settings on the trip latch.
G. PRIMARY CONTACT EROSION INDICATION

In the closed position, the erosion indicator disc (Figure 7, g) below the operating rod is aligned with a reference arm (Figure 7, e) on new interrupters. With the ground and test device in the closed position, the indicator disc after in service fault interruptions will move upward from alignment with the reference point due to contact erosion. Contact erosion will decrease the wipe which may be brought back to normal by performing wipe adjustment. When erosion reaches \( \frac{1}{8}'' \) (the misalignment of the indicator disc and the reference arm with the ground and test device closed) the interrupter should be replaced.

If an appreciable amount (but not more than \( \frac{1}{8}'' \)) of erosion is indicated, estimate the amount of interrupter life remaining before the \( \frac{1}{8}'' \) limit will be reached. Recheck the erosion indicator before reaching the estimated end of life.

Do not readjust the alignment of the erosion indicator except when installing a new vacuum interrupter assembly or replacing the operating rod.
Ch 6  Electrical Checks

A. HIGH POTENTIAL TEST

If high potential tests to check the integrity of the primary insulation is required, the AC high potential test described below is strongly recommended. DC high potential testing is not recommended. The following procedure must be adhered to:

CAUTION

If DC high potential testing is required, the DC high potential machine must not produce peak voltages exceeding 50kV.

Note:  Always recheck with an AC tester if initial results are questionable.

1) Primary Circuit

The ground and test device should be hipotted with the ground and test device closed. An AC hipot machine capable of producing the test voltages shown below may be used to hipot the ground and test device phase to phase and phase to ground.

The machine should be connected with its output potential at zero and the voltage increased at 500 volts per second to the test voltage and that voltage maintained for 60 seconds. The voltage should then be returned to zero and the test leads removed from the ground and test device and the ground and test device discharged to ground.

Note: Do not exceed the test voltage indicated for applicable ground and test device voltage rating. If the test should experience a failure, STOP, turn off the test set and discharge the ground and test device.

1. Check the test set up and leads for connection errors.
2. Wipe down the ground and test device to remove any moisture, dust, and contamination.
3. Retest the ground and test device at the proper test voltage.

2) Secondary Circuit

Prior to hipotting the ground and test device secondary circuit, disconnect the motor leads and thread a wire connecting all secondary disconnect pins, except #24 the ground pin. Connect the hipot machine from this wire to ground. Increase the voltage to 1125V (rms) 60Hz and maintain for 60 seconds. Reduce the voltage to zero and remove the hipot machine from the circuit. Remove the wire connecting the secondary disconnect pins and reconnect the motor leads.

3) Primary Circuit Resistance

A resistance check of the primary circuit may be made with the ground and test device closed. Use a low resistance measuring instrument rated 100 amperes which measures in microhms. The 100 ampere reading should not exceed 100 microhms when connected across the primary studs on the ground and test device side of the disconnect fingers. Do not connect directly to the disconnect fingers as errors may occur due to finger spring pressure.
4) Vacuum Interrupter Integrity Test

**NOTICE**

Use of DC hipot is not recommended, but can be used for quick field checks only. DC testers frequently yield false negative test results due to the capacitive component of the vacuum interrupter during the DC testing. In addition, most lightweight DC testers have a very low leakage current trip setting. Always recheck with an AC tester if initial results are questionable. Prior to performing any vacuum interrupter integrity test, the outside (external surface) of the vacuum interrupters should be wiped clean of any contaminants with a nonlinting cloth or industrial type wiper. This is critical: the entire external surface is to be completely free of all dirt, debris, dust, oil, etc.

**CAUTION**

X-radiation will be produced if an abnormally high voltage is applied across a pair of electrodes in a vacuum. X-radiation will increase as voltage increases and/or as contact separation decreases. Only test a correctly adjusted ground and test device.

During a high potential or vacuum integrity test, any X-radiation which may be produced will not be hazardous at a distance safe for high potential testing, if the test is conducted at the recommended voltage and with the normal open ground and test device gap.

Do not apply voltage that is higher than the recommended value. Do not use contact separation that is less than the recommended open position ground and test device contact gap.

A vacuum integrity test of the interrupter is required to ensure that no loss of vacuum has occurred. The vacuum integrity test is performed using an AC hi-potential tester. This test of the vacuum interrupter will determine its internal dielectric condition and vacuum integrity. With the ground and test device open, individually check each interrupter by connecting the hi-pot machine “Hot” lead to the primary bus bar and the ground lead to the ground bar on the mechanism. If the machine has a center point ground, the connections can be made either way. Apply minimum of 25kV (rms) 60Hz at 500 volts per second and hold for 10 seconds. If no breakdown occurs, the interrupter is in acceptable condition. After the high potential voltage is removed, discharge any electrical charge that may be present through the internal ground of the test machine or by a grounded cable to one of the phase bus bars. If failure of a vacuum bottle should occur during the integrity test, the test procedure should be reviewed and the pole piece cleaned.

Note the voltage level at failure on the first test, and retest the phase pole piece. If the pole piece passes test, the vacuum bottle is acceptable - STOP. If the test fails again at a higher voltage level than was observed in the first test, clean the pole piece and retest. If a failure on the integrity test occurs a third time, consider the vacuum bottle to have lost vacuum and replace the complete pole piece.
Many DC high potential machines are halfwave rectifiers. This type of hipot tester must not be used to test vacuum interrupters. The capacitance of the Power/Vac bottles is very low and the leakage in the rectifier and its DC voltage measuring equipment is such that the pulse from the halfwave rectifier may be in the neighborhood of 120kV when the meter is actually reading 40kV. In this case, some perfectly good bottles can show a relatively high leakage current since it is the peak voltage of 120kV that is producing erroneous bottle leakage current. In addition, abnormal X-radiation will be produced.

Although an AC high potential test is recommended for checking the vacuum integrity, a DC high potential test can also be conducted on the vacuum interrupter. If a DC hipot test is to be used, test voltage should not exceed 50kVDC, and should be applied for 10 seconds. Interrupters must be cleaned as previously discussed. If failure occurs, reverse the polarity and retest. If the interrupter passes the second test, STOP. The interrupter is acceptable. If the interrupter fails the second test, it is recommended a final test with an AC hipot before replacement.

No attempt should be made to try to compare the condition of one vacuum interrupter with another nor to correlate the condition of any interrupter to low values of DC leakage current. There is no significant correlation. After the high potential voltage is removed, discharge any electrical charge that may be retained.
Ch 7 Maintenance

A. Recommended Maintenance

The following operations should be performed at each maintenance check:

- Perform a visual inspection of the device. Check for loose or damaged parts.
- Perform the operation as described in Ch 5 Mechanical Checks and Adjustments, B. Slow Closing Operation.
- Check the Wipe and Gap as described in Ch 5 Mechanical Checks and Adjustments, F. Wipe and Gap Adjustment.
- Check the erosion indication as described in Ch 5 Mechanical Checks and Adjustments, G. Primary Contact Erosion Indication.

B. Lubrication

Proper lubrication is important for maintaining reliable ground and test device performance. The Power/Vac® mechanism uses bearings which have a synthetic lining in some locations. These bearings do not require lubrication to maintain low friction, but lubrication does not harm them and oiling lightly is recommended. Sleeve bearings are used in some linkage locations and needle or roller bearings are used for low friction on the flywheel, trip shaft, and close shaft.

Providing a fresh lubricant supply at periodic intervals is helpful in extending the useful life of the ground and test device mechanism especially where frequent operation may have forced lubricant out of the bearing surfaces. Use Mobile 29 (black grease) 0282A2048P005 on all mechanical bearings and sliding surfaces in the Power/Vac mechanism. This grease contains extreme pressure (EP) additives to improve its load bearing capability. Use the standard red grease on all other applications, such as the primary current disconnect fingers as described in the following.

Electrical primary contact surfaces also require periodic lubrication to inhibit oxidation and minimize friction. At each inspection and maintenance interval, do the following:

1. Metal contact surfaces such as the movable contact rod of the interrupter should be lubricated with 0282A2048P009 grease. This grease is available packaged in 4oz. collapsible tubes.
2. Silvered primary contact surfaces. Wipe clean and apply a light coat of 0282A2048P009 grease on primary disconnect fingers.
3. Pins of the secondary disconnect coupler should be lightly coated with 0282A2048P009 grease.

Care should be taken to ensure that the grease is only applied to the pins and not the body of the secondary coupler.
Ch 8  Recommended Renewal Parts and Replacement Procedures

A. ORDERING INSTRUCTIONS

1. Order renewal parts from Powell at www.powellind.com or call 1.800.480.7273.

2. Always specify complete nameplate information, including:
   - Ground and Test Device Type
   - Serial Number
   - Rated Voltage
   - Rated Amps
   - Impulse Withstand
   - Control Voltage (for control devices and coils)

3. Please refer to instruction bulletin 01.4IB.66000B for renewal parts and replacement procedures. Specify the quantity and description of the part and the instruction bulletin number. If the part is in any of the recommended renewal parts tables, specify the catalog number. If the part is not in any of the tables, a description should be accompanied by a marked illustration from this instruction bulletin, a photo or simply submit a sketch showing the part needed.
01.4IB.50100 Power/Vac®
ML-17 Mechanism

For use with all Power/Vac Electrical
Ground and Test Devices

July 2014