Instruction Bulletin - 01.4IB.50023A
PowlVac® Electrically Operated 15kV Ground and Test Device

15kV Electrically Operated G&T per Long Island Railroad Specifications
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Signal Words

As stated in ANSI Z535.4-2002, § 4.13-4.13.3 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** 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**, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

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

- **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 70®, is one familiar with the construction and operation of the equipment and 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.
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Ch 1 General Information

**WARNING**

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

The equipment is designed for use, installation, and maintenance by knowledgeable 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**

Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

**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 PowlVac® Electrically Operated 15kV Ground and Test Device:

- 60600G13 - 15kV - 1200, 2000, & 3000A
- 60600G14 - Series 4 - 15kV - 1200, 2000, & 3000A

B. **Purpose**

The information in this instruction bulletin is intended to provide information required to properly operate and maintain the PowlVac 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. 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 are shown using deenergized equipment.*

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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**

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

To contact the Powell Service Division call 1.800.480.7273 or email info@powellservice.com.

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

**A. Safe Work Condition**

The information in Section A is quoted from NFPA 70E 2018 - Article 120, 120.5 Establishing an Electrically Safe Work Condition.

120.5 Process or Establishing and Verifying an Electrically Safe Work Condition. Establishing and verifying an electrically safe condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

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. Release stored electrical energy.

5. Release or block stored mechanical energy.

6. Apply lockout/tagout devices in accordance with a documented and established procedure.

7. Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

**N Exception No. 1:** An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage of the conductors or circuit parts at the work location, provided it meets the all following requirements: (1) It is permanently mounted and installed in accordance with the manufacturer's instructions and tests the conductors and circuit parts at the point of work; (2) It is listed and labeled for the purpose of verifying the absence of voltage; (3) It tests each phase conductor or circuit part both phase-to-phase and phase-to-ground; (4) The test device is verified as operating satisfactorily on any known voltage source before and after verifying the absence of voltage.

**N Exception No. 2:** On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.

Informational Note No. 1: See UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements, for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical system 1000 volts and below.

**N Informational Note No. 2:** For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, Live Working - Voltage Detectors - Part 1: Capacitive type to be used for voltages exceeding 1kV a.c., or IEC 61243-2, Live Working - Voltage Detectors - Part 2: Resistive type to be used for voltages of 1kV to 36kV a.c., or IEC 61243-3, Live Working - Voltage Detectors - Part 3: Two-pole voltage type.
8. 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 de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

a. **Placement.** Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer’s job planning.

b. **Capacity.** Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

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**N** Informational Note: ATSM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.

c. **Impedance.** Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

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**B. SAFETY GUIDELINES**

Study this instruction bulletin and all other associated documentation before uncrating the circuit breakers.

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.

The ground and test devices described in this instruction bulletin are operated by a high-energy, high-speed mechanism that is interlocked to provide specific operating sequences. 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 PowlVac® Electrically Operated 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 devices' reliability and safety.

3. Service conditions and ground and test device applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; 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 precaution 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 close the grounding switch on an energized circuit. The circuit to be grounded should always be treated as energized until proven otherwise.
2. Use great care when opening the test port shutters to gain access to the test receptacles. The test receptacles should always be treated as energized circuits until proven otherwise.
3. Any test device plugged into the test receptacles must be properly rated for the circuit voltage being tested and all connections must be properly insulated.
4. Use only the test probes furnished with the device to plug anything into the test ports. Use of other plugs may damage the test port or may result in a poor connection which could be dangerous to the operator and/or damaging to the equipment.
5. Even though insulated, the test probes must not be inserted or extracted from energized test ports. The test probe insulation is only one part of a complete line-to-ground insulation system and the surface of the test probe may be energized at a voltage above ground potential when connection to an energized test port.
6. Do not attempt to force or bypass any interlocks. The interlocks are furnished for the safety of the operator and the protection of the equipment being tested and the test device. Forcing or bypassing the interlocks can result in a condition dangerous to the operator and/or damaging to the equipment.
7. 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.
8. For service, the device must be in the OPEN position and all operating springs must be discharged. These conditions should be verified before removing any covers or attempting any service.
9. Store the electrically operated ground and test device in a clean, dry area free from dust, dirt, moisture, caustic atmosphere, and vermin.
10. Keep all insulating surfaces, which include primary support insulation and insulation barriers, clean and dry.
11. Check all primary circuit connections to make certain that they are clean and tight.
12. 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 circuit breaker is handled, operated, or maintained.

**NOTICE**

*Warning and Caution labels are located in various places. Do NOT remove or deface any of these warning/caution labels.*
Ch 3 Equipment Description

A. General

The PowlVac® Electrically Operated Ground and Test Devices stated in Ch 1 General Information, A. Scope are drawout elements that can be inserted into the circuit breaker compartment in the same manner as a PowlVac circuit breaker.

The ground and test device provides a means for obtaining access to the primary disconnecting devices of the switchgear compartment for purposes of grounding the primary circuits or conducting certain high voltage test procedures such as conducting high voltage withstand (hipot) tests.

The grounding switch is operated by a stored energy mechanism. It is capable of applying the ground against a live circuit if operational errors have not cleared the circuit. However, in such a case, the relaying at the source of power is expected to cause the source interrupter to clear the circuit.

B. Rating

The ground and test device has ratings similar to a power circuit breaker, with two very important exceptions: it has no continuous current rating, and it has no interrupting rating. This device has no continuous current rating because it cannot be used to carry a continuous current. It has no interrupting rating (or any of the ratings associated with the interrupting rating, such as interrupting time, etc.) because it is not designed to interrupt current.

In general, the ratings applied to any ground and test device are the same as those applied to the power circuit breaker it is designed to temporarily replace for grounding and testing purposes. The rating nameplate (Figure 1, i) on the front of the device will give the ratings applicable to any individual device.

C. Primary Disconnect Stabs

The ground and test device has three (3) primary disconnect stabs (Figure 2, f) similar in design to those on the PowlVac circuit breaker. These three disconnects will connect the three stationary primary disconnect stabs in the switchgear compartment when the ground and test device is racked into the connected position. They are mounted on the rear of a heavy insulated barrier near the rear of the ground and test device.

D. Ground Making Switch

A three-pole, single-throw ground making switch is mounted on the front of the insulating barrier on which the selector switch hinges are mounted. The three stationary contacts of the grounding switch (Figure 3, a) are connected to the three primary disconnect stabs so that the ground making switch can be connected to the upper set of primary disconnect stabs, allowing the line side of the switchgear compartment to be grounded.

The moving contacts and blades of the ground making switch (Figure 3, b) are operated by a high-speed stored energy mechanism. The ground making switch contact structure is specially designed for the close-and-latch and short-time current carrying duties to which it can be subjected. These contacts are not designed for continuous current carrying duty or for interrupting duty. The position of the ground making contacts can be observed when the device is in the switchgear compartment through transparent viewing panels (Figure 1, e) in front of the contacts.
The hinges of the three grounding contacts are connected together by a ground bus (Figure 3, d), which is in turn connected to a heavy duty ground connection located on the rear of the ground and test device frame between the center and right phases. This ground connection duplicates the ground connection on the PowlVac® circuit breaker and connects to the ground bus in the switchgear compartment, providing a path to ground from the ground making switch.

E. STORED ENERGY MECHANISM

The lower front cover has cutouts and apertures giving access to various operating and levering-in mechanism indicating and operating functions. Removal of the holding screws allows the removal of the upper portion of the front cover and the test port shutter assembly, giving access to the mechanism and its interlocks (Figure 3), auxiliary switches (Figure 3, c), charging motor (Figure 4, a), and motor cutoff switch (Figure 4, c).

The ground making switch is closed and opened by a stored energy mechanism (Figure 3) in which a gear motor is used to compress a closing spring. During a closing operation, the energy stored in the spring is used to close the ground making switch contacts, charge the opening springs and overcome friction forces. When the ground making switch is opened, the energy stored in the opening spring and the kickoff springs will open the contacts. Since the ground making switch has no interrupting rating, contact speed while opening is not important. The motor, located on the inside of the lower front cover at the left (Figure 4, a) is supported from the lower front cover. Its output shaft is screwed to a coupler which insert into the eccentric drive shaft. This shaft is supported in the needle bearings in the mechanism frame side sheets and transmits the motor torque from the left to the right side of the mechanism.

When the motor is energized, the eccentric shaft rotates and causes the driving arm links to pivot about the camshaft (Figure 3, l). The drive pawl located on the links engages with the ratchet wheel and rotates it. The ratchet wheel is prevented from rotating backwards by a holding pawl, which is supported on links which project upwards from the camshaft.

To ensure correct synchronization of the drive and hold pawls, the hold pawl links are located by a threaded shaft which passes through the lower front cover to the right of the mechanism. The position of the holding pawls is adjusted by a nut on the outer end of this shaft.

As the ratchet wheel is rotated, projections from its side faces will engage drive plates attached to the camshaft and the camshaft will rotate. Attached to the ends of the camshaft are crank arms and pointing outward from these are crank pins. These engage with the front ends of the connecting rods (Figure 4, d), the rear ends of which engage in pins projecting from the spring compression plate which straddles the main closing spring. As the camshaft rotates, the connecting rods pull the spring compression plate forward, compressing the closing spring.

The ratchet wheel will drive the camshaft so that the connecting rods go forward as far as possible and then start to move to the rear. At a certain point, the spring force will overcome friction and resistance and start to rotate the camshaft. At the same time, the pawls are uncoupled from the ratchet wheel and the motor cutoff switch is operated.
Figure 1  Ground and Test Device with Probes

a. Test Probes (shown with test leads attached)
b. Key Lock K3
c. Racking Assembly
d. Levering-In Shutter
e. View Window
f. Power Receptacle
g. Control Selector Switch
h. Key Lock K2
i. Nameplate
j. Secondary Disconnect Receptacle
k. Key Lock K1
l. Wheel
m. Manual Push to Trip Paddle
n. Closing Coil
Figure 2  Ground and Test Device Right View

a. Crank Arm Roller
b. Racking Gear
c. Racking Crank Arm
d. Worm Gear
e. Levering In Shutter Interlock
f. Primary Disconnecting Device
g. Secondary Disconnect Latch
h. Ground Connection
i. Anti-Rollout Latch
j. Wheel
When the close latch is released by the closing coil, the closing spring pulls the camshaft around and the main closing cam moves the main linkage into the closed position. The main linkage rotates the drive levers of the jackshaft, which is supported by the mechanism side sheets, where it is clamped by hook plates and by the ground and test device side panels. The jackshaft has three (3) upward pointing levers to which the operating rods are attached. The operating rods, approximately horizontal, are moved to the rear of the device by the rotation of the jackshaft.

The end of the operating rods remote from the jackshaft levers is connected to the movable contacts of the ground making switch. The stationary contacts of the ground making switch are mounted on the center insulating barrier. Directly beneath the stationary contacts are the movable contact kickoff springs. When the moving contacts of the ground making switch make contact with the stationary contacts, the springs are loaded by a force sufficient to assist their separation during opening of the ground making switch.

In the linkage position shown in Figure 5, the kickoff springs and the main opening spring are both acting to compress the three (3) main mechanism links. The linkage is restrained from movement by the secondary trip prop acting on the primary trip prop roller. The component of force tends to make the primary trip prop move downward, but it is restrained by the secondary trip prop face acting on the primary trip prop roller. The clearance between the primary trip prop roller and the secondary trip prop is controlled by the primary trip prop adjusting screw. When the trip shaft is rotated by the action of the manual trip plate or the optional electric trip solenoid (when furnished), the secondary trip prop moves forward and permits the primary trip prop to move down, thus permitting the main linkage to move down and the jackshaft to rotate, opening the ground making switch. The left hand of the jackshaft has a connection for the opening spring. A projection of the left hand operating lever also operates the auxiliary switch (Figure 3, c).

With the standard electrical control scheme (Figure 9), the closing spring is not charged until a closing operation is called for by an external signal. As soon as the spring is fully charged, the tripped linkage can reset under the action of the reset spring (Figure 5, l) and the primary and secondary trip props can fall into the reset position. The reset spring stretches between an extension on the main cam roller pin and a spring support pin located on the right mechanism side sheet. The trip latch check switch operated by a lever on the trip shaft will now close. This allows the closing coil to energize, closing the ground making switch. The closing spring remains discharged after a closing operation.
**Figure 3  Mechanism - Top View**

a. Grounding Switch Stationary Contacts  
b. Ground Making Switch Moving Contacts  
c. Auxiliary Switch  
d. Ground Bus  
e. Control Relay  
f. Stored Energy Mechanism  
g. Pawl Return Spring Weldment  
h. Ratchet Wheel  
i. Pawl Support Arm  
j. Eccentric Roller  
k. Crank Arm  
l. Camshaft
**Figure 4  Mechanism - Left View**

- **a. Charging Motor**
- **b. Shunt Trip Coil**
- **c. Motor Cutoff Switch**
- **d. Connecting Rod**
- **e. Close Latch Adjusting Screw**
**Figure 5  Mechanism and Trip Linkages**

- **a.** Center Phase Operating Lever
- **b.** Jackshaft
- **c.** Primary Trip Prop Adjusting Screw
- **d.** Main Cam Roller
- **e.** Primary Trip Prop
- **f.** Main Drive Cam
- **g.** Primary Trip Prop Roller
- **h.** Secondary Linkage Roller
- **i.** Camshaft
- **j.** Trip Bar
- **k.** Secondary Trip Latch
- **l.** Reset Spring
- **m.** Secondary Trip Prop Adjusting Screw
**Figure 6  Cam and Fundamental Link Positions**

A. Device Open - Springs Charged - Links Reset

B. Device Closed - Springs Discharged

C. Device Open - Springs Discharged
F. Test Ports

The ground and test device is equipped with three (3) high voltage test ports (Figure 7, a), mounted on a third insulation panel on the upper front of the device. These test ports are covered with insulating shutters (Figure 7, c) which can be interlocked to control access to the test ports.

The upper set of three (3) test ports is connected to the primary disconnecting devices.

A set of three (3) test probes (Figure 7, b) is supplied with each ground and test device. These probes are specially made to connect to the test ports of the device and should be used for all connections to the test ports. Grooves around the circumference of the test probes allow them to be held captive in the test ports by slots in the shutters which cover the test ports. This feature can be used with interlocks to control the sequence of test operation.

G. Levering-In Device

The ground and test device is moved between the disconnected and connected positions by the levering-in device. This consists of a shaft which is supported by the device side sheets and which has a crank arm at each end (Figure 2, c). Rollers (Figure 2, a) attached to the crank arms engage vertical slots in plates attached to the cell and rotation of the shaft causes the device to move in and out of the breaker housing. The levering-in shaft supports a racking gear at its right end just outside the right device side sheet. The racking gear is rotated by a worm gear on a shaft which is terminated in a hexagon drive nut attached with a shear pin. This shaft points in a direction from the front to the back of the ground and test device. This shaft has a threaded portion carrying a threaded plate. As the worm shaft is rotated, the threaded plate moves along the shaft until it encounters either a front or a back sleeve attached to the shaft and further rotation of the worm shaft is prevented. At this point, the ground and test device is either fully inserted into the breaker compartment or is in the fully disconnected position.

CAUTION

The interlocking provided on the PV-E 60600G13 electrically operated ground and test device is of rugged construction and is designed to deter incorrect operation but any interlock mechanism can be damaged or rendered inoperative by deliberately bypassing or removing it, by force or by careless abuse. Interlock mechanisms should not be tampered with or abused. They exist for the safety of the operator and the protection of the equipment.

Figure 7 Test Ports

a. Test Port
b. Test Probe Inserted into Test Port
c. Insulating Shutter
H. **INTERLOCKING**

The ground and test device is provided with numerous interlocks as standard features, and many more can be added if required by a specific user. The standard interlocks include:

1. The levering-in mechanism cannot be operated unless the grounding switch is in the open position. The window in the front cover which gives access to the levering-in shaft is covered by a shutter (*Figure 1, d*). When the manual trip paddle (*Figure 1, m*) is in its normal position, a pin in this shutter rests on a shutter interlock arm (*Figure 2, e*). Pushing in on the trip paddle opens the grounding switch. This action also causes the shutter interlock arm to swing forward, allowing the levering-in shutter to drop, exposing the levering-in shaft. When the shutter is down, the pin drops behind the shutter interlock arm, holding the trip paddle in its operated position and blocking closing of the grounding switch. This ensures that the device cannot be inserted into or withdrawn from a switchgear cell unless the grounding switch is open.

2. The levering-in shutter and the trip paddle are further interlocked to block closing of the grounding switch in any position of the ground and test device other than fully inserted into or fully withdrawn from the compartment. The levering-in shaft has a cam plate attached to it next to the racking gear. This cam has two notches in it. The back end of the shutter arm has another pin, which must drop into one of these notches in order to raise the shutter and release the trip paddle. The two notches are positioned so that the pin on the shutter will enter one notch when the ground and test device is in the fully inserted position and the other notch when the device is in the fully withdrawn position. In all other positions of the ground and test device, the pin on the shutter rides on the surface of the cam and blocks closing of the shutter which in turn blocks closing of the grounding switch.

3. The manual trip paddle (*Figure 1, m*) may be padlocked in the operated position, ensuring that the grounding switch remains open, or it may be padlocked in the non-operated position, preventing the opening of the grounding switch.

4. The shutters covering the test receptacles may be padlocked or they may be interlocked using key interlocks (*Figure 1, b*).

I. **SHUTTERS**

In addition to moving the ground and test device in and out of the connected position, the crank arm rollers sliding in the slots in the plates on the switchgear compartment operate the shutters over the primary disconnects in the compartment. Downward movement of the rollers in the slots move the shutters before there is any movement of the ground and test device toward the connected position.

J. **OPERATING SOLENOIDS**

1) **Closing Coil**

The closing coil (*Figure 1, n*) is located just inside the lower front cover of the ground and test device. It is attached to the lower front cover by two screws, accessible from the front of the ground and test device.

2) **Shunt Trip Coil**

When supplied, the shunt trip coil (*Figure 4, b*) is located to the left of the mechanism to the rear of the ground and test device.
K. **Control Relay**

The control relay is mounted on the left hand mechanism enclosure side sheet, near the top (Figure 3, e).

L. **Trip Paddle Interlock Switch**

The trip paddle interlock switch is mounted just above the floor pan of the ground and test device, at the rear of the trip paddle mechanism. The switch is opened whenever the trip paddle is pushed. The switch opens the electrical closing circuit, blocking electrical closing of the grounding switch when the trip paddle is pushed.

M. **Remote Control Box**

The ground and test device draws its operating power through a control box connected to the ground and test device. The control box (Figure 8) contains a line fuse and a close push button. The control box is connected to the ground and test device by a 20 foot, four-conductor power cord. The cord is permanently attached to the control box, with a four-conductor twist-lock type receptacle at the ground and test device end.

![Figure 8 Remote Control Box](image)

N. **Key Locks**

The ground and test device is provided with numerous key lock interlocks and include:

1) **Key Lock “K1” (Key KA)**

The key lock “K1” interlock is a one cylinder lock used to electrically enable or disable the ground and test device.

Key lock “K1” interlock is a one cylinder transfer lock equipped with an electrical switch element. The switch is closed when key “KA” is retained. When the switch is “OPEN”, the ground and test device is electrically disabled and cannot be electrically or mechanically tripped “OPEN”.

2) **Key Lock “K2” (Keys KA and KB)**

The key lock “K2” interlock is a two cylinder lock used to electrically enable or disable the ground and test device.

In the PowlVac ground and test device design, the locking bolt of key lock “K2” interlock can not be extended unless the ground and test device is in the “CLOSED” position. The key lock “K2” interlock is equipped with an electrical switch element that electrically blocks a closing command.

The key lock “K2” interlock is operable only when key “KA” is inserted and the ground and test device is “CLOSED”. When the key lock “K2” interlock is operated with the locking bolt extended, the closing function is electrically disabled and key “KA” is retained and key “KB” is released.
Figure 9  Typical Control Schemes
3) **Key Lock “K3” (Key KB)**

The key lock “K3” interlock is a single cylinder lock. The key lock “K3” interlock is used to open and lock the test port shutters.

Key “KB”, which normally resides in the key lock “K2” interlock, is available only when the ground and test device is in the “CLOSED” and locked position. Key “KB” is then inserted in to key lock “K3”. With the locking bolt retracted and the test port shutters unlocked, key “KB” is retained.

**O. Control Selector Switch**

A control selector switch ([Figure 1, g](#)) is mounted on the front of the ground and test device. This selector switch enables and disables the closing function of the ground and test device.

The selector switch is a three position rotary switch that operates in association with the remote OPEN/CLOSE push button control box. The snap action positions are OPEN, OFF, and CLOSE.
**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.

Estimated size and weight for shipping a PowIVac® on a pallet:

- Size: 42” width x 42” depth x 47” height
- Weight: 500 lbs.

*Figure 10* shows the ground and test device enclosed in the carton used for shipment. The carton is attached to the shipping pallet by metal bands. Remove these bands and lift the carton from the pallet so that the ground and test device is visible. The ground and test device is attached to the pallet by metal bands. 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.

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**CAUTION**

*Do not handle or move the circuit breaker 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 circuit breaker floor pan. The forks on the truck should be set for a dimension over the forks of 28 inches. The forks should then ride under the wheel axles.
C. Storage

Since the ground and test device is an accessory device not normally in continuous service, it is very important that it be stored carefully so that it will be available when needed. The following precautions must be taken to assure proper storage of the ground and test device:

1. Since moisture has an adverse effect on the insulating parts, the device should be carefully protected against condensation, preferably by storing it in a warm dry room of moderate temperature, such as 40°-100°F. Ground and test devices used in outdoor metal-clad switchgear should be stored in the equipment only when power is available and the anti-condensation heaters are in operation.
2. The ground and test device should be stored in a clean location free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a corrosive effect on many parts.
3. Unplated surfaces, such as, rollers, latches, etc., of the operating mechanism should be coated with grease/oil to prevent rusting.

If the ground and test device is stored for any length of time, it should be inspected periodically to see that rusting has not started and to ensure good mechanical condition. If the ground and test device is stored under unfavorable atmospheric conditions, it should be cleaned and dried before being placed into service.
4. The device should be covered with a cloth or plastic cover to prevent dust accumulation on the device during long term storage. This cover must not cut off air flow to the device or condensation may occur under the cover.

D. Electrical Operation Check

In order to check the basic electrical operation of the ground and test device, the device must be placed near a circuit breaker test cabinet.

1) Test the Closing Operation of the Ground and Test Device

Perform the following to test the closing operation of the ground and test device:

a. Connect the secondary disconnect plug from the test cabinet to the secondary disconnect receptacle on the ground and test device (Figure 13).
b. Ensure the Key KA is captive in Lock K1 (Figure 16).
c. Connect the power cord of the remote control box to the ground and test device and rotate the plug clockwise to lock (Figure 12).
d. Turn the test cabinet power “ON” and verify that the control selector switch is in the “OFF” position (Figure 11).
e. Move the control selector switch to the “CLOSE” position.
f. Turn the remote control box to the “ON” position and depress the “CLOSE” button.
g. Move the control selector switch to the “OFF” position.

2) Test the Opening Operation of the Ground and Test Device

Perform the following to test the opening operation of the ground and test device:

a. Perform steps a through g of Test Closing Operation of the Ground and Test Device.
b. Move the control selector switch to the “OPEN” position.
c. Turn the remote control box to the “ON” position and depress the “OPEN” push button to open the ground and test device.
d. Move the control selector switch to the “OFF” position and turn the test cabinet power “OFF”.
e. Disconnect the remote control box from the ground and test device.

When the electrical checks are completed disconnect the secondary disconnect of the test cabinet from the ground and test device.

E. **Inserting Ground and Test Device Into Switchgear Equipment**

Refer to Instruction Bulletin 01.4IB.51000D for information and cautions before attempting to insert a circuit breaker into the metal-clad switchgear equipment. The information and cautions found in Instruction Bulletin 01.4IB.51000D also apply to the ground and test device. Ensure that the levering-in crank arms at the sides of the device point in the direction of the main disconnects.

Each ground and test device and each compartment is provided, when required, with a coding plate designed to ensure that no device with less than the required voltage or momentary current rating is placed in any compartment. If attempting to insert an improperly rated device into the switchgear, these coding plates will interfere with each other and deter the insertion of the device. The interference occurs before the device reaches the “DISCONNECT” position.

1) **Inserting Ground and Test Device Into Upper Compartment**

Refer to Instruction Bulletin 01.4IB.51000D for detailed procedures for this operation. The same instructions apply for the ground and test device.

2) **Racking Ground and Test Device to the Connected Position**

Perform the following to rack the ground and test device to the “CONNECTED” position:

a. Verify that the control selector switch is in the “OFF” position.
b. Push the manual push to trip paddle on the lower portion of the front of the device *(Figure 1, m)*. The levering-in shutter will open automatically and the trip paddle will be held captive in the “TRIP” position.

---

**CAUTION**

*Do not force the device past the interference or remove the coding plate from the compartment or the ground and test device.*
c. Insert the racking handle onto the hex shaft and rotate the handle clockwise. When the device is being inserted into the compartment, the force needed to rotate the handle will be low at the beginning of motion when movement of the crank arms is only opening the shutters; however, as the device moves into the compartment, the device primary disconnecting devices will engage the fixed stabs located in the compartment and the force required to rotate the handle will increase appreciably. This is normal and as soon as the contacts are fully engaged the force will decrease. Further rotation of the handle will cause the device to move further into the compartment ensuring wipe or overlap of the primary disconnecting devices and continues until a positive stop is reached.

3) Moving the Ground and Test Device from the Connected Position to the Disconnected Position

Perform the following to rack the ground and test device from the “CONNECTED” position to the “DISCONNECTED” position:

a. Ensure the grounding switch is in the Open position.

b. Push the manual push to trip paddle in and insert the racking handle.

c. Rotate the handle counter-clockwise until a positive stop is reached.

Do NOT attempt to rotate the handle counter-clockwise any further or damage to the mechanism may occur.

d. Once the device has reached the “DISCONNECTED” position, remove the racking handle and pull up on the levering-in shutter, returning it to its normal closed position. The trip paddle will be released by this action and will return to its normal position.

4) Removing the Ground and Test Device from the Upper Switchgear Compartment

Refer to 01.4IB.51000D for the detailed procedure for removing a circuit breaker from the upper compartment and follow the same procedures to remove a ground and test device.

d. Once the device has reached the “CONNECTED” position, remove the racking handle and pull up on the levering-in shutter, returning it to its normal closed position. The trip paddle will be released by this action and will return to its normal position.

The maximum force required on the racking handle for normal insertion of the ground and test device will not exceed 35 ft-lbs. Excessive force may damage the device or the switchgear.
Ch 5  Operating Procedures

The PowlVac® Electrically Operated Ground and Test Device is designed to provide access to the stationary primary disconnecting devices of metal-clad switchgear compartments to ground those terminals or to perform tests on either energized or deenergized circuits. Because this device gives access to switchgear components that are normally energized with dangerous voltages, great care must be exercised when using this device. All primary circuits should be considered to be energized until proven otherwise.

The operational instructions given in this instruction bulletin cover the basic operations required to use the ground and test device. In addition, many users will have operational and interlocking procedures of their own that must be followed. The operator must be knowledgeable of any procedures required by the user of the equipment and should also examine the drawings furnished with the particular switchgear equipment being grounded or tested, as these drawings may include additional information or instructions.

A. Procedure for Applying Ground

Because the two-high construction of PowlVac metal-clad switchgear requires the bus connections to be located on the upper disconnect stabs of some compartments and the lower disconnect stabs of other compartments, it is vital that the operator be sure which set of disconnect stabs is to be grounded before inserting the device into the switchgear compartment. Determine the circuit to be grounded and carefully examine the drawings provided with the switchgear equipment to determine in which compartment this circuit is located and whether it is connected to the upper or lower disconnect stabs. Once this is known, perform the following:

1. Deenergize the circuit to be grounded. Ensure that it is deenergized not only at the switchgear where the ground and test device is being inserted, but also at the remote end if it can be energized from that end.
2. Remove the circuit breaker from the compartment to be grounded and insert the ground and test device. Refer to Ch 4 Installation, E. Inserting Ground and Test Device Into Switchgear Equipment for instructions on inserting the ground and test device into the switchgear.
3. Verify that the control selector switch is in the OFF position.

CAUTION

Although the PowlVac Electrically Operated Ground and Test Device is designed and rated to close against a short circuit current within its rating, it should not be used to deliberately apply a ground to an energized line or bus. The operator should ensure that the circuit to be grounded is deenergized before closing the grounding switch.
4. Connect the remote control box to the ground and test device and rotate the plug clockwise to lock (Figure 12).

5. Connect the compartment secondary disconnect plug to the secondary disconnect receptacle on the ground and test device.

6. Move the control selector switch to the CLOSE position.

7. Turn the remote operating station ON and depress the CLOSE push button.
8. Move the control selector switch to the OFF position.
9. Turn the remote control box OFF.

B. Procedure for Testing Feeder

Perform steps 1 through 9 of Ch 5 Operating Procedures, A. Procedure for Applying Ground prior to the following:

1. Rotate Key in Lock K1, thereby extending the bolt and locking the manual “Push to Trip” paddle. The OPEN circuit is now electrically disabled and cannot be electrically or mechanically tripped “OPEN”. Key KA is now available (Figure 16).

2. Insert Key KA into Lock K2 (Figure 17) and rotate Key KA. Key KA is now captive and the close circuit is now electrically disabled, leaving Key KB now available (Figure 18).

3. Insert Key KB into Key Lock K3 (Figure 19) and rotate Key KB. Key KB is now captive and the test port shutters are accessible.
Operating Procedures

01.4IB.50023APowlVac® Electrically Operated 15kV Ground and Test per Long Island Railroad Specifications

**Figure 19  Inserting Key KB into Key Lock K3**

4. Open the test port shutters using the slider handle. Install the test probes into the test ports *(Figure 20).* Move the test port shutter to the left to capture the test probes in the test probe shutters.

5. Rotate Key KB to lock the test probes in the test ports. Key KB is now available.

6. Transfer Key KB to Key Lock K2 and rotate. Key KB is now captive and Key KA is available.

7. Transfer Key KA to Key Lock K1 and rotate *(Figure 16).* The ground and test device control circuit is now enabled. Key KA is captive.

8. Move the control selector switch to the OPEN position.

9. Turn the remote control box ON and depress the OPEN push button on the remote control box to OPEN the ground and test device *(Figure 21).*

10. Move the control selector switch to the OFF position.

11. Turn the remote control box OFF.

12. The ground and test device is now prepared for testing.
C. Testing Ports

The three (3) test ports provided on the front of the ground and test device may be used to provide access to the primary disconnecting devices of the switchgear compartment for testing purposes. Three (3) test probes are provided for use in these test ports.

The test ports are covered with shutters, one shutter for the upper three test probes. The shutters and test probes are made so that the shutter will interlock with a groove around the circumference of the test probe when the test probe is fully inserted into the test port, holding the test probes captive in the ground and test device.

The test ports are connected to the primary disconnecting devices. Each test probe is provided with a threaded stud projecting from the outer end of the probe. This stud may be used for attaching leads to test apparatus. The thread is 3/8-16 UNC. Since the end of these studs is accessible when the test probes are inserted in the test receptacles, the stud will be energized if the ground and test device is connected to an energized circuit. It is imperative that the operator insulate the ends of these test probes before inserting them into the ground and test device.

The test probes are not high current devices. They are suitable for testing procedures such as high potential testing, phasing out circuits, phase rotation testing, and primary voltage measurements.

Since the test probes give access to primary circuits, it is essential that any test apparatus connected to the test probes be rated for the primary circuit voltage. Test leads used for these connections must also be rated for the primary circuit voltage.

Actual testing procedures are to be determined by the user, taking into account the safety practices and cautions given in this instruction bulletin.

CAUTION

Even when insulated, the test probes should not be handled when energized. The test probe insulation is only one part of a complete line-to-ground insulation system and the surface of the test probe may be energized at a voltage above ground potential.
Ch 6  Maintenance

A. General Description

CAUTION

Prior to beginning any maintenance procedures, make certain that the control circuits are deenergized and the circuit breaker is resting securely outside the circuit breaker compartment. Do not work on a closed circuit breaker or a circuit breaker with the main closing spring charged.

NOTICE

Before attempting any maintenance work, it is important to study and fully understand the safety practices outlined in Chapter 2 of this instruction bulletin. If there is any reason to believe there are any discrepancies in the descriptions contained in this instruction bulletin, or if they are deemed to be confusing and/or not fully understood, contact Powell immediately.

1) Introduction

A regular maintenance schedule must be established to obtain the best service and reliability from the ground and test device. The ground and test device is designed to comply with industry standards requiring maintenance every 250 operations or once a year.

Actual inspection and maintenance will depend upon individual application conditions such as number of operations, time between uses, and storage conditions. If the ground and test device is used relatively infrequently, the interval between inspections may be longer than a year, but may include only a few operations. When the ground and test device has been in storage for an extended period of time, it is recommended that it be inspected and cleaned before being used. See Ch 4 Installation, C. Storage for storage recommendations. Follow those recommendations to minimize the need for maintenance before using the device after prolonged storage.

A permanent record of all maintenance work should be kept, the degree of detail depending upon the operating conditions. The record will be a valuable reference for subsequent maintenance work and for station operation. It is also recommended that the record include reports of tests performed, the condition of circuit breakers, and any repairs or adjustments that were performed. This record should begin with tests performed at the time of installation and energization, and all data should be graphed as a function of time to ensure a proper maintenance cycle is being scheduled. The actual reading of the operations counter should be recorded when the device is first used and whenever any maintenance is performed.

2) Inspection and Cleaning

Visually check for loose or damaged parts. Tighten or replace loose or missing hardware. Any part damaged so as to interfere with the normal operation of the device should be replaced.

Clean the ground and test device, removing loose dust and dirt.
CAUTION

Do NOT use compressed air to clean the device. This may result in loose dirt or grit being blown into bearings or other critical parts and causing excessive wear.

Either use a vacuum cleaner or wipe with a dry lint-free cloth or industrial-type wiper.

Primary insulation, including the insulating support plates on which the selector switch and grounding switch contacts are mounted and the operating rods, should also be cleaned. Wipe clean with a dry lint-free cloth or an industrial-type wiper. If dirt adheres and will not come off by wiping, remove it with distilled water or a mild solvent such as denatured alcohol. Be sure that the ground and test device is dry before returning it to service. Do not use any type of detergent to wash the surface of the insulators, as the detergent may leave an electrical conducting residue on the surface as it dries.

B. MECHANISM AREA

1) Mechanical Operation

Remove the upper portion of the front cover of the ground and test device. Make a careful visual inspection of the mechanism for loose, damaged or excessively worn parts. Operate the grounding switch several times. Operate the levering-in mechanism through one or two complete cycles and check for smoothness of operation.

2) Lubrication

Lubricate the mechanism and other specified parts in accordance with the lubrication chart, Table A, Lubrication.

The chart shows the location of all surfaces which should be lubricated together with the type of lubricant and the method of application. The guiding rule in lubrication should be to lubricate regularly, use lubricant sparingly and remove all excess lubricant.

Rheolube 368A should be lightly applied to those bearing surfaces which are accessible and a light synthetic machine oil such as Anderol A456 should be used to penetrate through to surfaces which are inaccessible. There is no necessity to disassemble the mechanism for lubrication. Tilting the device will facilitate the entry of the lubricant to the bearing surfaces.

3) Mechanism Adjustments

There are several factory adjustments in the mechanism which are described below. No adjustment of these settings is required for routine maintenance, but they may need to be adjusted after major overhaul or removal of the mechanism. Do not adjust these settings unnecessarily.
### Table A Lubrication

<table>
<thead>
<tr>
<th>Location</th>
<th>Reference Figure</th>
<th>Lubricant</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Parts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Primary Disconnect Fingers</td>
<td>Figure 22, a</td>
<td>Mobilgrease 28</td>
<td>Wipe clean. Apply lubricant only to actual contact surface.</td>
</tr>
<tr>
<td>Grounding Switch Hinges</td>
<td>Figure 22, b</td>
<td>Mobilgrease 28</td>
<td>With switch closed, wipe clean and apply as close to hinge as possible. Repeat with switch open.</td>
</tr>
<tr>
<td>Grounding Switch Contacts</td>
<td>Figure 22, c</td>
<td>Mobilgrease 28</td>
<td>With switch open, wipe clean and apply lube only to actual contact surfaces.</td>
</tr>
<tr>
<td><strong>Mechanical Parts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levering-In Device Worm and Wheel</td>
<td>Figure 22, d</td>
<td>Rheolube 368A Grease</td>
<td>Feed grease between worm and wheel while rotating worm shaft between disconnected and connected positions.</td>
</tr>
<tr>
<td>Worm Shaft Bearings</td>
<td>Figure 22, e</td>
<td>Anderol 456 Oil</td>
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</tr>
<tr>
<td>Levering-In Shaft Support Bearings</td>
<td>Figure 22, f</td>
<td>Anderol 456 Oil</td>
<td></td>
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<tr>
<td>Levering-In Crank Arm Rollers</td>
<td>Figure 22, g</td>
<td>Anderol 456 Oil</td>
<td>Tilt device sideways and rotate roller while oiling.</td>
</tr>
<tr>
<td>Spring Yoke Pins</td>
<td>Figure 22, h</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Trip Shaft Support Bearings</td>
<td>Figure 22, i</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Crank Pins</td>
<td>Figure 22, j</td>
<td>Anderol 456 Oil</td>
<td></td>
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<tr>
<td>Motor Drive Shaft Roller Needle Bearings</td>
<td>Figure 22, k</td>
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<tr>
<td>Pawls</td>
<td>Figure 22, l</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Close Latch Shaft Face</td>
<td>Figure 22, m</td>
<td>Rheolube 368A Grease</td>
<td>Apply a light coating of grease and remove all excess.</td>
</tr>
<tr>
<td>Ratchet Wheel</td>
<td>Figure 22, n</td>
<td>Rheolube 368A Grease</td>
<td></td>
</tr>
<tr>
<td>Jackshaft Lever Pins passing through Operating Rod Clevises</td>
<td>no image available</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Fixed Link Pin</td>
<td>Figure 22, o</td>
<td>Anderol 456 Oil</td>
<td>Apply to penetrate where pin passes through end link.</td>
</tr>
<tr>
<td>Main Closing Spring Guide Rod</td>
<td>Figure 22, p</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Primary Trip Prop Shaft Support Bearings</td>
<td>Figure 22, q</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Primary Trip Prop Shaft Roller</td>
<td>Figure 22, r</td>
<td>Anderol 456 Oil</td>
<td></td>
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<tr>
<td>Open-Close Flag Drive Lever Pin at Jackshaft</td>
<td>Figure 22, s</td>
<td>Anderol 456 Oil</td>
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</tr>
<tr>
<td>Flag Support Pins</td>
<td>Figure 22, t</td>
<td>Anderol 456 Oil</td>
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<tr>
<td>Jackshaft Supports at Mechanism</td>
<td>Figure 22, u</td>
<td>Anderol 456 Oil</td>
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<tr>
<td>Wheel</td>
<td>Figure 22, v</td>
<td>Anderol 456 Oil</td>
<td>Tilt device sideways and rotate wheels while oiling.</td>
</tr>
<tr>
<td>Motor Drive Shaft Support Bearings</td>
<td>Figure 22, w</td>
<td>Anderol 456 Oil</td>
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<tr>
<td>Camshaft Needle Bearings</td>
<td>Figure 22, x</td>
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<td></td>
</tr>
<tr>
<td>Close Shaft Support Bearing</td>
<td>no image available</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Motor Cutoff Switch Cam</td>
<td>Figure 22, y</td>
<td>Rheolube 368A Grease</td>
<td>Apply to peripheral surface only.</td>
</tr>
<tr>
<td>Fundamental Link</td>
<td>Figure 22, z</td>
<td>Anderol 456 Oil</td>
<td></td>
</tr>
<tr>
<td>Fundamental Link Cam</td>
<td>Figure 22, aa</td>
<td>Rheolube 368A Grease</td>
<td></td>
</tr>
</tbody>
</table>
Figure 22  Lubrication

a. Main Primary Disconnect Fingers
b. Grounding Switch Hinges
c. Grounding Switch Contacts
d. Levering-In Device Worm and Wheel
e. Worm Shaft Bearings
f. Levering-In Shaft Support Bearings
g. Levering-In Crank Arm Rollers
h. Spring Yoke Pins
i. Trip Shaft Support Bearings
j. Crank Pins
k. Motor Drive Shaft Roller Needle Bearings
l. Pawls
m. Close Latch Shaft Face
n. Ratchet Wheel
o. Fixed Link Pin
p. Main Closing Spring Guide Rod
q. Primary Trip Prop Shaft Support Bearing
r. Primary Trip Prop Shaft Roller
s. Open-Close Flag Drive Lever Pin
t. Flag Support Pins
u. Jackshaft Supports
v. Wheel
w. Motor Drive Shaft Support Bearings
x. Camshaft Needle Bearings
y. Motor Cutoff Switch Cam
z. Fundamental Link
aa. Fundamental Linkage Cam
a. Adjustment of Ratchet Wheel Holding Pawl

The ratchet wheel holding pawl is adjusted by a nut on the outer end of a threaded shaft. If the pawl is not properly adjusted, there will be a “knocking” noise when the ratcheting mechanism is operating, or the mechanism will not ratchet at all. To adjust the pawl, turn the nut while charging the spring using the charging motor. Bring the pawl into adjustment by turning the nut clockwise. Do not turn the nut counterclockwise.

Figure 23 Mechanism Detail - Right Side

b. Adjustment of Primary and Secondary Trip Props and Latch Check Switch

Adjust the secondary trip prop adjusting screw (Figure 5, m) so that the overlap of the secondary trip prop on the primary trip prop roller is approximately 0.125”. Adjust the primary trip prop adjusting screw (Figure 5, c) so that with the main linkage in the reset position the clearance between the primary trip prop roller and the secondary trip prop is 0.005” to 0.015”. With a 0.015” wire gauge between the trip bar lever and the secondary trip prop adjusting screw, the latch check switch should be open. With no gap between the lever and the screw, the latch check switch should be closed.

c. Adjustment of Close Latch

The close latch shaft passes through the side sheets of the mechanism frame at the front of and below the camshaft. The right end of the shaft is shaped to make a latch face and interferes with the latch arm which is fixed to the camshaft. The other end of the close shaft is on the left side of the mechanism and a small lever attached to it is positioned by an adjusting screw (Figure 4, e).

Adjustment of this latch must be made with the main closing spring charged. Since the control circuit of the ground and test device is designed to close the grounding switch immediately on completion of the charging cycle, it is necessary to unplug the closing coil from the wiring harness before adjusting the close latch. With the closing coil disconnected, plug the control cord into a power source of the proper rating and press the “CLOSE” push button on the control box. The mechanism will charge the main closing spring and stop. Disconnect the control cord from the power source before proceeding.
With the main closing spring charged, turn the latch adjusting screw upwards until the latch is released and the grounding switch closes. Unscrew the adjustment screw 2½ turns and lock in position with the locking nut. The latch adjusting screw is accessible from beneath the ground and test device through a clearance hole in the base pan. The locking nut is accessible from above the base pan, on the left side of the main mechanism.

After completing the adjustment of the close latch, reconnect the closing coil.

4) Electrical Operation

After any necessary mechanical maintenance and lubrication is done, operate the ground and test device electrically several times to ensure that the electrical control system works properly. Refer to Ch 5 Operating Procedures.

C. Grounding Switch Area

1) Routine Maintenance

Lubricate the blades as shown in Table A, Lubrication. Examine the contact areas, both moving and stationary, for evidence of overheating, pitting, cracking or other damage. Any damaged parts should be replaced.

2) Moving Contact Adjustments

There are two factory adjustments of the moving contacts which are described in this section. No adjustment of these settings is required for routine maintenance, but they may need to be adjusted after major overhaul or replacement of contact parts. Do not adjust these settings unnecessarily.

a. Initial Kick-Off Spring Height Adjustment

The initial height setting of the kick-off springs is measured with the ground making switch open. The height from the back side of the impact snubber and the insulating support is 2½". This height is adjusted by grasping the impact snubber and turning the 1/₄-20 hex head bolt. Turning the bolt clockwise will decrease the gap, and turning the bolt counterclockwise will increase the gap (Figure 24).

b. Kick-Off Spring Pressure Adjustment

With the ground making switch in the closed position, measure the gap between the back of the insulating barrier that supports the kick-off springs and the underside of the 1/₄-20 hex head bolts that retain the springs. This gap should be between ¼" and ⁵/₁₆" (Figure 24). This measurement does not include the flat washer. To adjust the gap, open the ground making switch. Remove the pin connecting the operating rod clevis to the jackshaft arm. Loosen the locknut on the operating arm clevis and rotate the clevis one or more half turns to adjust the length of the operating rod. The clevis should be screwed into the operating arm cross member (turned clockwise) to decrease the gap between the bolt head and the mounting barrier and screwed out (turned counterclockwise) to increase the gap. Reconnect the clevis to the jackshaft arm and tighten the locking nut. Close the ground making switch and recheck the gap. Repeat as necessary to achieve optimum adjustment of the gap.
1) **High Voltage Insulation Integrity**

With the grounding switch “OPEN” wire the three upper primary stabs of the device to a high potential test set and ground the three lower primary stabs and the frame of the ground and test device. Perform the one minute high voltage test prescribed in ANSI Standard C37.20.2, 5.5 and 4.2.3, at the voltage level appropriate for the equipment.

![Figure 24: Ground Switch Contacts](image)

2) **Control Voltage Insulation Integrity**

If the user wishes to check the insulation integrity of the control circuit, it may be done with a 500V or 1000V insulation tester or with and AC high potential tester. The AC high potential test should be made at 1125V, 60Hz, for one minute. The charging motor must be disconnected at its connection plug prior to testing the control circuit. The motor itself may be similarly tested at a voltage not to exceed 675V, 60Hz. Be sure to remove any test jumpers and reconnect the charging motor when the tests are complete.

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**CAUTION**

Remove all grounding conductors applied for this test before placing the ground and test device into service.

**D. High Potential Tests**

These tests are not ordinarily required for routine maintenance, but should be performed if the ground and test device has been in storage for an extended period of time, especially in a damp location or other adverse environment, or if the insulation of the device shows any signs of damage or deterioration.

c. **Hinge Bolt**

Disconnect the operating rod at the movable contact by removing the pin. With the movable contact not touching the stationary contacts, apply a force gauge to the outer end of the contacts. The hinge bolt (**Figure 24**) should be tightened so that the force necessary to start the blades in motion is 9-12 lbs.
Ch 7  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. 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.

B. Recommended Renewal Parts

A sufficient amount of renewal parts should be stored to enable the prompt replacement of any worn, broken or damaged part. A sufficient amount of stocked parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, a larger quantity of renewal parts should be stocked depending on the severity of the service and the time required to secure replacements parts.

Since parts may be improved periodically, renewal parts may not be identical to the original parts. Table B, Recommended Renewal Parts lists the recommended spare parts to be carried in stock by the user. The recommended quantity is not specified. This must be determined by the user based on the application. As a minimum, it is recommended that one set of parts be stocked per ten circuit breakers or less.

Powell recommends that only qualified technicians perform maintenance on these units. Refer to the Qualified Person section in the front of this instruction bulletin. If these circuit breakers are installed in a location where they are not maintained by a qualified technician, a spare circuit breaker should be on site ready for circuit breaker replacement. The malfunctioning unit can then be returned to the factory for reconditioning.

<table>
<thead>
<tr>
<th>Table B  Recommended Renewal Parts</th>
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Notes: 1) For other control voltages, contact factory.
2) When device is equipped with this optional feature.
C. Replacement Procedures

This section includes instructions for replacing the parts recommended as renewal parts. Before attempting any maintenance repair work, take note of the safety practices outlined in Ch 2 Safety of this instruction bulletin.

1) Grounding Switch Movable Contact

The grounding switch movable contacts (Figure 3, b) are located at the top of the moving arms of the grounding switch, behind the windows in the front cover.

Perform the following steps to replace the grounding switch movable contact:

a. Remove upper portion of ground and test device front cover.

b. With grounding switch in “OPEN” position, remove two 3/8” bolts holding movable contact to top of moving arm (Figure 24).

c. Bolt the new movable contact in place, using existing hardware. Torque 3/8” bolts to 20-30 ft-lbs.

d. Close grounding switch and check the kick-off spring pressure as described in Ch 6 Maintenance, C. Grounding Switch Area, b. Kick-Off Spring Pressure Adjustment. If necessary, adjust the spring pressure.

e. Replace the front cover.

2) Grounding Switch Stationary Contacts

The grounding switch stationary contacts are located on the front of the middle insulating barrier of the ground and test device (Figure 3, a).

Perform the following steps to replace the grounding switch stationary contacts:

a. Remove the upper portion of ground and test device front cover.

b. Remove six insulating tubes from the test port jacks.
c. Remove three $\frac{5}{16}$" bolts holding the stationary contact to the contact support bar. Bolt the new stationary contacts in place using the existing hardware. Torque the $\frac{5}{16}$" bolts to 15-20 ft-lbs. No adjustment of the contacts is required.

d. Reinstall the six insulating tubes around the test jacks. Make sure that each test jack is seated in the hole in the supporting barrier, and that the grooved end of the insulating tube is toward the front of the ground and test device.

e. Reinstall the upper front cover assembly. Make sure that the grooved end of each of the six test port insulating tubes is seated in the hole provided in the front insulating barrier before replacing the mounting bolts.

3) Closing Coil Assembly

Perform these steps to replace the closing coil assembly:

a. Remove the upper portion of the ground and test device front cover.

b. Unplug the closing coil from the wiring harness.

c. Remove the two bolts holding the closing coil assembly to the lower front cover and withdraw the closing coil from the front of the ground and test device.

d. Insert new closing coil assembly into the device from the front, bolt it into place and plug it into the wiring harness. No adjustment is required.

e. Close the grounding switch electrically several times to ensure that the coil is working properly.

f. Replace the upper front cover.

4) Charging Motor Assembly

The charging motor assembly is located in the lower left of the ground and test device, just behind the lower front cover (Figure 4, a).

Perform these steps to replace the charging motor assembly:

a. Remove the upper portion of the ground and test device front cover.

b. Unplug the charging motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the lower front cover and slide the motor to the left, disconnecting the motor shaft from the mechanism, and lift the motor out.

d. Lubricate the end of the shaft of the new motor liberally with Rheolube 368A.

e. Position the new motor assembly in the device, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.

f. Bolt the motor to the front cover and plug it into the wiring harness.

g. Close the grounding switch electrically several times to ensure that the motor operates smoothly.

h. Replace horizontal front cover.

5) Shunt Trip Coil

When supplied, the shunt trip coil is located to the left of the mechanism near the rear (Figure 4, b).

CAUTION
Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the shunt trip coil:

a. Remove the upper portion of the ground and test device front cover.

b. Unplug the trip coil from the wiring harness.

c. Remove the two bolts holding the trip coil assembly to the mechanism frame and remove the assembly.

d. Insert the new trip coil assembly into the device, bolt it into place and plug it into the wiring harness.

e. With the mechanism in the reset position, check the gap between the trip coil armature and the trip lever extending from the trip shaft. This gap should be between \( \frac{1}{4}" \) and \( \frac{5}{16}" \). If necessary, bend the trip lever slightly to achieve this setting.

f. Close and trip the grounding switch electrically several times to ensure that the coil is working properly.

g. Replace the upper front cover.

6) Control Relay

The control relay is mounted on the left side of the mechanism on the lower front cover (Figure 3, e).

CAUTION
Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the control relay:

a. Remove the upper portion of the ground and test device front cover.

b. Disconnect leads from the control relay, being careful to note which wires go to which terminals.

c. Loosen lower mounting screw of relay.

d. Remove upper mounting screw and lift relay off lower screw.

e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.
f. Reconnect all wires to the proper terminals of the relay.
g. Close the grounding switch electrically several times to ensure that the relay is working properly.
h. Replace the upper front cover.

7) Latch Check Switch

The latch check switch is located on the right side of the mechanism near the rear (Figure 23, a).

CAUTION

Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the latch check switch:

a. Remove the upper portion of the ground and test device front cover.
b. Remove two screw holding switch to mechanism. Do not lose nut plate into which these screw are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in Ch 6 Maintenance, B. Mechanism Area, 3) Mechanism Adjustments, b. Adjustment of Primary and Secondary Trip Latches and Latch Check Switch in this instruction bulletin.
f. Close the grounding switch electrically several times to ensure that the mechanism is working properly.
g. Replace the upper front cover.

8) Trip Paddle Interlock Switch

The trip paddle interlock switch is located on the right side of the mechanism just above the floor pan (Figure 23, d). It is accessible from the rear of the ground and test device.

CAUTION

Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the trip paddle interlock switch:

a. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
b. Disconnect wires from switch.
c. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
d. Adjust switch so that its contact is closed when the trip paddle is in its normal position (fully forward) and is open when the trip paddle is depressed far enough to get a padlock in front of the trip paddle and into the hole in the trip paddle interlock bracket. This may require bending the arm of the switch.
e. Check to be sure the mechanism will not charge when the trip paddle is padlocked in the depressed position.
f. Replace the upper front cover.
9) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located in the lower left of the ground and test device, just behind the lower front cover (Figure 4, c).

⚠️ CAUTION
Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the motor cutoff switch:

a. Remove the upper portion of ground and test device front cover.
b. Disconnect leads from switch, being careful to note which wires came from which terminals.
c. Remove the two bolts holding the switch mounting bracket to the lower front cover and remove the assembly.
d. Install new motor cutoff switch assembly, bolt it to the front cover and reconnect the wiring harness.
e. Close the grounding switch electrically several times to ensure that the mechanism operates smoothly.
f. Replace the upper front cover.

10) Auxiliary Switch

The auxiliary switch is located on the left hand side panel of the ground and test device (Figure 3, c).

⚠️ CAUTION
Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the auxiliary switch:

a. Remove the upper portion of the ground and test device front cover.
b. Remove two screws holding switch to the side panel. Do not lose nut plate into which these screws are threaded.
c. Disconnect leads, being careful to note which leads are connected to which terminals.
d. Reconnect all leads to proper terminals of new switch.
e. Locate new switch on side panel and reinstall two mounting screws. Do not tighten screws.
f. Adjust by rotating the switch about the lower mounting hole. The upper hole is enlarged to allow rotation. The switch is properly adjusted when there is continuity between the terminals marked “Common” and “Normally Open” with the ground and test device in the open position. Check both switches that make up the assembly. It may be required to bend the arm on one or the other of the switches in order to accomplish this adjustment.
g. Close the grounding switch electrically several times to ensure that the auxiliary switch operates smoothly.

h. Replace the upper front cover.

11) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact stabs (Figure 2, f).

**CAUTION**

Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the primary contact spring assembly:

a. Depress spring support sufficiently to allow keeper to be removed.
b. Remove slotted washer, spring support, and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Place slotted washer over spring support on other side of spring from fingers.
e. Depress head of spring support and install keeper in end of spring support.
f. Release spring slowly, allowing keeper to seat properly.

**Note:** Springs are to be installed in every other slot in fingers; top, center, and bottom. The second and fourth slots are empty.

12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the ground and test device floor pan, between the center and right poles (Figure 2, h).

**CAUTION**

Ensure that the control circuits are deenergized and the ground and test device is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed ground and test device or a ground and test device with the main closing spring charged.

Perform these steps to replace the ground shoe finger assembly:

a. Elevate the ground ant test device so that there is at least 6” of clear space below the bottom pan of the device.
b. Remove the bolts holding the two ground shoe mounting brackets to the ground bar, and remove the two brackets.
c. Press down on finger assembly and remove it from the bottom of the ground and test device.
d. Remove four socket head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off ground bars on ground and test device and apply a thin coat of contact lubricant MobilGrease 28 to ground bars.
g. Insert new finger assembly from below the floor pan and press up until the upper lobe of the fingers snaps into place on the ground bus.
h. Reinstall the two mounting brackets.
01.4IB.50023A
PowlVac® Electrically Operated
15kV Ground and Test Device

15kV Electrically Operated G&T per
Long Island Railroad Specifications

April 2020