INSTRUCTIONS

GEK-19701A
Supersedes GEK-19701

VACUUM INTERRUPTER

15.5kV Class POWER/VAC* Vacuum Interrupter

CONTENTS

POWER CIRCUIT BREAKER DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

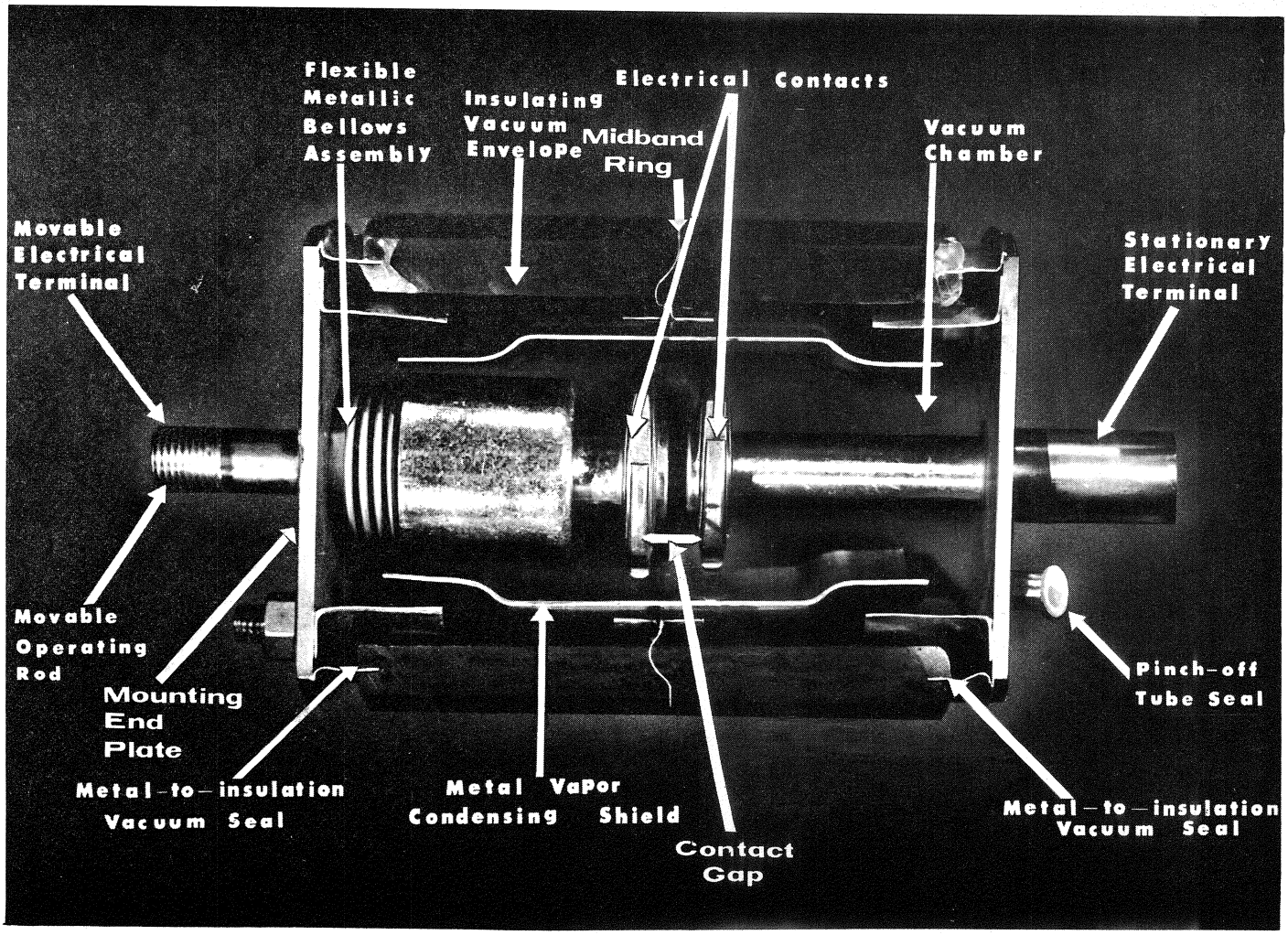

Fig 1 (8915865A)

Fig 1 Typical Vacuum Interrupter Nomenclature

VACUUM INTERRUPTER

15.5kV Class POWER/VAC* Vacuum Interrupter

INTRODUCTION

Vacuum interrupters display many of the features of an ideal interrupter including long life, low maintenance, and rapid, quiet interruption. This instruction is a general guide to assist in the application of vacuum interrupters in circuit switching and interrupting equipment where the interrupter will operate within the voltages and currents listed on the specification sheet. Fig. 1 shows a typical vacuum interrupter.

RECEIVING, HANDLING, INSPECTION AND STORAGE

The vacuum interrupter construction is sufficiently rugged to withstand any normal handling required. Each unit is tested and inspected before being packed in its specially designed shipping container. However, immediately upon receipt a careful examination of each interrupter should be made for possible damage incurred during shipment. If any damage is detected, a claim should be filed at once with the transportation company and notification given to the nearest General Electric Sales Office.

When removing the interrupter from its carton do not grasp it by the movable electrical terminal or rock the rod from its centered position. Excessive radial displacement can permanently distort the bellows or cause deformation of other internal parts. Since bellows damage can lead to early failure while in service, this area should be given a careful visual inspection, looking down inside the bellows with the aid of suitable illumination. If any obvious damage is detected such as sharp dents, creases, or other distortions in the normally smoothly rounded contours, the interrupter may still be operable but the mechanical life could be significantly impaired.

The insulating vacuum envelope should be examined carefully for cracks in the area of the metal-to-insulation seals on both ends and around the midband ring. Since a certain amount of transmitted light is usually required to detect cracks, the inspection should be done in a well lighted area. If the midband ring has been bent by an accidental impact, that area should be specially scrutinized for glass seal damage. Small external chips, however, will not impair the useful life of the interrupter.

When placing the interrupter on its side on a hard surface for examination or in storage, do not allow the weight of the interrupter to be supported on the protruding edge of the midband ring. When storing the interrupter, it should preferably be kept in its shipping carton with the shipping guides in place on the rods.

The pinch-off tube seal is coated with soft solder and epoxy for protection. Care should be exercised to avoid cutting into the solder or bending or denting the pinch-off tube which could result in loss of vacuum.

A slight rattling of the main shield may possibly occur if the interrupter is shaken. This is a normal condition. However, if the metal vapor condensing shield is obviously not centered within the envelope, or is inclined to the axis of the envelope, the interrupter has been damaged and is not in serviceable condition. When examining for shield alignment one should not allow the optical distortion which may result from looking through the envelope glass to mislead his observations.

Twisting of the movable operating rod must be strictly avoided when making either electrical or mechanical connections to the interrupter. Any rotational twist in excess of two degrees from the normal free position of the rod will cause permanent damage to the bellows, resulting in early mechanical failure. For this reason, the operating rod must be held firmly to limit its movement with respect to the envelope whenever any connections are being made or removed.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

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When placing the sleeve of an operating rod guide on the rod and inserting the sleeve into the bellows cavity, caution must be exercised to prevent the guide from contacting the bellows convolutions. The rod should be essentially centered in the bellows before any attempt is made to install a guide sleeve. If necessary, the movable operating rod can be restored to a more central position by exerting a straight axial pull of about 30 to 50 pounds on the rod, moving a slight distance radially and releasing. This should be repeated if necessary until the rod is centered.

HIPOT TESTING

Hipot testing, in addition to careful visual inspection, provides the best means of verification of the interrupter's condition. This hipot test procedure should also be observed after the interrupter is mounted in place in its mechanism and prior to being put into actual service.

Prior to actually applying any voltage to the interrupter the surface of its insulating envelope should first be wiped clean of any surface contaminants, acquired during shipping, storage, or manual handling. Normally, wiping the surface with methanol poured on a clean cloth or industrial wiper is sufficient for this purpose. The contact gap is set to the rated stroke using a suitable guide on the movable operating rod.

A hipot voltage source is then connected across the interrupter contacts and the voltage slowly increased to the test voltage. A withstand of 35 kV (rms) or 40 kV dc is adequate to establish that the interrupter is in serviceable condition.

> CAUTION: Although the procedure in hipotting a vacuum interrupter is similar to that of any other electrical device, there are two areas which require the exercise of extra caution.

(1) During any hipotting operation the main shield inside the interrupter can acquire an electrical charge which is usually retained even after the hipot voltage is removed. This shield is attached to the midband ring of the insulating envelope and a grounding stick should always be used to discharge the ring before touching the interrupter or removing it from the circuit.

(2) High voltage applied across open gaps in a vacuum can produce X-radiation which can constitute a health hazard on prolonged exposure at close range unless the source is adequately shielded. No X-radiation is emitted in the normal current-carrying mode since there are no open contacts. When the contacts are open in service within the rated 15.5 kV class normal line voltage, X-radiation at 1 meter is below the level of concern at the recommended contact gap (see the specifications for each model number). The patented internal metallic shield of the General Electric vacuum interrupter contributes to X-radiation control by providing a measure of radiation shielding.

As with any open contacts in a vacuum, hazardous X-radiation can be produced if the voltage exceeds a certain level, or if the contact gap is reduced; therefore, DO NOT operate 15.5 kV class vacuum interrupters with personnel closer than 1 meter, at voltages higher than the rated insulation withstand test voltages specified in USASI C37.06-1966 and C37.09-1964, or at less than the recommended gap, unless appropriate measurements and procedures against possible hazards of X-rays are followed. The 110 kV impulse test per USASI C37.06-1966 should not exceed a rate of 10 impulses per hour (or 40 impulses per hour with personnel no closer than 2 meters). DC test voltages should not exceed 40 kV.

When performing insulation withstand tests per USASI C37.09-1964 (75% of the rated low frequency withstand voltage applied for one minute) on circuit breakers after delivery to the user or after fault duty, all normal metallic panels should be installed on the breaker to take advantage of the added shielding afforded by the steel enclosure. Equivalent precautionary measures should be taken when a steel enclosure is not available. The equipment manufacturer should specify to the user that the insulating withstand tests per USASI C37.09-1964 on circuit breakers after delivery to the user should be performed with normal metallic panels installed on the breaker or with equivalent precautionary measures when a steel enclosure is not available.

INSTALLATION

INITIAL CONTACT SEATING PROCEDURE

The life of the interrupter is determined in general by the erosion life of the contact surfaces. Therefore, an external initial reference dimension or mark is usually required against which the wear of the contact can be measured during the serviceable life of the interrupter. The dimension frequently used is the distance from the outer end of the movable operating rod to the mounting end plate. An alternate reference dimension is the distance from the outer end of the movable operating rod to the outer end of the stationary electrical terminal. However, the normal wipe forces and impacts encountered by the interrupter during closing causes a slight initial change in this dimension. This initial change may amount to 3/64 of an inch, especially if the closing motion contains a slight radial displacement. Therefore, the interrupter should be mounted in place, connected to the operating mechanism and operated approximately 50 times before the reference dimension is measured. Any subsequent change in this dimension then can be attributed to contact wear.

MOUNTING CONSIDERATIONS

The vacuum interrupter, generally speaking, consists of a pair of contacts enclosed in an evacuated insulating envelope. For clarity, the designations "stationary end" and "movable end" have been given to the conducting extremities of the interrupter. The stationary contact is attached to a stationary conductor extending outward from the end plate. The movable contact is attached to the movable operating rod which is capable of axial movement and which is connected to its end plate through a flexible bellows. Provisions for mounting the "movable end" to the breaker framework are provided either by studs attached to the end plate in certain models, or by peripheral slots in a secondary end plate in others. The interrupters rated for 10,000 amperes and higher interrupting current have a provision on the mounting end plate to center the movable operating rod guide. (The user must provide this operating rod guide which centers the moving contact and restricts its movement essentially to axial motion only.)

Normal circuit breaker engineering concepts are employed when designing the interrupter mechanism and mounting arrangement. Some areas requiring special consideration and general comment are listed below.

MECHANICAL

(1) Enclosure

The enclosure containing the interrupters should be free from contaminants, such as moisture and dust. If environmental conditions can cause condensation to form inside the enclosure, the use of heaters inside the enclosure may be required to prevent moisture from condensing on the interrupter surface, or on other surfaces of the enclosure from which it might either run or fall on the interrupter.

The vacuum interrupter can be mounted in any orientation and configuration provided the minimum axial center line spacing of the interrupters is as described in the electrical section of these instructions.

(2) Interrupter Mounting

Specific recommendations cannot be given which will cover all situations but in general, the design of the vacuum interrupter requires that it be supported at both the stationary and movable ends. The movable end is provided either with 1/2 inch diameter studs projecting from the end plate or with slots designed to take 3/8 inch diameter bolts. Torque limits of 45 foot pounds should be observed when tightening the nuts on the 1/2 inch diameter studs.

The external mechanical operator is connected to the steel rod or stud in the center of the movable operating rod. The static and dynamic stresses of the mechanical connection and mounting should be carefully analyzed to assure that high stresses in the interrupter do not occur. Bending, cantilever, or torsional forces should not be applied to the interrupter and the forces which the movable operating linkage apply to the movable operating rod of the interrupter should be limited to the axial direction. This will assist in preventing application of non-axial forces to the interrupter.

The connection to the stationary electrical terminal should provide some effective impact absorption quality to limit axial displacement and to assist in achieving the contact bounce requirements listed in the specifications.

(3) Contact Closing Force

An external static force must be applied to the closed contacts to oppose the magnetic forces of the short circuit currents which can cause contact separation. This force can be applied by a relatively low gradient, preloaded wipe spring in the operating linkage, designed to apply an essentially constant force independent of contact erosion and linkage variation.

(4) Contact Opening

Under certain conditions it can be expected that the contacts of vacuum interrupters will tend to adhere when closed. It is recommended that the kinetic energy developed in the mechanism during the period of unloading the wipe spring be used to provide an impact force to the contacts to assist in their initial opening. The wipe spring should be located close to the interrupter to utilize the wipe spring force effectively.

(5) Contact Motion

The motion of the movable contact should be controlled to prevent overtravel beyond the specified limit upon opening; otherwise, damage to the bellows may result.

The bellows cavity has been designed to accept an operating rod guide which will ensure motion of the rod concentric with the interrupter end plate and restrict the contacts to axial travel. The guide should have two closely fitting insulating bearing surfaces separated by as much axial length as practical. It is recommended that the inner bearing be located as close to the contact as possible within the dimensional restriction shown on the Customer Outline Drawing. The diameter of the bellows cavity available for the guide is also shown on the Outline. This dimension is intended to cover a wide range of conditions. However, the designer should assure himself that there can be no metal contact between the bellows and the guide which could result in damage to the bellows and loss of vacuum.

The operating mechanism should not contribute any torsional forces to the movable rod. Limits of angular displacement are indicated on the customer outline drawing of the particular interrupter.

Figure 2 shows a typical movable contact travel curve. This curve defines the travel requirements listed in the interrupter specification.

ELECTRICAL

(1) Power Leads

Conventional breaker design can be applied to the arrangement

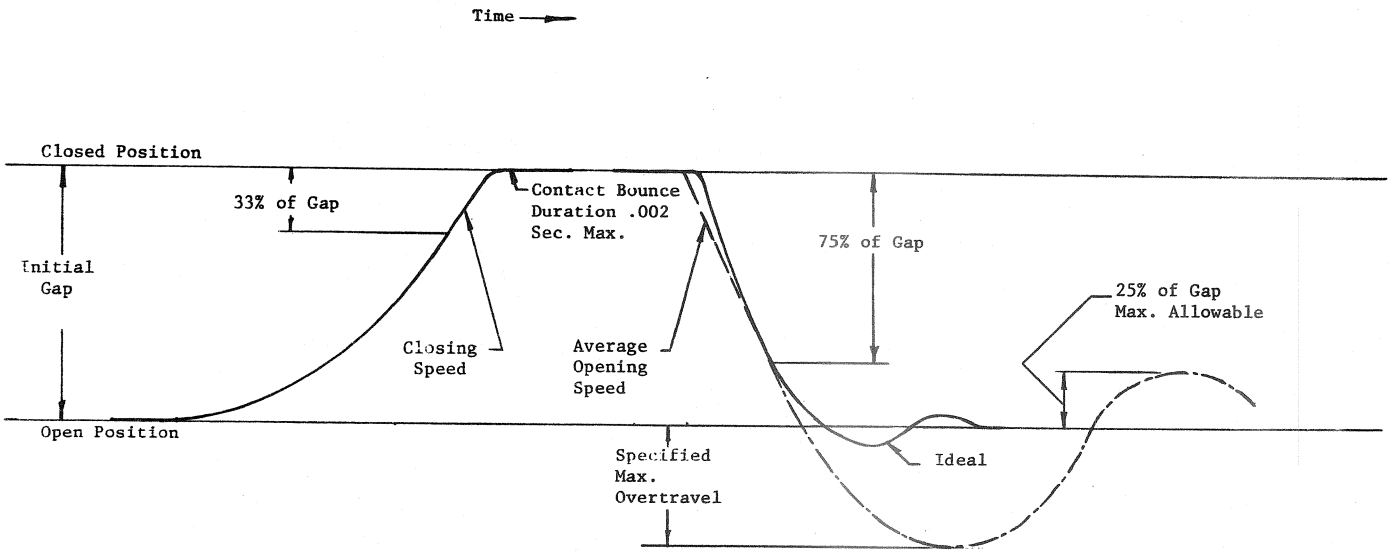

Fig 2 (8915875)

Fig 2 Typical Moving Contact Travel Curve

of entrance bushings, interrupter supports, and interrupter location to satisfy the dielectric and electromagnetic requirements. For applications where the interrupter and return conductor spacings are not dictated by dielectric requirements there are minimum dimensions imposed by electromagnetic interaction. A minimum center line spacing of 12 inches must be maintained between adjacent interrupters and between interrupters and return conductors for interrupters with 10,000 amperes and higher interruption rating. For interrupters with less than 10,000 amperes interruption rating, a 6 inch minimum spacing is recommended.

(2) Bellows Shunt

A low electrical impedance connection should be provided between the mounting end plate of the interrupter and the movable electrical terminal. This connection provides a current path around the bellows for any transient current that enters the end plate from the main shield and should have a resistance of less than 200 microhms.

(3) Electrical Terminal Connections

Electric connections are made through flexible braids to the movable terminal and through a nonmovable connection to the stationary terminal. The flexible braids to the movable terminal must be arranged so that the electromagnetic force developed by high current does not apply a rotational force to the operating rod. This could damage the bellows, as outlined in the mechanical section.

(4) Interrupter Terminal Temperature

The heat generated in a vacuum interrupter is removed by the current-carrying conductors; therefore, the temperature rise at the terminals can be regulated by providing a heat sink. In many applications the bus connected to the interrupter terminals will be adequate.

EQUIPMENT DESIGN

All applications of vacuum interrupters require competent engineering analysis and design to achieve successful equipment performance. All equipment using vacuum interrupters must be suitably tested by the equipment manufacturer to assure correct application of the vacuum interrupters and performance of the equipment. The equipment manufacturer must review the design and application of equipment using vacuum interrupters to assure equipment product safety under all possible contingencies including the unlikely event of loss of vacuum in the interrupter.

Instructions issued with the equipment should contain appropriate instructions concerning possible X-radiation hazards, as noted above in connection with HIPOT TESTING.

ORDERING INFORMATION

To order vacuum interrupters, call or write the nearest General Electric Company Industrial Sales Office. If there are questions on a particular vacuum interrupter, give the complete data shown on the nameplate such as the serial number, model number, and if possible the number of the original requisition on which the interrupter was ordered. Original equipment manufacturers should be prepared to service their own end-use switching and interrupting equipments including supplying replacement interrupters to their customers.

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