Accessories

LIQUID-LEVEL GAGE

Magnetic liquid level gages, Figs. 1 and 2, are used to indicate the level of the insulating liquid in the main transformer tank and in associated compartments. The gage consists of a float arm and magnet on one side of a liquid-tight partition and a second magnet and indicating pointer on the other side. See Fig. 3. The gage can be removed whenever the liquid is at or below the 25C level.

Gages which have a snap-action switch can be wired to give an alarm when the liquid level approaches a point too low for safe operation of the transformer. A cam on the indicator shaft will operate the switch when the pointer drops to the "LOW" mark on the dial. As the liquid level rises the pointer indicates the change, but the switch will not clear the alarm circuit until the pointer has advanced from five to ten degrees above the "LOW" mark. Switch contacts are connected to a three-conductor cable as shown in Fig. 9 and are rated as follows:

Circuit	Type of Load	Circuit Volts	Amperes	
AC	Inductive and Non-Inductive	115	10	
		230	5	
DC	Inductive	125	0.05	
		250	0.03	
	Non-Inductive	125	0.25	
		250	0.20	
AC or DC	Inductive	125 And 250	Restrict starting inrush currents to values below	
			Already Closed Contacts	Closing Contacts
			30	15

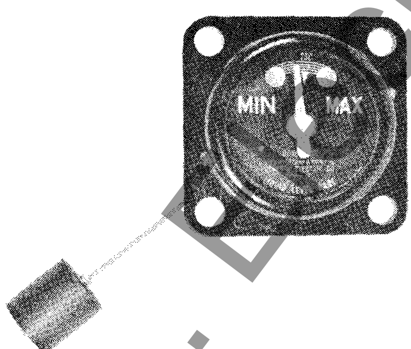


Fig. 1. 3-inch magnetic liquid-level gage

LIQUID TEMPERATURE INDICATOR

The type AL liquid temperature indicator, Fig. 4, is used to indicate the top liquid temperature of the transformer. When internal switches are required for controlling fans, pumps, and/or to initiate an alarm, the type ALR liquid temperature indicator-relay, Fig. 5, will be furnished. Both of these instruments are of the local type, mounted at the transformer's top liquid level. When an eye-level thermometer is provided with the transformer refer to separate instructions for information pertaining to that device.

Dial readings taken at frequent intervals will aid in detecting abnormal conditions affecting the transformer, but should not be relied upon as an indication of permissible load.

THERMOMETER

The thermometer is mounted with its temperature sensitive bulb inserted in a well which extends into the insulating liquid at the top of the transformer. The well is liquid-tight, thus permitting removal of the thermometer without the need of lowering the liquid level or disturbing the transformer seal. Dial calibration is in degrees centigrade with a yellow or white pointer to indicate top liquid temperature and a red pointer to show the maximum temperature which has been attained since last reset. To reset the maximum reading pointer remove the magnet and wipe it across the face of the dial.

SWITCHES

Type ALR thermometers are equipped with snap-action switches (see Fig. 9) which are operated by cams on the indicating pointer shaft. In the standard, two-switch device Switch No. 1 is normally used to control fans and Switch No. 2 is available for use in an alarm or control circuit. Switches are set to operate on rising temperature at values that depend on the guaranteed winding rise of the transformer as follows:

Fig. 2. Magnetic liquid-level gage with 6-inch dial and alarm switch

Switch No. 1 65C
Switch No. 2 90C

Transformers having forced-air/forced-oil cooling equipment are provided with a three-switch ALR device. In this thermometer, Switch Nos. 1 and 2 are used to control the transformer cooling equipment in two stages and Switch No. 3 is used for the alarm circuit. Switch contacts are normally set as

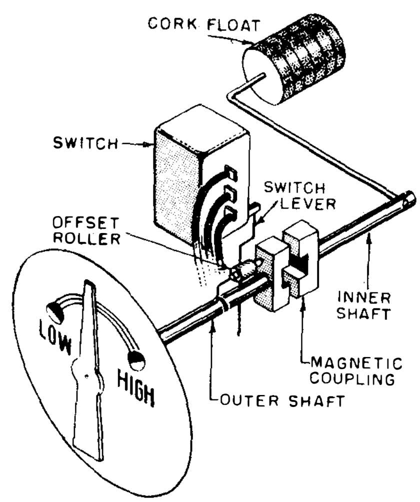


Fig. 3. Schematic view of magnetic liquid-level gage with alarm switch

These instruction 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.

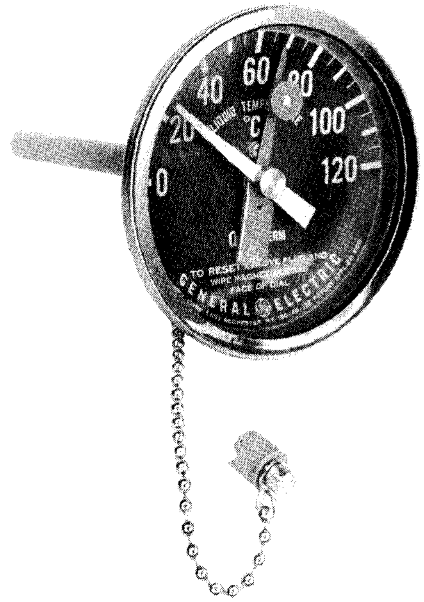


Fig. 4. Type AL liquid temperature indicator

follows:

Switch No. 1	60C
Switch No. 2	65C
Switch No. 3	90C

With falling temperatures the switches operate between 5 C and 10 C below these settings. Switch contacts are wired to a multi-conductor cable as shown in Fig. 9. Two-switch devices have Switch No. 1 rated at 15 amps and Switch No. 2 rated at 5 amps. Three-switch devices have Switches Nos. 1 and 2 rated at 15 amps and Switch No. 3 rated at 5 amps. Switch current ratings are at 115 or 230 volts a-c. Five-amp switches are also rated 0.05/0.03 amps inductive and 0.25/0.20 amps non-inductive at 125/250 volts d-c.

Fig. 5. Type ALR liquid-temperature indicator-relay

When the thermometer switch contacts are used to control operation of the transformer cooling equipment, one or more separate "Hand-Auto" switches will be furnished for manual control and a magnetic contactor will also be included if the connected load exceeds the switch rating or if three-phase motors are employed. Refer to the transformer Connection Diagram for details.

TESTING

To check the operation of the thermometer or the temperature at which the switches operate, remove the device from the transformer. Immerse its temperature sensitive bulb in a container of liquid, along with an accurate Centigrade thermometer, and heat to a constant temperature. The reading of the liquid temperature indicator and the test thermometer should be within ± 2C of one another at any temperature on the dial. Switch operation can be checked by connecting a test light or alarm across the contacts and heating the bulb. Each switch should operate within ± 2C of its setting when compared with the indicator dial.

ADJUSTMENT

Dial calibration should remain within tolerance for the life of the instrument and no provisions have been made for field adjustment. However, if a change in switch setting is necessary, slotted plugs in the top of the indicator case can be removed to provide access to the adjusting screws. After making the necessary adjustments, reseal the case, using G-E compound A15A11A or Teflon tape on the plug threads.

In the two-switch thermometer the Switch No. 1 adjustment is on the right, facing the dial, and the Switch No. 2 adjustment is on the left. To raise the temperature setting, turn the No. 1 screw counterclockwise and the No. 2 screw clockwise. Switch No. 1 can be adjusted through a range of 50C to 90C and Switch No. 2 from 65C to 110C.

In the three-switch thermometer, Switches Nos. 1 and 2 have a common adjustment on the right, are raised by turning in the counterclockwise direction, and have a range of 50C to 70C with Switch No. 2 always 5C higher than Switch No. 1. The Switch No. 3 adjustment is on the left, is raised by turning in a clockwise direction, has a range of 70C to 100C, and must always be at least 15C higher than Switch No. 2.

PRESSURE RELIEF DEVICE

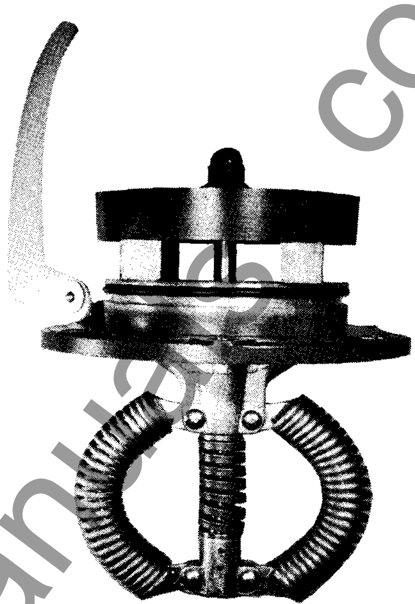


Fig. 6. Pressure relief device blocked open with alarm in vertical position

The mechanical, self-resetting, pressure-relief device, Fig. 6, is used on transformers to protect the tank against excessive internal pressures such as those which may accompany an arc under the insulating liquid. It is mounted on top of the transformer either on the main cover or on a man-hole cover and is also used occasionally on associated liquid-filled compartments. It consists primarily of a mounting flange, cover, two trigger springs and an "O" ring gasket. A mechanical alarm is furnished with the device and upon request, an electrical alarm can also be furnished. Both types of alarms are normally removed for shipment and are to be installed before placing the transformer in service. See "Alarms".

OPERATION

The relief cover is used as the means of sensing pressure and tripping the device. The gas pressure within the transformer is applied over the entire area of the cover which in turn exerts a force against the two trigger springs. The load is applied along a line outside the spring column as shown in Fig. 7 but no appreciable deflection of the

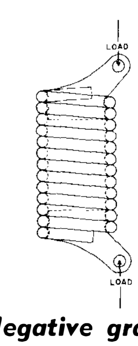


Fig. 7. Negative gradient spring

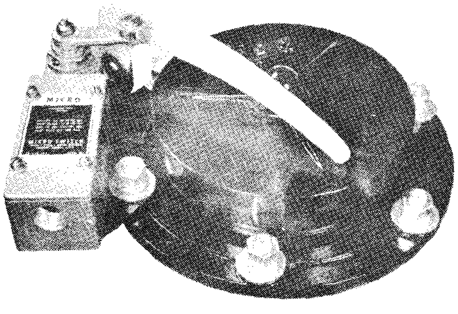
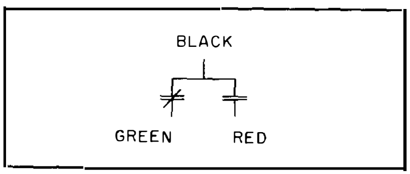
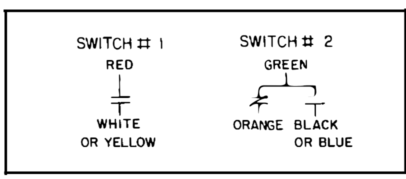


Fig. 8. Pressure relief with mechanical and electrical alarm

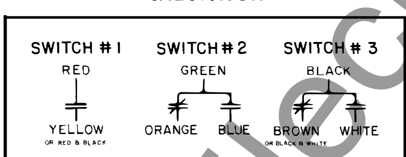
springs will take place until the load has been increased to a critical value. Beyond this value the springs will bow out, permitting the cover to open and relieve the excessive gas pressures within the transformer tank. A bumper spring assembled on the center shaft cushions the opening shock and limits travel of the device. When the transformer pressure has returned to normal the device will return to its original position, automatically resetting itself and resealing the transformer.



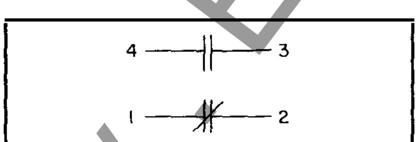
A. Liquid level gage



B. Two-switch liquid temperature indicator



C. Three-switch liquid temperature indicator



D. Pressure relief device

NOTE — Color coding of one lead may differ. Unless otherwise specified by user, connections will be made to the normally open contacts and leads from the normally closed contacts will be taped up.

Fig. 9. Switch and cable connections for alarm contacts (when furnished)

The transformer seal is maintained by an "O" ring gasket between a vertical section of the mounting flange and the cover. The compression forces are at right angles to those acting on the cover to trigger the device and therefore have no effect on its calibration. To keep drag at a minimum, a wider-than-normal gasket groove is used which permits the "O" ring to roll rather than slide during the first part of the tripping action. By the time the "O" ring reaches the top of the groove the trigger springs have bowed beyond their critical point and sufficient force is then readily available for sliding the cover over the gasket.

Different gasket materials are used, depending upon the application. Relief devices designed for use on oil-filled transformers are identified by the letter "O" embossed on the cover and those for use on Pyranol®-filled equipment are identified by the letter "P". The pressure at which the relief is set to operate is determined by the operating pressure of the transformer tank. The tank operating pressure is shown on the transformer nameplate and is also embossed on the cover of the relief device. Tanks operating up to 5 psi have reliefs set at approximately 8 psi and 7½ psi tanks have their reliefs set at approximately 11½ psi.

ALARMS

The pressure relief device is provided with a mechanical alarm to give local indication of relief operation. The alarm consists of a plastic vane pivoted on a bracket and is normally removed for shipment. To install the alarm, remove a nut from one of the relief mounting studs, place the bracket over this stud with the vane resting on top of the relief cover, and replace the nut. The vane will then remain in a *horizontal* position until the pressure-relief device operates, at which time the cover will push the vane into a *vertical* position.

Upon request an electrical alarm can be furnished to provide remote indication of relief operation. It consists of a spring-loaded, snap-action switch in a weatherproof housing and is assembled on a common bracket with the mechanical alarm. The assembly is removed for shipment and is to be installed as shown in Fig. 8. The switch is operated by the plastic vane as it moves into the vertical position. A set of normally open and a set of normally closed contacts are provided with connections being made to the normally open set unless otherwise specified. Switch contacts can be identified as shown in Fig. 9, and have a rating of 15 amps at 115 or 230 volts a-c.

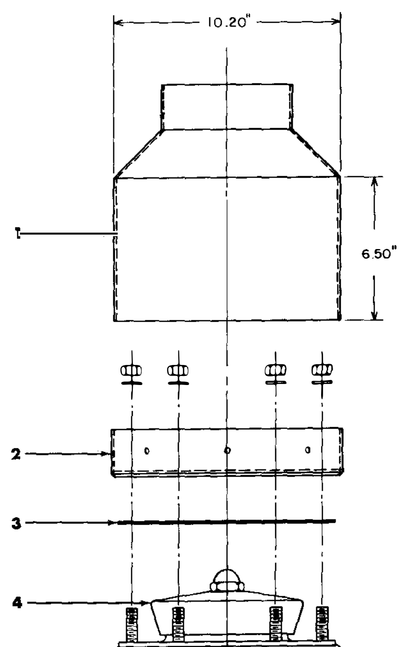
After tripping, the mechanical and electrical alarms must both be reset in order to indicate subsequent operations.

GAS ABSORBERS AND VENT PIPES

If a Pyranol-filled transformer is located in a poorly ventilated indoor area, provisions should be made to either absorb or carry off any discharged gases. Refer to the National Electric Code for regulations pertaining to the indoor installation of Pyranol-filled transformers.

Gas absorbers are designed for mounting directly on top of the pressure relief using the same mounting studs. Instructions for installing and filling the absorber are furnished with that device. A special adapter flange and gasket (Items 2 and 3, Fig. 10) are available upon request for connecting vent pipes to the relief device. Order by drawing number 112A4035 G1 through the nearest Apparatus Sales Office of the General Electric Company.

The reducer (Item 1, Fig. 10) is to be made by the user and can be fabricated of sheet metal with a maximum outside diameter of 10.20" in order to fit the 10.25" inside diameter of the adapter. The height to the first bend must be at least 6.50" to clear the relief device cover when it opens and the other dimensions can be made as required.



1. Reducer
2. Adapter flange
3. Gasket
4. Pressure-relief device

Fig. 10. Exploded view of vent pipe accessories

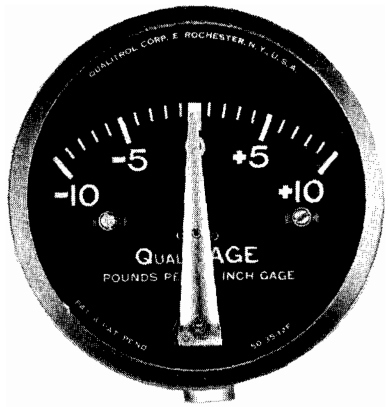


Fig. 11. Pressure-vacuum gage

PRESSURE-VACUUM GAGE

The pressure-vacuum gage, Fig. 11, is of the compound type calibrated in psi. Gage readings should vary as the transformer temperature changes and should normally indicate a positive pressure. (The instrument should not be expected to read accurately near the zero point.) When the transformer is de-energized or is operating under light or no-load conditions in a low ambient temperature, the gage may indicate a vacuum within the tank. A lack of any change in reading with changes in temperature is an indication of a leak in the transformer seal and should be investigated.

PRESSURE-VACUUM BLEEDER

Oil-filled, sealed-tank transformers are normally equipped with a pressure-vacuum bleeder. The bleeder, Fig. 12, is used on these units to maintain the internal tank pressure or vacuum within the maximum operating limits shown on the transformer nameplate. When load conditions and/or changes in ambient temperature cause the pressure or vacuum to become excessive, the device will automatically bleed air into or out of the gas space, preventing undue stress on the transformer tank. It is seldom required to operate, however, and serves primarily as a safety device.

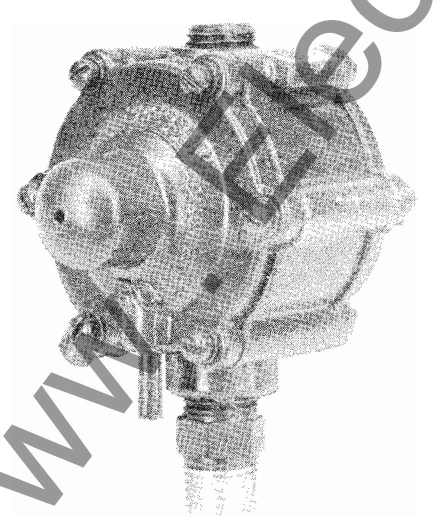


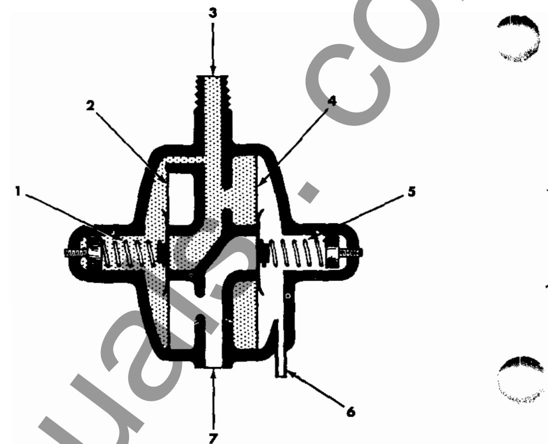
Fig. 12. Pressure-vacuum bleeder

OPERATION

Fig. 13 is a *multi-section* view showing the internal arrangement of the bleeder in *schematic* form. If a pressure exists in the transformer gas space, the pressure in the chamber to the left of diaphragm (4) will be greater than the atmospheric pressure in the chamber to its right. When the difference becomes great enough spring (5) will be compressed, permitting air from the transformer to bleed out through port (6). If a vacuum exists, the atmospheric pressure in the chamber to the right of diaphragm (2) will be greater than the transformer pressure in the chamber to its left. When the difference becomes great enough spring (1) will be compressed, permitting air to bleed into the transformer.

The pipe nipple and plug (Fig. 12) can be interchanged to permit installation of the bleeder from either the top or bottom, depending upon the application. If the device is ever removed from the transformer, use G-E compound A15A11A or Teflon tape on the threads when replacing and make sure the vent pipes face downward to prevent entrance of water.

The bleeder is factory calibrated to function at the operating pressure shown on the transformer nameplate and no changes should be made in these settings.



1. Spring
2. Vacuum diaphragm
3. Transformer coupling
4. Pressure diaphragm
5. Spring
6. Equalizer vent
7. Breather port

Fig. 13. Schematic view of pressure-vacuum bleeder

WEDGE-TYPE TAP CHANGER

Wedge-type tap changers provide a means of changing the voltage ratio of a de-energized transformer without breaking the transformer seal. Several different sizes are used, depending upon the current and voltage requirements of the circuit in which they are applied. They are shipped in place and are set on the position corresponding to the rated voltage shown on the transformer nameplate unless otherwise requested by the user.

Tap leads from the transformer windings are connected to a circular group of nickel-plated copper rods which are held together between two insulting heads. Fig. 14 shows a typical tap changer having the most common rod diameter and spacing arrangement. A wedge in the middle can be moved by a crankshaft to wedge between any two adjacent rods. A spring between the wedge and crankshaft maintains a high-pressure line contact between current carrying components.

When the crankshaft is turned to move the wedge from one operating position to another, pressure is gradually reduced on the spring and the wedge is withdrawn from between rods. A "U"-shaped guide on the opposite side then pivots the wedge around to the next set of rods. As the crankshaft continues to turn, pressure is again applied to the spring and the wedge is forced into position with a wiping action, insuring positive contact.

The drive mechanism, Fig. 15, is located on the side or cover of the transformer and is connected through an insulator to the crankshaft of the tap changer. The cap covering the mechanism is gasketed to the mounting flange and an "O" ring gasket is used

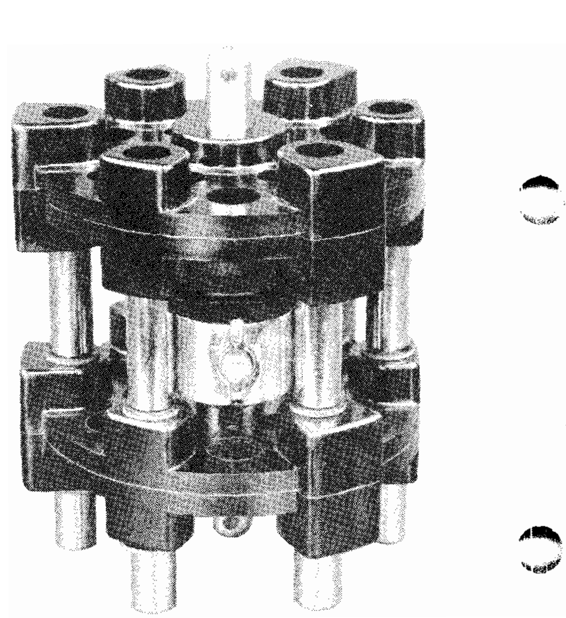


Fig. 14. Typical wedge-type tap changer

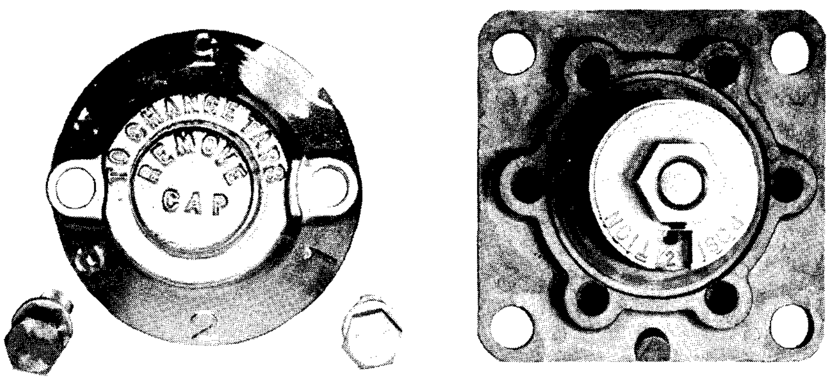


Fig. 15. Tap changer drive mechanism with cap removed

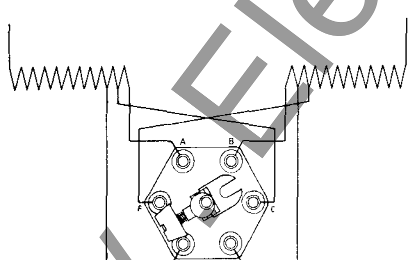
between the mounting flange and drive shaft to maintain the transformer seal. One of the screws used to hold the cap in .place has an oversize head with a hole in it for padlocking if desired. When requested, provisions can also be included for interlocking with the primary circuit breaker (or high-voltage disconnect switch) as explained under "Interlocks". Position indication is provided by an arrow on the mounting flange and a corresponding number on the cap.

OPERATION

CAUTION! The tap-changer must not be operated while the transformer is energized! Serious personal injury and/or damage to the transformer may result if this is attempted.

Fig. 16 shows a typical connection arrangement for a five-position wedge-type tap changer having two steps above and two steps below the rated voltage of the transformer. A similar table on the transformer nameplate gives the voltage and current rating for each tap position.

TO CHANGE TAPS, REMOVE THE TAP CHANGER CAP and use a wrench to turn the hexhead drive mechanism. The mechanism must be rotated through 5/6 of a turn to make a change of one tap. With the cap removed, the tap position can be observed through a slot in the indicator cams (see Fig. 15). Although the drive mechanism can be turned continuously in either direction placing the wedge in any one of six different positions, only five positions are numbered for use as shown on the transformer nameplate. The unnumbered position is unauthorized and should not be used.



CONTACTS BRIDGED	PERCENT VOLTAGE	POSITION NUMBER
A – B	105	1
B – C	$102\frac{1}{2}$	2
C – D	100	3
D – E	$97\frac{1}{2}$	4
E – F	95	5

Fig. 16. Typical connection of a wedge-type tap changer

After the desired change has been made, make sure that the cap gasket is in good condition and replace the cap. Note that the slots in the two indicator cams must coincide before the cap can be seated properly. This is to insure that the cap is not replaced until the tap changer is on position and also serves to align an appropriate position number on the cap with the arrow on the mounting flange.

INTERLOCKS

Upon request, the operating mechanism can be equipped with a key-operated, plunger-type lock to provide a mechanical interlock with the circuit breaker (or disconnect switch) feeding the transformer. See Fig. 17. The key for this lock is normally held in a similar lock on the primary circuit breaker and can be removed only by opening the breaker and locking it open. This de-energizes the transformer and permits the key to be removed and used to unlock the tap changer.

To place the transformer back in service after the desired tap change has been made, lock the tap changer in position, remove the key, and unlock and reclose the primary circuit breaker.

NOTE: A duplicate key is furnished with the transformer. This key is for emergency use only and should be removed from the operating area to insure the effectiveness of the interlock system.

REMOVING AND REASSEMBLING

If it becomes necessary to disconnect or remove a tap changer drive mechanism it should be placed on position 1 before removal in order to facilitate reassembly. To remove the drive mechanism, unbolt the flange and lift the device out as an assembly. Note that drive mechanisms are not interchangeable! When two or more are removed at the same time, care should be taken to reassemble them in the same location from which they were removed.

When replacing, see that the tap changer and the drive mechanism are both on position 1. The tap changer is on position 1 when the wedge bridges tap leads A and B and the index marks on the drive shaft and support structure are in line with one another. To reassemble, place the drive shaft through the opening in the mounting flange and slide the coupling over the tap changer shaft. The slotted end of the coupling should engage a pin in the tap changer shaft without difficulty if both mechanisms are in the proper position.

After reassembling, check to see that the wedge seats itself properly in each position by observing the torque required to turn the drive mechanism in each direction. The mechanism will be at the center of a high torque region when the wedge is properly seated. If the device was correctly reassembled, the position indicator should accurately show the various positions.

TESTING

Before placing a transformer in service, test the tap changer to determine that the positions are correct and the steps progress in accordance with the transformer nameplate. To do this, apply a low voltage to one winding (normally the high-voltage) and measure the voltage on the other winding for each tap-changer position. *CAUTION—The turns ratio must be taken into consideration when making this test, as voltages endangering the operating personnel may be present.*

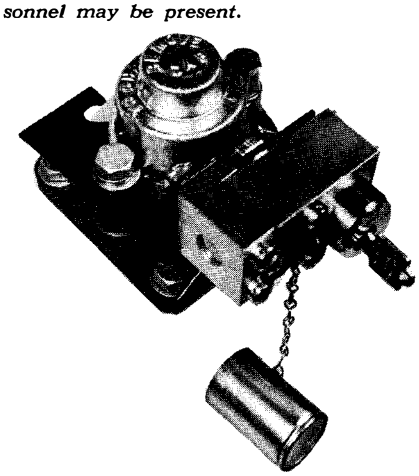


Fig. 17. Tap changer operating mechanism with key interlock

MEDIUM TRANSFORMER DEPARTMENT

GENERAL ELECTRIC

ROME, GEORGIA

PRINTED IN U.S.A.