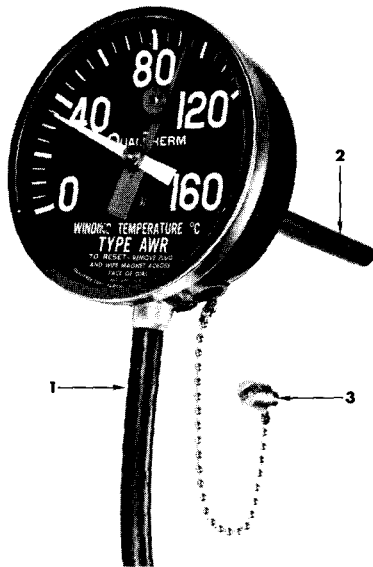




# Winding Temperature Equipment

## LOCAL, EYE-LEVEL, AND REMOTE



1. CABLE
2. TEMPERATURE DETECTOR
3. RESET MAGNET

**Fig. 1. Local winding temperature indicator.**

### INTRODUCTION

Winding temperature equipment is used to provide a means of reading an equivalent of the transformer winding hot-spot temperature. Two types of instruments are used, the indicator (Type AWR) and the detector (Type AW). The indicator provides visual indication at the transformer and the detector permits remote indication when connected to suitable external equipment.

Furnished with each of these devices are a heater well located in the top liquid of the transformer, a current transformer to supply a current proportional to that of the winding and, when necessary, a calibrating resistor connected in parallel with the heater.

Where the effects of unbalanced three-phase loading need to be determined, separate equipment is used in each phase.

### DESCRIPTION

#### INDICATOR

The winding temperature indicator

consists of a thermometer with either two or three snap-action switches. The switches permit the instrument to be used to start transformer cooling equipment and to initiate an alarm in the event winding temperatures become excessive. Thermometer dials are calibrated in degrees centigrade with a white pointer to indicate the winding hot-spot temperature and a red pointer to show the maximum temperature which has been obtained since last reset.

Two types of thermometers are used, the local device (Fig. 1) mounted at the top liquid level and the eye-level device (Figs. 2 and 3) mounted at an easily readable and accessible height above ground level. The temperature-sensitive bulb of the local thermometer consists of a helix-wound, bi-metallic coil enclosed in a sealed tube at the back of the case. The temperature-sensitive bulb of the eye-level thermometer contains a liquid which expands or contracts with variations in temperature. These changes are transmitted through capillary tubing to a Bourdon tube which operates the indicator shaft.

#### Switches

Snap-action switches in the thermometer are operated by cams on the indicating pointer shaft. Transformers having self-cooled/forced-air-cooled ratings are normally provided with a two-switch thermometer in which Switch No. 1 is used to control fans and Switch No. 2 is available for use in an alarm or control circuit. A three-switch device is also available upon request for use on transformers with the above rating. Switches are set to operate on rising temperatures as follows:

	2-Switch	3-Switch
Switch No. 1	85C	85C
Switch No. 2	120C	90C
Switch No. 3		120C

Transformers having a self-cooled/forced-air/forced-oil-cooled ratings are provided with a three-switch device having slightly different switch settings. In this thermometer Switches 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 set as follows:

Switch No. 1	80C
Switch No. 2	85C
Switch No. 3	120C

With falling temperatures the switches operate between 5C and 10C below these settings. Switch contacts are wired to a multiconductor cable and are color coded as shown on the transformer connection diagram. Unless otherwise specified by the user, connections will be made to the normally open contacts and leads from the normally closed contacts will be taped up.

The switches in the thermometer are rated as follows:

AWR Device	Switch	Switch Ampere Rating				
		A-C Volts		D-C Volts		
		125	250	480	125	250
Two-Switch, eye-level	No. 1 No. 2	15	15	15	.50	.25
Two-Switch, local		5	5	—	.25	.20
Three-Switch, eye-level	All	15	15	15	.50	.25
Three-Switch, local						

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 wiring details.

#### DETECTOR

The winding temperature detector consists of a non-inductively wound copper coil having a resistance of 10 ohms at 25C. The coil is assembled inside a stainless steel bulb with leads brought out through a receptacle as shown in Fig. 4. Leads are normally wired down to a junction box or to a conduit and are identified as A (black), B (green), and C (red or white). Leads B and C are common to the same point at one end of the resistor as required for connection to the remote instrument. More than one detector may be connected to a single indicator through the use of a selector switch. For further information concerning the remote indicator and its connections, refer to the instructions furnished with that device, or contact the nearest Apparatus Sales Office of the General Electric Company.

*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.*

**HEATER WELL AND CURRENT TRANSFORMER**

The heater well consists of a stainless steel tube surrounded by an outer brass shell with an air space between tube and shell. The assembly is mounted near the top of the transformer in the hottest part of the insulating and cooling liquid. The tube itself is used as the heating element by connecting each end of it to the secondary of a current transformer. See Fig. 5.

The air between the tube and brass shell acts as a thermal insulator and permits the heater to raise the temperature of the detector bulb above that of the surrounding cooling liquid. Since the well is liquid tight, the detector bulb can be inserted or removed without lowering the liquid level or breaking the seal of the transformer. A union nut is used to secure the detector in the well.

The current transformer is located inside the main tank. **CAUTION:** *The secondary circuit of an energized current transformer MUST NOT be opened at any time.* If any work needs to be done on the wiring of the AWR, the current transformer must be short-circuited.

When required for calibration purposes, a resistor is connected in parallel

with the heater (Fig. 5). The calibrating resistor is normally mounted inside the transformer control center. If the transformer is not equipped with a control center, the resistor is mounted on the underside of the main cover. Note that these leads must be disconnected whenever the cover is to be removed.

When more than one winding temperature indicator is used, the elementary connections for each instrument will be the same as those shown in Fig. 5 for a single unit. If an indicator and detector are both required in the same phase, their heater wells will be connected in series and separate calibrating resistors will be provided for each well as shown in Fig. 6. Similar connections are used for each pair required.

the gasket is in place between the shoulder of the detector and the well before tightening the union nut.

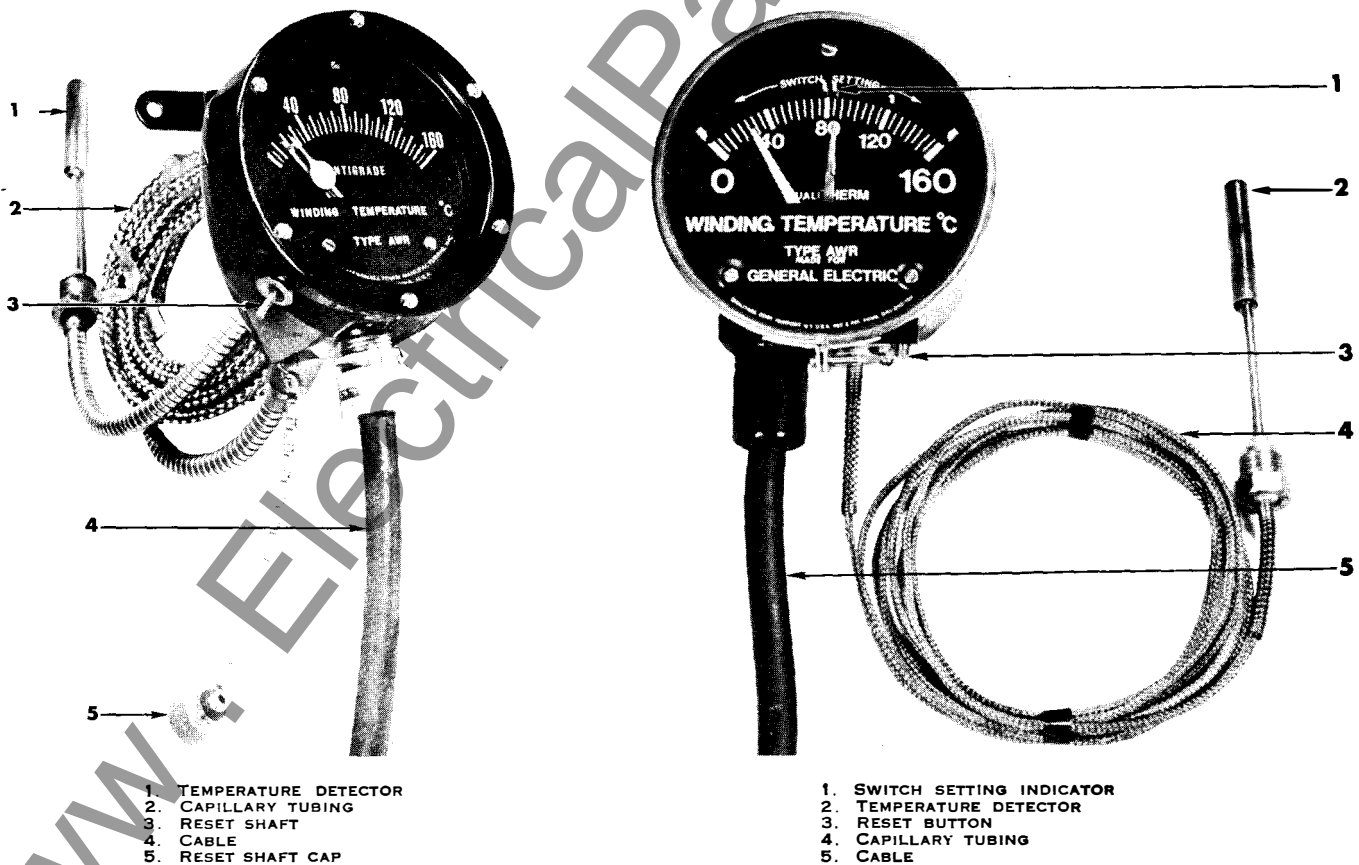
To install the eye-level device, mount the thermometer on the transformer as shown on the outline drawing. Remove the plug from the well and insert the temperature detecting bulb. Attach the capillary tubing along the side of the transformer, coiling any excess and securing with the clips provided. The minimum safe bending radius for this tubing is 2 inches and undue bending and other abuses should be avoided. Make cable connections as indicated on the transformer connection diagram.

**OPERATION**

The hot-spot temperature of a transformer winding is determined by the load it carries, its thermal characteristics, and the temperature of its cooling liquid. From the relationship between these factors a heater can be designed which, when supplied with a current proportional to that in the winding, will duplicate the winding hot-spot rise over top liquid. Placing such a heater around a well in the top liquid permits this rise to be added to the top liquid temperature. An equivalent of the winding hot-spot temperature can thus be measured by inserting the temperature-

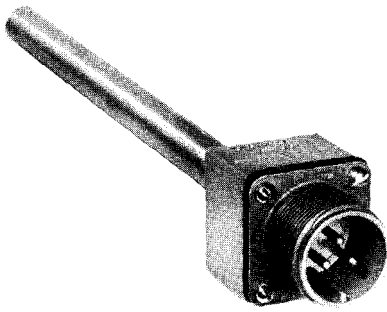
**INSTALLATION**

Thermometers and detectors are normally shipped in place on the transformer. When a device is removed for shipment, it will be identified by an appropriately marked copy of the shipping list. The temperature-sensitive bulb of each device is covered with a material to furnish electrical insulation between it and the heating tube. Use care when inserting the bulb in the well to prevent damage to this insulation. Make sure



**Fig. 2. Two-switch eye-level winding temperature indicator.**

**Fig. 3. Three-switch eye-level winding temperature indicator.**



**Fig. 4. Winding temperature detector.**

sensitive element of either the indicator or detector in this well.

In the case of the detector, its resistance coil readily assumes the temperature of the well and therefore changes resistance in conformance with changes in well temperature. These variations in resistance are interpreted by the remote instrument in terms of degrees centigrade to indicate the heater-well temperature and thus the winding hot-spot temperature.

**RESETTING MAXIMUM—READING POINTER**

To reset the red pointer on the local thermometer, remove the magnet (No. 3, Fig. 1) from its recess and place it over the magnetic disk mounted on the red pointer. Slowly wipe the magnet to the left across the face of the dial, keeping the magnet and disk aligned. The red pointer will follow the magnet across the dial until it rests against the white indicating pointer. When the magnet is not in use, replace it in the recess and magnetic action will hold it in place.

On the two-switch eye-level device remove the chained cap at the bottom of the case and pull the projecting shaft (No. 2 on Fig. 2) slowly until the red pointer rests against the white pointer. Replace the cap immediately to reseal

the case.

To reset the pointer on the three-switch eye-level device push the button (No. 2 on Fig. 3) on the bottom of the case until the red pointer rests against the white pointer.

**TESTING AND ADJUSTING**

To check the operation of an indicator and its switches or the detector and its remote indicator, remove the temperature detecting bulb from the well. Immerse the bulb in a container of liquid along with an accurate centigrade thermometer, heat to a constant temperature, and compare the instrument reading with that of the test thermometer.

**INDICATOR**

The reading of the indicator and the test thermometer should be within plus 3C minus 1C 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  $\pm 2C$  of its setting when compared with the indicator dial.

The instruments are factory calibrated and no changes are recommended. However, the following provisions have been made for making adjustments when necessary.

**Local, Two-Switch**

Slotted plugs in the top of the indicator case can be removed to provide access to the switch adjusting screws. After making the necessary adjustments, reseal the case using G-E compound A15A11A or Teflon tape on the plug threads. The adjusting screw for Switch No. 1 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 75C to 90 C and Switch No. 2 from 100C to 125C.

**Local, Three-Switch**

Access for adjustment is through plugs in the case as with the two-switch instrument. Switches Nos. 1 and 2 have a common adjustment on the right and their settings are raised by turning the screw in a counterclockwise direction. The Switch No. 3 adjustment is on the left and is raised by turning the screw clockwise. Switch No. 1 has an adjustment range of 75C to 85C and Switch No. 2 is fixed at 5C above the setting of Switch No. 1. Switch No. 3 has a range of 100C to 125C and must be set at least 15C above Switch No. 2.

**Eye-Level, Two-Switch**

Provisions have been made at the rear of the case for adjusting the pointer with relation to the dial.

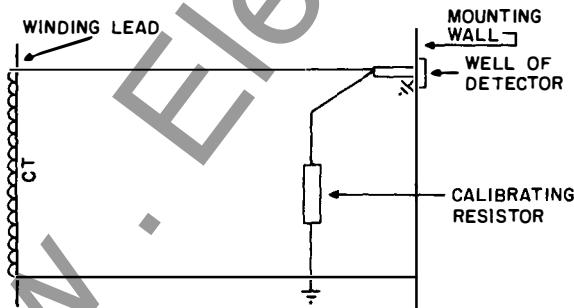
To change switch settings, the glass face and nameplate must be removed. The set screws can then be loosened to permit adjustment of the switch operating cams on the indicating pointer shaft. Switch No. 1 can be adjusted through a range of 60C to 100C and Switch No. 2 has a range of 95C to 130C. When replacing the glass, be sure the gasket is in place to seal the case.

**Eye-Level, Three-Switch**

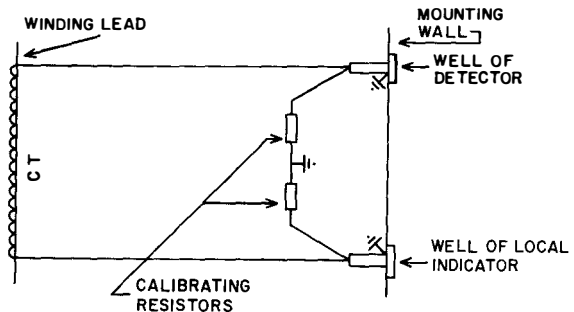
To adjust the pointer with relation to the dial, remove the glass face and nameplate, loosen the set screw at the base of the pointer, rotate the pointer as required, and retighten the screw.

To change the switch settings, move the switch setting indicator (No. 3 on Fig. 3) to a notch above the temperature indicated on the dial at which the switch is to operate. The switch adjustment range extends from 0 to 160C.

When replacing the glass, be sure the gasket is in place to seal the case.



**Fig. 5. Elementary diagram for one heater well.**



**Fig. 6. Elementary diagram for indicator and detector heater wells in series in the same phase.**

**MEDIUM TRANSFORMER PRODUCTS DEPARTMENT  
GENERAL ELECTRIC COMPANY  
ROME, GEORGIA 30161**

**GENERAL  ELECTRIC**