TYPE KCA POLYPHASE WATTHOUR AND THERMAL KVA DEMAND METER is a combination of the Type CA polyphase meter and a thermal KVA demand meter in one unit. The meter measures both kilowatt hours and maximum KVA demand.

The KVA demand unit consists of both a current thermal element and a voltage thermal element. An indicating pointer is geared to the shaft of the current element which is connected, through a linkage, to the shaft of the voltage element. A pointer deflection, caused by the current element, is modified through the linkage by the voltage element to give a reading of KVA demand on the logarithmic principle.

The thermal KVA demand unit and two-element polyphase watthour meter are both mounted in a standard three-element base. Overall dimensions are the same as for the Type CA-3 meter except for an increased overall depth due to the demand type cover. The meter terminal block connections for all types are the same as for the corresponding standard watthour meters.

WESTINGHOUSE SPECIAL FEATURES

1. **UNIQUE IN DESIGN**—A very simple method of measuring KVA demand with a meter having a minimum of movable parts and a wide operating range.

2. **SIMPLIFIED INSTALLATION**—One mounting for both watthour and KVA demand meter. This eliminates one of the major problems in applying thermal demand meters.

3. **LOW MAINTENANCE**—The characteristics of the thermal meter make it more nearly approach the low maintenance of the standard watthour meter. Test schedules can be arranged on the same basis as for separate watthour meters.

4. **MINIMUM SIZE**—Overall dimensions are the same as for a three-element watthour meter except for the increased depth of the demand type cover.

**EFFECTIVE AUGUST 4, 1950**
CONSTRUCTION

A polyphase watthour meter and a polyphase thermal KVA demand meter are both mounted on a standard three-element base. The meters are separate and neither interferes with the operation of the other.

The watthour meter consists of an electromagnet, frame, moving element, bearings, permanent magnet and register.

1. POINTERS do not interfere with the reading or accessibility of the watthour meter register. The demand scale is at the bottom of the dial. Two demand pointers are provided; one operates as a pusher and the other indicates maximum demand. They are returned to zero by means of a manually operated reset device in the glass cover.

2. INTERNAL CURRENT TRANSFORMERS are mounted at the rear on each side of the watthour meter frame. They are used to reduce the line current to a value which when dissipated in the thermal heater circuit will not raise the ambient temperature of the meter, and are an integral part of the phase shifting network required for correct operation of the demand element.

3. THE MUTUAL REACTOR of the current thermal element is mounted at the top of the meter. The resistance of the current thermal circuit is the spool of wire mounted behind the current thermal unit. Separate heaters are used to heat the rear spring of the thermal bimetallic shaft. The front spring acts as a compensator for ambient temperature changes.

4. THE VOLTAGE ELEMENT operates from a small transformer mounted in the rear of the meter above the electromagnets. The secondary is connected to the rear spring of the thermal element bimetallic shaft assembly.

5. THE CURRENT ELEMENT is linked to the voltage element and the pointer is geared to the current element shaft. The connecting link is easily removed for calibration purposes.

ADJUSTMENTS—The watthour meter elements have standard adjustments for full load, light load, balance and power factor. The thermal elements have adjustments for the position of the pusher pointer at zero and full scale. The thermal elements also have adjustments for mutual reactor and linkage mechanism.
DEMAND DIALS

Demand dials are direct reading to suit the meter capacity and require no multiplier on the demand scale. They are available with either the standard scale or block type of scale marking.

APPLICATION

Heretofore, the relatively expensive initial cost and maintenance of KVA demand metering equipment has discouraged its use on smaller loads. The thermal KVA demand meter, with its low maintenance requirements, provides an economical means of measuring KVA demand on loads which have been too small to justify that type of metering.

Self-Contained and Transformer Type Meters—For Use On:

Type KCA-2 . . . . . . . . . . . 3-phase 3-wire service
Type KCA-5 . . . . . . . . . . . 3-wire network systems
Type KCA-7 . . . . . . . . . . . 3-phase 4-wire delta service
Type KCA-8 . . . . . . . . . . . 3-phase 4-wire wye systems

TIME RESPONSE CURVE

Thermal demand meters have no definite time interval such as determined by timing devices in block interval demand meters. The time interval of a thermal meter is the time required for the meter to read 90 percent of the applied load, as shown on the curve.
POLYPHASE KVA DEMAND METERS
COMBINATION WATT HOUR AND THERMAL
TYPES KCA-2, KCA-5, KCA-7, KCA-8

PRINCIPLE OF OPERATION

The watthour meter proper operates on the induction principle entirely independent of, and unaffected by, the associated KVA thermal element.

TWO ELEMENTS—the KVA demand unit is comprised of two distinct elements—current and voltage. Separate thermal elements respond to current and voltage changes in the circuit. There is a leverage arm on each of the shafts and these are coupled by a movable link. The indicating pointer is geared to these linked shafts. The meter is basically a polyphase ampere-demand meter whose reading is modified by voltage changes (acting through the voltage element) to give KVA.

PHASE SHIFTING—in the determination of polyphase ampere demand no measurements of the ampere demands of the individual phases give a true picture of the demand of the entire circuit. It is necessary to:

1. Employ a method of properly shifting the phase of voltages derived from the individual currents (these voltages proportional in magnitude to the magnitude of the currents).
2. Obtain their vector sum.
3. Apply this sum to a demand device.

No combination of the algebraic sums or differences of the currents will accomplish this.

The basis of the method of phase shifting is the fact that a given current flowing through a resistance will produce a voltage drop in phase with the current, while the same current flowing through the primary winding of a mutual inductance will produce an induced voltage in the secondary, which is ninety degrees out of phase with the current. The illustration at the right shows the basic circuit and vector diagrams for use on a three-phase, three-wire system.

The principles shown here are applicable to other polyphase circuits. "M" is a mutual inductance, "R" a resistor, "RH" the heater resistor in the current thermal unit, and "N" the ratio of the current transformers.

CIRCUIT KVA—for visualization of the operation the following assumptions can be made:

1. Balanced load of 5 amperes.
2. \( R = \sqrt{3} \)
3. \( \omega M = 1 \)
4. \( N = 1 \) to 1; \( 2N = 2 \) to 1
5. The heater is open circuited.

The current (SA) in line 3 (I3) goes through the 2N transformer and secondary current of 2.5 amperes flows through R and the mutual reactance primary in series. This results in drops of 2.5 \( \sqrt{3} \) volts (across the resistor in phase with I3) and 2.5 volts (across the mutual-reactor secondary leading I3 by 90°). These two add to give 5 volts which is the net voltage from I3.

The current in line (I1) goes through the N transformer and 5 amperes secondary current flows through the primary of the mutual reactor only. This causes a secondary voltage of 5 volts leading I1 by 90°. The total voltage E is 5 \( \sqrt{3} \) which is \( \sqrt{3} \) times the voltage drop caused by either phase current. This is a correct measure of the KVA of the circuit which equals \( \sqrt{3} \) VI or \( \sqrt{3} \) times the KVA of one phase alone.

Now if the heater circuit is closed, a current will flow in RH directly proportional to E. Heat produced in RH activates the current element bimetal shaft. Currents of any magnitude or power factor will cause a current in the heater proportional to the total volt amperes.

THE VOLTAGE DEMAND UNIT uses a direct heated bimetallic spring. A small transformer has its primary connected across one of the phases and its secondary connected directly to one of the bimetallic springs on a thermal shaft assembly. An arm on this shaft is coupled to an arm on the current element shaft by a movable link.

The mechanism is so arranged that when there is no load on the meter the link and the arm (on the current element shaft) are in line. Therefore, under these conditions, voltage variations do not cause any motion of the pointer. As soon as the load causes the current element to move the pointer off zero, variations in voltage affect the reading. The two thermal units and the linkage mechanism are so designed as to give a correct indication of KVA over a wide variation of voltage and currents. The meter takes into account individual magnitude variations of the currents and assumes that the voltages are balanced as it measures the variations of only one of the phases.
# Polyphase KVA Demand Meters

## Combination Watthour and Thermal Types KCA-2, KCA-5, KCA-7, KCA-8

## List Prices—Type KCA Two-Element Meters

<table>
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<th>Currents</th>
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* Style number and list price for self-contained meters include meter complete with glass cover, but do not include potential indicating lamps. If potential indicating lamps are required add $1.00 net to net price of meter and suffix "PI" to style number.

† Style number and list price for transformer type meters include potential indicating lamps. There will be no reduction in price should the meters be required without potential indicating lamps.

§ Meters with 2 potential coils for US service with both current and potential transformers can be supplied upon request.

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### Ordering Information

**When Ordering**—Specify the type, style number and complete meter rating. This will include the frequency, the voltage and ampere ratings, the demand scale required and the type service to which the meter will be applied. Inquiries for ratings other than those listed should be referred to the nearest District Office.

Prices Subject to Change Without Notice
TYPE KCA-2: 3-PHASE, 3-WIRE

Fig. 1—Self-Contained

Voltage Element
Shaft—Rear
Spring

Current Element
Rear Heater

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.

Fig. 2—Transformer Type

Voltage Element
Shaft—Rear Spring

Current Element
Rear Heater

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.

TYPE KCA-5: 3-WIRE, NETWORK

Fig. 3—Self-Contained

Voltage Element
Shaft—Rear
Spring

Current Element
Rear Heater

Connections are shown for 1-2 phase rotation. If phase rotation is 2-1, interchange lines 1 and 2.

Fig. 4—Transformer Type

Voltage Element
Shaft—Rear Spring

Current Element
Rear Heater

Connections are shown for 1-2 phase rotation. If phase rotation is 2-1, interchange lines 1 and 2.

Potential transformer when used should be connected as shown below.

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WIRING DIAGRAMS—Front View (Continued)

TYPE KCA-7: 3-PHASE, 4-WIRE, DELTA

Fig. 5—Self-Contained

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.

Fig. 6—Transformer Type

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.

TYPE KCA-8: 3-PHASE, 4-WIRE, WYE

Fig. 7—Self-Contained

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.

Fig. 8—Transformer Type

Connections are shown for 1-2-3 phase rotation. If phase rotation is 1-3-2, interchange lines 1 and 2.
OUTLINE DIMENSIONS IN INCHES


NET WEIGHT IN POUNDS

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LITERATURE REFERENCE

Instruction Leaflet 42-340