CROPICO

LEAFLET No. 61
August 1963

CROYDON PRECISION INSTRUMENT CO.

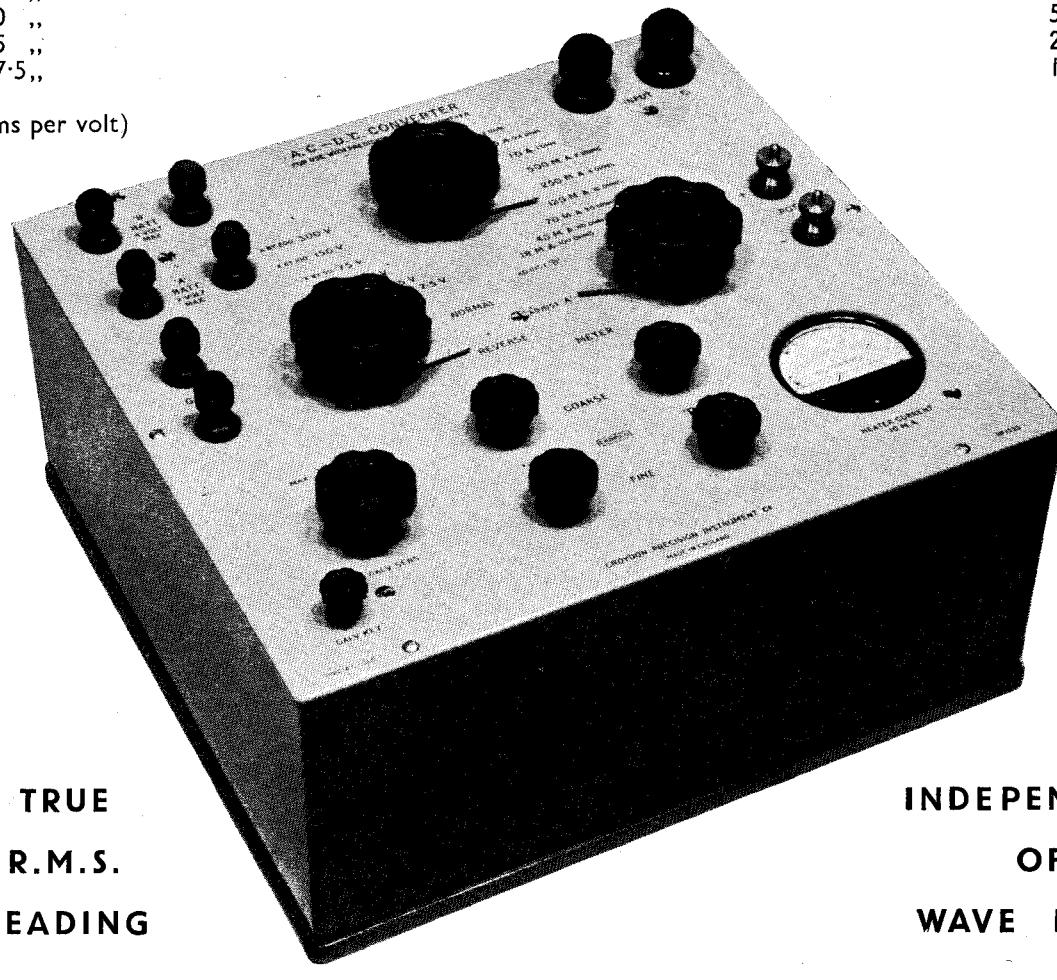
AC—DC CONVERTER

(VACUO JUNCTION TYPE)

VOLTAGE RANGES
300 volts
150 ,,
75 ,,
30 ,,
15 ,,
7·5,,

(100 ohms per volt)

CURRENT RANGES
5·0 amps
2·5 ,,
1·0 ,,
500 mA
250 ,,
120 ,,
70 ,,
40 ,,
18 ,,



TRUE R.M.S. READING

INDEPENDENT OF WAVE FORM

For use with all types of Precision D.C. Potentiometers. For the precise measurement of R.M.S. alternating currents and voltages

Accuracy: ±0·05% up to 10 kc/s.

Hampton Road, Croydon, Surrey, England

Telephone: THOrnton Heath 4025 and 4094

CROPICO

AC—DC CONVERTER

Introduction

This A.C.-D.C. Converter has been designed to fill the growing need for a precise instrument for the measurement of alternating currents and voltages over a wide frequency range with the highest possible accuracy. It is intended for use as an accessory for the precision Vernier Potentiometer (Type P.10) and the combined equipment is one of the most powerful tools for precise A.C. and D.C. laboratory measurements generally available.

The basis of all precise alternating current measurements is a transfer device which is calibrated on direct current and whose calibration can then be used on alternating current with negligible error. The vacuo-thermo-junction is a suitable device for this purpose and forms the basis of the A.C.-D.C. Converter. It consists of a fine heater wire mounted between relatively massive supports, with a thermocouple fixed at the mid-point in order to measure the mid-point temperature rise, the whole being sealed in an evacuated glass envelope. Calibration is normally effected by passing known direct currents through the heater and measuring the e.m.f. of the thermocouple with a potentiometer. This calibration can then be used on alternating current.

Transfer errors can arise in practice due to a variety of causes. It is essential for the thermocouple to be insulated from the heater, otherwise some of the heater current crosses the junction and causes large reversal errors in the d.c. test. Even with insulated couples reversal errors on the d.c. test are encountered in practice. These reversal errors are due to Peltier heating at the heater supports and are only noticeable if the couple is not at the mid-point of the heater. Exact mid-point placing of the couple is virtually impossible to achieve, but it can be shown that the mean of the forward and reverse readings obtained on the d.c. test gives an accurate a.c. calibration. Large reversal errors are inconvenient and selection of the couples is necessary.

The existence of Thomson heating in the heater wire causes some asymmetry of temperature distribution on direct current which is not present when the heater is energised with alternating current. This causes an irreducible transfer error which, can, however, be minimised by the use of heater materials with a relatively low Thomson effect. In general a heater composed of 80Ni 20Cr alloy will show a transfer error of about 1 part in 10^4. An error of this magnitude is negligible in alternating current work.

The vacuo-thermo-couple is sensitive to ambient temperature changes, and the temperature coefficient varies from unit to unit and may amount to 0·2% per °C. The heater resistance also changes significantly with test current, due to its high operating temperature. These two limitations are, however, almost entirely eliminated by the method of operation, and special circuits adopted in the converter.

The Converter incorporates a specially selected 10 mA vacuo-thermo-junction having a low reversal error, a range of shunts and multiplier for current and voltage measurement, together with special circuits to eliminate the effect of heater resistance, an auxiliary potentiometer for balancing purposes, direct current regulators, a rectifier meter for protective purposes, and all necessary switches.

Accuracy and Frequency Range

The accuracy of voltage and current measurement is generally within plus and minus 0·05% over a frequency range from 25 c/s to 10 kc/s. The Converter can be used at higher frequencies, the accuracy attainable then being determined by the electrical constants of the shunts and multipliers, and is dependent upon the range.

An N.P.L. report can be provided at cost.

Ranges: Voltage: 3 to 300 volts. 25 c/s to 10 kc/s.
Current: 10 mA to 5A. 25c/s to 10 kc/s.

Dimensions: 15in. × 14in. × 10in. (37 cms. × 34 cms. × 25 cms.).

Weight: 22 lbs. (10 Kgs.).

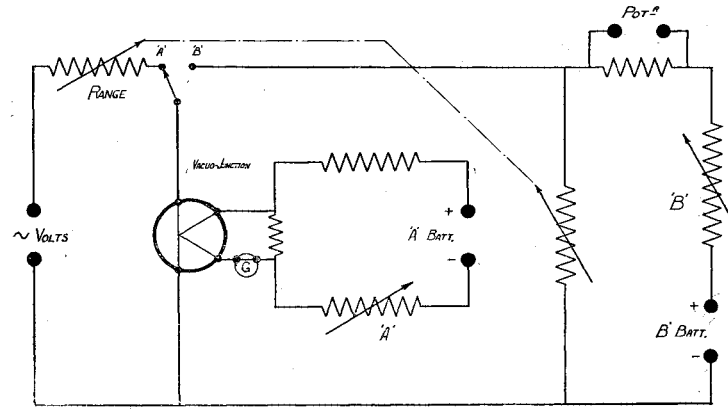
Construction: This instrument is contained in a screened polished teak case, with a dust-tight light alloy cover panel grey painted.

PRINCIPLE OF OPERATION:—Part of the A.C. supply to be measured is passed through the heater of the junction and the resulting E.M.F. from the thermocouple is balanced against an internal auxiliary potentiometer (controls A).

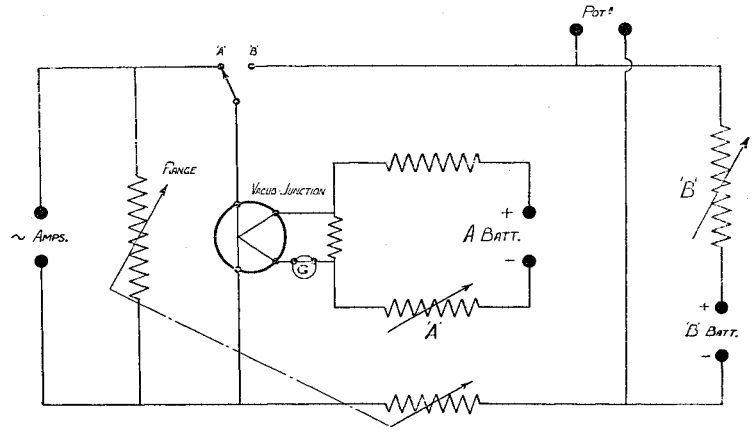
The Junction Heater is then heated by a D.C. supply which is adjusted by controls B until the E.M.F. from the couple is exactly the same as when heated by A.C. Part of this D.C. supply is then measured on the main potentiometer. This reading is readily converted into Voltage or Current by referring to the multiplying factors on the potential divider, or the resistance values of the shunts.

CROPICO

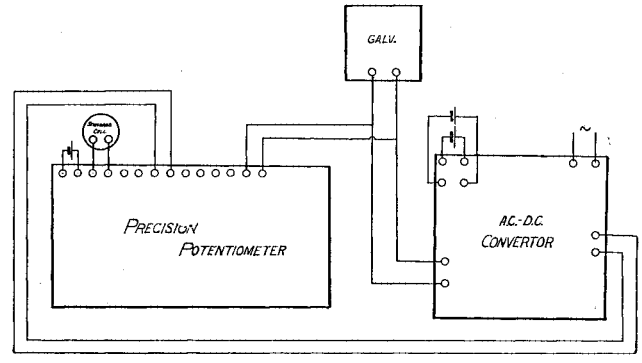
BASIC CIRCUIT
VOLTAGE MEASUREMENT



BASIC CIRCUIT
CURRENT MEASUREMENT



CONNECTION DIAGRAM
COMPLETE EQUIPMENT



CROPICO

OPERATING INSTRUCTIONS

(1) Connect the AC/DC Converter to the potentiometer, galvanometer and its supply batteries as per the diagram leaflet No. 61. The 2 volt accumulators should be connected 3-4 hours prior to measurements being taken to ensure maximum stability as the results obtained will depend upon the stability of these supplies.

(2) Set the selector switch in the "meter" position.

(3) Select range on range switch i.e. current or voltage to the figure required and connect the supply to be measured, taking care that the earthy side of the input is connected to the terminal marked "E". The panel is connected to the earth terminal and the internal screen.

As a precaution it is sometimes advisable whether measuring voltage or current to set the selector switch on the highest range and the range position lowered until the meter reads between 5 and 10 mA.

(4) The meter should be regarded as an indicator of the heater current only, its calibration being no better than $\pm$ 10%.

(5) Operate at a heater current as near as possible to 10 milliamps as this condition will give maximum galvanometer sensitivity during the transfer process i.e. adjustment of controls "A" and "B".

(6) Set selector switch to position "A", then adjust coarse and fine controls engraved "A" until the galvanometer is balanced to zero.

(7) Move selector switch to position "B" and balance galvanometer to zero by means of the coarse and fine "B" controls.

(8) With the selector switch still in position "B" measure the voltage at the terminals engraved "Potentiometer", by means of the 1st grade D.C. Potentiometer.

(9) For work of the highest precision the reversing switch is reversed and operations (7) and (8) repeated. The mean of the two potentiometer readings may then be taken as the correct value.

Notes

(1) On switching to position "B" the reading on the voltmeter or ammeter under test may alter slightly. This is due to alteration in the impedance of the circuit caused by introduction of the rectifier meter into the circuit on position "B".

It is emphasised that this alteration is of no consequence since the reading of the meter under test is only significant when adjusting "A" controls i.e. passing alternating current through the test meter and in the "B" position the test meter plays no part in the measurement.

Hence the required value on the meter under test should be adjusted whilst on "A" position and no further adjustment made during the remaining operations.

(2) When adjusting controls "B" it must be remembered that the D.C. current through the heater is being varied, resulting in either the heating or cooling of the junction and a due time allowance must be made during adjustments.

(3) When measuring voltage the potentiometer reading is multiplied by the multiplying factor of the range used; this is engraved adjacent to the range switch on the instrument panel.

When measuring current the value is determined by means of ohms law

$$I = \frac{E}{R}$$ Where E = the Potentiometer reading and R = the converter shunt resistance used.

Replacement of Vacuo-Junction

Remove the bakelite cover fitted to the bottom of the instrument; the junction can then be seen and replaced. Junctions are normally connected by soldering but provision is made for valve base type junctions to be plugged in.

Printed in the United Kingdom

CROPICO

MANUFACTURERS OF ELECTRICAL
MEASURING INSTRUMENTS

HAMPTON ROAD • CROYDON • SURREY

AC/DC CONVERTER

Operating Instructions

(1) Connect the AC/DC Converter to the potentiometer, galvanometer and its supply batteries as per the diagram leaflet No. 61. The 2 volt accumulators should be connected 3-4 hours prior to measurements being taken to ensure maximum stability as the results obtained will depend upon the stability of these supplies.

(2) Set the selector switch in the "meter" position.

(3) Select range on range switch i.e. current or voltage to the figure required and connect the supply to be measured, taking care that the earthy side of the input is connected to the terminal marked "E". The panel is connected to the earth terminal and the internal screen.

As a precaution it is sometimes advisable whether measuring voltage or current to set the selector switch on the highest range and the range position lowered until the meter reads between 5 and 10 mA.

(4) The meter should be regarded as an indicator of the heater current only its calibration being no better than ± 10%.

(5) Operate at a heater current as near as possible to 10 milliamps as this condition will give maximum galvanometer sensitivity during the transfer process i.e. adjustment of controls "A" and "B".

(6) Set selector switch to position A, then adjust coarse and fine controls engraved A until the galvanometer is balanced to zero.

(7) Move selector switch to position "B" and balance galvanometer to zero by means of the coarse and fine "B" controls.

(8) With the selector switch still in position "B" measure the voltage at the terminals engraved "Potentiometer", by means of the 1st grade D.C. Potentiometer.

(9) For work of the highest precision the reversing switch is reversed and operations (7) and (8) repeated. The mean of the two potentiometer readings may then be taken as the correct value.

Continued...

Telephone THORNTON HEATH 4025—4094
Telegrams and Cables—CROPICO—CROYDON

CROPICO

MANUFACTURERS OF ELECTRICAL
MEASURING INSTRUMENTS

HAMPTON ROAD • CROYDON • SURREY

Notes

(1) On switching to position "B" the reading on the voltmeter or ammeter under test may alter slightly. This is due to alteration in the impedance of the circuit caused by introduction of the rectifier meter into the circuit on position "B".

It is emphasised that this alteration is of no consequence since the reading of the meter under test is only significant when adjusting "A" controls i.e. passing alternating current through the test meter and in the "B" position the test meter plays no part in the measurement.

Hence the required value on the meter under test should be adjusted whilst on "A" position and no further adjustment made during the remaining operations.

(2) When adjusting controls "B" it must be remembered that the D.C. current through the heater is being varied resulting in either the heating or cooling of the junction and a due time allowance must be made during adjustments.

Replacement of Vacuo-Junction

Remove the bakelite cover fitted to the bottom of the instrument the junction can then be seen and replaced. Junctions are normally connected by soldering but provision is made for valve base type junctions to be plugged in.

When measuring voltage the potentiometer reading is multiplied by the multiplying factor of the range used, this is engraved adjacent to the range switch on the instrument panel.

When measuring current the value is determined by means of ohms law

$$I = \frac{E}{R}$$

Where E = the Potentiometer reading
and R = the converter shunt resistance used.

Telephone THORNTON HEATH 4025—4094
Telegrams and Cables—CROPICO—CROYDON