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Title The Synchronous Commutator for Tube Voltage Drop Measurements

By

Electronic Tube Engineering Div.

Information prepared for .....

Tests made by .....

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Countersigned by .....

Date 2-21-38

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## The Synchronous Commutator for Tube Voltage Drop Measurements

Vacuum Tube Eng. Dept.

February 21, 1938.

### Foreword

The cathode ray oscillograph has proven fairly satisfactory for drop measurements of small tubes, but because of its extreme susceptibility to electrostatic and electromagnetic fields and for other reasons as later outlined, became troublesome or inadequate for high current work. This paper shows a synchronous commutator which is immune to these hazards which is recommended where accurate quantitative data are required.

### Cathode Ray Oscillograph Method

Standard procedure is: by throwing a switch at the oscillograph to match the height of the trace as located by a straight edge, with d-c - which is then read in volts. An amplifier may or may not be used.

### Advantages

Where conduction is only 5 or 10 cycles periodically, as in welder tests, this is the only choice. The trace can be located for a few cycles.

### Disadvantages

The circuit is inherently weak, hence subject to pick-up of all kinds. The tube itself is sensitive to electrostatic fields, and electromagnetic fields with the result that in high current work the oscillograph must be far removed from the set. This in turn adds a long lead for pick-up, which is not compensated for in calibration. It also necessitates two operators - one far removed with the other at the set. Steady or intermittent heavy loads or r-f loads nearby on other equipment affect the readings. Further, by nature of the method requires considerable time in voltage matching per reading - during this time drift cannot be observed as the calibrating switch is closed.

### Results

Many sets of data have been laboriously and carefully taken only to find results do not check, and contain unexplainable drops and rises. The writer found that by turning on or off a nearby high current exhaust set, a difference of 7 volts in readings being taken, was produced. It was thus concluded that for a series of work where not qualitative but accurate quantitative data were required, a

better means was imperative.

### The Synchronous Commutator

A commutator is driven by a small synchronous motor and so arranged to charge a condenser about 5 degrees of each cycle. By selecting the charging period a voltmeter across the condenser reads tube drop. The condenser is large enough so that it discharges only a fraction of a volt between chargings. A short low impedance circuit connects to the tube. Calibration is by comparison to a low impedance d-c source which also goes through the commutator system. No. 523409 shows a photograph of the equipment being used. K-5103093 shows the circuit diagram and operating instructions of the equipment.

#### Advantages

The equipment is immune to all electrostatic and electromagnetic fields and to pickup of all kinds, hence can be put right at the test set with short leads. It is electrically of low impedance throughout. Calibration is available by closing a switch. Readings are directly in volts. In one second, steady state conditions obtain, then the voltage is always under observation: drift if any will at once be detected. The commutator may be phased to any desired portion of the conducting half cycle - or readings at various phasing may be taken as fast as they can be recorded. Since it only remains to read the voltmeter after each current setting, complete series of current versus voltage drop may be taken in 2 or 3 minutes. The equipment is simple to operate and fully portable.

#### Disadvantages

Since a full second is required to reach steady conditions, this system is not adaptable to measurements of intermittent firing.

#### Results

Data were taken on eight types of tubes, six of which are shown on H-539993 and H-539994. Both the curves and the data points are completely reproducible. Typical data, shown in the order taken with check points, are from the 258A at 40° C.

| <u>I peak</u> | <u>Volts</u> |
|---------------|--------------|
| 130           | 11           |
| 250           | 12.2         |
| 365           | 13.2         |
| 570           | 14.8         |
| 810           | 16           |
| 1100          | 16.2         |
| 1425          | 17           |
| 240           | 12           |
| 645           | 15           |

New information concerning the 238A was at once observed; namely that at 20° C, and above 500 amperes the immediate drop drifts lower during 5 or 10 seconds. At 1400 amperes this change is 4 volts. Similar drifts were found in several other metal tubes of baffled construction.

Curves taken were smooth traces largely free of unexplainable dips and raises. If the reader is further interested he may take reference to the curves above referred to.

Conclusions

The synchronous commutation is recommended for quantitative tube drop measurements because it brings freedom from error, caused by pickup on leads, magnetic fields, intermittent loads on other equipment, and supply voltage variation, or any other. It is convenient to use because it is portable, reads in volts directly, may be set anywhere for operation and offers no complications of any kind.

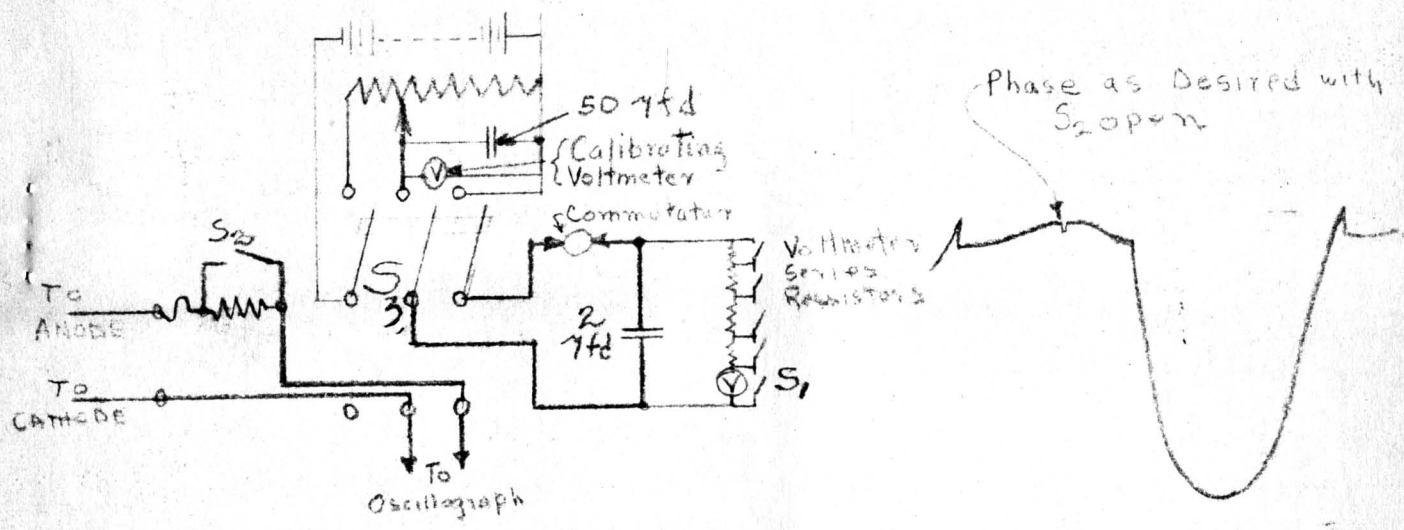
L.D. Miles

LDM:HT

- WC White
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*L.D. Miles*  
*Febr 21, 1938*



CIRCUIT DIAGRAM

TYPICAL PHASING

INSTRUCTIONS FOR OPERATION

- 1 Plug synchronous motor with 115 V a-c source
- 2 Snap switch to bring to synchronism then back to run position
- 3 Close protecting switch S<sub>1</sub>
- 4 Open S<sub>2</sub>
- 5 Connect to tube
- 6 Connect oscillograph
- 7 Rotate brushes to give desired phase as shown by the commutating point on the cathode ray oscillograph
- 8 Close S<sub>3</sub> toward bottom, open S<sub>1</sub> and adjust series resistor for the desired voltmeter calibration.
- 9 Close S<sub>2</sub>
- 10 Close S<sub>3</sub> forward and reading will now be direct.
- 11 Change tube conditions as desired. The meter will register drop continuously.

Suggested calibration scales are:

- 1- direct 30 volts full scale
- 2- k=2 60 " " "

SYNCHRONOUS COMMUTATOR

ALSO FOR RATING AS SHOWN ON THE REVERSE SIDE OF THIS PRINT

VT<sup>8</sup>  
**GENERAL ELECTRIC WORKS**

DRAWN BY L. D. MILES FEB 21, 38  
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**K-5103093**