INSTRUCTIONS

INSTRUCTION MANUAL
FOR
DC VOLTAGE-CURRENT STANDARD
TYPE 2853

Edit. 2

YOKOGAWA ELECTRIC WORKS, LTD.

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DC VOLTAGE-CURRENT STANDARD
TYPE 2853

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'67. 11. 25 YOKOGAWA ELECTRIC WORKS, LTD.

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Features of this instrument are as follows.

(1) Strictly selected temperature-compensated Zener diodes are employed for use as reference voltages. In addition, the voltage dividers and the output setting circuits are composed with YEW's unique wire-wound precision resistor. This combination makes the output precize and stable.

(2) Internal circuits are shielded by a double-housing. Therefore, even if a potential-to-earth becomes existent, the resulting influences can be reduced by taking the guard.

(3) The in-line display makes the read-out of set value easy.

(4) The overload protective unit is employed. Therefore, the instrument and the circuits are protected from damage due to erroneous wiring.

(5) All-transistorized construction results in light weight and small size.

1. GENERAL DESCRIPTION

1.1 Features

DC Voltage/Current Standard Type 2853 is a stable power supply equipment designed to be capable of delivering an accurate DC voltage and current through use of the numerical dial setting.
For outputs, four voltage ranges; 10V/1V/100mV/10mV, and three current ranges; 100mA/10mA/1mA are provided, with four digits setting available, and at an accuracy of ±0.07% of reading +1 division. Three direct-reading dials optimize speed and accuracy of voltage or current range selection.
Major applications are as follows:

(a) Reference voltage or current for test purposes at laboratory or in the field.

(b) Adjustment and test for various kinds of electromechanical and electronic apparatus and component.

(c) Calibration of DC measuring instruments.

(d) Precision measurement and zero-method measurement of DC voltage (with use of galvanometer).

(e) Expanded indication of a minute voltage-variation (with use of high sensitivity voltmeter).

(f) Standard voltage generator of 0~1200V, in conjunction with Voltage Unit Type 2861.

(g) Standard current generator of 0~36A, in conjunction with Current Unit Type 2862.

(h) Temperature measurement and thermometer calibration, in conjunction with Thermocouple Compensating Adaptor (with use of thermocouple and galvanometer).

Fig. 1.1 External view of DC Voltage/Current standard, Type 2853

1.2 Specifications

(1) Ratings

Range	Range of Output Setting	Resolution	Maximum Output	Accuracy ※ % of Setting	Internal resistance	Noise in Bandwidth 0 ~ 50 Hz	Temperature Coefficient in 5 ~ 35°C
10 V	0 ~ 11.999 V	1 mV	Approx. 0.12 A	±0.07% + 1 mV	Below 10 mΩ	Below 1 mV P-P	Within ±0.05%/10 deg.
1 V	0 ~ 1.1999 V	100 μV	Approx. 0.12 A	±0.07% + 200 μV	Below 10 mΩ	Below 100 μV P-P	" ±0.04% + 200 μV/10 deg.
100 mV	0 ~ 119.99 mV	10 μV		±0.07% + 10 μV	Approx. 1 Ω	Below 10 μV P-P	" ±0.05%/10 deg.
10 mV	0 ~ 11.999 mV	1 μV		±0.07% + 2 μV	Approx. 1 Ω	Below 10 μV P-P	" ±0.05%/10 deg.
100 mA	0 ~ 119.99 mA	10 μA	Approx. 6 V	±0.07% + 10 μA	Approx. 1 MΩ	Below 10 μA P-P	Within ±0.06%/10 deg.
10 mA	0 ~ 11.999 mA	1 μA	Approx. 6 V	±0.07% + 1 μA	Approx. 10 MΩ	Below 1 μA P-P	" ±0.06%/10 deg.
1 mA	0 ~ 1.1999 mA	0.1 μA	Approx. 6 V	±0.07% + 0.1 μA	Approx. 10 MΩ	Below 0.5 μA P-P	" ±0.06% + 0.1 μA/10 deg.

※ Test condition
Ambient temperature 20°C ±2 deg.
Power line voltage ~~100~~ 220 V
Warming-up time More than 10 minutes

(2) Warming-up time: More than 10 minutes since switch-in.

(3) Common mode rejection:

NOTE: (a) The circuits are floated above the outer case by the double housing construction.

(b) Earth terminal ... Outer case

(c) Guard terminal ... Inner case

Employing the guard through the guard terminal, the influence given to the voltage or the current output by the common mode voltage of DC to 50 Hz will be rejected to about -120 db and 0.1 μA/V respectively.

(4) Line regulation: Within ±0.05% / ±10% line voltage change.

(5) Insulation:
Case - Guard: More than 100 MΩ at 500V DC
Power supply - Case: More than 100 MΩ at 500V DC

(6) Dielectric strength: ~~100~~ 220 V AC between case and guard

(7) Operating temperature: 0~45°C, at less than 75% of humidity

(8) Power supply: ~~100~~ 220 V ±10V AC 50 or 60 Hz, power consumption about 10 VA
(AC 115V, 200V, or 230V is available, in request.)

(9) Dimensions and weight: 223 (W) x 149 (H) x 360 (D) mm, approx. 7.4 kg

(10) Accessories: 2 - Fuses (0.5A)
Output signal lamp (for ON, OFF)

2. OPERATION

2.1 Installation

Be careful not to use the instrument at a place which may be directly exposed to the sun, near a high temperature thermal source, or of high humidity.

2.2 Panel Functions (Refer to Fig. 2.1)

1 Set-value indicator

Output set-value are indicated by IN-LINE.

2 Setting dial

1st digit	0 ~ 11
2nd digit	0 ~ 9, endless
3rd digit	0 ~ 99, slide type endless

3 Range selector

This switch is used for output range selection: 100mA, 10mA, 1mA, 10mV, 100mV, 1V, 10V, and for the voltage unit type 2861, the current unit type 2862

4 OUTPUT terminals

These terminals are used for the output voltage or the current.

5 GUARD terminal "G"

This terminal is connected with the internal guard case and the guard rings of the output terminals.

6 Terminals for the thermocouple compensating adaptor type 2863

The thermocouple compensating adaptor may be attached to these terminals.

7 OUTPUT ON/OFF SWITCH

This is the jumping type toggle switch which will set the output voltage and the output current ON and OFF.

8 OUTPUT SIGNAL LAMP

When an output current in the range of 1, 10, 100mA or an output voltage in the range of 10mV, 100mV, 1V, 10V passes through the OUTPUT terminals the upper GREEN lamp (ON) will light up. On the contrary, the lower Red lamp (OFF) will switch on when there is no output.
It glows up when the overload protecting circuit of the present generator starts to work at the moment the OUTPUT ON OFF switch is pushed to the lower position.

9 POWER ON-OFF

This is the power switch.

10 Mounting screw of the main body

The main body is fixed by these screws.

11 Connector for the voltage unit type 2861

The voltage unit is to be connected through this connector.

12 Connector for the current unit type 2862

The current unit is to be connected through this connector.

13 Power Cord

14 FUSE

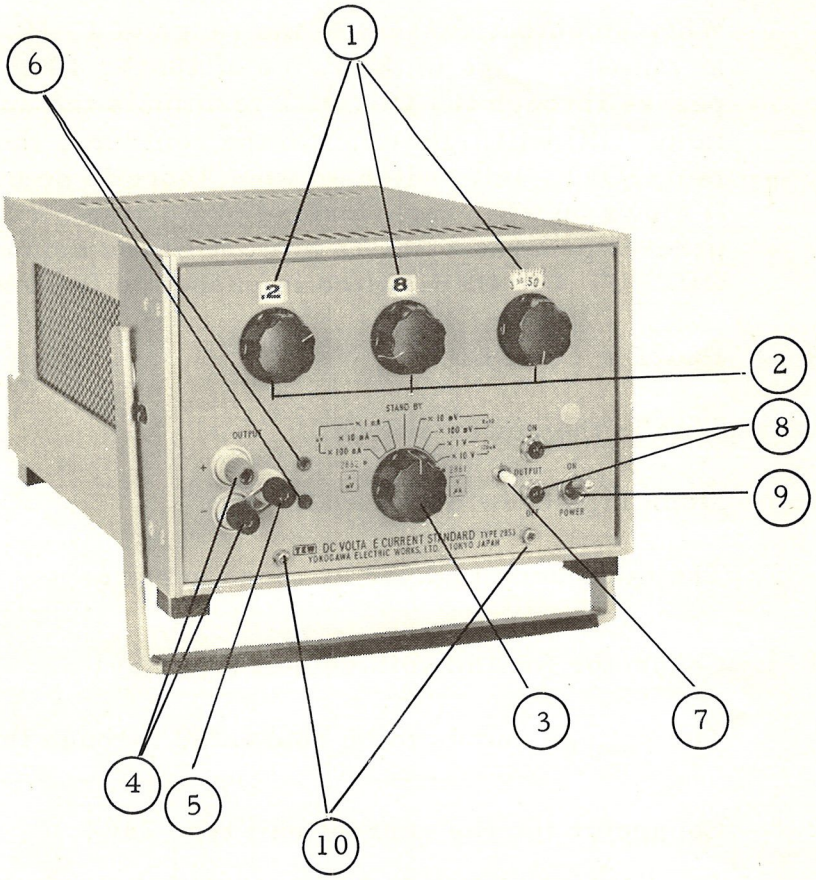
0.5A capacity.

15 Blind Cap (OUTPUT)

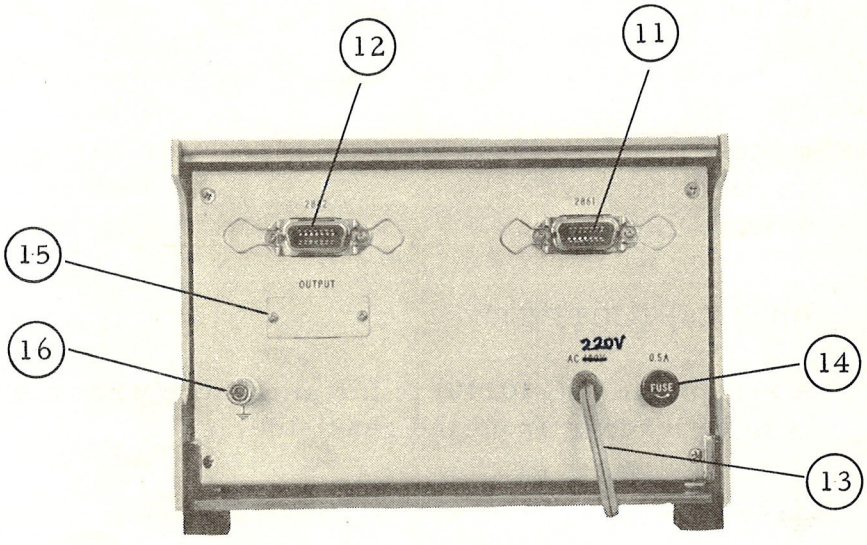
A receptacle (57-40140) is installed here when the output is to be lead out from the rear side.

16 ⏚

This terminal is for grounding and has connection to the outer case.



(a) Front panel



(b) Rear panel

Fig. 2.1 Panel functions

2.3 Warm-up

(1) Place the range selector switch to the position of STAND BY.

(2) Insert the plug of the power cord into a receptacle of 100V AC.

(3) Switch the power ON. If the red lamp (OUTPUT OFF) is lighted up, push the OUTPUT ON OFF switch to the ON side to let the green lamp glow up.

(4) Warm-up the instrument for 15 minutes or more in this state.

2.4 Connection of Terminals

When the load used has a potential-to-earth and is considered dangerous, ground the grounding terminal. It is recommended to ground it at all times.

2.4.1 Set of voltage or current output

(1) Connect the load to the output terminals. Red one is for ⊕ and black one for ⊖ .

(2) Connect the GUARD terminal to the earth side terminal of the load. (Refer to Fig. 2.2)

2.4.2 Precautions for connection

Fig. 2.2 shows the guard connection by depending on the load. The GUARD terminal should be connected in accordance with the manner shown in this figure. If not so, the output may accompany error or ripple. The above influence is attributed to the common mode earth potential of the load.

2.5 Output Setting

Calibration of this instrument is made in the absolute unit (abs)*. The procedures are as follows:

(1) Set the RANGE selector to the desired range.

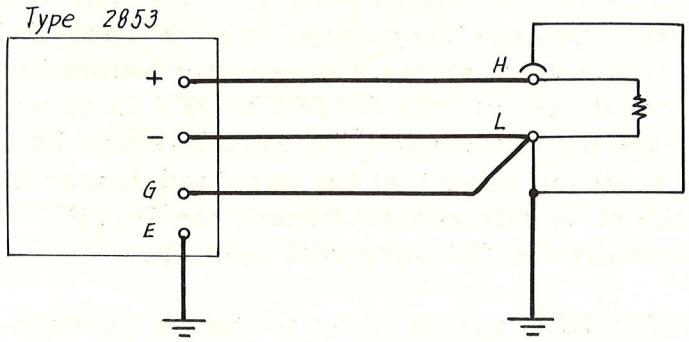
(2) Set the setting dial to the desired value. An output of the set value will come out at the output terminal.

(3) When no output is needed, set the range selector switch to STAND BY position or cut OFF the output using the OUTPUT ON OFF switch.

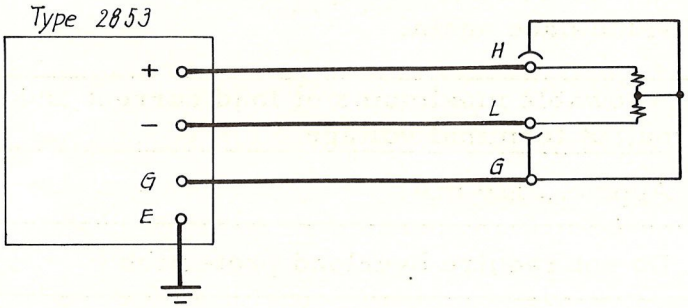
(4) Since there is the danger that an overload current, and an overload voltage may be sent to the measured circuit by mistake damaging it, when the range selector switch is suddenly changed over at a set point, be sure to cut OFF the OUTPUT ON OFF switch before altering the range.

NOTE: When changing the position of the RANGE selector, be sure to reset the first digit to zero. If the selector is changed-over remaining a certain set value, an over voltage or current may be erroneously applied to the circuit under test.

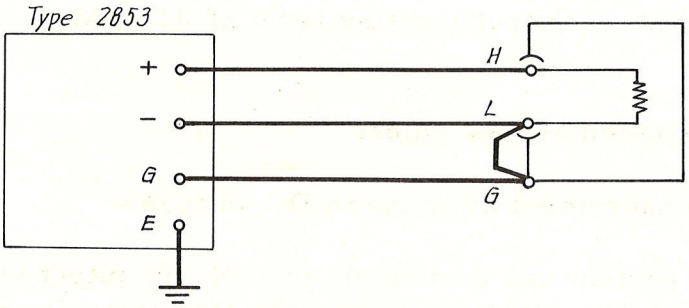
Fig. 2.2 Connection for GUARD terminal according to the kind of the load



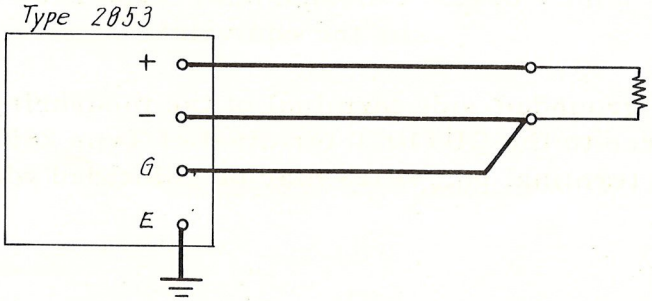
(a) The load is grounded or connected to its outer case at one terminal.



(b) The internal circuit of the load is connected to the guard terminal.



(C) The load is isolated from both the ground and the guard terminal.



(d) The load has none of the guard terminal, shield case and metallic case or panel.

2.6 Overload Protection

When the load current at a voltage setting or the load voltage at a current setting exceeds the values listed in Table 2.1 the overload protecting circuit starts its operation automatically cutting off the output circuit, the OUTPUT OFF lamp will glow up. When the OUTPUT ON OFF switch is pushed to the upper side (ON position) after that the overload danger has been avoided, the circuit is reestablished, the OUTPUT OFF lamp will go out while the ON lamp will light up.

If the OUTPUT ON OFF switch is set to the ON position while in the state of overloading, the OUTPUT OFF lamp will stay lighted on, the overload protecting circuit will continue to work. When the ON lamp does not glow up even after that the OUTPUT ON OFF switch has been pushed to the ON side, check the load value once again.

Range	Allowable maximums of load current and output terminal voltage
10V	Approx. 120 mA
1V	
100mV	Do not require overload protection
10mV	
100mA	Approx. 6V
10mA	
1mA	

Table 2.1 Output limiting level of ALARM

2.7 Examples of Applied Measurement

2.7.1 Precise measurement of unknown DC voltage

Since this instrument can accurately provide an output voltage, measurement of DC voltage is made potentiometrically possible in conjunction with an external galvanometer.

Instrument to be jointly used: Galvanometer Type 2709 or the equivalent

(1) Connect the grounded-side terminal of the measuring voltage source to the OUTPUT terminal of Type 2853 so that both terminal polarities may be coincided with each other.

(2) Connect the rest of terminals to each other through the galvanometer. In this case, both the guard-side terminal and the guard terminal of the galvanometer are to be connected to the side of Type 2853.

(3) When the source under test has the guard terminal, connect it to the guard terminal of the galvanometer. (Refer to Fig. 2.3)

(4) Set the output voltage of Type 2853 to a predicted value of the measuring voltage.

(5) Adjust the set voltage to establish no deflection on the galvanometer. When the balance is secured, read-out the set value.

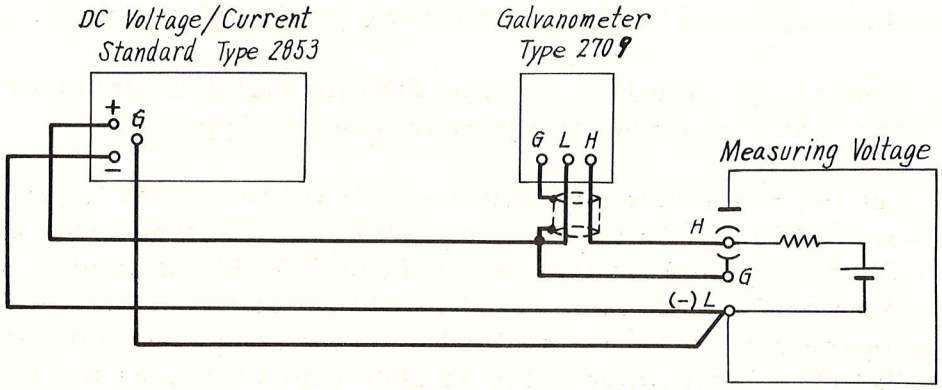


Fig. 2.3 Precise measuring circuit for DC voltage

2.7.2 Measurement or recording of small voltage change

Instruments to be jointly used: High sensitivity voltmeter
Type 2709 or the equivalent

Recording voltmeter
Type 3046 or the equivalent

NOTE: The input terminals should be floated free above the grounding.

(1) Connect the circuit according to the procedures described in 2.7.1 (1) ~ (4), substituting the galvanometer with the voltmeter or the recorder. (Refer to Fig. 2.3)

(2) Adjust the set voltage so that the balance may be obtained. If once the balance is secured, only the variation of the measuring voltage is expanded and indicated on the voltmeter or the recorder.

(3) Thus, the value of the measuring voltage is given by the sum of the value set with Type 2853 and the value indicated on the voltmeter.

2.7.3 High voltage generation in conjunction with Voltage Unit Type 2861

By employing Type 2853 in conjunction with Voltage Unit, a voltage of 0~1199.9V DC can be taken out at an accuracy of 0.15%.

(1) Change-over the range selector switch of Type 2853 to the position of "2861", and set the setting dial to zero.

(2) Connect Voltage Unit to Type 2853 through the connector for "2861" mounted on the rear panel of Type 2853.

(3) Set the range selector switch of "2861" to "x100V", "x500V" or "x1000V". In the state of "x100V", a voltage value as 100 times much as that set on Type 2853 is obtained. With x500V, a tension equal to 500 times the set value (of the generator) is obtained. Likewise, in the state of "x1000V", a voltage value as 1000 times much as the set value is obtained. Thus, a desired voltage can be obtained by setting a value on the dial.

(4) In case an overload (load more than 10mA) is brought about, the overload protector operates automatically, and cuts out the output circuit. On this occasion, the OUTPUT OFF lamp lights. If the OUTPUT ON OFF switch is pushed to the ON side after that the overload danger has been avoided, the circuit is reestablished and the ON lamp (green) will light up.

(5) After use, cut OFF the output of the present generator, turn the range selector switch of the TYPE 2861 to OFF position avoiding the creation of a high voltage.

(6) Note that the black output terminal of voltage unit is connected to the case, i.e., it is grounded by the (-) side output terminal.

2.7.4 Large current generation in conjunction with Current Unit Type 2862

By employing this instrument in conjunction with Current Unit, a DC current from 0 up to 35.997 (A) can be taken out at 0.2% accuracy.

(1) Change-over the range selector switch of Type 2853 to the position of "2862", and set the setting dial to zero.

(2) Through the connectors for "2862", connect the current unit, using the attached cords.

(3) Change-over the range selector switch of "2862" to any one position of "x1A", "x10A", and "x30A".
At the position of "x1A", a current value equal to the value set on Type 2853 is obtained. Likewise, at "x10A" and "x30A", values as 10 times and 30 times large as the set values are obtained respectively.
Thus, a desired value of the current can be obtained by setting a proper value or the dial.

(4) In case of overloading (load exceeding 1V), the overload protecting circuit will start to work automatically, cutting off the output circuit, the OUTPUT OFF lamp will light up. If the OUTPUT ON OFF switch is pushed to the ON side after having avoided overloading, the circuit is reestablished and the OUTPUT ON lamp will glow up. (refer to section 2.6)

(5) After the measurement, restore the setting on Type 2853 to zero.

2.7.5 Precise measurement of temperature in conjunction with Thermocouple Compensating Adaptor Type 2863

Instruments to be jointly used: Galvanometer Type 2709
or the equivalent Thermocouple

The calibration of a thermocouple can be easily made by the combination use of this DC voltage/current standard and the galvanometer. Also, by the combination use of the galvanometer, thermocouple, and Thermocouple Compensating Adaptor, the precise measurement of temperature is made possible.
Procedures for this temperature measurement are as follows:

(1) Fix the thermocouple compensating adaptor to the corresponding terminals on the front panel of Type 2853.

(2) Connect the thermocouple and the galvanometer according to Fig. 2.4.

(3) Set the value corresponding to the thermoelectromotive force of the thermocouple at the temperature of the thermocouple cold junction by the use of the compensating dial.

(4) Set the range selector switch of Type 2853 to the position of "x 10mV" or "x 100mV", and then adjust the setting value through the setting dial so that the galvanometer will indicate zero deflection. The setting value on this occasion is equal to that of the thermoelectromotive force of the thermocouple corresponding to the reference temperature. Thus, the measuring temperature is accurately known through the conversion table of thermo-electromotive force vs. temperature.

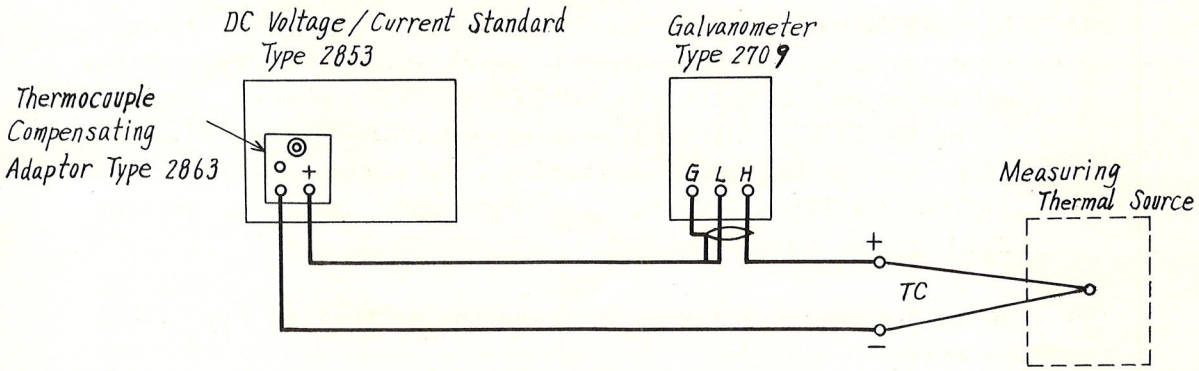


Fig. 2.4 Precision measuring circuit for temperature

3. MAINTENANCE

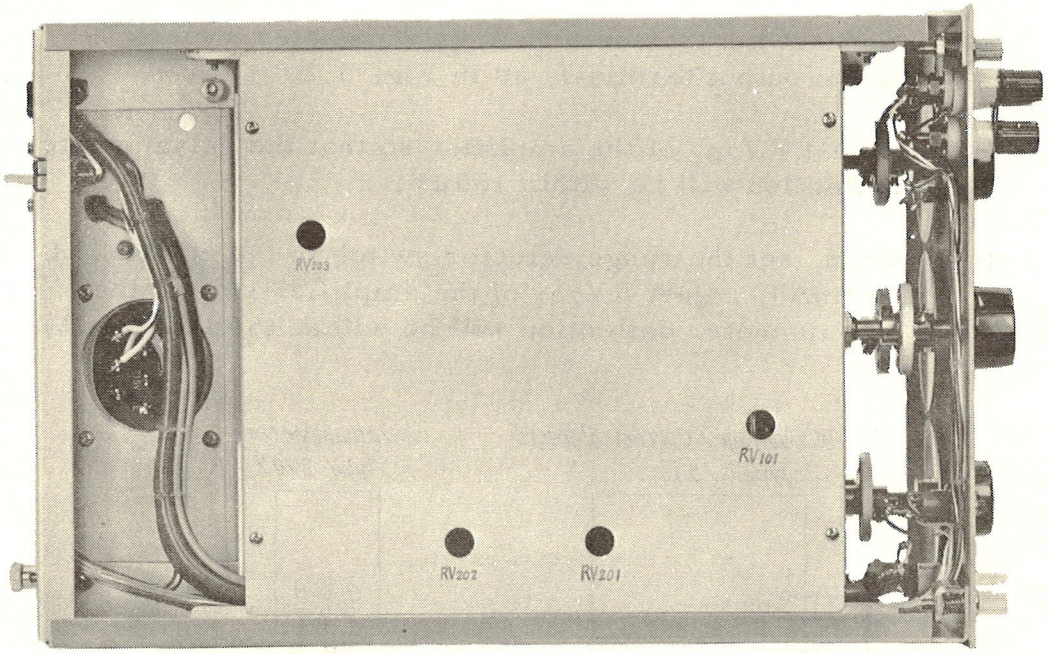


Fig. 3.1 Uncased instrument view from the bottom

3.1 Calibration

Because this DC Voltage/Current Standard is a precision instrument, it is desirable to conduct a periodical calibration about once a year. This will maintain high precision of the instrument.
A simplified calibration method will be described below.

Instruments to be jointly used:

- Galvanometer Type 2709 or the equivalent with the internal resistance of about 1 kΩ
- High precision reference voltage generator (calibrated at about ±0.02% of accuracy) such as Type 2851, Type 2852, or standard cell Type 2742.

3.1.1 Zero adjustment on amplifier

(1) Set the range selector switch to the position of "x 1V", and set the dial to zero.

(2) Connect the transistorized galvanometer Type 2709 to the output terminal, as in Fig. 3.2.

(3) Adjust RV_{202} of the amplifier so that the galvanometer deflection will be within ±50 μV.

(4) Then, set the range selector switch to the position of "x 1mA", adjust RV_{201} of the amplifier so that the galvanometer deflection will be within ±50 μV (±50 μA).

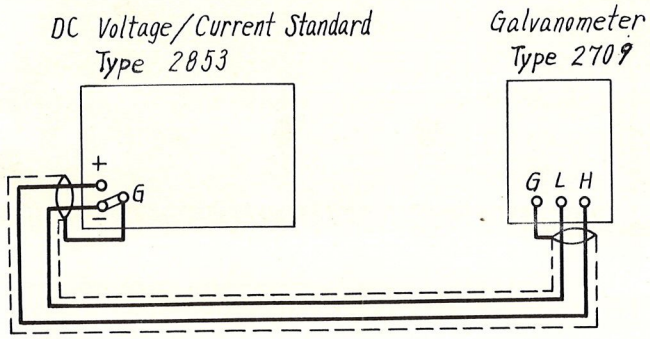


Fig. 3.2 Circuit for zero adjustment of amplifier

3.1.2 Calibration of 1V-range

After having finished the calibration as described in 3.2.1, conduct the calibration of the 1V-range in the following manner.

(1) Connect the circuit as in Fig. 2.3.

(2) Change-over the range selector switch to "x 1V", and set the dial to 1.0000(V). (When the range is calibrated by the use of standard cell, the dial should be set to 1.0186(V).)

(3) Adjust RV_{101} of the reference voltage circuit of Type 2853 so that the galvanometer will indicate zero when the voltage generated by the reference voltage generator is 1.0000(V) ±0.02%.

(4) In case the standard cell is used for the calibration, be careful so as not to flow any over current through the cell. Otherwise, the standard cell may be damaged.

3.2 Adjustment of the Overload Protecting Circuit

When the range of the protecting action does not agree with section 2.6 adjust it by using the RV_{203} of the overload protecting circuit.

(1) Change-over the range selector switch to "x100mA", and set the dial to zero.

(2) Connect a direct current voltmeter (a tester will do the work) to the output terminals, with an output voltage of 12.5V adjust the RV_{203} of the overload protecting circuit to make the OUTPUT OFF lamp light up.

3.3 Other Troubles

This DC Voltage/Current Standard is a high precision instrument. If once repaired, it requires careful and delicate adjustments. In case of unknown trouble, contact YEW.

4. COMPOSITION AND OPERATING PRINCIPLE

4.1 Operating Principle

Fig. 4.1 (a) illustrates the operating principle. The instrument comprises six major parts: reference supply E_S', potentiometer P, amplifier A, voltage divider D, current shunt R_S, and power unit.

The reference supply E_S' is divided by the potentiometer P into a variable standard input voltage E_S. For the voltage setting, the output voltage E_O is divided into 1/n through the voltage divider D, and the output thus attenuated is fed-back to be compared with E_S. For the current setting, the output current produces a voltage drop $R_S I_O$ across the current shunt R_S. This drop is compared with E_S.

The voltage resulting from the comparison is amplified by the amplifier so as to produce an accurate output voltage E_O or output current I_O.

In case the amplifier gain is large enough, the difference voltage may be neglected in comparison with E_S, and thus,

$$E_S = \frac{1}{n} E_O \qquad \therefore E_O = n E_S \quad \text{in the voltage setting}$$

and

$$E_S = R_S I_O \qquad \therefore I_O = \frac{E_S}{R_S} \quad \text{in the current setting}$$

That is, the output which is determined only by E_S and R_S is obtained, being free from variation in the amplifier gain and amount of the load resistance R_L. When setting a low voltage, a divided voltage is utilized as the output. Fig. 4.1 (b) shows the circuit composition of Type 2853.

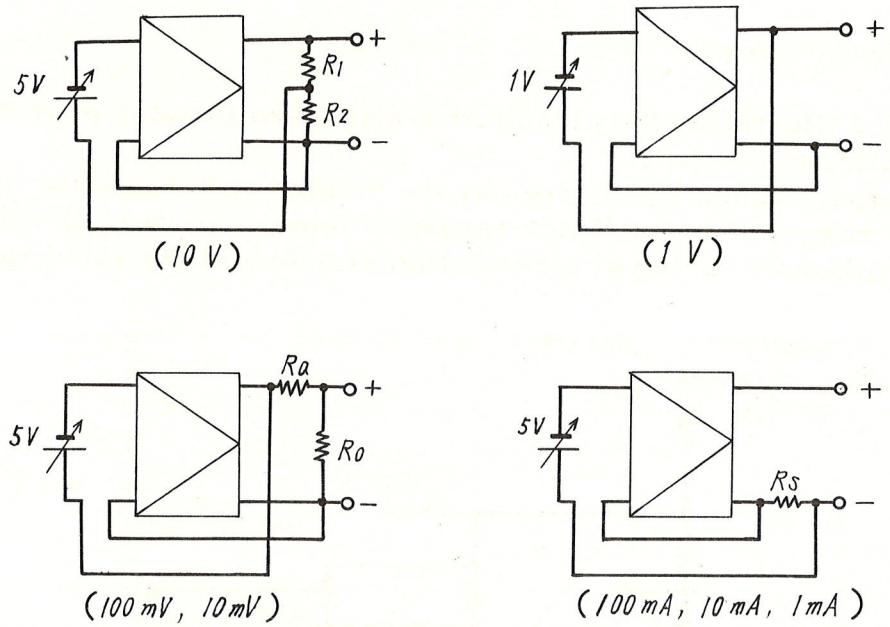


Fig. 4.1 (a) Operating principle of DC Voltage/Current Standard Type 2853

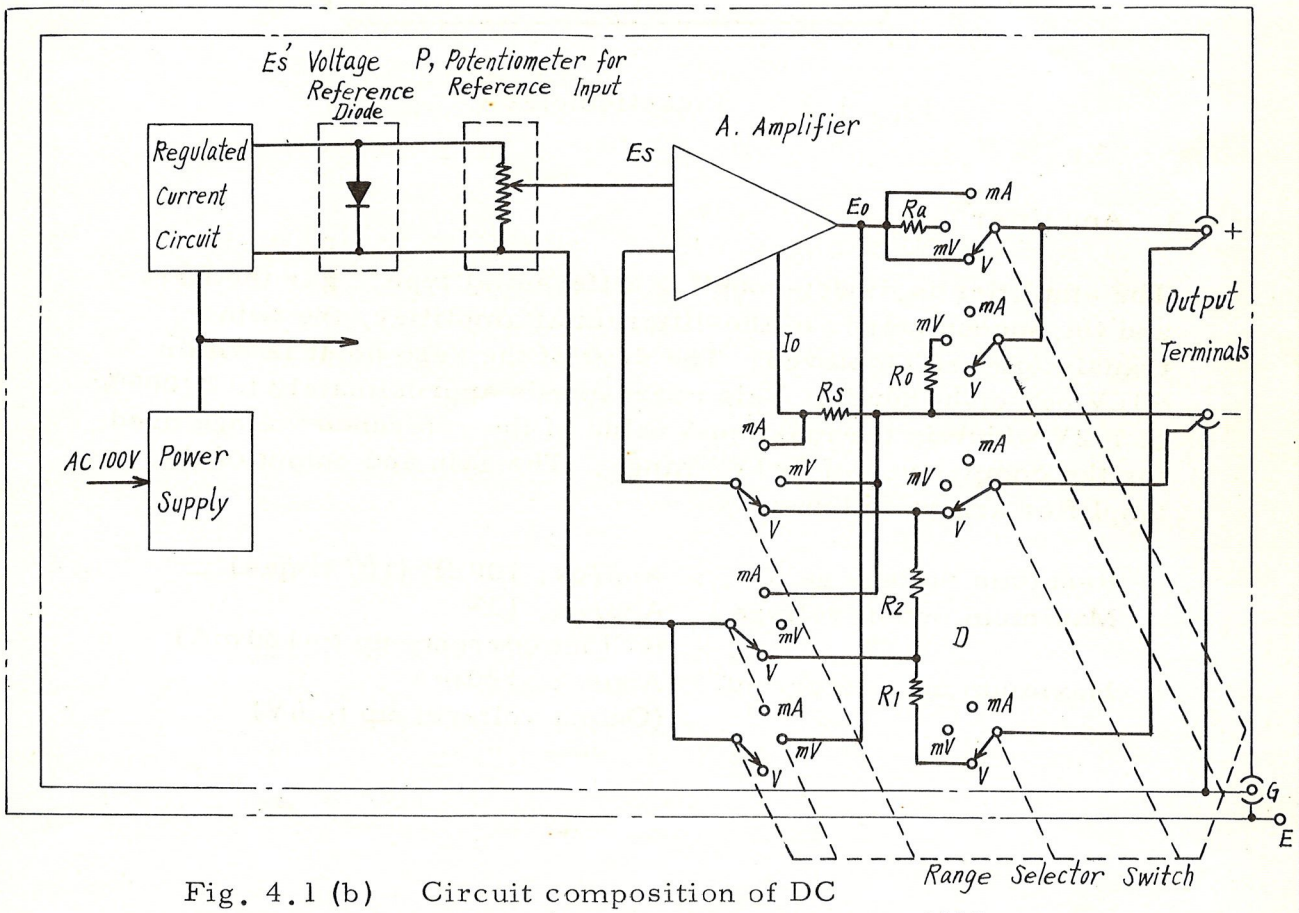


Fig. 4.1 (b) Circuit composition of DC Voltage/Current Standard Type 2853

4.2 Potentiometer

Fig. 4.2 illustrates the circuit of 3-dial potentiometer provided for setting the output.
The output voltage E_S is given by the voltage of 0~1.2V (for only "x 1V" range) or of 0~6V (for ranges of other than "x 1V") which is continuously varied at a resolution of 0.01% of the rated value.

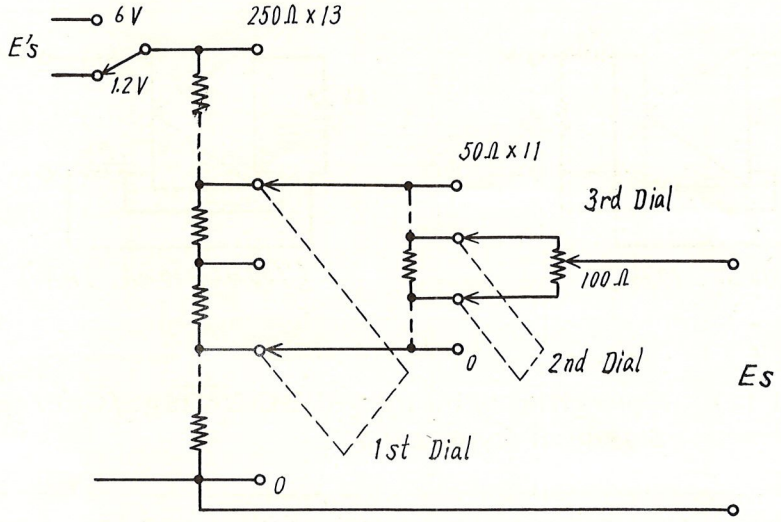


Fig. 4.2 Potentiometer

4.3 Amplifier

The amplifier is direct-coupling differential type. For the first and the second stages of the differential amplifier, the twin transistors are employed. The drift of the zero point is within 50 μV per eight hours. This corresponds approximately to 0.005% of 1.2V which is the maximum value of the reference voltage used for the comparison of "x 1V" range. The gain and output of the amplifier are as follows:

Resultant voltage gain	Approx. 100 dB (10^5 times)
Maximum output voltage	Approx. 12V (Output current, up to 120 mA)
Maximum output current	Approx. 120 mA (Output voltage, up to 6V)

4.4 Overload Protector

The overload protector is illustrated in a block diagram in Fig. 4.5. For the protection, each case of the current in the voltage output and the voltage in the current output is detected at the output end of the amplifier, and the detected value is compared with the limit value of the overload. When the output exceeds this value, a protective relay is actuated to cut off the output circuit.

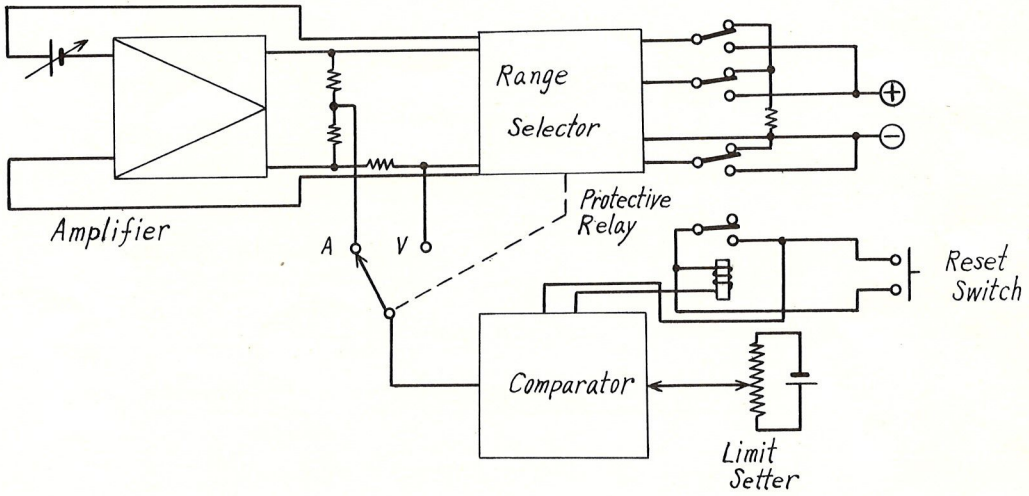
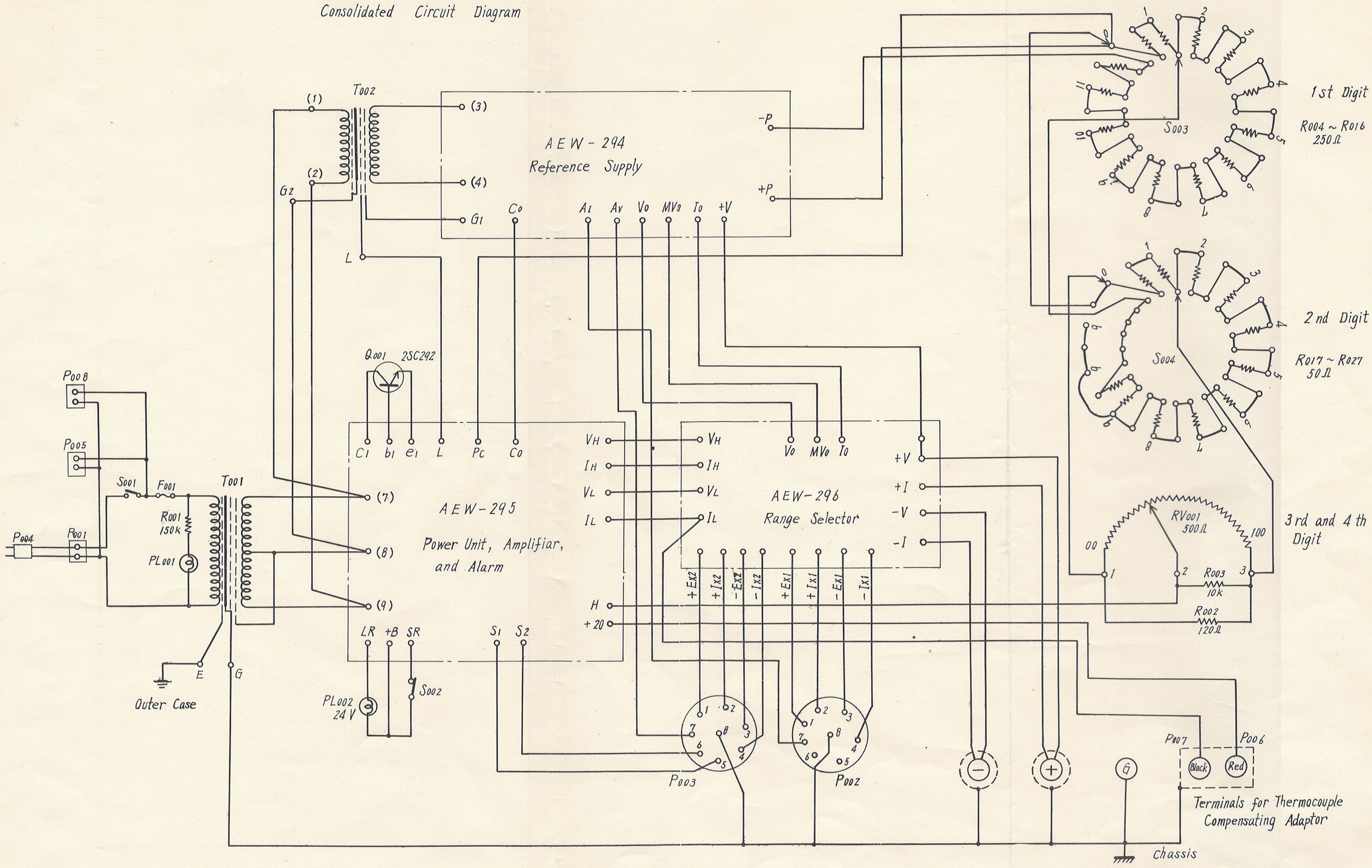


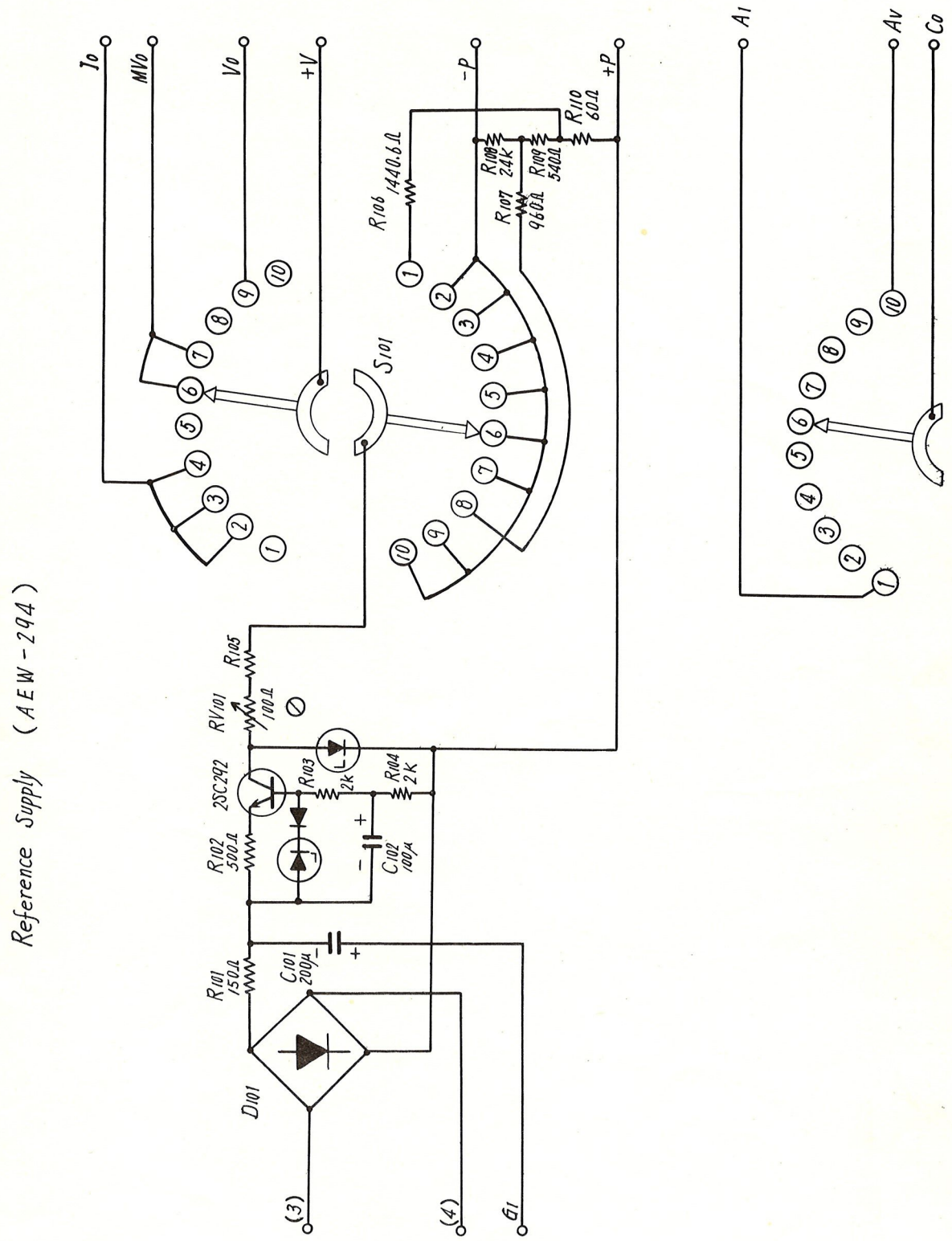
Fig. 4.5 Overload protector

5. CIRCUIT DIAGRAMS

The following diagrams illustrate the circuits of Type 2853.

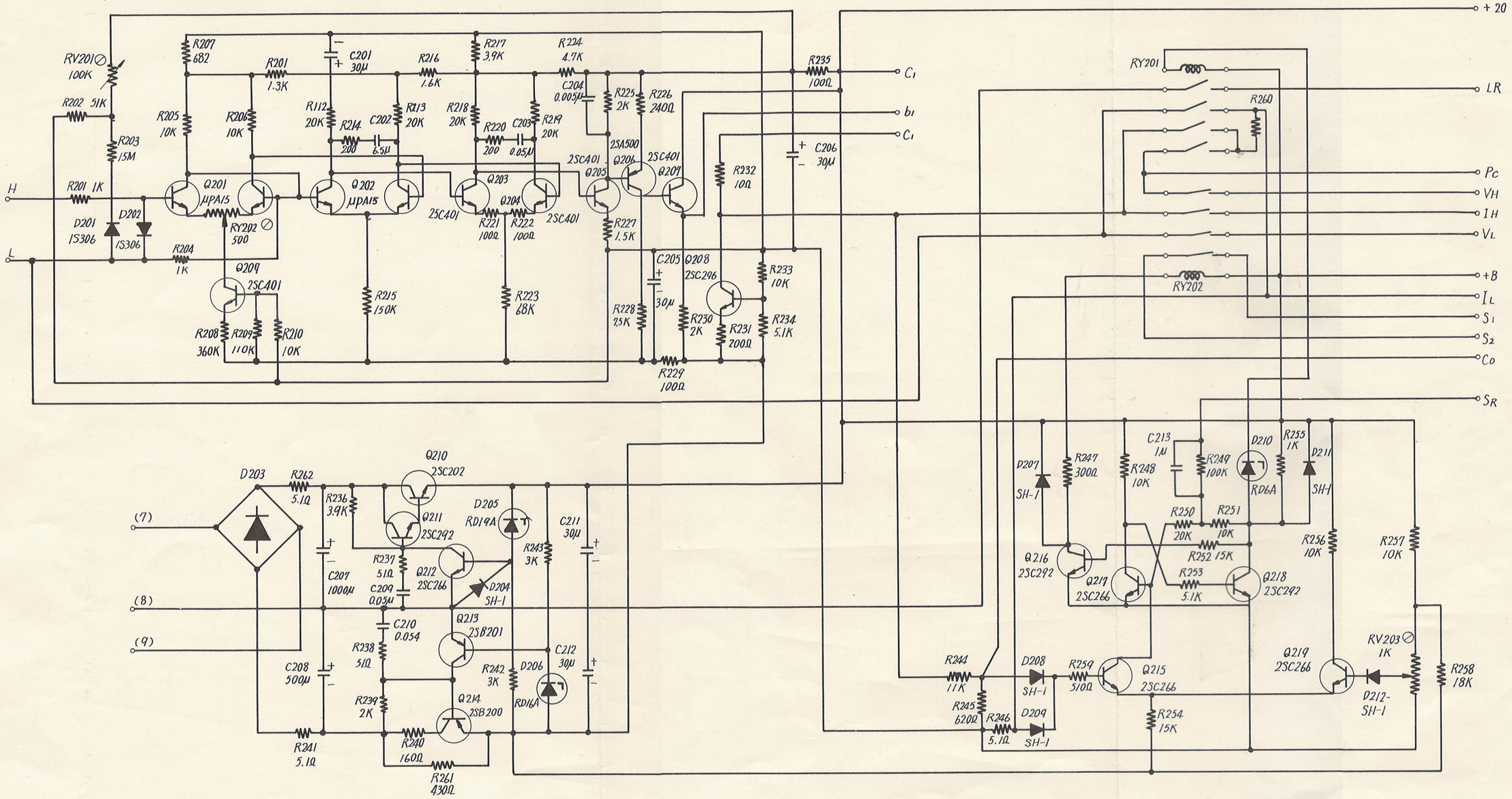
Consolidated Circuit Diagram



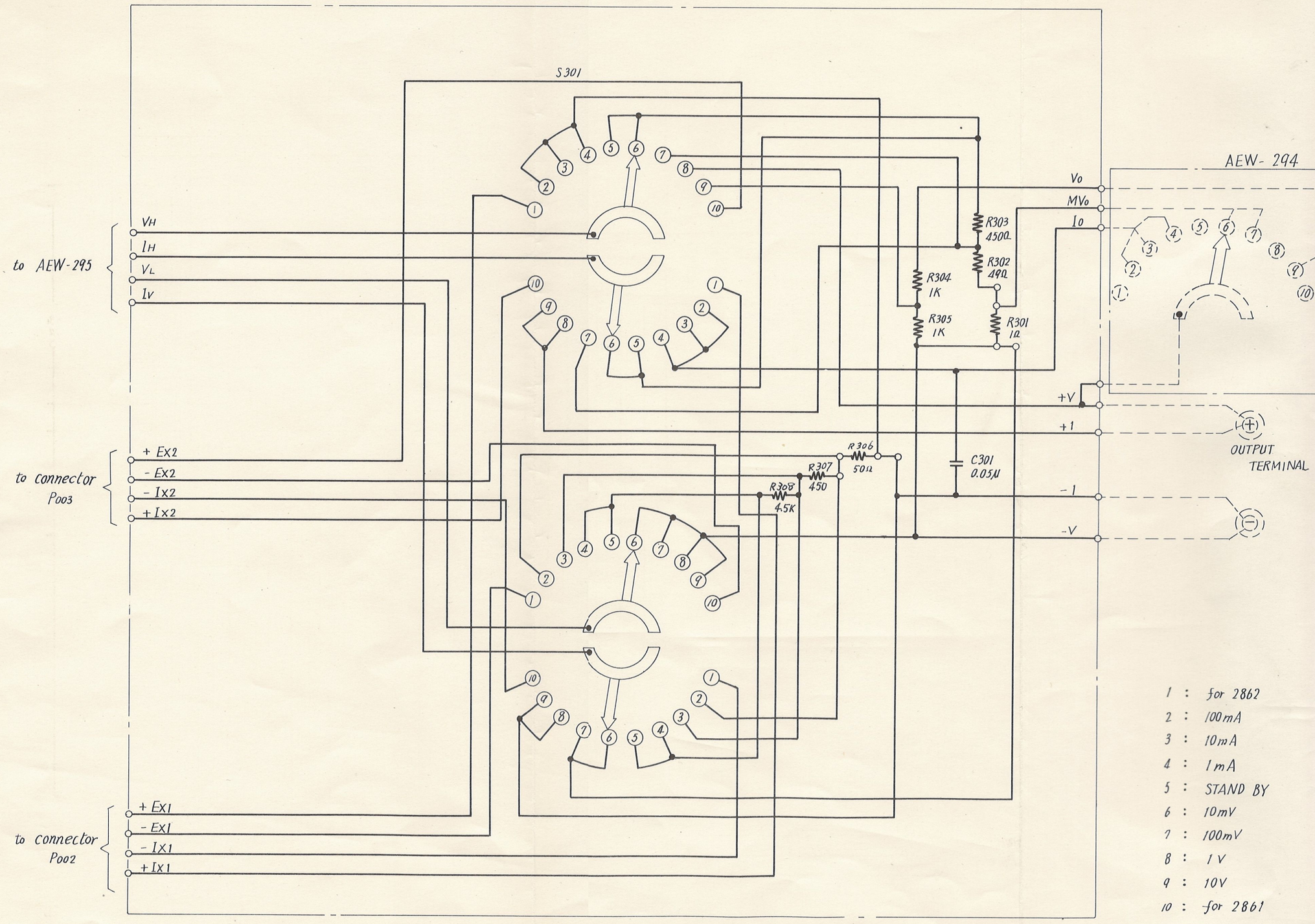


Reference Supply (AEW-294)

Power Unit, Amplifier, and Alarm (AEW-295)



Range Selector (ALW-296)



Main Products

Electrical Measuring and Recording Instruments:

Electrical Indicating Instruments; Laboratory Standard, Portable Instruments, Panel & Switchboard Instruments. Transducers; AC Voltage, AC Current, Watt, Reactive Power, Phase, and Frequency Transducers. Tachometers; Photo Tachometers, Panel & Switchboard Tachometers. Temperature Measuring Instruments; Thermocouple Thermometers, Thermistor Thermometers, Optical Pyrometers, Surface Temperature Indicators. Precision Measuring Instruments; DC Galvanometers, DC Potentiometers, DC & AC Bridges. Resistors; Standard Resistors, Dial Resistors, Slide Resistors. Digital Measuring Instruments; Digital Voltmeter, Digital Ohmmeter, Digital Multimeter. Standard Instruments; DC & AC Voltage & Current Standards, Standard Watt Converter. Oscillographs; Photocorders (Electromagnetic Oscillographs), Micro Pen-Oscillograph. Recorders; Direct-Acting Electrical Recorders, Laboratory Recorders, X-Y Recorders. Peripheral Equipment for Oscillographs and Recorders; Series Resistor, Shunt Resistor, DC Amplifiers, Strain Amplifiers, Logarithmic Converter, F-V Converter. Field Testers; Circuit Testers, Insulation Testers, Earth Resistance Testers, Portable Luxmeter, Sound Level Meter, Cycle Counter. Magnetic Material Testing Equipment; Gauss Meter, Electronic Fluxmeter, Epstein Iron Loss Test Sets, AC & DC Hysteresis Loop Tracers. Analog Computers; Analog Computer, Logic Assembly.

Industrial Process Instruments:

EBS Series Electronic Instruments, ERB Series Electronic Instruments, PCI Series Pneumatic Instruments, for measurement and control of Temperature, Pressure, Flow, Liquid Level, Density, Humidity, Dewpoint, Displacement, Velocity, Electrical Quantity, etc.

Analytical Instruments:

Instruments for Liquid Analysis; pH Meters, Turbidity Measuring Instruments, Liquid Density Measuring Instruments, Solution Conductivity Measuring Instruments, Viscosity Measuring Instruments, Process Titrator, Residual Chlorin Analyzer. Instruments for Gas Analysis; Chromatographs, Petroleum Sulfur Analyzer. Radiation Instruments; β Ray Thickness Gauge, γ Ray Density Meter.

Digital Control Systems:

Direct Digital Control Systems, Computer Control Systems, Digital Blending Control Systems.

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