BENCH MODEL DC POWER SUPPLY

PE 1535/00

SERVICE MANUAL

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S&i

Scientific & Industrial equipment division

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1. Principles of operation

In this section, the operating principles of series-regulation power supplies are briefly considered for constant voltage and constant current stabilised power supplies.

1.1 Series-regulation voltage stabiliser

The operation of the series-regulation voltage stabilised power supply is best understood by analysing the voltages in a simplified diagram (Fig. 400) with a d.c. input source. The unregulated voltage, referred to as U_1, is generally only within ±10%, not including the effect of its internal resistance R_i. The stabilised voltage is U_3, with a deviation for various changing parameters (e.g. load current, input voltage, ambient temperature) in the order of millivolts or hundredths of a percent. This degree of stability is due to the effect of the closed-loop control of the stabiliser. This control circuit compares a part of the output voltage with a reference source (normally a zener voltage). The resulting control feeds a base current to the series transistor in order to eliminate the difference between the reference and the proportional part of the output voltage.
In this way, the transistor dissipates the difference power between input and output.
The output current is almost equal to the input current and $U_1 = U_{Ri} + U_2 + U_3$. The voltage U_2 must be higher than 3 V approximately to avoid saturation of the transistor, and is limited by the maximum power in the junction. In turn, this depends on the efficiency of the heatsinking of the transistor. The maximum dissipation of the series stage for an adjustable power supply occurs for maximum output current and minimum output voltage. It is therefore most important when servicing the power transistors to ensure good thermal contact between them and the heatsinks.

1.2 Constant voltage, constant current stabiliser (Fig. 40, 401)

The principle of operation for the constant voltage, constant current stabiliser is the same as described in the previous section, except that there are now two closed loops, one created by the operational amplifier A_U and one by A_I. The operational amplifiers tend to reduce their respective input voltages to zero.
In the voltage regulation mode, the diode V2 is blocked as the output of A_I is high (the shunt voltage is then lower than the reference voltage and the input of A_I is positive). When the shunt voltage is equal to the current reference, A_I takes over the base current for V_1 coming from A_U. In this way, by increasing the load, the output voltage will decrease and the current will be held constant. This facility also permits the power supply to be short-circuited without any adverse effect. The constant current regulation acts, in this sense, also as a current limit protection device. The output characteristic of this power supply is shown in Fig. 40.

1.3 Mains-operated stabiliser

The regulation circuits for voltage and current already described for a d.c. source are the same for a mains-operated power supply. In this event, the input d.c. voltage of the regulator is derived from a 50 Hz mains transformer, a rectifier circuit and a smoothing capacitor.

2. Block diagram description (Fig. 402, Fig. 500)

The PE 1542 is a stabilised d.c. power supply for bench use. It produces precise output voltage (0-40 V, 0-0,5 A) protected against short-circuit.

2.1 The main circuit

The mains voltage is transformed by T26 to give lower secondary voltages which are rectified and smoothed by V26, C26 and C27. The series-pass element is formed by transistors V26-V109, in Darlington pair configuration. Shunt resistors (R136-R137) provide current-detecting devices. Voltage detection is derived from the resistors R127-R128. The output capacitor C104 ensure frequency stability and noise reduction.

2.2 The auxiliary circuits

A negative supply voltage eliminates the leakage current from the main transistors. (Fig. 413).
The auxiliary circuits are supplied by the input voltage through resistors (R114,R118) and zener diodes (V104, V106-V107).
The voltage control is achieved by the integrated circuit voltage regulator D101 and the current control is achieved by the differential amplifier V102, V103.

3. Circuit description

3.1 The main circuit (Fig. 403, 410, 411, 500)

The power supply is connected to mains via the front-panel double-pole switch S2. The mains input circuit is protected by the thermal fuse located on the transformer. The mains transformer T26, adapted to the mains voltage (see Fig. 460), provides the required secondary voltage . Capacitor C28 on the secondary filter any radio-frequency interference to the mains.
The secondary voltage is rectified by V101, smoothed by C26-C27. The power stage (series-pass elements) comprises transistors V26-V109 (connected in Darlington configuration). The power transistors network is protected against reverse voltage by diodes V111. Capacitor C104 provides output smoothing and in protected against reverse voltage by diodes V112.

3.2 The auxiliary supplies (Fig. 413)

* The positive auxiliary supply : the input d.c. voltage provides the positive auxiliary voltage through the resistors R114, R116 and the zener diodes V104, V106-V107.

* The negative auxiliary voltage : in order to obtain a zero voltage and a zero current, a negative supply voltage is supplied by the circuit composed by : V113, V114, V116, C106, C107.
  This negative voltage compensates for the I_{CBO} (or leakage current) from the main transistor(s) and is connected to the output by means of R134.

3.3 Voltage regulation loop (Fig. 403, 410, 500)

The voltage regulator (Fig. 403, operational amplifier type µA723CL) tends to reduce the input voltage difference (pin 2 and 3) to zero.
The supply of the regulator (pin 8 + pin 5 -) is obtained by the resistor R116 and the zener diodes V106, V107.
The output (pin 6 and 1) is polarised by the zener diode V107.
The internal reference of D101 is used :
- as reference for the voltage and current regulation amplifier D101
- as reference for the current amplifier (see Section 3.4).

D101		V102 -	V103
pin 3	pin 2	reference	input
R117	R1	R111	R2
R118	R123	R108	R101
	R126	R109	R102
		R107	R103
			R104
			R110

The reference value given by R1 and the output value are introduced at pin 2 by the divider R128, R127, R121. See Fig. 410.
At equilibrium, the terminals 2 and 3 are at equal voltage : the sum of the input 2 is a constant value. This input analyses continuously the voltage from the power supply and on the slider of R1. A difference between terminals 3 and 2 will be amplified by D101 and this signal controls the output of D101 and the base current of V109. This latter transistor determines the base current of the output series stage, adapting the output voltage to correct the difference. Capacitors C105 change the value for a.c. signals. Terminal 2 (D101) is protected against sudden negative input voltage by the circuit V105-R120. The filter C102-R119 limits the bandwidth of the operational amplifier D101.

3.4 Current regulation loop (Fig. 411, 500)

The current regulation circuit reacts on the amplifier (D101) via a long-tailed pair stage : V102, V103, R112, R113, R106.
The supply voltage is obtained by R114-V104.
The voltage drop across the shunt resistor (R137) is applied to one input of the long-tailed pair. This input is adjusted by :
- R108 for the zero current
- R104 for the maximum output current.

The resistor R2 determines the cross-over point (see Fig. 40). The voltage generated by the long-tailed pair is connected through R112 to terminal 10 of D101. The current decreases at the output of D101 : the value of output current is stable and the value of voltage is reduced. The filter C109-R110 ensures frequency stability in the current mode. The resistor R110 compensate for the 100 Hz ripple at the output of the power supply in the constant current mode. This technique is also referred to as feed-forward.

3.5 Volt-Amp Meter

By means of a switch and a dual scale, the measurement of volts or amperes are possible using the same instrument.
- Volts : R139
- Amps : R138

4. Fault-finding procedure

4.1 Introduction

This part of the Service Manual is intended for use by skilled maintenance personnel in order to maintain the stabilisers in good condition. It describes the fault-finding procedure, routine maintenance and lists the test equipment and tools that are required.
As the stabilisers are normally protected against most external faults, a blown fuse generally indicates a major defect. Before replacing a fuse, the electronic circuit should always be completely checked. In the event of unsatisfactory operation of a stabiliser, first check the following points :
- mains supply : check voltage, frequency, external fuses, mains leads and connections
- application : verify that the stabiliser is being used correctly by reference to the Operating Manual
- ambient conditions : check ambient temperature, cooling, etc.

Note : Before carrying out any repair or adjustment, all warnings given in the Operating Manual must be strictly observed.

4.2 Test equipment

For normal repairs :

- Multimeter PM 2503 (or PM 2412 A).
- Isolating transformer (test voltage 1,5 kV a.c.) and variable transformer 8 A (2422 530 05404).
- Adjustable high voltage d.c. supply 2000 V - 1 mA (2 x).

For performance tests :

- Item for normal repairs
- Oscilloscope PM 3240
- Moving-iron Voltmeter 260 V, class 1,5
- Moving-iron Ammeter 0,5 A, class 1,5
- Moving-coil ammeter (class 1) : 0,6 A (or shunt)
- Load resistor (adjustable) : 0 - 1 kΩ (0,5 A)
- Digital Multimeter PM 2526 or PM 2527

4.3 Dismantling and Assembly

WARNING : Before opening the instrument, ensure that the mains supply is disconnected (see also Operating Manual).

For servicing on print-unit A1, open the instrument as follow :

- Unscrew the nuts securing the cover panel
- Remove the cover panel
- Pull off the two potentiometer control knobs
- Remove . the screws on the print-unit from the terminals
  . the nuts ensuring the Volt-Amp Meter
- It is now possible to provide access on the print-unit.

For correct maintenance, it is important that the following checks are carried out systematically in the order given.
Except during measurements, the mains supply must be completely disconnected during these maintenance checks.

4.4 Component locations (see Fig. 200)

- On the front panel : . left : mains switch S2
  voltage control R1 (40 V)
  . middle : V.A. meter P1
  switch S1 (U-I)
  terminals X1(-) X2(+)
  . right : current control R2 (0,5 A)
  terminal X3 (earth)
- On the rear panel : mains cable
- Fig. 220, 230, 310, 320 give the locations for other items such as capacitors, resistors, etc.

4.5 Fault-finding

The faults that can occur are now dealt with according to their symptoms and are discussed in some detail.

4.5.1 Visual inspection (mains disconnected)

Dismantle the instrument as described in the previous section and carefully inspect the following points :

- wiring and printed-circuit tracks for damage (fractures, potential short-circuits, etc.)
- damage to components

4.5.2 Fuse blown

As the stabiliser is normally protected against most external faults, a blown fuse indicates generally a major defect.
In this event, proceed as follows :
- disconnect all connectors to or from the power supply
- thoroughly check the power supply for short-circuits
- replace the fuse (remove the cap of the fuse by pushing the clip)
- check the mains current consumption using a moving-iron ammeter while slowly increasing the input voltage with the variable transformer (Fig. 450).

Under no-load conditions, the current consumption should be approximately 40 mA a.c.

- If the input current increases rapidly with the input voltage, check the following components for short-circuits in the following order : C26, C27, C106, C107
  V101, V114, V116, V26, V109
  V112, V111
- If the current consumption is correct, check the input and auxiliary voltages (applying a mains voltage of 220 V and no load : across : C26, C27 : approximately 67 V
  across : C107 : approximately 48 V

Check the output voltage (adjustable by R1)
Check also the current limit function by gradually loading the output (adjustable by R2).

4.5.3 Output voltage is zero

In this case, check successively

- fuse (see Section 4.5.2)
- under no-load conditions
  . the series transistors : V109, V26
  . the shunt resistors : R137
  . the zener diodes : V104, V106, V107
  . the internal reference of the integrated regulator D101 on pin 4 : between 6,8 V and 7,5 V
  . the voltages available on pin 2 and pin 3 of the voltage regulator are equal
  . the long-tailed pair stage V102-V103 (when V102 is open or V103 in short-circuit, the current limiting is complete and the output voltage is zero).

4.5.4 Output voltage equals unregulated input voltage

In this event, the most common fault is breakdown of the power transistors due to the following causes :

- inefficient heatsinking ; e.g. loose transistor fixing screws (0,4 Nm $<$ torque $<$ 0,6 Nm)
- operating at too high an ambient temperature and at low output voltage and maximum output current (see Operating Manual)
- defective current-limiting circuit and short-circuited output.
  Before replacing the power transistors, ensure that the cause of breakdown has been located and remedied.

Another cause of excessive voltage at the output of the stabiliser is a defect in the voltage regulating circuit D101. If due to fault condition, pin 6 of the voltage regulator will be at about 5,6 V ; the output transistor is fully conducting and power transistors will be saturated.

4.5.5 Output voltage drift

- Check the input voltages on pin 2 and 3 of D101 for drift.
- Check D101 for drift by subjecting it to a hot-air stream (soldering iron) or cooling it with an aerosol freezer can.

4.5.6 Output current drift

- Subject the different parts of the long-tailed pair circuit composed of V102-V103 to temperature variations as described in Section 4.5.5.

4.5.7 Excessive output ripple : (Measure with oscilloscope)

When excessive ripple occurs on the output (see Operating Manual) the open-loop amplification may be too low, due to deterioration of D101 and of the output transistors. Defects in capacitors C104 (output capacitor) elements could also cause excessive ripple.

5. Functional tests (Fig. 450)

5.1 Performance tests

The various tests outlined in this section provide a means of checking this range of power supplies to ensure that they meet the performance specifications laid down. See Fig. 310 to locate the adjustment resistors.

5.1.1 Voltage adjustments

- with no mains, check or adjust the mechanical zero of the voltmeter
- referring to Fig. 450, set the mains voltage at 220 V (±2%), no load condition and by means of the external voltmeter :
  . potentiometer R1 to maximum, check or adjust : 40,0 V +1% -10% by R127
  using R139 adjust the voltmeter P1 of the instrument.
  . potentiometer R1 to minimum, check or adjust : 0 V ±40 mV by R123.

5.1.2 Current adjustments

- Referring to Fig. 450, set the mains voltage at 220 V (±2%), short-circuit the output (with the measuring shunt and the ammeter).
  . potentiometer R2 to minimum : 0 A - 0 mA + 5 mA by R108
  . potentiometer R2 to maximum : 0,535 A - 0% + 1% by R104
- Repeat this procedure
- Set S1 on position I. By means of R2,adjust the current through the measuring shunt to 0,5 A.
  Adjust the correct deviation of the ammeter by means of R138.

5.1.3 Output stability and ripple

5.1.3.1 Constant voltage mode

- Set : . R1 to maximum
  . nominal load (0,45 ... 0,5 A)
  . main voltage to 198 V a.c.

Note the output voltage. Set mains voltage to 242 V. Check that the difference in output voltage does not exceed : $\Delta U_o \leqslant 4$ mV.

Set the "-" terminal to X1 (earth).
Check that the ripple is not greater than 1,5 $mV_{eff.}$

- Set : . R1 to maximum
  . nominal mains voltage (220 V ±2%)
  . no-load

Note the output voltage. Set nominal load (0,5 A). Check that the difference in output voltage does not exceed : $\Delta U_o \leqslant 4$ mV.

5.1.3.2 Constant current mode

- Set : . R1 to maximum
  . mains voltage to 242 V a.c.
  . S1 to U

  Adjust the potentiometer R2 and the load so that the output is : U_o = 36 V ±1 V, I_o = 0,5 ... 0,55 A.

  Note the output current.
  Set mains voltage to 198 V a.c. Check that the difference in output current does not exceed $\Delta I_o \leqslant$ 2,5 mA.

- Set : . R1 to maximum
  . nominal mains voltage (220 V a.c.)

  Adjust the potentiometer R2 and the load so that the output is : U_o = 36 V ±1 V, I_o = 0,5 ... 0,55 A.

  Short-circuit the output through the shunt and check that the current variation compared with the above value does not exceed 4 mA.

- Set : . R1 to maximum
  . mains voltage to 242 V a.c.
  . short-circuit the output through a load 1 Ω
  . R2 to maximum

  Check that the ripple current is not greater than : 1 mA r.m.s.

5.2 Safety tests

After each repair, it is strongly recommended that the safety tests outlined in IEC 348 as routine tests are repeated. These are given in the following sections.

5.2.1 Dielectric strength test (Fig. 451)

As this is a repeated test, it must be performed at 80% of its nominal value (see Operating Manual). The primary voltage between the short-circuited input and chassis must be 1700 V d.c.
The secondary voltage between the short-circuited outputs and chassis must be 1700 V d.c. but in opposition with the primary voltage in order to obtain 3400 V between primary and secondary.
These voltages have to be increased from zero to maximum in two seconds and maintained for a further two seconds.
Check that no flash-over and breakdown occurs.

5.2.2 Protective earth terminal test

The resistance between the earth connector device on the socket inlet of the flexible mains lead and any point on the metal enclosure of the instrument must be less than 1 ohm.

5.3 Running test

Set the instrument to a mains voltage of 220 V a.c. and short-circuit the output terminals to give maximum output current for one hour.
Ensure that the natural air circulation is not impeded and that the ambient temperature does not exceed 40°C.
After this test, the instrument should be checked for stability and ripple performance.

REFERENCE	FIG.	ORDERING NUMBER	VALUE	TYPE
C26	230	4822 124 20184	680 µF	ELCO 100 V
C27	220, 230	4822 124 20184	680 µF	ELCO 100 V
C28	220	4822 121 40427	220 nF	10% 100 V
C101	310	4822 122 31173	220 pF	10% 100 V
C102	310	4822 122 30103	22 nF	CER 40 V
C103	310	4822 122 30128	4,7 nF	CER 100 V
C104	310	4822 124 20799	150 µF	ELCO 63 V
C105	310	4822 121 40522	100 nF	10% 100 V
C106	310	4822 124 20729	15 µF	ELCO 63 V
C107	310	4822 124 20729	15 µF	ELCO 63 V
C109	310	4822 122 30114	2,2 nF	10% 100 V
D101	310	5322 209 84655		µA 723 CL
P1	200,220,230	5322 344 64123		VOLT-AMMETER
R1	200, 230	4822 101 20298	4,7 kΩ	POT 0,25 W 20%
R2	200,220,230	4822 101 20298	4,7 kΩ	POT 0,25 W 20%
R101	310	4822 116 51235	1 kΩ	MR 25 1%
R102	310	4822 116 51252	6,81 kΩ	MR 25 1%
R103	310	5322 116 54608	7,5 kΩ	MR 25 1%
R104	310	5322 101 14072	100 Ω	POT 0,5 W 20%
R105	310	5322 116 54716	162 kΩ	MR 25 1%
R106	310	5322 116 54651	26,1 kΩ	MR 25 1%
R107	310	4822 116 51252	6,81 kΩ	MR 25 1%
R108	310	5322 101 14067	4,7 kΩ	POT 0,5 W 20%
R109	310	5322 116 55318	511 Ω	MR 25 1%
R110	310	4822 110 63214	10 M Ω	CR 25 10%
R111	310	4822 116 51252	6,81 kΩ	MR 25 1%
R112	310	4822 116 51268	100 kΩ	MR 25 1%
R113	310	4822 116 51268	100 kΩ	MR 25 1%
R114	310	5322 116 54648	24,9 kΩ	MR 25 1%
R116	310	5322 116 55226	2,2 kΩ	PR 52 5%
R117	310	5322 116 54637	17,8 kΩ	MR 25 1%
R118	310	5322 116 50567	95,3 kΩ	MR 25 1%
R119	310	5322 116 54519	402 Ω	MR 25 1%
R120	310	5322 116 54469	100 Ω	MR 25 1%
R121	310	5322 116 54637	17,8 kΩ	MR 25 1%
R122	310	5322 116 54651	26,1 kΩ	MR 25 1%
R123	310	5322 101 14072	100 Ω	POT 0,5 W 20%
R124	310	5322 116 54469	100 Ω	MR 25 1%
R125	310	5322 116 54567	1,69 kΩ	MR 25 1%
R126	310	5322 116 50555	1,27 kΩ	MR 25 1%
R127	310	5322 100 10118	22 kΩ	POT 0,5 W 20%
R128	310	5322 116 54694	90,9 kΩ	MR 25 1%
R129	310	5322 116 50557	46,4 kΩ	MR 25 1%
R131	310	4822 116 51235	1 kΩ	MR 25 1%
R132	310	5322 116 54511	316 Ω	MR 25 1%
R133	310	5322 116 50492	46,4 Ω	MR 25 1%
R134	310	5322 116 50572	12,1 kΩ	MR 25 1%
R135	310	4822 116 51253	10 kΩ	MR 25 1%
R136	310	5322 116 50635	1,47 kΩ	MR 25 1%

REFERENCE	FIG.	ORDERING NUMBER	VALUE	TYPE
R137	310	4822 113 60028	2,2 Ω	WW 2 W 10%
R138	310	4822 100 10255	1 kΩ	POT 0,5 W 20%
R139	310	5322 100 10118	22 kΩ	POT 0,5 W 20%
R141	310	4822 116 51266	68,1 kΩ	MR 25 1%
S1	200	5322 277 24062		SLIDE SWITCH
S2	200	4822 277 10021		TUMBLER SWITCH
T26	220	5322 146 14143		TRANSFORMER
V26	230	4822 130 40449		BDY 20
V101	310	4822 130 30414		BY 164
V102	310	4822 130 44196		BC 548 C
V103	310	4822 130 44196		BC 548 C
V104	310	4822 130 34268		BZX 79 - C16
V105	310	4822 130 30613		BAW 62
V106	310	4822 130 34382		BZX 79 - C8 V2
V107	310	4822 130 34382		BZX 79 - C8 V2
V108	310	4822 130 34398		BZX 79 - C24
V109	310	4822 130 40665		BD 138
V111	310	4822 130 30659		BYX 36 - 300
V112	310	4822 130 30659		BYX 36 - 300
V113	310	4822 130 34297		BZX 79 - C10
V114	310	4822 130 30659		BYX 36 - 300
V116	310	4822 130 30659		BYX 36 - 300

MECHANICAL PARTS

QUANTITIES	FIG.	ORDERING NUMBER	DESCRIPTION
2	220	5322 325 24007	INSULATOR
2	200	5322 414 34108	CONTROL KNOB
2	200	4822 492 61974	CLAMPING SPRING
2	200	5322 414 74014	COVER
4	220, 230	5322 255 44241	CLAMP FOR ELCO
4	200, 210	5322 462 44366	FOOT
4	200, 210	4822 462 70497	PLUG (FOR FOOT)
1	200	5322 267 34058	TERMINAL (BLUE)
1	200	5322 267 34057	TERMINAL (RED)
1	200	5322 267 34059	TERMINAL (GREY)

FRONT VIEW.

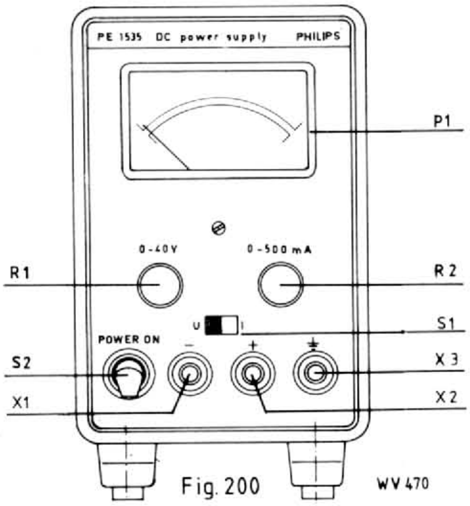


Fig. 200

WV 470

REAR VIEW.

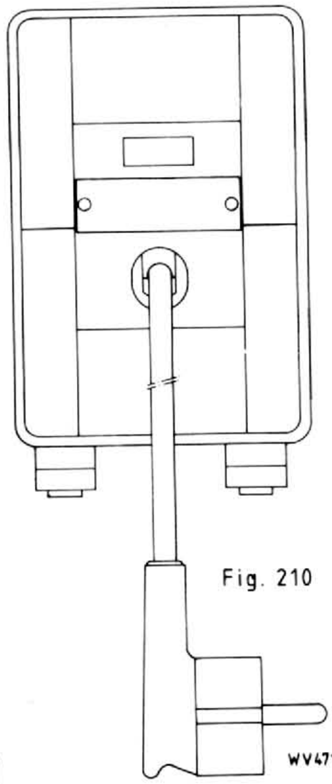


Fig. 210

WV471

SIDE VIEW (OPEN).

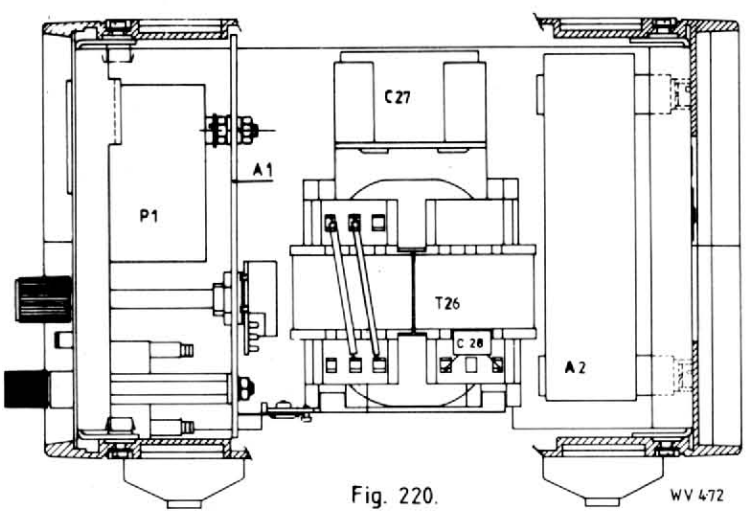


Fig. 220.

WV 472

UNIT A2

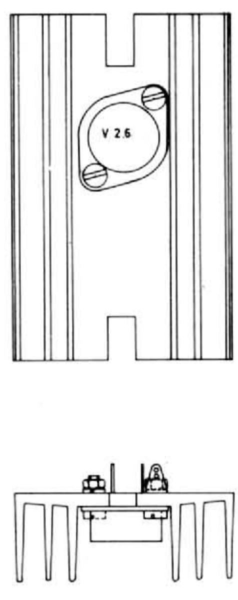


Fig. 320

WV474

TOP VIEW (OPEN)

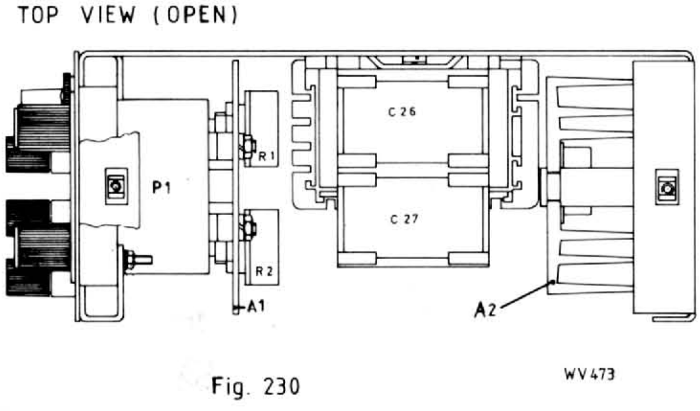


Fig. 230

WV473

SERIES REGULATOR

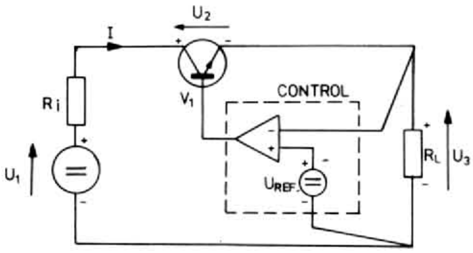


Fig. 400 WV 448

CONSTANT VOLTAGE, CONSTANT CURRENT POWER SUPPLY

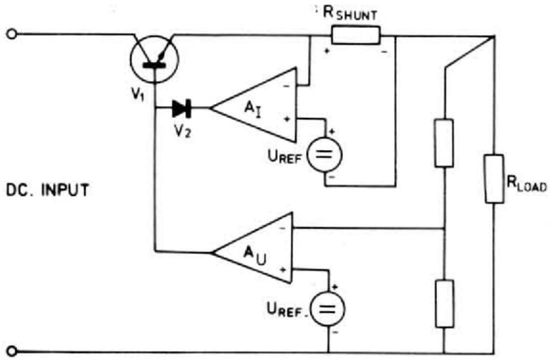


Fig. 401 WV 449

BLOCK DIAGRAM

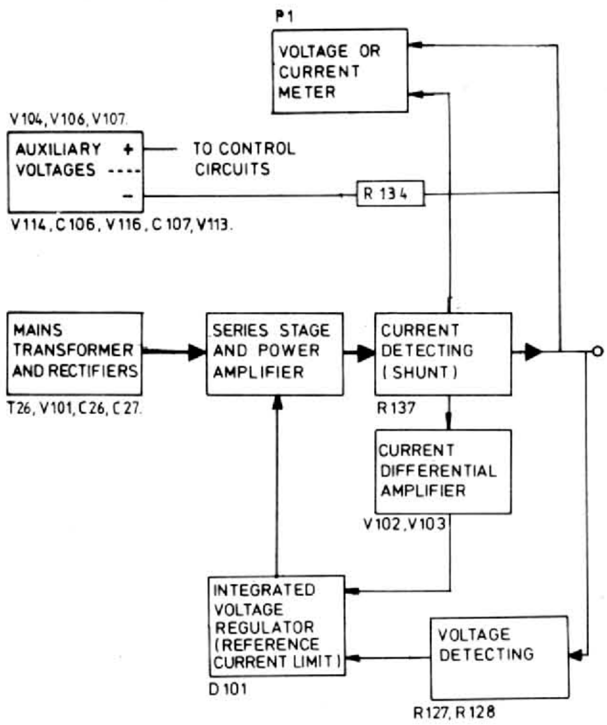


Fig. 402 WV 477

INTEGRATED VOLTAGE REGULATOR µA 723 CL

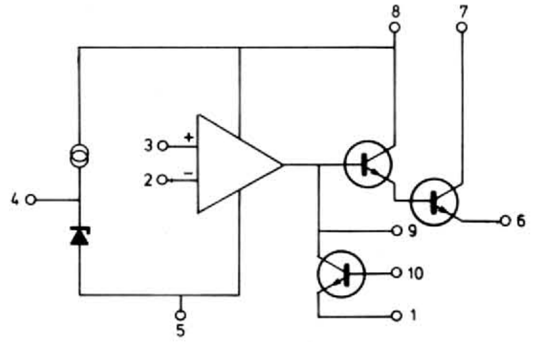


Fig. 403 WV 451

VOLTAGE REGULATION LOOP

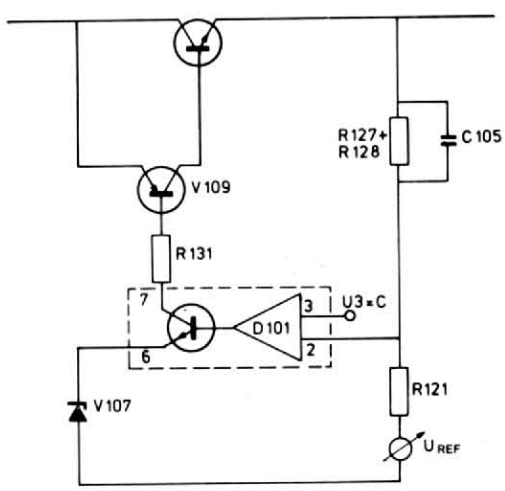


Fig. 410 WV 452

CURRENT REGULATION LOOP

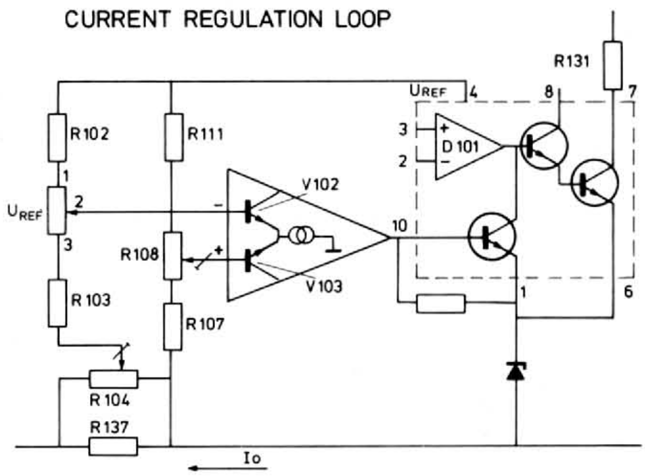


Fig. 411 WV 453

OUTPUT CHARACTERISTIC

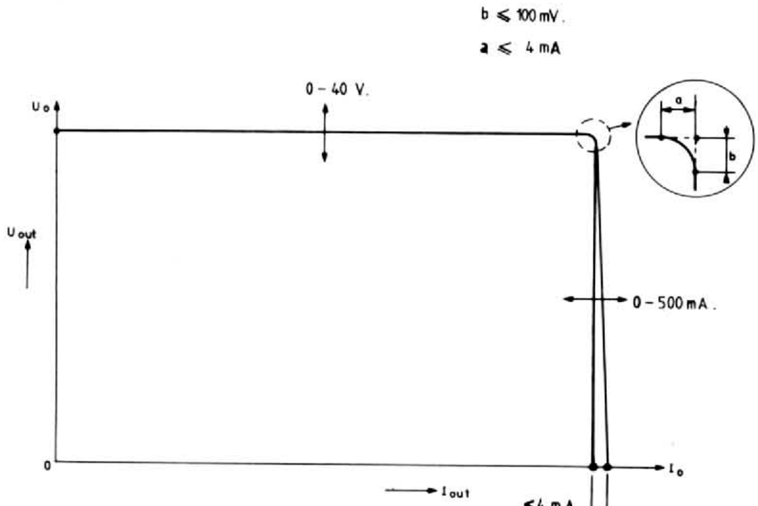


Fig. 40

WV 476

PRINT UNIT A1

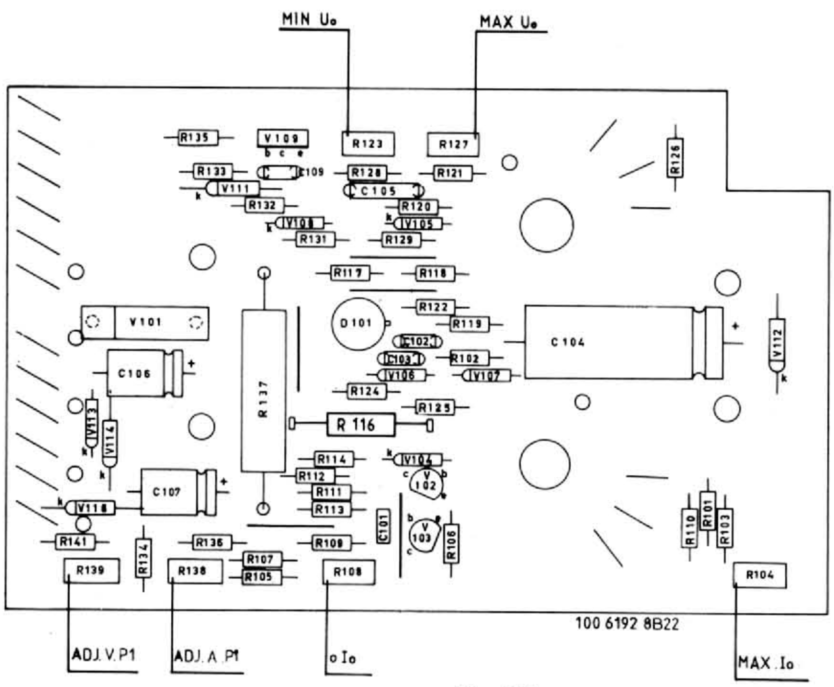


Fig. 310

WV475

NEGATIVE AUXILIARY VOLTAGE

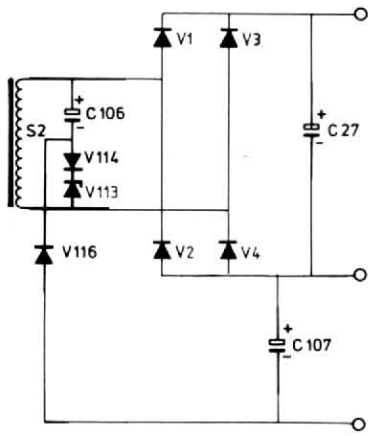


Fig. 413

WV 478

DIELECTRIC STRENGTH TEST SET-UP

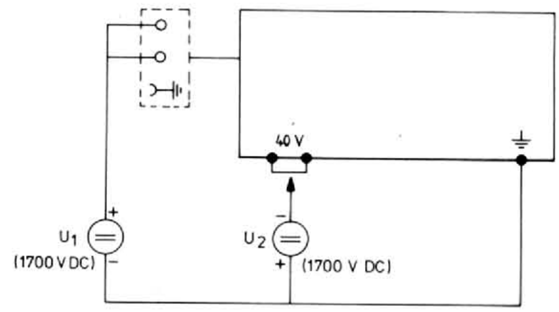


Fig. 451

WV 480

TEST SET-UP

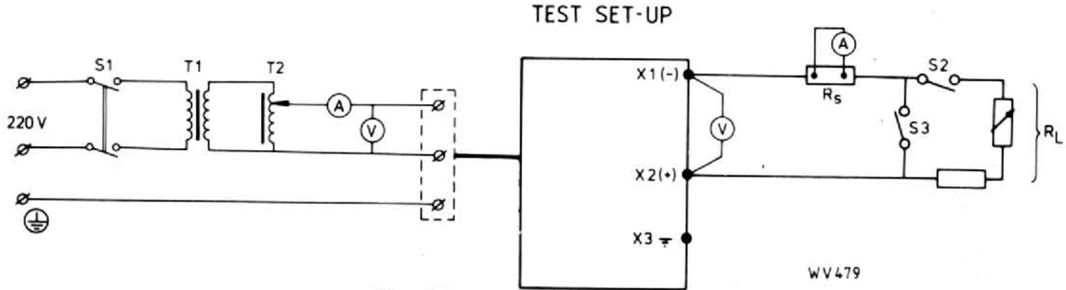
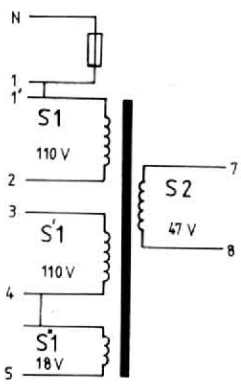
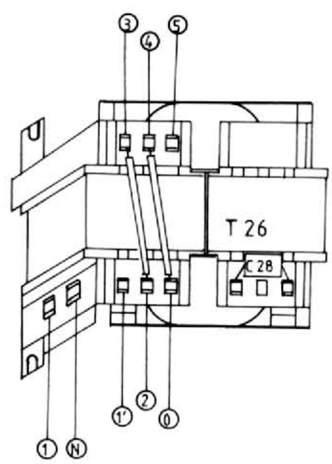


Fig. 450

MAINS CONNECTIONS





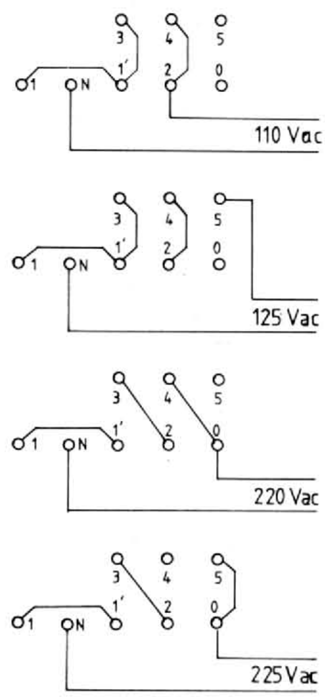


Fig. 460

WV 481

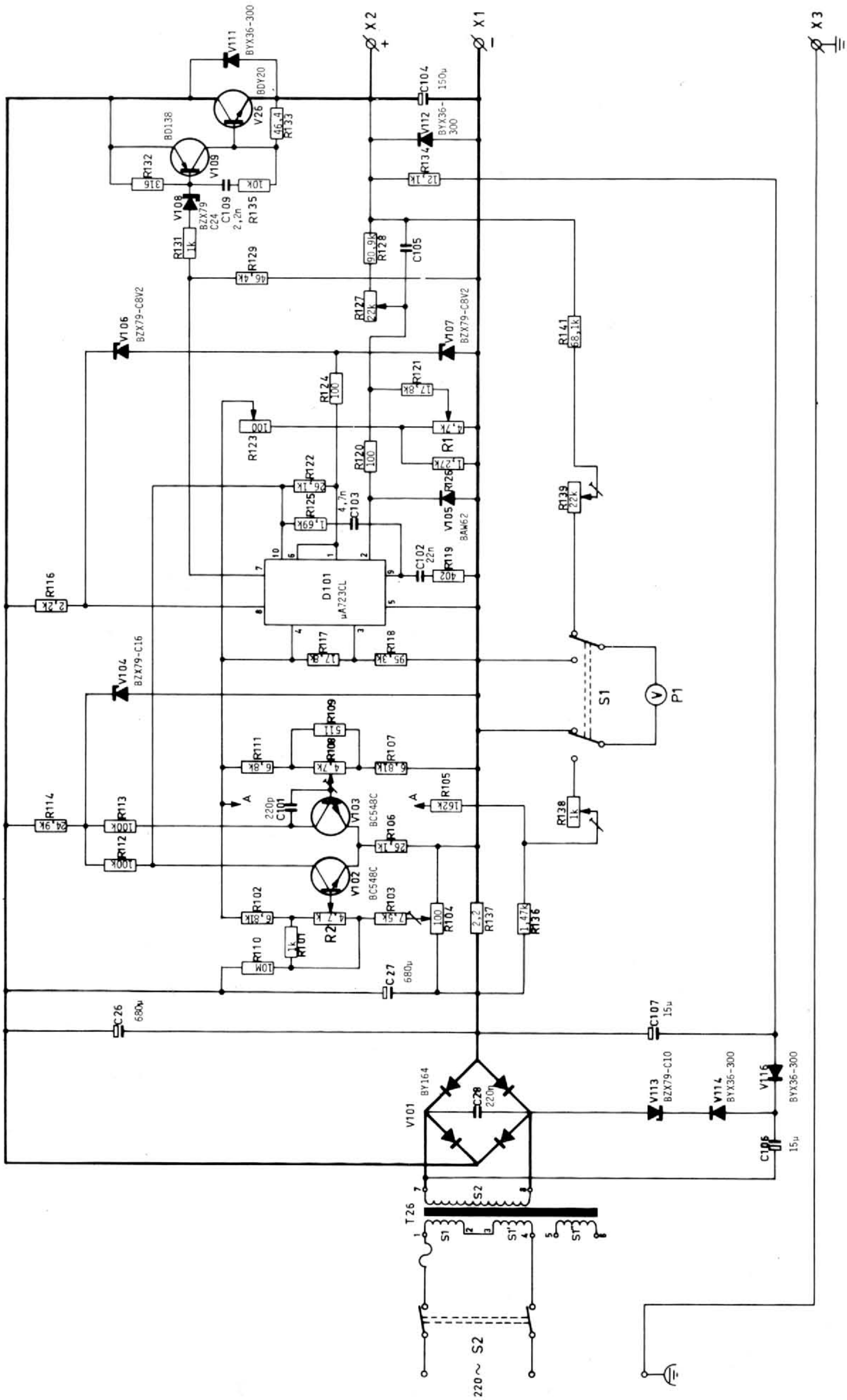


Fig. 500

WV 5067.

SERVICE
Scientific & Analytical Equipment
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Industrial Controls
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Industrial Data-processing Systems

Scientific & Industrial Equipment Division

BENCH MODEL DC POWER SUPPLY

PE 1535/00

SERVICE MANUAL 9499 165 01411 791125

Page 7. - 5.1.3.1 Constant voltage mode

- the difference in output voltage does not exceed

  $\Delta U_0 \leqslant$ 4 mV : READ $\Delta U_0 \leqslant$ 20 mV

  (lines regulation)

- the difference in output voltage does not exceed

  $\Delta U_0 \leqslant$ 4 mV : READ $\Delta U_0 \leqslant$ 40 mV

  (load regulation).

PHILIPS

OPERATING MANUAL

Provisional

Regulated D.C. power supply

PE 1535

9499 160 07811

780720

1. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class I instruments and has been supplied in a safe condition. The present Operating Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

1.1. Technical data

1.1.1. General

Safety	In accordance with IEC 348, Safety Class I.
D.C. test voltage	2100 V between primary and chassis 4200 V between primary and secondary 2100 V between secondary and chassis
Output terminals	Floating with respect to earth. The maximum permissible d.c. voltage between any one of the output terminals and earth is 250 V. The "+" or "–" terminal may be connected to the chassis, if desired.
Radio interference	According to VDE 0875 below the K curve.

1.1.2. Input

A.C. voltage	110-125-220-235 V (+ or – 10 %)
Frequency	50 - 60 Hz
Consumption	40 VA
Protection	Thermal fuse in transformer T26

1.1.3. Output

a. As d.c. voltage stabiliser

Range	0 ... 40 V continuously adjustable with R1.
Output effects (Stability related to static operation)	
1. Line regulation	For mains voltage variation of + or – 10 % Source effect + settling effect ≤ 0,05 % or 4 mV, whichever is greater applies.
2. Load regulation	For load variations from no-load to full-load and vice versa. Load effect + settling effect ≤ 40 mV.
3. Temperature effect	≤ 0,02 % per K from the adjusted output voltage or 2 mV per K, whichever is the greater.
4. Periodic and random deviation (PARD)	R.M.S. value. ≤ 1,5 mV Bandwidth 50 MHz.
Dynamic operation	
1. Transient recovery time	≤ 10 μs for a step change from 80 % full-load to full load and vice versa, and a $\frac{di}{dt} \leq 1$ A/μs.
2. Dynamic internal impedance	For sinusoidal load variations from 80 % full-load to full-load and a frequency of: 1 kHz ≤ 0,02 Ω 10 kHz ≤ 0,03 Ω 100 kHz ≤ 0,2 Ω 250 kHz ≤ 0,2 Ω

b. As a current stabiliser

Range	0 to 500 mA, continuously adjustable with R2.
Output effects (stability related to static operation)	
1. Line regulation	For mains voltage variation of + or − 10 %. Source effect + settling effect ⩽ 2,5 mA.
2. Load regulation	For load variations from point D to E and vice versa (see Fig. 1.). Load effect + settling effect ⩽ 4 mA.
3. Temperature coefficient	⩽ 0,1 % per K from the adjusted output current or 0,5 mA/K, whichever is the greater.
4. Ripple current	R.M.S. value ⩽ 1 mA.
Cross-over point	See point B-C-D in Fig. 1. This value applies for any set output voltage between 0 and 40 V, and output current between 0 and 500 mA.

c. Series connection — Instruments may be series connected until the maximum permissible d.c. voltage of 250 V is reached between an output terminal and chassis.

d. Parallel connection — An arbitrary number of instruments may be connected in parallel for greater current outputs.

1.1.4. *Environmental data*

The environmental data are valid only if the instrument is checked in accordance with the official checking procedures. Details on these procedures and failure criteria are supplied on request by the PHILIPS Organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

Ambient temperature:	
– rated range of operation	0 to + 40 °C
– storage and transit	−40 °C to +70 °C.
Cooling	Convection cooled. The air convection may not be impeded.
Damp heat, cyclic tests (12 + 12 hour cycle)	21 days ambient temperature 25 °C to 40 °C at a humidity of 93 %.
Bump tests	1000 bumps at an acceleration of 100 m/s^2, ½ sine for 6 ms duration in each of three directions.
Vibration tests	30 min. in each of three directions 10 Hz to 150 Hz, 0.7 mm_{p-p} and 50 m/s^2 acceleration.

1.1.5. *Mechanical data*

Dimensions	Height 133 mm Width 88 mm Depth 210 mm
Mass	2 kg net 2,3 kg with packaging.

2. INSTALLATION

Before connecting the instrument to the mains, visually check the cabinet, controls and connectors etc., to ascertain whether any damage has occured in transit. If any defects are apparent, do not connect the power supply to the mains.

Before any other connections are made, the protective earth terminal shall be connected to a protective conductor (see section 2.2. Earthing).

Warning: This instrument generates high voltages and should not be operated with the cabinet plates removed. The mains plug must be removed before attempting any maintenance work, and any relevant high-voltage points must be discharged.

2.1. Adapting the power supply to the local mains voltage

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.
On delivery, the power supply is set to 220 V. If the power supply is to be used with 110, 125 or 235 V mains supply, the connections on the mains transformer must be changed in accordance with Fig. 2. The transformer is accessible after removing the bottom half of the cabinet. To this end, remove the two screws at the bottom.

Warning: The instrument shall be set to the local mains voltage only by a skilled person who is aware of the hazard involved. The power supply shall be disconnected from all voltage sources when it is to be adapted to a different mains voltage.

2.2. Earthing

Before switching on, the power supply shall be connected to a protective earth conductor in one of the following ways:

- via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.
- via the protective earth-terminal on the front panel.

The circuit to be supplied may be earthed via the earthing terminal on the front panel.

Warning: Any interruption of the protective conductor inside or outside the power supply, or disconnection of the protective earth terminal, is likely to make the power supply dangerous. Intentional interruption is prohibited.

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

2.3. Cooling

Make sure that the natural air-circulation via the air vents in the cabinet is not blocked.

2.4. Series or parallel connection

It is permissible to connect serveral power supplies in series or parallel. With parallel connection, the power supplies must be set to the same output voltages. With series connection, the voltage between the output terminals and earth must not exceed a d.c. voltage of 250 V.

3. OPERATING INSTRUCTIONS

Before switching on, ensure that the power supply has been correctly installed in accordance with section 2. INSTALLATION and that the precautions outlined have been observed.

The operation of the power supply appears from Fig. 3 with its appertaining text.

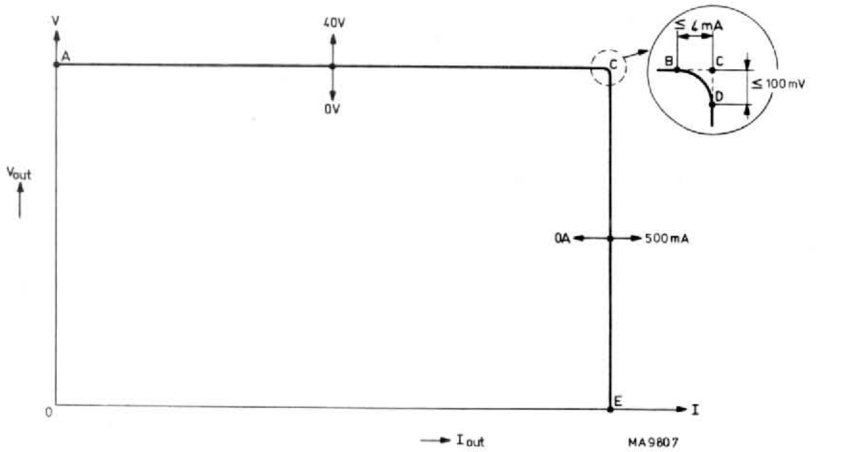

Fig. 1. Current voltage characteristic.

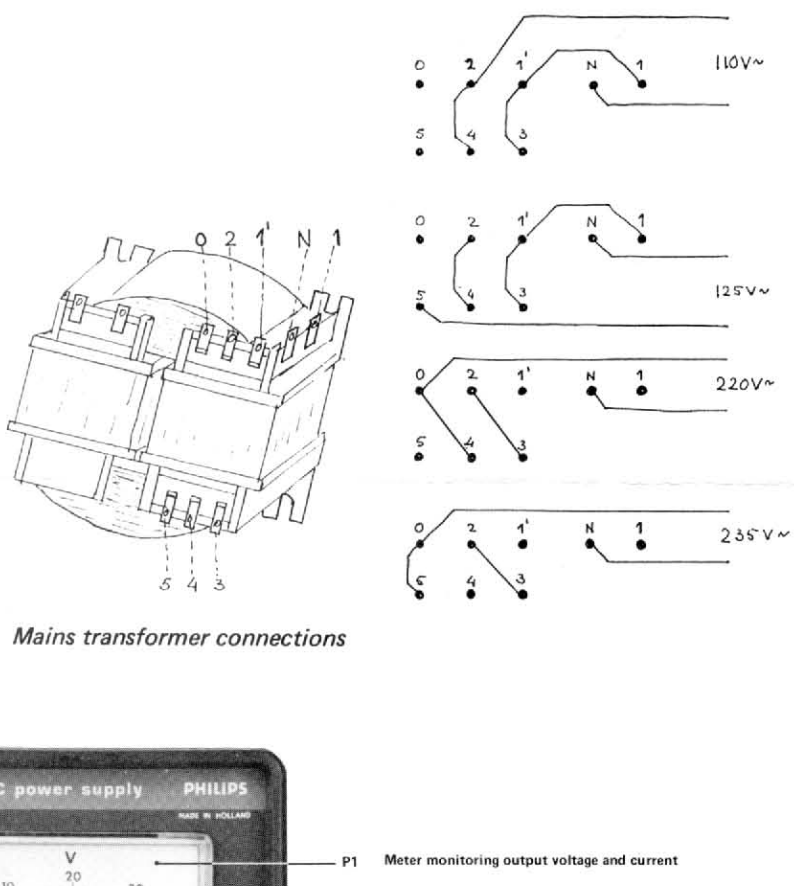

Fig. 2. Mains transformer connections

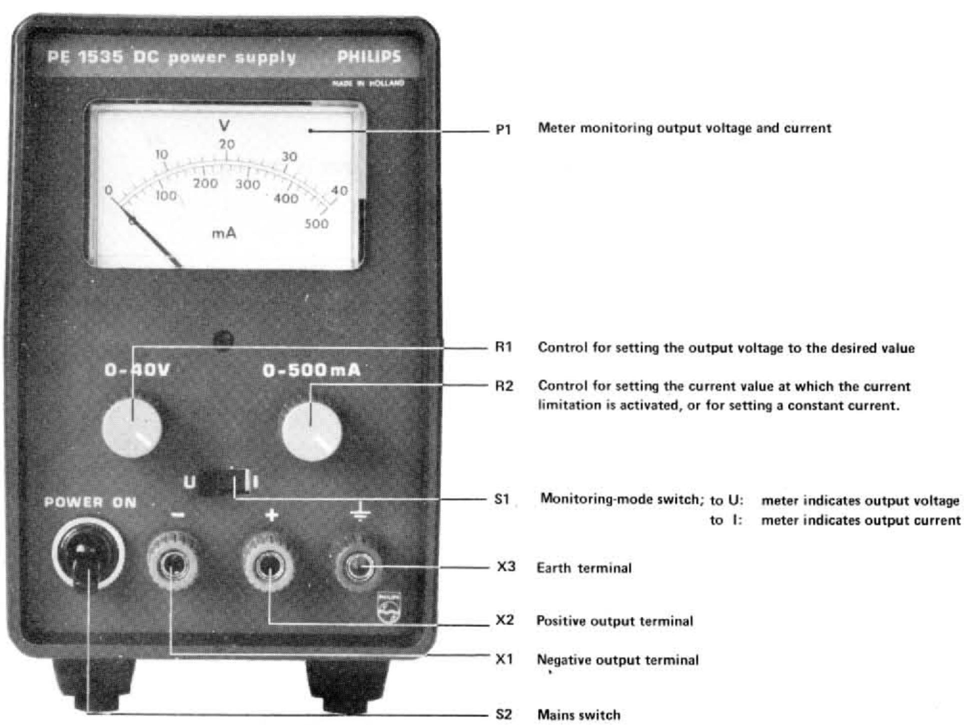

Fig. 3. Front view

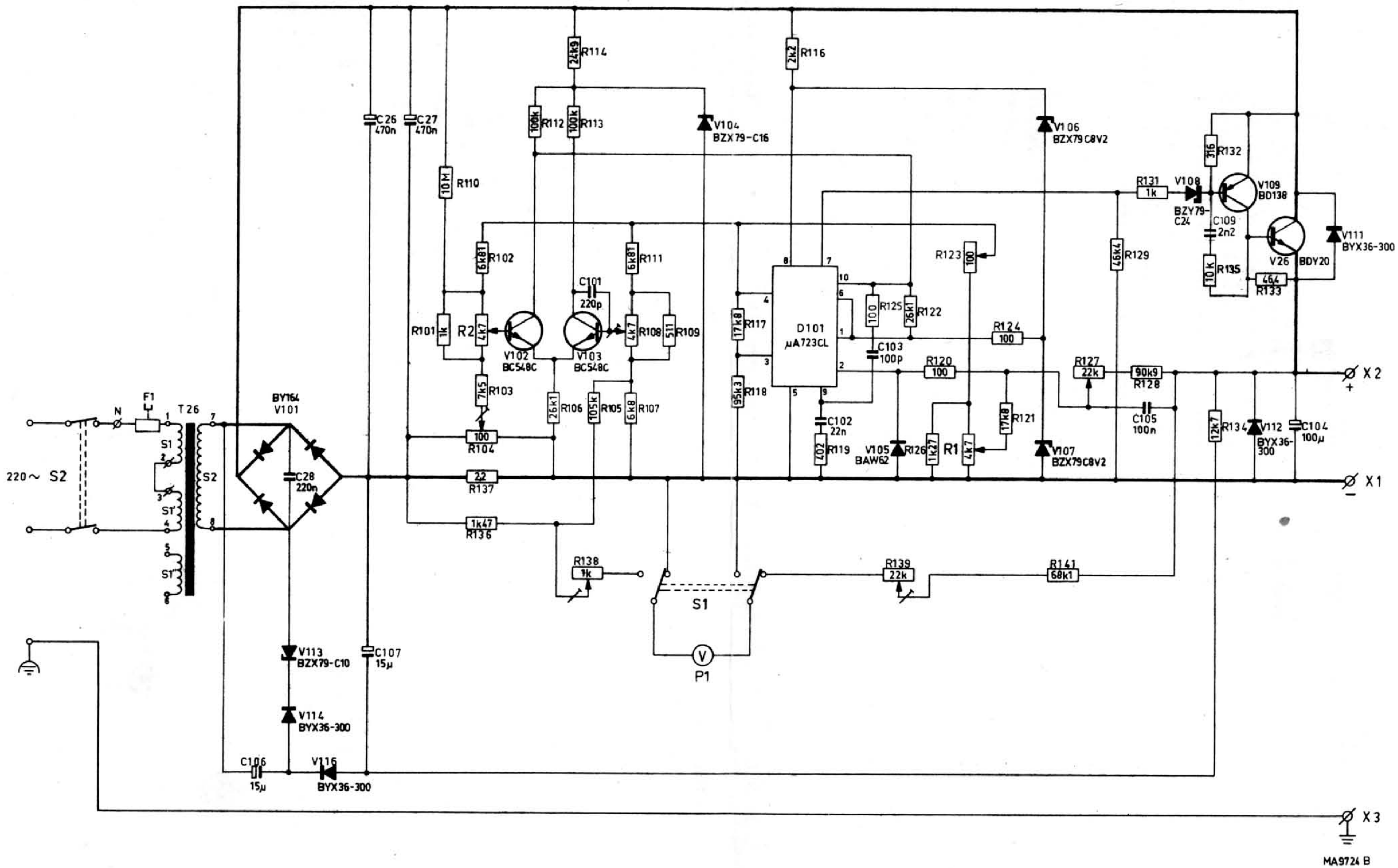

Fig. 4. Circuit diagram