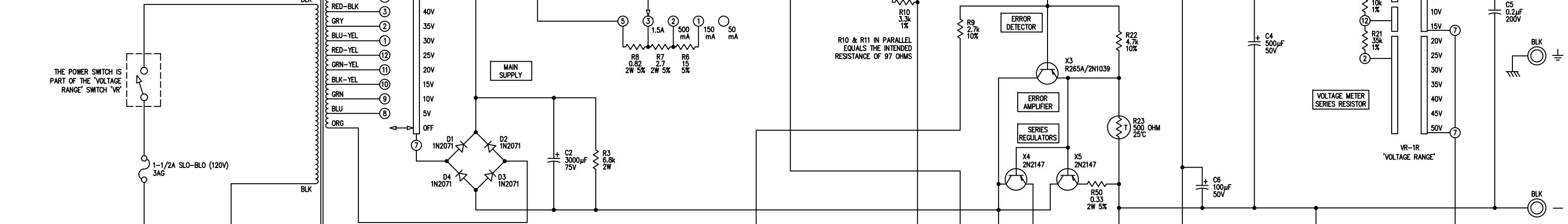


'D.C. REGULATION' CALIBRATION PROCEDURE (OPTIONAL)

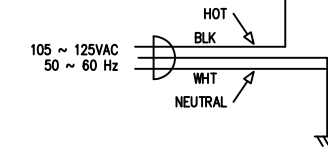
- USE A 10 OHM RESISTOR RATED FOR AT LEAST 22W, OR AN EQUIVALENT CONSTANT RESISTANCE ELECTRONIC LOAD
- 'VOLTAGE RANGE' SWITCH SET TO '15V'
- 'CURRENT RANGE' SWITCH SET TO '1.5A'
- METER 'CURRENT-VOLTAGE' SWITCH SET TO 'VOLTAGE'
- 'CURRENT LIMIT' R2 SET TO FULL CW
- ADJUST 'FINE VOLTAGE' R42 TO ACHIEVE A READING OF 15V ON METER (FULL SCALE READING)
- REMOVE GUARD NUT FROM 'D.C. REGULATION' (DCR) R16
- OBSERVE METER WHILE ALTERNATELY CONNECTING AND DISCONNECTING LOAD FROM SUPPLY OUTPUT TERMINALS; ADJUST DCR TO ACHIEVE NO VOLTAGE READING CHANGES ON METER
- REPLACE GUARD NUT ON DCR

METER VOLTAGE SCALES

- THE 5V RANGE USES THE METER AT FULL SCALE = 5V
- THE 10V & 15V RANGES USE THE METER AT FULL SCALE = 15V
- ALL OTHER RANGES USE THE METER AT FULL SCALE = 50V



THE POWER SWITCH IS PART OF THE 'VOLTAGE RANGE' SWITCH 'VR'

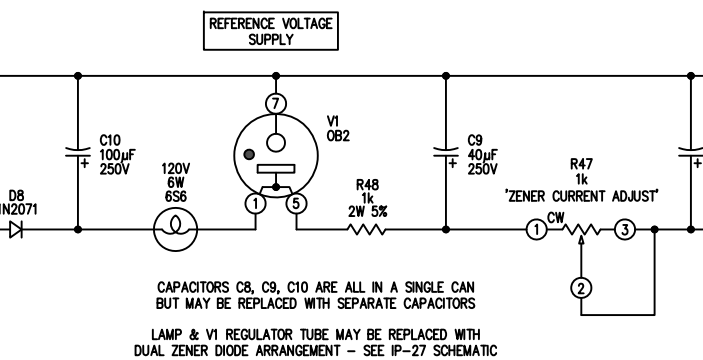


- NOTES:**
- 1) RESISTORS ARE 1/2W UNLESS MARKED DIFFERENTLY. % TOLERANCES ARE SHOWN FOR ALL.
 - 2) ALL POTENTIOMETERS ARE WIRE-WOUND TYPE.
 - 3) THE HEATHKIT MANUAL DOES NOT SPECIFY CAPACITOR VOLTAGES; VOLTAGES SHOWN HERE ARE EITHER AS MARKED ON THE ACTUAL PARTS, OR ARE REASONABLE GUESSES.
 - 4) HEATHKIT PRODUCED MULTIPLE VERSIONS OF THE SCHEMATIC DIAGRAM FOR THE IP-20. THERE ARE SOME SMALL DISCREPANCIES BETWEEN THEM, AND SOME COMPONENTS THAT APPEAR ON ONE VERSION BUT NOT ANOTHER, OR IN DIFFERENT PLACES IN THE CIRCUIT (SOME MAY BE PRODUCTION REVISIONS WHILE OTHERS MAY BE ERRORS). IN PARTICULAR, SOME VERSIONS SHOW EXTRA ELECTROLYTIC CAPACITORS AROUND TRANSISTOR X2, AND/OR AN EXTRA DIODE ACROSS THE BASE-EMITTER JUNCTION OF TRANSISTOR X3, AND/OR THE RELAY COIL BEING IN A DIFFERENT PART OF THE CIRCUIT, AN EFFORT HAS BEEN MADE TO HAVE THIS SCHEMATIC BE REPRESENTATIVE OF LATER REVISIONS OF THE PRODUCT.
 - 5) THIS SCHEMATIC INCORPORATES AN ADDITIONAL TWO COMPONENTS WHICH WERE RECOMMENDED BY HEATHKIT AS A RETROFIT; THE IP-20 WAS SUBJECT TO HAVING ITS OUTPUT (SERIES PASS) TRANSISTORS, AND/OR THEIR DRIVER (ERROR AMPLIFIER) TRANSISTOR, DAMAGED IF THE USER CHANGED THE 'VOLTAGE RANGE' SWITCH TOO RAPIDLY THROUGH MULTIPLE POSITIONS, AND THE RETROFITTED COMPONENTS SHUNT THE POTENTIALLY DAMAGING VOLTAGE TRANSIENTS. THIS IS PER HEATHKIT SERVICE BULLETIN IP-27-1, DATED JUNE 1971, AND IS ALSO APPLICABLE TO THE IP-20.
 - 6) THE POSITIONS OF THE 'VOLTAGE RANGE' SWITCH 'VR' REPRESENT THE HIGHEST VOLTAGE FOR THE SELECTED RANGE, WITH THE LOWEST VOLTAGE IN THE RANGE BEING ABOUT 6V LOWER, e.g. THE '45V' RANGE SPANS ABOUT 39V ~ 45V, OR A BIT HIGHER.
 - 7) THE ROTARY SWITCHES ARE REPRESENTED HERE 'STRAIGHTENED OUT'. TOGGLE SWITCHES AND SLIDE SWITCHES ARE SHOWN HERE USING TRADITIONAL BASIC SYMBOLOLOGY.
 - 8) THE HEATHKIT CODE FOR IDENTIFICATION OF THE SELECTOR SWITCH WAFERS IS AS FOLLOWS: THE PREFIX 'VR' MEANS THAT THE SWITCH WAFER IS PART OF THE 'VOLTAGE RANGE' SWITCH, WHILE THE PREFIX 'CR' MEANS THAT THE SWITCH WAFER IS PART OF THE 'CURRENT RANGE' SWITCH. THE NUMERICAL DIGIT THAT FOLLOWS THE PREFIX REFERS TO THE WAFER, WITH WAFER 1 BEING THE ONE CLOSEST TO THE FRONT PANEL, AND HIGHER WAFER NUMBERS BEING PROGRESSIVELY FURTHER FROM THE FRONT PANEL. THE LETTER SUFFIX 'F' REFERS TO THE FRONT SIDE OF THE WAFER (FRONT BEING CLOSER TO THE FRONT PANEL), 'R' REFERS TO THE REAR SIDE OF THE WAFER.
 - 9) THE IP-20 IS ALMOST ENTIRELY THE SAME CIRCUIT AS THE LATER IP-27, EXCEPT WITH A DIFFERENT CASE DESIGN. OTHER DIFFERENCES ARE THAT THE FUNCTIONALITY OF THE SINGLE 6B2 REGULATOR TUBE IN THE REFERENCE VOLTAGE SUPPLY OF THE IP-20 WAS HANDLED BY A PAIR OF 110V AND 68V ZENER DIODES IN THE IP-27. THE IP-27 HAD TWO TRANSFORMER PRIMARY WINDINGS TO ALLOW 120V & 240V OPERATION, COMPONENT DESIGNATIONS WERE ENTIRELY DIFFERENT BETWEEN THE MODELS, THE NUMBERING OF SWITCH TERMINALS WAS DIFFERENT, AND THE IP-27 HAD TWO NEON INDICATORS (AND ASSOCIATED RESISTORS) TO HIGHLIGHT WHETHER THE METER WAS IN CURRENT OR VOLTAGE MODE. COMPONENT VALUES ARE VIRTUALLY IDENTICAL BETWEEN THE TWO MODELS. THE AUTHOR OF THIS SCHEMATIC HAS ALSO PREPARED A SEPARATE IP-27 SCHEMATIC.
 - 10) THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A LEGIBLE AND MORE EASILY UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IP-20. AN EFFORT HAS BEEN MADE TO SIZE AND SCALE COMPONENTS AND TEXT FOR THE LARGEST AND BEST VISIBILITY AND LEGIBILITY WHILE STILL FITTING ON A NORMAL 11 X 17" SHEET OF PAPER. ALL COMPONENT VALUES AND DESIGNATIONS, TERMINALS, AND WIRE COLORS ARE SHOWN AS VERIFIED BY EXAMINATION OF A BUILT AND WORKING IP-20 POWER SUPPLY.
 - 11) THE COPYRIGHT HOLDER HEREBY GIVES PERMISSION TO FREELY DISTRIBUTE THIS DOCUMENT, AS LONG AS NO ALTERATIONS ARE MADE AND CREDIT IS GIVEN, ALONG WITH THE COPYRIGHT NOTICE.

SEMICONDUCTOR REPLACEMENT TABLE

HEATHKIT PART NUMBER	GENERIC PART NUMBERS			LIMITED SPECIFICATIONS
	FIRST	SECOND	THIRD	
57-27	1N2071	1N4005	1N5397	SILICON DIODE, 600PIV, 1A (1N5397 IS 1.5A)
56-13 (VR-56)	1N5943A	1N5231B	1N5370A	56V ZENER DIODE, 1.5W
417-43	2N398A	R265A	2N1039-1	GERMANIUM PNP TRANSISTOR, 50V, 150mA, TO-5
417-20	R265A	2N1039-1	2N2553	GERMANIUM PNP TRANSISTOR, 40V, 3A, STR-10
417-44	2N2147	2N1548	2N2869	GERMANIUM PNP TRANSISTOR, 75V, 5A, TO-3
417-42	CQT-701A	2N1548	DTG-600	GERMANIUM PNP TRANSISTOR, 60V, 5A, 60W, TO-3

'FIRST' & 'SECOND' PART NUMBERS ARE HEATHKIT'S RECOMMENDATIONS, 'THIRD' PART NUMBER SHOULD WORK



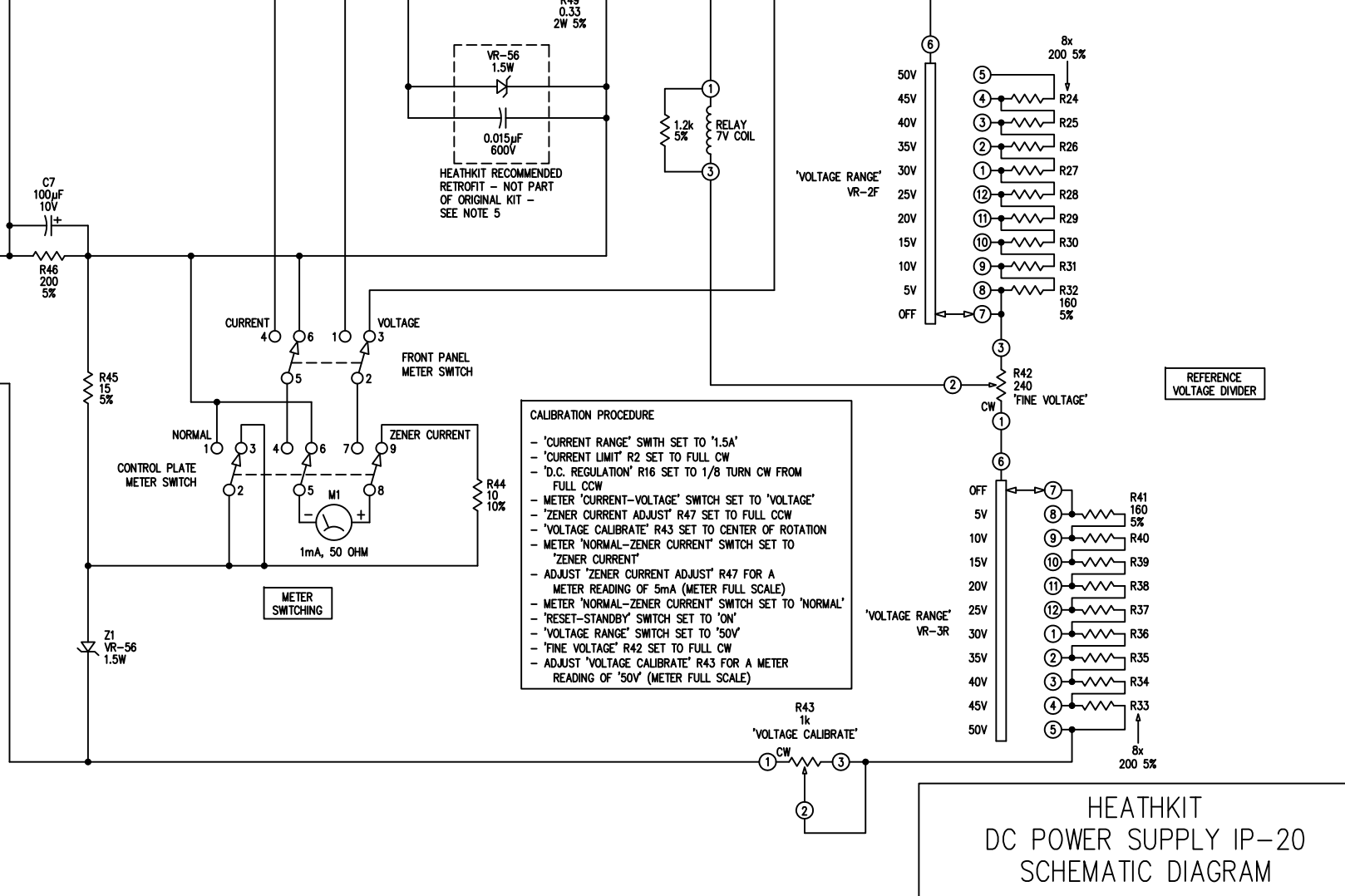
REFERENCE VOLTAGE SUPPLY

CAPACITORS C8, C9, C10 ARE ALL IN A SINGLE CAN BUT MAY BE REPLACED WITH SEPARATE CAPACITORS

LAMP & V1 REGULATOR TUBE MAY BE REPLACED WITH DUAL ZENER DIODE ARRANGEMENT - SEE IP-27 SCHEMATIC

THE IP-20 HAS TWO MODES OF OVER-CURRENT PROTECTION:

- THE PRIMARY MODE IS SOLID STATE CURRENT LIMITING, WHEN THE OUTPUT CURRENT FLOWING THROUGH THE 'FINE CURRENT' POTENTIOMETER R5 AND ASSOCIATED SHUNT RESISTORS IS SUFFICIENT TO GENERATE ENOUGH VOLTAGE DROP AT THE WIPER OF R2 THAT THE DIODE D6 IS FORWARDED BIASED, IN WHICH CASE LIMITER BIAS SUPPLY IS SHUNTED, BYPASSING THE BASE-EMITTER JUNCTION OF TRANSISTOR X1 SO THAT IT COMES OUT OF SATURATION, THUS INCREASING ITS RESISTANCE TO THE FLOW OF THE OUTPUT CURRENT.
- IF A SHORT CIRCUIT OR A VERY LOW RESISTANCE LOAD IS CONNECTED TO THE OUTPUT, THE + AND - OUTPUT TERMINALS ARE NEARLY AT THE SAME POTENTIAL, AND SINCE THE OUTPUT - TERMINAL AND THE - SIDE OF THE REFERENCE VOLTAGE SUPPLY ARE COMMON, THE WIPER OF 'FINE VOLTAGE' POTENTIOMETER R42, WHICH IS BASED ON THE REFERENCE SUPPLY VOLTAGE, WILL NOW BE POSITIVE IN RELATION TO THE SUPPLY'S + OUTPUT, THUS FORWARD BIASING D7 WHICH THEN ALLOWS SUFFICIENT CURRENT TO FLOW FROM THE + SIDE OF THE REFERENCE SUPPLY, THROUGH THE RELAY COIL AND D7, AND THEN THROUGH THE LOW AND BACK TO THE - OUTPUT TERMINAL (COMMON TO THE REFERENCE SUPPLY'S - SIDE), AND SUCH CURRENT THEN DEVELOPS 7 VOLTS ACROSS THE RELAY COIL, ACTUATING THE RELAY AND OPENING THE NORMALLY CLOSED RELAY CONTACTS, DISCONNECTING THE VOLTAGE SOURCE FROM THE + OUTPUT. AS LONG AS THE LOW RESISTANCE LOAD REMAINS CONNECTED, THE RELAY WILL KEEP THE SUPPLY DISCONNECTED FROM THE OUTPUT. OPENING THE 'RESET-STANDBY' SWITCH, OR DISCONNECTING THE LOAD, WILL ALLOW THE RELAY TO DE-ENERGIZE, RECONNECTING THE SUPPLY TO THE + OUTPUT.



CALIBRATION PROCEDURE

- 'CURRENT RANGE' SWITCH SET TO '1.5A'
- 'CURRENT LIMIT' R2 SET TO FULL CW
- 'D.C. REGULATION' R16 SET TO 1/8 TURN CW FROM FULL CCW
- METER 'CURRENT-VOLTAGE' SWITCH SET TO 'VOLTAGE'
- 'ZENER CURRENT ADJUST' R47 SET TO FULL CCW
- 'VOLTAGE CALIBRATE' R43 SET TO CENTER OF ROTATION
- METER 'NORMAL-ZENER CURRENT' SWITCH SET TO 'ZENER CURRENT'
- ADJUST 'ZENER CURRENT ADJUST' R47 FOR A METER READING OF 5mA (METER FULL SCALE)
- METER 'NORMAL-ZENER CURRENT' SWITCH SET TO 'NORMAL'
- 'RESET-STANDBY' SWITCH SET TO 'ON'
- 'VOLTAGE RANGE' SWITCH SET TO '50V'
- 'FINE VOLTAGE' R42 SET TO FULL CW
- ADJUST 'VOLTAGE CALIBRATE' R43 FOR A METER READING OF '50V' (METER FULL SCALE)