TECHNICAL DATA

VERTICAL AMPLIFIER AND ATTENUATOR

3dB bandwidth	d.c. or 2Hz - 10MHz
10 to 90% risetime	35ns nominal
Calibrated deflection sensitivity ±5%	10mV - 50V/cm
Minimum sensitivity approx.	125V/cm
Maximum input (via 400V capacitor a.c.-coupled)	400Vp
Maximum display amplitude	6cm d.c. - 5MHz
reducing to approx.	3cm at 10MHz
Input impedance approx.	1megohm and 47pF

HORIZONTAL DEFLECTION SYSTEM

Trigger

Internal — minimum deflection	2mm
External — a.c.-coupled	1·5Vp-p to ±15V
input impedance approx.	100kilohms and 10pF
Useful bandwidth approx.	
Automatic	50Hz - 1MHz
Trigger level	10Hz - 1MHz with 2mm amplitude 1MHz - 4MHz rising to 5mm amplitude
HF	1MHz - 10MHz or better

Sweep generator

Calibrated sweep speeds ± 5%	0·2μs - 2s/cm
Maximum speed range approx.	40ns - 5s/cm

Horizontal amplifier

3dB bandwidth	d.c. - 1MHz
10 to 90% risetime	0·35μs nominal
Deflection sensitivity approx.	0·6 - 3V/cm
Input impedance approx.	1megohm and 30pF
Maximum input	400Vp

CATHODE RAY TUBE

Display area	6 x 10cm
Overall post-deflection acceleration	4kV
Available phosphors	P31 (standard), P7 and P11
External intensity modulation	
Coupling	a.c. to first grid
Signal for cut-off at average brilliance	−20Vp approx.
Time constant	10ms approx.

FRONT PANEL OUTPUTS

Calibrator — supply frequency	500mVp-p ± 2%
Sweep sawtooth	
Amplitude	1 - 35V approx. d.c.-coupled
Minimum load	30kilohms
Probe test	0·5V approx.

POWER REQUIREMENTS

Voltage	100 - 125V in 5V steps
	200 - 250V in 10V steps
Frequency	48 - 440Hz
Consumption	24VA approx.

PHYSICAL DATA

Approximate overall dimensions and weight:

	High	*Wide*	*Deep*	*Weight*
S54A	24cm	17cm	42cm	8 kg
	9½in	6¾in	16½in	17½lb
S54AR	13·3cm	48cm	45cm	11kg
	5¼in	19in	17¾in	23¾lb

Cooling	Convection	
Approximate ambient temperature limits		
Operating	−15 to +40°C	+ 5 to +104°F
Non-operating	−25 to +70°C	−13 to +158°F

CIRCUIT DESCRIPTIONS

BLOCK DIAGRAM — Figure A

INPUT ATTENUATOR AND VERTICAL AMPLIFIER

The signal to be observed is applied via the BNC input socket to the attenuator; this either passes the signal directly to the Y (vertical) amplifier or reduces the amplitude of the signal to a convenient level. The four-stage Y amplifier drives the Y plates of the CRT, causing the electron beam to be deflected in the vertical axis. On internal trigger, a fraction of the amplifier output is fed to the trigger circuit to enable the timebase sweep to lock to the signal displayed.

CALIBRATOR

A 500mVp-p squarewave at power-line frequency is provided for checking Y amplifier gain and timebase sweep speed.

TRIGGER

The circuit provides pulses of suitable amplitude and polarity to fine the sweep generator in synchronism with the internally or externally derived trigger waveforms.

SWEEP GENERATOR AND HORIZONTAL AMPLIFIER

When triggered, the sweep generator provides a ramp waveform which is fed to the X (horizontal) amplifier and to a front-panel terminal; at the same time the trace is unblanked. When the TIME/CM switch is set to EXT X, the sweep generator is disabled, the trace unblanked and an external signal may be applied to the X plates of the CRT via the horizontal amplifier.

UNBLANKING AMPLIFIER

An unblanking pulse is derived from the sweep generator to deflect the electron beam on to the CRT phosphor for the duration of a sweep A fast-rising pulse is provided at PROBE TEST for the adjustment of high-impedance probes.

CATHODE RAY TUBE

Controls affecting the appearance of the trace on the CRT screen are incorporated in this circuit. Scale illuminator and trace rotation controls are mounted at the rear of the S54A.

POWER SUPPLIES

All voltages are derived from a double-wound power transformer protected by a delay fuse.

DETAILED DESCRIPTIONS

ATTENUATOR — Figure 1

The attenuator consists of four frequency-compensated resistive dividers with ratios of 100:1, 10:1, 5:1 and 2:1. No dividers are in circuit on the basic 10mV/cm range. CV2, 5, 8 and 12 enable the input time-constant to be standardised; CV4, 7, 11 and 14 compensate each attenuator section.

Y AMPLIFIER — Figure 2

The output from the attenuator is fed to the gate of TR21. an N-channel field-effect transistor. TR21 and 22 form a paraphase amplifier with their sources long-tailed through TR23. The base of TR23 is held at about half the negative line potential by D21; this causes amplifier gain to vary in direct proportion to small changes in supply voltage and compensate for inversely proportional changes in CRT deflection sensitivity. The stabilised voltage established by D21 is also taken to the shift and calibration circuits.

CV21, C22, R30, 40, 21 and 22 serve to protect TR21 against overload, CV21 and C22 compensating the divider. VARIABLE, RV25, alters the gain of TR21 and 22 by a factor of at least 2·5. Changes in input capacitance of TR21 are compensated for by C20 in parallel with the capacitance of a short length of wire. RV26 is set to equalise the source currents of TR21 and 22 irrespective of the setting of RV25. RV73 compensates for resistor tolerances and differences in gm of the FET's which would otherwise cause unbalanced outputs at the drains of TR21 and 22 when the −12V line fluctuates in sympathy with supply voltage.

Shift voltage is applied to the gate of TR22; RV37 serves as a shift-centring adjustment. The supply to the fine and coarse shift controls is stabilised by N21 and D21.

The output at the drains of TR21 and 22 is fed to the bases of push-pull emitter-followers TR24 and 27, which reduce the loading effect of TR25 and 26 on TR21 and 22. From the emitters of TR24 and 27 the signal passes to the bases of TR25 and 26. The overall amplifier gain of about 750 is set in this stage by RV39. R60 and 70 with C30 and 31 provide thermal compensation which is adjusted by RV41. RV52 sets the mean collector potential of TR25 and 26 and thus the mean base potential of TR28 and 29; this fixes the collectors of TR28 and 29 at the appropriate level for maximum output.

TR28 and 29 are neutralised by C25 and 26, while RV57 and CV28 provide high-frequency compensation. Part of the output at the collectors is taken to the trigger selector switch to provide internal triggering.

RV66 controls current through the trace rotation coil L21; reversal of current and range of adjustment is accomplished by reversing the connecting plug.

The 500mVp-p squarewave calibrator output is developed across R61 by using an output from the power transformer to switch D24 alternately on and off. D24 is in series with the divider chain RV56, R58 and 61 between the −6·2V line and chassis; RV56 is used to set the current through the chain and consequently the voltage developed across R61.

N21 serves as the power-on indicator as well as providing a stabilised positive supply for the shift circuit.

TRIGGER CIRCUIT — Figure 3

The bases of input amplifiers TR101 and 102 are fed with the triggering signal via switches S101e and d. S101e selects the source, either the vertical amplifier for internal operation or the EXT TRIG terminal, while S101d determines the slope on which triggering occurs.

When switched in by S102, RV115, the TRIG LEVEL control, varies the base potentials of TR101 and 102 in anti-phase. This alters the quiescent voltage on the base of TR103 and so varies the d.c. level of signal necessary to trip the Schmitt trigger formed by TR103 and 104.

With S102 switched to AUTO, feedback is applied from TR104 collector to TR102 base via R124 and 122 and from TR103 collector to TR101 base via R125 and 106. This causes TR101 and 102 to oscillate at a frequency in the order of 50Hz determined by C108, R124 and 125. The amplitude of the free-running output of TR102 is adjusted by the trigger sensitivity pre-set RV132 which adjusts the hysteresis gap of the Schmitt. Set automatic pre-set RV114 is adjusted to take up component inequalities and provide symmetric operation of TR101 and 102.

The feedback networks R108, 109, C104, 105 and R118, 119, C106, 107 extend the frequency response of the amplifier and enable a high input-impedance to be presented to external trigger signals.

With S101a, b and c in the NORMAL position, TR103 and 104 operate as a Schmitt trigger with coupling resistor R131 and speed-up capacitor C111. RV132 adjusts the hysteresis gap or degree of backlash. The fixed-amplitude rectangular-wave output from the collector of TR104 is differentiated by C113 and R137 and the resulting bidirectional pulses applied to series clipper D101 which provides the collector of TR105 in the timebase circuit with positive-going trigger pulses.

In the TV positions of S101a and b, TR103 is converted into a sync separator by R127 being switched out of circuit and C109 being switched across R128 to give a 350ms time constant. TR104 changes into an inverter with decoupling capacitor C114 being switched across R133. In the TV FIELD position the differentiating time-constant of C113 and R137 is increased by the addition of R136.

With S101c in the HF position, R130 is placed in series with RV132 across C112, these components together with TRIG LEVEL determine the frequency at which TR103 and 104 oscillate. The frequency varies from approximately 250kHz to 1MHz.

TIMEBASE — Figures 4 and 5

The sweep generator consists of the Miller run-up stage TR108 with TR107 as a source-follower; TR105 and 106 form the sweep-gating bistable; TR112 drives the para-phase X output stage TR113 and 114, while TR109 and 111 constitute the beam-unblanking amplifier.

In the quiescent condition of the timebase TR105 is off and TR106 on. D105 and 106 are on, holding CT the timing capacitor (selected by S276 2F), discharged between the gate of TR107 and the collector of TR108. TR108 conducts heavily, with its collector clamped by D105 close to chassis potential. TR109 is on, causing g2 of the CRT to be biased negatively to a1, thus deflecting and blanking the electron beam.

When a positive-going trigger pulse is applied to the base of TR106 via D101, C116 and R152, the bistable switches over; TR106 goes off and TR105 on. The collector of TR106 goes negative until clamped by D104 at about chassis potential; D105 and 106 are cut off and current flows into CT through RT (selected by S276 1R) and RV276 to start the sweep.

The gate of TR107 and base of TR108 gradually fall, causing the collector of TR108 to rise and provide the positive-going sweep. The tendency of the gate of TR107 to go negative is limited by the large loop gain giving almost constant current flow into CT.

As the collector of TR108 rises, D103 is turned on and CH, the hold-off capacitor (selected by S276 1F) charges; D102 becomes reverse-biased and cuts off. The rise in voltage across CH is applied to the base of TR105 via R146; at a point determined by the setting of RV149, TR105 and 106 switch over with TR105 off and TR106 on. The sweep ends and the flyback begins.

D106 is turned on and CT discharges through TR106 causing the gate of TR107 and base of TR108 to rise. The collector of TR108 falls linearly, due to a reversal of the Miller action that took place during the sweep until D105 comes on and the flyback ends, the collector of TR108 being clamped by D105 at the same level as at the start of the sweep. During the flyback D103 is turned off and CH starts to discharge, taking the base of TR105 in a negative direction.

A trigger pulse occuring during the hold-off period cannot cause a repetition of the above sweep and flyback cycle until the hold-off capacitor has discharged sufficiently to turn on D102 and clamp the base of TR105 at a potential set by RV142. If this potential is too high, as when the STABILITY control is anti-clockwise, an incoming trigger pulse is of insufficient amplitude to switch over the bistable. If STABILITY is advanced, the base potential of TR105 falls and the bistable can be switched. When STABILITY is advanced still further clockwise, the base of TR105 falls sufficiently to turn off TR105 and cause a recurrent sweep whether or not trigger pulses are applied. RV144 is set to make the hold-off time twice as long as the flyback time in the free-running condition.

TR109 is switched off at the start and on at the end of the sweep as TR105 and 106 change state. D107 clamps the emitter of TR109 at about chassis potential. As the collector of TR109 goes respectively positive and negative, so does g2 of the CRT, by coupling through the emitter-follower TR111; this causes the CRT electron beam to be alternately unblanked and blanked. A fast-edged pulse is available from a tapping on the emitter load of TR111 for probe capacitance compensation.

On EXT X, the beam is unblanked by disconnecting the base of TR105 from D102, this causes the bistable to switch and cut off TR109.

The external horizontal signal is applied via R293 to the gate of TR107, which with TR108 forms an operational amplifier with feedback through R287. RV155 is set to produce zero volts at the input terminal while CV291 compensates for the input capacitance of TR107.

The sawtooth or external X signal at the collector of TR108 is applied via RV159 and R163 to the base of TR112, an operational amplifier, where it is mixed with the shift potential from RV166. D108 limits the negative excursion of the base of TR112. The gain of TR112 is controlled by RV169 in the feedback loop from collector to base.

The output at the collector of TR112 is applied to the base of TR113, which with TR114 drives the X-plates in push-pull. D109 prevents TR113 from bottoming thus reducing hole storage; RV178 sets the mean operating point of the collectors of TR113 and 114 at about half the HT voltage; RV182 balances the currents in the two transistors when there is no potential across RV169.

POWER SUPPLY AND CRT CIRCUIT — Figure 6

Power Supplies

All voltages are derived from the power transformer T401 which has two primary and two secondary windings. The primaries are connected in parallel for operation from 100 - 125V and in series for operation for 200 - 250V. A tapped secondary provides all EHT, HT and LT supplies with the exception of the CRT heater which is separately fed from a 6·3V winding floated at about −1kV.

EHT The positive supply for the CRT PDA helix is obtained from D401 and 403 which form a voltage-doubling circuit with C401, 403 and 404; the supply is filtered by R403 and C406.

The negative supply for the electron gun is provided by D404, 405 and 407 in series; C409, 411 and 412 in series form the reservoir capacitor.

HT D408, acting as a half-wave rectifier, provides the +105V supply for RV300, the Y amplifier and timebase circuits; after decoupling by R170 and C122 (Figure 4) the supply is returned to RV301 and a1 of the CRT.

LT The positive and negative lines are obtained from D406 and D402 respectively. The 13·5V transformer tapping also supplies the scale illumination lamps via RV401 and the calibrator circuit in the Y amplifier via R402. The −12V A line feeds the timebase and trigger; after additional filtering by L452 and C476, the −12V B line feeds the timebase and Y amplifier.

CRT

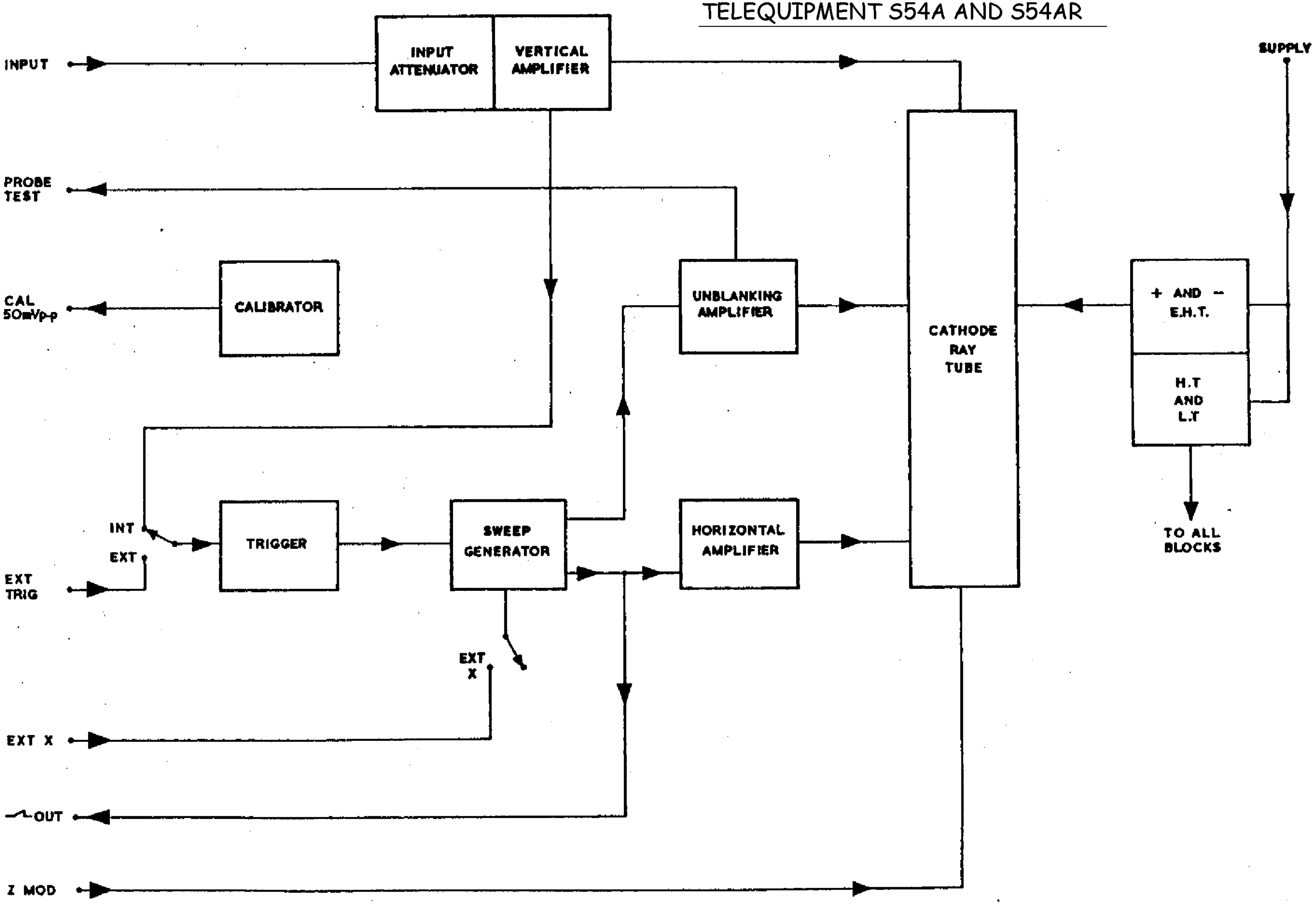
A 13-centimetre diagonal rectangular tube with helical PDA is used; alternatives to the standard P31 phosphor are available. Beam control is carried out electrostatically with the exception of rotation which is magnetic. The front-panel controls RV305, 303 and 301 adjust for brilliance, focus and astigmatism on g1, a2 and a3 respectively. D301 provides a low-resistance path for cathode current.

The current through the trace rotation coil L21 is adjusted by RV66 (Figure 2); if necessary, the direction of current may be reversed by reversal of the connecting plug.

The beam is unblanked during a sweep and when the timebase is switched to EXT X by raising the potential on g2 to that of a1, at all other times g2 is held negative to a1 deflecting and blanking the beam.

External intensity modulating signals are applied to g1 via C306.

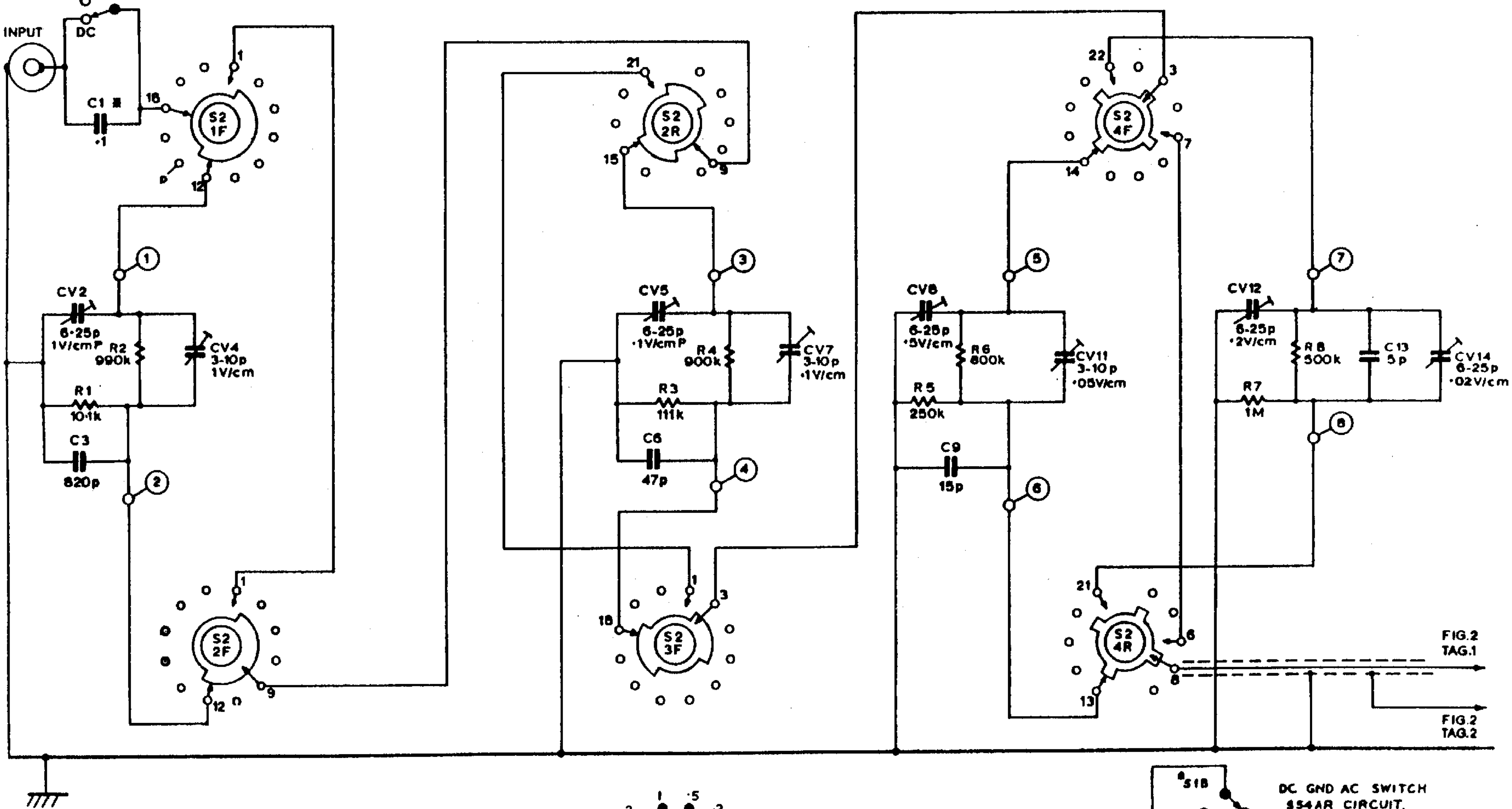
TELEQUIPMENT S54A AND S54AR

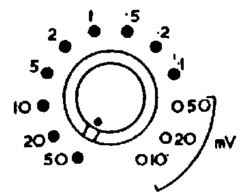


BLOCK DIAGRAM FIGURE A

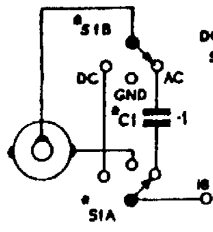
MISC		S1			S2	S2						S2				
C	1	3				6			CV8		CV11		CV12			CV14
CV	CV2			CV4		CV5		CV7		9					13	
R	1		2			3	4		5	6			7	8		

TELEQUIPMENT S54A AND S54AR





S 2 (VOLTS/CM) SWITCH POSITIONS



DC GND AC SWITCH S54AR CIRCUIT.

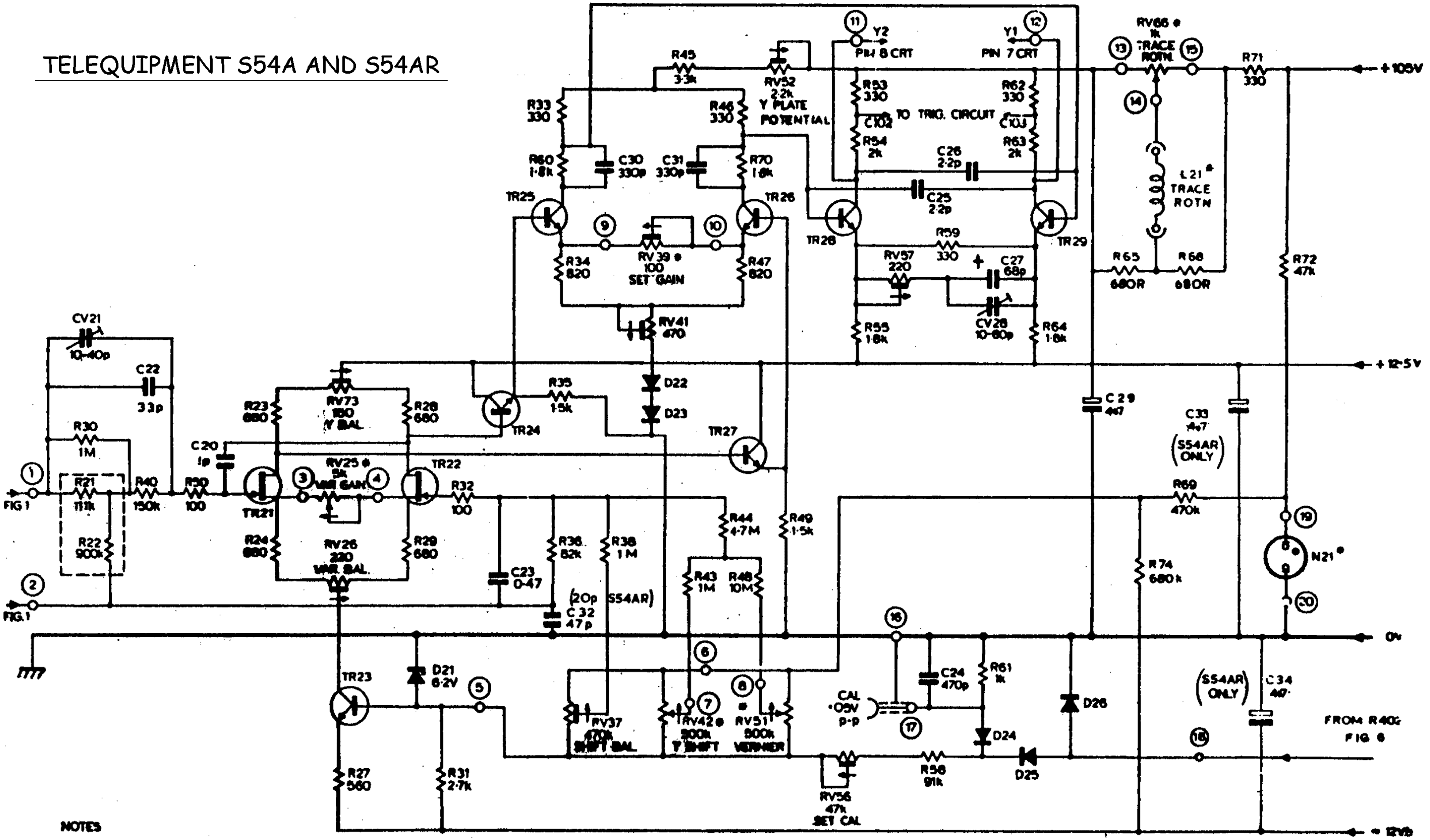
NOTES:-
1. (No) DENOTES TAG NOS. ON P.C.73
2. SWITCHES SHOWN IN FULLY ANTI-CLOCKWISE POSITION
3. ✱ DENOTES COMPONENTS NOT MOUNTED ON P.C. 73

ATTENUATOR

FIG. 1

MISC.	TR21 TR23 TR22 D21 TR24 TR25 D22 D23 TR26 TR27 TR28 D24 TR29 D25 D26 L21 N21
C CV	CV21 22 20 23 32 30 31 25 24 26 27 CV28 29 33 34
R RV	30 21 22 40 50 23 24 RV73 RV25 RV26 27 28 29 31 32 33 35 60 36 34 38 RV37 RV39 RV41 RV42 45 43 44 46 70 47 48 RV52 49 RV51 53 54 RV56 56 RV57 58 59 61 62 63 64 65 RV66 67 74 68 69 71 72

TELEQUIPMENT S54A AND S54AR



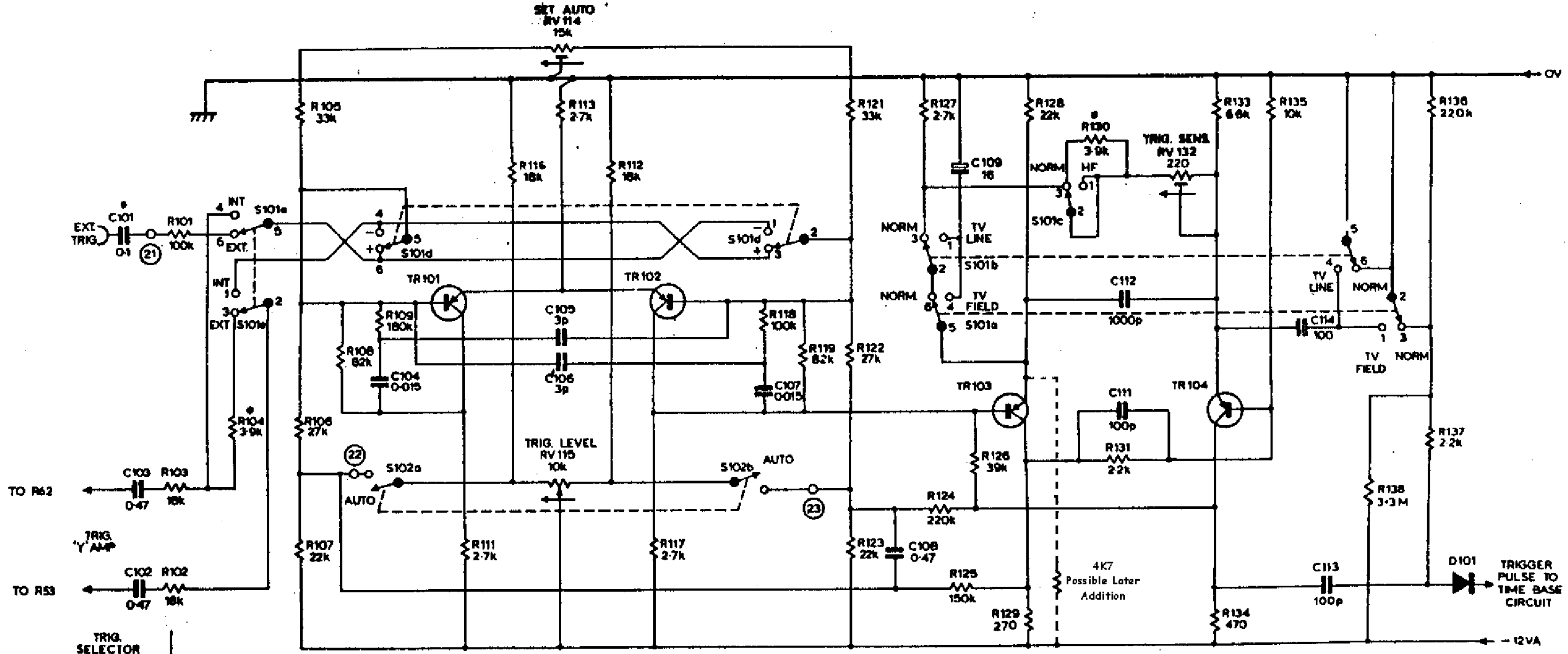
NOTES

1. (No) DENOTES TAG No ON PRINTED CIRCUIT BOARD P.C.70
2. • DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARDS
3. ✝ DENOTES 100p ON S54AR

Y AMPLIFIER CIRCUIT

FIG. 2

MISC	S101e · S101d S102a · TR101 · TR102 · S101d S102b · S101a · TR103 · S101c · TR104 · D101
C.CV	101 102 103 · 104 · 105 106 · 107 · 108 · 109 · 112 111 · 114 113
R RV	101 102 103 · 104 · 105 106 107 · 108 · 109 · 111 · 116 · RV114 113 RV115 · 112 · 117 · 118 · 119 · 121 122 123 · 127 124 125 · 126 · 128 129 · 130 · 131 · RV132 · 133 134 · 135 · 138 · 136 137



TRIG. SELECTOR OUT	IN	
NORMAL	TV FIELD	S101 a
	TV LINE	S101 b
	HF	S101 c
+	−	S101 d
EXT. TRIG.	INT	S101 e

PUSH BUTTON SWITCH (LOOKING AT COPPER SIDE OF BOARD)

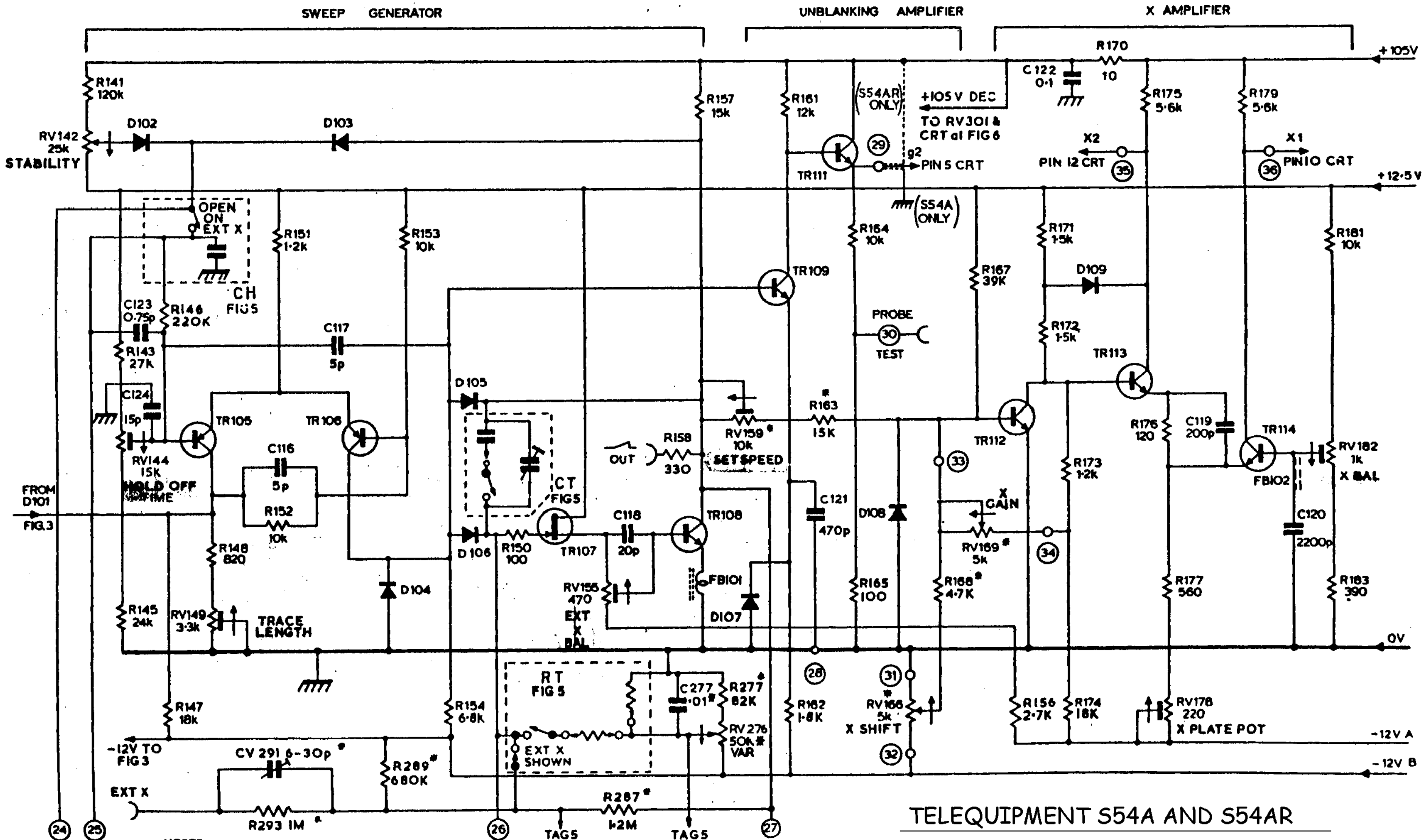
NOTES:-

1. • DENOTES COMPONENTS NOT MOUNTED ON PRINTED CIRCUIT BOARD P.C.70.
2. (N) DENOTES TAG NUMBERS ON PRINTED CIRCUIT BOARD P.C.70.
3. S101a - e SHOWN IN THE OUT POSITION
4. ARROWS → ON POTENTIOMETERS INDICATE CLOCKWISE SENSE OF CONTROL

TRIGGER CIRCUIT FIG. 3.

TELEQUIPMENT S54A AND S54AR

MISC	D102 TR105 D103 TR106 D104 D106 D105 TR107 TR108 D107 TR109 TR111 D108 TR112 D109 TR113 TR114
C CV	123 124 116 CV291 117 118 277 121 122 119 120
R RV	141 RV142 143 RV144 145 146 147 148 RV149 151 152 293 289 153 154 150 RV155 156 287 158 157 FB 101 277 RV276 RV159 161 162 163 164 165 RV166 168 167 RV169 171 172 173 174 170 175 176 177 RV178 179 181 RV182 183



TELEQUIPMENT S54A AND S54AR

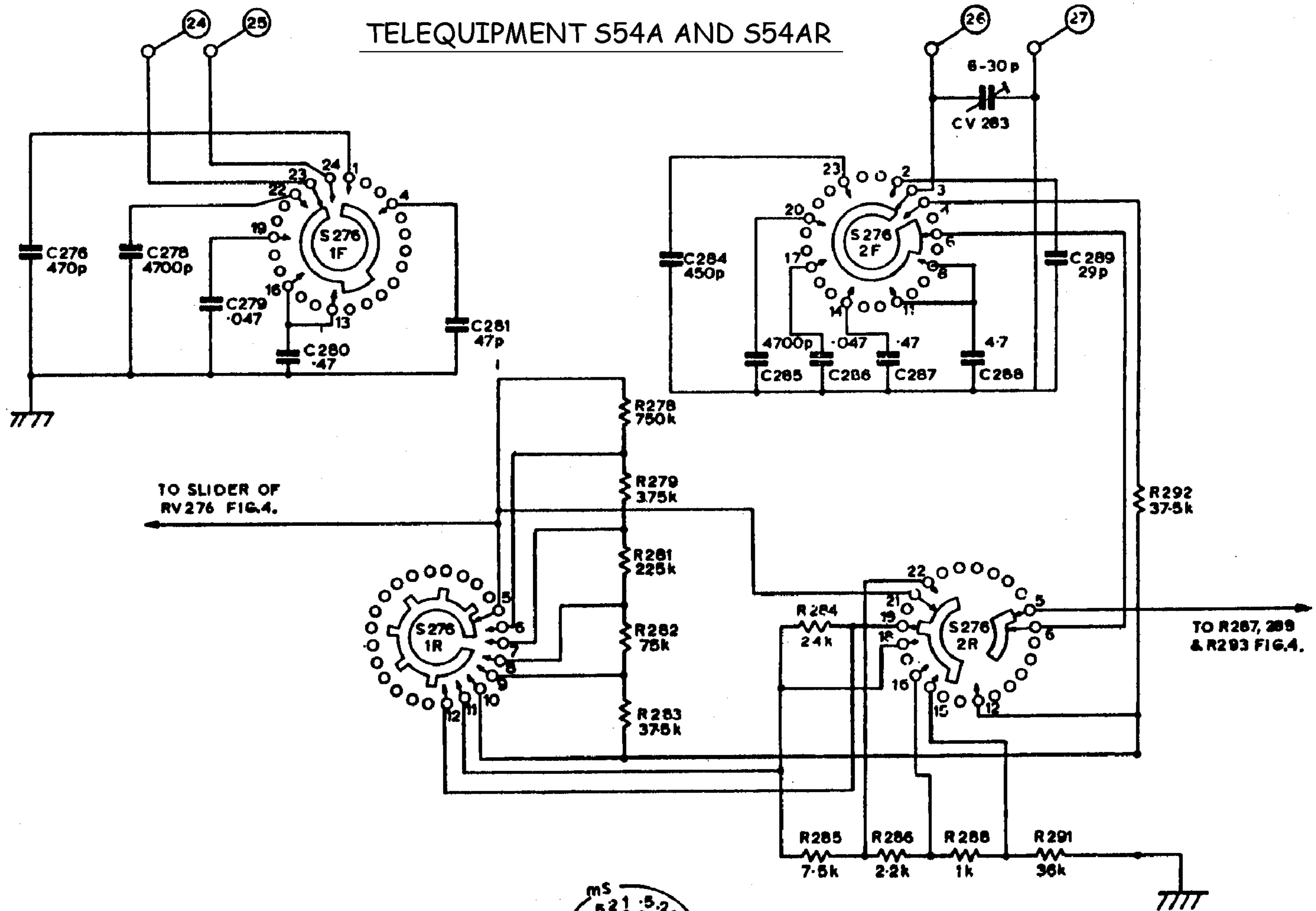
NOTES:-
1 (No) DENOTES TAG No ON P.C.70
2 * DENOTES COMPONENTS NOT MOUNTED ON P.C.70

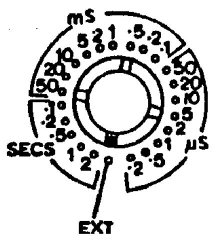
TIMEBASE CIRCUIT

FIG.4

MISC	S276
C CV	276 277 278 279 280 281 284 285 286 287 CV283 288 289 282
R	278 281 279 283 284 285 286 288 291 292
RV	R282

TELEQUIPMENT S54A AND S54AR





TIME / CM SWITCH POSITIONS

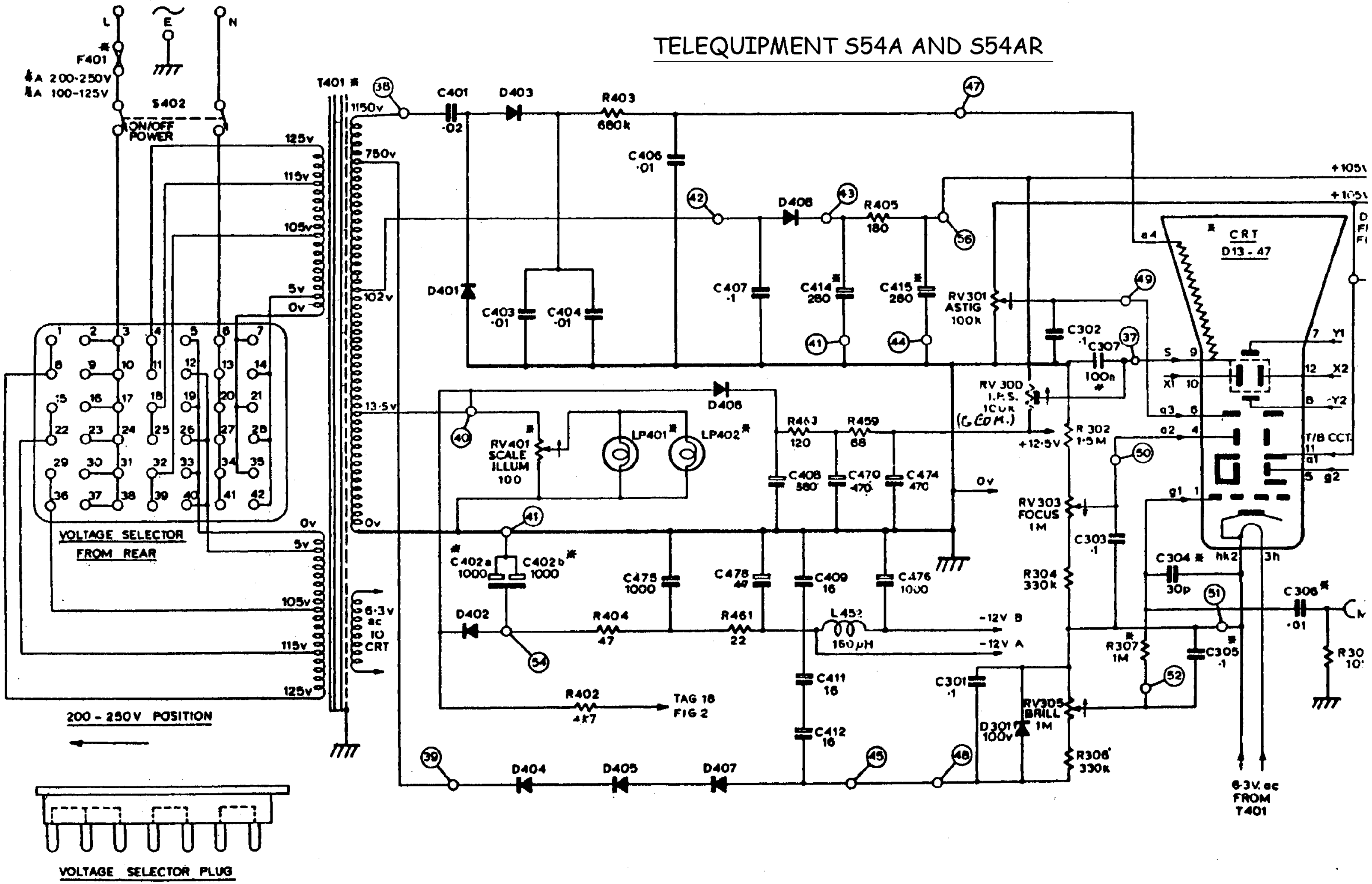
NOTES:-

1. (No) DENOTES TAG Nos. ON P.C.70.
2. S276 SHOWN IN FULLY ANTI-CLOCKWISE POSITION WAFERS VIEWED FROM FRONT.

TIME / CM SWITCH FIG. 5

MISC	F401 S402 T401 D401 D402 D403 D404 D405 LP401 LP402 D406 D407 D408 L452 D301
C	401 402 403 404 475 405 406 407 478 409 408 411 412 414 470 476 474 415 301 302 303 304 305 306
R RV	RV401 402 403 404 461 463 459 405 RV301 RV300 302 R303 304 306 RV305 307 308

TELEQUIPMENT S54A AND S54AR

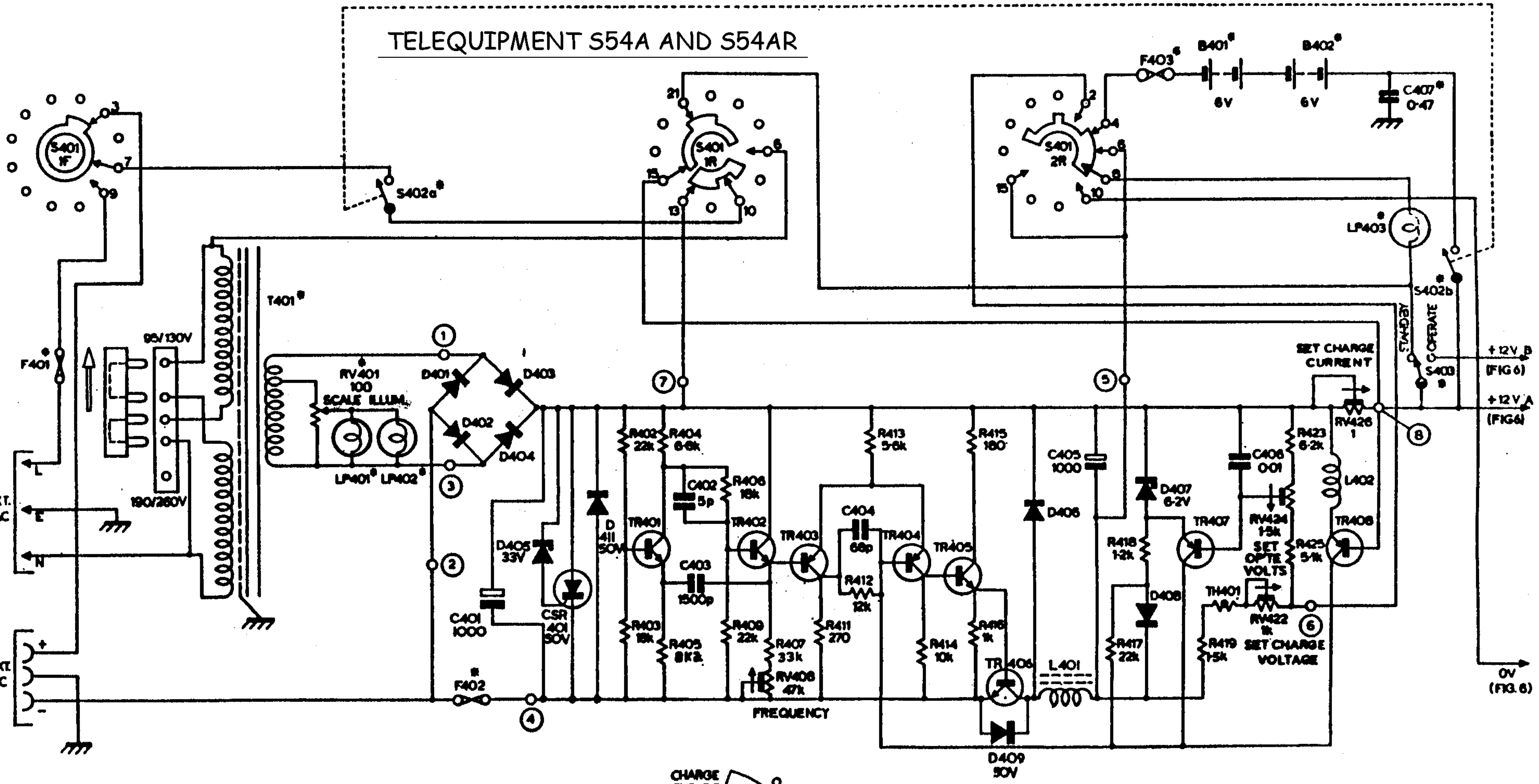


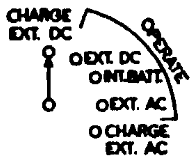
NOTES:-

1. (No) DENOTES TAG NUMBERS ON P.C.70
2. * DENOTES COMPONENTS NOT MOUNTED ON P.C.70
3. # C307 APPLIES TO S54AR ONLY

POWER SUPPLY & CRT CIRCUIT FIG. 6

MISC.	S401 S402a D401 D403 D405 TR401 TR402 TR403 TR404 TR405 TR406 S401 D407 TR407 B401 B402 TR408 LP403 S402b F401 T401 LP401 LP402 D402 F402 D404 CSR401 D411 S401 D409 D406 L401 D408 F403 TH401 L402 S403
C CV	401 402 403 404 405 406 407
R RV	402 404 406 407 411 413 415 418 423 RV426 RV422 RV424 RV401 403 405 409 RV408 412 414 416 417 419 425





(S401) POWER SELECTOR SWITCH POSITIONS

NOTES

1. (No) DENOTES TAG Nos. ON P.C.71
2. SWITCHES SHOWN IN FULLY ANTI-CLOCKWISE POSITION
3. * DENOTES COMPONENTS NOT MOUNTED ON P.C.71

AC / DC POWER SUPPLY FIG.7