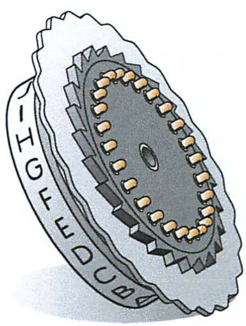
EC Mark II

Part B - Technical Manual

June 1956 (est.)

Project Easy Chair



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I. THE MODULATOR

General

The modulator has the function of supplying the required modulation power for the v.h.f. transmitter. This modulation consists of an amplified microphone voltage used to convey speech information to a remote point as required for carrier-pigeon operation, and a 20 kc/s signal used to activate a muting switch in the base station receiver.

During speech intervals the signal to noise ratio of the transmitted signal should be as high as possible, dictating a switching circuit in the microphone amplifier path and the use of an overall r.f. - a.f. negative feedback from aerial plug to input of the modulation amplifier.

Easy and smooth operation is obtained by making the switching circuits voice-operated and choosing the time constants of switching on and off in accordance with the characteristics of speech.

The modulation depth of the transmitter should not vary appreciably during control of the output power over a range of approximately 1 : 100.

Description of the circuits

Microphone pre-amplifier (Fig. 1)

The microphone voltage is amplified by cascaded transistors V_1 and V_2, after which the signal splits up. One path leads via transistor V_4 to the speech detector (Fig. 2). The other path goes via amplifier V_3 to the audio switch (Fig. 3).

The gain of amplifier V_1 and V_2 is manually controlled in 8 steps by a variable feedback switch S_1 and resistors (Fig. 7). A preference for the higher audio frequencies of the microphone used is compensated by a condenser C_5 shunted across a feedback resistor R_{11}.

The gain of transistor V_3 is automatically controlled by a d.c. control voltage derived from the rectified transmitter r.f. output, the purpose of which will be discussed later.

Speech detector (Fig. 2)
The input audio signal comes from the microphone pre-amplifier and drives the transistor V_5, the latter being normally non-conducting by a negative bias on the emitter, into a conductive state.
The voltage across condenser C_{16}, which is normally high, drops rapidly to a low value during conduction of V_5. The loading on this condenser by subsequent circuits is minimized by cascaded emitter-followers V_6 and V_7. The result is a rapid switchover from the "no-speech" to the "speech" situation and a slow return from the "speech" to the "no-speech" situation, the latter time-constant being about 0,2 second.
A part of the output from V_7 is fed to V_8, V_8 serving the purpose of "slicer" and of current amplifier for activation of the audio-switch(Fig. 3).
The output of emitter-follower V_7 also feeds the oscillator transistor V_9 in combination with the bleeder R_{33} - R_{34}. In the "speech" situation this oscillator generates a 20 kc/s voltage and drives the buffer transistor V_{10} which, in turn, drives the 20 kc/s power amplifier (Fig. 5). The output of the buffer transistor V_{10} is stepped down to a low-impedance by transformer T_2. The low-impedance output voltage is also used as a local negative feedback to the emitter of V_{10}.
In the "no-speech" situation the supply voltage to the oscillator is reversed in polarity, thereby ensuring a non-oscillating condition.

Audio switch (Fig. 3)
The amplified microphone voltage from the microphone pre-amplifier is fed to the input of the audio-switch. During "no-speech" situations connection 6 is negative with respect to connection 5 which renders diodes D_3 and D_4 conducting and diodes D_1 and D_2 non-conducting. Therefore no unwanted background noise from the microphone or microphone pre-amplifier can pass to transformer T_3.
When the speech detector (Fig. 2) is transferred to the "speech" situation as a result of speech actuating the microphone, the polarity of the voltage between terminals 5 and 6 is reversed.

This reverses the conducting state of the diodes mentioned and the incoming audio signal is passed almost entirely to transformer T_3.
The output of transformer T_3 is combined with the A.C. part of the rectified transmitter output, entering this panel on connection 2, so as to give the desired degree of overall r.f. - a.f. negative feedback. To preserve stability in the feedback loop phase-correcting condensers C_{22} and C_{23} have been added.
The combined output goes via connection 3 to the input of the driver amplifier. (Fig. 4).

Driver amplifier (Fig. 4)
The input emitter-follower V_{11} provides a high input impedance to reduce the loading on the preceding audio switch. The signal is amplified by transistor V_{12} and an inversed-phase signal is generated by V_{13}. The symmetrical audio signal thus obtained drives the emitter-followers V_{14} and V_{15}.
Bias voltage for the power output transistors located on the audio power amplifier panel (Fig. 6), comes from the same and enters the driver amplifier at connection 5, to be passed to the power amplifier transistors again together with the audio signal from V_{14} and V_{15}.
Phase-correction by R_{54} - C_{30} improves feedback stability.
The 20 kc/s signals entering the driver amplifier via the feedback circuit might reduce the driving possibilities of the power output transistors and might interfere with the regular 20 kc/s modulation of the transmitter. Therefore signals of this frequency are shorted by the series-tuned circuit L_1 - C_{29}.

20 kc/s Power amplifier (Fig. 5)
The 20 kc/s signal from the speech detector directly drives the power transistor V_{16} which is normally non-conducting. The collector load of V_{16} consists of the tuned transformer T_4. Part of the secondary of this transformer is connected in series with the anode voltage circuit of the r.f. transmitter output amplifier, thus causing a 20 kc/s amplitude modulation of the r.f. signal.

The 20 kc/s voltage across the whole secundary of T_4 is connected to a neon bulb NE. This neon bulb serves the double purpose of giving an instantaneous indication of the "speech" situation and of stabilizing the amplitude of the 20 kc/s modulating voltage under widely differing conditions of loading by the transmitter.
Also contained in this panel is a voltage-dropper to reduce the 13,5 V d.c. from the rectifier-stabilizer to 6,5 V d.c. as required by the low-level circuits of Fig. 1, 2 and 4.
A Zener diode D_5 in the lower branch of the voltage divider provides a low internal impedance.

<u>Audio power amplifier</u> (Fig. 6)
The output from the driver amplifier (Fig. 4) drives the output power transistors V_{19} and V_{20} via the impedance-lowering emitter-followers V_{17} and V_{18}.
The collector outputs of V_{19} and V_{20}, working as class-B amplifiers, are connected to the modulation matching transformer T_5 (Fig. 7).
The power supply for the modulator is also contained in this panel.
An a.c. voltage from the transmitter power transformer T_8 (Fig. 10) is rectified by bridge-rectifier D_8 and fed through a voltage stabilizing circuit in which transistor V_{22} acts as a variable series resistor.
The driving voltage for V_{22} comes from V_{21} and is derived from the difference between the d.c. output voltage and a d.c. reference voltage obtained from a pair of Zener diodes D_6 and D_7.
This circuit gives an effective hum suppression and shows a low output impedance to the varying load by the class-B output power amplifier.
A voltage divider in which the lower branch consists of a temperature-dependent resistor R_{68} supplies the necessary bias voltage for the power transistors V_{19} and V_{20}, this voltage being fed via V_{14}-V_{15} and V_{17}-V_{18} to the bases of V_{19} and V_{20}.
The storing condenser C_{38} and the decoupling condensers C_{36} and C_{37} are mounted on a separate panel (Fig. 7).

Control panel, etc. (Fig. 7)

On the control panel two plugs are mounted, one for the microphone and the other one for interconnection with the r.f. transmitter.
The microphone plug is wired to the microphone pre-amplifier input via a shorting contact on the microphone sensitivity switch S_1, which shorts the microphone when the carrier-pigeon procedure is not required.
Besides this shorting position the switch S_1 has 8 other positions, each position differing from the next one by a 5 db difference in microphone sensitivity. The sensitivity differences are obtained by switching in different values of negative feedback resistance in the microphone pre-amplifier circuit.
Also mounted on the control panel is the neon indicator NE.
Mounted in the cabinet, directly behind the control panel, is the modulation matching transformer T_5 and a shunting impedance R_{70}-C_{35} across the secondary of T_5 which improves stability in the feedback loop and decreases loss of 20 kc/s modulation signal across T_5.
The plug interconnecting modulator and transmitter carries the 50 c/s supply voltage, the modulator output voltage, the rectified transmitter output for negative r.f. - a.f. feedback and an interconnection preventing damage to the transmitter output tube when the interconnecting cable is not plugged in at both ends.
At the right-hand side of the cabinet the condensers C_{36} and C_{37} are mounted, as well as a bank of 18 condensers, designated as C_{38}.

Some remarks about the modulator operating details (Fig. 9)

A good understanding of the co-operation between and the peculiarities of the combinations of circuit elements chosen is thought very helpful for maintenance and test purposes.
The r.f. output stage of the transmitter is anode-modulated and offers to the modulator a load resistance of approx.: anode voltage divided by anode current.

/6

The output power control varies the screen voltage of the r.f. output tube and the anode current thereby varies in accordance. Thus the load resistance offered to the modulator also varies.
The audio modulator output stage is a class-B transistorized amplifier having a high internal resistance (if not saturated). Therefore the voltage gain of this stage increases with increasing values of load resistance.
This means that for a given modulation percentage the driving voltage for the transistor audio amplifier must be smaller when the output power control is adjusted to a lower value.
It is for this reason that the d.c. part of the rectified r.f. output power is used to control the gain of amplifier stage V_3 in the microphone pre-amplifier, counteracting in this way the change of sensitivity of the audio power-amplifier.
The ratio of microphone output voltage and modulation percentage is thereby held reasonably constant over a wide range of r.f. output powers.
Another point of interest is the constancy of the negative feedback factor.
With a lower output power setting the gain in that part of the audio amplifier, which is included in the feedback loop, is higher, but the a.c. part of the negative feedback voltage, derived from the rectified r.f. output, is at the same time smaller. These effects oppose each other largely, thereby maintaining the gain around the feedback loop reasonably constant, and ensuring good feedback stability under all conditions of varying r.f. output.
The 20 kc/s modulation percentage is also constant regardless of the power control setting due to the presence of a stabilizing neon bulb NE across the 20 kc/s output circuit in the modulator, serving as an indicator at the same time.

Servicing of the modulator

The modulator cabinet can be opened up for inspection by removing the bottom and the front panel, which are held in place by a number of sheet metal screws. Note that one of these screws is slightly longer than

/7

the others and that it has to be used for the hole directly beneath the neon indicator in the front panel. The knob on S_1, designated "MICR.SENS." has to be removed also.
With panels taken off, and the knob on S_1 eventually replaced, the equipment is in full working condition.
The left-hand part of the cabinet holds units I, II, III, IV and V, which are embedded in expanded polyvinyl. To remove any of these units it is necessary to unsolder the wires connecting this particular unit, and to loosen 3 sheet metal screws at the outside of the cabinet, these screws being used to fix a clamping plate at the right-hand side of the 5 units mentioned.
Exchanging a particular component in one of these units is relatively easy when first of all its position has been located by consulting the component layout drawing to be found directly after the respective circuit diagram and bearing the same number with the suffix A.
The same holds for unit VI which is to be found slightly to the right of the center of the cabinet, and which can be taken out by unsoldering 12 connections and loosening 4 sheet metal screws at the outside of the cabinet.
At the extreme right-hand side of the cabinet a bank of 20 condensers C_{36}, C_{37} and C_{38} can be found, which can be taken out by loosening 3 metal screws at the outside of the cabinet.
The control panel can be inspected by taking out 2 sheet metal screws at the top of this panel, after which it can be bent back, hanging on the wires.
The screening cap of switch S_1 can be taken off after removing two hexagonal nuts, thus giving access to resistors R_{71} till R_{77} inclusive.
Behind the control panel , but mounted in the cabinet, transformer T_5 will be found.

A list of voltages, etc. to be used for comparison purposes in case of trouble is given hereafter.

Test data of modulator

Emitter	V_1	1,55 V
"	V_2	1,50 V
"	V_3	0,13-1,65 V (dep. on r.f. power)
"	V_4	0,58 V
"	V_5	0,27-0,2 V ("no speech"-"speech")
"	V_6	5,5 -0,4 V (" " ")
"	V_7	5,6 -0,7 V (" " ")
"	V_8	1,4-1,03 V (" " ")
"	V_{11}	1,25 V
"	V_{12}	1,12 V
"	V_{13}	1,16 V
"	V_{14} & V_{15}	0,35 V
"	V_{17} & V_{18}	0,19 V
"	V_{21}	13,7 V

Collector	V_1	3,3 V
"	V_2	3,4 V
"	V_3	5,75-3,2 V ("no speech"-"speech")
"	V_4	1,8 V
"	V_8	1,45-5,0 V (" " ")
"	V_{12}	3,6 V
"	V_{13}	3,55 V
"	V_{14} & V_{15}	5,65 V
"	V_{17} & V_{18}	12,8 V

Junction	R25 -R26	1,65 -0,32 V ("no speech"-"speech")
"	R33 -R34	4,85 -4,75 V (" " ")
"	R28 -R29	3,3 - 3,4 V (" " ")
"	R21 -C15	5,95 V
"	R60 -C31	6,25 V
"	R64 -D6	13,9 V
"	R69 -R64	16,5 V

Connection	VI-3	21,5 V
"	VI-5	13,5 V
"	VI-7	0,47 V
"	V -2	6,45 V
"	IV-6	1,5 V
"	III-2	6,5 - 72,5 V (dep. on r.f. power)
"	VI-1 to VI-2	16,9 V R.M.S.

Current through connection	I-2	5,0 mA
" " "	II-2	10,5 mA
" " "	IV-2	5,5 mA
" " "	V-3	25 - 140 mA ("no sp"- "speech")

Collector current V_{19} & V_{20} 60 mA ("no speech")

d.c. resistance of	L_1	15 ohms
" " "	T_3 primary	2 x 28,5 ohms
" " "	T_3 secundary	37 ohms
" " "	T_5 primary	2 x 0,28 ohms
" " "	T_5 secundary	60 ohms

II. THE TRANSMITTER

General

The transmitter supplies an r.f. output adjustable between the limits of 0,4 and 40 Watts, the frequency of which is crystal-controlled.
The use of r.f. - a.f. negative feedback decreases the microphony and hum level to a very low value.
Amplitude modulation up to 70 percent is possible with the aid of the separate modulator.
The transmitter cabinet contains the necessary power supplies for the transmitter and the modulator.
Metering facilities are included for tuning and monitoring purposes.

Description of r.f. part of the transmitter (Fig. 11)

The transmitter frequency is crystal-controlled by a quartz crystal X with a fundamental frequency of 14 Mc/s.
The quartz crystal is part of a tritet oscillator with tube V_{33}, which also acts as a frequency tripler supplying a 42 Mc/s drive for the next tube V_{34}, V_{34} again tripling the frequency to 126 Mc/s, whilst V_{35} in turn triples to the final frequency of 378 Mc/s.
The r.f. power at this frequency is stepped up by cascaded straight amplifiers V_{36} and V_{37}. Final r.f. power at a level of maximum 40 Watts is taken off by a coupling loop L_{16} and fed to antenna plug P7.
A 50 ohms load will provide an optimum match.
Circuits at frequencies of 14, 42 and 126 Mc/s are of the lumped-constant type, all circuits at 378 Mc/s are of the distributed-constant, electrical half-wave type, the capacity at the far end of the line being adjustable by an integrated compression-type teflon-isolated condenser.
The r.f. voltage at the antenna plug P7 is rectified by diode V_{38} and is used for negative feedback and output power monitoring purposes.
The output power can be adjusted in 1,5 dB steps by switch S_5 between the approximate limits of 40 and 2 Watts on the "high" position of S_6 and of 8 and 0,4

Watts on the "low" position of S_6.
This power control is effected by variation of the screen grid voltage of V_{37} and of the screen grid voltage of V_{36} to a lesser extent.
By means of test switch S_4 and meter M2 the adjustment of all tuned circuits can be checked.
The test positions from 1 to 6 indicate respectively V_{34} grid drive, V_{35} grid drive, V_{36} grid drive, V_{37} grid drive, V_{37} anode current and r.f. output voltage.
The engravings near the holes in the front panel, giving access to the preset tuning controls of the screw or hexagonal nut type, correspond with the positions of the test switch to be used for each adjustment. Position 5 of the test switch serves no direct purpose in the tuning procedure but checks the input power to the output amplifier.
Filaments of V_{34}, V_{35}, V_{36} and V_{37} each are series-connected for a 12,6 V. filament supply, the filaments of V_{33} and V_{38} being adapted to this voltage by series-resistors.

<u>Description of transmitter power supply</u> (Fig. 10)
The transmitter power supply is designed to deliver 12,6 V. a.c. at 2,7 A. for the filaments, 16,5 V. a.c. at an intermittent current of 2 A. for the modulator and 350 V. d.c. at a maximum of 350 mA as the transmitter h.t.
Switch S_7 enables power transformer T_8 to be fed by either 110 V or 220 V at 50 - 60 c/s.
Switch S_3 connects or disconnects primary and secundary circuits of T_8 in three combinations "off - fil.- h.t.", indication being obtained by pilot lamps PL_1 and PL_2.
Fuses F_1 and F_2 protect the primary circuit and the secundary h.t. circuit against overloads.
Plug P_6 interconnects transmitter and modulator. It carries the 16,5 V a.c. for the modulator supply, the modulation voltage, the feedback voltage, and a safety interconnection presenting the application of h.t. voltage to the transmitter when the interconnecting cable is not plugged in at both ends.
The modulation voltage supplied by the modulator is connected in series with the h.t. supply to the r.f. output amplifier anode.

The rectifiers are connected in a single-phase voltage-doubling circuit.
Hum reduction is effected in a slightly unusual way by means of power transistors V_{31} and V_{32} in the negative h.t. lead between first and second smoothing condensers.
The internal dynamic collector-to-emitter resistance of transistors V_{31} and V_{32} is increased appreciably by current feedback with resistors R_{130} and R_{131} in the emitter leads.
The base voltages necessary for proper working conditions of transistors V_{31} and V_{32} are supplied by transistors V_{29} and V_{30} connected as cascaded emitter-followers in order to increase the base input resistance.
The input voltage should contain no a.c. component and is derived from the voltage drop across power transistors V_{31} and V_{32} with a voltage divider R_{136}, R_{137} and R_{138}, eliminated by condensers C_{69} and C_{70}.
The whole circuit shows a high dynamic resistance, in this case to be compared with several tens of Henrys of conventional smoothing choke.
Switching on the h.t. might impose a severe surge voltage on the transistors due to the charging current of the smoothing condensers C_{67} and C_{68}, flowing through transistors V_{31} and V_{32} which are at that very instant almost non-conducting because of the absence of a suitable d.c. voltage at the base connection of V_{29};
This surge voltage is limited to a safe value within the maximum ratings by Zener diodes D_{17}, D_{18}, D_{19} and D_{20}. These diodes normally are non-conducting, but become conducting rapidly when the voltage across this combination rises to more than 25 V, thus almost instantaneously charging condenser C_{69} and thereby bringing transistors V_{31} and V_{32} in a highly conductive state which prevents the buildup of a dangerous voltage across them.

Servicing of the transmitter

Access to the interior of the transmitter is obtained by loosening the sheet metal screws holding the top panel and/or the bottom panel.

Taking off these covers leaves the transmitter in working order although the tuned circuits will be detuned and unwanted interaction between them will occur, making it advisable to use only low settings of the output power control.
With the top panel taken off access is obtained to tubes V_{33}, V_{34}, V_{35} and V_{38}, the quartz crystal X, power transformer T_8, the pilot lamps and to the control panel.
The control panel can be turned aside after taking out a number of metal screws and taking off the knobs, access now being possible to plugs P_5 and P_6, meter M_2, switch S_7, fuse holders F_1 and F_2, rectifiers D_{15} and D_{17} and the transistorized smoothing circuit.
Taking off the bottom panel gives access to the switches S_3, S_4, S_5 and S_6 as well as to the wiring of the frequency multiplier stages and to the r.f. amplifier tubes. To remove either V36 or V37 the tuned anode circuit has to be taken out first. Therefore the knurled nuts of the anode clips are loosened with the aid of a small hexagonal steel tool to be found in the r.f. power amplifier compartment of the transmitter cabinet and being held there by two clips. This tool fits into holes in the knurled nuts and eases their handling. After loosening these knurled nuts a metal screw holding the tuning condenser end of the anode line in a slotted hole is loosened about two turns and the entire tuned circuit can be removed, after which the respective tube is ready for handling.
Due care should be taken not to exert dangerous stresses to the anode seals of the r.f. tubes during replacement.
A list of voltages, etc. to be used for comparison purposes in case of trouble is given hereafter.

Test data of transmitter

(Values dependent on r.f. output power)

Mains voltage		220 V R.M.S. 50 c/s
Transformer secundary	h.t.	164 V. R.M.S.
" "	fil.	13,0V R.M.S.
" "	mod.	16,9V R.M.S.

Rectified h.t. voltage	350 - 382 V
Collector voltage V_{31} & V_{32}	6,1- 11,1 V

Voltage at	V_{33}	screen grid	108 - 117 V
" "	V_{34}	" "	146 - 150 V
" "	V_{35}	" "	165 - 178 V
" "	V_{36}	" "	100 - 117 V
" "	V_{37}	" "	12 - 202 V

Voltage drop across	R_{142}	55 - 60 V
" " "	R_{146}	19 - 20,5 V
" " "	R_{150}	7,2 -7,6 V
" " "	R_{155}	4,0 -5,0 V
" " "	R_{161}	6,5 -72,5 V

d.c. resistance of	T_8 primary	3,1 and 3,4 ohms
" " "	T_8 secundary (h.t.)	6,0 ohms
" " "	T_8 secundary (fil.)	0,25 ohms
" " "	T_8 secundary (mod.)	0,32 ohms

III. THE RECEIVER

General

The base station receiver consists of a r.f. detector and an audio amplifier, permanently connected to each other by means of a coaxial cable.
The audio circuits contain a switching circuit which breaks up the amplifier chain when the base station transmitter is modulated. This is in order to prevent annoyance of the operator by his own voice at a deafening sound level and very badly distorted.
The receiver is fully transistorized as far as the audio part is concerned and is self-contained with respect to power demands by dry batteries which will last for a considerable time due to the low power drain.

Description of the circuit

Detector

The circuit diagram of the detector is given in Fig. 13.
The rectifier D_9 is a silicon crystal diode. The detector incorporates a continuously variable attenuator. By turning the outer tube the attenuation can be adjusted. Attenuation is increased by mismatching the matching section before the crystal. In the position of minimum attenuation the detector is matched for the power level which gives optimum signal to noise ratio. A matching circuit is chosen which at the same time performs the function of low pass filter in order to cut out harmonics of the transmitter which would otherwise cause a bad minimum local oscillator level.
The V.S.W.R. of the detector at minimum attenuation and a crystal current indication of 10 scale divisions (= 0,2 mA) is 1,07 with a bandwidth of 110 Mc/s between points of V.S.W.R. 2,0.
The maximum attenuation is 29 dB.
The second harmonic reduction is 20 dB.

Audio amplifier

During reception periods at the base station the

signal from the remote point, detected by crystal detector D_9, is amplified by transistor V_{23} after which it passes, via diode D_{10} and transformer T_6 through the audio switch on to the volume control R_{98}.
The signal is amplified further by transistors V_{26} and V_{27} and transfered to a low impedance level by emitter-follower V_{28}.
Negative feedback has been applied over transistors V_{26} and V_{27}, whilst C_{55} in the feedback path increases gain at the lower audio frequencies in order to make up for some of the deficiencies of the microphone used in the passive element.
During base station reception intervals transistor V_{25} is non-conducting, which renders diodes D_{10} and D_{11} in a conductive state, whilst diodes D_{12} and D_{13} are non-conducting. Therefore the attenuation of the audio signal is negligible.
Emitter resistor R_{82} of transistor V_{23} is left unbypassed for audio frequencies, but condenser C_{41} boosts the 20 kc/s input signal to be expected during base station speech transmission intervals. This 20 kc/s signal, being radiated as a modulation of the transmitted r.f. signal during said intervals is taken from V_{23} collector and fed to the 20 kc/s amplifier V_{24}. The collector load of V_{24} consists of a 20 kc/s tuned circuit C_{45} - T_7 and a detector D_{14}. the resulting d.c. voltage occurring during said intervals renders transistor V_{25} conducting, which brings the audio switch in a highly attenuating position. In this case shunt diodes D12 and D13 across T_6 primary are conducting whilst series diodes D_{10} and D_{11} are non-conducting.
The d.c. current from the detector crystal D_9 is indicated by meter M_1, shunted to a f.s.d. of about 2 mA.
The audio output from the receiver is fed to two headphone receptacles in parallel, the grounded side of which is indicated by a black dot.

Servicing of the receiver

The silicon crystal detector can be reached by turning the rear cap of the crystal holder counterclockwise

and taking it off. Access to the interior of the audio part of the receiver is obtained by removing a number of sheet metal screws holding the front and bottom covers of this unit and by taking off the knob of volume control R_{98} and switch S_2.
The position of components may be located with the aid of the component layout drawing 12A.
Batteries are contained in the metal cylinder alongside the cabinet and access to them is obtained by turning the cap counterclockwise, after which the batteries will slide out.
Before putting in new batteries it is advisable to safeguard against corrosion by covering them with spray-on plastic, taking care not to isolate the contact points of the batteries.

A list of voltages, etc. to be used for comparison purposes in case of trouble is given hereafter.

Test data of receiver

Battery voltage	4,3 V
Battery current (unmodulated transmitter)	3,8 mA
Battery current (modulated transmitter)	4,8 mA
Emitter voltage V_{23}	0,34 V
" " V_{24}	1,74 V
" " V_{25} (unmodulated transm.)	0,03 V
" " V_{25} (modulated transm.)	0,20 V
" " V_{26}	0,81 V
" " V_{27}	0,72 V
" " V_{28}	0,55 V
Collector voltage V_{23}	1,8 V
" " V_{25}(unmodulated transm.)	3,75 V
" " V_{25}(modulated transm.)	0,3 V
" " V_{26}	2,05 V
Voltage at junction R_{94}- R_{95} (unmodulated transmitter)	3,1 V
Voltage at junction R_{94}- R_{95} (modulated transmitter)	2,05 V
Voltage at junction D_{14}- C_{47} (modulated transmitter)	0,6 V
Primary resistance T_6	2 x 190 ohms
Secundary resistance T_6	250 ohms
Primary resistance T_7	24 ohms
Secundary resistance T_7	16 ohms

IV. ANTENNA AND DUPLEXER

The duplexer

The duplexer consists of a coaxial directional coupler and two tuners.
The configuration is clearly shown in the attached photograph (Fig. 14A) and the circuit diagram is given in Fig. 14.
The characteristics of the directional coupler at a frequency of 378 Mc/s are:

Coupling:	-5,8 dB
Insertion loss:	1,7 dB
V.S.W.R.:	1,02
Directivity:	-31,4 dB

Isolation between transmitter and detector arm: 37,2 dB

The tuners are especially designed for the purpose, the main advantages over a normal double stub tuner being:

1. No sliding contacts, preventing severe crackling noise in the receiver during tuning procedure.
2. Large bandwidth in order to reduce detection of frequency modulated components from the transmitter.
3. Smaller size.

In case of damage to the duplexer replacement and realignement should preferably be carried out in the laboratory.

The antenna

The antenna is a 2 bay 4 element Yagi-array.
The spacings between elements and the element lengths were optimized with respect to gain and front to back ratio. Thereby the total length of the antenna was kept within 60 cm, dictated by the available storage space.
The characteristics of the antenna are:

Gain:	15 dB
Front to back ratio:	20 dB
Centerfrequency:	378 Mc/s
Bandwidth:	30 Mc/s

A closer inspection of the photographs (Fig. 2 and 3)

of the Operational Manual will show how the antenna is constructed.
Both Yagi-arrays are in broadside configuration and interconnected by a coaxial T, which incorporates two 1/4 wavelength transformers in order to provide a 50 ohm match at all three terminals.
The Yagi-arrays are individually matched with a coil.
The broadside configuration requires the Yagi-arrays to be non-identical with respect to the connection to the coaxial line, but to have the connections transposed, whereby the center conductors are connected to the elements at the same side of the antenna in the assembled condition.
For the Yagi-arrays and the coaxial T,"General Radio" panel connectors type 874 - PB and basic connectors type 874 - B were used respectively.
When servicing to one of the connectors becomes necessary, careful attention should be paid to the instructions contained in the "Assembly instructions" for General Radio connectors, included in this manual.

V. THE PASSIVE ELEMENT

General

The passive element contains a dipole antenna, a silicon crystal detector, a junction unit, a pair of headphones, a three-stage transistorized audio amplifier and a microphone.
The r.f. field set up by the transmitter activates the dipole and detector, the resulting rectified voltage being used to supply the d.c. power needed for operation of the audio amplifier.
The microphone voltage is amplified in the audio amplifier and the last transistor is connected as a direct load across the rectifier output, the value of which load is modulated by the amplified microphone signals. The load variations on the crystal detector cause the r.f. impedance offered to the dipole to change accordingly. This means that the amount of power absorbed or reflected by the dipole is modulated also.
The d.c. voltage from the silicon detector also contains an a.c. component when the transmitter at the base station is amplitude-modulated. This a.c. component is fed to a pair of headphones via a junction unit. These headphones will reproduce the speech modulation on the base station transmitter.
When the special features of carrier-pigeon operation are not essential, the headphones and the junction unit can be omitted, after which normal Easy-Chair operation is possible.

Circuit description of the audio part

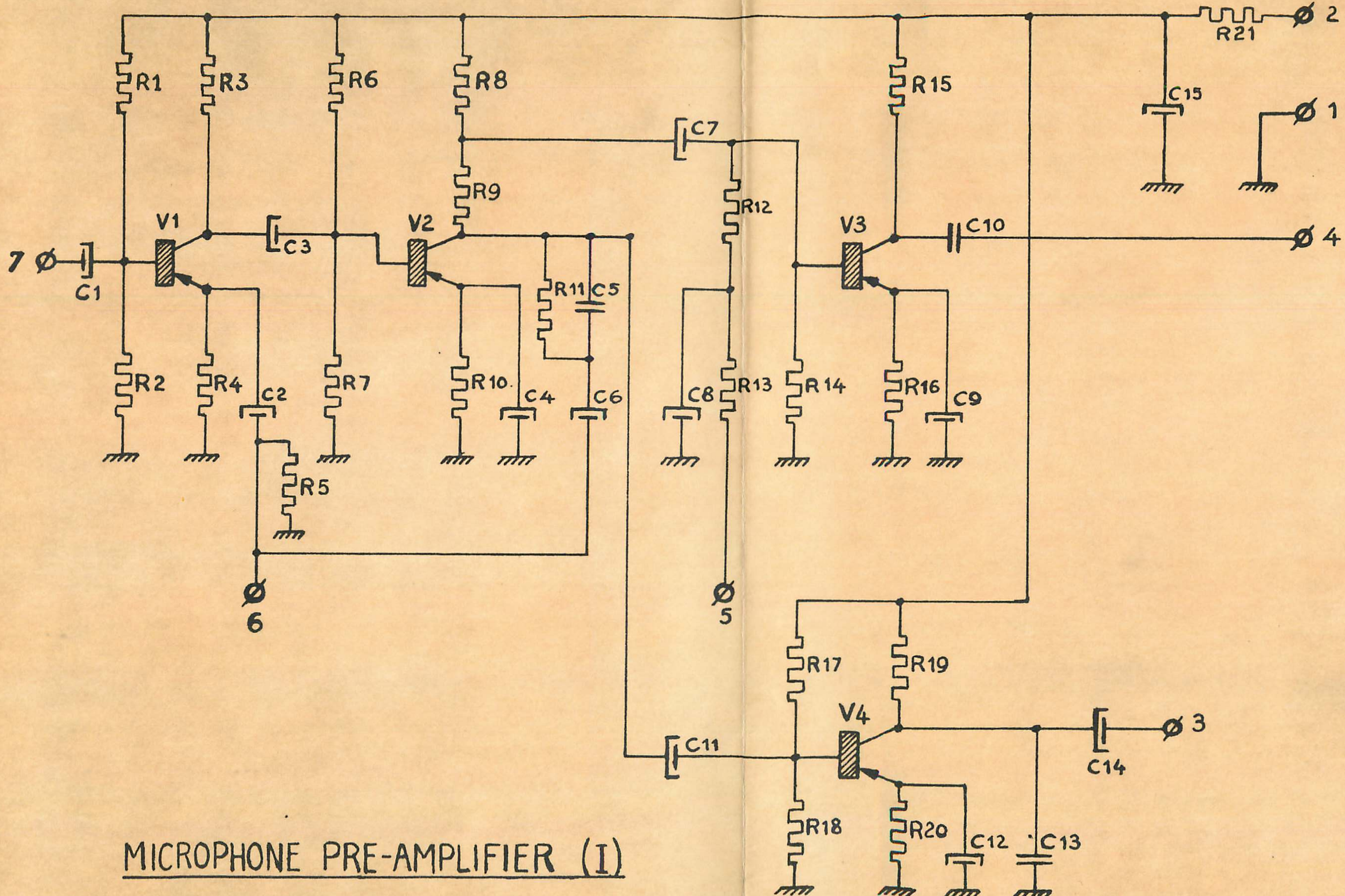
The audio amplifier has been molded in opaque epoxy resin. Connections are made by means of colour-marked miniaturized receptables.
The circuit diagram is given in Fig. 15.
All transistors are operating in the grounded emitter way, the coupling impedances for transistors V_{33} and V_{34} being inductances L_{17} and L_{18}. The load impedance as seen by the output transistor V_{35} is the internal impedance of the rectifier d.c. output circuit.

This rectifier output circuit at the same time delivers the d.c. supply power necesaary for operation of the transistors. The amplified microphone voltage however is at the same time superimposed on this d.c. voltage and has to be removed before the d.c. voltage can be used to supply transistors V_{33} and V_{34}. This filtering is done with inductances L_{19} and L_{20} and condensers C_{100} and C_{101}.
The power requirements for the audio amplifier had to be as low as possible and therefore no temperature compensation or frequency characteristic corrections have been included. As a result the characteristics of the passive element are to a certain amount governed by circumstances, but normal ranges of temperature and component tolerances will give no rise to any trouble.
A pair of headphones is connected, via a d.c. blocking condenser C_{103}, across the wires connecting the audio amplifier and the detector. These headphones should be of the high-impedance variety.
The amplified passive element microphone voltage can also be heard in these headphones and might give an experienced operator useful indications about the activating power level of the passive element.
When the headphones are close to the passive element microphone, accoustic feedback will occur, producing a sustained note which might be helpful during initial setting-up trials at the base station.

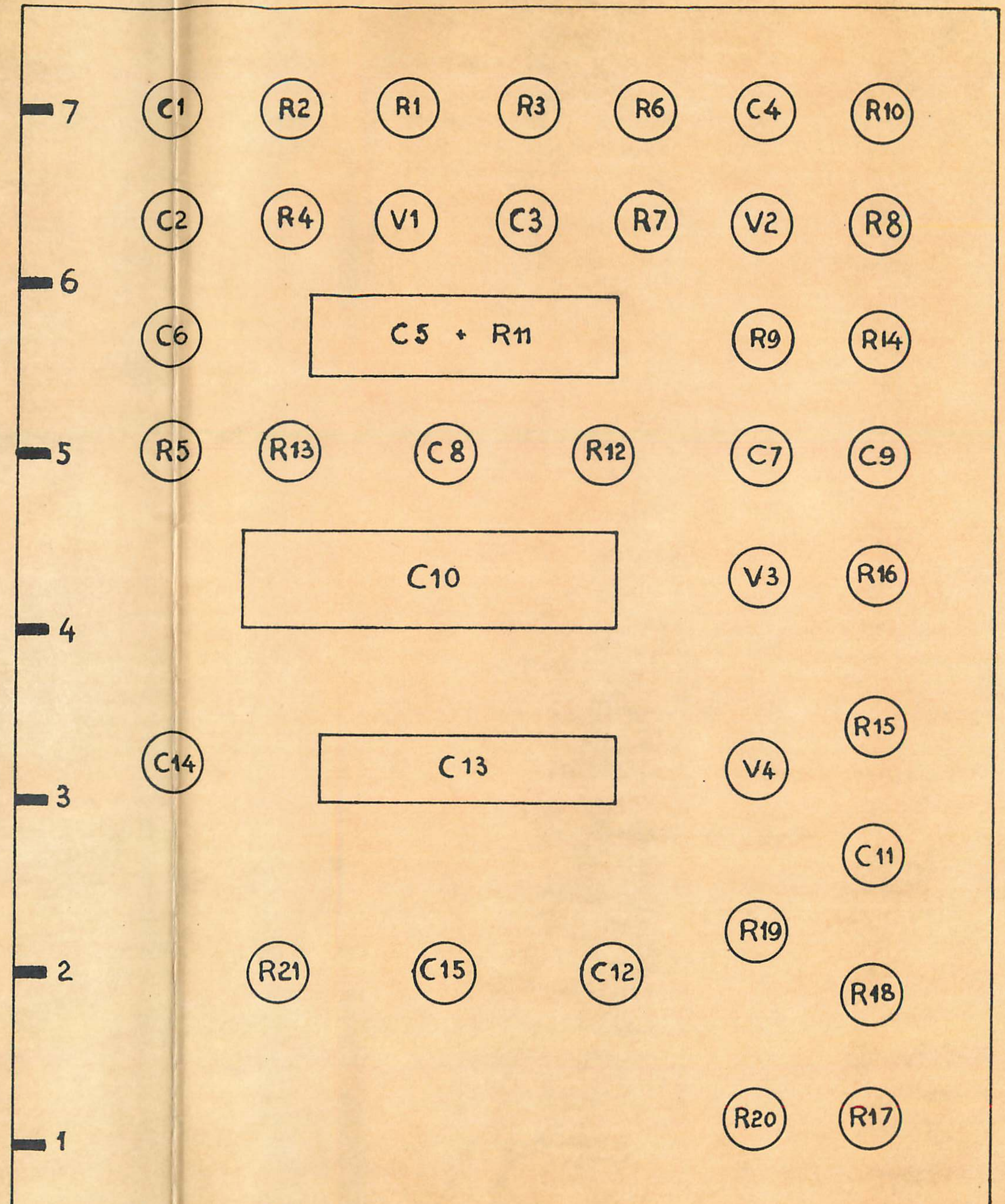
Description of the r.f. part

The r.f. part consists of a dipole and a crystal rectifier. The rectified current is fed to two miniaturized receptacles via r.f. chokes.
The crystal rectifier is a cartridge type crystal CS2A (British Thomson Houston). Other types of r.f. crystal rectifiers such as the 1N22 can be used as well, whereby attention should be paid to the polarity.
The dipole is made longer than half a wavelength to obtain a better match to the impedance of the crystal.
The inductance due to the increase in length at the same time matches the stray capacitance of the crystal.
The nature of the substance wherein the dipole is suspended determines the optimum length of the dipole.
In general it can be said that the optimum length

of a dipole suspended in a non-conducting substance with relative dielectric constant K $= \frac{1}{\sqrt{K}}$ times the optimum length in free space.
The dipole is made of insulated wire. This has the advantage that the dipole can be bent somewhat, whereby the performance will not be reduced seriously.
The insulation reduces attenuation by objects to which the dipole is mounted. The crystal rectifier can be replaced easily.
The red dot on the perspex housing marks the positive receptacle.
Whenever soldering near the crystal is necessary, care should be taken, not to heat the crystal or, even better, the crystal should be taken out.
Crystal rectifiers will be damaged by mishandling or exposure to strong radio frequency fields. Care should be taken therefore, to keep the dipoles away from the transmitter antenna when power is switched on. In addition it is recommended to keep the dipole perpendicular to the rods of the transmitting antenna when the dipoles are not in use.



MICROPHONE PRE-AMPLIFIER (I)



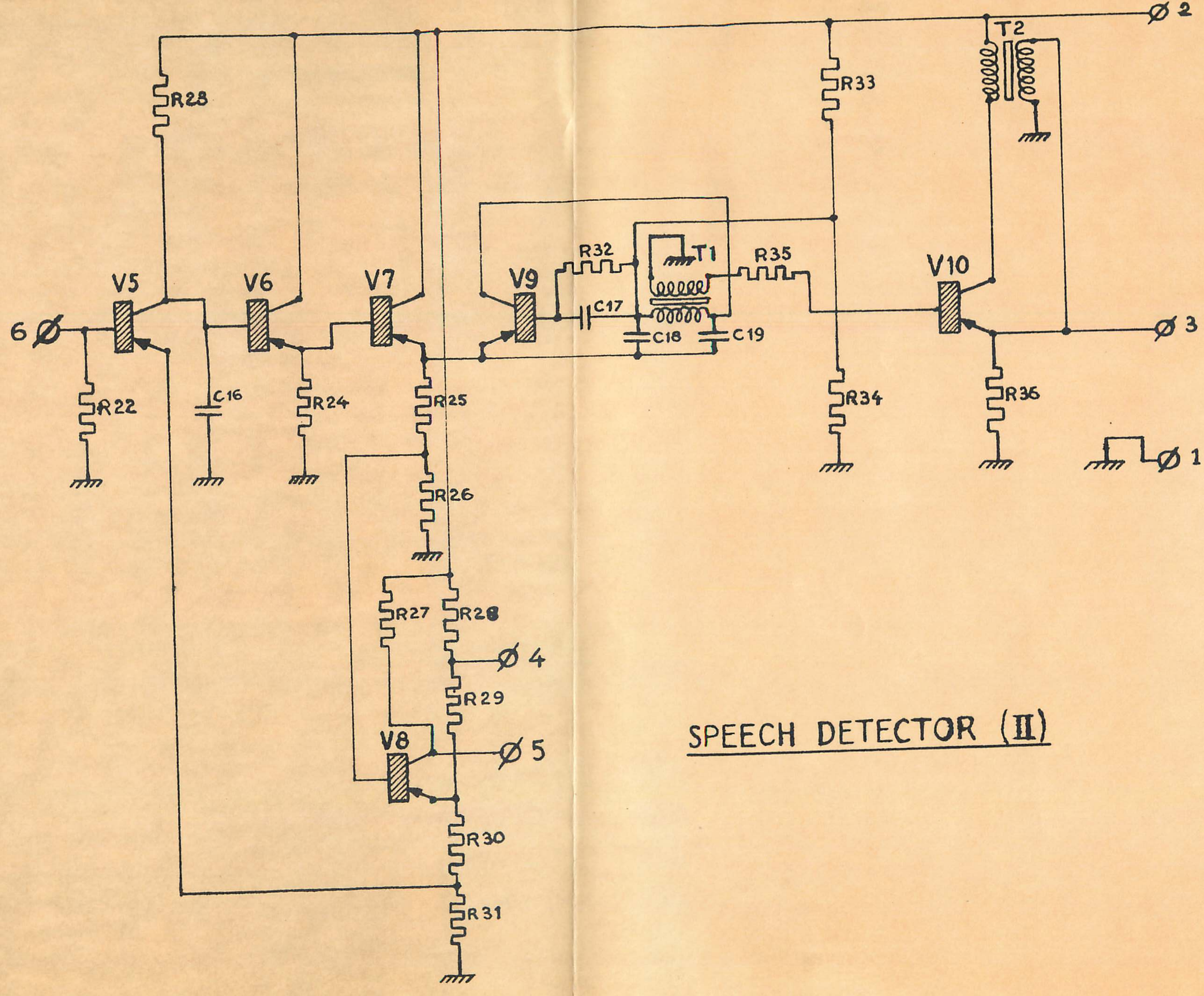
MICROPHONE PRE-AMPL. I A

Modulator components, unit I, Fig. 1

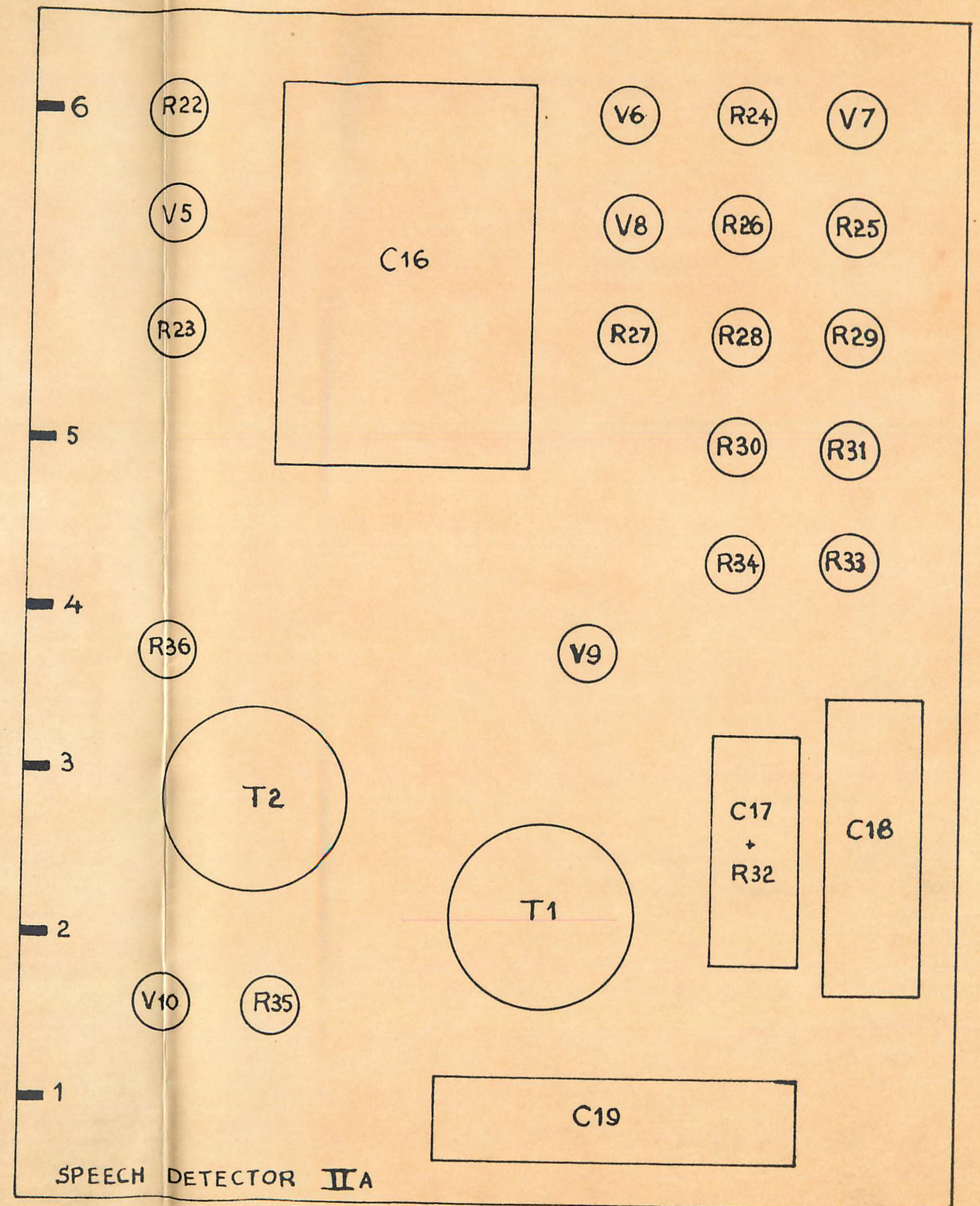
R1	resistor,	Erie,	22.000 ohms,	1 W	10%	
R2	"	"	8.200 "	½ W	"	
R3	"	"	3.900 "	½ W	"	
R4	"	"	2.200 "	½ W	"	
R5	"	"	3.900 "	½ W	"	
R6	"	"	22.000 "	1 W	"	
R7	"	"	8.200 "	½ W	"	
R8	"	"	680 "	½ W	"	
R9	"	"	1.200 "	½ W	"	
R10	"	"	1.200 "	½ W	"	
R11	"	"	3.900 "	½ W	"	
R12	"	"	39.000 "	1 W	"	
R13	"	"	220.000 "	1 W	"	
R14	"	"	8.200 "	½ W	"	
R15	"	"	1.200 "	½ W	"	
R16	"	"	680 "	½ W	"	
R17	"	"	27.000 "	1 W	"	
R18	"	"	4.700 "	½ W	"	
R19	"	"	2.700 "	½ W	"	
R20	"	"	390 "	½ W	"	
R21	"	"	100 "	½ W	"	

C_1	condenser	Philips	1 mf	6 VDCW	electrolytic
C_2	"	"	32 "	3 "	"
C_3	"	"	1 "	6 "	"
C_4	"	"	32 "	3 "	"
C_5	"	Wima	0,01 mf	500 VDCW	paper
C_6	"	Philips	8 mf	25 "	electrolytic
C_7	"	"	8 "	25 "	"
C_8	"	"	25 "	25 "	"
C_9	"	"	25 "	25 "	"
C_{10}	"	Wima	0,1 mf	500 "	paper
C_{11}	"	Philips	1 mf	6 "	electrolytic
C_{12}	"	"	8 "	25 "	"
C_{13}	"	Wima	0,05 mf	500 "	paper
C_{14}	"	Philips	1 mf	6 "	electrolytic
C_{15}	"	"	50 "	12,5"	"

V_1	transistor	Philips	OC71
V_2	"	"	OC71
V_3	"	"	OC71
V_4	"	"	OC71



SPEECH DETECTOR (II)


6
5
4
3
2
1
R22
V5
R23
C16
V6
R24
V7
V8
R26
R25
R27
R28
R29
R30
R31
R34
R33
R36
V9
T2
T1
C17
+
R32
C18
V10
R35
C19
SPEECH DETECTOR II A

Modulator components, unit II, Fig. 2

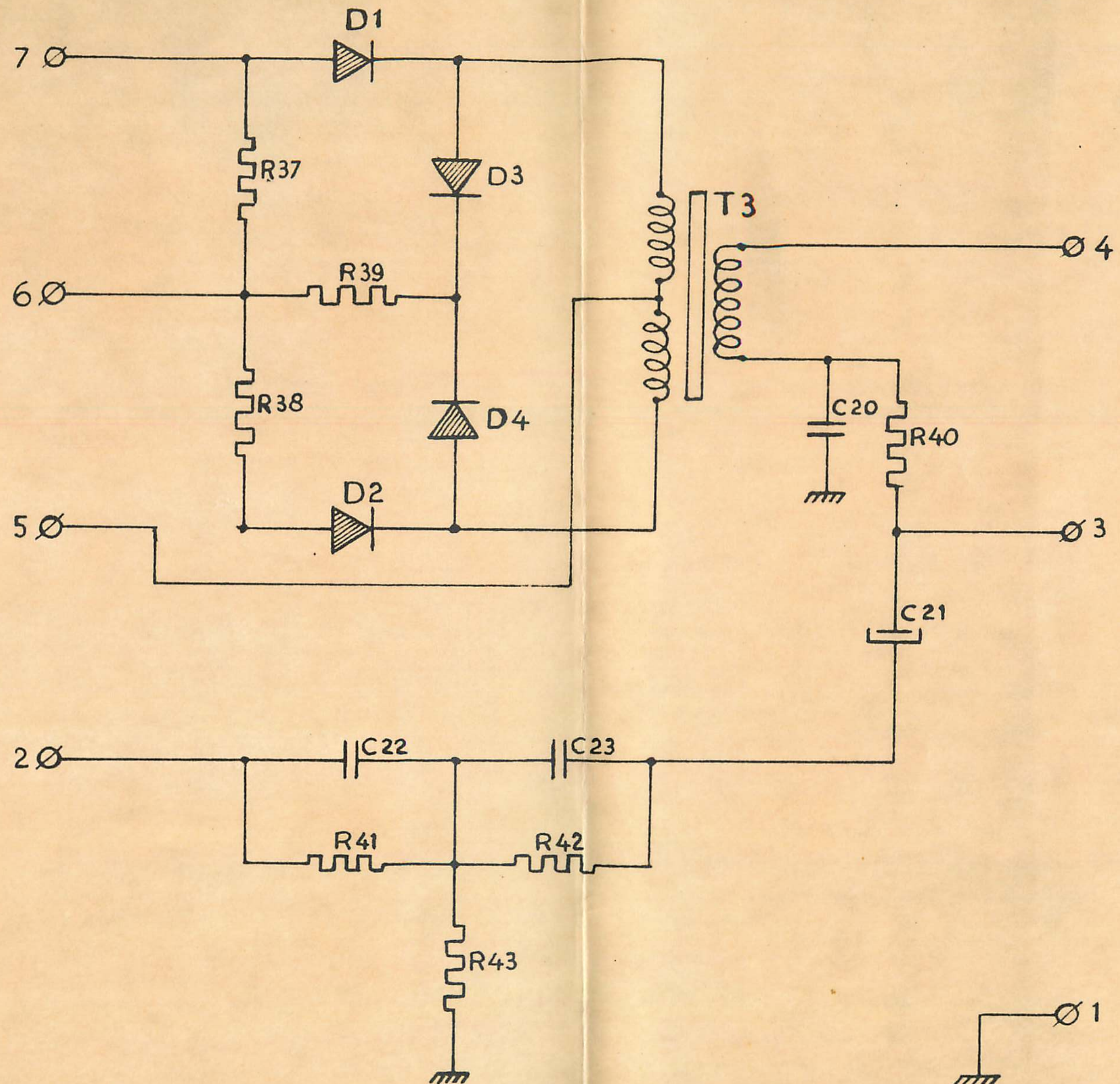
R_{22}	resistor	Erie	5.600	ohms	½ W	10 %
R_{23}	"	"	470.000	"	1 W	"
R_{24}	"	"	390.000	"	1 W	"
R_{25}	"	"	4.700	"	½ W	"
R_{26}	"	"	3.300	"	½ W	"
R_{27}	"	"	1.800	"	½ W	"
R_{28}	"	"	470	"	½ W	"
R_{29}	"	"	330	"	½ W	"
R_{30}	"	"	120	"	½ W	"
R_{31}	"	"	27	"	½ W	"
R_{32}	"	"	220.000	"	1 W	"
R_{33}	"	"	1.500	"	½ W	"
R_{34}	"	"	4.700	"	½ W	"
R_{35}	"	"	1.000	"	½ W	"
R_{36}	"	"	27	"	½ W	"

C_{16}	condenser	Wima	1	mf	500	VDCW	paper
C_{17}	"	"	0,05	"	500	"	"
C_{18}	"	"	0,1	"	500	"	"
C_{19}	"	Ducati	0,0127	"	500	"	mica, 1%

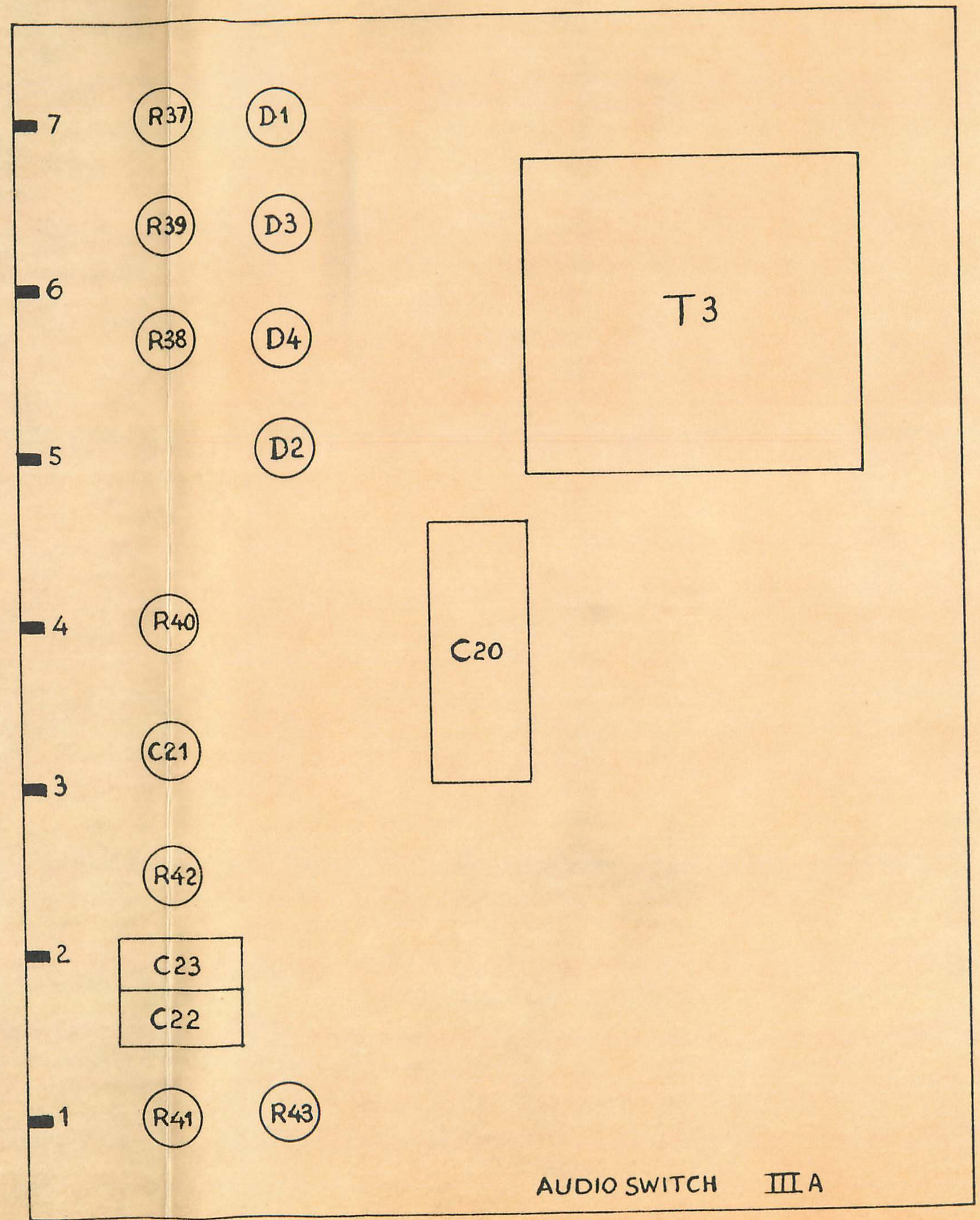
V_5	transistor	Philips	OC44
V_6	"	"	OC44
V_7	"	"	OC71
V_8	"	"	OC71
V_9	"	"	OC71
V_{10}	"	"	OC73

T_1 transformer Philips Ferroxcube core D18-12
airgap 0,2 mm
prim. 230 turns 0,2 mm en. L=6,1 mH
sec. 50 turns 0,2 mm en.

T_2 transformer Philips Ferroxcube core D18-12
airgap 0,0 mm
prim. 225 turns 0,22mm en. L=50 mH
Sec. 30 turns 0,22mm en.



AUDIO SWITCH (III)


7
R37
D1
R39
D3
6
R38
D4
T3
5
D2
4
R40
C20
C21
3
R42
2
C23
C22
1
R41
R43
AUDIO SWITCH III A

Modulator components, unit III, Fig. 3

R37	resistor	Erie	3.300	ohms	½ W	10%
R38	"	"	3.300	"	½ W	"
R39	"	"	2.200	"	½ W	"
R40	"	"	12.000	"	1 W	"
R41	"	"	47.000	"	1 W	"
R42	"	"	82.000	"	1 W	"
R43	"	"	3.900	"	½ W	"

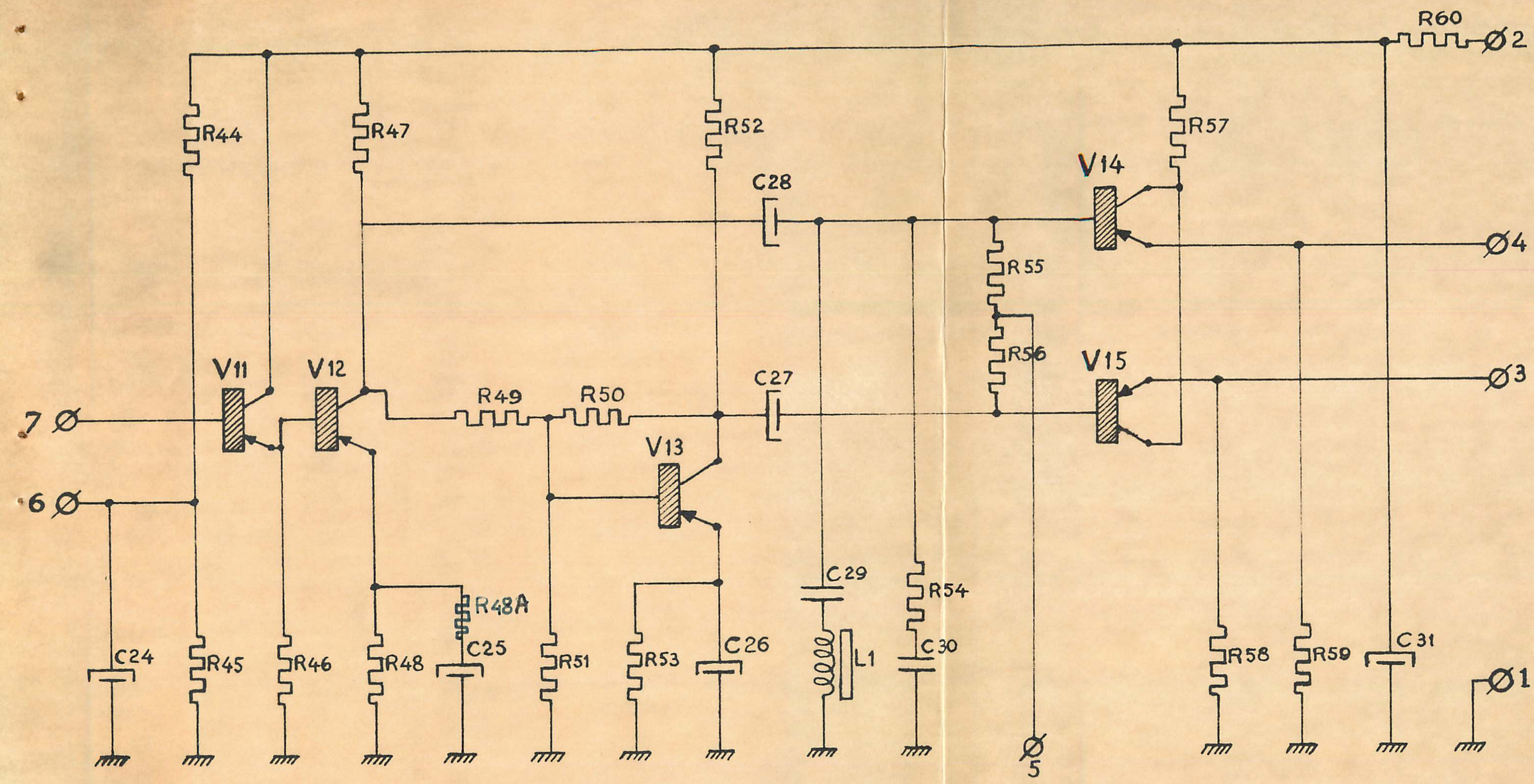
C20	condenser	Wima	0,03	mf	500 VDCW	paper
C21	"	Philips	25	"	25 "	electrolytic
C22	"	"	220	mmf	500 "	mica, 2%
C23	"	"	150	"	500 "	" "

D1	germanium diode	Philips	0A81
D2	" "	"	0A81
D3	" "	"	0A81
D4	" "	"	0A81

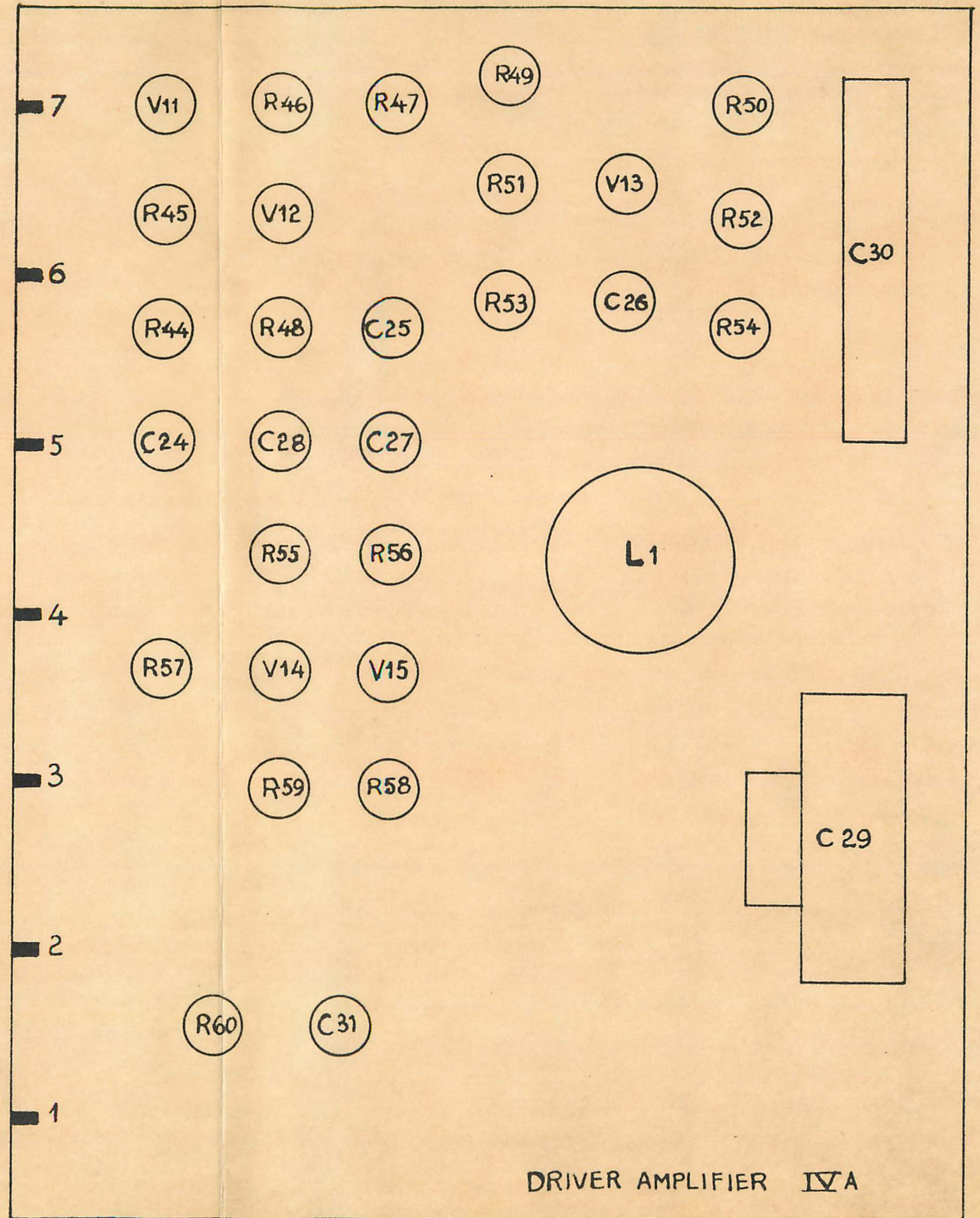
T3 transformer

laminated mu-metal core
core area 7 x 7 mm^2, airgap 0,0mm
prim. 2 x 600 turns bifilar wound, 0,14 mm en.
sec. 600 turns 0,14 mm en.

enclosed in mu-metal screening can, wall thickness 1 mm.



DRIVER AMPLIFIER (IV)

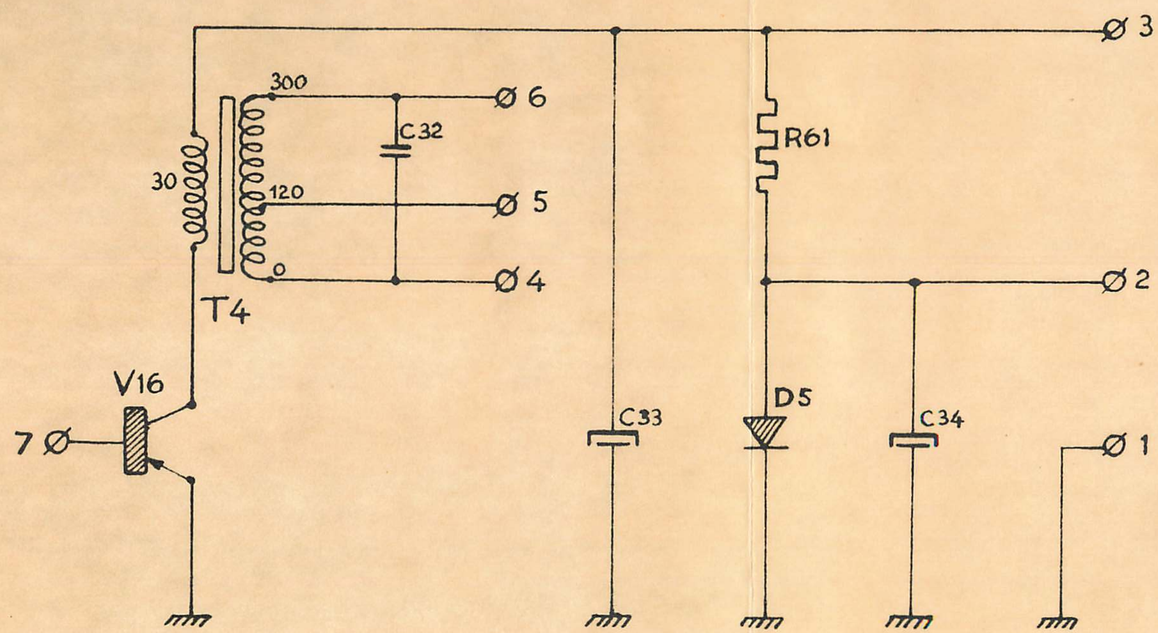

7
6
5
4
3
2
1
V11
R46
R47
R49
R50
R45
V12
R51
V13
R52
C30
R44
R48
C25
R53
C26
R54
C24
C28
C27
R55
R56
L1
R57
V14
V15
R59
R58
C 29
R60
C31
DRIVER AMPLIFIER IV A

Modulator components, unit IV, Fig. 4

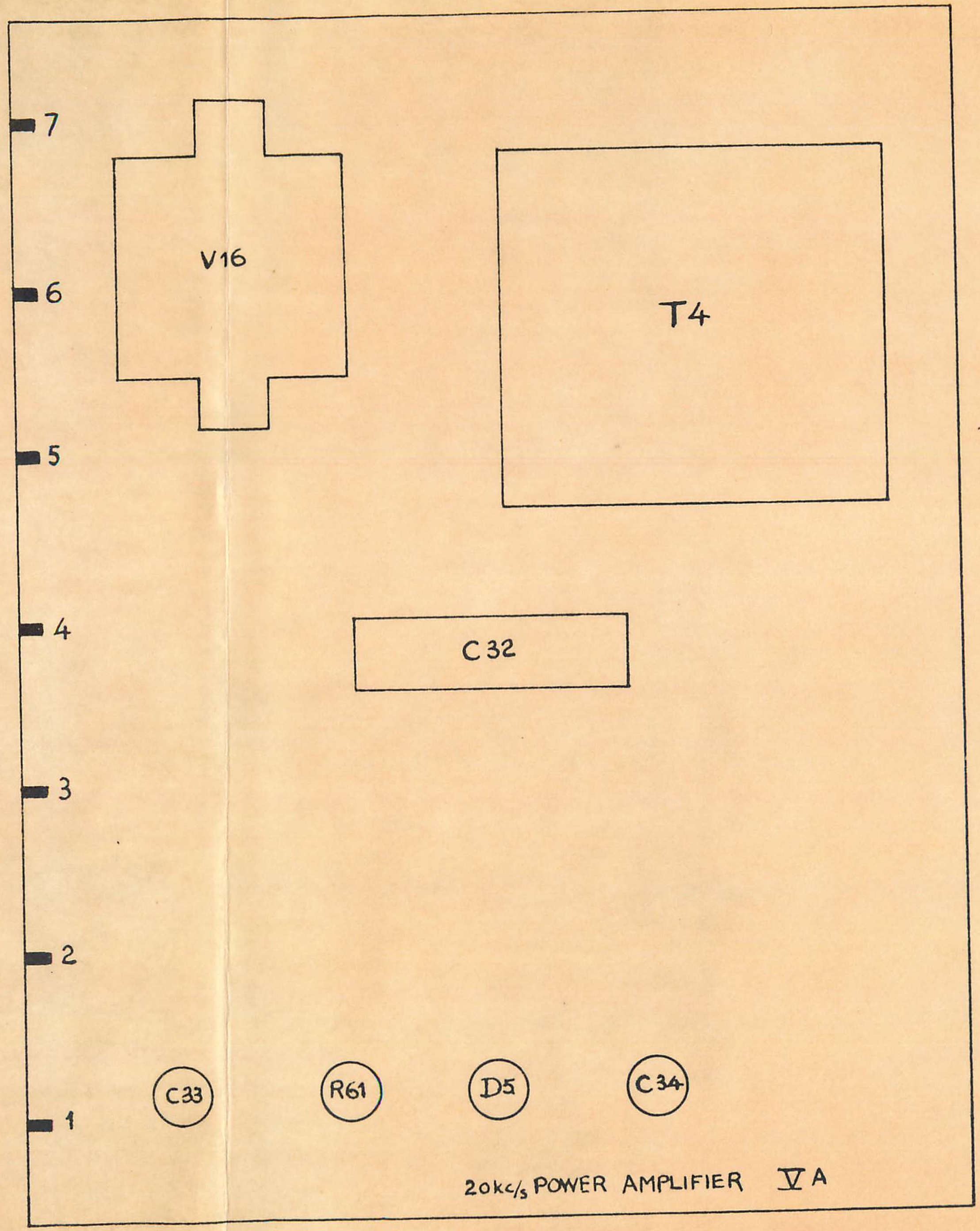
R44	resistor	Erie	15.000	ohms	1	W	10%
R45	"	"	5.600	"	½	W	"
R46	"	"	1.800	"	½	W	"
R47	"	"	1.500	"	½	W	"
R48	"	"	680	"	½	W	"
R49	"	"	10.000	"	½	W	"
R50	"	"	10.000	"	½	W	"
R51	"	"	3.300	"	½	W	"
R52	"	"	1.500	"	½	W	"
R53	"	"	680	"	½	W	"
R54	"	"	180	"	½	W	"
R55	"	"	4.700	"	½	W	"
R56	"	"	4.700	"	½	W	"
R57	"	"	560	"	½	W	"
R58	"	"	820	"	½	W	"
R59	"	"	820	"	½	W	"
R60	"	"	39	"	½	W	"
R48A	"	"	56	"	½	W	"
C24	condenser	Philips	32	mf	3	VDCW	electrolytic
C25	"	"	32	"	3	"	"
C26	"	"	32	"	3	"	"
C27	"	"	25	"	25	"	"
C28	"	"	25	"	26	"	"
C29	"	Wima	0,0174	"	500	"	paper
C30	"	"	0,05	"	500	"	"
C31	"	Philips	50	"	12,5	"	electrolytic

V11	transistor	Philips	OC71
V12	"	"	OC71
V13	"	"	OC71
V14	"	"	OC71
V15	"	"	OC71

L1 inductance Philips Ferroxcube core D14-8
air-gap 0,2 mm 220 turns 0,13 en.
L = 3,6 mH



20 kc/s POWER AMPLIFIER (V)


7
6
5
4
3
2
1
V16
T4
C32
C33
R61
D5
C34
20kc/s POWER AMPLIFIER V A

Modulator components, unit V, Fig. 5

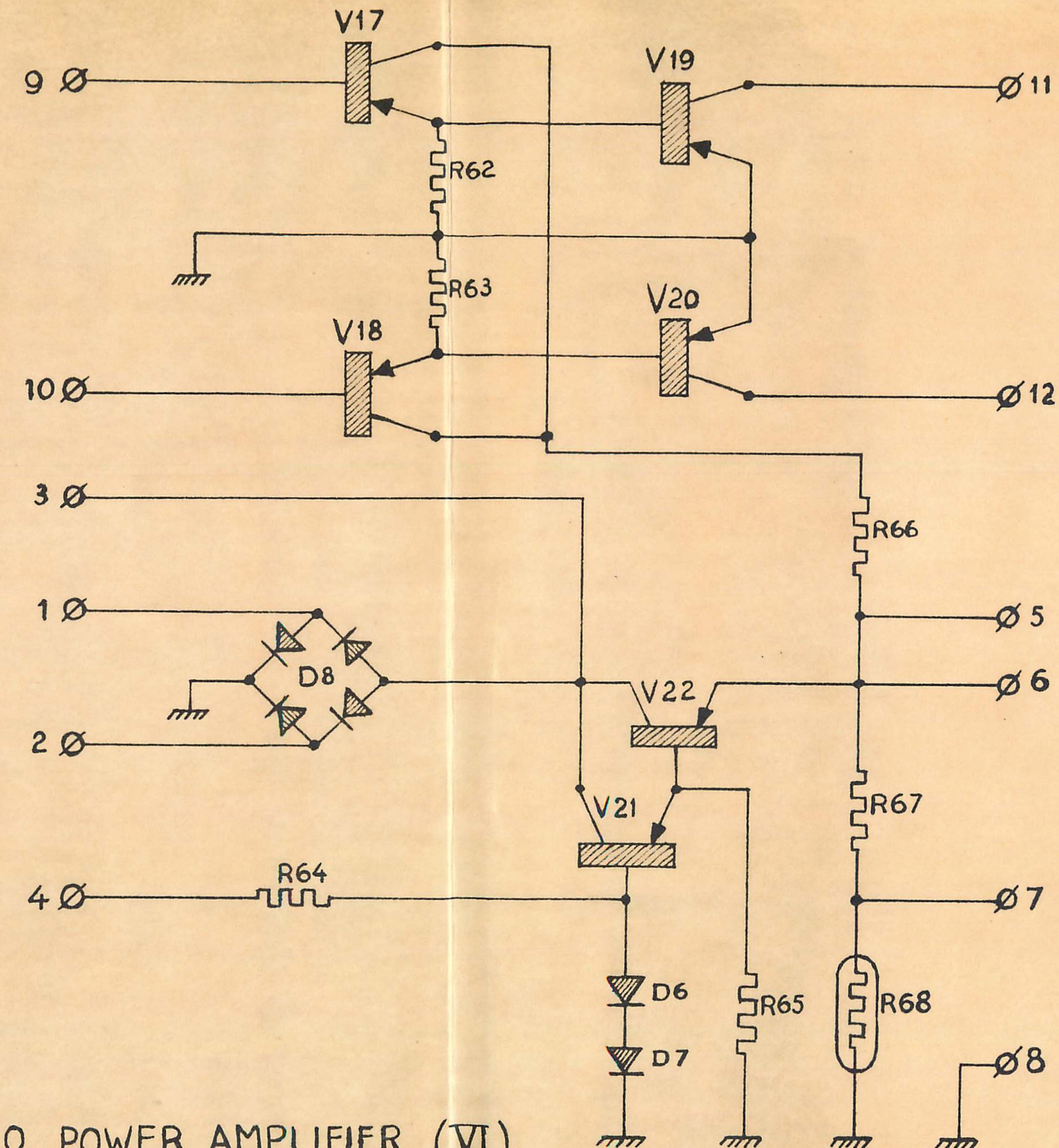
R_{61} resistor Erie 270 ohms ½ W 10%

C_{32} condenser Philips 820 mmf 500 VDCW mica 2%
C_{33} " 25 mf 25 " electrolytic
C_{34} " 25 mf 25 " "

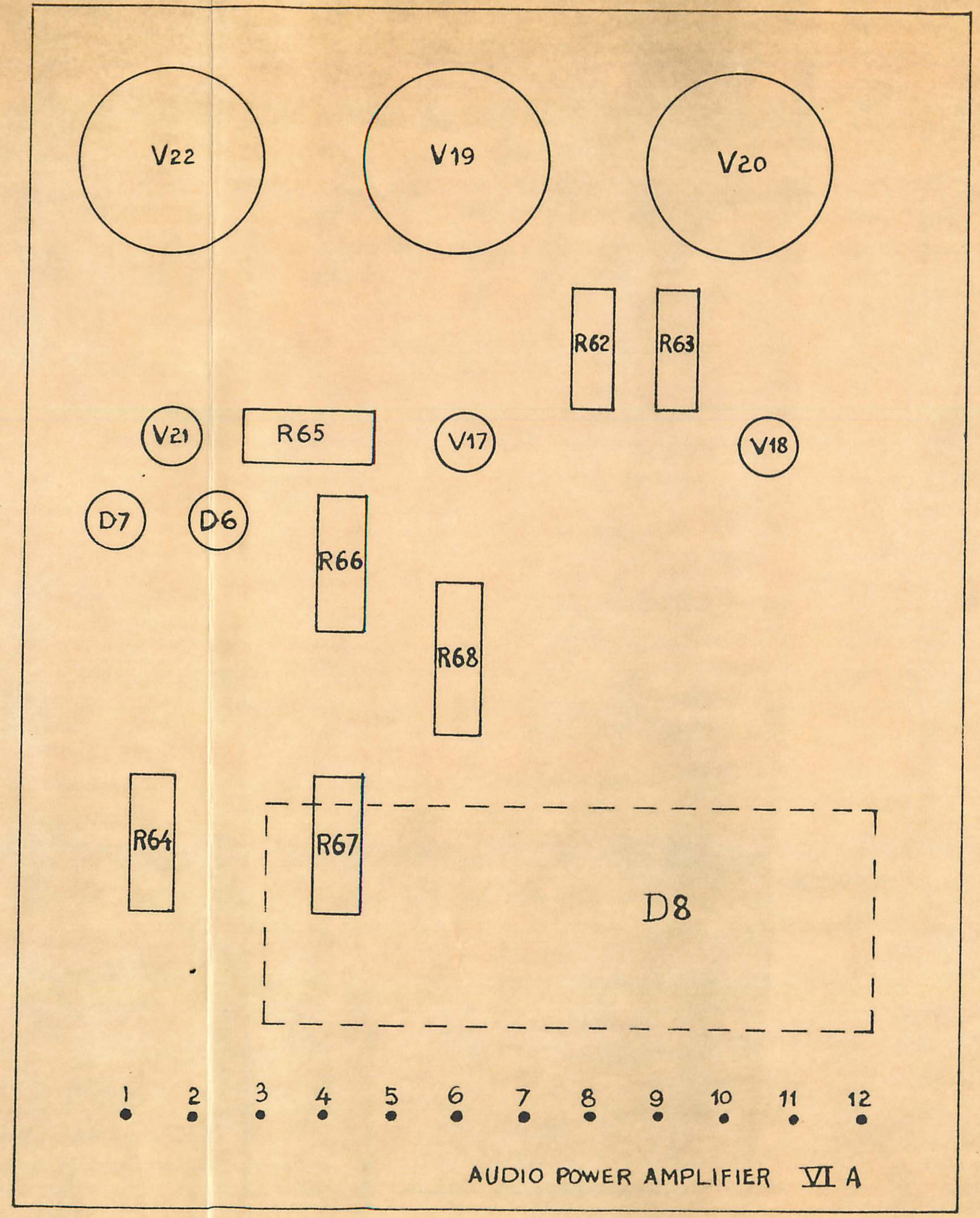
V_{16} transistor Philips OC16

D_5 silicon diode Intermetall Z6 ZENER 6,5 Volts

T_4 transformer Philips Ferroxcube D36-22
air-gap 0,15 mm
prim. 30 turns, 0,4 mm en.
sec. 300 turns tapped at 120 turns,
0,28 mm en. L=62mH.



AUDIO POWER AMPLIFIER (VI)



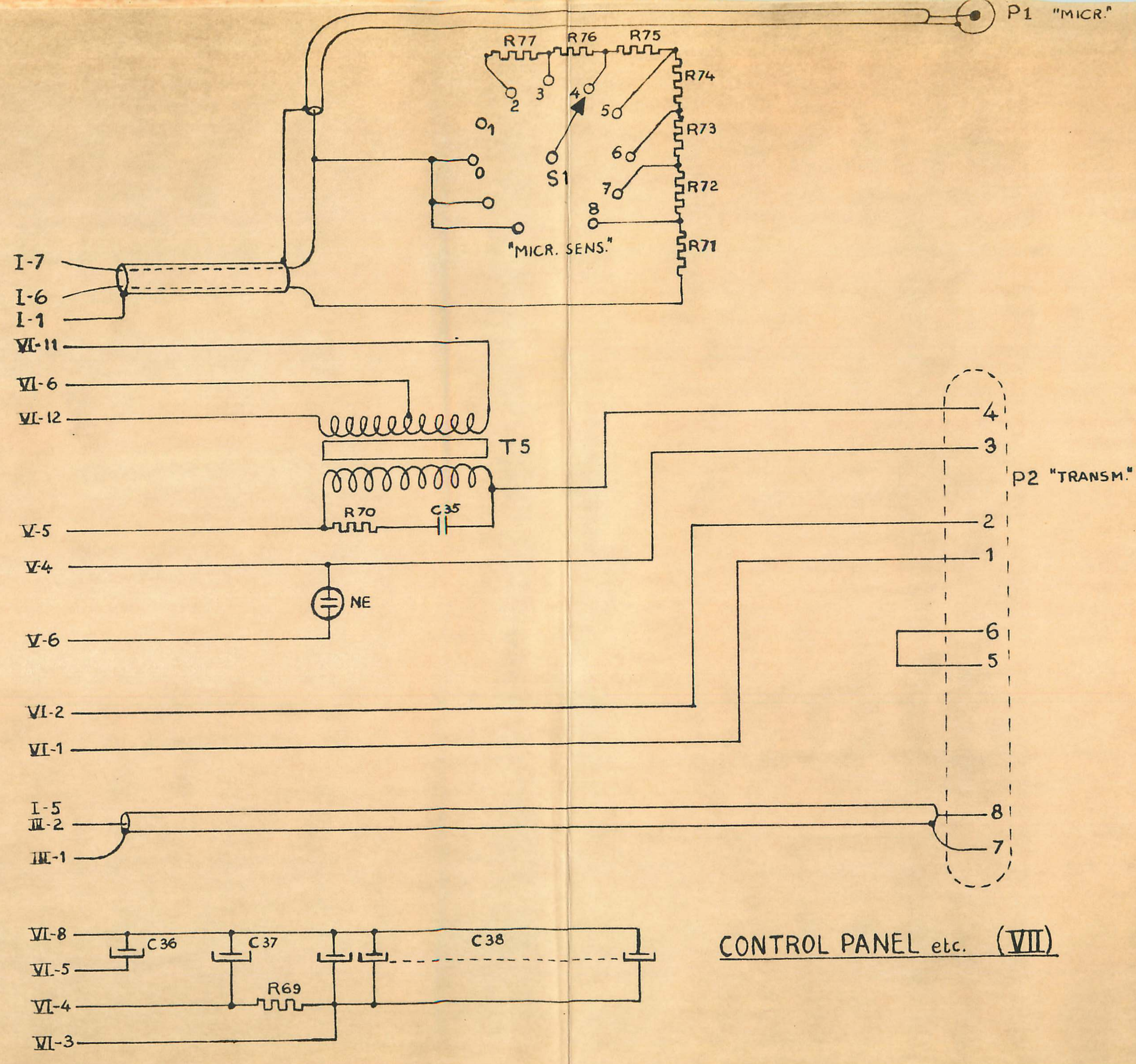
V22
V19
V20
R62
R63
V21
R65
V17
V18
D7
D6
R66
R68
R64
R67
D8
1 2 3 4 5 6 7 8 9 10 11 12
AUDIO POWER AMPLIFIER VI A

Modulator components, unit VI, Fig. 6

R62	resistor	Erie	82	ohms	½ W	10%
R63	"	"	82	"	½ W	"
R64	"	"	180	"	½ W	"
R65	"	"	2.200	"	½ W	"
R66	"	"	82	"	½ W	"
R67	"	"	12.000	"	1 W	"
R68	"	Philips	470	"	NEG.TEMP.COEFF.	

V17	transistor	Philips	OC72
V18	"	"	OC72
V19	"	"	OC16
V20	"	"	OC16
V21	"	"	OC76
V22	"	"	OC16

D6	silicon diode	Intermetall	Z6 ZENER	6,5 Volts
D7	" "	"	Z7 "	7,5 Volts
D8	selenium bridge rectifier Siemens, modified for 30 V - 1,2Amps.			



CONTROL PANEL etc. (VII)

Modulator components, unit VII, Fig. 7

R69	resistor	Erie	330 ohms	$\frac{1}{2}$ W	10%	
R70	"	"	820 "	1 W	"	
R71	"	"	10 "	$\frac{1}{2}$ W	"	
R72	"	"	18 "	$\frac{1}{2}$ W	"	
R73	"	"	27 "	$\frac{1}{2}$ W	"	
R74	"	"	56 "	$\frac{1}{2}$ W	"	
R75	"	"	100 "	$\frac{1}{2}$ W	"	
R76	"	"	330 "	$\frac{1}{2}$ W	"	
R77	"	"	1000 "	$\frac{1}{2}$ W	"	

C35	condenser	Wima	0,03	mf	500VDCW	paper
C36	"	Philips	100	"	25 "	elec-
C37	"	"	100	"	25 "	trolytic
C38	"	"	18 x 100	"	25 "	"

NE neon indicator, Philips, operating voltage 90 VDC

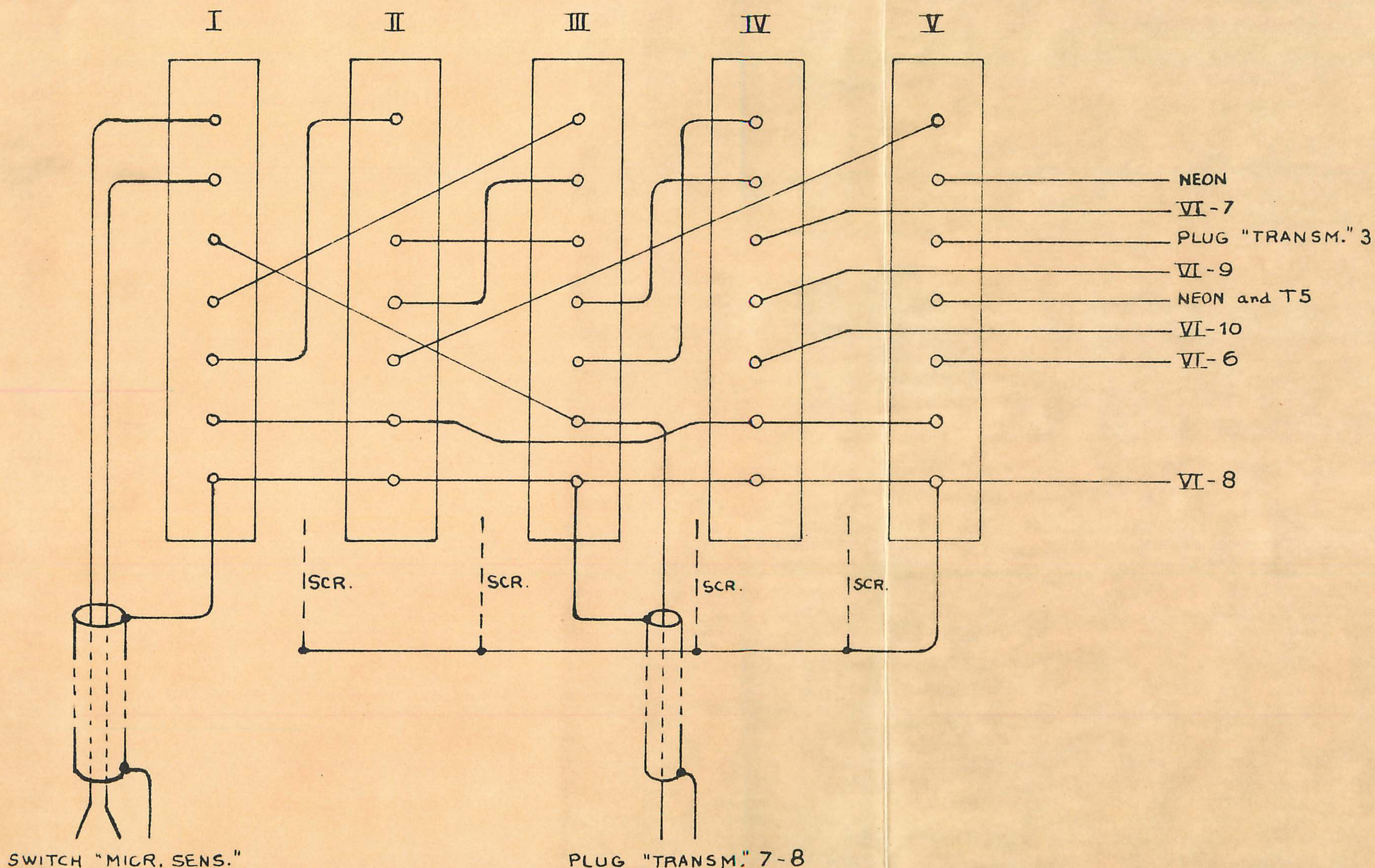
S_1 switch, 1 contact, 11 positions

P_1 plug, Amphenol, coaxial, microphone type

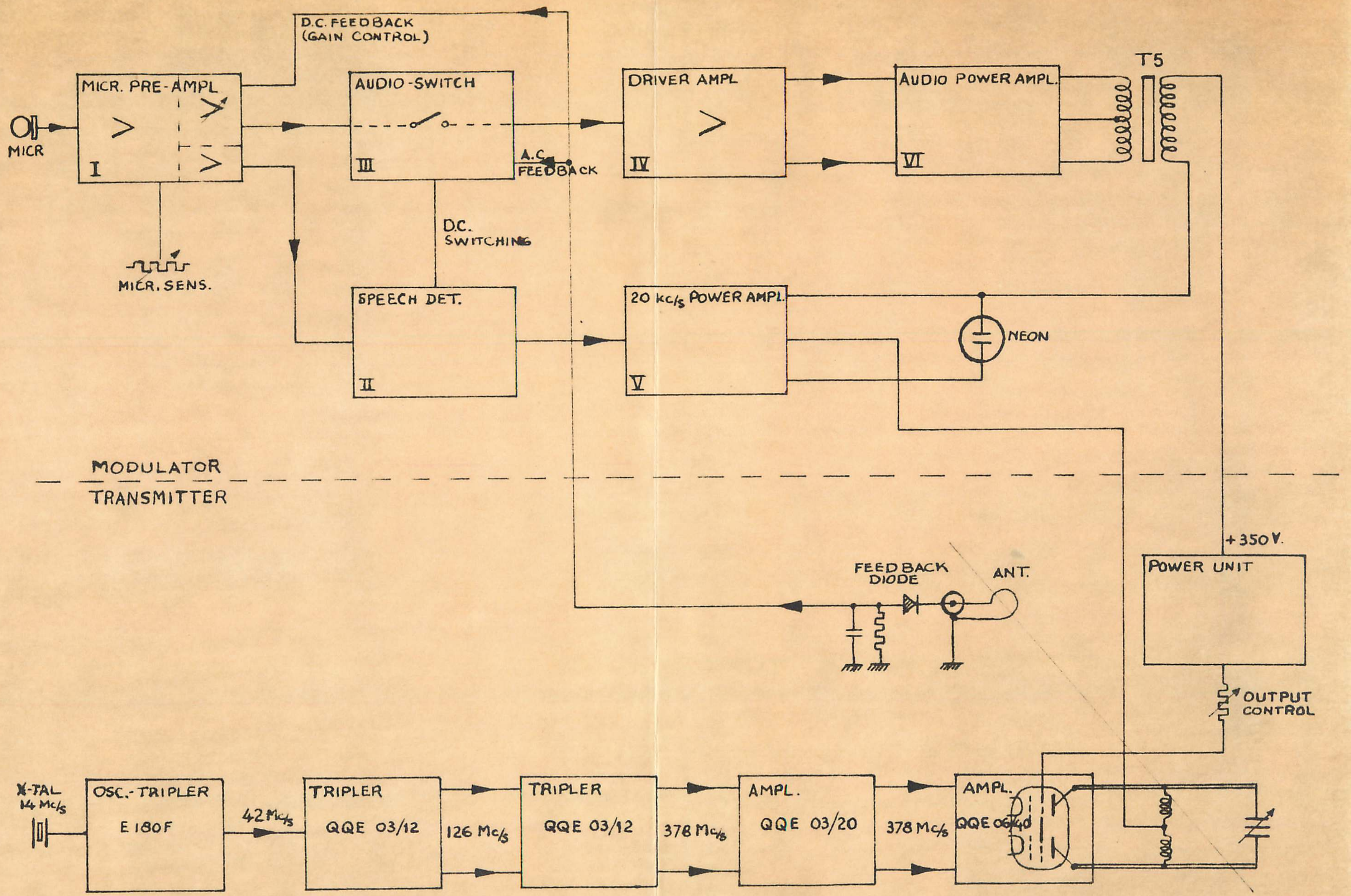
P_2 plug, ELCOM, 8-way, male

T_5 transformer, laminated iron core, core area 30 x 20 mm^2

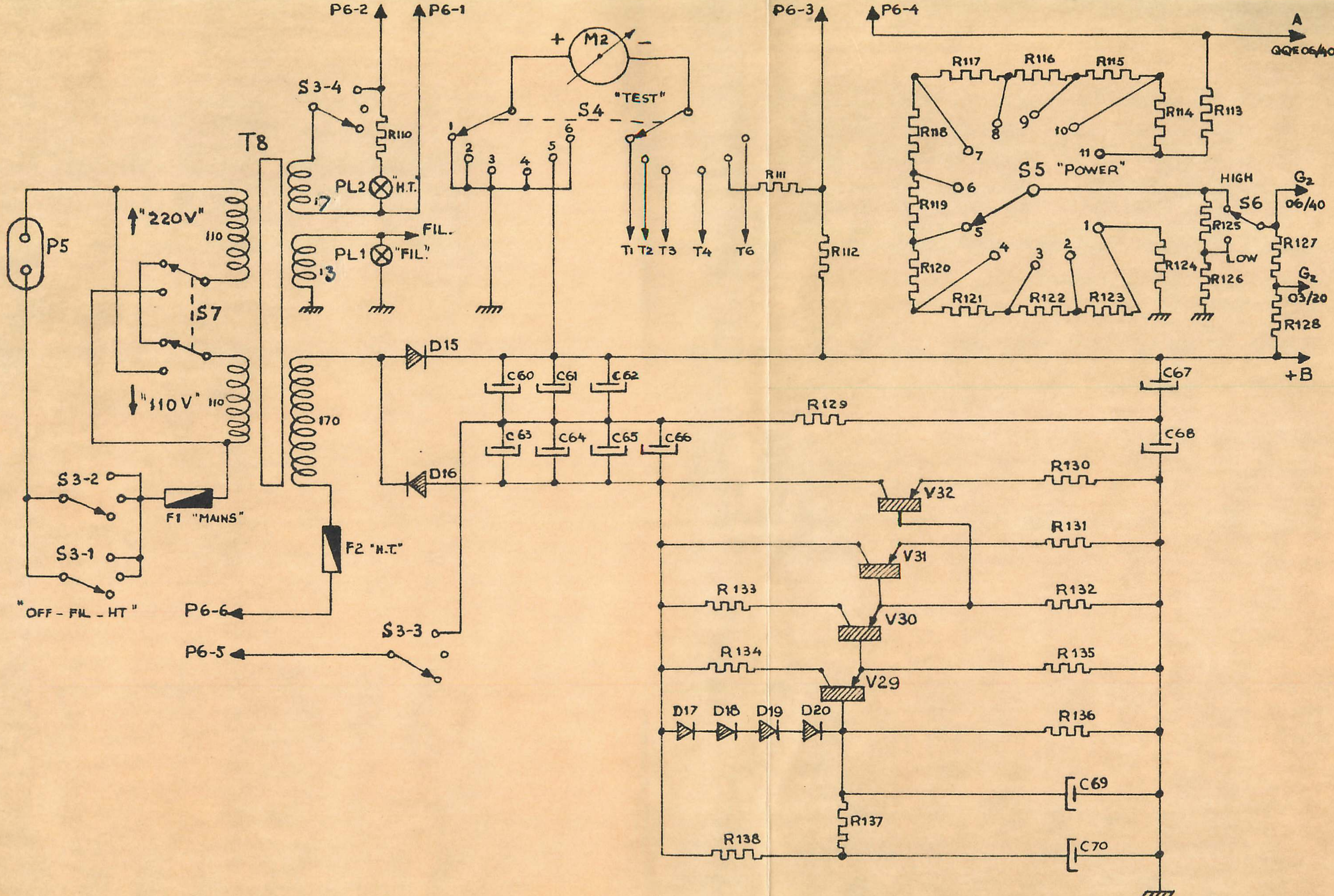
air-gap 0,25 mm
prim. 2 x 75 turns, 2 x 0,6 mm en.
sec. 1400 turns, 0,25 mm en.
$L_{sec.}$ = 2,1 H at 200 mA d.c.



INTERCONNECTION BETWEEN UNITS I - V



BLOCK-DIAGRAM MODULATOR AND TRANSMITTER



TRANSMITTER POWER SUPPLY

Transmitter power supply components, Fig. 10

R110	resistor	VITROHM	47	ohms	1	W	10%	
111	"	Erie	2.200	"	½	W	"	
112	"	VITROHM	5	"	1	W	"	←(2 x 10 ohms ½W in par.)
113	"	Erie	9.000	"	3	W	"	←(3 x 27.000 ohms 1W in par.)
114	"	"	8.200	"	1	W	"	
R115	"	"	10.000	"	1	W	"	
116	"	"	12.000	"	1	W	"	
117	"	"	15.000	"	1	W	"	
118	"	"	12.000	"	1	W	"	
119	"	"	8.200	"	1	W	"	
R120	"	"	6.800	"	1	W	"	
121	"	"	5.600	"	1	W	"	
122	"	"	4.700	"	1	W	"	
123	"	"	6.800	"	1	W	"	
124	"	"	56.000	"	1	W	"	
R125	"	"	47.000	"	1	W	"	
126	"	"	47.000	"	1	W	"	
127	"	"	150.000	"	1	W	"	
128	"	"	180.000	"	1	W	"	
129	"	"	150.000	"	1	W	"	
R130	"	"	12	"	1	W	"	
131	"	"	12	"	1	W	"	
132	"	"	5.600	"	½	W	"	
133	"	"	680	"	½	W	"	
134	"	"	6.800	"	½	W	"	
R135	"	"	6.800	"	½	W	"	
136	"	"	22.000	"	1	W	"	
137	"	"	39.000	"	1	W	"	
138	"	"	47.000	"	1	W	"	

C60	condenser	Philips	50	mf	350	VDCW,	electrolytic
61	"	"	100	"	300	"	"
62	"	"	100	"	300	"	"
63	"	"	100	"	300	"	"
64	"	"	50	"	350	"	"
C65	"	"	50	"	350	"	"
66	"	"	50	"	350	"	"
67	"	"	100	"	300	"	"
68	"	"	100	"	300	"	"
69	"	"	4	"	50	"	"
C70	"	"	4	"	50	"	"

/contnd.

Transmitter power supply components, Fig. 10
(continued)

V_{29}	transistor	Philips	OC73
V30	"	"	OC76
V31	"	"	OC16
V32	"	"	OC16

D15 selenium rectifier, Siemens, 3 x E250C130 in parallel
D16 " " " " "
D17 silicon diode, Intermetall Z7 Zener 7,5 V
D18 " " " Z7 " "
D19 " " " Z6 " 6,5 V
D_{20} " " " Z6 " "

M_2 moving coil meter, ERNEST TURNER, 500 micro Amp. f.s.d., 66 ohms.

P_5 plug, BULGIN, 2-way, male
P_6 " ELCOM 8-way, female

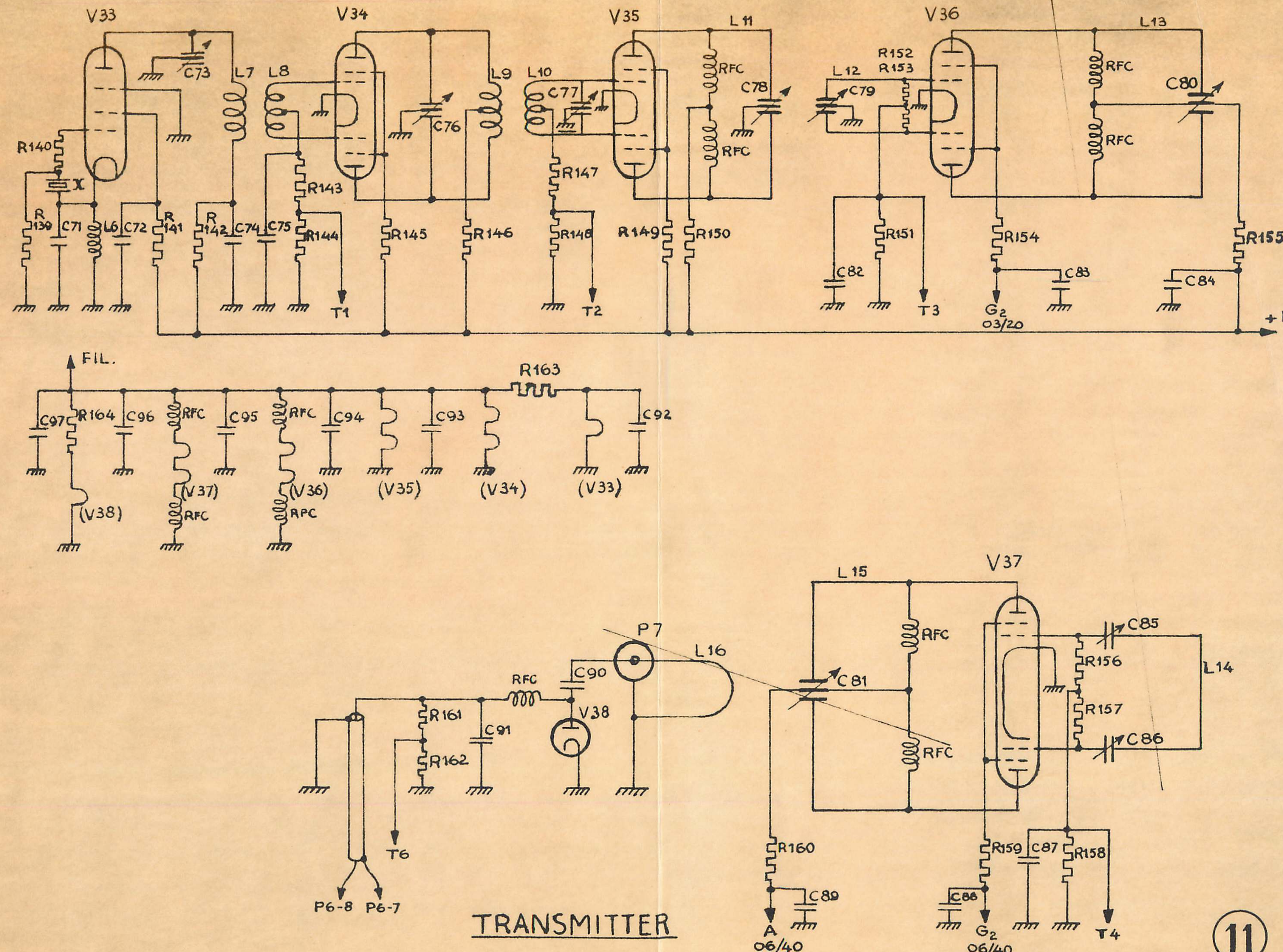
PL_1 pilot lamp, Philips, 12 V - 2W.
PL_2 " " " " "

F_1 fuse, 4 Amps for 110 V operation, 2 Amps for 220 V operation.

F_2 fuse, 1,5 Amps

S3	switch	MALLORY	4 contacts	3	positions
S4	"	"	2 "	6	"
S5	"	"	1 "	11	"
S6	"	BULGIN	1 "	2	"
S7	"	"	2 "	2	"

T_8 transformer, laminated iron core, core area 60 x 25 mm^2
air-gap = 0,0
prim. 1: 336 turns, 0,7 mm en.
" 2: 336 " 0,7 mm en.
sec. 1: 520 " 0,6 mm en.
" 2: 44 " 4 x 0,5 mm en.
" 3: 54 " 2 x 0,7 mm en.



TRANSMITTER

Transmitter components, Fig. 11

R139	resistor	Erie	150.000	ohms	1 W	10%
R140	"	"	56	"	½ W	"
141	"	"	150.000	"	1 W	"
142	"	"	6.800	"	1 W	"
143	"	"	56.000	"	1 W	"
144	"	"	15	"	½ W	"
R145	"	"	100.000	"	1 W	"
146	"	"	560	"	1 W	"
147	"	VITROHM	56.000	"	½ W	"
148	"	Erie	15	"	½ W	"
149	"	"	82.000	"	1 W	"
R150	"	"	150	"	1 W	"
151	"	"	22	"	½ W	"
152	"	"	56.000	"	1 W	"
153	"	"	56.000	"	1 W	"
154	"	"	2.700	"	1 W	"
R155	"	"	100	"	1 W	"
156	"	"	22.000	"	1 W	"
157	"	"	22.000	"	1 W	"
158	"	"	3,3	"	1½W	" (3 x 10 ohms,
159	"	"	1.200	"	1 W	" ½W in par.)
R160	"	"	10	"	1 W	"
161	"	"	27.000	"	1 W	"
162	"	"	15	"	½ W	"
163	"	PAINTON	22	"	4 W	" 5%, wire-wound
R164	"	Erie	45	"	2 W	" 10% (82 and 100 ohms 1W in par.)

C71	condenser	Philips	33	mmf	500	VDCW	2%. mica	
72	"	TCC	1500	"	"	"	ceramic	(one
73	"	Philips	8	"	"	"	butterfly	half
74	"	TCC	1500	"	"	"	ceramic	used)
C75	"	"	1500	"	"	"	"	
76	"	Philips	4	"	"	"	butterfly	
77	"	"	1,6	"	"	"	"	
78	"	compression type, integrated with L_{11}						
79	"	" " " " L_{12}						
C80	"	" " " " L_{13}						
81	"	" " " " L_{15}						
82	"	Rosenthal	600mmf		500VDCW		feed-through	
83	"	Rosenthal	" "		" "		" "	
84	"	"	" "		" "		" "	
C85	"	Philips	5	"	modified trimmer			

/ctnd.

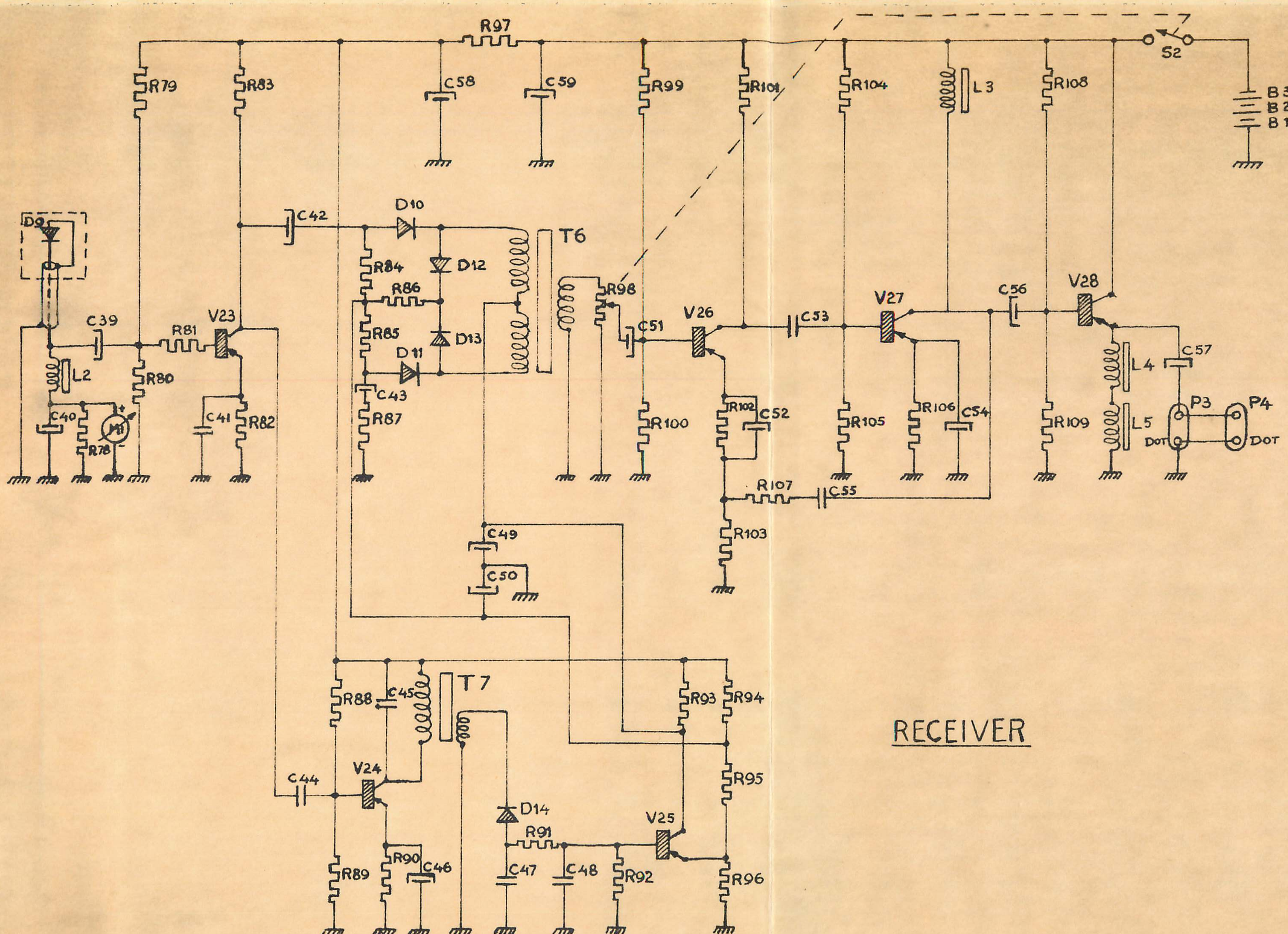
Transmitter components, Fig. 11 (Continued)

C86	condenser	Philips	5	mmf	modified		trimmer
87	"	Rosenthal	600	"	500	VDCW	feed-through
88	"	"	600	"	"	"	" "
89	"	"	600	"	"	"	" "
C90	"	Philips	220	"	"	"	ceramic
91	"	"	220	"	"	"	"
92	"	TCC	1500	"	"	"	"
93	"	"	1500	"	"	"	"
94	"	"	1500	"	"	"	"
C95	"	Rosenthal	600	"	"	"	feed-through
96	"	"	600	"	"	"	" "
C97	"	"	600	"	"	"	" "

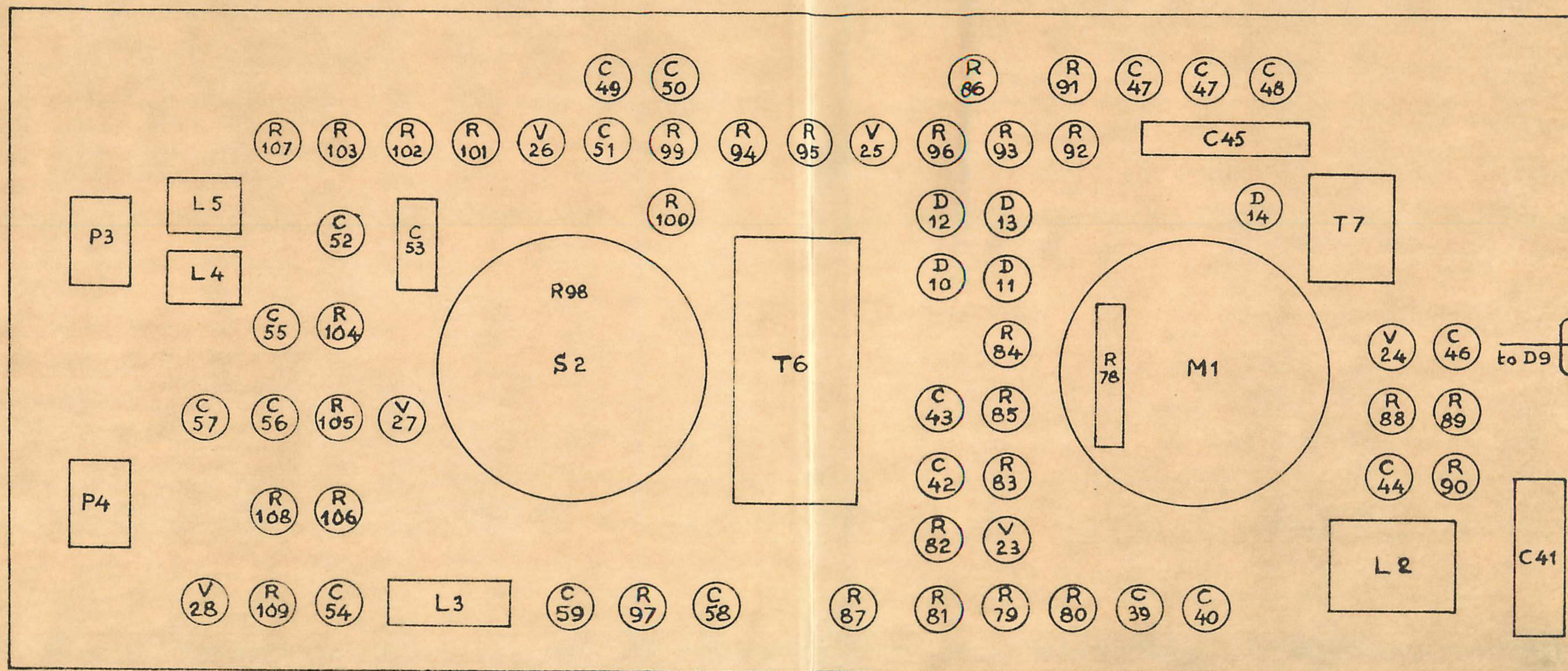
V33	tube	Philips	E 180 F	= 6688	
V34	"	"	QQE 03/12	= 6360	= CV 2798
V35	"	"	QQE 03/12	= 6360	= CV 2798
V36	"	"	QQE 03/20	= 6252	= CV 2799
V37	"	"	QQE 06/40	= 5894	= CV 2797
V38	"	R.C.A.	9004		

X quartz crystal, STABILIX, 14Mc/s

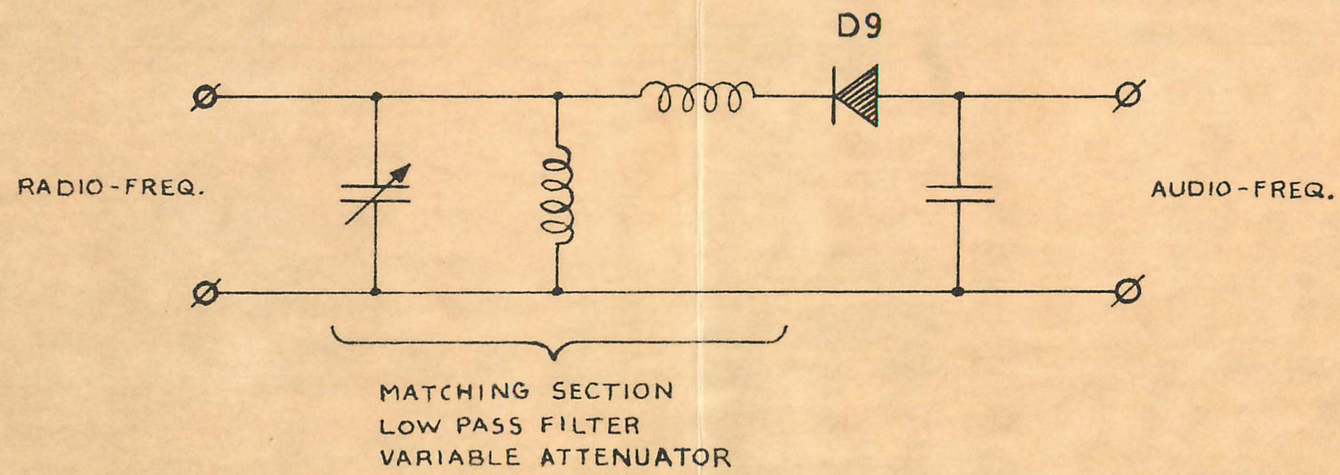
P7 plug, GENERAL RADIO, 874 - PB


R97
S2
R79
R83
C58
C59
R99
R101
R104
L3
R108
B3
B2
B1
D9
C42
D10
T6
R84
D12
R86
R98
C56
V28
V27
C39
R81
V23
V26
C53
C51
R85
D13
D11
C57
L2
L4
R80
C43
P3
P4
C40
C41
R82
R87
R102
C52
R106
C54
R100
R105
R109
L5
DOT
DOT
R78
R107
C55
C49
R103
C50
R88
C45
T7
R93
R94
C44
V24
R95
D14
V25
R91
R90
C46
R89
C47
C48
R92
R96

RECEIVER



BOTTOM VIEW RECEIVER


D9
RADIO-FREQ.
AUDIO-FREQ.
MATCHING SECTION
LOW PASS FILTER
VARIABLE ATTENUATOR

DETECTOR

Receiver components, Fig. 12 & 13

R78	resistor	Erie	39	ohms	½ W	10%
79	"	"	33.000	"	1 W	"
80	"	"	4.700	"	½ W	"
81	"	"	1.500	"	½ W	"
82	"	"	560	"	½ W	"
83	"	"	3.900	"	½ W	"
84	"	"	10.000	"	½ W	"
R85	"	"	10.000	"	½ W	"
86	"	"	4.700	"	½ W	"
87	"	"	3.900	"	½ W	"
88	"	"	47.000	"	1 W	"
89	"	"	27.000	"	1 W	"
R90	"	"	2.700	"	½ W	"
91	"	"	4.700	"	½ W	"
92	"	"	10.000	"	½ W	"
93	"	"	3.300	"	½ W	"
94	"	"	3.300	"	½ W	"
R95	"	"	8.200	"	½ W	"
96	"	"	100	"	½ W	"
97	"	"	100	"	½ W	"

98 potentiometer, LESA, 25.000 ohms, mechanically linked with S_2.

99	resistor	Erie	120.000	ohms	1 W	10%
R100	"	"	33.000	"	1 W	"
101	"	"	10.000	"	½ W	"
102	"	"	4.700	"	½ W	"
103	"	"	33	"	½ W	"
104	"	"	120.000	"	1 W	"
R105	"	"	33.000	"	1 W	"
106	"	"	1.800	"	½ W	"
107	"	"	12.000	"	1 W	"
108	"	"	82.000	"	1 W	"
R109	"	"	33.000	"	1 W	

C39	condenser	Philips	1	mf	6	VDCW	electrolytic
C40	"	"	25	"	6	"	"
41	"	Wima	0,02"		500	"	paper
42	"	Philips	1	"	6	"	electrolytic
C43	"	"	1	"	6	"	"
44	"	TCC	3300	mmf	500	"	ceramic
45	"	DUCATI	8000	"	500	"	mica, 1%
C46	"	Philips	8	mf	25	"	electrolytic

/continued

Receiver components, Fig. 12 & 13

C47	condenser	TCC	9400	mmf	500	VDCW	ceramic
48	"	"	4700	"	500	"	"
49	"	Philips	1	mf	6	"	electrolytic
C50	"	"	1	mf	6	"	"
51	"	"	1	"	6	"	"
52	"	"	25	"	6	"	"
53	"	Wima	0,02	"	500	"	paper
54	"	Philips	25	"	6	"	electrolytic
C55	"	Wima	0,01	"	500	"	paper
56	"	Philips	1	"	6	"	electrolytic
57	"	"	25	"	6	"	"
58	"	"	25	"	6	"	"
C59	"	"	25	"	6	"	"

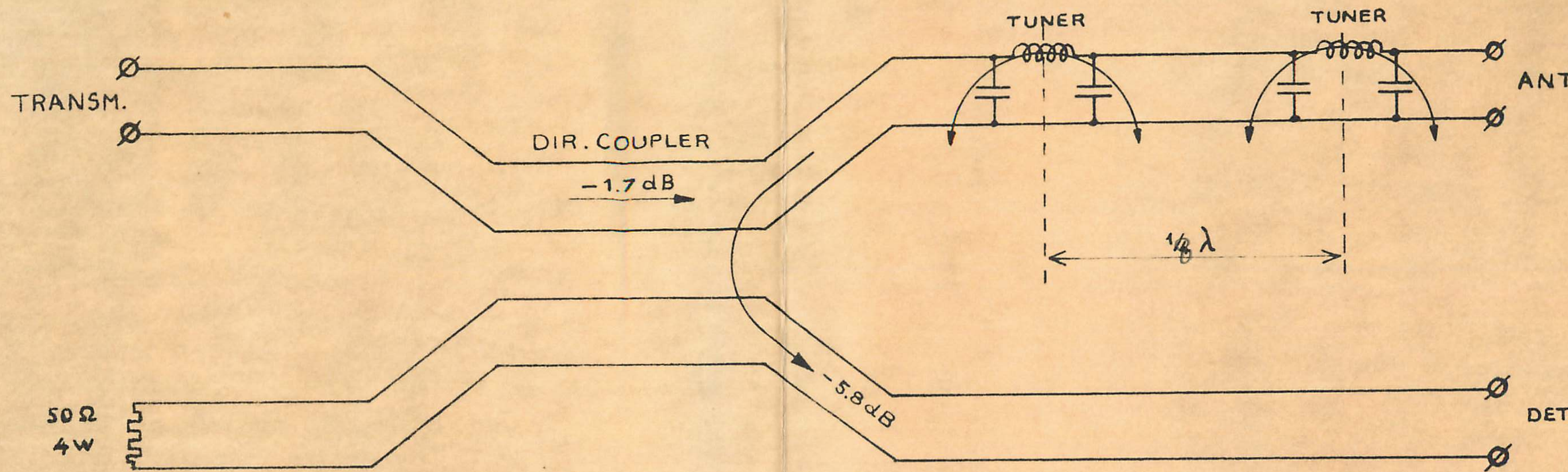
B1 dry battery 1,5 Volts, size ½" x 2"
B2 " " " " " ½" x 2"
B3 " " " " ½" x 2"

V23 transistor Philips OC71
V24 " " "
V25 " " "
V26 " " "
V27 " " "
V28 " " "

D9 silicon diode, B.T.H., CS2A, cartridge
D10 germanium diode, Philips OA81
D11 " " " "
D12 " " " "
D13 " " " "
D14 " " " "

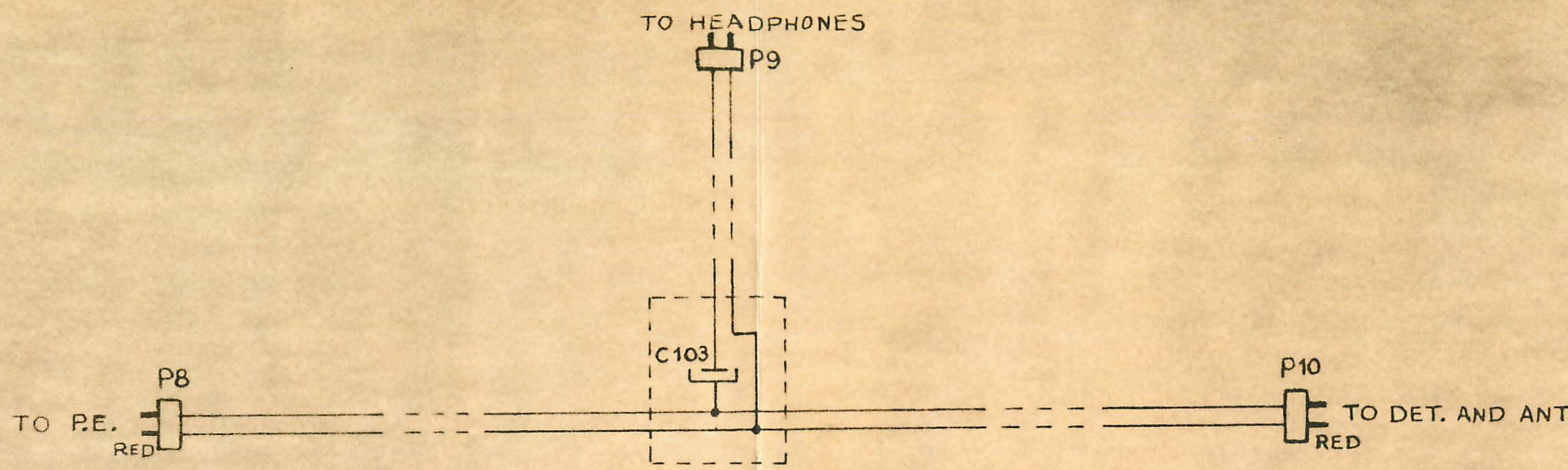
L2 inductance FORTIPHONE EX 192 1,5H - 150 ohms
L3 " " " " " "
L4 " " " " " "
L5 " " " " " "

S2 switch, mechanically linked with R98
M1 moving coil meter, 100 microAmp. f.s.d.,800 ohms approx.
P3 headphone receptacle, DYNA-EMPIRE, D68FT, female
P4 " " " " " "

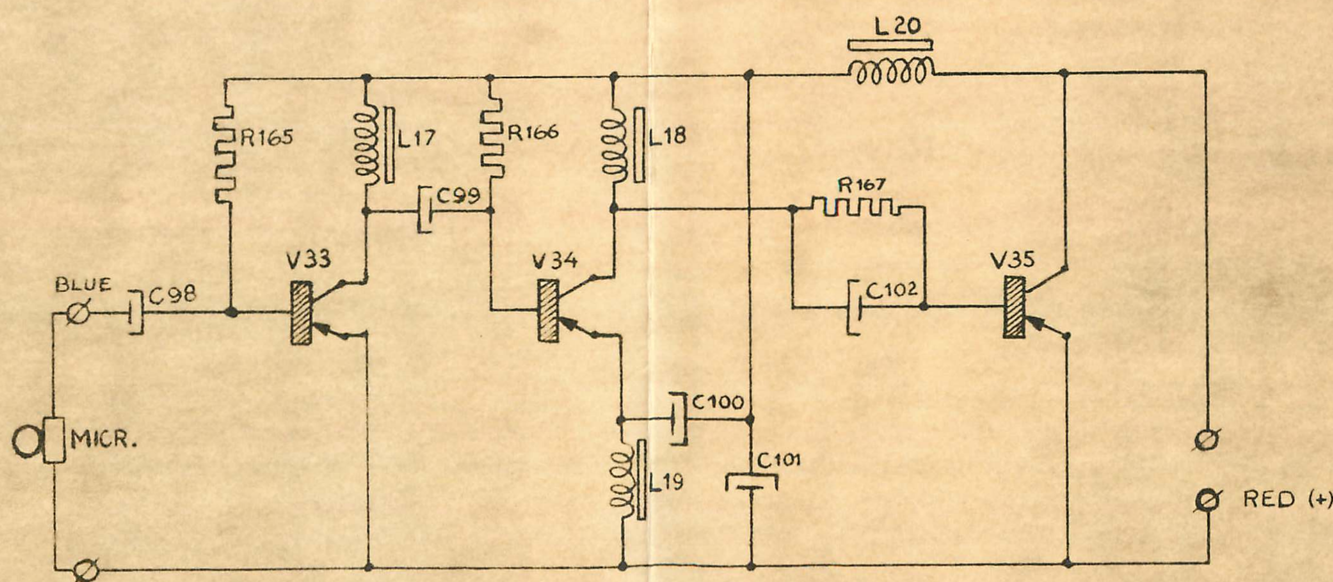


DUPLEXER

DUPLEXER



INTERCONNECTING CORD



PASSIVE ELEMENT

Passive element components, Fig. 15

R165	resistor	VITROHM	330.000 ohms	½ W	10%	
R166	"	"	220.000 "	½ W	"	
R167	"	"	22.000 "	½ W	"	

C98	condenser	Philips	1,25 mf	3 VDCW	electrolytic
C99	"	"	1,25 "	3 "	"
C100	"	T.C.C.	6 "	1,5 "	"
C101	"	"	4 "	4 "	"
C102	"	Philips	1,25 "	3 "	"
C103	"	"	1 "	6 "	"

L17	inductance	FORTIPHONE	EX192	1,5 H -	150 ohms
L18	"	"	"	"	"
L19	"	"	"	"	"
L20	"	"	"	"	"

V33	transistor	Philips	OC71
V34	"	"	OC71
V35	"	"	OC71

P8	plug	TELEX,	miniature
P9	"	"	"
P10	"	"	"

MICR. microphone, FORTIPHONE, FM5