EMI

INSTRUCTION MANUAL

PORTABLE CONTAMINATION MONITOR

TYPE 1

DOCUMENT REFERENCE

TL.1175

E·M·I ELECTRONICS LIMITED

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duces exceptionally large yields of graft copolymer and a minimum of homopolymer. Small dose rates are more efficient than large ones because polymerization depends on intensity to a power smaller than one. Intermittent application allows time for diffusion of monomer to the polymer grafting sites; the process becomes more efficient. In this way methylmethacrylate can be copolymerized onto polyethylene film until the original film weight is multiplied by 64 (*16*). To do it a total dose of 31,400 r was delivered at an instantaneous dose rate of 31,400 r/hr and a duty cycle of 2 min on, 28 min off for 15 hr. Homopolymer content was only ~3%. Instantaneous grafting rate appeared to be autoaccelerated by production of active grafting sites on both the original polyethylene backbone and newly grafted methylmethacrylate side chains.

Radiation Synthesis

Laboratory preparation of certain dichlorophosphines and nitroso compounds is more convenient by radiation synthesis than by conventional methods (*18*). The big advantages are (a) one-step processes and (b) simple starting materials.

Particularly productive are combination reactions, in which free radicals from different components of a mixture combine to form the product. In this manner dichlorophosphines have been directly synthesized from phosphorus trichloride and aliphatic, olefinic and aromatic hydrocarbons.

Scavenger reactions also have good yields. For example, you can continuously add the radical scavenger nitric oxide to maintain a low concentration in irradiated organic liquids (*18*). The process forms trichloronitrosomethane from CCl_4-NO mixtures and dichloronitrosomethane, not previously synthesized, from $CHCl_3$-NO mixtures.

Other radiation synthesized compounds include dichlorocyclohexyl phosphine, 3-cyclohexenyl phosphorus dichloride, dichlorocyclohexylarsine, organic silicon trichlorides and trichloromethylcyclohexane. These compounds come from the formation by radiation of carbon bonds with silicon, chlorine, phosphorus, nitrogen and arsenic (*18*).

Emulsion Polymerization

A direct method for forming a stable cationic emulsion of polyvinyl acetate is radiation polymerization of the monomer in an aqueous solution containing a cationic detergent (*19*). Radiation appears to initiate the polymerization both by direct action on the monomer and by creation of radicals in the water that react with the monomer.

Irradiation of mixtures of different emulsified polymer lattices with vinyl monomers has been shown to be a useful method of preparing nonrandom graft copolymers (*20*). Relatively small doses are required, and product purification is achieved by fractional precipitation.

Other significant revelations at Warsaw were these: commercial production of graft-copolymer-coated Teflon that is bondable and dyeable (*21*), improvement of Nylon dyeability without loss of tensile strength by vacuum preirradiation (*22*), commercial availability of radiation crosslinked plastics with built-in memory (on heating they return to the shape in which they were irradiated) (*23*), the possibility of irradiating plastics before molding and heating to complete the cure (*23*), existence of a fission-product pilot plant in Romania for studying partial oxidation of paraffin hydrocarbons (*24*), radiation vulcanization of a better silicone rubber by a method simpler than peroxide curing (*25*), economic sterilization of ampoules of water for medicine (*26*), and radiation synthesis of colorants (*27*).

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The author acknowledges the able assistance of his associates, E. I. Heiba and R. P. Epple of Arthur D. Little, Inc., in reviewing the content of papers.

BIBLIOGRAPHY

All of the following references are papers presented at the Warsaw Conference on Applications of Large Radiation Sources, September 8–12, 1959. The authors' countries are indicated in parentheses, and the paper is identified by the number assigned to it at the conference.

1. J. I. Thomas (UK) CW/IIB/86
2. Borelko, Kartoshova et al. (USSR) (unlisted)
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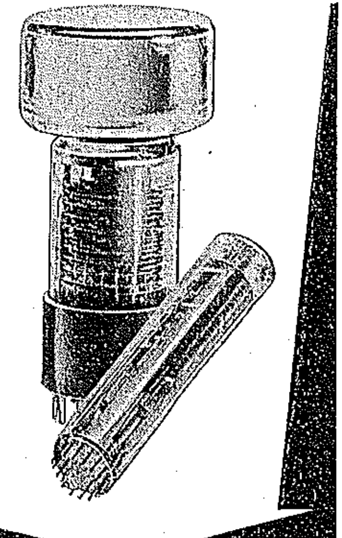

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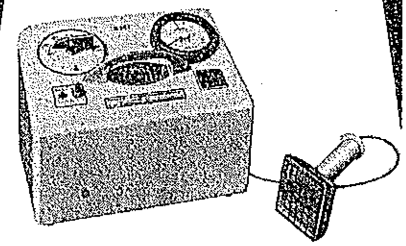

E.M.I. Portable Contamination Monitor Type 1

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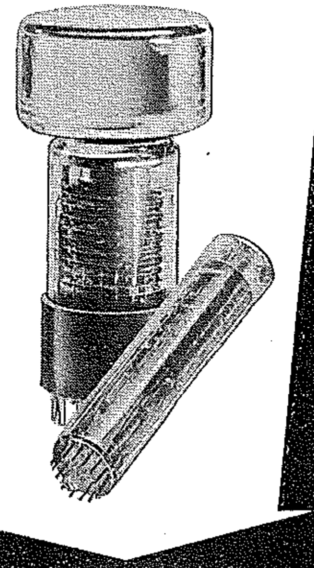

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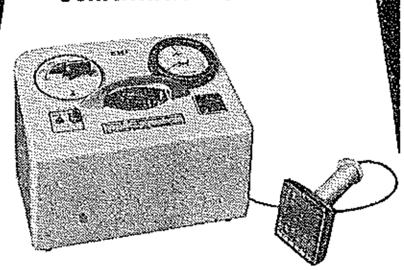

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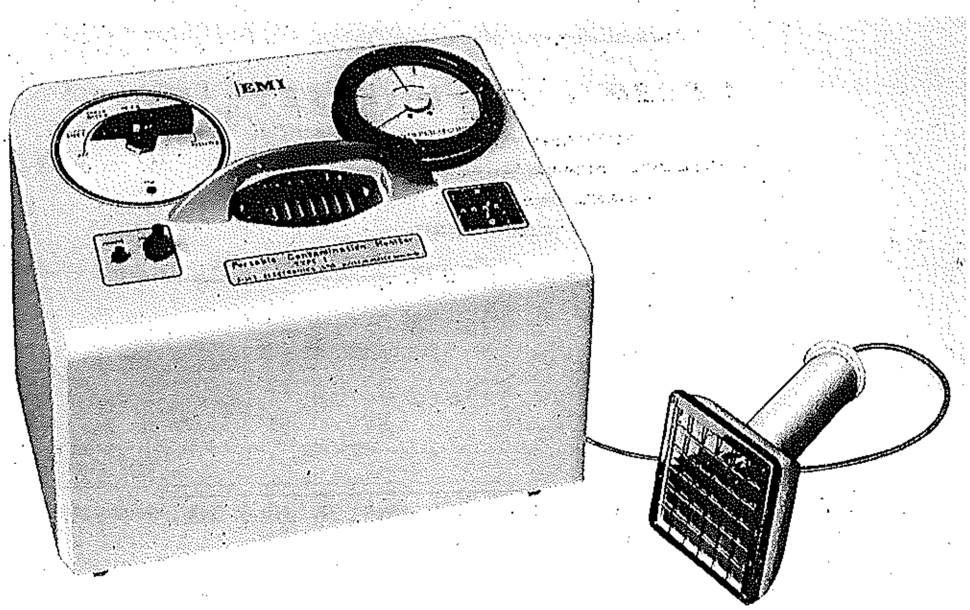

E.M.I. ELECTRONICS LTD.

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Printed in England

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CONTENTS

ILLUSTRATIONS & DRAWINGS

1. INTRODUCTION

The Portable Contamination Monitor Type 1 is a small, lightweight instrument designed for use with a suitable probe for the detection of radioactive contamination of benches, clothing, etc.

The instrument is particularly suited for use with the Dual Probe Type DP2 for the detection of alpha and beta contamination either separately or simultaneously.

It may be operated from commercially obtainable batteries (type U2). The meter may be used to check the battery potentials under their working load. Alternative mains supply power units, occupying the same space as the batteries, may be supplied as required.

A meter display indicates detection rates in the range of 1 - 5000 counts per second. Alpha counting rates of up to 6 counts per second may be determined more accurately from the number of counts indicated on an electromechanical register over a measured period of time.

The detection of alpha and beta particles is indicated by two distinctive audio signals in the loudspeaker. These signals may also be heard on headphones, if desired.

Printed circuit sub-assemblies and transistors are used throughout for utmost reliability and ease of servicing.

2. SPECIFICATION

Physical

Height:	$8\frac{1}{2}$ in.	22 cm.
Width:	$11\frac{1}{2}$ in.	29 cm.
Depth:	8 in.	20 cm.
Weight:	10 lb	4.5 kg.
Finish:	The case is made of self-coloured cream high-impact polystyrene.	

Electrical

Range of Measurements:	1 - 5000 counts per second.
Display:	3 in. meter with logarithmic scale.
Auxiliary Display:	Re-settable electro-mechanical register for alpha counts below 6 per second.
Audio Indication:	A high pitched note for every alpha particle and a click for every beta particle detected, thus giving distinct differentiation between alpha and beta contamination.
Resolution:	100 µsec.
Temperature Range:	$0^{\circ}C$ to $+45^{\circ}C$.
Battery Requirements:	Twelve U2 type 1.5V batteries.
Battery Life:	24 hours continuous operation.
Alternative Mains Supply Power Unit:	Power Unit PCM1 for operation from 50 - 60c/s mains at 90 - 130V or 200 - 240V. or Power Unit PCM2 for operation from 50 - 60c/s mains at 50V.

Mains Power	
Consumption:	5 Watts
Protection:	Two 0.25A miniature glass cartridge fuses.
Probe Connector:	P.E.T. series 100 fixed socket.
EHT available for the Probe:	850 - 1650V with a load of 66MΩ.
Minimum pulse required at input:	
α Channel	7.2V
β Channel	600mV
Power Output to Loudspeaker:	40mW. This may be reduced by operating the volume switch.
Headphone Connection:	Audio output is available at the two-pin socket provided (Electro Methods SM2SN).

3. INSTALLATION

Remove the instrument from its packing case and check that no external damage has been sustained in transit.

Lay the instrument on its left hand side and remove the four 4 BA cheese headed screws from the positions designated "A" on Fig. 3 and withdraw the battery housing, disconnecting the blue and red plugs and sockets exposed.

WARNING: On no account must the instrument be switched on unless a Probe is connected to the input socket.

For use with batteries

Remove the two knurled nuts to be found on one end of the housing and remove the battery cover. Insert twelve U2 type cells into the battery container, taking care to follow the polarity directions on the container.

Replace the cover, ensuring correct location of the keyway, and secure the knurled nuts. Replace the battery housing, first reconnecting the red and blue plugs and sockets and ensuring that the housing is correctly orientated, i.e. the large hole at one side aligns with the "Adjust EHT" label. Secure with the four cheese headed screws and washers.

For use with either of the alternative mains supply power units

Set the mains tapping on the power unit, in the case of Type PCM1, to the appropriate voltage.

Insert the power unit in place of the battery housing, connecting the red and blue plugs and sockets and ensuring correct orientation, i.e. the large hole at one side aligned with "Adjust EHT" label. Secure with the four cheese headed screws and washers. Connect the instrument mains lead to a suitable source of a.c. supply, RED to line, BLACK to neutral, and GREEN to earth.

Adjustments

Connect the probe to the instrument input and insert a telephone jack plug connected to a microammeter (0-50μA) into the EHT socket ensuring that the negative terminal is connected to the centre contact of the jack.

Switch on the instrument, checking the supplies at control switch positions BATT.1 and BATT.2 as described on Page 6. Set the control switch to $\alpha + \beta$ and adjust the EHT to give the current reading required as indicated on the label attached to the probe. This can be done by adjusting the E.H.T. voltage control, which is a pre-set potentiometer, accessible through a small hole in the battery or power unit cover on the underside of the instrument.

NOTE: If the current requirement of the probe is not known the instrument can be set up approximately in conditions of normal background gamma radiation by blanking off the window and setting the E.H.T. until 3 to 7 c.p.s. are indicated with the switch in $\alpha + \beta$ position.

4. OPERATING INSTRUCTIONS

CONTROLS AND CONNECTORS

Control Switch S1:	has seven operating positions as follows:
OFF:	Batteries disconnected from the rest of the circuit.
BATT 1:	The output meter is used to monitor the positive supply under working conditions. The pointer should lie over the green arc on the meter.
BATT 2:	The output meter is used in a similar manner to test the negative supply.
$\alpha + \beta$	The meter indicates the rate of detection of both α and β particles. A click is produced in the loudspeaker for every β particle, and a high pitched note is produced for every α particle detected.
β	The meter indicates the rate of detection of the β particles. A click is produced in the loudspeaker for every β particle detected.
α	The meter indicates the rate of detection of α particles only. A high pitched note is produced in the loudspeaker for every α particle detected.
REGISTER:	Counting rates of α particles up to 6 per second may be recorded on the register which can be manually rezeroed. A high pitched note is produced for every alpha particle detected.
Pilot lamp:	The window below the control knob marked ∼ is over a pilot lamp which is used only with a.c. power units. No pilot lamp is used on battery-operated instruments in order to conserve battery power.

PHONE: Headphones having an impedance of about 50 ohms may be connected to the instrument by using the plug supplied. When headphones are used, the loudspeaker still operates.

VOLUME: A push-button, consecutive-action switch permits the reduction of the volume at the loudspeaker. This control does not affect the output from the headphones.

PROBE: A miniature coaxial plug is used as a connector for the probe.

EHT: A telephone jack enables the connection of a microammeter in the EHT circuit for setting up the potential supplied to the probe.

OPERATION

WARNING: EHT potentials are generated within the instrument for supplying the probe. The EHT circuits must not be touched when the instrument is in operation. The instrument should ON NO ACCOUNT be switched on without a probe being attached, nor should a probe be detached until the instrument is switched off.

Switch on the instrument, check the supplies at positions CHECK BATT. 1 and CHECK BATT. 2 of the control switch S1.

Set the red cursor on the meter to a point indicating the acceptable upper limit of contamination.

When the switch is set to the $\alpha + \beta$, β, or α positions the meter will indicate the degree of contamination presented to the probe. When set to the REGISTER position the meter does not function; the mechanical register gives the visual indication in this condition. The loudspeaker indication will be heard in all switch positions other than the first two check positions.

The probe must be held very close to the surface under examination since α particles travel only a few cm. in air. However, the light tight window must not touch the surface being examined or it may itself become damaged or contaminated.

5. TECHNICAL INFORMATION

INTRODUCTION

The Portable Contamination Monitor Type 1 consists mainly of 10 units constructed as five modules. A list of these units together with their circuit identification numbers is given below:

Circuit Identification Number	Unit
1	Input Unit
2	Trigger Unit (β path)
3	Trigger Unit (α path)
4	Anti-Coincidence Unit
5	Ratemeter Unit
6	Tone Generator Unit
7	Audio Amplifier Unit
8	Power Unit
9	Register Unit
10	EHT Unit

Each module consists of a printed-circuit board on which are mounted all its electronic components. Throughout this handbook, each component will be identified by the number of the unit followed by the circuit reference within the unit, e.g. 1R2 will indicate R2 in the Input Unit. The complete circuit diagram is at Fig. 6.

(a) Circuit Description

DUAL PROBE TYPE DP2

The probe is designed to provide simultaneous monitoring of alpha and beta contamination. Light scintillations due to α and β particles are produced in the dual phosphor. These scintillations excite the cathode of a photo-multiplier which gives pulse outputs corresponding to the radiation particles reaching the probe. An aluminized window is fitted to the probe to exclude ambient light.

Referring to Fig. 2, the probe is shown as receiving both α and β radiation. The alpha particles are stopped in the zinc sulphide layer, and light scintillations are produced within the layer. These scintillations pass through the plastic phosphor layer which is transparent.

The beta particles pass through the zinc sulphide layer with little loss of energy and produce light scintillations in the plastic phosphor layer. The amount of light a Pu^{239} alpha particle produces is approximately twelve times that of a $Sr^{90} - Y^{90}$ beta particle.

In subsequent circuits, use is made of the different amplitudes of the pulses due to alpha and beta particles to display and count them separately if required.

The alpha efficiency is not less than 20% and the beta efficiency is not less than 30% for thin Pu^{239} and Sr^{90} radioactive sources respectively.

NOTE: Gamma radiation will also produce light scintillations in the plastic phosphor which cannot be distinguished by the instrument from those caused by β radiations.

INPUT UNIT (1)

The function of the Input Unit is to receive pulses from the probe at high-impedance and provide outputs at low-impedance to the α and β paths.

The potential divider network, consisting of 1R1 and 1R2, forms the load for the probe. The potential divider ratio is such that the pulse appearing at the junction of the resistors due to a Pu^{239} α particle is of approximately the same amplitude as the pulse due to a Sr^{90} β particle appearing across the whole load. H.F. compensating capacitors 1TC1 and 1C1 are incorporated to maintain constant potential divider ratio.

The signals at the junction of the two resistors are taken to the base of the emitter-follower transistor 1J1, and the output of 1J1 is taken to the α OUT terminal.

The signals across the whole potential divider are taken to the base of an identical emitter-follower transistor 1J2, and the output of 1J2 is taken to the β OUT terminal.

TRIGGER UNIT (2 and 3)

Two identical Trigger Units are used, one in the α path and the other in the β path. The function of the Trigger Unit is to provide a negative-going 50μS pulse at its output when a pulse, greater than a pre-determined level, is present at its input.

The input signal present at the IN terminal is taken to the base of the emitter-follower stage J1 which has a potentiometer load RV1. The adjustment of RV1 permits accurate setting of the input triggering pulse amplitude.

Due to the division of pulse amplitudes which takes place across 1R1 and 1R2, the β channel produces an output for both α and β input pulses and the α channel for α input pulses only.

The output pulse from the trigger is clamped by diode D1 and taken to the OUT terminal of the unit as a negative going pulse, the duration of which is set by RV2.

Silicon transistors are used for the trigger circuit because of their good temperature characteristics and low collector leakage current. Thus, over the temperature range $-10^{\circ}C$ to $+55^{\circ}C$, the pulse amplitude and duration will vary by less than 2% and the triggering threshold by less than 8%.

ANTI-COINCIDENCE UNIT (4)

The function of the Anti-Coincidence Unit is to suppress signals if they appear simultaneously at its two input terminals and to pass them if they appear only at the IN A terminal.

Let a negative-going pulse be present at the IN A or information terminal only. This pulse is fed via emitter-follower stage 4J1 to the base of 4J3, and gives rise to a positive-going pulse at the collector of 4J3.

However, if a negative-going pulse is present at the IN B terminal as well as the IN A terminal, this pulse will be fed via 4J2 and will produce a negative-going pulse at the emitter of 4J3. In this condition, both the emitter and base will go negative at the same time and no output will be present at the collector of 4J3. The capacitor 4C1 is used to cause a slight lengthening of the pulse at terminal A in order to ensure coincidence (in time) of the two input pulses.

The positive-going pulse at the collector of 4J3 is amplified by the transistor 4J4, clamped by the diode 4D1 and taken to the OUT terminal as a negative going 5V pulse.

RATEMETER UNIT (5)

The function of the Ratemeter Unit is to accept incoming signals from the Anti-Coincidence Unit and provide a display of their average rate on a logarithmically scaled meter.

The input present at the IN terminal is fed via two emitter-follower stages 5J1 and 5J2 connected in cascade which provide the high current gain necessary to drive the circuits following 5J2.

Two outputs are taken from the emitter of 5J2. One output is connected to the ⅂⅃ OUT terminal, the other output is taken to the input of three diode pump circuits connected in parallel. Each circuit covers a range of counting rates of just over a decade, the ranges of the three circuits being adjacent to one another. Thus, by combining the outputs of the three diode pumps, an approximately logarithmic meter scale is obtained.

The meter is designed to indicate counts per second in the range of 0 to 5000. The preset control 5RV1 is for setting the meter sensitivity.

TONE GENERATOR UNIT (6)

The function of the Tone Generator Unit is to provide a burst of oscillations at approximately 2kc/s for every pulse received at the IN α terminal and a negative-going square pulse (producing a click in the loud-speaker) for every pulse received at the IN β terminal. When the control switch on the front panel is switched to the $\alpha + \beta$ position, the unit produces one burst of oscillation for every α pulse and a negative-going square pulse for every α or β pulse.

The unit consists basically of a phase-shift oscillator 6J1, a gating circuit formed by transistors 6J2 and 6J3 having a common emitter load and a monstable multivibrator consisting of 6J4 and 6J5.

When no pulses are present at the IN α and the IN β terminals, 6J1 oscillates, 6J5 is conducting, thus cutting off 6J2 and preventing the oscillator waveform from reaching the OUT terminal.

Now, when a 50µS pulse arrives at the IN α terminal, it is applied to the base of 6J4 causing it to conduct and cut off 6J5. This, in turn, will cause 6J2 to conduct and oscillations from 6J1 will be passed by 6J2 to the OUT terminal until the multivibrator returns to its normal state after 50mS. During this period of 50mS a negative-going pulse which appears at the ‾|_|‾ OUT terminal will be taken to the Register Unit when the Control switch is in the REGISTER position.

A 50µS pulse arriving at the IN β terminal drives the base of the emitter-follower stage 6J3, and a 50µS square pulse is passed to the OUT terminal. This pulse will produce a click in the loudspeaker after amplification by the Audio Amplifier Unit.

AUDIO AMPLIFIER UNIT (7)

The function of the Audio Amplifier Unit is to amplify the 50mS bursts of oscillations and the 50µS negative-going square pulses received from the OUT terminal of the Tone Generator Unit. Every 50mS burst will produce tone in the loudspeaker (for an α particle) and every square pulse will produce a click (for a β particle).

This unit is a conventional two-stage r.c.-coupled audio amplifier consisting of 7J1, 7J2 and their associated components. The output to the loudspeaker is taken through 7T1 which is in the collector circuit of 7J2.

POWER UNIT (8)

The Power Unit receives its supply from batteries or the mainsPower Unit. The Power Unit consists of two identical sections. These sections provide stabilized low-impedance outputs: one at +5V and the other at -5V with respect to the OV line.

Referring to the lower section of the circuit diagram, the output current passes through the series power transistor 8J6. This current is controlled by a d.c. amplifier 8J2 which drives the base of the 8J6 via the intermediate amplifier stage 8J4. The preset control 8RV2 is used to set the output voltage to -5V.

The emitter of 8J2 is returned to a stable reference potential provided by the Zener diode 8Z2.

The upper section functions in a similar manner with the output +5V being adjusted by the pre-set potentiometer 8RV1.

REGISTER UNIT (9)

The function of the Register Unit is to amplify the square pulses received from the Tone Generator Unit in order to produce the large current pulses required to drive the electro-mechanical register.

The transistors 9J1 and 9J2 are emitter-follower amplifiers driving a power transistor 9J3.

Output pulses are taken to the electro mechanical register from the collector circuit of 9J3.

EHT UNIT (10)

This unit receives supplies of +5V and -5V from the Power Unit and provides the E.H.T. output for the probe.

The transistor 10J1 is an a.f. oscillator, its output voltage being stepped up by the transformer 10T1. The voltage across the secondary winding of 10T1 is rectified and smoothed before being taken to the E.H.T. terminal on the unit.

The output voltage may be adjusted by the preset control 10RV1 connected in series with the oscillator supply.

MAINS SUPPLY POWER UNIT

The mains supply power unit is a conventional crystal rectifier unit; its circuit is shown at Fig. 8.

COMPLETE INSTRUMENT

Control Switch S1 set to OFF

The battery supply is completely disconnected from the circuits.

Control Switch S1 set to BATT 1

A dummy load is switched across the batteries and the output meter is disconnected from the Ratemeter Unit. It is used as a voltmeter across battery 1 while delivering its full load.

Control Switch S1 set to BATT 2

The instrument functions as in the above paragraph but the output meter reads the voltage across battery 2 while delivering its full load.

Control Switch S1 set to α + β

The IN A terminal of the Anti-Coincidence Unit is connected via S1 to the Trigger Unit (β). Thus, both α and β pulses are present at this input. The IN B terminal, however, is earthed via S1 and no pulses appear at this terminal.

The output from the Anti-Coincidence Unit will thus consist of both α and β pulses. These output pulses are fed to the Ratemeter Unit, the output of which is indicated on the meter.

The output from the ‾⊔‾ OUT terminal of the Ratemeter Unit is taken to the IN β terminal of the Tone Generator Unit.

The output from the Trigger Unit (α) is taken via S1 to the IN α terminal of the Tone Generator Unit. Hence a 50mS burst of oscillation will be heard in the loudspeaker for every α particle detected and a click for every β particle detected.

Control Switch S1 set to β

Pulses (both α and β) from the Trigger Unit (β) are applied via S1 to the IN A terminal of the Anti-Coincidence Unit. At the same time, pulses (α only) from the Trigger Unit (α) are applied via S1 to the IN B terminal of the Anti-Coincidence Unit.

Since the α pulses are present simultaneously at the two input terminals of the Anti-Coincidence Unit, they are cancelled within the unit and the output will consist of β pulses only.

The output from the Anti-Coincidence Unit is taken to the Ratemeter Unit and displayed as a count rate on the meter; the output from the ‾⊔‾ OUT terminal of the Ratemeter Unit is applied to the IN β terminal of the Tone Generator Unit via S1.

The output of the Tone Generator Unit is a negative-going 50µS pulse for every β particle detected. These pulses are amplified in the Audio Amplifier Unit and produce a click in the loudspeaker for every particle detected.

Control Switch S1 set to α

The output from the Trigger Unit (α) is applied via S1 to the IN A terminal of the Anti-Coincidence Unit, the IN B terminal of the unit being earthed through S1.

The output from the Anti-Coincidence Unit which consists of a pulse for every α particle detected is fed to the Ratemeter Unit, the output of which is displayed as a count rate on the meter.

The output from the Ratemeter Unit's ⊔ terminal is brought via S1 to the IN α terminal of the Tone Generator Unit.

In the Tone Generator Unit each α pulse produces a 50mS burst of oscillation which is amplified in the Audio Amplifier Unit and applied to the loudspeaker.

<u>Control Switch S1 set to REGISTER</u>

The instrument functions as in the case when S1 is set to α except that the output meter is disconnected from the output of the Ratemeter Unit, and the Register Unit is connected to ⊔ OUT terminal of the Tone Generator.

Each pulse due to an α particle present at the IN α terminal of the Tone Generator Unit produces a 50mS burst of oscillatory tone in the loudspeaker.

Simultaneously, a pulse at the ⊔ OUT terminal of the Tone Generator Unit is applied to the input of the Register Unit via S1. After amplification, this pulse drives the electro-mechanical register which is used to count at rates of up to 6 pulses per second.

In all other positions of the control switch S1, the input to the Register Unit is earthed.

(b) Maintenance

NOTE: Care should be exercised to avoid accidental contact with the EHT circuits and subsequent possible damage to the instrument.

DISMANTLING

Ensure the instrument is switched off.

Lay the instrument on its back and remove the four 4 BA screws designated "G" on Fig. 3. Ease the base assembly from within the instrument case. The modules may now be withdrawn in two sections.

During maintenance and testing it is essential to disconnect the -5V supply from the EHT circuit to render this inoperative. This may be achieved by disconnecting both the Violet/blue/yellow and Violet/grey/violet leads from the EHT module and joining these leads together to ensure that the -5V supply is continuous to other modules. These leads are located along the upper edge of the module adjacent to the EHT rectifier.

SETTING UP PROCEDURE

Supply Voltages- controls 8RV1 and 8RV2

Check the battery potentials to ensure that the batteries are not run down - in both switch positions the meter should read within the green area.

Set the control switch to $\alpha + \beta$ positions. Measure the potential across 8C1 on the power module and adjust 8RV1 to make this reading 5V $\pm$ 0.1V. Measure the potential across 8C2 and adjust 8RV2 to make this reading 5V $\pm$ 0.1V.

Beta pulse width and threshold - controls 2RV2 and 2RV1

Connect an oscilloscope between the OUT terminal of the β trigger circuit (junction of 2R8 with 2J3) and the OV line.

Connect a suitable pulse generator giving negative going 1 μsec pulses between the "PROBE" terminal of the input circuit and the OV line. Set the control switch to " β ".

Set the Generator p.r.f. to 3000p.p.s. $\pm$ 60p.p.s. with output amplitude at zero.

Set 2RV2 and 2RV1 fully clockwise.

Set the generator amplitude to 5V $\pm$ 0.5V and adjust the oscilloscope controls to give a stable display of the square pulse output. Adjust 2RV2 to make the pulse width 50µsec $\pm$ 1µsec. Measure the amplitude of the displayed pulse - this should be approximately 2V.

Reduce the generator output amplitude to 600mV and adjust 2RV1 to obtain a stable display.

Repeatedly reduce and slowly increase the generator amplitude to ensure that the threshold triggering level is 600mV $\pm$ 15mV. During its adjustment ensure that a stable display is obtained without double pulsing.

Alpha pulse width and threshold - controls 3RV2 and 3RV1

Set the control switch to " α " and transfer the output of the generator between the junction of 1R1 and 1R2 on the input circuit, and the OV line. Connect the oscilloscope between the 'OUT' terminal of α trigger circuit, (junction of 3R8 and 3J3) and the OV line. Set 3RV2 and 3RV1 fully clockwise.

Adjust 3RV2 and 3RV1 as for 2RV2 and 2RV1 above; the measurements obtained should be the same. Disconnect the oscilloscope.

Set meter - controls 5RV1 and compensating capacitor - 1TC1

Set the control switch to β position.

Reconnect the pulse generator to the 'PROBE' input terminal on the input circuit. With the PRF set at 3000 and output amplitude to 600mV $\pm$ 15mV adjust 5RV1 to obtain a reading on the instrument ratemeter of 3000cps.

Set the control switch to β and increase the generator output to 7.2V

ERRATA: Page 18

Line 23: delete " β and increase" substitute " α and increase"
Line 26: after "3000 cps" add "Switch OFF and reconnect the -5V supply to the E.H.T. circuit." TL.1175/1

EHT socket ensuring that the negative terminal is connected to the centre contact of the jack. Switch on the instrument and adjust the EHT current to that value indicated on the PROBE label. If this is not known it can be set up approximately by adjusting the EHT current until 3 to 7 c.p.s. is indicated on the meter with the control switch set at $\alpha + \beta$ position. This is only possible in normal background gamma radiation.

Dual Probe DP2

A 100W lamp may be used to ensure that the probe is light-tight.

First check that the natural background is 3 to 7 counts per second. Place the lamp one foot from the window and remove the cover from the probe. The ratemeter reading should not increase. Move the lamp to illuminate all the surface round the head of the probe; the ratemeter reading should not increase.

To replace any part of the probe, switch off the instrument, disconnect the e.h.t. lead from the base, unscrew the base cap and withdraw the photomultiplier and dynode chain. Place the photomultiplier where it will not be exposed to a strong light.

Should any of the dynode chain components fail it will be necessary to replace the whole dynode chain assembly as the components are encapsulated.

When the protective grille surrounding the head of the probe is removed after undoing its four retaining screws, the twelve screws holding the window will be exposed; these should be unscrewed carefully and the screen lifted off. Care should be taken not to handle the surfaces of the window. Access to the dual phosphor screen is now possible should its replacement be necessary.

Efficiency

This may be checked by placing alpha and beta sources of known strength in turn on the centre of the probe windows, making sure that the source is not masked by the grille, and taking readings on the ratemeter.

The respective counts per second should be greater than:-

0.0030 x (alpha source disintegrations per minute) (20% efficiency)

0.01 x (beta source counts per minute) (30% efficiency)

The sources usually used are:-

Alpha:- Pu^{239} (RCC P.1.R.C.2)

Beta:- Sr^{90} (RCC S.1.R.C.1.)

Typical Waveforms

These waveforms are depicted in Fig. 7 and can be used to facilitate fault finding in the circuitry of the instrument. A pulse generator delivering negative-going pulses of 1µsec. duration and up to 10V amplitude together with a suitable oscilloscope are required for testing purposes.

(c) Component List

Circuit Reference	Description			Part No.		
Resistors (fixed)						
R1	6.2K	½W	2%	7A/A	5309	MB
R2	75K	1/8W	2%		37812	UK
R3	75K	1/8W	2%		37812	UK
R4	75	¼W	20%		33360	CT
R5	68		5%		33363	F
R6	68		5%		33363	F
1R1	1M	¼W	5%		33360	AG
1R2	62K	1/8W	2%		37812	WY
1R3	1M	¼W	5%		33360	AG
1R4	10K	½W	2%	7A/A	5309	TW
1R5	1M	¼W	5%		33360	AG
1R6	10K	½W	2%	7A/A	5309	TW
2R1	10K	½W	2%	7A/A	5309	TW
2R2	3.3K	½W	2%	7A/A	5309	WD
2R3	220K	1/8W	2%		37812	XE
2R4	22K	½W	2%	7A/A	5309	WQ
2R5	3.9K	½W	2%	7A/A	5309	WF
2R6	4.1K	½W	2%	7A/A	5309	CAA
2R7	22K	½W	2%	7A/A	5309	WQ
2R8	6.8K	½W	2%	7A/A	5309	WK
3R1	10K	½W	2%	7A/A	5309	TW
3R2	3.3K	½W	2%	7A/A	5309	WD
3R3	220K	1/8W	2%		37812	XE
3R4	22K	½W	2%	7A/A	5309	WQ
3R5	3.9K	½W	2%	7A/A	5309	WF
3R6	4.1K	½W	2%	7A/A	5309	CAA
3R7	22K	½W	2%	7A/A	5309	WQ
3R8	6.8K	½W	2%	7A/A	5309	WK
4R1	6.8K	½W	2%	7A/A	5309	WK
4R2	470	½W	2%	7A/A	5309	VP
4R3	6.2K	½W	2%	7A/A	5309	MB
4R4	750	½W	2%	7A/A	5309	VU

Circuit Reference	Description			Part No.		
4R5	3.3K	½W	2%	7A/A	5309	WD
4R6	7.5K	½W	2%	7A/A	5309	TU
4R7	1K	½W	2%	7A/A	5309	ME
4R8	4.3K	½W	2%	7A/A	5309	WG
5R1	1M	¼W	5%		33360	AG
5R2	22K	½W	2%	7A/A	5309	WQ
5R3	6.8K	½W	2%	7A/A	5309	WK
5R4	10K	¼W	5%		33360	A
5R5	51K	1/8W	2%		37812	LQ
5R6	51K	1/8W	2%		37812	LQ
5R7	51K	1/8W	2%		37912	LQ
6R1	3.3K	½W	2%	7A/A	5309	WD
6R2	6.8K	½W	2%	7A/A	5309	WK
6R3	6.8K	½W	2%	7A/A	5309	WK
6R4	100K	1/8W	2%		37812	UM
6R5	100K	1/8W	2%		37812	UM
6R6	1K	½W	2%	7A/A	5309	ME
6R7	47K	1/8W	2%		37812	WW
6R8	22K	½W	2%	7A/A	5309	WQ
6R9	200	½W	2%	7A/A	5309	TK
6R10	680	½W	2%	7A/A	5309	VT
6R11	2.2K	½W	2%	7A/A	5309	WA
6R12	1K	½W	2%	7A/A	5309	ME
6R13	1K	½W	2%	7A/A	5309	ME
6R14	10K	½W	2%	7A/A	5309	TW
6R15	33K	½W	2%	7A/A	5309	
6R16	2.2K	½W	2%	7A/A	5309	WA
6R17	33K	1/8W	2%			
6R18	2.2K	½W	2%	7A/A	5309	WA
7R1	15K	½W	2%	7A/A	5309	JT
7R2	10K	½W	2%	7A/A	5309	TW
7R3	1.2K	½W	2%	7A/A	5309	TL
7R4	8.2K	½W	2%	7A/A	5309	WL
7R5	4.3K	½W	2%	7A/A	5309	WG
7R6	22K	½W	2%	7A/A	5309	WQ
7R7	100	½W	2%	7A/A	5309	TF

Circuit Reference	Description			Part No.		
8R1	1.2K	½W	2%	7A/A	5309	TL
8R2	470	½W	2%	7A/A	5309	VP
8R3	1.2K	½W	2%	7A/A	5309	TL
8R4	470	½W	2%	7A/A	5309	VP
8R5	200	½W	2%	7A/A	5309	TK
8R6	200	½W	2%	7A/A	5309	TK
8R7	470	½W	2%	7A/A	5309	VP
8R8	470	½W	2%	7A/A	5309	VP
9R1	22K	½W	2%	7A/A	5309	WQ
9R2	10K	½W	2%	7A/A	5309	TW
9R3	220	½W	2%	7A/A	5309	VF
9R4	100	½W	2%	7A/A	5309	TF
9R5	150K	½W	2%		37812	UT
10R1	47	¼W	5%		33360	E
10R2	150	½W	2%	7A/A	5309	TJ
10R3	2.5K	½W	2%	7A/A	5309	ZT
10R4	1M	¼W	5%		33360	AG

Resistors (variable)

2RV1	5K			7A/A	5308	A
2RV2	2.5K			7A/A	5308	B
3RV1	5K			7A/A	5308	A
3RV2	2.5K			7A/A	5308	B
5RV1	5K			7A/A	5308	A
8RV1	1K			7A/A	5308	C
8RV2	1K			7A/A	5308	C
10RV1	1K			7A/A	5308	C

Capacitors (fixed)

1C1	82pF		2%	7A/A	2956	C
1C2	50pF		20%	7A/A	896	A
1C3	50pF		20%	7A/A	896	A
2C1	0.01μF	150V	10%	7A/A	5316	C
2C2	0.01μF	150V	10%	7A/A	5316	C
2C3	0.005μF	150V	10%	7A/A	5316	B

Circuit Reference	Description			Part No.		
3C1	0.01μF	150V	10%	7A/A	5316	C
3C2	0.01μF	150V	10%	7A/A	5316	C
3C3	0.005μF	150V	10%	7A/A	5316	B
4C1	0.01μF	150V		7A/A	5316	C
4C2	0.1μF	150V		7A/A	5318	A
4C3	25μF	12V		7A/A	5315	
5C1	0.25μF	150V	10%	7A/A	5318	B
5C2	100μF	6V		7A/A	5314	
5C3	16μF		10%	7A/A	5317	
5C4	0.25μF	150V	10%	7A/A	5318	B
5C6	0.01μF	150V	10%	7A/A	5316	C
5C7	25μF	12V		7A/A	5315	
5C8	2μF	150V	10%	7A/A	5318	E
5C9	0.04μF	150V	10%	7A/A	5316	F
6C1	0.01μF	150V	10%	7A/A	5316	C
6C2	0.01μF	150V	10%	7A/A	5316	C
6C3	0.01μF	150V	10%	7A/A	5316	C
6C4	0.01μF	150V	10%	7A/A	5316	C
6C5	0.1μF	150V	10%	7A/A	5318	A
6C6	0.01μF	150V	10%	7A/A	5316	C
6C7	25μF	12V		7A/A	5315	
6C8	0.1μF	150V	10%	7A/A	5318	A
6C9	0.25μF	150V	10%	7A/A	5318	B
6C10	6μF		10%	7A/A	5312	G
7C1	0.25μF	150V	10%	7A/A	5318	B
7C2	100μF	6V		7A/A	5314	
7C3	8μF	6V		7A/A	5313	
7C4	100μF	8V		7A/A	2996	K
8C1	1000μF	6V		7A/A	5304	
8C2	1000μF	6V		7A/A	5304	
8C3	100μF	6V		7A/A	2996	L
8C4	100μF	6V		7A/A	2996	L
9C1	200μF	12V		7A/A	5426	
9C2	200μF	12V		7A/A	5426	

Circuit Reference	Description		Part No.		
10C1	1000µF	6V	7A/A	5304	
10C2	0.005µF		7A/A	5324	B
10C3	0.05µF		7A/A	5324	A

Capacitors (variable)

1TC1	3-12.5pF	7A/A	5319	B

Transformers

7T1	Audio output transformer		92800	B
10T1	AF Oscillator transformer	7A/B	5362	

Miscellaneous

S1	Selector switch (9 pole 7 way)	7A/B	2486	
S2	Volume switch	7A/A	2508	
PL1	Connection to batteries (+ terminals)	7A/A	2498	C
PL2	Connection to batteries (- terminals)	7A/A	2489	G
PL3 red	Plug in battery unit	7A/A	2489	C
PL6 blue	Connection to batteries (- terminals)	7A/A	2489	G
	Headphone plug	7A/A	2507	B
	Headphone plug hood	7A/A	2507	C
SKT1	Connection to batteries (+ terminals)	7A/A	2490	C
SKT2	Connection to batteries (- terminals)	7A/A	2490	G
SKT3	Connection to batteries (+ terminals)	7A/A	2490	C
SKT4	Signals from probe (single way)	7A/A	2045	
SKT5	Loudspeaker output	7A/A	2507	A
SKT6 blue	Socket in battery unit	7A/A	2490	G
M1	Counting-rate meter	7A/B	5340	
J1	EHT jack	7A/A	2499	
ILP1	6V 0.3A for mains unit only		35421	D
X1	Register	7A/A	2487	
LS1	$2\frac{1}{2}$ in. loudspeaker	7A/A	2498	
	Dual probe	7A/B	5353	

Diodes

2D1	OA 202	crystal diode
3D1	OA 202	crystal diode

Circuit Reference	Description		Part No.
4D1	OA 202	crystal diode	
5D1	CV 448	crystal diode	
5D2	CV 448	crystal diode	
5D3	CV 448	crystal diode	
5D4	CV 448	crystal diode	
5D5	OA 202	crystal diode	
5D6	OA 202	crystal diode	
5D7	OA 202	crystal diode	
6D1	CV 448	crystal diode	
8Z1	157033A	Zener diode	
8Z2	157033A	Zener diode	
10MR1	EHT rectifier	K3/60	7A/A 2496
Transistors			
1J1	OC 44		
1J2	OC 44		
2J1	OC 44		
2J2	OC 201		
2J3	OC 201		
3J1	OC 44		
3J2	OC 201		
3J3	OC 201		
4J1	OC 44		
4J2	OC 44		
4J3	OC 44		
4J4	OC 44		
5J1	OC 44		
5J2	OC 44		
6J1	OC 44		
6J2	OC 44		
6J3	OC 44		
6J4	OC 44		
6J5	OC 44		
7J1	OC 44		
7J2	OC 72		

Circuit Reference	Description	Part No.
8J1	OC 139	
8J2	OC 139	
8J3	OC 44	
8J4	OC 44	
8J5	V15/30P	
8J6	V15/30P	
9J1	OC 71	
9J2	OC 72	
9J3	V15/30P	
10J1	OC 77	

MAINS SUPPLY POWER UNIT PCM1 (110/230V) and PCM2 (50V)

Resistors (fixed)

R1	10	5%	C20006 A
R2	10	5%	C20006 A
R3	10	5%	C20006 A
R4	10	5%	C20006 A
R5	10	5%	C20006 A
R6	10	5%	C20006 A

Capacitors (fixed)

C1	1000µF	15V	7A/A 2950
C2	1000µF	15V	7A/A 2950
C3	1000µF	15V	7A/A 2950
C4	1000µF	15V	7A/A 2950
C5	1000µF	15V	7A/A 2950
C6	1000µF	15V	7A/A 2950

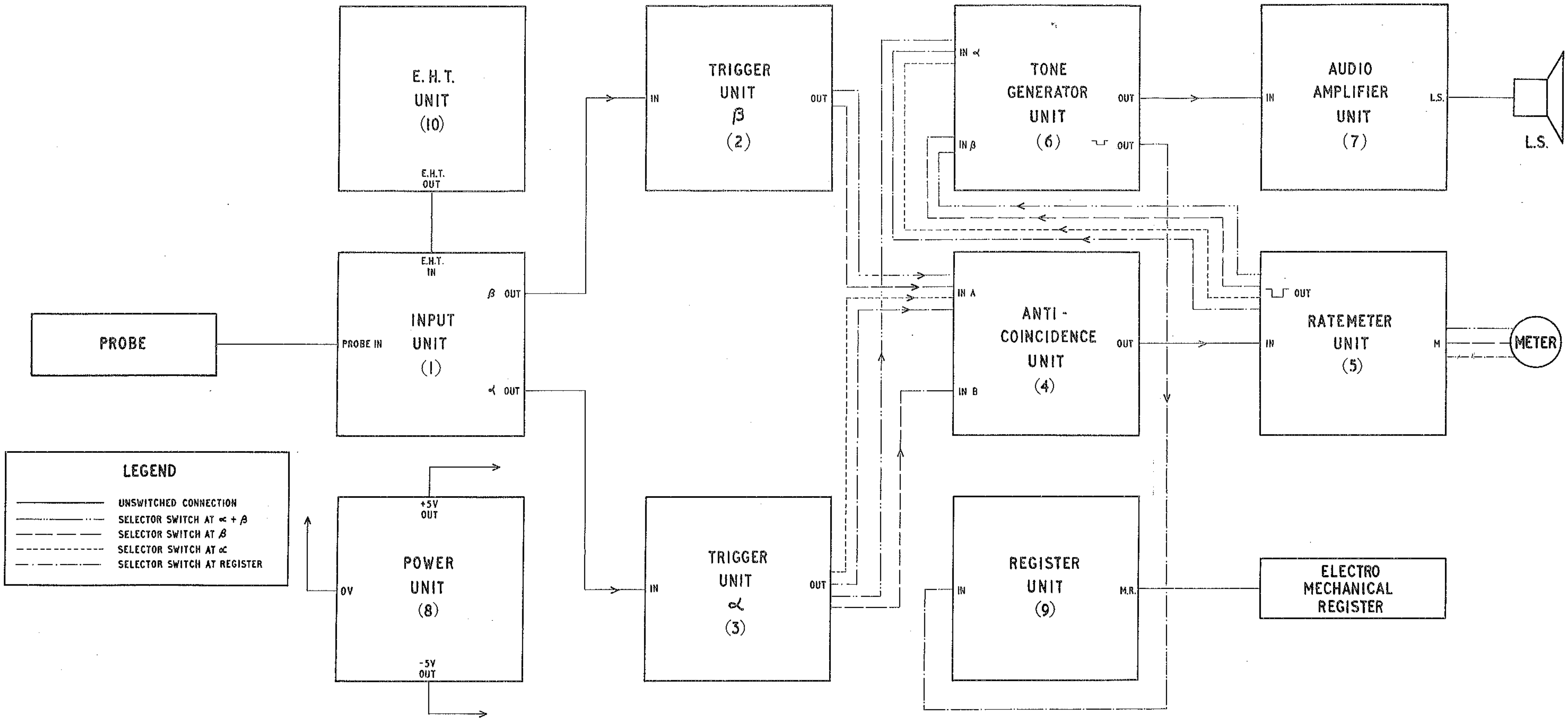
Rectifiers

MR1	Rectifier	OA10
MR2	Rectifier	OA10
MR3	Rectifier	OA10
MR4	Rectifier	OA10
MR5	Rectifier	OA10
MR6	Rectifier	OA10
MR7	Rectifier	OA10
MR8	Rectifier	OA10

Circuit Reference	Description	Part No.
Transformers		
T1	PCM1 only	7A/A 2520
	PCM2 only	7A/A 2588
Miscellaneous		
TB1	Voltage selector panel PCM1 only	7A/A 1141
PL3	Plug red (3 way)	7A/A 2489 C
SKT6	Socket blue (3 way)	7A/A 2490 G
FS1	250mA } 250V PCM1 only	4A/A 8719
FS2	250mA } 250V PCM1 only	4A/A 8719
FS1	500mA } 110V PCM1 only	4A/A 8721
FS2	500mA } 110V PCM1 only	4A/A 8721
FS1	1 amp } 50V PCM2 only	4A/A 8720
FS2	1 amp } 50V PCM2 only	4A/A 8720
DUAL PROBE DP2		
Tube assembly (containing encapsulated C's & R's)		7A/A 1438
Valves		
9524B	Photomultiplier (E.M.I. 1")	
Miscellaneous		
	Melinex Screen Assembly	7A/A 1488
	Grille	7A/A 1444
	Gasket	7A/A 1442
	Plug 1 way (Straight entry) P.E.T.	7A/A 2046
	Connecting cable	148/504/071
	Phosphor (dual)	7A/A 5355

(d) Basic Spares List

Description	Quantity	Part No.
Transistors		
OC 44	6	
OC 201	2	
OC 72	2	
V15/30P	2	
OC 139	2	
OC 71	1	
OC 77	1	
Photomultiplier Tube	1	EMI 9524 B
Crystal Diode		
OA 202	2	
CV 448	2	
157033A (Zener)	2	
EHT Rectifier (K3/60)	1	7A/A 2496
Lamp (6V 0.3A)	1	35421 D
Phosphor Screen	1	7A/A 5355
Aluminised Window	1	7A/A 1488
Grille	1	7A/A 1444
Meter	1	7A/B 5340



TL 1175

BLOCK SCHEMATIC DIAGRAM

FIG. 1

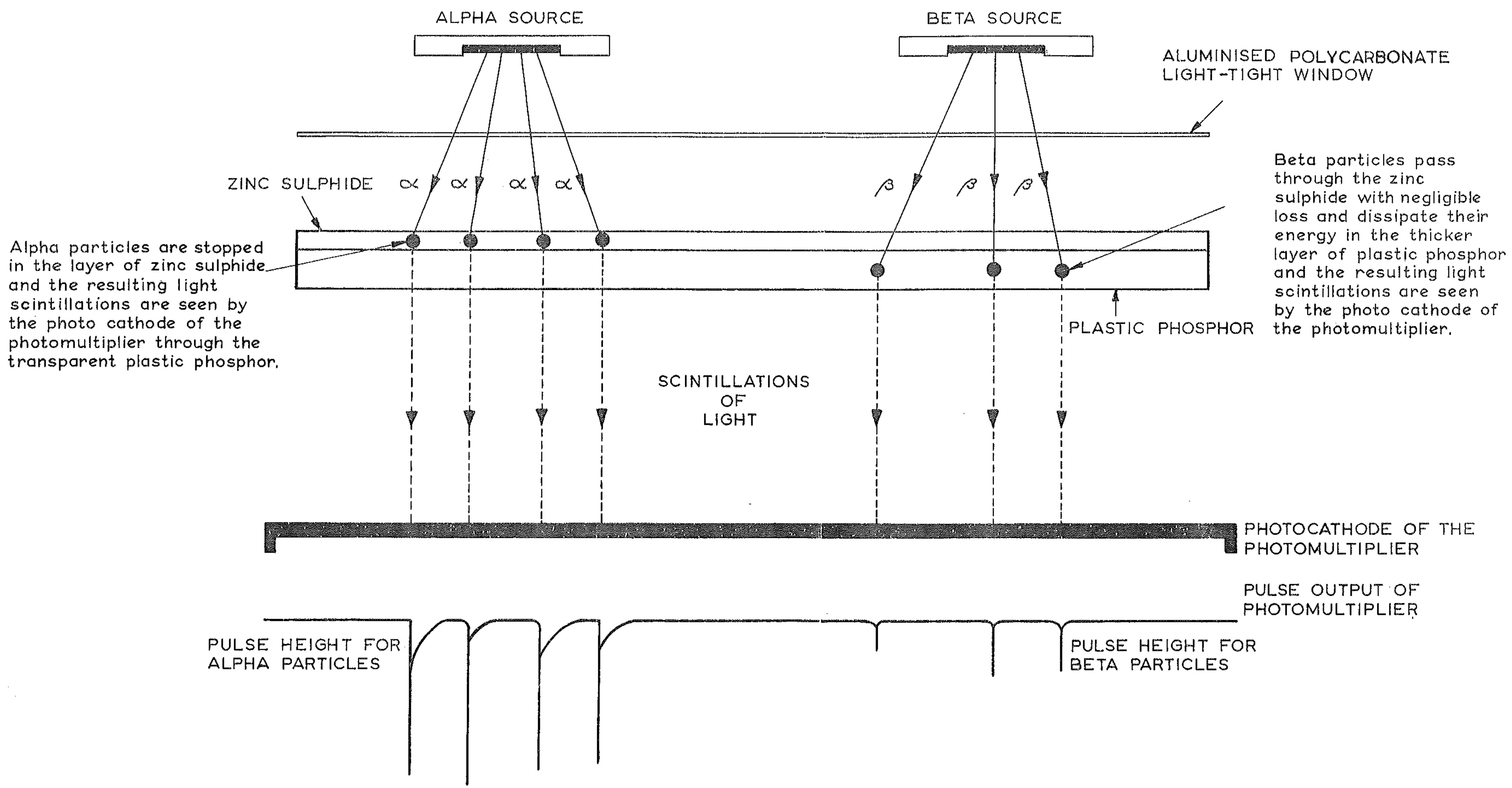
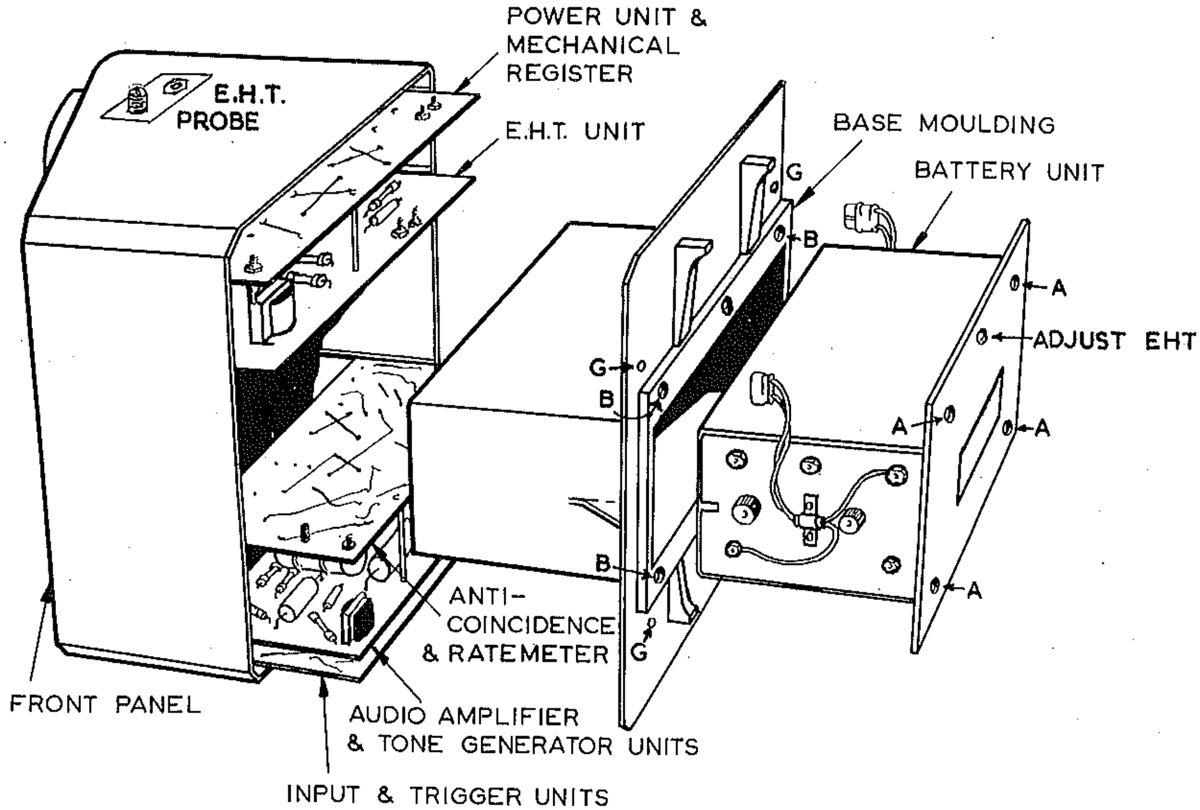
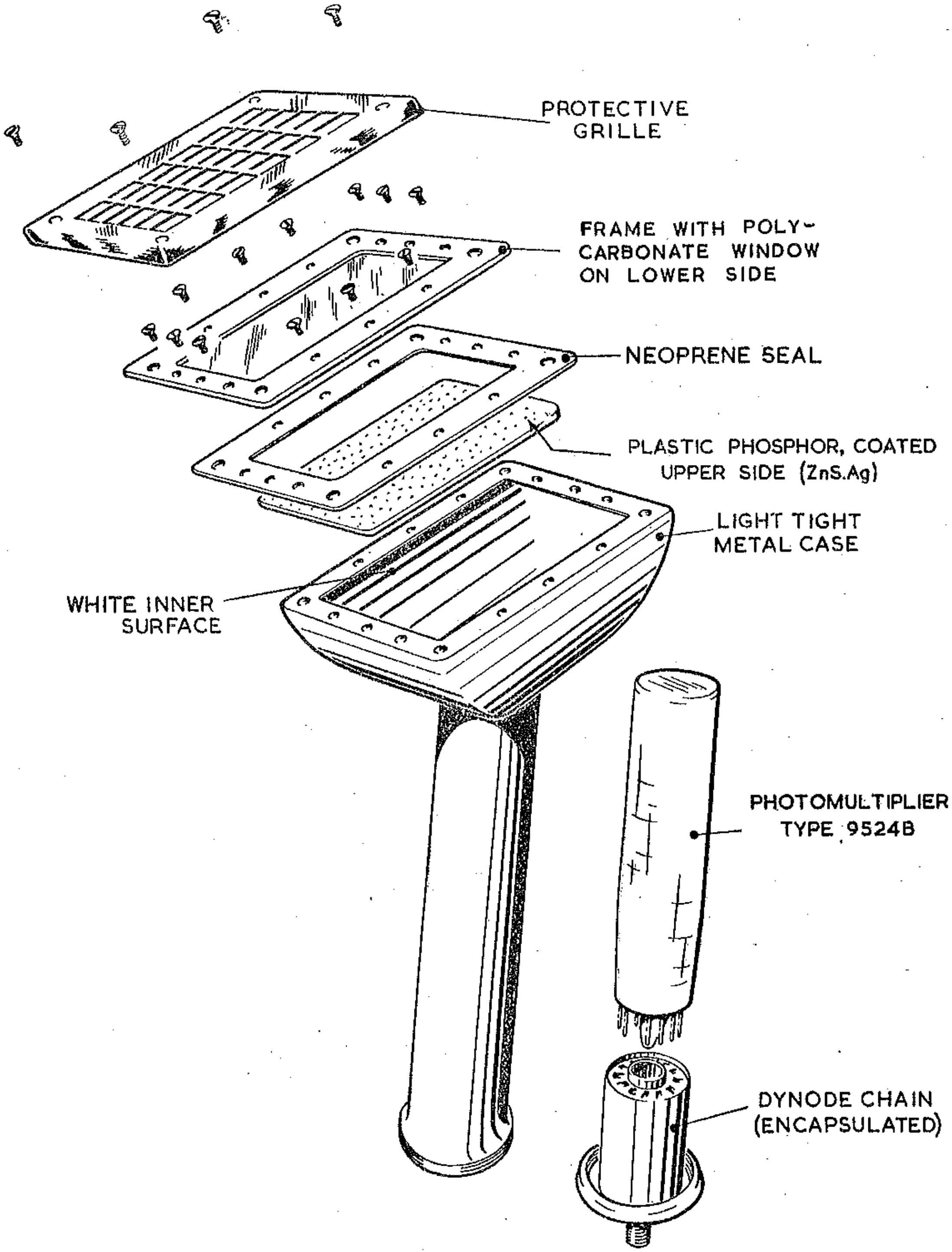


FIG. 2 FUNCTIONAL DIAGRAM OF THE PROBE TL.1175



TL.1175 EXPLODED VIEW OF MAIN UNIT FIG.3



TL.1175 DUAL PROBE TYPE DP2 FIG.4

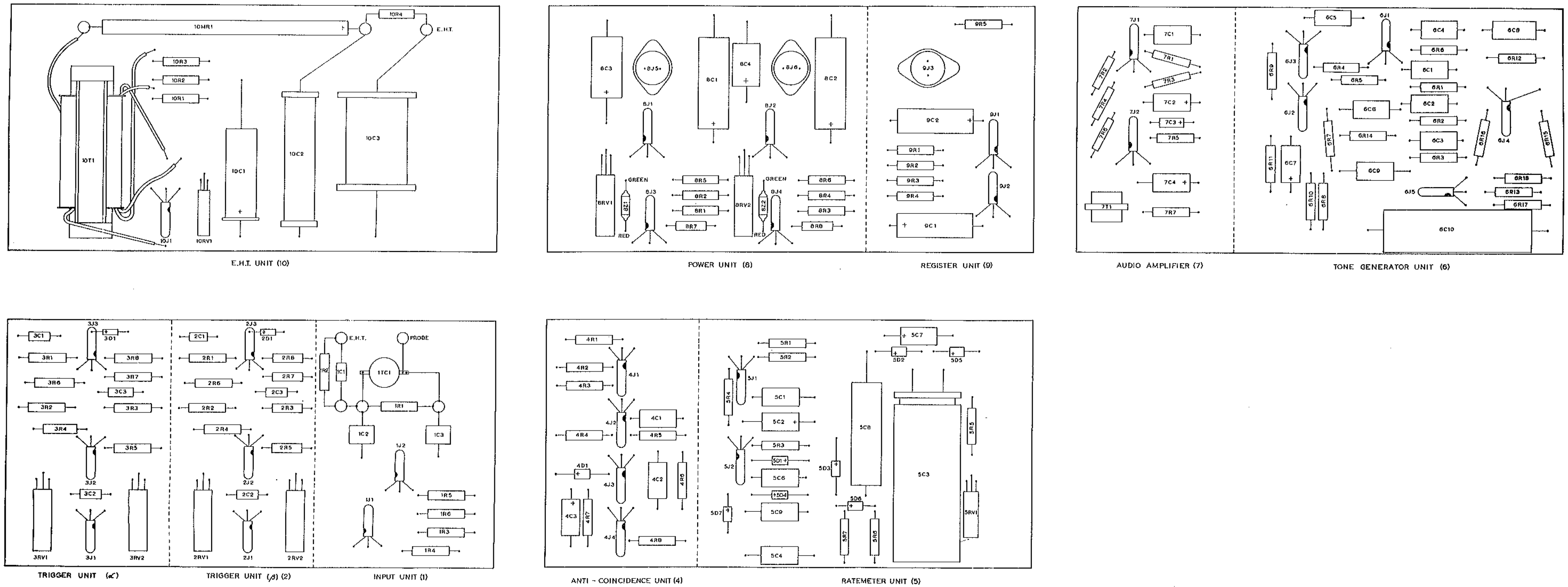
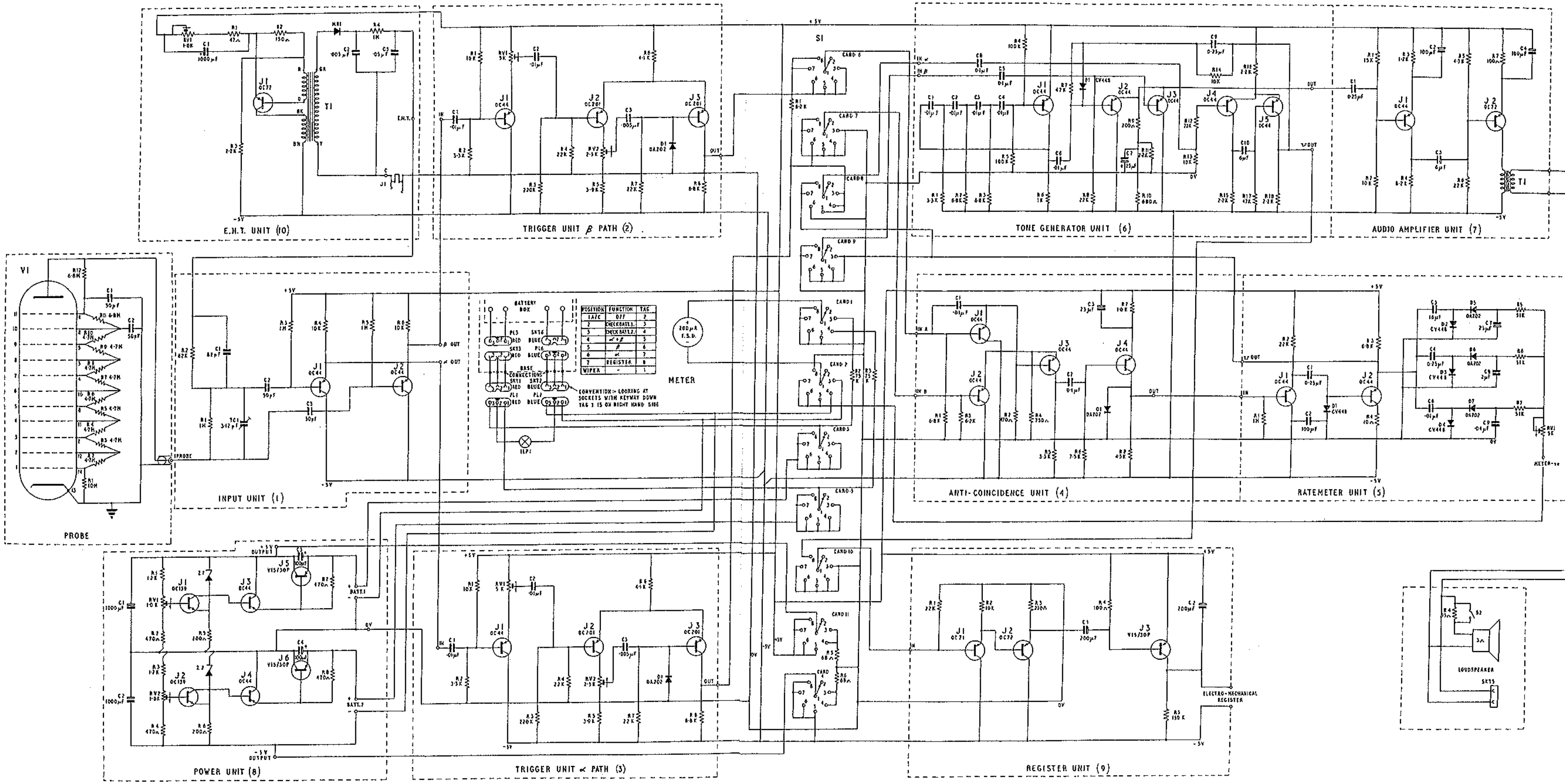


FIG.5 PCM1-COMPONENT LAYOUT

TL.1175



TL.1175

PCM1 - CIRCUIT DIAGRAM

FIG.6

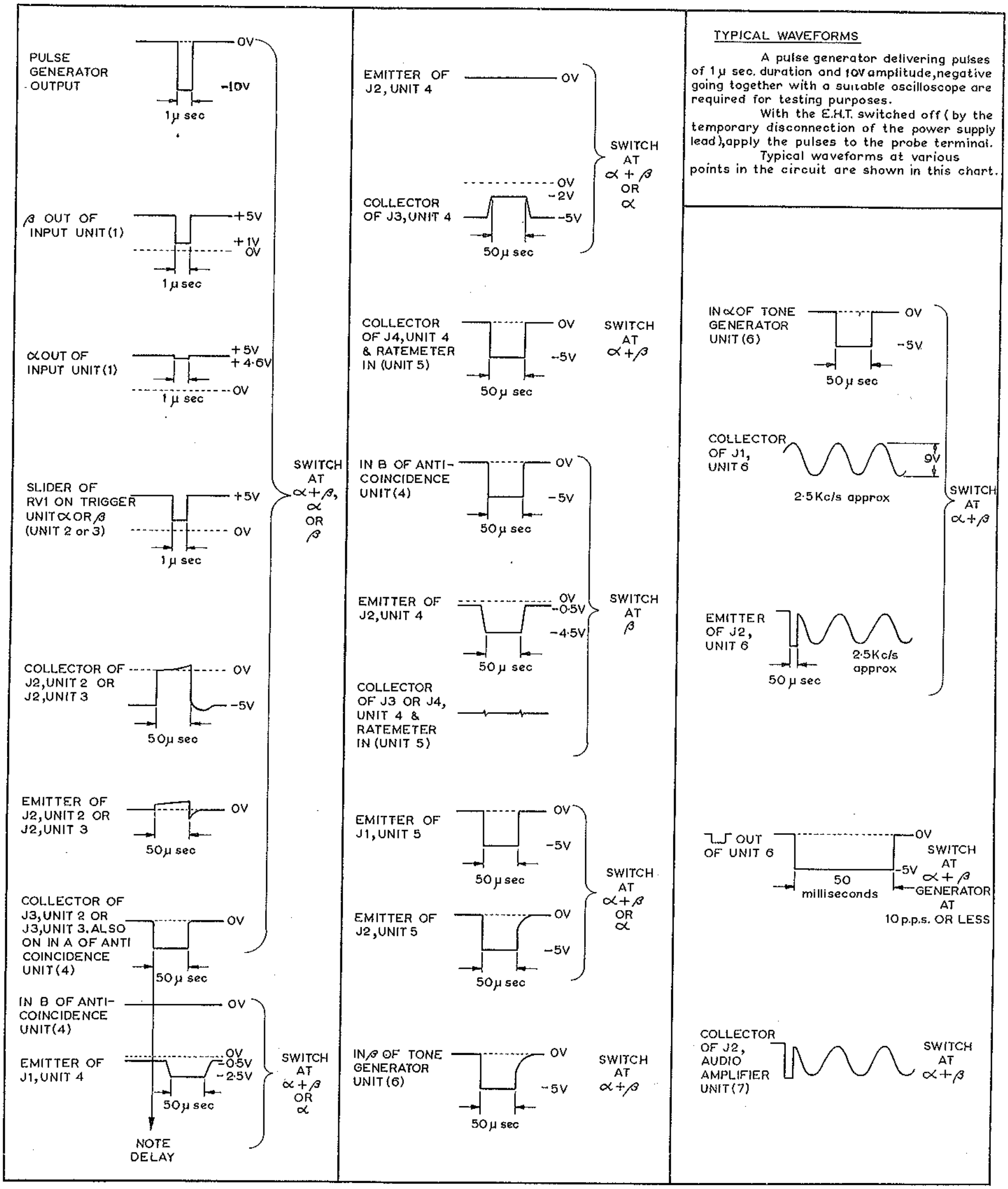
N

TYPICAL WAVEFORMS

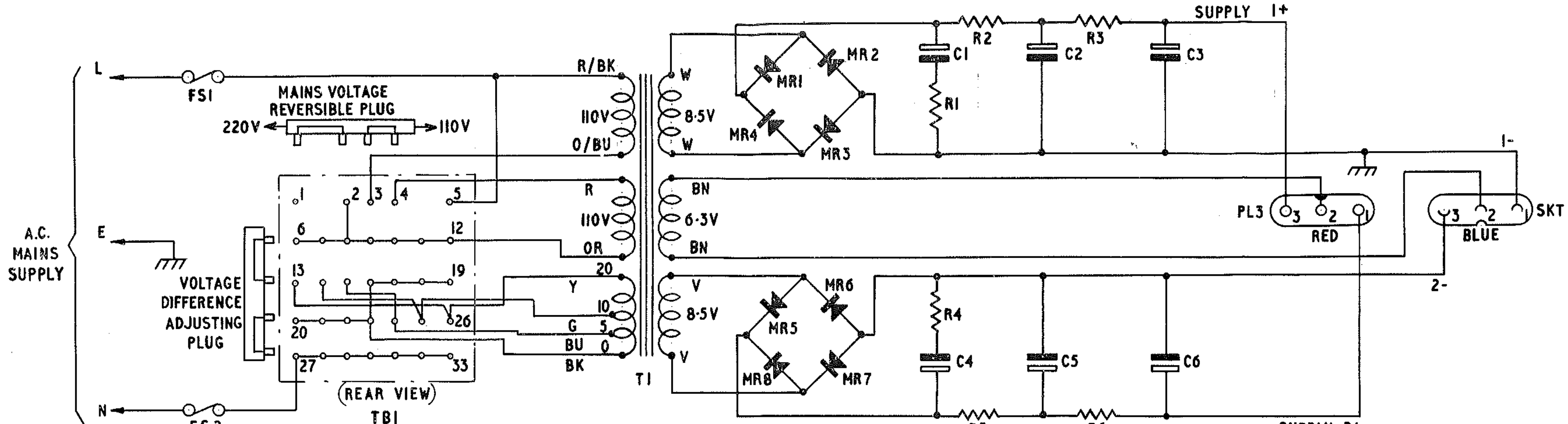
A pulse generator delivering pulses of 1μ sec. duration and 10V amplitude, negative going together with a suitable oscilloscope are required for testing purposes.

With the E.H.T. switched off (by the temporary disconnection of the power supply lead), apply the pulses to the probe terminal.

Typical waveforms at various points in the circuit are shown in this chart.

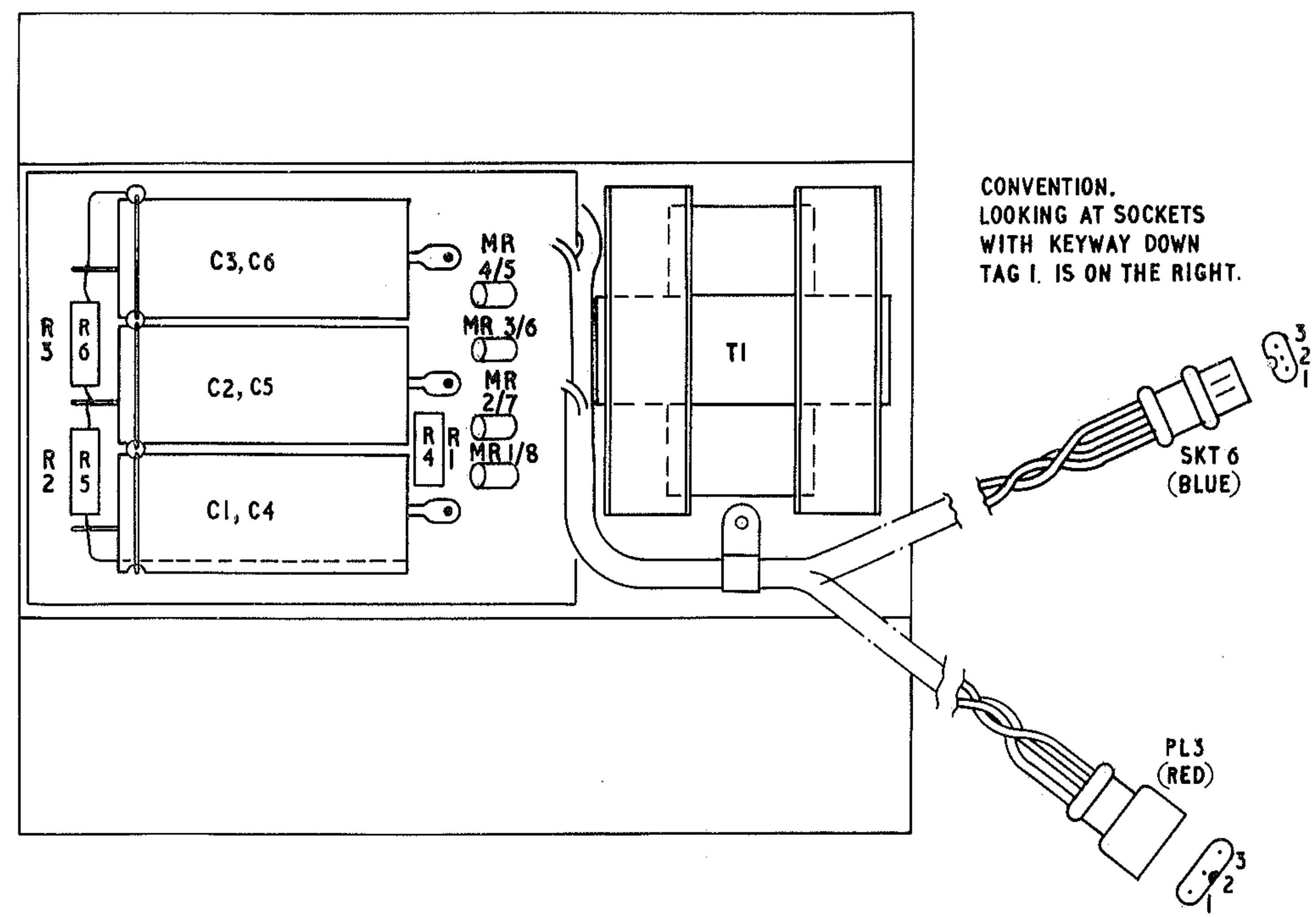


TL.1175 TYPICAL WAVEFORMS FIG.7



CIRCUIT DIAGRAM

NOTE: FOR 50 VOLT MAINS ONLY ONE PRIMARY WINDING CONNECTS TO 'L' AND 'N', WITHOUT TB1 & PLUGS.



COMPONENT LAYOUT

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MAINS SUPPLY POWER UNIT TYPES PCM1 & PCM2

FIG. 8