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MANUAL

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MANUAL FOR THE MAINTENANCE OF THE MRL SMOKE CHAMBER INSTRUMENTATION AND RECORDING SYSTEM

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S U M M A R Y

This manual describes the history, circuitry, setting-up and operating instructions for the MRL Smoke Chamber IR Scanning Radiometer (2 to 15 μm waveband) for the Australian Smoke Programme. It describes in detail the progress over a number of years of the modifications required and the reasons for these modifications from the original design in 1979.

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1. INTRODUCTION

The smoke chamber, which is situated at MRL, was built and developed to investigate the transmission properties of current and novel obscurants. The chamber can be used to investigate transmission in the visible and infrared, up to 15 μm.

This manual should be used as the current working and maintenance manual; it contains sufficient detail to duplicate, set up and maintain the facility.

Earlier reports describe the associated data logging system(ref.1) and the philosophy behind the smoke chamber(ref.2).

2. HISTORY

This transmissometer system was developed in 1979 in ERL (IOC Group) as its contribution to the Australian smoke programme. MRL's contribution is the running of the Smoke Chamber and testing and development of various obscurants.

The visible and short waveband IR region was measured by using several discrete passband filters switched into the optical train in turn, and the IR band from 2 to 15 μm by using a continuously rotated Circular Variable Filter (CVF).

For the IR system, since low level signals were contemplated, synchronous detection was chosen as desirable, and because of the wide spectrum (2 to 15 μm) a Golay cell was required as the detector, this being the only available detector to conform to low level signals, wide dynamic range and wide spectral response.

The IR source needed to have a large proportion of IR content, and so the choice was between a glow bar from Oriel, or a Nernst Glower (NG). A NG was chosen because of its higher temperature output above 1000°K. Two suppliers of NGs are Perkin Elmer and Barr and Stroud (used in the Beckman IR4 Spectrometer).

At the time of system design, an Oriel Circular Variable Filter set (CVF) was available with the required accuracy in wavelength and transmission and was used to design a three filter set covering a range of 2 to 15 μm in the three sections:

(a) 2.46 to 4.48 μm;

(b) 4.47 to 8.04 μm; and

(c) 8.24 to 14.57 μm.

Initially this system was designed to use a chart recorder and the appropriate data reduction carried out at a selected number of points, with the idea that in the future a computer data logging system would be used: hence the CVF has a graticule marked in 100 pulses/marks/segment, but only every one-tenth could be used by the chart recorder.

The concept was to note 'no input' reading level from the Golay cell, with the NG blanked off. The system and chart recorder are then started and the reading level recorded with no smoke present ('no smoke' run). Smoke or other obscurant is then introduced into the chamber and a set of measurements called the 'smoke' run are recorded. As noise is a problem, several sets of readings, ie several revolutions of the CVF, need to be taken and each point (ie each wavelength interval) averaged for both 'no smoke' and 'smoke' runs. There are usually 3 and sometimes 5 revolutions of the CVF to be averaged in this way.

2.1 The electronic design

A standard laboratory synchronous detector circuit was used, taking its reference from the Oriel chopper at the Nernst Glower end of the transmissometer, and generating an ac signal at approximately 15 Hz. A 15 Hz chopping frequency was chosen since the Golay cell cannot adequately follow signals faster than this, and still retain sufficient gain. This factor dictated the speed at which the CVF could revolve.

The system wavelength resolution is defined by the size of the image focussed on the CVF, the limited speed of response of the Golay cell, and the scan rate of the filter. Sampling at the rate of 458 samples/complete revolution in 33.3 s provided a resolution of 100 samples/filter segment, in a time sufficiently short to prevent significant changes in the obscurant sample, such as settling(ref.1).

A mass produced IR source and detector were available from Hewlett Packard as an integral unit, with quite high resolution and speed. This HEDS1000 was used for reading the CVF graticule using a comparator IC LM311 with a small amount of hysteresis. The signal was, however, too fast for the chart recorder to follow and so each 100 pulse train was divided by 10, using a time-out/reset circuit which incorporated a gated free running oscillator into a counter, the output of which triggered the 'synchronisation pulse detected' monostable which is set for 1.5 s pulse. The same triggering action resets the divide by 10 counter.

The signal from the Golay cell was ac amplified through a low noise amplifier with a gain of 5, before being synchronously detected; some gain and isolation being necessary to get sufficient signal to be handled by the synchronous detector, and prevent loading of the high impedance Golay output signal by periodic clamping of the synchronous detector, respectively. This dc signal from the integrating synchronous detector was passed down a transmission line to the chart recorder. Since the chart recorder could not follow signals greater than a couple of cycles, this system appeared quite satisfactory.

Deflections corresponding to transmission at each wavelength of concern were measured from the chart records and tabulated for 3 runs, and then averaged. A 'no smoke' or clear air run, and a 'smoke' or obscurant run were manipulated in this way before the mass extinction coefficient for each wavelength could be calculated. Since the mass extinction coefficient is calculated from ratios of 'smoke' and 'no smoke' readings, absolute readings were unimportant, as long as the signal was greater than the noise and precautions were taken to prevent amplifier 'bottoming' during current alignment. Therefore long term deterioration of the IR source or the detection system was basically unimportant: short term drift, however, could cause errors.

To minimise these errors the Nernst Glower was set to run at a (low) colour temperature (1000°K), and for stability a dc power supply was designed using the constant current collector characteristics of the transistor. Since the original Nernst Glowers were sintered, switching on and off resulted in a high failure rate, and so when not in use the Nernst Glowers were put in 'standby'mode, using sufficient current to keep them self sustaining. This meant a running current of 0.7 A and a standby current of 0.2 A for the 3 mm diameter Nernst Glower.

The original Nernst Glowers used were probably spares from the Beckman IR4 spectrometer of 1.5 mm diameter: these required 0.6 A to run at 2100°K, and 0.2 A for 'standby'. These Nernst Glowers were superseded by the Perkin Elmer type No 221-0451, a true ceramic, which is 30 mm long and has a diameter of 3 mm, requiring similar currents able to run at 1000°K.

Both Nernst Glowers require heating to start them, and until recently heaters from the Beckman IR4 were used - these required some 5 A at 10 V.

The Nernst Glower housing and lens assembly were modified Oriel types Nos 6361 and 6362 respectively. Mica brackets held the 'glower and heaters in position, and not being mechanically reliable needed mica wedges to separate the elements to their desired positions subsequent to any movement and/or installation.

A Nernst Glower is a ceramic mixture of zirconium, yttrium, thorium and other oxides, which is heated externally to 400°C before it will pass sufficient current to sustain itself.

The Smoke Chamber system was computerised using an LSI 11/03 computer; the PDP 11/34 mainframe was used to develop the programmes which were then run on the LSI 11/03. A configuration was devised to conform to the initial specifications, and was initially oriented to the 2 to 15 μm region which is still the region of main area of interest. After installation, a 'setting up' procedure needed to be closely followed. The initial extinction coefficient results were no better than those obtained using the 10 points measured from the chart recorder, but subsequently the system was improved to such an extent that the test results from various calibration filters eventually conformed remarkably well with published data, as various problems were identified and solved.

2.2 Future developments

Since the electronics are spread over several boxes and parts of the system are duplicated and or redundant a tidier electronic design, which is functionally identical to the existing system, is contemplated. In the event of a catastrophic failure, it is desirable that the existing system can be readily replaced by this updated version.

Also, since the Golay cell is expensive and has a comparatively slow response (25 Hz), a faster detector system should be found, which would then increase the speed of data logging by at least ten times. This should make the system perform closer to a real time situation ie less probability of particle differential fall-out due to the 33 s CVF revolution.

Another point to be considered is the heating of the Platimum NG heaters which will probably require a constant current source because of the wide tolerances of the CZ12 NTC resistors used: ie their heating time constants appear to change by at least 3:1, which causes problems.

3. PRESENT SYSTEM DESCRIPTION

3.1 Source

The Nernst Glower housing is still being developed. The original housing was one from the Oriel range but modified to hold the Nernst Glower. A new chopper which was installed in the side wall caused noise and vibration so this was changed to a vertical mounting. (Vibration will reduce the life of the Nernst Glower and so resonances had to be eliminated by muffling or design.) A 5 mm square aperture is placed at the focal point of a bloomed germanium transmitting lens. (See figure 1).

A Nernst Glower is designed to operate in air at a temperature of 2100°K (1827°C). What appears to be a polarising problem within the Nernst Glower, when using a dc power source beyond 0.8 A, is eliminated by using a controlled ac power supply. This ac power supply was designed to drive the Nernst Glower from its "dc @ 1000°K" capability to an upgraded limit of 2000°K. This alone should give a 4:1 increase in useful IR energy in the range 2 to 15 μm.

The Nernst Glower has a negative resistance coefficient with a slope -7.3 Ω/A at an operating temperature of 2100°K, the current required being 2.1 A. Therefore the Nernst Glower power supply needs to deliver 92 W, but to first 'strike' the Nernst Glower a voltage in excess of 70 V is required. (See figure 2).

A Cadmium Sulphide (CdS) detector is used as the sensing element for luminous flux control. This detector is in a bridge circuit with the 'I_{NG} SET' potentiometer feeding into a high gain operational amplifier (A_V = 100), then to the controlling transistor network to the magnetic amplifier. Circuit layout problems have been taken into consideration (ie earth loops considered).

The power supply is a controlled current unit using a magnetic amplifier, which was designed in AEL, for control from a single transistor. This magnetic amplifier has been designed to produce a near sine-wave output even when operated at maximum dc input (which provides maximum power to the NG). The objective of the smoothly varying ac waveform was to minimise rapid current changes and to prevent build up of polarising effects in the NG.

Another problem which is not normally encountered is the heaters required to start the NG. Since the NG runs at such a high temperature, platinum heaters were the choice of the NG manufacturers. This material has a large positive temperature coefficient such that at the running temperature it requires 60 V at 2 A (30 Ω) but when cold the resistance is much lower and it draws excessive current from the transformer. Therefore a Negative Temperature Coefficient (NTC) resistor had to be found that could handle 2 A while running; its resistance has to drop to parts of ohms when hot, and be at least 30 Ω resistance when cold. A CZ12 was the only device available.

Once the NG became self sustaining the heaters needed to be switched off, and so a unique method was devised to achieve this. Using the forward voltage drops across 3 diodes (1N5626), and a small bridge rectifier and smoothing capacitor, to give a dc 'signal'; an opto isolator of the type H13A1 was used to sense the NG current. The sensed I_{NG} is fed into a comparator which is set to switch at I_{NG} greater than 0.3 A, which is the minimum sustaining current for the NG. A solid state relay is used to switch off the heaters - this method cannot burn contacts and is a zero voltage crossing switch which reduces RFI potential problems.

3.2 Chopper

A controlled chopper was decided to be necessary and a loudspeaker was found to have the appropriate characteristics. A 12 W 8 Ω high resilience loudspeaker has the necessary depth of throw and frequency response with the power to drive a chopper blade over a 7 mm distance. The shaft should be longitudinally polished to reduce wearing of the bearings, and the chopper positioned vertically, also to reduce bearing wear, but more importantly to reduce vibration and noise. (See figures 1 and 3).

The chopper driver consists of two transistors, one of which biases the chopper blade from half open to fully open, and the other drives the blade fully closed, on command.

Adjustments for various choppers (resilience change) is controlled by either parallelling 27 Ω 12 W resistors to adjust the 'opening' bias, and/or to series 1 Ω 12 W resistors for driving the blade closed. Normally this circuit and chopper combination will function up to 50 Hz, and some as high as 70 Hz: the requirement, in fact, is only 15 Hz (13.7 Hz). No other device so far has been found to give at least 5 mm throw and at least 20 Hz response.

3.3 Sampling and detection

The radiometer consists of various parts - some mechanical, others optical and electronics (see figures 4 to 7, Table 1).

The electronics block diagram (and schedule) are shown in figure 8 and Table 2.

IR radiation from the NG crosses a 5 m path length and enters a germanium lensed telescope focusing on a slit 1.2 mm wide with the CVF wheel directly behind. The resolution varies with the filter segment in use and is 1.99×10^{-2} µm, 3.67×10^{-2} µm, 6.4×10^{-2} µm respectively, as resolved by the computer(ref.1,2).

Being a pneumatic operating device, and therefore its microphonic nature, the Golay cell is mounted on an antivibration mount. It is positioned behind the CVF (see figures 9 and 10).

The chopped IR energy, being generated by the 'driver chopper', is amplified within the detector housing before being cabled to another low noise ac coupled amplifier which feeds into the synchronous detector system.

The CVF is driven via a gearbox from a mains synchronous motor and the CVF wheel takes 33.3 s to turn one revolution. The CVF is a 3 segmented filter set, set in a wheel to which is attached a glass rim with a vacuum deposited nichrome graticule which has 100 marks/segment, and a synchronising mark just prior to segment No 1 (see figures 11 and 12). These marks are detected using a HEDS1000 light and detector unit (see figures 13 and 14) which has a sharp focus to detect each mark as it passes through its operating field. The signal is 'squared up' using an LM311 comparator, the output of which is termed 'Read Pulses'. (The HEDS1000 was originally designed by Hewlett Packard to be used in bar code readers).

These 'Read Pulses' go to four areas, one being the synchronous detector; another the data logger, the third area generates a more suitable pulse train for writing on the backup chart recorder, and the fourth area generates suitable delays and pulse widths for the controlled chopper (and the synchronous detector) (see figure 16). The chart recorder can only resolve one-tenth the 'Read Pulses' speed and so a divide by ten circuit is used, with a pulse stretching monostable generating a pulse suitable for use with the chart recorder. This circuit has a gated (by the Read Pulses) oscillator and counter which gives a 'carry out' signal only on the synchronising pulse (see figures 15 and 26).

The 'Read Pulses' from the HEDS1000 comparator latch the synchronously detected IR signal into a sample and hold circuit (see figure 16). This had been found necessary since the synchronised signal is only valid at one point in time, due to the Golay cell response and the synchronous detector type used, so the chart recorder printout is basically a stepped trace.

It should be noted that electrically, the Read Pulses are shifted one pulse which would cause the apparent CVF position marker to be out of step with the IR signal; but since only 96 of the 100 pulses available are used, the software takes this apparent discrepancy into account by only using, and aligning the correct wavelength position of the CVF. Hence the software looks at 100 pulses, but ignores one pulse at each end because of non linearities at the filters ends. The first pulse, however, is used to initiate the chopping sequence. The chart recorder cannot resolve less than 4 pulse widths and so was not affected by this problem in the past.

Timing and phasing of the various driver signals derived from the CVF Read Pulses need to be tuned for maximum signal from the Golay cell, and so are probably more complex than need be.

The timing is initiated from the CVF Read Pulses HEDS1000 comparator circuit. As it has been said before, it branches to four main areas: the one considered now is to the synchronous detector circuitry (see figures 17 to 21). This has two delay branches, one delay approximately 30 ms triggers the chopper driver at the NG end; the other delays and 'latches' the synchronous detector - an initial delay of approximately 5.5 ms and then a 31 ms 'on' time for the synchronous detector.

These three delays (monostables) are tuned so the computer does an analogue to digital conversion at the peak of the IR signal, (see figure 22). The top is comparatively flat, and the edges can and do vary in time due to the variation in spacing of the CVF graticule marks.

3.4 Power supplies

The power supplies need not be described in any detail as they are fairly standard, mostly of the IC type. However, the Golay cell power supply (see figures 23 to 25) can be classified as a high loss (high impedance) type which relies on a high voltage (approximately 130 V dc) and large resistors (18 kΩ) for filtering, and the output only becomes 24 V when loaded with the appropriate Golay amplifier circuit. That is, the filtering in particular divides down the ripple content. The Golay's 'lamp' power supply, however, is a discrete component circuit. This lamp circuit also incorporates a constant current device (within the Golay cell housing).

4. COMPUTER INTERFACING AND CONFIGURATION

4.1 Computer system hardware

The computer data logger is an LSI 11/03 Q-bus frame and CPU, with a parallel card, two serial cards, and analogue to digital conversion card DRV11, DLV11, DLV11-J, DT2764 respectively, talking to the outside world (see figure 27). The serial cards DLV11 and DLV11-J talk to the console (keyboard and VDU), plotter and printer, all through software 'handlers' and so are not normally associated directly with user control. DEC standard addressing is normally used.

Because 'bit 15' can be easily read by the Macro instruction TST the parallel card 'DRV11 bit 15 input' is the logical bit to use to fast read the pulses from the CVF Read Pulses.

The DT2764 is a 12 bit analogue to digital converter card specifically designed by Data Translation to suit the DEC/LSI Q-bus. It has been configured for single ended input, which then dictates that 16 channels are available (the first channel is used), and an input voltage range of ±10 V, using 2^s compliment at the output. This gives the ADC output to input range of 2047 (decimal) equivalent to 9.99 V, and -2048 (decimal) equivalent to -10.0 V.

It should be noted that the computer must be switched on before the Golay cell radiometer output becomes meaningful, as the computer, when switched off, loads the CVF Read Pulses, and prevents them from being read even by the chart recorder.

4.2 Chart recorder backup

The chart recorder used is a Curken model 250-3A. The radiometer electronics produces the 'divide by 10 Read Pulses' which use channel No 1 of this 3-pen X-T recorder to display the 'position' of the IR on the CVF. A trace of about 20 mm high is sufficient, and this allows the majority of paper width to be used for both IR and visible radiometer results. Channel No 3 records the visible radiometer which has ten filter positions, but three are used, namely, eye-response, 1.06 μm, and 0.72 μm filters; while channel No 2 shows the IR vs wavelength response. The visible radiometer system has not yet been incorporated in the computer system.

These three signals should be carried from the radiometer table at the end of the smoke chamber to the computer room, which also houses this chart recorder, via twin shielded cables, to reduce interference both into and out of the cables. Earth loop problems are reduced by referring the signals back to the radiometers, and only earthing the shield at one place. A 10 kΩ or higher resistor could be taken from signal return to earth to prevent signals floating.

5. SETTING UP/TUNING THE SYSTEM

To obtain the best possible performance from this overall system, each stage needs to be individually optimised and then collectively tuned. Using the proposed methods, an increase of perhaps five times in sensitivity could be achieved, compared to only trimming the sections individually. The radiometer only 'takes' relative readings and so overall trimming improves the noise figure and dynamic range; the accuracy is basically unaffected.

5.1 Nernst Glower

The Nernst Glower needs to be run as hot as possible without melting its connecting leads. The top lead is subjected to more heat stress via radiation and convection than the bottom one, and so an empirical method is used to determine maximum Nernst glower temperature (see figure 28). Platimum, the lead material, melts at 1942°K but is approximately 3 mm away from the Nernst glower which could therefore be run 200°K higher. The better scheme would be to keep the leads well below their melting point and have the Nernst Glower temperature set to about 2000°K or 1730°C (which can be read on an optical pyrometer). For this temperature to be reached, the Nernst Glower needs a current of 1.8 A. With efficient reflectors this current may be reduced, and possibly a decrease in temperature could be tolerated. A four times improvement in IR energy is sought compared with the original dc drive and 1000°K response.

To adjust the Nernst Glower power supply (see figures 29 to 32): set the 'run/standby' switch to 'run', set the 'set standby current' potentiometer to maximum resistance, set the 'heater off' potentiometer to the 'high' side (positive end), and set the Nernst Glower current potentiometer to approximately 1 kΩ (one-fifth of maximum resistance). Place a voltmeter across the heater transformer primary, setting the meter for 250 V ac range. On switching the mains, the 'mains' indicator should glow, and no volts read on the meter. Turn the 'heaters off' potentiometer down until the meter reads mains voltage of 230 V ac. The heaters will take about 20 s to begin to glow, and heat the Nernst Glower. This delay is due to the CZ12 negative temperature coefficient resistance (NTC) which prevents current surge into the platinum heaters. After about 90 s the Nernst Glower comes up to temperature as set by the I_{NG} potentiometer; there is normally an overshoot of perhaps 0.3 A for a second before dropping back to its set running current. The heaters should also have switched off (ac voltmeter reading). The Nernst Glower current should be about 1.4 A. Switch to 'standby', and adjust standby current to 0.3 A with the 'standby' potentiometer: the heaters should not switch on at this level. Reduce the 'set I_{NG}' potentiometer so ING drops to 0.2 A and then adjust the 'set heaters off' potentiometer until the heaters switch on (ac volt meter). Before the heaters begin to glow, readjust the I_{NG} potentiometer back to 0.3 A, whereby the heaters should again switch off. Put the power supply into the 'RUN' mode and readjust the I_{NG} potentiometer to set the current to 1.6 A. (This reduces the IR level somewhat but increases the Nernst Glower's life - unless more IR is really required).

This power supply should then be ready to use.

The Nernst Glower bar or heater wires should never be touched because contamination can destroy these parts.

5.2 Chopper

The chopper needs to be checked for proper operation. With the Nernst Glower lens assembly removed (the 85 x 60 mm flanged tube), look at the chopper blade to determine its rest position (see figure 1). It should be approximately half way across the 5 mm square aperture. Switch on the NG power supply (with chopper connected) and note that the chopper blade should pull down and fully open the aperture. Drive the chopper input terminals with a 0 to +5 V square wave at 15 Hz, and note the swing of the chopper blade. It should fully close off the aperture. There are two points to watch while trimming this:

(1) the blade should have an overall travel of 6 mm minimum and completely open and completely close the aperture; and

(2) the chopper should not bottom on its housing in either direction.

If the chopper travel is critical then both mechanical and electrical adjustments are required. Mechanical adjustments could take the form of shims under the chopper housing, or replacing the blades (and this is not recommended). Electrical adjustments are simpler.

Without any square wave signal the chopper should open the aperture; however, if it closes then the chopper drive leads are crossed. If the opening travel is not far enough (or too far) adjust/pad the 27 Ω resistors. When driving the chopper circuit with a 15 Hz 5 V signal adjust the 1 Ω resistors to effect sufficient travel of the blade.

5.3 Source collimator lens

The lens assembly is replaced, and the NG and lens pointed such that at least a clear 3 m path length is needed for collimating the IR beam. The area should be darkened to IR signals so that stray signals will not be read by the aligning IR detector, and mark the receiving area to show limiting (and centre) positions of view of the NG assembly. The objective is to get as small and uniform a spot as possible which is both round and has the IR level consistently flat over that area, by adjusting the focus of the lens. A hand held PbS detector circuit is suitable as an indicator for this procedure. Refer figure 33. The IR beam axis should be determined and a line marked on the source housing to aid alignment with the Golay radiometer's telescope. This position is trimmed later when overall system tuning is carried out.

5.4 Sampling indicator (read pulses)

If the CVF HEDS1000 detector needs to be shifted/adjusted, then the computer must be recalibrated. Focusing of the HEDS1000 detector needs care. Measurements are taken from the top face of its housing and are typically 4.27 mm to target surface. There may be a variation of 0.5 mm for maximum signal for best focus, and so the focus distance should only have a ±0.2 mm discrepancy from its natural focus; its image diameter is 0.17 mm. The central wavelength of the detector is 700 nm. There is no adjustment for the HEDS1000 after it is soldered into position, so this information must be implemented precisely for aligning (installing) a new detector. In service, using the glass substrate with nichrome markings (see figure 12), its output to the LM311 comparator should be in the order of 0.9 V PP with an average/dc level of +1.4 V dc (see figure 13). This 1.4 V dc is also the level at which the comparator is set. 'No signal' is equivalent to 'low' V out. This signal is available at the rear end of the Golay cell housing on a BNC connector marked 'Read Pulse' (see figure 6).

(a) The CVF itself houses three $\Delta\lambda$ segments (see figure 11); however, Nos 2 and 3 sections have been installed back to front and only give the pretence of normality when the results are plotted. This is corrected in the computer programme, but only needs to be recognised as a phenomenon here.

To adjust any of the Golay's signal path the CVF needs to be put in its maximum transmission position, which is 200° as marked on the position graticule as viewed through the port above the IOC Group's Logo, and the drive motor to the CVF switched off. The 'Read Pulses' lead is taken off the Radiometer, from the synchronous detector, and plugged into the 'CVF Simulator' box (see figure 34)*. This then gives a constant output from the Golay cell that for all intents and purposes drives the chopper, synchronous detector and computer as though the system is fully functional.

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* Available at Electronics Research Laboratory

5.5 Golay detector

Since the Golay cell box should never be opened, only a superficial description needs to be given. The Golay cell is a pneumatic cell that changes its volume when energy falls onto its input window; the cell wall on the aft side moves and deflects a light beam from a constant current light emitting device. There are two sections to the Golay 'electronics', one being the light emitter and detector, and the other is the low noise dc amplifier. The cell itself, of the Golay cell, comprises two sections with a slow leak between them. When in the presence of a high ambient energy source the working part of the cell can go into a nonlinear region, but recovers, so the built in preamplifier will also work over its linear range. The signal of concern 'rides' on the ambient light level. The signals to date are in the order of 6 mV PP of random noise (no IR input) and 600 mV PP for maximum signal.

5.6 Detector telescope

The Golay cell's telescope should not need to be adjusted, but may be cleaned with an alcohol dampened soft cloth, being careful not to scratch the germanium lens's bloomed surface. If need be, the telescope is focused by using the CVF Simulator, tuning the telescope for maximum Golay cell output. Since the optical and mechanical axes are not coincident if this focus is varied, then the whole system needs to be recalibrated.

To 'point' the radiometer for maximum signal the CVF Simulator needs to be used while the CVF itself has been set to the 200° mark and the motor switched off. The Golay output is monitored by a CRO, and the whole housing moved/wedged etc for maximum output (the objective being to centre the telescope objective lens in the beam from the Nernst Glower, and to ensure that the lens axis is sufficiently aligned with the beam axis to maximise signal). The electronics can be tuned for maximum output from the synchronous detector.

5.7 Electronic circuit tuning

The IR signal from the synchronous detector gets a final dc amplification with an appropriate offset voltage to force the analogue signal to the computer to be always positive, and not overloaded by varying its gain (see figure 16). Positive 9.8 V should be maximum signal for the analogue to digital converter. Set the offset potentiometer such that with no IR input to the Golay cell, with the telescope 'capped', the output to the A/D converter should now be small but positive - say +15 mV. This should be done with no IR signal, but the CVF itself should be turning. The time at which the computer takes a reading is critical (see figure 22). With too short a time the signal is still rising up to the value, but with too long a time the synchronous detector has begun to 'clamp', preparing for the next signal pulse.

In order to generate the proper timing of chopper drive, synchronous detection and sample and hold circuits, the first (of the 100 pulses in each segment) pulse detected initiates the timing sequence controlled by 'monostable' delays such that the first analogue to digital conversion reading is invalid.

This area of the circuit operation is as follows: when the CVF pulse goes high a Read Pulse is generated which is detected by the computer (and the divide by ten circuit for the chart recorder), and if it is detected as a 'read pulse' and not a 'synchronising pulse' an A/D conversion is performed, and stored. But since on the first pulse (of each segment) the synchronous detection and integration circuitry have not the desired time scale, this reading would be erroneous. But as well, since this first reading also appears to suffer from edge/end effects (reflections) from the mounting (of the filter segments) and out of tolerance (linearity) of the wavelength vs angular rotation of the filter, this first reading is set to zero, as an error, and therefore not graphed.

The circuit is such that a reading on the A/D converter is taken just prior to the chopper closing off the IR signal at the Nernst Glower (approximately 3 ms chopper reaction time). Timing of the chopper drive monostable is not especially critical, but is a compromise of maximum available signal being effectively read, and settling time for the synchronous detector to define the zero point of the signal. Period is approximately 73 ms, with the chopper-shut time of 30 ms (29 ms).

The synchronous detector needs a delay from this reference edge of 4 ms so the IR signal can be read by the signal reading/latching system before the synchronous detector switches over to admitting the IR signal. The synchronous detector passes this IR signal for 34.5 ms, but the Golay cell will not peak until about the 26th ms; therefore there is only about 3 ms in which the signal out of the last amplifier is at its peak and is there to be read by the A/D converter. Therefore the 'art' of tuning this system is to reduce droop at point a) and make point b) as high and flat as possible (on the sample and hold (S/H) input waveform) using the Read Pulses on the reference edge. (Rising edge latches the S/H circuit) (see figure 22).

5.8 Chart recorder time reference

Because the chart recorder can only follow one-tenth the speed of the computer, the 100 Read Pulses need to be divided down to 10 modified Read Pulses, and the synchronising pulse needs to be broadened. The Read Pulses are put through a divide by 10 counter - a 4017 - which then triggers a 1 s monostable. The 'high' value of the Read Pulses enables the 340 Hz oscillator which is counted by the 4024. Normally the count is cut short by the falling edge of the Read Pulse and resets this counter, but when the synchronising pulse is encountered, the 4024 terminally counts; it resets the 4017 and triggers a 1.5 s monostable. These two monostable pulses are summed and fed to the chart recorder channel No 1.

6. PROGRAMMING

Two programmes MRLV20 and MRLGRP form a suite to obtain and display IR data from the Smoke Chamber.

The philosophy is to keep the current version of the running programme, both MRLV20 and MRLGRP along with IRUN(=1), on the 'data disc' (DK:) which then ensures that the data gathered is relevant, and if an outdated programme is used it should be readily detected by reading the onboard (disc) programme.

The programme, MRLV20, for the Data Logger section was mainly written in Fortran for ease of programme maintenance, and is Menu driven for ease of use. Each selection is a subroutine with a Common Block (of memory) for passing data and parameters. Reference 1 describes the data reading and storing Macro subroutine, READ43.MAC, with sufficient detail to not need describing here. (The listing is in Appendix I.)

MRLGRP uses existing data on disc, and was written to graph not only Mass Extinction Coefficient but also the Raw Data ('smoke' and 'no smoke' readings on the same graph). Also it provides a Percentage graph of 'smoke run' for comparing filter calibration results for checking system integrity (a 'fall back' system whereby a problem may be solved by using a 'lower level' result).

Since machine limitations (PDP 11/34, VT103/440) negate a single programme editable at one session, these two programmes needed to be suitably divided into several sections and 'linked' (the PDP word for joining and completing compiling of several programmes to make one large one).

6.1 Graphing routines

(1) MRLGRP.FOR, (figures 35 to 38 show flow charts, and Appendix II the listing), is the filename which comprises the MAIN routine (figure 35) consisting of initialising and setting of data blocks, variables and manipulating the Menu. There are four subroutine calls, selected via the Menu, one for RERUN which reads run data from the disc, and three to RAW (IFIL) which pass the appropriate flag for the required graph type. 'End Programme' waits a short time before the computer returns to the Operating System and presents the period (.) prompt.

(a) Subroutine LOCLIN ('locate line'), figure 36, draws to the current X and Y coordinates (calculated in the subroutine RAW (IFIL)) and if the graphing is not out of range will put the 'pen down' and returns to the calling programme; if out of range this subroutine lifts the pen. It is called from the graphing of Extinction Coefficient.

(b) Subroutine RERUN, figure 37, asks for a run number and then loads three files of data from disc into memory; these files are INSK00.DAT 'no smoke', ISMK00.DAT 'smoke', and ICLK00.DAT 'calculations' (---00.DAT is a run number between 01 and 50) ('background' is not necessary here).

(c) Subroutine CLS, figure 38, clears the Visual Display Unit (VDU) by writing twenty five lines. Mode switching of the VDU is not satisfactory since several VDU types may be used.

(2) MRL3.FOR listed in Appendix III is the filename which holds the

(a) Subroutine RAW(IFIL), figure 39, which is the main graph drawing routine. If IFIL=0 the graph draws Raw Data, a graph of absolute values of 'no smoke' and 'smoke' against wavelength position of the Circular Variable Filter (CVF). (Comparison of this with previous tests can point to system misalignment or contamination.) If IFIL=1 the graph drawn is for Filter Calibration which is the percentage ratio $\frac{\text{'smoke' x 100}}{\text{'no smoke'}}$ vs wavelength position of the CVF.

If IFIL = 2 the Mass Extinction Coefficient is drawn; identical to the data logger programme MRLV20.

(b) Subroutine CLIN is very similar to LOCLIN except the limits have been changed. This is called from graphing both 'raw data' and 'filter calibration'.

6.2 Data logging routines

The main data logging programme MRLV20 is formed by 'linking' four editable files; MRLV20.FOR, MRLV21.FOR, MRLV22.FOR and READ43.MAC (listings are in Appendices I,IV,V and VI). (There is a variation of MRLV20 called MRLF20 which allows greater concentration of obscurant from ≃ 100 g to ≃ 30 kg so fog oils may be tried for their extinction coefficients (MRLV20's concentration allowed is from 1 mg to 100 g).)

(1) MRLV20.FOR, figure 40, comprises the MAIN routine which consists of a 'common block' of RAM (Random Access Memory), fixed data block for generating run numbers for dynamic file name construction, wavelength number generation equations, initialising routines. It reads the current run number stored on disc, and a menu which calls nine subroutines, the 'no smoke' subroutine twice.

(a) Subroutine GRP, figure 41, is the actual graphing subroutine which consists of the 'common block', it assigns the plotter handler to 'logical unit No 3', and then prepares for plotting - such as 'paper, pen, plotter ready?'. (The plotter used is a Houston Instrument DMP-4 A4 size single pen X-Y plotter having a step size of 0.1 mm.) After defining the Origin point the borders are drawn using 'tick' markers for later annotation. Labelling and annotation is followed by printing the appropriate data, and finally the Mass Extinction Coefficient is drawn. The initial position (X and Y coordinates) is determined and LOCLIN is called to position and (normally) to put the 'pen down'; from here each segment is drawn via LOCLIN; 100/points are determined per segment of the CVF, and if out of range the pen is 'lifted'. At the end of each segment the pen is lifted. At the end of drawing the third segment the raised pen returns to the origin. Segments numbers 2 and 3 were installed in reverse, and so the plotter plots these two from right to left.

(b) Subroutine LOCLIN is identical to the one described in paragraph 6.1(a) above.

(2) MRLV21.FOR, figures 42 and 43 (listing in Appendix V) holds the subroutines RERUN and ERROP.

(a) Subroutine RERUN, figure 42, reloads data files 'nosmoke', 'smoke', and calculations stored on disc back into memory; and is described in paragraph 6.1(b) above.

(b) Subroutine ERROP(x,x,x), figure 43, an error detecting subroutine, has passed to it two variables which are compared to statistical limits which, if not returned to zero, give a confidence inference of 90% for that particular plotted reading.

(3) MRLV22.FOR, figures 44 to 48 (listing in Appendix VIII) holds the subroutine CLS which clears the VDU screen, WEN resets the run number, NUR alters the run number, NSK(IBAK) does 'background' and 'no smoke' data gathering, SK does smoke data gathering, CLC calculates each point, TABUL tabulates results, and FIN updates run number before ending the programme session.

(a) Subroutine CLS clears the VDU screen by writing 25 blank lines to the screen. This subroutine is identical to the one described in paragraph 6.1(c) above.

(b) Subroutine WEN*, figure 44, is used when installing a new data disc. It resets the IRUN counter to '1'. This subroutine reduces the problem of over-running the IRUN numbers, ie it keeps the run numbers below 50.

(c) Subroutine NUR*, figure 45, allows a single key-stroke to increment the run number, or to change the current run number for the purposes of reloading a set of data files from disc, or updating/upgrading data, eg using existing data to patch up an incomplete set of data files. (A calculation file may need to be copied so a particular run number has the three files required for reloading).

(d) Subroutine NSK(IBAK), figure 46, is used to obtain a background file, and a no smoke file. If IBAK=0 a 'no smoke' run is implied; but if IBAK=1 a 'background' run is implied. The main difference between these two 'set-ups' is that the background needs the Nernst Glower blanked off so any hot spots/reflections etc in the Spectro-radiometer and Smoke Chamber itself are noted and then can be subtracted from the 'no smoke' and 'smoke' runs before they are manipulated or stored on disc.

Looking at figure 46 shows minimal differences except for 'averaging' and 'storing'; the main difference is blanking off of the Nernst Glower source, to get a background-reading set of data, the 'numbers' of which vary with the CVF wheel position.

Since time-of-day will pinpoint the run data this needs to be put in by hand because the 'line time clock' built into the computer has been disabled, so timing in the Macro data gathering loop can be guaranteed.

To gain more reliable data, averaging at each wavelength is required, but since memory space is limited a maximum of 7 revolutions, of the CVF, can be stored in RAM before averaging. Normally 3 to 5 revolutions would be used.

When the parameters are set, the Macro READ43.MAC, figures 51 to 58, COLDAT (collect data) is called(ref.1). On returning from COLDAT, each wavelength position is averaged before being stored in the respective disc file. This subroutine NSK(IBAK) returns control to the menu.

(e) Subroutine SK, figure 47, is similar to NSK(IBAK) in that it is used to collect and store smoke/obscurant data. It asks for time-of-day, smoke type description, temperature and humidity in the Smoke Chamber itself, and then the number of revolutions of the CVF required (3 to 5 revolutions) before calling the data collecting Macro COLDAT. Each wavelength is averaged and then background is subtracted before being stored in the smoke array ISMK(I), and finally stored onto disc.

(f) Subroutine CLC, figure 48, calculates the Mass Extinction Coefficient when given the amount of material that was used during the 'smoke run'. The Mass Extinction Coefficient parameters are

----

* NEW and RUN may be interpreted by the computer as command words which could make it 'crash', so the simplest method is to reverse the words to WEN and NUR respectively.

tested in the ERROP subroutine to determine if the reading is within the 90% confidence area, if not it will be forced to zero where the graphing routine will detect it as an error and not graph that point, but leave a hole in the graph at that position. The ACALC(I) data, date, time, concentration, temperature and humidity are then stored onto disc before returning to the menu.

(g) Subroutine TABUL, figure 49, writes all the data to the VDU. It includes number of revolutions used, date, time of 'no smoke' and 'smoke', temperature, humidity, smoke description, concentration, and the three files of data ACALC(I), INOSMK(I), ISMK(I) against ALAMDA(I).

(This part of the programme has hard-copy printout 'commented out' since there is no readily usable printer in the Smoke Chamber building.)

The programme then returns to the Menu.

(h) Subroutine FIN, figure 50, increments the IRUN counter which is then stored onto disc, after which the programme session (data logging) ends.

To completely describe the MRL Smoke Chamber Instrumentation and Recording System the Macro data gathering and storing subroutines are flow diagrammed in figures 51 to 58.

A breakdown of each flow diagram is:-

Figure 51 -
The main controlling Macro COLDAT, with parameters passed, and called from the Fortran;

Figure 52 -
Subroutine READ. It reads and stores one CVF wheel of data;

Figure 53 -
PRMT is a short subroutine which displays a prompt on the VDU;

Figure 54 -
Subroutine ECD is the 'edge change detector' which detects a HEDS1000 Read Pulse;

Figure 55 -
Subroutine CNVT performs an analogue to digital conversion when required;

Figure 56 -
Subroutine TRS controls the data gathering for 100 pulses or readings each segment;

Figure 57 -
Subroutine TIM2 is a software timer which is used in taking intersegment background readings;

Figure 58 -
Subroutine TIM1 is a software timer for 1 ms which needs to be adjusted to suit whatever LSI system is used. Each LSI system has a specific data clock rate which determines the instruction timing.

7. ACKNOWLEDGEMENTS

This radiometer was conceived in October 1979 for the Australian smoke programme by Dr D. Gambling ERL (IOC Group) to determine the effectiveness of various IR obscurants in controlled conditions. The chemistry and chamber structure is the responsibility of personnel at MRL, in particular Mr R. Hancox MRL (EMG Group), and the radiometer (transmissometer) and data reduction responsibility now is Mr O. Scott's at ERL (IOC Group) who also determined the problem areas which were eventually resolved. The electronic system was initially designed by Mr R. Dale, and the concept and optics designed by Dr D. Gambling.

TABLE 1. SMOKE TRANSMISSOMETER

PARTS LIST	CODE IDENT NO Z0004	TITLE SMOKE TRANSMISSOMETER				PL 99658	SHEET 1 OF 4	
ITEM OR FIND NUMBER	QTY REQ'D	QTY REQ'D	CODE IDENT	PART OR IDENTIFYING NUMBER	SHEET SIZE	DESCRIPTION	PLANNING USE: TOTAL QTY. REQ'D	PLANNING USE: REQUISITION NUMBER
				99658	A1	SMOKE TRANSMISSOMETER		
				98958	A3	CCT. DIAG., OPTICAL ENCODER SENSOR		
1		1		99465	A4	WINDOW HOLDER		
2		1		99659	A2	CLUSTER GEAR		
3		1		99660	A2	CLUSTER GEAR		
4		1		99661	A3	RESOLVER DISC		
5		1		99662	A4	MAIN SHAFT		
6		1		99663	A4	BEARING CAP		
7		1		99664	A4	BEARING CAP		
8		1		99665	A4	KNOB		
9		1		99666	A4	SELECTOR FORK		
10		1		99667	A4	SELECTOR SHAFT		
11								
12								
13								
14								
15		1		99668	A3	CARD MOUNT		
16		1		99669	A3	LEVER HOUSING		
17		1		99670	A4	GEAR LEVER		
18		1		99671	A4	LENS RETAINER		
19		1		99672	A4	HOUSING		
20		1		99673	A4	HOUSING		
21		1		99674	A4	WINDOW BODY		
22		1		99675	A4	WINDOW RETAINER		
23		1		99676	A3	TELESCOPE BODY		
24		1		99677	A4	NUT		
25		1		99678	A4	LENS HOUSING		
26		1		99679	A4	LENS RETAINER		
27								
28								
29								
30		1		99708	A4	PRIMARY LENS		
31		1		99709	A4	SECONDARY LENS		
32		1		99710	A3	TELESCOPE MOUNT		
33		1		99712	A2	MAIN HOUSING		

ISS	DATE	DESCRIPTION OF CHANGE	APPD			
2	10/80			3	10/80	
1	9/80	ORIGINAL ISSUE				PL 99658 — SHEET NO 1 OF 4

DRCS 0.5.14 7530-TN-990-0000

TABLE 1(CONTD.).

PARTS LIST	CODE IDENT NO Z0004	TITLE SMOKE TRANSMISSOMETER	PL 99658	SHEET 2 of 4

ITEM OR FIND NUMBER	QTY REQ'D	QTY REQ'D	CODE IDENT	PART OR IDENTIFYING NUMBER	SHEET SIZE	DESCRIPTION	PLANNING USE: TOTAL QTY REQ'D	PLANNING USE: REQUISITION NUMBER
34		1		99713	A2	FRONT PLATE		
35		1		99714	A1	DETECTOR HOUSING		
36		1		99715	A3	COVER		
37		1		99716	A3	COVER		
38		1		99717	A3	DETECTOR A.V. BASE		
39		1		99719	A2	FILTER WHEEL		
40		1		99739	A4	WINDOW		
41		1		99772	A3	HANDLE		
42		1		99842	A4	GASKET		
43		2		99843	A4	STUD		
44		2		99844	A4	NUT		
45		1		99845	A4	PACKING		
46		2				'O' RING TOROIDAL SEALING 7/64" I.D. CROSS SECT. φ 0.040"		
47		1				'O' RING TOROIDAL SEALING 5/16" I.D. CROSS SECT. φ1/32"		
48		2				'O' RING TOROIDAL SEALING 1/2" I.D. CROSS SECT φ1/16"		
49		1				'O' RING TOROIDAL SEALING 3/4" I.D. CROSS SECT φ1/16"		
50		1				'O' RING TOROIDAL SEALING 1" I.D. CROSS SECT. φ1/16"		
51		1				'O' RING TOROIDAL SEALING 1 1/16" I.D. CROSS SECT φ1/16"		
52		1				'O' RING TOROIDAL SEALING 2 9/16" I.D. CROSS SECT. φ3/32"		
53								
54		16				SPACER φ6.3 BORE φ3.2 X 6.3 LONG STEEL CADMIUM PL. & PASSIVATE.		
55		4				A.V. MOUNT MACKAY		
56		1				CIRCLIP CARBON STEEL EXTERNAL NOMINAL SHAFT φ3/16"		
57		2				BEARING DEEP GROOVE BALL SHAFT φ3/16", HOUSING φ1/2"		
58								
59		2				SCREW GRUB HEX. SKT. M2X0.4-4LG. STEEL CADMIUM PL. & PASSIVATE.		
60		1				SCREW GRUB HEX. SKT. M3X0.5-6LG. STEEL CADMIUM PL. & PASSIVATE		
61								
62		1				SCREW M/C PAN HD. M2X0.4-6LG STEEL CADMIUM PL. & PASSIVATE		

ISS	DATE	DESCRIPTION OF CHANGE	APPD				
2	10/80			3	10/80	ITEM 41 ADDED	PL 99658 SHEET NO 2 of 4
1	9/80	ORIGINAL ISSUE					

DRCS 8 5 14 7530 TN-998-6686

TABLE1(CONTD.).

PARTS LIST	CODE IDENT NO Z0004	TITLE SMOKE TRANSMISSOMETER	PL 99658	SHEET 3 OF 4

ITEM OR FIND NUMBER	QTY REQ'D	QTY REQ'D	CODE IDENT	PART OR IDENTIFYING NUMBER	SHEET SIZE	DESCRIPTION	PLANNING USE: TOTAL QTY REQ'D	PLANNING USE: REQUISITION NUMBER
63		4				SCREW M/C PAN HD. M2 X 0.4 - 16LG STEEL CADMIUM PL. & PASSIVATE		
64		2				SCREW M/C PAN HD. M3 X 0.5 - 6LG STEEL CADMIUM PL. & PASSIVATE		
65		4				SCREW M/C PAN HD. M3 X 0.5 - 12LG STEEL CADMIUM PL. & PASSIVATE		
66		16				SCREW M/C PAN HD. M3 X 0.5 - 16LG STEEL CADMIUM PL. & PASSIVATE		
67								
68		4				SCREW M/C PAN HD. M4 X 0.7 - 30LG STEEL CADMIUM PL. & PASSIVATE		
69		19				SCREW M/C CAP HD HEX SKT M3 X 0.5 - 10LG STEEL CADMIUM PL. & PASSIVATE		
70								
71								
72		10				SCREW M/C CAP HD HEX SKT M4 X 0.7 - 10LG STEEL CADMIUM PL & PASSIVATE		
73		6				SCREW M/C CAP HD HEX SKT M4 X 0.7 - 12LG STEEL CADMIUM PL & PASSIVATE		
74								
75		10				SCREW M/C CAP HD HEX SKT M5 X 0.8 - 12LG STEEL CADMIUM PL & PASSIVATE		
76		1				SCREW M/C CAP HD HEX SKT M6 X 1 - 14LG STEEL CADMIUM PL & PASSIVATE		
77		10				SCREW M/C CAP HD HEX SKT M6 X 1 - 20LG STEEL CADMIUM PL & PASSIVATE		
78								
79		5				WASHER PLAIN SMALL Ø2 STEEL CAD. PL. & PASS.		
80		43				WASHER PLAIN SMALL Ø3 STEEL CAD. PL. & PASS		
81		20				WASHER PLAIN SMALL Ø4 STEEL CAD. PL. & PASS		
82		5				WASHER PLAIN SMALL Ø5 STEEL CAD PL & PASS		
83								
84								

ISS	DATE	DESCRIPTION OF CHANGE	APPD
1	9/80	ORIGINAL ISSUE	
2	10/80	ITEM 64 WAS 10LG	
3	10/80	ITEM 76 ADDED ITEM 77 WAS [illegible]	

PL 99658 — SHEET NO 3 OF 4

DRCS B 5 14 7530-TN 998 6686

TABLE1(CONTD.).

PARTS LIST — CODE IDENT NO Z0004 — TITLE: SMOKE TRANSMISSOMETER — PL 99658 — SHEET 4 OF 4

ITEM OR FIND NUMBER	QTY REQ'D	QTY REQ'D	CODE IDENT	PART OR IDENTIFYING NUMBER	SHEET SIZE	DESCRIPTION	PLANNING USE: TOTAL QTY REQ'D	PLANNING USE: REQUISITION NUMBER
85								
86		4				NUT THIN PRECISION M4 STEEL CAD PL & PASS		
87								
88		1				PIN DOWEL ϕ1.5 NOM. X 4 LG SILVER STEEL		
89		1				PIN DOWEL ϕ3 NOM X 10 LG SILVER STEEL		
90		2				PIN DOWEL ϕ6 NOM X 20 LG SILVER STEEL		
91		As Req'd				THREAD SEALANT PVC TAPE		
92		As Req'd				PLASTIC SHEET "GLAD WRAP" OR SIMILAR		
93		As Req'd				SEALANT SILASTIC DOW CORNING 732 OR EQUIV.		
94		1				MOTOR/GEARBOX ASSY 2 RPM CROUZET No. 82.334		
95		1				DESSICATOR/HUMIDITY INDICATOR HUMIDIAL No 2156-123P-DA1 HUMIDIAL Co. 465 MT. VERNON AVE. P.O. 465 COLTON CALIFORNIA 92324 U.S.		
96		1				INFRARED DETECTOR PART No. IR50 KRS-5/3 ORIEL CORP. OF AMERICA STAMFORD CONN.		
97		1				TANK VALVE & CAP SCHRADER 622A-1 & 660F		
98		SET				CIRCULAR NEUTRAL VARIABLE DENSITY FILTERS (3 SEGMENTS) 2.5μ-14.5μ		
99								
100		1				CONNECTOR CANNON DE-9P		
101		1				CONNECTOR BNC UG 657/U		

ISS	DATE	DESCRIPTION OF CHANGE	APPD		
2	10/80	ITEM 85 WAS M3 NUTS		3	10/80
1	9/80	ORIGINAL ISSUE			

PL 99658 — SHEET NO 4 OF 4

DRCS 8 5 14 7530-TN-998-6686

TABLE 2. GOLAY RADIOMETER

CODE IDENT	ISS	DESCRIPTION	AUTH NO	DRN	CHKD	APPD/DATE
Z0004	1	ORIGINAL ISSUE	—	–	–	—

DRN: Sanders 13.4.83 · CHKD: · APPD:

SECURITY CLASSIFICATION UNCLASSIFIED · USED ON —

FIND NUMBER	PART OR IDENTIFYING NUMBER	SHEET SIZE	SHEET NO	CODE IDENT	DESCRIPTION	QUANTITY REQUIRED a	b	c	d	PLANNING USE TOTAL QTY REQD	REQUISITION NUMBER
	102492 002	A2			GOLAY RADIOMETER. WIRING DIAGRAM.						
	102492 003	A3			HEDS1000 POSITION DETECTOR CCT DIAG.						
	102492 004	A3			GOLAY DETECTOR. CCT. DIAG.						
	102492 005	A2			READ PULSE MARKERS & GOLAY AMP. CCT. DIAG.						
	102492 006	A2			GOLAY POWER SUPPLIES. CCT DIAG.						
	102492 007	A3			CHOPPER DRIVER CCT DIAG.						
	102492 008	A2			BUFFERS, DELAY & CHOPPER DRIVE. CCT DIAG.						
	102492 009	A4			I.R. SYNCHRONOUS DETECTOR CCT DIAG.						
	102492 010	A3			VISIBLE SYNCHRONOUS DETECTOR CCT DIAG						
	102492 011	A3			SYNCHRONOUS DETECTOR UNIT POWER SUPPLIES CCT DIAG.						

REFERENCE NO	COL	VARIANT TITLE
	d	
	c	
	b	
	a	

DEFENCE RESEARCH CENTRE SALISBURY

SECURITY CLASSIFICATION UNCLASSIFIED

CONTRACTORS DRG REF —

TITLE: GOLAY RADIOMETER

PARTS LIST FOR 102492002

SH NO

DRCS 8-6-14 7530-TN-998-5686

REFERENCES

No.	Author	Title
1	Ingram, J.D.	"A Data Logging System for the MRL Smoke Chamber". ERL Special Document ERL-0250-SD, September 1982
2	Gambling, D., Dale, F.R. and Bentley, J.	"A Laboratory Facility for the Measurement of the Optical Properties of Obscurants". ERL-0287-TM, August 1983

APPENDIX I

READ43.MAC

```
        .TITLE  READ43.MAC
;
;       OLD     .TITLE  READ4,MAC
;
;LINK OBJS OF  MRLV20.FOR,MRLV21.FOR,MRLV22.FOR,READ43.MAC
;
        .GLOBL  COLDAT
;
        .MCALL  .PRINT,.EXIT,.TTYOUT,.TTYIN
;
START:
        MOV     #0,R2               ;INITIALLY JAMS R2 LOW
        MOV     R2,R1
        JSR     PC,ECD              ;FINDS RISING EDGE
        JSR     PC,ECD              ;FINDS FALLING EDGE
        MOV     @#CTR,R4
        CMP     #300.,@#CTR         ;LONG CNT IS SYNC PULSE
        BPL     START
        JSR     PC,PRMT
        BR      START
;
;
CRLF3:
        JSR     PC,CRLF
CRLF2:
        JSR     PC,CRLF
CRLF:
        TSTB    @#177564
        BPL     .-4
        MOV     #15,@#177566
        TSTB    @#177564
        BPL     .-4
        MOV     #12,@#177566
        RTS     PC
;
PRMT:                               ;PRINTS PROMPT
        JSR     PC,CRLF
        TSTB    @#177564
        BPL     .-4
        MOV     #45,@#177566        ;%
        TSTB    @#177564
        BPL     .-4
        MOV     #40,@#177566        ;SPACE
        RTS     PC
;
CIN:                                ;GETS CHARACTER IN  K/BOARD
        TSTB    @#177560
        BPL     .-4
        MOVB    @#177562,R0
        BIC     #177600,R0          ;WIPE OFF PARITY BIT
        RTS     PC
CO:                                 ;PUTS CHAR OUT TO VDU
        TSTB    @#177564
        BPL     .-4
        MOVB    R0,@#177566
        RTS     PC
;
;
;
TIM1:                               ; 1 MILLISECOND TIMER
```

```
        MOV     #60,R0
LP1:
        COM     R2
        COM     R2
        DEC     R0
        BNE     LP1
        RTS     PC
;
;
TIM2:
        MOV     #2220,R5          ;20 PULSES DELAY=1.17 SECS
LP4:
        JSR     PC,TIM1
        DEC     R5
        BNE     LP4
        RTS     PC
;
;
CNVT:
        MOV     #1,@#177000       ;ADC CONVERSION &STORE DATA
        TSTB    @#177000
        BPL     .-4
        MOV     @#177002,(R4)+
;       MOV     @#COUNT,(R4)+     ;LLL
;       INC     @#COUNT
;TEMP PATCH TO OVERRIDE ADC NON EXISTENT CARD
        RTS     PC
;
;
TRS:                              ;T A K E  R E A D I N G S  S U B
        MOV     #100.,R5          ;TAKE  1 0 0  READINGS
LP5:
        JSR     PC,ECD            ;DETECTS RISING EDGE
        JSR     PC,CNVT           ;ADC AND STORE DATA
        JSR     PC,ECD            ;DETECTS FALLING EDGE
        DEC     R5
        BNE     LP5
        RTS     PC
;
;
ECD:
        MOV     #0,@#CTR          ;ZEROS LOOP COUNTER
LP7:
        JSR     PC,TIM1
        CMP     #17000,@#CTR      ;MOD COUNT
        BMI     LP9
LP11:
        MOV     @#167774,R1       ;FILTER WHEEL INPUT
        BIC     #77777,R1         ;BIT 15   USED AS INPUT
        CMP     R1,R2
        BEQ     LP10
        MOV     R1,R2
        RTS     PC
LP9:
        DEC     @#CTR             ;MAINTAINS CNTR MAX CNT
        BR      LP11
LP10:
        INC     @#CTR
        BR      LP7
;
```

```
;
;
;BEFORE THIS PROGRAM IS USED DETSTR INTO R4
;R4 THEN CURRENT STORE LOCATION
;
;READS ONE REVOLUTION OF FILTER WHEEL POINTS     300 + 3 BACKGROUND
READ:
        MOV     #0,R2           ;INITIALLY JAMS R2 LOW
        MOV     R2,R1
        JSR     PC,ECD          ;FINDS RISING EDGE
        JSR     PC,ECD          ;FINDS FALLING EDGE
        CMP     #300.,@#CTR     ;LONG CNT IS SYNC PULSE
        BPL     READ
        MOV     #3,R3           ;THREE SEGMENTS COUNTER    R3
LP14:
        MOV     #0,R2           ;JAMS R2 LOW (SHOULD ALREADY BE LOW)
        JSR     PC,TRS          ;TAKE 100 DETECTOR READINGS
        JSR     PC,TIM2         ;20 PULSES DELAY 1.17 SECS
        MOV     #0,(R4)+        ;SEPARATOR
        JSR     PC,CNVT         ;STORES BACKGROUND READING
        MOV     #0,(R4)+        ;SEPARATOR
        DEC     R3
        BNE     LP14
        MOV     #0,(R4)+        ;SEPARATORS DEPICTING END OF REV
        MOV     #0,(R4)+        ;
LP13:
        RTS     PC
;
;
COLDAT:                         ;READS & STORES 'ONE REVOLUTION' OF DATA
                                ;TIMES THE NUMBER OF REVS REQD.
;       MOV     #0,@#167770     ;DISABLES INTERRUPTS
        TST     (R5)+           ;DUMMY  (USED TO PASS NUMBER OF PARAMETERS)
        MOV     (R5)+,R1        ;TEMP
        MOV     @(R5)+,R0       ;REVS
        MOV     R1,R4           ;PUTS STORE START ADDR IN R4
        MOV     R0,@#REVS       ;STORES CURRENT NUMBER OF REVS
        MOV     #2200.,R0
        MOV     #0,@#COUNT      ;TEMPORARY COUNTER FOR ADC DATA INPUTTING
CL5:
        MOV     #0,(R1)+        ;CLEARS TEMP STORE AREA
        DEC     R0
        BNE     CL5
        INC     @#REVS
REV1:
        DEC     @#REVS
        BEQ     REVEND
        JSR     PC,READ
        JSR     PC,PRMT         ;MARKS END OF EACH REVOLUTION
        BR      REV1
REVEND:
        RTS     PC
;
;
;
COUNT:
        .BLKW   1
CTR:
        .BLKW   1
REVS:
```

```
        .BLKW   1
        .EVEN
;
;
        .END    START
```

APPENDIX II

MRLGRP.FOR

```
C         FILENAME:- MRLGRP.FOR
C       OLD FILE NAME   FILENAME:-  MRLMAN.FOR
C
C         LINK OBJS OF  MRLGRP.FOR,MRL3.FOR
C
C         MODIFIED FOR GRAPHING ONLY
C
C        MRL SMOKE CHAMBER PROGRAMME
C        ACCEPTS GOLAY CELL INPUT
C        STORES & ANALIZES DATA
C
C
C                                                                         X
        COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
      *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
      *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY
C
         LOGICAL*4 ANSKT,ASMKT,RING
         LOGICAL*4 DT1,DT2,DT3
C
C        DYNAMIC GENERATION OF WAVELENGTH NUMBERS
C        ========================================
C
C        AMCEN1=3.4155
         AMCEN1=3.5125
C        AMCEN2=6.2020
         AMCEN2=6.2762
C        AMCEN3=11.4972
C        AMCEN3=11.3072
         AMCEN3=11.4381
         AMDEL1=0.0200707
         AMDEL2=0.0372490
C        AMDEL2=0.0371111
         AMDEL3=0.0659303
C        AMDEL3=0.0566809
C
         ALAMDA(1)=(AMCEN1-AMDEL1/2.)-49.*AMDEL1
         ALAMD(1)=(AMCEN2+AMDEL2/2.)+49.*AMDEL2
         ALAM(1)=(AMCEN3+AMDEL3/2.)+49.*AMDEL3
                 DO 530 I=2,100
         AI=I
         ALAMDA(I)=ALAMDA(1)+AMDEL1*AI
         ALAMD(I)=ALAMD(1)-AMDEL2*AI
         ALAM(I)=ALAM(1)-AMDEL3*AI
 530     CONTINUE
C
C        END OF DYNAMIC WAVELENGTH GENERATION
C        ====================================
C
         DATA NRUN/'01','02','03','04','05','06','07','08','09','10',
     +             '11','12','13','14','15','16','17','18','19','20',
     +             '21','22','23','24','25','26','27','28','29','30',
     +             '31','32','33','34','35','36','37','38','39','40',
     +             '41','42','43','44','45','46','47','48','49','50'/
C
C
C         INITIALLIZE COMMON VARIABLES TO ZERO
C
C
          DO 3 I-1,10
```

```
          RING(I)=0
 3        CONTINUE
C
          INSKR=3
          ISMKR=3
          TH=00.0
          RH=00.0
          CONC=00.0
          IBAKGD=0
C
C
C
         CALL ASSIGN (2,'DY1:IRUN.DAT',0,'OLD')
         READ (2,9) IRUN
  9      FORMAT (I2)
         CALL CLOSE (2)
C
C
        CALL CLS
        TYPE 10
 10     FORMAT (////)
        TYPE 13
 13     FORMAT (10X,'G R A P H I N G   R O U T I N E S'/)
         IRUN=1
 80     TYPE 30
 30     FORMAT(/20X,'M   E   N   U'/20X,'=========='/)
        IF (IRUN.GT.49) IRUN=1
        TYPE 35,IRUN
 35     FORMAT (10X,' RUN NUMBER IS    #',I2/)
        TYPE 40
 40     FORMAT (5X,'GIVE A DIGIT BETWEEN  1 & 5'/)
         TYPE 50
C                                                                      X
 50      FORMAT (10X,'1 = LOAD DISC-STORED DATA INTO  R A M'/10X,'2 = GR
     *APH EXTINCTION COEFFICIENT')
         TYPE 60
 60      FORMAT (10X,'3 = GRAPH RAW DATA'/10X,'4 = GRAPH FILTER CALIBRAT
     *ION'/10X,'5 = END PROGRAMME')
        READ (5,*) JA
        IF (JA.LT.1.OR.JA.GT.5) GO TO 80
        GO TO (100,105,110,115,999) JA
C       GOTO SUBROUTINES
 105    IFIL=2
        CALL RAW(IFIL)
        GO TO 160
 100    CALL RERUN
        GO TO 160
 110    IFIL=0
        CALL RAW(IFIL)
        GO TO 160
 115    IFIL=1
        CALL RAW(IFIL)
        GO TO 160
 160    CALL CLS
        DO 190 I = 1,10000
 190    CONTINUE
        GO TO 80
 999    CONTINUE
        TYPE 998
 998    FORMAT (1X,'END OF PROGRAMME')
```

```
      END
C
C
C
C       LOCATES START OF LINE AND PUTS PEN DOWN
C
        SUBROUTINE LOCLIN
C                                                                        X
      COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY
C
        IF (IYY.GT.1200.OR.IYY.LE.0) GO TO 335
        WRITE (3,300) IXX,IYY
        WRITE (3,305)
C       PEN DOWN.
 330    RETURN
 335    WRITE (3,310)
C       PEN UP
        GO TO 330
 300    FORMAT('A',I6,',',I6,' ')
 305    FORMAT('D ')
 310    FORMAT('U ')
        END
C
C
C
C      RE-RUN OF EXISTING DATA STORED ON DISC
C
       SUBROUTINE RERUN
C                                                                        X
      COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY
C
        INTEGER*2 DINK(7),DISK(7),DICK(7)
C
        DATA DINK/'DY','1:','IN','SK','00','.D','AT'/
        DATA DISK/'DY','1:','IS','MK','00','.D','AT'/
        DATA DICK/'DY','1:','IC','LK','00','.D','AT'/
C
       CALL CLS
 705   TYPE 710
 710   FORMAT (10X,'RE-RUN OF PREVIOUS DISC-STORED DATA'//5X,'GIVE
     *R U N   N U M B E R   YOU WANT TO SEE')
       READ (5,711) IRUN
 711   FORMAT (I2)
C
        DINK(5)=NRUN(IRUN)
        CALL ASSIGN (2,DINK,14,'OLD')
        READ (2,715) (INOSMK(I),I=1,312)
 715    FORMAT (63(5(I10,2X),/))
        READ (2,716) DT1,DT2,DT3,ANSKT,INSKR
 716    FORMAT (A2,A3,A2,5X,A4,5X,I2)
        CALL CLOSE (2)
C
        DISK(5)=NRUN(IRUN)
        CALL ASSIGN (2,DISK,14,'OLD')
        READ (2,720) (ISMK(I),I=1,312)
 720    FORMAT (63(5(I10,2X),/))
```

```
      READ (2,721) DT1,DT2,DT3,ASMKT,ISMKR,(RING(I),I=1,10)
 721  FORMAT (A2,A3,A2,5X,A4,5X,I2,10A4)
      CALL CLOSE (2)
C
      DICK(5)=NRUN(IRUN)
      CALL ASSIGN (2,DICK,14,'OLD')
      READ (2,725) (ACALC(I),I=1,312)
 725  FORMAT (63(5(F6.3,2X),/))
      READ (2,726) DT1,DT2,DT3,ASMKT,CONC,TH,RH,IBAKGD
 726  FORMAT (A2,A3,A2,5X,A4,5X,F6.4,5X,F6.2,5X,F6.2,5X,I6)
      CALL CLOSE (2)
C
      TYPE 730,IRUN,DT1,DT2,DT3,(RING(I),I=1,10),CONC
 730  FORMAT (//5X,'RUN  #',I2,5X,'DATE:-',A2,A3,A2/5X,'SMOKE TYPE:-',
     *10A4/5X,'CONCENTRATION  ',F6.4,' GMS/CUB.METRE'//10X,'IS THIS THE
     *CORRECT RUN ?  Y/N')
      READ (5,735) COR
 735  FORMAT (A1)
      IF (COR.NE.'Y') GO TO 705
      RETURN
      END
C
C
C
      SUBROUTINE CLS
C     CLEARS   V D U    SCREEN
      TYPE 5
 5    FORMAT (///////////////////////////)
      RETURN
      END
C
```

APPENDIX III

MRL3.FOR

```
C       FILENAME:-  MRL3.FOR
C
C        LINK OBJS OF  MRLGRP.FOR,MRL3.FOR
C
C       MRL SMOKE CHAMBER PROGRAMME
C       ACCEPTS GOLAY CELL INPUT
C       STORES & ANALIZES DATA
C
C
C
C
C       DRAWS A GRAPH OF RAW DATA  IFIL=0
C        DRAWS  FILTER CALIBRATION   IFIL=1
C        DRAWS  EXTINCTION COEFFICIENT  IFIL=2
C
C
        SUBROUTINE RAW(IFIL)
C
C
C
        COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY
C
C
         CALL ASSIGN(3,'PL:',0,'NEW','NC')
C        CALL ASSIGN(3,'TT:',0,'NEW','NC')
C        CALL ASSIGN(3,'LP:',0,'NEW','NC')
C
        CALL CLS
 501    FORMAT (////20X,'F I L T E R  C A L I B R A T I O N'///10X,'PAPE
     *R READY  Y/N ?'/)
 510    IF (IFIL.EQ.0) GO TO 512
         IF (IFIL.EQ.2) GO TO 300
        TYPE 501
        GO TO 504
 300     TYPE 305
         GO TO 504
 305     FORMAT (////10X,'G R A P H I N G  E X T I C T I O N  C O E F F'
     *///10X,'PAPER READY  Y/N ?'/)
 512    TYPE 500
C
 500    FORMAT (////20X,'G R A P H I N G  R A W  D A T A '///10X,'PAPER
     *READY  Y/N ?'/)
 504    READ (5,505) PAP
 505    FORMAT (A1)
        IF (PAP.NE.'Y') GO TO 510
        TYPE 520
 520    FORMAT (10X,'PEN READY  Y/N ?'/)
        READ (5,525) PEN
 525    FORMAT (A1)
        IF (PEN.NE.'Y') GO TO 510
 530    TYPE 540
 540    FORMAT (10X,'PLOTTER ACTIVE  Y/N ?'/)
        READ (5,545) PLT
 545    FORMAT (A1)
        IF (PLT.NE.'Y') GOTO 530
C
C       DRAW, PLOT, ETC
C
```

```
C       ACTIVATE PLOTTER
        WRITE (3,650)
C       PLOTTER ACTIVE, HOME(BOT.L/H CNR),POSITION 2CM UP AND
C       ALONG,ORIGIN AT THAT POINT
 650    FORMAT(' H A100,200 O ')
C
C
C       GO TO 888
        IF (IFIL.EQ.2) GO TO 310
 590    FORMAT('R',I5,',',I5,' ')
 595    FORMAT('M20 ')
C       595 = TICK FOR X-AXES AND Y-AXES
C
C       DRAW BORDER OF GRAPH    RAW DATA & FILTER CAL
        WRITE (3,565)
        DO 600 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,605)
 605    FORMAT('R150,0 ')
 600    CONTINUE
C
        DO 610 I=1,10
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,615)
 615    FORMAT('R0,100 ')
 610    CONTINUE
C
        DO 620 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,625)
 625    FORMAT('R-150,0 ')
 620    CONTINUE
C
        DO 630 I=1,10
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,635)
 635    FORMAT('R0,-100 ')
 630    CONTINUE
        WRITE (3,575)
C
C       END OF BORDER
        LAB=0
        IXX=-100
        IYY=-25
        WRITE (3,560) IXX,IYY
        DO 660 I-1,10
        WRITE (3,655) LAB
        LAB=LAB+1
        WRITE (3,615)
        WRITE (3,710)
C       STEP VERTICAL
 660    CONTINUE
        WRITE (3,655) LAB
        GO TO 215
C
C       DRAW EXTINCTION    BORDER
```

```
 310    WRITE (3,565)
        DO 315 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,605)
 315    CONTINUE
C
        DO 316 I=1,6
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,317)
 317    FORMAT('R0,200 ')
 316    CONTINUE
C
        DO 318 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,625)
 318    CONTINUE
C
        DO 319 I=1,6
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,320)
 320    FORMAT('R0,-200 ')
 319    CONTINUE
        WRITE (3,575)
C
C       END OF BORDER
        LAB=0
        IXX=-80
        IYY=-25
        WRITE (3,560) IXX,IYY
        DO 210 I=1,7
        WRITE (3,655) LAB
        LAB=LAB+1
        WRITE (3,317)
        WRITE (3,710)
 210    CONTINUE
C       WRITE LABELLING
C
 215    LAB=0
        IXX=-60
        IYY=-50
        WRITE (3,560) IXX,IYY
C       POSITION ABSOLUTE
        DO 645 I=1,15
        WRITE (3,655) LAB
 655    FORMAT('S12 ',I2,'_')
C       HEIGHT=2.5mm,ROTATION=NORMAL
        LAB=LAB+1
        WRITE (3,705)
C       MOVE TO NEXT LOCATION
 645    CONTINUE
        WRITE (3,655) LAB
 705    FORMAT('R105,0 ')
 710    FORMAT('R-50,0 ')
C
C       ANNOTATION
C
```

```
      IXX=650
      IYY=-120
      WRITE (3,560) IXX,IYY
      WRITE (3,665)
 665  FORMAT('S12 WAVELENGTH   (uM)_')
C     HEIGHT=3mm,ROTATION=NORMAL
      IXX=-100
      IYY=200
      WRITE (3,560) IXX,IYY
      IF (IFIL.NE.2) GO TO 220
      WRITE (3,225)
 225  FORMAT('S42 EXTINCTION COEFFICIENT  (SQM/GM)_')
      GO TO 230
 220  WRITE (3,670)
 670  FORMAT('S42 NORMALLIZED DATA   (N/10)_')
C     HEIGHT=3mm,ROTATION=270^
 230  IXX=0
      IYY=1230
      WRITE (3,560) IXX,IYY
      WRITE (3,675) TH,RH
C                                                                    X
 675  FORMAT('S12 TEMP:-',F6.2,'C    REL.HUMIDITY:-',F6.2,'%_')
      IXX=450
      IYY=1350
      WRITE (3,560) IXX,IYY
      WRITE (3,680) DT1,DT2,DT3,ASMKT,IRUN
 680  FORMAT('S12 DATE:- ',A2,'/',A3,'/'A2,'     TIME:-',A4,'     RUN
    *#',I2,'_')
      IXX=200
      IYY=1290
      WRITE (3,560) IXX,IYY
      WRITE (3,685) (RING(I),I=1,10)
 685  FORMAT('S12 SMOKE TYPE:- ',10A4,'_')
      IXX=150
      IYY=1450
      WRITE (3,560) IXX,IYY
 420  FORMAT ('S13 FILTER CALIBRATION_')
      IF (IFIL.EQ.0) GO TO 410
      IF (IFIL.EQ.2) GO TO 235
      WRITE (3,420)
      GO TO 470
 235  WRITE (3,240)
 240  FORMAT('S13 MRL SMOKE CHAMBER MEASUREMENTS_')
      GO TO 470
 410  WRITE (3,690)
 690  FORMAT('S13 MRL SMOKE CHAMBER RAW DATA_')
C
C
C     END OF ANNOTATION
C
 470  FIL=FIL
 560  FORMAT('A',I5,',',I5,' ')
C
C     PLOTTING ACTUAL VALUES FROM DATA
C     ================================
C
 720  FORMAT('M21 ')
 565  FORMAT('D ')
C     PEN DOWN
 575  FORMAT('U ')
```

```
C       PEN UP
        WRITE (3,575)
C
        IF (IFIL.EQ.0) GO TO 888
        IF (IFIL.EQ.2) GO TO 350
C
C       *****FILTER CALIBRATION*****                              X
        IXX=INT((ALAMDA(3)*150)+0.5)
        ANOS=FLOAT(INOSMK(3))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 400
        IYY=INT(FLOAT(ISMK(3))/ANOS*1000+0.5)
 400    CALL CLIN
        DO 440 I=3,100
        IXX=INT((ALAMDA(I)*150)+0.5)
        ANOS=FLOAT(INOSMK(I))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 401
        IYY=INT(FLOAT(ISMK(I))/ANOS*1000+0.5)
 401    CALL CLIN
 440    CONTINUE
        WRITE (3,575)
C
        IXX=INT((ALAMD(3)*150)+0.5)
        ANOS=FLOAT(INOSMK(106))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 402
        IYY=INT(FLOAT(ISMK(106))/ANOS*1000+0.5)
 402    CALL CLIN
        DO 450 I=106,202
        IXX=INT((ALAMD(I-103)*150)+0.5)
C       IXX=INT((ALAMD(I-105)*150)+0.5)
        ANOS=FLOAT(INOSMK(I))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 403
        IYY=INT(FLOAT(ISMK(I))/ANOS*1000+0.5)
 403    CALL CLIN
 450    CONTINUE
        WRITE (3,575)
C
C                                                                 X
        IXX=INT((ALAM(3)*150)+0.5)
        ANOS=FLOAT(INOSMK(209))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 404
        IYY=INT(FLOAT(ISMK(209))/ANOS*1000+0.5)
 404    CALL CLIN
        DO 460 I=209,305
        IXX=INT((ALAM(I-206)*150)+0.5)
C       IXX=INT((ALAM(I-208)*150)+0.5)
        ANOS=FLOAT(INOSMK(I))
        IF (ANOS.EQ.0) IYY=0
        IF (ANOS.EQ.0) GO TO 405
        IYY=INT(FLOAT(ISMK(I))/ANOS*1000+0.5)
 405    CALL CLIN
 460    CONTINUE
        WRITE (3,575)
        GO TO 430
C
C       *****NOSMOKE  THEN   SMOKE  PLOT****
```

```
 888    IXX=INT((ALAMDA(3)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(3))/2+0.5)
        CALL CLIN
        DO 570 I=3,100
        IXX=INT((ALAMDA(I)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(I))/2+0.5)
        CALL CLIN                                           X
 570    CONTINUE
        WRITE (3,575)
C
C
        IXX=INT((ALAMD(3)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(106))/2+0.5)
        CALL CLIN
        DO 580 I=106,202
        IXX=INT((ALAMD(I-103)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(I))/2+0.5)
        CALL CLIN
 580    CONTINUE
        WRITE (3,575)
C
        IXX=INT((ALAM(3)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(209))/2+0.5)
        CALL CLIN
        DO 585 I=209,305
        IXX=INT((ALAM(I-206)*150)+0.5)
        IYY=INT(FLOAT(INOSMK(I))/2+0.5)
        CALL CLIN
 585    CONTINUE                                            X
        WRITE (3,575)
C       PEN UP ---- AT END OF PLOTTING
C
C
C       ---------------------------------------------------
  88    IXX=INT((ALAMDA(3)*150)+0.5)
        IYY=INT(FLOAT(ISMK(3))/2+0.5)
        CALL CLIN
        DO 70 I=3,100
        IXX=INT((ALAMDA(I)*150)+0.5)
        IYY=INT(FLOAT(ISMK(I))/2+0.5)
        CALL CLIN
  70    CONTINUE
        WRITE (3,575)
C
        IXX=INT((ALAMD(3)*150)+0.5)
        IYY=INT(FLOAT(ISMK(106))/2+0.5)
        CALL CLIN
        DO 80 I=106,202
        IXX=INT((ALAMD(I-103)*150)+0.5)
        IYY=INT(FLOAT(ISMK(I))/2+0.5)
        CALL CLIN                                           X
  80    CONTINUE
        WRITE (3,575)
C
C
        IXX=INT((ALAM(3)*150)+0.5)
        IYY=INT(FLOAT(ISMK(209))/2+0.5)
        CALL CLIN
        DO 85 I=209,305
        IXX=INT((ALAM(I-206)*150)+0.5)
```

```
      IYY=INT(FLOAT(ISMK(I))/2+0.5)
      CALL CLIN
 85   CONTINUE
      GO TO 430
C     ^^^^^^^^^^^^^^^^^^^^^^^^^
C     *****EXTINCTION   PLOT*******
 350  IXX=INT((ALAMDA(3)*150)+0.5)
      IYY=INT((ACALC(3)*200)+0.5)
      CALL LOCLIN
      DO 355 I=3,100
      IXX=INT((ALAMDA(I)*150)+0.5)
      IYY=INT((ACALC(I)*200)+0.5)
      CALL LOCLIN
 355  CONTINUE
      WRITE (3,575)
C
      IXX=INT((ALAMD(3)*150)+0.5)
      IYY=INT((ACALC(106)*200)+0.5)
      CALL LOCLIN
      DO 360 I=106,202
      IXX=INT((ALAMD(I-103)*150)+0.5)
      IYY=INT((ACALC(I)*200)+0.5)
      CALL LOCLIN
 360  CONTINUE
      WRITE (3,575)
C
      IXX=INT((ALAM(3)*150)+0.5)
      IYY=INT((ACALC(209)*200)+0.5)
      CALL LOCLIN
      DO 365 I=209,305
      IXX=INT((ALAM(I-206)*150)+0.5)
      IYY=INT((ACALC(I)*200)+0.5)
      CALL LOCLIN
 365  CONTINUE
C     ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
 430  WRITE (3,575)
C     PEN UP ---- AT END OF PLOTTING
C
      WRITE (3,640)
 640  FORMAT('H @ ')
C     INACTIVATE PLOTTER
 700  FORMAT('A',I6,',',I6,' ')
      CALL CLOSE (3)
C
C
C
C
     TYPE 550
 550 FORMAT (///10X,'END OF GRAPHING',10X,'PRESS RETURN KEY'/)
     READ (5,555) DUD
 555 FORMAT (A1)
     RETURN
     END
C
C
C     LOCATES START OF LINE AND PUTS PEN DOWN
C
      SUBROUTINE CLIN
C                                                                      X
     COMMON INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
```

```
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY
C
        IF (IYY.GT.1000.OR.IYY.LE.0) GO TO 35
        WRITE (3,30) IXX,IYY
        WRITE (3,5)
C       PEN DOWN
  33    RETURN
  35    WRITE (3,10)
C       PEN UP
        GO TO 33
  30    FORMAT('A',I6,',',I6,' ')
   5    FORMAT('D ')
  10    FORMAT('U ')
        END
C
C
```

APPENDIX IV

MRLV20.FOR

```
C        FILENAME:-  MRLV20.FOR
C
C        OLD      FILENAME:-  MRLMAN.FOR
C
C        LINK OBJS OF  MRLV20.FOR,MRLV21.FOR,MRLV22.FOR,READ43.MAC
C
C       MRL SMOKE CHAMBER PROGRAMME
C       ACCEPTS GOLAY CELL INPUT
C       STORES & ANALIZES DATA
C
C        MODIFIED TO USE  312  BACKGROUND READINGS
C
C
C                                                                     X
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
        LOGICAL*4 ANSKT,ASMKT,RING
        LOGICAL*4 DT1,DT2,DT3
C
C
        DATA NRUN/'01','02','03','04','05','06','07','08','09','10',
     +            '11','12','13','14','15','16','17','18','19','20',
     +            '21','22','23','24','25','26','27','28','29','30',
     +            '31','32','33','34','35','36','37','38','39','40',
     +            '41','42','43','44','45','46','47','48','49','50'/
C
C       DYNAMIC GENERATION OF WAVELENGTH NUMBERS
C       ========================================
C
        AMCEN1=3.5125
        AMCEN2=6.2762
        AMCEN3=11.4381
        AMDEL1=0.0200707
        AMDEL2=0.0372490
        AMDEL3=0.0659303
C
        ALAMDA(1)=(AMCEN1-AMDEL1/2.)-49.*AMDEL1
        ALAMD(1)=(AMCEN2+AMDEL2/2.)+49.*AMDEL2
        ALAM(1)=(AMCEN3+AMDEL3/2.)+49.*AMDEL3
        DO 200 I=2,100
        AI=I
        ALAMDA(I)=ALAMDA(1)+AMDEL1*AI
        ALAMD(I)=ALAMD(1)-AMDEL2*AI
        ALAM(I)=ALAM(1)-AMDEL3*AI
 200    CONTINUE
C
C       END OF DYNAMIC WAVELENGTH GENERATION
C       ====================================
C
C        INITIALLIZE COMMON VARIABLES TO ZERO
C
         J=1
         DO 1 I=1,2200
         J=J+1
         ITEMP(I)=J
 1       CONTINUE
C
         DO 3 I=1,10
```

```
          RING(I)=0
 3        CONTINUE
C
          INSKR=3
          ISMKR=3
          TH=00.0
          RH=00.0
          CONC=00.0
          IBAKGD=0
C
C
C
         CALL ASSIGN (2,'DY1:IRUN.DAT',0,'OLD')
         READ (2,9) IRUN
  9      FORMAT (I2)
         CALL CLOSE (2)
C
C
        CALL CLS
        TYPE 10
 10     FORMAT (////)
        TYPE 13
 13     FORMAT (10X,'S M O K E   C H A M R E R   M E A S U R E M E N T S
      *'//)
        TYPE 18
 18     FORMAT (10X,'GIVE DATE  EG  02NOV82'/)
        READ (5,20) DT1,DT2,DT3
 20     FORMAT (A2,A3,A2)
 80     TYPE 30
 30     FORMAT(////20X,'M  E  N  U'/20X,'=========='/)
        IF (IRUN.GT.49) IRUN=1
        TYPE 35,IRUN
 35     FORMAT (10X,' RUN NUMBER IS   #',I2)
        TYPE 40
 40     FORMAT (5X,'GIVE A DIGIT BETWEEN  1 & 10')
        TYPE 50
 50     FORMAT (10X,'1 = TAKE BACKGROUND READINGS'/10X,'2 = NO SMOKE MEAS
      *UREMENT'/10X,'3 = SMOKE MEASUREMENT')
        TYPE 60
 60     FORMAT (10X,'4 = CALCULATE DATA'/10X,'5 = GRAPH RESULTS')
        TYPE 70
 70     FORMAT (10X,'6 = TABULATE RESULTS'/10X,'7 = NEW DATA DISKETTE HAS
      * BEEN INSTALLED')
        TYPE 75
 75     FORMAT (10X,'8 = NEW RUN  NUMBER REQUIRED'/10X,'9 = CLOSE DOWN CO
      *MPUTER FOR THE DAY')
        TYPE 77
 77     FORMAT (10X,'10= RE-RUN OF PREVIOUS DISC-STORED DATA')
        READ (5,*) JA
        IF (JA.LT.1.OR.JA.GT.10) GO TO 80
        GO TO (95,100,110,120,130,140,143,145,150,155) JA
C       GOTO SUBROUTINES
  95    IBAK=1
        CALL NSK(IBAK)
        GO TO 160
 100    IBAK=0
        CALL NSK(IBAK)
        GO TO 160
 110    CALL SK
        GO TO 160
```

```
  120   CALL CLC
        GO TO 160
  130   CALL GRP
        GO TO 160
  140   CALL TABUL
        GO TO 160
  143   CALL WEN
        GO TO 160
  145   CALL NUR
        GO TO 160
  150   CALL FIN
        GO TO 999
  155   CALL RERUN
        GO TO 160
  160   CALL CLS
        DO 190 I = 1,10000
  190   CONTINUE
        GO TO 80
  999   CONTINUE
        TYPE 998
  998   FORMAT (1X,'END OF PROGRAMME')
        END
C
C
C
C
C
C       DRAWS A GRAPH OF EXTINCTION COEFFICIENT V WAVELENGTH
C
        SUBROUTINE GRP
C
C
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
C
         CALL ASSIGN(3,'PL:',0,'NEW','NC')
C        CALL ASSIGN(3,'TT:',0,'NEW','NC')
C        CALL ASSIGN(3,'LP:',0,'NEW','NC')
C
        CALL CLS
  510   TYPE 500
  500   FORMAT (////20X,'G R A P H I N G'///10X,'PAPER READY  Y/N ?'/)
        READ (5,505) PAP
  505   FORMAT (A1)
        IF (PAP.NE.'Y') GO TO 510
        TYPE 520
  520   FORMAT (10X,'PEN READY  Y/N ?'/)
        READ (5,525) PEN
  525   FORMAT (A1)
        IF (PEN.NE.'Y') GO TO 510
  530   TYPE 540
  540   FORMAT (10X,'PLOTTER ACTIVE  Y/N ?'/)
        READ (5,545) PLT
  545   FORMAT (A1)
        IF (PLT.NE.'Y') GOTO 530
C
C       DRAW, PLOT, ETC
C
```

```
C       ACTIVATE PLOTTER
        WRITE (3,650)
C       PLOTTER ACTIVE, HOME(BOT.L/H CNR),POSITION 2CM UP AND
C       ALONG,ORIGIN AT THAT POINT
 650    FORMAT(' H A100,200 O ')
C
C
C       GO TO 888
C       DRAW BORDER OF GRAPH
 590    FORMAT('R',I5,',',I5,' ')
 595    FORMAT('M20 ')
C       595 = TICK FOR X-AXES AND Y-AXES
        WRITE (3,565)
        DO 600 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,605)
 605    FORMAT('R150,0 ')
 600    CONTINUE
C
        DO 610 I=1,6
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,615)
 615    FORMAT('R0,200 ')
 610    CONTINUE
C
        DO 620 I=1,15
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,625)
 625    FORMAT('R-150,0 ')
 620    CONTINUE
C
        DO 630 I=1,6
        WRITE (3,595)
C       WRITE (3,565)
        WRITE (3,635)
 635    FORMAT('R0,-200 ')
 630    CONTINUE
        WRITE (3,575)
C
C       END OF BORDER
C
C       WRITE LABELLING
C
        LAB=0
        IXX=-60
        IYY=-50
        WRITE (3,560) IXX,IYY
C       POSITION ABSOLUTE
        DO 645 I=1,15
        WRITE (3,655) LAB
 655    FORMAT('S12 ',I2,'_')
C       HEIGHT=2.5mm,ROTATION=NORMAL
        LAB=LAB+1
        WRITE (3,705)
C       MOVE TO NEXT LOCATION
 645    CONTINUE
        WRITE (3,655) LAB
```

```
 705    FORMAT('R105,0 ')
 710    FORMAT('R-50,0 ')
C
        LAB=0
        IXX=-80
        IYY=-25
        WRITE (3,560) IXX,IYY
        DO 660 I=1,7
        WRITE (3,655) LAB
        LAB=LAB+1
        WRITE (3,615)
        WRITE (3,710)
C       STEP VERTICAL
 660    CONTINUE
C
C       ANNOTATION
C
        IXX=650
        IYY=-120
        WRITE (3,560) IXX,IYY
        WRITE (3,665)
 665    FORMAT('S12 WAVELENGTH   (uM)_')
C       HEIGHT=3mm,ROTATION=NORMAL
        IXX=-100
        IYY=200
        WRITE (3,560) IXX,IYY
        WRITE (3,670)
 670    FORMAT('S42 EXTINCTION COEFFICIENT  (SQM/GM)_')
C       HEIGHT=3mm,ROTATION=270^
        IXX=0
        IYY=1230
        WRITE (3,560) IXX,IYY
        WRITE (3,675) TH,RH,CONC
C                                                                    X
 675    FORMAT('S12 TEMP:-',F6.2,'C    REL.HUMIDITY:-',F6.2,'%  CONCE
     *NTRATION:- ',F6.4,' GM/CUB.METRE_')
        IXX=450
        IYY=1350
        WRITE (3,560) IXX,IYY
        WRITE (3,680) DT1,DT2,DT3,ASMKT,IRUN
 680    FORMAT('S12 DATE:- ',A2,'/',A3,'/'A2,'      TIME:-',A4,'  RUN
     *#',I2,'_')
        IXX=200
        IYY=1290
        WRITE (3,560) IXX,IYY
        WRITE (3,685) (RING(I),I=1,10)
 685    FORMAT('S12 SMOKE TYPE:- ',10A4,'_')
        IXX=150
        IYY=1450
        WRITE (3,560) IXX,IYY
        WRITE (3,690)
 690    FORMAT('S13 MRL SMOKE CHAMBER MEASUREMENTS_')
C
C       END OF ANNOTATION
C
 560    FORMAT('A',I5,',',I5,' ')
C
C       PLOTTING ACTUAL VALUES FROM DATA
C       ================================
C
```

```
 720    FORMAT('M21 ')
 565    FORMAT('D ')
C       PEN DOWN
 575    FORMAT('U ')
C       PEN UP
        WRITE (3,575)
C
 888    IXX=INT((ALAMDA(3)*150)+0.5)
        IYY=INT((ACALC(3)*200)+0.5)
        CALL LOCLIN
        DO 570 I=3,100
        IXX=INT((ALAMDA(I)*150)+0.5)
        IYY=INT((ACALC(I)*200)+0.5)
        CALL LOCLIN
 570    CONTINUE
        WRITE (3,575)
C
        IXX=INT((ALAMD(3)*150)+0.5)
        IYY=INT((ACALC(106)*200)+0.5)
        CALL LOCLIN
        DO 580 I=106,202
        IXX=INT((ALAMD(I-103)*150)+0.5)
        IYY=INT((ACALC(I)*200)+0.5)
        CALL LOCLIN
 580    CONTINUE
        WRITE (3,575)
C
        IXX=INT((ALAM(3)*150)+0.5)
        IYY=INT((ACALC(209)*200)+0.5)
        CALL LOCLIN
        DO 585 I=209,305
        IXX=INT((ALAM(I-206)*150)+0.5)
        IYY=INT((ACALC(I)*200)+0.5)
        CALL LOCLIN
 585    CONTINUE
        WRITE (3,575)
C       PEN UP ---- AT END OF PLOTTING
C
        WRITE (3,640)
 640    FORMAT('H @ ')
C       INACTIVATE PLOTTER
 700    FORMAT('A',I6,',',I6,' ')
        CALL CLOSE (3)
C
C
C
C
       TYPE 550
 550   FORMAT (///10X,'END OF GRAPHING',10X,'PRESS RETURN KEY'/)
       READ (5,555) DUD
 555   FORMAT (A1)
       RETURN
       END
C
C
C       LOCATES START OF LINE AND PUTS PEN DOWN
C
        SUBROUTINE LOCLIN
C                                                                     X
       COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
```

```
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
      IF (IYY.GT.1200.OR.IYY.LE.0) GO TO 335
      WRITE (3,300) IXX,IYY
      WRITE (3,305)
C     PEN DOWN
 330  RETURN
 335  WRITE (3,310)
C     PEN UP
      GO TO 330
 300  FORMAT('A',I6,',',I6,' ')
 305  FORMAT('D ')
 310  FORMAT('U ')
      END
C
C
```

APPENDIX V

MRLV21.FOR

```
C        FILENAME:-  MRLV21.FOR
C
C        OLD      FILENAME:-  MRL1.FOR
C
C        LINK OBJS OF  MRLV20.FOR,MRLV21.FOR,MRLV22.FOR,READ43.MAC
C
C       MRL SMOKE CHAMBER PROGRAMME
C       ACCEPTS GOLAY CELL INPUT
C       STORES & ANALIZES DATA
C
C        MODIFIED TO USE 312 BACKGROUND READINGS
C
C
C       RE-RUN OF EXISTING DATA STORED ON DISC
C
        SUBROUTINE RERUN
C                                                                        X
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
        INTEGER*2 DINK(7),DISK(7),DICK(7)
C
        DATA DINK/'DY','1:','IN','SK','00','.D','AT'/
        DATA DISK/'DY','1:','IS','MK','00','.D','AT'/
        DATA DICK/'DY','1:','IC','LK','00','.D','AT'/
C
        TYPE 700
 700    FORMAT (10X,'W R I T E   D O W N   E X I S T I N G   R U N   N U
     *M B E R'/10X,'NOW PRESS RETURN KEY')
        READ (5,795) DUD
 795    FORMAT (A1)
        CALL CLS
 705    TYPE 710
 710    FORMAT (10X,'RE-RUN OF PREVIOUS DISC-STORED DATA'//5X,'GIVE
     *R U N   N U M B E R   YOU WANT TO SEE')
        READ (5,711) IRUN
 711    FORMAT (I2)
C
        DINK(5)=NRUN(IRUN)
        CALL ASSIGN (2,DINK,14,'OLD')
        READ (2,715) (INOSMK(I),I=1,312)
 715    FORMAT (63(5(I10,2X),/))
        READ (2,716) DT1,DT2,DT3,ANSKT,INSKR
 716    FORMAT (A2,A3,A2,5X,A4,5X,I2)
        CALL CLOSE (2)
C
        DISK(5)=NRUN(IRUN)
        CALL ASSIGN (2,DISK,14,'OLD')
        READ (2,720) (ISMK(I),I=1,312)
 720    FORMAT (63(5(I10,2X),/))
        READ (2,721) DT1,DT2,DT3,ASMKT,ISMKR,(RING(I),I=1,10)
 721    FORMAT (A2,A3,A2,5X,A4,5X,I2,10A4)
        CALL CLOSE (2)
C
        DICK(5)=NRUN(IRUN)
        CALL ASSIGN (2,DICK,14,'OLD')
        READ (2,725) (ACALC(I),I=1,312)
 725    FORMAT (63(5(F6.3,2X),/))
        READ (2,726) DT1,DT2,DT3,ASMKT,CONC,TH,RH,IBAKGD
```

```
 726    FORMAT (A2,A3,A2,5X,A4,5X,F6.4,5X,F6.2,5X,F6.2,5X,I6)
        CALL CLOSE (2)
C
        TYPE 730,IRUN,DT1,DT2,DT3,(RING(I),I=1,10),CONC
 730    FORMAT (//5X,'RUN  #',I2,5X,'DATE:-',A2,A3,A2/5X,'SMOKE TYPE:-',
     *10A4/5X,'CONCENTRATION   ',F6.4,' GMS/CUB.METRE'//10X,'IS THIS THE
     *CORRECT RUN ?  Y/N')
        READ (5,735) COR
 735    FORMAT (A1)
        IF (COR.EQ.'Y') GO TO 740
        GO TO 705
 740    TYPE 745
 745    FORMAT (//20X,'R E M E M B E R ! !'/5X,'RE-INSERT WRITTEN DOWN R
     *UN NUMBER BEFORE CLOSING DOWN COMPUTER,'/5X,'OR CARRYING ON WITH A
     *NOTHER LEGITIMATE RUN,'//5X,'OR THE DISC DATA FILES MAY BECOME OVE
     *R-WRITTEN ! !'///5X,'PRESS RETURN TO GET TO   M E N U')
        READ (5,795) DUD
        RETURN
        END
C
C
C
        SUBROUTINE ERROR(V1,V2,IERR)
        DIMENSION UV2(17),AV2(17)
        DATA UV2/.0155,.024,.0335,.044,.054,.064,.074,.084,.014,
     *  .24,.332,.44,.54,.64,.738,.825,.92/
        DATA AV2/.0039,.0027,.00223,.00194,.00179,.00167,.0016,
     *  .00153,.0013,.00118,.00111,.00105,.000102,.00099,.00097,
     *  .00096,.00094/
        IERR=0
        IF (V1.LT.0.025) GO TO 1
        IF(V1.LT.0.1) GO TO 10
C
C    ***********************************************************
C
C    VALUES OF V1 BETWEEN 0.1 AND 1.0

        J=I+8
        DO 29 I=1,9
              A=0.1+0.1*FLOAT(I-1)
              B=A+0.1
              IF(V1.GE.A.AND.V1.LT.B) GO TO 21
              GO TO 29
  21          IF(V2.LT.AV2(J).OR.V2.GT.UV2(J)) GO TO 1
              GO TO 99
  29    CONTINUE
        GO TO 99
C
C    ***********************************************************

C    VALUES OF V1 BETWEEN 0.025 AND 0.1
C
  10    IF(V1.GE.0.025.AND.V1.LT.0.03) GO TO 11
        DO 19 I=1,7
              A=0.03+0.01*FLOAT(I-1)
              B=A+0.01
              IF(V1.GE.A.AND.V1.LT.B) GO TO 12
              GO TO 19
  12          IF(V2.LT.AV2(I+1).OR.V2.GT.UV2(I+1)) GO TO 1
              GO TO 99
```

```
  19    CONTINUE
        GO TO 99
C
C   **************************************************************
C
C   VALUES OF V1 BETWEEN 0.025 AND 0.03
C
        WRITE(3,*)V1,V2
  11    IF(V2.LT.AV2(1).OR.V2.GT.UV2(1)) GO TO 1
        GO TO 99
C
C   **************************************************************
C
C   DATA UNACCEPTABLE DUE TO UNACCEPTABLE ERRORS
C
  1     IERR=1
  99    CONTINUE
        RETURN
        END
```

APPENDIX VI

MRLV22.FOR

```
C       FILENAME:-  MRLV22.FOR
C
C       OLD      FILENAME :-  MRL2.FOR
C
C       LINK OBJS OF  MRLV20.FOR,MRLV21.FOR,MRLV22.FOR,READ43.MAC
C
C       MODIFIED TO USE 312 BACKGROUND READINGS
C
C
      SUBROUTINE CLS
C     CLEARS  V D U  SCREEN
      TYPE 5
 5    FORMAT (////////////////////////////////)
      RETURN
      END
C
C
C
C     INITIALLIZE IRUN COUNTER   FOR NEW DISKETTE
      SUBROUTINE WEN
C
      COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
      IRUN=1
      RETURN
      END
C
C
C
C     INCREMENT TRIAL RUN NUMBER
      SUBROUTINE NUR
C
      COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
       CALL CLS
       TYPE 800
 800   FORMAT (10X,'CHANGE   RUN     NUMBER'//10X,'DO YOU WANT TO INCR
     *EMENT RUN NUMBER,'/' OR CHANGE THE RUN NUMBER ?   TYPE  I/C')
       READ (5,805) CH
 805   FORMAT (A1)
       IF (CH.EQ.'C') GO TO 810
       IRUN=IRUN+1
       GO TO 820
 810   TYPE 830
 830   FORMAT (10X,'GIVE REQUIRED RUN NUMBER')
       READ (5,840) IRUN
 840   FORMAT (I2)
       TYPE 845,IRUN
 845   FORMAT (20X,'RUN  #',I2//10X,'PRESS RETURN KEY')
       READ (5,850) DUD
 850   FORMAT (A1)
 820   RETURN
      END
C
C
C
```

```
C       NO SMOKE  &   BACKGROUND  SUBROUTINES
        SUBROUTINE NSK(IBAK)
C
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
C
         INTEGER*2 DISK(7),DIS(7)
C
C
         DATA DISK/'DY','1:','IN','SK','00','.D','AT'/
         DATA DIS/'DY','1:','IB','AK','00','.D','AT'/
C
C
C       CLEAR NO SMOKE DATA FIELD
C        DO 200 I = 1,312
C        INOSMK(I) = 0
C 200    CONTINUE
C       NO SMOKE DATA FIELD CLEARED
         TYPE 270
 270     FORMAT (//,3X,'USE   E X I S T I N G   DATA (NOT MORE THAN
     * ONE HOUR OLD)  Y/N')
         READ (5,275) Y
 275     FORMAT (A1)
         IF (Y.NE.'Y') GO TO 280
         IF (IBAK.EQ.0) GO TO 213
         GO TO 223
 280     CALL CLS
 214     IF (IBAK.EQ.0) GO TO 210
         TYPE 211
C                                                                      X
 211     FORMAT (////10X,'B A C K G R O U N D   R E A D I N G S'//1
     *0X,'B L A N K   O F F    N E R N S T   G L O W E R'/)
         GO TO 212
 210    TYPE 220
 220    FORMAT (////20X,'N O  S M O K E  M E A S U R E M E N T'/)
        TYPE 225
 225    FORMAT (20X,'GIVE TIME   EG  0900')
        ACCEPT 222,ANSKT
 222    FORMAT (A4)
 212    TYPE 230
 230    FORMAT (/10X,'GIVE A NUMBER BETWEEN  1 & 7  FOR REVS REQUIRED'/)
        READ (5,231) INSKR
 231    FORMAT (I2)
        IF (INSKR.LT.1.OR.INSKR.GT.7) GO TO 214
C
        CALL COLDAT(ITEMP,INSKR)
C
         IF (IBAK.EQ.0) GO TO 218
C        AVERAGE BACKGROUND READINGS
         N=INSKR
         DO 219 I=1,311
         IB=0
         DO 221 J=1,N
         IB=IB+ITEMP(311*(J-1)+I)
 221     CONTINUE
         IBACK(I)=IB/N
 219     CONTINUE
         GO TO 223
```

```
C
C       AVERAGE NOSMOKE DATA AND STORE IN NSMK ARRAY
 218    N = INSKR
        DO 240 I = 1,311
        IB = 0
        DO 250 J = 1,N
        IB = IB+ITEMP(311*(J-1)+I)
 250    CONTINUE
        INOSMK(I) = IB/N-IBACK(I)
 240    CONTINUE
C
C
C
C
C       STORE ON DISC ?    ***USE CURRENT RUN NUMBER
C       AS PART OF FILE NAME
C
 223     IF (IBAK.EQ.0) GO TO 213
         DIS(5) = NRUN(IRUN)
         CALL ASSIGN (2,DIS,14,'NEW')
         WRITE (2,243) (IBACK(I),I=1,312)
         CALL CLOSE (2)
         IF (Y.EQ.'Y') GO TO 266
         TYPE 216
         GO TO 217
C                                                                      X
 216     FORMAT (5X,'R E M O V E   S O U R C E    B L A N K'/10X,'T
     *HEN PRESS ENTER KEY')
 213     DISK(5) = NRUN(IRUN)
         CALL ASSIGN (2,DISK,14,'NEW')
         WRITE (2,243) (INOSMK(I),I=1,312)
 243     FORMAT (63(5(I10,2X),/))
         WRITE (2,244) DT1,DT2,DT3,ANSKT,INSKR
 244     FORMAT (A2,A3,A2,5X,A4,5X,I2)
         CALL CLOSE (2)
         IF (Y.EQ.'Y') GO TO 266
C
C        DATE,NOSMOKE START TIME AND NUMBER OF REVS -ON END OF DATA
C
 217     TYPE 260
C                                                                      X
 260    FORMAT (//10X,'END OF MEASUREMENT',10X,'PRESS RETURN KEY'/)
         READ (5,265) DUD
 265    FORMAT (A1)
 266     RETURN
        END
C
C
C
C       SMOKE SUBROUTINE
C
        SUBROUTINE SK
C
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
         INTEGER*2 DISK(7)
C
C
```

```
        DATA DISK/'DY','1:','IS','MK','00','.D','AT'/
C
C
C
        DATA RING/10*'    '/
C
C
C       CLEAR DATA FIELD
        DO 300 I = 1,312
        ISMK(I) = 0
 300    CONTINUE
C       SMOKE DATA FIELD CLEARED
        CALL CLS
 310    TYPE 320
 320    FORMAT (////20X,'S M O K E   M E A S U R E M E N T'/)
        TYPE 325
 325    FORMAT (20X,'GIVE TIME   EG  0930')
        ACCEPT 322,ASMKT
 322    FORMAT (A4)
        TYPE 360
 360    FORMAT (/10X,'GIVE SMOKE TYPE/DESCRIPTION'/)
        ACCEPT 370,(RING(I),I=1,10)
 370    FORMAT (10A4)
        TYPE 380
 380    FORMAT (/10X,'GIVE CHAMBER TEMPERATURE    IN DEGREES CENT.'/)
        ACCEPT *,TH
        TYPE 375
 375    FORMAT (/10X,'GIVE RELATIVE HUMIDITY    IN PERCENT'/)
        ACCEPT *,RH
        TYPE 230
 230    FORMAT (/9X,'GIVE A NUMBER BETWEEN  1 & 7  FOR REVS REQUIRED'/)
        READ (5,382) ISMKR
 382    FORMAT (I2)
        IF (ISMKR.LT.1.OR.ISMKR.GT.7) GO TO 310
C
        CALL COLDAT(ITEMP,ISMKR)
C
C       AVERAGE SMOKE DATA AND STORE IN SMK ARRAY
        N = ISMKR
        DO 330 I = 1,311
        IB = 0
        DO 340 J = 1,N
        IB = IB+ITEMP(311*(J-1)+I)
 340    CONTINUE
        ISMK(I) = IB/N-IBACK(I)
 330    CONTINUE
C
C
C
C       STORE ON DISC ?   ***USE CURRENT RUN NUMBER
C       AS PART OF FILE NAME
C
        DISK(5) = NRUN(IRUN)
        CALL ASSIGN (2,DISK,14,'NEW')
        WRITE (2,342) (ISMK(I),I=1,312)
 342    FORMAT (63(5(I10,2X),/))
        WRITE (2,344) DT1,DT2,DT3,ASMKT,ISMKR,(RING(I),I=1,10)
 344    FORMAT (A2,A3,A2,5X,A4,5X,I2,10A4)
        CALL CLOSE (2)
C
```

```
C
C       DATE, SMOKE START TIME, SMOKE REVS ON END OF DATA
C
C
C                                                                          X
        TYPE 350
  350   FORMAT (//10X,'END OF SMOKE MEASUREMENT',10X,'PRESS RETURN KEY'/)
        READ (5,355) DUD
  355   FORMAT (A1)
        RETURN
        END
C
C
C
C       CALCULATE SMOKE & NOMSOKE READINGS, FOR RELATIVE VALUES
C
        SUBROUTINE CLC
C
        COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
      *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
      *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
C
C
         INTEGER*2 DISK(7)
C
C
         DATA DISK/'DY','1:','IC','LK','00','.D','AT'/
C
C
C
C
C       CLEAR CALC DATA STORE
        DO 400 I=1,312
        ACALC(I)=0
  400   CONTINUE
C       CALC FIELD CLEARED
        CALL CLS
        TYPE 410
  410   FORMAT (////20X,'C A L C U L A T E   D A T A'/)
        IB=0
        IB=IB+INOSMK(102)
        IB=IB+INOSMK(205)
        IB=IB+INOSMK(308)
        IB=IB+ISMK(102)
        IB=IB+ISMK(205)
        IB=IB+ISMK(308)
        IB=IB/6
C        IB = 0
C        TAKE OUT                  IB=0     *******
        IBAKGD=IB
C       BACKGROUND AVERAGED
        VOL=4.5*2.63*2.74
C       VOLUME OF CHAMBER
        ALEN=5.0
C       LENGTH OF DETECTOR PATH
  415   TYPE 420
  420   FORMAT (//10X,'GIVE MASS OF SMOKE USED  IN GRAMS'/)
        READ (5,*) AMASS
        CONC=AMASS/VOL
```

```
      DO 430 I=1,312
      IF (INOSMK(I).EQ.0) GO TO 430
       IF (ISMK(I).EQ.0) GO TO 430
      GOLA=FLOAT(ISMK(I))/FLOAT(INOSMK(I))
      IF (GOLA.LE.0.0) GO TO 430
       ACALC(I)=(-ALOG(GOLA))/(ALEN*CONC)
C      ******************************
       V1=(FLOAT(INOSMK(I)))/2000
       V2=(FLOAT(ISMK(I)))/2000
       CALL ERROP (V1,V2,IERR)
       IF (IERR.NE.0) ACALC(I)=0.0
C      ************************
 430  CONTINUE
C
C
C
C     STORE ON DISC ?   ###USE CURRENT RUN NUMBER
C     AS PART OF FILE NAME
C
       DISK(5) = NRUN(IRUN)
       CALL ASSIGN (2,DISK,14,'NEW')
       WRITE (2,442) (ACALC(I),I-1,312)
 442   FORMAT (63(5(F6.3,2X),/))
       WRITE (2,444) DT1,DT2,DT3,ASMKT,CONC,TH,RH,IBAKGD
 444   FORMAT (A2,A3,A2,5X,A4,5X,F6.4,5X,F6.2,5X,F6.2,5X,I6)
       CALL CLOSE (2)
C
C
C     DATE,SMOKE START TIME, CONCENTRATION,TEMPERATURE
C     RELATIVE HUMIDITY,BACKGROUND READING-- ON END OF DATA
C
C
      TYPE 440
 440  FORMAT (//10X,'END OF CALCULATIONS',10X,'PRESS RETURN KEY'/)
      READ (5,445) DUD
 445  FORMAT (A1)
      RETURN
      END
C
C
C
C
C     TABULATE RESULTS SUB
C
      SUBROUTINE TABUL
C
C
      COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
C
C
      CALL CLS
      TYPE 600
 600  FORMAT (////20X,'T A B U L A T E   R E S U L T S'//)
 615  TYPE 605
 605  FORMAT (10X,'PRINTER READY  Y/N ?')
      READ (5,610) PR
 610  FORMAT (A1)
```

```
      IF (PR.NE.'Y') GO TO 615
C
C
      TYPE 620
C      PRINT 620
 620  FORMAT (//////)
      TYPE 625
C      PRINT 625
 625  FORMAT (//7X,'M R L   S M O K E   C H A M B E R   M E A S U R E M
     1 E N T S'/5X,'====================================================
     1============'//)
C      PRINT 630,IRUN,DT1,DT2,DT3
      TYPE 630,IRUN,DT1,DT2,DT3
 630  FORMAT (10X,'RUN  #',I2,20X,'DATE:- ',A2,'/',A3,'/',A2/)
C      PRINT 635,ANSKT,INSKR
      TYPE 635,ANSKT,INSKR
 635  FORMAT (3X,'NOSMOKE:-  TIME = ',A4,3X,'REVS = ',I2)
C      PRINT 637,ASMKT,ISMKR
      TYPE 637,ASMKT,ISMKR
 637  FORMAT (5X,'SMOKE:-  TIME = ',A4,3X,'REVS = ',I2/)
C      PRINT 640,TH,RH
      TYPE 640,TH,RH
 640  FORMAT (3X,'CHAMBER TEMPERATURE:- ',F6.2,' C',10X,'RELATIVE HUMID
     1ITY:- ',F6.2,'%')
C                                                                      X
C      PRINT 645,(RING(I),I=1,10)
      TYPE 645,(RING(I),I=1,10)
 645  FORMAT (3X,'SMOKE DESCRIPTION:- ',10A4)
C      PRINT 642,CONC
      TYPE 642,CONC
 642  FORMAT (15X,'CONCENTRATION:-  ',F6.4,' GMS/CUB.METRE')
C      PRINT 647,IBAKGD
      TYPE 647,IBAKGD
 647  FORMAT (15X,'BACKGROUND READING:-',I6/)
C      PRINT 650
      TYPE 650
C                                                                     X
 650  FORMAT (3X,'FILTER #',6X,'EXT COEFF',6X,'LAMDA UM',6X,'NOSMOKE #
     1',6X,'SMOKE #')
C
C
      J=0
      DO 660 I=1,100
      K=I+J
C      PRINT 665,K,ACALC(I),ALAMDA(I),INOSMK(I),ISMK(I)
       TYPE 665,K,ACALC(I),ALAMDA(I),INOSMK(I),ISMK(I)
 665   FORMAT (4X,I5,9X,F6.3,8X,F6.3,8X,I6,8X,I6)
 660   CONTINUE
C
      J=-3
      DO 670 I=104,203
      K=I+J
C      PRINT 665,K,ACALC(I),ALAMD(I-103),INOSMK(I),ISMK(I)
       TYPE 665,K,ACALC(I),ALAMD(I-103),INOSMK(I),ISMK(I)
 670   CONTINUE
C
      J=-6
      DO 675 I=207,306
      K=I+J
C      PRINT 665,K,ACALC(I),ALAM(I-206),INOSMK(I),ISMK(I)
```

```
      TYPE 665,K,ACALC(I),ALAM(I-206),INOSMK(I),ISMK(I)
 675  CONTINUE
C
C     PRINT 620
      TYPE 620
C
C
      TYPE 690
 690  FORMAT (/10X,'TABLE COMPLETED',10X,'PRESS RETURN KEY'/)
      READ (5,695) DUD
 695  FORMAT (A1)
      RETURN
      END
C
C
C
C     FINISH PROG BY STORING ALL RELAVENT DATA ON DISC
C
      SUBROUTINE FIN
C
C
      COMMON ITEMP(2200),INOSMK(312),ISMK(312),ACALC(312),ALAMDA(103),
     *ALAMD(103),ALAM(105),RING(10),DT1,DT2,DT3,ANSKT,INSKR,ASMKT,ISMKR
     *,TH,RH,CONC,IBAKGD,IRUN,NRUN(50),IXX,IYY,IBACK(312)
C
      INTEGER*4 DISC(3)
      DATA DISC/'DY1:','IRUN','.DAT'/
C
C
      IRUN=IRUN+1
C
      CALL ASSIGN (2,DISC,12,'NEW')
      WRITE (2,888) IRUN
 888  FORMAT (I2)
      CALL CLOSE (2)
C
      RETURN
      END
```

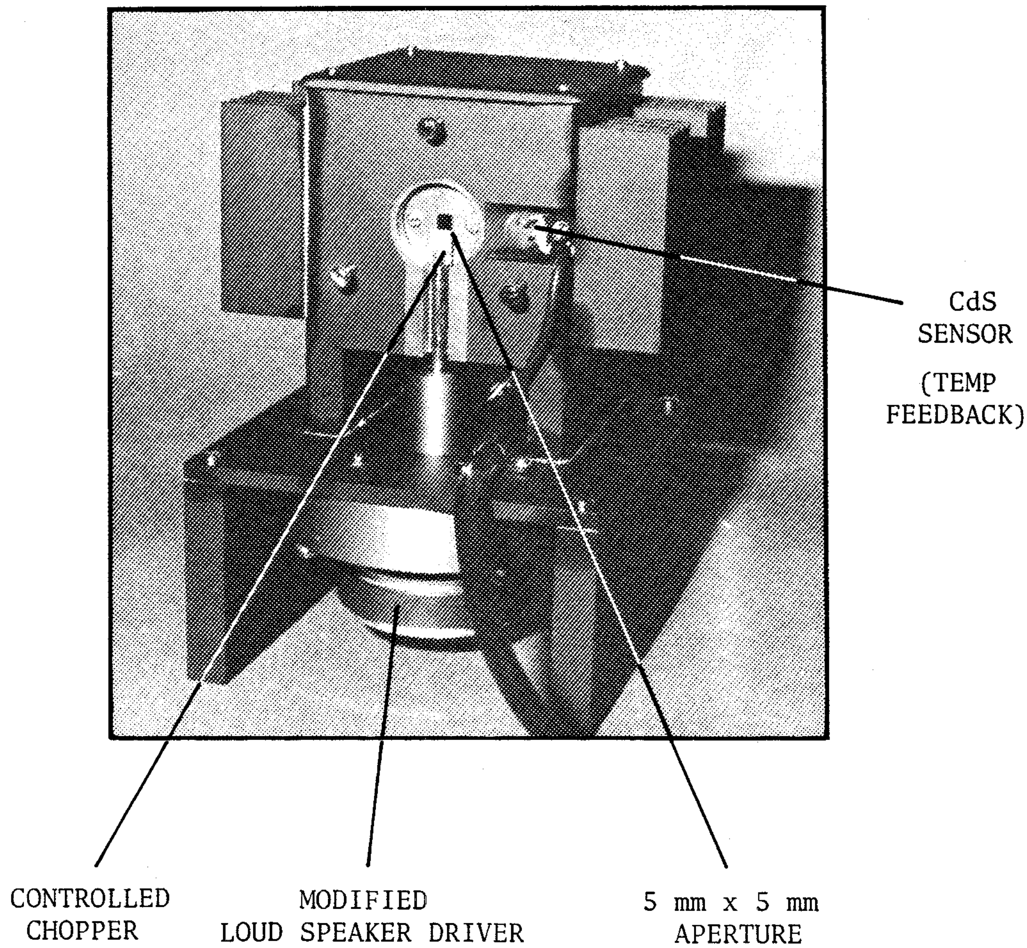


Figure 1. Existing Nernst Glower housing

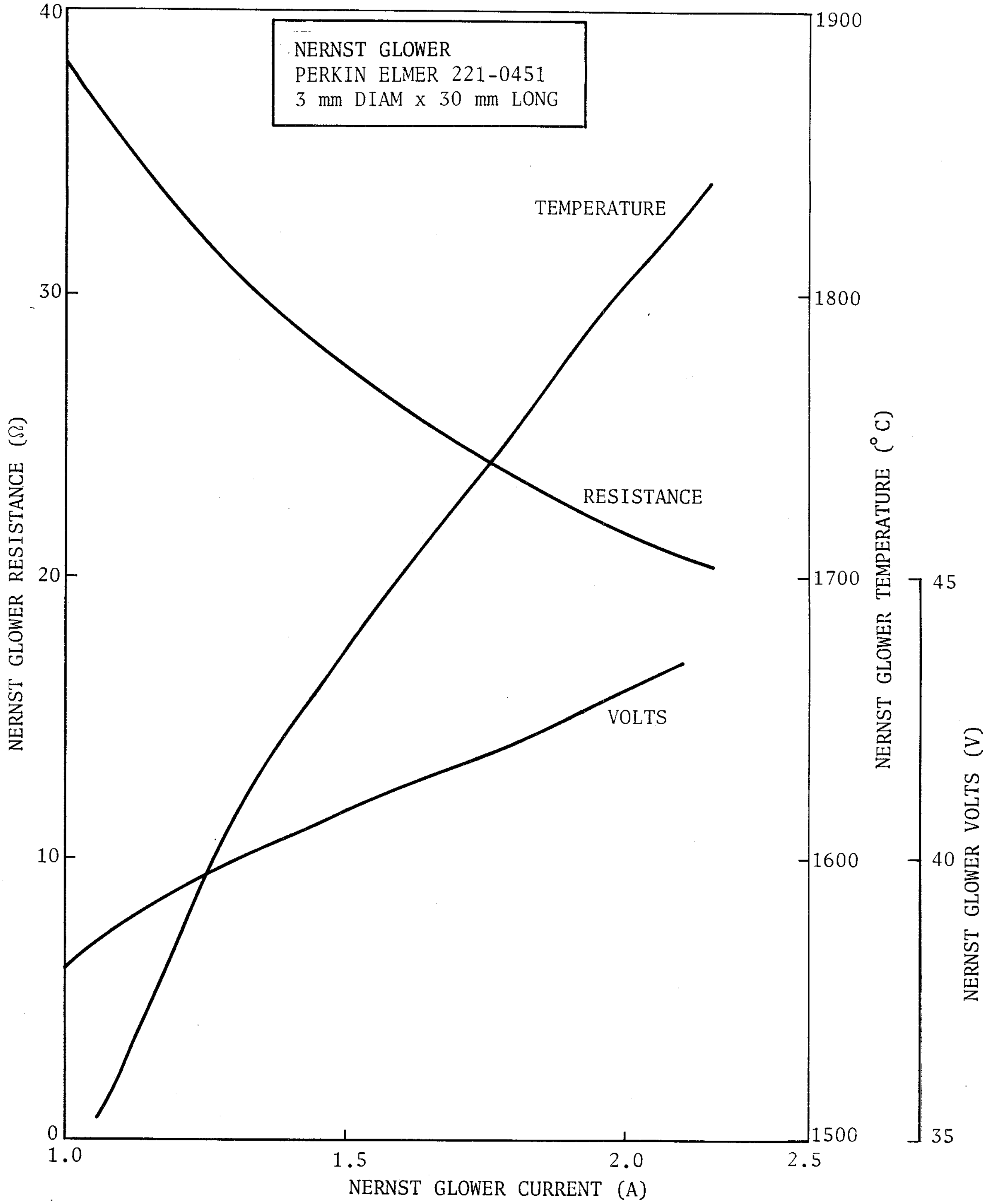
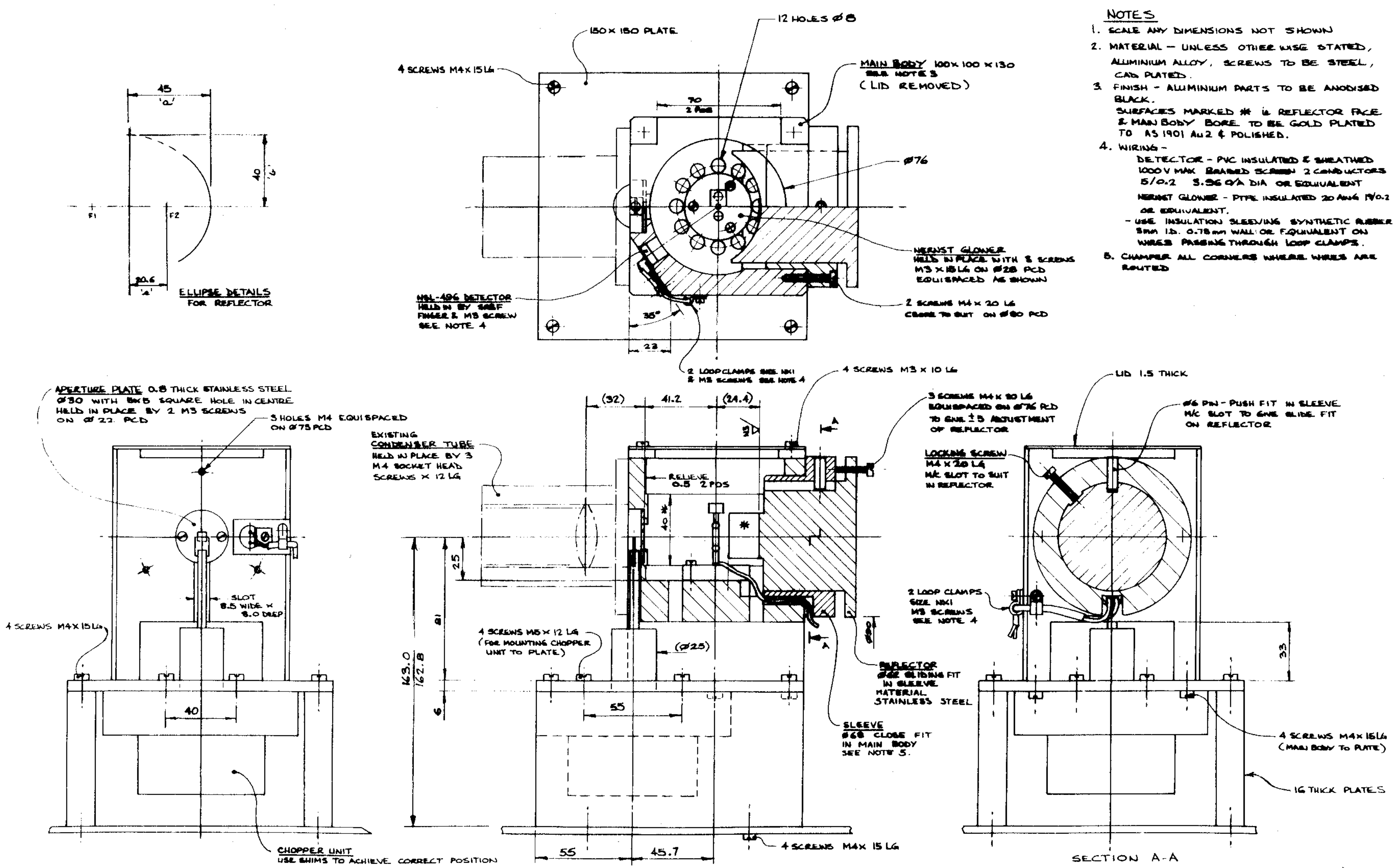


Figure 2. Nernst Glower characteristics



DRG NO 103344

Figure 3. Nernst Glower housing (Workshop drawing)

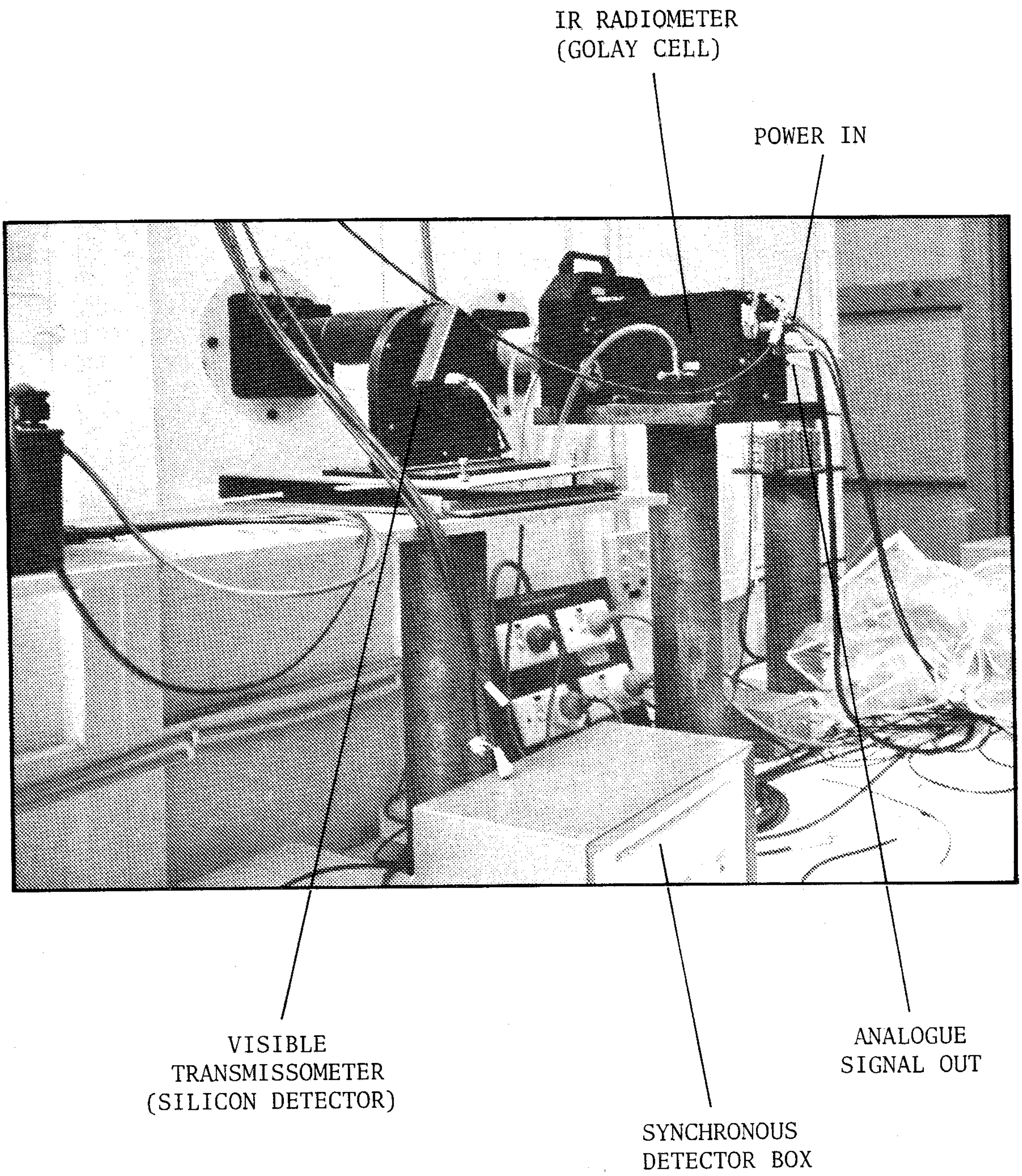
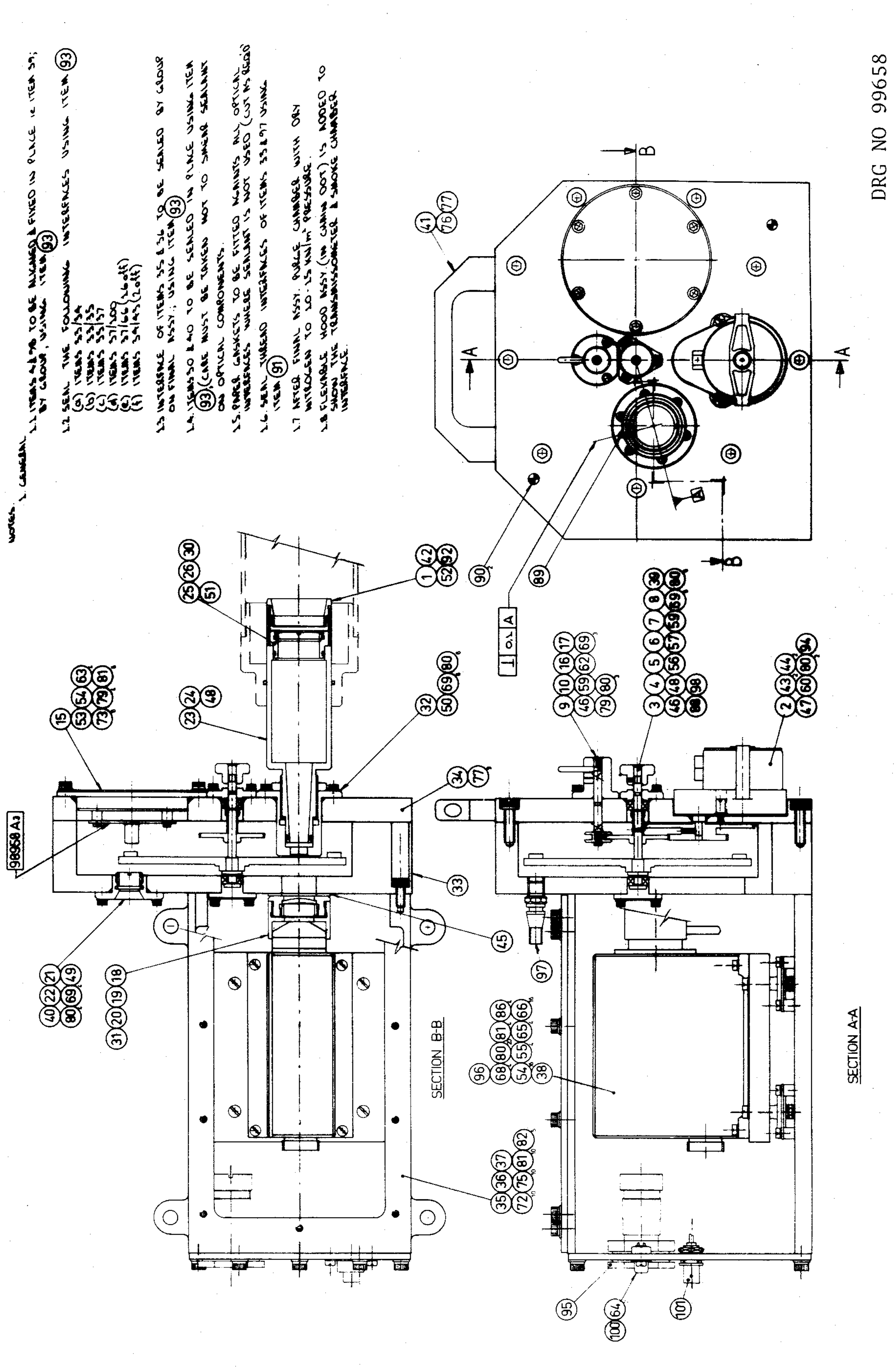


Figure 4. Golay cell radiometer



DRG NO 99658

Figure 5. Smoke IR transmissometer general assembly

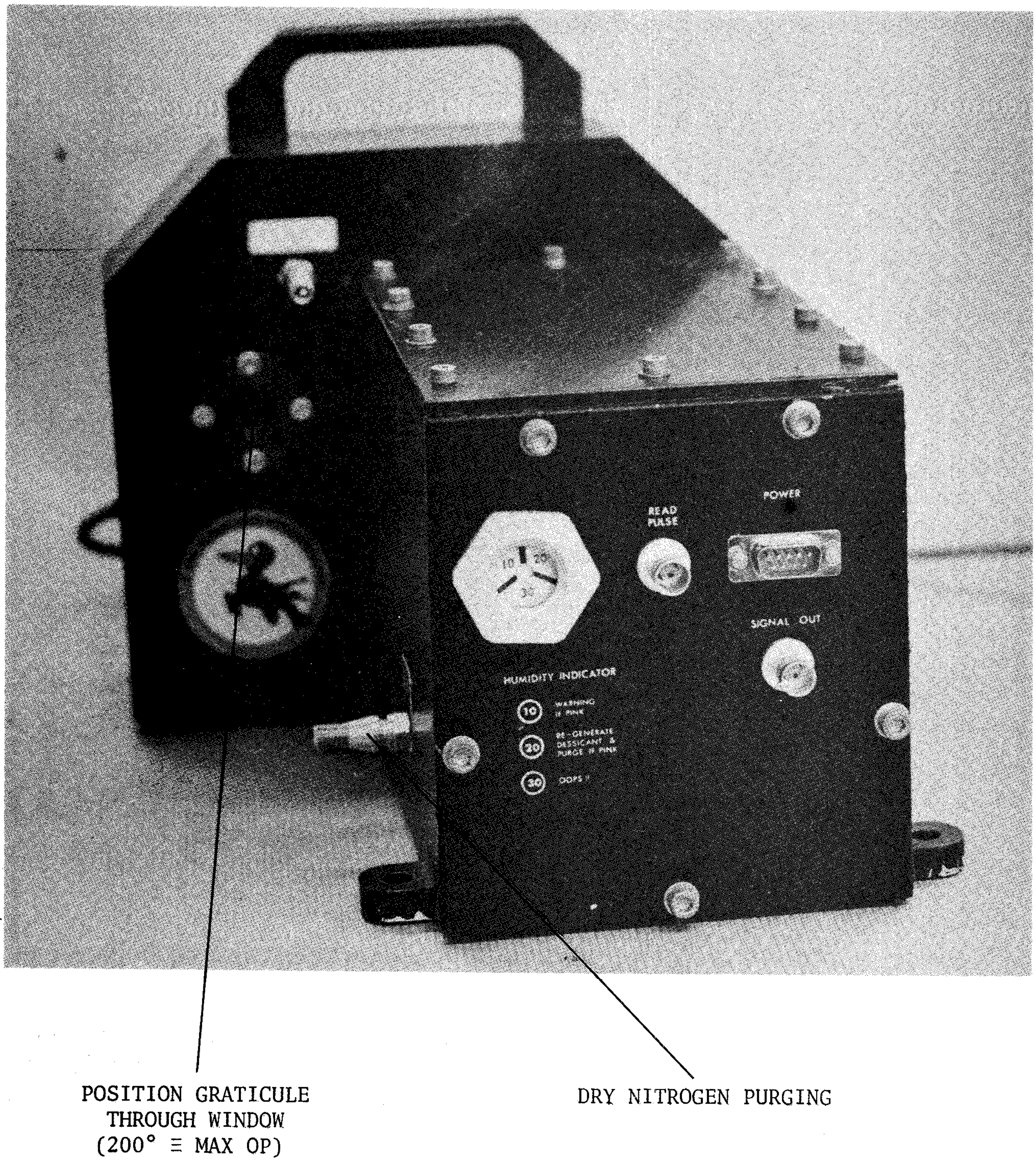


Figure 6. Radiometer rear view

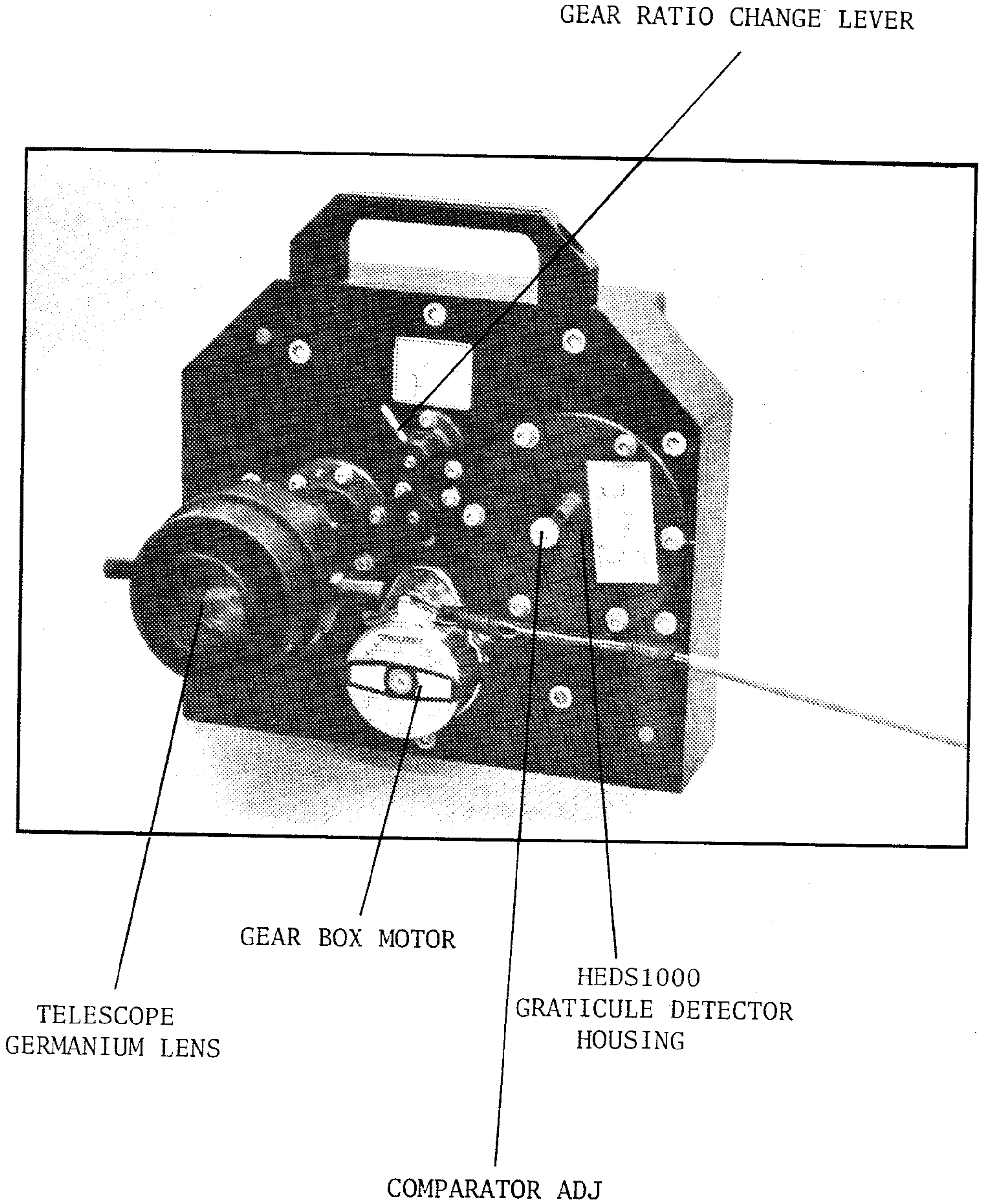
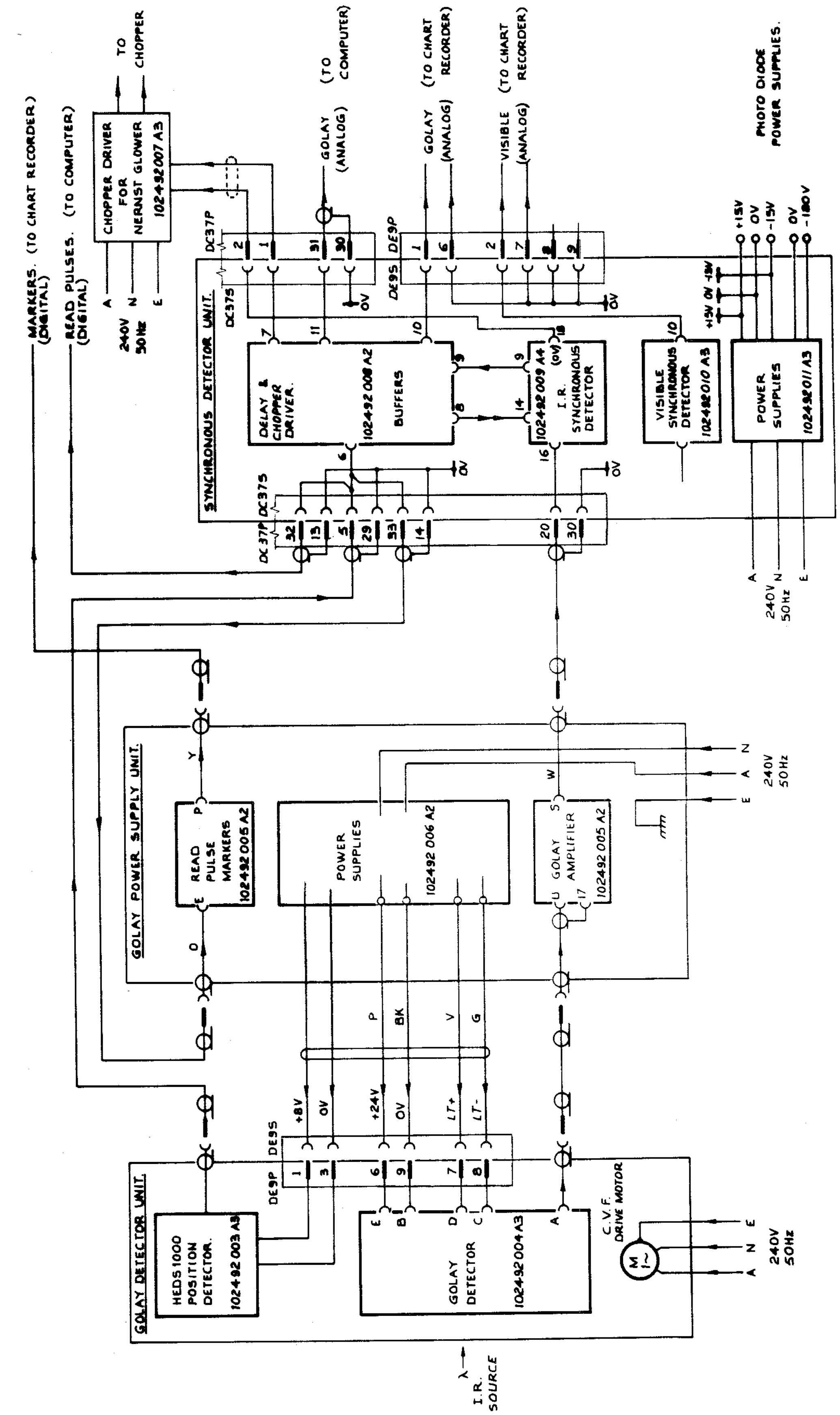


Figure 7. Radiometer front view



DRG NO. 102492002

Figure 8. Radiometer electronics block diagram

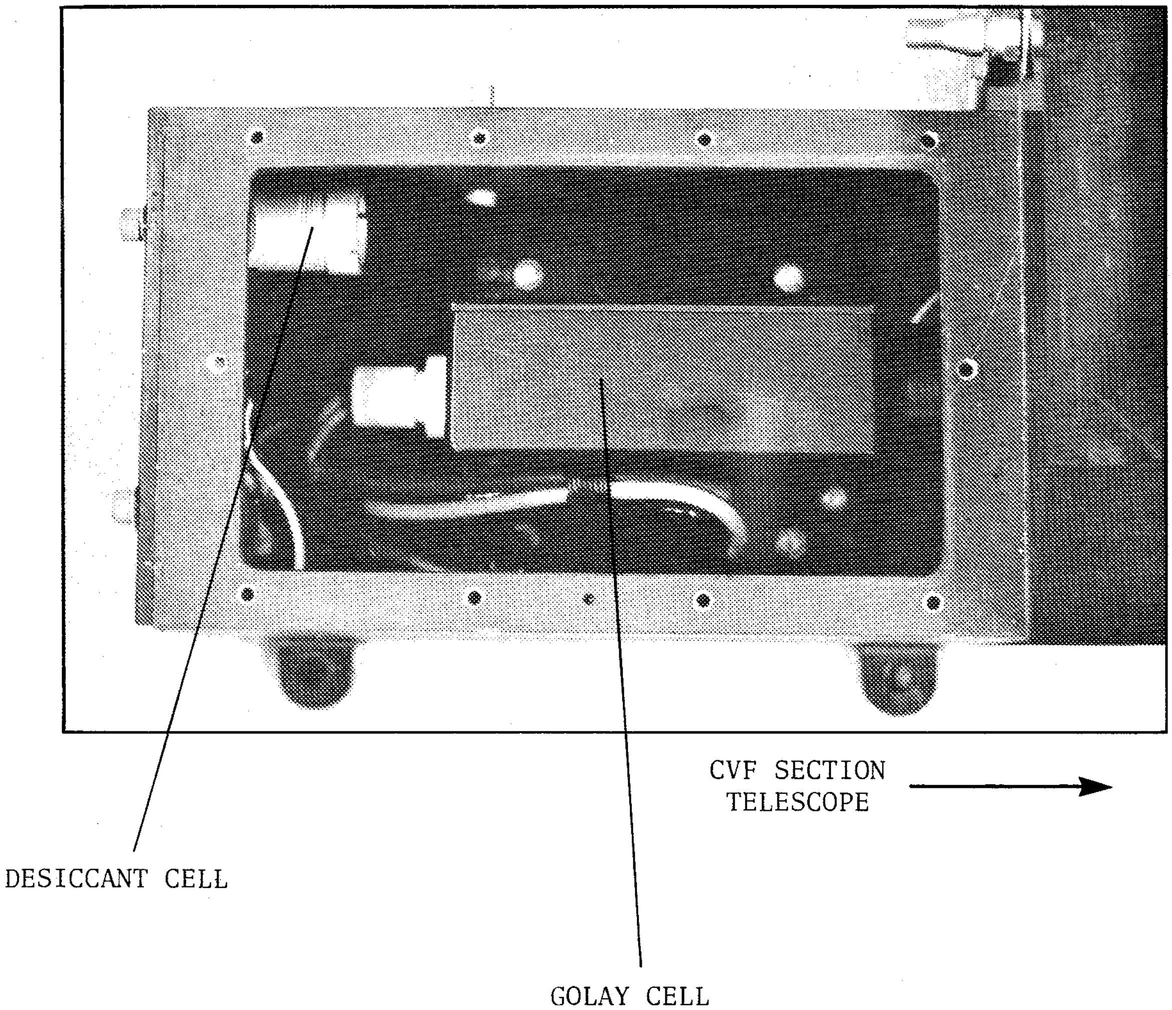
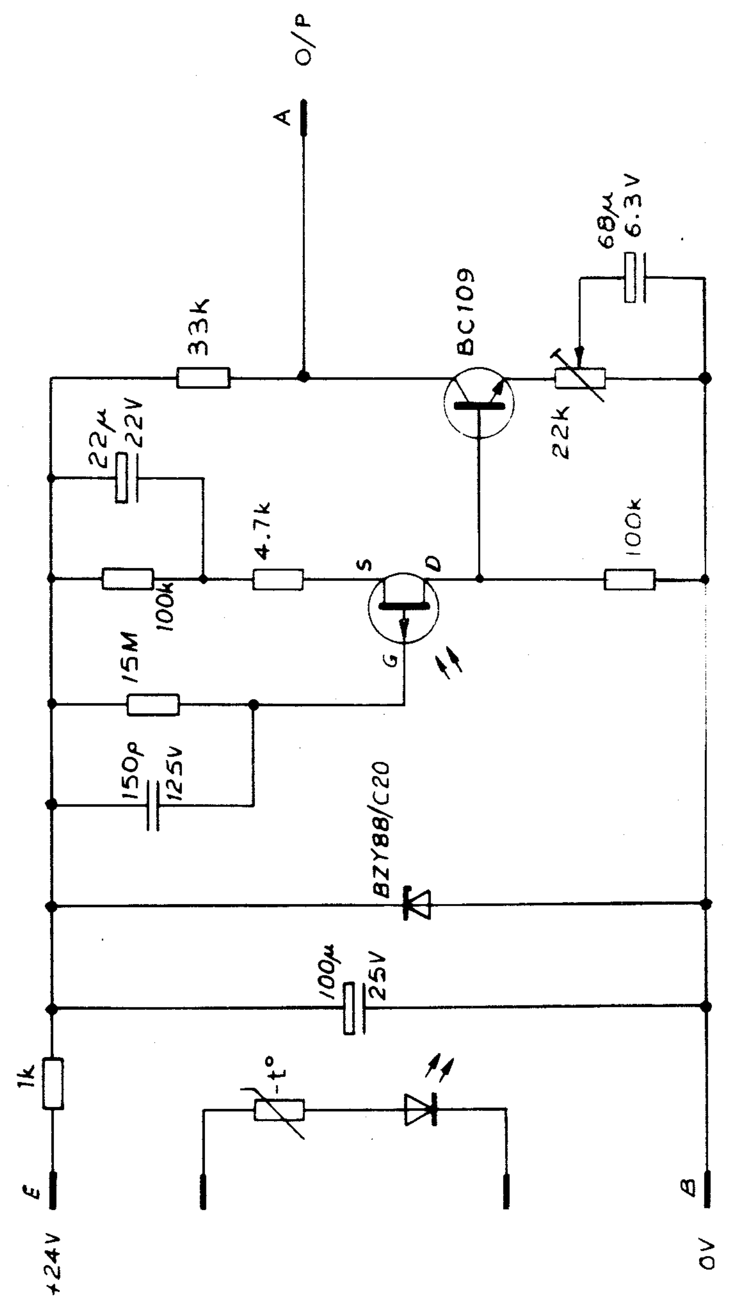


Figure 9. Radiometer top view



DRG NO 102492004

Figure 10. Golay detector (inside cell housing)

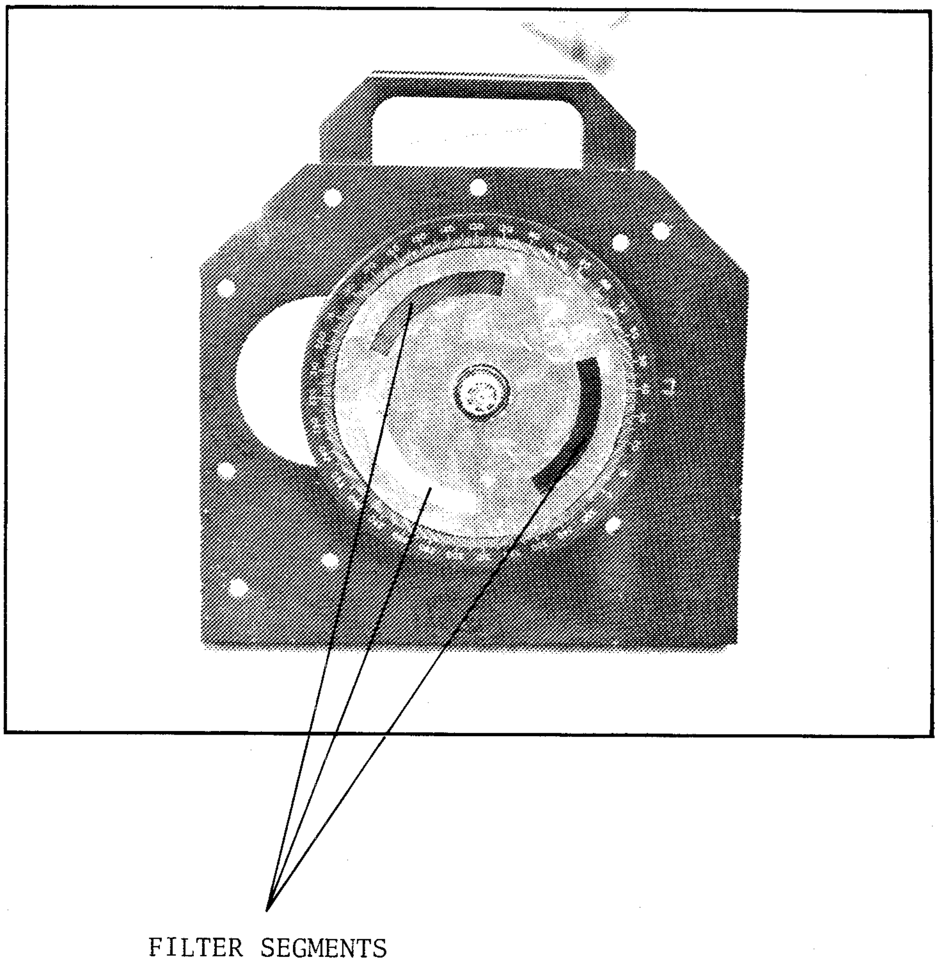


Figure 11. Radiometer inside

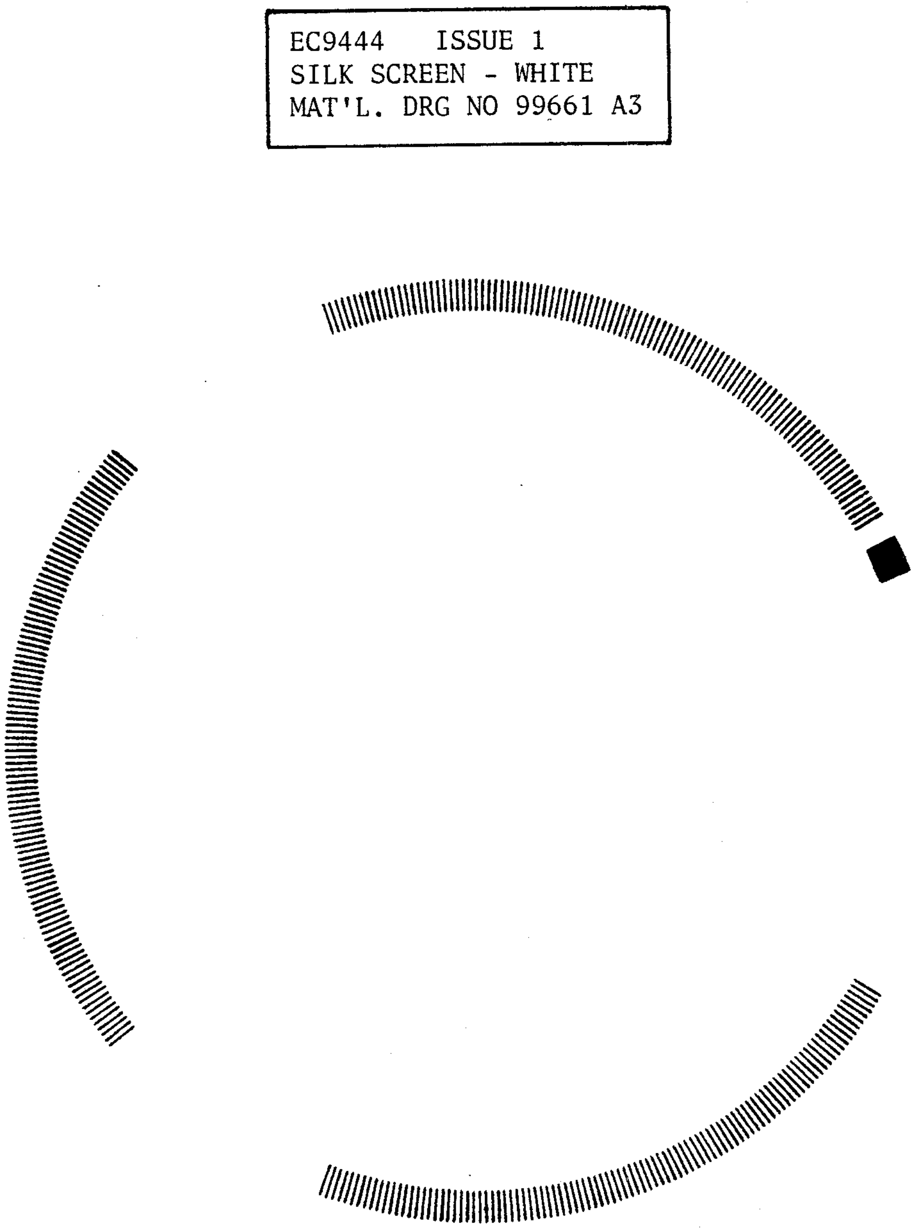
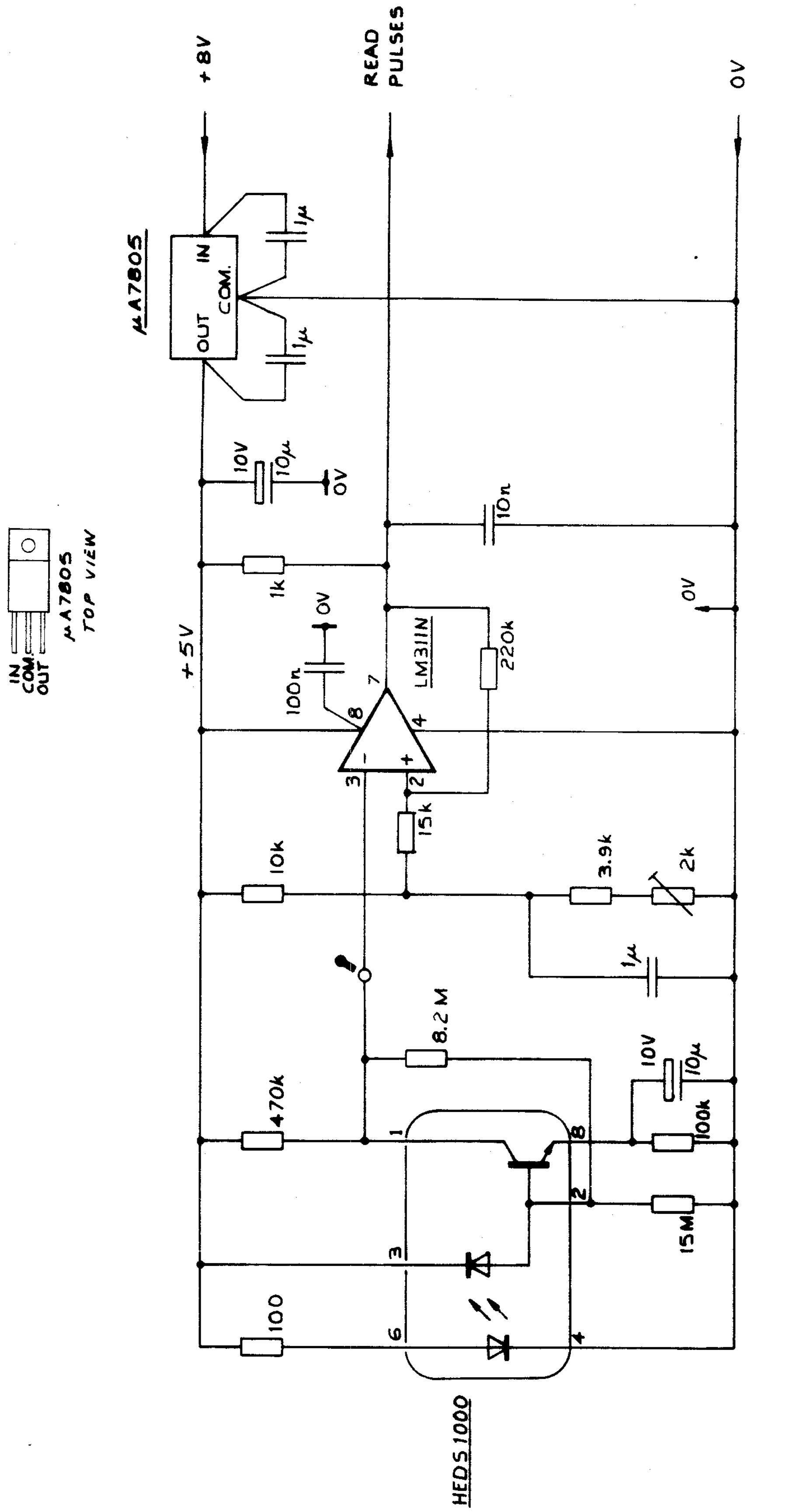


Figure 12. Nichrome on glass graticule (read by HEDS1000 detector)



DRG NO 102492003

Figure 13. HEDS1000 circuit (comparator)

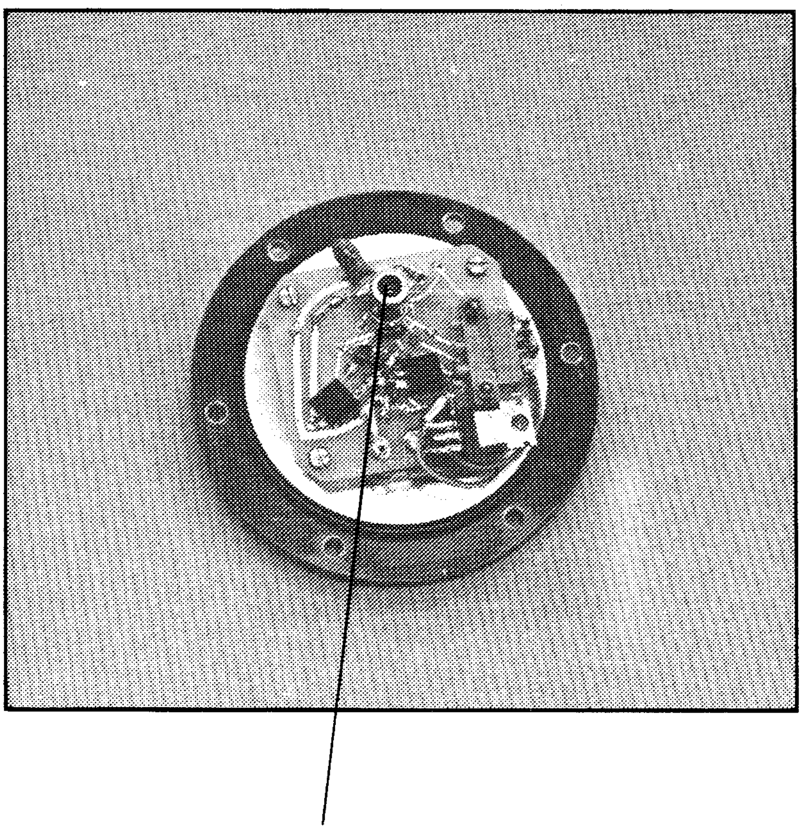
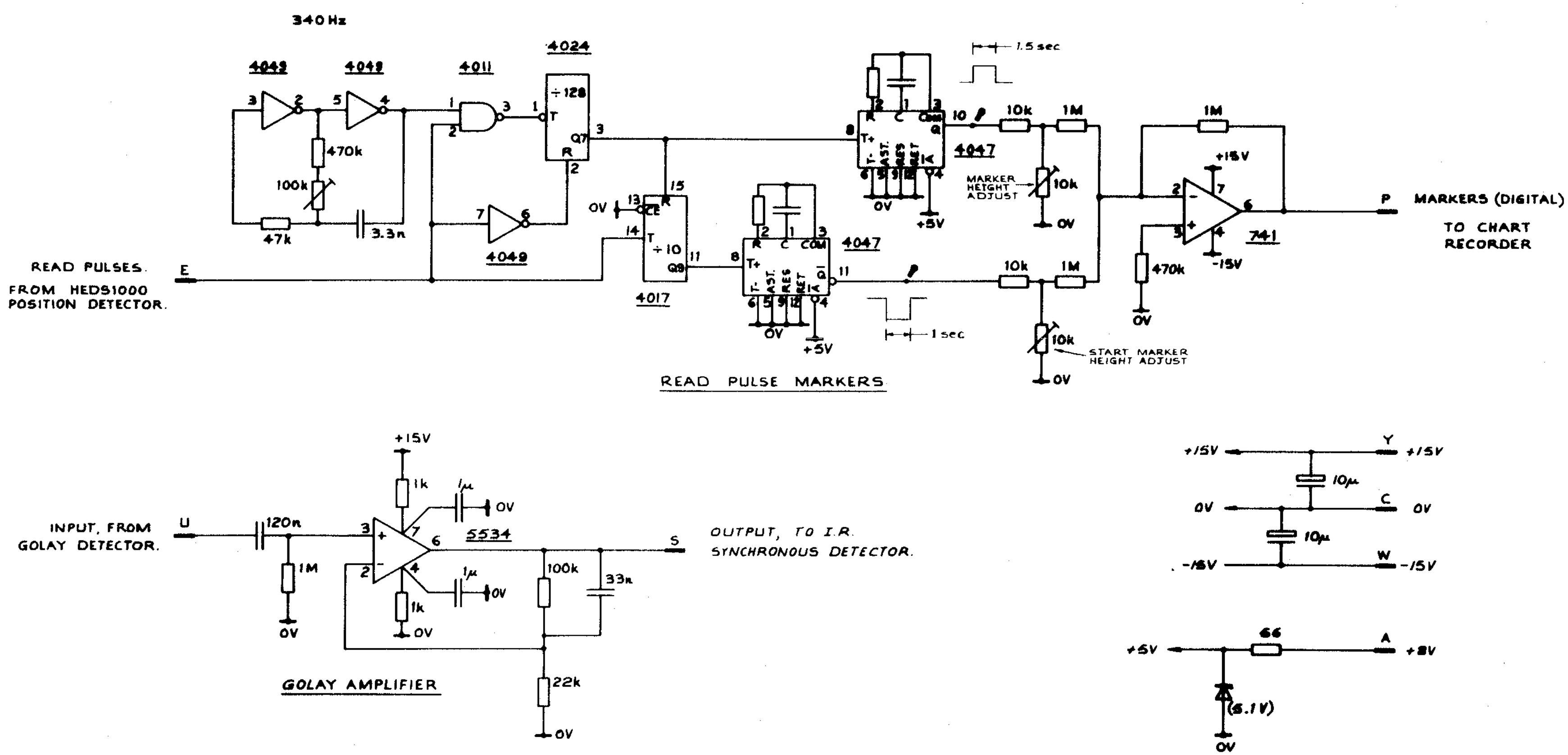
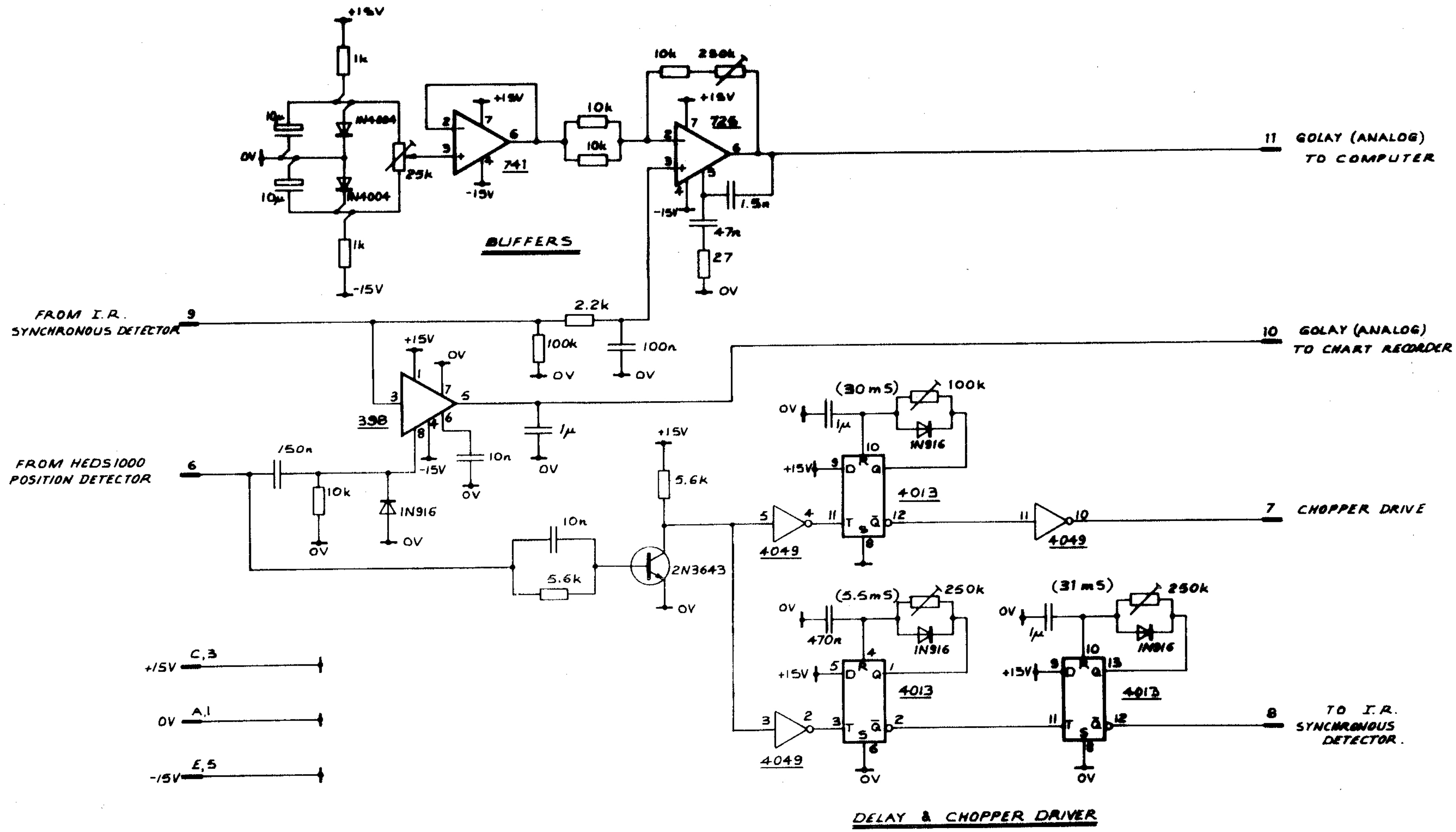


Figure 14. HEDS1000 housing and circuit board



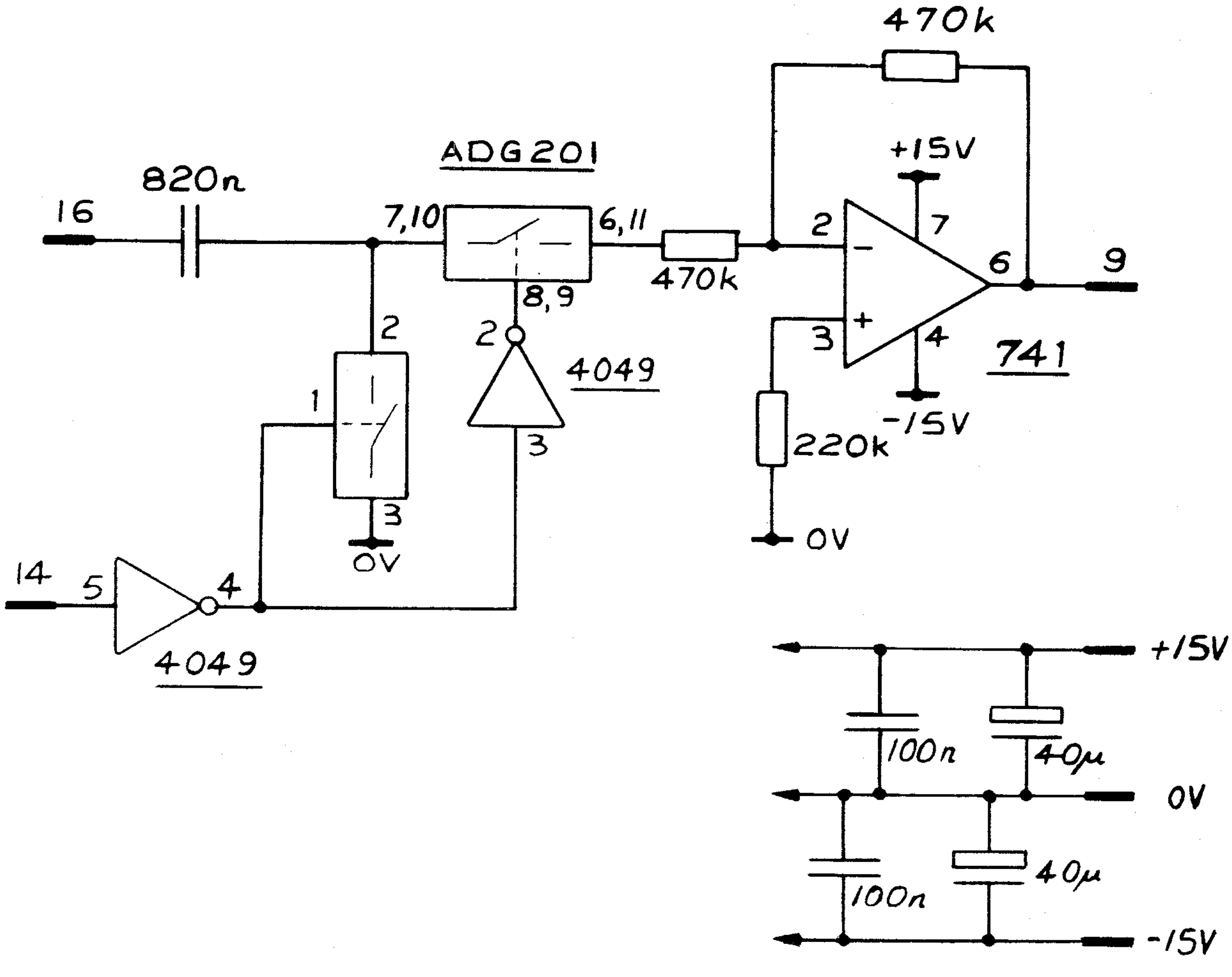
DRG NO 102494005

Figure 15. Chart recorder read pulses (÷10) + Golay amplifier



DRG NO 102492008

Figure 16. Sample and hold, and delays, circuit (Card 3)



DRG NO 102492009

Figure 17. IR synchronous detector circuit (Card 1)

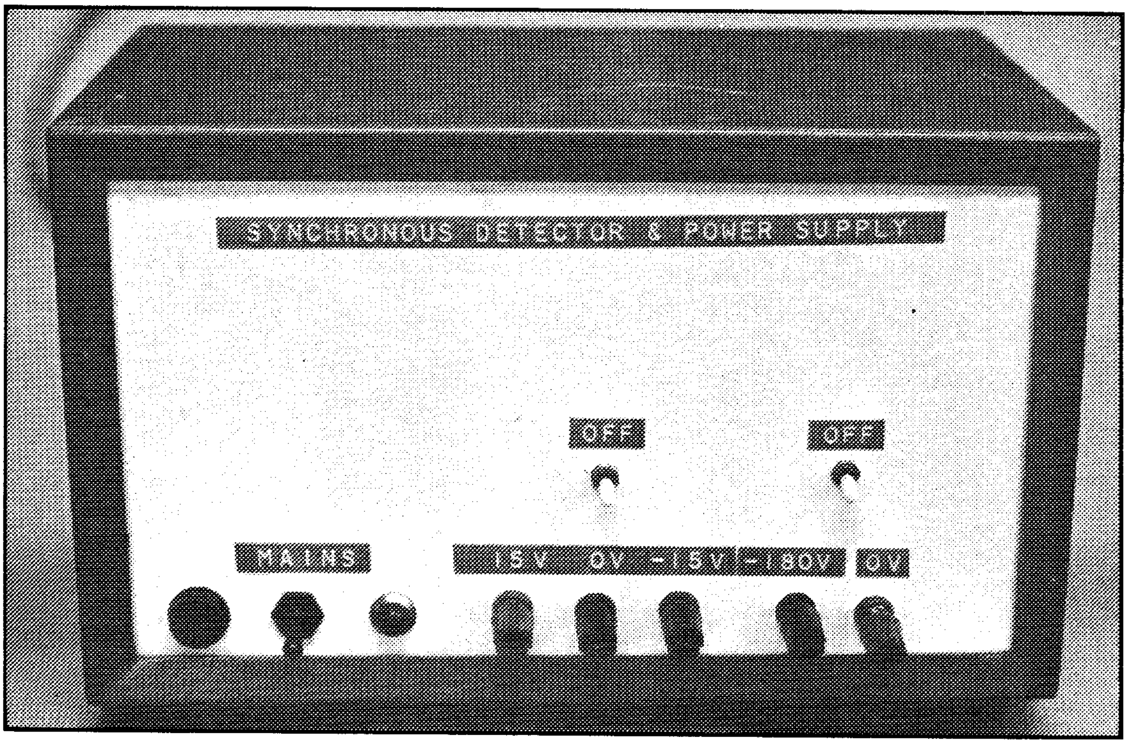


Figure 18. Synchronous detector housing

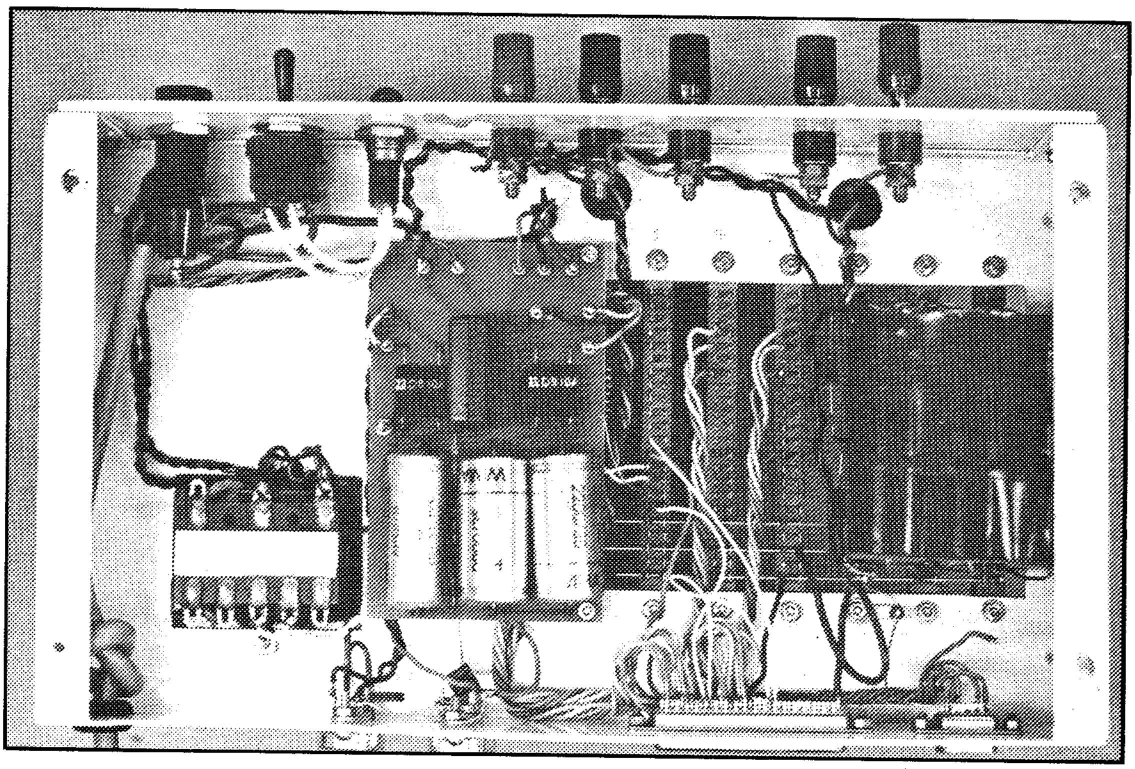


Figure 19. Synchronous detector under chassis view

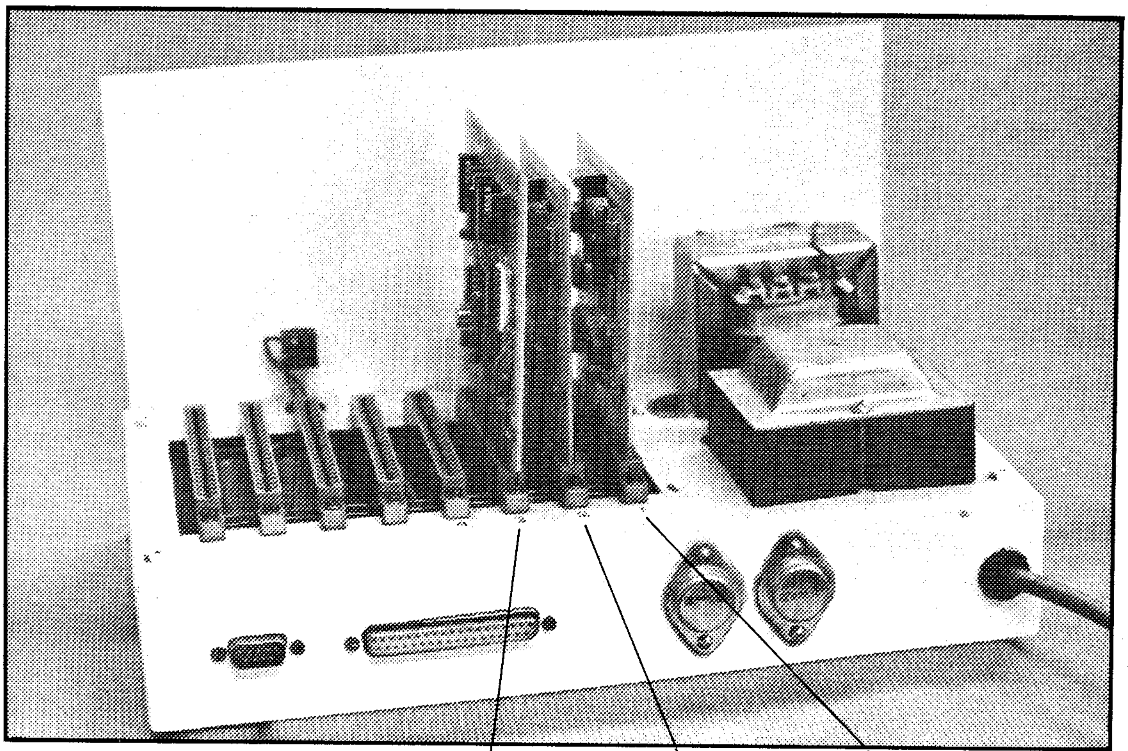
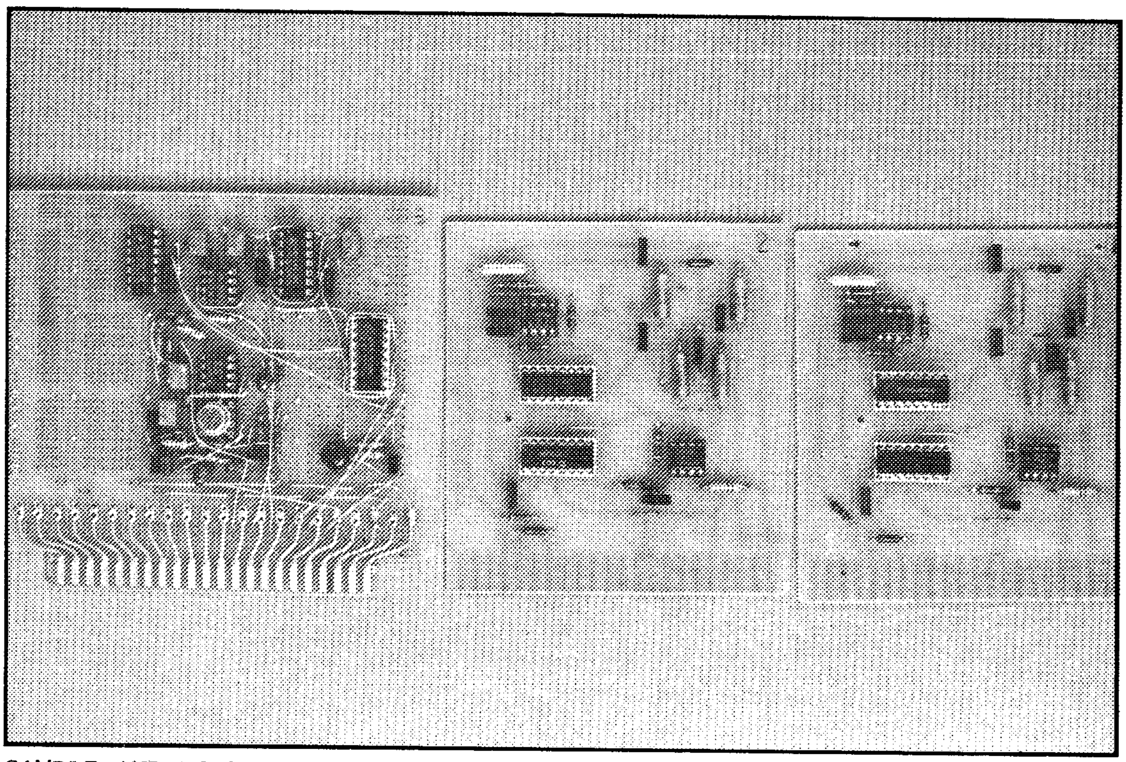


Figure 20. Synchronous detector rear view



SAMPLE AND HOLD CARD (DRG 102492008)

'VISIBLE' SYNCHRONOUS DETECTOR CARD (DRG 102492010)

'INFRARED' SYNCHRONOUS DETECTOR CARD (DRG 102492009)

Figure 21. Synchronous detector cardset

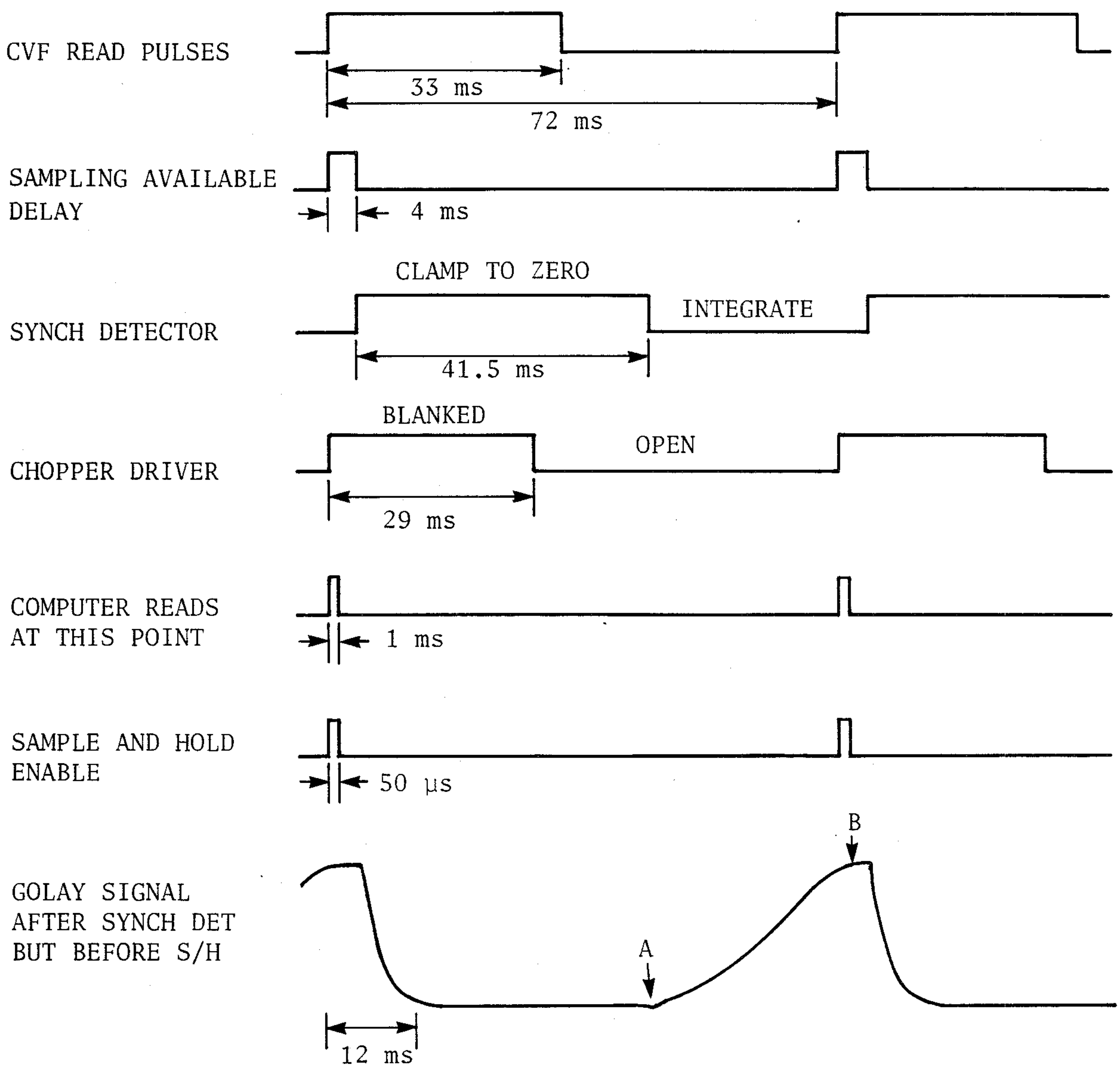
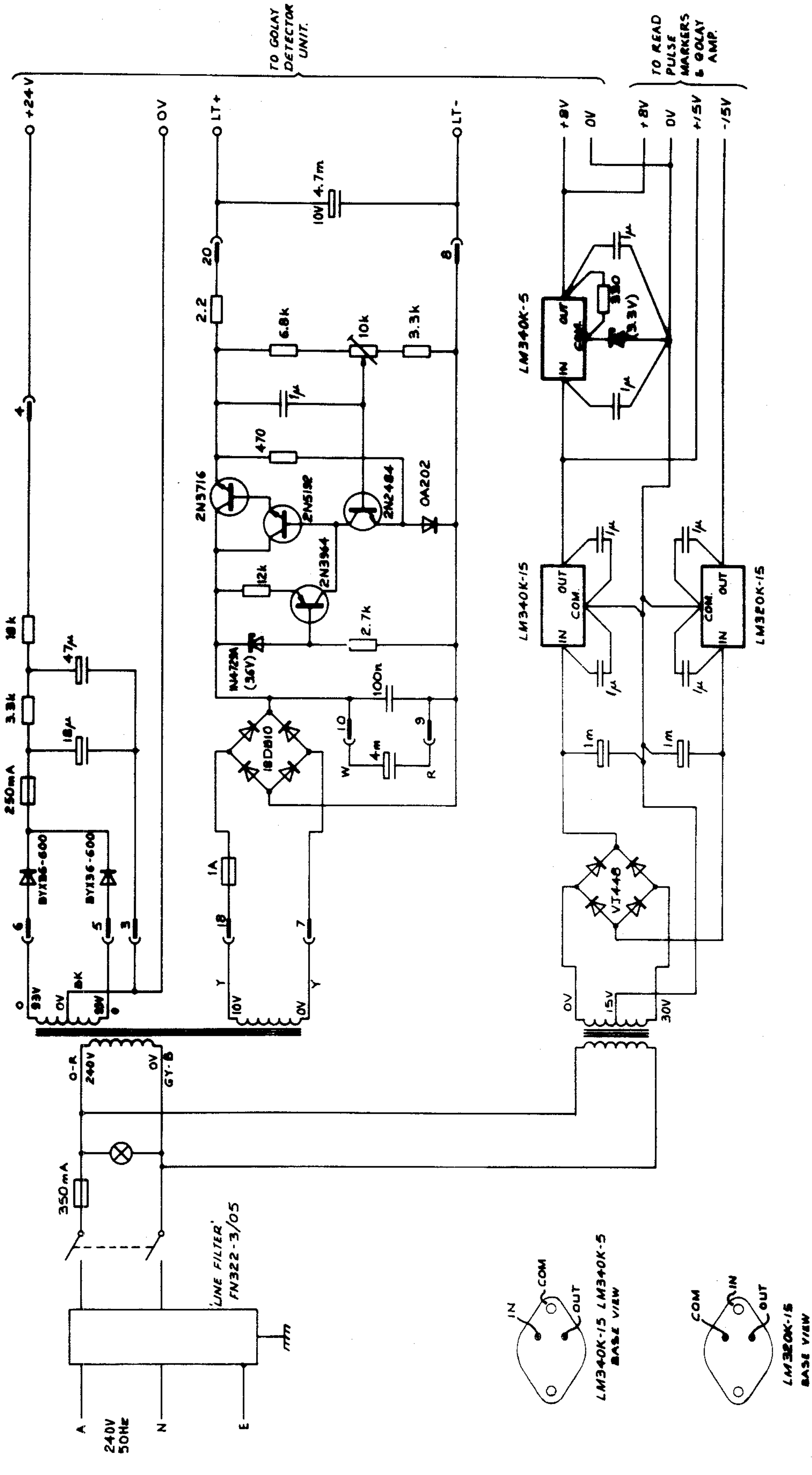


Figure 22. Electronic waveforms timing



DRG NO 102492006

Figure 23. Golay power supply circuit

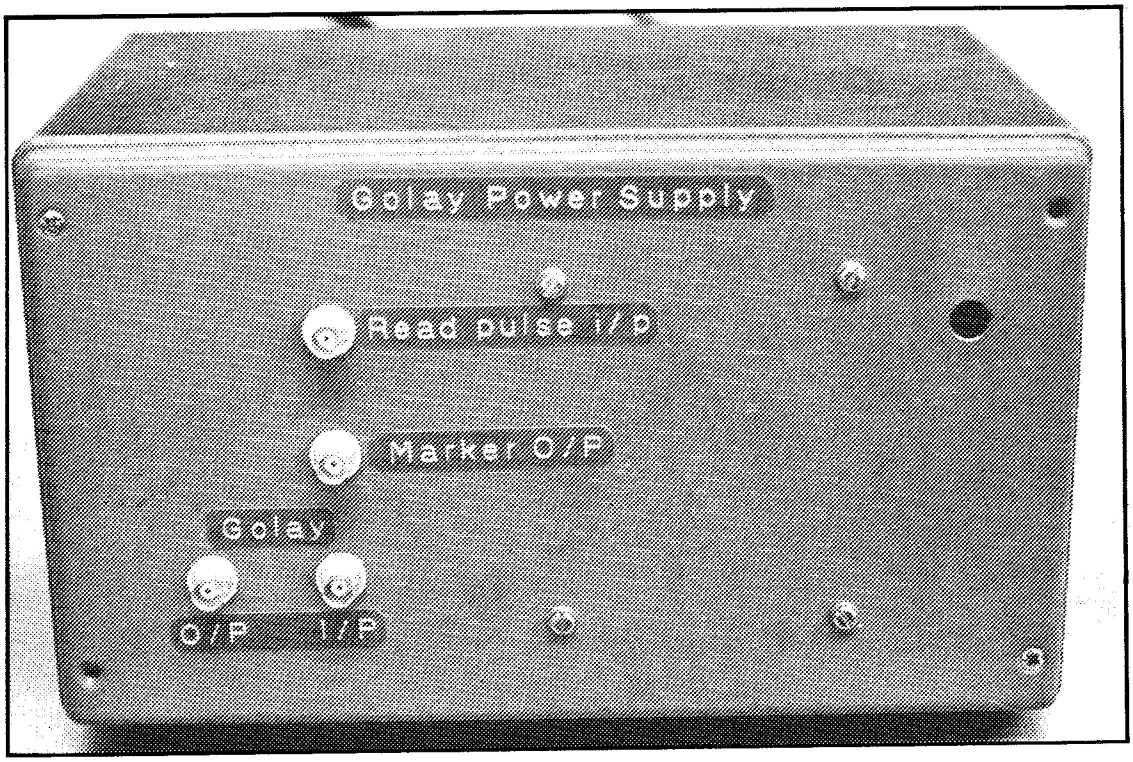


Figure 24. Golay power supply and preamp box

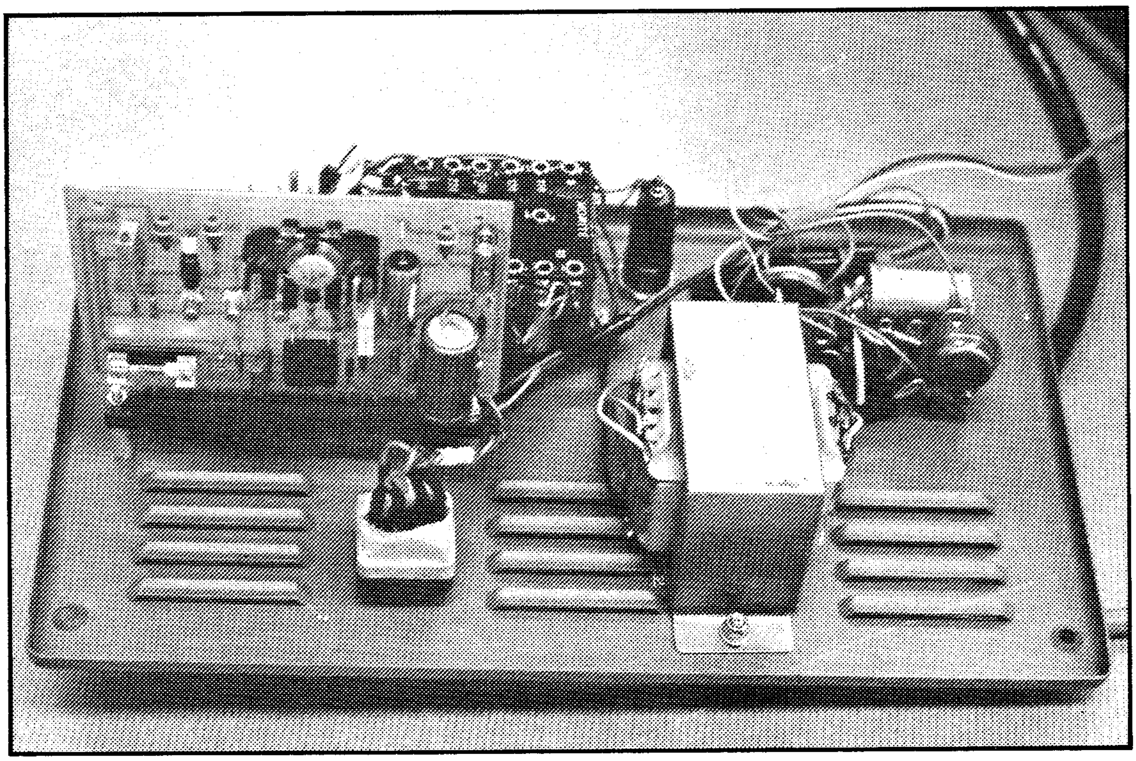


Figure 25. Golay power supply (Circuit figure 23)

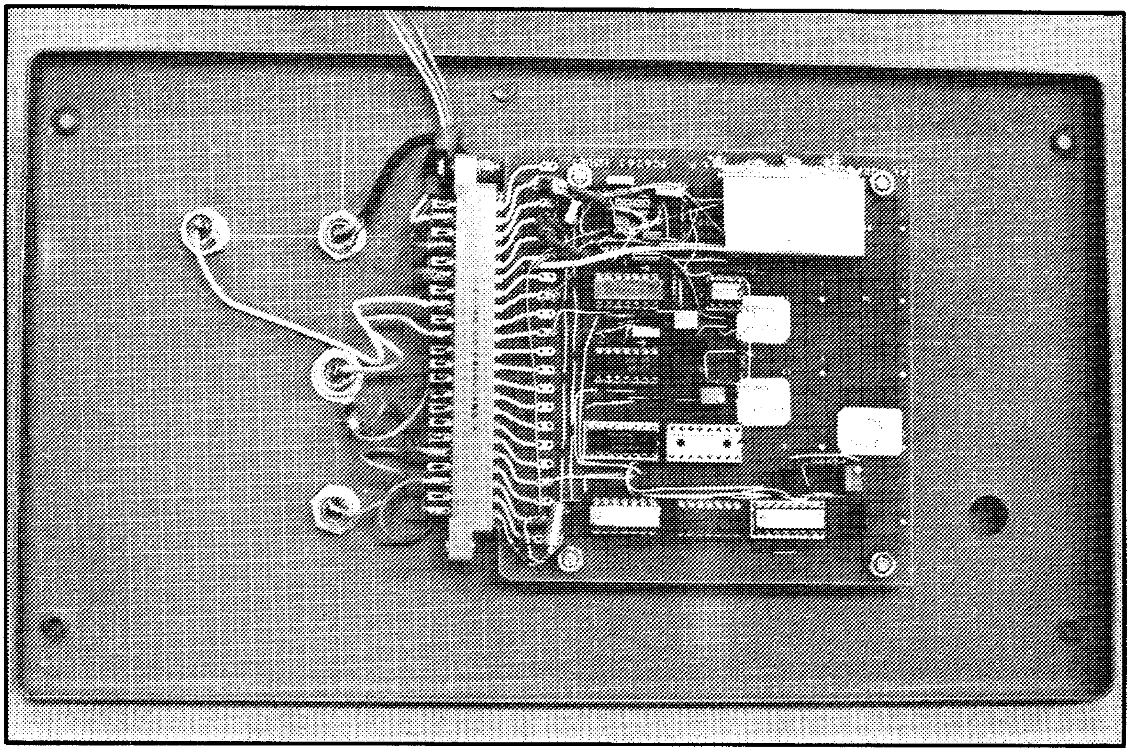


Figure 26. Read pulses ÷10 circuit + Golay preamp (Circuit figure 15)

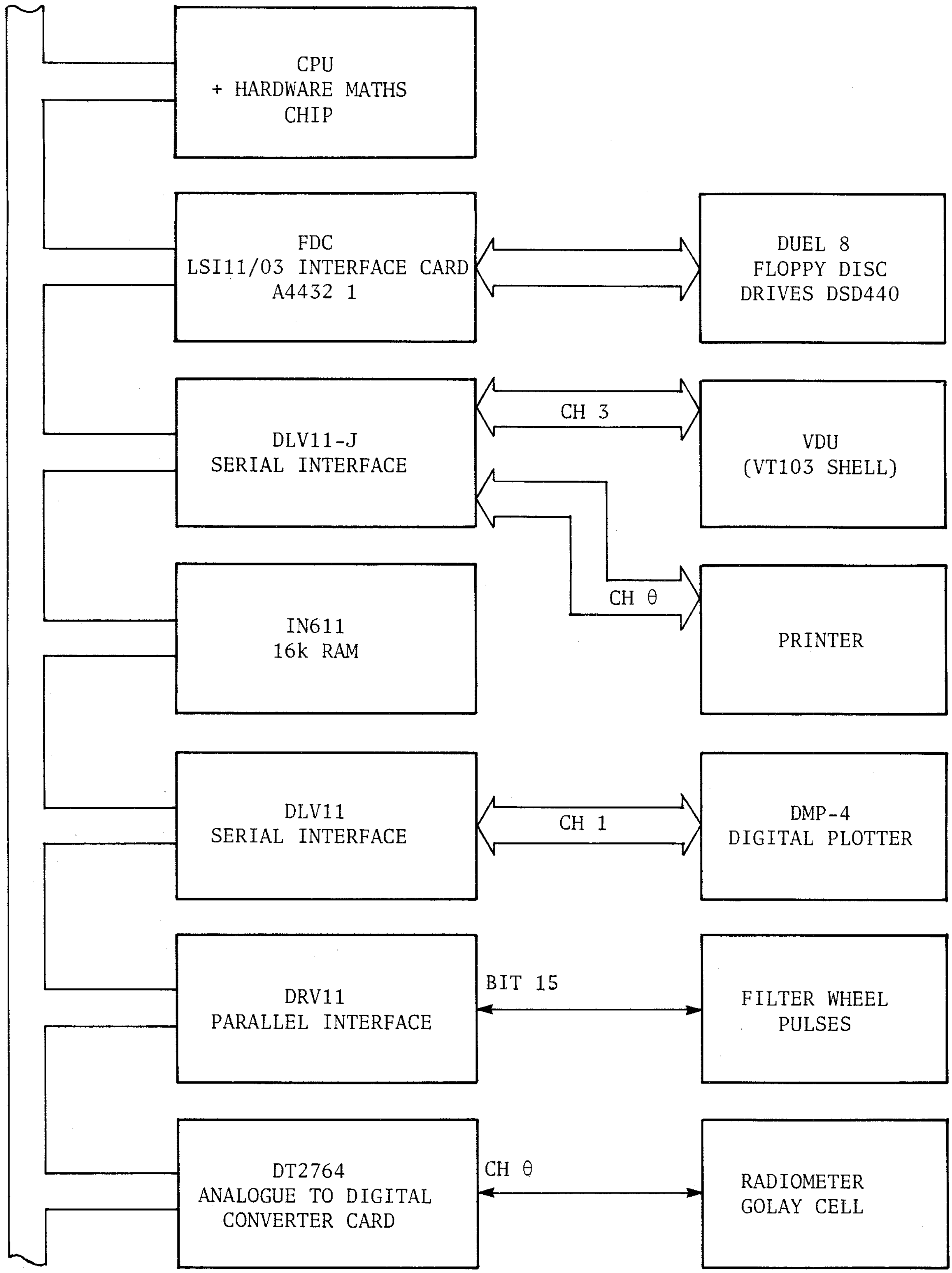


Figure 27. Data-logging/computer block diagram

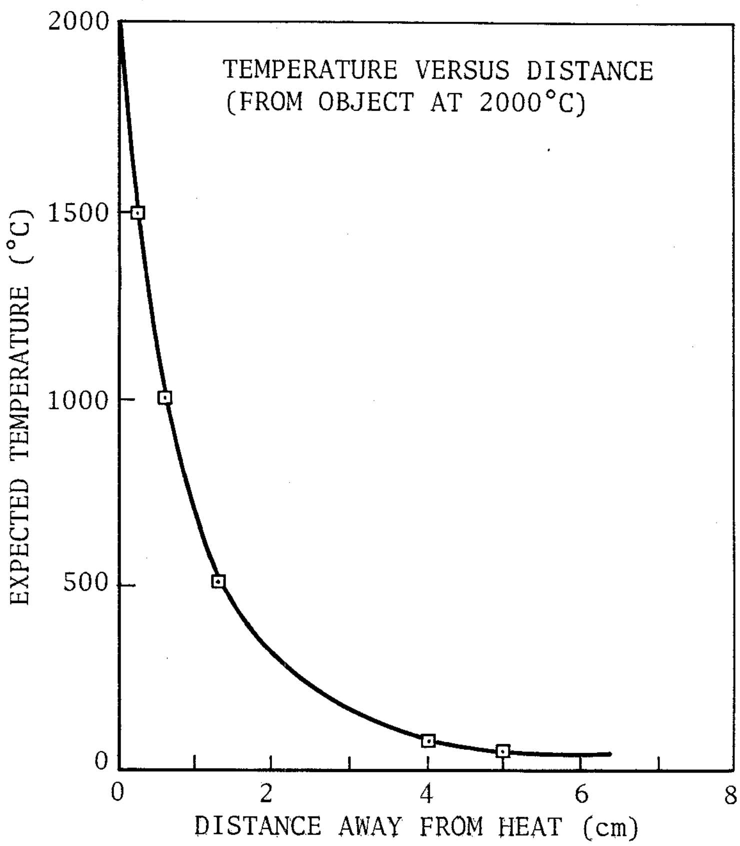
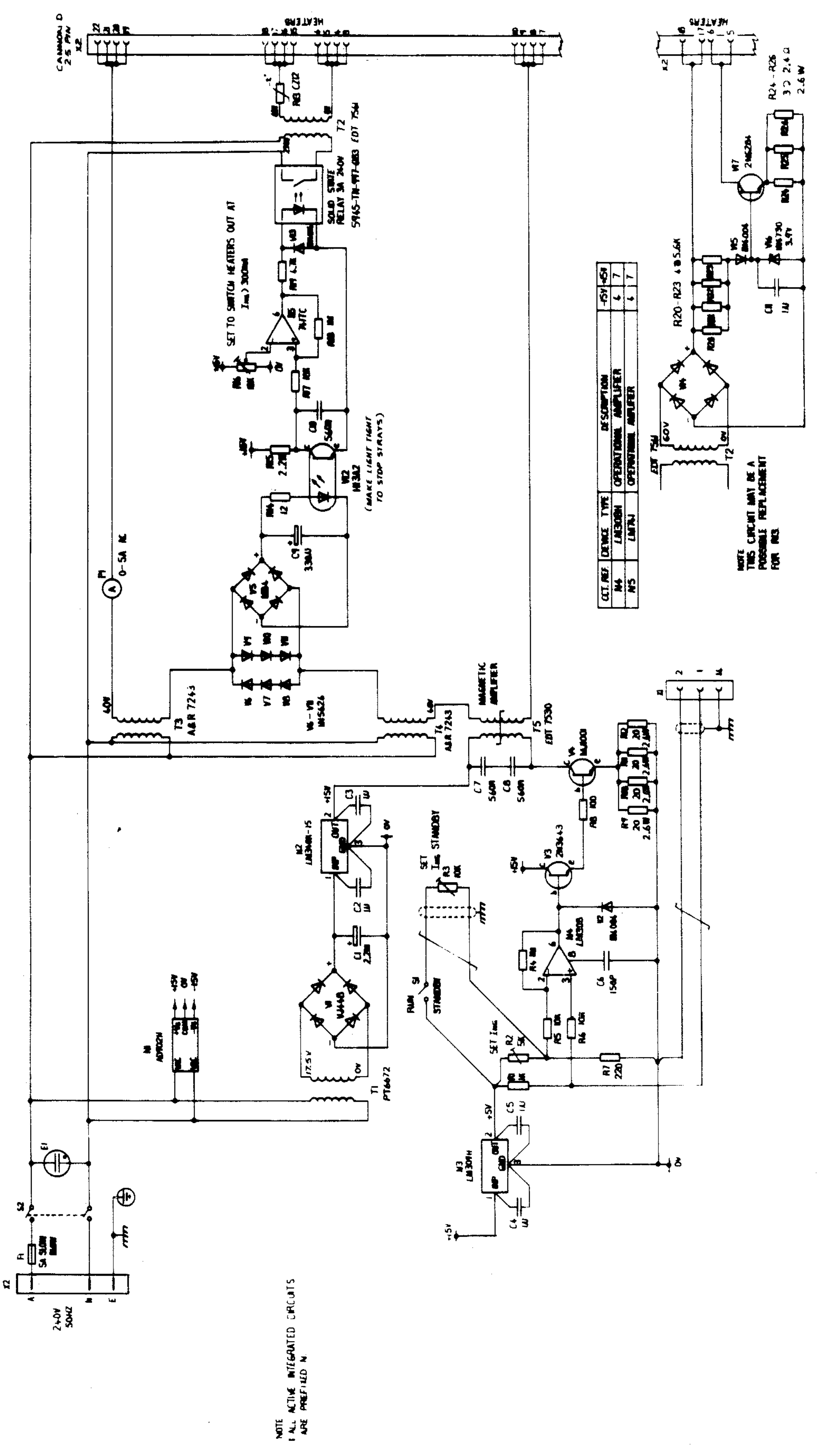
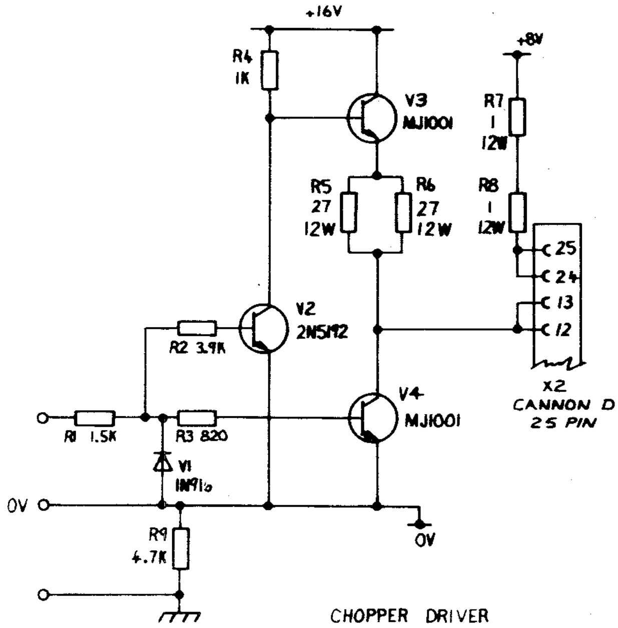


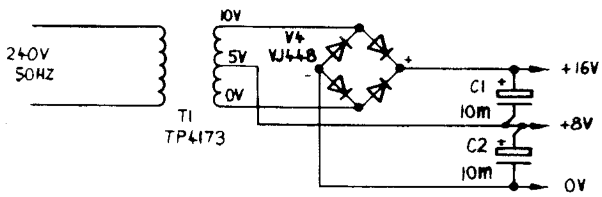
Figure 28. Empirical graph to determine aperature material temperature at a distance from a hot source (Nernst Glower) at 2000°C)



DRG NO 104054002

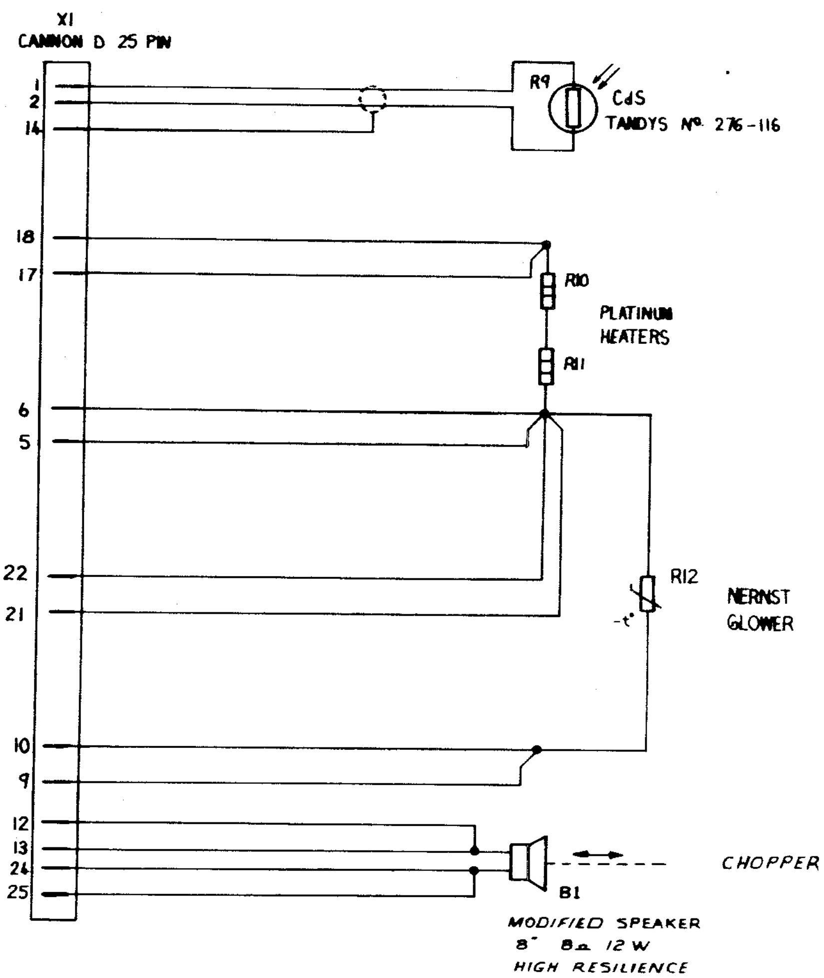
Figure 29. Nernst Glower AC power supply





DRG NO 104006002

Figure 30. Chopper driver circuit



DRG NO 104056002

Figure 31. Nernst Glower housing to power supply cable

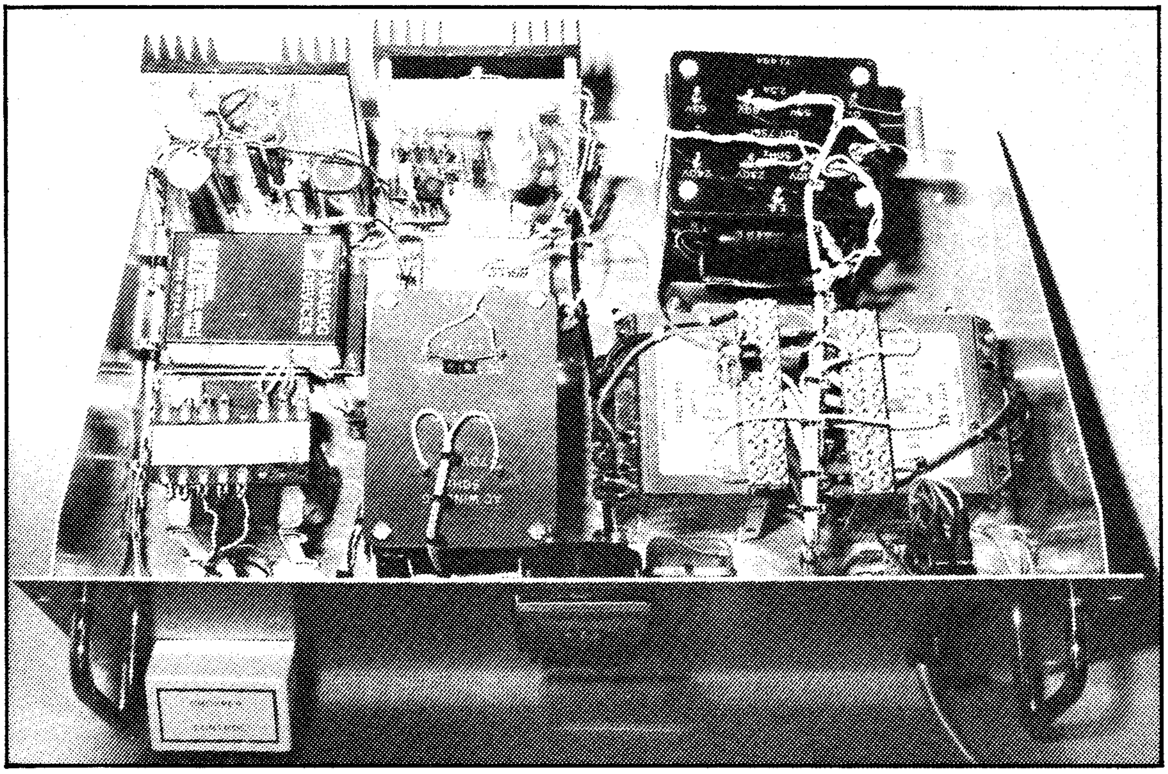
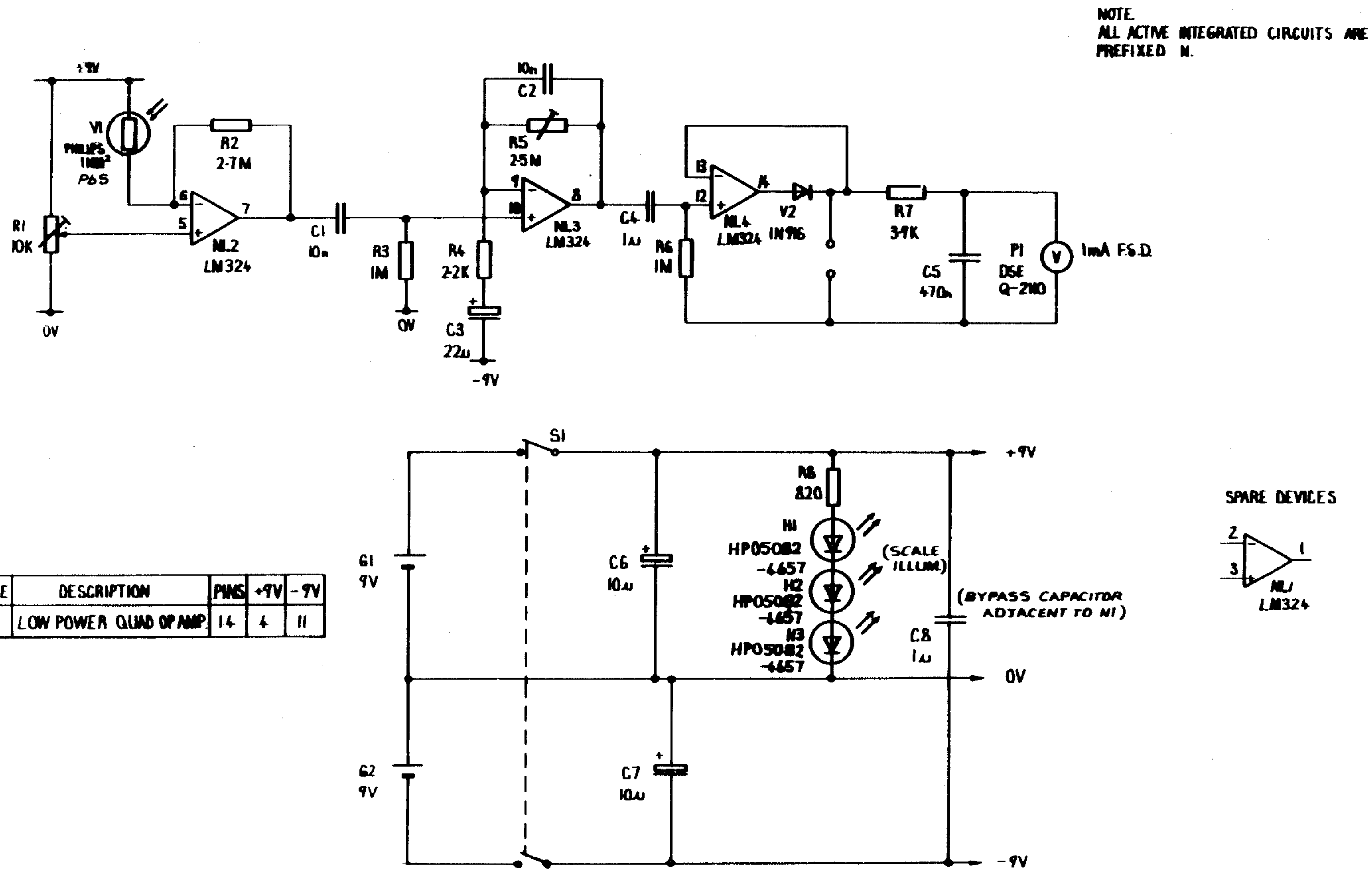


Figure 32. Nernst Glower AC power supply and chopper driver



CCT REF	DEVICE TYPE	DESCRIPTION	PINS	+9V	-9V
N1	LM324	LOW POWER QUAD OP AMP.	14	4	11

DRG NO 104055002

Figure 33. Handheld IR beam finding detector

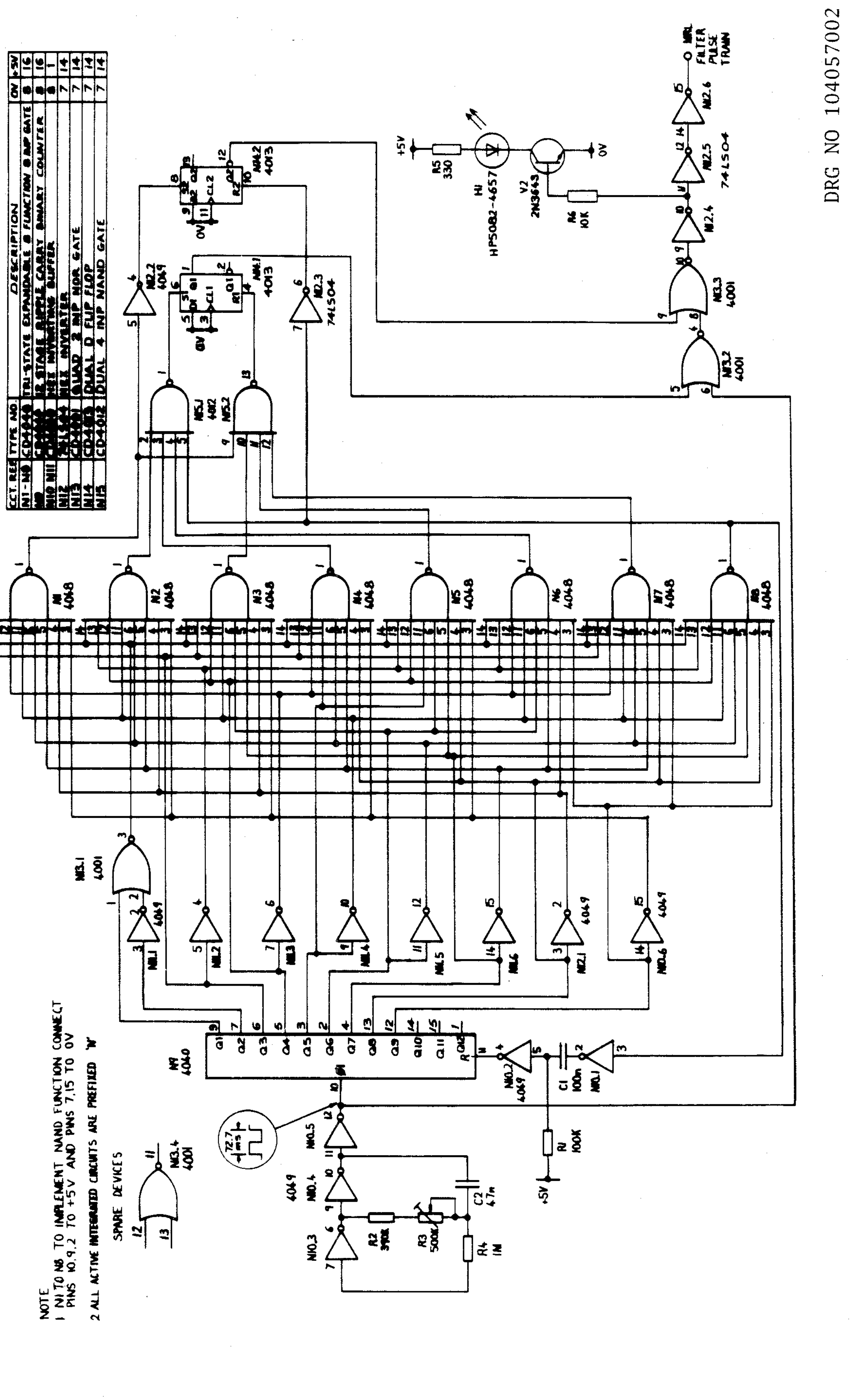


Figure 34. Circular variable filter simulator circuit

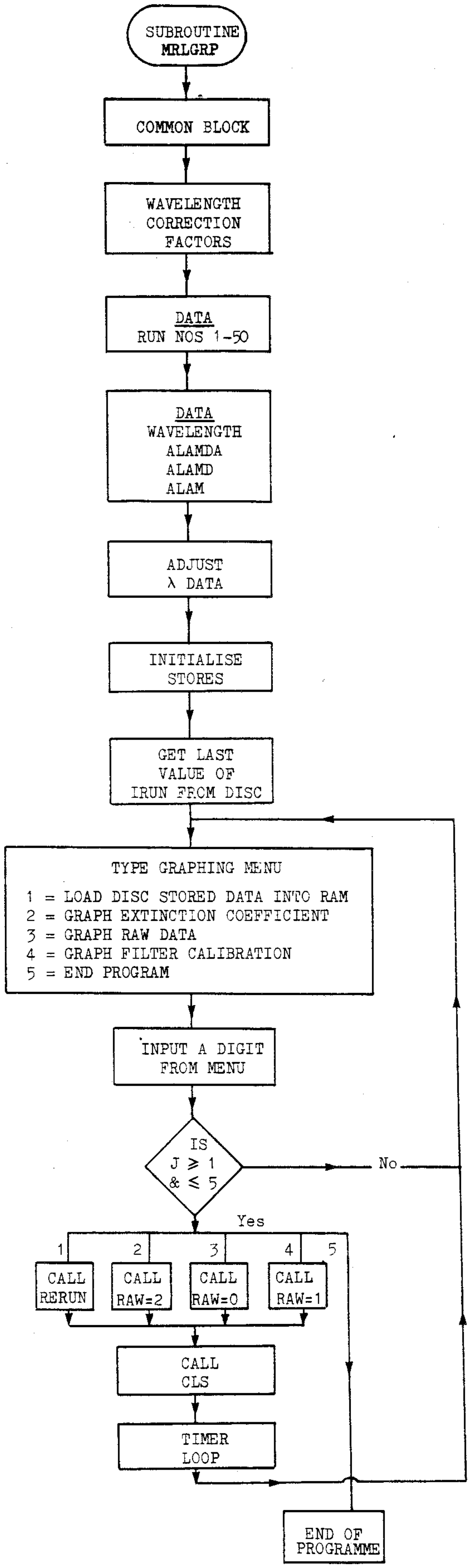


Figure 35. Subroutine MRLGRP

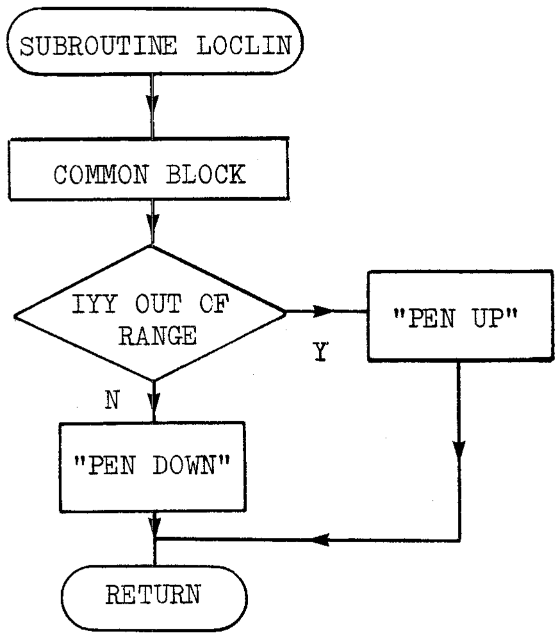


Figure 36. Subroutine LOCLIN

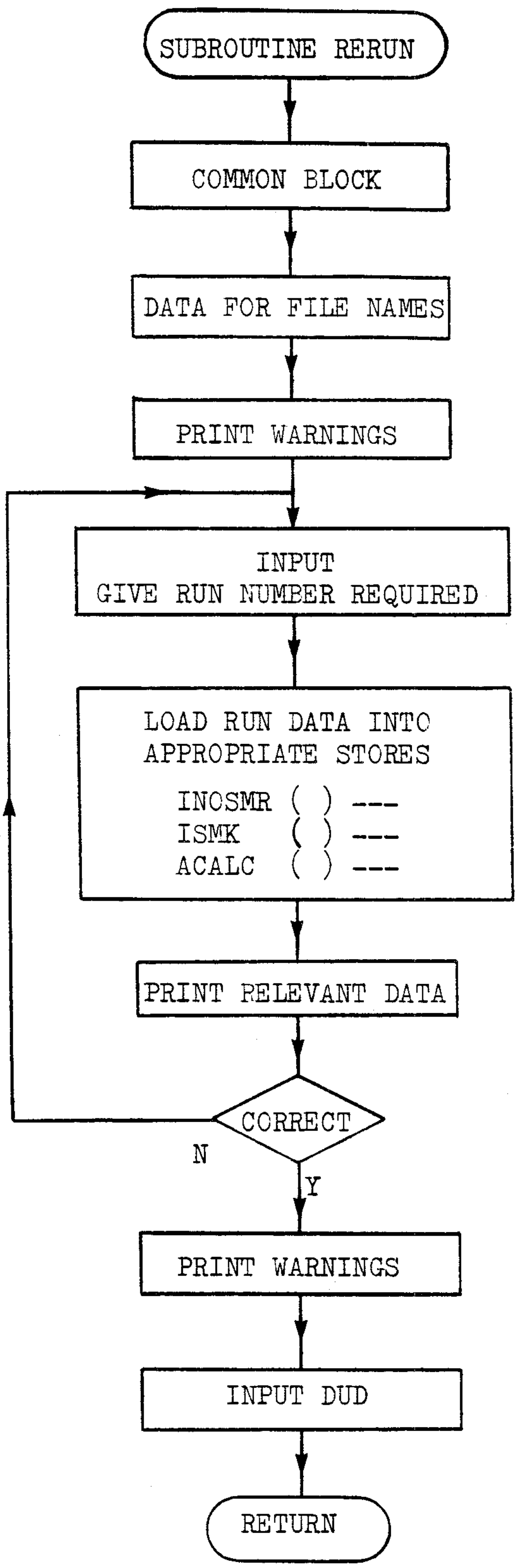


Figure 37. Subroutine RERUN

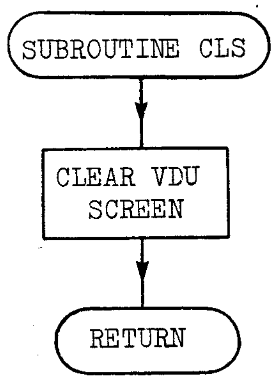


Figure 38. Subroutine CLS

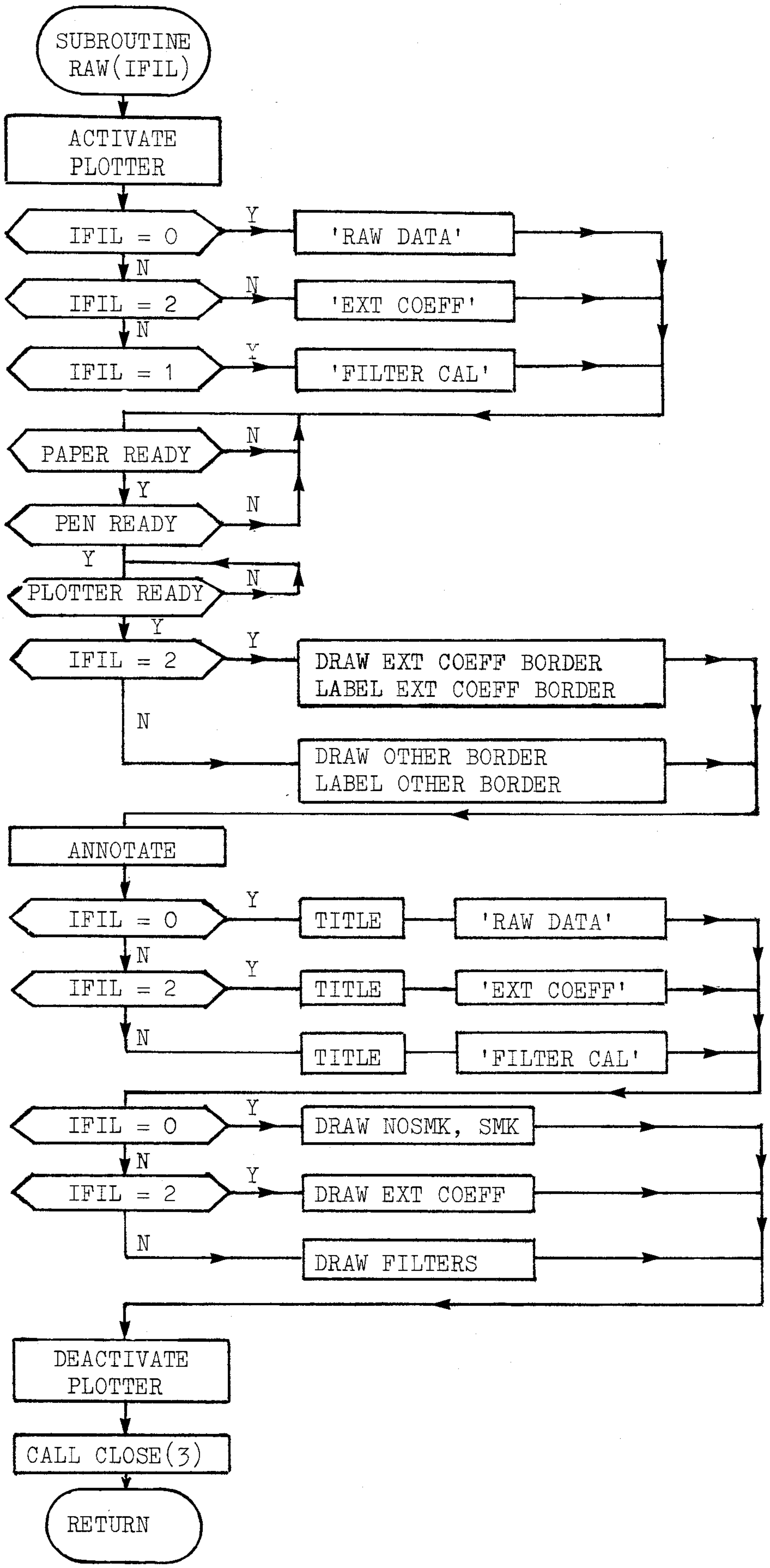


Figure 39. Subroutine RAW(IFIL)

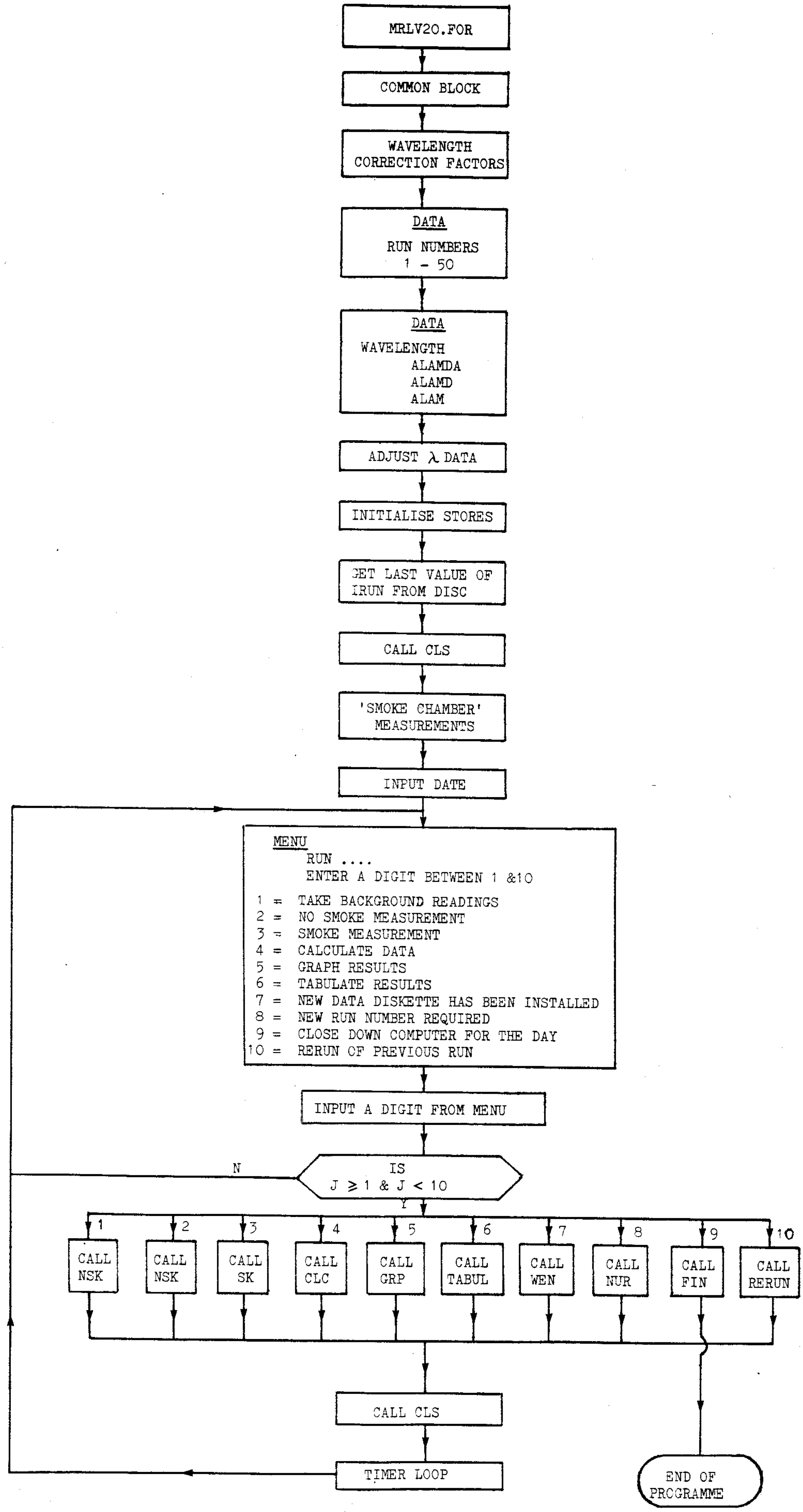


Figure 40. Subroutine MRLV20.FOR

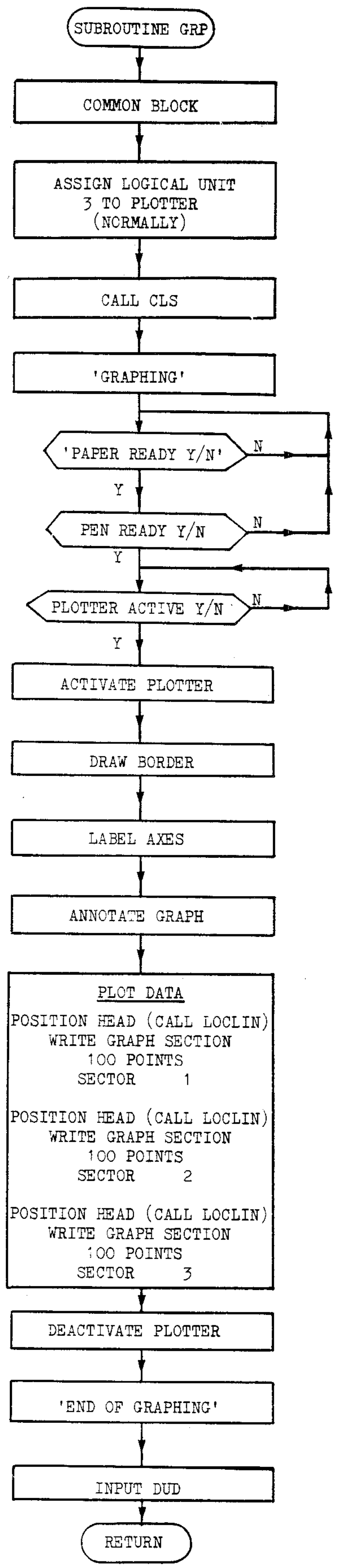


Figure 41. Subroutine GRP

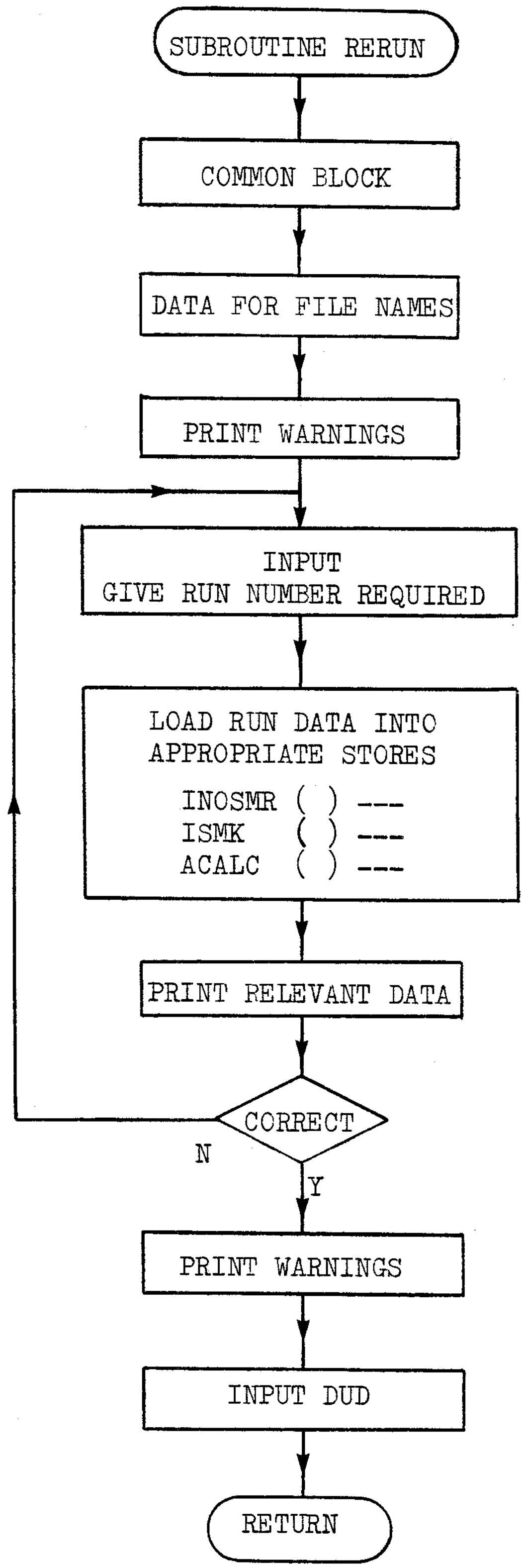


Figure 42. Subroutine RERUN

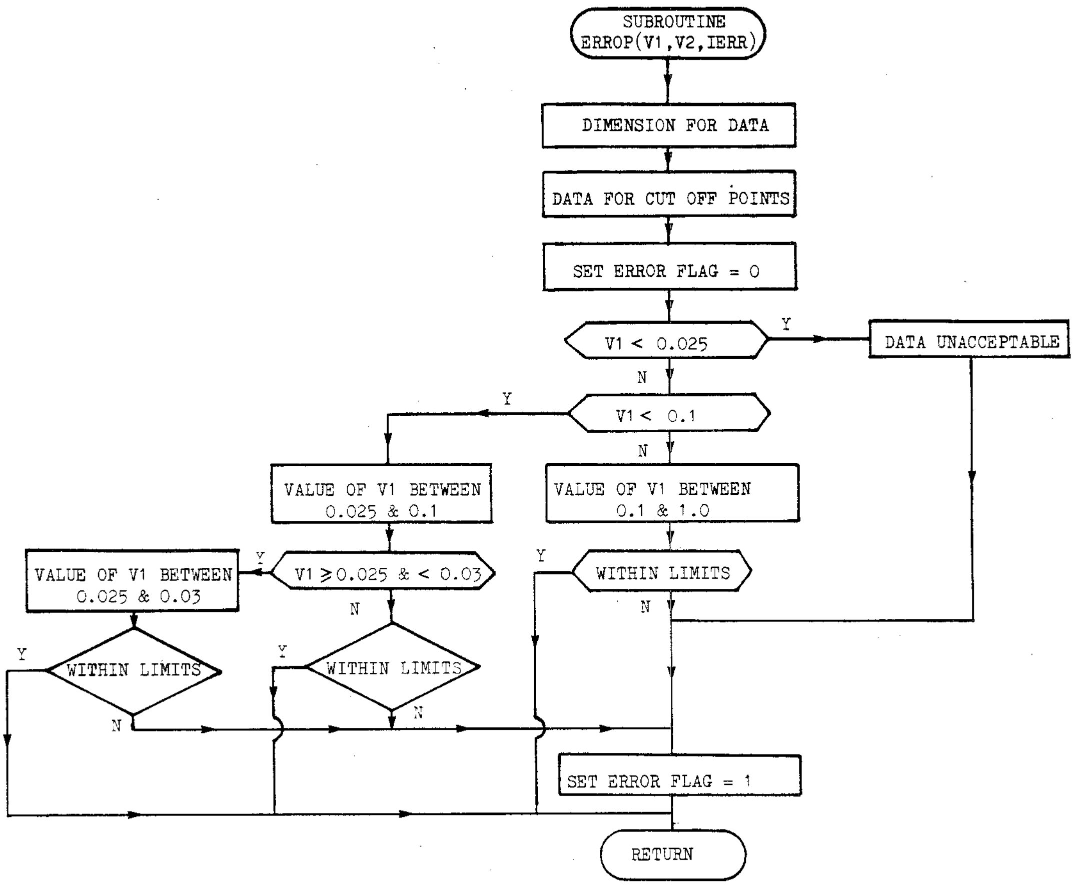
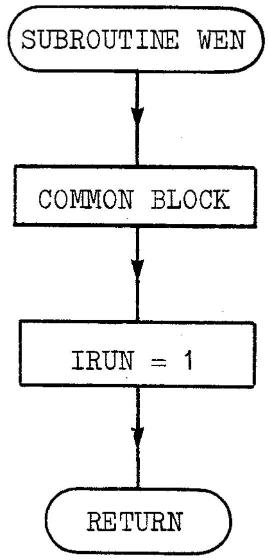


Figure 43. Subroutine ERROP



N.B. Initialise IRUN counter for new diskette

Figure 44. Subroutine WEN

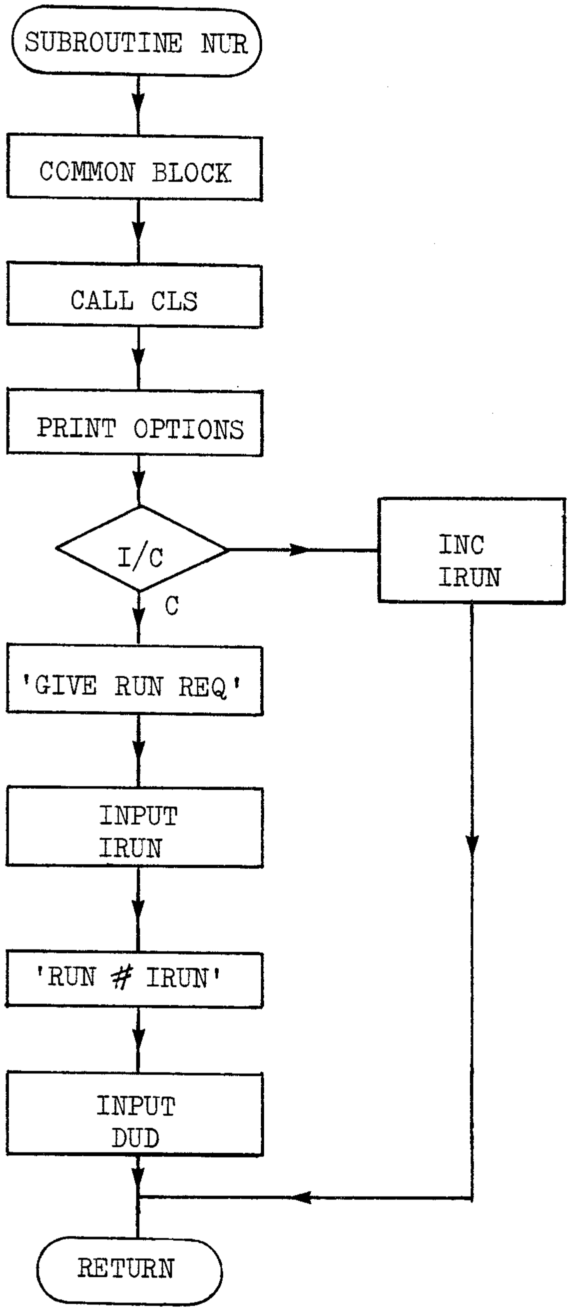


Figure 45. Subroutine NUR

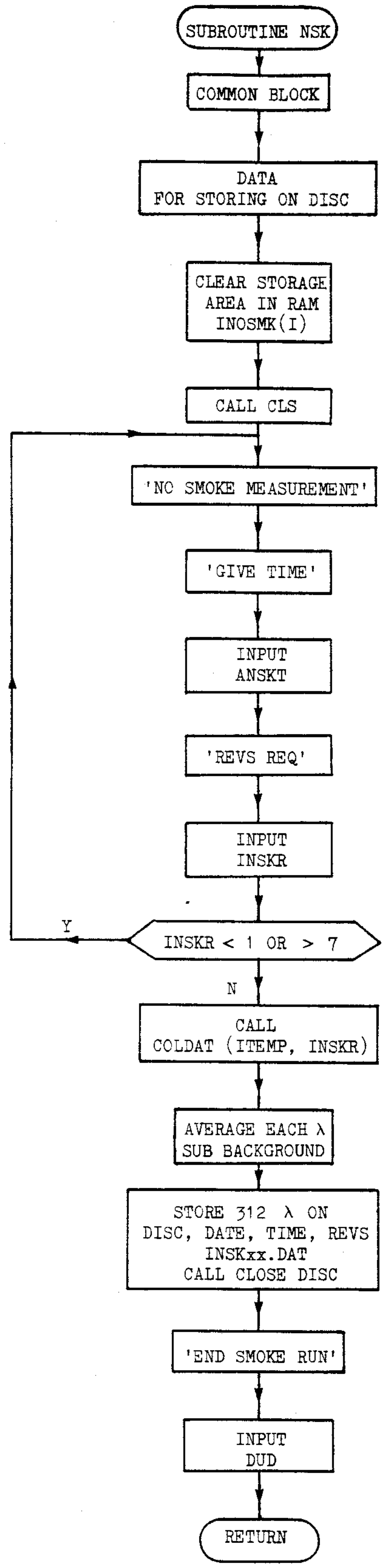


Figure 46. Subroutine NSK

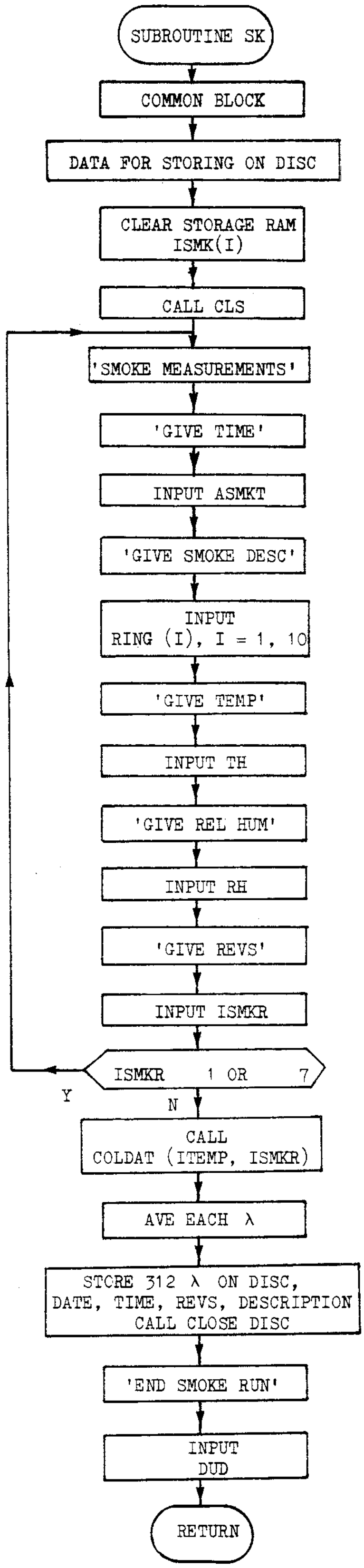


Figure 47. Subroutine SK

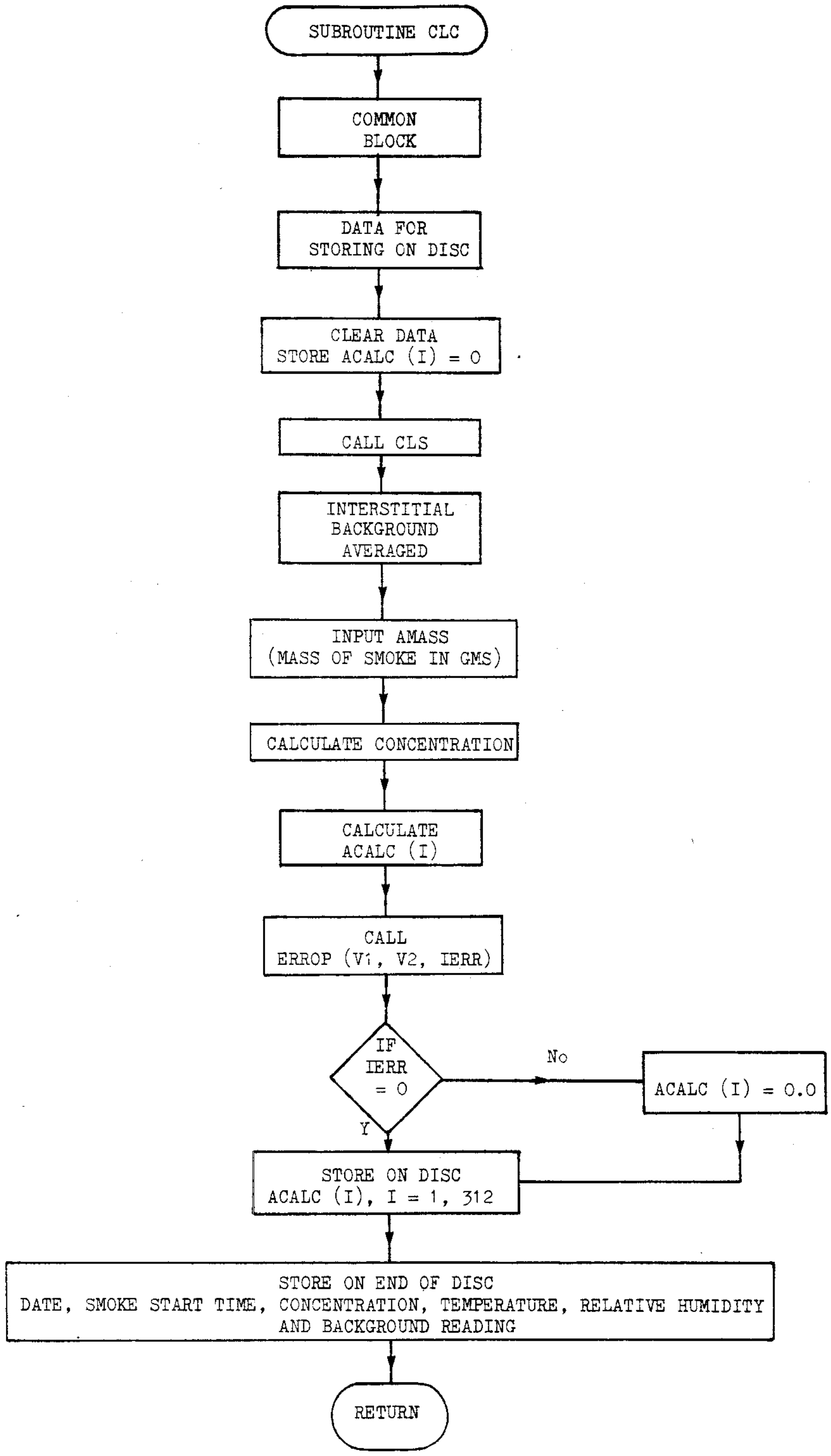


Figure 48. Subroutine CLC

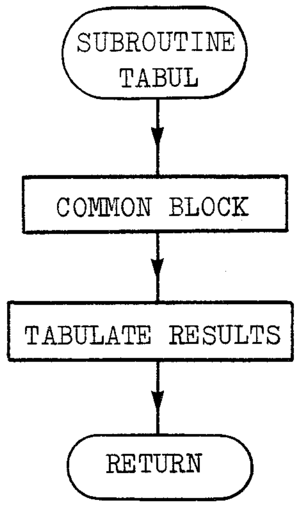


Figure 49. Subroutine TABUL

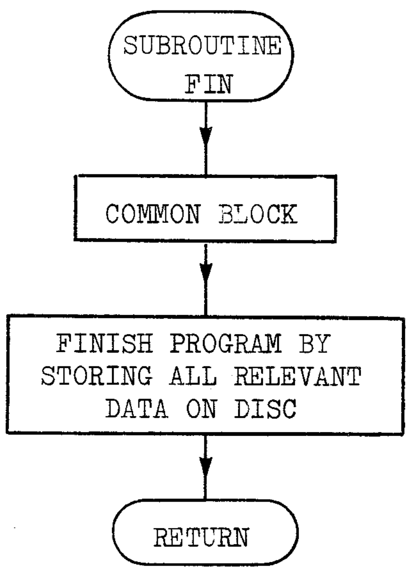


Figure 50. Subroutine FIN

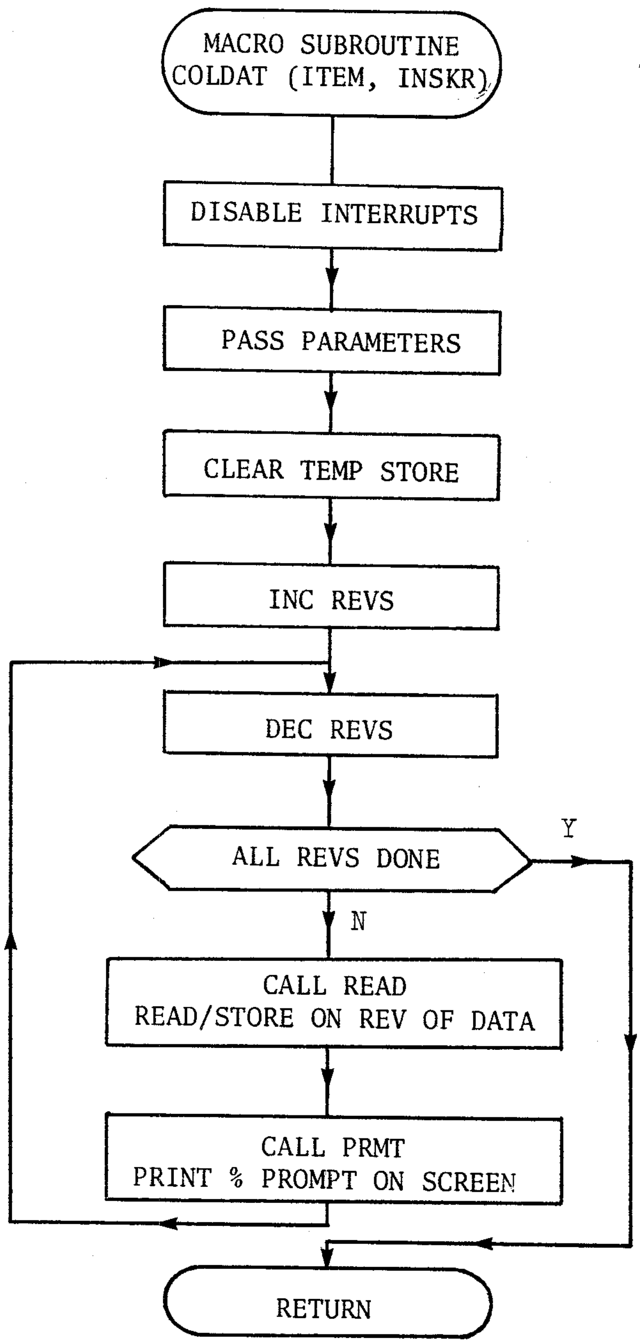


Figure 51. Macro subroutine COLDAT

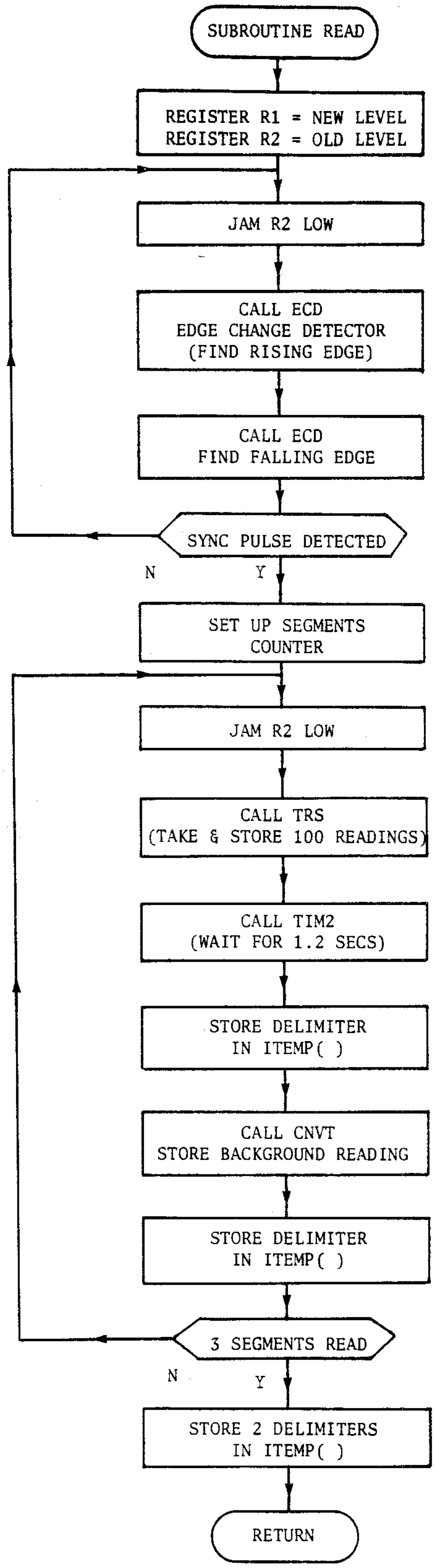


Figure 52. Subroutine READ

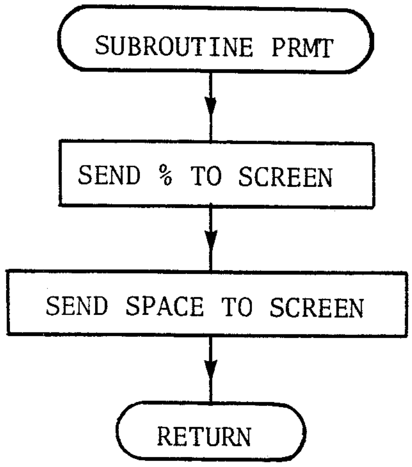


Figure 53. Subroutine PRMT

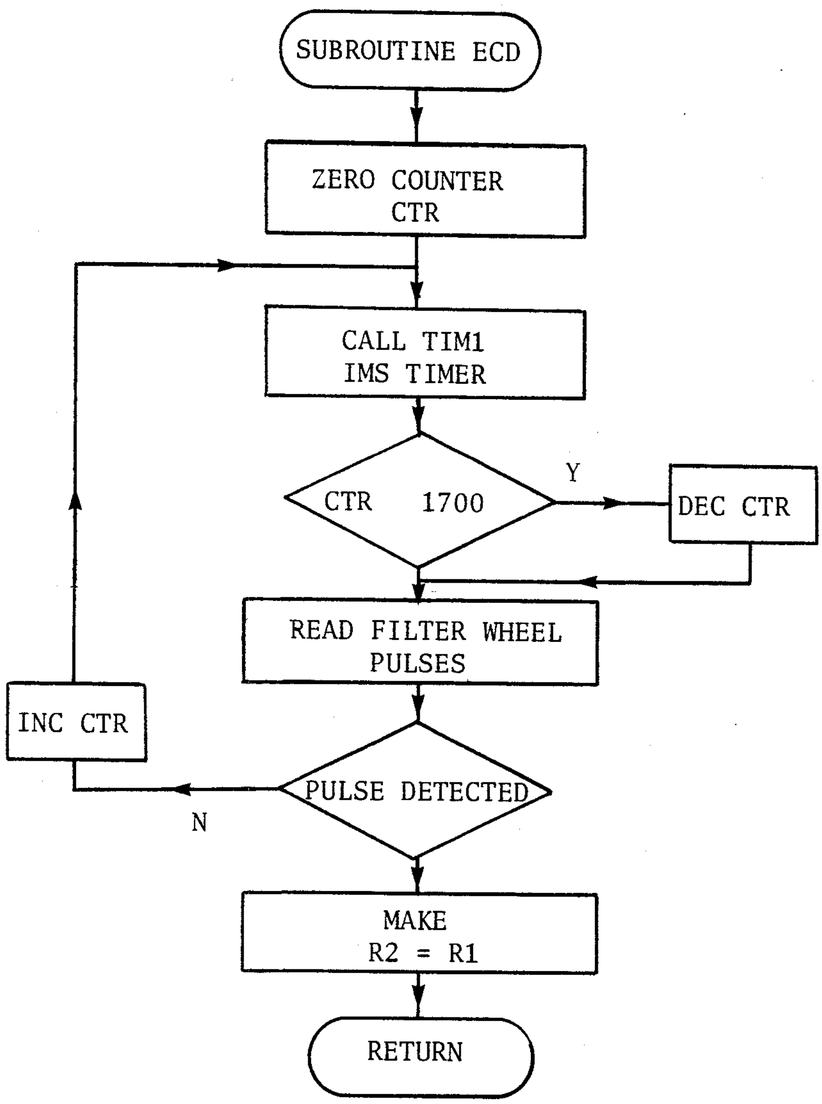


Figure 54. Subroutine ECD

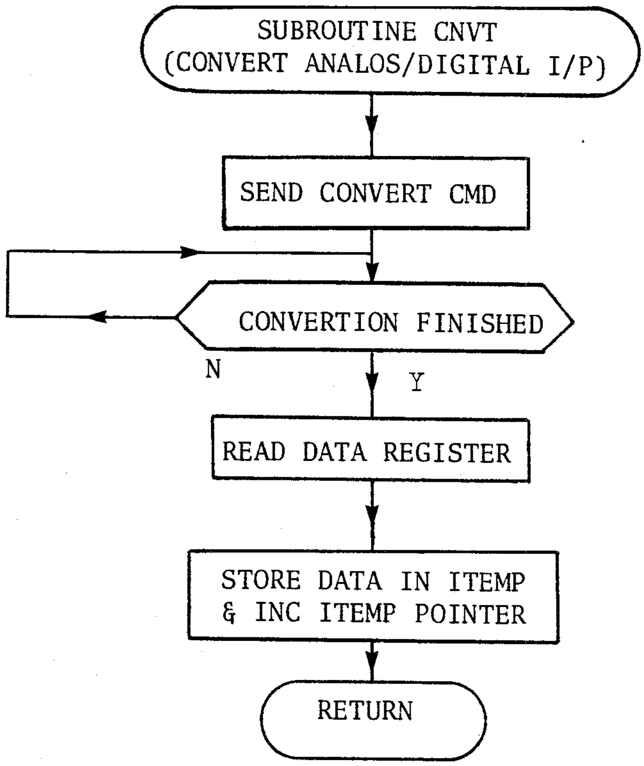


Figure 55. Subroutine CNVT

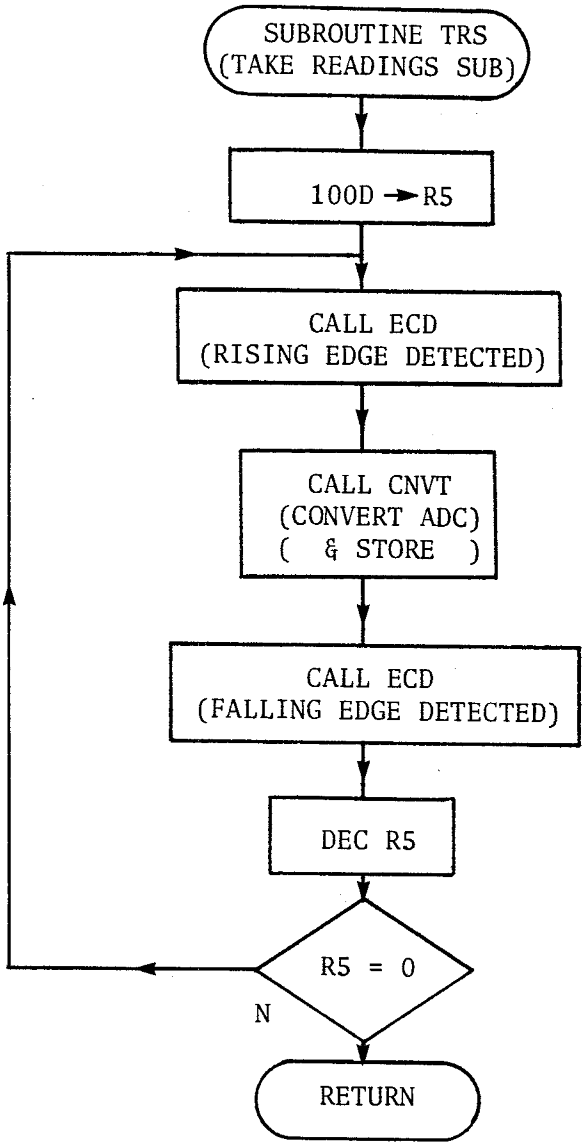


Figure 56. Subroutine TRS

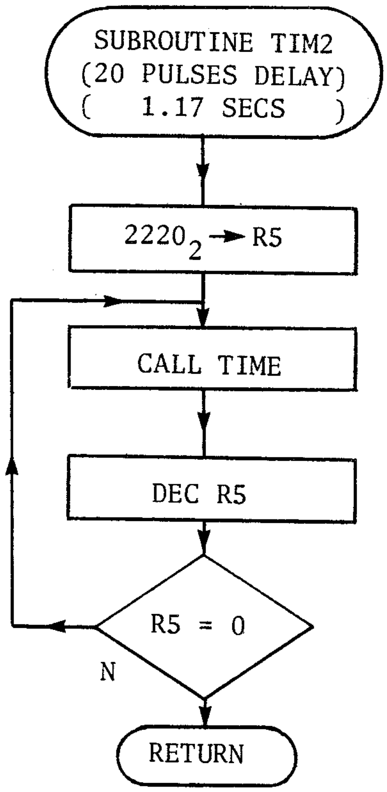


Figure 57. Subroutine TIM2

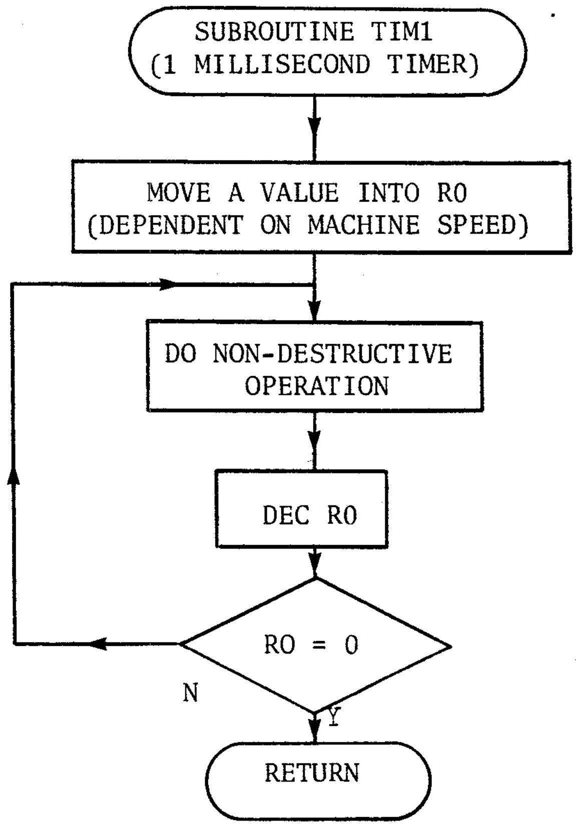


Figure 58. Subroutine TIM1

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Smoke screens
Test chambers
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Infrared obscurants
Data handling
Data logging
Data processing
Data presentation
Smoke chambers

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16 SUMMARY OR ABSTRACT:
(if this is security classified, the announcement of this report will be similarly classified)

This manual describes the history, circuitry, setting-up and operating instructions for the MRL Smoke Chamber IR Scanning Radiometer (2 to 15 μm waveband) for the Australian Smoke Programme. It describes in detail the progress over a number of years of the modifications required and the reasons for these modifications from the original design in 1979.

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