

W.H. Smith and Son

A. R. Waugh
Pembroke College

17½p 3/6

LAB

Narrow Feint Ruling

Notebook

25th Oct 71 — 23 Jun 1972



2.
Fri 25th Oct

250 125 60 30 15 8 4 2 1 2 4 6 8 10 12 20 30

W Tungsten tip 78° 1 film
↳ Grain boundaries
He+Ne

✓ Thurs 28th Oct

Same tip, angle changed slightly towards centre.

He+Ne 78°

4×10^{-5} Torr on ion gauge

Tip flashed at end of 2nd film.

- Hysteresis effect observed: on winding down volts slowly from evaporation point, image suddenly became dimmer & higher contrast - brightness distribution changed (brighter away from centre). But would not happen in reverse as voltage was increased, but was repeatedly observed on decrease to 31 V from evap. voltage.
? Check Helipot on tip eht supply for sudden changes in R.

retrospectively 29th Tip replaced again with W.

2×10^{-8} with Ne

Mon - pressure poor, $\sim 2 \times 10^{-7}$. Field emission unstable. ? leak. Picture unstable ? discontinuous eht

Nov Fri 12th Eht connections at tip rewelded. Pumping restarted, same tip (W, 1 grain boundary)

Mon 14th Pressure 1.5×10^{-7} . Fell to 1.3×10^{-8} on cooling dewars with Ne. ? Dirty system (dirt in top trap of diff pump) as pumped quicker on Fri without diff pump.

Th 25
Th 18
Tues 7/11
Wed 10
Thurs

Mon could Pumping stopped, pressure change noted
Base pressure (ion pump, N_2 in dewars) = $1.3 \cdot 10^{-8}$ T on ion gauge.

Time (sec)	Pressure	Time	Pressure
0	$1.7 \cdot 10^{-8}$		
20	1.85		
60	1.9	\sim stable @	$2 \cdot 10^{-8}$
120	1.9		
4 mins	2.0		

Imaged in $4 \cdot 10^{-5}$ He : tip curved, off centre, ~ 10 kV. Flashed.

Top ring baked out - @ 205° (chromel thermocouple)

playing with $75T's$, presump (curcode) Another specimen put in. Pressure rise (from 10^{-8} with N_2 to $\sim 2 \cdot 10^{-7}$) when screen chlt applied - probably discharge between lead & case of mic.

Fri 19th D specimen ~~put~~ in, ~~per~~ sub-pump filaments changed & outgassed (only) microscope pumped out. Eht internal screen lead ^{was} moved away from side tube when mic was up to air.

Mon 22nd Nor Pressure $\sim 10^{-8}$ T, down to $7 \cdot 10^{-9}$ T with N_2 in dewars. Rose only to $1 \cdot 10^{-8}$ when screen chlt applied - great improvement, but not cure. Tips ~~are~~ collected only 5-10 stray contaminants when chlt removed for 60 sec.

Tues 23 Attempt to look @ field emission using EDB's 20kV chlt set. Picture went from faint unidentifiable pattern to v. bright unstable image with slightest change of chlt control. Relocked @ with Field ion apply. Faint image - scintillating - seen @ 15kV in $4 \cdot 10^{-5}$ T He (ion gauge) - independent of He pressure, so due to contaminant gases. Image of very blunt-tips seen in He @ ~ 15 kV. Pictures of pretty round spikes on end of tips were taken.

Wed 24 W tip replaced. Took long time to pump down to 10^{-3} T - eventually found He leak valve mysteriously open. Difficult to get it to close tightly - ? contaminated He and damaged valve. Pressure reduced to $\approx 6 \cdot 10^{-6}$ T when ion pump was valved off from system. Pressure dropped to $5 \cdot 10^{-6}$, while ion pump current, by then 10 mA, was seen to be increasing. Pump turned off, but was found to be full of gas when attempting to reopen valve to system. Everything shut off.

Th 25 Pressure $\approx 5 \cdot 10^{-6}$. System pumped with diff pumps to $2 \cdot 10^{-5}$ and ion pump valve cautiously opened. Little pressure rise. System pumped to $5 \cdot 10^{-6}$ on diff & sub pumps, then ion pump restarted. Worked well & pressure dropped rapidly to $1.2 \cdot 10^{-6}$ T, where pumping speed dropped drastically. Sub pump (20 min, 40 sec) & ion pump overnight.

Fri 26 Pressure $\approx 1 \cdot 10^{-7}$ T $\rightarrow 8 \cdot 10^{-8}$ with diff pump in ≈ 3 hours. N_2 added, $\rightarrow 2 \cdot 10^{-8}$ $\rightarrow 5 \cdot 10^{-8}$ with screen on. Imaged tip @ $4 \cdot 10^{-5}$ T He (? dirty - picture was contaminated in ≈ 2 sec if volts were reduced). Tip imaged @ 1.2 kV - took volts up to 4 kV taking photos. Pumped out system; pressure now 10^{-7} with screen on, $5 \cdot 10^{-8}$ or less without.

Mon 29th Pressure $13 \cdot 10^{-9}$ T. With $N_2 \rightarrow 8 \cdot 10^{-10}$ T $\rightarrow 2.5 \cdot 10^{-9}$ with screen on. Imaged in $3 \cdot 10^{-5}$ T He & looked at field emission ($10^3 \Omega$ series resistor, $\approx 5-10$ kV) - picture unidentifiable. Much crud on tip when f. ion looked at, so He probably contaminated. Throw away when new bottle available. 4 kV tip at end of day.

Tues 30 Nothing exptl.

Wed 1 } Off air, with cold.

Thurs 2

Fri 3 Pressure $7 \cdot 10^{-10}$ Torr this morning (pumps left on since Monday). Π built like microscope. Roughed out. Darkening due to something like UHV valve defective.

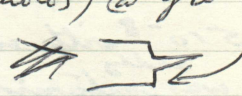
Sat 4th Fixed UHV valve. Pos. Roughed mic out.

Mon 6th Put in w specimen, pumped down to $4 \cdot 10^{-6}$. Pressure rose briskly on shutting off diff pump. ? leak, contamination?

Tues 7th Pressure in system quite high; $0(10^{-2}-10^{-1})$. Rapidly pumped out to $3 \cdot 10^{-6}$, then much slower. $P \rightarrow 8 \cdot 10^{-7}$ with N_2 . Air leak found at ion gauge flange. Tightened $P \rightarrow 9 \cdot 10^{-8}$, Ion gauge doesn't read on log scale.

Wed 8th P in air overnight $\rightarrow \sim 10^{-3}$. Pumped down to $2 \cdot 10^{-7}$ by 6:00.

Thurs 9th P overnight $4 \cdot 10^{-4} \rightarrow 1.6 \cdot 10^{-7}$ T @ 6:00.

Fri 10th " " " " $\rightarrow 1.4 \cdot 10^{-7}$ T @ 4:00 $\rightarrow 3.4 \cdot 10^{-8}$ with N_2
1. raised lip, looking (photos) @ spot on surface. Tip study
v. strange - probably  sharp edge.

Sat

Sun

Mon 13th Let up to air, remove channel plate for A. Stovin to use.

Pump out mic. AS has screen. Mic leaks round window gasket

Tues 14th Printing pics.

Wed 15th Replace window gasket, $P \rightarrow 4 \cdot 10^{-7}$ rapidly, then v. slow.

Valved off at $3 \cdot 10^{-7}$ T. Rate of rise 10^{-6} T in 35 secs. T1 data books arrive.

Jan 72

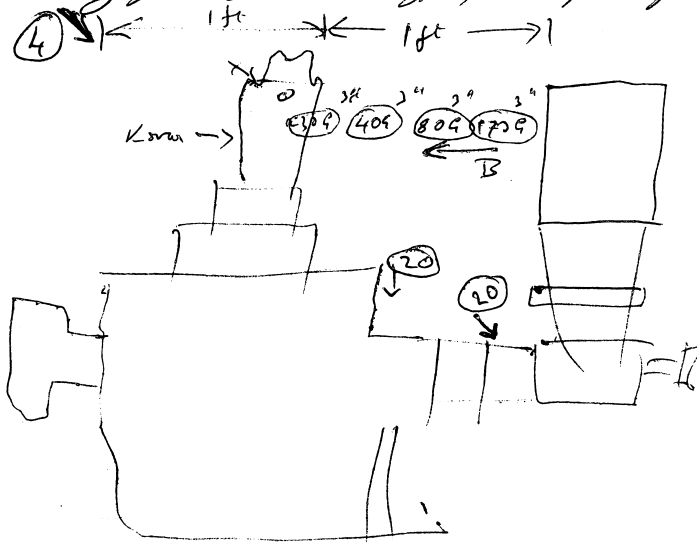
Mon 3 Returned to sunny Cambridge

Tue 4 Drawing bits of HM

Wed 5 " " "

Thurs 6 " " Start up engine & steam engine backing lines. All OK

Fri 7 What is magnetic field round Kovar seal in zero-length window?
 Hand magnetometer borrowed but un-zero-able: returned. Electron microscope group " borrowed off John Chapman. Field from window dwarfed by leakage from (unscreened type) iron pump: -



figures in Gauss: G

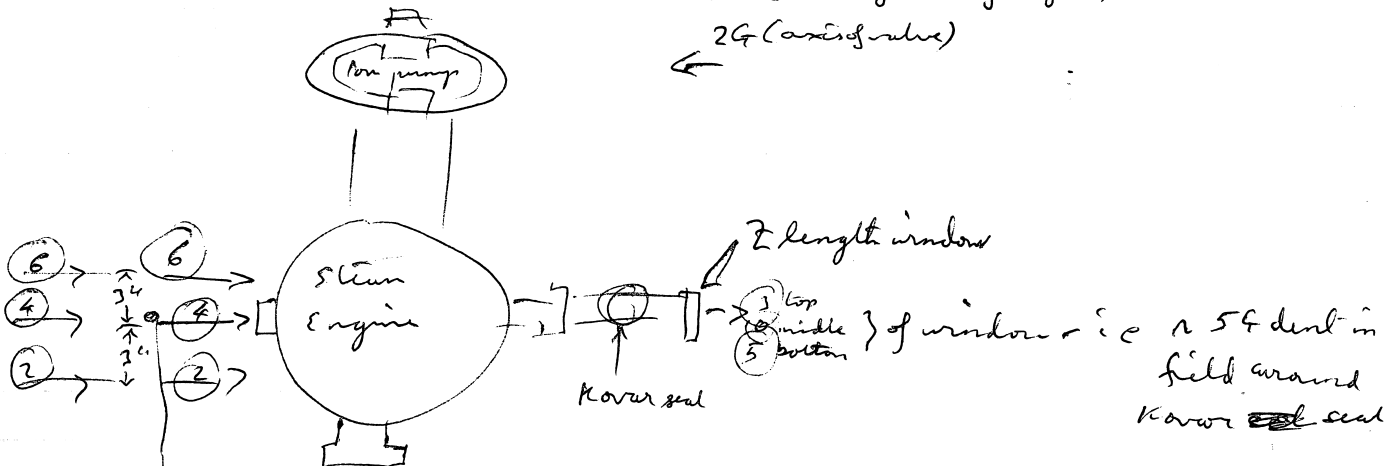
} 1st was calibrated & zeroed

Field $\approx 1 - 2$ Gauss at surface of welded base of mi: decayed with $\frac{1}{2}$ length ≈ 3 inches

$\leftarrow 54$ (axis of centre of magnet)

$\leftarrow 24$ (axis of valve)

\leftarrow



Up to ≈ 9 Gauss (max) at level of magnet - (same both sides of boiler)
 - field sloped downwards slightly, same direction as at lower level.

Conclusions: 1) screen ion pump as field is 7 earths 4 or more feet away from it 2) zero length window does not apparently affect field more than 2" or 3" away from it (difficult to be exact because field mainly due to ion pump on S-engine). Probably less than $\frac{1}{2}$ Gauss 6 inches away, anyhow.

Sat 8
Sun 9

Mon 10 | Drawing energy analyses from Eignoury microscopes
Tue 11
Wed 12
Thu 13
Fr 14

This weeks thought: take ~~good~~ good W tips out of mic & deposit a thin film of carbon on it from e-m evaporator. Look at film in Ne or Ar in Jim to see if get rings etc as on Al of which has been put in e. mic. Alt., heat to $> 1000\text{K}$ in atmosphere $\approx 10^{-5}\text{T}$ of CO_2 - need other leak valve on steam-engine to do this. Tube not working: Alan has the 2nd long channel-plate.

Mon 17th - Definitely a Monday. Yes. Indeed. Monon.

}
Tue
Drawing

Misc turned off on Fri 11 : of power units (everything)

Sat Bought con soldering iron from Coes

14th Feb (Mon)

Ordered TTL & 7 seg ~~dis~~ displays from LST, Marshalls, & West Hyde Developments.

15

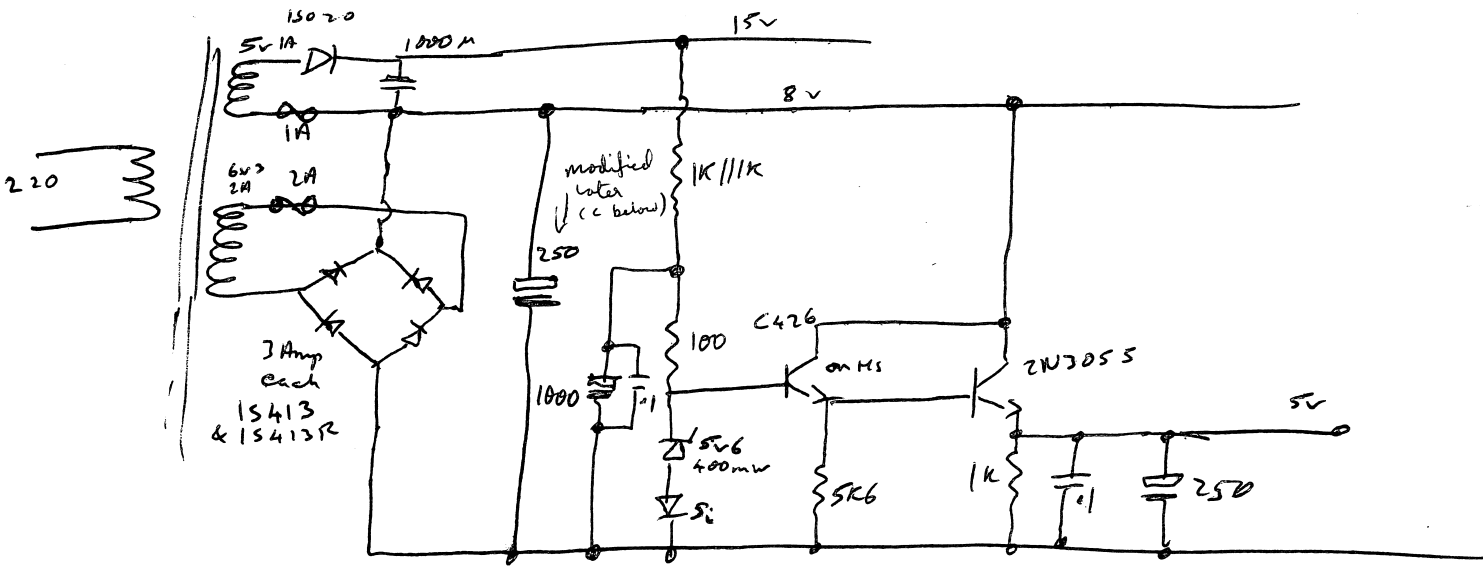
Tue

Ordered shts and boards from (APT?) Lethbridge.

Wed

Built soldering iron stand with Soc's assistance (or was?)

Thurs 17 Built 5V \approx 2A psu.



ND add means filter when in box & 5.6 Zener across output

Pts from Cur Stores & Met. "

Fri Finished dismantling 14" rack container (Carterwell): phoned Chiltonhead re Hewlett packard LED's type 4440 - they are panel mounting. Will order some. Moved electronic odds & sods into new office as bench top to work on & a bloodier sight warmer over there.

Mon 21st Feb Bugs for ~~lower~~ counter arrive (less 7404 inverters - LST & will send when they arrive, they say).

Built patchboard for 1c's & set up for up down counter & display driver.

Checked out drawings for microscope.

Tues Bernard Hanks came from VGI to give estimate for microscope. Estimated price much as expected.

Power cut day, so not much else able to be done.

Doodling preamps (p.c.b. & fibreglass) & LED's ordered from Chittimaal yesterday).

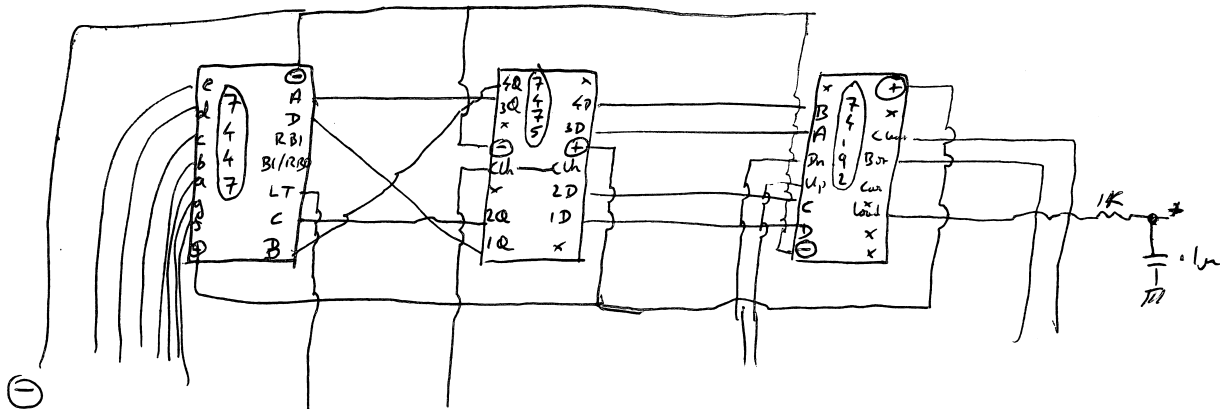
Wed Borrow Paddy's marconi scope & test updown counter circuit. Start on metalwork for cabinet of counter.

Thurs Lehtoskit boards/plug ins arrive. Build rails to support edge-connections, & other bits of counter box. Start building decade counter boards.

Fri Building decade counter boards

Sat Finish the 6 boards & put into cabinet

Layout of each

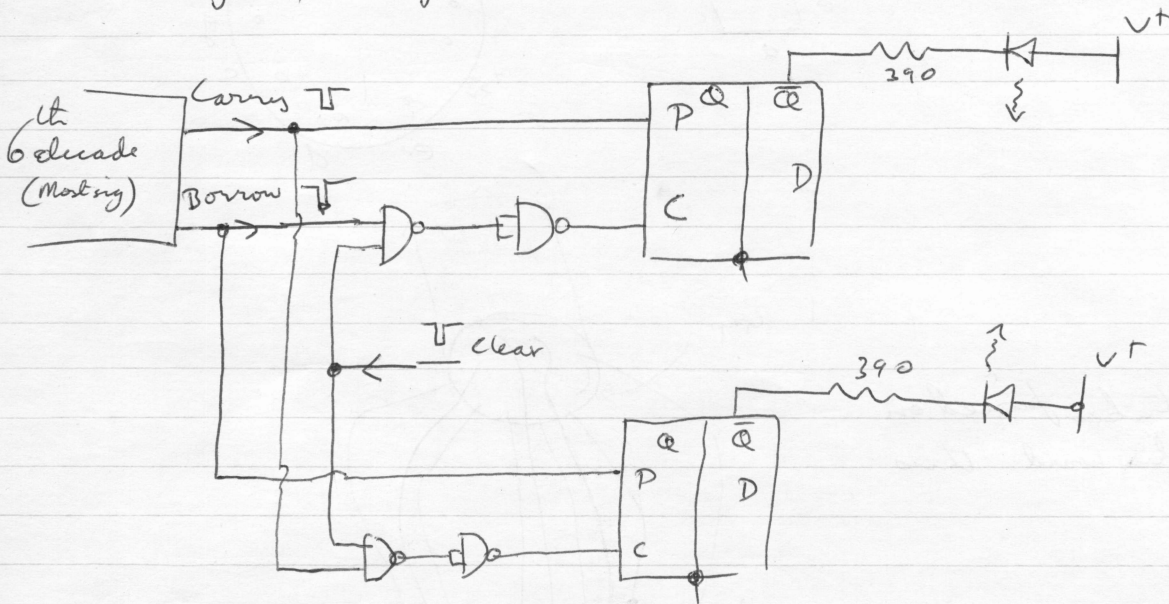


Worked first time!

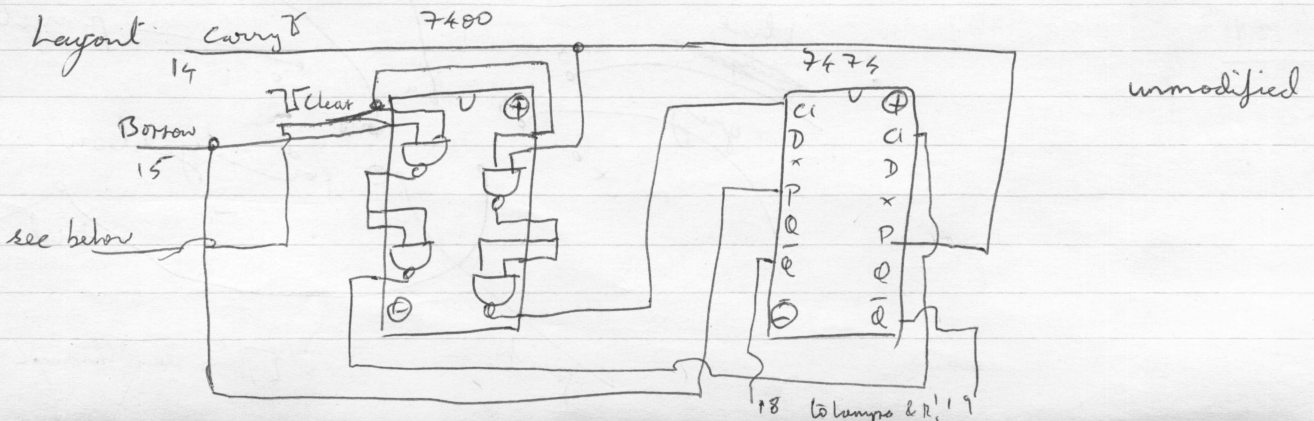
Capacitors added to first smoothing cap in PSU (8V rail)
 Total now $1000 + 2 \times 500 + 1600$ — still enough ripple
 to rev. bias $2W3055$ & produce ≈ 100 mV ripple on ϕ .

— Increase to at least $5000 \mu F$, pref 10 mF

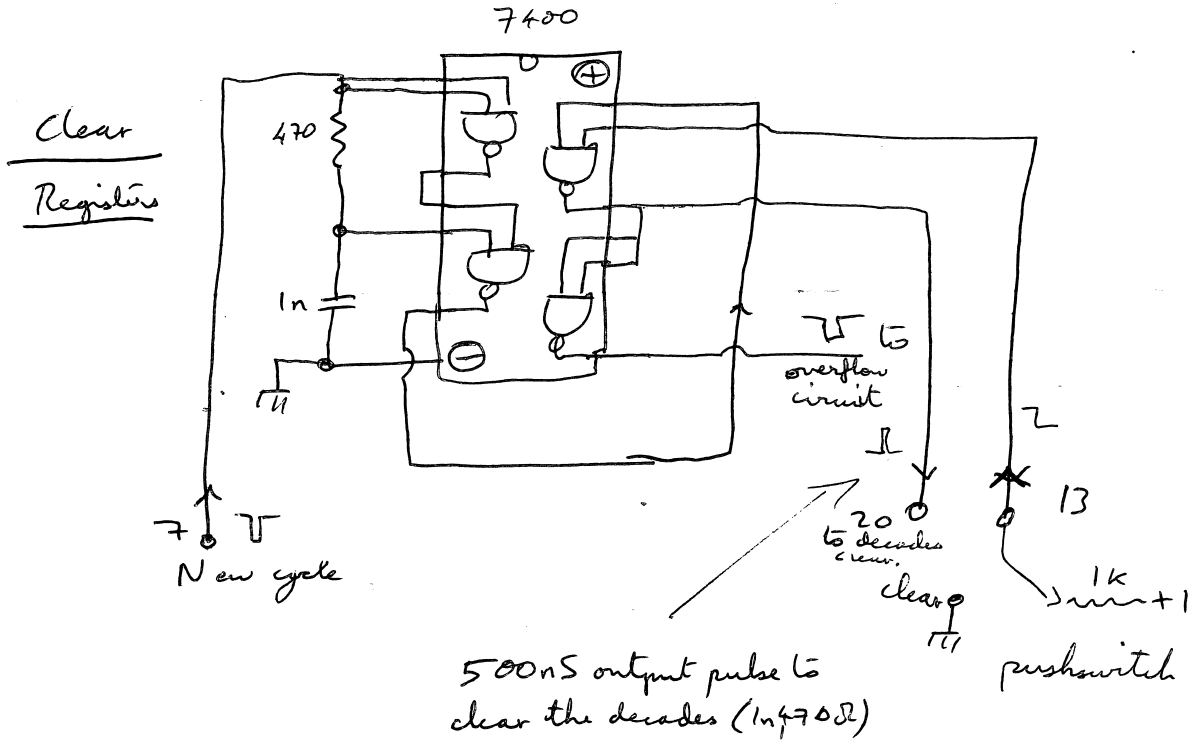
Wed Overflow/Underflow indicator built:



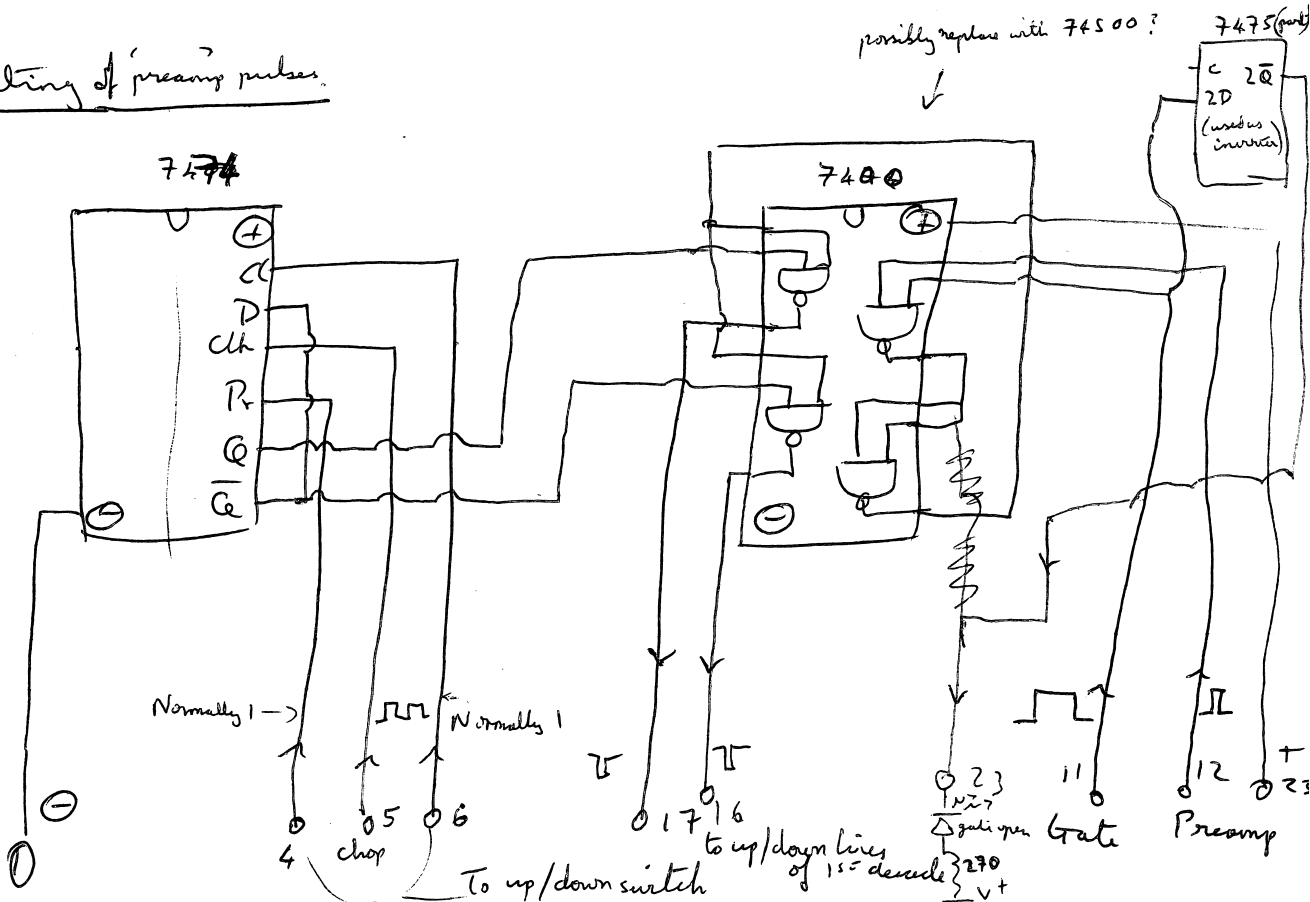
However, has defect that overflow light lights also on
 transition from ~~999~~ -1 to 0 (both lights should go out
 for nos. between 0 and 999,999). Have to modify somehow.



Also Clear and gating circuits built on same board.

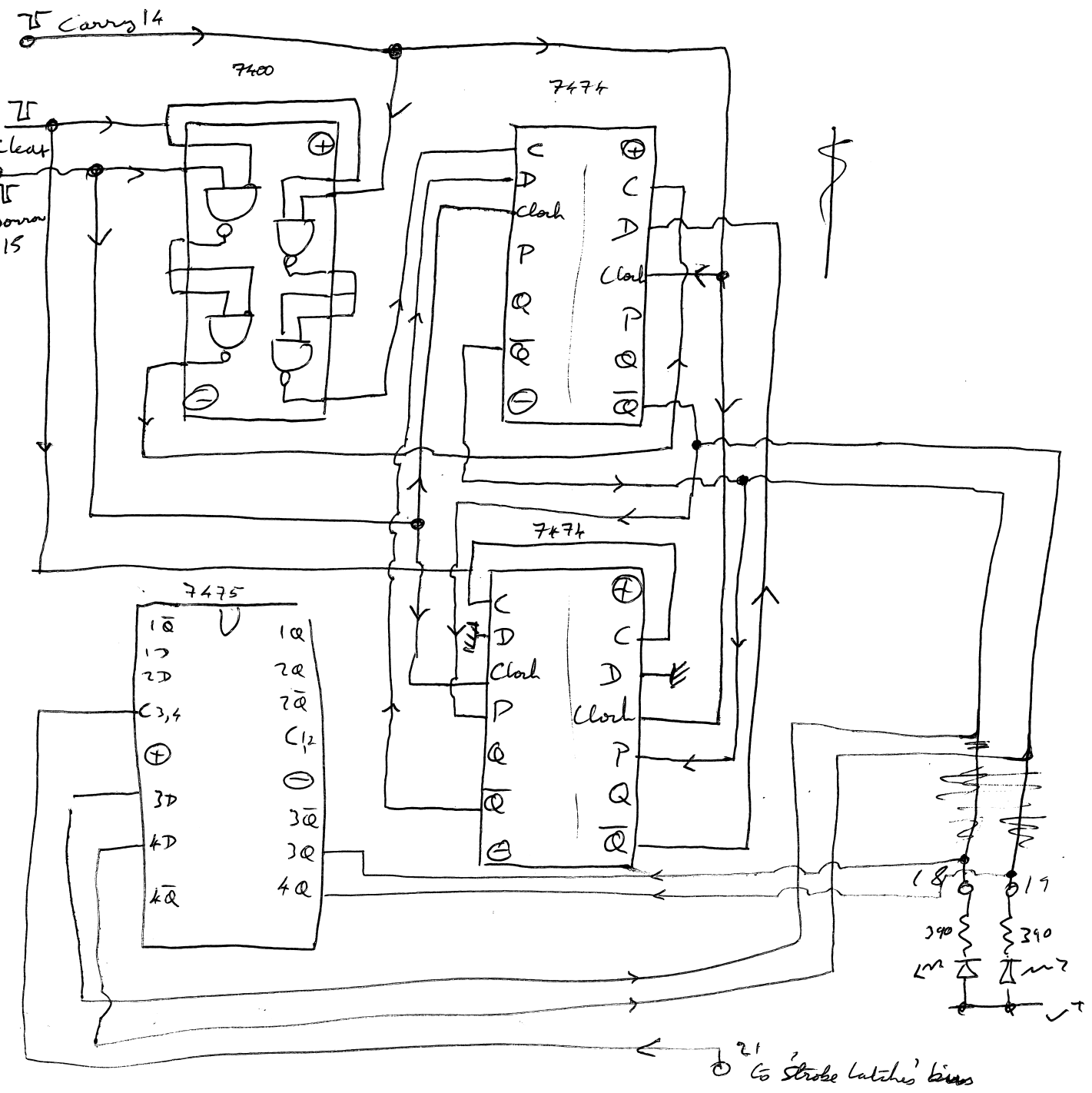


Gating of preamp pulses.

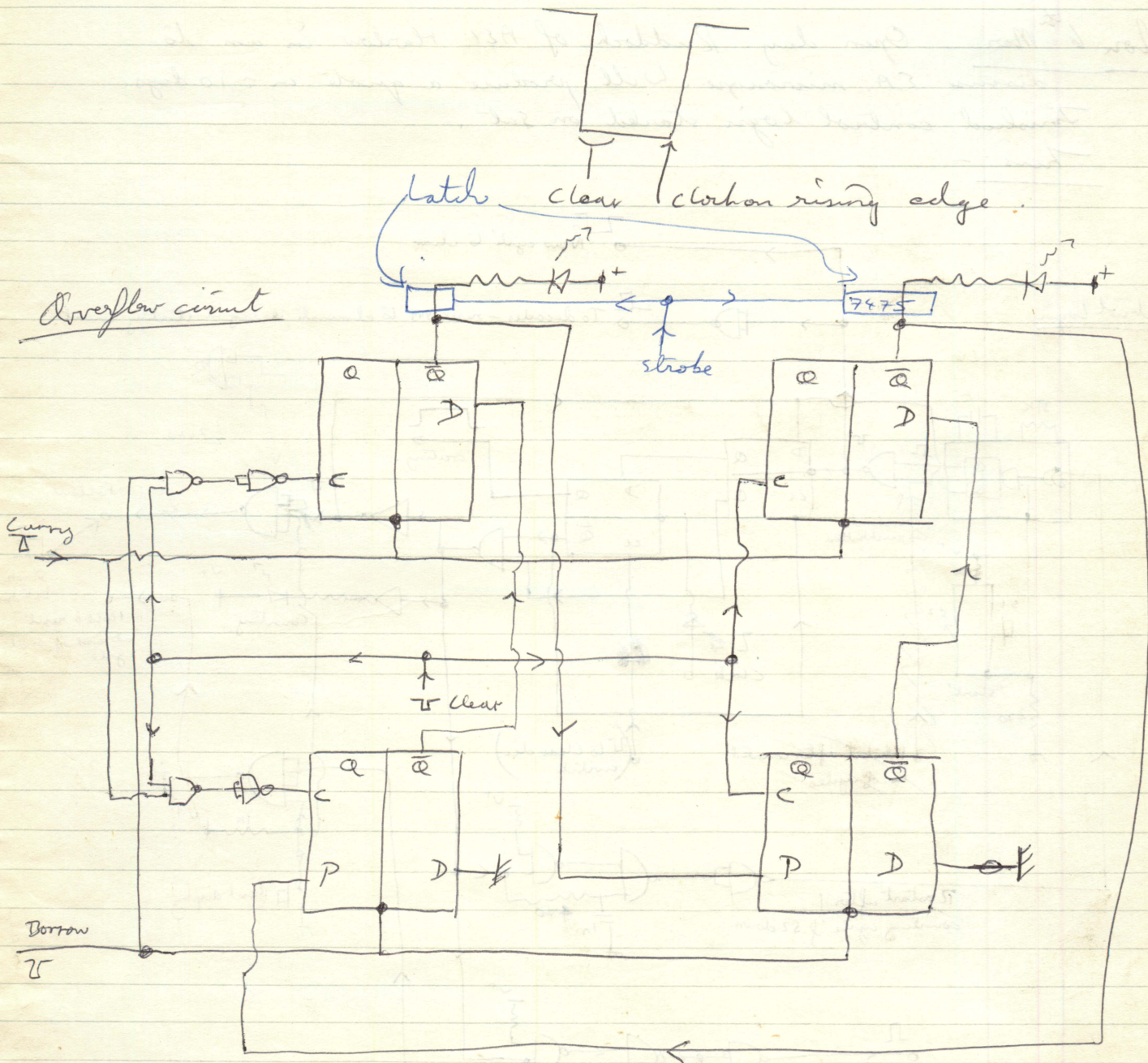


Thurs Visit to Electro-Optical Exch. @ Metropole in Brighton
 - photomulti, imag convs., chan-plate, LED's, lasers etc.

Fri ^{end of power cuts.} Returned ~~from Brighton~~ Modified overflow indicator thus...



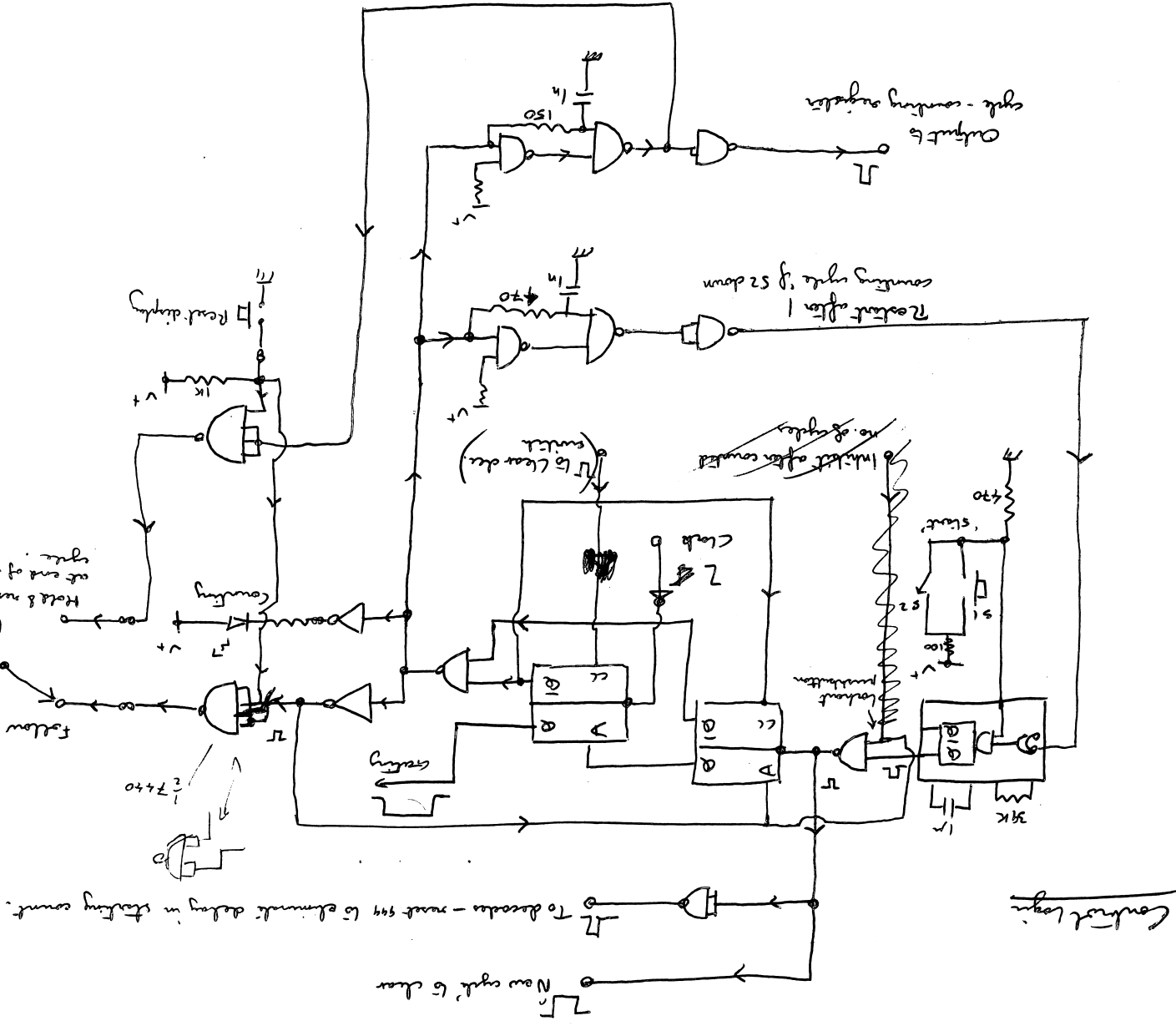
Requires input pulse 50-70 ns minimum so that the pulse has enough time to clear flipflops before clocking the others



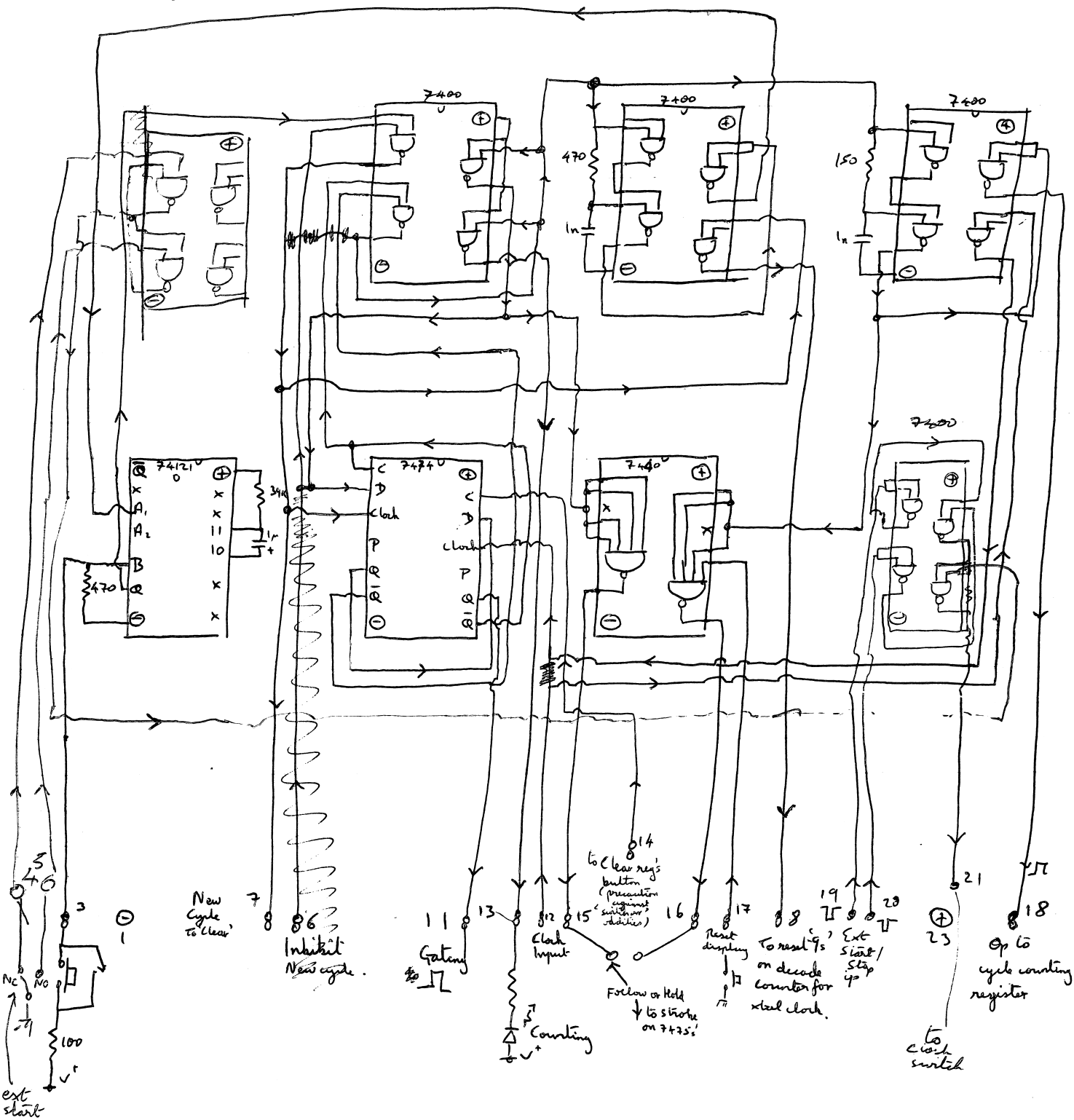
Lights a lamp if count < 0 or $> 999,999$, but not for $0 \rightarrow 999,999$ even if has just been negative or > 1 May.

Sat Started work on the 'short-counting' and gating drive circuitry.
 Sun pm Helped Ed & third page + Dennis with the Pulse Plane Probe.
 Started up cube magnetron & vacuum system again after pm. cuts. → 310 in vacuum overnight.

Mon 6th Mar
 Open day. Ruddle of HSE Hasdon in am to discuss E.P. microscope. Will produce a probe in ~10 days.
 Finished control logic started on sat.
 Thus: -

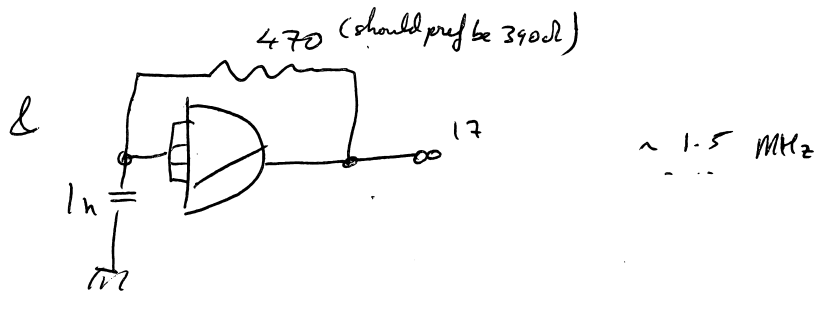
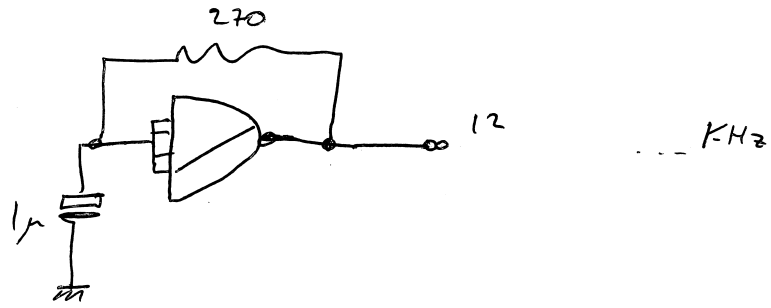


Control Logic Board

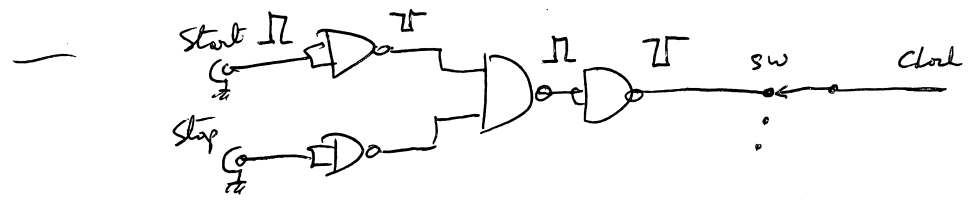


Pressing 'start' button causes counting to start on first clock pulse received & to finish on second. Red light goes on & then off after 2nd clock pulse. Holding button down causes cycle to be repeated after a delay in which the counters are cleared, display set, and clock dividers reset to 999... There is also a delay due to the monostable. Should increase $1\mu F$ to say 100μ to give time to note down display reading. One is fed to cycle counting reg (when built) at end on each count cycle.

Tues 7th Built decade divider board - 7 x 7490s - 1 missing. Set to give symmetrical output waveforms for ease of observation on scope & etc. Also test oscillator board using Schmitt 7413



Wed Drilling & wiring up panel. Constructed start/stop input is.



On control logic board

Thurs Modified start flip to look as drawn above. Extra outputs from decade clock dividers added. Finished wiring up front panel. Tested. Upped voltage (a) to pos to eliminate ripple (Vpp!) by stacking secondaries :-



- tends to fry 2N3085, but wind behaves better.

Phoned up Cathodion re Xtal oscs - 10-12 wks delivery on modules, 2-3 wks on Xtal's (incl order!)

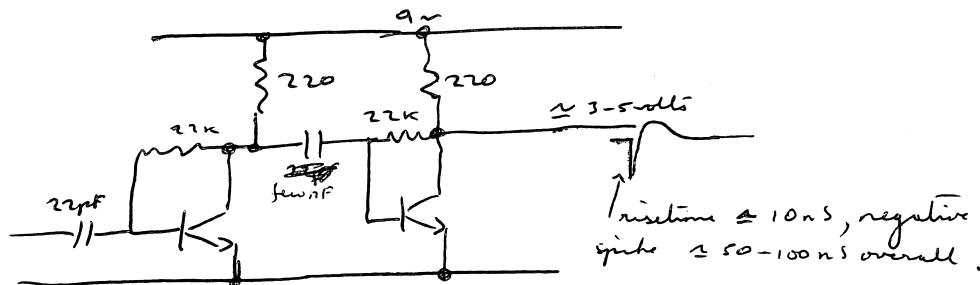
Fri Coffee mit Prof H in am. Still no 5000 μ reservoir from P.S.

Discoveries; 1) Where the monostable fires to restart the cycle & clear counters, etc, supply volts change enough to shift clock oscillator ~~from~~ visibly on scope (say 1.5 MHz to 1.7). ~~the~~ moral: don't try to run Xtal clock from some supply as $\tau \ll \dots$? MVR 5 volt regulator from radiospares @ £1.2 (50 $\frac{1}{2}$ A) 1 (gr)

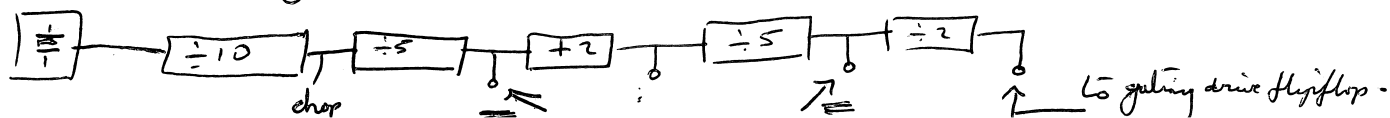
2) The overflow/underflow indicators flush when counting is being chopped - also tend to end up the wrong way round.
 ∴ 1) put in a latch to isolate from ~~counter~~ overflow detector & 2) find out why display gets wrong answer. ? not long enough for flip flops to clear before being reset (i.e. if chop signal comes half-way through a pulse - NB signal coming from external osc ^{if short enough} 1:1 mark space, not a series of pulses. might be OK on these, - check.

Acquired 710 comparators from Paddy to tame signal from Bernards amps - order some more for Paddy - or just ones.

Bernards circuit
(Boggl!)



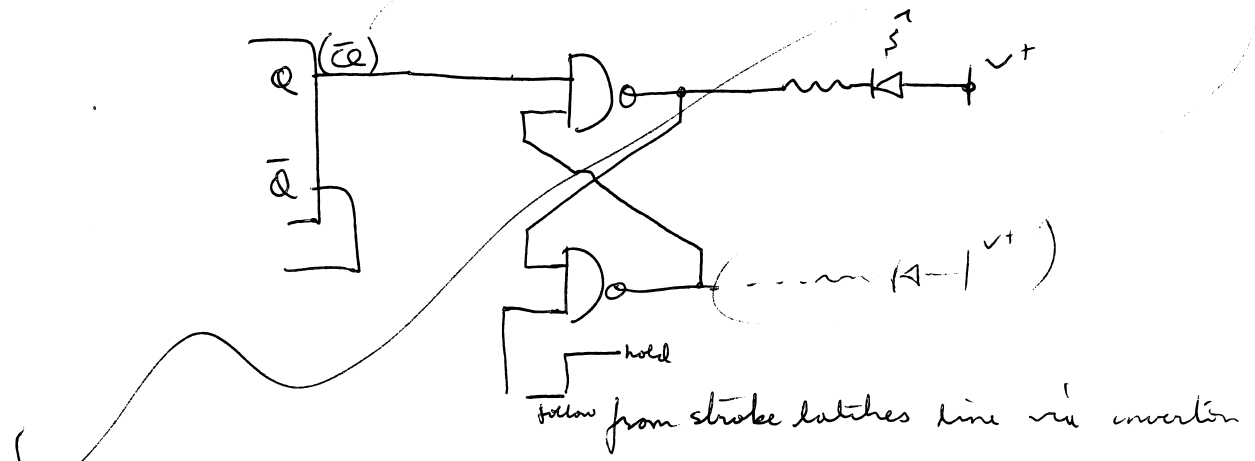
? Do I get equal nos of up-down counts if divide by five is used in timing chain :-



- test with faster clock than 23 kHz one used at moment.
- probably ok if chop comes 1 decade divider at least away from the gating signal, but check carefully.

V_G quote is up the creek - they can't add & have quoted for unwanted 50kV feedthrough. Also no. of ports on chamber is wrong & sign of offset on PDR. Query this.

Suggested latch for overflow indicators :-



No good ∴ flip of Q goes 1 to 0 with control at hold.

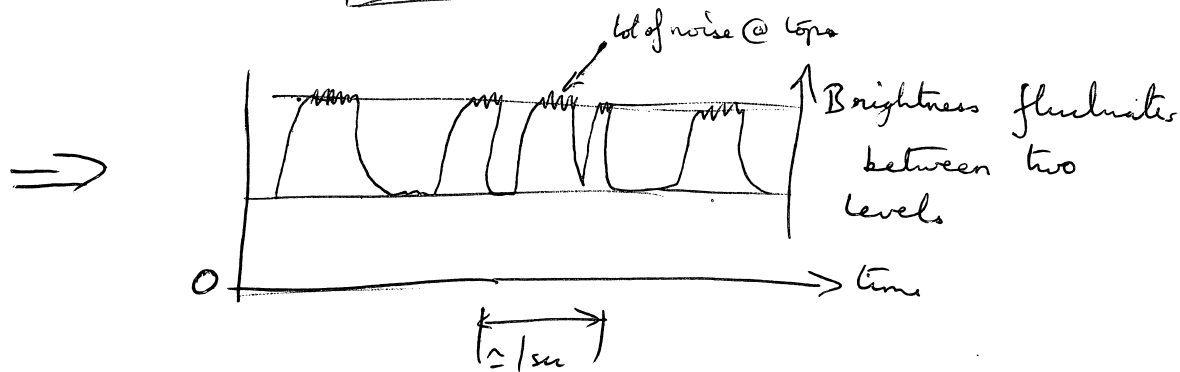
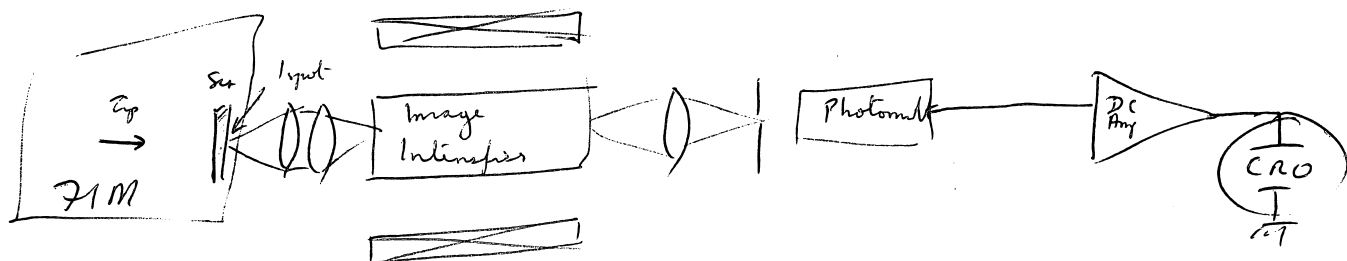
Better to use 7475 latch (uses same clock waveform as counters). Order it.

Mon 13th March

Ordered more bugs to finish stage 1 of counter.
Acquired 2N918's, 2N5819 for presamp.

- reading AP Sunssen's (Bangor) Thesis re effect of
neon on imaging in He - Intensity fluctuations
presumably due to Ne sitting over bright spots.

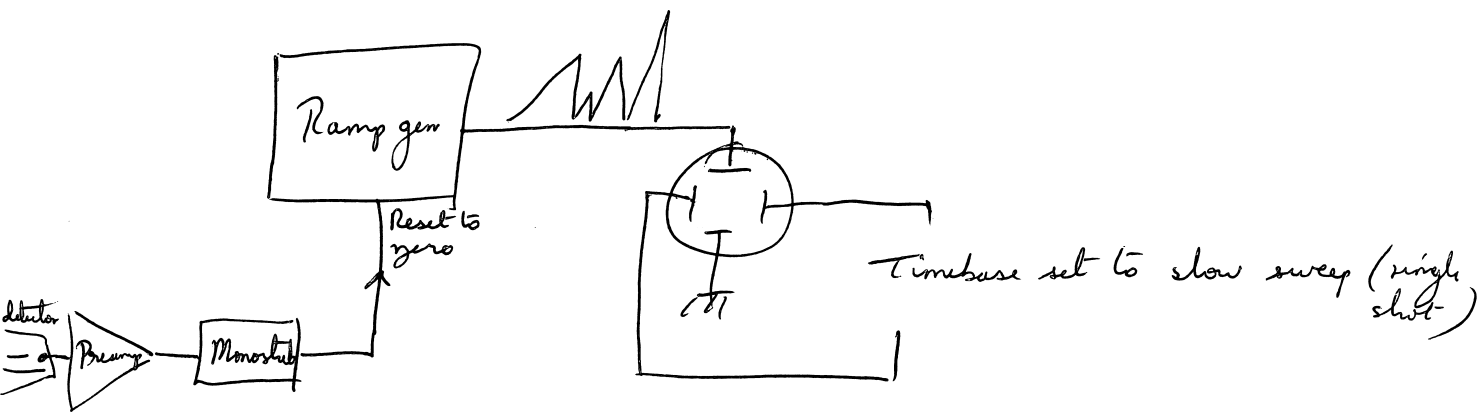
His setup :-



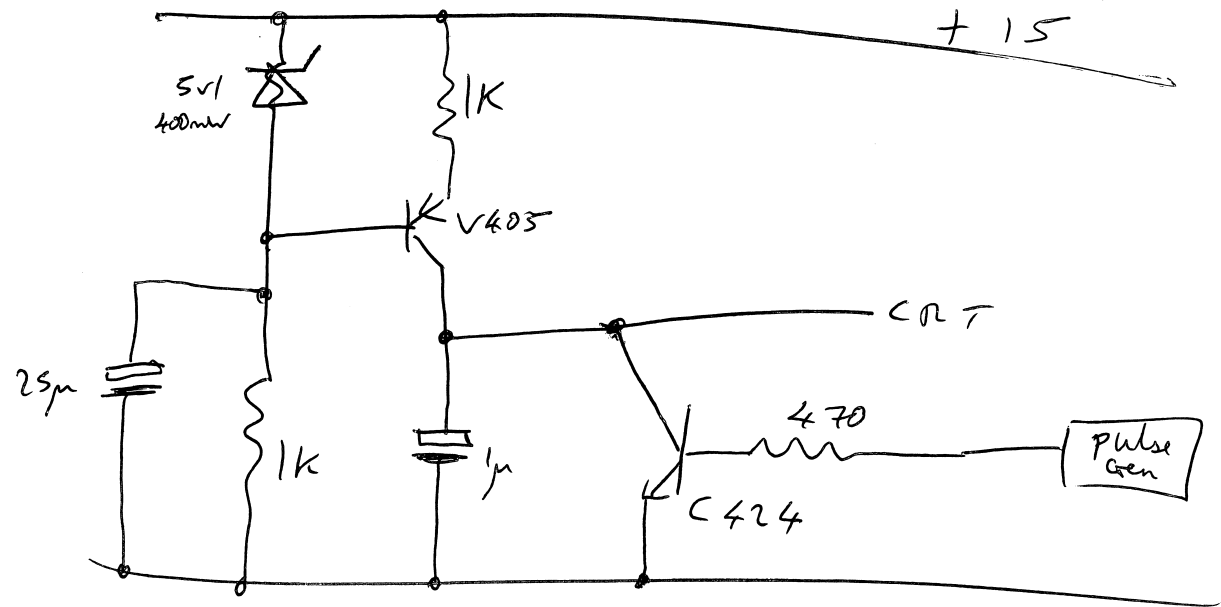
@ 78°K, ~~1~~ No pressure 10^{-8} - 10^{-8} Torr

He pressure $3 \cdot 10^{-3}$ Torr Helium (!?)

MSS suggests looking at spot in PST's atomprobe, selecting spot with probe hole, & using some sort of counter to look at rates. However, in view of time-scale of fluctuations (< 1 sec) this would be tricky (i.e. to select hi or low state).
Therefore, I suggest using ramp generator reset by each arriving ion to zero, to indicate time between arriving ions directly, & to give (rate) immediately - see over.



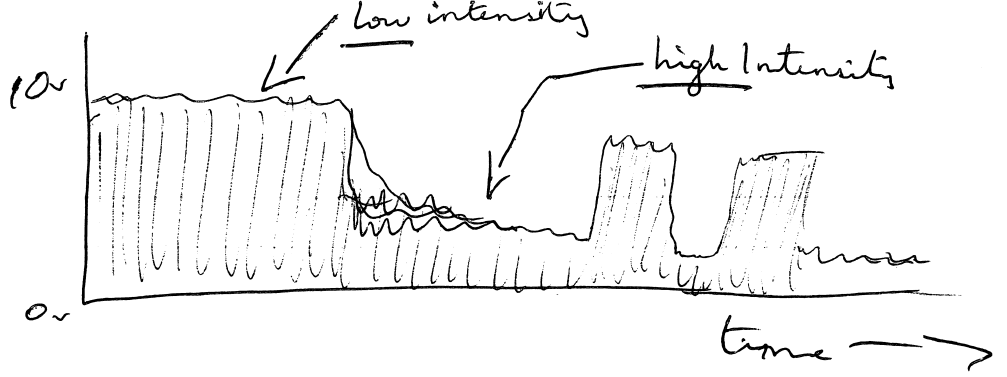
Circuit tried (crude but effective!)



Reset pulse needs to be $\geq 50 \mu\text{sec}$ to reset integrator to zero.
 Full scale at ≈ 100 p.p.s. (≈ 10 volts)

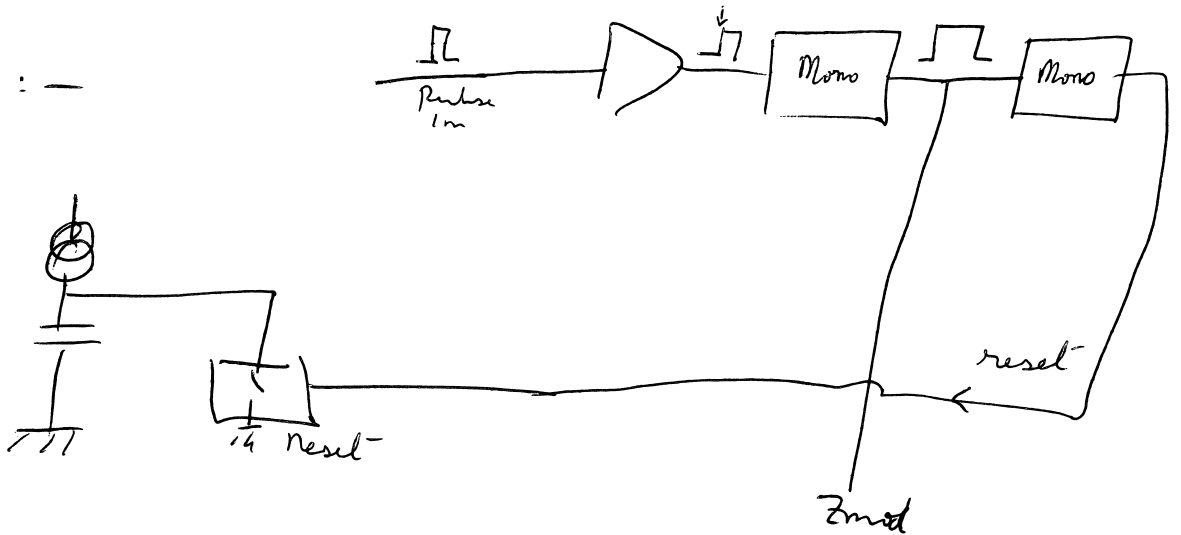
→ case $\cdot 1 \mu$ for 1 Kpps rep-rate

→ hopefully

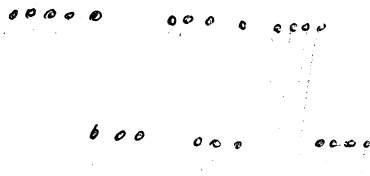


Could use Z mod to bright up trace just before resetting. to give clearer display.

Z mod :-



→



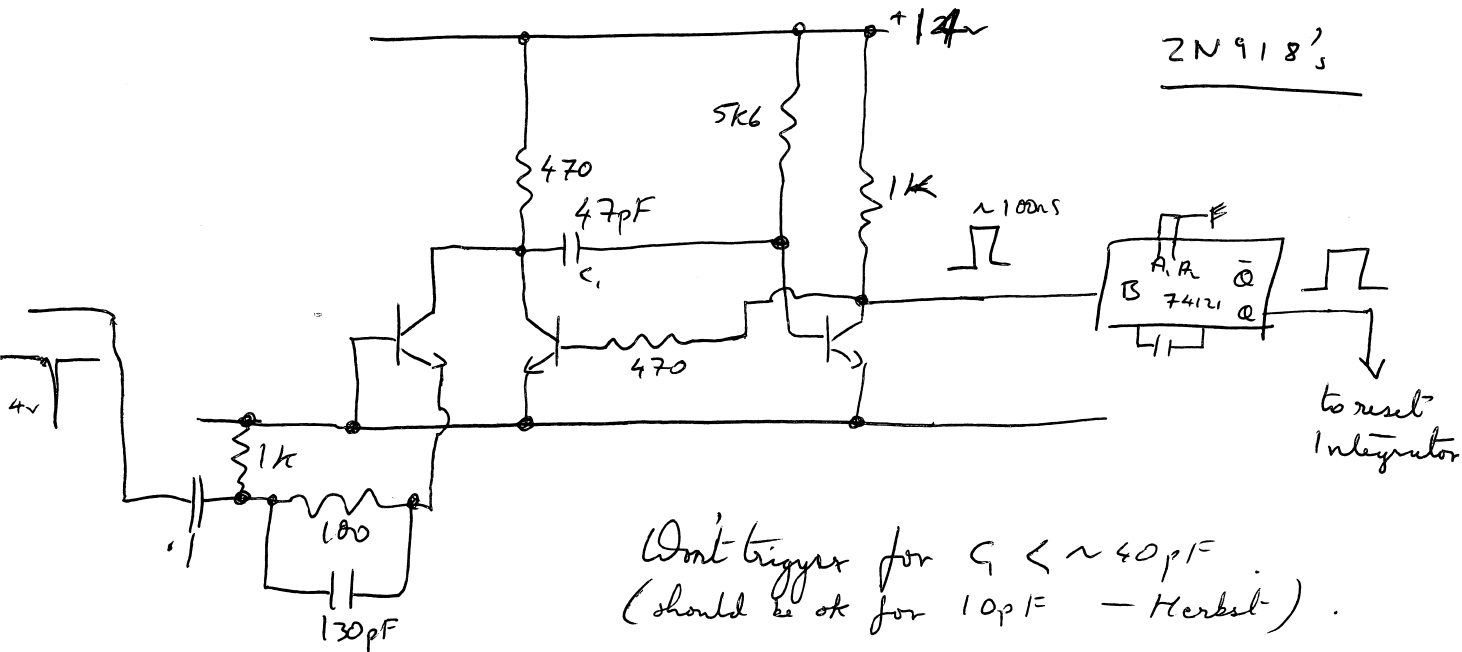
○ _____

This works, using pulse gen for delay & reset pulses. (A & B channels)

? How to get pulse out of presump. Monostable 74121 apparently won't trigger off a 25ms negative spike (spec says 30-50ms min).

Tuesday 14th

Monostable to accept -ve spike from BSR's preamp :-



Circuit used to fire 1 μ s monostable (74121) to reset integrator shown above.

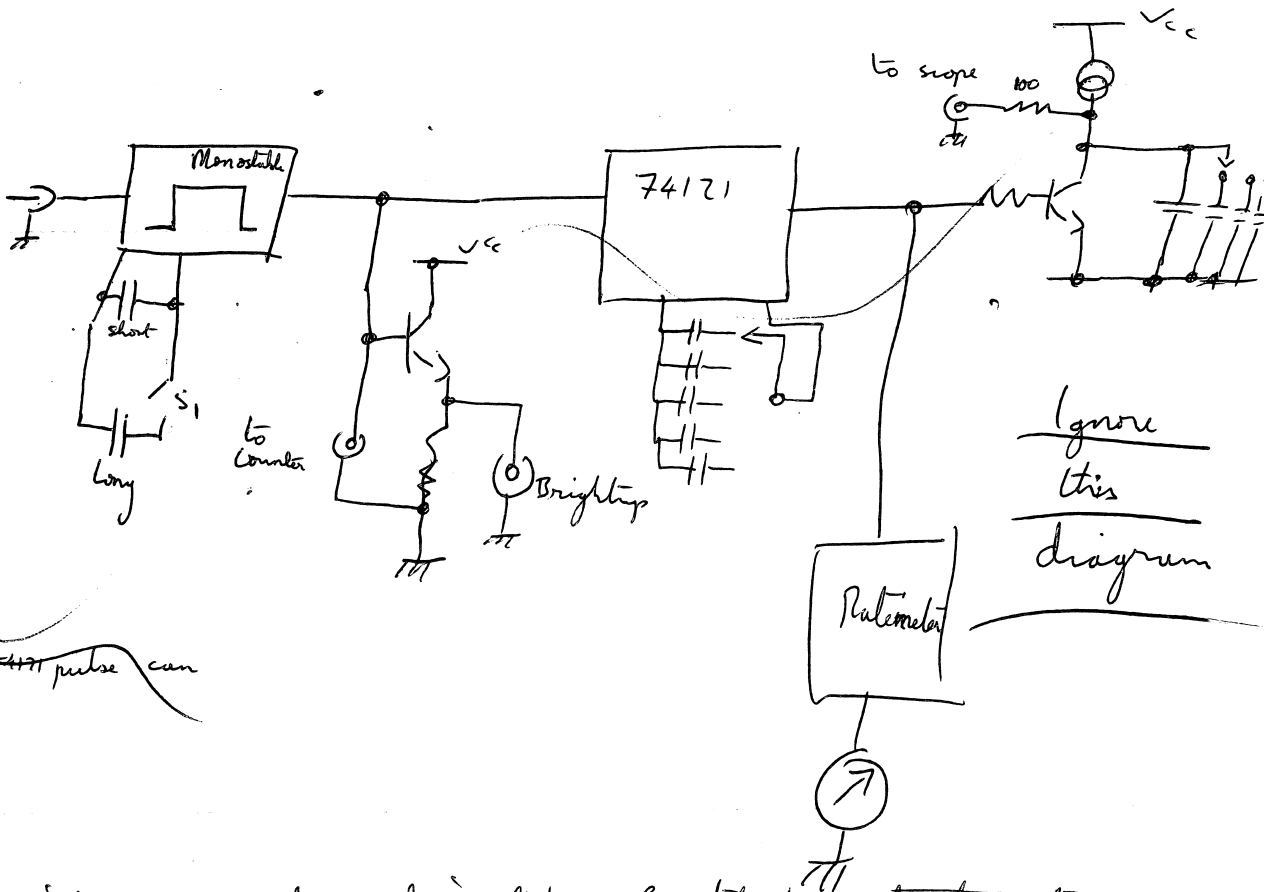
Circuit tried out on Paddy's atom-probe. Apparently works, though integrator doesn't set to zero every time apparently - drive switch harder/use faster switch/longer pulse - Not many image gas ions (~ 100 /sec) so with .1 μ integrating cap doesn't get proper raster.

- Conor
- 1) Fit 74121 with ~~range~~ range-switch & capacitors to drive a restemeter as well as raster generator.
 - 2) Fit ~~switch~~ switch & caps to integrator so can adjust over range say 10 to 10^4 ions/sec & Put in box with BNC input/output/power in & space for meter. ? meter from old pirani gauge box.

Fit first monostable with a ~~larger~~ larger cap & smaller cap so can use small ($\sim 40-50$ ns) for driving counter & larger ($\sim 5\mu$ s) to brighten trace of raster at peaks to avoid losing & short

time intervals among a lot of fast ones.

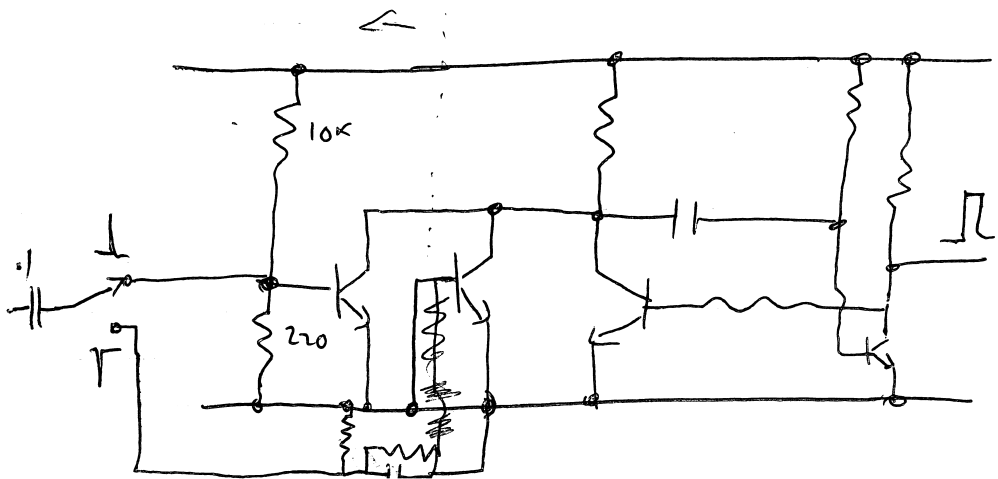
So:-



If use 2 x 5 74121 pulse can

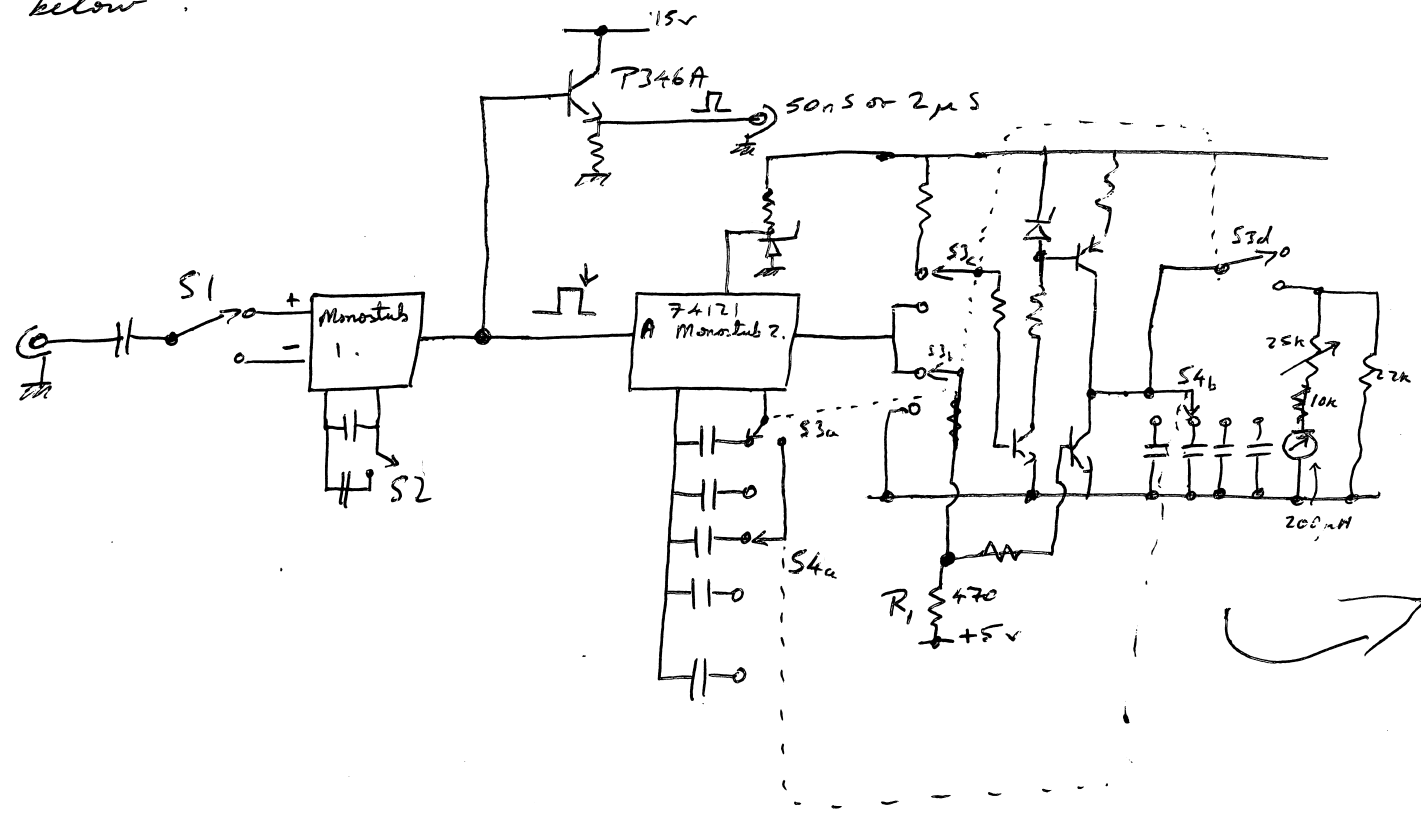
Wed am acquired 200 μ A meter, display box & switches for ratemeter etc.
pm Physics exhib @ Alexandra Palace. Not much interesting. Met
 Ernie Lucas from CCR.

ppm decided need 7475 to latch overflow indicators on counter (see above somewhere)
 Decided to mod ratemeter to accept either sort of pulse: - viz



Wed Thurs
below.

Drilled box & assembled ratemeter / timer as



Trace brighter & effective — med 4k7 series resistor for Marconi scope.
Risetime $\approx 7ns$,

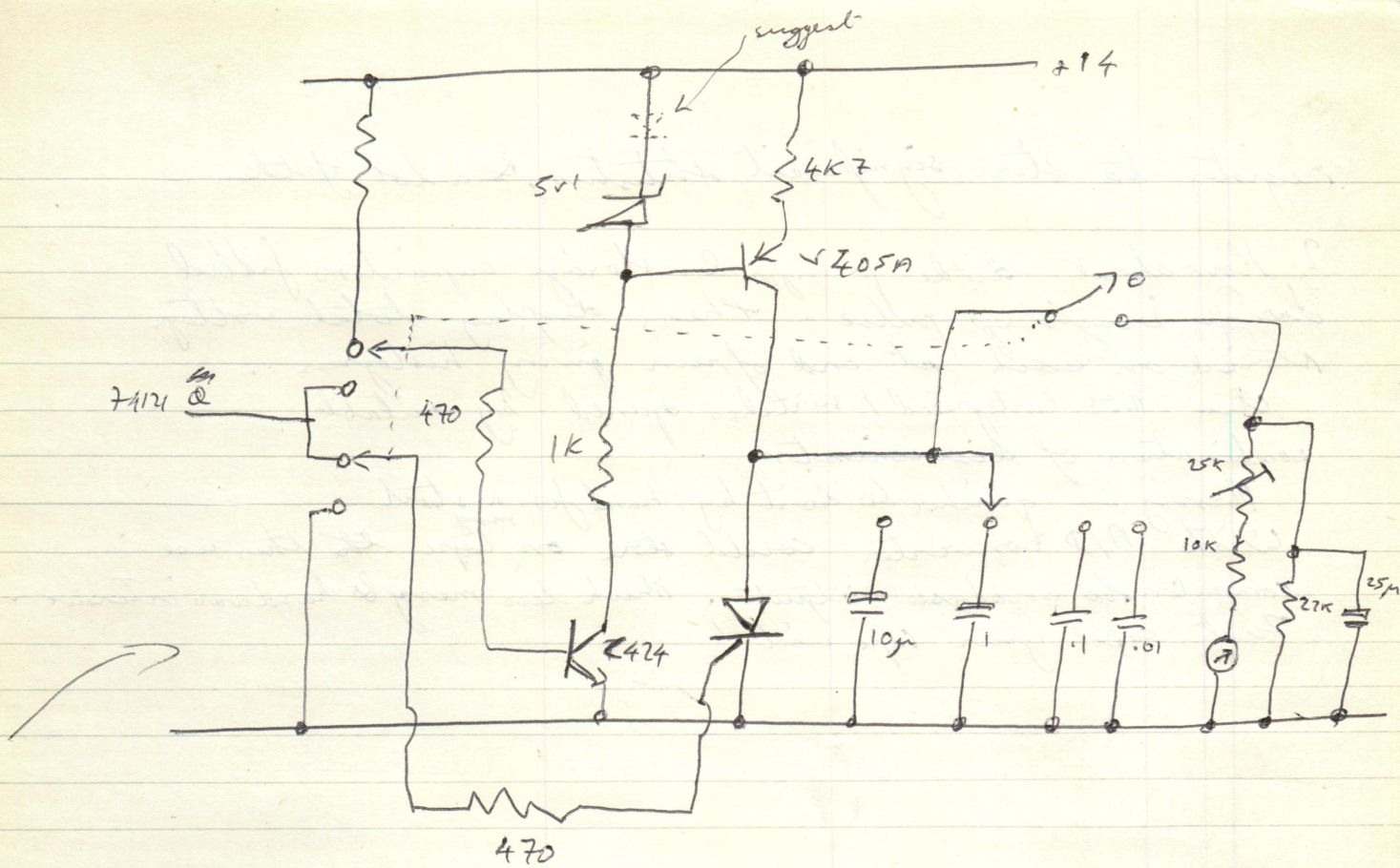
Smoothing (25µ) cap removed from zero in current source as
a) unnecessary b) has to discharged for each ion in ratemeter configuration.

⚡ Circuit does not work as drawn as the switching transistor can't discharge integrating capacitor in the 2µS allowed (would need to draw $\approx 50A$)

741 Integrator replaced using MRLD's glorious 'white spot' thyristor: now works beautifully;

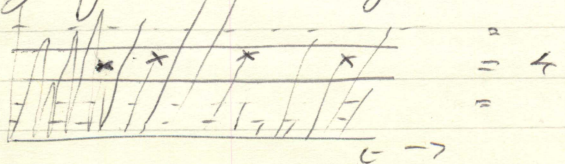
10.000 M2 seal arrived from Serator Labs (36 Valleyfield Rd, London SW16 2HT);

£1.50.



Tested on atom-probe. Rate of arrival of ions $\approx 200/\text{sec}$.
 Seems to work v. well. Discussed expts with M5S & decided there was a lot to be done — eg ions inverts from single spots under different conditions — “ “ “ spots with adsorbed NO à la Burgess — randomness of currents (eg whether Poisson distrib — does this fail to hold for short times between events & if so how short) — rate of recovery of current after the application of an evaporation pulse to the tip (desorbing gas but prefer not substrate atom being imaged)

? Is there a quick way of analysing output from timer — ie no of peaks lying between 2 given levels on the trace :-



Digital counters would be complex : need large

register to store significant statistics, & a lot of them.

? How about diode prongs & storage capacitors filled during brightening pulse. Then display total voltage stored on each at end of run giving histogram.

Use MOS (integrated) switches opened by suitable combination of discriminators.

Messy — quarter to do it by hand for a start.

With A/D converter could store on ^{mag} tape then use computer to analyse output. Much less messy & hardware intensive.
First catch your tape unit!

AEI's phoned estimates (17/Mar/72) for system.

Sub pump £155

Cryostat £189

Flanged ft. £100

" " £33

Main ass £797

Extras flanges
nuts bolts etc's blocks £185

Assembly £45

155
189
100
33
797
£ 185
1459
32

? What the hell goes on about cryostats?

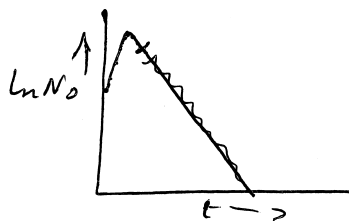
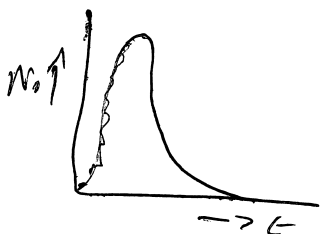
Monday 20th March

Started on transistorized stool clock (Clock using 7400 seems to drift rather, - 'orrible waveform).

Received official AECI quote, same figures as above.

Borrowed atomprobe to measure time between
cosms using ratemeter / timer & storage scope - photographed
on Tri-X Pan, F4, $\frac{1}{8}$ sec.

Developed & printed film, measured up 24 out of 32
plates (boring!!) - see opposite - and plotted
on a graph



Fall off at low t is very likely due to the
difficulty of measuring a small peak close to the
next - scope trace is fairly thick & storage screen is grainy.

If prepared to lose longer spaces can use smaller
integrating capacitor. Probably better to use timer (digital)

takes up the correct value. GOK why. Investigate.

Also to fix: - display over-underflow lights to be latched

- add a "gate open" light.

- add a chop-frequency switch.

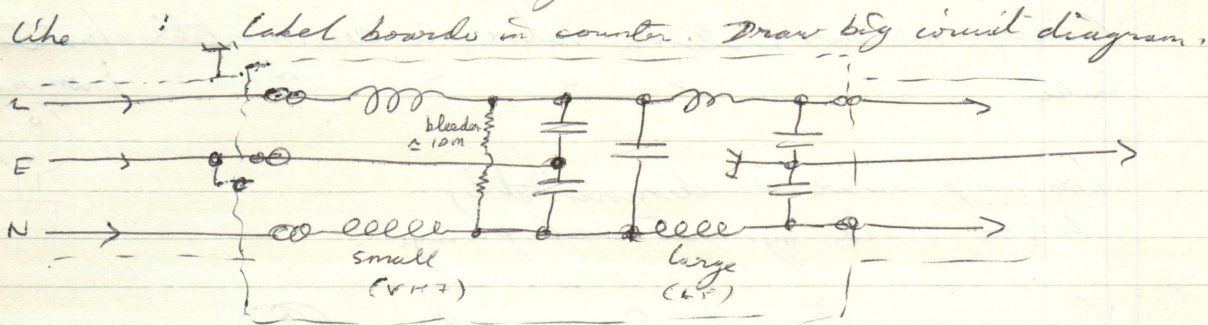
- cover over 2V3055 on back panel.

- paint & ~~write~~ label front panel.

- build a mains filter.

summary like

THIS



Also to be done ✓ Order ~~EA~~ EA micr. (but see below) (is manipulator OK) 28 Mar

Check length of Te sub pump filament holder } looks about right, vacuum system

- Check out bakeout control circuit.

Check out orientation of flanges on EA.

9 May
Build

✓ Design table / support brackets.

Design manipulator support & adjustment } & get them built,

camera stand.

Build channel plate assy.

analysis support assy.

Order Mirror / screen / BeO washers / Mumebat / Tip support

silica glassware / stainless steel for ep mount /

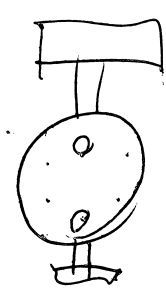
- encapsulated resistors / Bakeout heaters / sub pump
cryostat / bits for overs.

Build Preamp / PSU's for lenses (Harwell writes

a) floatable b) stable @ 100 v ?

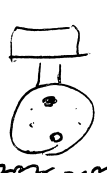
3m

3 space & 1 on cube.



X 4 — value on resonator system & different spaces with holes the other way around

Various measuring systems value & demonstrable / not demonstrable from not demonstrable



For pump value & demonstrable 4 1/2 and 2" of symmetrical flanges

Various measuring value & non rate



Now 4 1/2 sub pump value & non rate demonstrable

- 1) Important - drawings, testing? Force?
- change of cut-outs in made shield (mumps/ultra shaper)
- see 3) below for (notable) FC 100 flange
- 2) a) FIM chamber with 10 x 1 1/2" od ports + FC 38 flanges - quote says 11

3) a) Munsell & actually 10 5/8" (270mm) long, not 10 1/2"

b) F 100 notifiable flange should be on main chamber, not on manifold, so that our rotate the converter of it's mounted on the 6" blank.

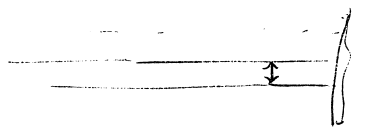
4) or

s) c) a) 1/2" red not 1/4"

b) length > 12"

b) length > 1 3/8" (34mm)

radius is 1 3/8"



7) Is $\frac{3}{4}$ " id ok - check with paddy. ~~to~~ Check what length this is

8) Offset of RD? should be 15mm.

9) ok

10) ok

11) Don't want this, Delete.

12) ok

13) Drawn as $\frac{3}{4}$ " manifold, ? should I be rotatable,

14) a) For FC100 read FC150.

b) For FC100 read FC150.

d) Insert $1 \times 2\frac{1}{2}$ " od port terminating in FC64 fixed flange.

Total price = ?

15 ? Assembly & bake.

16 ? Drawing.

Fr 24th world

Time between image gas ions in
μSec obtained from P5's alone, probe
with counter - 50 nS, pulse from scale meter

W 110 Zone dec 50 k He 6.6 kV BIV
5 10⁻⁶ Ion Gauge reading. 230 on Helipot

3201	2043	1691	1559	4325	2497	7418
1782	5302	7302	2316	2030	4671	496
2409	1009	11548	3529	462	3369	1209
933	1668	11923	434	3998	1769	1874
418	16259	483	1975	12644	1904	2295
4185	391	2527	101	656	3311	403
15922	407	2152	1147	4392	698	105
9557	19	308	3611	6600	5208	4478
4220	14679	2424	500	2059	9085	46
1082	13506	6933	1	94	8585	962
7140	7013	809	2447	7290	23643	1930
7990	543	1149	459	5221	11285	3358
303	3805	87	1328	11061	10278	1212
5687	828	14620	3987	6634	1597	4459
8643	3923	3185	2996	2411	2028	1991
1272	4908	2056	1218	920	1038	1
1403	1662	7974	10986	2022	8384	520
809	2485	3525	4271	1000	937	1221
1285	1172	3119	1603	1613	191	1787
100	3421	12433	2230	6581	874	739
2069	7546	6627	1076	2500	931	4204
2548	7980	592	425	115	5413	621
6364	385	851	3459	10350	1140	17625
2259	8413	2029	6995	1694	1590	5731
1761	3845	2573	525	1476	728	2099
2772	487	9488	5067	9227	9937	5947
1604	6814	192	578	4826	495	970
1	1823	2137	620	4660	5737	60
342	2776	99	100	3834	10640	867
4979	1093	907	480	3089	4920	4763
6838	384	96	5759	18836	398	4032
8144	4640	18353	879	12359	2145	131
<u>123022</u>	<u>131429</u>	<u>149192</u>	<u>72667</u>	<u>154989</u>	<u>145526</u>	<u>83554</u>

Contd

$\frac{150}{420}$

5257	3993	831	68	2367	710	2079
10852	135	245	6977	983	1965	6177
6860	4408	5219	2750	3968	3272	1850
8067	68	8816	2233	8250	8373	704
5764	5506	2181	8017	956	9811	2495
14029	10463	1922	2520	3883	133	1228
1134	1349	5136	260	5681	22906	4523
3815	533	202	2904	9214	20709	15962
397	1662	5380	2195	607	973	6883
6893	8080	6882	87	2113	647	762
3238	4009	4785	3472	6450	6555	4401
4353	3027	1977	12128	2841	3268	1012
1894	3493	1538	2670	3760	6609	267
2300	5783	2169	2182	546	4246	872
2929	1904	1307	12066	111	7793	658
6697	1931	3329	1113	350	11385	2608
2999	17216	567	3546	713	973	1315
1882	9648	568	905	207	2315	2464
1579	6969	5272	105	5172	8431	2106
861	274	957	10817	1885	2552	6779
2464	5886	4526	5370	640	909	9479
6801	372	6039	14032	4631	2424	12309
2364	3891	7124	1211	2401	1440	15508
1314	6037	2425	2041	424	7782	6489
2222	12	5689	875	2100	4027	10698
1	2746	15081	4655	615	6635	3376
747	598	2390	1079	2987	1616	410
4403	209	3224	4686	228	2044	9503
5870	4089	7389	11093	1814	17478	458
2213	879	2060	2036	2909	462	730
1532	7140	15866	2055	11246	18469	447
1012	4185	57	1073	5289	13067	2590
1785	3360	1078	1483	6742	2252	15411
14141	7515	2334	2256	2738	523	5433
660	312	2	1906	5	6553	12669
<u>139,329</u>	<u>137,904</u>	<u>144,694</u>	<u>133,686</u>	<u>104,826</u>	<u>209,307</u>	<u>172,655</u>

Conid

Rate of arrival

ions in 1 sec - apparently

Conid	1955	1956	Current $2.5 \cdot 10^{-17}$ Amp. 180	Rate of arrival	Notes
13695	195	1956	(!)	161	has drifted since beginning when was ≈ 250 .
2717	5435	2504		163	
5877	5983	904		169	
17487	6104	25217		185	
2390	10431	10430		176	
8936	744	2010		221	
3513	3002	2326		227	
3386	4935	4681		185	
4403	3742	32401		162	
3912	5828	1168		199	
5525	1624	412		192	
12055	21233	2177		186	
11043	4103	161		189	
1593	8234	1654		204	
3922	1215	1872	350 +	188	
12853	15715	6337	<u>224</u>	175	
977	15903	747	574 ions pairs recorded.	173	
7735	955	5190	<u>2.530008</u>	188	
279	4095	11460	574	197	
3426	4253	9034	= 4.4076 mSec mean	205	
9387	473	2920	separation of ions.	183	
4966	2747	6316		193	
23806	1495	8469	$\frac{1}{4.4076} = .2268$	181	
7509	19162	1712		169	
285	4022	8989		190	
14477	1209	4458		192	
1188	13763	2921		212	
3125	5079	70		201	
6072	9617	9513		196	
6179	12692	3093		207	
5323	8065	9910		181	
2776	5711	14		213	
2750	2933	2409		187	
376	5978	7951		199	
7218	1125	13070			
<u>21131</u>	<u>220741</u>	<u>204356</u>	$\div 20530,008 \text{ sec}$	640	

$$\frac{6403}{34} = 188.3235$$

$$\frac{1000}{188.3235} = 5.3100$$

25th Sat Working out table opposite & producing graph which shows theory & expt. apparently agreeing for times > 1 ms between ions. Good number of ions in range $0 - 100 \mu s$, tho - not enough for 'statistically meaningful analysis' (BSR 2, 1991). Need some sort of ~~some~~ window-type sorting on taking data, as ions opposite total up to only $2\frac{1}{2}$ secs of actual observing time - taking $\approx 1\frac{1}{4}$ to do & more to sort out. Inefficient!!

26 Sun

27 Mon } Sorting out queries on ~~EA~~ EA mic quote from VG, putting dimensions on drawings.

28 Tues Went to VG of East Grinstead (via Bournebury to drop off HT sets for repair) met T.S.T. Long time arguing over shape of radn shield - interesting to see what actually arrives! Arthur Kaye & Co. Also long argument of over price of cryostat - v. reluctant to come down to a good price, but better than their original quote of £450 (but no testing or drawings). Ordered system eventually.

29 Wed Bungy around. Painting pretty nice for pop.

30 Th Go home for Easter.

6 April Th Come back from home.

7th Fri More or less back. Designing manipulator support, can't finalise \therefore don't know of bellows.

10th Mon Arthur Kaye phoned up re 5.5 rods for mounting analyser. - whether $\frac{3}{8}$ or $\frac{7}{16}$. Told him $\frac{3}{16}$. Also said would send him copy of Paddy's manipulator. Designing table for mic (alumin. alloy).

11 Tues Pondering in Rayleigh on the surface interior finish of vacuum chambers. Time taken to pump out from

atmosphere to UHV is v. prolonged compared to the amount of material actually pumped out — i.e. most of pumping time spent at low pressures where pumps don't bite. If a chamber at UHV is filled to 10^{-4} with, say He, then pumped out with a slow diff pump, pressure goes down extremely rapidly to UHV. If system is at 10^{-4} & full of crud, water, etc, takes v. long time to pump out. Ergo, time taken to desorb said crud from walls of chamber is limiting factor.

If crud is only weakly bound on walls ($E_{ad} \ll 15 \text{ kcal}$) may be fairly readily desorbed at room temp & rapidly at $200^\circ +$. If $E_{ad} > 25 \text{ kcal}$ very little indeed is liberated at room temp & chamber may go to UHV readily. Some is liberated on bakeout. In range $15 - 25 \text{ kcal}$ is released slowly at room temp & not much more quickly at bakeout temp. Also, some physisorbed gases may become chemisorbed on bakeout if the activation energy is high. These are most awkward. Also most relevant seems to be the slow release of H_2O from the pores of the oxide films on the surface of metals.

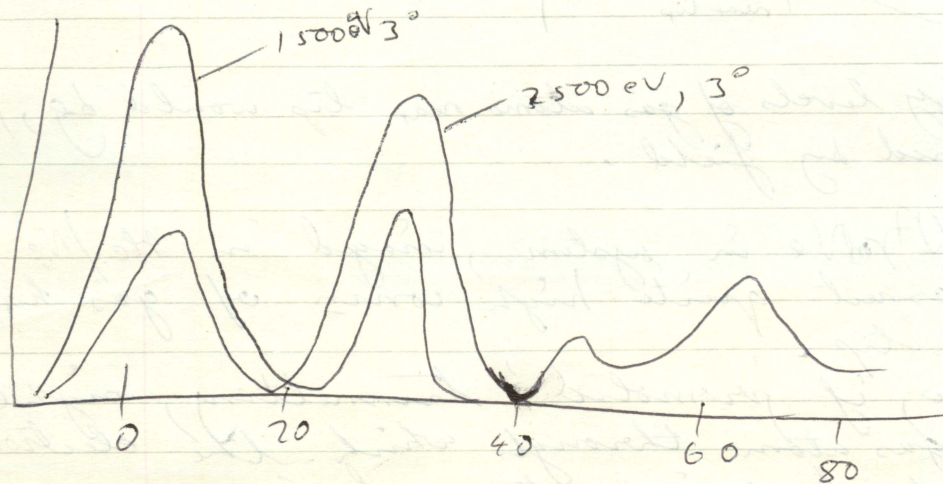
Diffusion of H_2 through steel (4×10^5 in atmosphere + more liberated by decomposition of water vapour on surface of steel (not stainless) also a limiting factor in 10^{-11} range. Also observed to get reduction of pressure by $\frac{1}{2}$ when cool ^{glass} envelope of ion gauge from normal 50°C to room temp, with significantly less H_2 (from H_2O in glass presumably) — from 3×10^{-10} to 1.5×10^{-10} in expt quoted in thin film book.

Question is, is a thin film (1000 Å say) of say gold is evaporated in UHV onto baked S.S., can one cover up surface of oxide with a non-porous film of not greatly increased area (irregular) of metal which

does not oxidise & is hydrophobic. Even if same amount
 of water is adsorbed, should be less tightly
 bound & come off much more readily.
 Film must not trap H_2O below surface or allow
 it to get in thro' porosity. ? Evaporate onto
 still hot ($\approx 100 - 150^\circ$) chamber walls - rate
 $\approx 1000 \text{ \AA/sec}$ for good order in film, apparently.
 P S T thinks may have been tried but could find ref
 & is not sure if only total desorbed gas was about
 same, & time not measured to get user. Also,
 Au is apparently not permeable to H_2 , so should
 discourage it from diffusing through the envelope.
 Investigate further. ? Try it on the cube.

Wed Looking at Bardon et al J Phys B 1 1968 p1083
 & " " " 3 '70 207

on subject of scattering of He^+ by He, Ne, Ar, Kr, & Xe in
 $\approx 310^{-14} \text{ s}$. Scattering over 1° to 10° of beam $500 - 3000 \text{ eV}$
 leads to an energy loss spectrum caused by inelastic
 collisions raising neutral target atom from its ground state
 to a higher state. Deflected ions detected in 127° e-s
 analyser ($\Delta E/E \approx 2 \cdot 10^{-3}$) to give spectra -



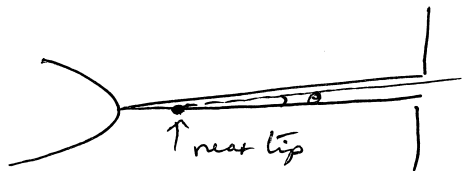
? Would this be capable of providing any significant & detectable energy loss in 7im EA?

1) Intensity of scattered beam in Baudouin's expt was weak, needing multi chan analyser for data collection, while incident beam was apparently much stronger \rightarrow path less in target area of several inches, probably.

2) How much denser is He gas near 71M tip due to a) oxygenic cooling b) electrostatic attraction
 If much more conc than 10^{-4} for 10^{-4} in chamber, might expect significant scattering.
 Scattering of 3° leads to change of energy in forward dir $\approx E \tan \theta \approx E \theta = E \frac{3}{20}$

— should be thrown out by EA if scattered = $\frac{2000}{20} = 100 \text{ eV}$ through this angle. \angle subtended by probe hole

$\approx \frac{2 \text{ mm}}{30 \text{ mm}} = 4^\circ$, or 2° \angle angle, so would collect ions scattered from edge of spot towards centre of image of spot.



3) Energy levels of gas atoms near tip would be, presumably broadened by field.

With Ar^+ in system, imaged in He/Ne, might expect quite high concn of gas 'hopping' round tip.

Also, if 'promoted' tunnelling, might not the gas atom through which the electron tunnels be raised to a higher energy, state resulting in loss of energy of exiting ion —

probably unlikely, since ion which is ~~leaving~~ doesn't acquire kinetic energy sufficient to ~~excite~~ excite gas atom (i.e. $\approx 20\text{eV}$) until has travelled $\frac{20\text{eV}}{\approx 4\text{V}/\text{cm}} = 5\text{ cm}$ which is a fairly large distance.

(X section $\sigma \approx 10^{-17}\text{ cm}^2$, $\sqrt{10^{-17}} \approx \frac{1}{2}\text{ cm}$).

Should be easy to check if there is any correlation by looking at F^+ spectra for inert gases and comparing with known loss-spectra or energy levels.

? Could losses of field evaporated ions be attributed to energy levels above ground state in departing evaporated ion. If so what mechanism, & why the observed distribution (? what-actually is the distribution?)

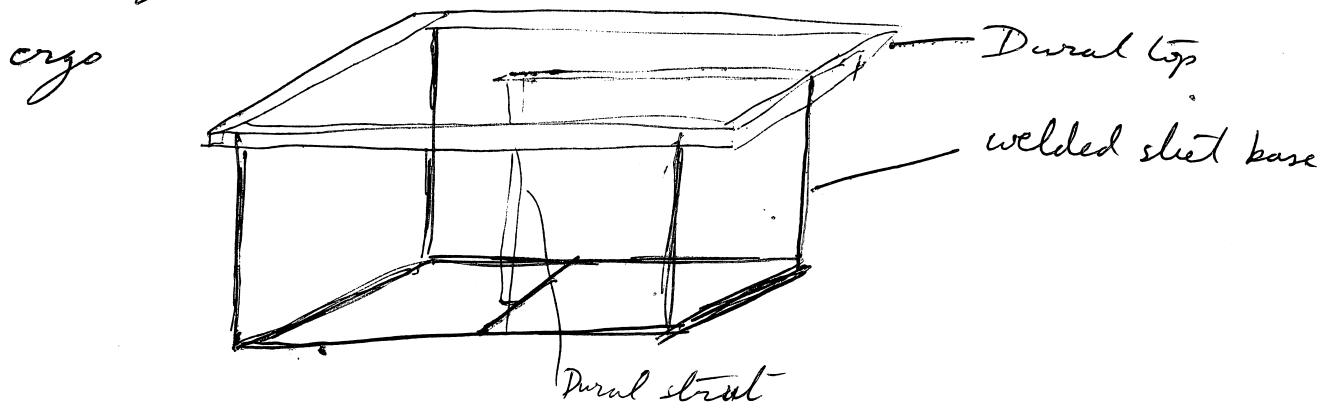
? How do excited atoms lose energy (? UV radn or collisions with walls of chamber. (or green?))

? Richard Forbes et al observe violet light from region of tip/tip mount - commonly attributed to secondary electrons from screen. ? does this go away if suppress e^- with magnet. if not possibly from deexcitation of ~~some~~ ^{some} gas in some manner (expect UV for He, but what about others?). Probably nothing to do with it.

- Thus Considering whether to put an extra port on back of analyser flange to allow
- beam extraction for retarded atom probing (see Muller looking for plasmon effects)
 - Insertion of seven screen + plate to allow alignment; looking in thro' back of flange.
 - Allow addition of extra feedthroughs if necessary. etc.

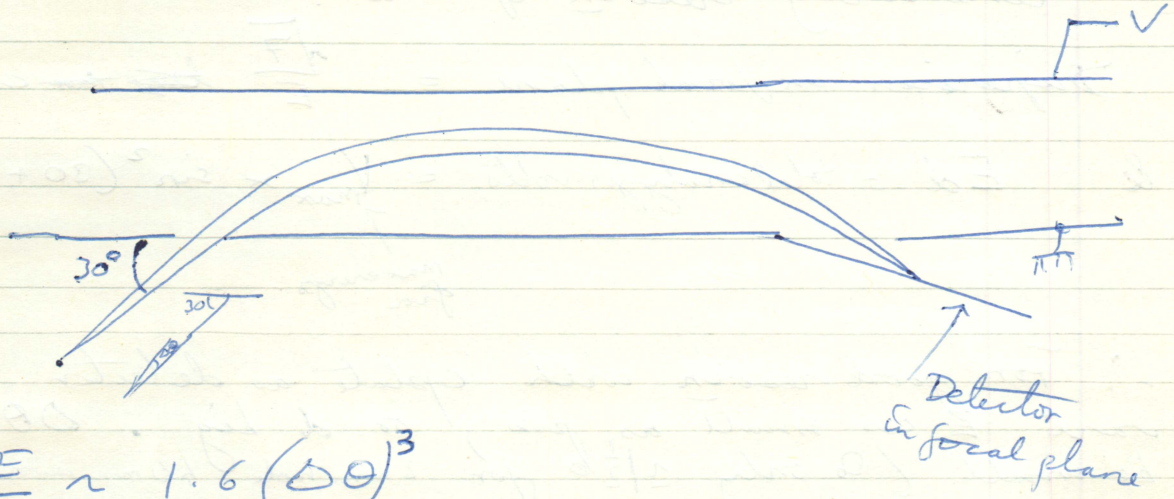
However, phoned up V.G. & found that metal-ceramic ~~ET~~ ET-5 feedthrough is $1\frac{1}{2}'' \pm$ S.F.A. ; this only leaves room for a $\frac{1}{2}''$ pipe + miniconflat, & really not worth the trouble. Unfortunately.

Decided to make frame for microscope with welded steel base & aluminium alloy top — reason is — already have compumps & rotary pump excluding stray fields, & walls of microscope rooms are (!!!*) mild steel — or ferroconcrete — so heavy screening probably essential anyway.



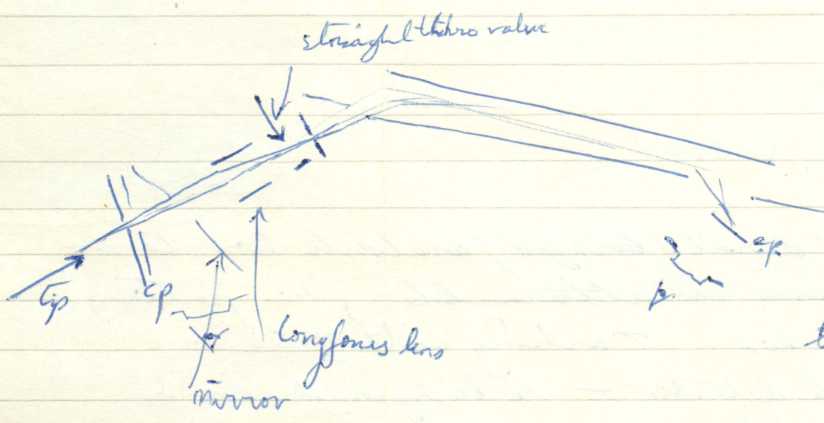
Should be much more rigid than bolted dural frame, & simpler to build. Thick asbestos-board top $4' \times 3'$.

Fri Reading about energy analysers - in particular
 parallel plate species (Proca et al) ~~Rev Sci Instrum~~ Dec '70



$$\frac{\Delta E}{E} \approx 1.6 (\Delta \theta)^3$$

Using channel plate & prox focus as detector, as sensibly sized instrument should give energy distributions with a resolution of better than 1 volt at 4 KV total energy (assuming 10 lines/mm resolu for c.p.). Shouldn't need retarding lens or any lenses at all for this resolution, though could improve it by suitable means :-



Analysers needn't be in UHV for this arrangement: can use aperture stop as a diff. pumpup aperture. Could use a scintillator to give time resolved spectroscopy, perhaps

Could polish grounded plate & use instead of 45° mirror to save space & get distance between tip & ground plane as small as

possible) making instrument more compact.

Out Considering resolu of inst.

Dispersion on focal plane = $\frac{\sqrt{7}}{E}$ ~~cm~~ cm/volt

& $E d = \text{total analyzer volts} = \underset{\substack{\uparrow \\ \text{max energy} \\ \text{from}}}{V_{\text{max}}} \times \sin^2(30 + \Delta\theta)$

∴ For good resolu with cplate as detector want E as small as poss, or d big. Δθ must be small (Q only $\approx \frac{1}{2} \theta$ for 2mm hole 40mm away from tip.

$\rightarrow \frac{\Delta E}{E} = 1.6 \times \left(\frac{1}{40}\right)^2 = \frac{1.6}{1600}$

= .25 10⁻⁴ which is bloody good.

? make 7cm = d analyzer in 4" tube or in large Ni plated brass box.

Now Considering spectrographs further.

tries Constructing brass / dural / boraxed / araldite box to see what sort of vacuum is attainable, re putting analyzer in such a box. Talking with MSS on desirability of channelplate detector - re background noise & reciprocity failure in film: can one detect everything or not? experiments required. See P Cartwright's thesis.

Wed 19th - Measurements of ion current measured on 'up/down' counter via ratemeter on PST's clamp probe. Slight interference on opp of BR's preamp, not apparently counted. ≈ 1 spot He 50°K W Near 110 on zone decoration - several spots under probe - Hole. B 1 V ≈ 6.3 KV

Pressure $1.02 \cdot 10^{-5}$ Torr on ion gauge (He) Background $\approx 8 \cdot 10^{-10}$ unbaked.

10 sec count =	8582	8601	8525	8619	8207	8859		
	9208	9305	9293	9008	9332	9096		
Helipot = 221	8730	8880	9023	9062	9032	9084		
16.3 KV	9047	9159	8885	8826	8779	8941		
	9010	8961	9101	8878	9063	9093		
	8957	9100	8916	8911	8789	8893		
	8980	9192	9014	9132	9007	8952		
	8887	9018	8917	8936	9012	8978		
2 v. high readings, unexplained & rounded.	8989	→ 27115	8927	9035	8966	8900	9132	
	8992	8831	8776	8902	8891	8956		
	9144	8903	8886	9078	8881	9047		
	9023	9095	9028	8900	9001	9203		
	9150	9123	8913	9100	9124	9195		
	9183	9132	9125	9151	9026	9144		
	9140	9042	9117	9018	9297	9208		
	9284	9320	9369	9293	9039	9007		
924.42	9223	9075	9322	9174	9185	9154		
	9383	9142	9183	9188	9367	9176		
	9239	9181	9279	9543	9402	9179		

This series of measurements was made to see if the ~~total~~ ion current was drifting due to gas pressure changes or to a slow decrease in gain of multiplier or any other part of system. No long term drift was apparently apparent (!) after a minute or two.

Same spot

388 chip part
341 Paddy

~~388~~
103

$\frac{3}{10^3} \times 10^9$ 30

Helipot
230
(6.6kV)

9563	9582	9733	9567	9537	9815
9614	9736	9535	9442	9614	9567
9777	9670	9628			→ 962.5333

225	9497	9383	9623	9589	9616	9444	9474
	9705	9424	9507	9335	9351	9325	9501
	9372	9508	9202	7450	9586	9566	9313
							→ 946.5285

220	9015	8997	9019	9008	9091	9151	9058
6.3	9092	9135	9211	9092	9030	8918	8956
	8943	9299	8923	9040	9048	9229	9146
							→ 906.6717

215	7785	8198	8110	8065	8057	7989	8053
	8070	8031	7860	8037	7957	8014	7913
	7895	7917	7949				→ 799.4117

210	6372	6263	6295	6214	6370	5793	5497
	5428	5427	5976	6149	6195	6197	6155
	5927	5764	6278	6010	6281		→ 603.1105

205	4065	4135	3751	3399	4108	3535	3769
	3566	3473	3972	3985	3746	3757	4186
	3912	3778	3943	4142	4249	4409	4135
							390.5476

200	2576	2509	2580	2609	2575	2620	2560
	2580	2611	2641	2626	2628	2597	2522
	2590	2568	2531	2607	2690	2618	2563
							→ 259.1476

195	1368	1453	1381	1373	1449	1450	1428
	1400	1451	1480	1439	1397	1447	1458
	1456	1496	1454	1440	1432	1440	1740
	1498	1523	1417	1472	1468	1491	1481

→ 145.65

Helijost

190	709	730	709	778	748	754	780	761
	859	764	742	741	720	760	812	745
	766	771	771	787	764	762	762	778
	755	736	$\Sigma = 19764$		$\rightarrow 76.0152$			

190 (50 sec) \rightarrow 3778 3998 3821 3745 3750 \rightarrow 76.368
73

185	1924	1901	1865	1839	2232	1983	2363
							\rightarrow <u>40.3052</u>

180	1754	1814	1241	1318	1268	1318	1249
(5.1Kv)							\rightarrow <u>28.4628</u>

175	1022	1685	1582	after Ten 1481
(50 sec)	(100 sec)	(100)	not quite as cold	\rightarrow <u>16.4857</u>

All above are with the lens voltage optimised for 31V

Effect of lens voltage, 10 sec ^{count time averages} 175 on Helijost

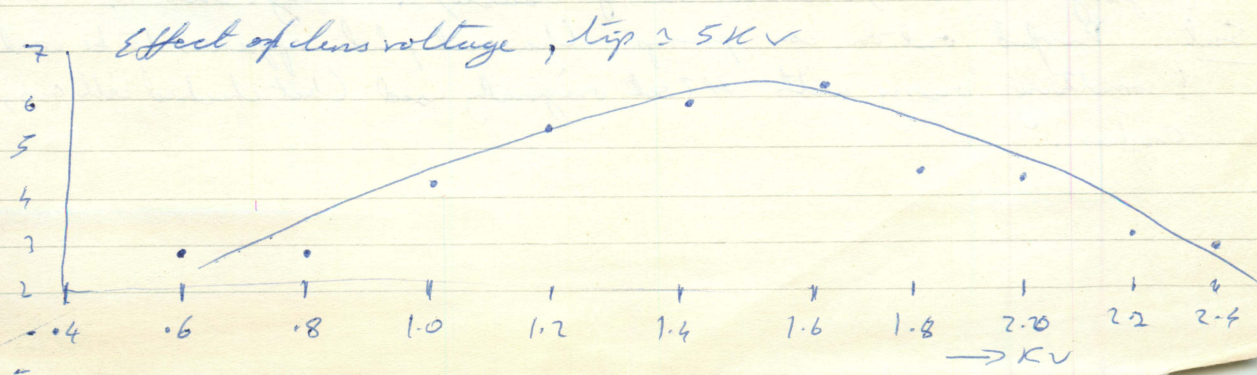
1KV	1.2	1.4	1.6	1.8	2.0	2.2	2.4	1.0	0.8	0.6
154	164	191	181	150	127	96	83	164	97	90
127	176	176	213	143	157	105	103	150	98	98
142	188	223	240	163	154	111	111	138	93	106
<u>473</u>	<u>548</u>	<u>590</u>	<u>633</u>	<u>456</u>	<u>438</u>	<u>312</u>	<u>297</u>	<u>452</u>	<u>288</u>	<u>294</u>

221, lens 1.9Kv, 10 sec

9206 9231 9166 9102 9270

so current is still the same as was at start of the run.

to



trip ≈ 6

lens ≈ 1.9

channelplate ≈ 9.2

Lens voltage was not changed for the current/voltage run, ~~was~~ but left at ≈ 1.9 KV (optimised for DIV) so current readings at lowest voltage will be $\approx 20\%$ low ($\frac{1}{5} > 20$ ions/sec = add 4 to total)

Dark current in multipliers was not measured ~~at~~ on this occasion \therefore of each of time; do on next available occasion.

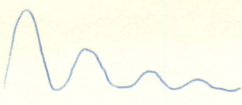
A discriminator after preamp would be a good thing, to ease calculation of absolute current, allowing for statistical variations.

Thurs Fiddling around with Luke's backing line - grotty bellows fixed.

Fri Reclaiming H7 set & leads from 'ppp' to use on steam engine.

Problems with channel plate, like no picture, hot up to air, & prodded around with awo - nothing visibly wrong. Fitted new He bottle (old one is contaminated with air: new one so fitted with a damaged flanged knife-edge buttered, but will see if usable). Rough out.

Sat Purged out on con pump, channel plate appears to be working OK
? something wrong with H7 set originally used (but checked with awo, so what was?)
anyhow.



Mon 24th 50K He $110^{-5} T$ ($9.85 \cdot 10^{-6}$) W

10 sec

230	11046	11024	11123	= 1106.4	Zone decoration (110) for 2 spots
225	11541	12593	12328	= 1215.4	
220	12313	12343	12197	= 1228.4	
215	10844	10732	10696	= 1075.9	
210	8492	8343	8358	= 839.8	
205	6108	5946	6044	= 603.3	
200	3560	3562	3418	= 351.3	
195	1771	1771	1789	1722 = 176.3	
190	791	851	833	897 [50K] 4262 = 84.83	
185 (50)	1978	<u>2606</u> ?	1939	1743 1720 = 36.950	
180	<u>588</u>	196	<u>232</u>	158 <u>297</u> 153 215 208 190	
?	172	168	175	225 270 <u>324</u> 149 329 327	
?	221	<u>304</u>	<u>451</u>	212 221 152 137 145 175 161	
.	171	183			

175	<u>207</u>	91	89	87	<u>393</u>	133	122	85	79
?	77	<u>172</u>	80	88	95	<u>134</u>	105	134	84
.	90	99	75	<u>131</u>	75	108	60	104	75

170	<u>174</u>	63	65	56	68	64	45	64	<u>183</u>	95
	48	52	75	54	63	46	48	<u>163</u>	<u>104</u>	54
	81	53	<u>164</u>	<u>159</u>	52	54		<u>60.00</u>		

165	29	55	26	<u>102</u>	51	<u>131</u>	47	44	50	61
	24	36	40	37	38	54	41	39	<u>226</u>	<u>70</u>
	74	33		= 4.244						

160	28	26	29	24	24	27	23	24	39	27
	39	24	<u>133</u>	30	31	30	<u>141</u>	<u>43</u>	30	24
									= 2.865	

10 sec still

0	7	5	1	3	8	1	2	1	1	3	2	3
	(35)	9	4	7	4	6	6	6	7	6	(23)	6
	2	7	2	2	2	3	0	2	6	(16)	(31)	2
= 0.367	2	(17)	(77)	5	0	1	4	3	3	(22)	3	(236)

PTO

Comments. With tip volts = 0, measurements of background noise showed a number of large counts. A peak of 236 was observed at the same time as a maged passed outside? ignition interference.

With pressure in system 5×10^{-5} Torr, the count rate was 0 (49000) in 10 sec, which is less than 5×12000 . Presumably collisions in flight-tube or saturation of the Bendix multiplier is becoming important. ~~at the~~

at tip volts ≈ 175 & below, small bright spots were seen moving on the image (? we) these presumably account for some of the apparently spurious high readings obtained.

Turning volts back to 210 gave 26815, 6778, 6766 etc (after at least 10 mins at 0 volts) so some hysteresis effect apparent.

With preamps turned off, no counts on counter after > 8000 sec (traffic), but no mageds! (1 scooter!)

5127 5002

Zone dec on 1st magd out from (110) = ~~8765~~ 8765 8723
(10 sec) { 8746 8742
8966

Small cluster on centre of central (110)
4857, 4865
4911, 4800, 4919

central 110, small cluster

230 4764 4826 4800 = 479.7

225 4919 5017 4973 4985 = 497.4

220 4839 4966 4821 4734 = 484.0

215 4660 4517 4717 4703 = 464.9

210 4426 4404 4396 4433 = 441.5

205 3716 3627 3780 3647 = 369.3

200 2690 2664 2803 2738 = 272.4

195 1457 1440 1434 1406 = 143.4

190 660 671 706 652 721 882 650 665 618
 650 681 = 66.74

Lens voltage constant at 2.0KV for this & previous run

moved

185 305 316 306 324 300 314 288 313 275 304
 292 217 = 30.46

180 153 229 162 143 146 127 119 150 138 130 152
 146 = 14.24

175 112 93 164 76 78 94 99 64 84 146 57
 73 78 82 84 97 75 = 8.100

170 45 51 64 40 50 44 38 38 44 47 49 42 44
 34 42 40 39 40 56 117 85 51 44 48 51
 = 4.69

165 27 30 34 41 36 37 28 33 31 32 32 22
 32 39 27 28 38 38 34 35 35 27 = 3.255

160 19 19 28 33 28 24 17 33 25 19
 = 2.45

$$160 \quad 130 \quad 104 \quad 122 \quad 126 \quad 133 \quad 139 \quad 143 \quad 127 \quad 124 \quad 109 = 12.57$$

~~155~~

$$153 \quad 71 \quad 67 \quad 66 \quad 53 \quad 65 \quad 71 = 6.55$$

$$150 \quad 28 \quad 33 \quad 26 \quad 30 \quad 24 \quad 20 = 2.68.$$

$$220 \quad 4011 \quad 4072 \quad 2917 \quad 3846 \quad 4069 = 298.3$$

Edge of (111) \approx 2 spots :-

$$220 \quad 5680 \quad 5563 \quad 5671 = 563.8$$

$$230 \quad 3436 \quad 3330 \quad 3296 \quad 3345 = 335.1$$

$$225 \quad 4141 \quad 4129 \quad 4157 \quad 4156 = 414.6$$

$$220 \quad 5765 \quad 5707 \quad 5653 = 570.8$$

$$215 \quad 8106 \quad 7916 \quad 8112 \quad 7911 = 801.1$$

$$210 \quad 10171 \quad 10020 \quad 10016 = 1006.9$$

$$205 \quad 11455 \quad 11375 \quad 11307 \quad 11107 \quad 11145 = 1127.7$$

$$200 \quad 11603 \quad 11333 \quad 11152 \quad 11313 = 1135.0$$

$$195 \quad 9305 \quad 9180 \quad 9109 = 919.8$$

$$190 \quad 5545 \quad 5484 \quad 5505 \quad 5896 \quad 5294 = 555.9$$

$$185 \quad 3510 \quad 3515 \quad 3484 \quad 3644 = 353.8$$

$$180 \quad 2467 \quad 2459 \quad 2461 \quad 2475 \quad 2507 = 247.4$$

(10secs)

175 = 1716 1711 1773 1662 1723 1818 = 173.4
flapping bright spot

170 = 1257 1177 1160 1193 1146 1171 = 118.4
= 79.77

165 = 766 787 770 816 878 807 836 769 752

160 = 518 484 508 507 508 512 458 512 = 50.01

155 = 213 209 228 221 222 235 218 = 22.23

150 = 63 82 63 85 74 71 72 85 112 85 80
= 7.40

145 = 16 16 21 19 22 26 28 25 127 74 28 25
29 34 22 31 = 2.44

145 = 90 72 48 65 110 2879 67 51 54 6854
less 14000
1.3KV = 6.9625 14907
35257

back to 220 = 5472 5457 5661 5589 5618 5476
5592 = 555.2

A number of bursts of noise (including BSR) turned up at end of run - source not known. Little hysteresis over BIV values of current for this run

[NB Readings underlined have been ignored as probably are spurious - ignition or other interference. Must screen/filter Bendix p.s.u. Readings should be \pm within $\sigma(\text{Mean} \pm \sqrt{\text{Mean}})$]

Graphs of current/voltage plotted. Not quite like Chan & Feldman but points in common.

Vacuum Mic F4 Pentax HPV

Tues He 78°K W 1090V on cp 2.8KV screen

Blackboard

25
 2 x 1 sec @ 4×10^{-5} T on ion gauge,
 2 x 10 ~ " 4×10^{-6}
 2 x 100 4×10^{-7}
 1 x 10, 1 x 20, 1 x 1 @ 4×10^{-7} (down 3×10^{-7} at end)
 1 x 1000 @ 6×10^{-8} (background 2×10^{-8})
 1 x 10, 20, 30, 40, 50, 60. at 6×10^{-8} norm.
 1 x 300 sec with no tip voltage, 6×10^{-8} norm ($\approx 5.5 \times 10^8$)

Wed $\approx 4 \times 10^{-10}$ Background on Atom-probe.

26

→ 5×10^{-8} Ne } Ion Gauge readings
 1 x 10^{-5} He }
 1st → Fritures F4 $\frac{1}{8}$ sec Trix Pen.

	163	146	170	200	153	186	164	192	202	145	144
ions/sec	169	182	192	181	163	192	128	222	163	195	150
	193	191	172	143	169	129	192	172	181	194	
	153	162	216	121	128	185	150	192	146	202	

2nd Friture 1×10^{-7}

5×10^{-7}

2 x 1000 libase Diff place 5×10^{-8} Ne 5×10^{-5} He 8 pins

≈ 450 ions/sec. end of filament.

10.50°K

Film 2. Same spot as last pairs

1	10^{-7} Ne	7 x 2 secs per trace	3 x $\frac{1}{2}$ sec per trace
2	10^{-7} Ne	7 x " " " "	3 x " " " "
3.5	10^{-7} Ne	5 x 2 secs	
3	10^{-6} Ne	5 x 2 secs	1 x $\frac{1}{2}$ sec

All on (112), 2nd ring out from centre.

Helipot volts 257 (7.4kV) (bit below 31V).
 Δ 430 ions sec at end.

7/28
something like 11 22 (55) 10 10 20 20 30 (30) 60 60 300
1 1 22 55 10 10 20 20 30 60 60

f1 [noyuss tmin
 $\sim 10^{-7}$ Torr
1,250 cp 3.5 screen 6.5kV tip. ~~Flu~~ ~~Trix~~

— above are taken on varian system using
~~the~~ Langham Thomson camera with F1 Wray lens. all
v slightly out of focus. Idea was to get pictures at
low gas pressure so that only a few ions would
arrive per spot, to give an idea of 1 ion would register
~~on~~ on the film, (re c plate as detector in deflection-type
spectrometer). Expt not very useful: lot of cond in
system gave image of sorts even with no He officially there —
probably air leaking into gas-bottle through
known faulty knife-edge on conflat flange.

D reconstructing En pm

Mon 1

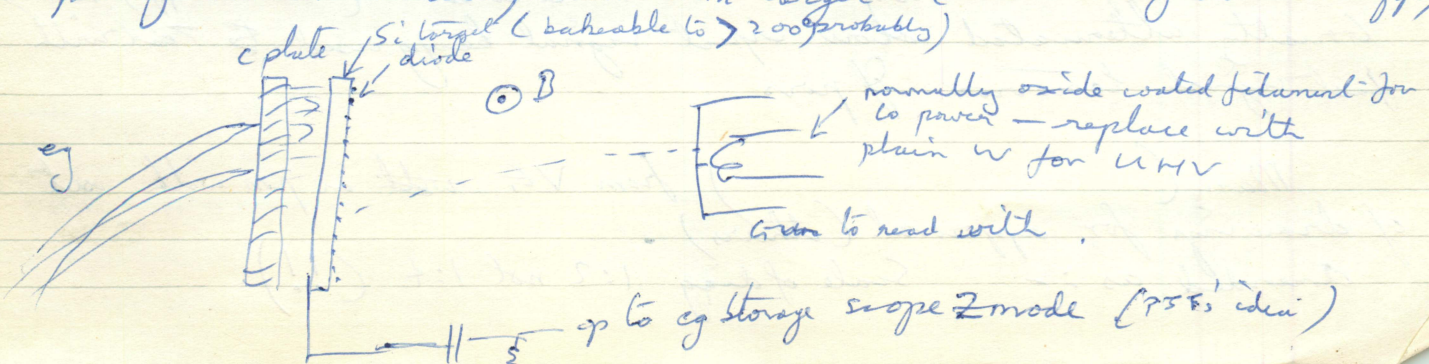
Tues 2 Melomed lecturing on Oxide film on Iron (ellipsometry & lead) also some FIM & FEM.

Wed 3 Demonstrating in am.

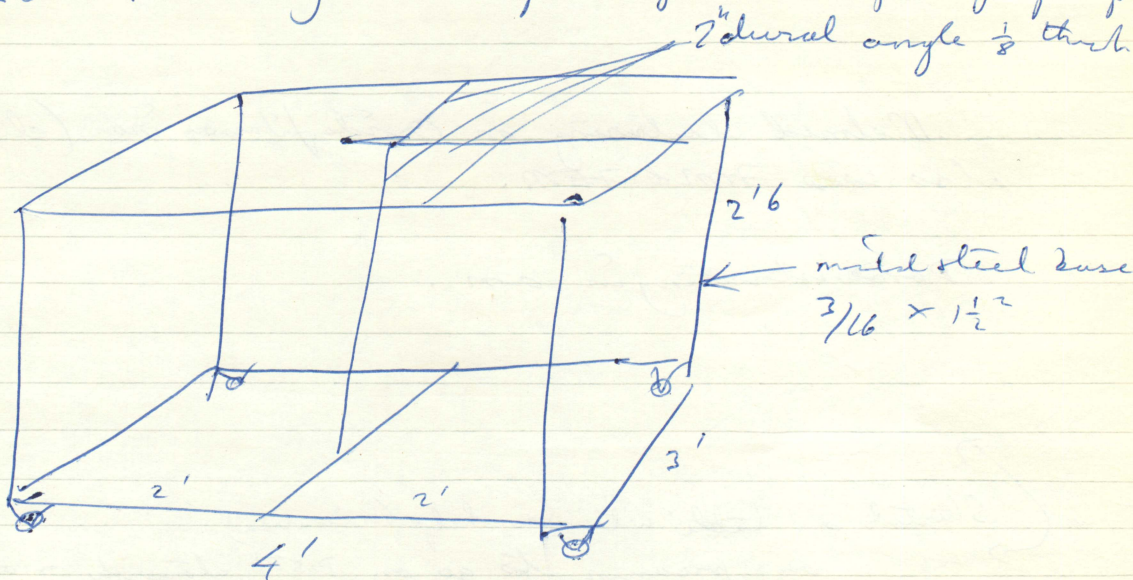
Thurs 4 Started on table with Soc's help (vice versa) on preamps to go on PST's at any rate or on multiplier output from energy analyser. Double-sided fibreglass board in box. Circuit given below somewhere.

Fri 5 Welding table, cutting dural for top. Demonstrating PM

Talking to P Cartwright on subject of detectors to go after channel plate in deflection spectrometer. Various storage plates under development but awkward to use. Better bet seems to be silicon target with ~~array~~ array of isolated diodes on back. Electrons arriving on this (conventionally from photo-detecting screen) produce $\approx 10^3$ electron-hole pairs, $1/2$ of which drift to diodes & are stored (until read off by beam on other side (electron-bombardment vidicon). Short-term storage adequate. $\approx 10\mu$ spacing between diodes, 16mm diam target (P 8061 English Electric type)



Monday 8 Finishing table apart from base plate for pumps.
2" dural angle $\frac{1}{8}$ " thick



Tuesday 9. Fiddling about with preamp, looking up references.

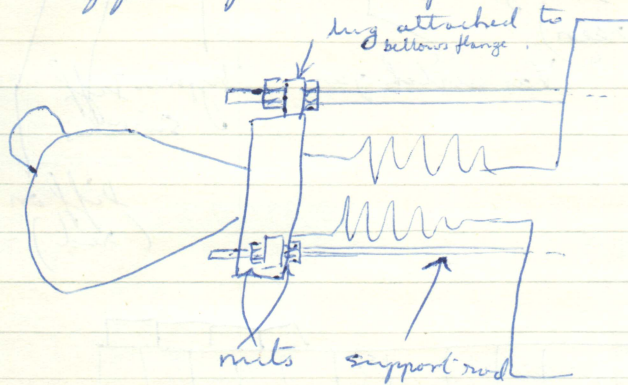
Wed 10 Still fiddling with preamp. Put on atom probe in place of BSR's preamp. First expt, long time const ($> 100\text{ns}$) of no emitter follower on off ($1\text{K}\Omega + 22\text{ft coax}$). Plenty of gain, tending to oscillate. So reduced gain & added emitter follower. Better rise time & so more noise, but not enough gain to get all input pulses near to saturating amp (although most above noise level: better to increase gain to give discriminator a chance). Added differentiation 50ns time const - (~~470~~ 470pf , 100Ω). Generally attenuated slow input signal being used. ~~to~~ Test with fast signal tomorrow if possible.

Man () from V&I with in pos with set of drawings for approval (others).
amended as:- Scale of diag 1:2 not 1:4 (!!)

Some dimensions added where necessary.

~~Detached~~ ? re support for manipulator

- drawn as

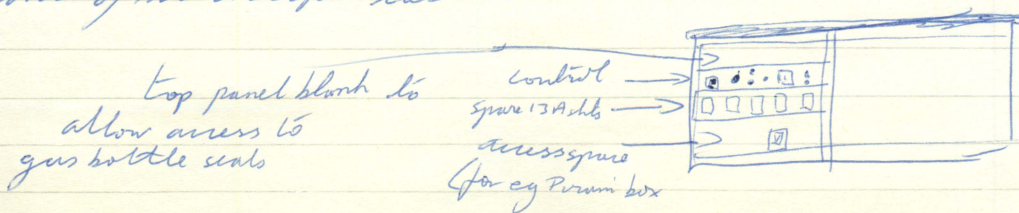


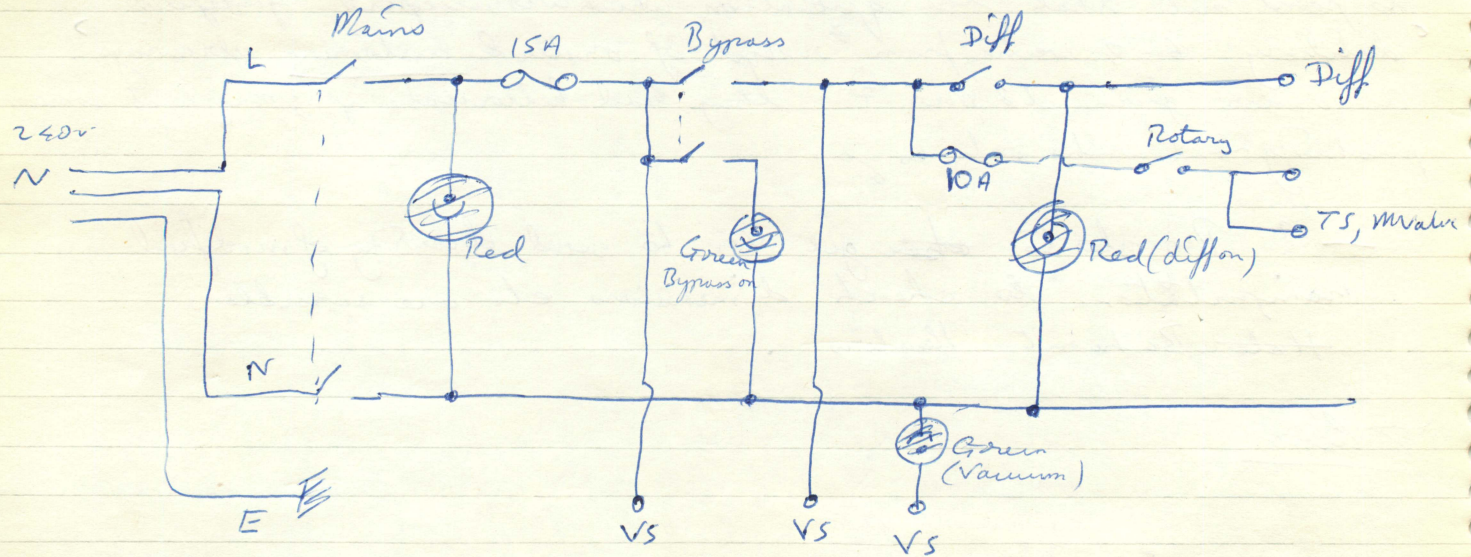
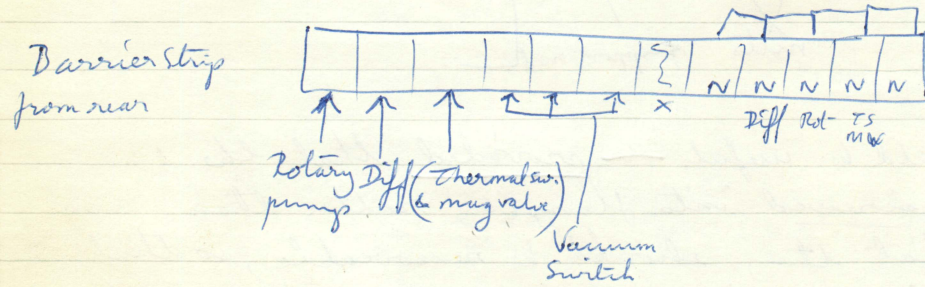
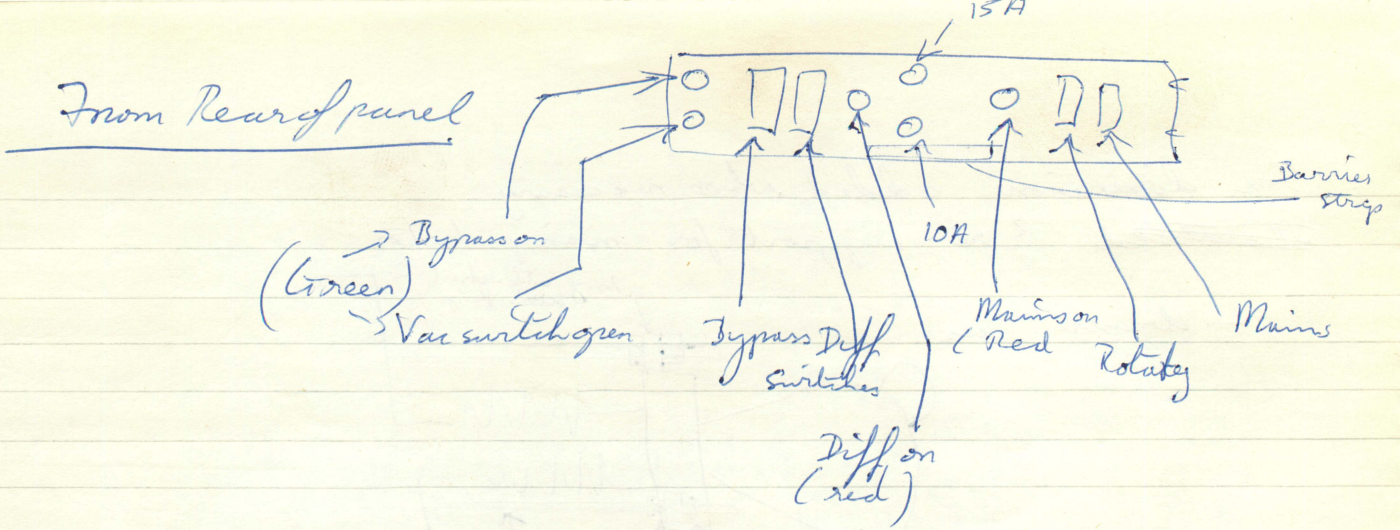
- suggested that would be useful - provided that the studs are actually screwed into flange (6") rather than welded: specified that they should be removable, so that can attach a semiuniversal manipulator. Approved amended drawing. VG will ^(say this will, say how) phone up on Friday to give delivery date - had to point out that the quotation which was accepted specified 'delivery 6-8 weeks from receipt of order & customers drawings'. As order given 28 Mar 72 they had better wake up; may need some pushing - 2 weeks only to go.

- ? Remember to ~~also~~ get VG to send drawing of modified manipulator to check dimensions etc are sensible.
Hate Bakeout Heaters.

Thurs

Fri, Sat fixed control panel for microscope (see overleaf).
Some additions to normal circuit. 14" panel mounting to go on front of microscope table: -





Monday 15th May

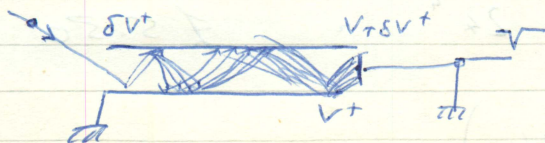
P57 phoned VG re system: - they seem to be v. disorganised -
A Kaye just back from honeymoon & Hayes (?) (ergonomics) has left: will write
to us sometime this week to give ~~the~~ delivery date & will try to
expedite: get impression that nothing will appear for 4 weeks or more,

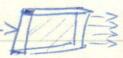
Joe proceeding, when pushed, with metalwork for table (to support
19" panels for controls & 13A sockets).

Fiddling with preamp in evening.

Tuesday Helping (?) J.R. with metalwork - 19" panels etc. Also
adding brass screen to preamp & ~~what follows~~ complementary
emitter follower output. Appears to work (9 pm). Test tomorrow, with
luck. V. tedious not having a fast risetime low amplitude
charge source for testing - ? rig something up with LED &
~~electro~~ photomultiplier. How about polyscop - testing amplifiers to
reveal all sorts of sordid details in freq response. Wiser not to!
 $\approx \frac{1}{2}$ volt noise on output of preamp with (hopefully) 50 ns diff.
time constant. Suspect have left out integrating τ . Lots
of gain apparently anyhow.

Spent some time on mod Monday looking up 'homemade'
Bendix type electron multipliers: -



Made by evaporating silicon doped with Mo onto glass plate &
coating with a 50 Å (I think) of Al_2O_3 to provide \approx secondary electrons.
- Nurb Inst Meth May '72. Made as flat rectangle  so
that they can be stalked for spectrometers, in focal plane.

Possibly useful. Gain $10^5 - 10^9$ (so better than a channelplate in this respect ≈ 10 noise pulses/minute).

Letter from P Cartwright (EEV) re conversation about detectors for spectrometer. Conclusions not very clear but no obvious reason why shouldn't use a TV type pickup device from back of channelplate.

Wed Thur Fri Worsening with so-called amplifier, which tends to oscillate with screened lead fitted to input - sometimes, added a brass screen inside box but little improvement.

19" panel with 4 13A chits on it for microscope - distribution board.

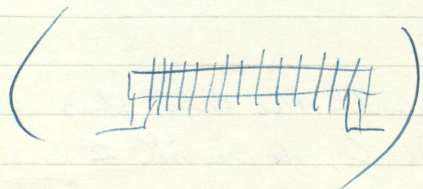
Black sindanyo top for microscope will have to be replaced with natural sindanyo, cooking \approx to 250°C with a hot air blower (+ thermocouple) ~~stays~~ decomposes board - black (pitch?) gunge oozes out of it. Useless.

More drawings from VG - manipulator & radiation shield. Pointed out that shield is OFHC Cu, not stainless. Phoned VG Fri \therefore hadn't written re delivery date - mumble mumble 3rd week in June. N.B.G.

Inquired about Finned heaters for microscope

- 850 watt 14" overall £3.50

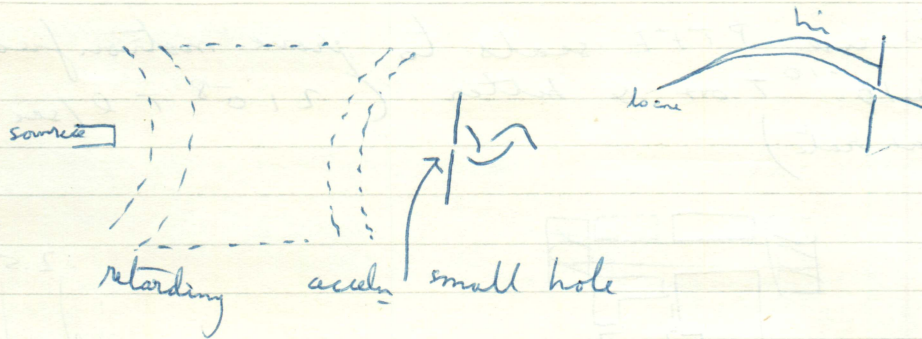
1750 watt 24" " £5.50



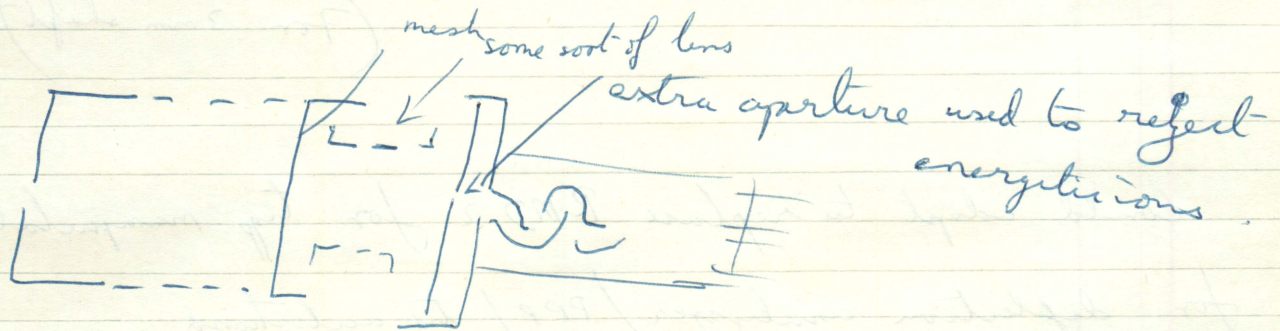
Wondering about construction of deflection analyzer
 - rigidity etc. ? Cut-glass strips to separate plates
 - what about pumping, tho? Also rigidity of box.

Also reading paper about improved retarding analyzer,
 - uses (Reel Si but or 5 Si last, 11mg) extra lens to
 remove highest energies & \therefore improve S/N ratio

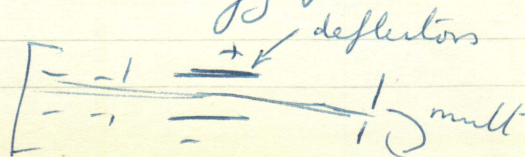
- vis



Might be able to adapt this to Plummers
 analyzer



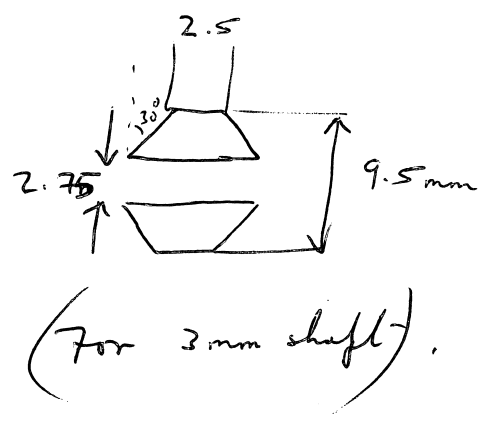
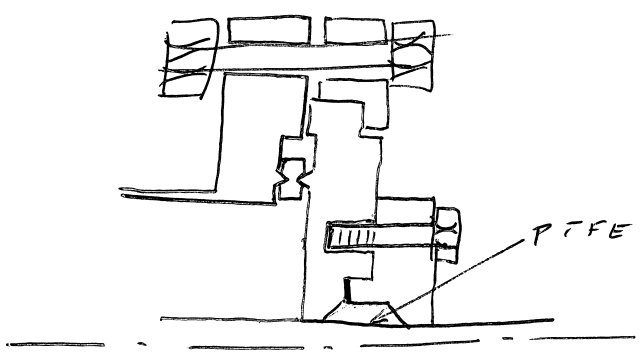
This would be v. useful if it could be made to
 work reliably & will repay further investg. when,
 in the dim distant future, the apparatus is assembled
 or how about an energy filter



trouble to, only ~ 20 v energy spread - should be possible.

Mon 22nd May Cool back from home 30c so nowt in air.

Considering manipulators :- Mills, Par Si Inst ¹⁹⁷² 4, 5, p 819
claims to use PTFE seals to prove motion feedthroughs
at 2×10^{-10} Torr & better (2×10^8 T L/sec upper limit
on Ar leak rate)



Could adapt to replace RMD 2 for tip manipulator
for deflection analyzer / PPP / tip autochange

Tres He $6 \cdot 10^{-8}$ LiAl background (approx) $4 \cdot 10^{-10}$ cold.

1725 volts on cp 3.5KV screen.

1 sec 1 1 10 10 50 background, 10, 50

tip off 1 10 50 sec

Trex Wrang 71 lens Leonard-Thomson camera
(A Hildon's)

Run static.

This was an attempt to see if 1 ion would register on film, with tip at BIV ~~on~~ (≈ 6 KV) and $6 \cdot 10^{-8}$ He ion gauge reading exposures of $\approx 1, 10$ and 50 sec were made. The 1 second exposures showed considerable numbers of spots - including a large no. of blurred ones as the camera was apparently not square to the screen. The image was clearly visible in the 10 sec exposures, and fairly well developed after 50 sec.

The pressure was then reduced to $\approx 5 \cdot 10^{-10}$ and more exposures made. Again, many spots were recorded, but no image was apparent. The tip voltage was then reduced to zero, and further exposures made, to get an idea of the noise level. A 1 sec exposure had $\approx 120 - 150$ spots on it, not particularly randomly distributed.

Used to measure current (Wed 19th April) @ $1 \cdot 10^{-5}$ T, 6KV BW,
current ≈ 900 ions/sec off a typical bright spot -

\therefore @ $6 \cdot 10^{-8}$, should be ~~$\frac{1 \cdot 10^{-5}}{6 \cdot 10^{-8}} \times 900$~~ $\frac{6 \cdot 10^{-8}}{1 \cdot 10^{-5}} \times 900 \approx 4.2$ ions
per bright spot, & much less for dimmer parts of the image
@ $5 \cdot 10^{-10} \rightarrow \approx 0.04$ ions/sec. Therefore it seems likely

that a large proportion of single ions register on the film.

Wed Royal Society surfaces meeting in London.

Thurs Expts on ~~the~~ 'dark current' of channel plate.

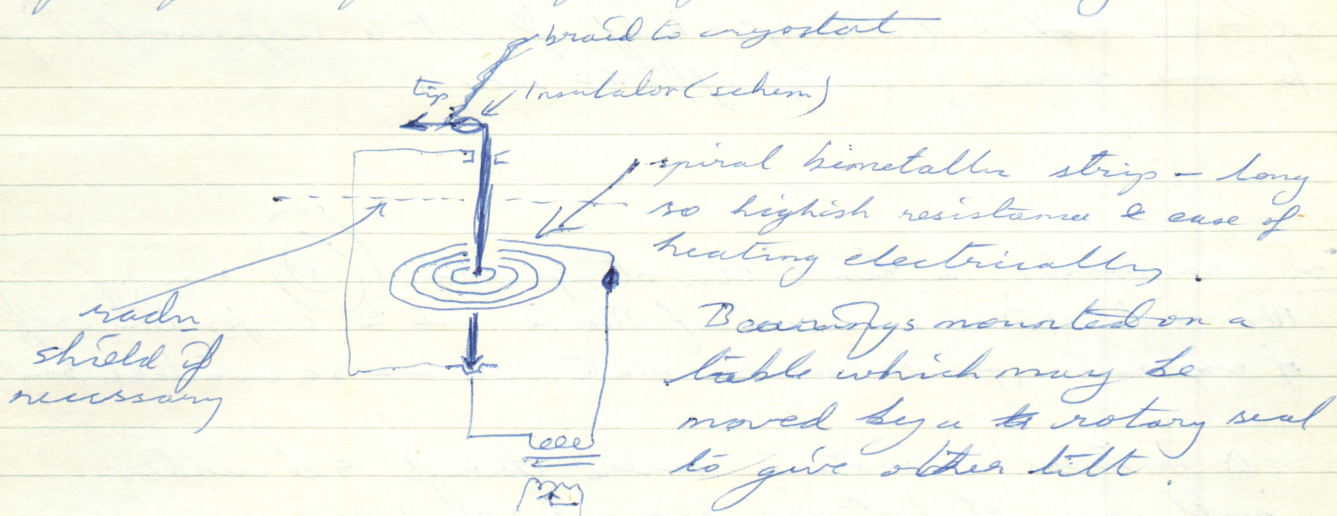
With 4×10^{-10} in chamber & screen at 3.5 kV the channel plate was run between 1000V & 1700V. The noise current appeared to start to increase at 1500V & to be quite large at 1700V. Noise was apparent in several forms: single random scintillations; permanently lit up-channel, whose brightness fluctuated a small amount; noisy channels which flashed at a second or so intervals; and ~~the~~ 'chains' of ~~spots~~ channels lighting up for a brief moment simultaneously (? high energy particles passing through the plate - cosmic rays etc). The latter appeared to occur frequently (1 every 5 sec - 20 sec) near the centre of the plate, but not very often near the edges (? different gain, or radioactive particle in plate itself). Also a small number of bright flashes lighting up large areas of the plate - ? particles becoming detached from the screen, or a shower of secondary electrons from some cosmic ray event. The lower portion of the screen also had a diffuse weak background glow which did not appear to consist of ^{large} scintillations. Apparently too weak to register on the film anyhow.

Optimum voltage to offset noise/gain seems to be about 1500 volts \pm 100 volts, I would think. Mullard only quote gain figures up to 1000V, so

1700 v & perhaps pushing things too hard. Lot of
 semi-permanently lit up channels at that voltage.

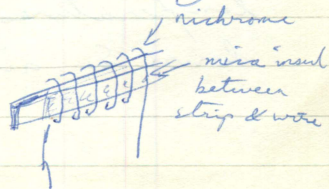
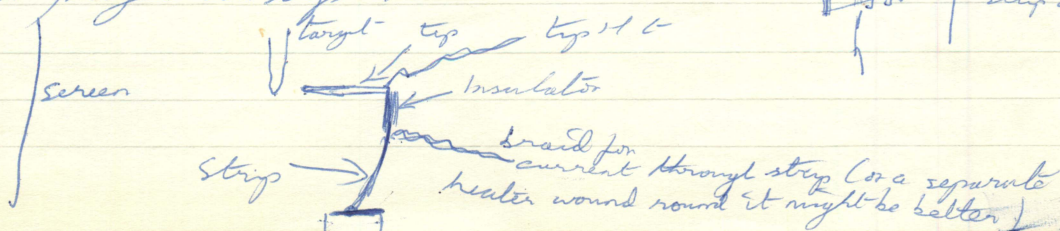
Handout from ~~Stato~~ Schlumberger arrived
 giving details of electron / ion multipliers
 (variation blind and shaped diodes types)
 - available complete with resistors &
 some available for up to $+200^{\circ}\text{C}$ (normal 125°)
 Description given of how to set up bias current
 $3\text{m}\Omega$ ~~at~~ seems to be typical dropper resistor value.

On ~~thurs~~ Wed, considering use of bimetallic
 strip as a specimen manipulator. Originally
 suggested it for Ed's field emission projection tip
 to give wide range of (hopefully) controllable
 motion. However, might be useful for
 simple tip manipulator for field ion - eg



Might be problems with outgassing so use a long
 strip run fairly cold.

Simpler for projection tips: -



OR what about a Bourdon-type unit
with coiled thin ss tube & compressed
air?

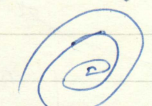


~~25 mag~~
25 mag With 1500v on channel plate, Wray 71 lens
exposes at 78°C,

2 10^{-8} He BIV	1, 1, 1, 1, 10, 10, 50, 1 sec
background $5 \cdot 10^{-10}$ DIV	1 1 10 50
$5 \cdot 10^{-10}$ Ov only	1 1 10 10 50

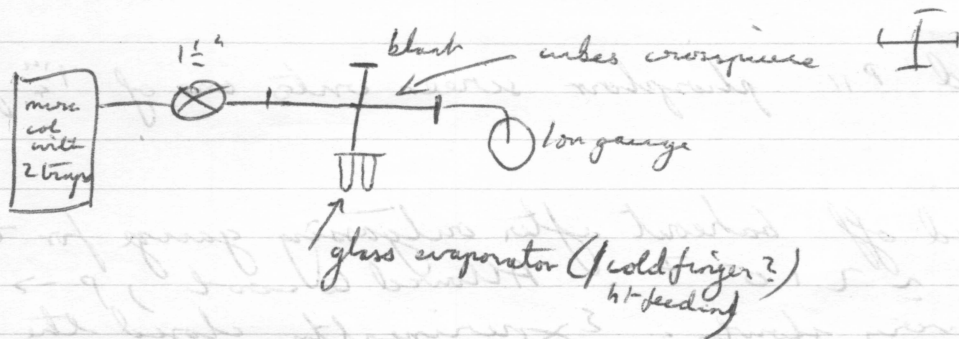
6 Kv BIV, Varian microscope

Much less noise apparent at this channel plate
voltage ($\approx 20/\mu\text{c}$). 5 still appears to register most
single cones $\approx 1/\text{sec}$ at this pressure, & with
a reasonable (though half of picture unfocused slightly
for some reason) image after 50 secs.

For Constructed a bimetallic strip coil  using
Mo and stainless steel (Mo @ 2nd to W for low coeff
of expansion for reasonable materials - also available from PST)

≈ 4 turns. Rotates centre through 90° under
influence of hot air blow ($300-400^\circ\text{C}$ 1 gress).
Quite stiff, too, so need ≈ 10 turns for reasonable
temperatures. Quite a time lag (> 10 secs to cool
down in air, worse in vacuo).

Mon 29 Considering with M55, then EDB, the construction of a small FIM/FEM using cubes mercury column & small amount of pipework, mainly $1\frac{1}{2}$ ". Purpose of machine: - to be UHV compatible ~~and~~ so can be used for field emission studies (eg different evaporated films etc) to have a cold finger cooled tip so can use for field ion, using direct heating or 1" channel plate if we can find it (or buy one, \approx £90). Simple rapidly pumping device for trying ideas on (eg autochange, evaporation of gold film on nice chamber, etc - any lunatic idea which wouldn't be a good thing to do to a 'proper' microscope but which would be worth a quick try, and which the non-uker 'schubert' machine is no good for (heavy fragile glassware, few 10^{-8} after a bake on a good day, 1" gun assembled with ed boy's assistance a selection of bits (ex cube/evaporator/etc).



Tues Baked 'microscope' using heating tapes - after a prolonged struggle raised gauge to $\approx 220^\circ$, rest of metalwork to $\approx 120-150$. Pressure 2×10^{-6} max on bakeout $\rightarrow 1 \times 10^{-8}$ on cooling down (on Wed am) - not baked overnight. Ordered 2×30 mm screens from wintgenti

Wed 110^{-8} in device, so baked out top traps on nice owing to lunatic arrangement of (inherited) heater tapes ~~to~~ ^{top} traps at 230° while valve at only 110 or so. After cooled with N_2 pressure on valving in system was

still $\approx 1-2 \cdot 10^{-8}$. On valving off system $p \rightarrow \sim 2 \cdot 10^{-7}$
where rate of rise slowed down muchly.

Thurs Pressure after being valved off overnight
was $\sim 2 \cdot 10^{-6}$ & fell when ion gauge was left on
10 mA emission (≈ 1 lps pumping speed),

very little change on cooling with liquid nitrogen.

Suspected diff pump might be short of Hg so
drained it — contents ≈ 70 cc (will work with
25 according to P57). Refilled it. Removed F
and bolted ion gauge directly onto the ~~system~~
valve. Baked system again — bottom trap cold,
top trap at $200-230^\circ$, gauge at 230 . Cooled
trap and baked valve to 190° , and left overnight
baking.

Settled P11 phosphor screen onto one of $1\frac{1}{4}$ glass discs.

Fri Turned off bakeout after outgassing gauge for 20 mins.
Pressure $\approx 2 \cdot 10^{-7}$. Allowed to cool, $p \rightarrow 4 \cdot 10^{-8}$ and
falling very slowly. Experimentally closed the valve
@ ≈ 1230 . Pressure immediately started to fall
rapidly, $\approx 6 \cdot 10^{-10}$ by 6 or 7.


\therefore Valve / traps / pump up the creek. Mass spect
leak detected not immediately available, try & get it on
Monday. EDB suggests a) baking top trap & valve with
bottom trap empty, in case bottom trap is foiled with
Hg or other contaminants b) putting ion gauge in
place of the valve (valve was reconditioned 18 months
ago and has been little used since). Traps full of N_2 ,
so have to leave till tomorrow.

Sat Top trap & valve baked with bottom traps empty
then cooled sequentially ± 1 hr intervals.
Pres $\approx 2 \times 10^{-8}$ Torr.

Mon 5th June Dismantled pumping column &
cleaned out diff pumps (fair amount of brown
residue in it). Cleaned out traps. Top trap to
valve adaptor is an Al ~~to~~ 8% Si wire seal (Edwards) others
Ston (pumps & intertrap) should be good for few 10^{-10} ; argon.

Tues Reassembled column. $\approx 4 \times 10^{-8}$. (ion gauge alone $\approx 10^{-9}$)
Layed $1\frac{1}{4}$ " screen for cube mic.

Wed Baked column for $2\frac{1}{2}$ hrs $\rightarrow 1\frac{1}{2} \times 10^{-8}$.

V6 Phoned re EA - had cut groove round base of center drawer too
wide : as metal is $\frac{1}{4}$ " thick here should be ok, so do it
them to leave it. Not sure when mic will be delivered \therefore
man in charge was at Derby (!).

Asked Tom Hepple of V6 about ^{glass} encapsulated resistors: says
that they come from Electrautom; V6 don't have any in stock.
Moved 19" rack across to new bldg + some of electronics (cht units)

Thurs Much discussion with M S S P S T B Ragan re Paul
Fund money, as Pashley & Anderson visiting on Fri to see how
we spent.

Removed valve from ~~the~~ cubes column & put gauge
directly on top trap — $p \rightarrow 2 \times 10^{-4}$ (!), probably \therefore of
mercury or cond $\therefore p \rightarrow 2 \times 10^{-8}$ on adding N_2 & waiting 1 hr.

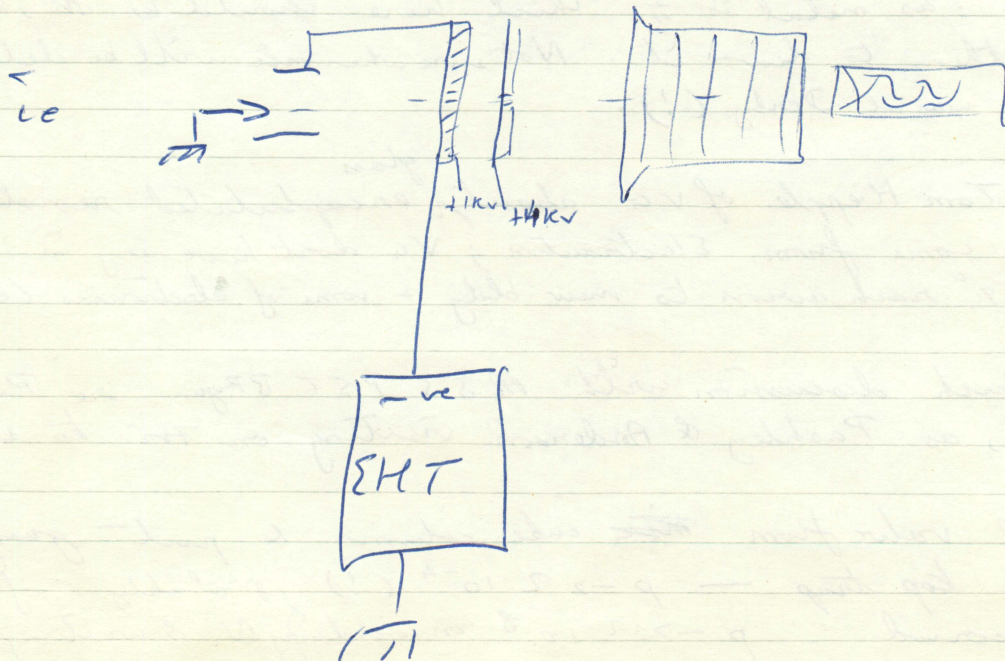
Fri Moved other 14" rack across + sub pump control unit, bakeout control unit. lot of dismantling to do.

Left column jumping with bottom trap \rightarrow full.
 $\rightarrow \approx 1 \cdot 10^{-5}$

Electronics say that glass encapsulated resistors come from Pyroil of USA but are out of production - will send data of cermet types but probably no good. ? try EMI or other photomultiplier manuf.

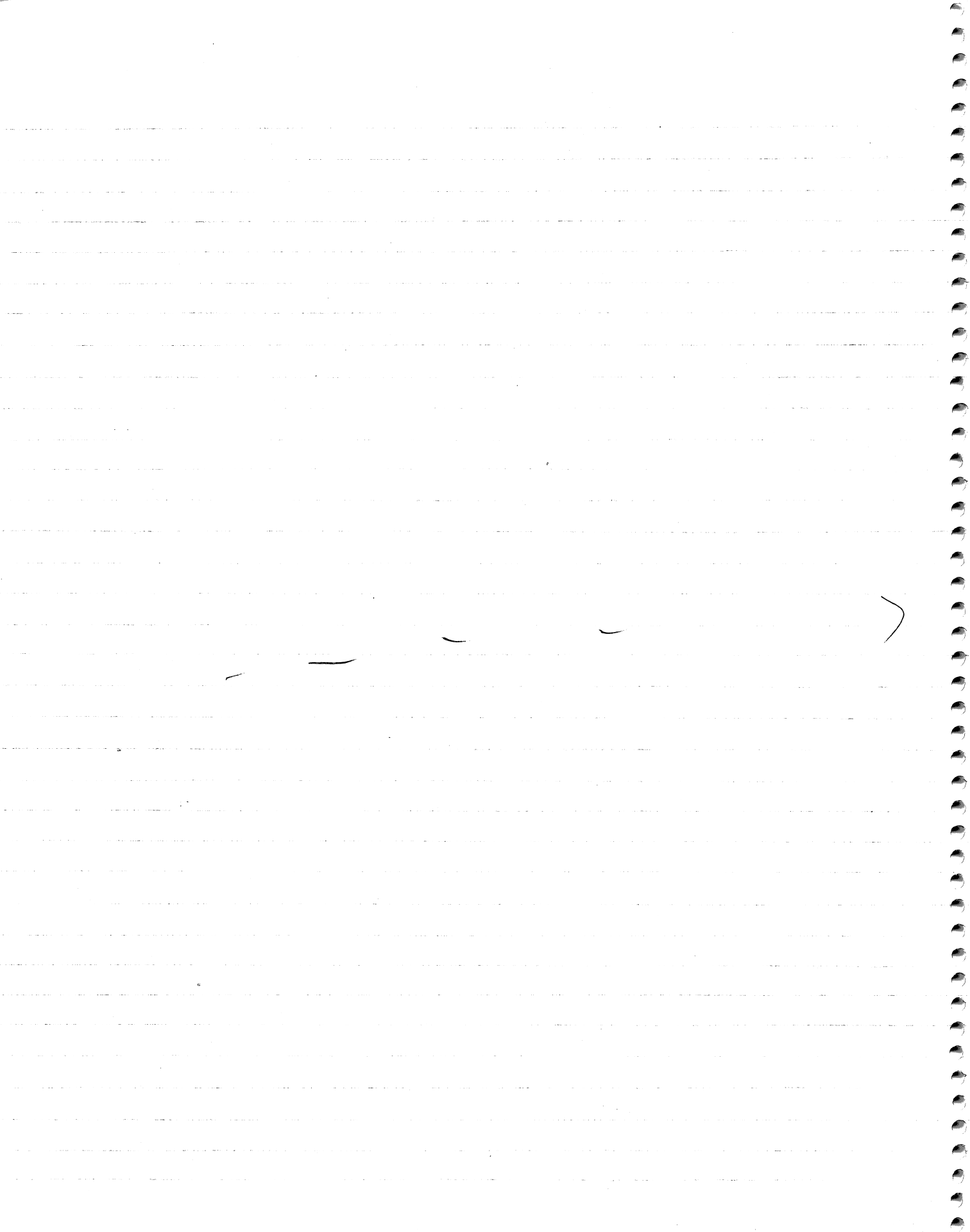
Sat tourist guide.

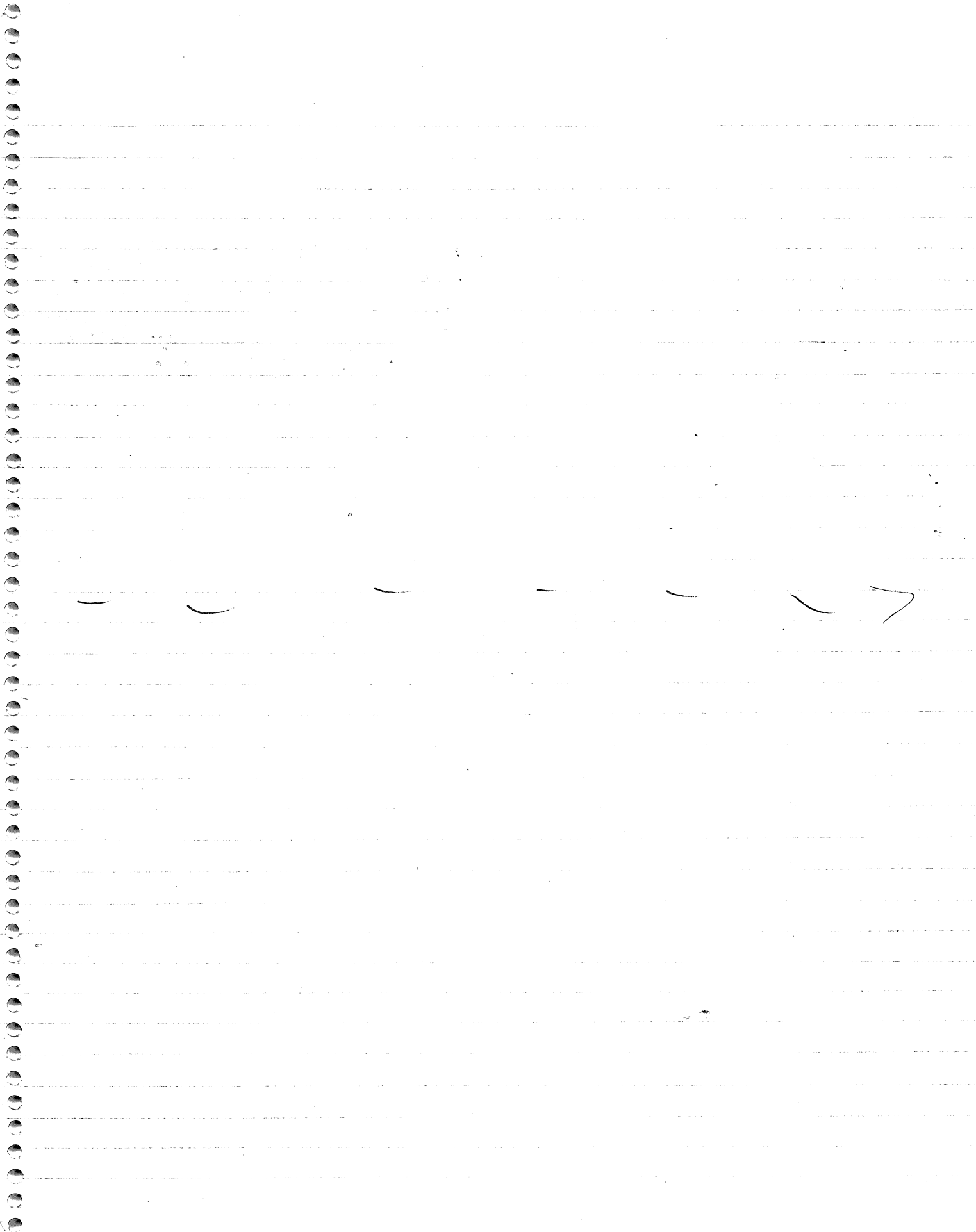
Also done: working out no of feedthroughs utilized, PSU's etc, in particular arrangements needed for trap cp & screen voltages, which have to be floated at the negative HT voltage in EA mic.



Soln appears to be a brandenburg module
driven from a) Mains isolating transformer,
which is available but huge
b) Inverter etc like March '71 W.V.

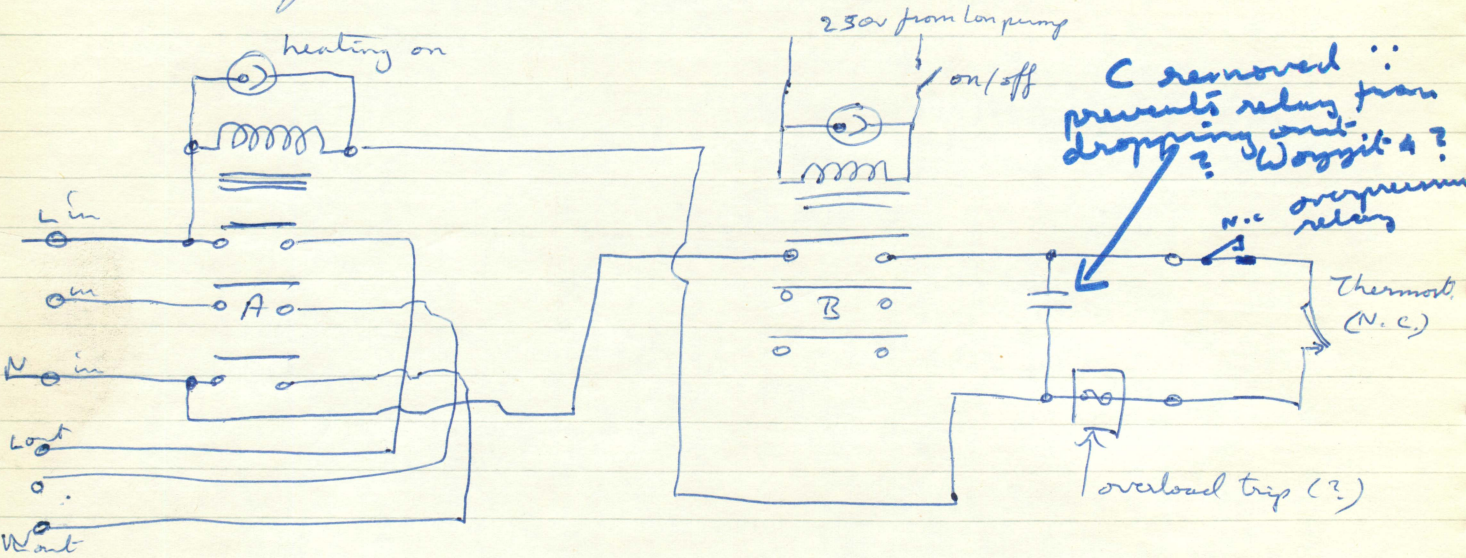
Mondays
12th June



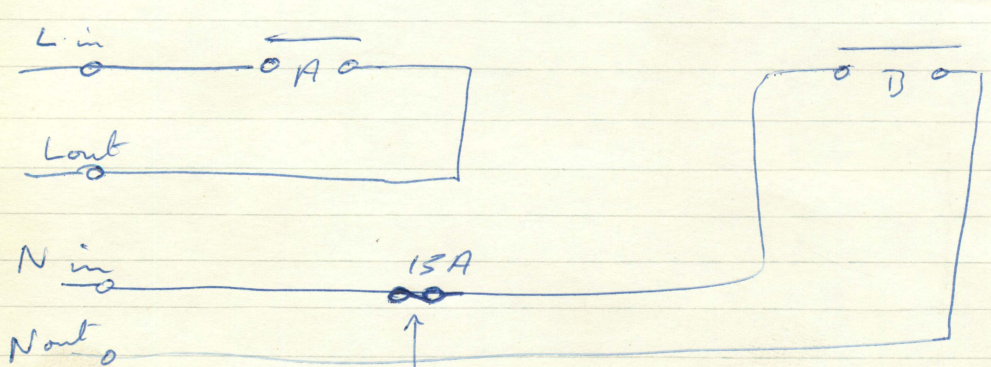


Mon 26th June

Circuit of Varian Bakeout control D₂ -



Contacts won't handle full 17A (3 x 850w, 1 x 1750w) so use ~~extra~~ spare contacts A, B to switch another heating input: -

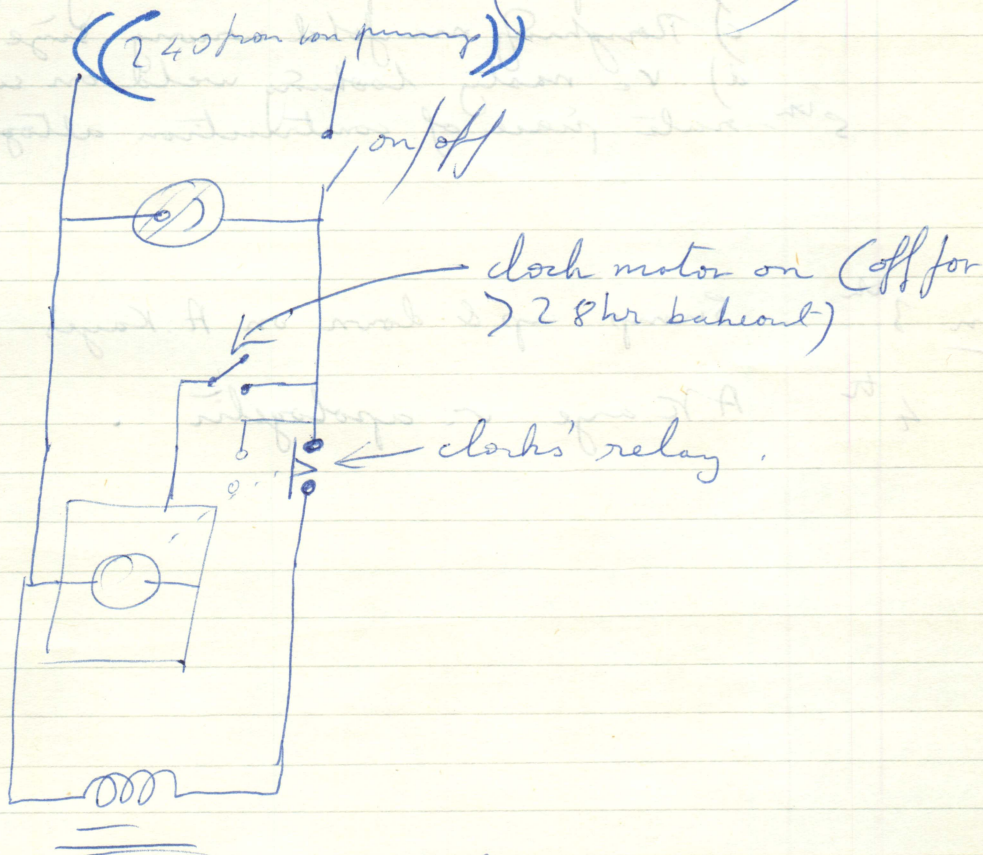


fuse in neutral line — first circuit breaker has overload cutout; not second.

Control did not work on 'steam engine' because one of the thermostats (in series) had contacts shorted to earth, hence relay was always switched on irrespective of control switch.

Feb 15th '73

Mod to include 24 hr clock (Omron NSY)



clock resets to off if mains interrupted but mains interrupt switches off variator pump unit

May 15 '74 → Vc pump has no mains o/p, just an overpressure relay.
 so 240 v o/p now from heating circuit i/p 1, relay in series with thermostat.

~~Put Edg~~

Thurs 29th June System delivered from VG.
Me at Glyndebourne so not there to accept it.

Fri 30 Unpacking system & checking it.

Discover

- Manipulator $\approx 1\frac{1}{2}$ " too long.
- Evaporator port missing from chamber.
- Roughing manifold wrong size.
- v. nasty looking weld on sub pump, which is 5th rate piece of construction altogether.

Mon 3rd Sump up & down on A. Kaye's sidekick.

4th A.K. aye v. apologetic.

5th Silly Wed System goes back to 1 & to have
manipulator shortened, port added, manifold shortened.

6

7

9 Sun

10

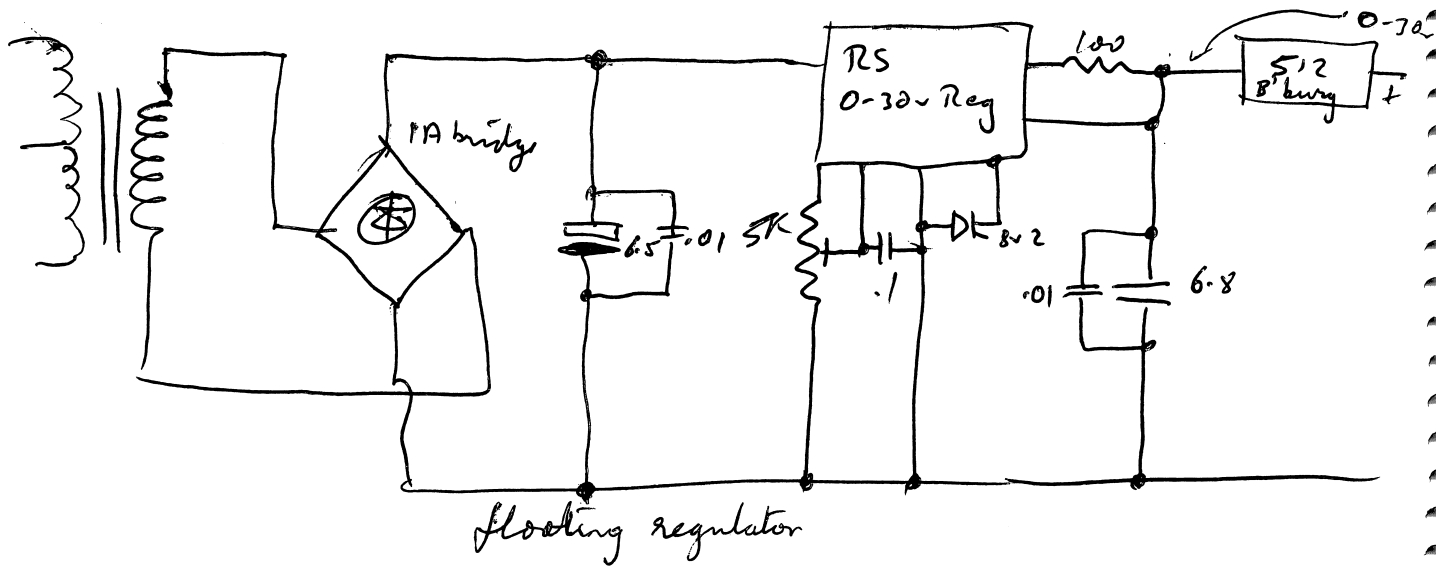
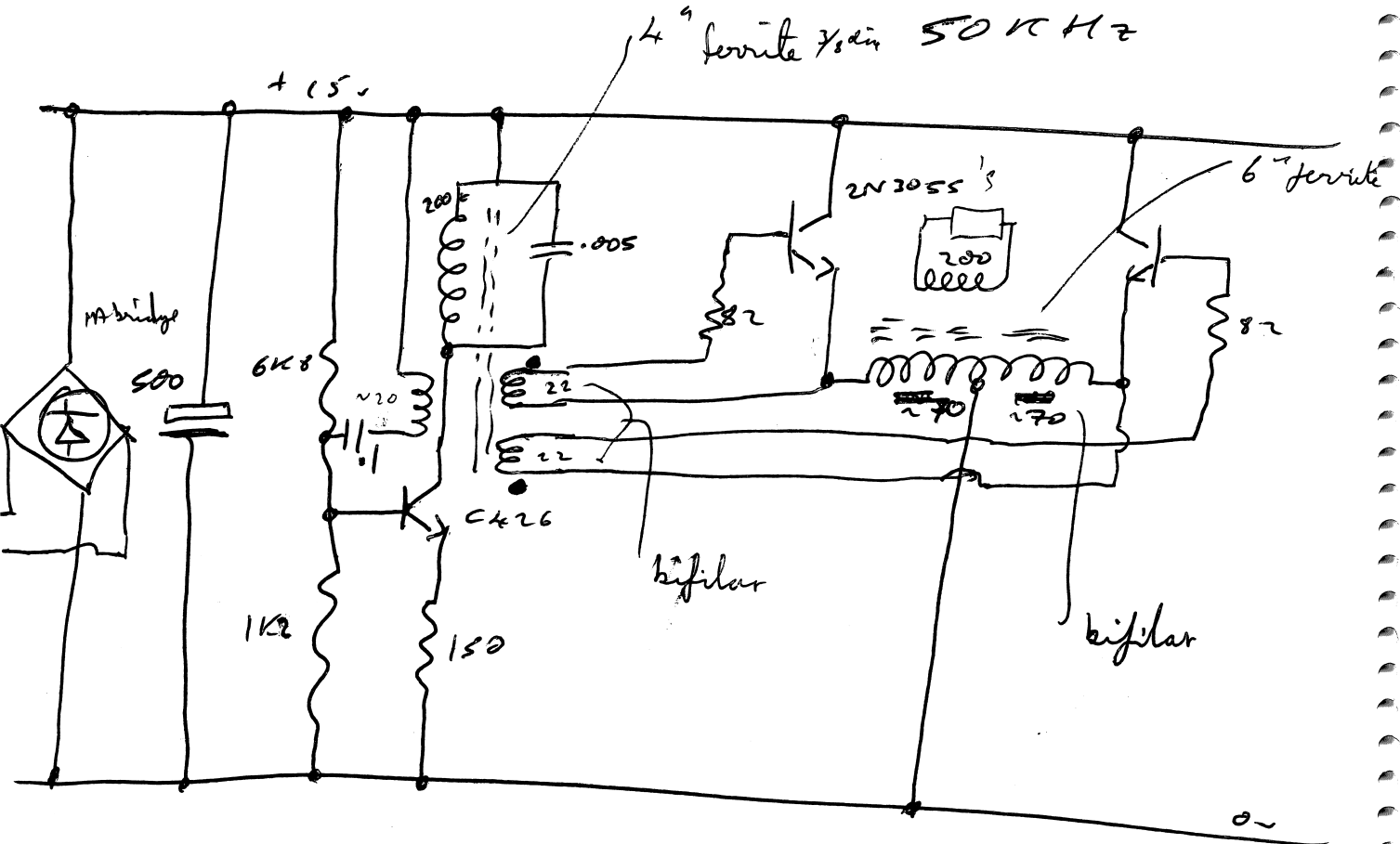
Constructing inverters & experimenting generally.
Ours with transformer driven from collectors
of C426's seem very susceptible to odd behaviour
(ringing, etc). Substitute emitter driven circuit,
find it won't work with C426's, but works v well
with 2N3055's. Ours not to reason why. Build
respectably. Build stabilized pwr to go on other
ends of transformer. 0-10 v, several watts.

11

12

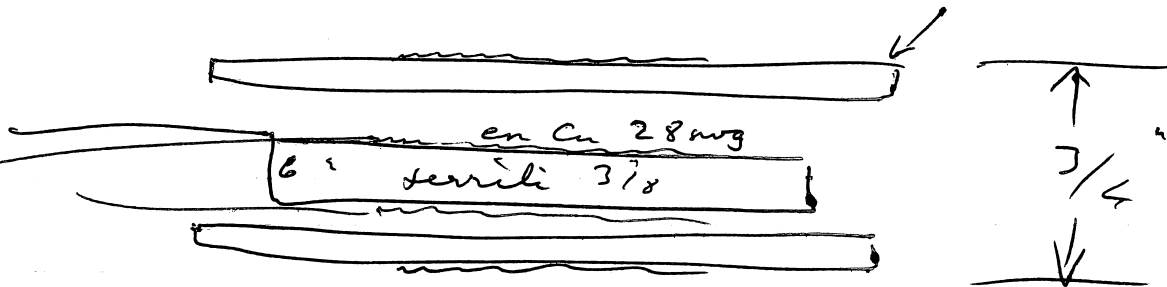
17th July

Circuit of isolating transformer to feed channel-plate floated @ HV voltage.



Isolating transformer

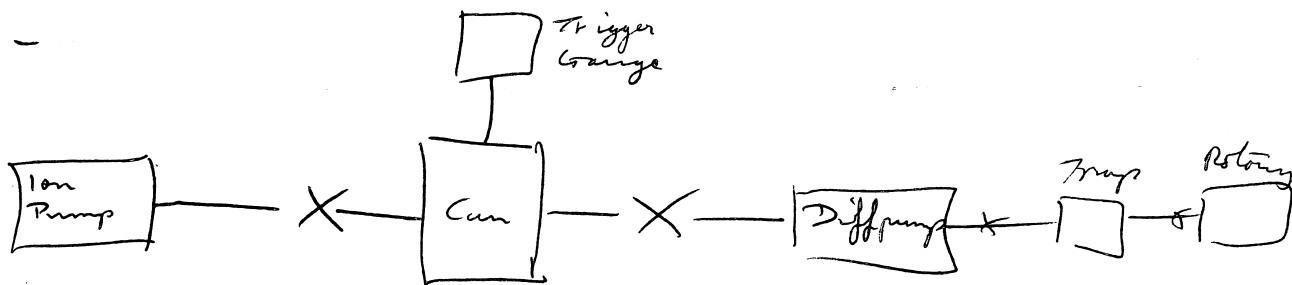
perspex tube 1/2"



14th July (Fri)

Testing sub-pump can (which has a dubious weld) :-

System :-



— down to ~~4 to 10⁻⁸ Torr~~ $4 \cdot 10^{-7}$ Torr, $4 \cdot 10^{-8}$ Torr
6 hrs. Valve off diff pump (which has just been transported & reassembled), $P \rightarrow 3 \cdot 10^{-8}$, so will leave on ion pump overnight & take trap in am.
Some fluctuations in ion pump current ($\pm 5 \mu A$ at 40 μA)
dunno why.

— went down to $\approx 4 \cdot 10^{-9}$ Torr over weekend, unattended.

17th Mon, July.

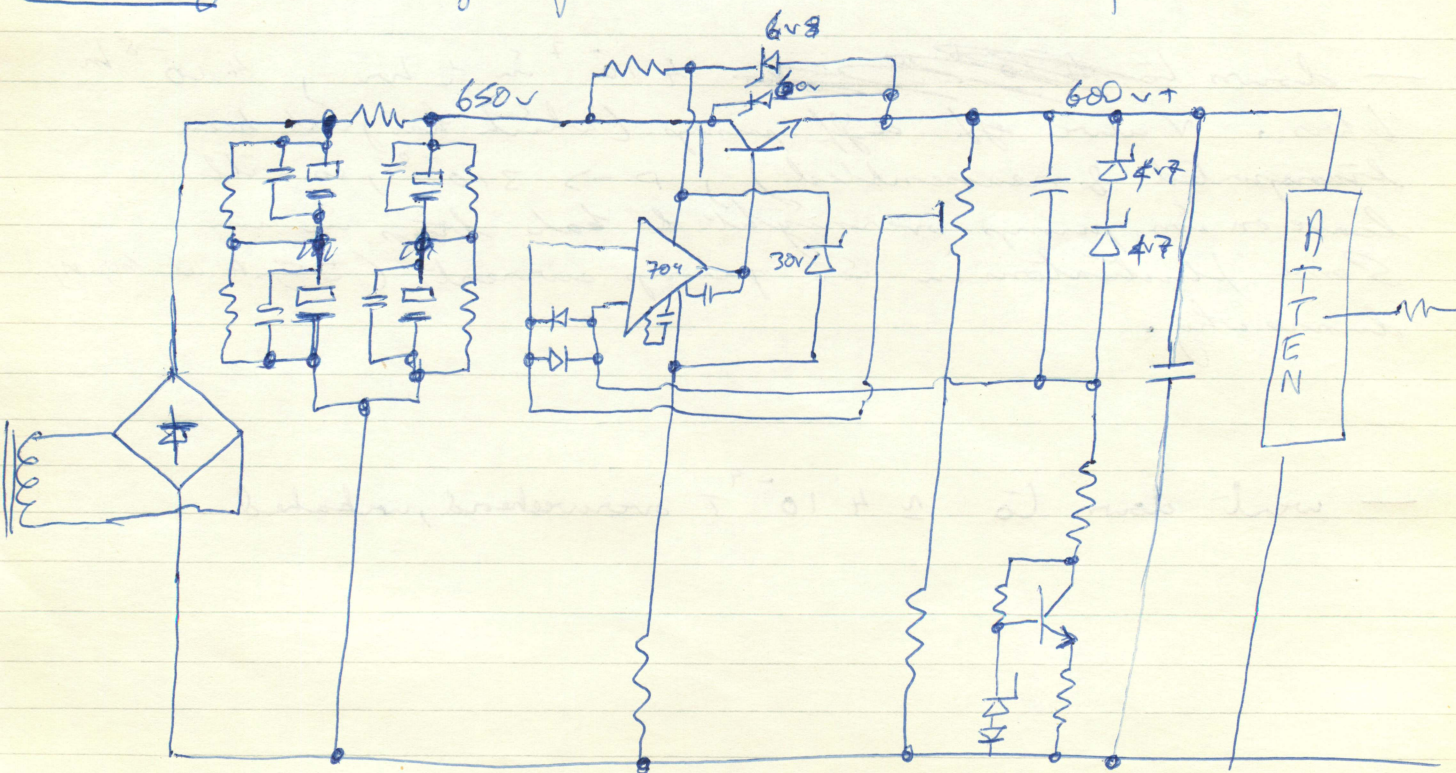
Top Trap of diff pumps wired up for baking, & baked.
— unsuccessful (? could baked into valve) ∴
pressure went up from ~~400~~ $\approx 10^{-8}$ (part of sub pump can was
warm) to $\approx 7 \cdot 10^{-7}$ when valve was opened, then
subsided. ? v dirty valve / trap. 'Rebake'.

Distribution boards in 6' & 5' racks wired up.

Isolation transformer fitted to Harwell control shelf
so that this can be floated for driving the analyser.

+ 300 - 150 v Harwell unit tested - ? faulty, one blown
fuse & 1 light don't work. Investigate.

Tuesday Design for a 0-600 v lens psu.



System arrived back from VG, apparently OK
Put together Fe. Baking line welding done
on Saturday. $\frac{1}{2}$ hr to enough out (joint on roughing
line later found to leak). 4×10^{-6} in $1\frac{1}{2}$ hrs, 3×10^{-7} overnight
 $\rightarrow 2 \times 10^{-8}$ with LiNi $\rightarrow 9 \times 10^{-7}$ on waiting

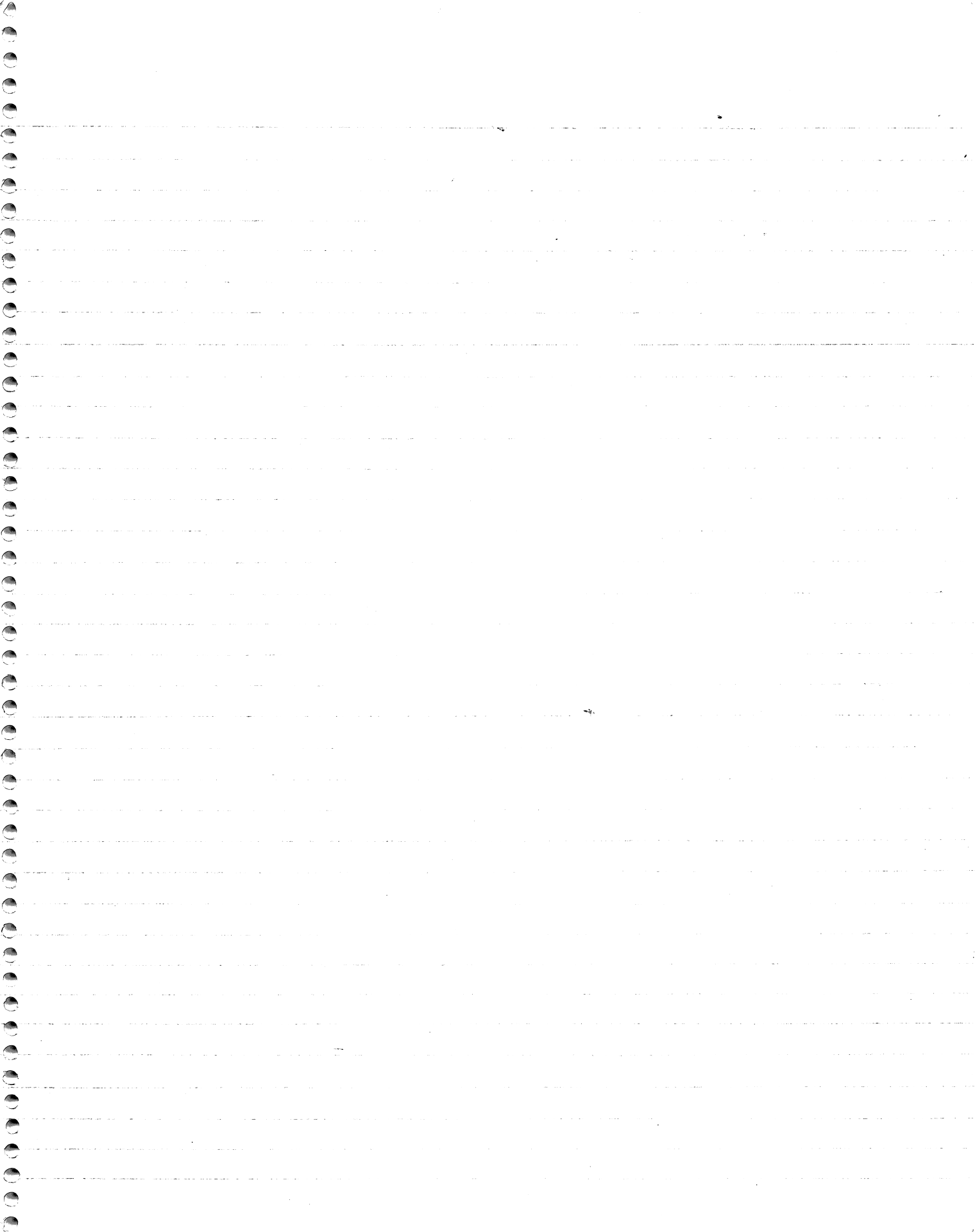
9×10^{-8} next am no LiNi

Baked using modified steam engine ovens.
 3×800 watt + 1×1750 watt VG heaters.
Thermostat set at 250° using thermocouple
& hot air gun.

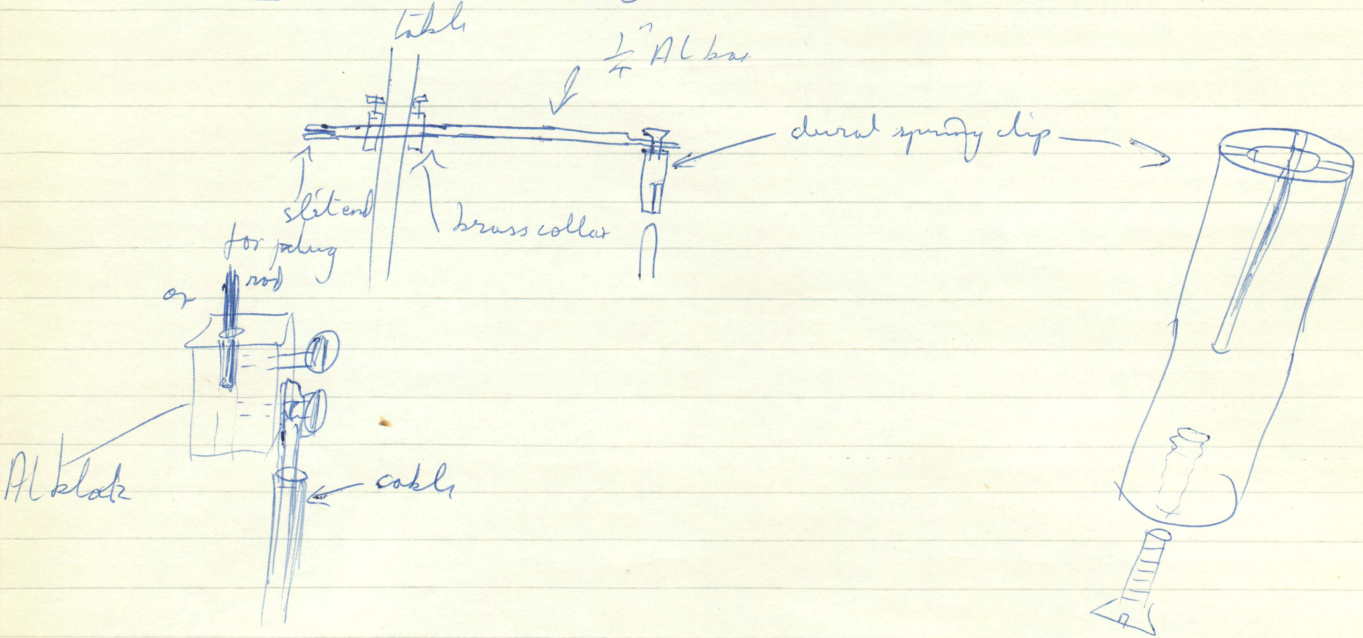
Pressure reduced to $\sim 3 \times 10^{-10}$ with LiNi
after several bakes.

Pressure rising to ~ 4 mtorr ion pump
on baking - baking stopped at this point - to
reduced pressure. Each time cycled, temp
getting higher before having to stop. $\rightarrow 200^\circ$ at
top of system eventually.

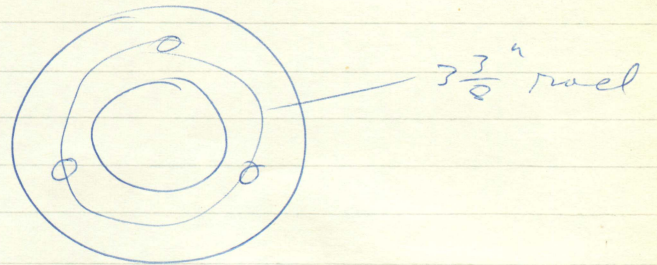
Evacuate over weekend of 27th till Monday.



Mon-Fri Constructing sub pump power lead ins



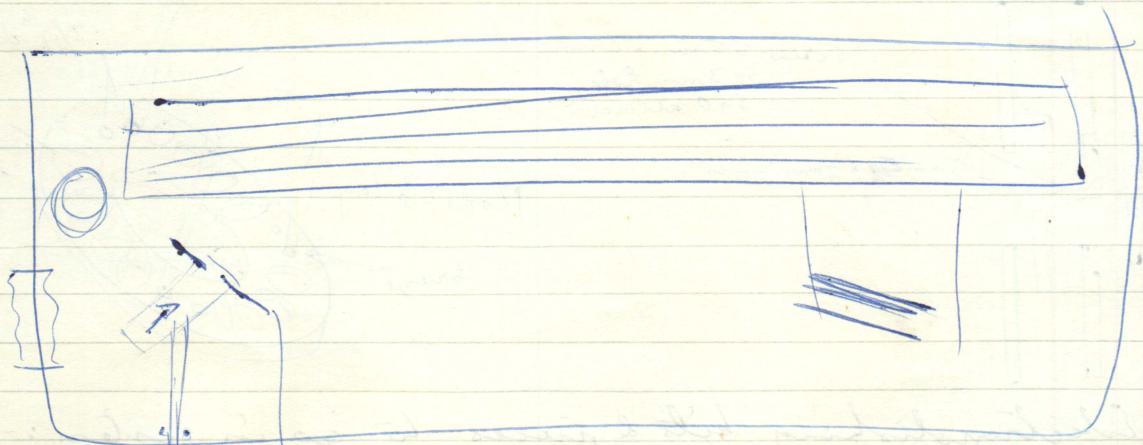
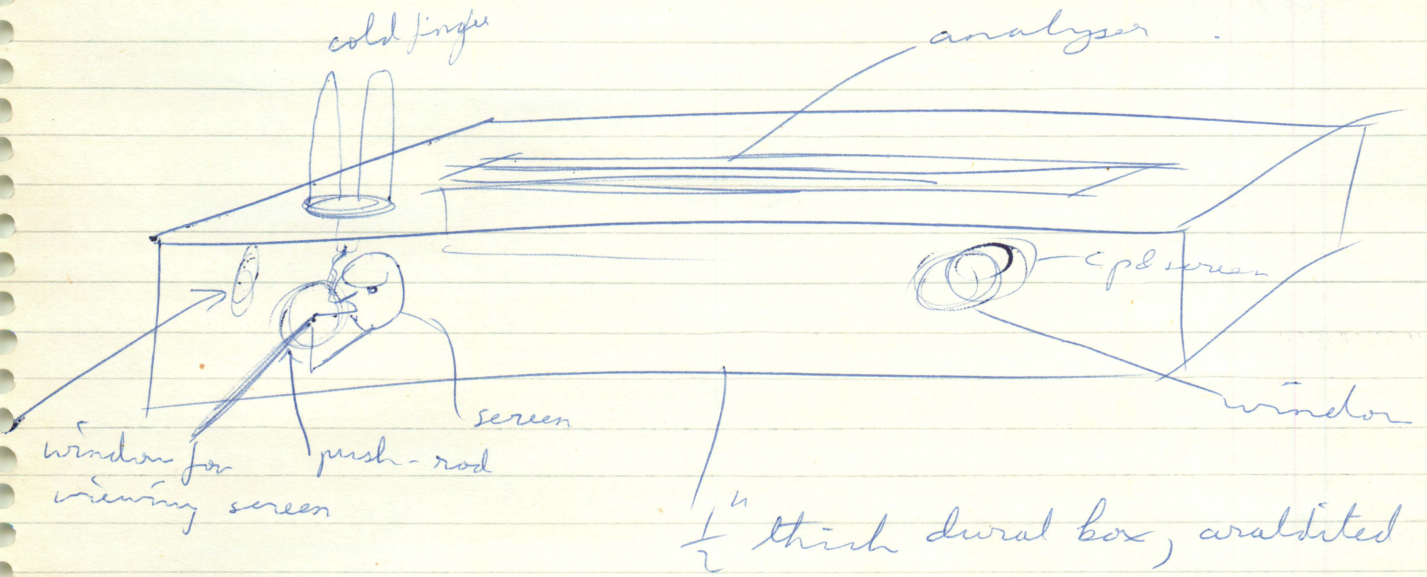
Cutting on lathe disc to make into channel-plate holder



analyser

Also designery mark π & a box for it

generally something like :-

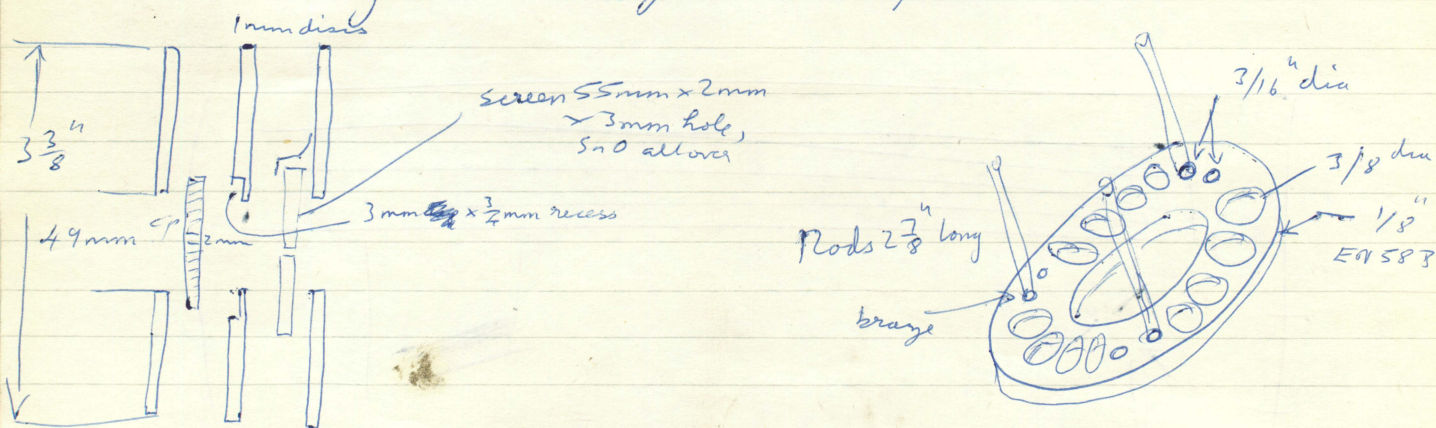


screen fixed to manipulator to allow setting
up 30° angle for beam.
moved to & fro to adjust focus of
device

Sun 6 Constructing frame for 19" box

Mon 7 Finishing 19" box to put channel plate ext. supply in.

Tues Drilling holes in support ring for channel plate mount. Sol cutting out discs for channel plate: -



Wed 9 Electropolishing bits & pieces to go in system: -
brazed to channel plate support ring & rods together
& polished, together with sub-pump baffles.

Brew is glycerol: - 500 ml
orthophosphoric acid: - 300 ml
water: 90 ml

Temperature 90-110°C — boil-kill (~130°)
current dc ~80 mA/cm² (also for Ni, Cu etc)
Electrodes of stainless steel (thick)

Thurs 10 Indicated pressure $\approx 2.5 \cdot 10^{-10}$ on trigger g.
Ion pump current $\approx 85 \mu\text{A}$ (originally $\approx 3 \mu\text{A}$
for some Tg reading so probably field emission
from a flake of Ti inside). Hope.

System valved off.

Pressure	Time
$1.8 \cdot 10^{-8}$	0
3 4	15
5	20
8	20
$1.5 \cdot 10^{-7}$	40
2	50
4	60
6	70
$1.5 \cdot 10^{-6}$	80
$3 \cdot 10^{-6}$	90
8	120
$1.2 \cdot 10^{-5}$	150
1.55	170
1.65	180
1.7	240

Stutter at $\approx 1.6 \cdot 10^{-5}$ (recovered)

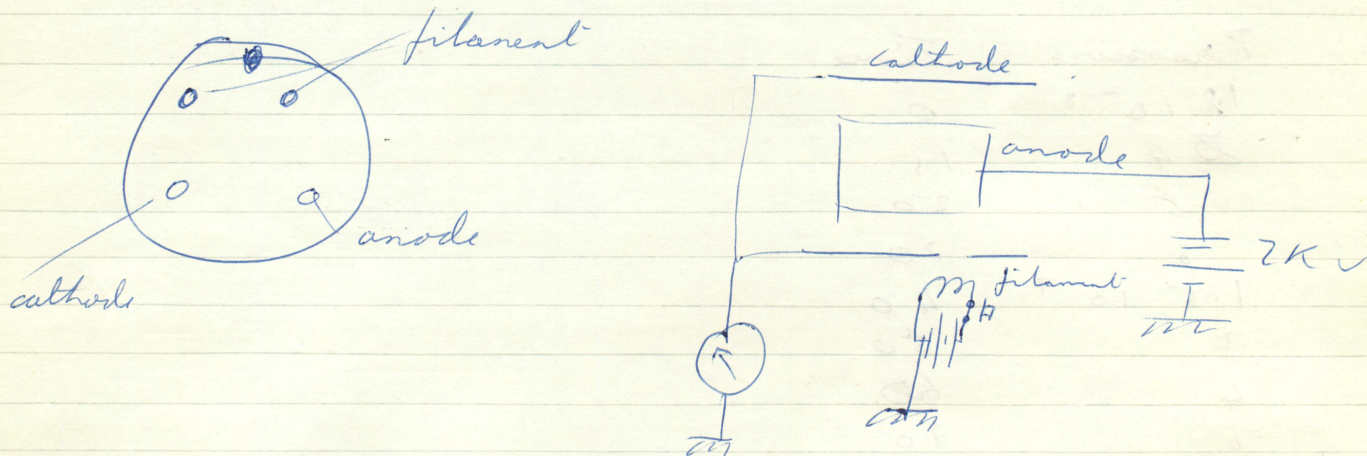
$1\frac{1}{2}$ hrs $3.8 \cdot 10^{-5} = 3.8 \cdot 10^{-6}$

Added 4 v_g leak valves to system, + Ar bottle (others
at Dignito's still).

Roughed out in 15 min.

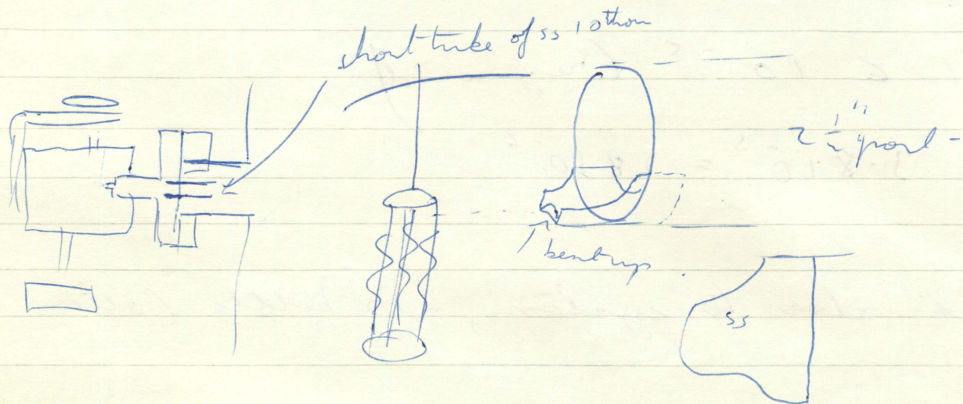
When attempted to outgas filament of trigger gauge by
holding 'start' button on for 5 sec, HT tripped out after 2 sec.
~~It~~ Couldn't be zeroed & read over fsd when on low range.

Replaced with other control unit & found same symptoms. Checked pins on gauge head with aro & found that there was a sizeable conductance between filament & cathode; control unit behaved if the cathode lead was unplugged from its back.



∴ Gauge head presumably faulty.

Baffles put in sub-pumps can to prevent Ti arriving on pads in valves.



7/21 Added ~~the~~ Varian made ion gauges off
steam engine to system. Trigger gauge
persuaded to work again temporarily, then
died again.

8/1 Cutting ceramics for channel plate mount
from using PST's diamondwheel ultramicrotome.

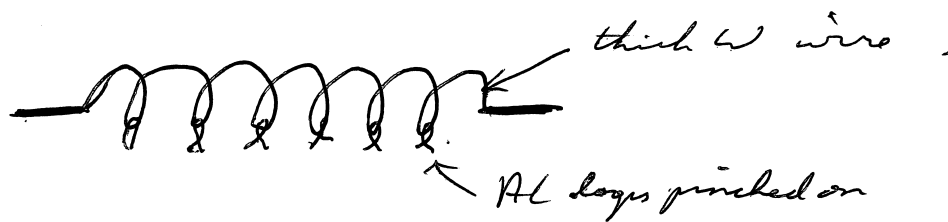
Assisting (?) DSR & EDB with the PPP,
which produced 10,000 ions at the same voltage
(probably common).

Monday Drilling holes in s.s. discs for channel plate
mount. Getting around.

Tuesday Am showing Richard Forbes' research student from
Aston in Brum around lab. He is sceptical about
vacuum technique used in CdS work there. Hopes to
look at Si with new AEC/plummer hemispherical analyser.
pm ~

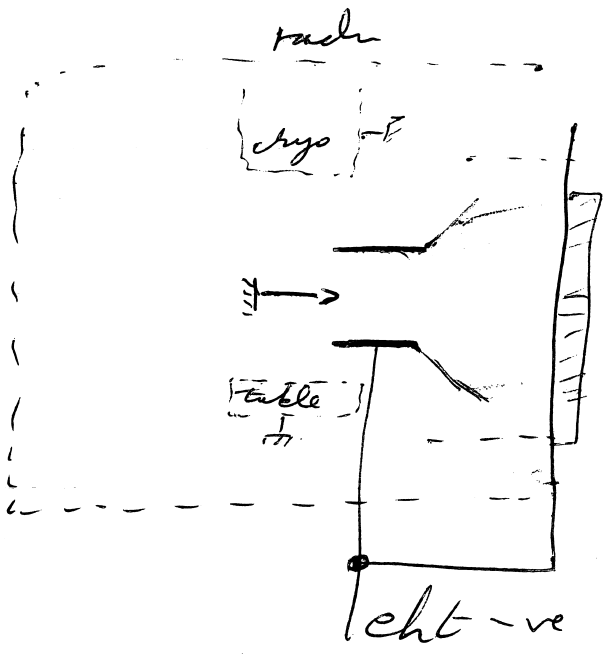
ppm watching EDB evaporating aluminium
on q mirrors on 7L71 class evaporator.

— use thick W wire helical coil, otherwise wire breaks
(W soluble in Al to ~ 5%).



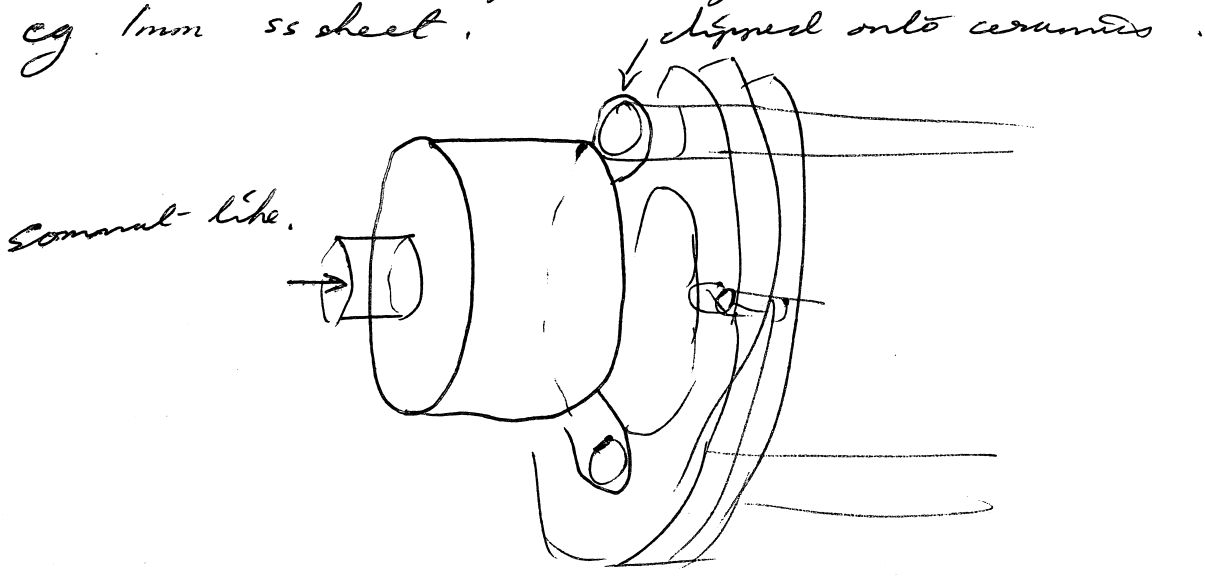
Wed enlarged holes in cp mount. Found some too large
already, so modified ceramuses cut.

Thurs electropolished channel plate mounts.
Fiddled around with arounds to find fresh way
of putting together cp/radn shield / tip assemblies.
? does radn shield have to be floated if there
is a mantle close to the tip.



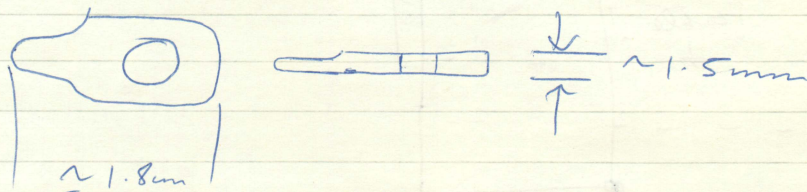
only effect for axial tip would be slight compression of the picture - no disadvantage.
 ? off axis tip, and might wander somewhat

However, so much earth gunk inside the radn shield that is probably better to leave shield earthed, & add extra electrical shield on front of barrel plate mount. Thick, so no field emission off it. eg 1mm ss sheet.



Fri Experimenting with Cu braids for connecting tips & mantle to ~~the~~ cryostat & chf.

Cut spade terminals from 6" od 4" id Conflat gasket (OFHC Cu)

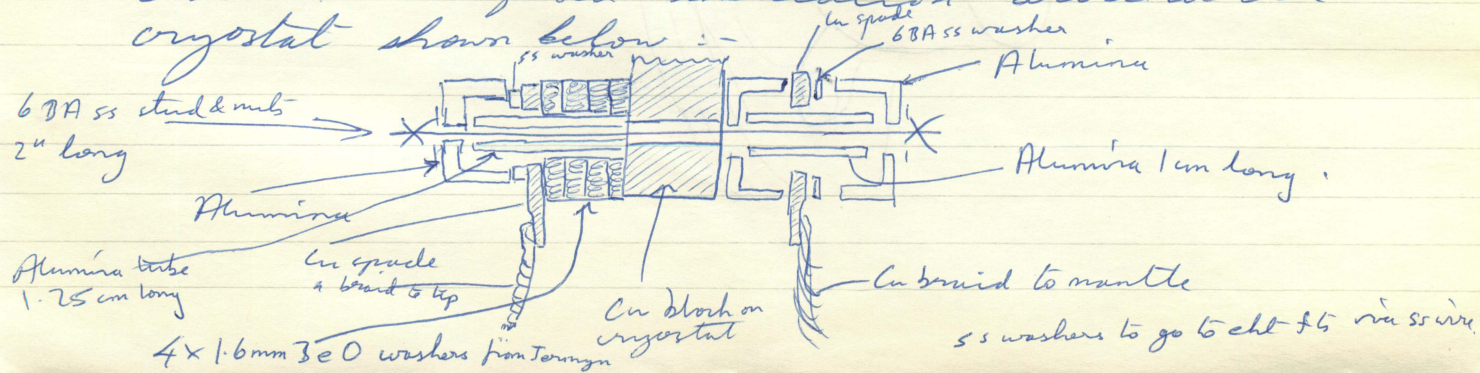


Braids made from ≈ 22 strands of 33 swg bare Cu wire (x-section $\approx 1 \text{ mm}^2$)

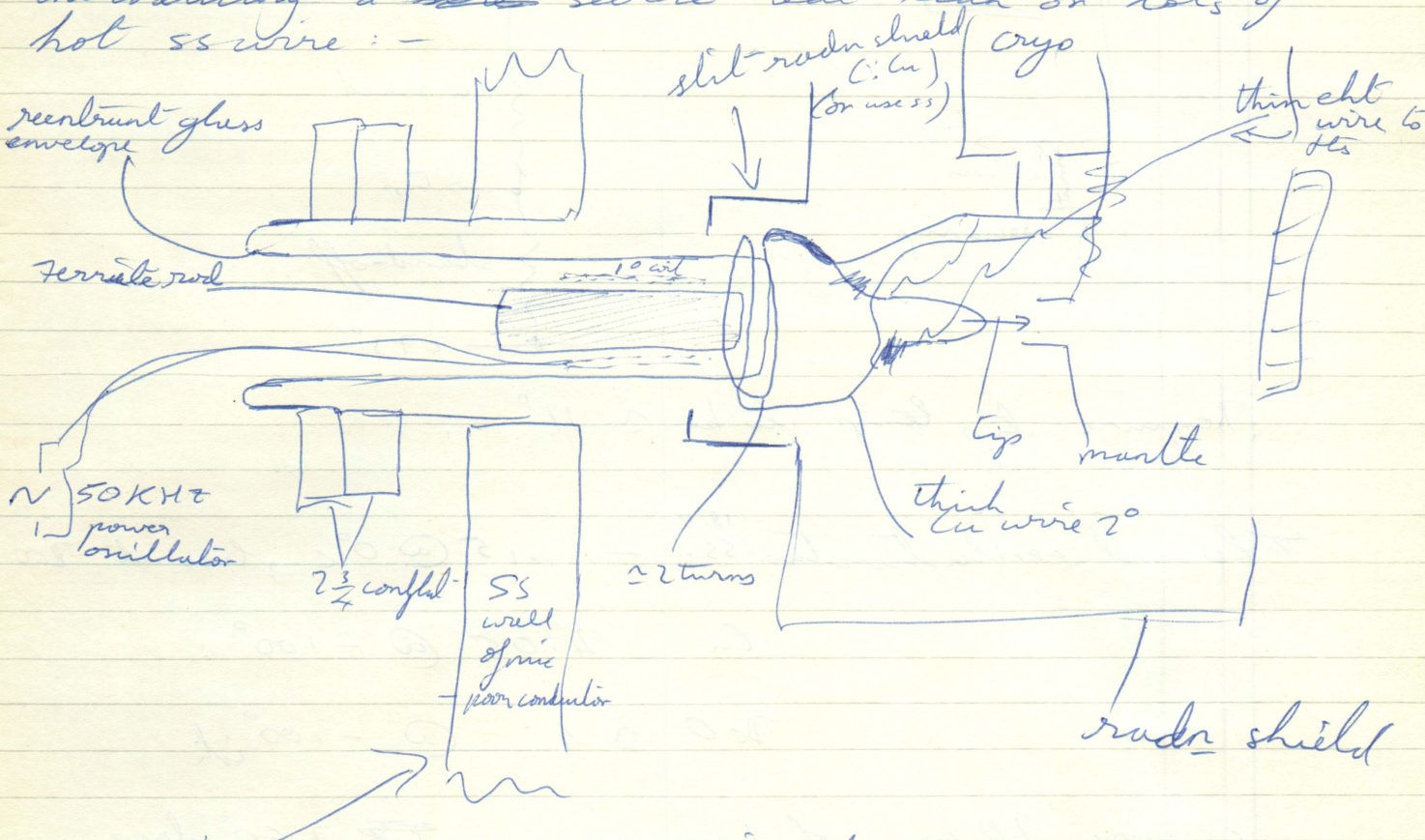
Tried to weld Cu braids & terminals together but using oxy-propane torch. Get apparently good welds but the braid is brittle near the joint & work-hardens & breaks quickly. Brazing using Cu/Ag eutectic seems to produce a more flexible joint.

Cut MSS & P.S.F. off to USA for F.E.S.
ARW off down Backs with a camera.

Sun, Cutting more spade terminals & ceramics to fit them. Proposed insulation around the cryostat shown below -



Proposal for connecting heater loops to current without introducing a ~~severe~~ severe heat leak on lots of hot ss wire: -



back 3" port of mic.

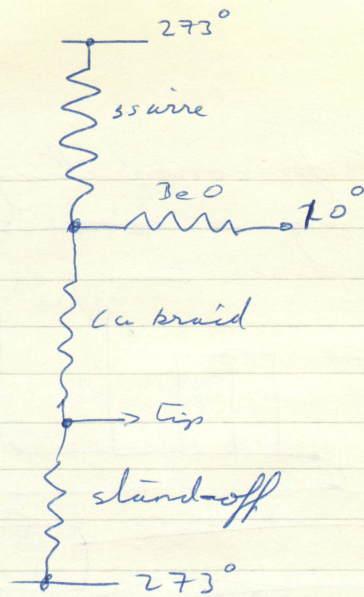
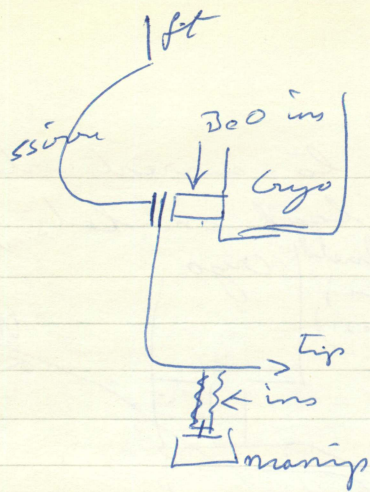
view hot tip through evaporator port.

Need ≈ 10 watts in 2° .

Use high freq so only need ferrite core

Slit radn shield so not to induce eddy currents in it.

Shield wire from thermal radiation to ~~maximize~~ minimize heat loss.



Require tip temp to be $\approx 11^\circ$

Thermal conductivities ^{18/8} SS: - .15 @ 0°C , less at -200

Cu 4.05 @ -100° .

BeO ≈ 4 @ -100°ish

SS wire 10 cm of 1 mm wire, ~~260~~ 260° drop,

$$Q = KA \frac{\Delta T}{l} = \frac{.15}{10} \times .01 \times \frac{260}{10} = 26 \times 5 \times 10^{-4} = 130 \times 10^{-4} = .026 \text{ watts/cm}$$

$$\text{BeO } Q = \frac{4 \times 1 \times 0}{.6} = 6.6 \theta \text{ Joules/sec}$$

$$\text{Cu braid } Q = \frac{4 \times .01 \times 1}{8} = .005 \text{ watts } / ^\circ\text{C}$$

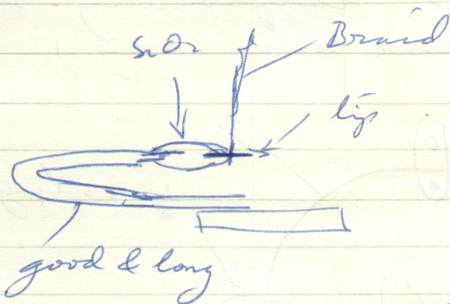
Standoff $Q = \frac{.05 \times .01 \times 260}{6} = \frac{.1 \times .01 \times 260}{6} = \frac{.260}{6} = .04 \text{ watts}$
 say 3 cm of inner SS tube

From which one deduces that 300 A per too good a conductor

& that tip temp will be $\approx 8^\circ$ higher than coolant.

& that silica $K \approx .01$ would improve situation by factor of 5 for 3cm

Hence



should be ok $\approx 2^\circ$ higher at most, ignoring radn.

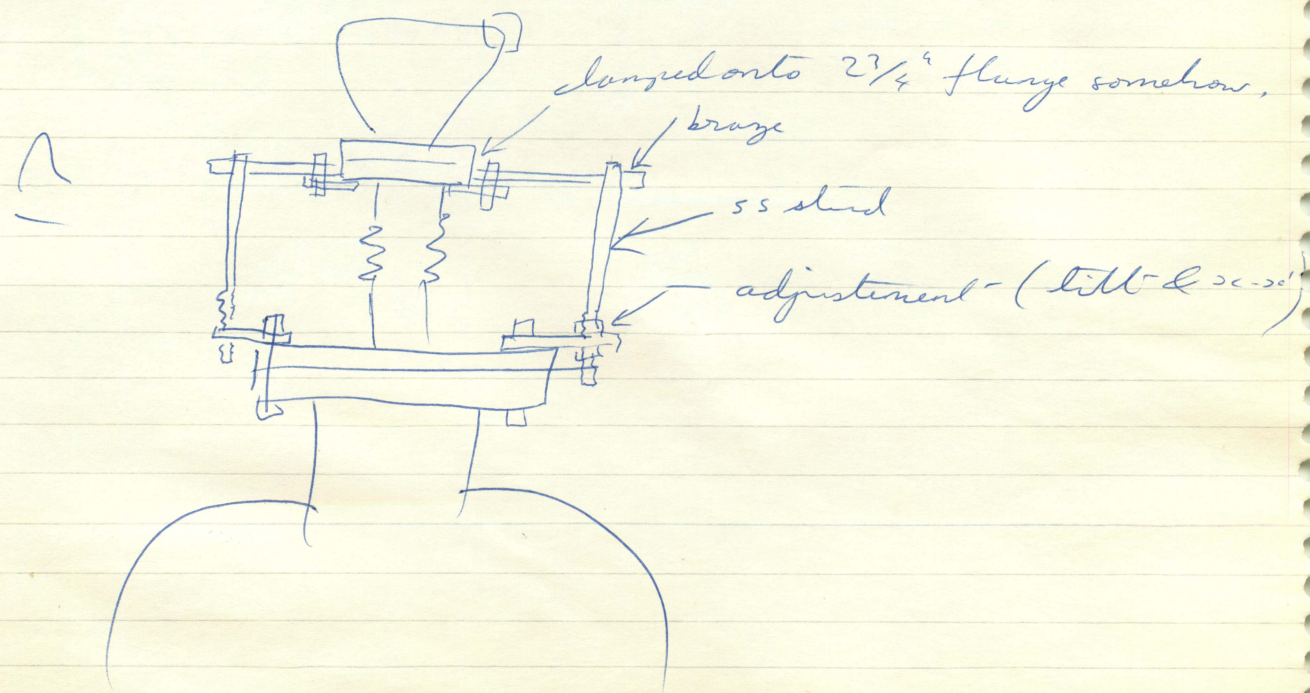
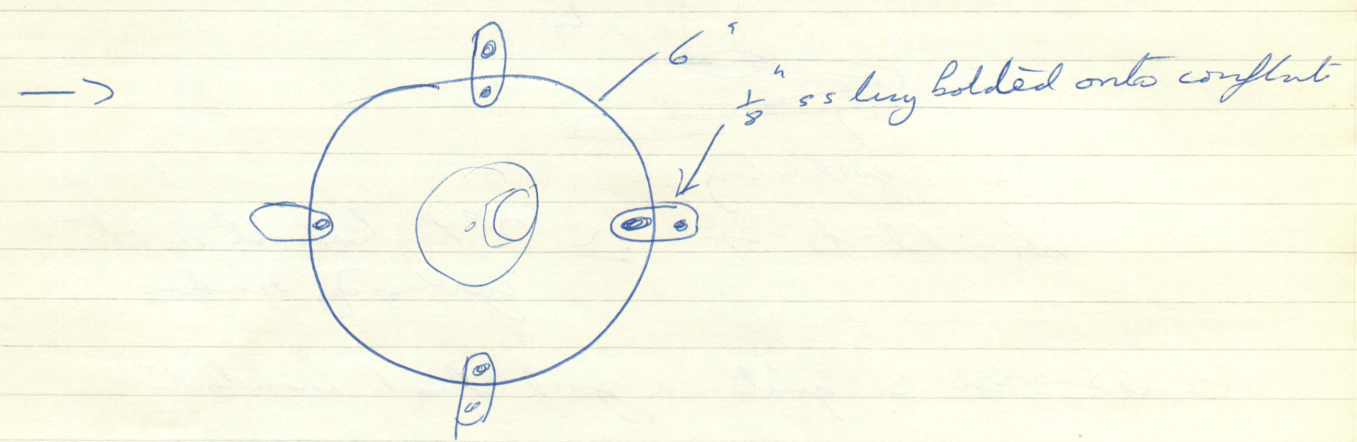
& 1mm² SS wire is quite a good heat insulator

6mm² x 2cm silica

$$Q = .01 \times .06 \times \frac{260}{2} = 130 \times 6 \times 10^{-4} = 78 \cdot 10^{-3} = .078$$

Mon Adding gas-bottles (Ne , He , H_2) to system.
 Trigger-gauge head removed to be sent back
 to AEC Harlow (David Hall) for fixing.
 System lightly baked in pm

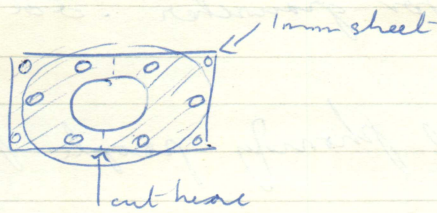
Tues $P \approx 7 \times 10^{-9}$. Rebake in pm .
 Trying to cut temporary support for
 manipulator (hand saw nbg).



- quicker to make than proper granular (x, y & tilt) to allow testing of analyser & multiplier. Resistors^(2,2) have been ordered from 20th century by CDB.

Wed London to try to get camera fixed.

Thurs. ~~Research~~ Making attachment device to fix 2 3/4 conflats onto top of granular device



Fri Order phosphor screen from Mr Saunderson of EMI CRT Factory, Blythe Rd, Hayes, Middx - not Al-backed - i.e. low energy electrons. Res₁₀₀ 100 μ m + Blue, \approx 2 weeks from receipt of our blank.

Off on holiday for 2 weeks.

Sept-12th Tues Dash from Holiday in pm. Turn on rotary pumps.

Wed Only 10 UHV resistors (1 ind) have been supplied from 20th Century. No more available.

? What to do about multipliers

Thurs Trying to get resistors from EMI in pm.
am cutting legs for granacher. Sol cutting disc for top.

Fri Lot of time wasted phoning people for info on multipliers & resistors.

1) Mullard channel multipliers price $\begin{matrix} \text{B319 AL} \\ \text{BL} \end{matrix}$ } all 101 bakeable (no extra charge) £152-10

Several who (+4) delivery)
Order from ^{207 Division} Mullard House who will pass on to distributor

$\begin{matrix} \text{B318 AL} \\ \text{BL} \end{matrix}$ } £139-50

G 40-25 27mm c-plate £150.30

? What efficiency for lo-energy ions (v low below 10 KV according to Mullard brochure, but is this so, & if so, why?

2) 177 make multipliers, according to catalogue, but are hopeless about info & don't know who does know; try Valve division in Paignton (Ph 50762) or John Hervey who works at home (?) Wembourne (Dorset) 5874
Come across Murray Ramsey at STL Harlow 29531 who knows about image intensifiers -

3) 20th Century Multiplier, with resistors, type ED 525, £100.
14 stage, 2.5×10^5 gain

4) EM1 won't sell just resistors but can supply multipliers with them (have to remove glass envelope & pinch-sealed pins)

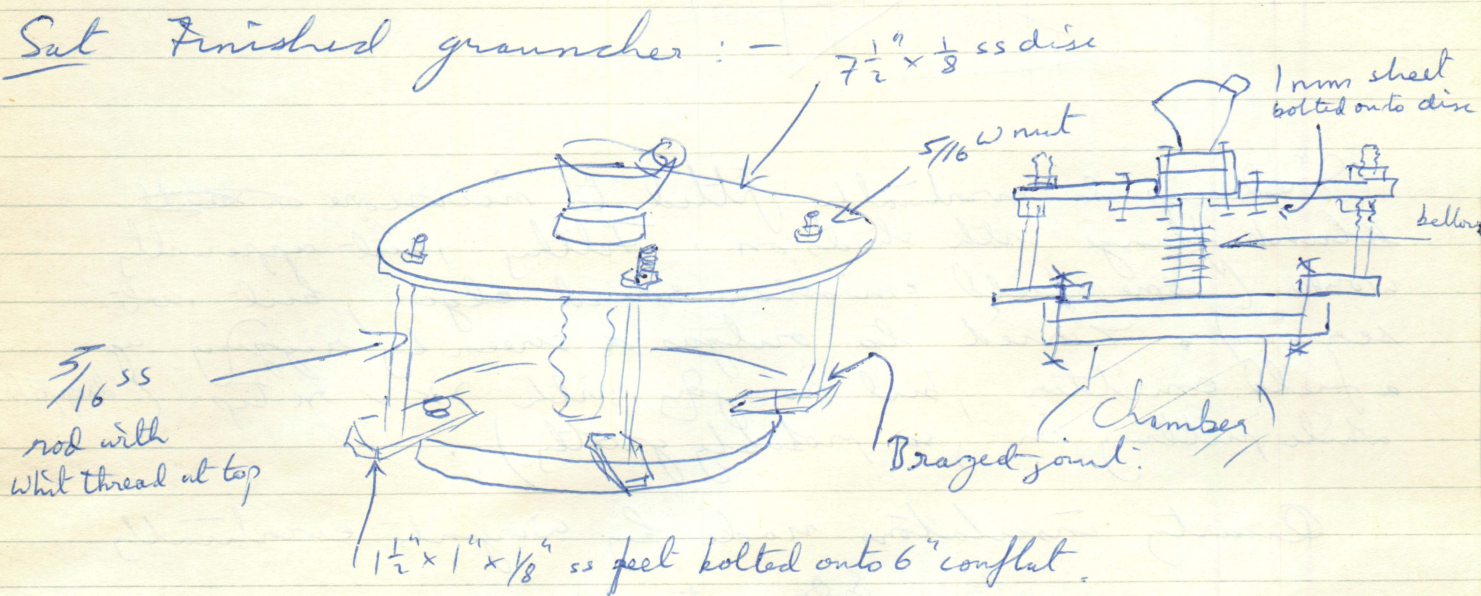
types 9643/33 17 stage Belu Varistor kind £54 16 Wms

9642/33 18 stage " " £59 off shelf.

Seems reasonable to order 9642/33 & if doesn't work we still have ~ £35 worth of useful & hard to get resistors.

Drilled holes in Disc & support system for granacher in ppm.

Sat Finished granacher: - $7\frac{1}{2}'' \times \frac{1}{8}''$ ss disc



Also Deposited Al mirror onto blank supplied by Wriggents.

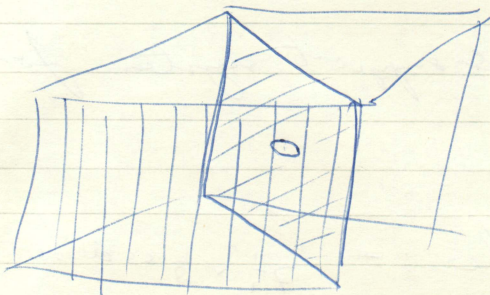
Sept 17 - Oct 8

Fitted granular to mic + bellows.

Baked into ^{bakeout machine} ~~vac~~ + sub pump for several days (couldn't leave overnight ^{because} getting hot - get thicker wire put it)

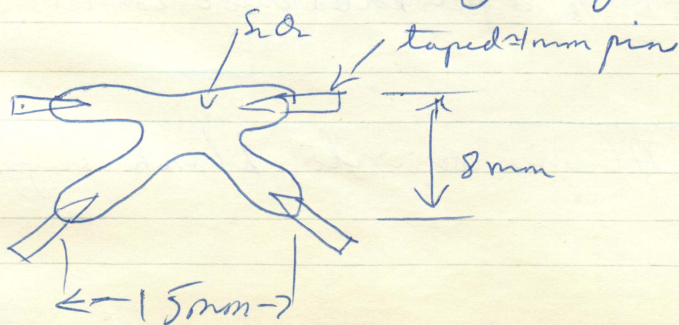
→ $\approx 5 \cdot 10^{-10}$ no nitrogen, first time N_2 added pressure
→ $2 \cdot 10^{-8}$ dynamic, $1 \cdot 10^{-5}$ static \therefore lot of contamination on radn shield. 2nd time $p \rightarrow 3 \cdot 10^{-10}$, 10^{-8} static

Put together channel plate mount; mirror put in a ss box with a fine Ni grid (homemade) to stop lens effects

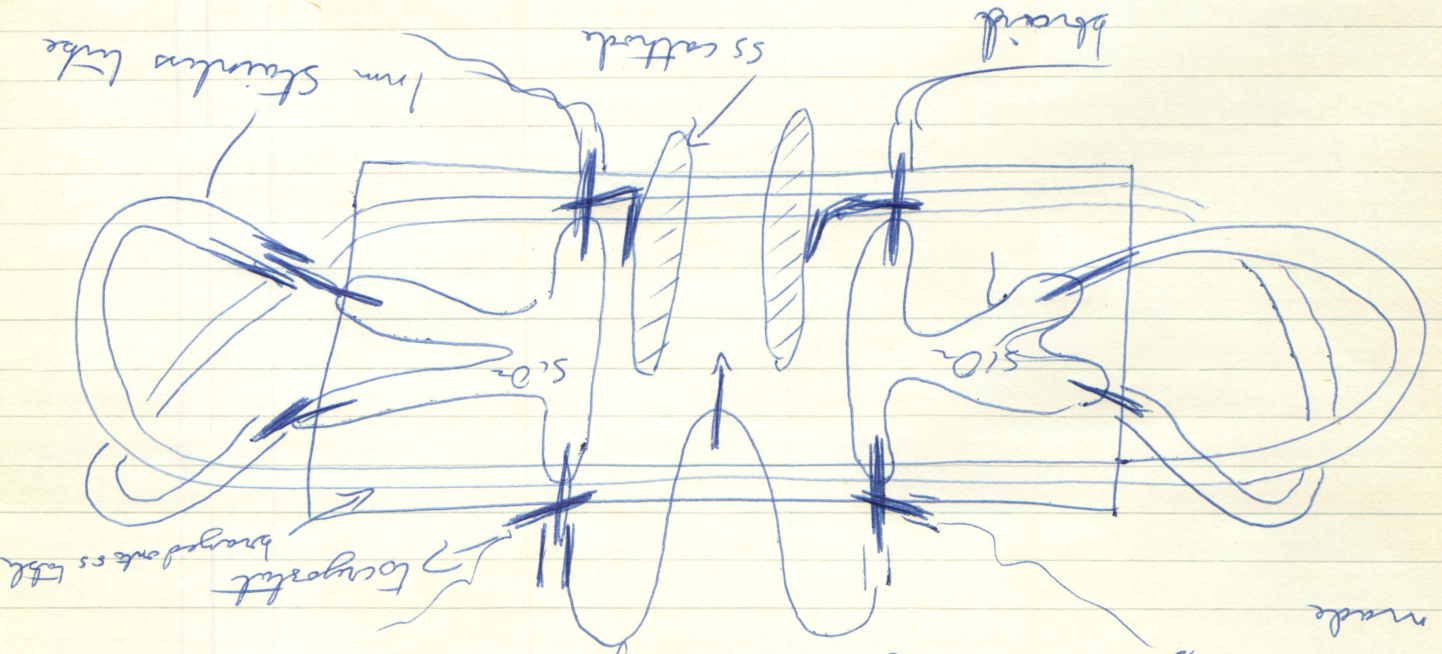


Wired up & eventually fitted to microscope on ~~small~~ blank flange with studs on. Filthy, but apparently works (some field emission round edges, but not serious). Tried to outgas a screen by rigging up a field emitter, but no joy with 2kV on tip (dropped while putting in, so probably grotty).

Quartz insulators made by Wright eventually

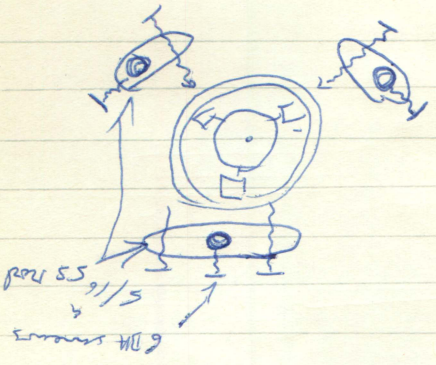
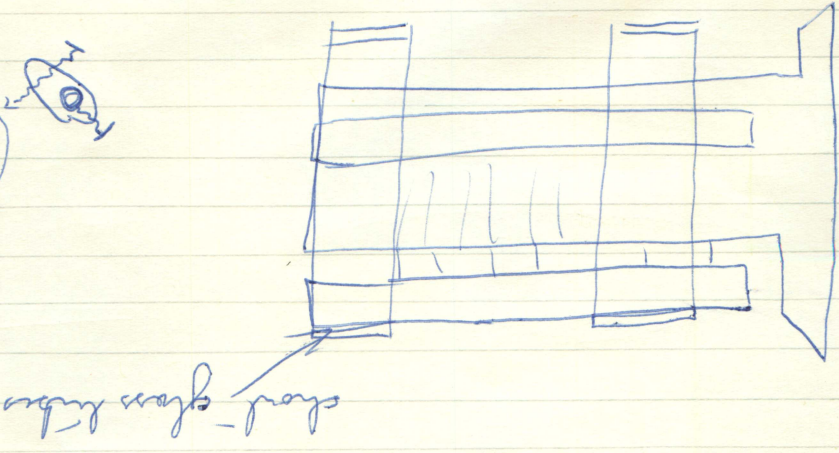


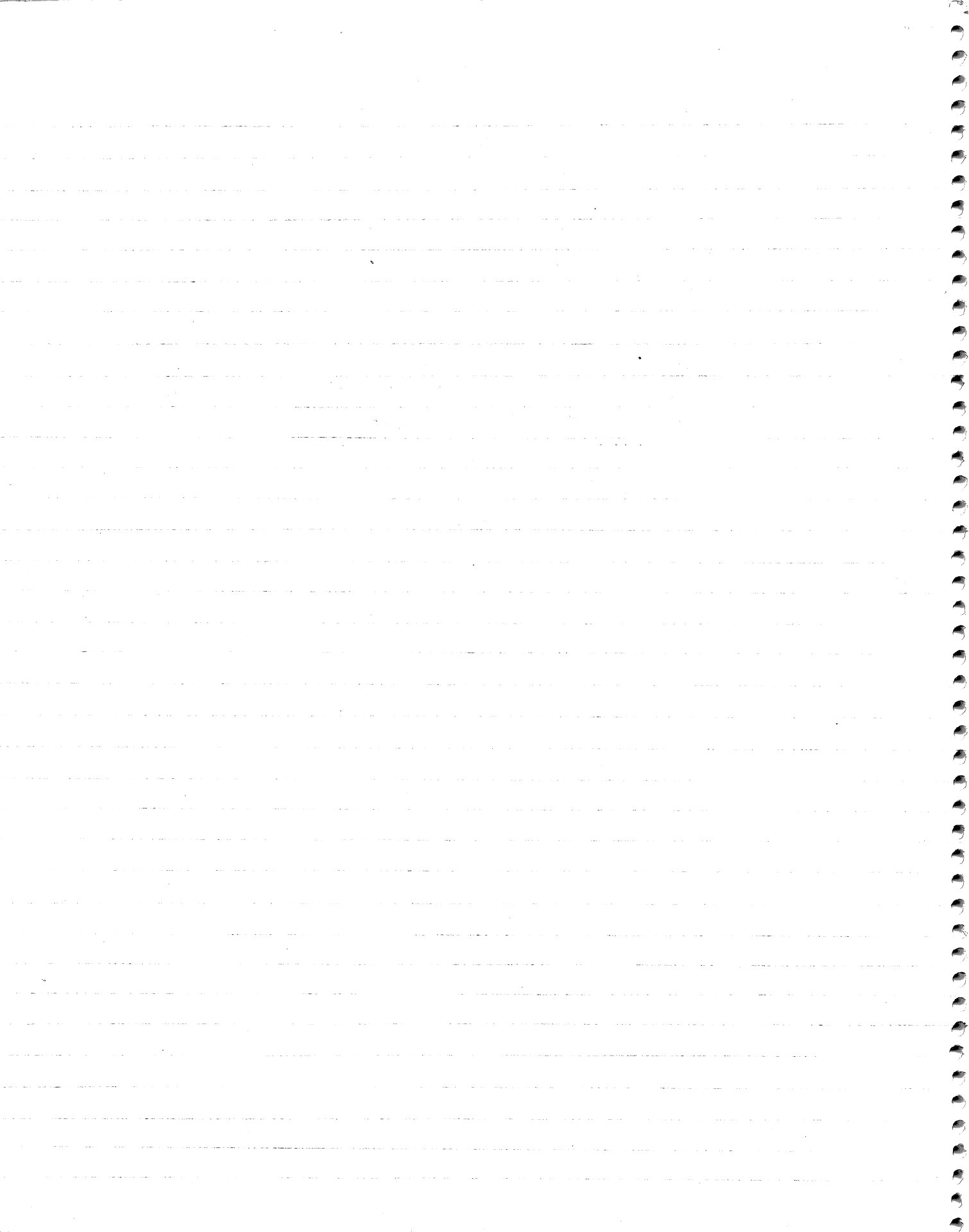
Stainless steel cathode made to fit on table. Table made made



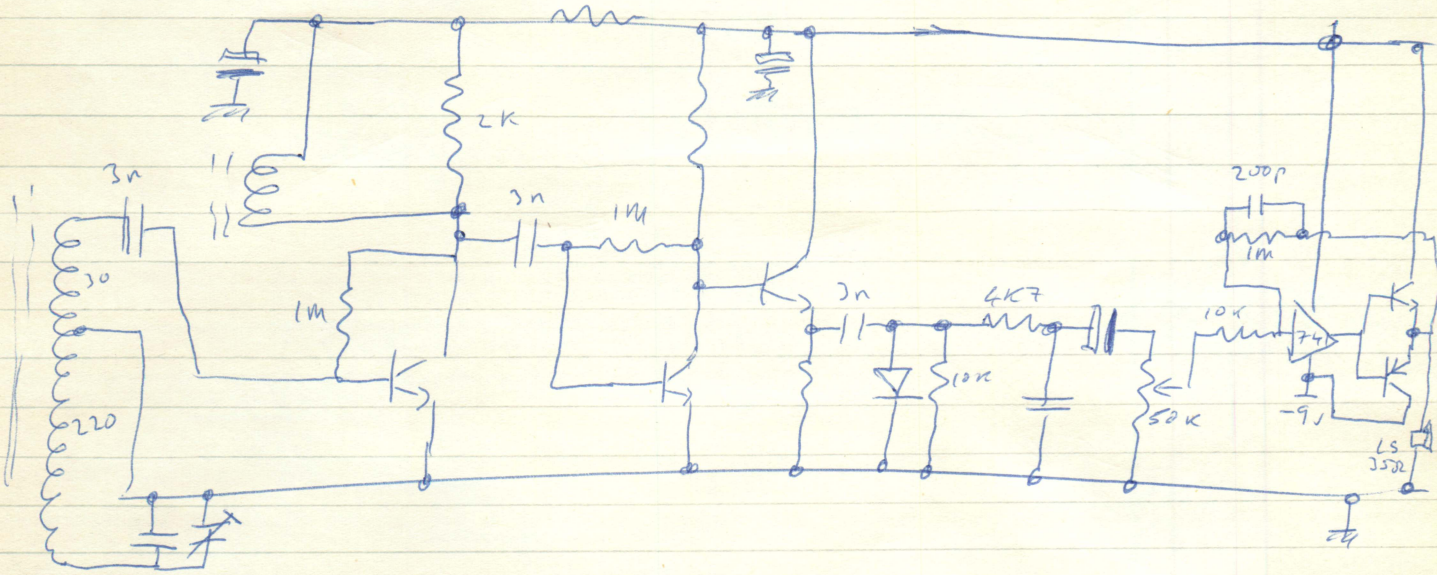
Somewhat better device designed (original)

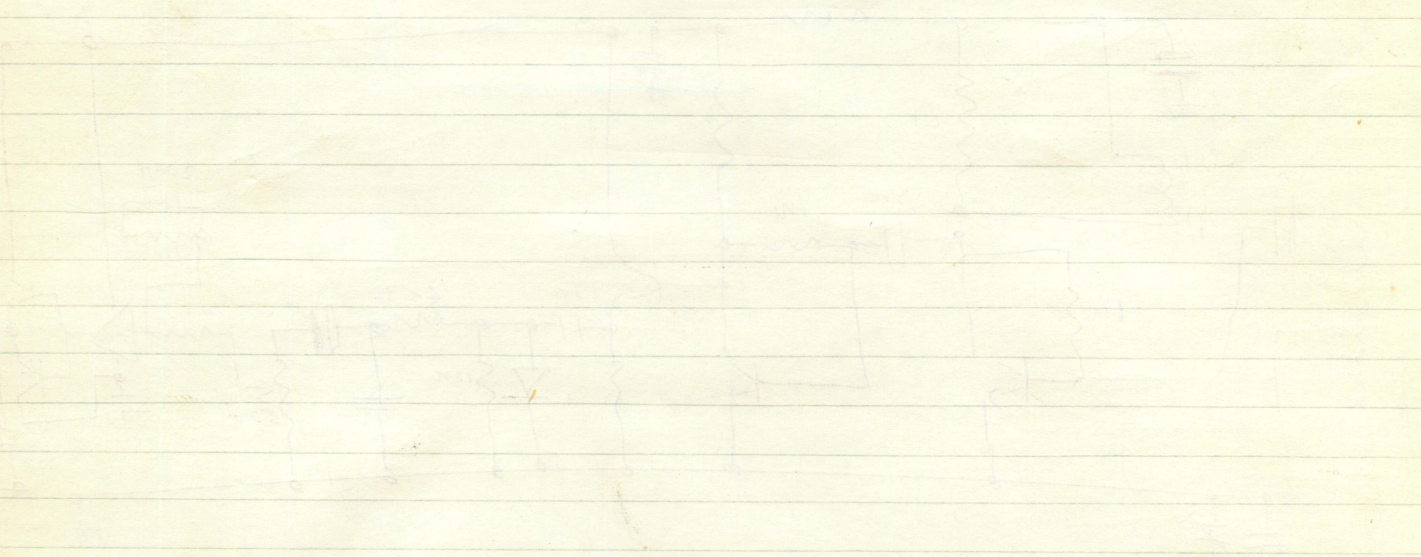
It's made to hold analyzer.



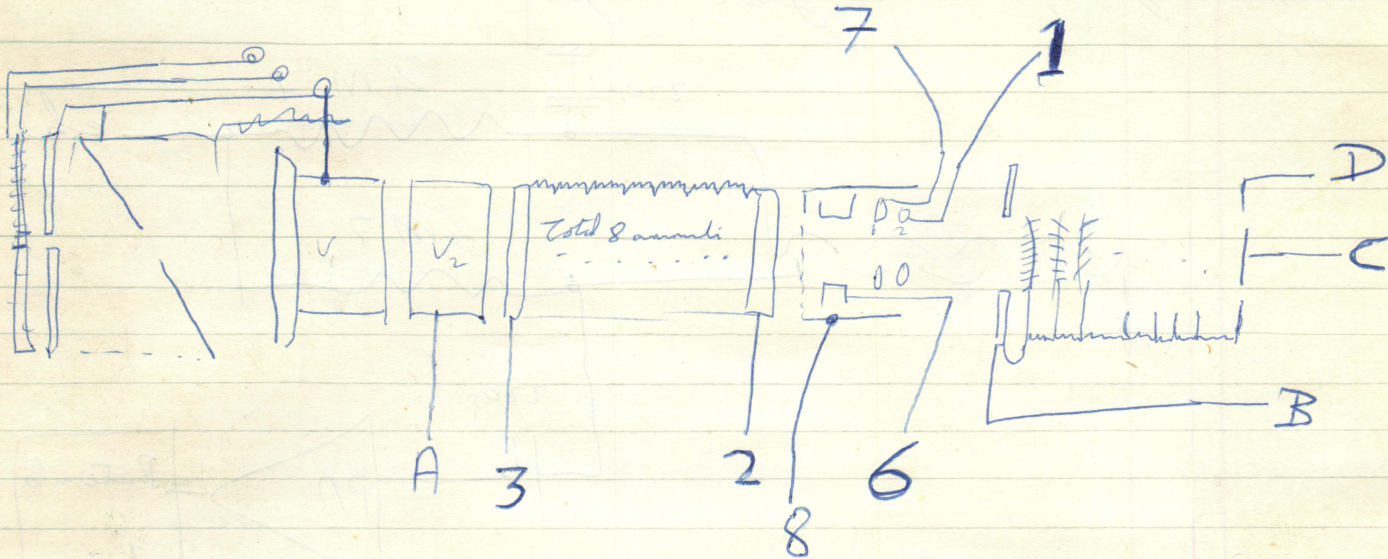


20 Nov Cryostat back from V.C. The Brazing has a lot of holes in, but apparently leaktight (to $\approx 10^{-8}$ Torr, N_2)
Building frequency standard.
Tuner part is

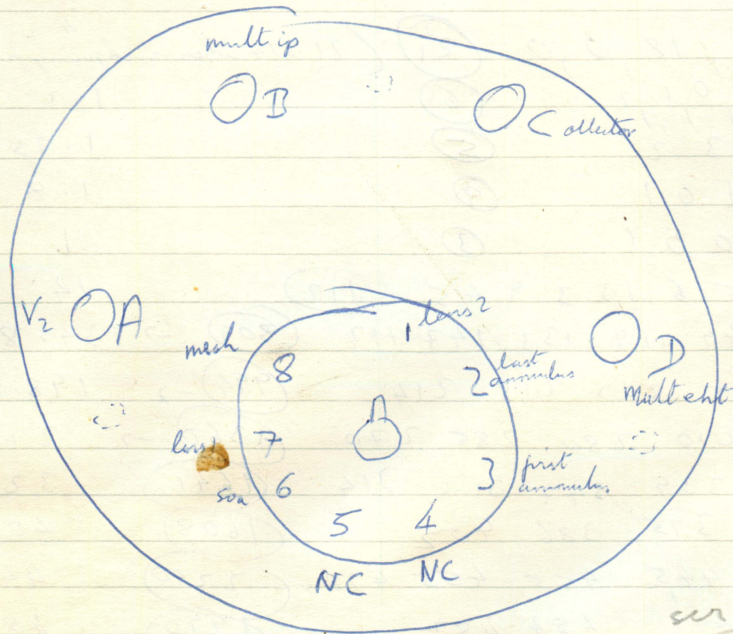




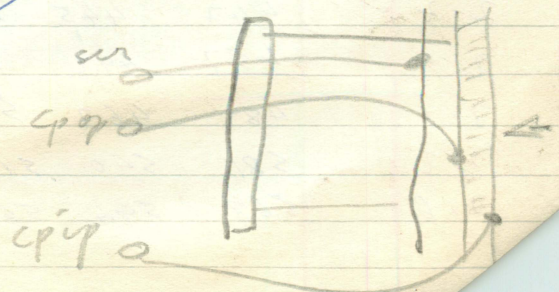
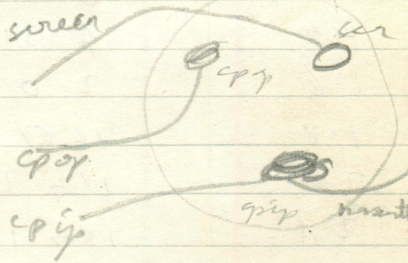
Fri
Dec 8th 72



From
 Outside



cht feedin top from outside

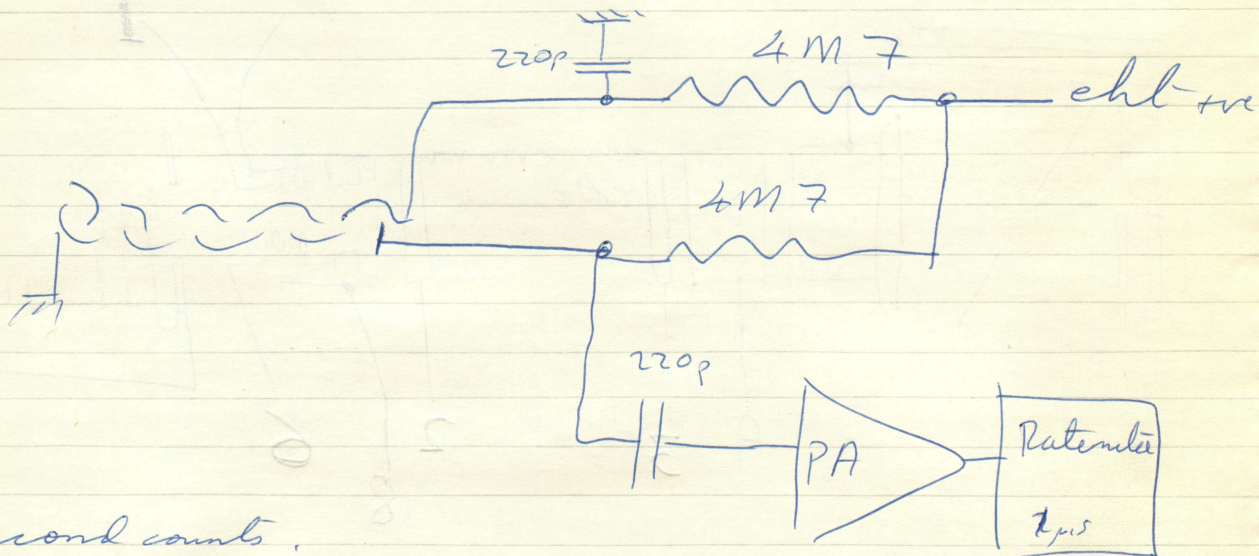


16 Dec 71

Multiplier noise

2×10^{-8} Torr

Gain of amp set to give output noise ≈ 1 v p.p



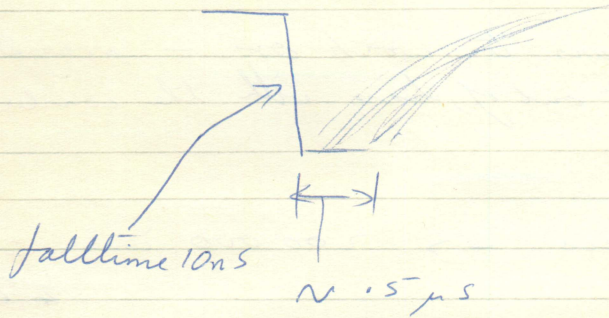
10 second counts.

Mult-Volts

1000	1, 2, 18, 0, 0	(21)	(21314 when sub pump fired!)	4.2
1.1 kV	3, 0, 0, 1, 2	(6)		1.2
1.2	0, 0, 3, 2	(5)		1.25
1.4	4, 3, 1, 0, 1	(9)		1.8
1.6	2, 0, 0, 0, 1	(3)		1
1.8	16, 5, 1, 5, 6, 13, 3, 9, 4, 5	(112)		14
2.0	11, 4, 14, 9, 11, 9, 13, 3, 14, 7, 11, 7	(809)	→	134.8
2.1	18, 4, 17, 5, 20, 7, 21, 8, 21, 4	(994)	→	198.8
2.2	27, 5, 25, 0, 28, 0, 28, 5, 27, 0	(1360)	→	272
2.3	32, 9, 33, 9, 34, 7, 31, 2, 31, 4	(1641)		328.2
2.5	42, 5, 39, 5, 38, 6, 40, 2	(1608)		402
2.7	44, 7, 44, 5, 45, 5, 45, 5, 47, 8	(2240)		448
2.9	45, 7, 49, 2, 48, 7, 48, 7	(1920)		480
3.1	48, 9, 46, 7, 52, 6, 53, 5	(2077)		509.3
3.2	58, 1, 54, 0, 51, 5, 51, 8	(2154)		538.5
6	56, 8, 59, 4, 56, 6, 53, 6, 53, 7			559.4

Counter

@ 2.3 kV pulses from presamp are mainly saturated :-



@ 3.7 kV width is up to 5 μs, same falltime.

3×10^{-5} He ion gauge reading

Tip is @ 5.5 kV 81V
110 zone line down.

Voltage on Mult, kV ions/sec

1.0	0
1.1	.
1.2	.
1.7	590 531 570 681 584 567 548
1.6	128, 126, 137, 136, 122 120, 109 116 120
1.8	1051 1157 1140 1120 1147 1152 1102
2.0	2063 2002 2016 2013 2047 2053
2.1	2150 2187 2204 2156 2252 2244
2.2	2288 2380 2359 2390 2351 2413
2.3	2485 2457 2454 2504 2468 2386 2447
2.5	2551 2507 2591 2485 2621 2489 2486
2.7	2486 2514 2538 2548 2472 2499 2585
2.9	2544 2485 2531 2466 2602 2551 2582
3.1	2523 2569 2521 2599 2562 2601 2514
3.2	2
3.6	2618 2584 2593 2472 2553 2584 2501

224077
18165

1.9	1718 1651 1756 1189 1768 1749 1699
1.7	662 617 616 677 718 663 645

Test on chop input of counter.

≈ 2000 cps integrated over 100 sec, chop freq 1Hz

≈ 200000 ions ± 450 cps 000263 999874 OK
50ns 001090 999781 000154 OK

\therefore Chop input now appears to work OK - over- & under-flow indicators don't get out of phase with the counter.

@ 2000 cps, 100 sec \rightarrow 200000 ions $\pm \approx 450$
 ~~± 70~~ 1.25%

Noise ≈ 40 cps \rightarrow 4000 ± 60 1.5%
Noise is 2% of total, error in noise is .03%

10 sec \rightarrow 20000 ± 140 .7%

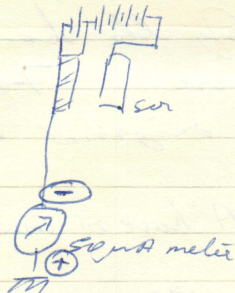
Noise $\approx 400 \pm 20$ 5%

Noise is 2% of total error in noise .1% of total

Tues 23rd Having put through ≈ 10 tips (W) which
 have all turned up @ ≈ 7 KV in Ar, 10-15KV in He,
 making some investigations of microscope. Removed table tip support
 & reweld joint, inspect for sharp edges, etc, looks \approx OK though
 found slightly lumpy, 1 or 2 loose ends on -ve side. smoothed
 em down. Put in tip, turned up at very small voltage
 in field emission. looked OK. Put in Ar, spots appeared @
 ≈ 5 KV, respectable sort of figure. Spots get smaller as
 volts go up. Behaves sensibly, apart from high volts needed.

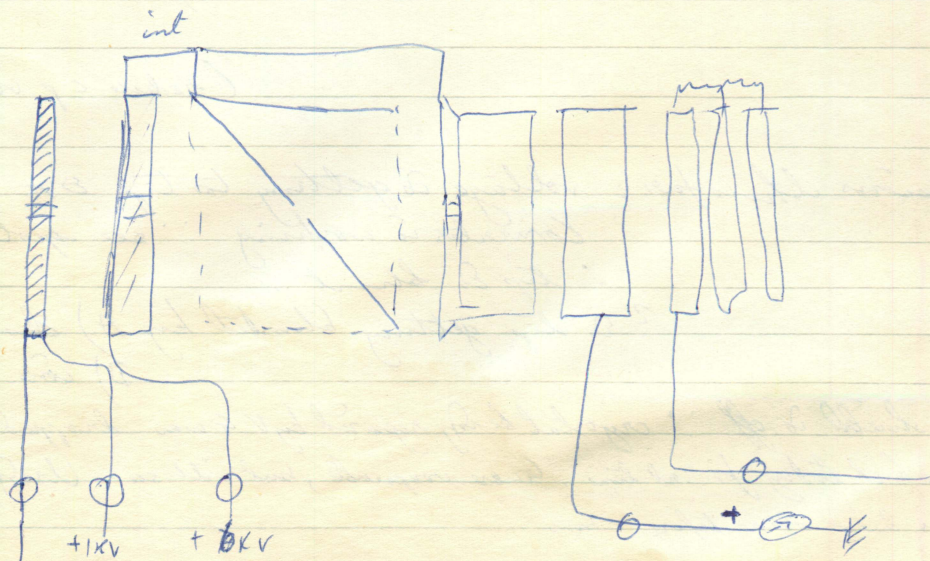
Calcn 10^9 tip resistor @ 1 KV $i_{tip} = \frac{10^3}{10^9} = 1 \mu A$

Measured current in earth lead connected to c-plate
 is $\approx 4 \mu A$

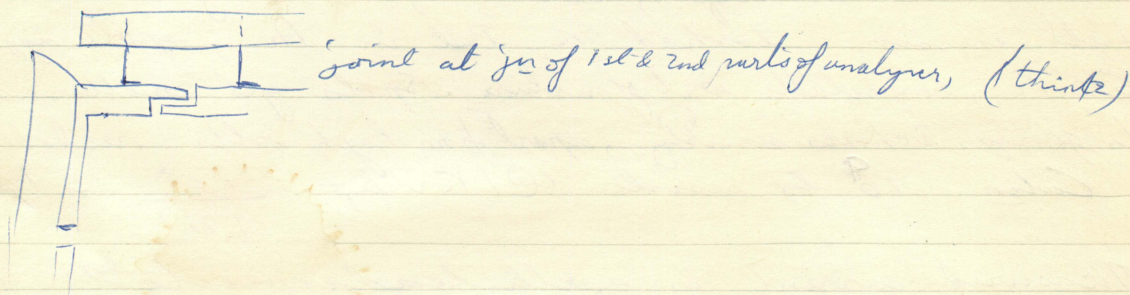


- electrons input to
 converter, from sign
 of current.

Screen ($\approx +7$ KV) is connected to input of analyser.
 Second lens of analyser is grounded via external lead.
 Current in lead is $4-5 \mu A$; and varies with
 converter ckt volts. \therefore field emission across first gap in
 analyser.

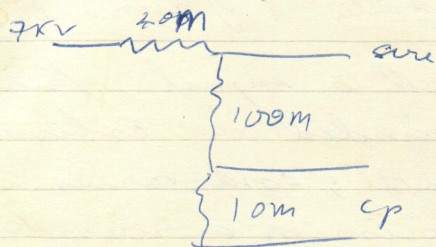


μ Commeter in series with tip & HT set showed no obvious deflection ($\leq 1 \mu A$) at +8KV on tip, with or without series 1G Ω resistor. Picture appeared at roughly same voltage without series resistor; therefore, tip insulation is OK at 8KV.



? Is this leak what is doing the damage? Has tip f.c. volts charged. measure. Fe voltage is at 1200 volts which is comparable with original volts, probably.

? what effect does $4 \mu A$ have on screen volts



$$\frac{7 \cdot 10^3}{4 \cdot 10^7} = 1.7 \cdot 10^{-4} = 170 \mu A$$

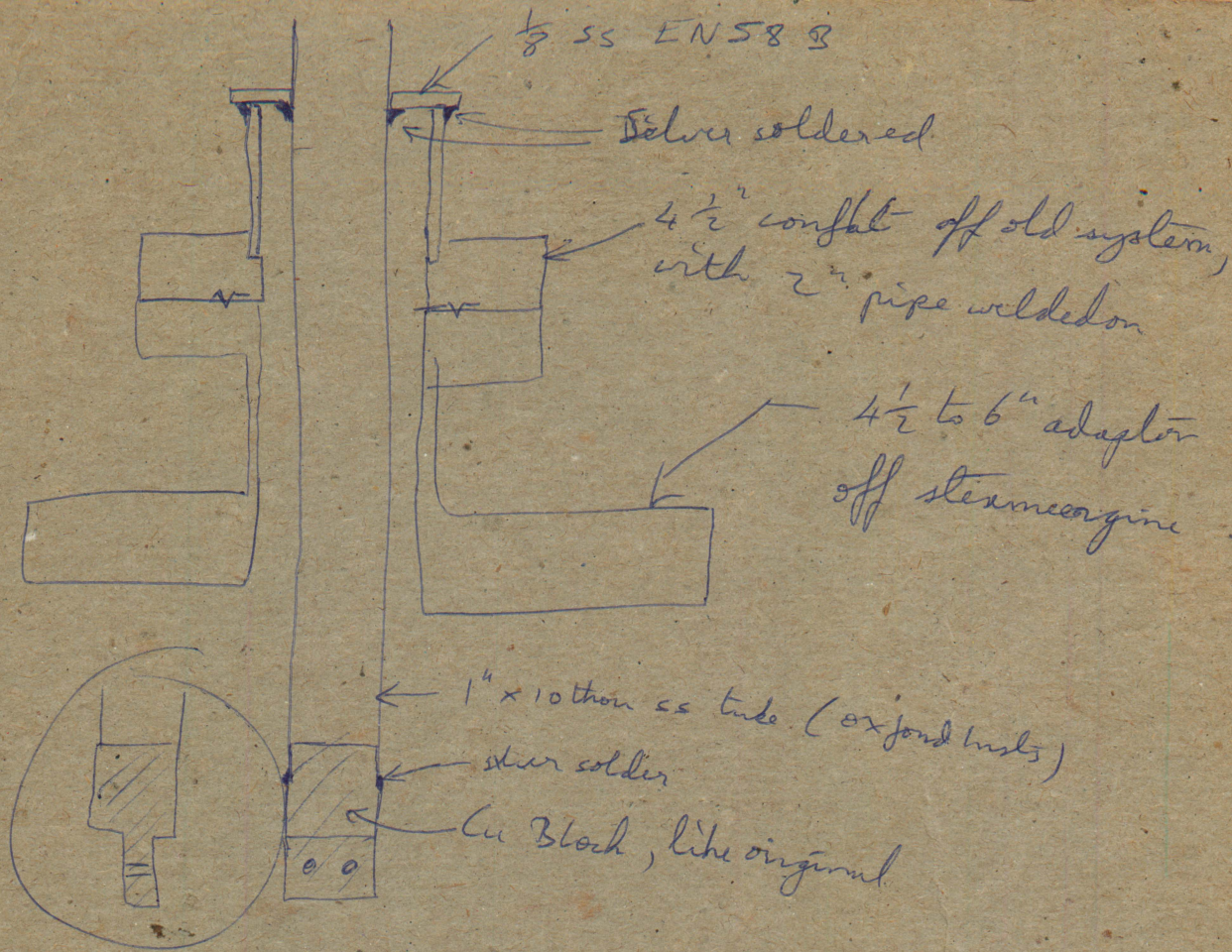
$\therefore 4 \mu A \times 40M = 160v$ should be negligible.

(reduce cp volts by $4 \times 10M = 40v$ only)

Conclusions thus far: voltage is getting to tip OK
 Converter is working \therefore see spots OK
 \therefore tip is blunt.

? Is tip getting blunted by A) discharge in analyzer.
 B) ions from e/gauge or i/pump

[radar shield is off \therefore crystal body repaired by V & was dropped from 10 miles by GPO & has gone back today for 3rd time. Guess irreparable, but will see. Usudy homemade crystal about me & J. or made before \times hrs.



Best pressure to date unbacked is 8×10^{-9} Torr



LAB

