ISR-MA/LR/rh

19th February 1971

ISR RUNNING-IN

Run 25 - 17th February 1971

First part: 18.00 - 21.00 h

20 bunches injected into Ring 1 at 15 GeV/c

1. Study of the brickwall as a function of the working point with as small as possible Q-spread across the aperture, in Ring 1

The variation of Q_V in the region normally used in our stacking experiments, namely from $\Delta p/p = -2\ \%$ to $\Delta p/p = +2\ \%$ is about 0.028, while that of Q_H is negligible (<0.005). In order to reduce the Q-spread across the aperture, the sextupoles were excited to produce

$$\Delta \frac{\partial Q_V}{\partial p/p} = -0.7 \qquad \Delta \frac{\partial Q_H}{\partial p/p} = 0$$

With these settings, stacks were made at the following working points:

a) ANNA : Q-meter readings at injection $Q_H = .778$; $Q_V = .699$

b) ANNA + $[\Delta Q_V = +0.01]$: Q-meter at injection $Q_H = .778$; $Q_V = .708$

c) ANNA + $[\Delta Q_V = -0.02]$: Q-meter at injection $Q_H = .778$; $Q_V = .676$

In all three cases, the brickwall was hit between 1.6 and 1.9 A (the records are with K. Hübner) - see Figs. 1, 2, 3 and 4.
Even when stacking was stopped before hitting the brickwall (typically around 1.4 A), a rapid catastrophic loss occurred after a short, flat plateau, lasting from a few seconds to a couple of minutes. All losses were accompanied by conspicuous signals from the high sensitivity pick-ups (through filters) - see pictures a), b) and c). The frequencies of the coherent oscillations appearing on the pictures correspond, in each case, to $9 - Q_V$: the small differences in Q_V are very clearly visible.

In conclusion:

a) The brickwall instability has appeared with the frequency of the vertical betatron oscillation as measured by the Q-meter on a single shot beam, and not at the frequency of a neighbouring resonance.

b) The instability has not been appreciably influenced by the displacement of the working point with respect to the neighbouring resonances.

c) The instability has appeared in the vertical plane, in which the Q-spread had been reduced, and at less than half the current normally stacked at the same working point with the normal Q-spread.

The above was considered as a strong indication that the line of attack in fighting the brickwall should be moved from the adjustment of the working point to the adjustment of the momentum dependence of Q.

2. Stacking with large momentum dependence of Q in Ring 1

2.1 Working point CLEO ($\Delta Q_H^{PFW} = +0.014$; $\Delta Q_V^{PFW} = -0.038$)

+ sextupole currents to give $\Delta \frac{dQ_H}{dp/p} = +3$; $\Delta \frac{dQ_V}{dp/p} = +2$.

Q-meter readings at injection: $Q_H = .782$; $Q_V = .566$.

A stack made under these conditions reached a maximum of 3.3 A (saturation): no sign of instability appeared. The decay rate after stopping was relatively fast, but levelling down (last reading $3 \cdot 10^{-3}$ min^{-1} at 2.8 A level) - see Fig. 5.

The early saturation and the initial loss were attributed to the presence of third and fourth order resonance lines inside the useful aperture. An RF scan (picture d) shows a depleted region inside the stack. Therefore, an attempt was made empirically to reduce the loss, as shown by the PIDC output during acceleration of one pulse. This resulted in the next working point.

2.2 Working point CLEO + weaker sextupoles $\left(\Delta \frac{dQ_H}{dp/p} = +1.5;\ \Delta \frac{dQ_V}{dp/p} = +1\right)$ and Terwilliger $T_{D1} = -5$ %

Q-meter readings at injection $Q_H = .797$; $Q_V = .601$

A stack made under this condition had a slower stacking rate than the previous one and started showing signs of saturation at 2.25 A, when it had to be stopped because of missing PS beam (Fig. 6).

The stacked current was very stable.

An RF scan was made (picture e), which showed a smoother stack than under 2.1 (only one significant notch).

The scan produced a loss: at the new level of 2.13 A the decay rate was measured to be about $3 \cdot 10^{-4}$ min^{-1}.

A second stack made to 2.23 A (Fig. 7) had also a small decay rate, i.e. about $4 \cdot 10^{-4}$ min^{-1}.

2.3 After some minor adjustment of the RF programme, the same operating conditions as under 2.1 were re-established. The Q-meter readings at injection were again $Q_H = .781$; $Q_V = .565$.

Under these conditions a stack to 3.3 A presented the identical rise curve and ceiling as that of 2.1, with the same decay rate afterwards.

A new stack was made, stopping at 3 A, in order to avoid saturation. This stack also decayed rather fast, at a progressively reducing rate.

It was scanned 3 times with RF (picture f - at 2.7 A level; picture g-at 2.5 A level; picture h- at 2.1 A level). The scans showed again notches as if at certain momenta the beam had been eaten off by resonances. The notches tended to deepen with time. It looks likely that the losses at each scan also occurred at the same notches.

L. Resegotti

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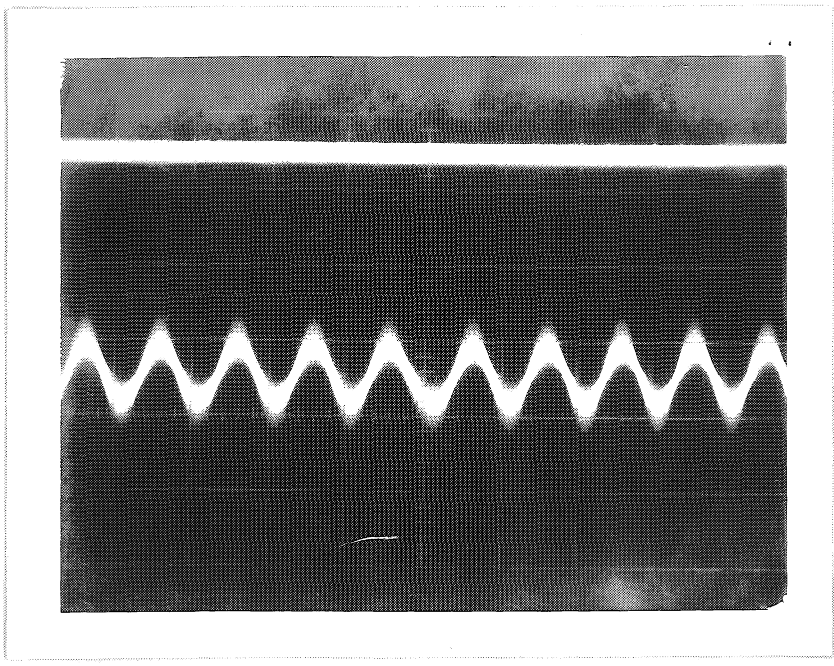
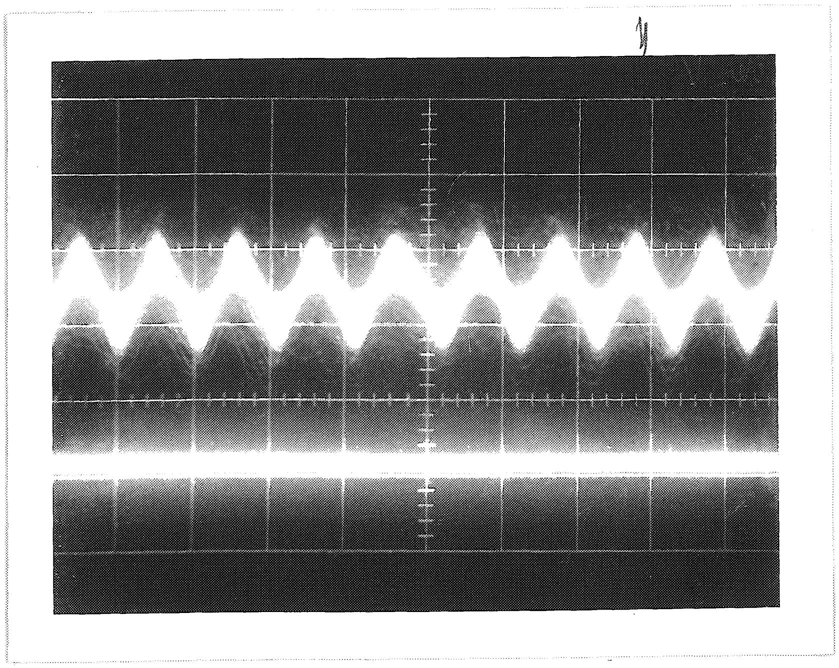
<u>Note</u> : During the whole exercise, a current of about 600 mA was kept circulating in Ring 2.

<u>Distribution:</u>

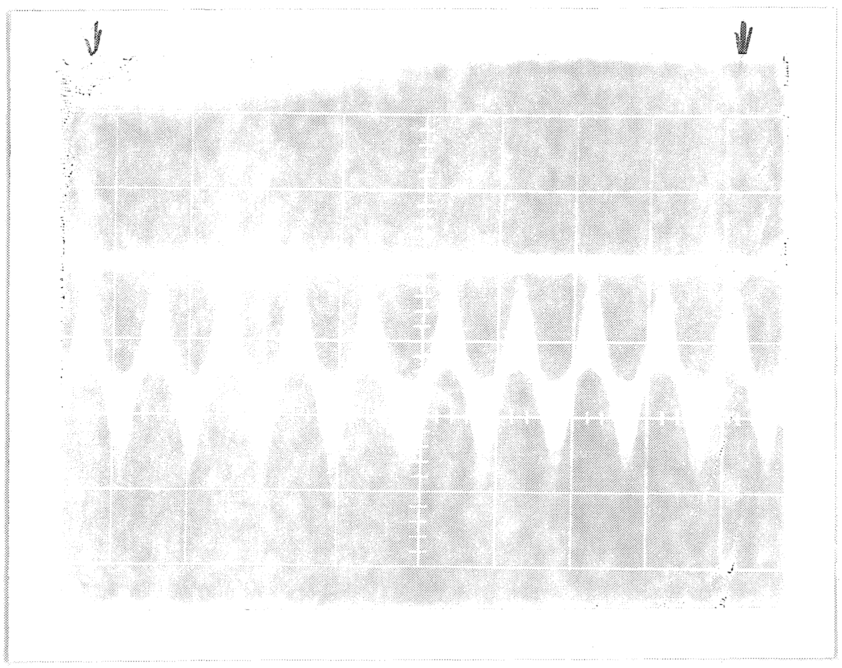
ISR Parameter Committee
ISR Running Executive Committee
Engineers-in-Charge
Sc.staff ISR-MA
Mr. M. Höfert HP
Mr. E. Brouzet MPS



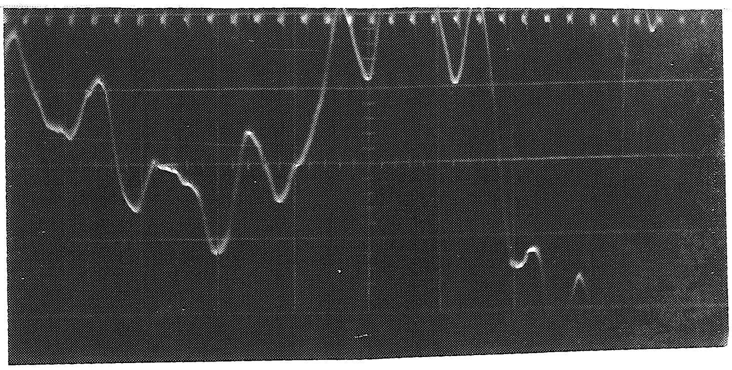
picture a)



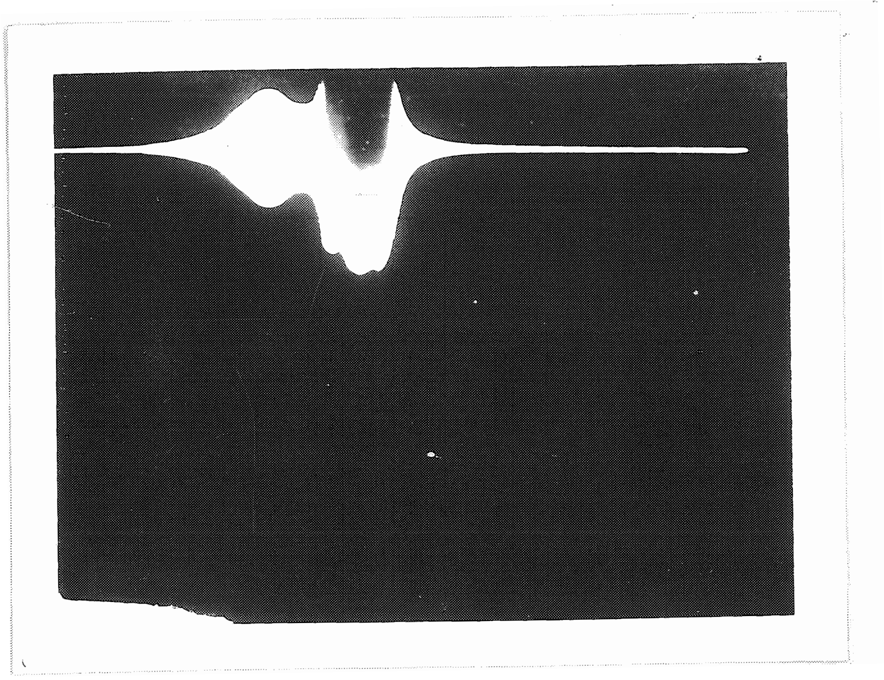
picture b)



picture c)

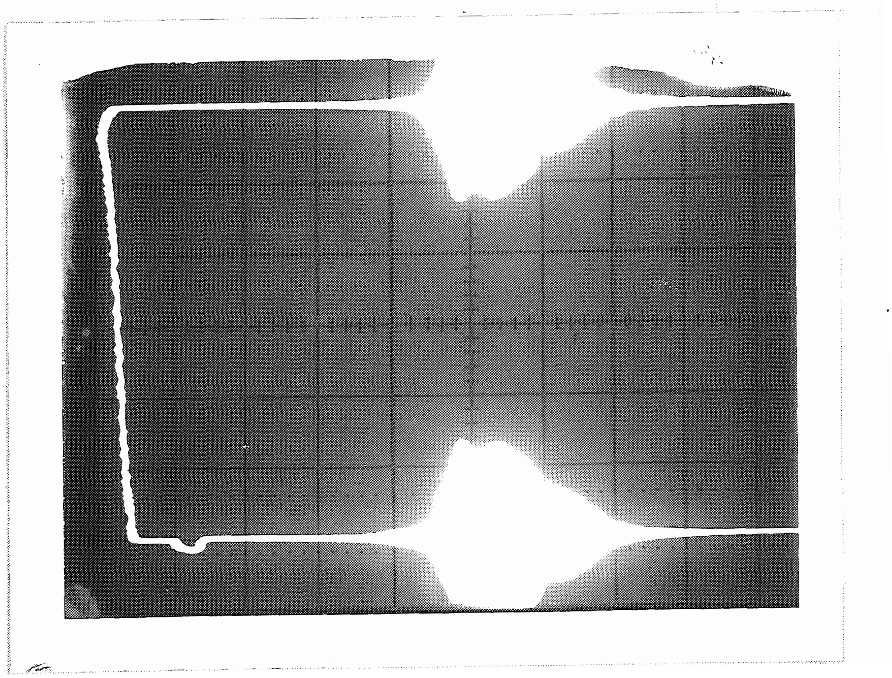


scale for pictures a) to c)

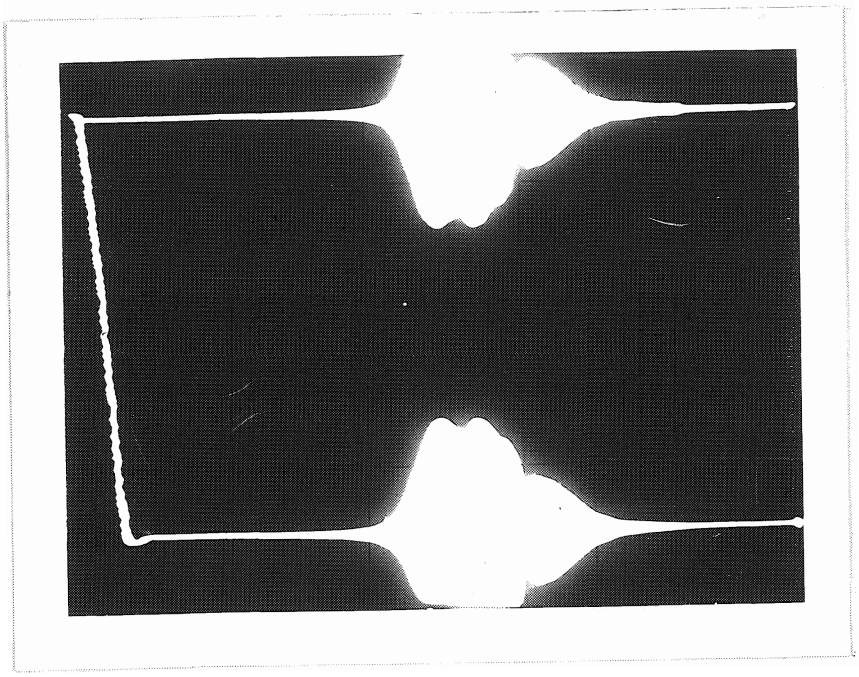


picture d)

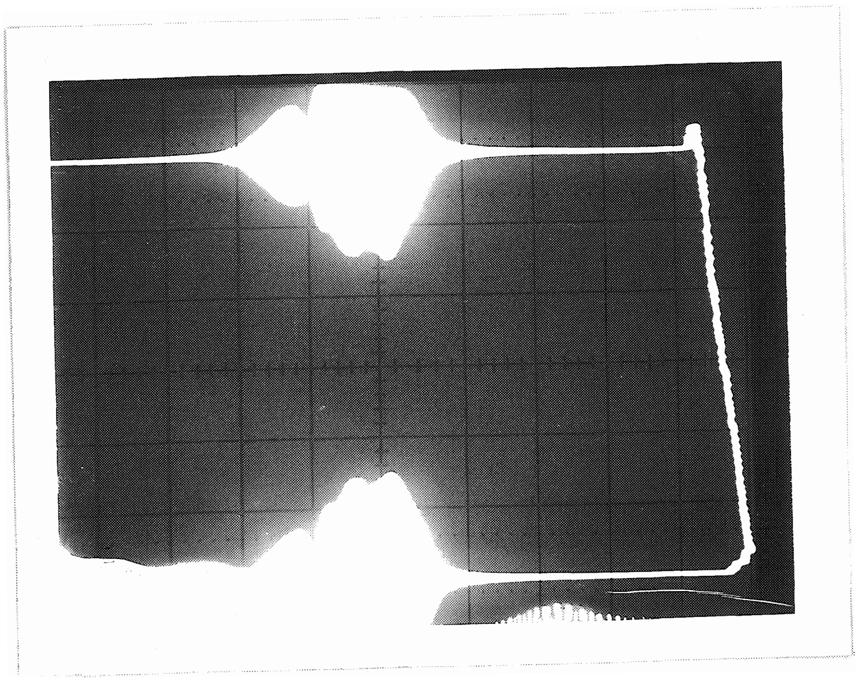
picture e)



picture f)



'picture g)



picture h)

Fig. 1

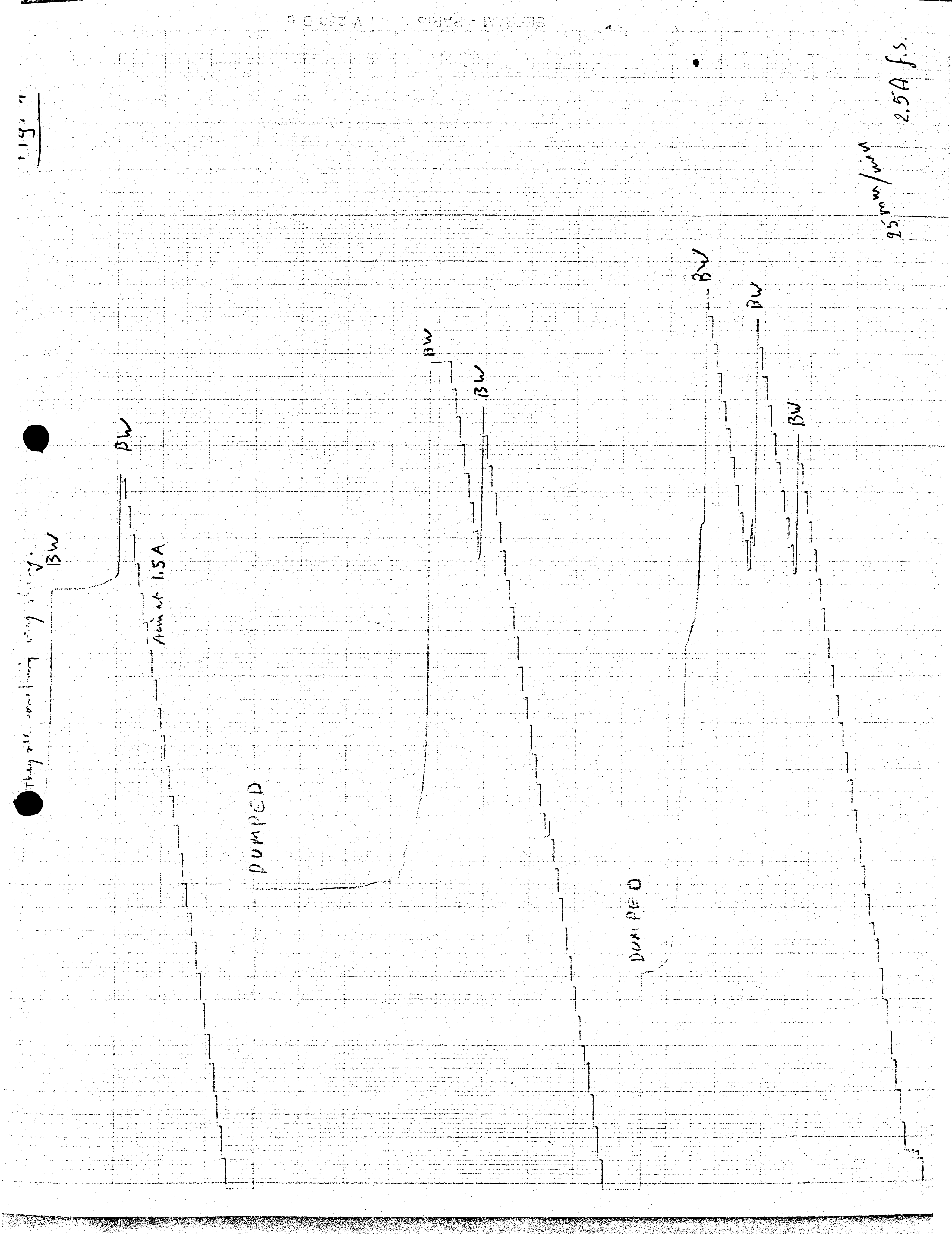


Fig. 2

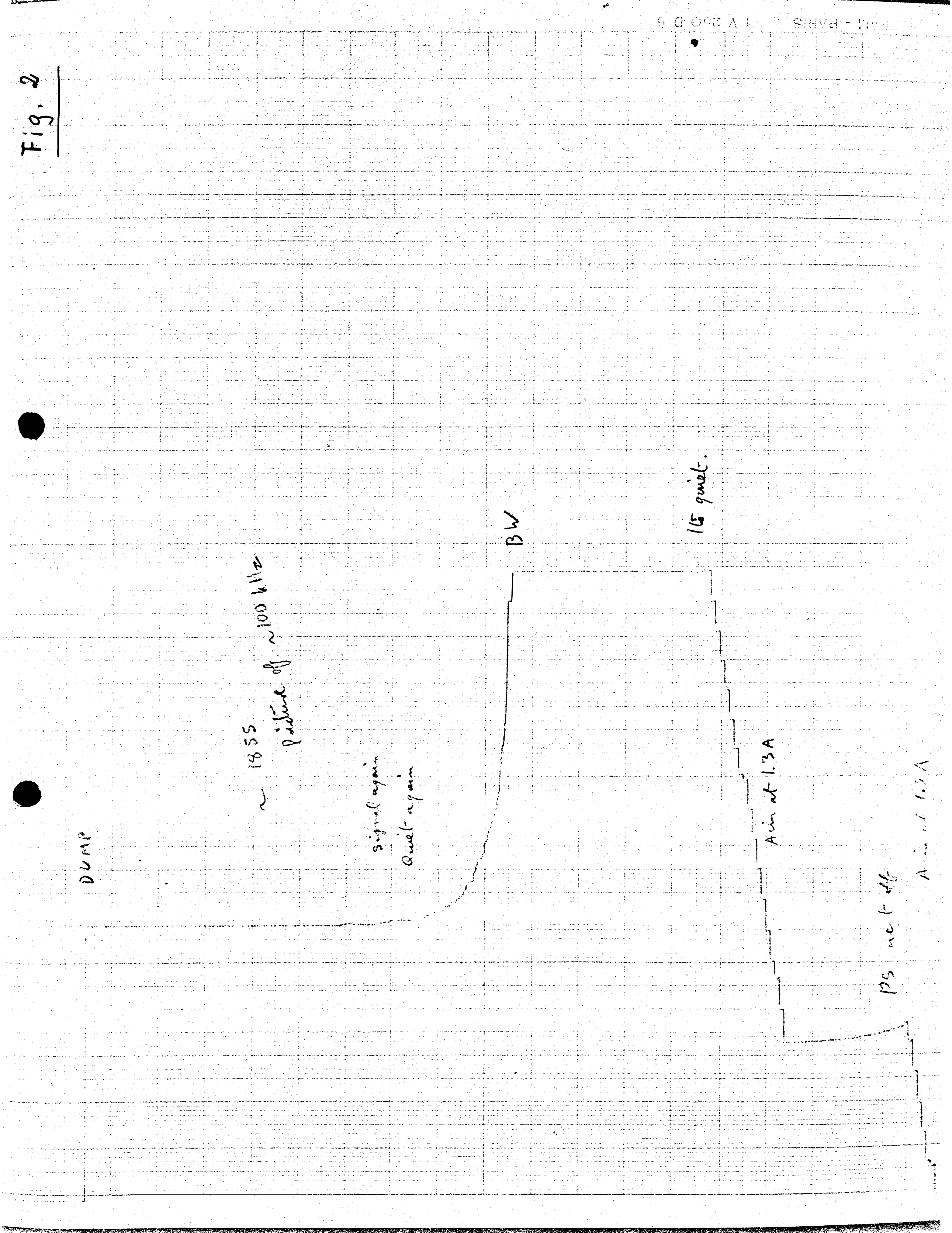


Fig. 2
DUMP
~ 1855
picture of ~100 kHz
signal again
Quiet again
BW
Aim at 1.3A

Fig. 3

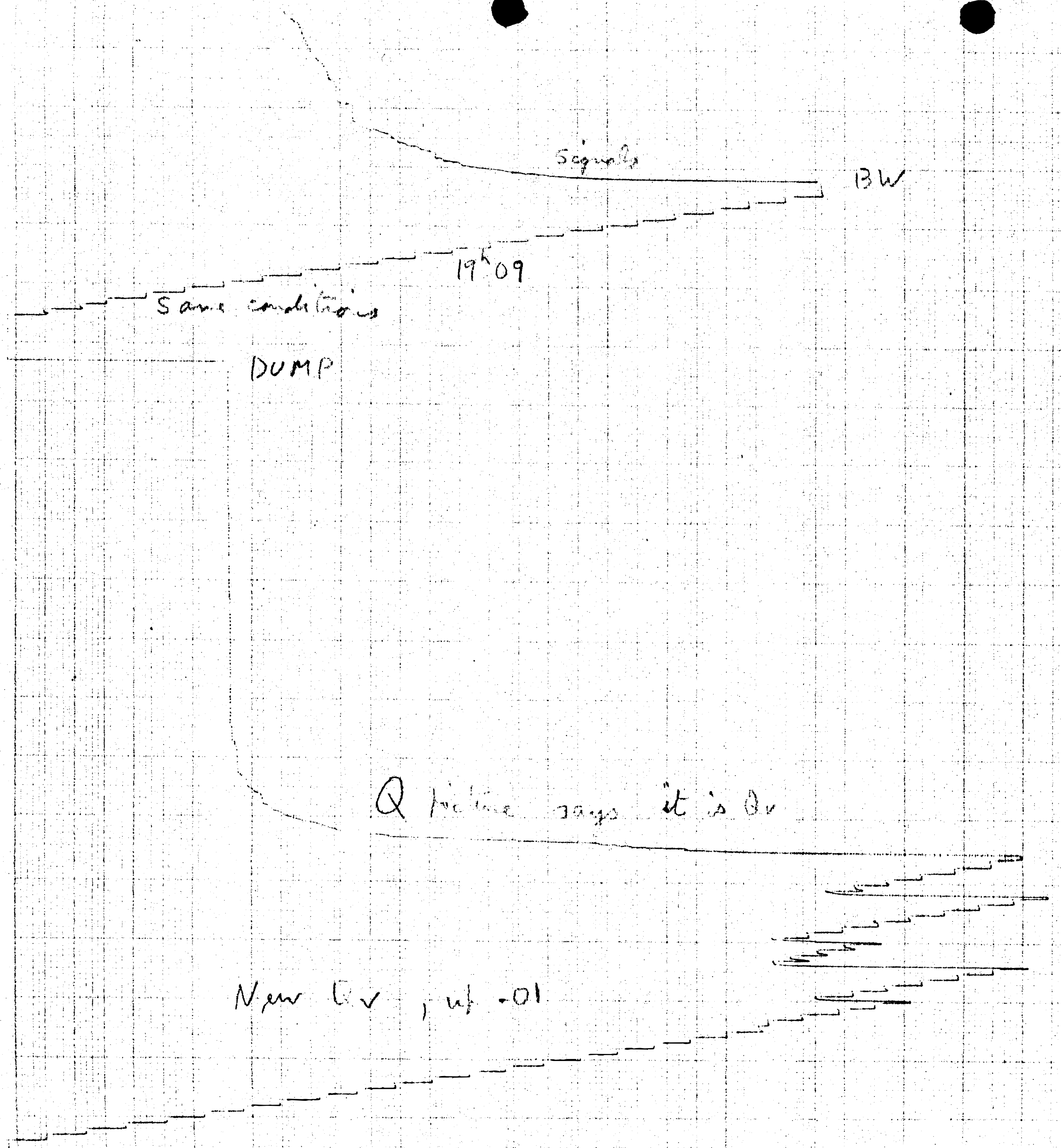


Fig. 3

Fig. 4

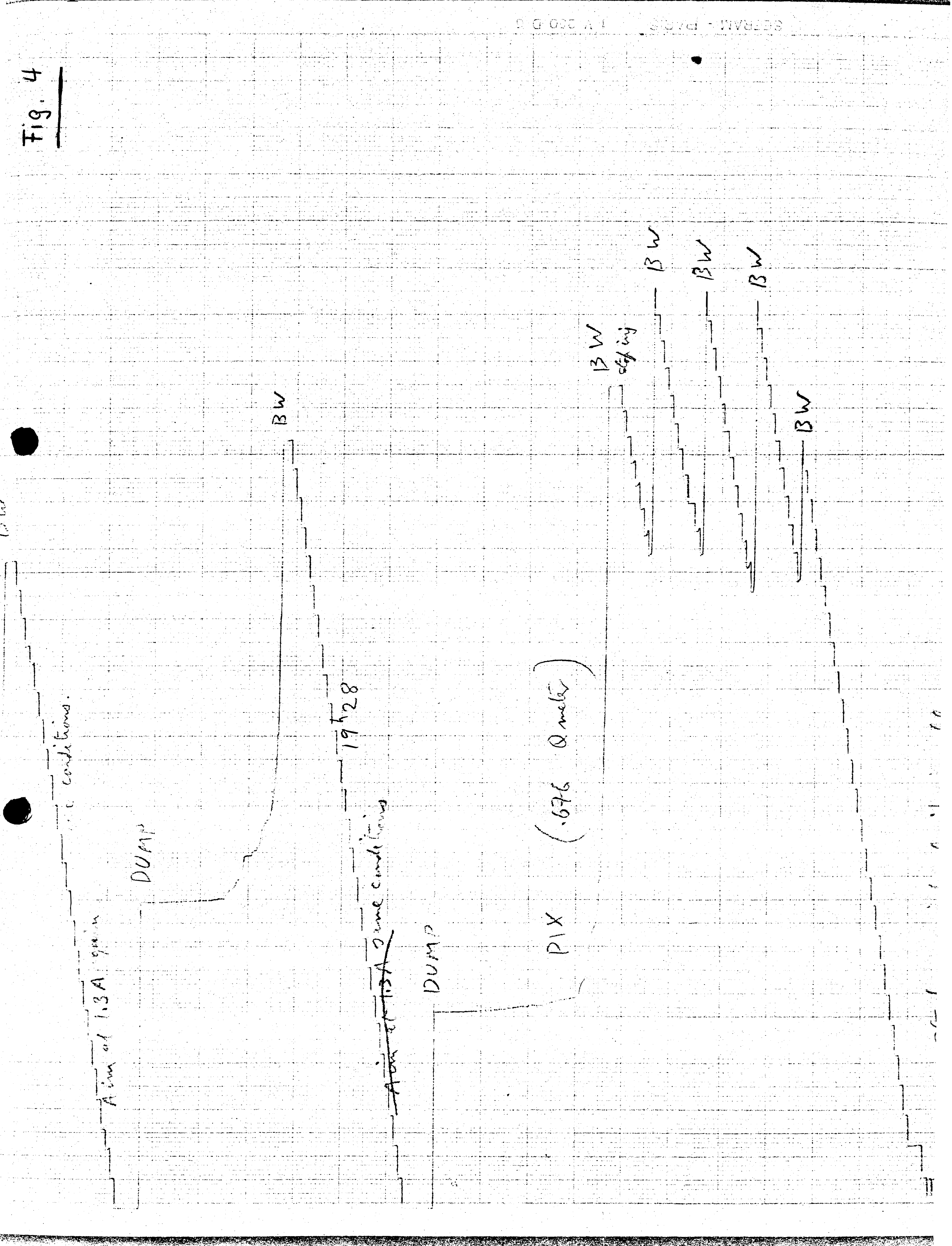


Fig. 5

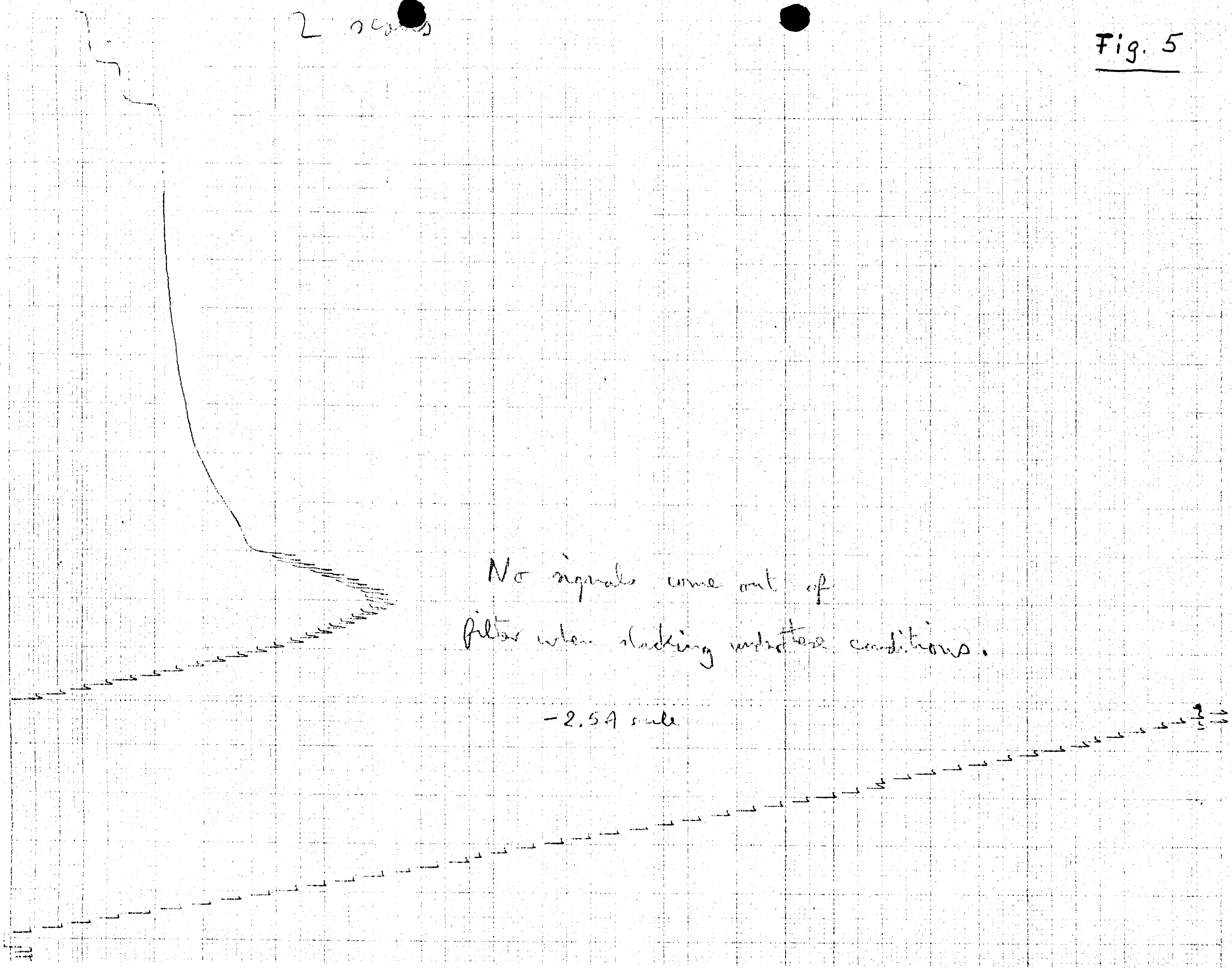

2 sc
No signals come out of
filter when checking under these conditions.
−2.5A scale

Fig. 5

Fig. 6

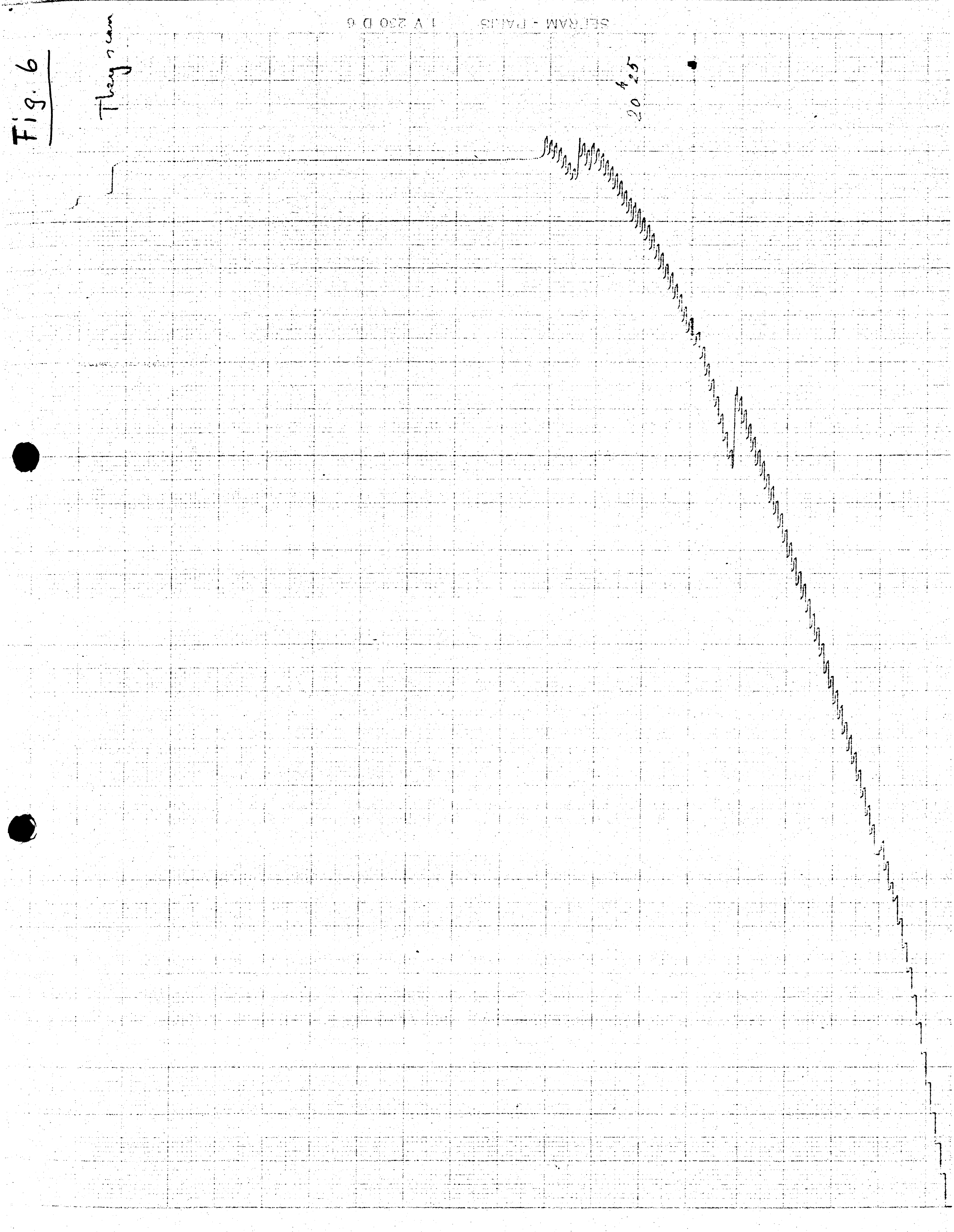


Fig. 7

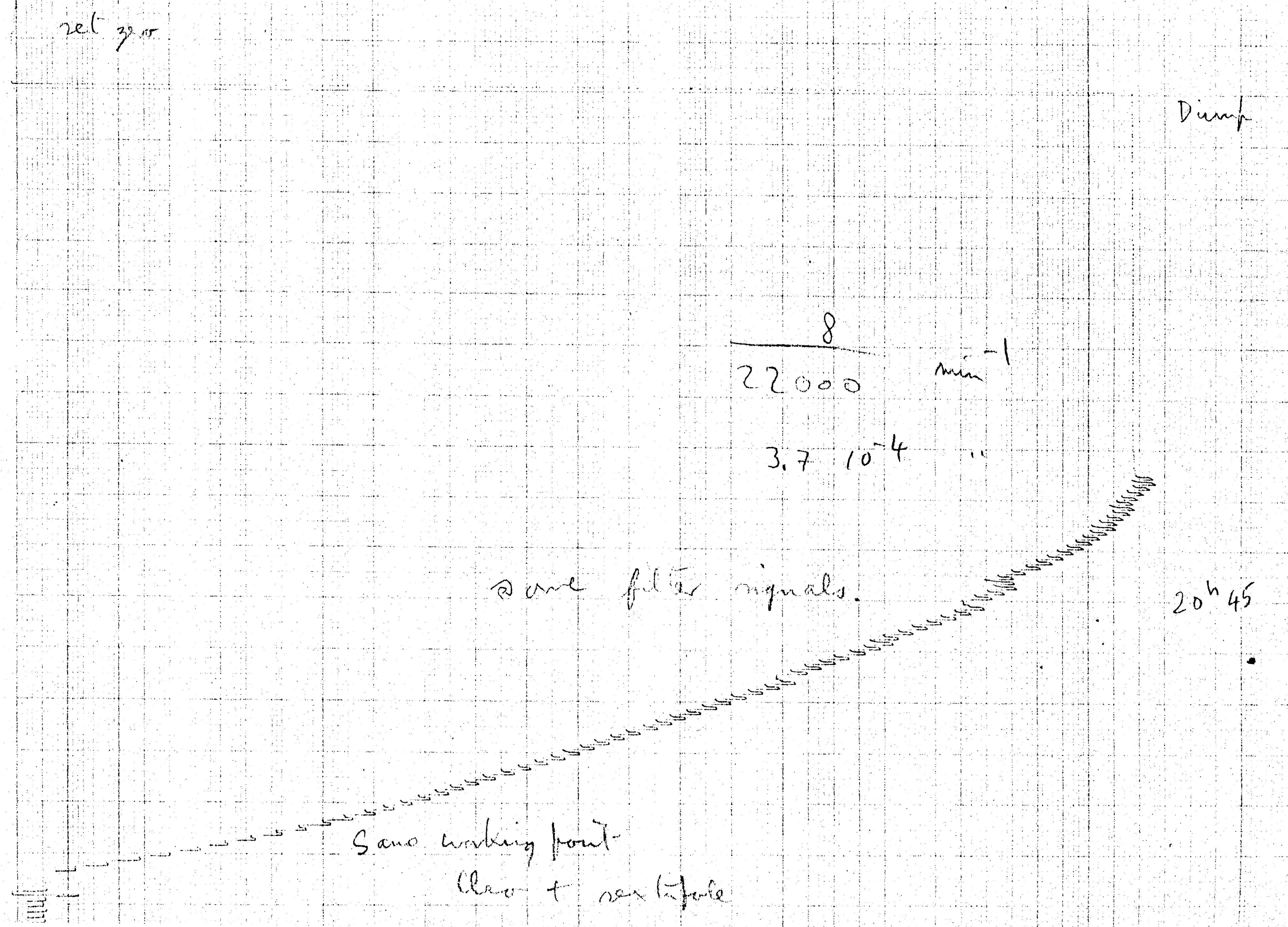

Dump
8 / 22000 min⁻¹
3.7 10⁻⁴
Same filter signals.
20h45
Same working point

Fig. 7

Fig. 8