ISR-TH/AH-VA/OG/amb

10.5.1974

E-6

ISR PERFORMANCE REPORT

RUN 451, 7.5.1974

Ring 1 and 2, 26 GeV

Further studies of electron-proton instabilities

Summary

We observed e-p lines for two different locations of the stack in the $Q_h - Q_v$ diagram, one containing resonances, the other being free of low-order resonances. No clear difference between the two cases could be seen. The frequency of an e-p line corresponded to a non-linear resonance. Turning off the clearing voltage in each octant one at the time, we found that this caused, for one octant in each ring only, a drastic increase of e-p lines activity. For Ring 2 this was the octant with the highest pressure.

Connection between e-p lines and non-linear resonances

There is some evidence that e-p lines are related to non-linear resonances: e-p lines seem to appear when a stack contains non-linear resonances, and the frequency of an e-p oscillation corresponds often to a resonance.

In this experiment we made a stack of $\sim$ 11 A using an FP working line.

a) Stack 1, containing resonances

First the stack was positioned in the $Q_h - Q_v$ diagram such that it contained horizontal and vertical resonances (stack I in Fig. 1). In Ring 1 we used clearing electrodes as monitor and observed first a horizontal double line which came out of both "Schottky scans"; out of the "slow wave" $(n_1 - Q)$ as well as out of the "fast wave" $(n_2 + Q)$ see Fig. 2a). (Clearing electrodes have been used in this picture as detectors which are more sensitive for vertical oscillations. The picture shows therefore vertical Schottky scans but horizontal e-p lines. The frequencies of the two lines are actually within the horizontal Schottky scan.)

The frequency of the lines in Fig. 2a) corresponds to a Q-value of 0.666 which indicates that the e-p oscillation is related to the 3rd order horizontal resonance which lies within the stack.

Theoretically, only e-p oscillations with frequency $f_{rev}(n_1 - Q)$ should be unstable; frequencies $f_{res}(n_2 + Q)$ are not expected and usually also not observed. A possible explanation for the appearance of such a line in Fig. 2a) has been given by H.G. Hereward [1]. In case the stack has a "hole" in the momentum distribution, it can be regarded as a smooth particle distribution plus a small "negative mass" beam. The smooth distribution can lead to the normal e-p frequency $f_{rev}(n_1 - Q)$, while the "negative mass" beam could lead to a $f_{rev}(n_2 + Q)$ frequency.

In our case we did not see a significant hole in the Schottky scan of the beam. Another possible explanation has been given by D. Kochkarev [2]. He pointed out that one could also have quadrupole mode e-p oscillations having a frequency $f_{rev}(n_3 - 2Q)$ which is consistent with the observed frequency in Fig. 2a).

Later during the run this double line disappeared and two ordinary horitontal e-p lines were observed (Fig. 2b)). The second of lines was pulsing with a repetition rate of $\sim$ 20 Hz (Fig. 2c)).

In Ring 2 we observed two lines (Fig. 2d)) having some time structure (Fig. 2e) and 2f)).

b) Stack II containing no (low-order) resonances

The stack was moved in the $Q_h - Q_v$ diagram to position II (Fig. 1) such that it contained no resonances of order smaller than 7. In Ring 1 we still observed the two horizontal lines (Fig. 3a)). Also in Ring 2 the two lines stayed (Fig. 3b)), but the repetition rate of the second line was faster (Fig. 3c) compared to Fig. 2f)). However, we do not know if this small change really happened at the moment and because of the Q-change.

2. Influence of the clearing on the behaviour of e-p lines

We watched the e-p lines while we turned the clearing voltage off in each octant, one at the time. The results are shown in Fig. 4 and 5. In Ring 1 only the turning off of the clearing in octant 7 had a drastic effect. A whole group of pulsing lines appeared. In Ring 2 no signiffi-cant effect was observed from the octants 1 - 7. However, turning off the clearing in octant 8, where the pressure was highest, produced a group of pulsing lines.

O. Gröbner A. Hofmann

References

1) H.G. Hereward; private communication

2) D. Kochkarev; private communication

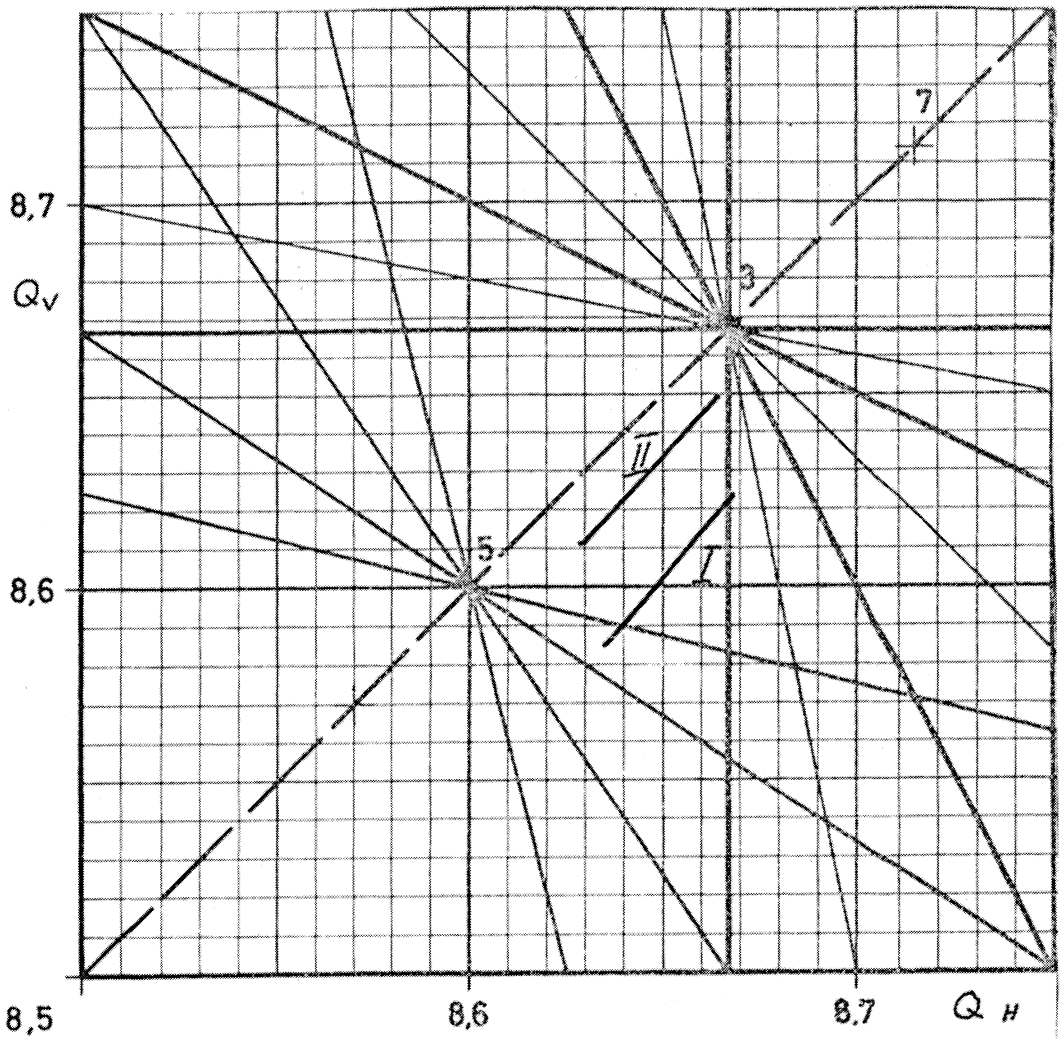
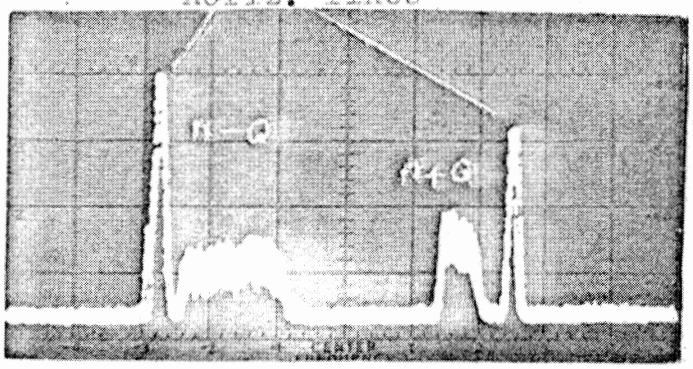


Fig. 1

Ring 1

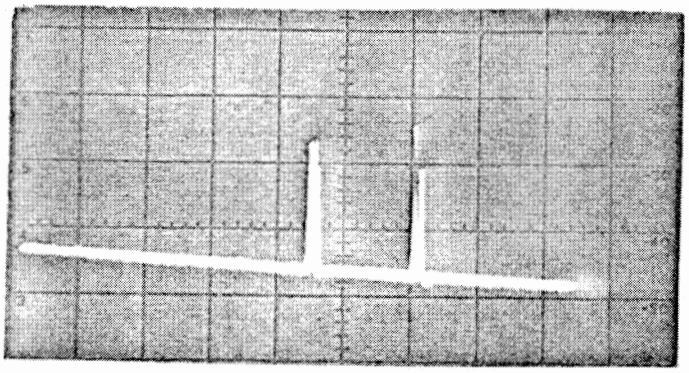
Ring 2

horiz. lines

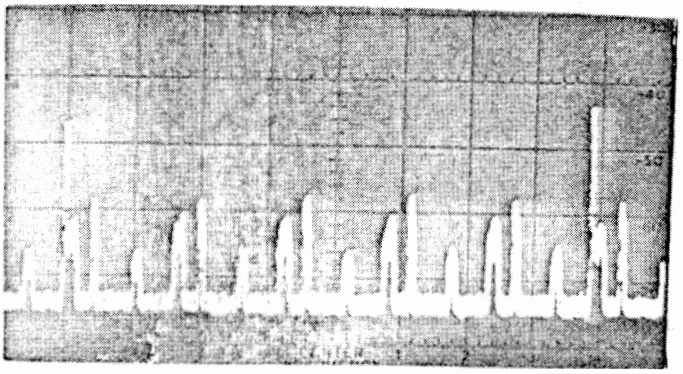


vert. scans

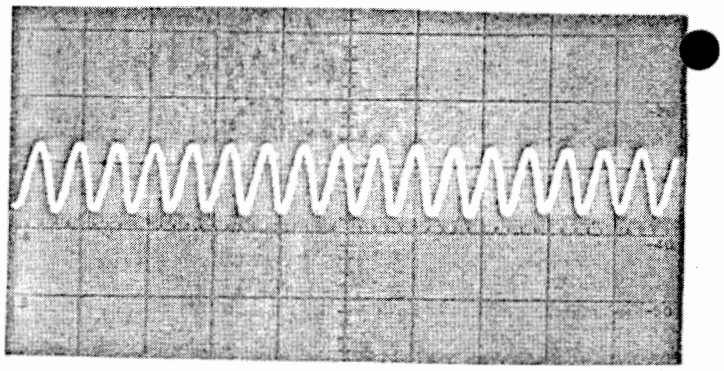
a) cf=12oMhz, 20khz/div



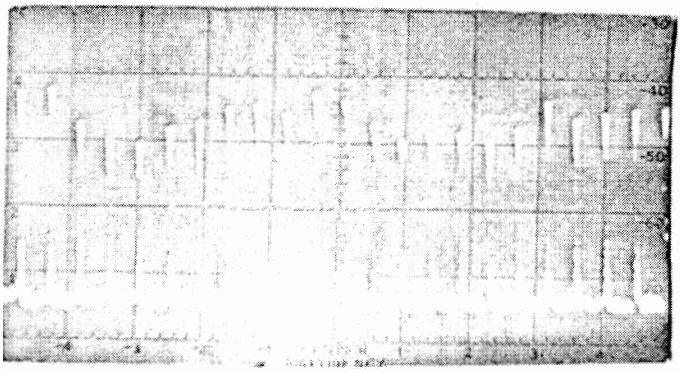
d) cf=12oMhz, 5Mhz/div



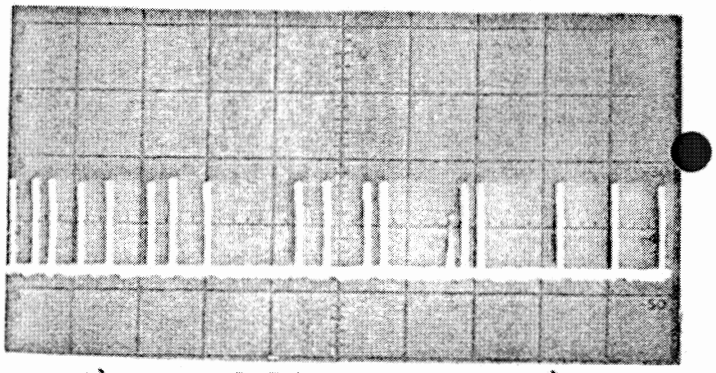
b) cf=12oMhz, 200khz/div



e) first line of fig. d) in time, 0.1 s/div



c) second line of fig. b) in time, 0.1 s/div

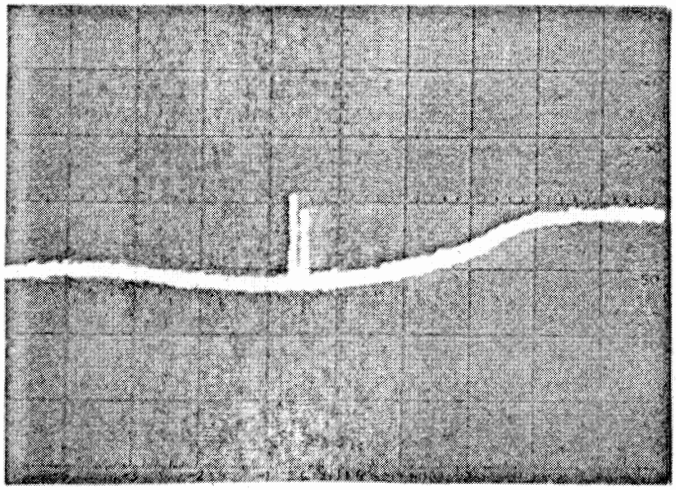


f) second line of fig. d) in time, 1 s/div

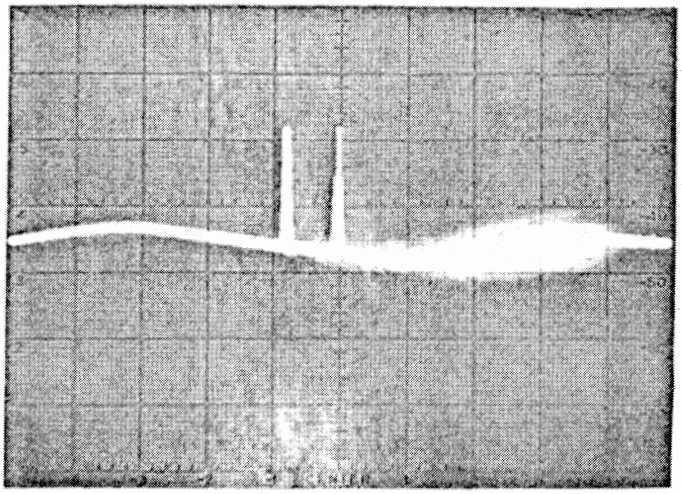
Fig. 2. Lines observed in stack I; vertical scale is 10 db/div. (In ring 1 clearing electrodes have been used as monitors which are more sensitive in the vert. direction, while in ring 2 the vert. microwave loops have been used).

Ring 1

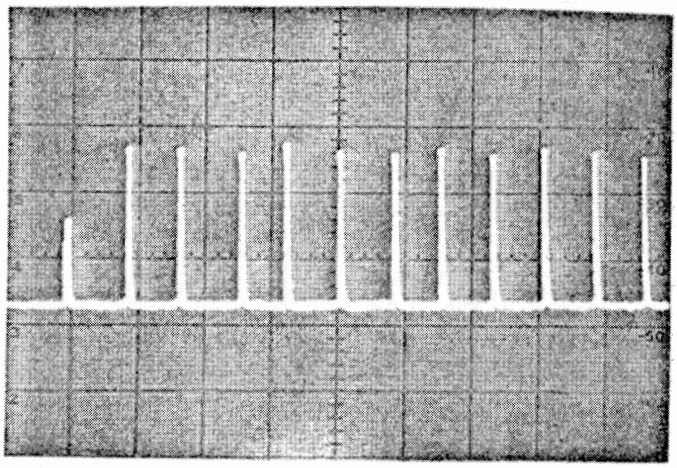
Ring 2



a) cf= 120 Mhz, 10 Mhz/div.

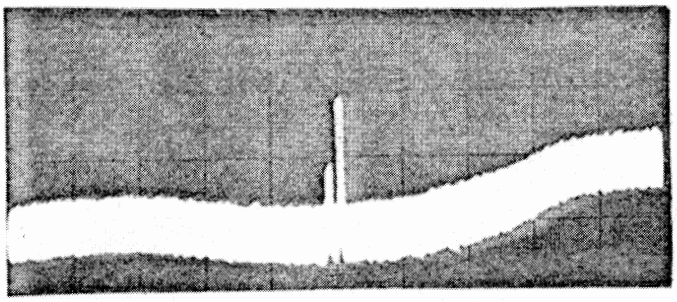


b) cf=120 Mhz, 10 Mhz/div

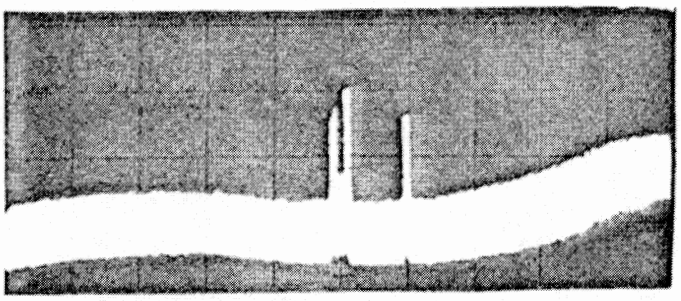


c) second line of fi. b) in time, 0.1 s/div

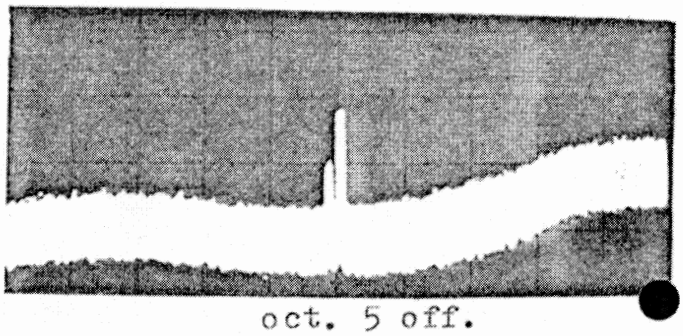
Fig. 3. Lines obseved in stack II; vertical scale is 10 db/div



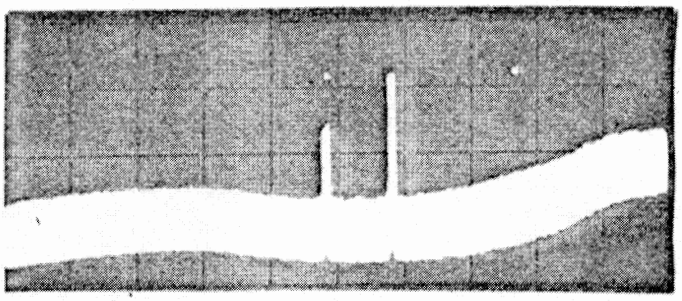
All C.E. on.



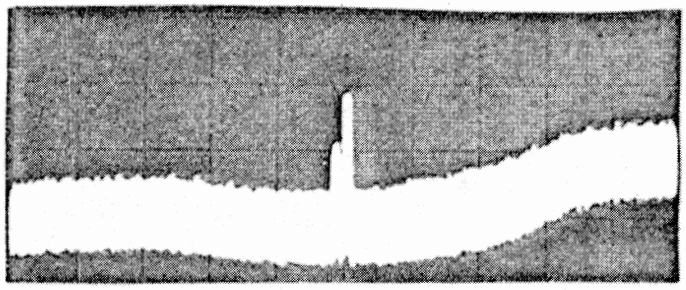
oct. 1 off.



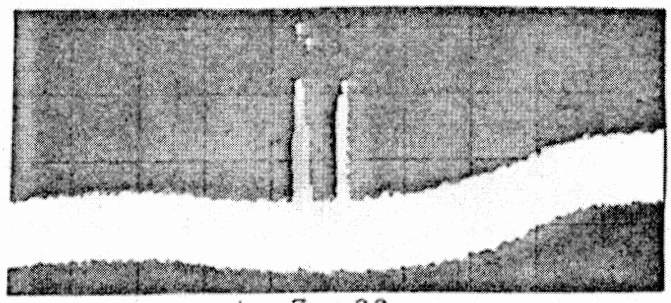
oct. 5 off.



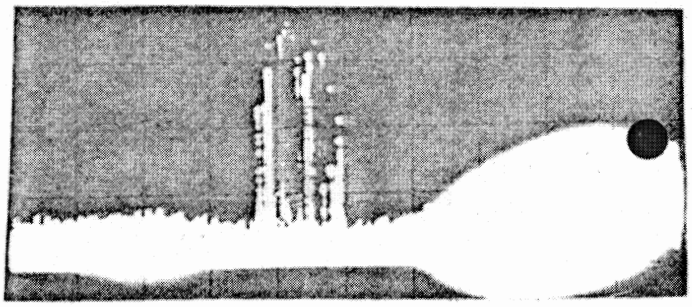
oct. 2 off.



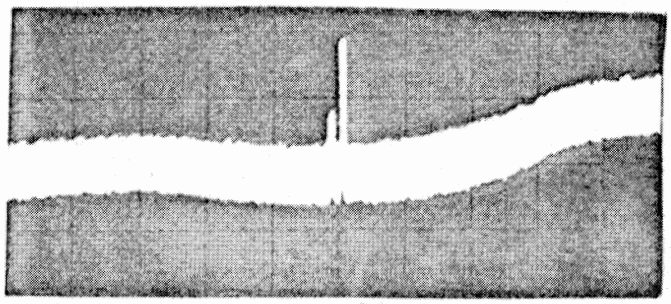
oct. 6 off.



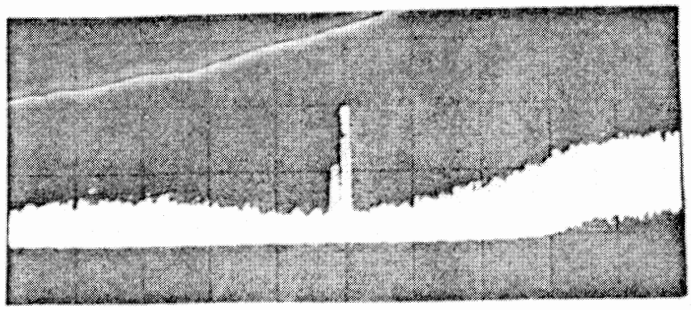
oct. 3 off.



oct. 7 off.



oct. 4 off.



oct. 8 off.

Fig. 4. Ring 1; e-p lines observed with clearing electrodes turned off in one octant.
Scale: horiz. 1o Mhz/div, vert. 1o db/div, cf = 12o Mhz

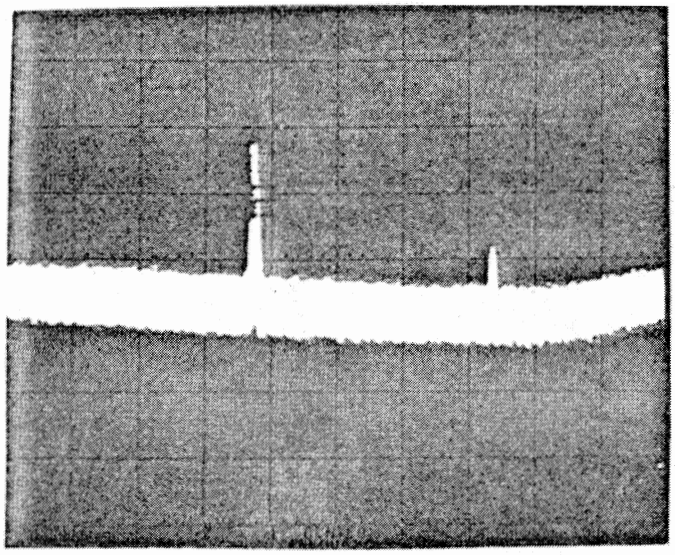


Fig. 5a). Ring 2; e-p lines observed with all clearing electrodes turned on.

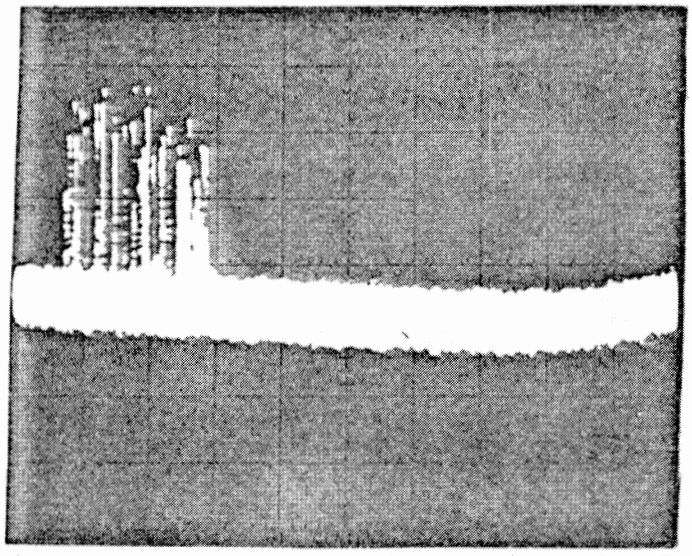


Fig. 5b). Ring 2; e-p lines observed with clearing elecrodes in octant 8 turned off.

Scale: vertical 10 db/div; horizontal 5 Mhz/div; center frequency 130 Mhz