RADIATION EFFECTS ON
ELECTRODE BEHAVIOR

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SUMMARY

Temperature effects on the Co-60 irradiation were taken into account by running, simultaneously, a non-irradiated cell at 45°C as a reference. This temperature corresponds to the temperature in the Co-60 source after thermal equilibrium is established. The overall voltage behavior of the irradiated cell appeared to drop approximately 10 mv relative to the reference cell during the 62 hour irradiation. Although the reference cell, on cooling, seemed to recover at least some of the decrease in output voltage caused by high temperature conditions, the irradiated cell showed no sign of such recovery.

Partial disintegration of the electrodes during irradiation in the Co-60 source (1.6×10^6 rads/hr.) was again observed with eleven milligrams of material being obtained after filtration of the electrolyte. Additional finely divided material could be easily wiped off of the Cd electrode after the run. The total weight of the cadmium electrodes is about five grams each, which value includes the skeleton, porous plate and cadmium impregnate. Quantitative analyses of such electrodes are being made.

Laboratory measurements on the temperature characteristic of the NiCd cells have not yielded consistent data. However, one cell cycled in order through 25-30-25-35-25-40-25-45-25°C appeared to recover, exhibiting nearly original behavior after the last cycle.

about 10 mv giving a total change of about 60 mv. Figures 4, 5 and 6 are corresponding open circuit curves for Run No. 3. The observation and conclusions from comparison of the results of these two runs can be summarized thus:

1. Radiation appears to cause a 10 mv shift in the open circuit voltage during the 62 hour irradiation period. Charge and discharge voltages appear to be affected to the same degree. This shift may grow larger with longer times. This point will be pursued further.

2. Three hours were needed to reach temperature equilibrium in the Co-60 cell. In Run No. 3, from the 16th to about the 28th hour of the run, the cell being irradiated was accidentally removed from the Co-60 source and was at room temperature.

3. Figures 7, 8 and 9 show the charging curves and figures 10, 11 and 12 show the discharge curves for Run No. 3. Upon removal from the Co-60 source the cell voltages did not return to their original values, whereas the reference cell voltage did show signs of recovery.

4. In Run No. 3, a break in the circuit to the reference electrode occurred during the Co-60 irradiation. This condition was corrected late in the run. The cause was thought to be a bubble in the salt bridge connection.

5. Eleven milligrams of material which had sloughed off of the electrodes was collected from the irradiated cell in Run No. 3. (An average weight of a cadmium

electrode is five grams.) Analysis of the sloughed material from this run is being carried out. Analyses of such material from prior runs, as well as other analyses are given in Table I. The samples were:

a. Solids washed from cellulose battery separator.

b. Sloughed-off residue from Co-60 Run No. 1.

c. Solids from filtrate of electrolyte of Co-60 Run No. 2.

d. Sloughed-off residue from Co-60 Run No. 2.

e. Sloughed-off residue from 17 day cycling of cell at room temperature.

A cadmium electrode was disassembled to give the skeleton weighing 0.9 grams and a powdered composite weighing 4 grams. These materials were submitted for quantitative analysis.

II. Temperature Characteristics of NiCd Batteries

Different electrodes from battery cells give various results when cycled with temperature. The manufacturers of our cell (Gulton Industries) pointed out that the batteries have a memory. That is, their operating characteristics may be very dependent on their previous thermal history. Our first runs as reported last period did not recover on excursions from 25 to 45°C and back to 25°C. A further run where the cycling was in five degree increments, e.g. 25-30-25-35-25 up to 45°C did recover. Additional study of this factor is planned.

CONCLUSIONS AND PLANS

Co-60 radiation appears to cause an irreversible change in the output voltage of a NiCd set of electrodes. A five to nine day

irradiation is planned for the next month period to confirm this result and to follow this decay further. Gas analysis and pressure measurements will also be made on this run, as it is anticipated that sufficient gas will be produced by radiolysis during this time period. It is known that the sloughing off of material from the electrodes occurs within 12 hours under Co-60 irradiation. Our experimental procedure has not permitted the time for the initiation of this effect, and its course with time to be determined. Several short runs are planned to ascertain this information. If the effect first becomes evident in a short time, e.g. - one hour or so, the effect of different dose rates on the initiation and magnitude of this effect will be determined.

Irradiation of a complete battery is also planned for the coming period to see if the same effect is observed.

The irradiation in the STF facility will be carried out soon after contractual and other matters related to use of this reactor are settled.

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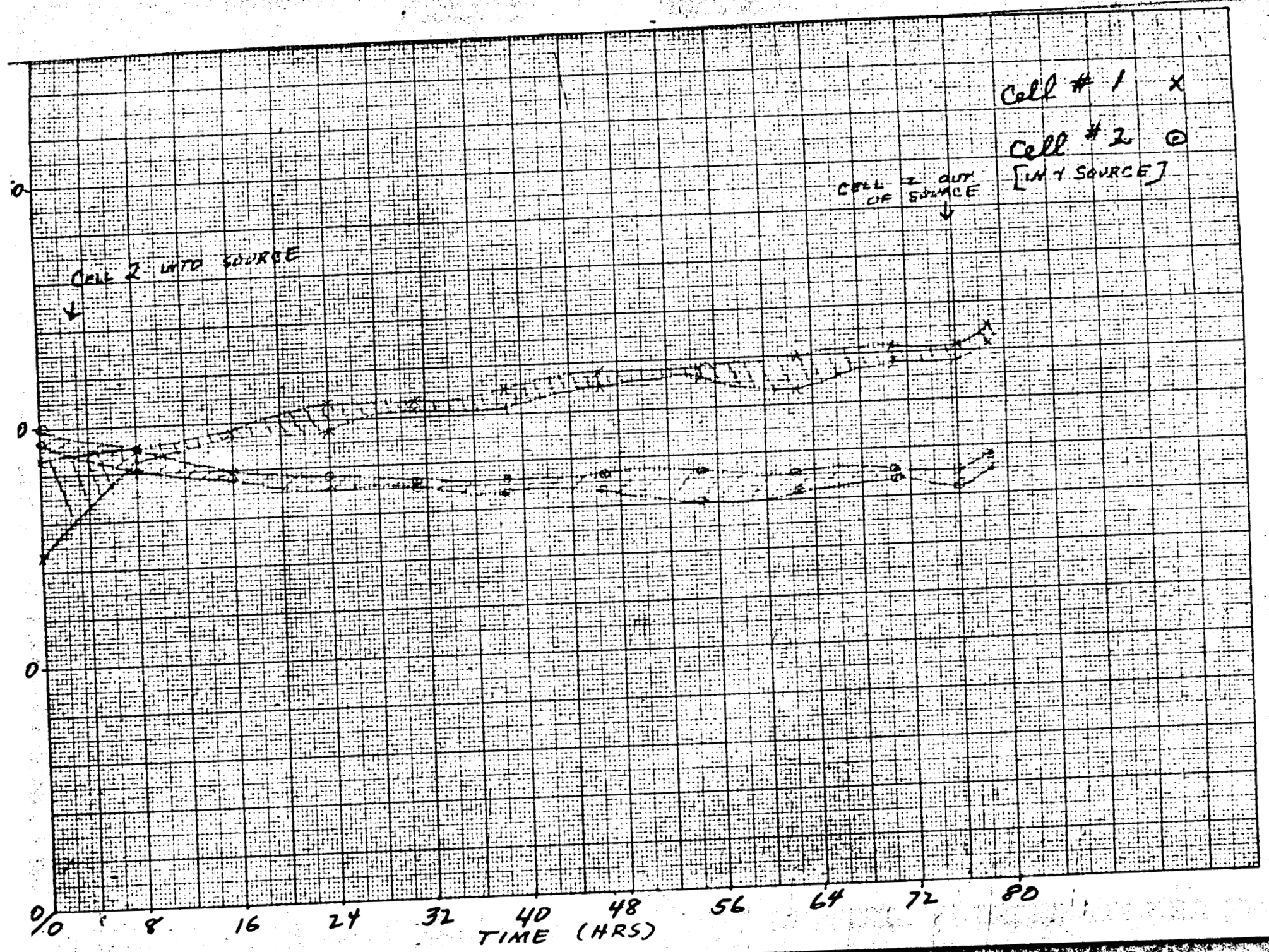
TABLE I

Emission Spectrographic Analyses of Various Post-Run Samples

Sample #	1	2	3	4	5
Ag	.5	.02	.05	.02	.3
Al	.3	.3	.1	.4	.3
B	.4	.03	.4	1	.1
Ba	<.01	.3	<.01	<.01	.3
Ca	.3	1	.03	.1	2
Cd	.1	3	<.01	.1	>10
Cr	.01	.01	.01	.05	1
Cu	.2	.3	.01	.03	.3
Fe	.1	.1	.1	.2	.2
Li	<.01	<.01	<.01	<.01	<.01
Mg	.005	.02	.005	.005	.01
Na	5	3	<.1	.5	.3
Ni	.3	.05	<.01	.05	3
Pb	<.01	.1	<.01	<.01	.05
Si	4	4	>10	>10	3
Sn	<.01	.05	<.01	<.01	<.01
W	<.5	2	<.5	<.5	<.5
Zr	<.05	<.05	.1	.5	<.05

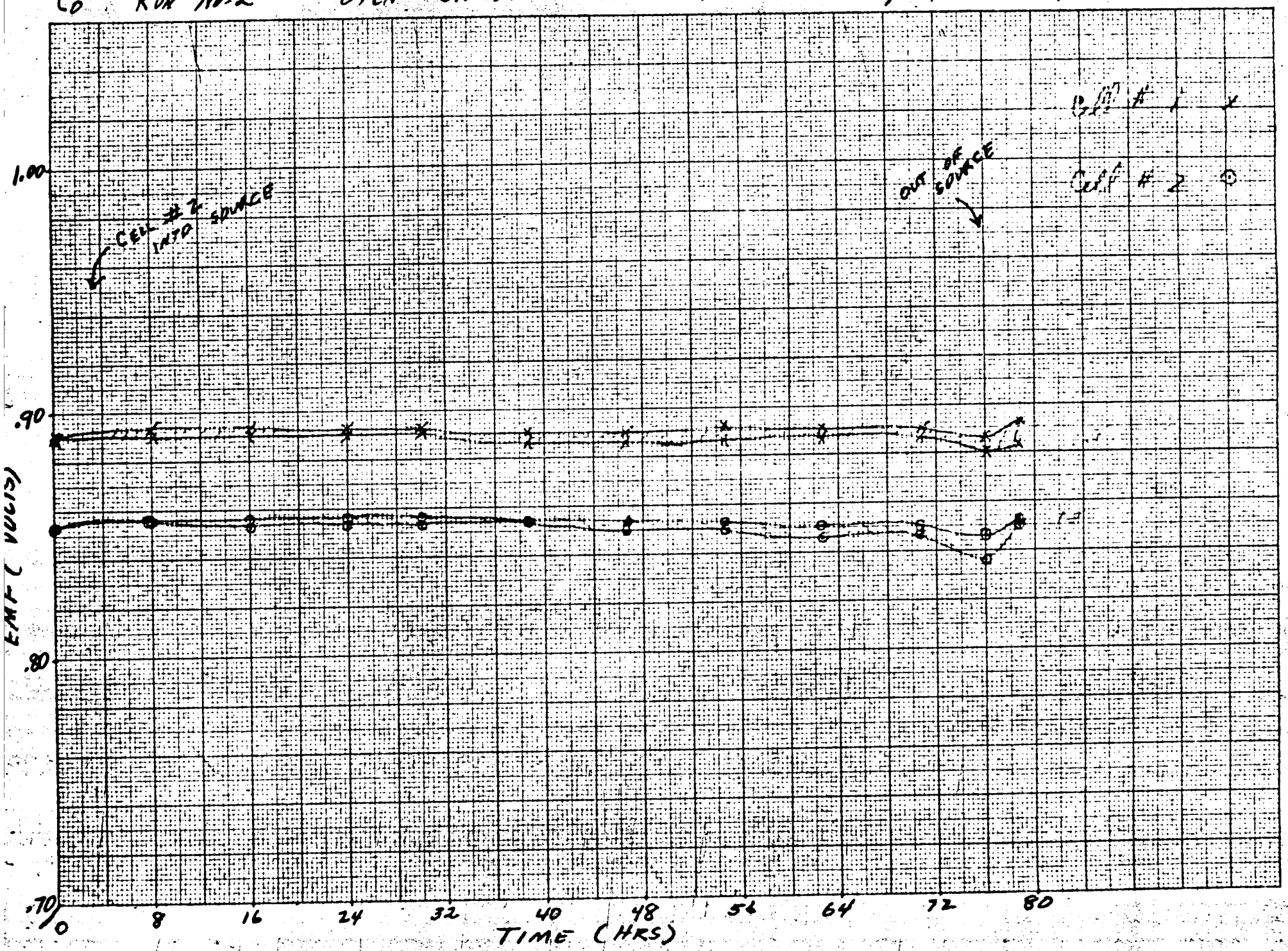
NOTE: Where a "<" value appears, element was not detected.

Values shown are in weight percent.


Cell # 1 ×
Cell # 2 ⊙
[IN γ SOURCE]
CELL 2 OUT OF SOURCE
CELL 2 INTO SOURCE
10
0
0
0/0
8
16
24
32
40
48
56
64
72
80
TIME (HRS)

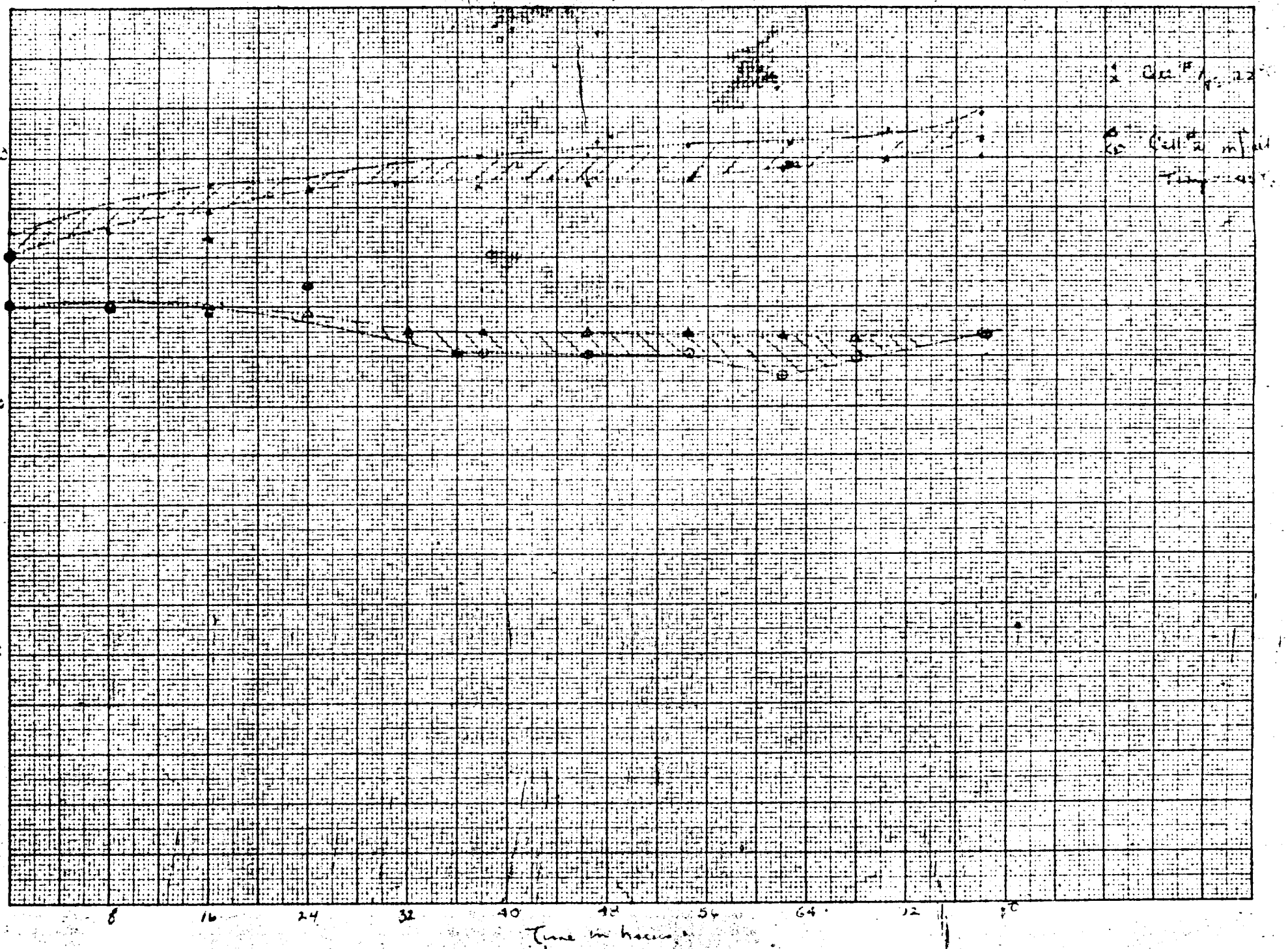
K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO.

Co^{60} RUN No. 2 - OPEN CIRCUIT VOLTAGE : Cd vs Hg/HgO FIGURE 2



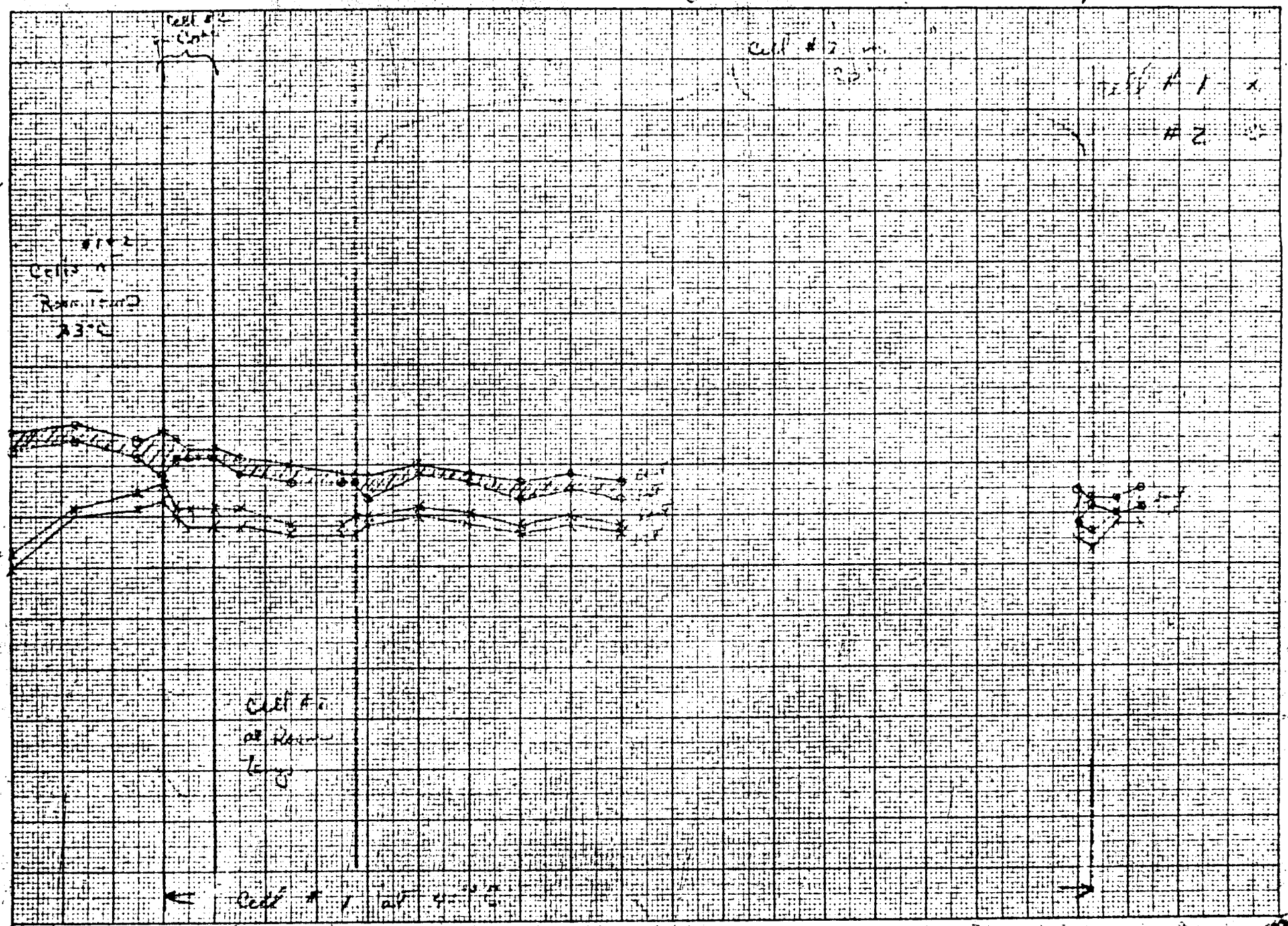
K+E 10 X 10 TO THE CM. 359-19
KEUFFEL & ESSER CO. MADE IN U.S.A.

Co^{60} RUN No. 2 N-Cd Open Circuit VOLTAGE FIGURE 3



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO.

FIGURE 4



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

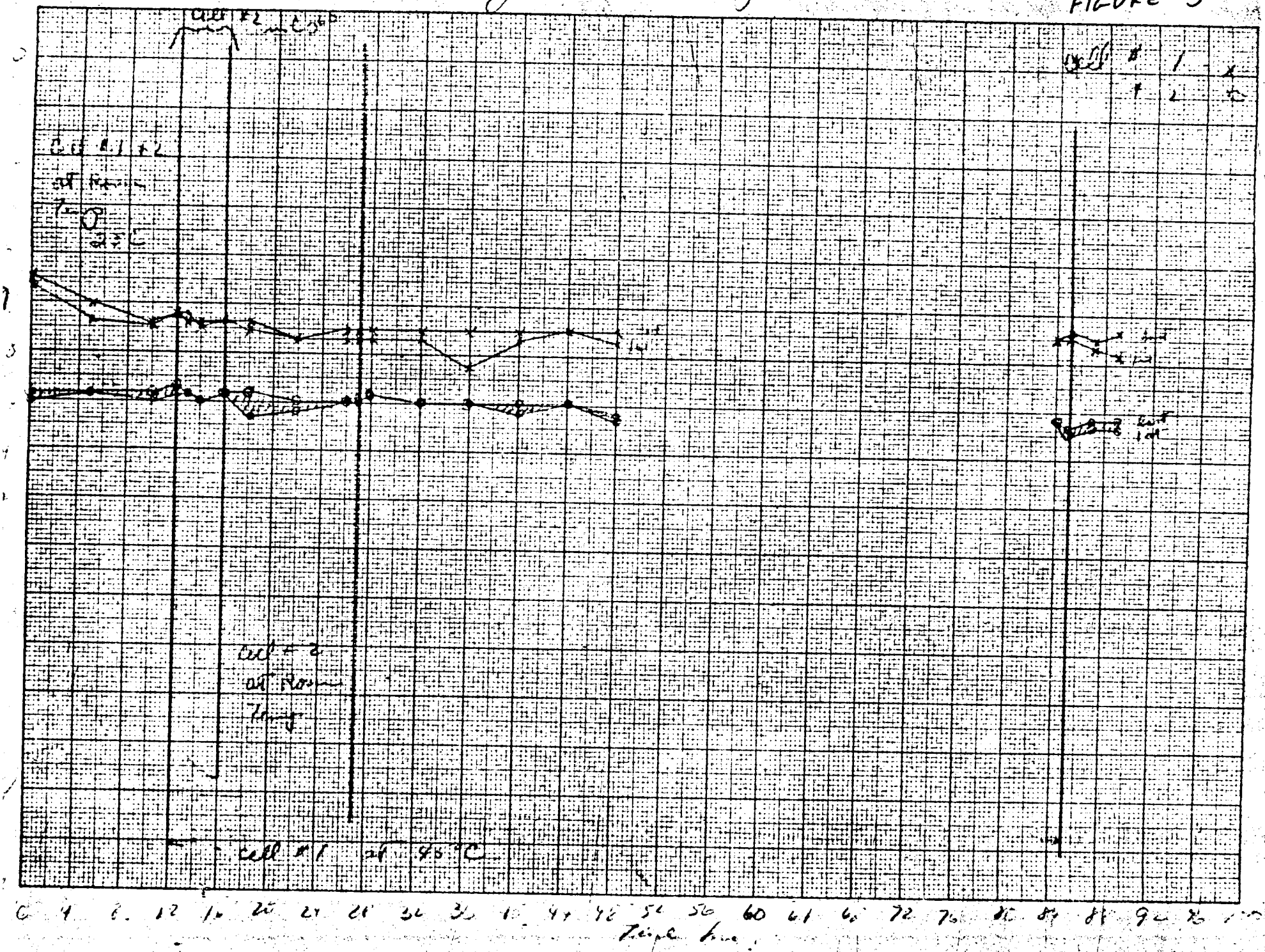
July 63

Cd // Hg / HgO

3rd Cs 60

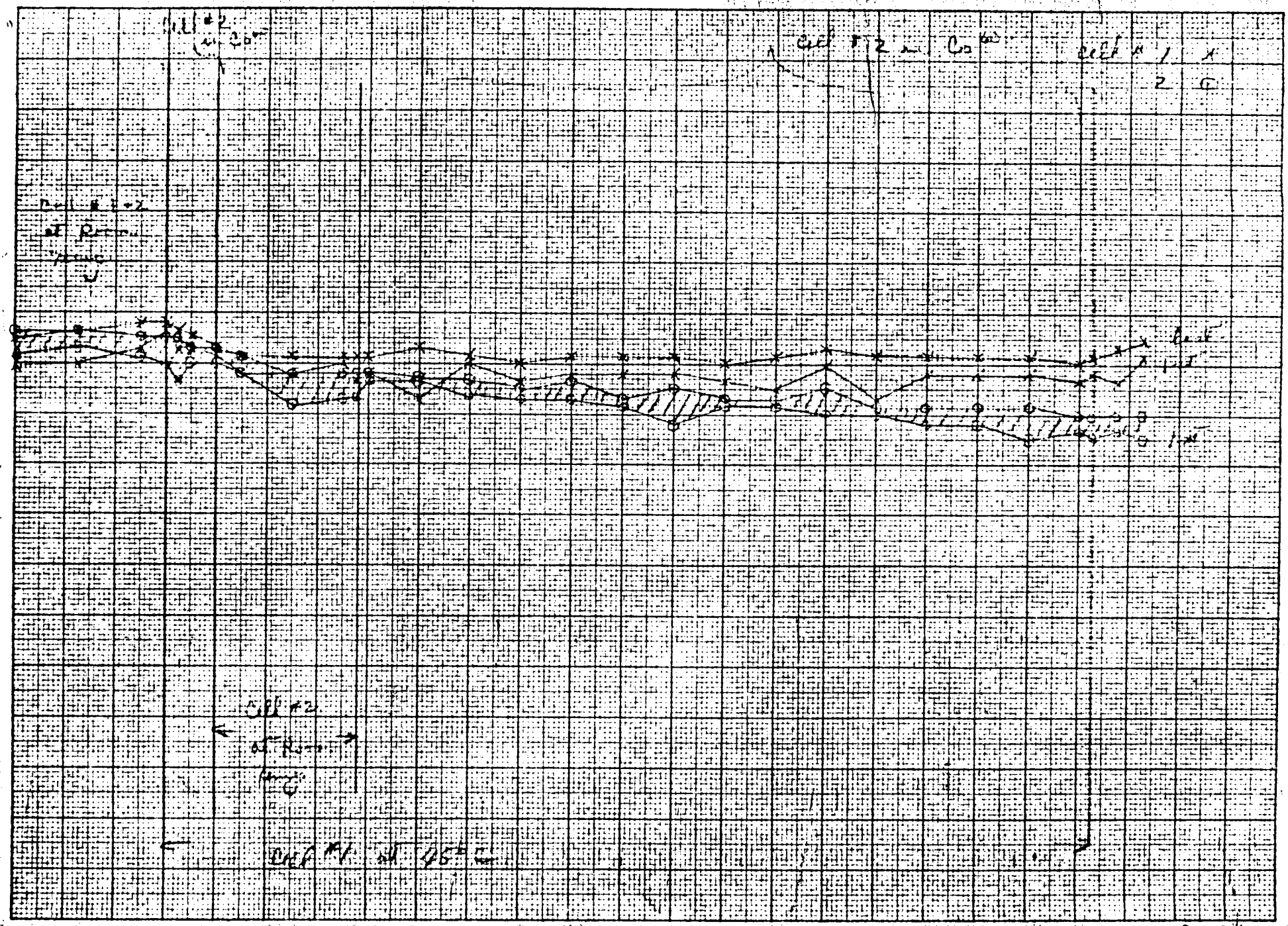
Open CIRCUIT

FIGURE 5



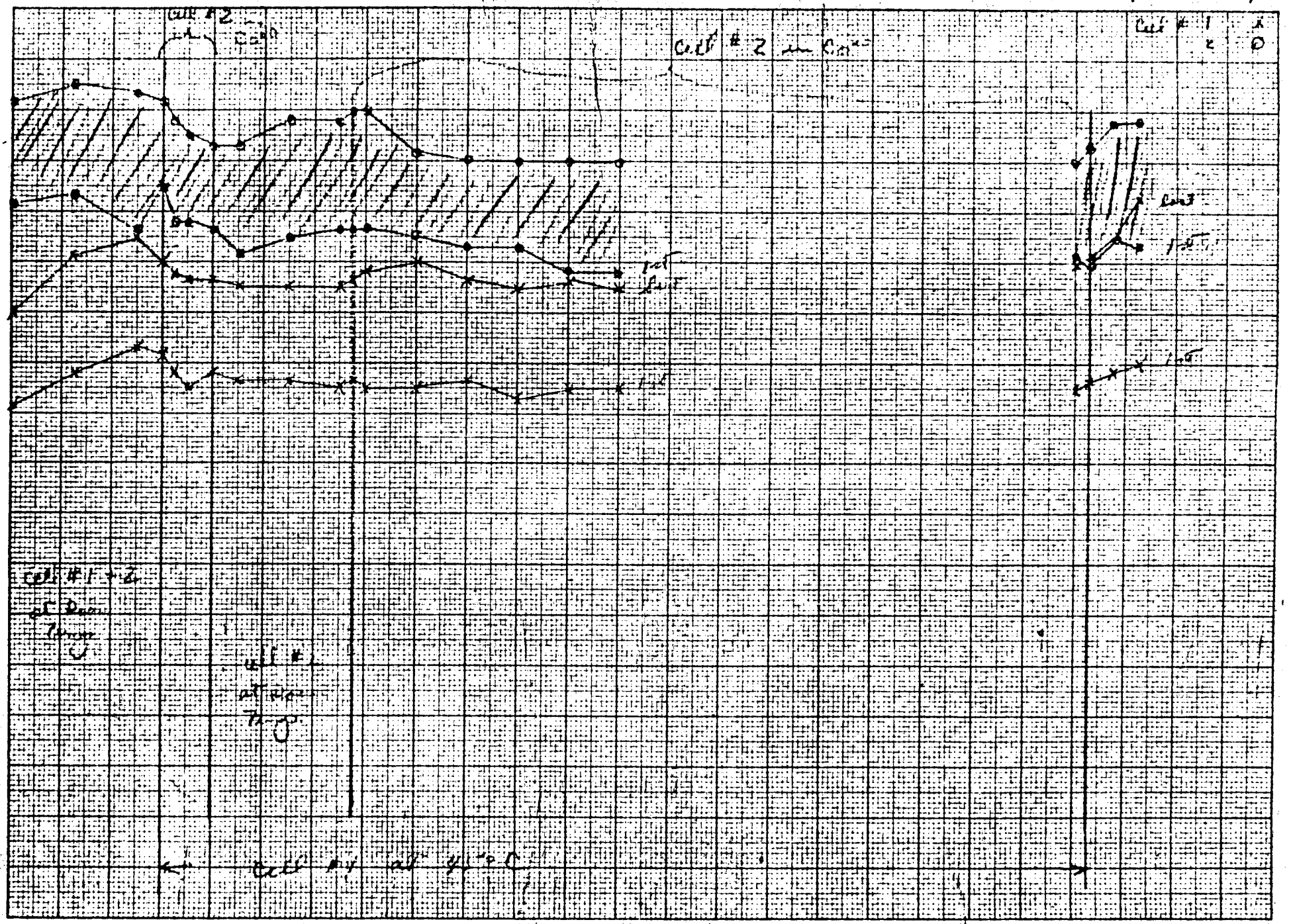
K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 6



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO.

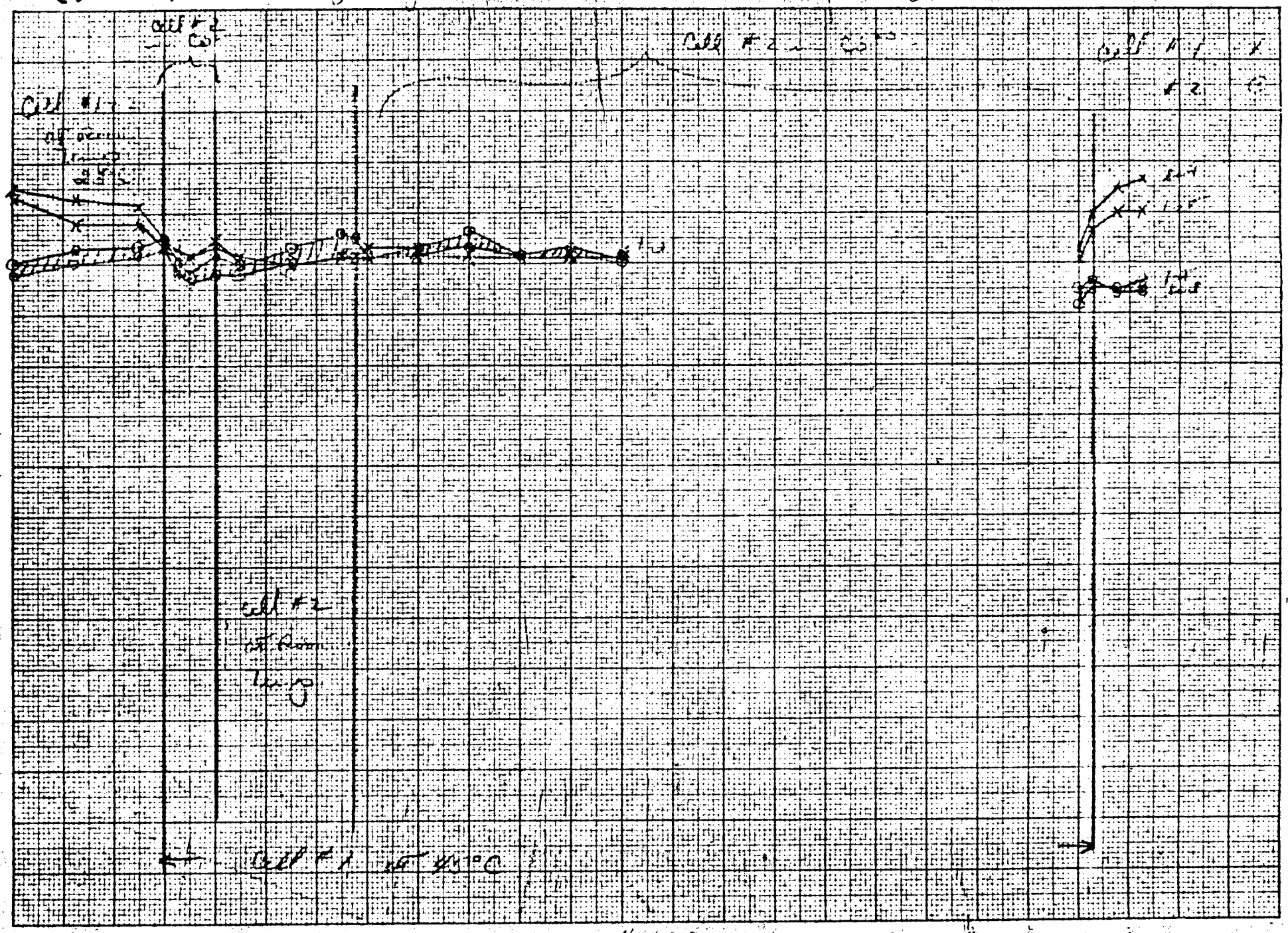
FIGURE 7



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

C.LO RUN No.3:

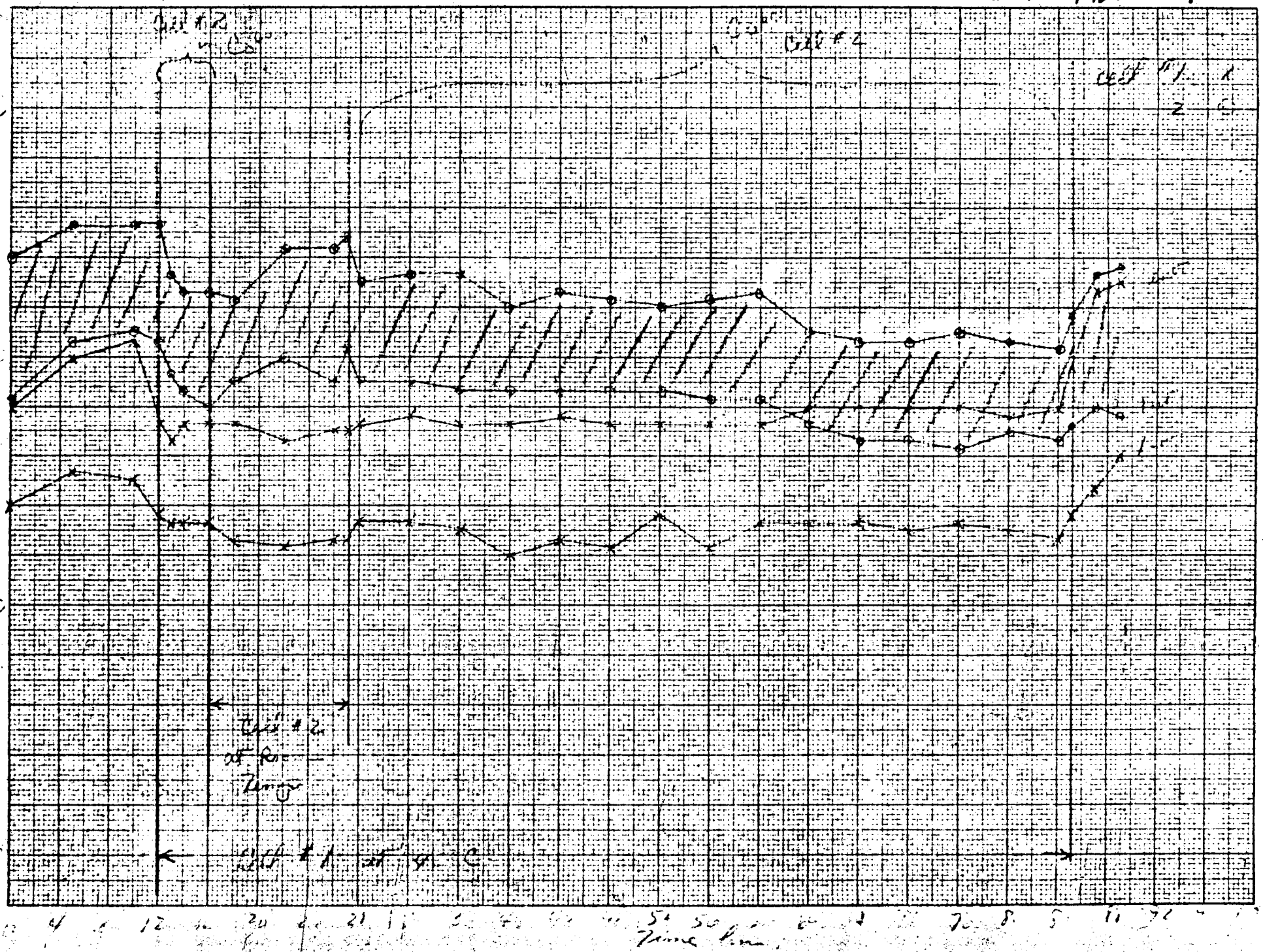
FIGURE 8



K&E KEUFFEL & ESSER CO. MADE IN U.S.A.

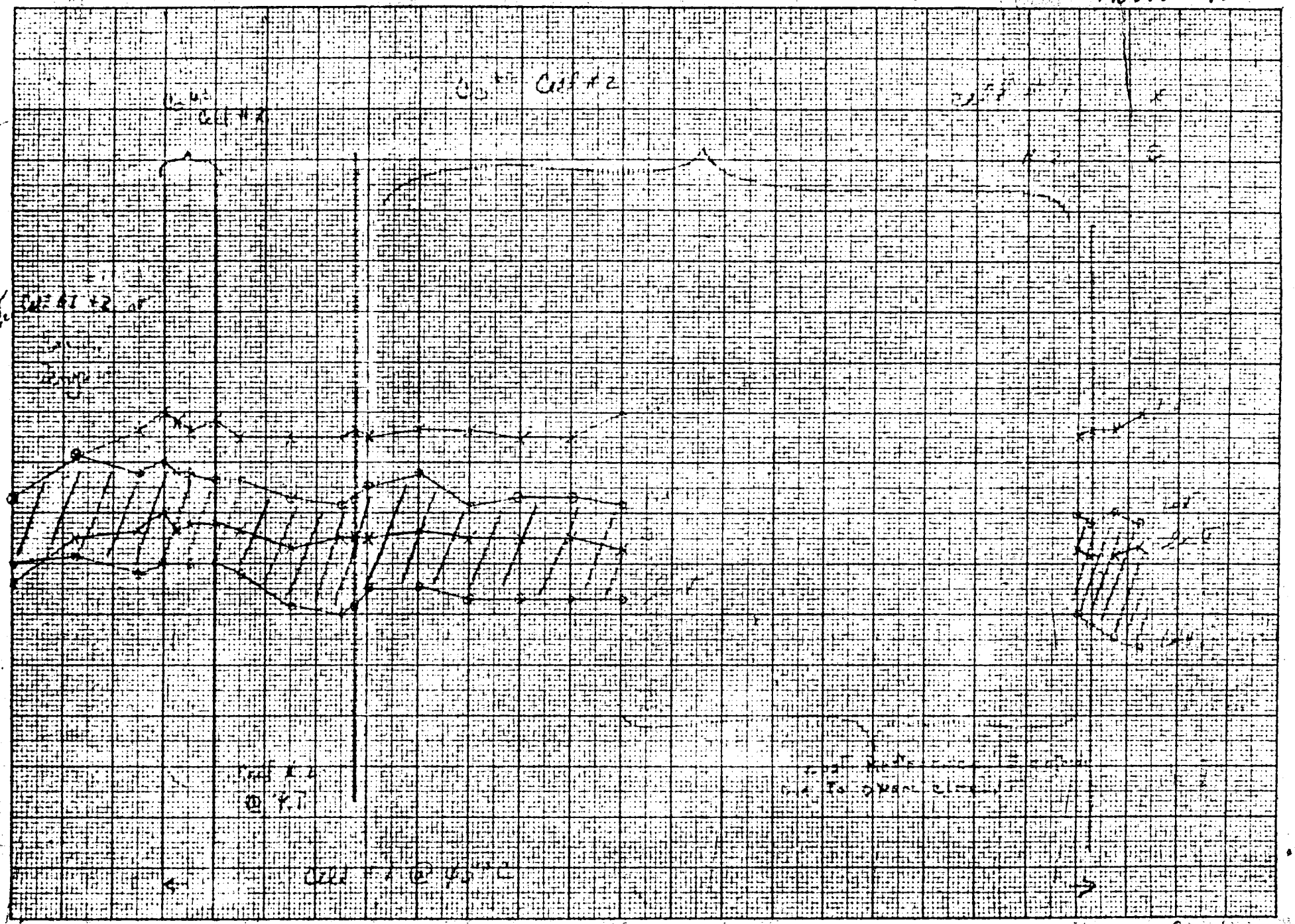
Cycle

FIGURE 9



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO.

FIGURE 10

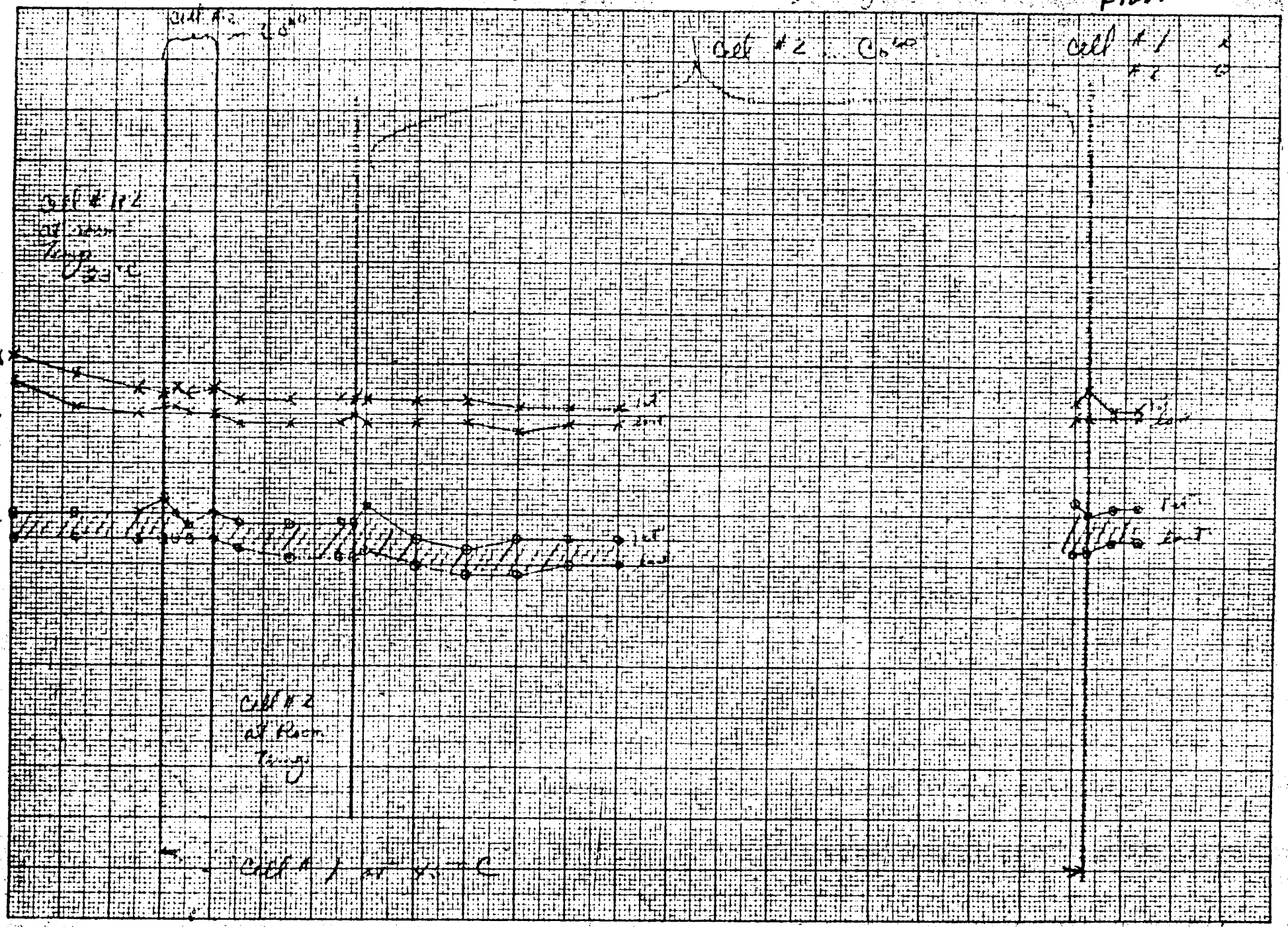


K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

Cd // Hg / HgO

Discharge Cycle

FIGURE 11



K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO.

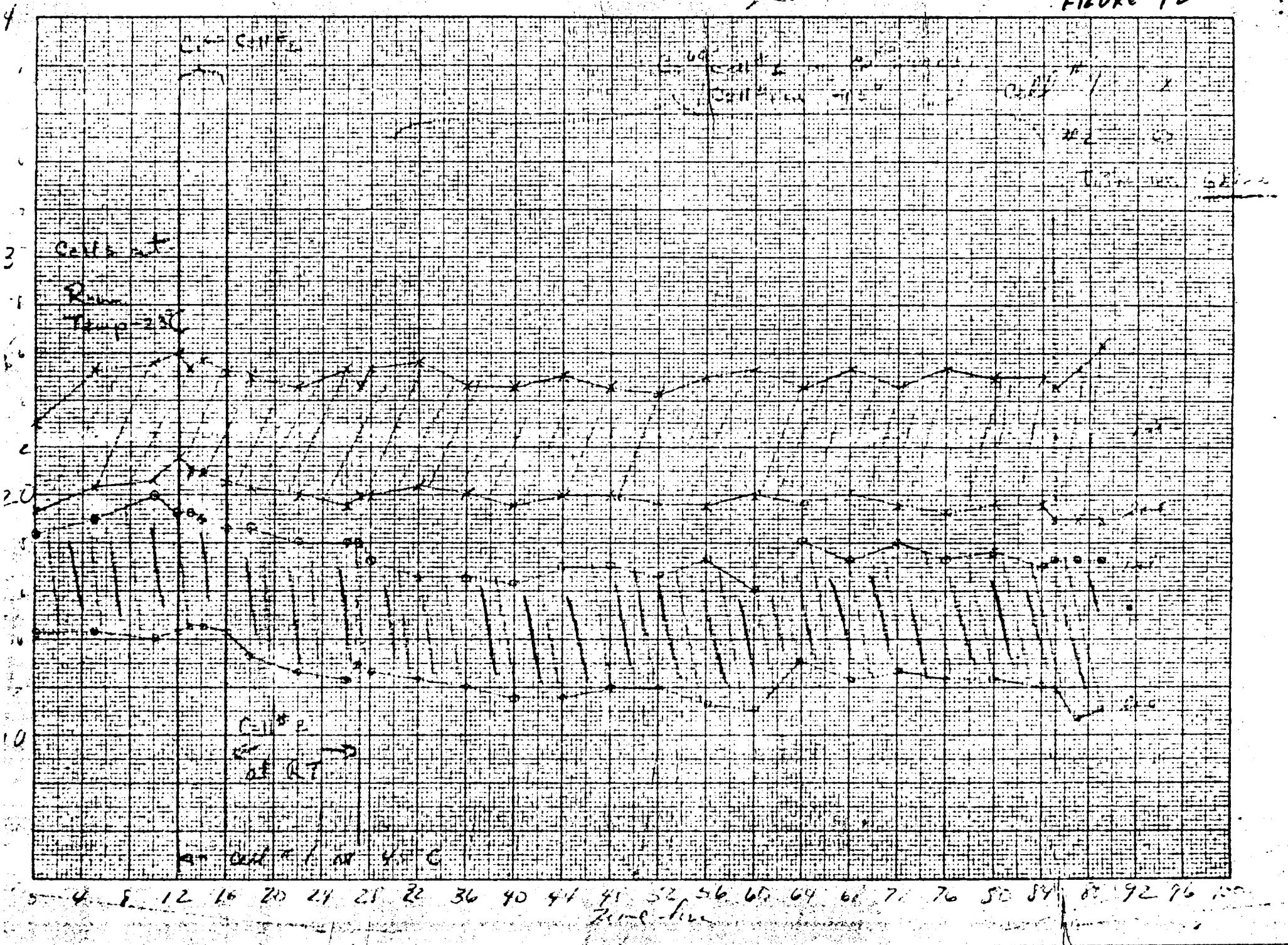



FIGURE 12