AD-A033 239 DUMONT ELECTRON TUBES CLIFTON N J F/G 9/1

STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE.(U)

SEP 67 H TIMAN DA-44-009-AMC-1811(E)

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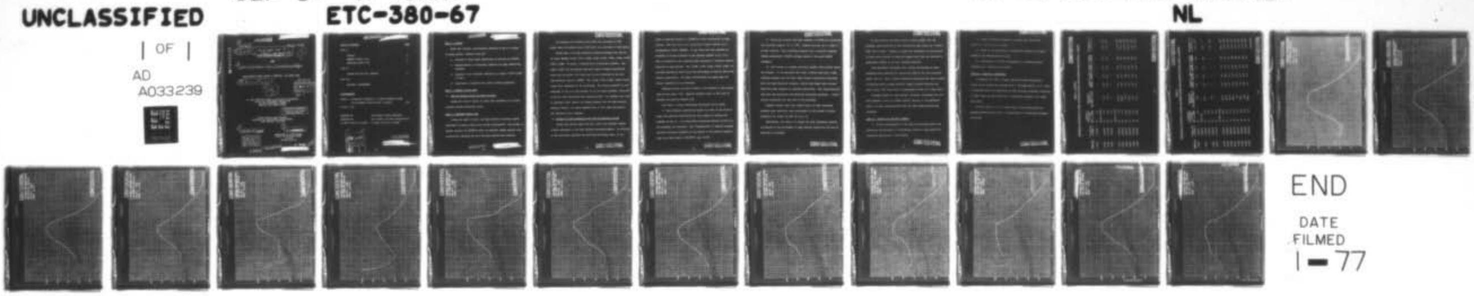

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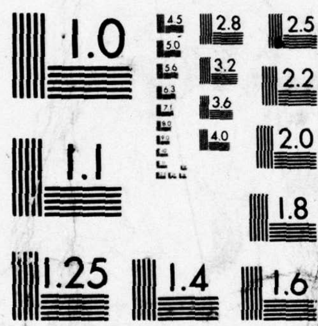

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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(14) ETC-380-67

COPY 1 OF 23

(9) Quarterly (3rd) rept. no. 9, 1 Feb - 30 Apr 67,

THIRD QUARTERLY REPORT NO. 9

~~FOR~~

(6) STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE. (U)

THIS REPORT COVERS PERIOD 1 FEBRUARY - 30 APRIL 1967

(10) Hans Timan

(12) 24p.

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SUPPLEMENTARY

PREPARED BY: Hans Timan, Project Engineer

RELEASED BY: Alan Howell, Contract Administrator

DU MONT CONTROL DOCUMENTS: SI-6384, T6-2018, MO-10198

UNCLASSIFIED [redacted]

PART I - PURPOSE

Under this contract, photoelectric emission of the S-1 surface is being studied. Specific aims are:

1. Increase of white light sensitivity to 100 μa/l for 2870°K.

2. Reproducibility of processing schedules for high sensitivity cathodes.

3. Lowering of the thermionic emission to a value of 10^{-13} A/cm^2 or less.

4. Measurement of physical and optical surface properties.

PART I - GENERAL FACTUAL DATA

A. Tube processing during the month of April

During the month of April, 19 tubes were assembled, 12 of which attained cathode processing status.

PART I - DETAILED FACTUAL DATA

During the month of April, the high infrared processing method described in previous reports was further investigated. The attempt to improve response at 10600Å by means of selective oxygen exposure were successfully continued and some very good results were achieved.

All surfaces with numbers below 0-200 were processed on 7052 glass, while all numbers above 0-200 refer to a new batch of 7056 glass.

During April, the high infrared processing technique was used in 10 tubes, Numbers 0-165, 0-171, 0-174, 0-201, 0-202, 0-203, 0-204, 0-206, 0-207, 0-208. Of these, 7 attained good or excellent surfaces. Nos. 0-202, 0-203, had the highest and third highest infrared sensitivity value ever processed; this high level is also reflected in the very high response figure at 11500Å. Nos. 0-165, 0-176, 0-204, showed severe slump after completion of the processing. The reason suspected is poor adherence of the Cs to the Ag-base, as in all these surfaces, "bake-off" of the Cs took place during the processing bake. Two attempts were made to introduce other alkalis for doping purposes into the high infrared process; however, all these attempts have, so far, been unsuccessful and resulted in poor cathodes.

B. Summary of work performed during the 3rd Quarterly Period

During this period, again the major effort was expanded towards further refinement of the high infrared processing method. In addition to the previously explained and described processing steps, it was tried to optimize response at 10600Å for future application in image devices. This was achieved by dosing final oxygen exposure with a monochromatic filter (10600Å). It was found that this resulted undoubtedly in strong increases in the response between 1.0 to 1.2 μ. This is reflected in the unusually high percentage of infrared response measured on many surfaces. Nos. 0-202, 0-203, 0-142, 0-136, 0-208, all had 2540 sensitivity above 10 μA with percentages as high as 18% of the luminous sensitivity. All these sensitivities are higher than any results reported by us or elsewhere.

Detailed results are given in Table I (For details on tube processing see also Rpts. 7,8). Spectral response curves of the tubes of interest are given in Figures 1-14.

From Table I several interesting conclusions can be drawn:

1) While luminous sensitivity figures are still in the 50-70 μa range, the spectral distribution has been changed by pulling down response in the .6 - .9 μ range while increasing response around 1.0 μ and extending the threshold. This "compensation" of spectral response has been discussed frequently in the reports of the previous contract (See e.g., Final Report, AMC-136(T), pgs. 32-33).

2) Nearly all surfaces with good response at 11500Å have relatively low resistance figures ($< 2 \times 10^6$). Compare also Rpt. No. 3, Table I, of this contract. This correlates possibly with a generally slightly thicker Ag-baselayer (55-65% coverage instead of the usual 45-55% coverage).

3) Dark current is strongly increased together with extended infrared response. It is remarkable that those surfaces which have a high infrared response with low white light luminous sensitivity invariably have very high thermionic emission, usually much higher than surfaces which have high luminous and infrared sensitivity. This observation has also been made previously with different processing schedules. A satisfactory explanation for this fact is not available.

"Doping" attempts with other alkali metals to lower thermionic emission have, generally, been unsuccessful in this method (Possible exception, No. 0-157, See Rpt. No. 8, p. 3).

Undoubtedly, the effect of a dopant for lower thermionic emission is contrary to the development of high infrared sensitivity and will be difficult to establish.

We were also not yet able to gain a better insight into the mechanism which accounts for the observations made during the "Cs-bake" after the Cs drift. Attempts to study this phenomenon in "slow motion" on tubes with attached ion pump and oxygen supply have not resulted in performance similar to the more standard procedure.

Some additional experiments with cooling and heating the glass substrates have confirmed the conclusions drawn in the last quarterly report (No. 6). None of those preparation techniques have shown promise of good and stable cathode formation (again possibly excepting the region below -10°C which will be investigated further at a later date).

Although planned for this quarter, dielectric substrates have not been prepared as yet for cathode studies, because of the preference given to further experimentation with the high infrared processing technique.

PART II - PROGRAM FOR THE NEXT INTERVAL

1. Further investigation of the high IR processing method with particular consideration of establishing criteria of the Ag-base for successful application of this method.

2. Study of doping techniques to suppress high thermionic current on high infrared cathodes.

3. Study of the preparation of dielectric substrates for application in the semi-transparent mode.

4. Continuation of optical measurements to determine optical constants on a representative sample.

PART III - MEETINGS, CONFERENCES

On February 17, 1967, H. Timan visited the ERDL Laboratories. Status of the program was reviewed with G. Burroughs and Dr. H. A. Stahl. A discussion about the application of high infrared processing techniques in image tubes was conducted with J. Johnson and members of the image tube group.

On April 11/12, Dr. H. A. Stahl visited these laboratories for program review and discussion. Demonstrations of processing techniques were given.

TABLE I (CONT'D)

ELECTRICAL PROPERTIES OF TUBES PROCESSED DURING THE QUARTERLY PERIOD 2/1/67 - 4/30/67

Tube No.	Processing Date	Luminous Sensitivity in µA/L WL	2540	Thermionic Emission in $A/cm^2 \times 10^{12}$	Absolute Sensitivity in mA/W 4535Å	6015Å	9500Å	11500Å	Resistance in Ω/□
0-153	3/21/67	52	7.3	-	-	-	-	-	-
		Severe slump							
0-154	3/15/67	59	7.8	8.0	1.8	3.3	2.6	.07	1.0×10^9
0-157	3/23/67	50	8.9	1.2 !	1.8	2.7	1.8	.19	1.8×10^6
0-165	4/24/67	50	2.8	-	-	-	-	-	-
		Severe slump							
0-171	4/12/67	53	7.5	40.0	2.4	3.8	1.9	.15	7.5×10^9
0-201	4/22/67	46	7.5	100.0	1.8	2.7	1.4	.18	1.8×10^5
0-202	4/20/67	69	13.5	9.5 !	3.0	3.4	2.3	.41	4.0×10^5
0-203	4/20/67	53	11.5	20.0	2.7	3.1	1.8	.38	5.0×10^4
0-206	4/27/67	50	6.2	4.2	1.6	2.9	2.0	.05	1.5×10^6
0-208	4/28/67	64	10.0	13.0	3.7	4.7	2.0	.27	1.5×10^7

TABLE I

ELECTRICAL PROPERTIES OF TUBES PROCESSED DURING THE QUARTERLY PERIOD 2/1/67 - 4/30/67

Tube No.	Processing Date	Luminous Sensitivity in μA/L WL	Luminous Sensitivity in μA/L 2540	Thermionic Emission in $A/cm^2 \times 10^{12}$	Absolute Sensitivity in mA/W 4535Å	6015Å	9500Å	11500Å	Resistance in Ω/□
0-127	2/01/67	46	5.3	3.0	3.6	3.3	1.0	.08	4.0×10^5
	5/08/67	Very low							
0-132	2/03/67	51	6.6	22.0	3.0	2.9	1.3	.16	1.5×10^3
	5/08/67	39	5.5	-	-	-	-	-	-
0-134	2/10/67	55	6.1	5.5	-	-	-	-	1.2×10^8
0-135	2/13/67	43	4.1	-	-	-	-	-	-
		Severe slump							
0-136	2/21/67	73	10.2	27.0	3.2	4.1	2.7	.22	6.0×10^5
0-138	2/24/67	37	5.1	66.0	2.0	2.4	1.3	.20	3.0×10^5
0-141	2/28/67	37	8.2	42.0	1.5	1.3	1.2	.23	1.5×10^3
0-142	3/02/67	68	12.0	28.0	2.1	3.3	2.4	.38	1.5×10^6
0-143	3/02/67	58	7.3	1.8	2.2	3.5	2.2	.06	4.0×10^7
0-145	3/06/67	44	8.0	66.0	1.5	1.9	1.6	.25	7.5×10^5
0-151	3/20/67	36	7.4	4.8	1.3	1.9	1.5	.03	1.5×10^6
0-152	3/21/67	41	8.0	110.0	1.7	2.1	1.5	.28	2.0×10^5

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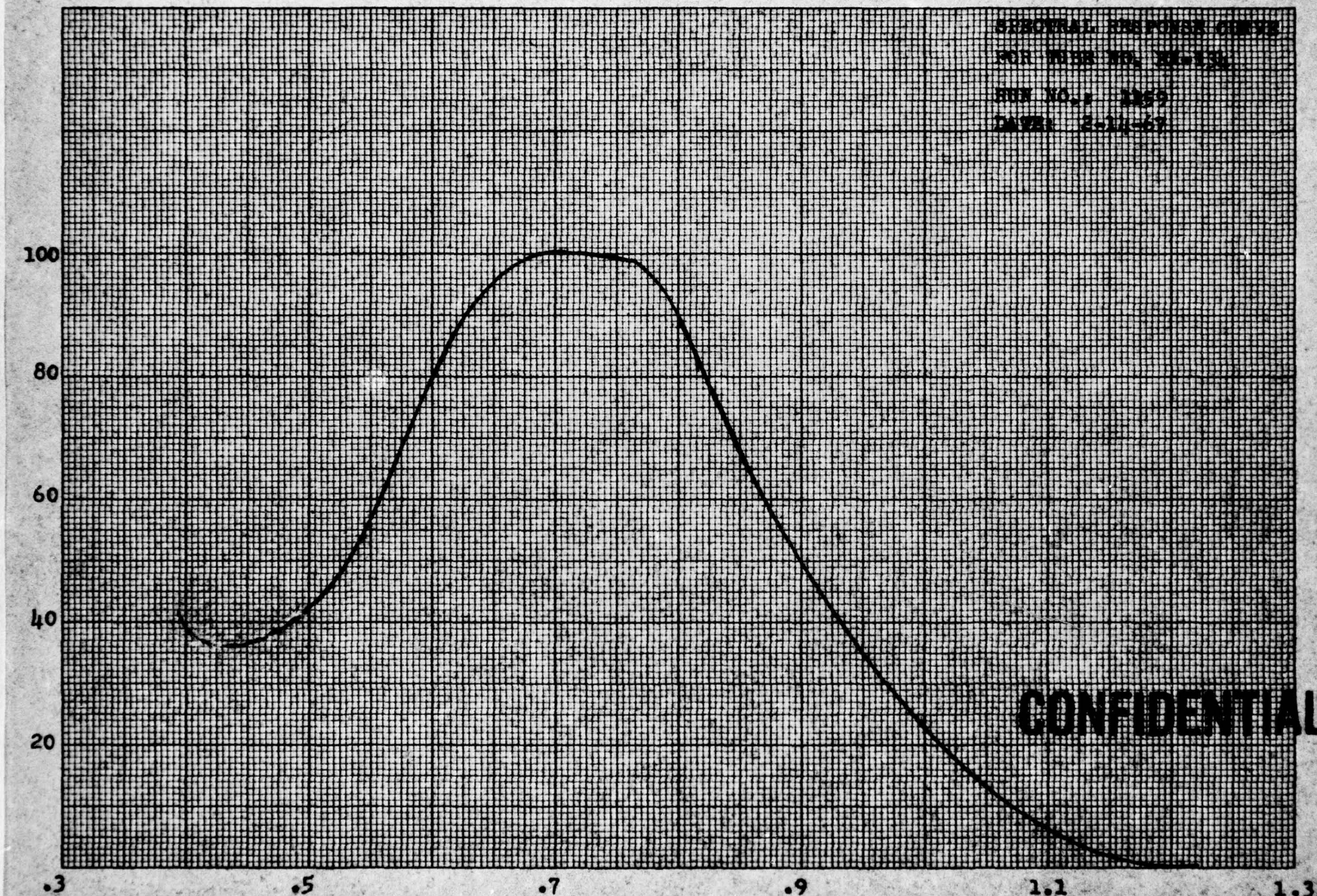

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FIGURE NO. 1

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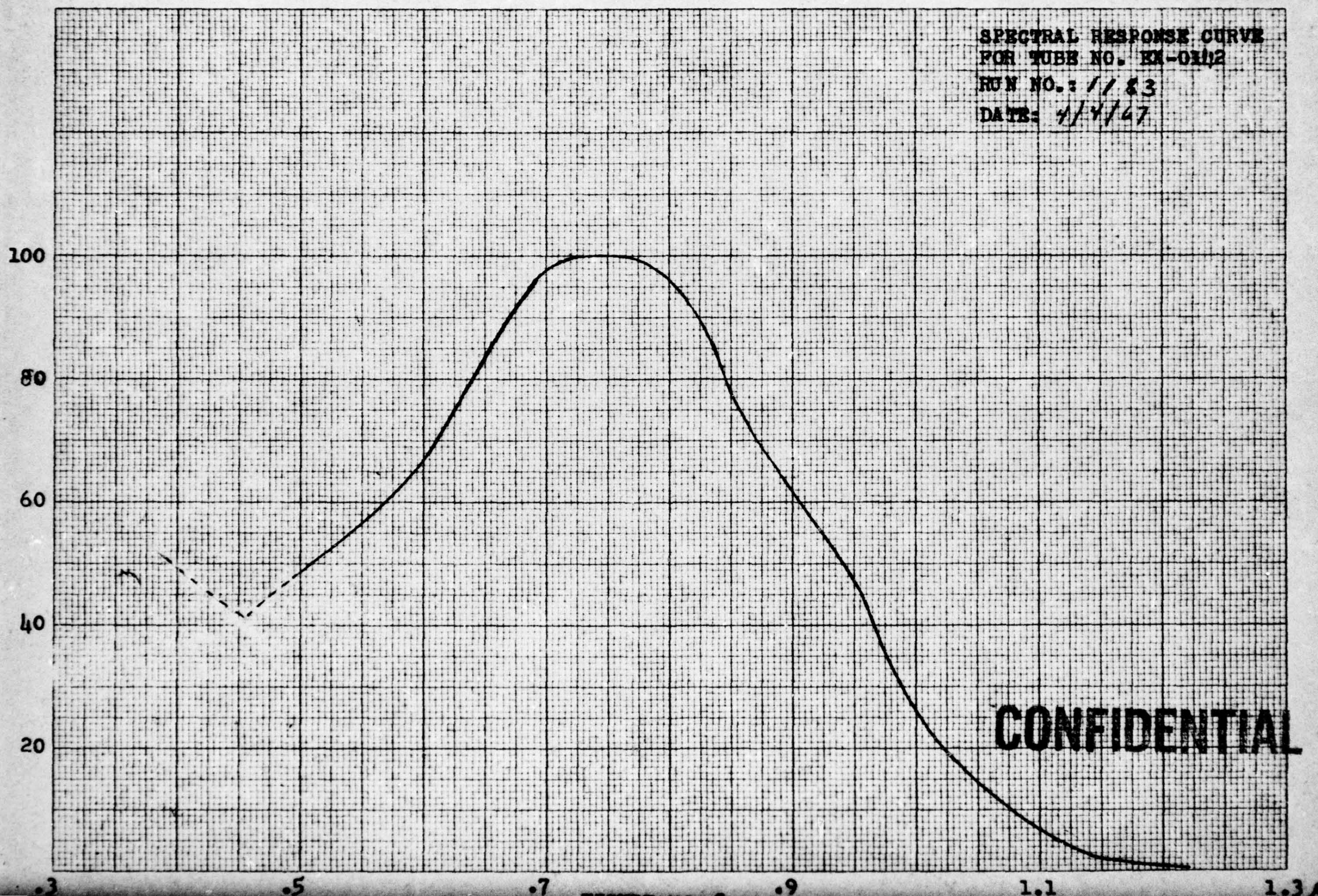

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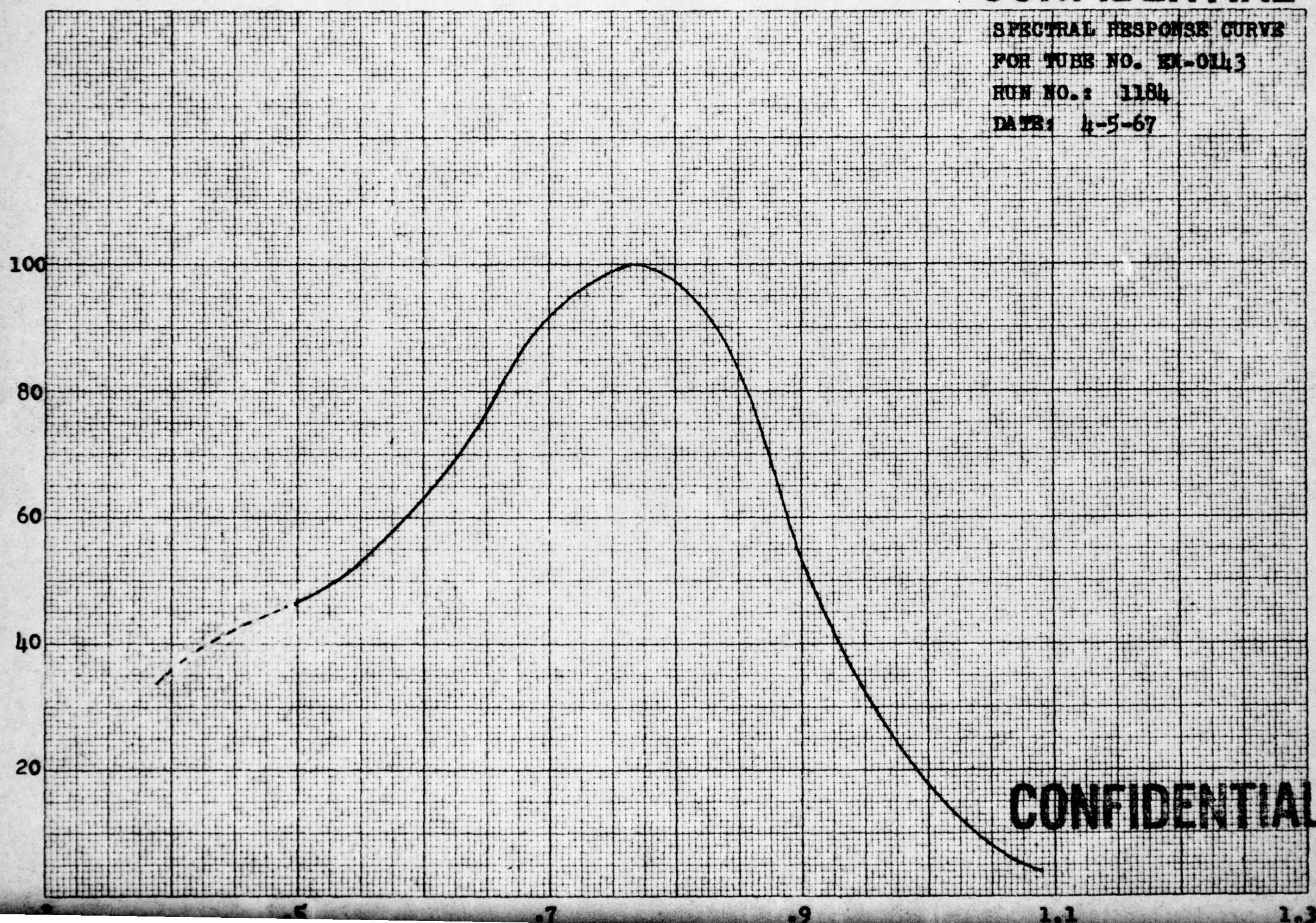

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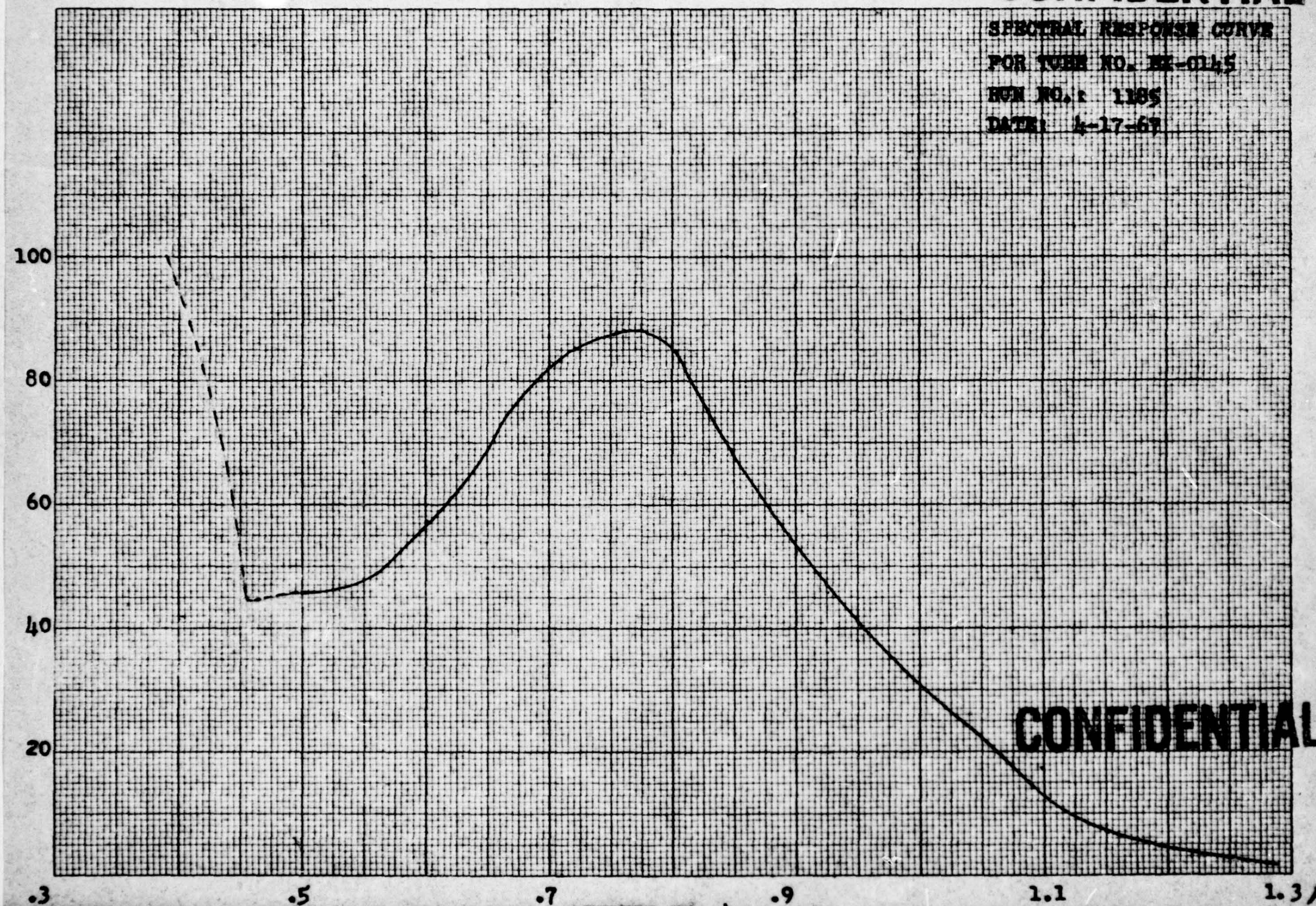

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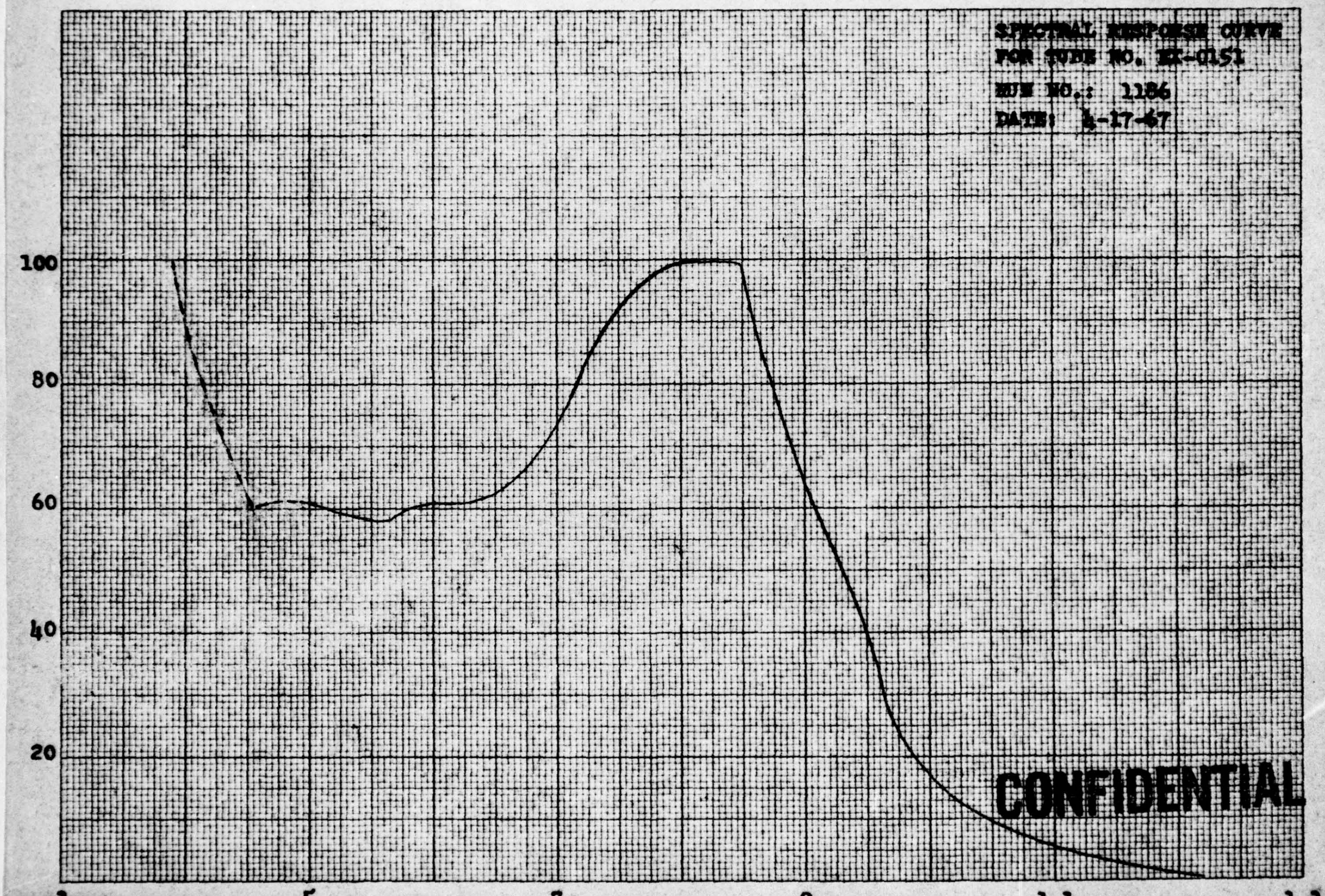
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FOR TUBE NO.
RUN NO.: 1186
DATE: 4-17-67
100
80
60
40
20
.3
.5
.7
.9
1.1
1.3 µ

FIGURE NO. 5

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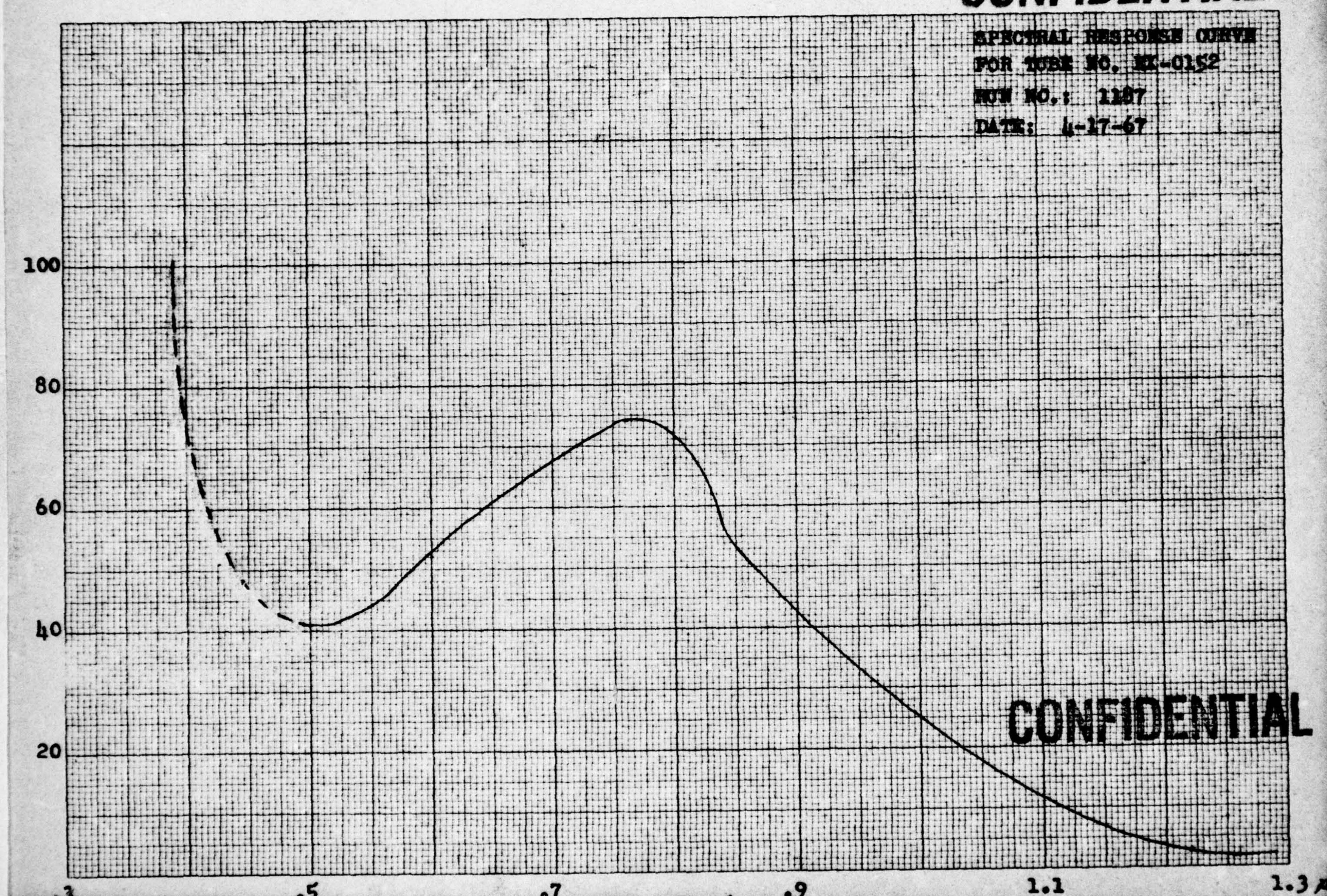

FIGURE NO. 6

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EUGENE DIETZGEN CO.
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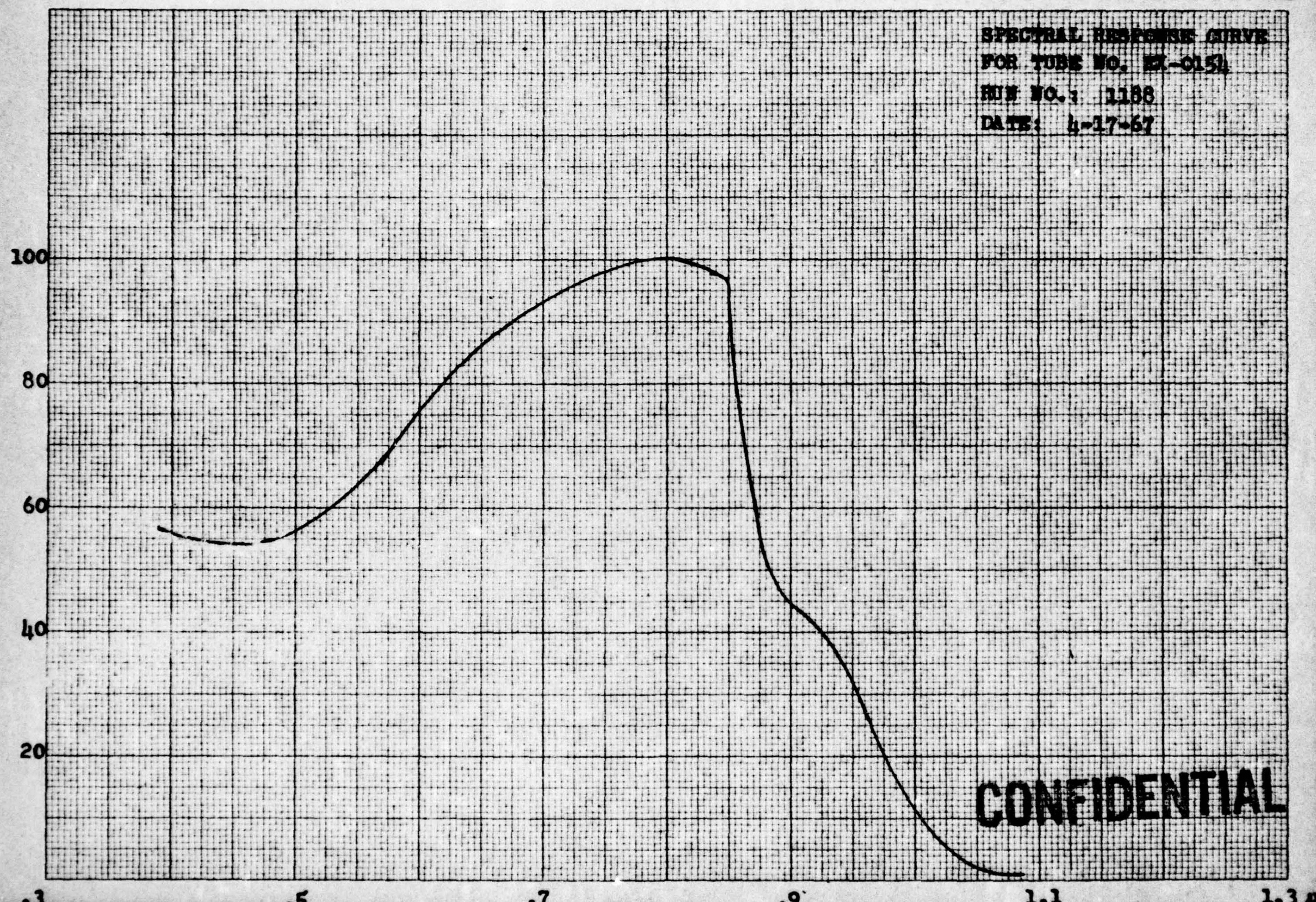

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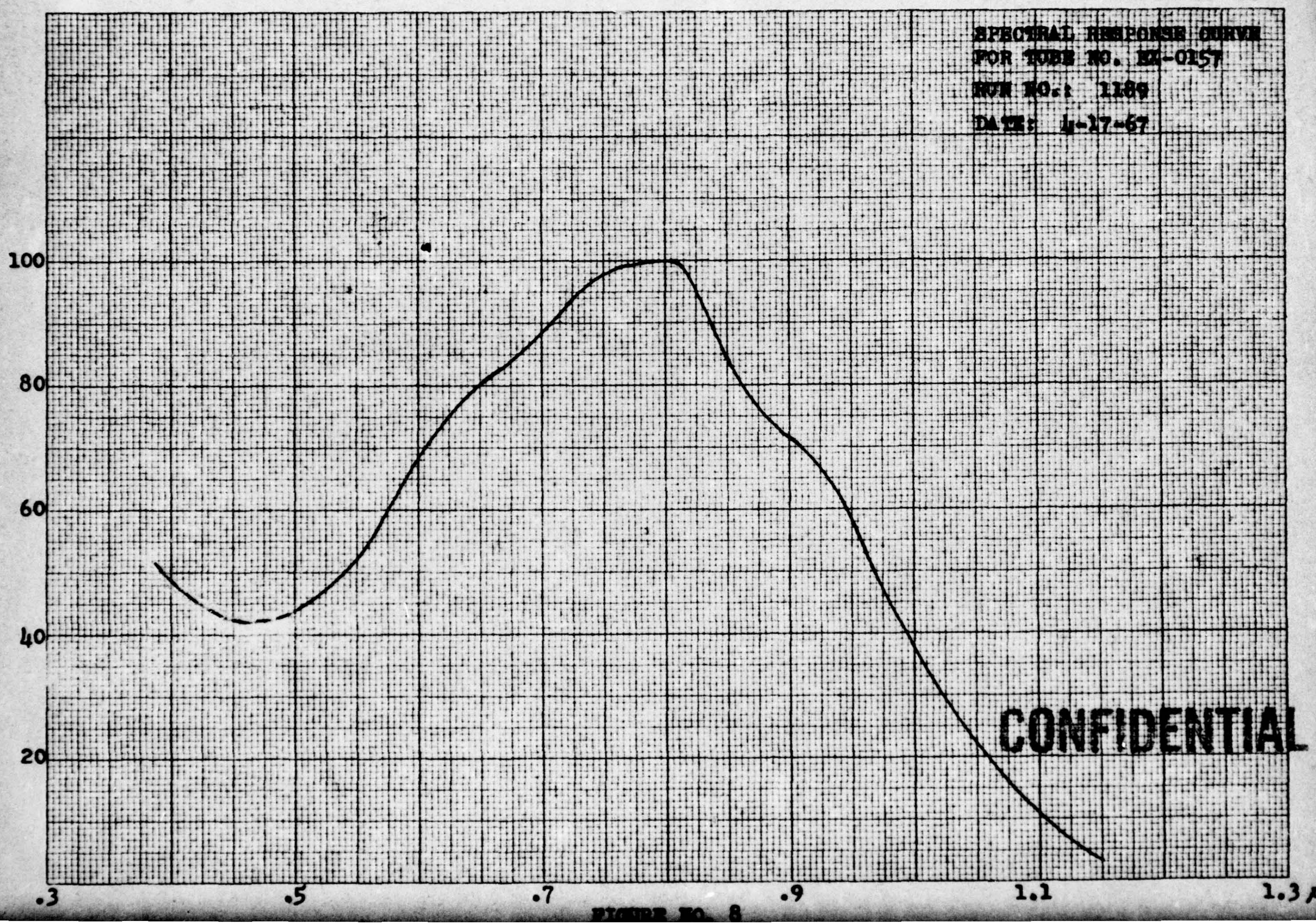

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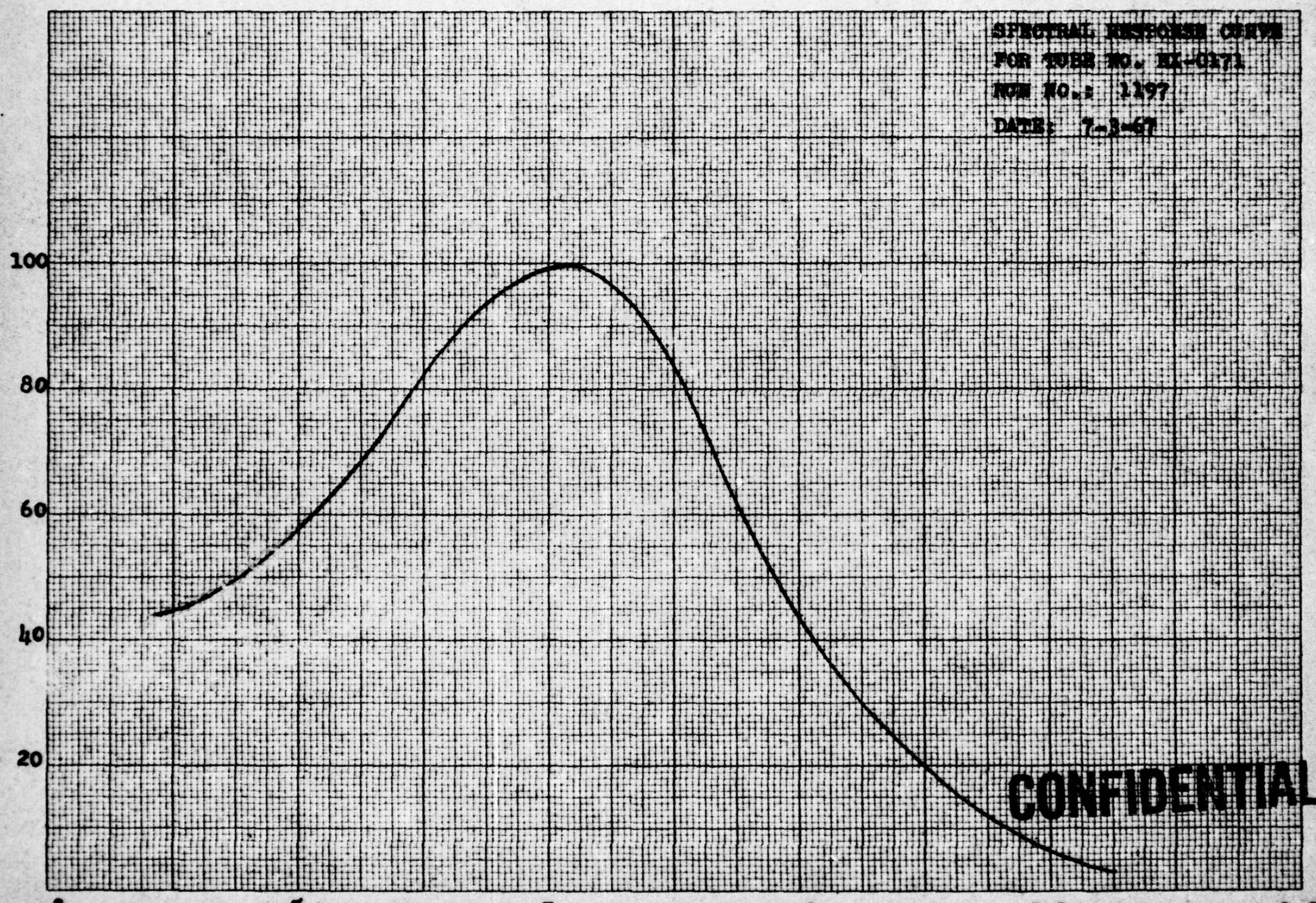

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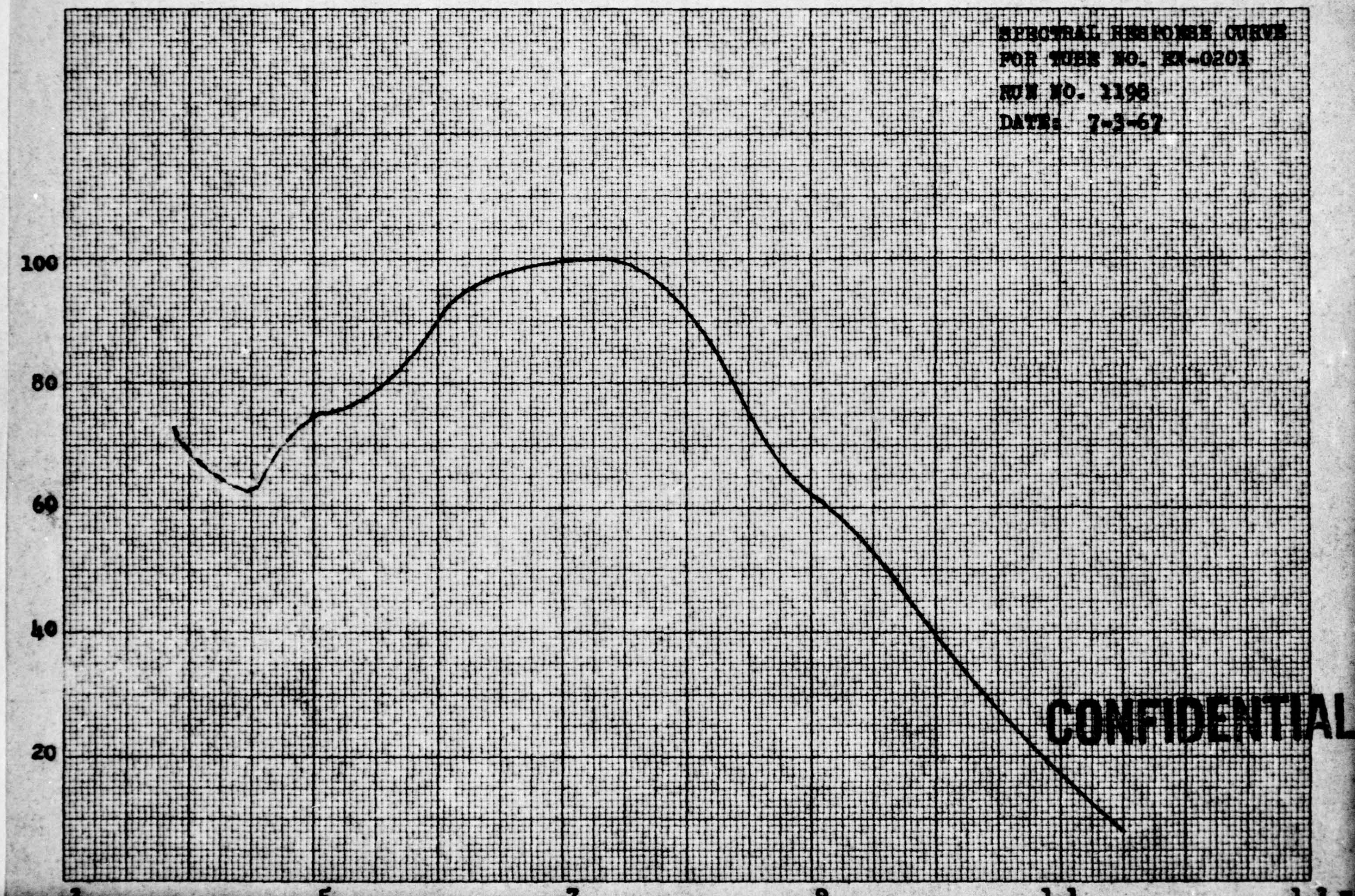

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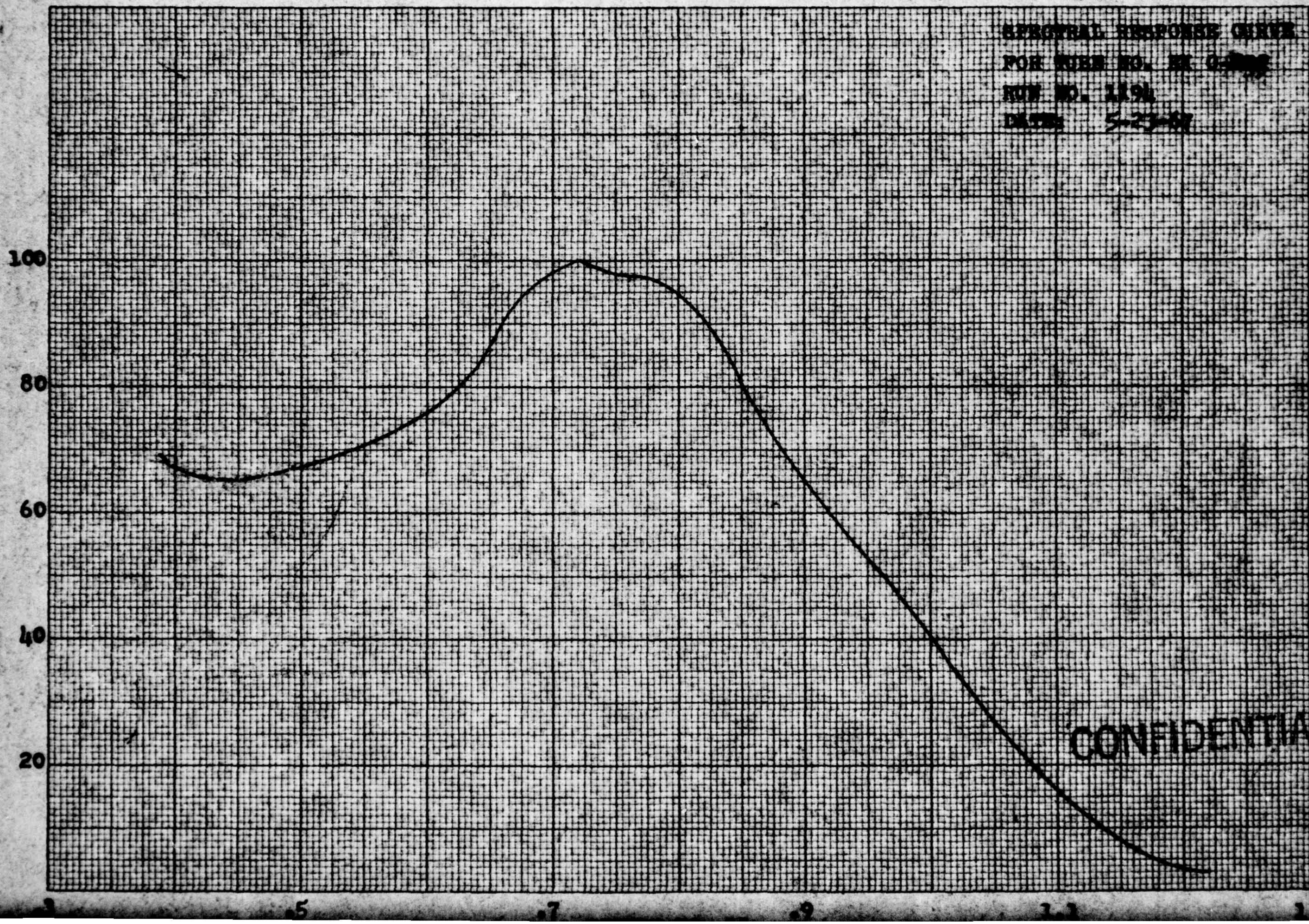

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MADE IN U. S. A.

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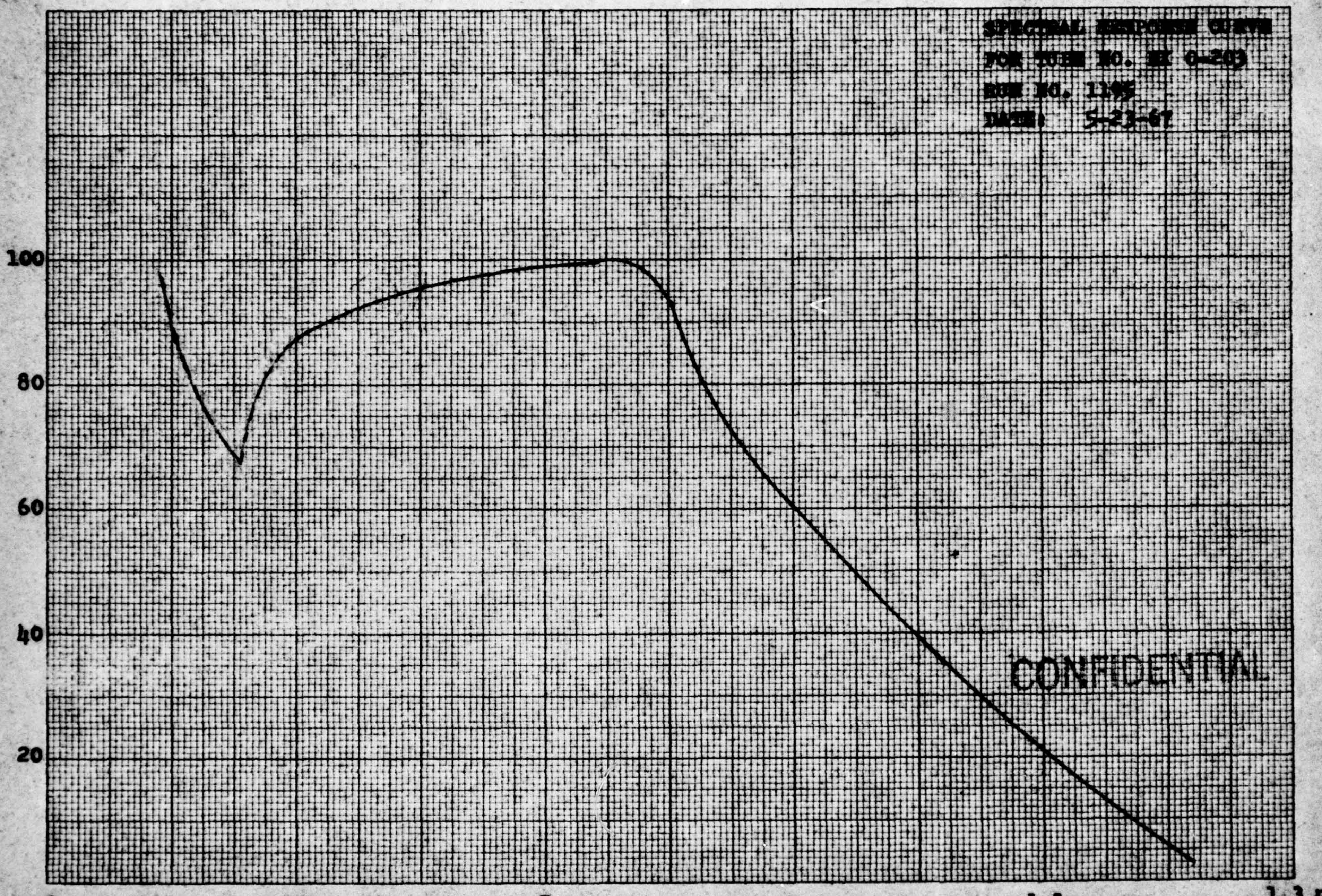

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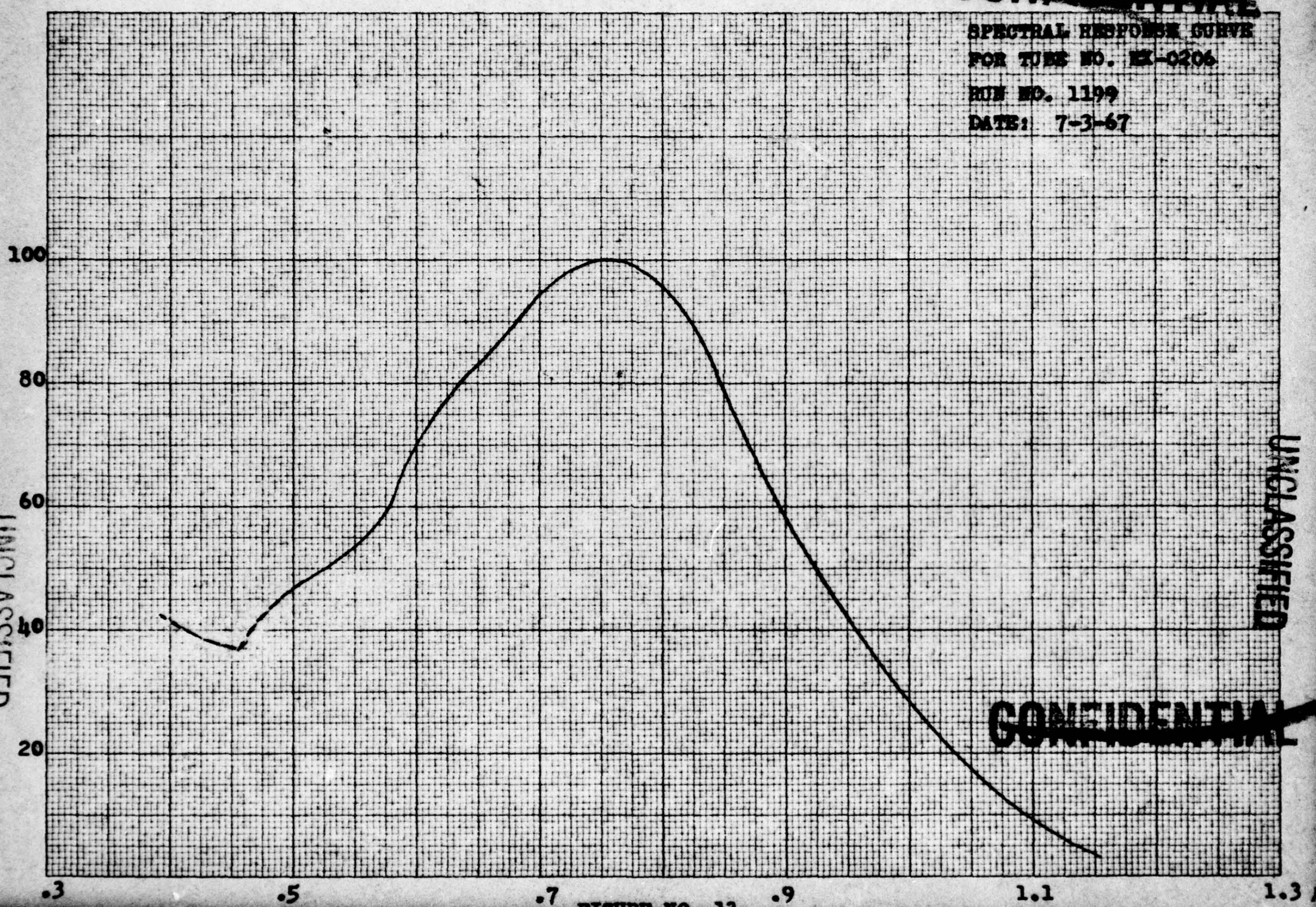
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FOR TUBE NO. EX-0206
RUN NO. 1199
DATE: 7-3-67
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80
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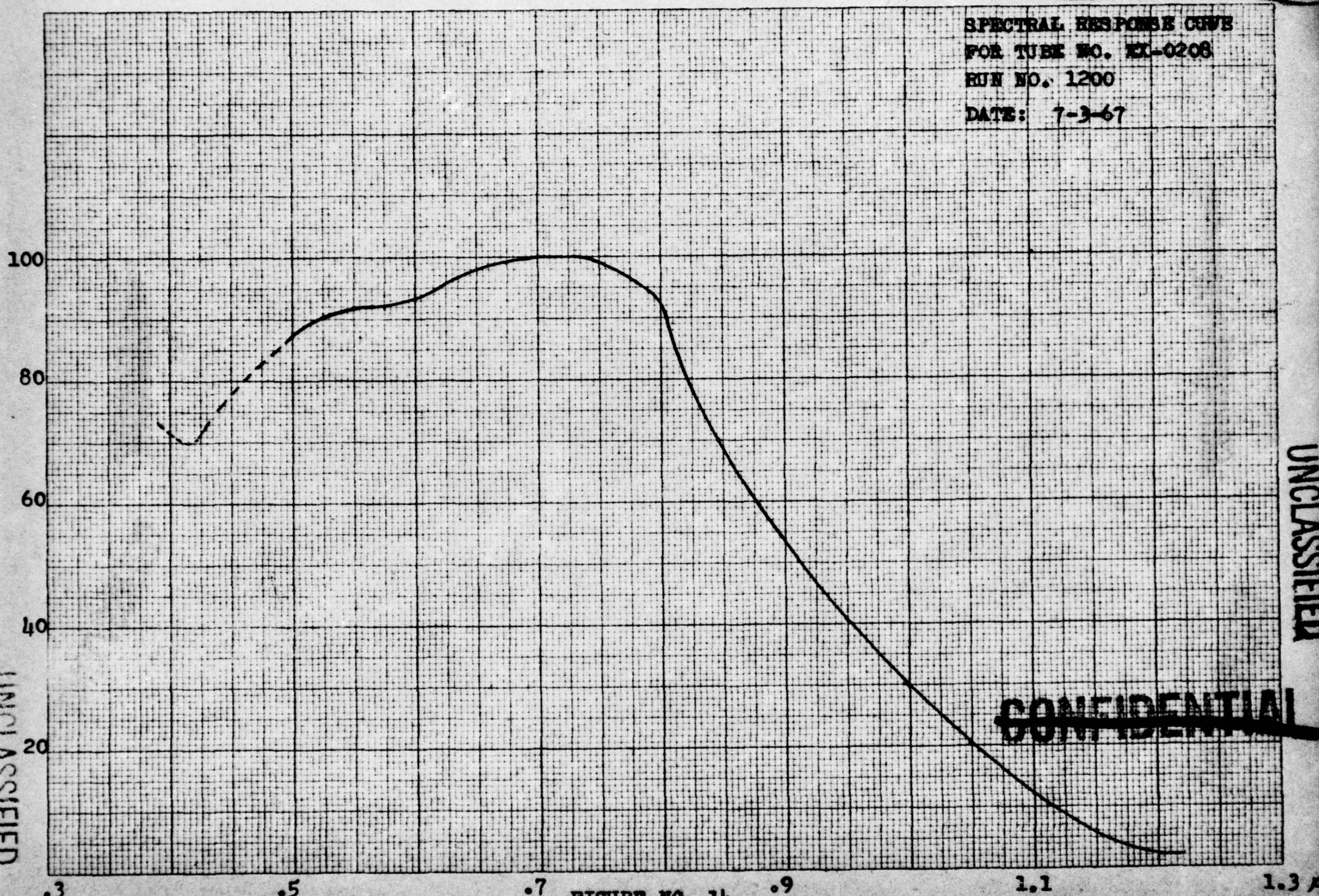
40
20
.3
.5
.7
.9
1.1
1.3

FIGURE NO. 13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FOR TUBE NO. EX-0208
RUN NO. 1200
DATE: 7-3-67
100
80
60
40
20
.3
.5
.7
.9
1.1
1.3 µ

FIGURE NO. 14