AD-A033 240 DUMONT ELECTRON TUBES CLIFTON N J F/G 9/1
STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE.(U)
MAY 67 H TIMAN DA-44-009-AMC-1811(E)
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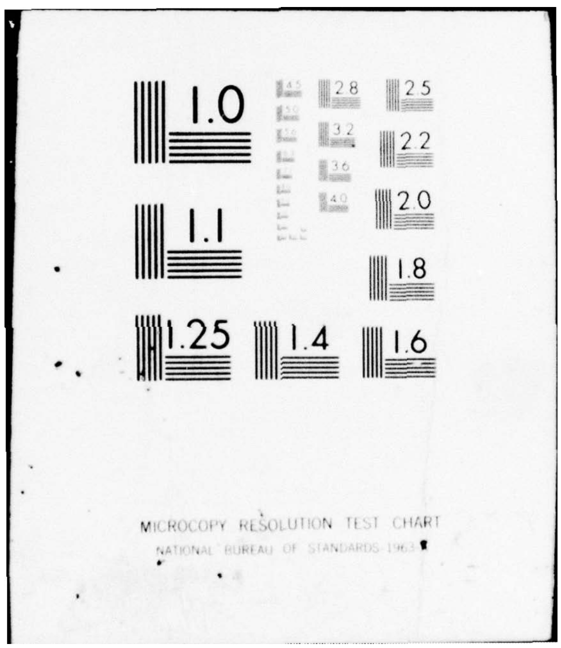
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SECOND QUARTERLY REPORT NO. 6

FOR

STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE

(9) Quarterly (2nd) rept. no. 6, 1 Nov 66 - 31 Jan 67

THIS REPORT COVERS PERIOD 1 NOVEMBER 1966 - 31 JANUARY 1967

(10) Hans Timan

(11) 22 May 67 (12) 23p.

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RELEASED BY: Alan Howell, Contract Administrator

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

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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

During the month of January, 21 tubes were assembled of which 16 attained cathode processing status.

PART I - DETAILED FACTUAL DATA

A. Tube processing during the month of January

During this month, substrate conditioning was investigated further.

In Nos. 0-113, 0-128, 0-129, Ag-laydown was performed at 180°C and 190°C. The observations were quite similar to those with laydown at 120°C (See Rpt. No. 5, p. 3). In both cases, strongly reflecting layer with no conductivity resulted, which took up large amounts of cesium, but good cathodes were not formed.

Laydown at 50°C was not markedly different from the usual pattern at 30°C. A medium cathode was formed (0-109). The thermionic current was remarkably high.

In Nos. 0-110, 0-111, 0-120, 0-121, the substrate was cooled to 10-15°C for evaporation and following Cs drift. In all cases, processing behavior was poor. The only cathode which seemed to retain Cs during formation (0-110) slumped badly later. All other cathodes showed very poor accommodation for Cs. Again, as observed earlier, (Rpt. No. 5, p. 4) the Ag-layer appeared colorless.

In Nos. 0-122, 0-124B, 0-125, 0-126, a high voltage field was applied between evaporator cup and cathode window. As we had reason to suspect that at least part of the Ag-vapor is positively charged, this was an attempt to control the rate of arrival at the substrate.

In No. 0-124B, +500V were applied to the cathode. No obvious effect was observed; a reasonable cathode with, however, very high thermionic emission resulted.

Pronounced effects were observed in 0-122 and 0-126 where +5000V and 2500V respectively were applied to the cathode area. In both cases, Ag-evaporation was difficult, i.e., a much higher than usual firing current had to be employed. The resulting layer was decidedly non-uniform; it had the appearance of a heavier (bluish) center with yellowish edges, as if deflection had taken place. Processing was extremely poor.

In No. 0-125, -2500V were applied to the cathode area. Although visually no change was observed, processing was again very poor.

In Nos. 0-114, and 0-124A, the high infrared processing technique was employed. Only 0-114 produced a stable cathode with good IR.

In No. 0-123A, the main Cs drift was performed at 10°C - following bake resulted in a reasonable white light sensitivity but low IR.

No. 0-115 was a tube with internal O_2 supply and will be reported on at a later date.

For details see Table I.

During this month, the 8975Å filter which was used for measurement of absolute sensitivity and infrared transmission of the Ag-base, was destroyed by heat.

Absolute sensitivity will therefore be measured at 9500Å while Ag-base IR transmission will be monitored at 10000Å or 10600Å.

B. <u>Summary of work performed during the 2nd Quarterly Period</u>

In this period, several environmental parameters were studied which relate to Ag-evaporation, and the high infrared processing technique developed in the last quarter.

The high infrared processing method was applied unmodified in only 15 tubes. Of these 15, five had 2540 sensitivity above 7.0 µA/L; two were above 6 µA/L while the rest were considerably less. In all of the poor surfaces, the first bake cycle had been unsuccessful (i.e., photosensitivity deteriorated at high temperatures) and reasonable sensitivity was achieved only after further processing steps. It seems, from results so far, that the highest infrared sensitivities are achieved if Cs adheres well to the Ag-base after the first interaction. In the light of the somewhat poorer results in this quarter, it is significant that early in this period an apparent contamination problem had been encountered which was cleared up in late December through additional cleaning steps.

The major effort was expanded this quarter towards the study of different substrate conditioning for the Ag-base-layer preparation. This was undertaken not only for cathode formation improvement and insight but also in order to study preparation techniques which would permit successful cathode formation in restricted geometries. The specific case in question was the PIP tube with its small evaporator-to-substrate spacing. It was hoped to find environmental conditions which would minimize the detrimental effects on the Ag-layer. Application of heat, cooling, and high voltage during evaporation was investigated.

In heating the cathode window from 50-190°C during base laydown, it was found that a very different behavior of the Ag-layer resulted. The 50% transmission layer was much more strongly reflecting and more "metallic" in appearance; however, no conductivity was observed. Thinner layers showed a brilliant yellow color. In all cases, apparently large amounts of Cs were taken up as observed by an unusually large decrease in transmission. In Tube Nos. 0-99, 0-100, 0-104, 0-106, medium cathodes were processed, however, thermionic emission was very high. The highest temperatures (180-190°C) applied did not yield good cathodes.

Cooling was tried only in the range of 5-15°C. Only in two cases (O-107, O-108) were reasonable cathodes achieved. The Ag-layer looked colorless under this condition.

Application of high positive voltage to the cathode window resulted in non-uniform layers. The observations support the assumption that at least part of the Ag-vapor is positively charged.

On the whole, none of these experiments show promise for application, e.g., in the PIP geometry. Except for some investigations in the very low substrate temperature region (-20 to -40°C) no further experiments of this nature are planned.

Spectral response curves of surfaces processed this quarter are given in Figures 1-13. Detailed data are given in Table I.

PART II - PROGRAM FOR THE NEXT INTERVAL

1. Further investigation of the high IR processing method.
2. Establishing criteria of the Ag-base for application of this method.
3. Suppression of high thermionic emission.
4. Study of dielectric substrates.

PART III - MEETINGS, CONFERENCES

On November 9/10, 1966, K. Kaldenback from ERDL visited these laboratories. The purpose of this visit was to familiarize him with processing techniques.

On November 18, H. Timan, of Du Mont, visited ERDL. Status and future activity of this research program were discussed with concerned personnel.

On December 9, 1966, H. A. Stahl from ERDL visited these laboratories. Present status and future development of the program were discussed.

TABLE I

ELECTRICAL PROPERTIES OF TUBES PROCESSED DURING THE QUARTERLY PERIOD 11/1/66 - 1/31/67

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Tube No.	Processing Date	Luminous Sensitivity in μA/L: WL	Luminous Sensitivity in μA/L: 2540	Thermionic Emission in A/cm² x 10^{12}	Absolute Sensitivity in mA/W: 4535Å	6015Å	9000Å	11500Å	Resistance in Ω/□
0-59	11/01/66	33	3.6	--	--	--	--	--	--
0-61	11/03/66	41	2.6	8.2	2.8	5.2	2.0	.01	2.0×10^{10}
0-65	11/11/66	28	4.1	--	--	--	--	--	--
0-67	11/10/66	50	5.5	4.8	3.8	5.7	2.9	.11	2.0×10^{12}
0-83	11/29/66	46	2.2	--	--	--	--	--	--
0-85	12/06/66	42	1.8	--	--	--	--	--	--
0-89	12/08/66	39	2.1	0.19	2.4	3.4	--	.01	1.3×10^{10}
0-92	12/12/66	55	7.8	54.0	2.8	2.8	--	.23	2.8×10^{10}
0-97	12/20/66	52	8.5	53.0	2.3	3.0	--	.24	--
	4/1967	--	--	--	2.3	3.0	1.7*	.17	--
0-98	12/20/66	50	8.1	7.2	--	--	--	--	2.0×10^{6}
	2/1967	45	7.8	2.5 !	2.7	2.8	1.4*	.25	1.5×10^{9}
0-99	12/22/66	37	5.1	34.0	2.6	3.0	--	.10	8.5×10^{6}
0-100	12/21/66	29	3.2	--	--	--	--	--	--
0-104	12/21/66	41	3.4	25.0	2.1	3.2	--	.07	2.4×10^{8}
0-106	12/29/66	44	5.8	180.0 !	2.4	3.3	--	.19	9.0×10^{6}

* Readings with asterisk are taken at 9500Å.

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TABLE 1 (CONT'D)

ELECTRICAL PROPERTIES OF TUBES PROCESSED DURING THE QUARTERLY PERIOD 11/1/66 - 1/31/67

CONFIDENTIAL

Tube No.	Processing Date	Luminous Sensitivity in µA/L WL	Luminous Sensitivity in µA/L 2540	Thermionic Emission in A/cm² x 10^{12}	Absolute Sensitivity in mA/W 4535Å	6015Å	9000Å	11500Å	Resistance in Ω/□
0-107	12/27/66	57	7.1	3.1	--	--	--	--	2.0×10^6
	2/1967	55	5.8	5.4	2.3	3.5	1.9*	.07	1.5×10^9
0-108	12/30/66	42	3.6	0.44	2.6	3.1	--	.06	9.0×10^5
	2/1967	30	1.2	--	--	--	--	--	--
0-109	1/04/67	43	7.1	31.0	1.5	2.4	--	.16	4.6×10^5
0-110	1/05/67	36	6.1	72.0	1.5	2.1	--	.04	2.6×10^5
	1/11/67	30	2.8	--	--	--	--	--	--
0-114	1/12/67	41	6.3	53.0	1.4	1.7	1.2*	.09	--
0-119	1/18/67	52	5.5	6.0	2.8	4.1	1.9*	.07	1.0×10^8
0-123A	1/23/67	46	2.8	9.0	2.2	3.2	1.9*	.01	2.2×10^8
0-124A	1/24/67	44	7.5	--	--	--	--	--	--
	2/13/67	19	1.4	--	--	--	--	--	--
0-124B	1/24/67	50	6.4	470.0 !	2.0	3.1	1.5*	.09	2.5×10^8

* Readings with asterisk are taken at 9500Å.

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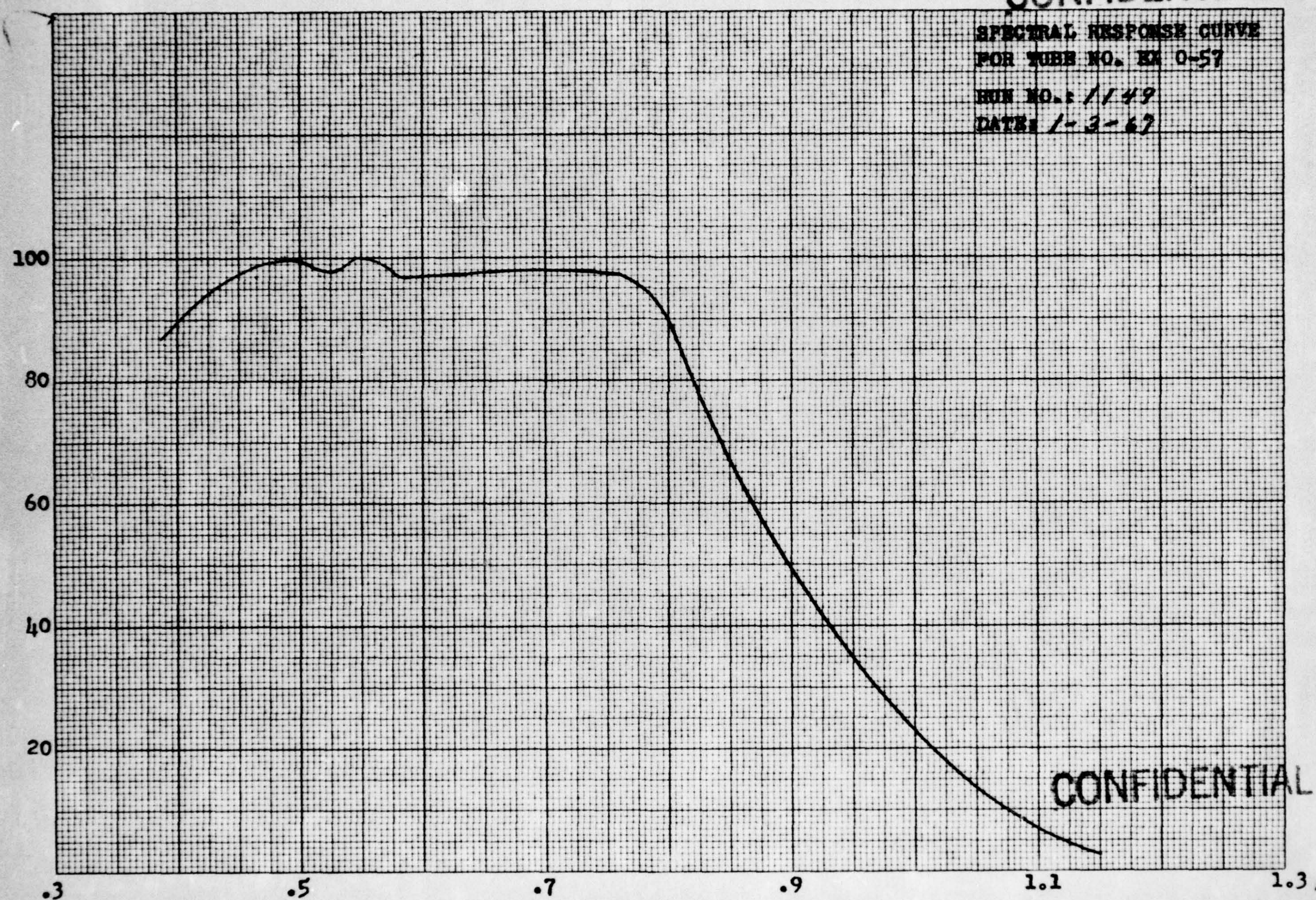

FIGURE NO. 1

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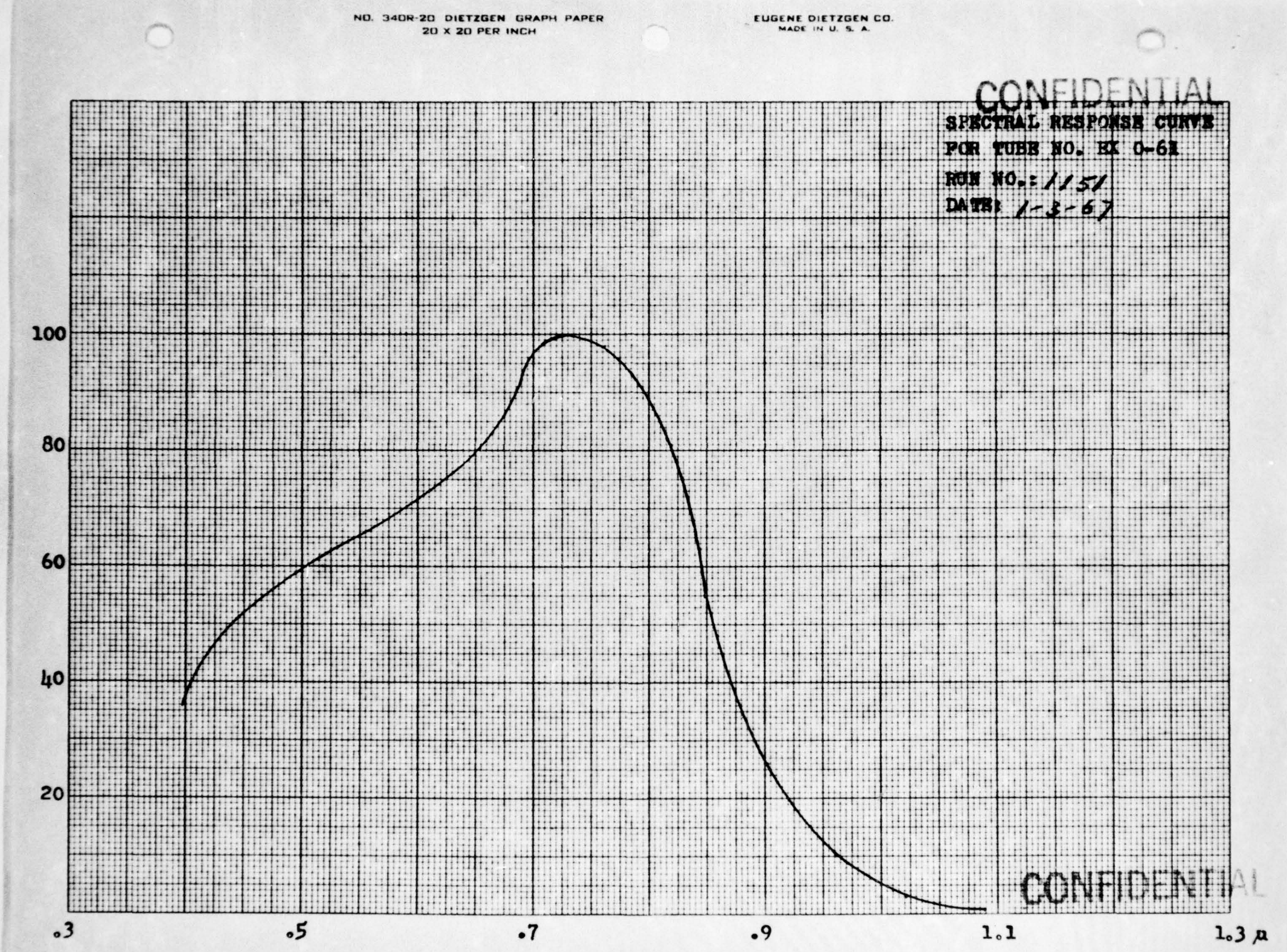
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FIGURE NO. 2

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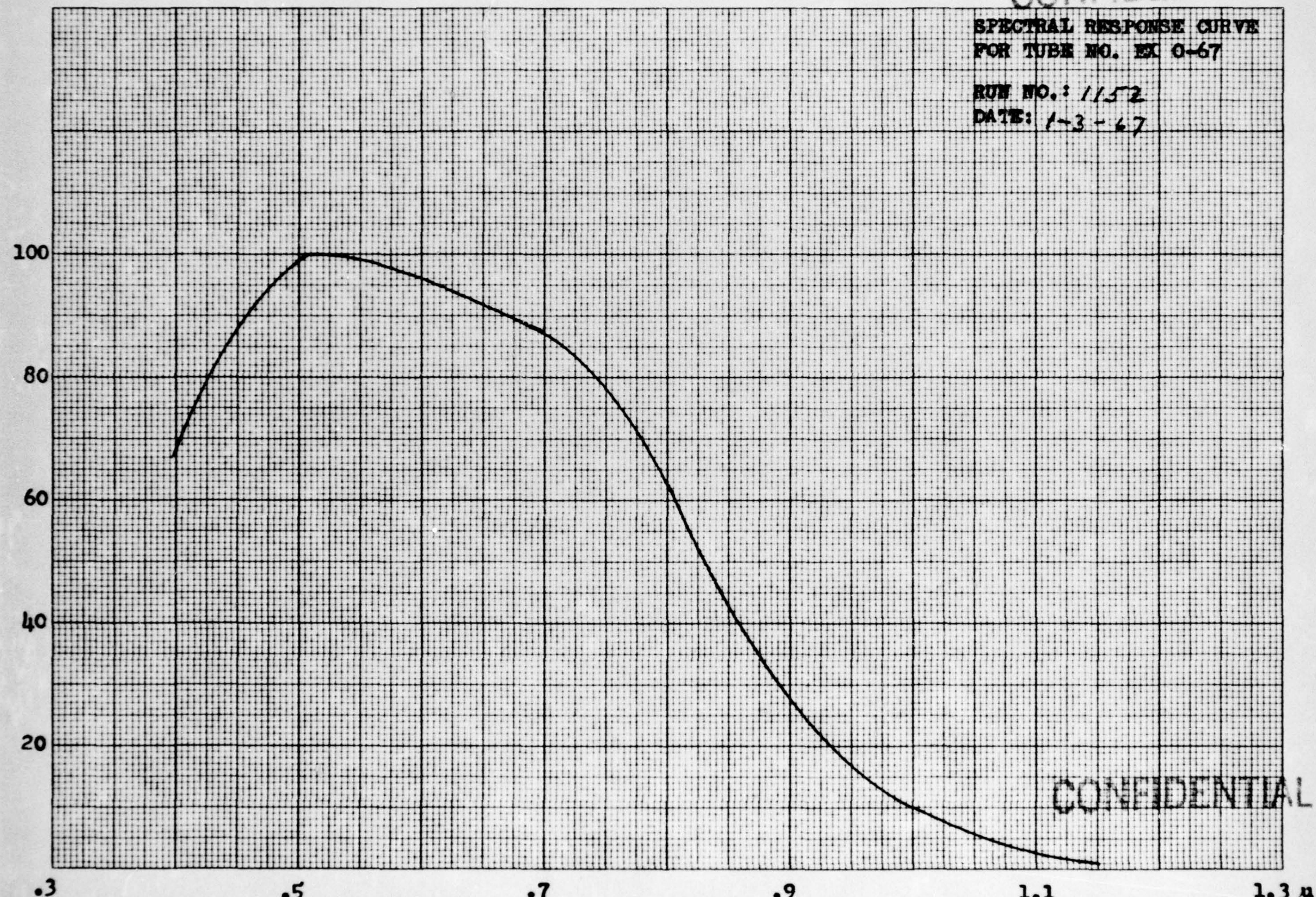

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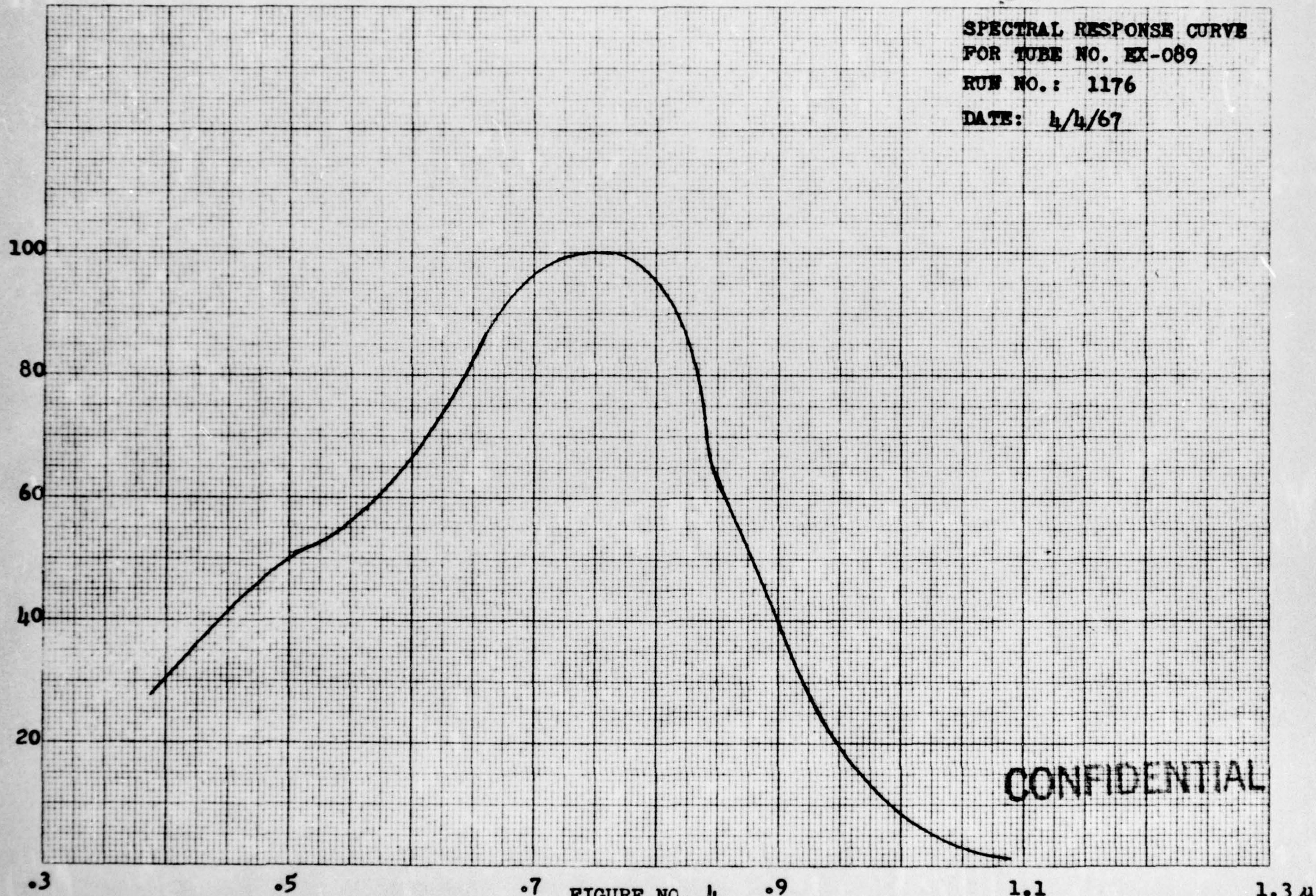

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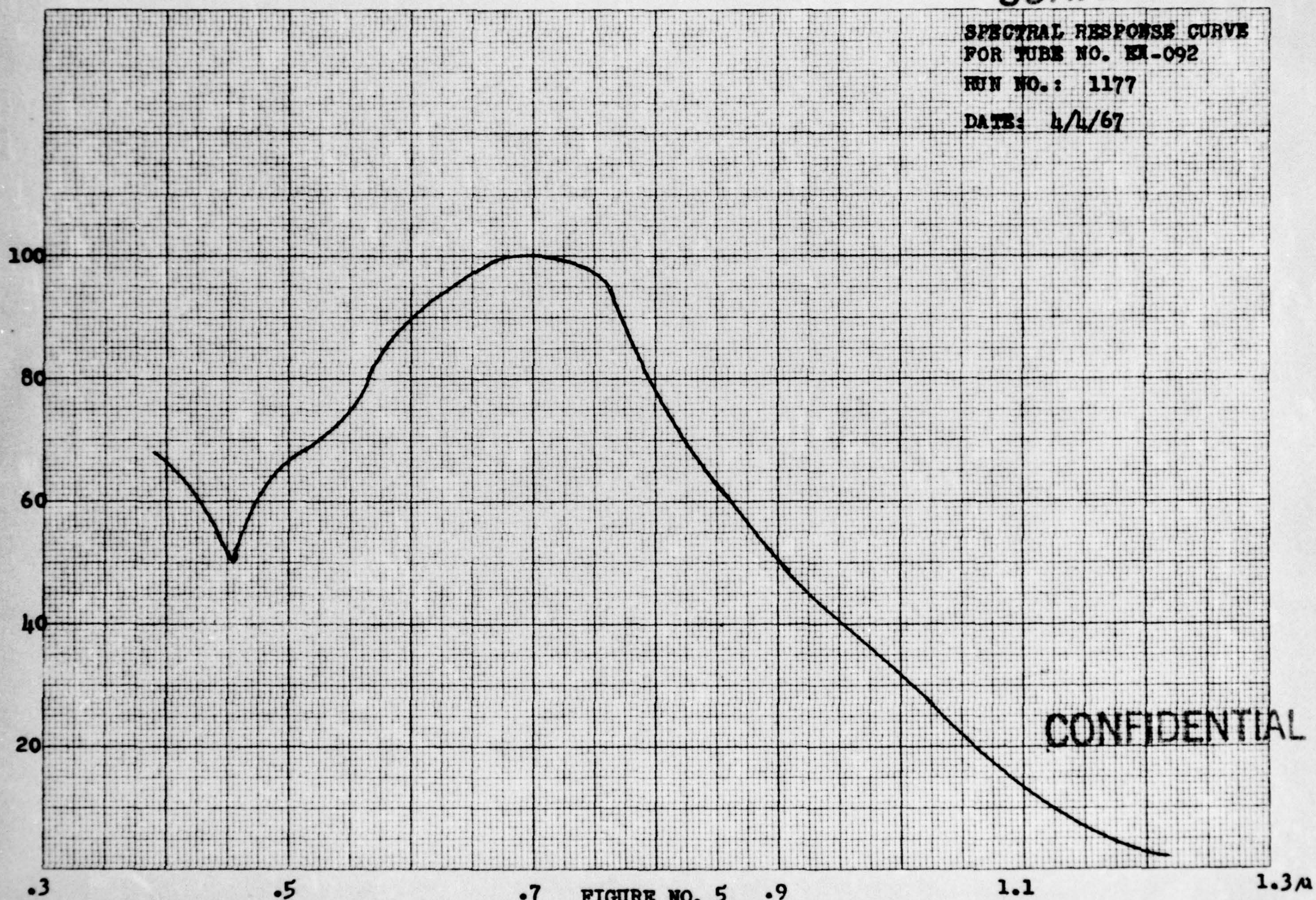

FIGURE NO. 5

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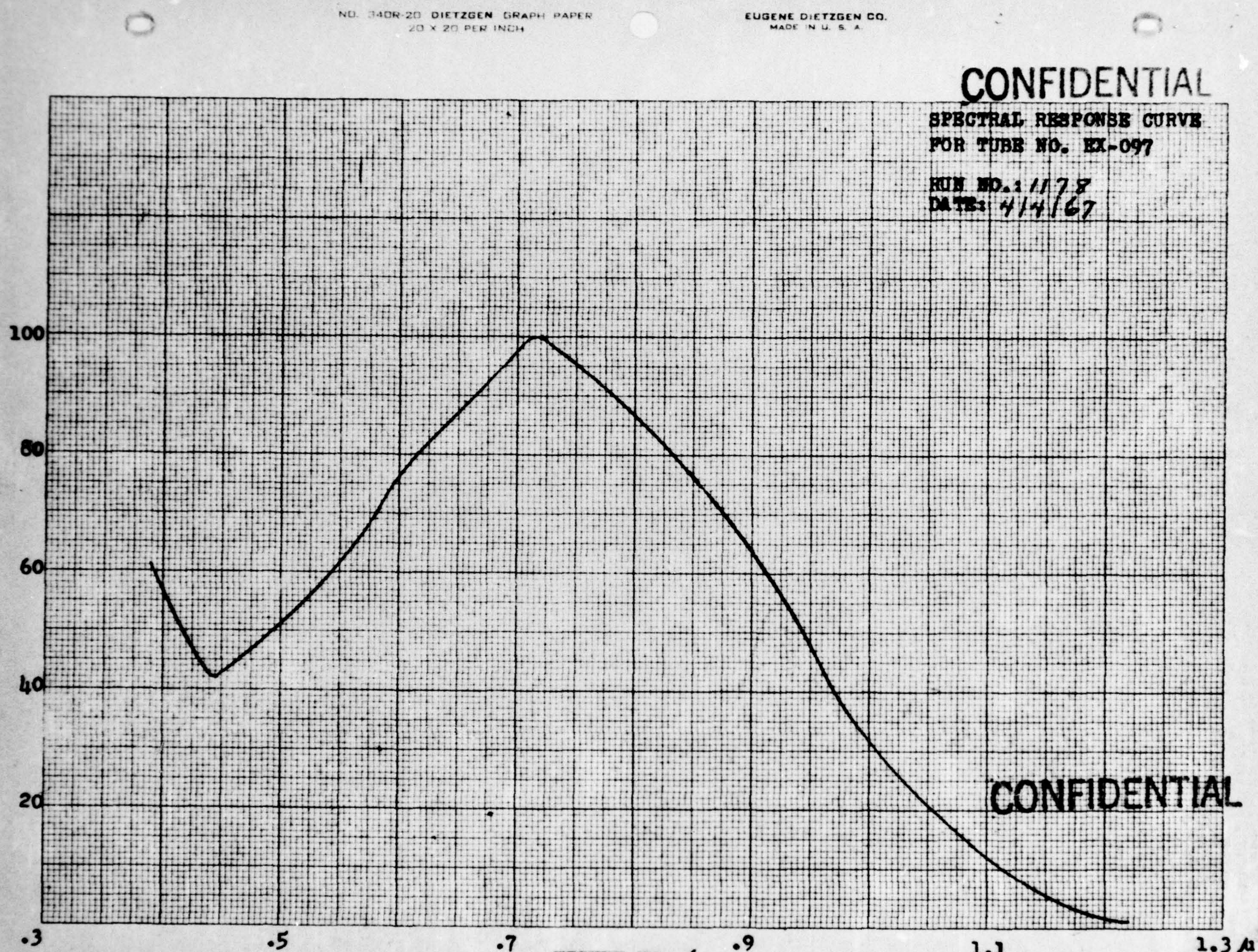

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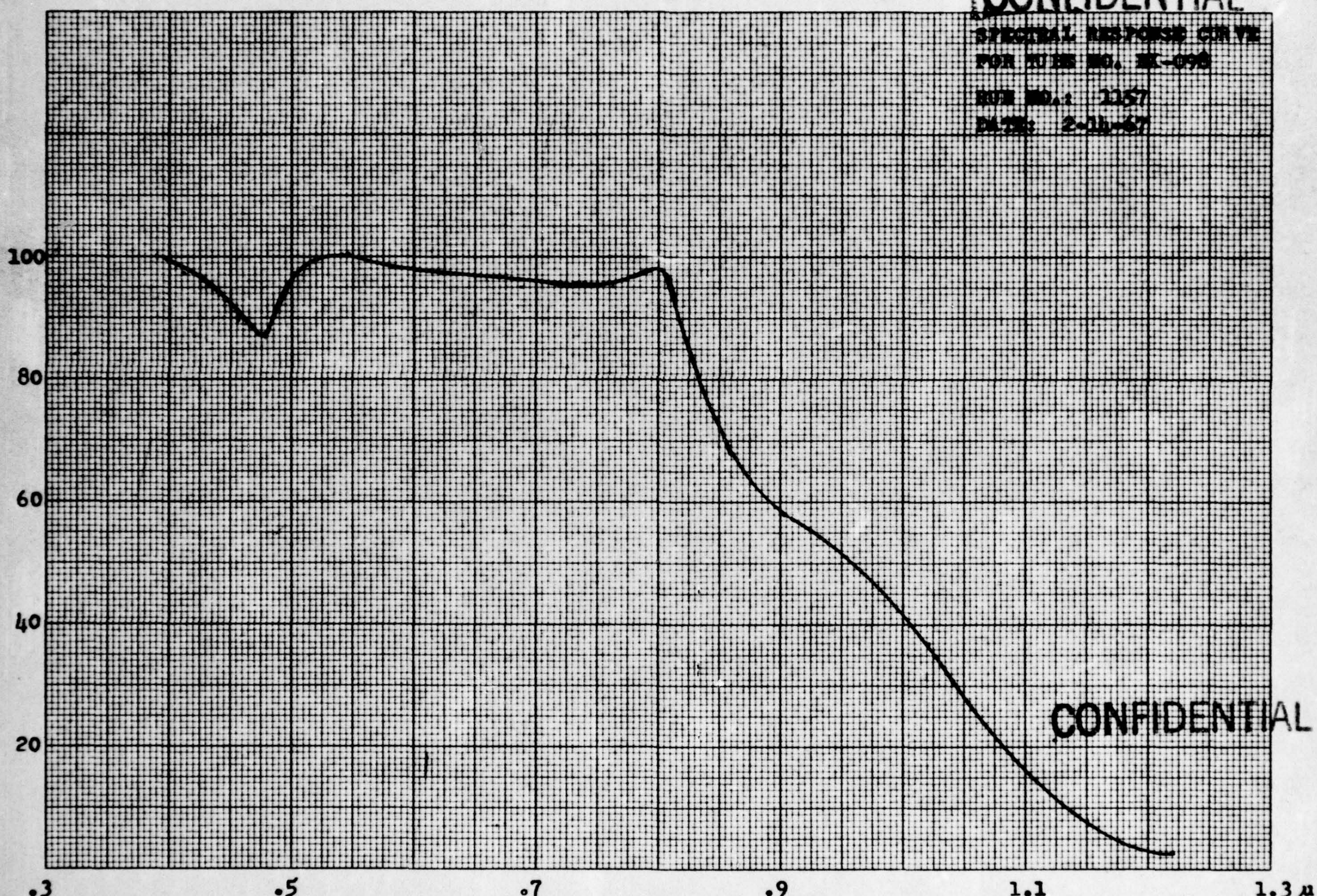

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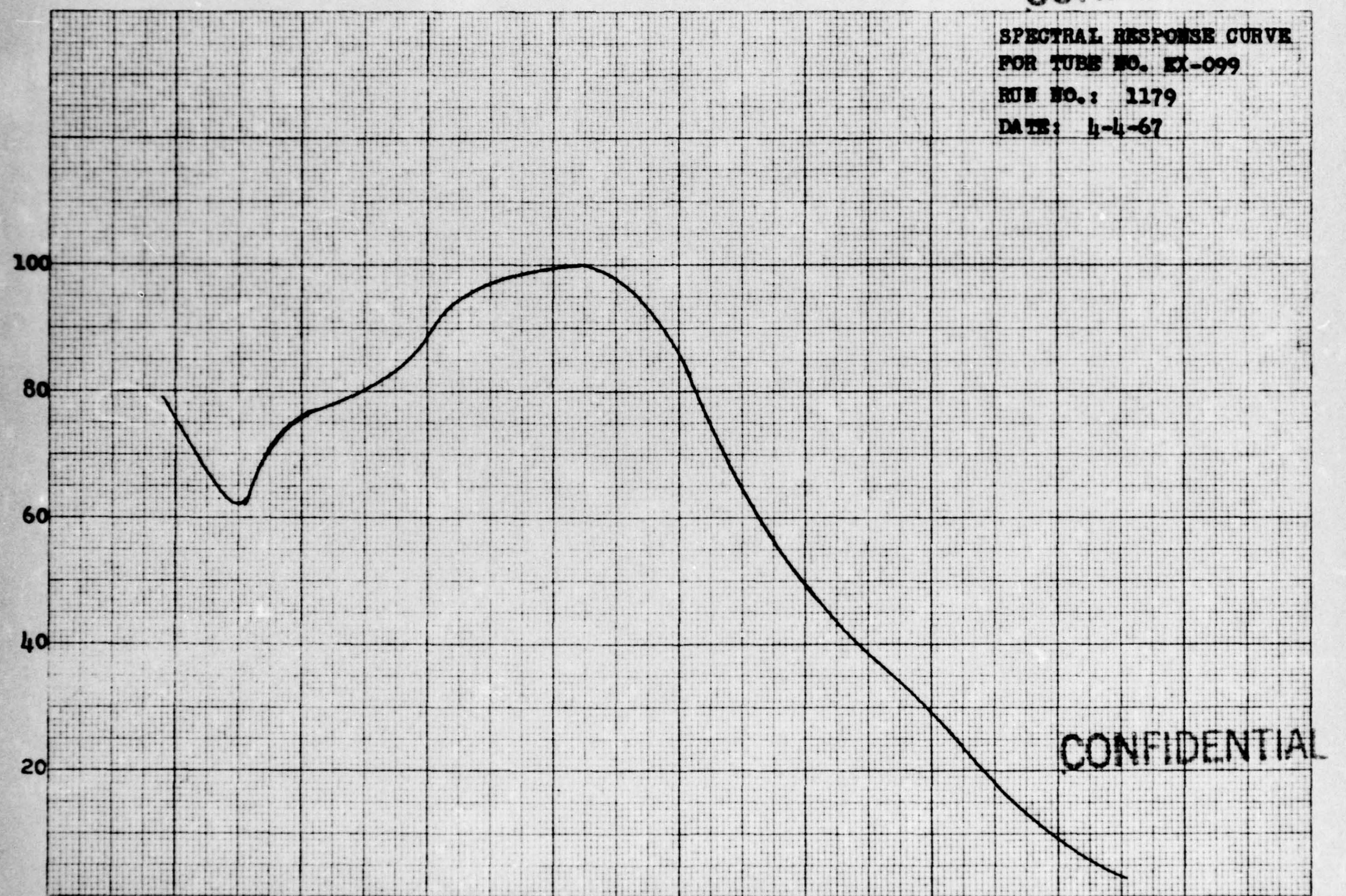

FIGURE NO. 8

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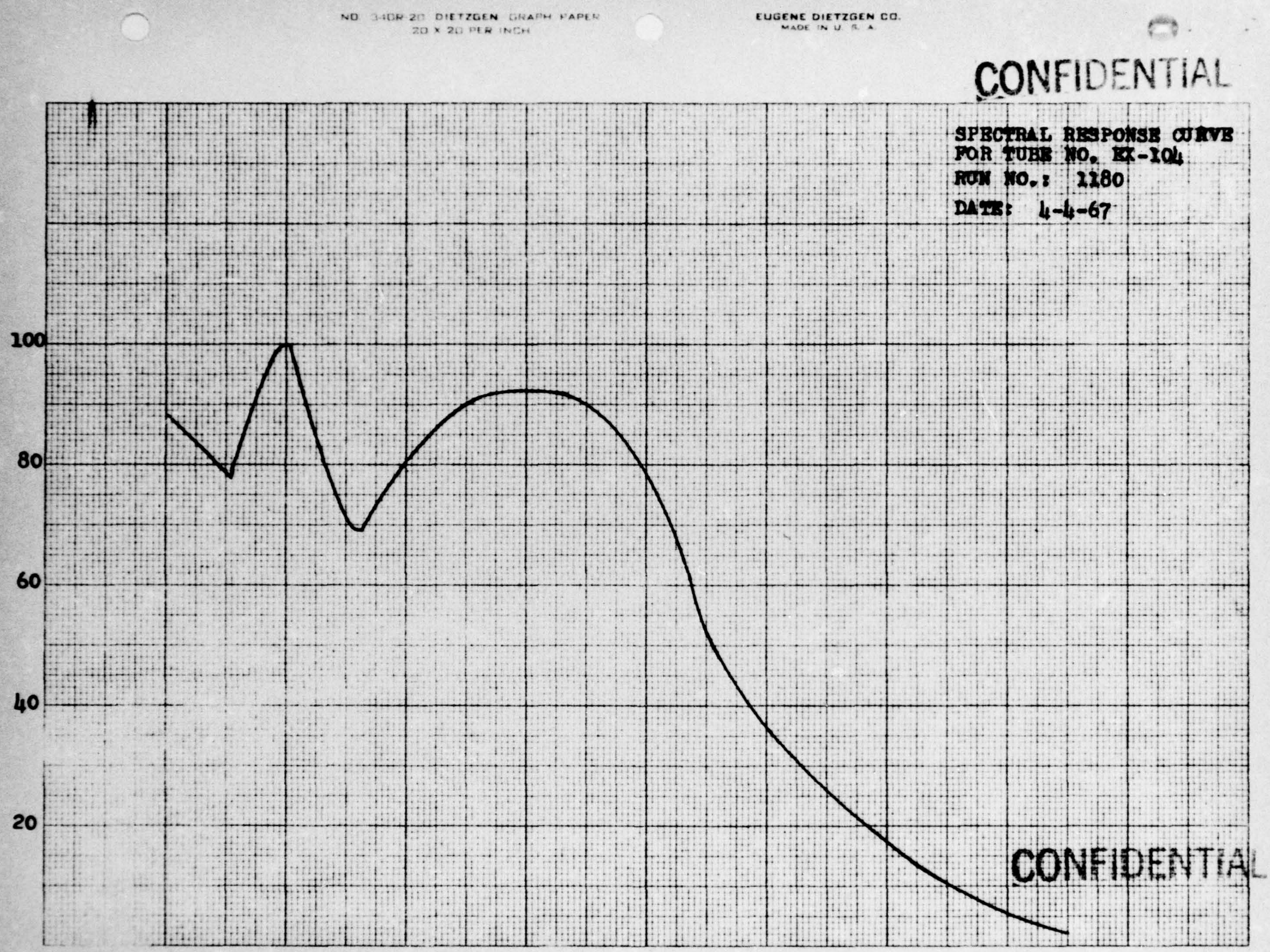

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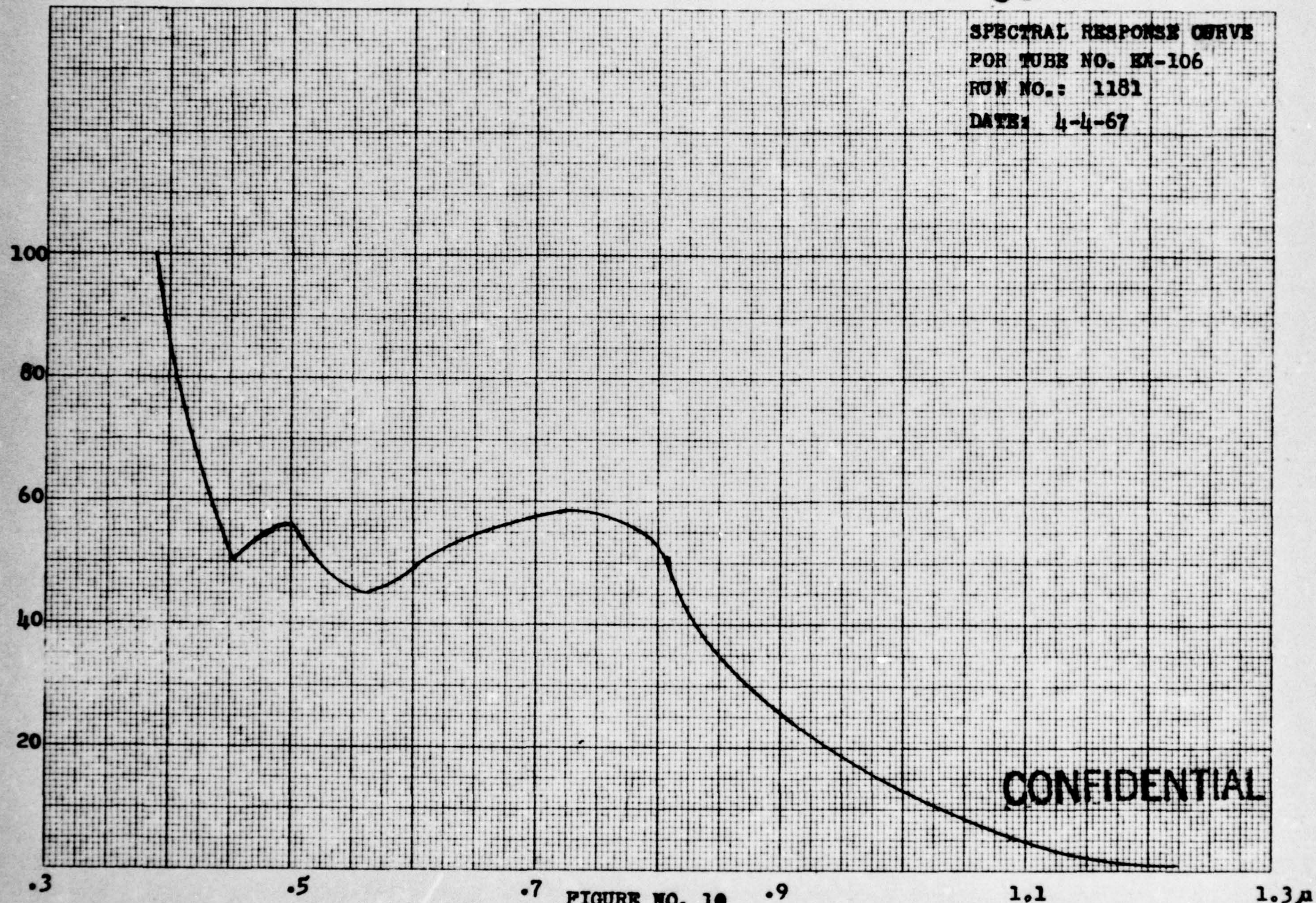

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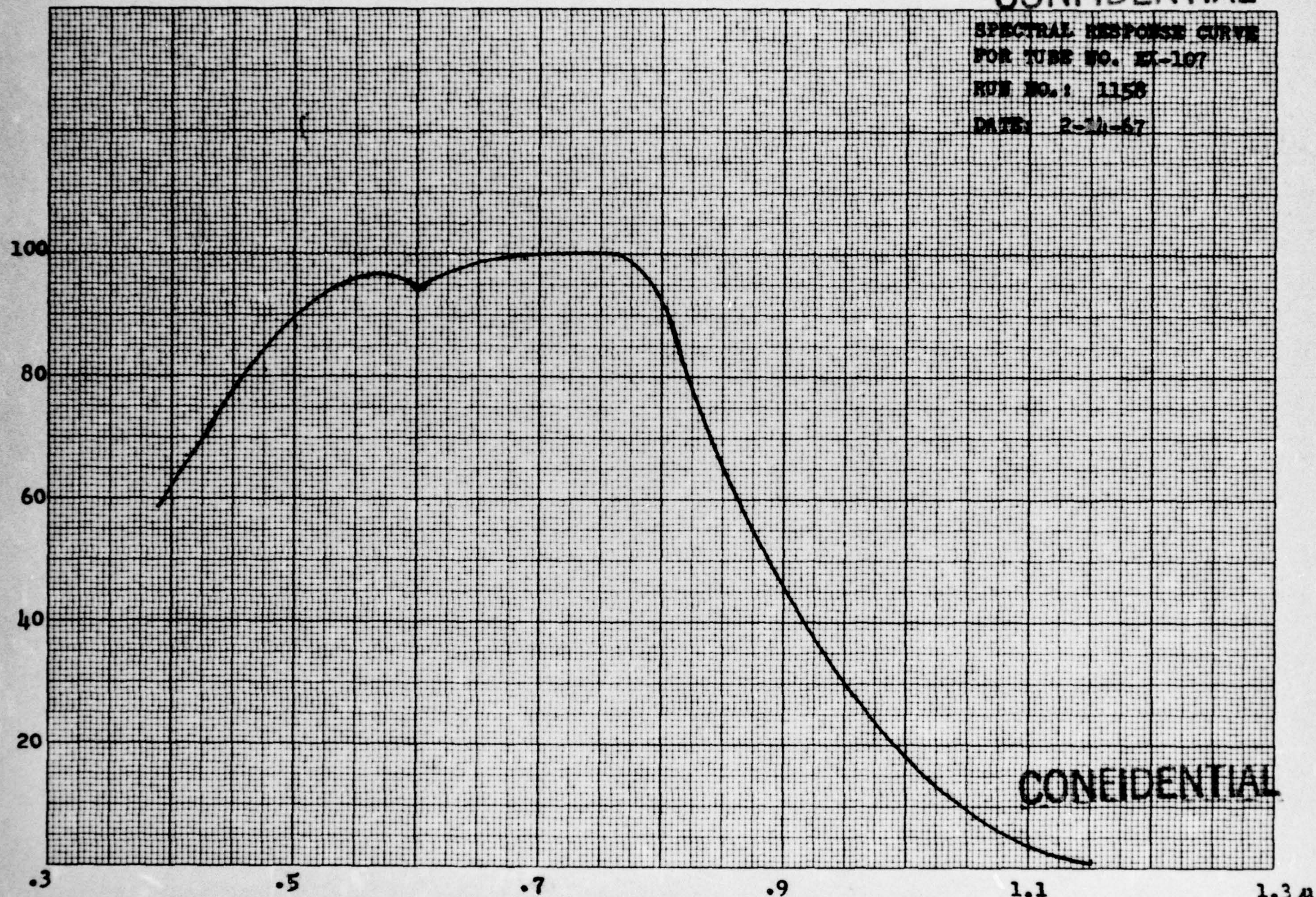

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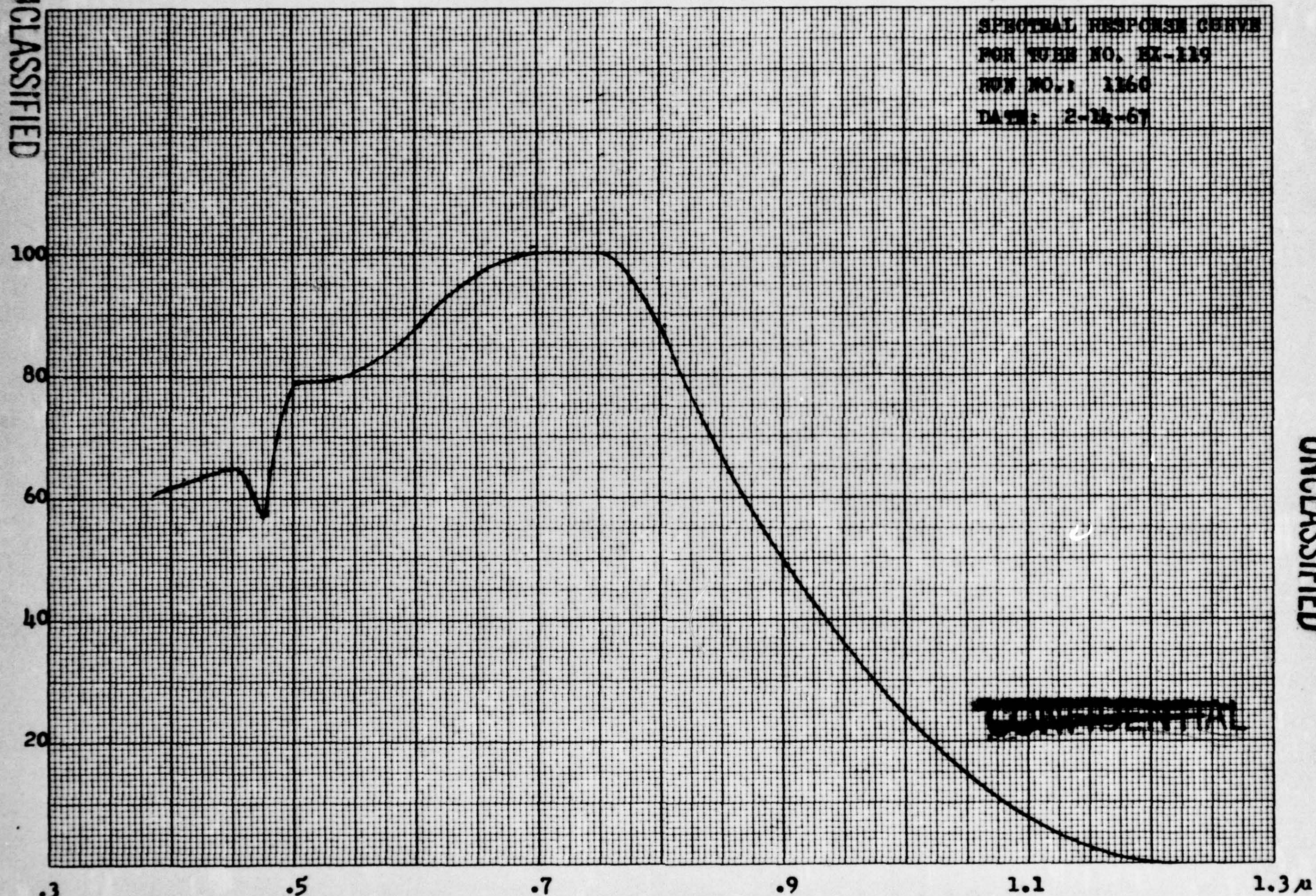

FIGURE NO. 12

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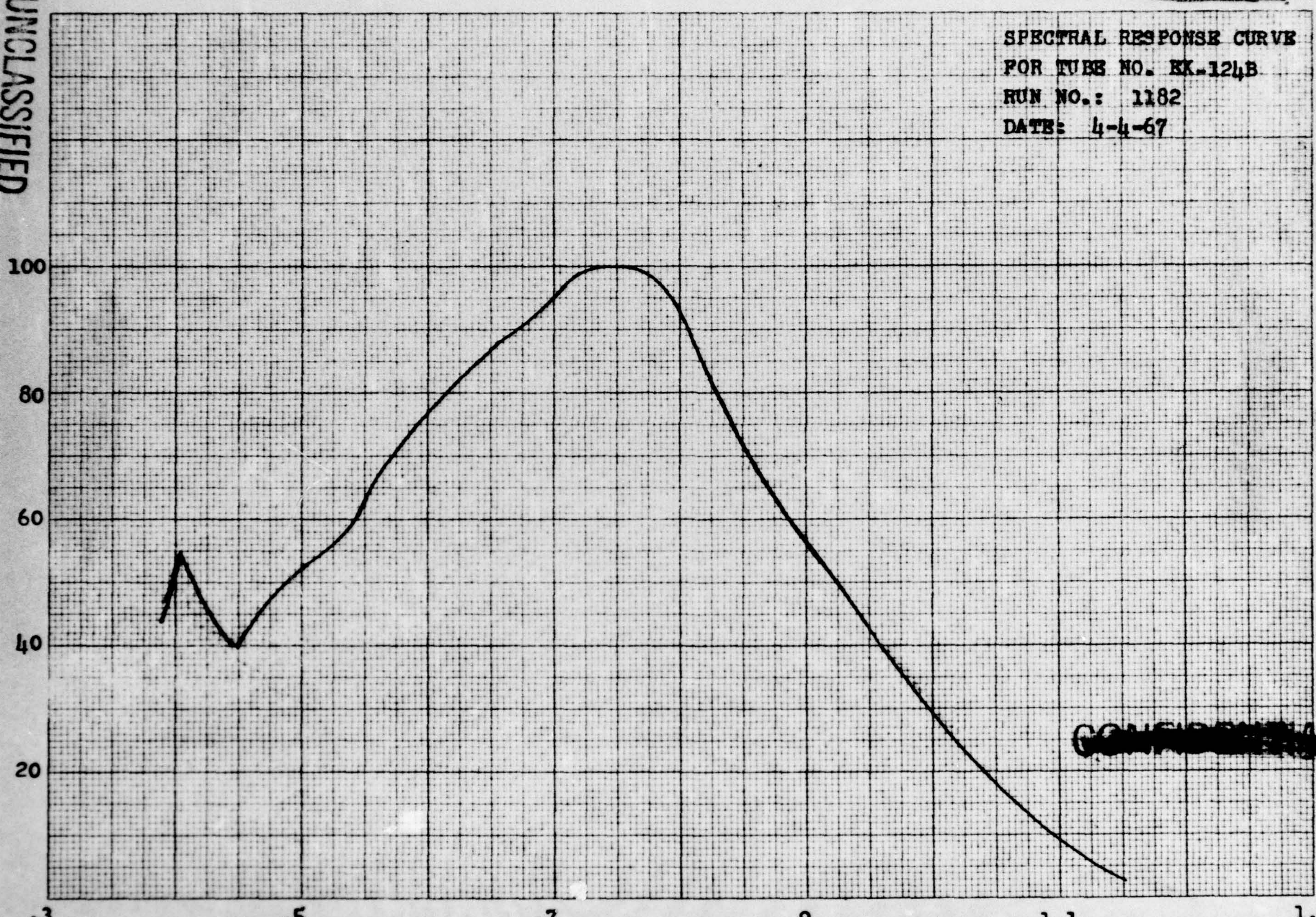

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FIGURE NO. 13

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