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LA REPORT-360 C.3

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September 28, 1945

This document contains 9 pages

JULY 16th NUCLEAR EXPLOSION: MICRO-BAROGRAPH PRESSURE MEASUREMENT

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ABSTRACT

Nineteen micro-barographs were located at various points from 6 to 100 miles from the explosion. Although the results scatter, they are consistent with the expected curve for 10,000 tons TNT.

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JULY 16th NUCLEAR EXPLOSION:
MICRO-BAROGRAPH PRESSURE MEASUREMENT

Primarily to provide data for refuting absurd damage claims, a request was received for pressure measurements at large distances from the explosion. The choice of instrumentation was subject to the following restrictions:

1) operation by untrained personnel;

2) no shop time available for construction;

3) practically no scientific personnel available for investigation of possibilities in advance of test;

4) very limited time for procurement.

In view of these conditions, a decision was taken to order commercial micro-barographs and hope that the time response would be adequate to give at least an approximate value of peak pressure. It was known that such instruments have a sensitivity of the order of 5 millibars (0.0725 psi) per centimeter deflection.

The instruments obtained were manufactured by Friez Instrument Division, Bendix Aviation Corporation, Baltimore, Md. They are designated "Barograph ML-3-A, Catalog No. 792". The model used was for 5000 feet altitude.

A schematic diagram is shown in Fig. 1. It may be noted that the pen is moved toward lower pressures by gravity, but a positive pressure provides a force directly transmitted to the pen. Fig. 2 is a photograph of the instrument. The recording is by inked pen on paper on a drum which can be driven at one revolution per day or one centimeter in about 9 minutes. This provides a time scale which helps determine the time of occurrence of the pressure pulse but obviously does not provide any good resolution.

A box was constructed for the instrument and connected with a pressure chamber so that a breaking cellophane diaphragm between the two would subject the whole instrument to a pressure pulse of variable magnitude. This pulse could be made a step

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function by using a completely closed expansion chamber (instrument box) or pulses of variable duration could be obtained by a variable leak in the expansion chamber.

With this equipment it was immediately evident that the pen supplied by the manufacturer would not feed enough to record the pulse. Other methods of recording were tried - waxed recording paper and stylus, waxed paper and electric spark; an ink pen of the Esterline-Angus type was finally adopted. A quantity of these were made locally and tested for writing speed. Each instrument was equipped with such a pen.

It was also observed that the pen frequently left the paper because of the shoc of the blast. This was remedied by increasing the pen pressure by a weight-thread system on the axis of rotation of the pointer.

Time did not permit an adequate investigation of frequency response and damping By visual inspection of the motion it was estimated that the period was less than 0.5 second and that the damping provided by distilled water in one dash-pot was approximately correct.

With these modifications, 15 of the instruments were issued to a group of men under Lt. D. H. Dailey for installation at surrounding towns. Each instrument was supplied with a three-legged, shock-mounting base containing a small compartment with auxiliary equipment: water, ink, spare pens, dropper. Instructions for operation were also furnished. All instruments were checked before they were sent to the field. The remaining four instruments were located at closer points. The locations and results are given in Table I.

Subsequent to the explosion, the response of the instrument was examined more carefully. With a tight expansion chamber the pressure indicated by the instrument agreed with that computed from the volumes and the compression-chamber pressure. As would be expected, the response was a function of the duration of the pressure pulse for the case of a variable leak in the expansion chamber. The time for the expansion

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chamber to reach atmospheric pressure was varied from ≪ 0.5 sec to 2 seconds by changing the size of the leak. The results are given in Table II.

TABLE II

Duration sec	Ratio $\frac{\text{Peak pressure}}{\text{Instrument reading}}$
≪ 0.5	3.2
0.5	2.3
1.0	2.1
2.0	2.2

Since at all field locations, the duration of the shock wave from the explos was greater than 0.5 sec an average correction factor of 2.1 was applied to the readings to obtain the true peak pressure (Column 4 of Table I). These values are plotted in Fig. 3 with the expected curve for 10,000 Tons TNT (LA-316). There is undoubtedly a terrain effect on the distant stations, but the results are reasonable. The purpose was not to obtain results of high accuracy, but it is believed that the true pressure can hardly be 50 percent different from these results. It should be noted that in this pressure range practically no previous experimental results are available for comparison.

The assistance of Lt. Dailey's men is appreciated and in no case can failure to obtain results be charged to them. All reports indicated that the instruments wer properly installed and placed in correct operation.

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TABLE I

Station	Air Line miles	Air Line yds x 10^{-3}	Reading psi	Corrected pressure psi	Remarks
1. Alamagordo	61.6	108	0		
2. Albuquerque	97.4	171	0		
3. Carrizozo	34.4	60.5	.019	.04	
4. Carthage	16.8	29.6	(.015)	.031	Uncertain, inking failure?
5. Cloudcroft	65.2	115	0		
6. Elephant Butte	55.2	97	0		
7. Hatch	80.6	142	0		
8. Mountain Air	59.4	104	0		
9. Nogal	44.8	78	.004	.008	
10. Oscuro	27.4	48.3	.015	.031	
11. Ruidoso	51.6	91	.003	.006	
12. San Antonio	28.4	50	.054	.113	
13. Socorro	35.4	62.3	.013	.027	
14 Tularosa	49.6	87.3	0		
15. Post 4	7.6	13.4	.149	.313	
16. Post 2	9.5	16.7	---		Inking failure
17. Base Camp	8.8	15.5	---		Inking failure
18. Base Camp	8.8	15.5	.064	.134	
19. W-10	5.8	10.0	.222	.467	

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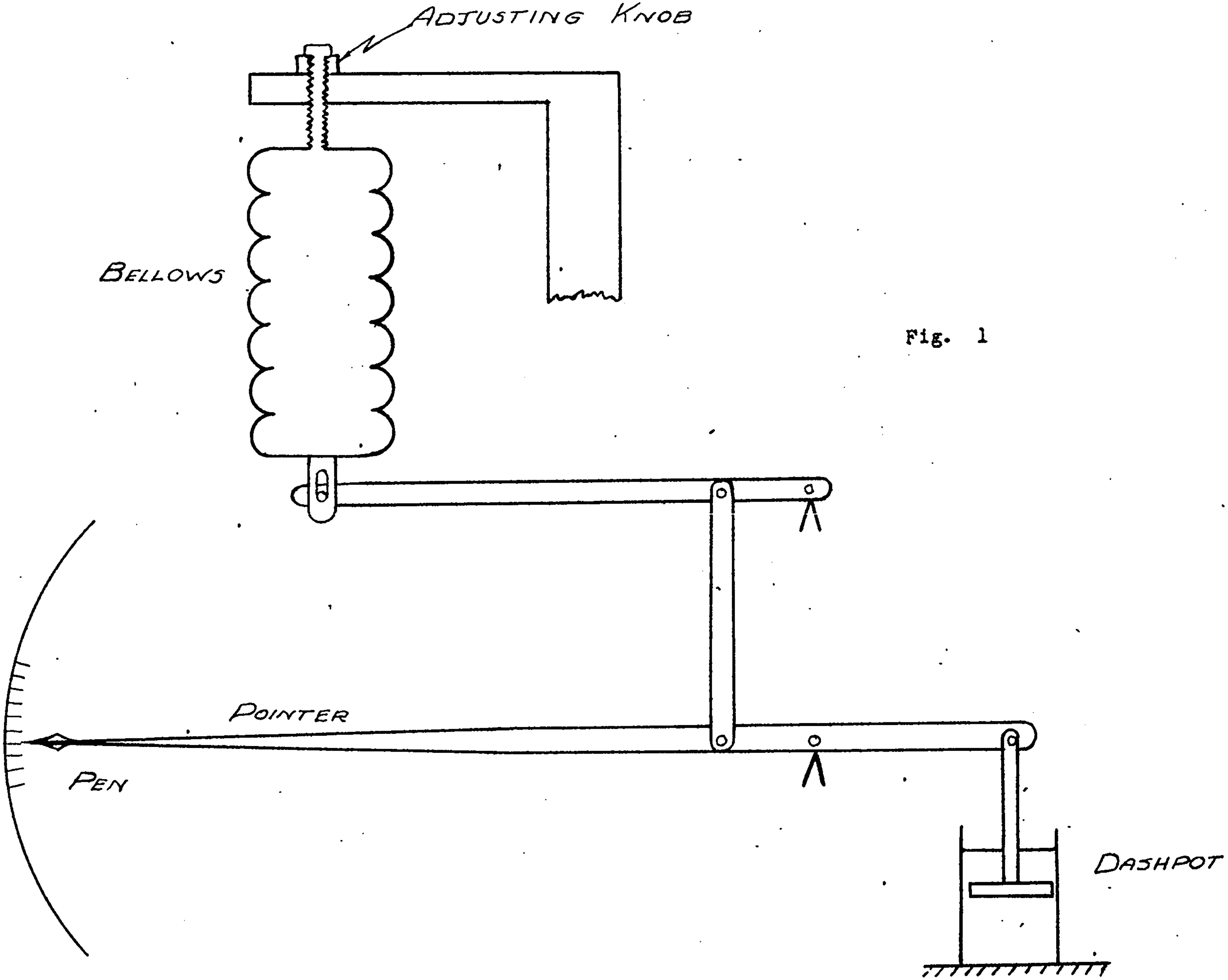

Fig. 1

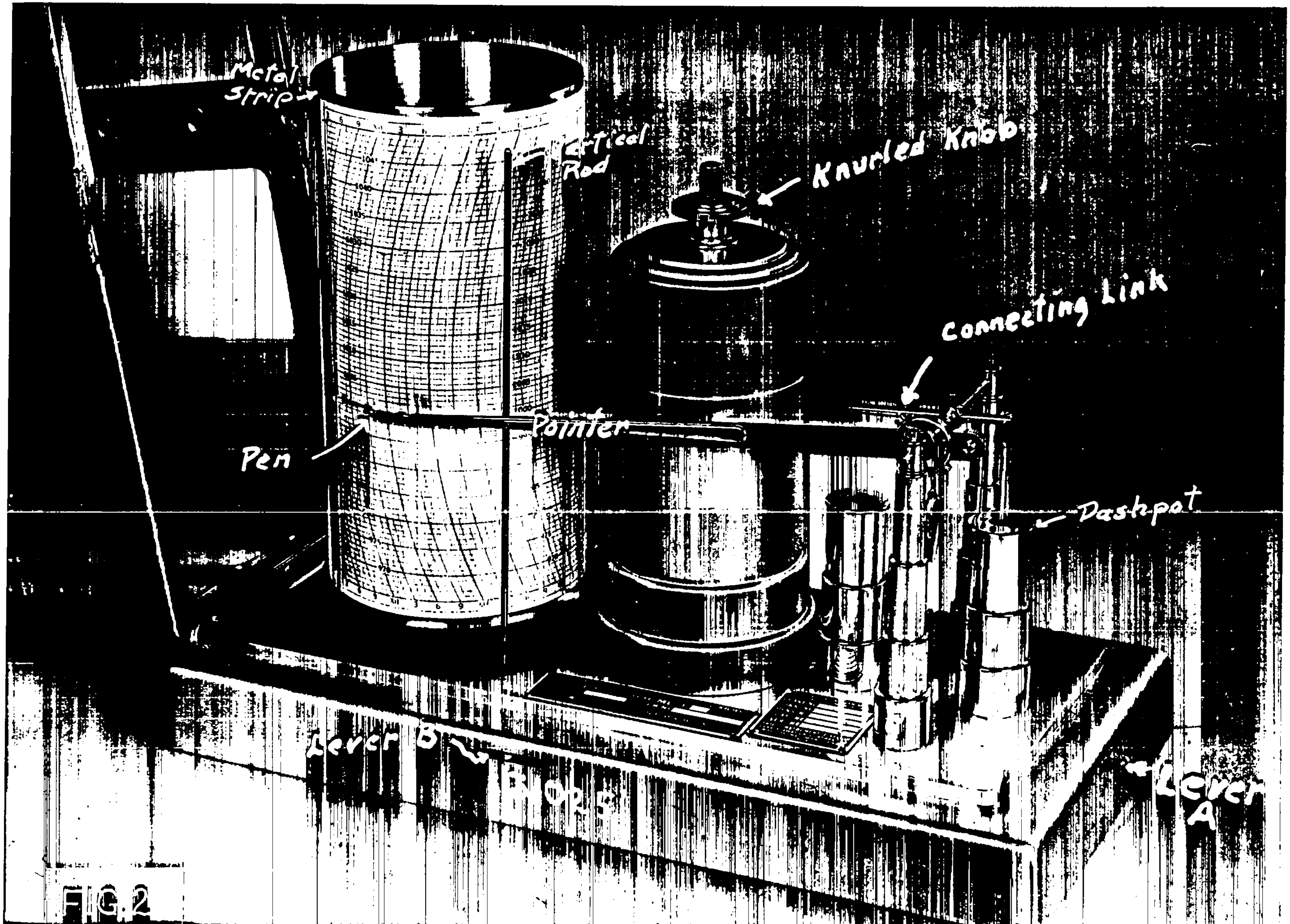

FIG. 2

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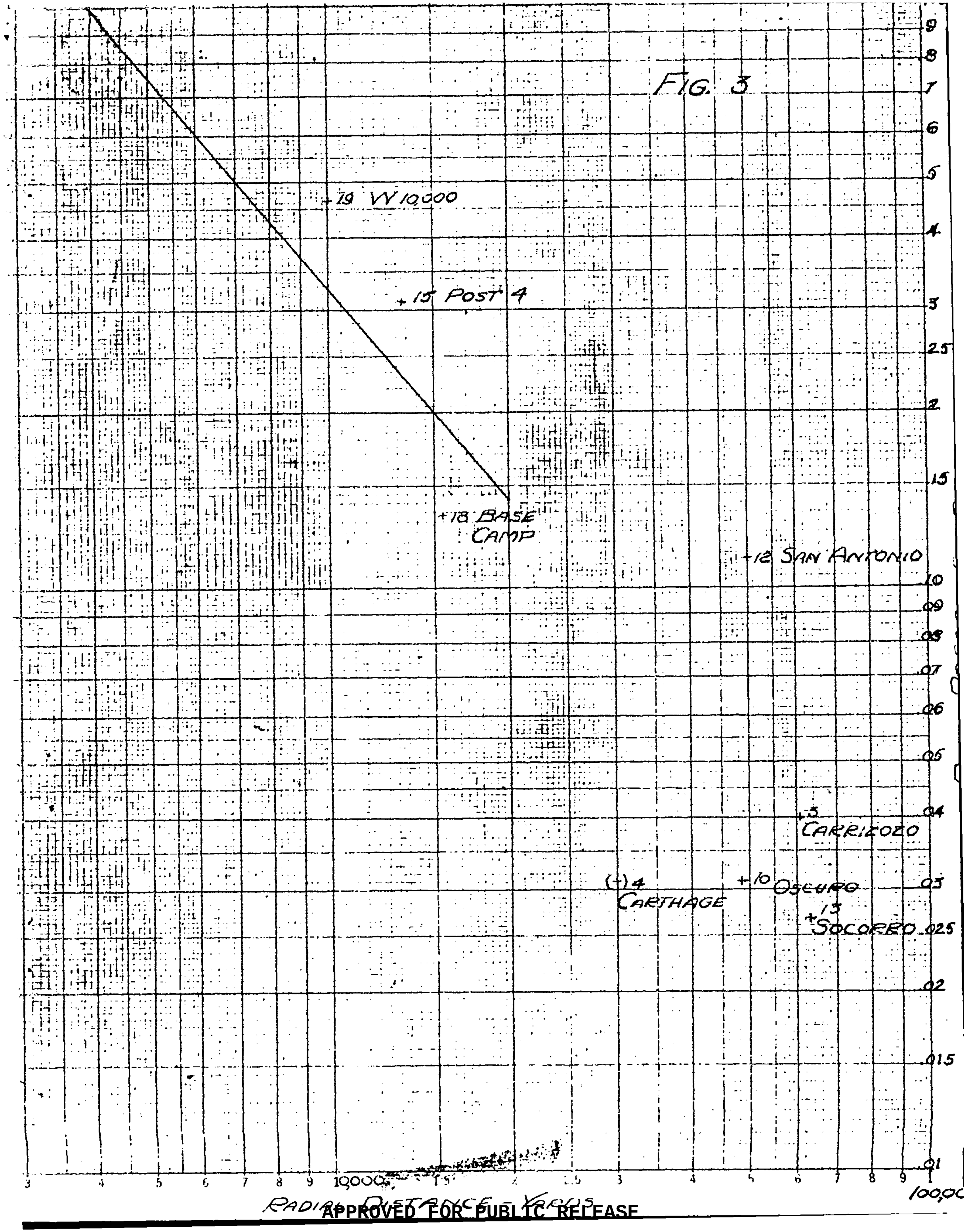
FIG. 3
+19 W 10,000
+15 POST 4
+18 BASE CAMP
+12 SAN ANTONIO
+5 CARRIZOZO
(-) 4 CARTHAGE
+10 OSCURO
+13 SOCORRO
9
8
7
6
5
4
3
2.5
2
1.5
1.0
.09
.08
.07
.06
.05
.04
.03
.025
.02
.015
.01
3
4
5
6
7
8
9
10000
1.5
2
2.5
3
4
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100,000
RADIAL DISTANCE - YARDS

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