Quarterly Progress Report No. 1

ACCELERATION FACTOR DETERMINATION FOR METAL FILM RESISTORS

Prepared under Contract No. NAS8-11076
Modification No. 2
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Prepared under Contract No. NAS8-11076
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by

ELECTRA MANUFACTURING COMPANY
Independence, Kansas

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Huntsville, Alabama

ABSTRACT

This Report covers work performed during the first quarter of Contract No. NAS8-11076, Modification No. 2.

All resistors to be tested were serialized to maintain positive individual identification throughout the various tests to be performed.

Noise measurements were performed on the test resistors with the Ericcson Distortion Analyzer and the Quan-Tech Test Set. Histograms of the various noise tests and scatter plots of Ericsson measurements vs. Quan-Tech measurements are included in the data section.

1.0 INTRODUCTION

The purpose of collecting noise data is to attempt a correlation between noise readings and resistance change due to resistor life testing. Also, an attempt is to be made to correlate D.C. noise measurements from the Quan-Tech Test Set with A.C. distortion measurements from the Ericsson Distortion Analyzer.

Prior to Life Test, the resistors are being scanned under various load conditions with a Barnes Radiometric Microscope. The initial infra-red readings obtained will be presented in the Quarterly Progress Report No. 2.

2.0 FACTUAL DATA

2.1 Serialization

Nine-hundred test resistors consisting of one-hundred each of three resistance values produced by three different manufacturers were serialized as shown in Table I.

TABLE I

Resistance		Serial Number
100 Ohm	Mfg. A	85101 - 85200
39.2 K Ohm		85301 - 85400
100 K Ohm		85501 - 85600
100 Ohm	Mfg. B	86101 - 86200
39.2 K Ohm		86301 - 86400
100 K Ohm		86501 - 86600
100 Ohm	Mfg. C	87101 - 87200
39.2 K Ohm		87301 - 87400
100 K Ohm		87501 - 87600

2.2 Noise Measurements

The Quan-Tech Model 315 Resistor - Noise Test Set measures the "current noise" developed by a resistor under a D.C. load. The noise measurements made by the Quan-Tech Test Set are performed in two steps. The first measurement is made with the test resistor in the circuit but no current passing through it. This is a measurement of the "system" noise which is the quadratic sum of the extraneous noise sources within the test system. The second measurement is made with current passing through the resistor and is an indication of "total" noise. The magnitude of current noise voltage is indicated by subtracting the effects of the presence of "system" noise from the "total" noise voltage measurements. Measurements are

made at rated voltage.

The Ericsson Distortion Meter ZTP 1271 measures the nonlinear distortion in the resistors under test. The distortion is a function of the current noise, thermal noise, and voltage coefficient of the resistor under test. The distortion is created by inherent film characteristics, irregularities in the resistive film, irregularities in the spiral path and poor mechanical connections.

A pure sine wave voltage of 10KC or 50KC is applied to the resistor under test. The third harmonic of 30KC or 150KC which is generated by the test resistor is then detected, amplified, and measured. The test system has an overall gain of 3,000 and the magnitude of the third harmonic is a direct function of the noise characteristics of the resistor under test.

The noise measurements taken on the Quan-Tech are either in $\mu v/v$ or db's, and the readings taken on the Ericsson are in millivolts. The following formula can be used to convert the Ericsson readings from millivolts to microvolts per volt:

$$N\ (\mu v/v) = \frac{E_1}{3E_2}$$

where E_1 = Noise reading in Mv.

E_2 = Applied voltage in volts.

A conversion chart from db to $\mu v/v$ for use with the Quan-Tech data is included as Fig. No. 1.

Ericsson measurements were made at 10KC and rated voltage for comparison with Quan-Tech measurements.

Equipment limitations made it impossible to obtain the 50KC measurement at rated voltage on those units above 100 ohm. Therefore, an additional 10KC reading and a 50KC reading were made at 1/10 rated power on the 39.2 K ohm and 100 K ohm units. This was done to provide a comparison of measurements at the two different frequencies. Also provided is a comparison of distortion levels at rated and 1/10 rated power. Measurements on the 100 ohm units were made only at rated power.

Figures 2 through 28 show the frequency distributions of various noise measurements.

Figures 29 through 37 are scatter plots of Quan-Tech readings vs. Ericsson readings. Readings from both systems have been converted into microvolts per volt ($\mu v/v$).

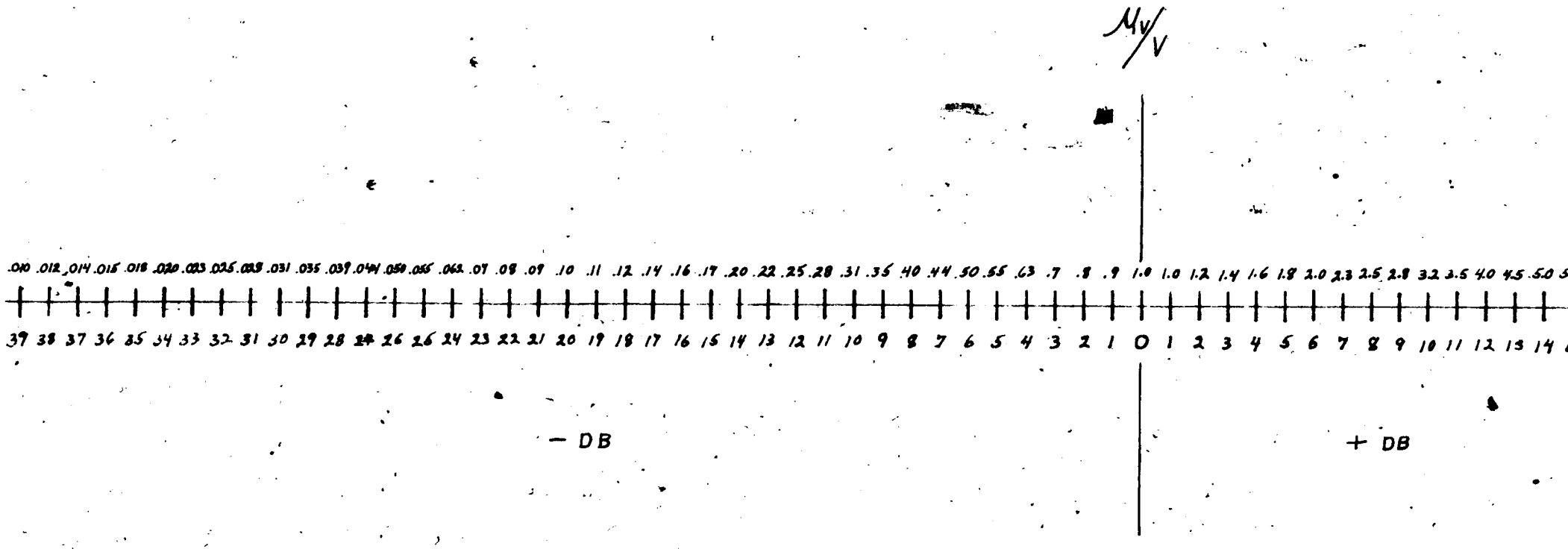
μv/v
.010 .012 .014 .016 .018 .020 .023 .026 .029 .031 .035 .039 .044 .050 .056 .063 .07 .08 .09 .10 .11 .12 .14 .16 .17 .20 .22 .25 .28 .31 .35 .40 .44 .50 .55 .63 .7 .8 .9 1.0 1.0 1.2 1.4 1.6 1.8 2.0 2.3 2.5 2.8 3.2 3.5 4.0 4.5 5.0
39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
− DB
+ DB

Fig. 1

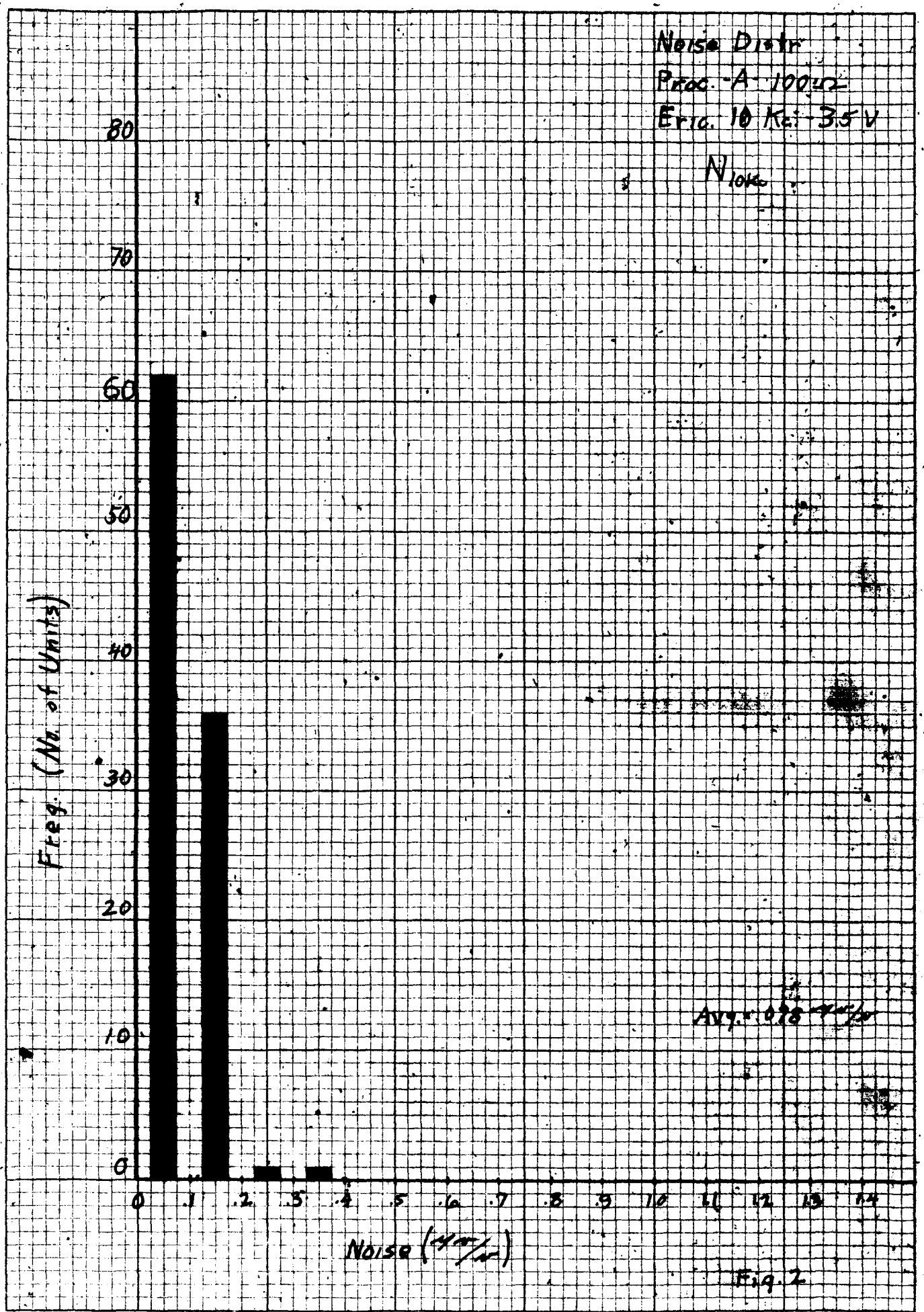

Fig. 2

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

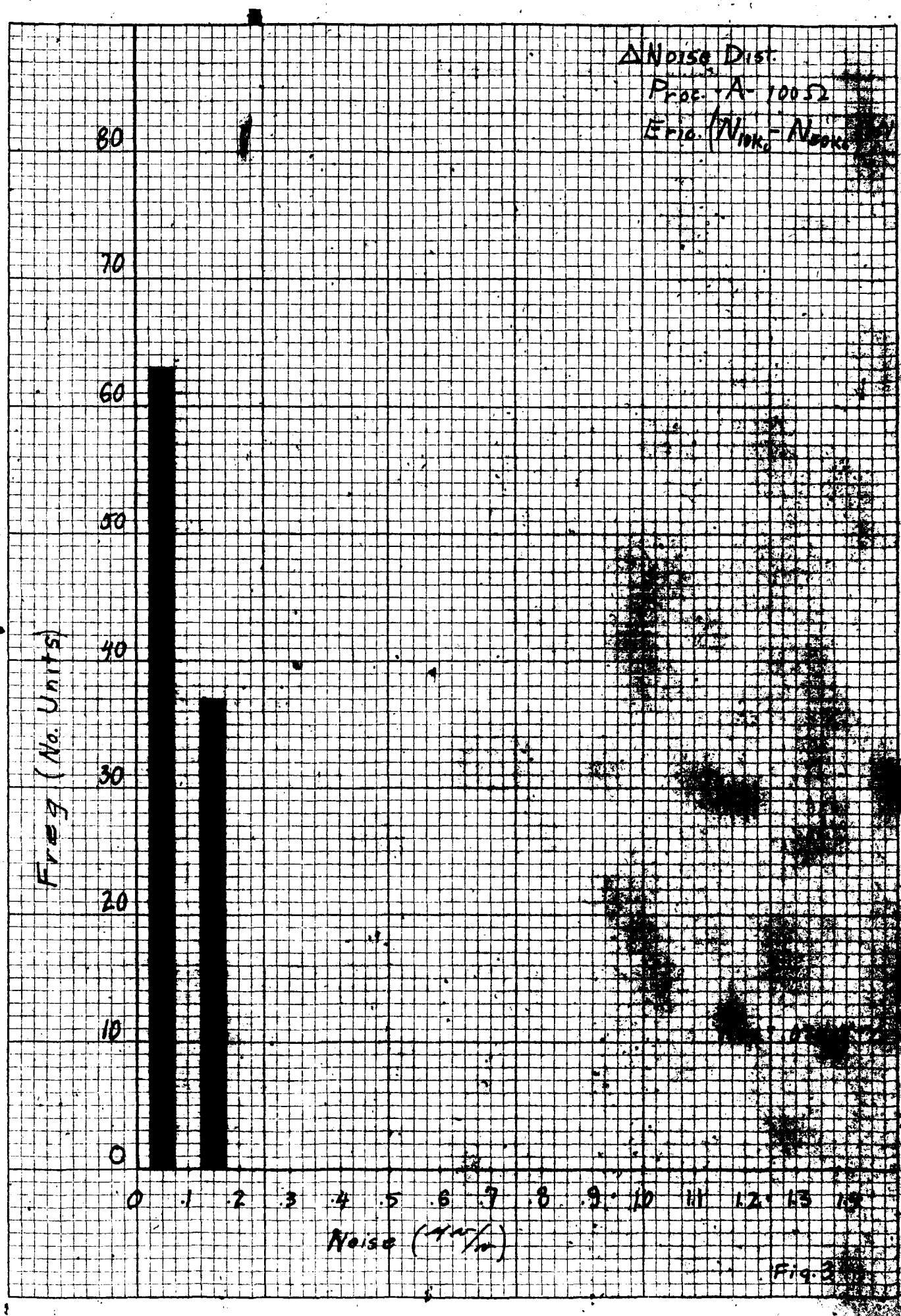

Fig. 3

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

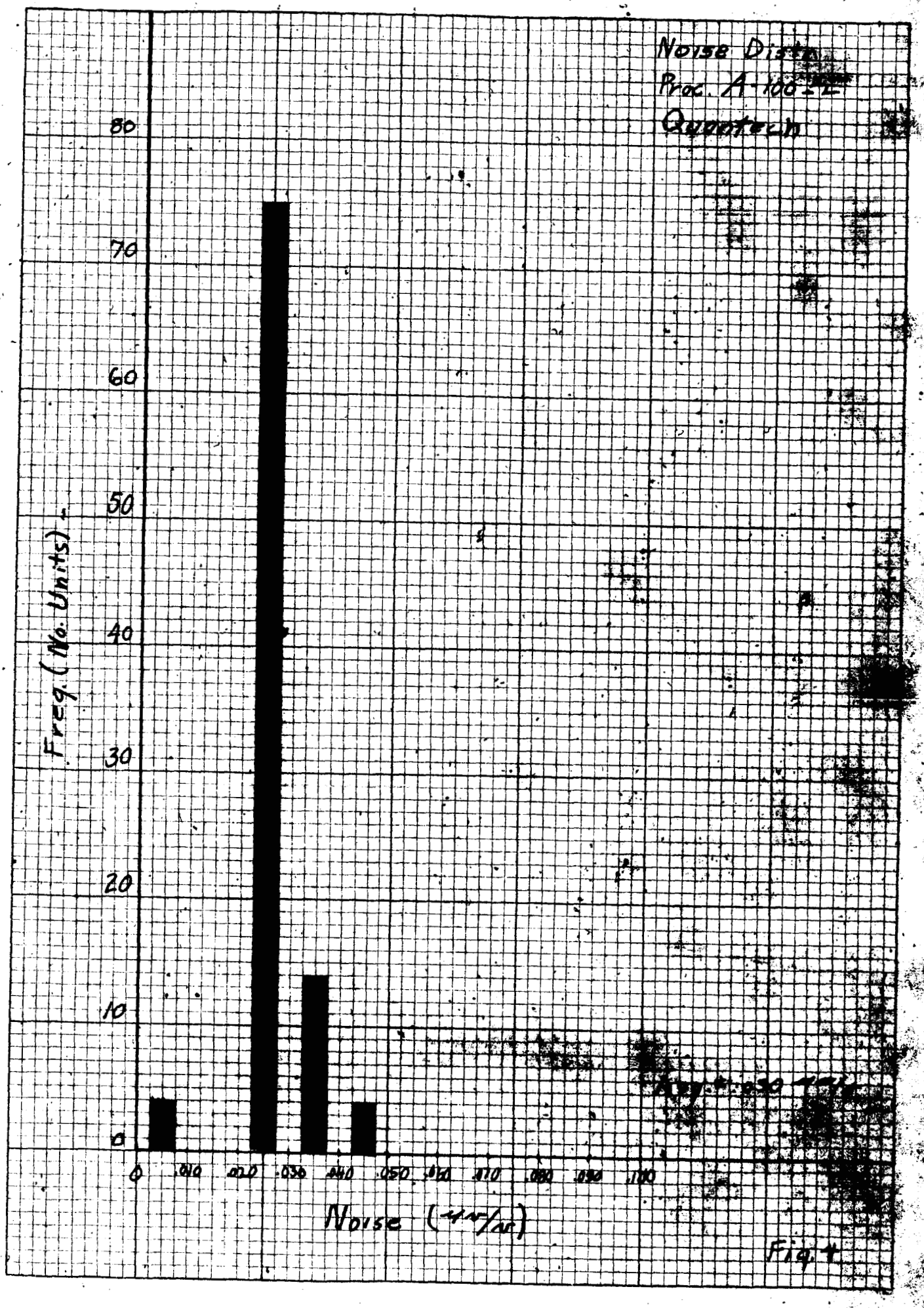

Fig. 4

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

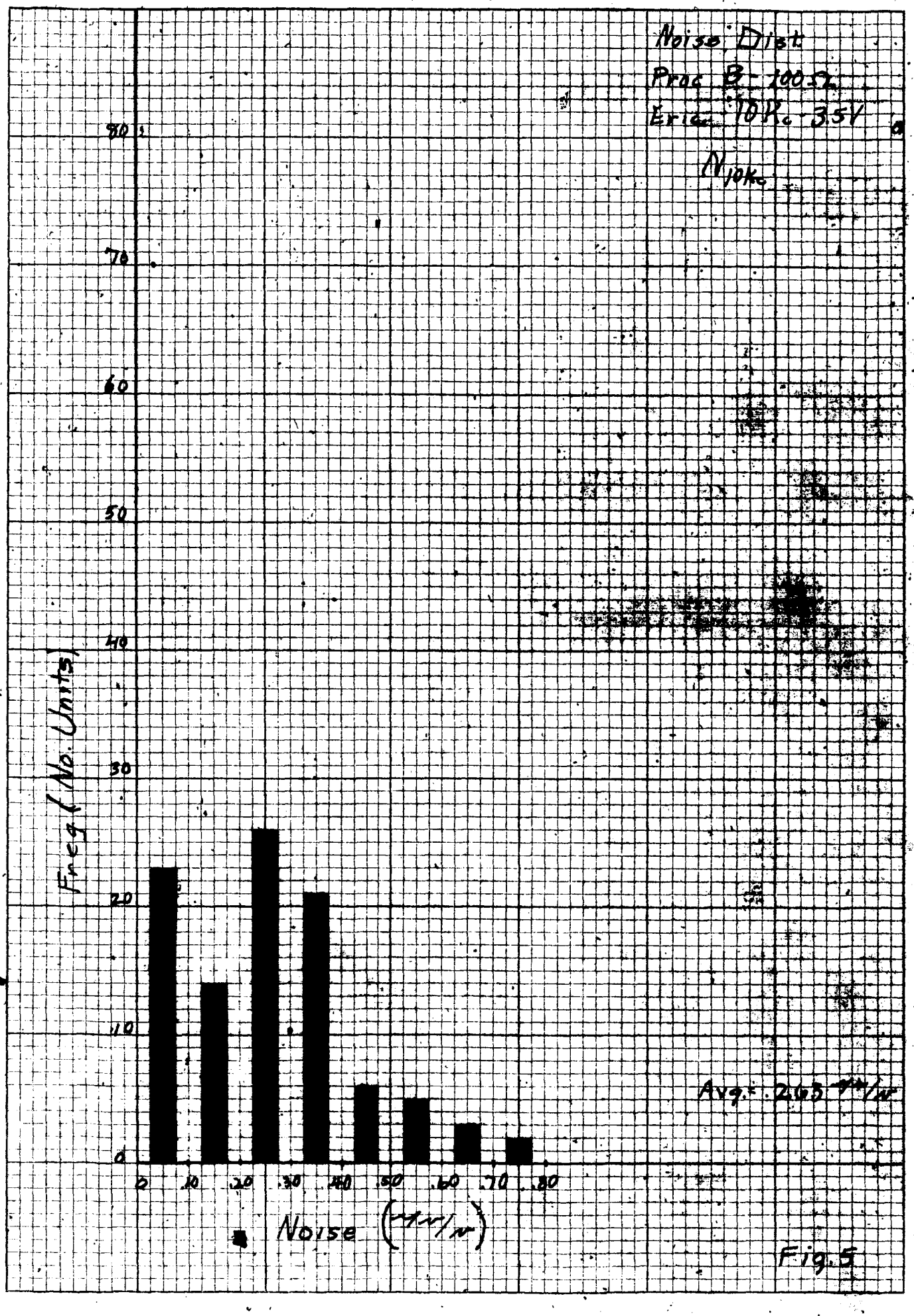

Fig. 5

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

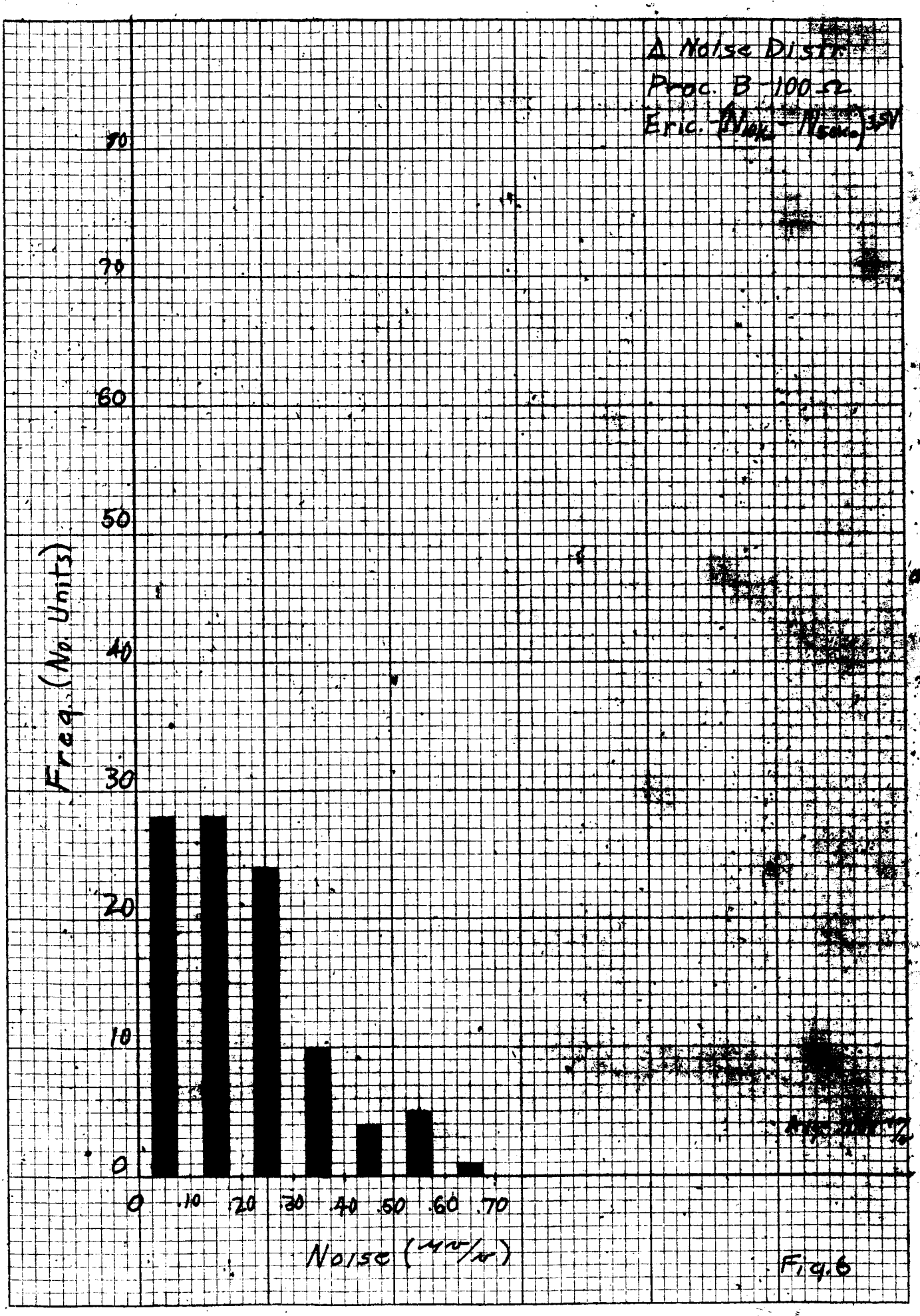

Fig. 6

K+E 10 X 10 TO THE INCH 359-5
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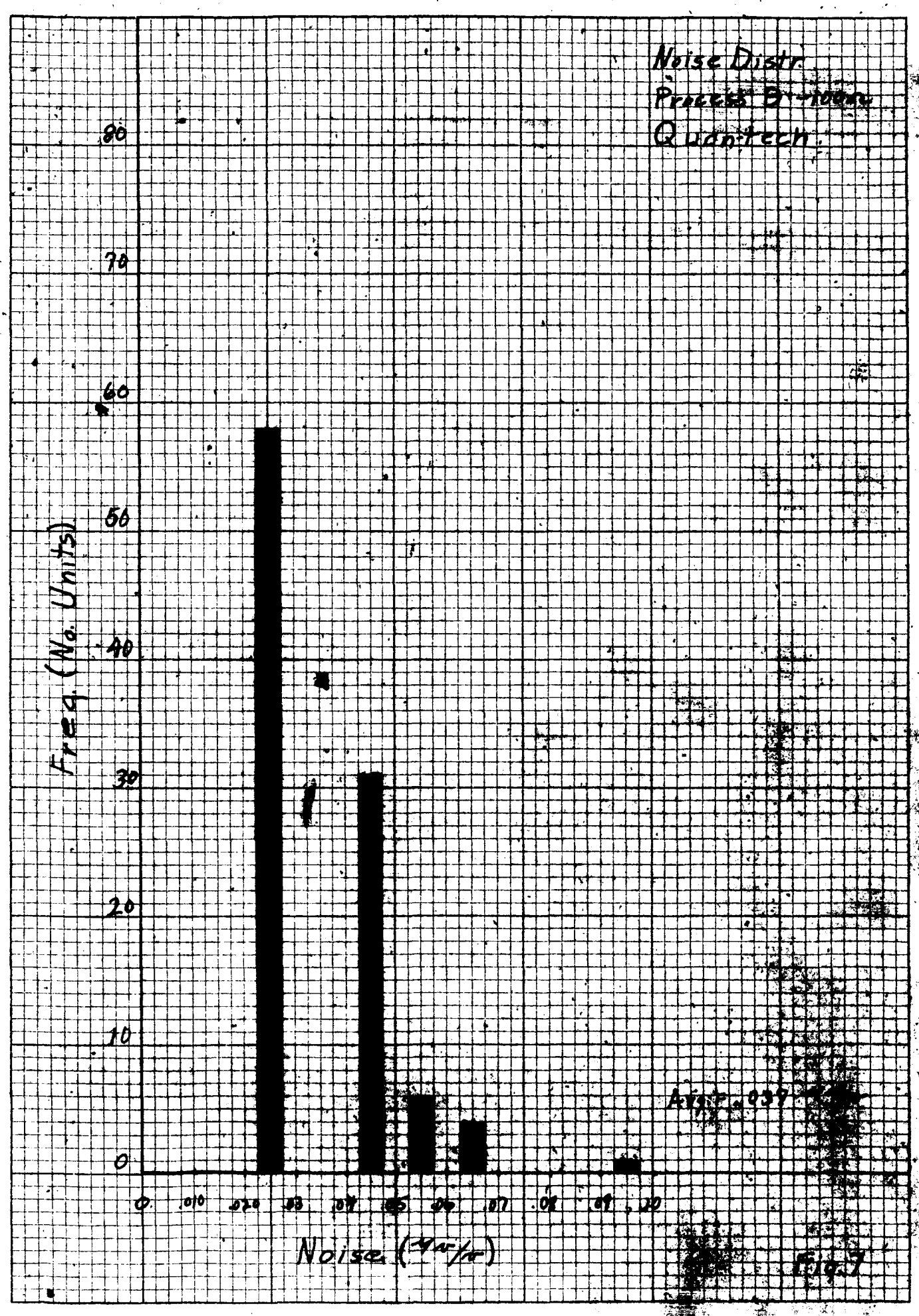

Fig. 7

K+E 10 X 10 TO THE INCH 359-5
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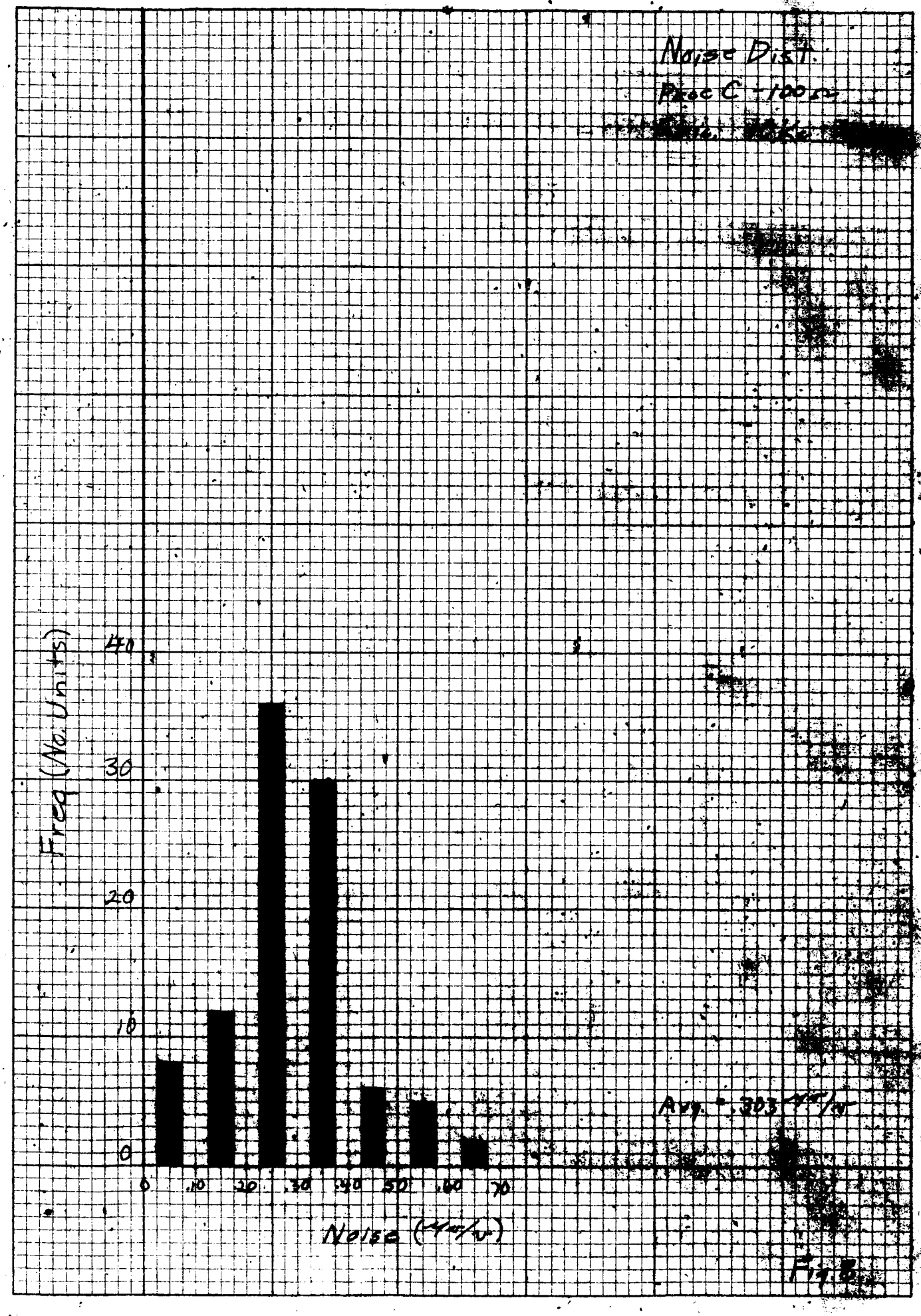

K+E 10 X 10 TO THE INCH 359-5
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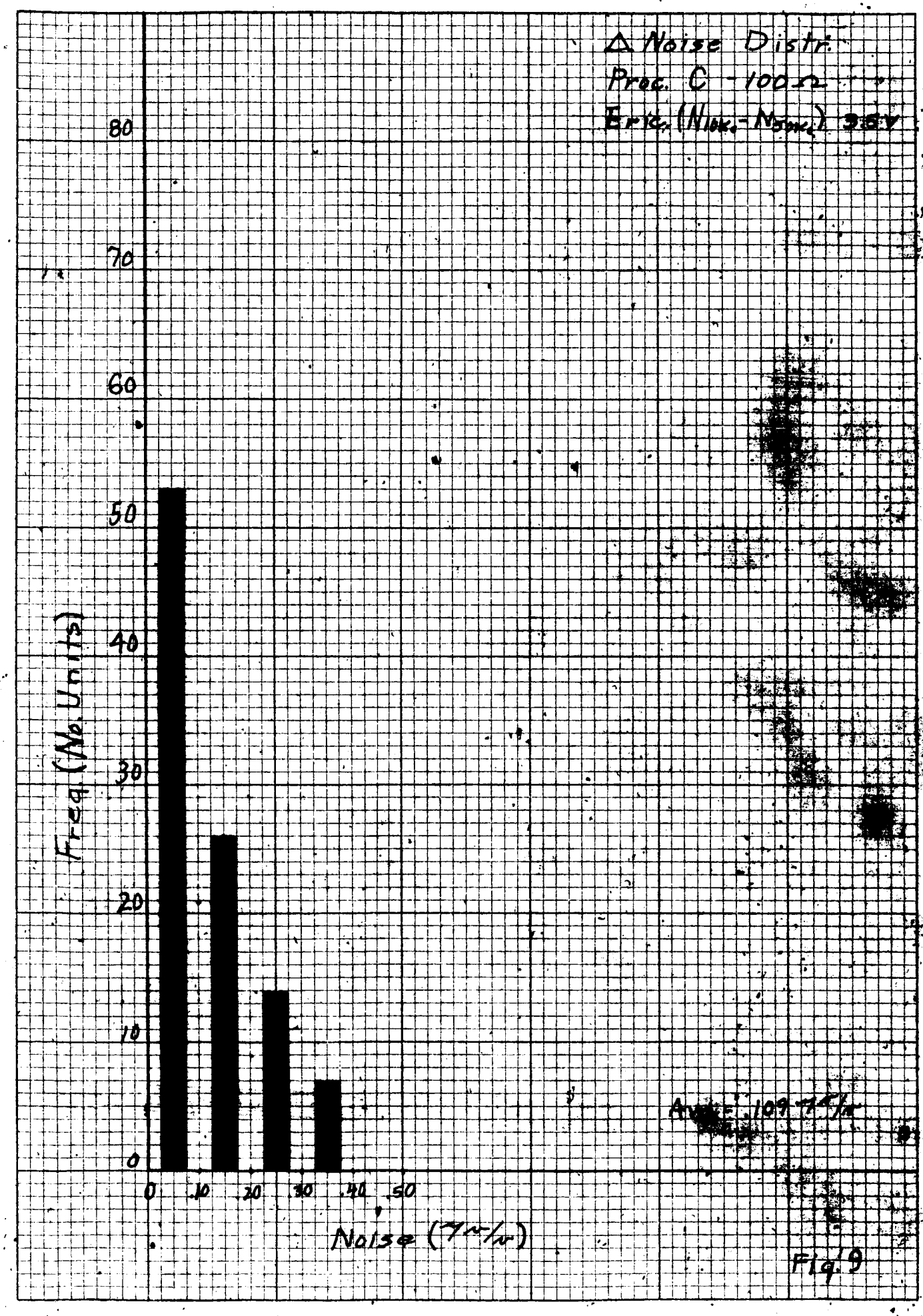
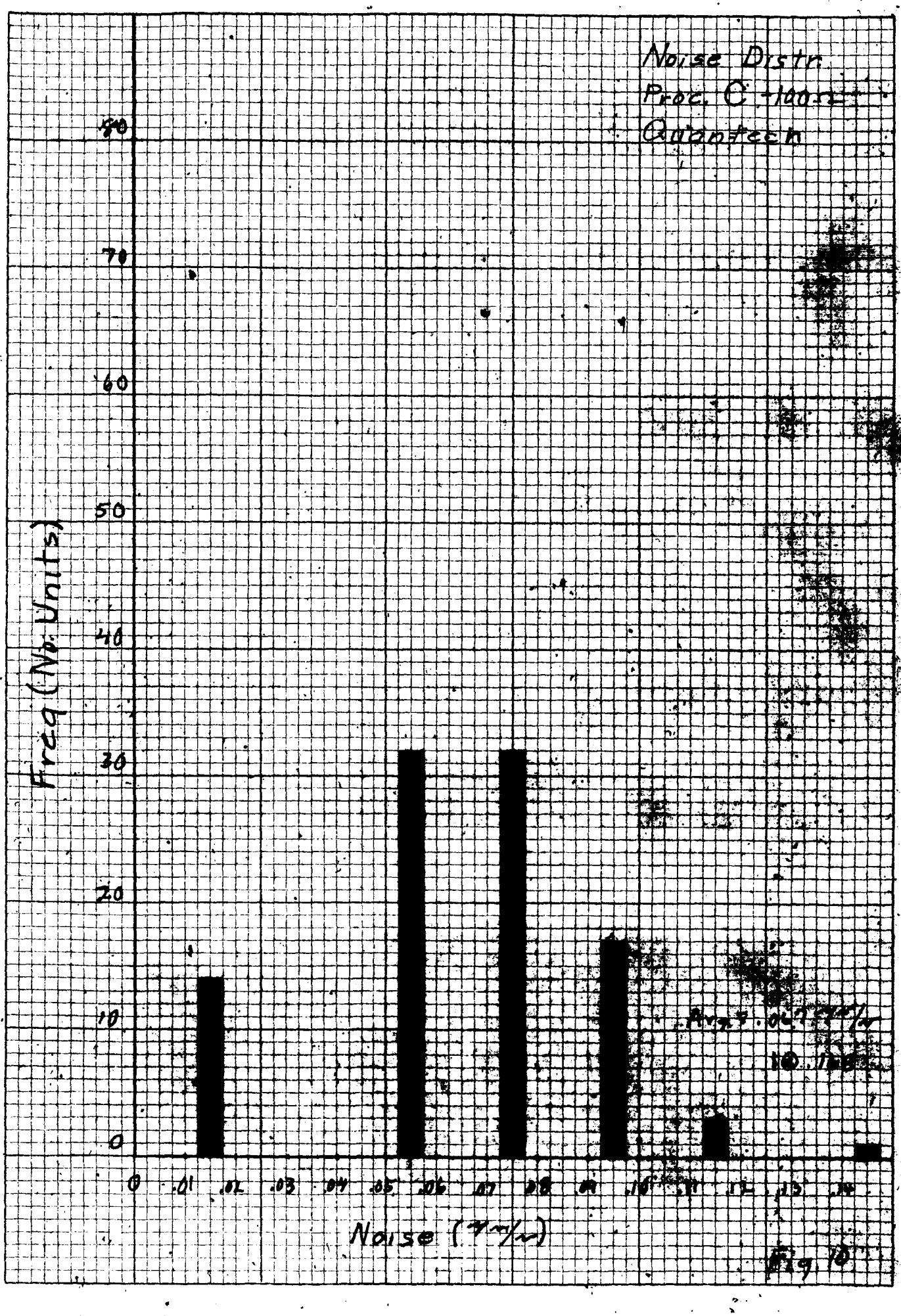


Fig. 9

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.



K&E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

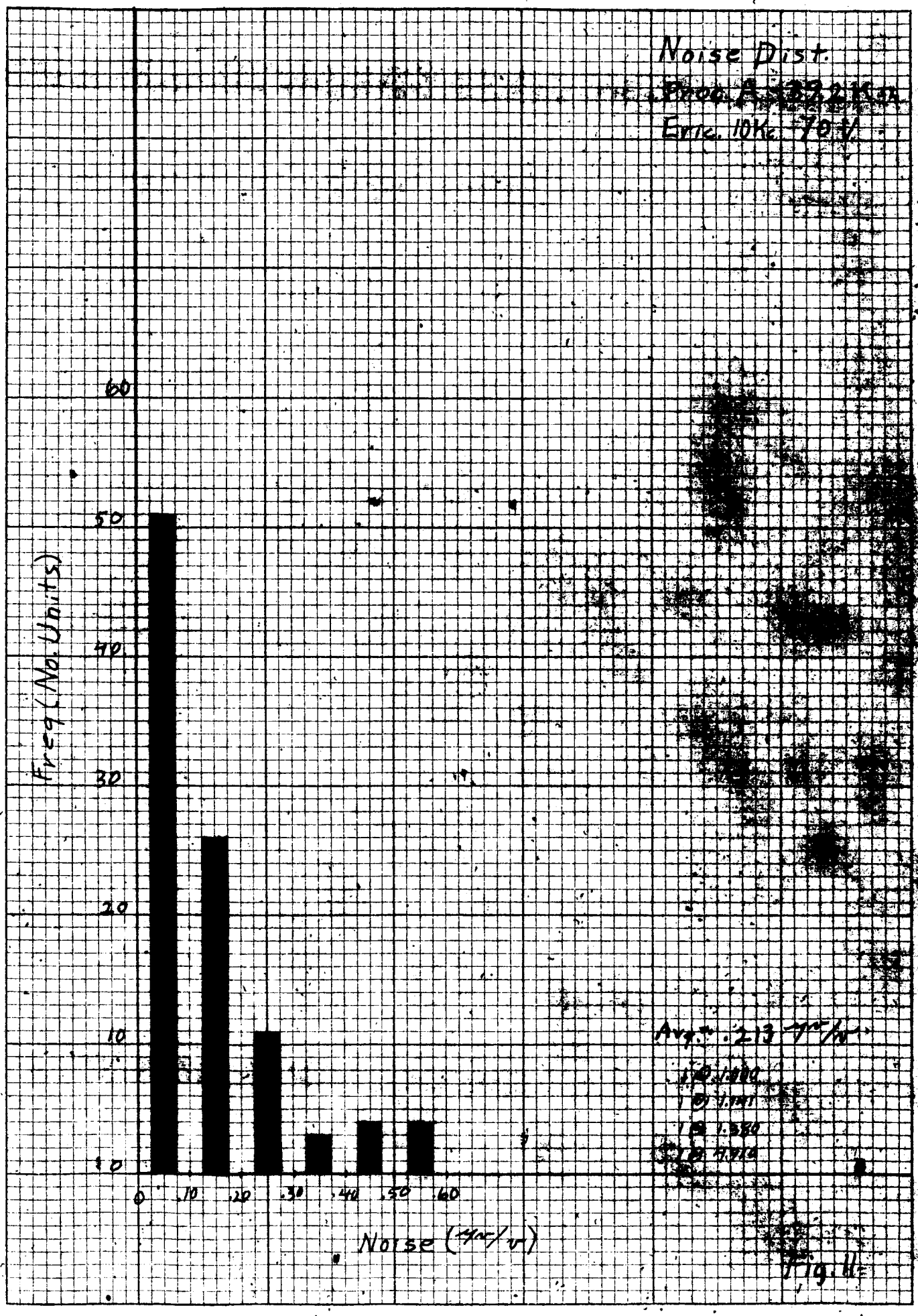


Fig. 11

K+E 10 X 10 TO THE INCH 359-5
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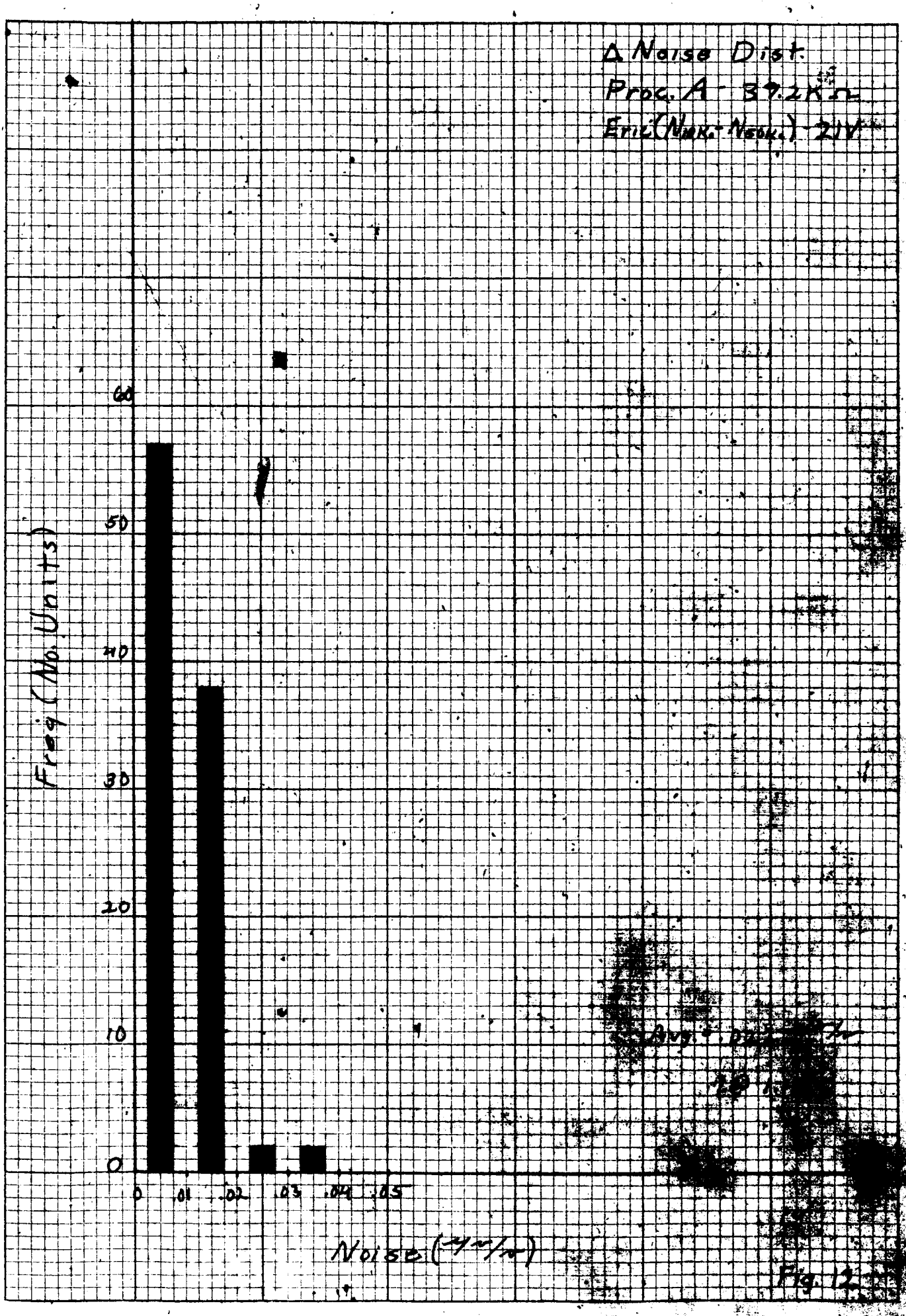

Fig. 12

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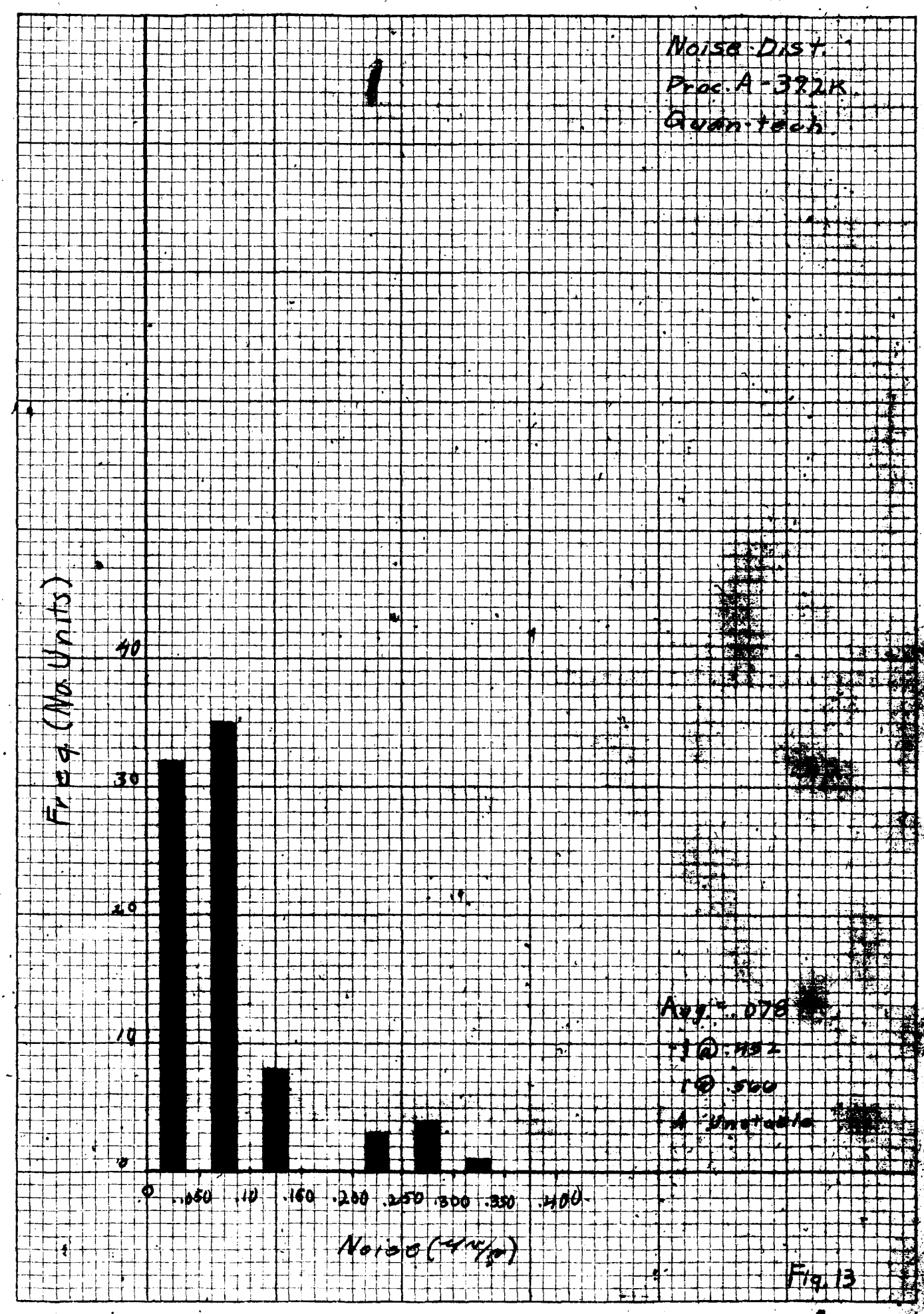

Fig. 13

K&E 10-X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

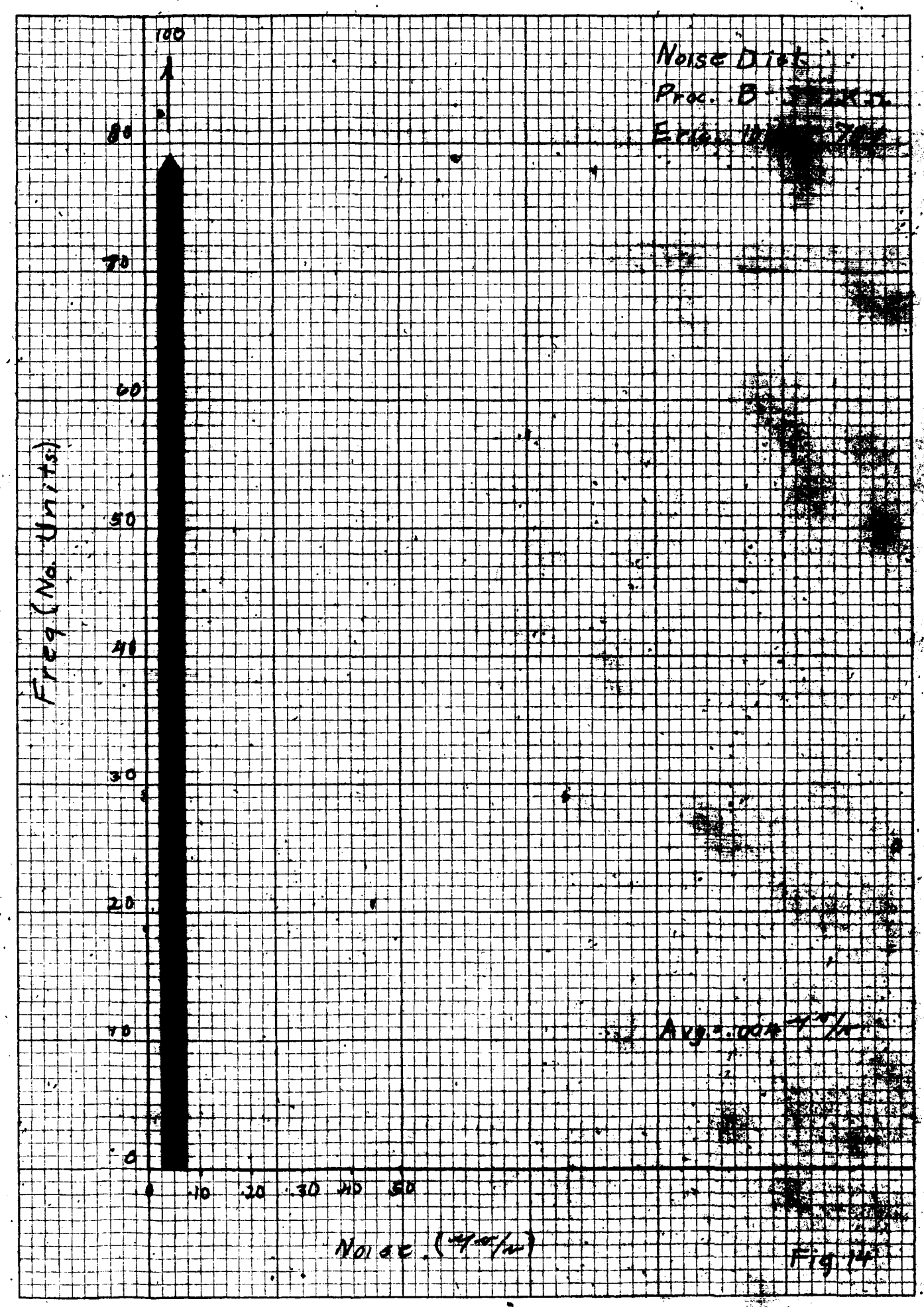

Fig. 14

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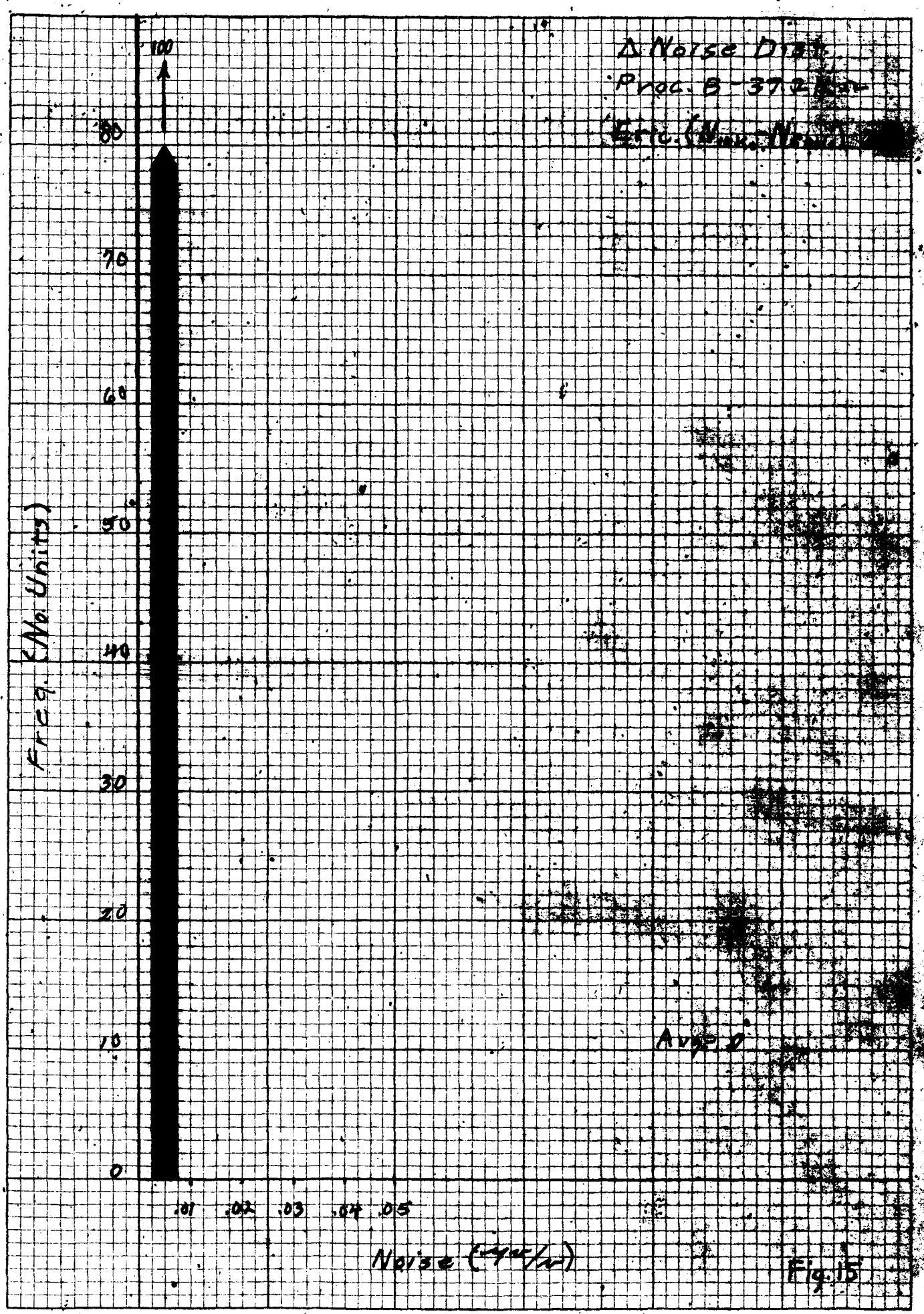

Fig. 15

K+E 10 X 10 TO THE INCH 359-5
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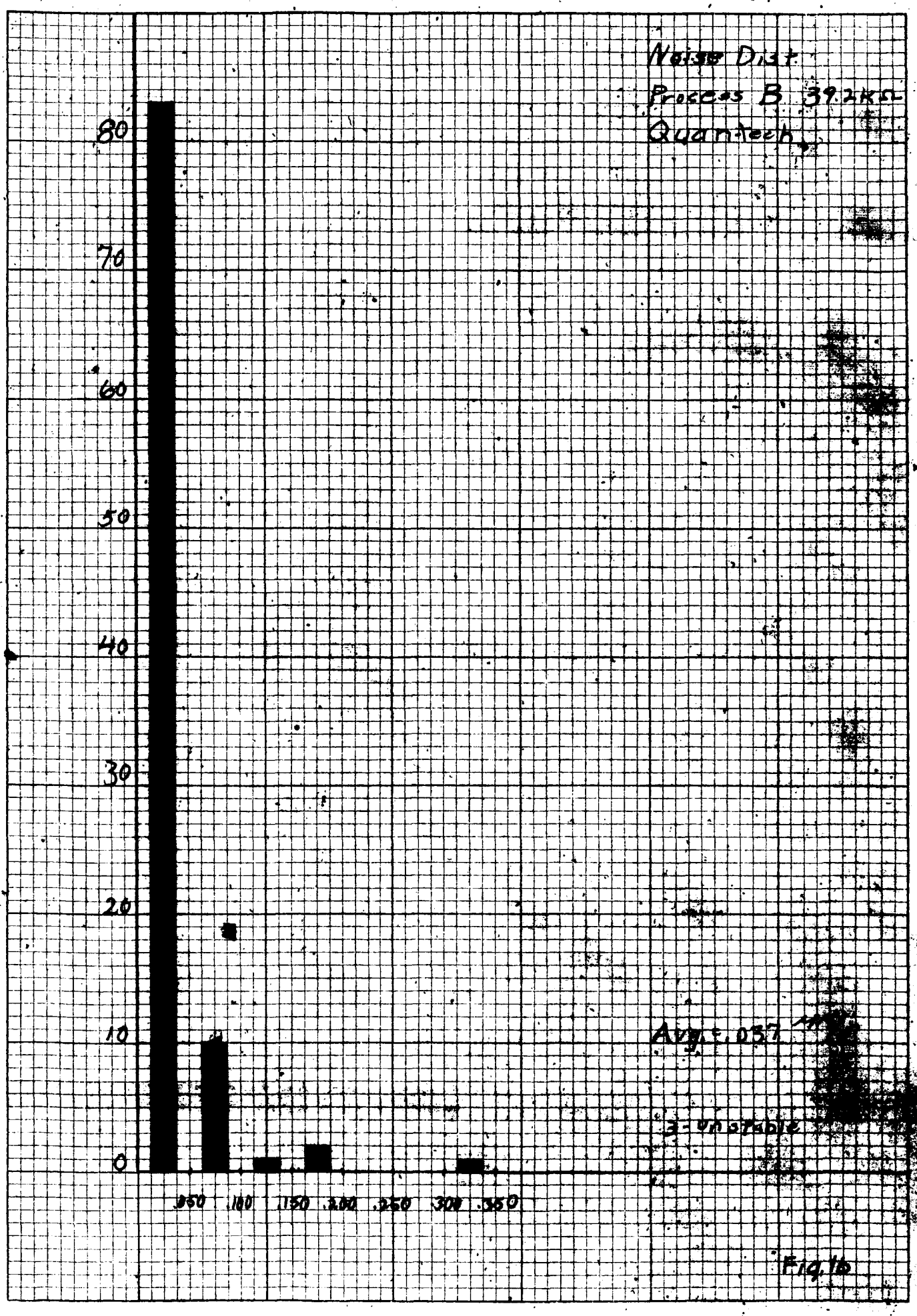

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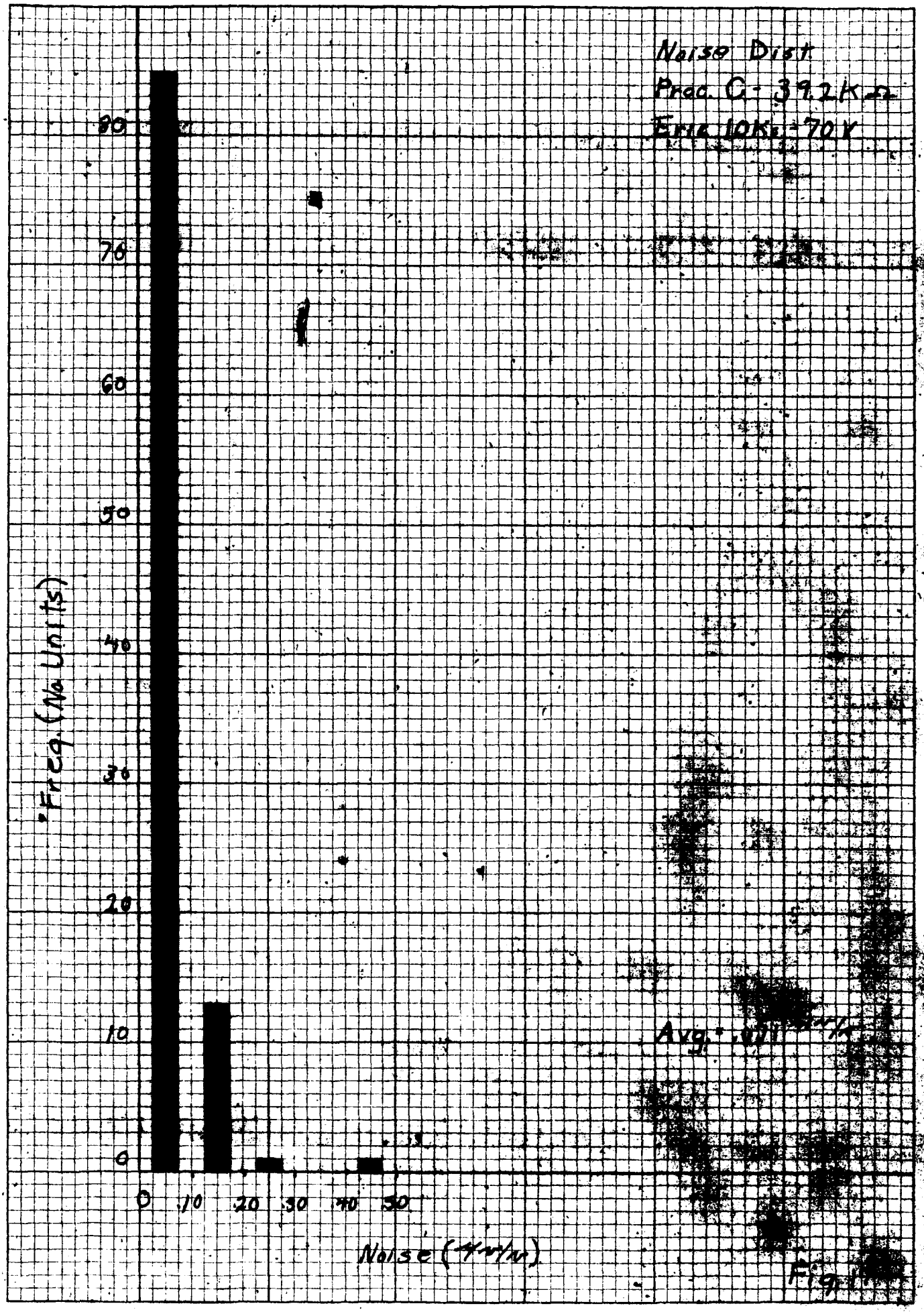

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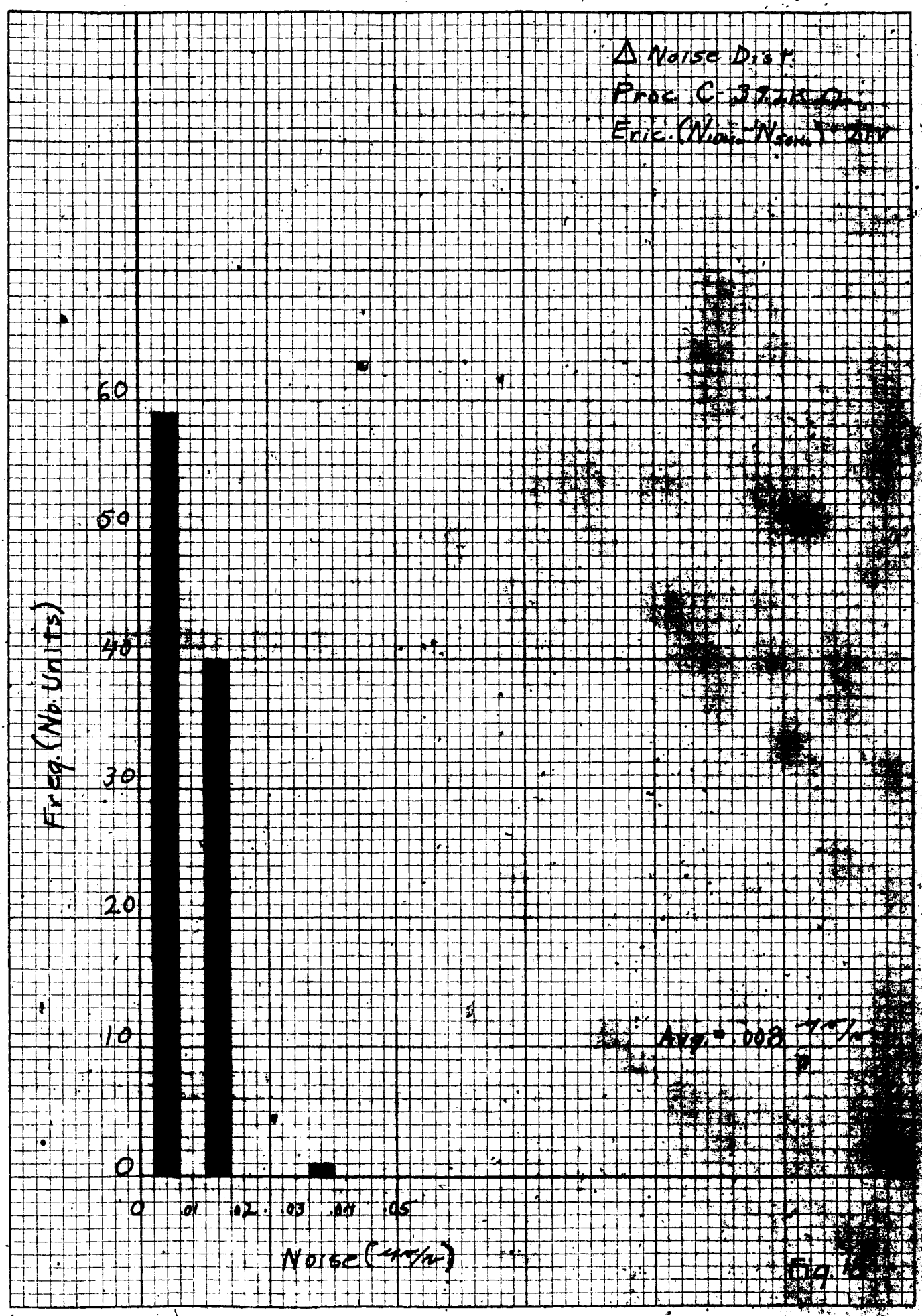

Fig. 12

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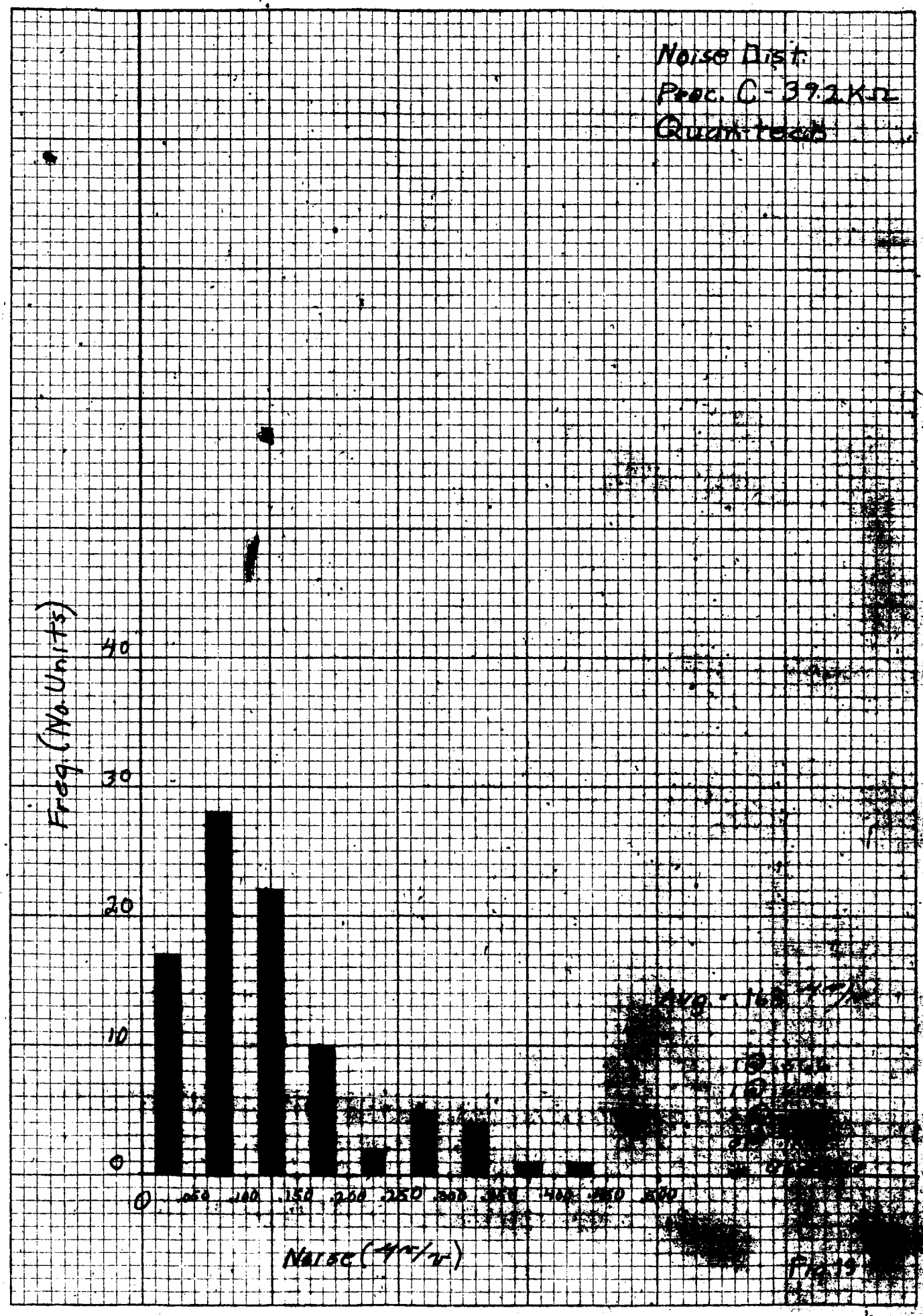

Fig. 19

K+E 10 X 10 TO THE INCH 359-5
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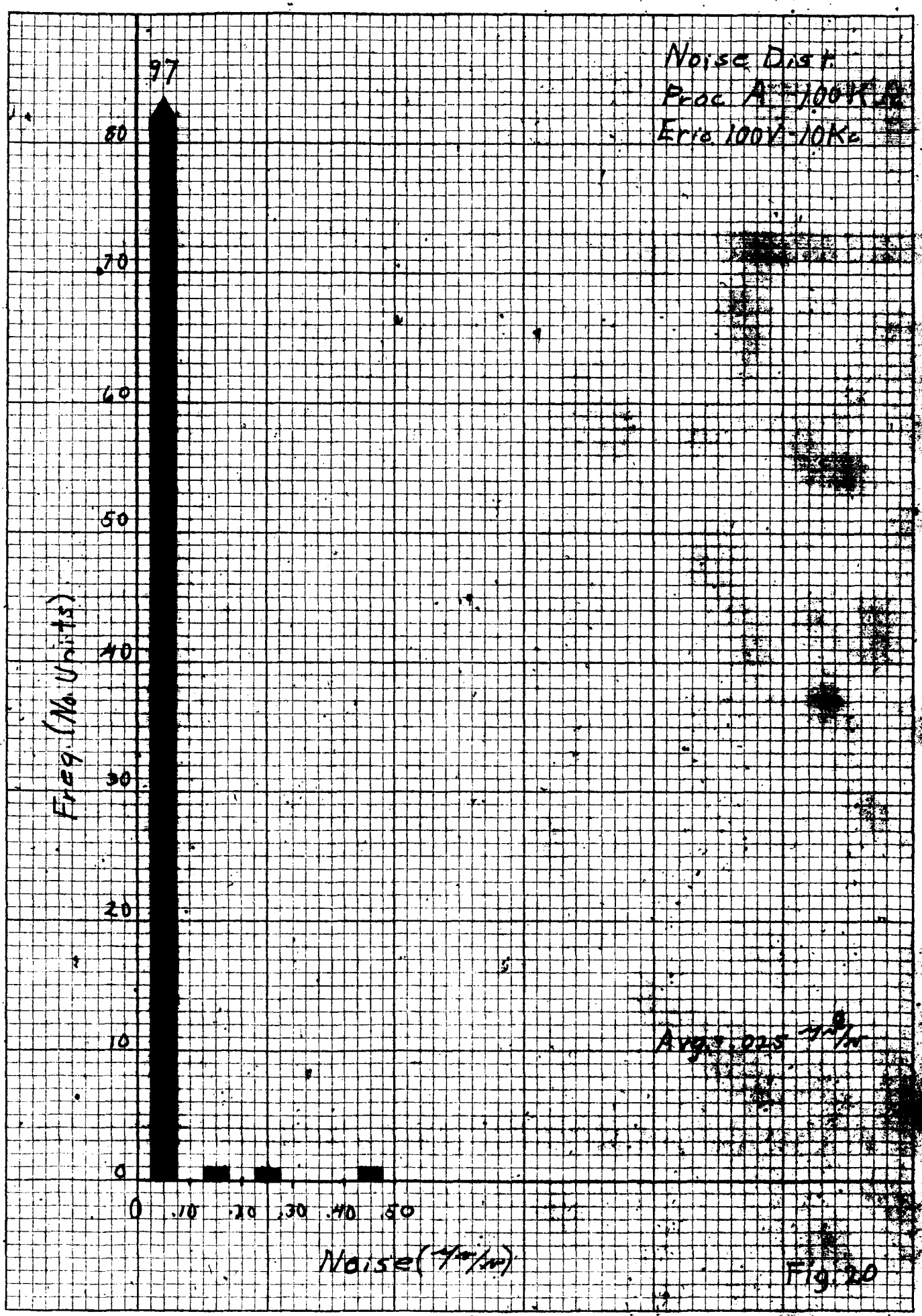

Fig. 20

K+E 10 X 10 TO THE INCH 359-5
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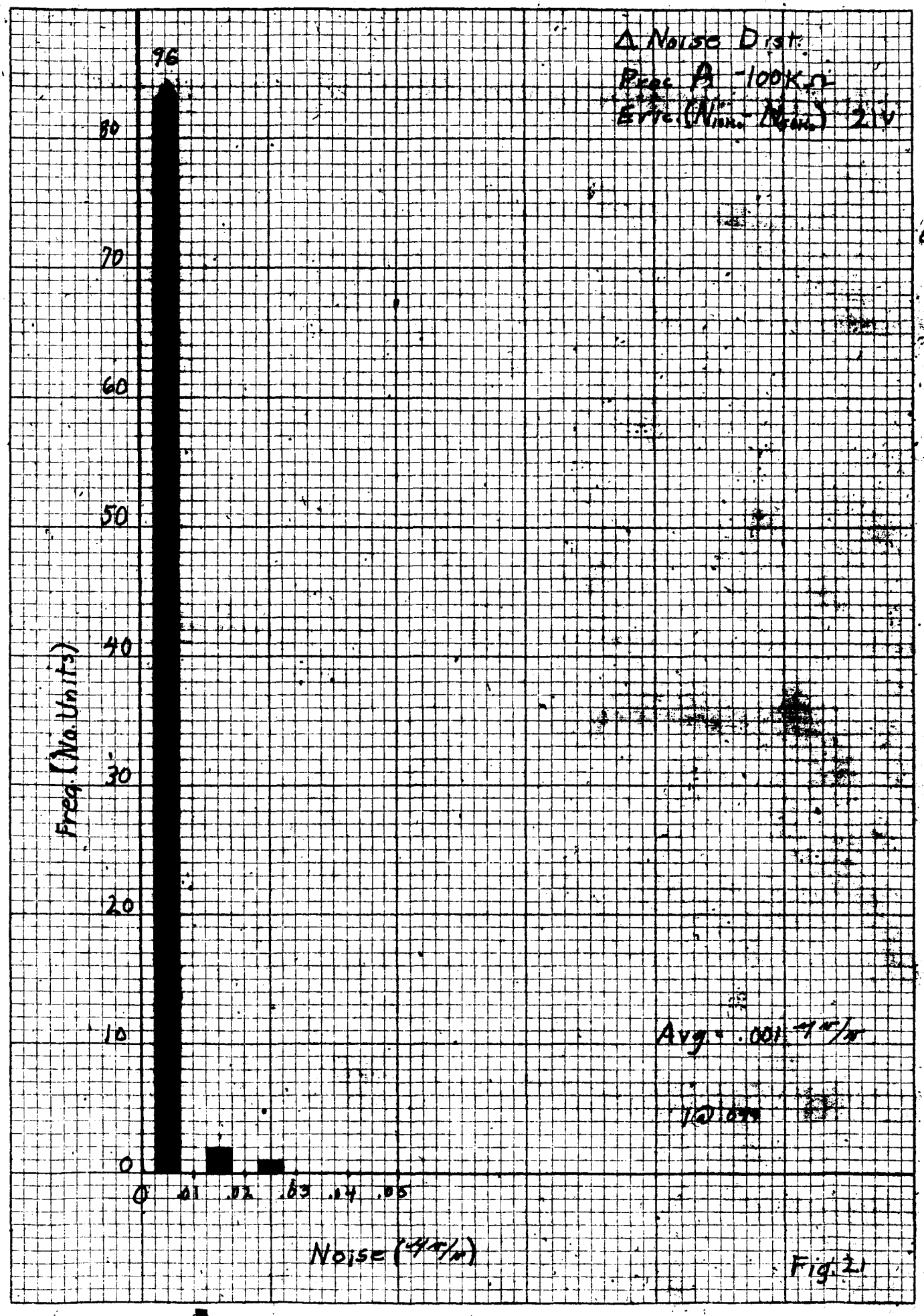

Fig. 2.

K+E 10 X 10 TO THE INCH 359-5 KEUFFEL & ESSER CO. MADE IN U.S.A.

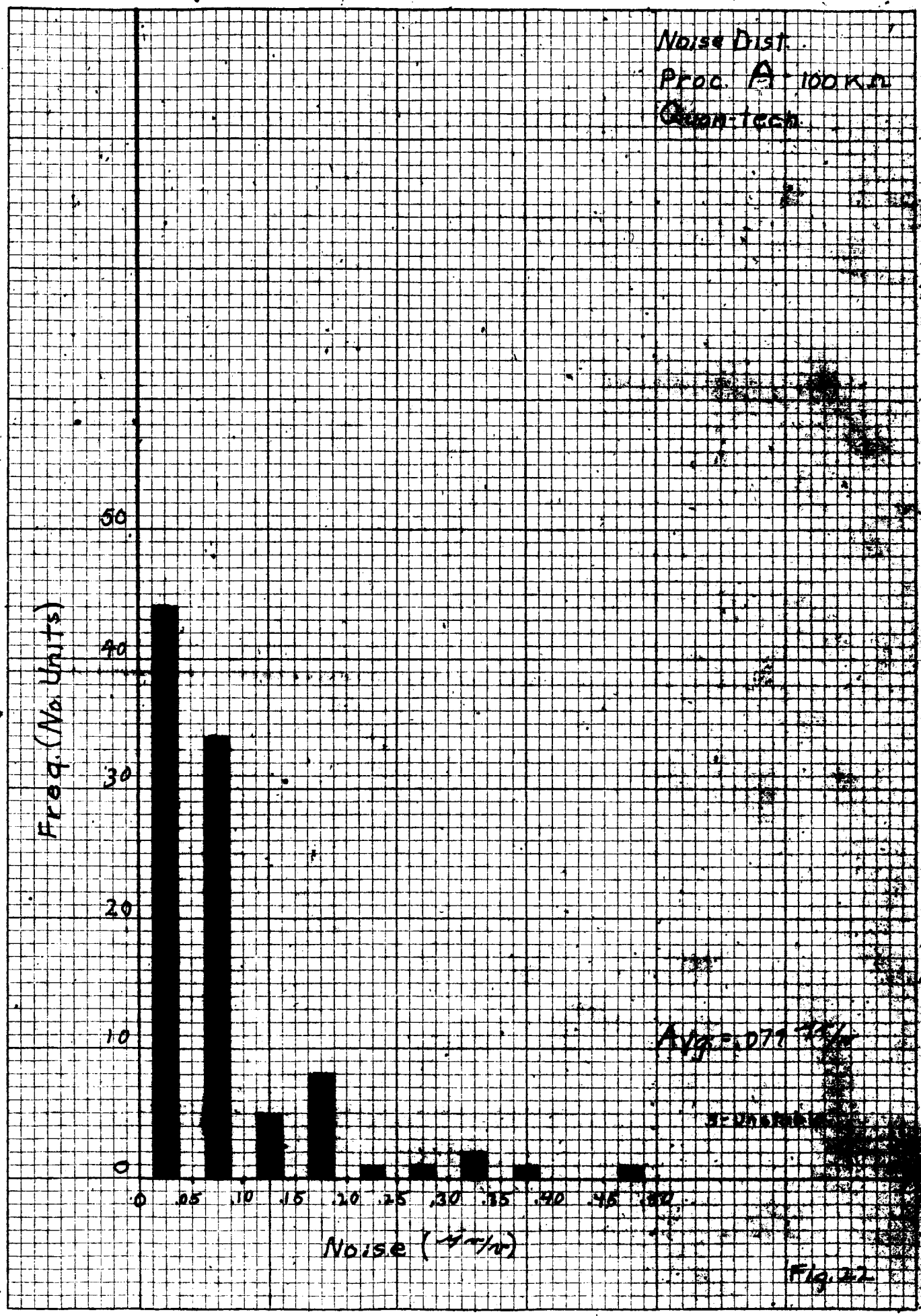

Fig. 22

K&E 10 X 10 TO THE INCH 359-5
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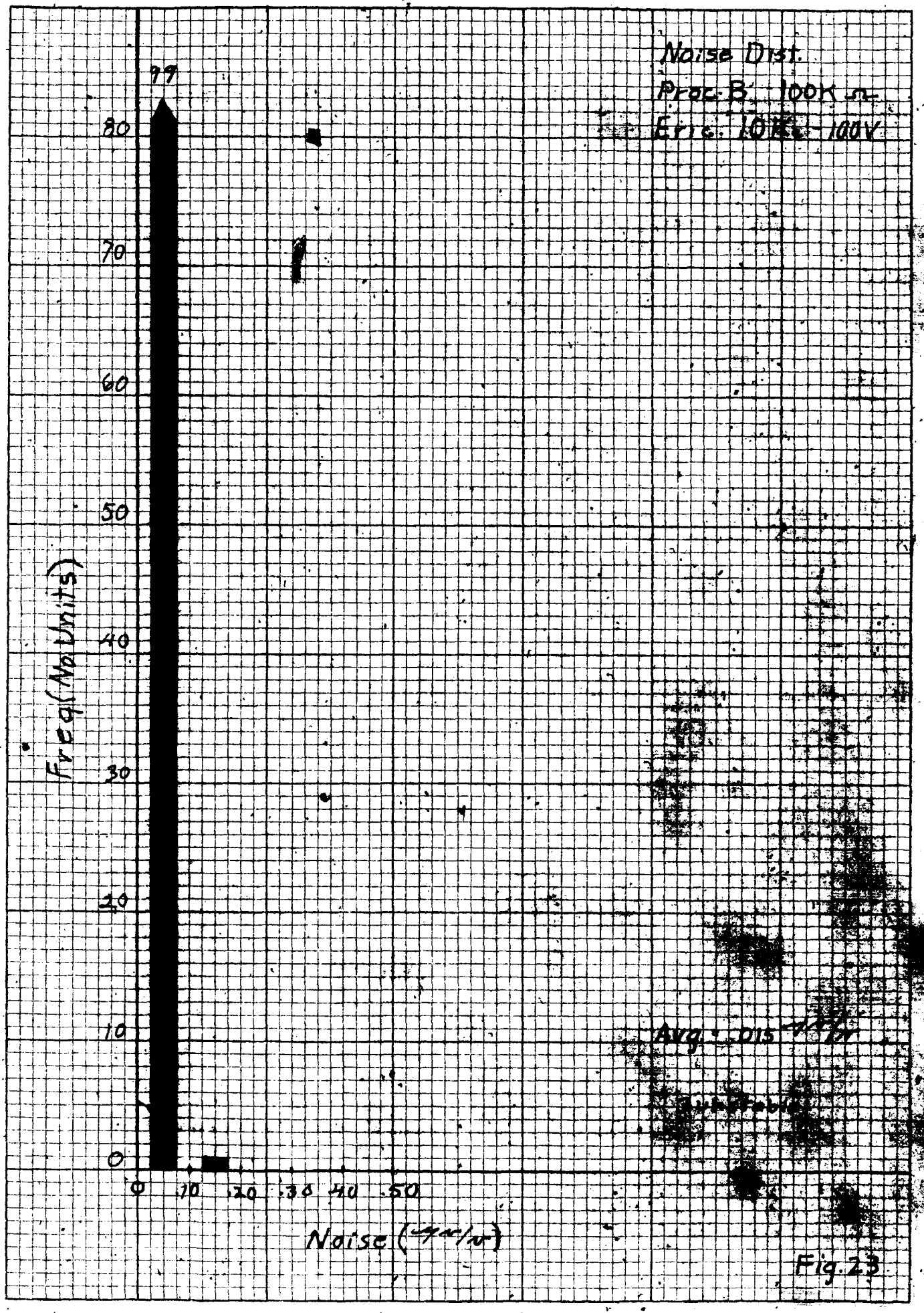

Fig. 23

K&E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

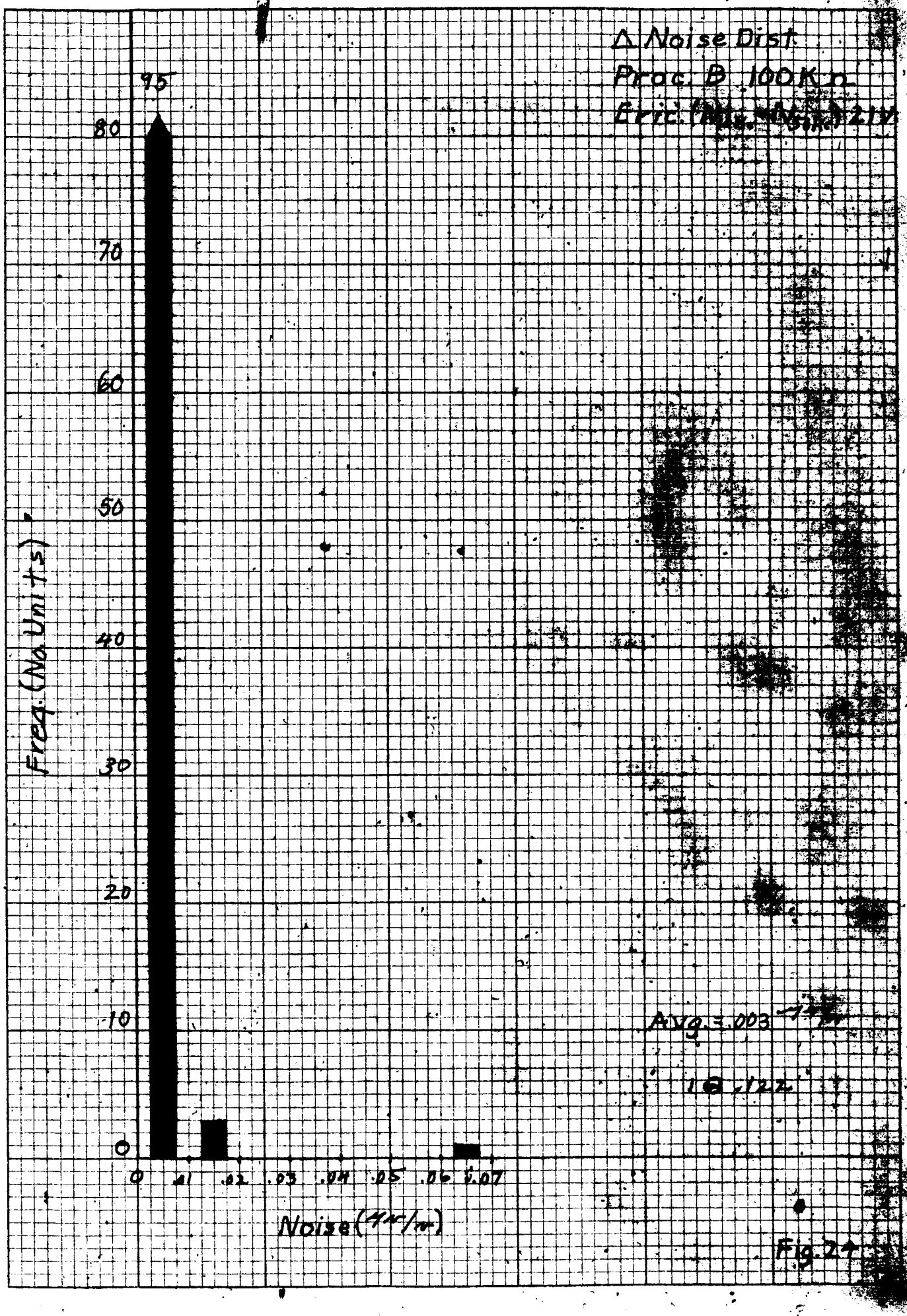

Fig. 2

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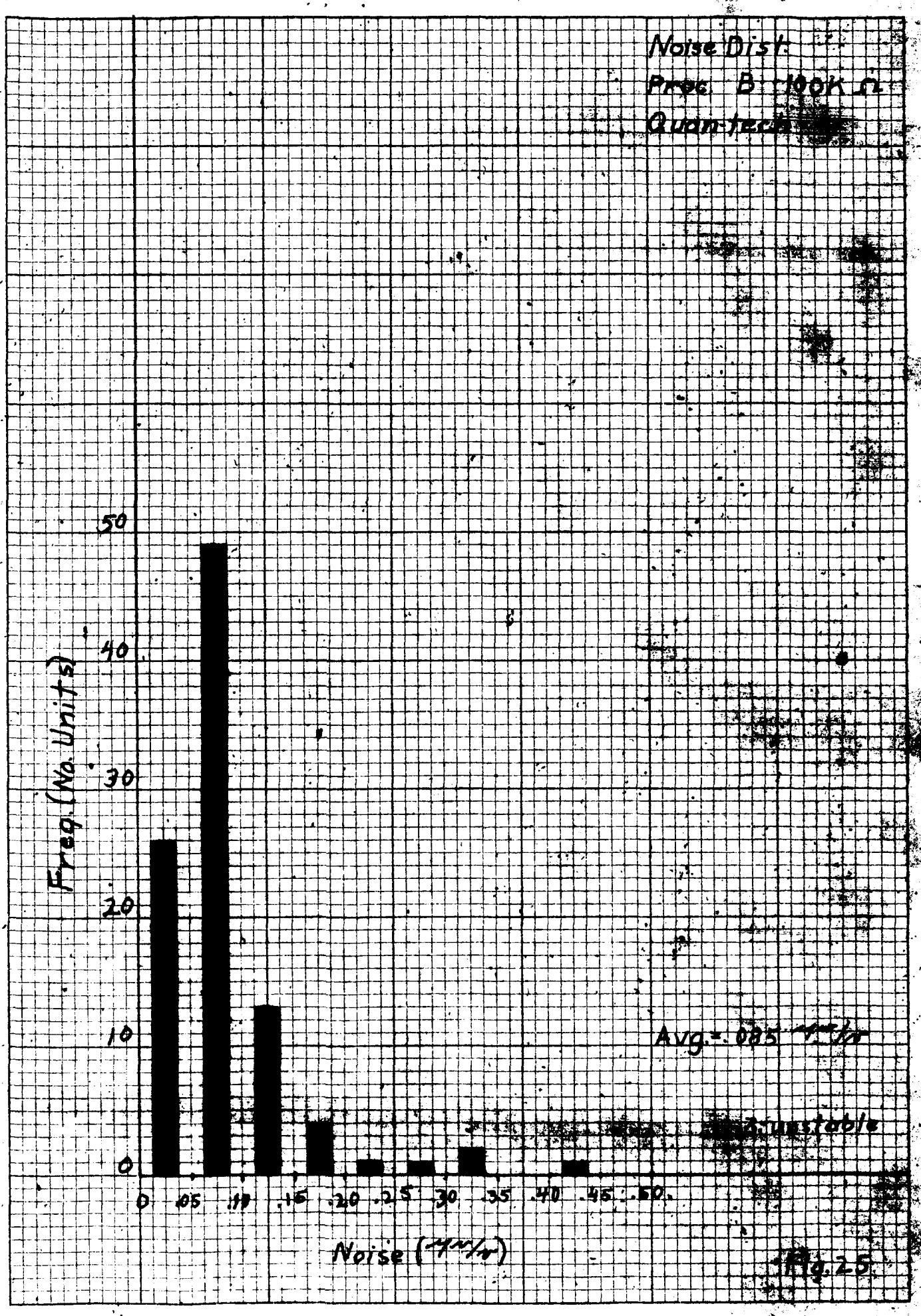

Fig. 25

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

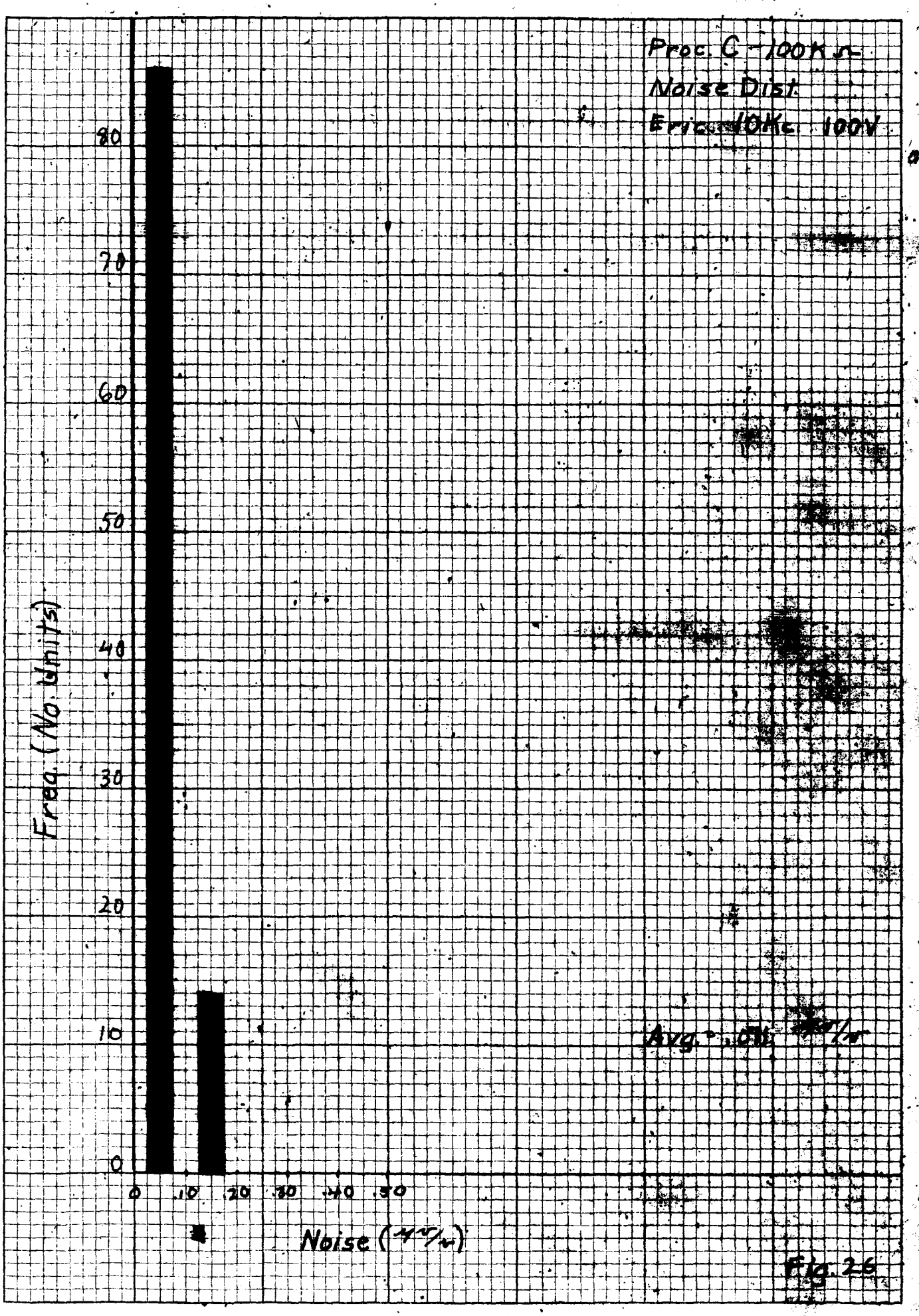

Fig. 26

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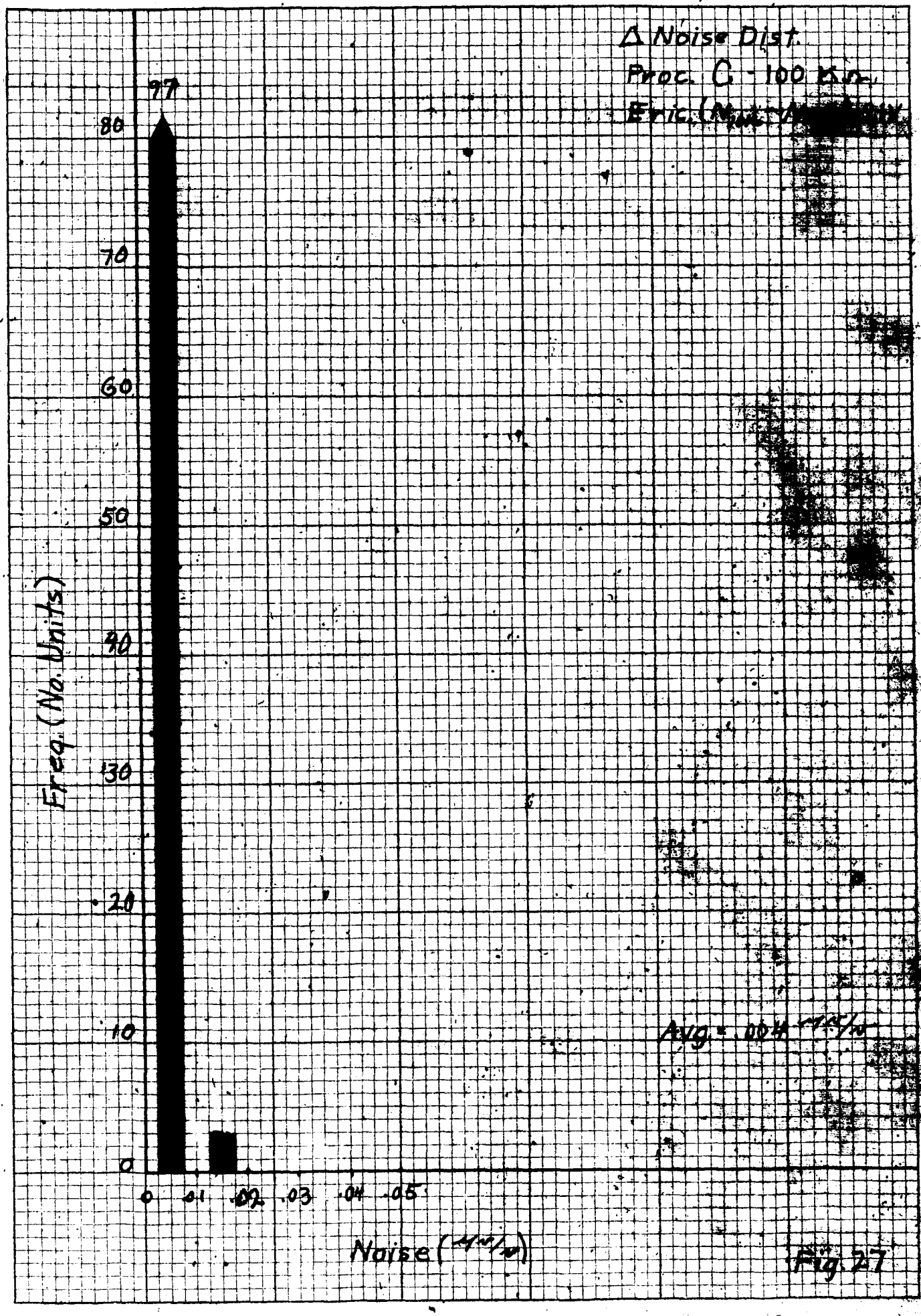

Fig. 27

K+E 10 X 10 TO THE INCH 359-5
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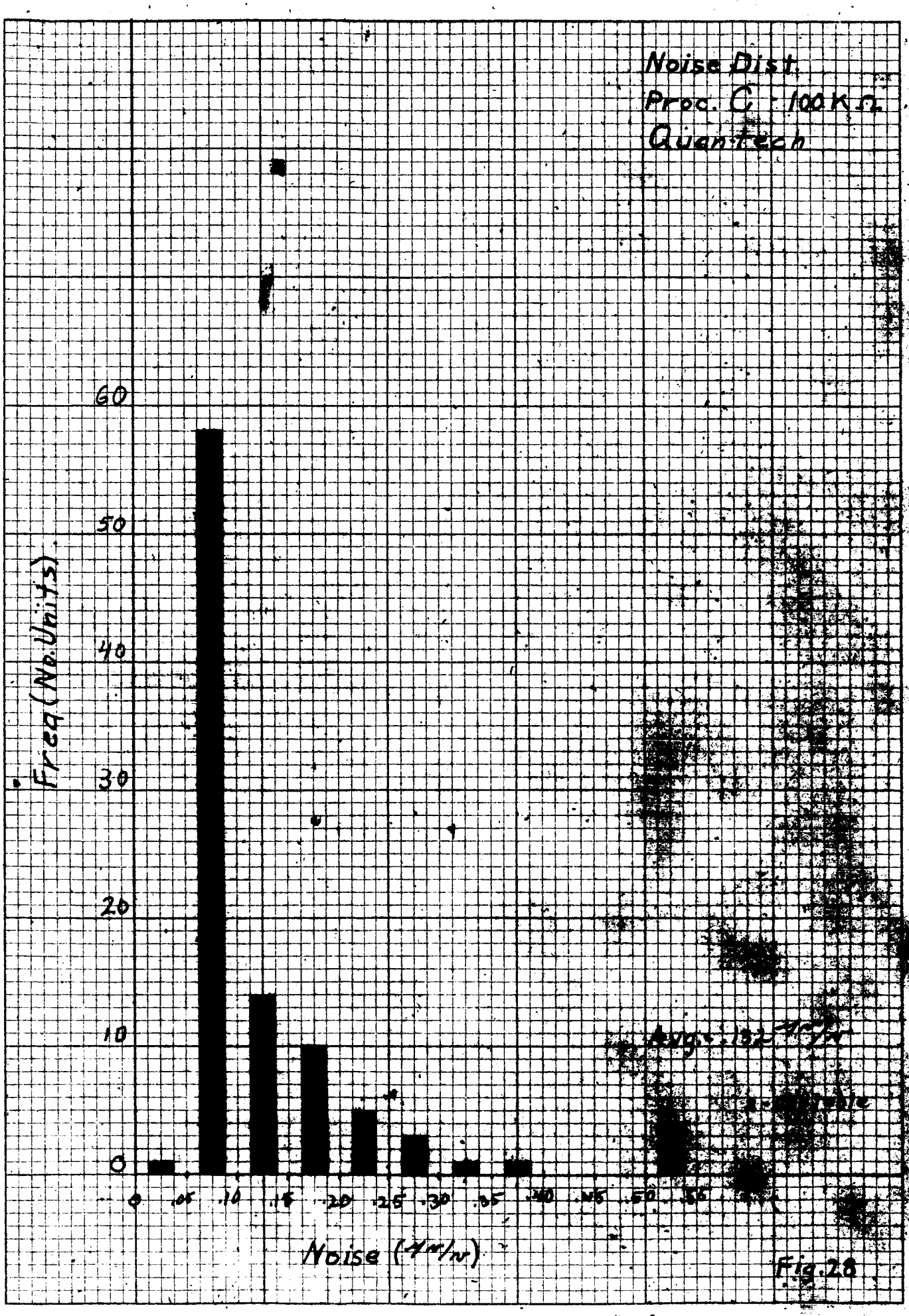

Fig. 28

K&E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

3.0 ANALYSIS

3.1 Figures 2 through 28 show the distributions of noise readings for the three values and three types of resistors tested. After completion of the 2,000-hour life test program, these distributions and the individual readings are to be compared with resistance change due to life test program, these distributions and the individual readings are to be compared with resistance change due to life test for correlation purposes.

Figures 29 through 37 are scatter plots of Quan-Tech readings vs. Ericsson readings made at 10KC and rated voltage. Visual examination of these plots indicates no high degree of correlation between the two types of measurements. Additional Ericsson data to be compared with Quan-Tech. data are the readings taken at 50KC, the difference in noise between the 10KC and 50KC readings, and the difference in noise readings taken at rated power and 1/10 rated power.

3.2 Comparison of the Quan-Tech and Ericsson readings is to be completed during the next quarter.

Infra-red profiles of all resistors to be life tested are being recorded, using the Barnes Infra-red Microscope and an X-Y plotter.

Life testing is to begin during the month of January.

The next quarterly report will include the initial infra-red proviles.

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

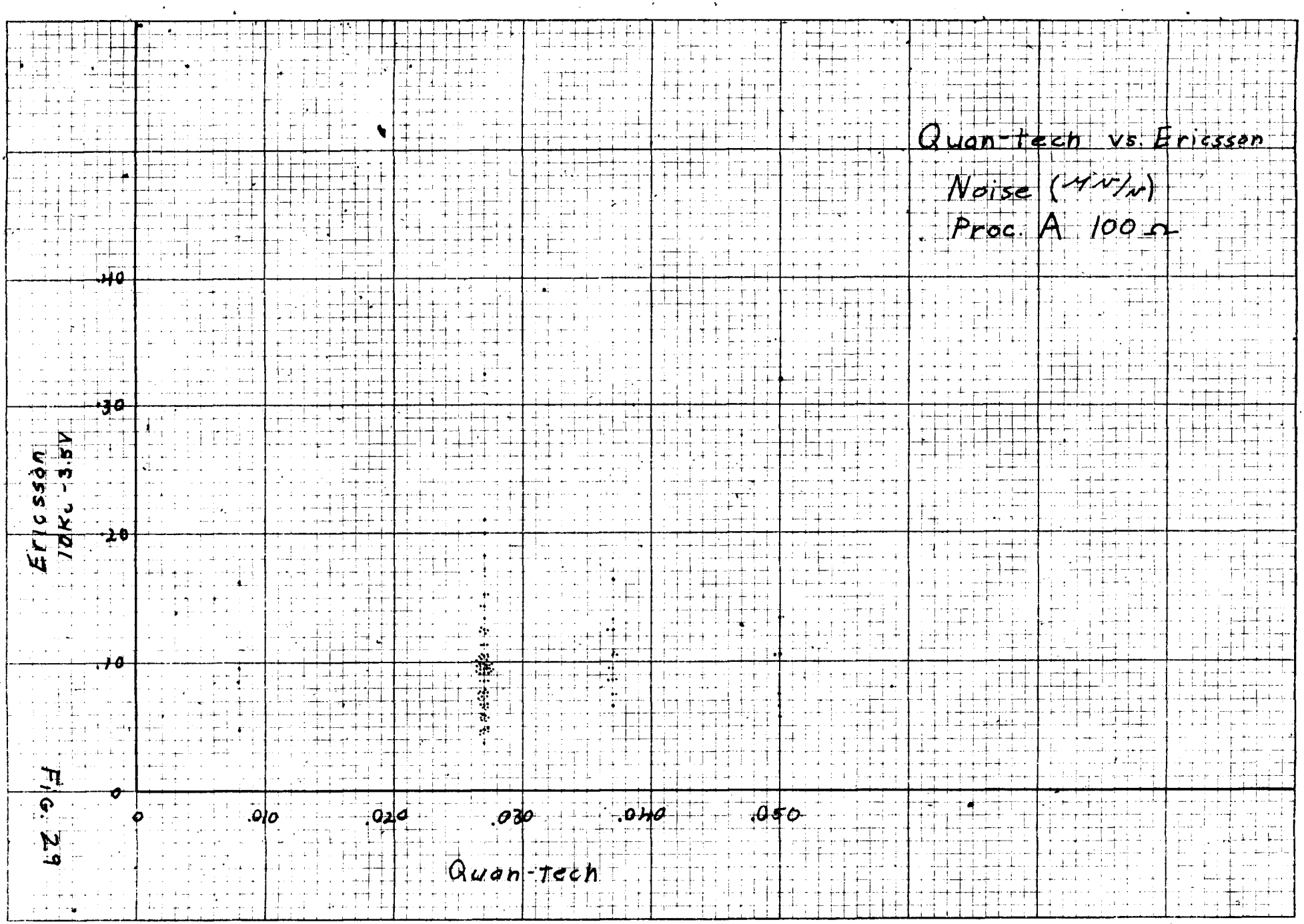

Fig. 2.9

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

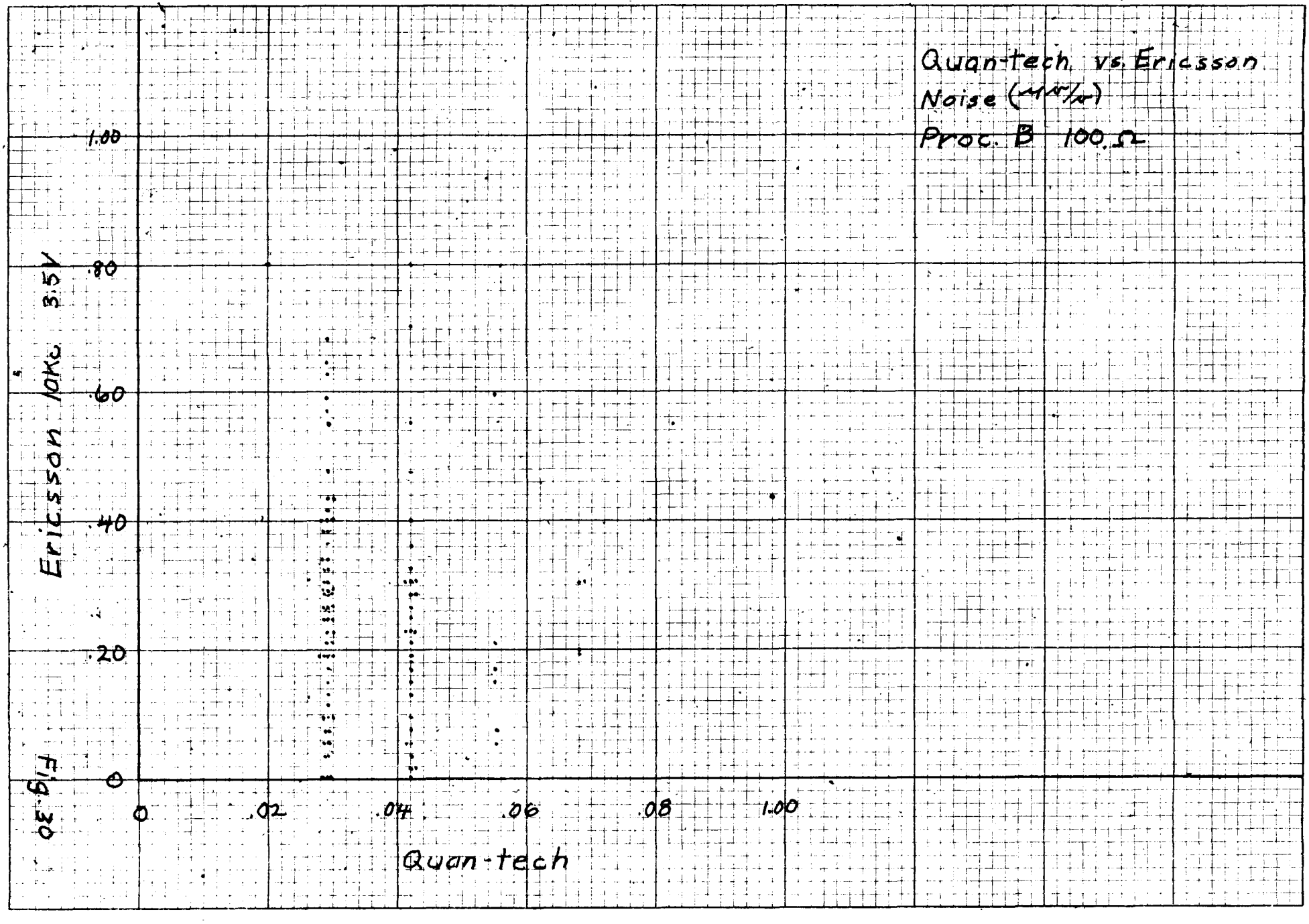

Fig. 30

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

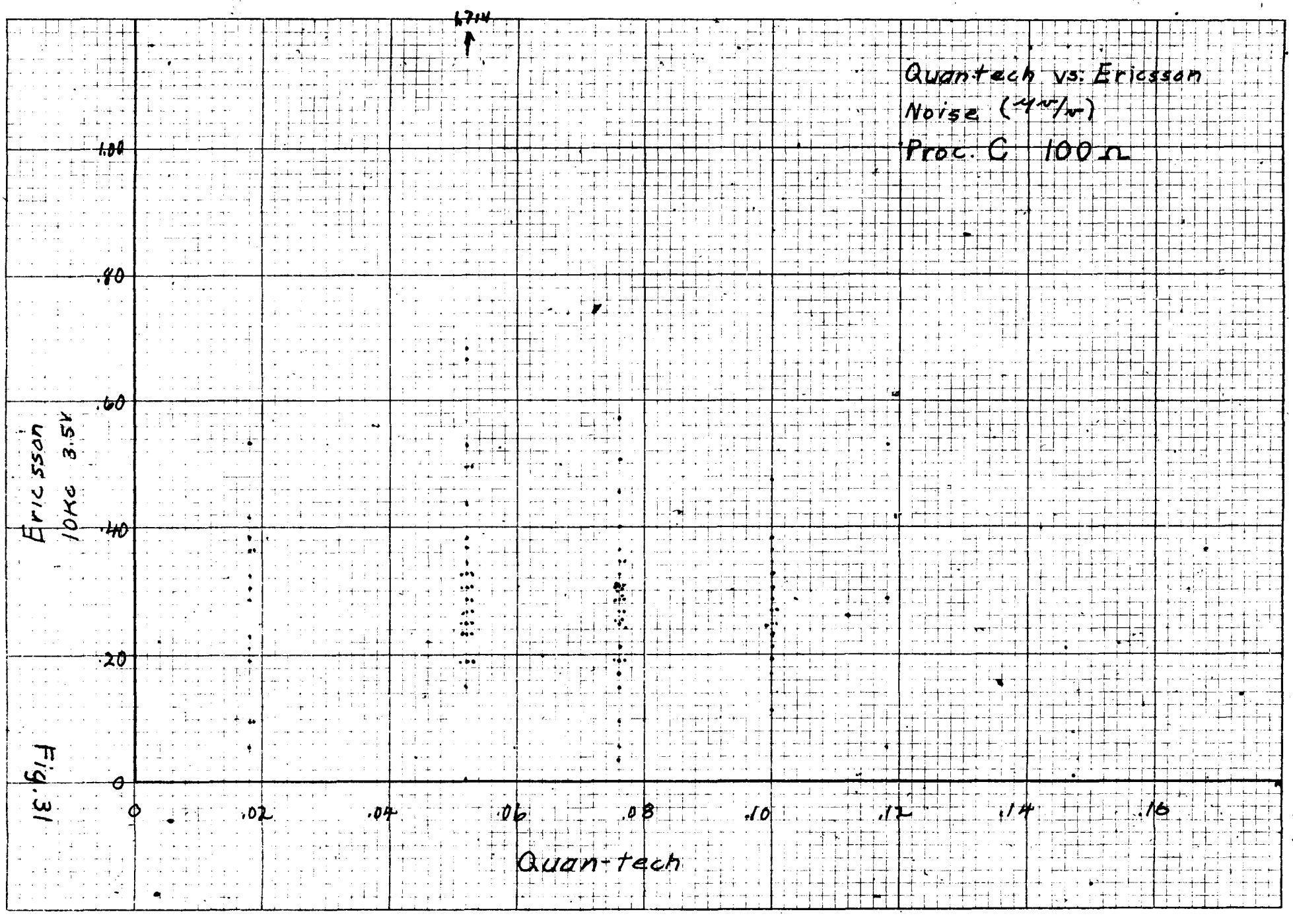

Fig. 31

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO.

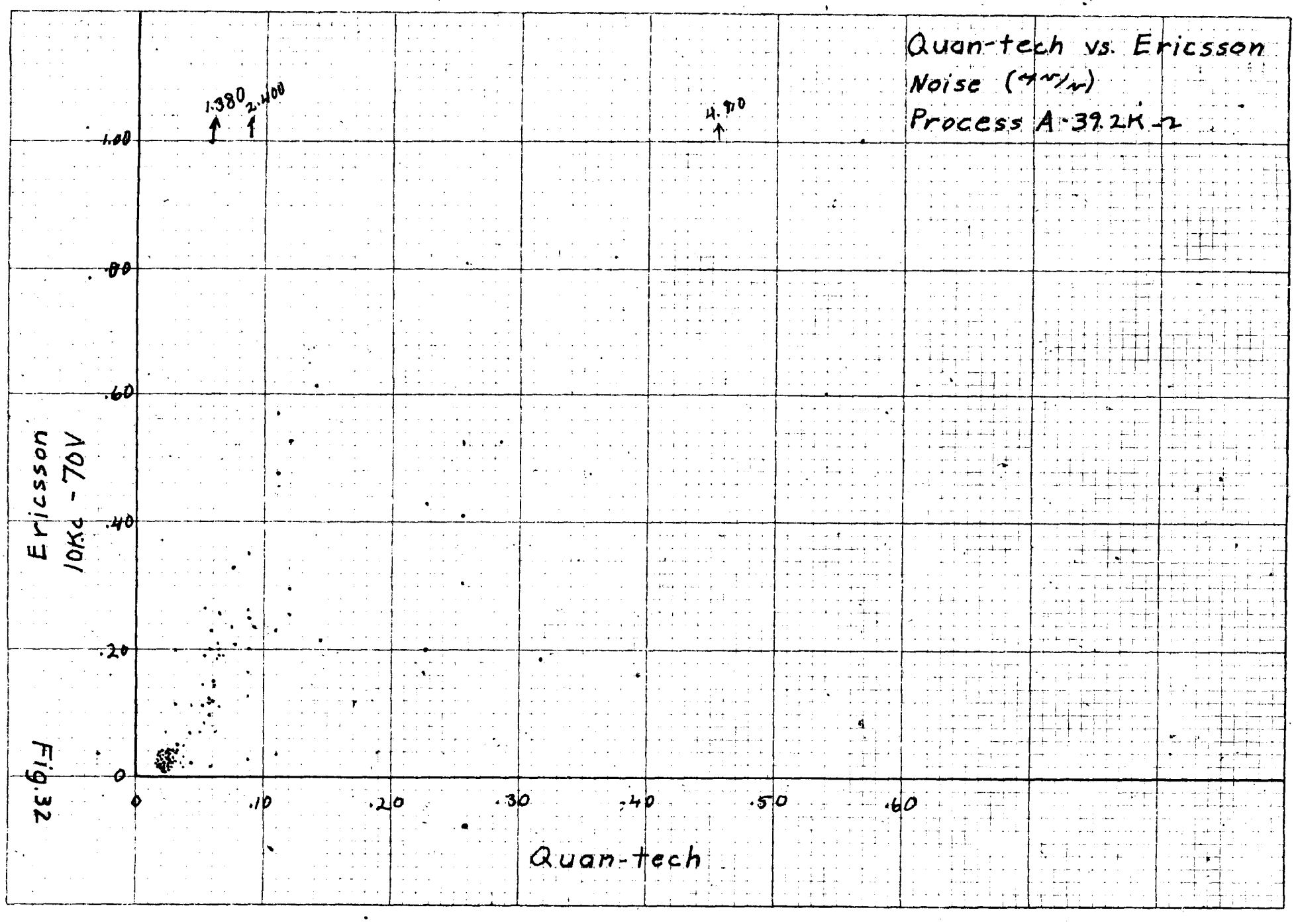

Fig. 32

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

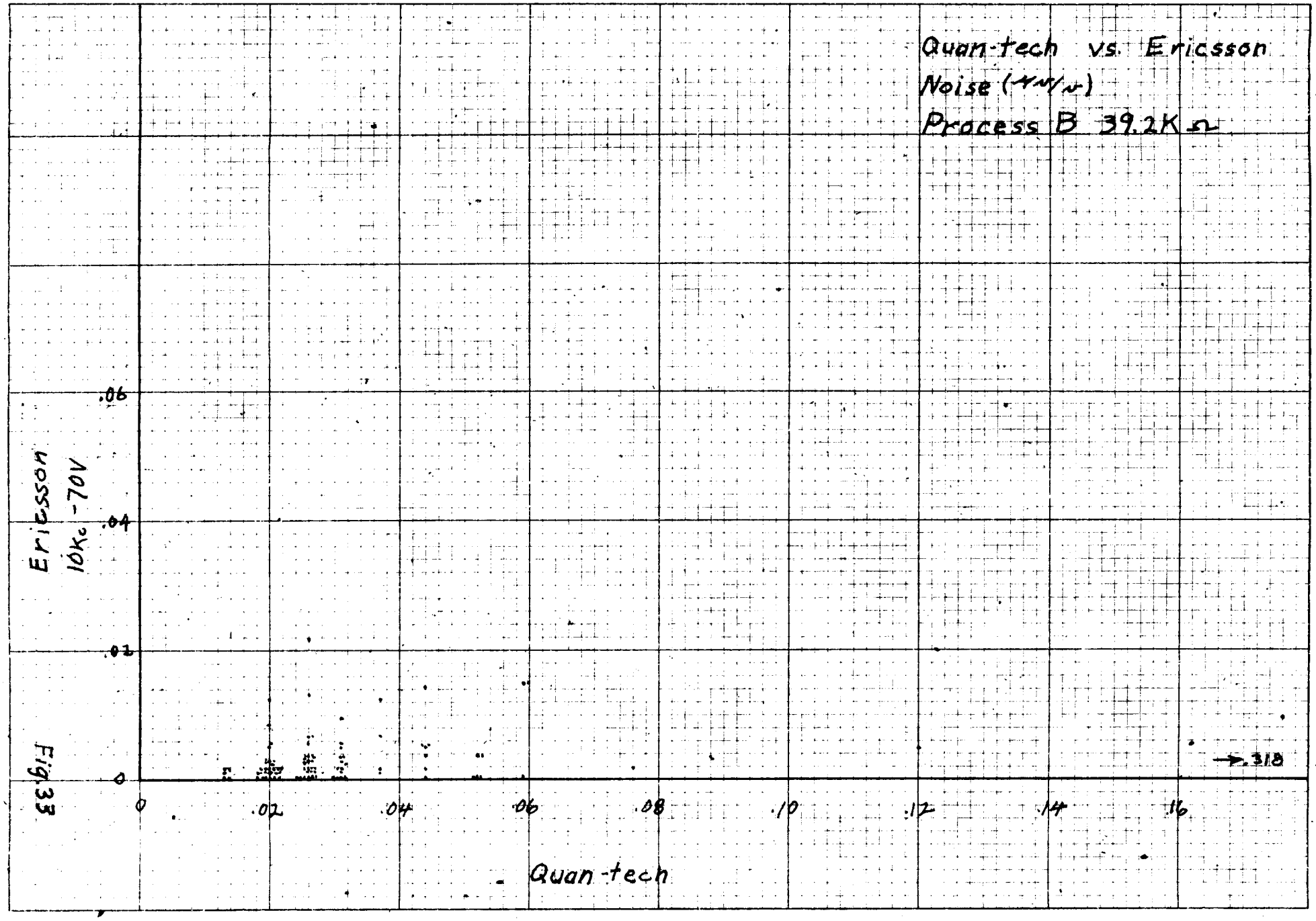

Fig. 33

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

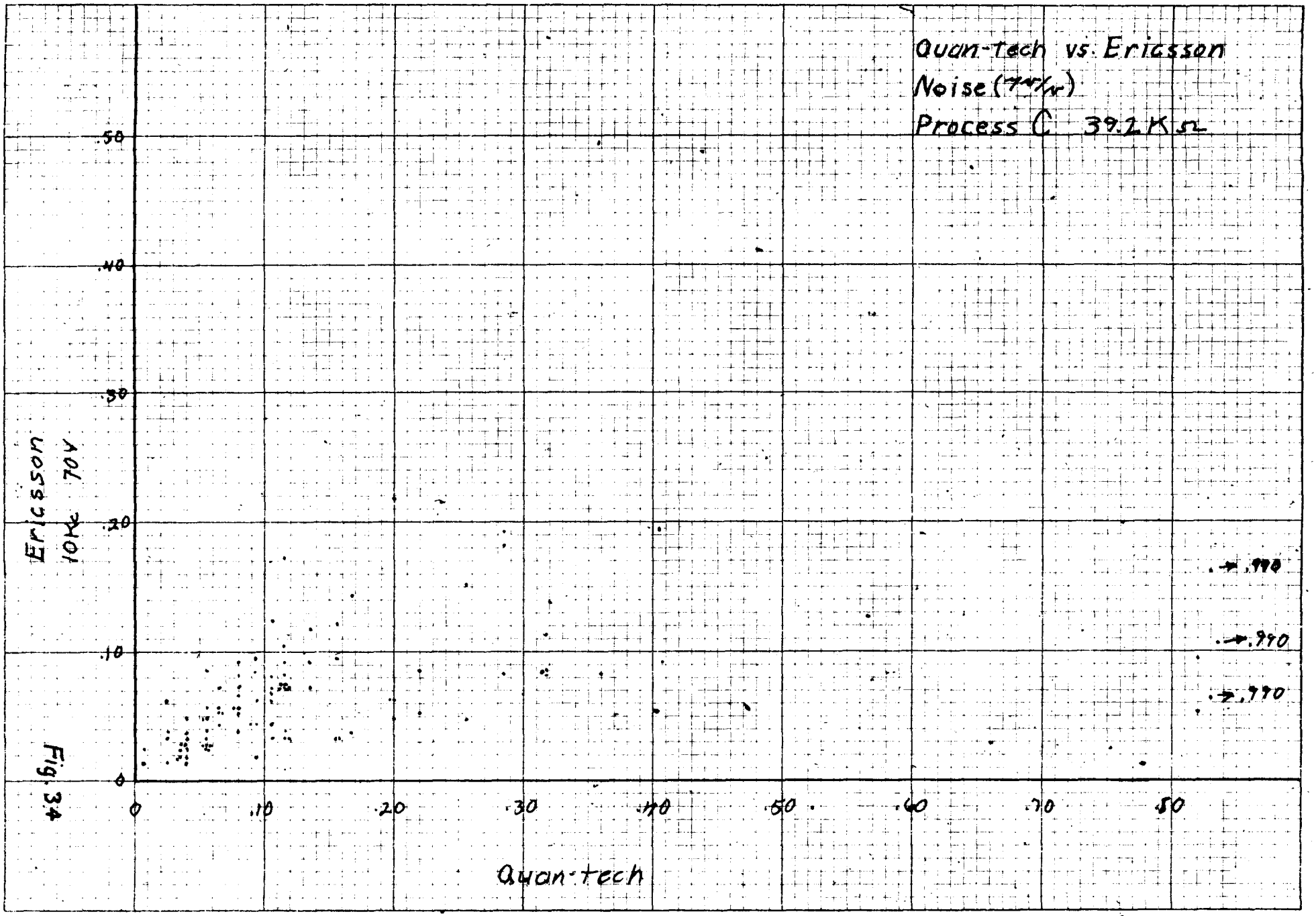

Fig. 34

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

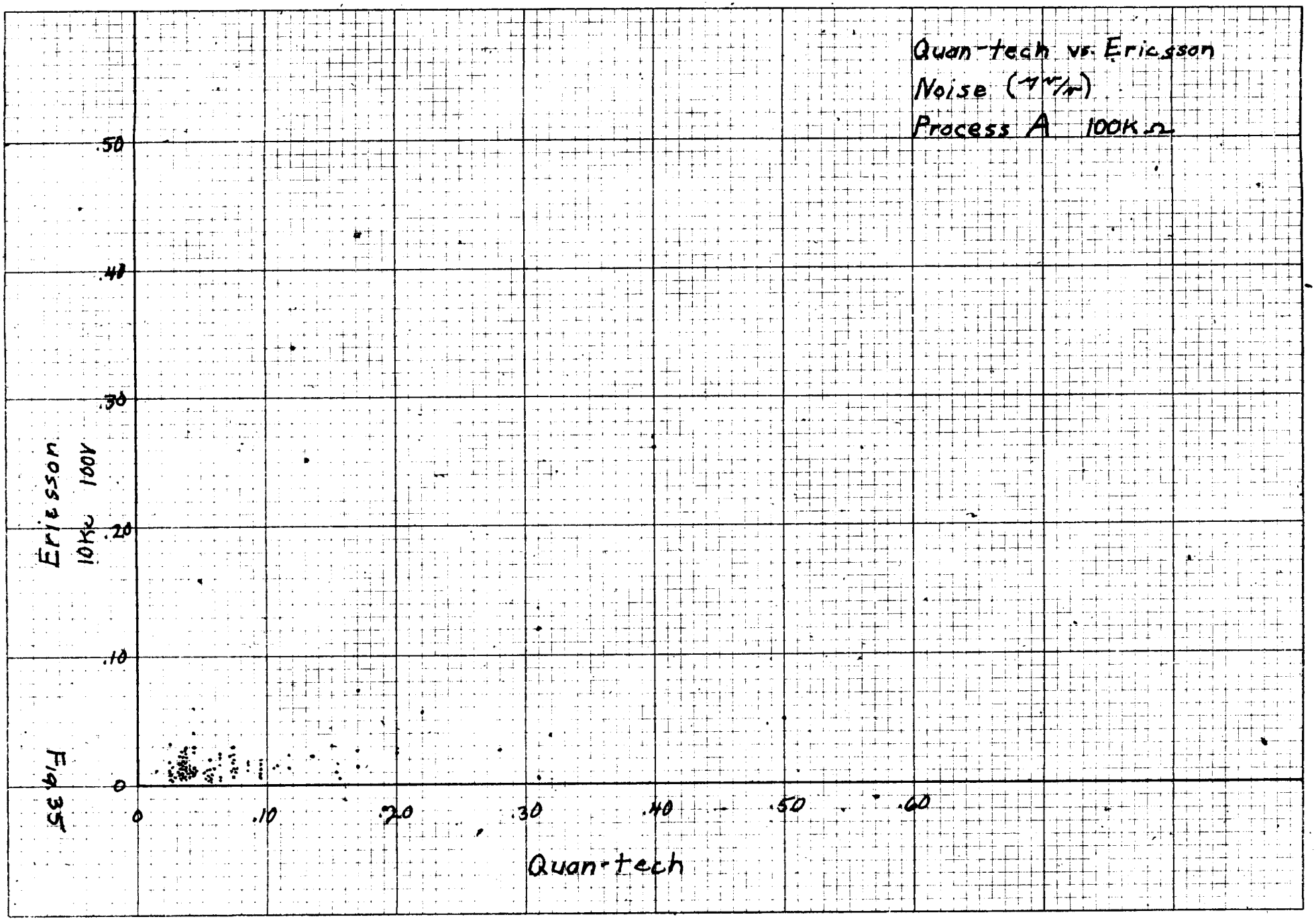

Fig. 35

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

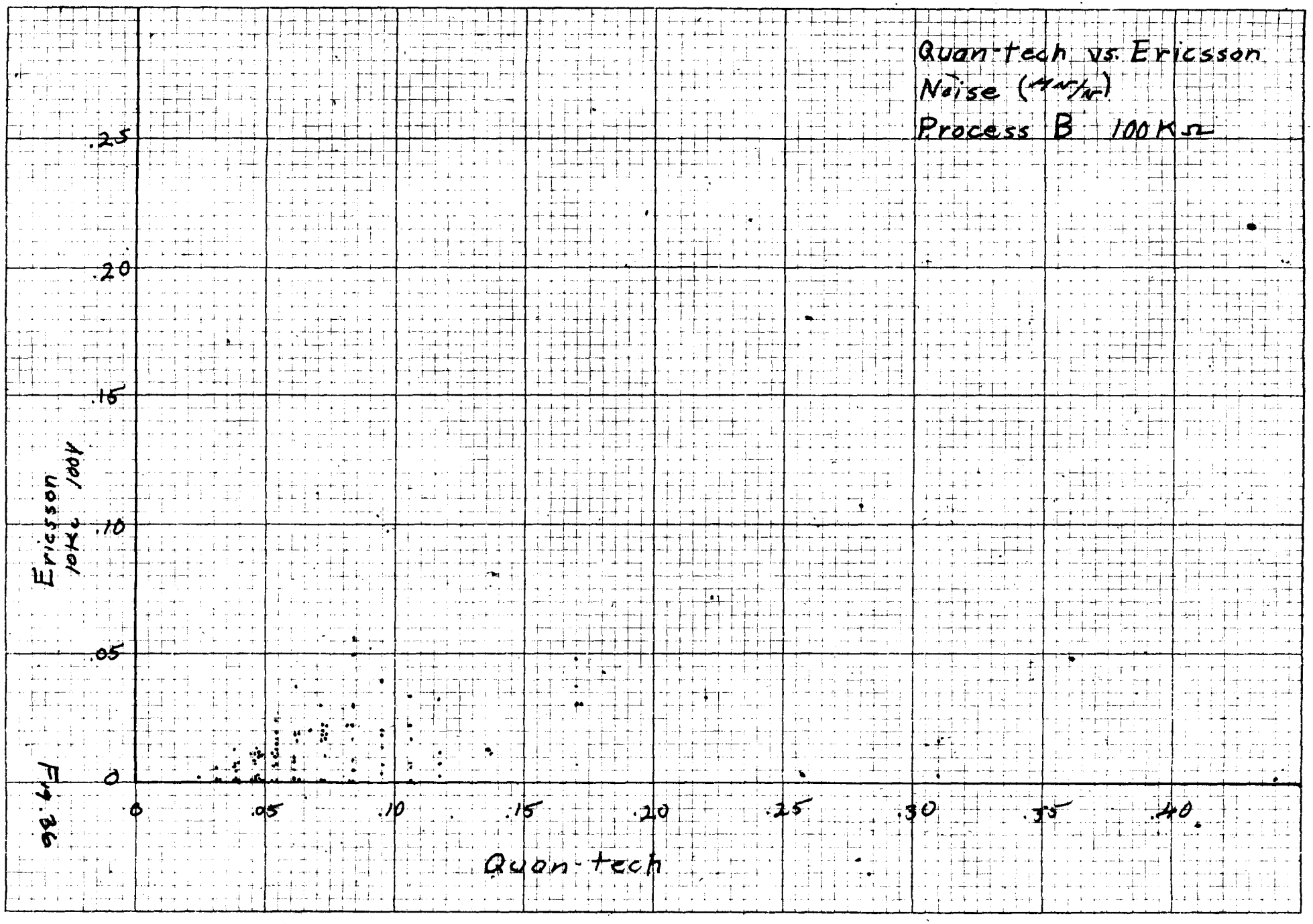

Fig. 36

K+E 10 X 10 TO THE INCH 359-5
KEUFFEL & ESSER CO. MADE IN U.S.A.

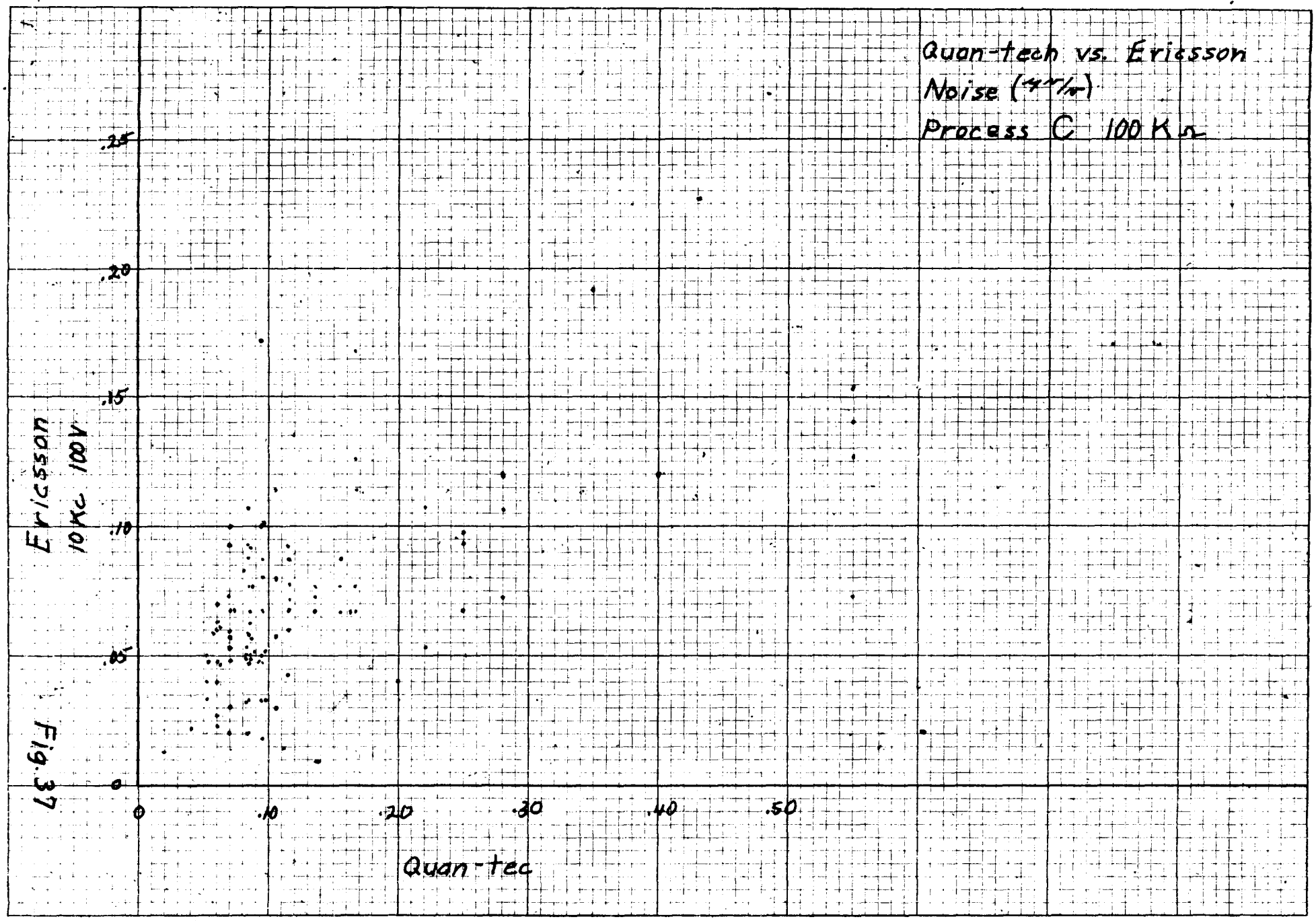

Fig. 37