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Preliminary report of settlement tests on insulation for army general purpose huts

Wilson, A. G.

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NATIONAL RESEARCH COUNCIL
CANADA

PRELIMINARY REPORT OF SETTLEMENT TESTS ON
INSULATION FOR ARMY GENERAL PURPOSE HUTS

by A. G. Wilson

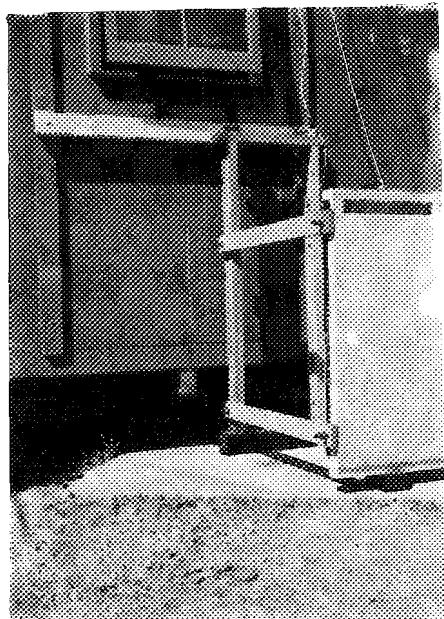
ANALYZED

Not for Publication

(Prepared for the Directorate of Engineer Development,
Department of National Defence)

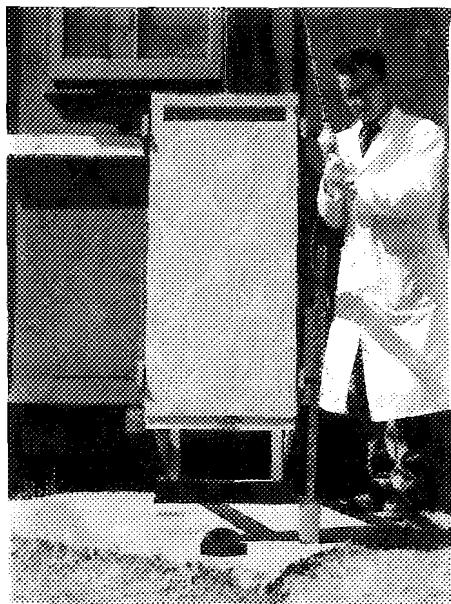
Research Report No. 10
of the
Division of Building Research

Ottawa, August 1952



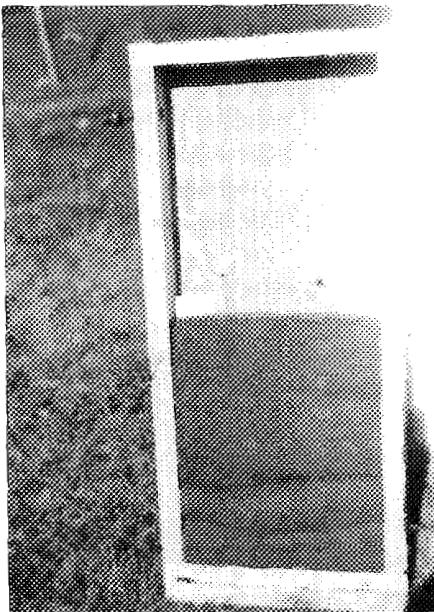
Test panel in rack prior
to bumping

DR 10385



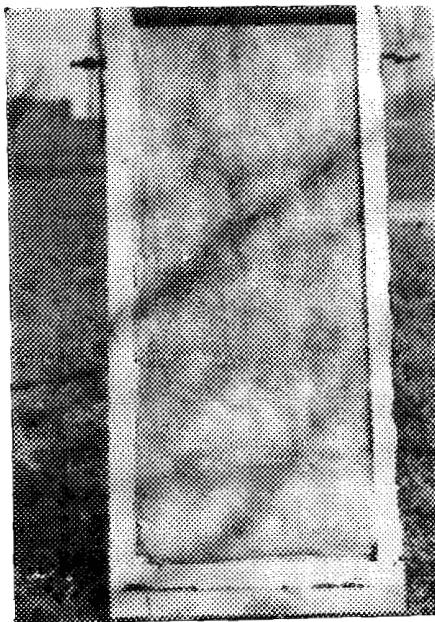
Test panel raised one foot
above block

DR 10386



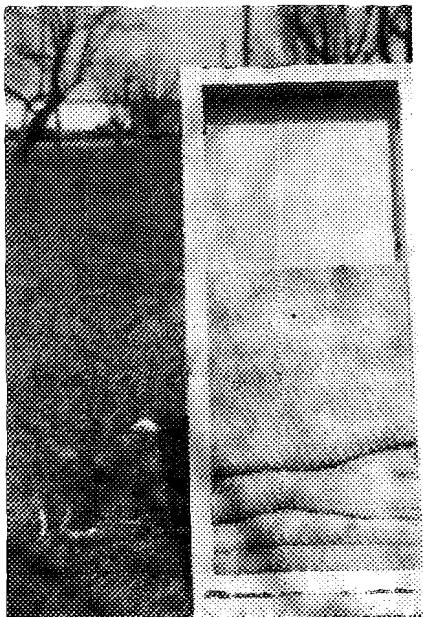
Westroc insulation (Lot 1),
installed with 3/4 inch
void. Front plywood panel
removed after 24 one foot
drops.

BR 10382



Fibreglas insulation (Lot 1),
installed with 3/4 inch void.
Front plywood panel removed
after 21 one foot drops.

BR 10381



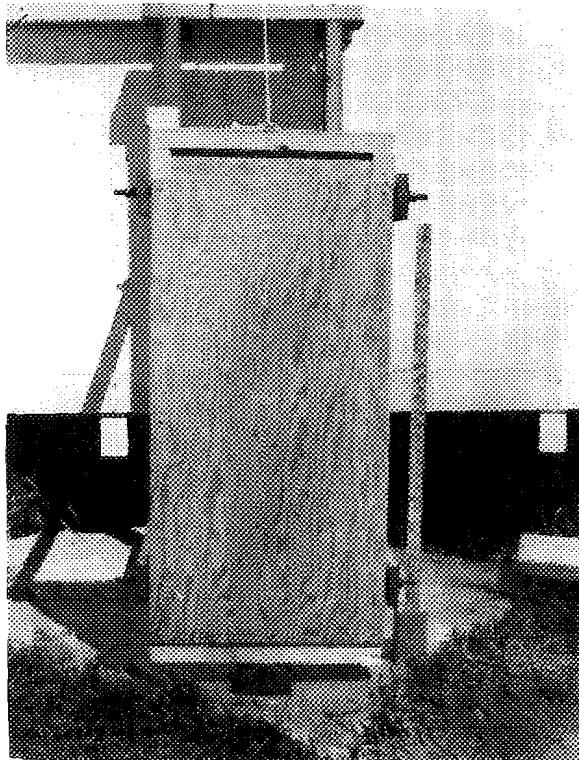
Johns-Manville (Lot 1)
installed with 3/4 inch
void. Front plywood panel
removed after 28 one foot
drops.

BR 10 344



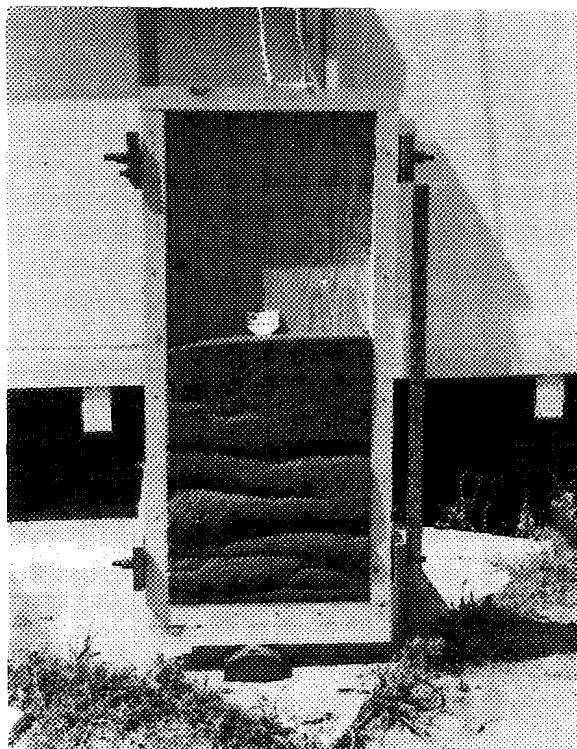
Holmes-Foundry (Lot 1)
installed in voidless panel.
Front panel removed after
25 one foot drops.

BR 10 343



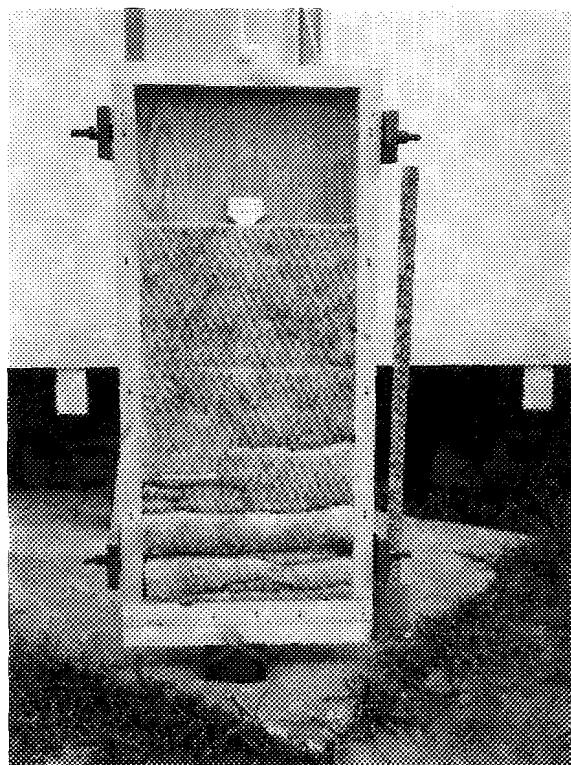
Fibreglas (Lot 1) installed
in voidless panel, after
25 one foot drops.

DK 10 383



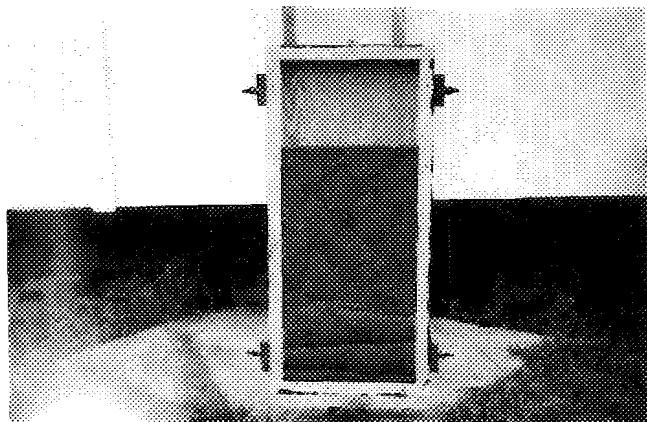
Westroc (Lot 1) installed
in voidless panel, front
plywood panel removed
after 25 one foot drops.

DK 10 384



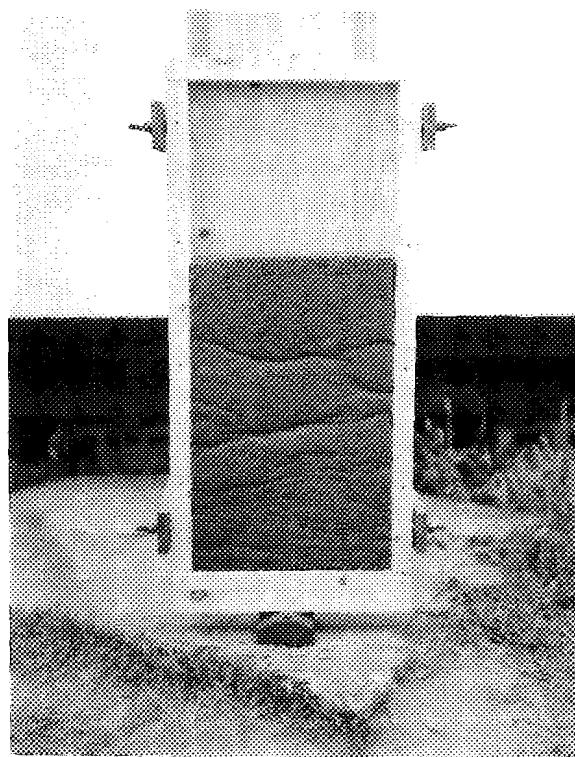
Johns-Manville (Lot 1)
installed in voidless
panel. Front plywood
panel removed after 25
one foot drops.

BK 10387



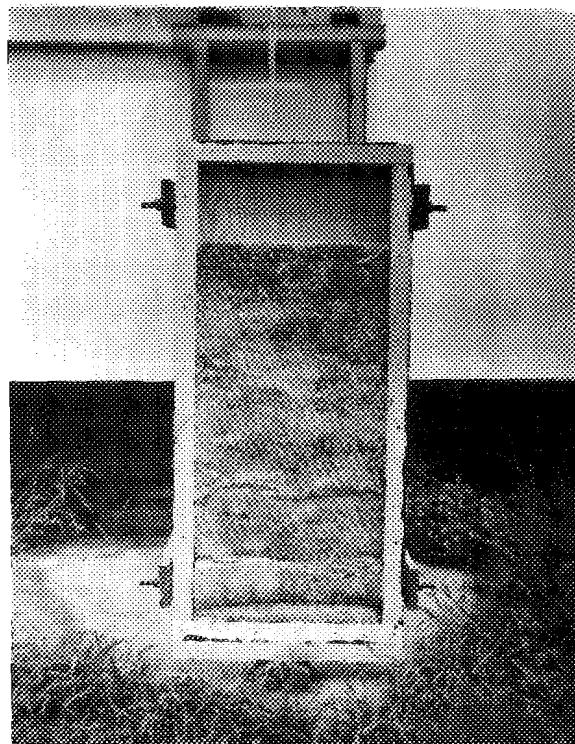
Westroc (Lot 1) installed
with 3/4 inch void. Front
plywood panel removed
after 125, 2 inch drops.

BK 10388



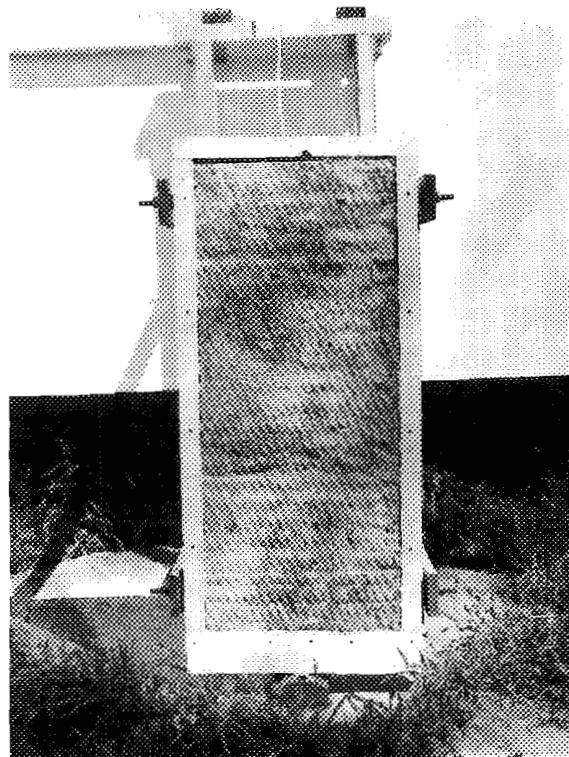
Westroc (Lot 2) installed
in voidless panel. Front
plywood panel removed
after 120, 2 inch drops.

BR 10390



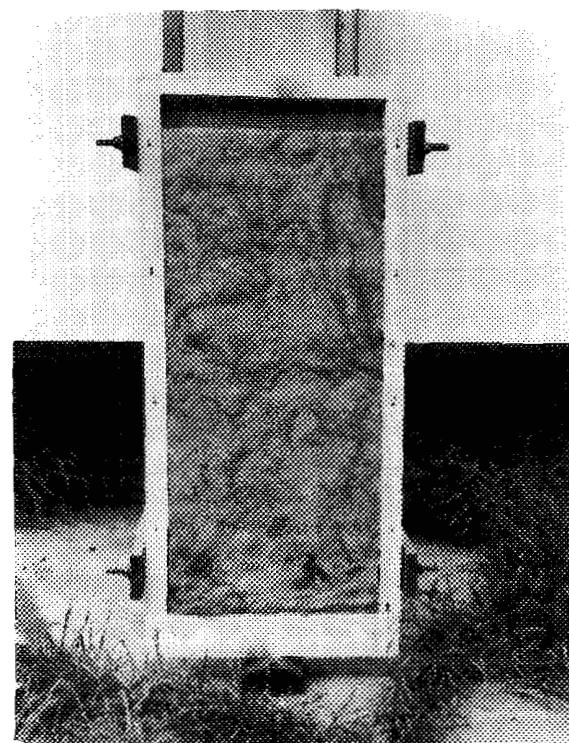
Johns-Manville (Lot 3)
installed with 3/4 inch
void. Front plywood panel
removed after 70, 2 inch
drops.

BR 10389



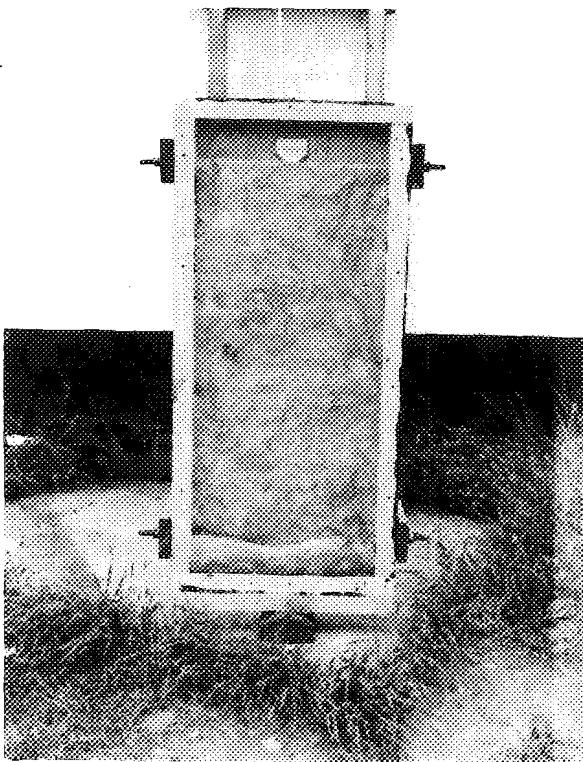
Johns-Manville (Lot 3)
installed with no void.
Front plywood panel removed
after 14, 2 inch drops.

BR 10 391



Holmes Foundry (Lot 2)
installed with no void.
Front plywood panel
removed after 65, 2 inch
drops.

BR 10 392



Holmes Foundry (Lot 2)
installed with 3/4 inch
void. Front plywood
panel removed after 50,
2 inch drops.

BR 10 380

HISTORY OF INVESTIGATION

Recently the Division of Building Research, at the request of the Directorate of Engineer Development, Department of National Defence, undertook an investigation of mineral wool insulations for use in Prefabricated Army General Purpose Huts. It was apparent that insulation for use in the construction of panels for the huts had several very special requirements, which need not be discussed fully here. Among the more important requirements, however, were the following:

- (1) Insulation must be sufficiently rigid and stable to permit reasonably rough handling by workers in preparing and installing in panels during fabrication;
- (2) Insulation must be resilient and not fracture when compressed by hand or during shipment;
- (3) Insulation must have sufficient strength and rigidity to withstand reasonably rough handling of panels during manufacture, storage, shipment and erection without excessive settling or shearing.

During the course of the investigation, the Division developed tests to define the strength, rigidity and resilience properties of mineral wool insulation. These tests were eventually incorporated into the insulation section of the Specifications for Prefabricated Army General Purpose Huts by the Directorate of Engineer Development (D.E.D.). The specific rigidity, dry resilience and "shear-tension" strength requirements set forth by D.E.D. in the specifications were designed to assure that the more general requirements listed above were met by the insulations used in the fabrication of the panels.

The figures specified, based on extensive tests, were chosen after much careful consideration and called for qualities not necessarily found in mineral wools for normal house application. It is not surprising, therefore, that several mineral wool manufacturers could not meet the specifications with their standard products. Because of the restrictive nature of the specifications it was natural that some of the specific test requirements were questioned. In particular, the Western Insulation Company, Vancouver, manufacturers of "westroc" insulation, felt that the shear-tension strength and rigidity limits specified were higher than necessary to meet the three general requirements listed above. To meet requirement (1), the Company was prepared to paper enclose their material, although doubted that this was necessary. They contended that there was little possibility of serious settlement of the insulation within the panel as required in (3), particularly if the insulation as installed completely filled the panel space. They had, in fact, the results of independent vibration tests to support this contention.

During the course of the Division's investigations, a simple panel bump test had been developed to simulate handling of the panels. Tests had been run on several insulations with this apparatus and the data used in the final assessment of insulation requirements. In all these tests, however, the insulation was secured to the panel by an asphalt adhesive, as had been originally called for in the specifications, and the results did not necessarily satisfy the questions raised by the Western Insulation Company. The Directorate of Engineer Development therefore requested the Division to develop a suitable test procedure to simulate realistic handling of the panels, and to obtain data on the resistance to settlement of "Westroc" as well as on the resistance to settlement of insulations which had been shown to meet the specifications.

APPARATUS

The apparatus used for the settlement tests was an adaption of the bump test apparatus used in the original investigations (when the insulation was secured to the panel with asphalt adhesive) and can be seen clearly in the photographs accompanying this report. The panel under test moved freely on the four supporting arms and could be raised or lowered by a rope and pulley arrangement. The panels were dropped on a rounded hard wood block supported on a concrete slab. The framing of the panels was of 2 in. material and in all cases the space within the panel was 1½ ins. wide by 36 ins. high, the approximate size of the largest space in a full size hut panel.

TEST PROCEDURE

Bump tests were run on each insulation with both a 2 in. drop and a 12 in. drop. In each case two series of tests were made as follows:

- (1) Insulation installed in a panel having a space 2-3/4 inches deep, so that the insulation did not completely fill the panel. Since the samples of insulation varied somewhat in thickness, the space between insulation and plywood was not the same in all cases.
- (2) Insulation installed in a panel so as to completely fill the space. Panels were specially fabricated to the thickness of the insulation in each case.

In preparing samples for test, only undamaged pieces were used. The insulation was cut to the length and width of the panel space and carefully installed. During test the panels were carefully raised to the required height above the hardwood block and then allowed

to drop freely. The settlement after each drop was measured at three locations, through the space at the top of the panel face, and the readings averaged. In most cases, bumping of the panel was continued until no further settlement occurred.

In addition to the bump tests, some shear-tension strength and rigidity tests were run on the insulations. The procedure for these tests was generally as outlined in the Specifications for Pre-fabricated Army General Purpose Huts.

DISCUSSION OF RESULTS

The results of the bump tests are shown on graphs 1 to 25 while the data on shear-tension strength and rigidity are given in tabular form. No attempt will be made in this brief preliminary report to analyze the data fully.

- (1) Settlement occurred with all insulations when the 12 inch drop was used. In some cases, serious settlement occurred with relatively few drops. In all cases the Westroc insulation showed the greatest settlement. The settlement of the Johns-Manville insulation was sufficient to cause concern. Carrying the 12 inch bump test to equilibrium is probably too severe to be realistic.
- (2) Settlement occurred with all insulations except Fibreglas when the 2 inch drop was used. In all cases the settlement of the Westroc was the greatest and far more than could be tolerated in actual hut panels. The results with the Johns-Manville were quite variable, and some tests showed greater settlements than should be tolerated in actual hut panels.
- (3) Although some insulations showed less settlement when the panel space was completely filled, the opposite occurred with the Westroc insulation, both with the 12 inch drop and with the 2 inch drop. Filling of the panel, therefore, does not guarantee reduced settling - in some cases it may increase the amount of settling.
- (4) Settlement of insulation in the panels is a problem requiring careful consideration. Settlement will definitely occur unless the insulation has special qualities.

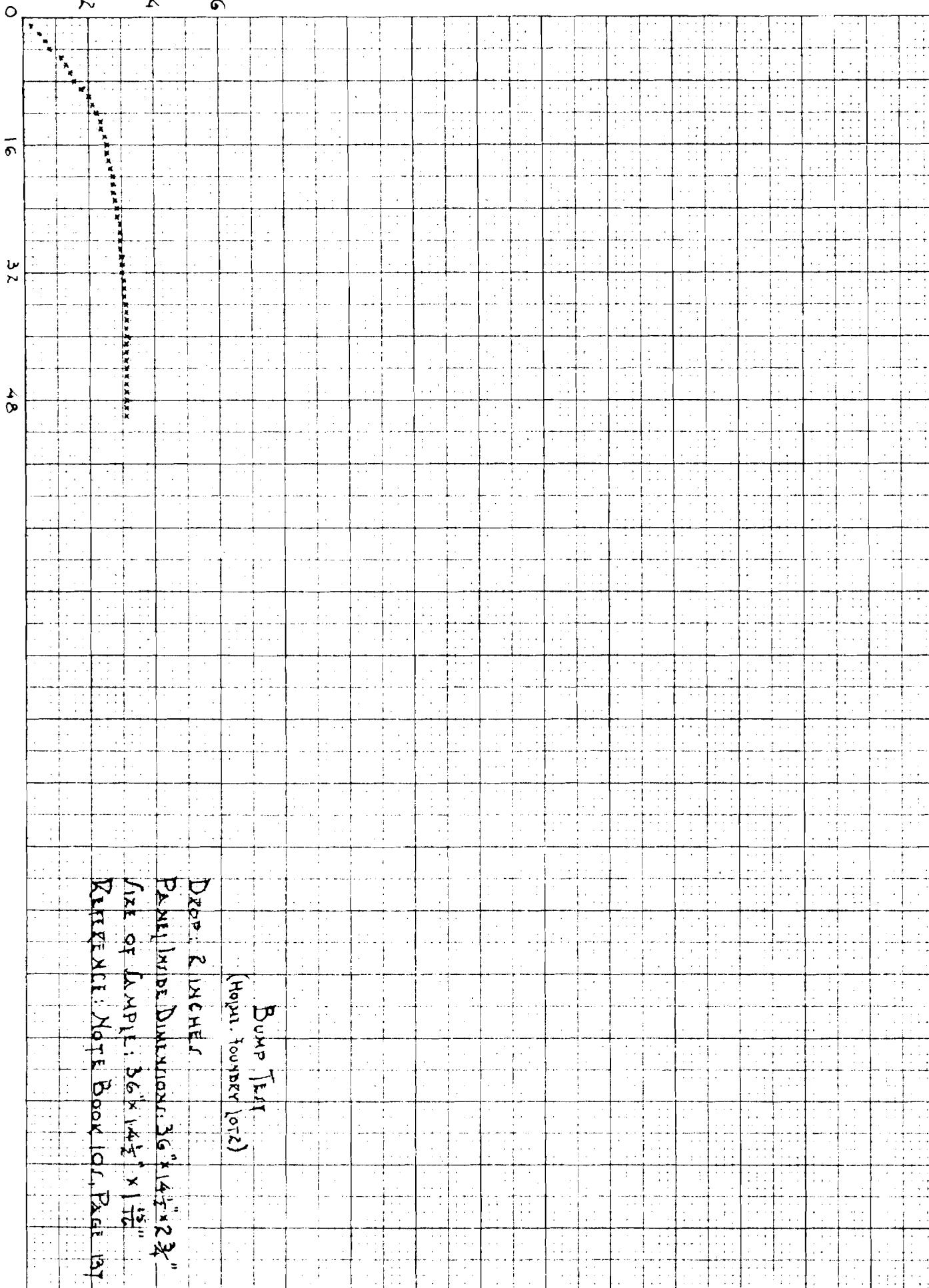
(5) The requirements for insulation presently set forth in the specifications for Army General Purpose Huts are not too severe, and indeed, some further tightening of the specifications might be considered. The present shear-tension strength and rigidity requirements do not necessarily guarantee an insulation that will not settle more than should be tolerated. Serious thought might be given to the inclusion of a settlement test similar to that used for this investigation.

INSULATION	SHEAR TENSION	NO. OF SAMPLES	DENSITY	NO. OF SAMPLES
FIBERGLAS (LOT 1)	7.62 lbs.	14	2.043 lbs/cu.ft.	15
WESTROC LOT 1)	1.05 lbs.	2	2.000 lbs/cu.ft.	4
JOHNS-MANVILLE (LOT 1)	6.525 lbs.	2	3.013 lbs/cu.ft.	3
HOLMES-FOUNDRY (LOT 1)	5.25 lbs.	2	4.605 lbs/cu.ft.	4
JOHNS-MANVILLE (LOT 3)	-	-	3.092 lbs/cu.ft.	2
HOLMES FOUNDRY (LOT 2)	4.875 lbs.	12	3.15 lbs/cu.ft.	14

KINETIC ASPECTS OF CIGARETTES

PISTOL	PISTOL	PISTOL-MANVILLE	PISTOL-MANVILLE
Sample No.1 Sample No.2 reflection reflection of free end of free end (roke) 16" 16"	Sample No.1 Sample No.2 reflection reflection of free end of free end 1 $\frac{1}{4}$ " 5/8"	Sample No.1 Sample No.2 reflection reflection of free end of free end 3-11/16" 3-11/16"	Sample No.1 Sample No.2 reflection reflection of free end of free end 1-3/16" 1-3/16"

SETTLEMENT IN INCHES



SETTLEMENT
IN INCHES

6

10

12

14

16

18

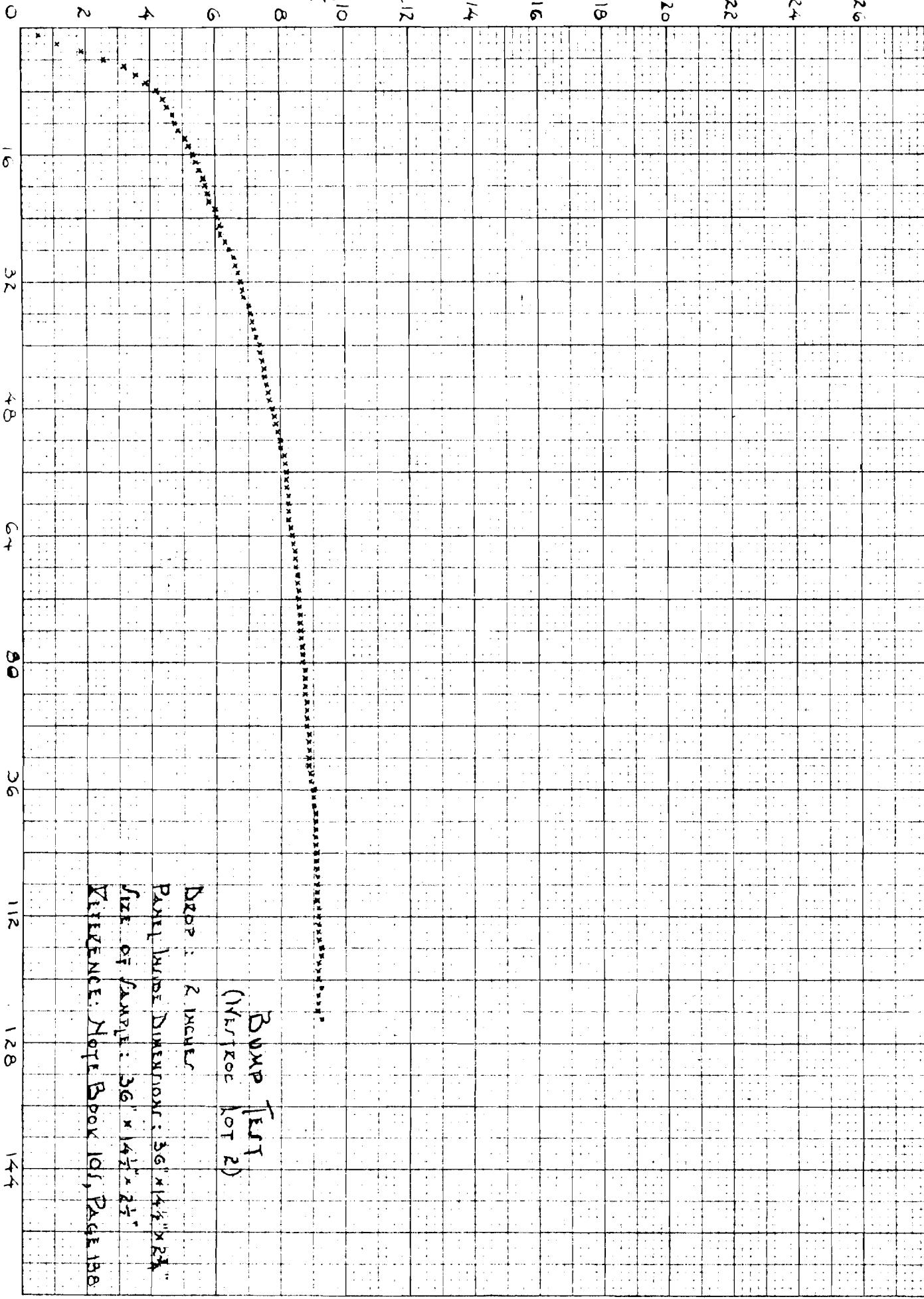
20

22

24

26

NUMBER OF DROPS



BUMP TEST
(WET ROCK LOT 2)

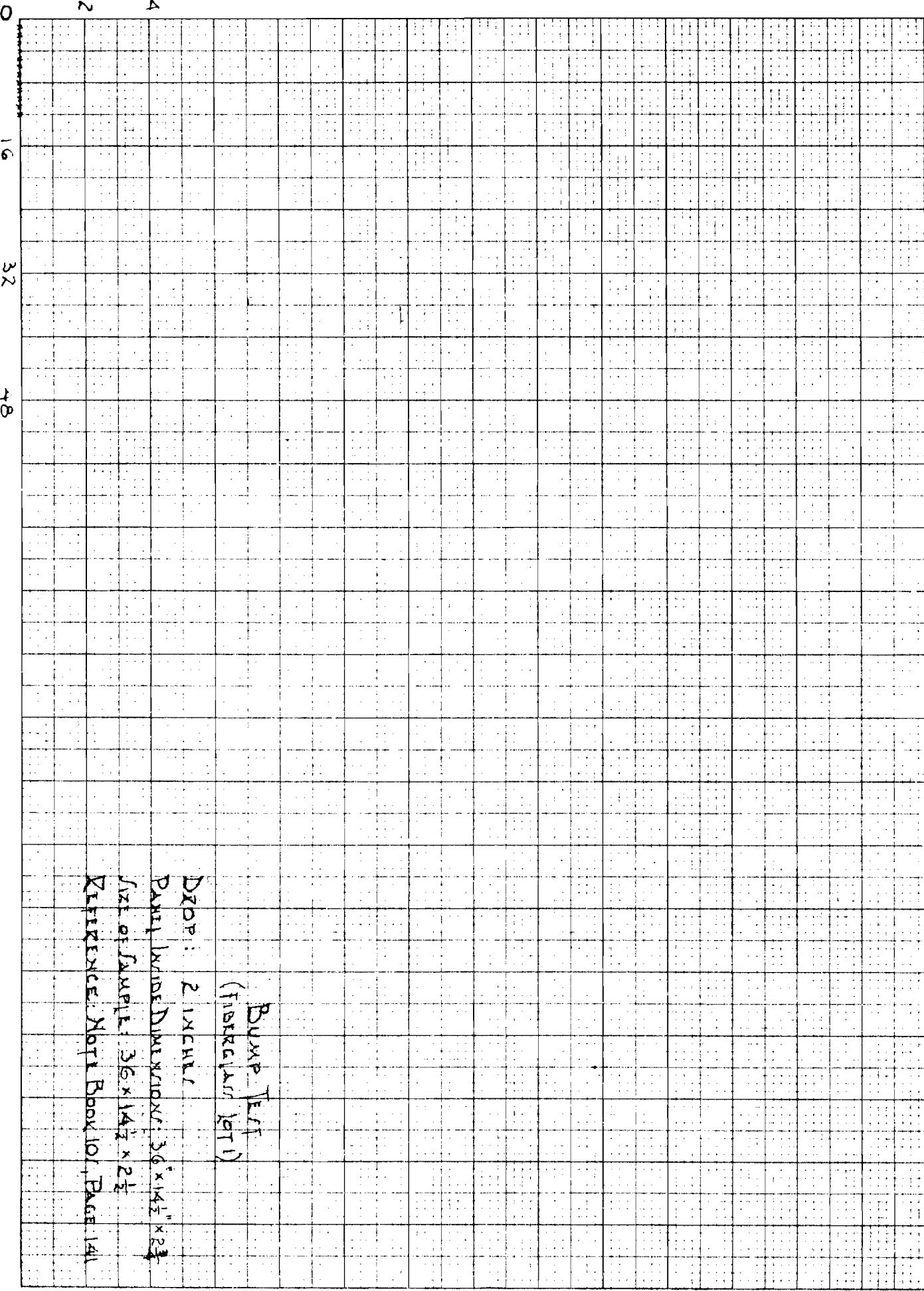
Drop : 2 inches

PAN LINED DIMENSIONS: 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{4}$ "

SIZE OF SAMPLE: 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{4}$ "

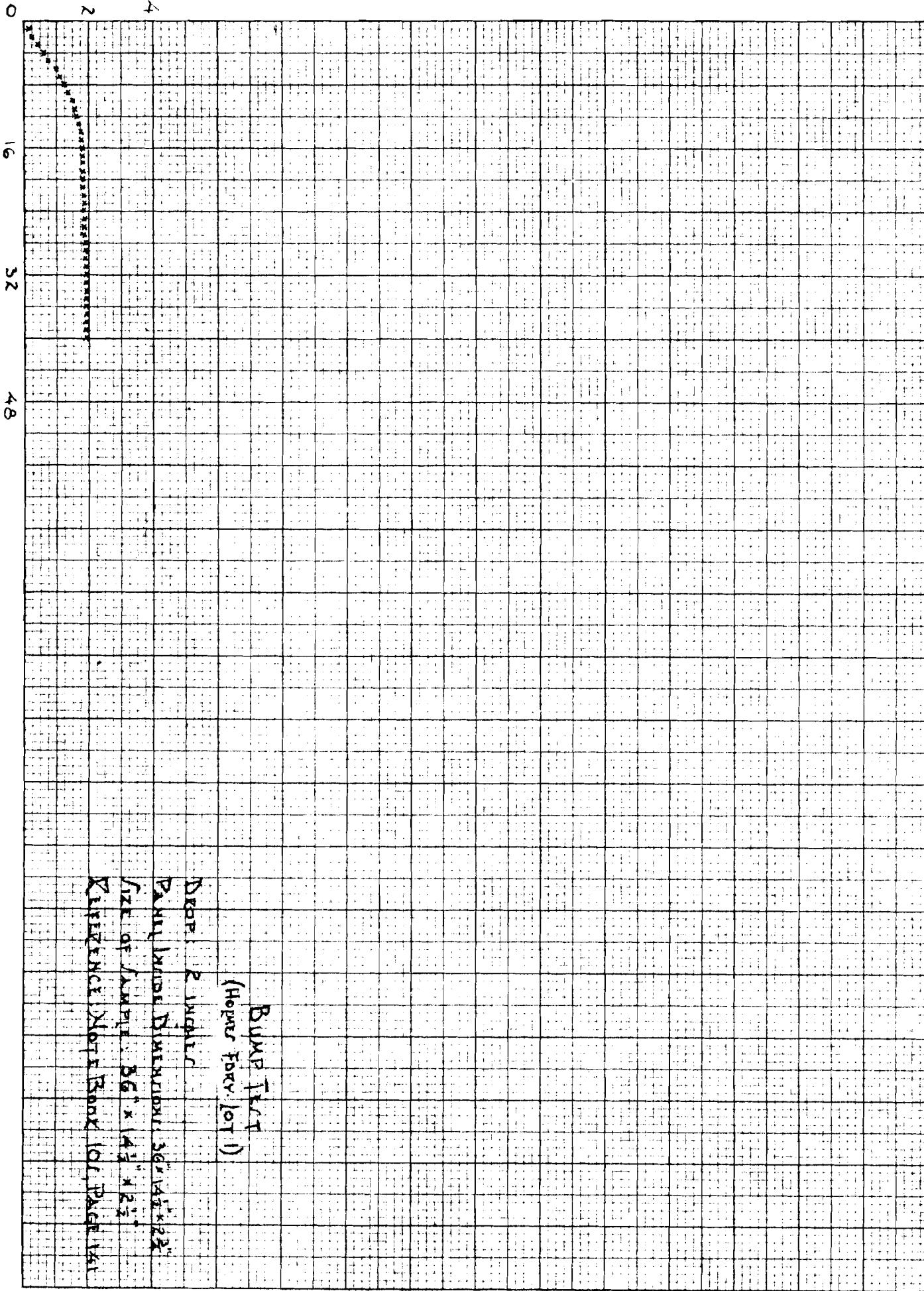
REFERENCE: NOTEBOOK 101, PAGE 138

SETTLEMENT IN INCHES

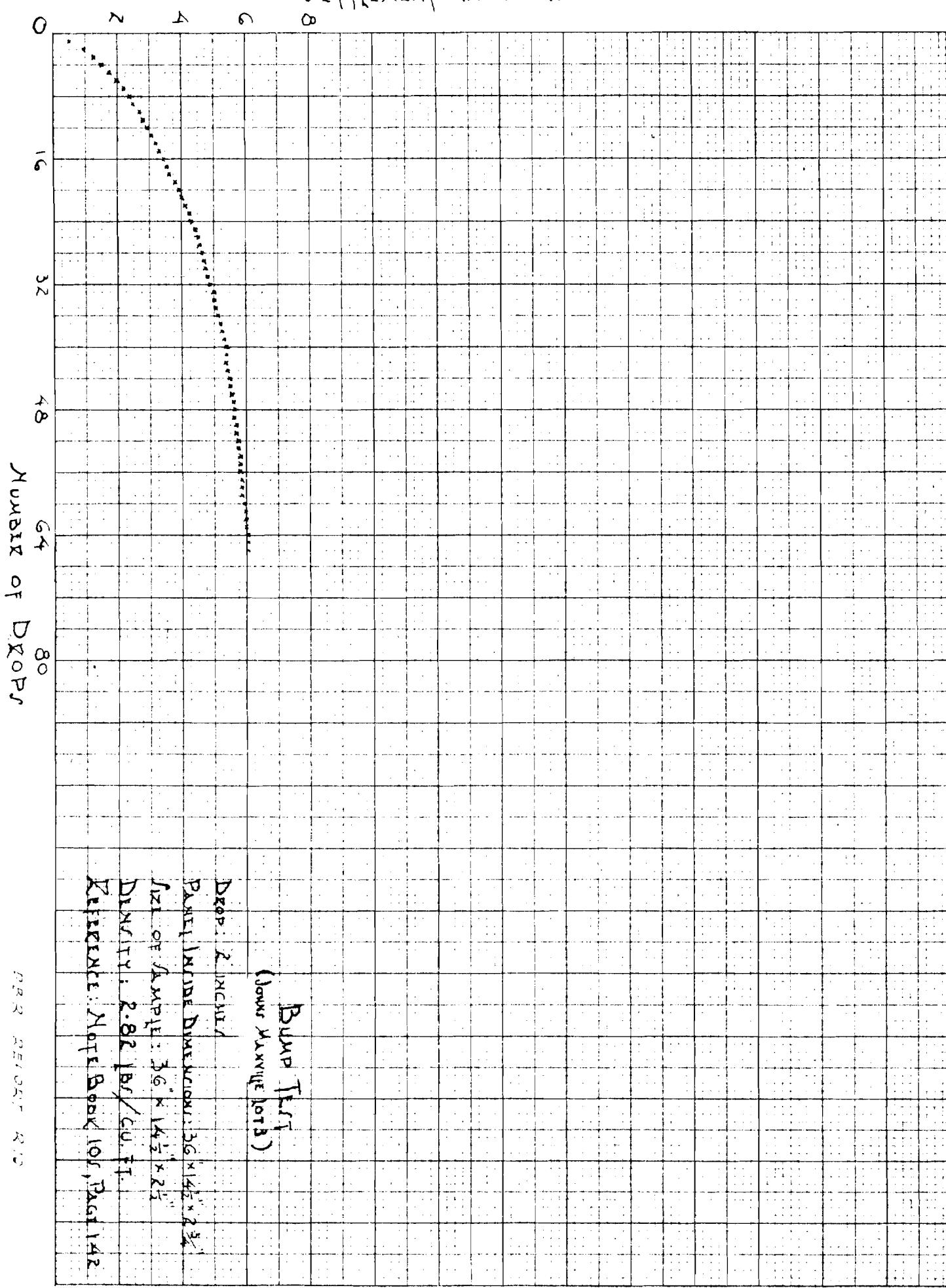


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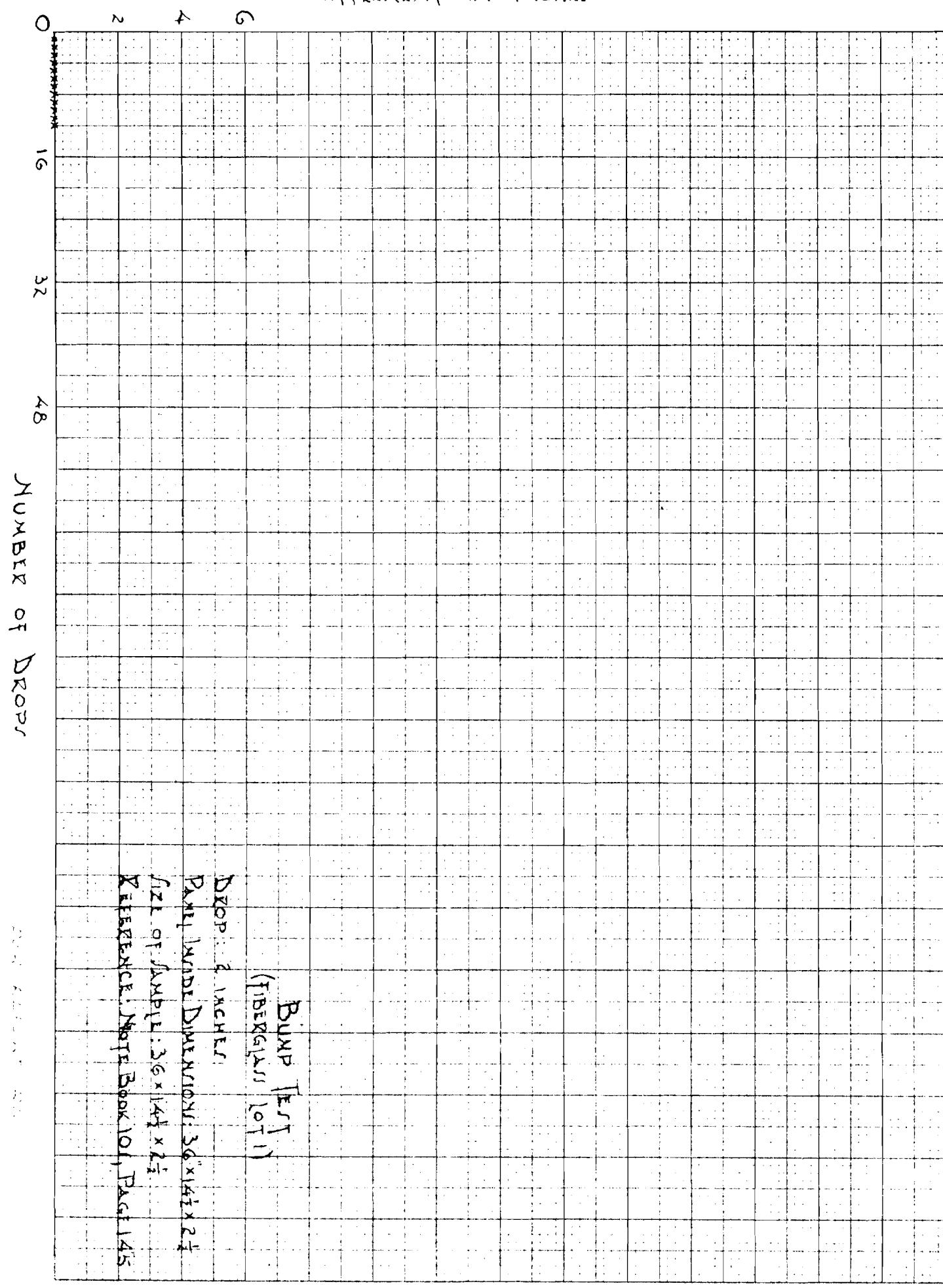
NUMBER OF DROPS



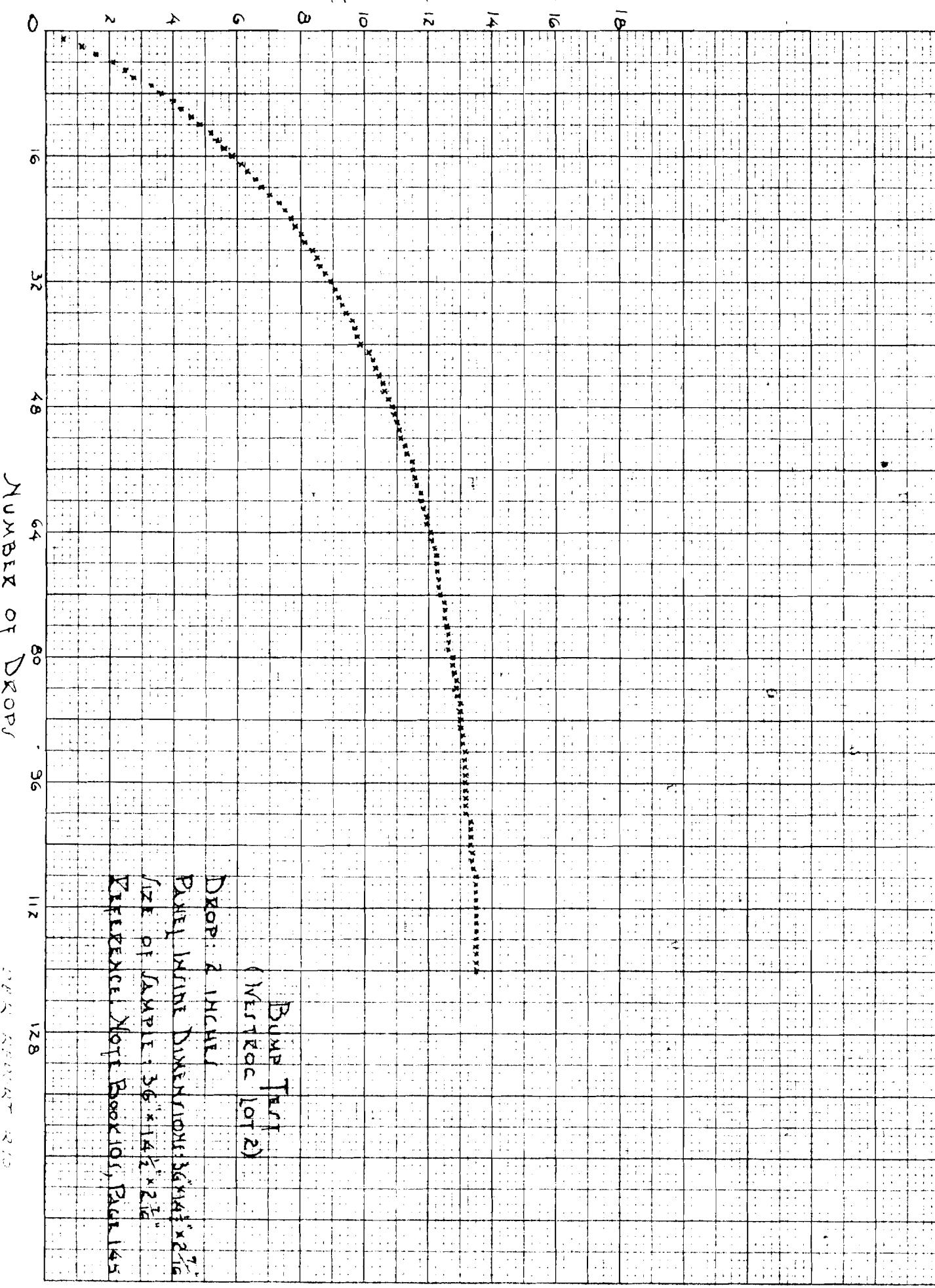
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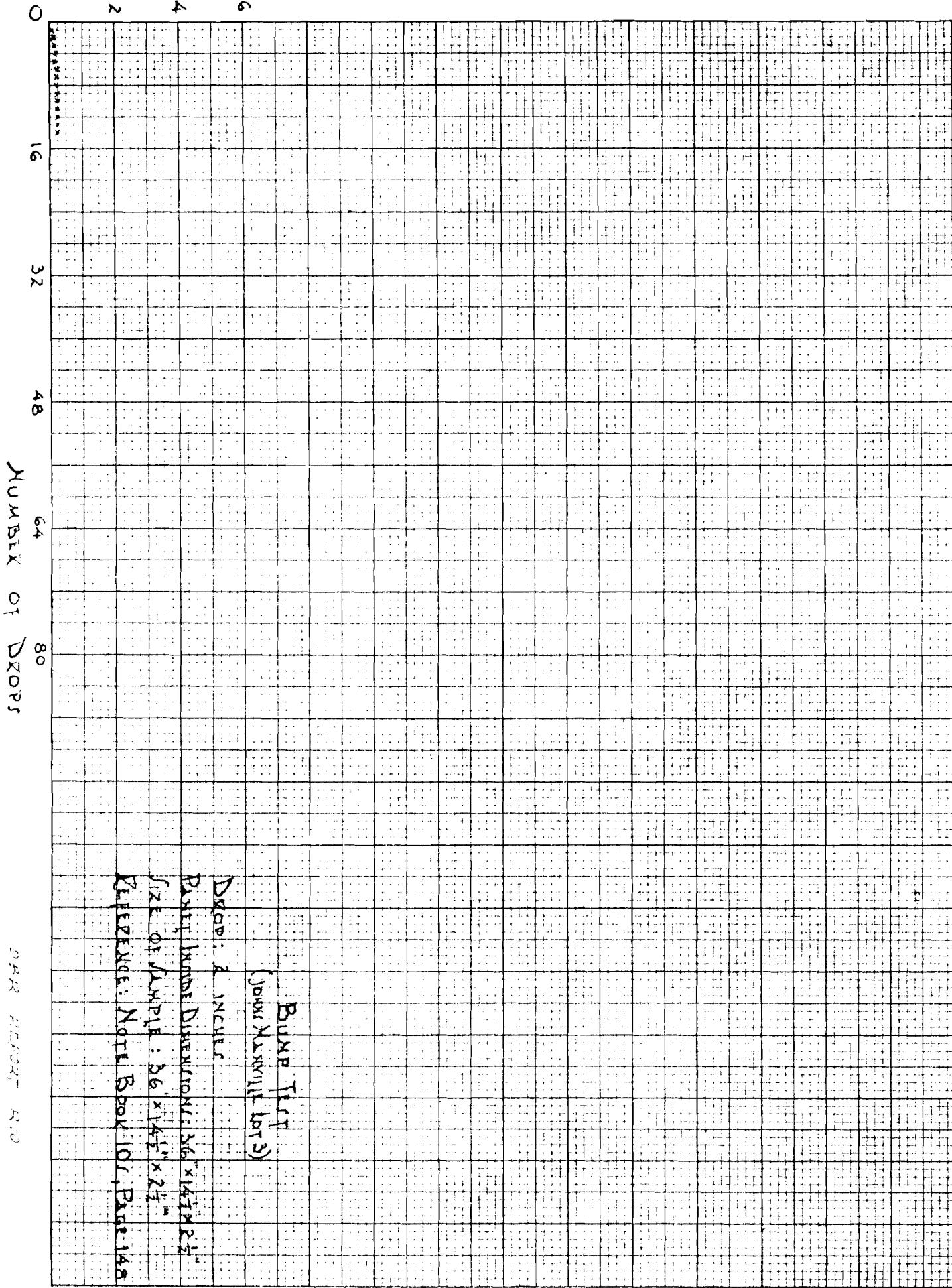
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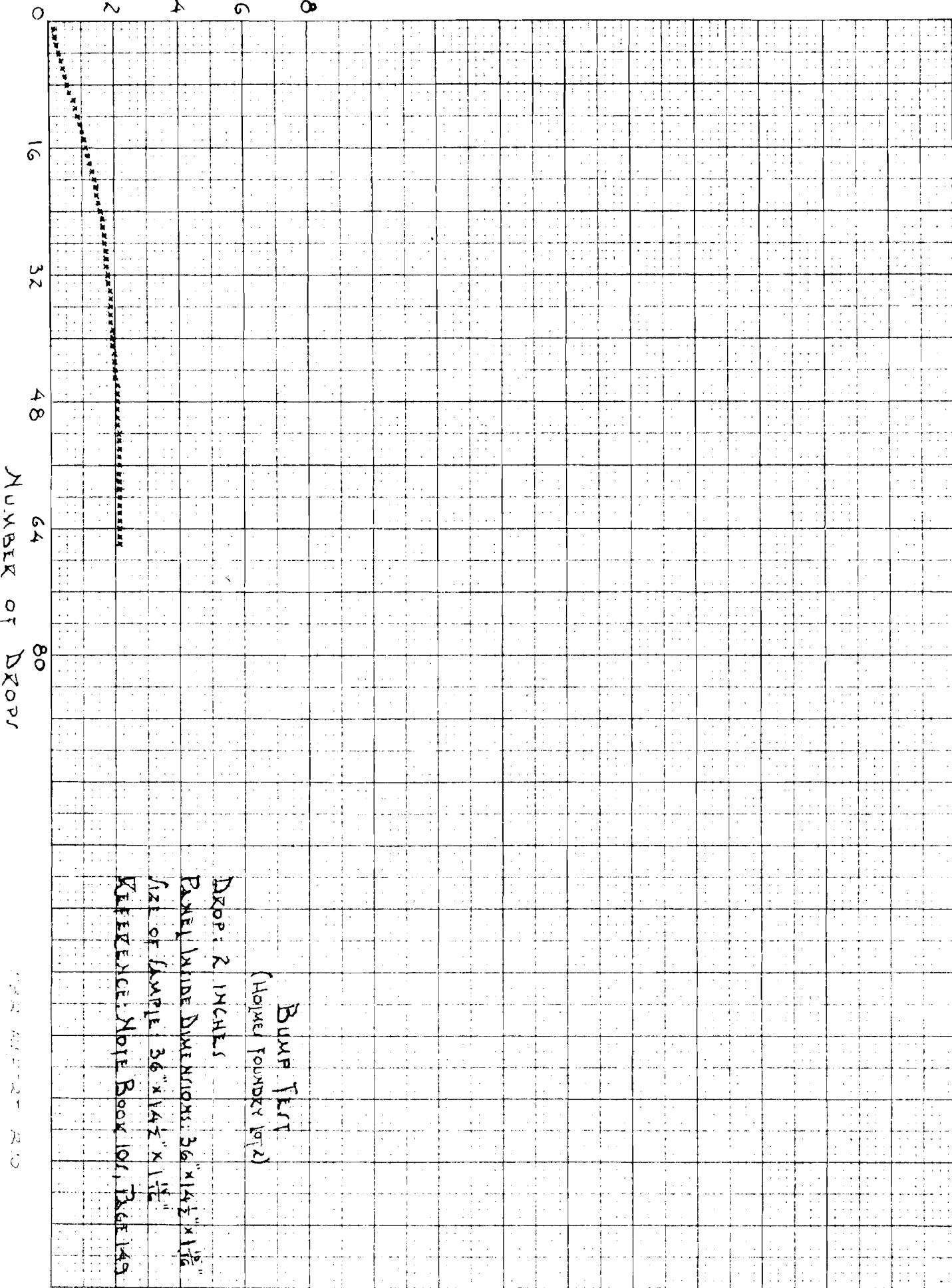
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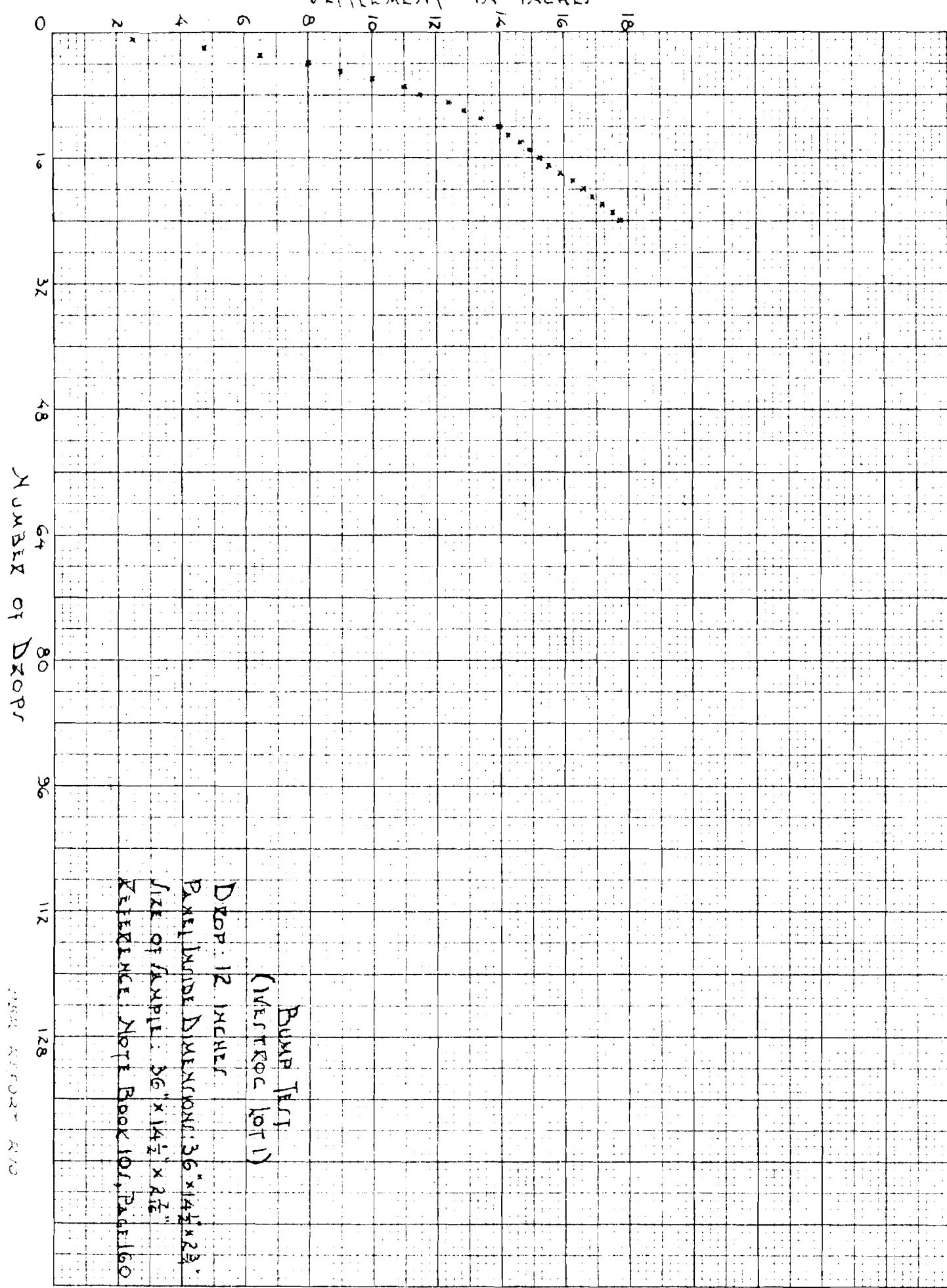
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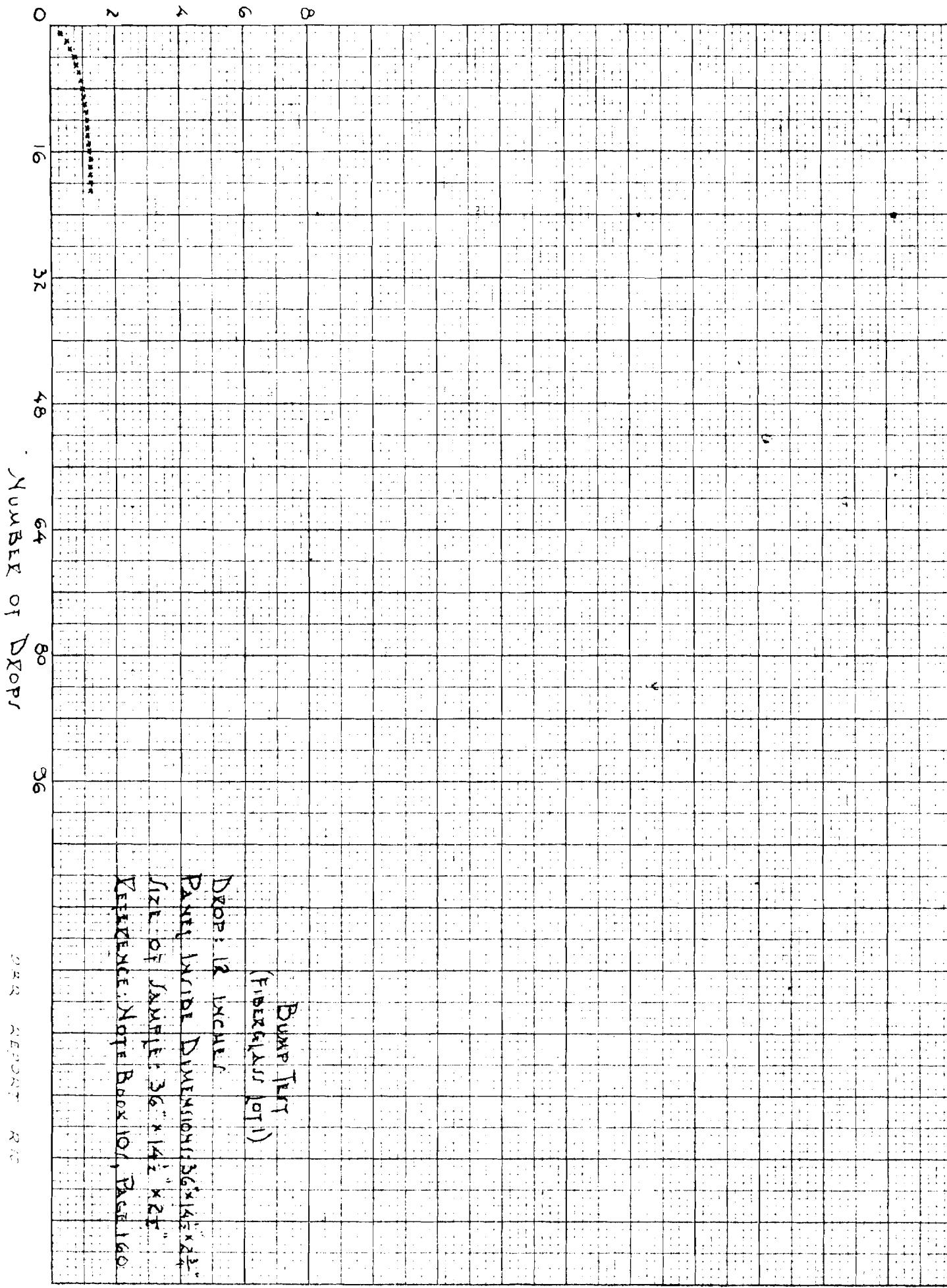
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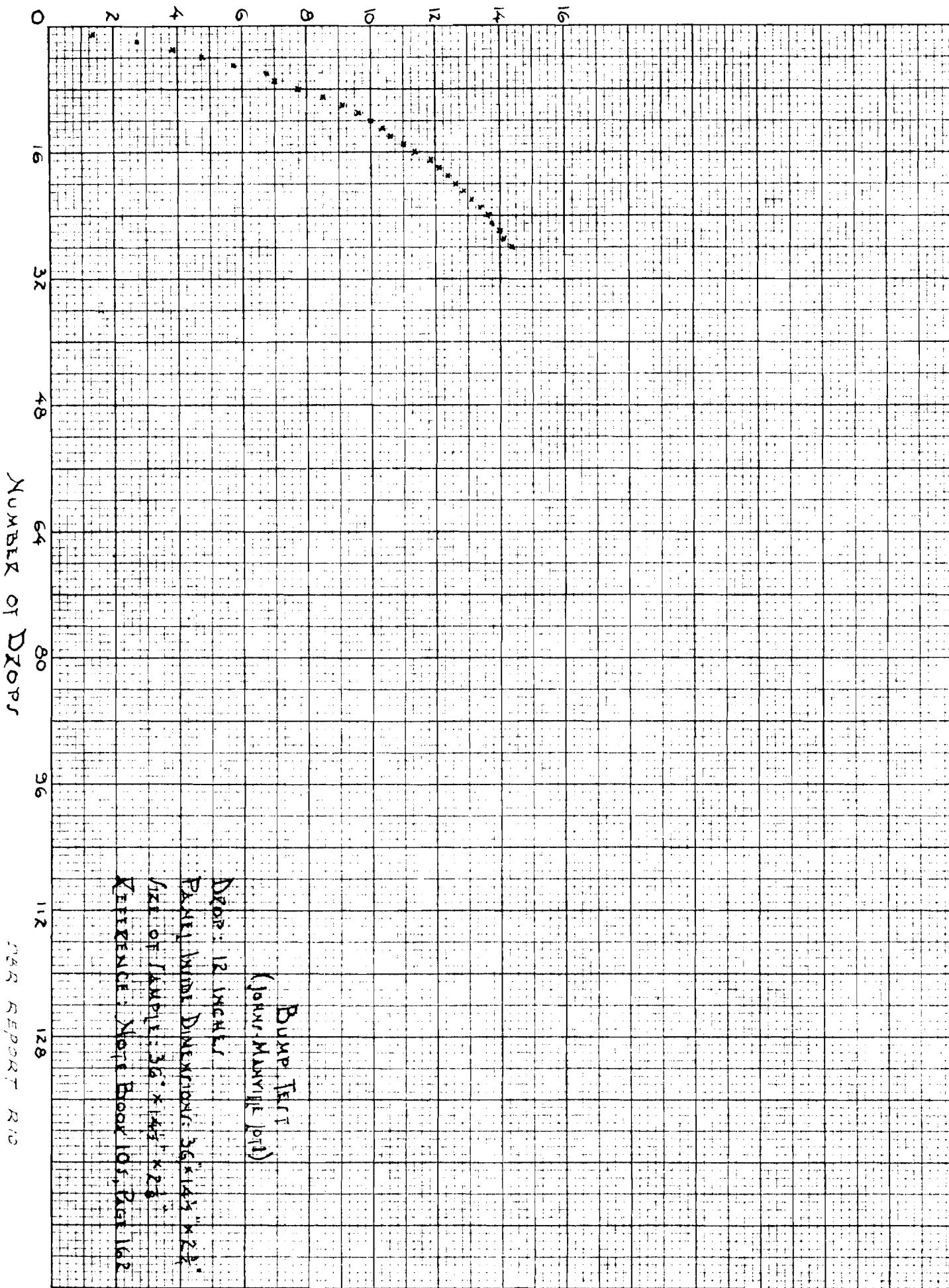
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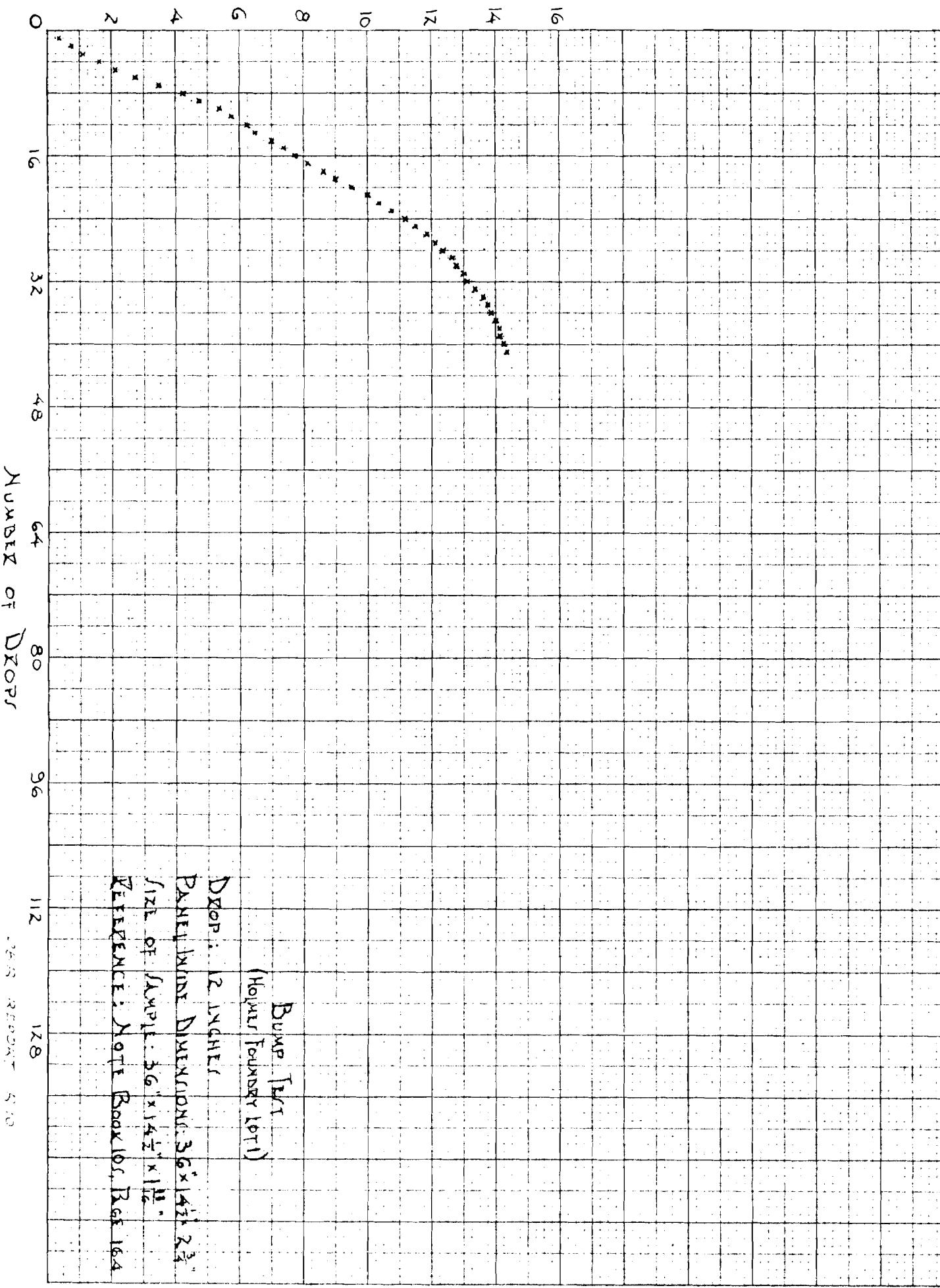
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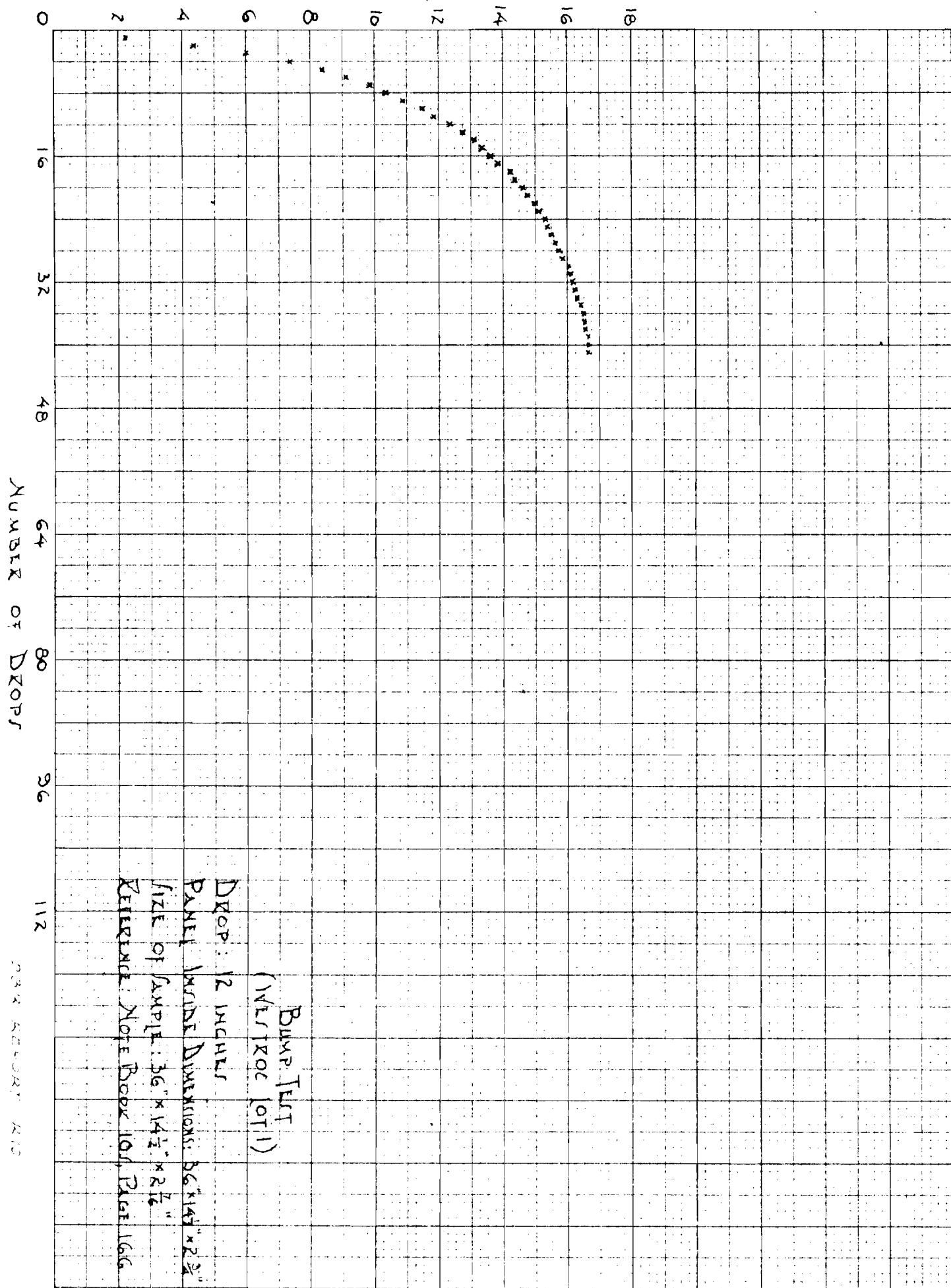
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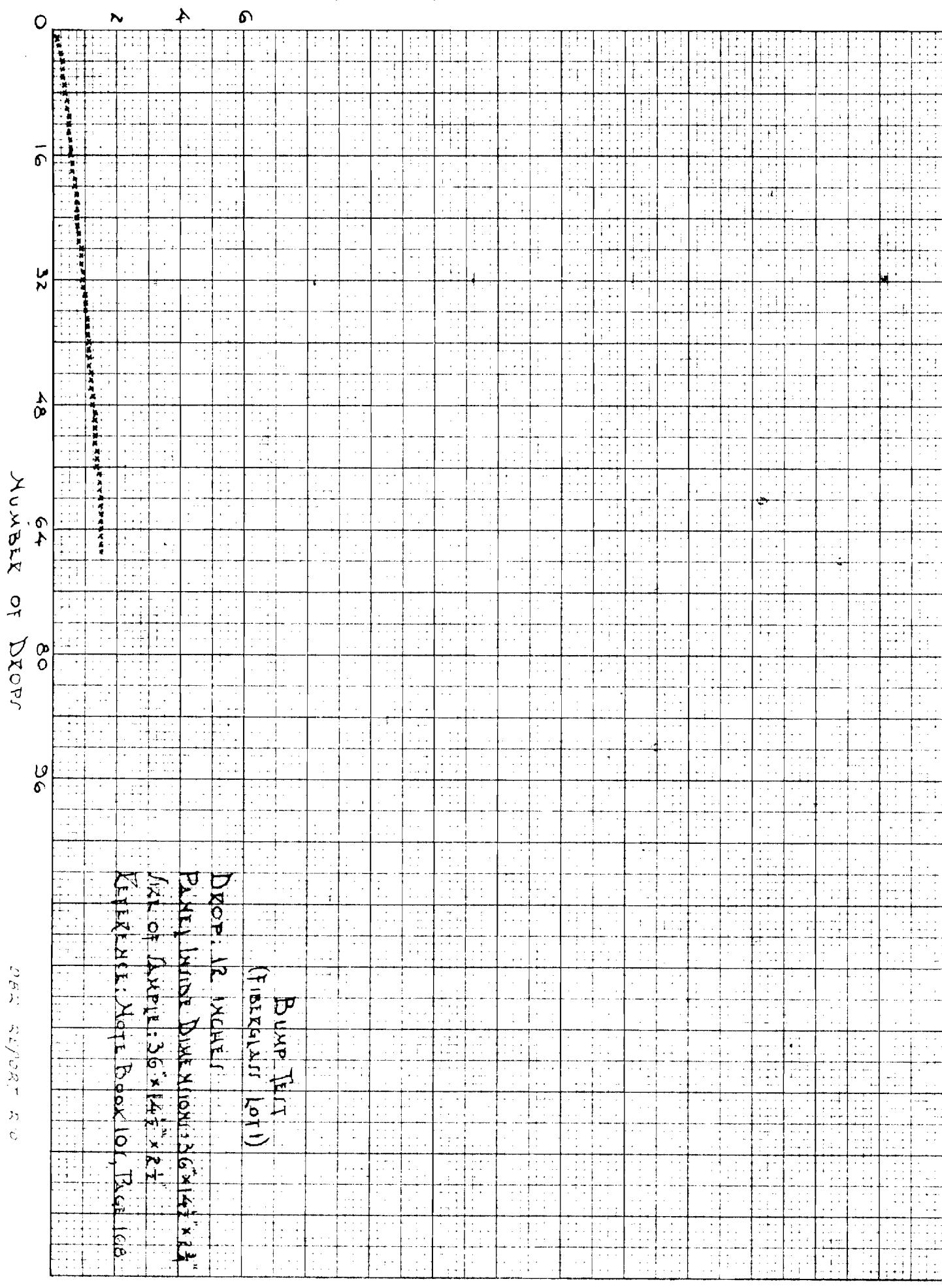
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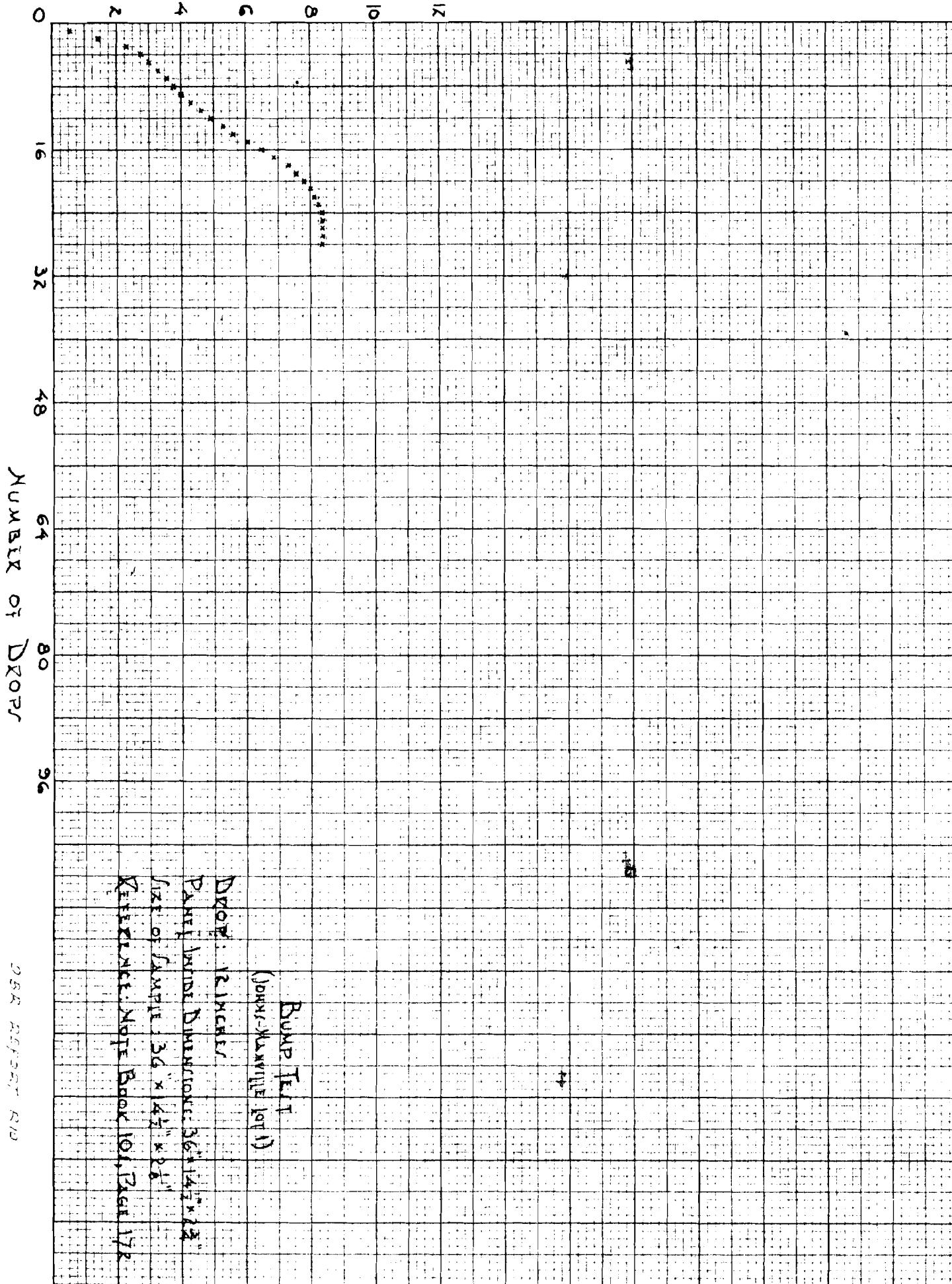
TEST LENGTH IN INCHES



SETTLEMENT IN INCHES



SETTLEMENT IN INCHES



BUMP TEST
(JOHNS-MANVILLE ROT)

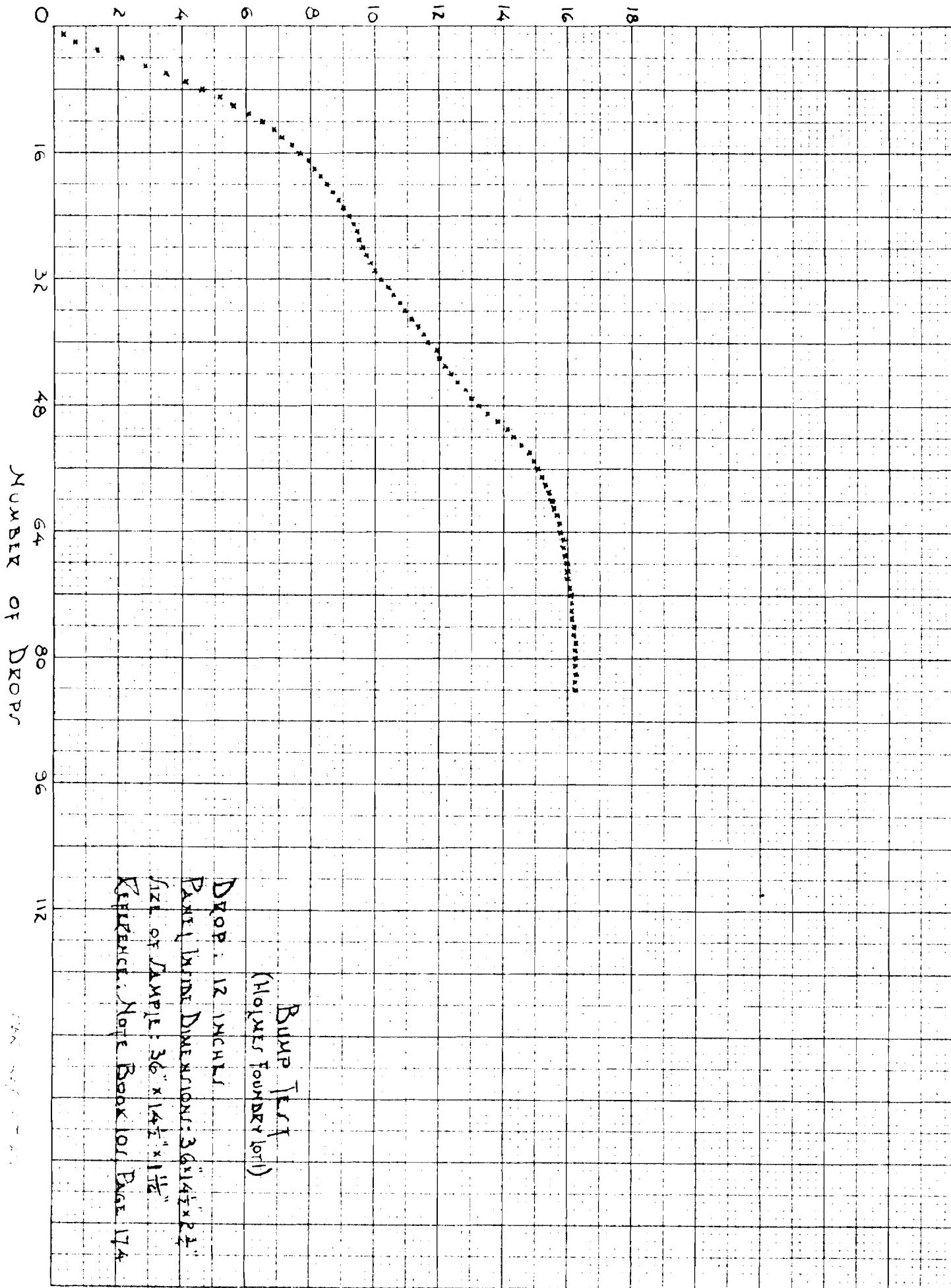
Drop: 12 inches

Panel Inside Dimensions 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ "

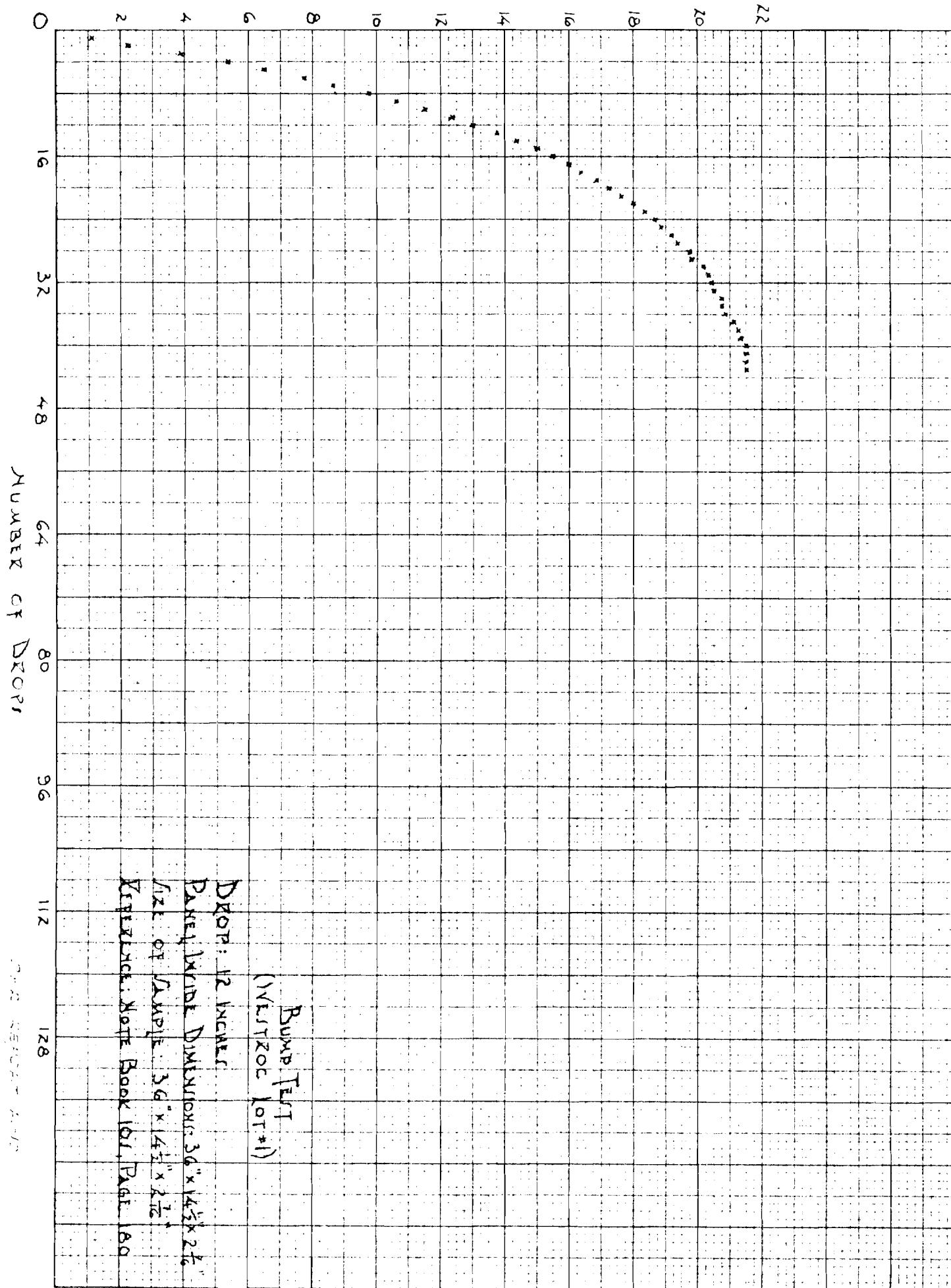
Size of Sample 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ "

Reference Note Book 101, Page 172

SETTLEMENT IN INCHES



SETTLEMENT IN INCHES



SETTLEMENT IN INCHES

0 A 6

16

32

48

NUMBER OF DROPS

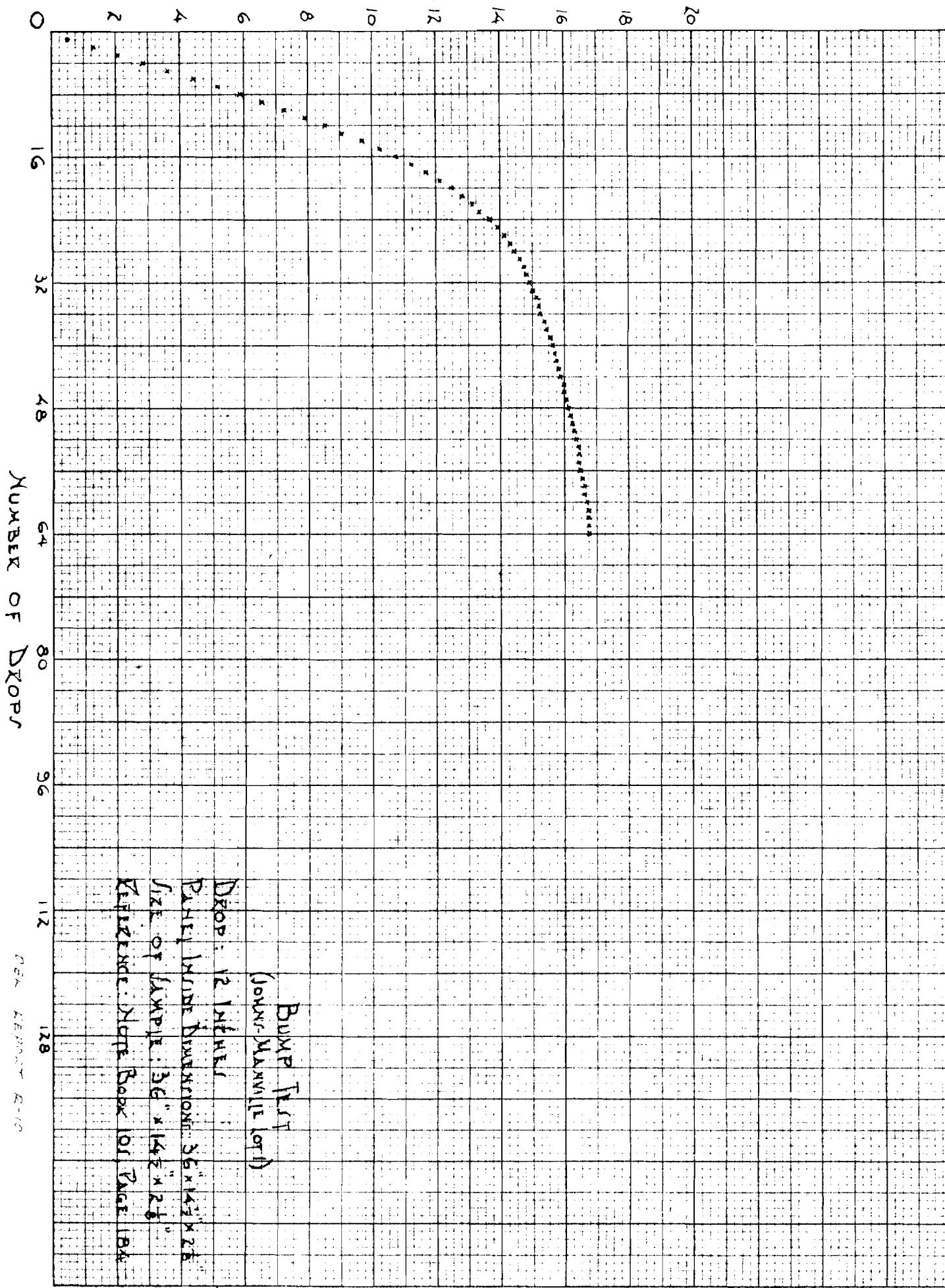
BUMP TEST
(FIBERGLASS LOT 1)

DROP: 13 INCHES

PANEL LINEAR DIMENSIONS: 36" X 14 $\frac{1}{2}$ " X 2 $\frac{1}{2}$ "SIZE OF SAMPLE: 36" X 14 $\frac{1}{2}$ " X 2 $\frac{1}{2}$ "

REFERENCE: NOTE BOOK NO. 1, PAGE 182

SETTLEMENT IN INCHES



BUMPER TEST
(JOHN'S MANHATTAN)

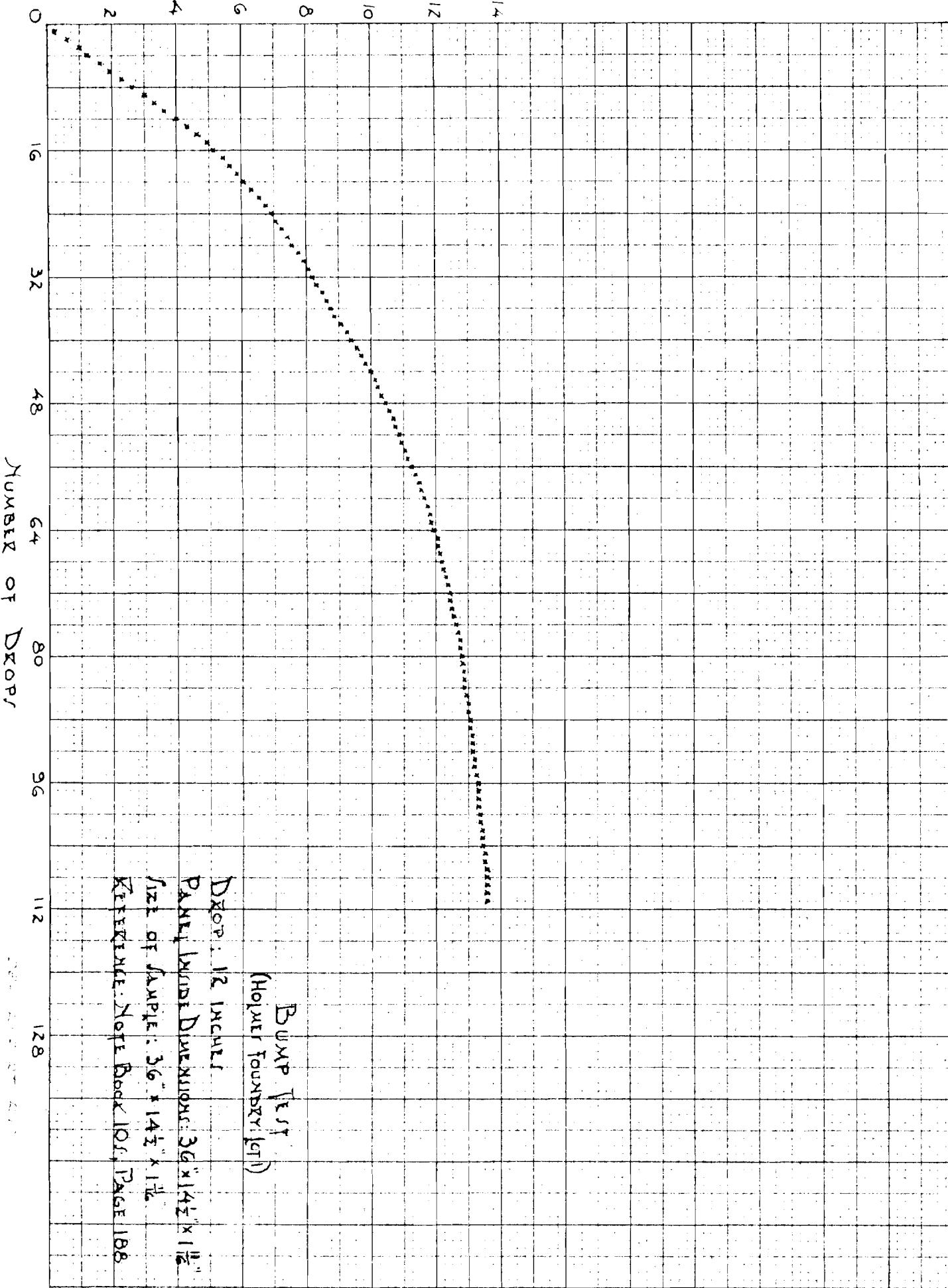
Drop: 12 inches

PAPER BOARD DIMENSIONS: 36" x 14.2" x 2.6"

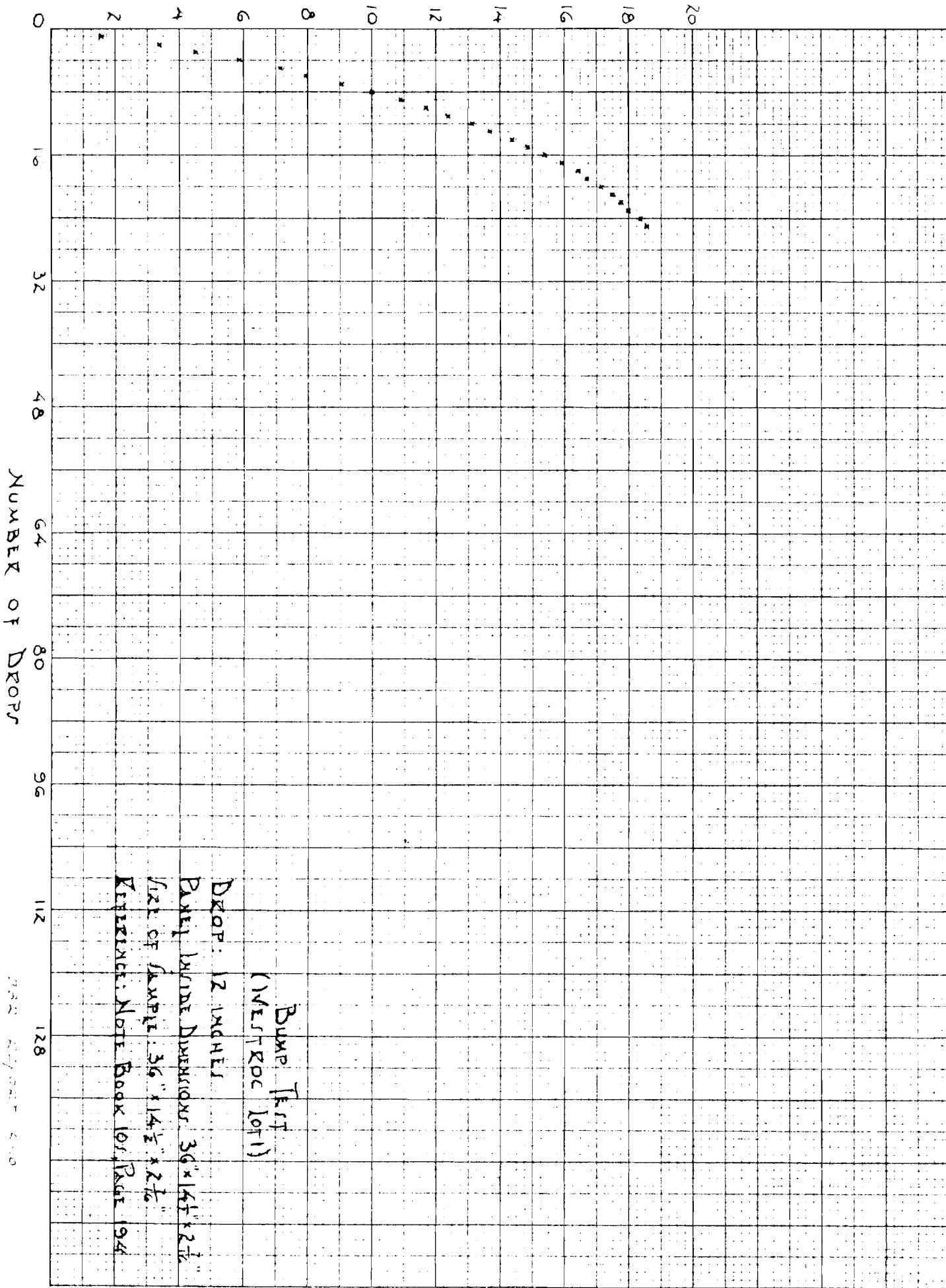
SIZE OF SAMPLE: 36" x 14.2" x 2.6"

REFERENCE: Note Book on Page 184

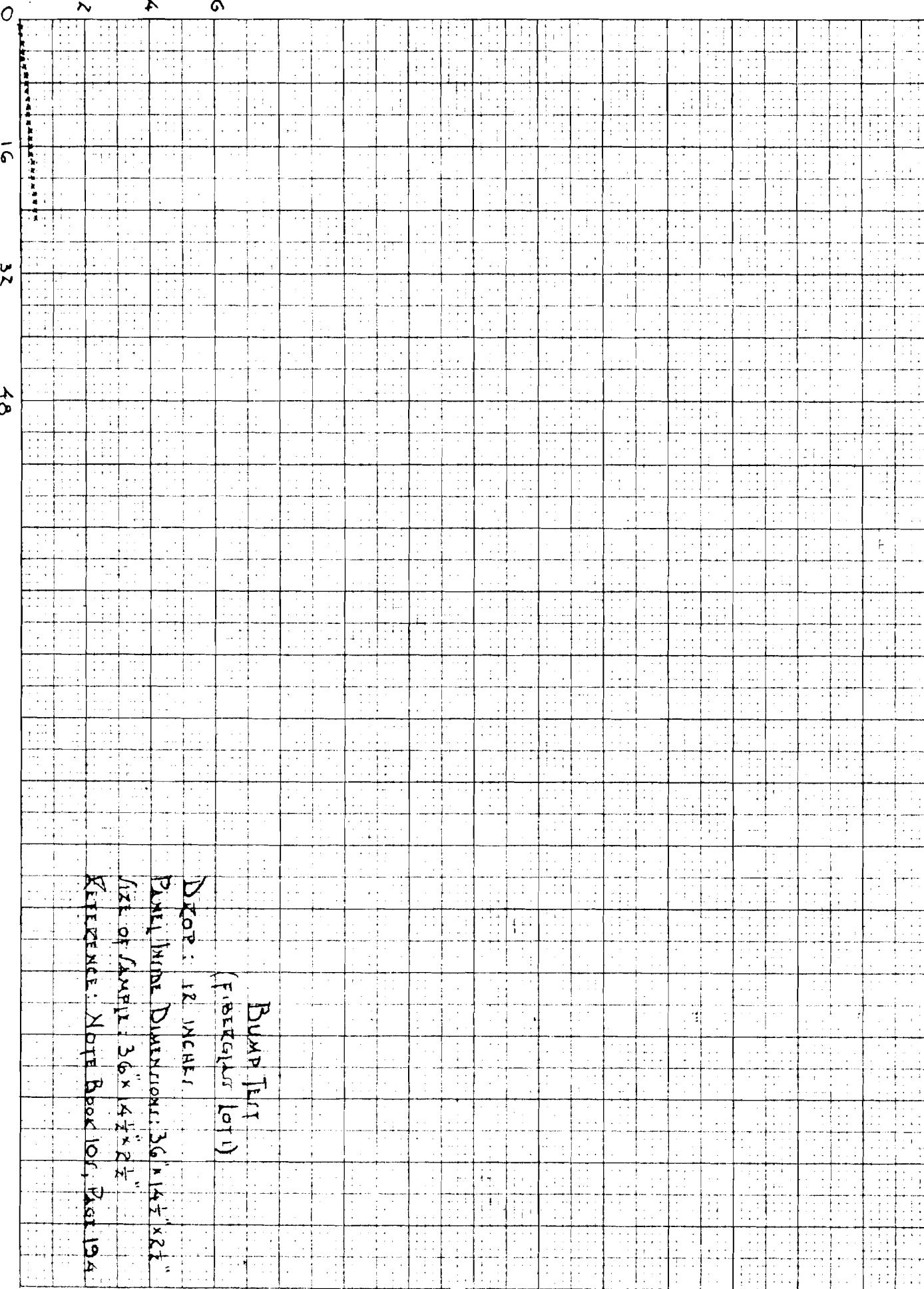
SETTLEMENT IN INCHES



SETTLEMENT IN INCHES



SETTLEMENT IN INCHES



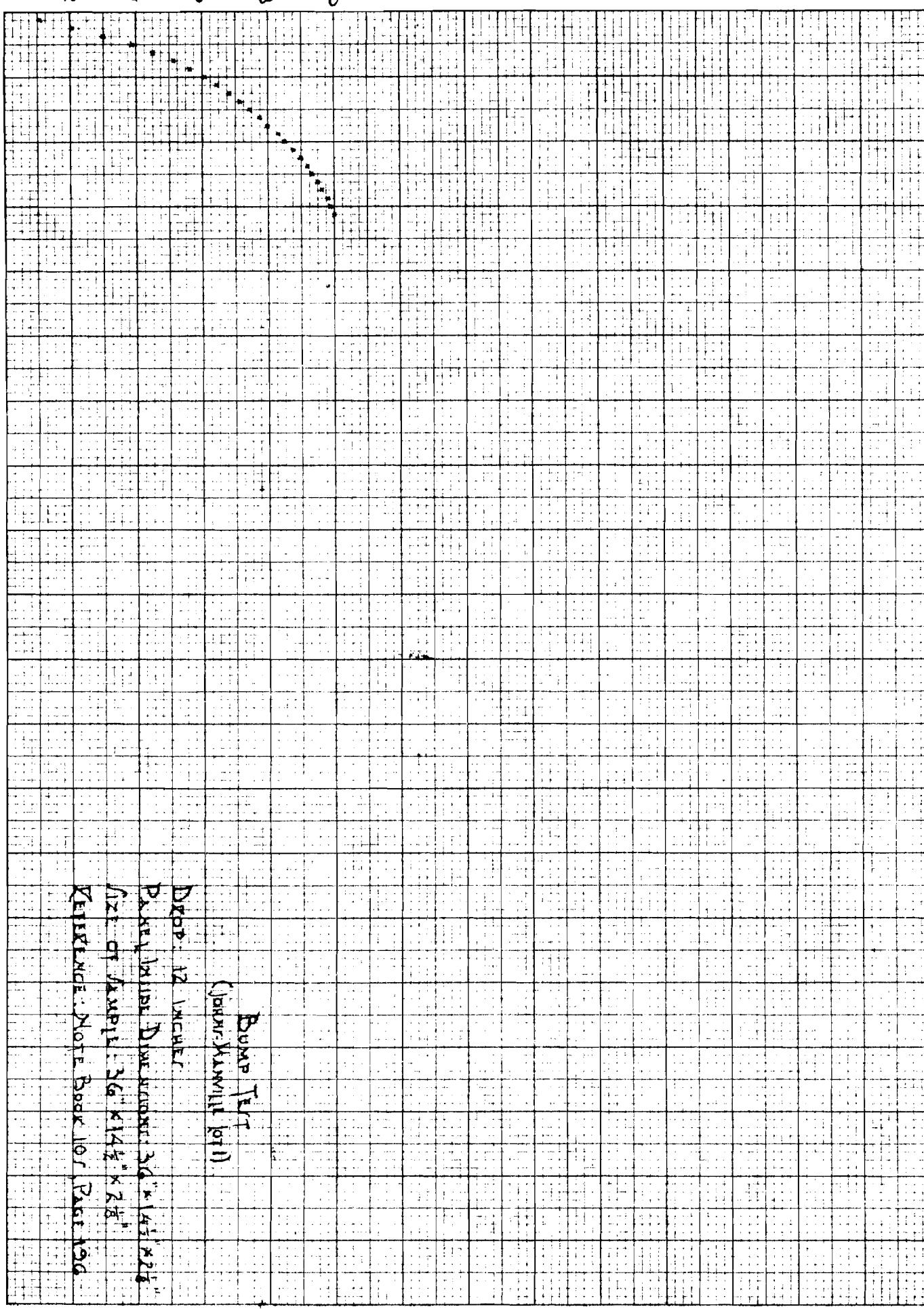
NUMBER OF DROPS

SETTLEMENT IN INCHES

0 2 4 6 8 10

16 32 48

NUMBER OF DROPS



BUMP TEST
(John F. Kammill pot)

Drop: 12 inches

Packed in soil dimensions: 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ "
size of sample: 36" x 14 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ "
REFERENCE: NOTEBOOK 101 PAGE 102

SETTLEMENT IN INCHES

