HIGHWAY RESEARCH REPORT

CONCRETE BEAM BREAKER

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December, 1967

STATE OF CALIFORNIA

TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 645168

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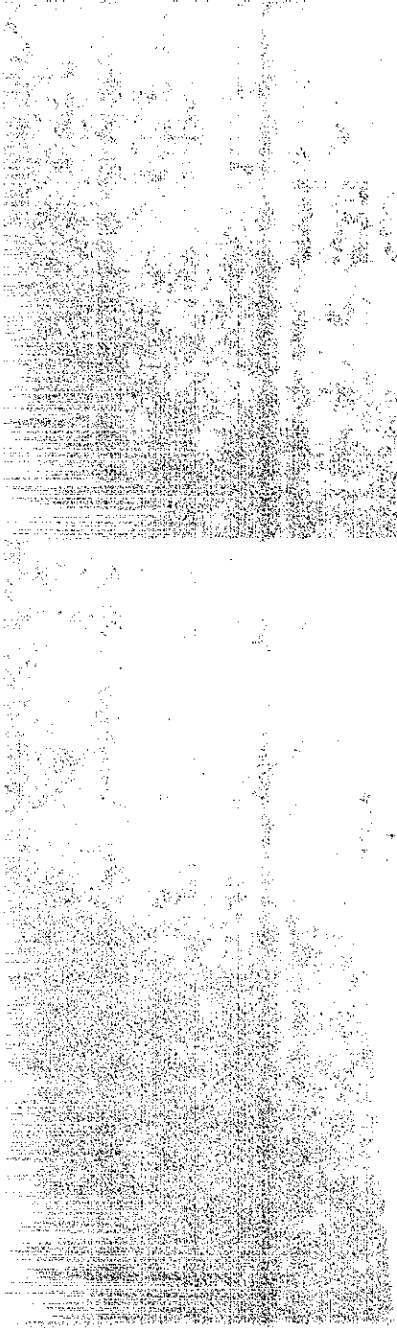

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STATE OF CALIFORNIA—TRANSPORTATION AGENCY RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

December, 1967

M & R Research Project
Work Order No. 645168

Mr. J. A. Legarra
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

CONCRETE BEAM BREAKER

Donald L. Spellman
Principal Investigator

James H. Woodstrom
Co-Investigator

B. F. Neal
Project Engineer

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

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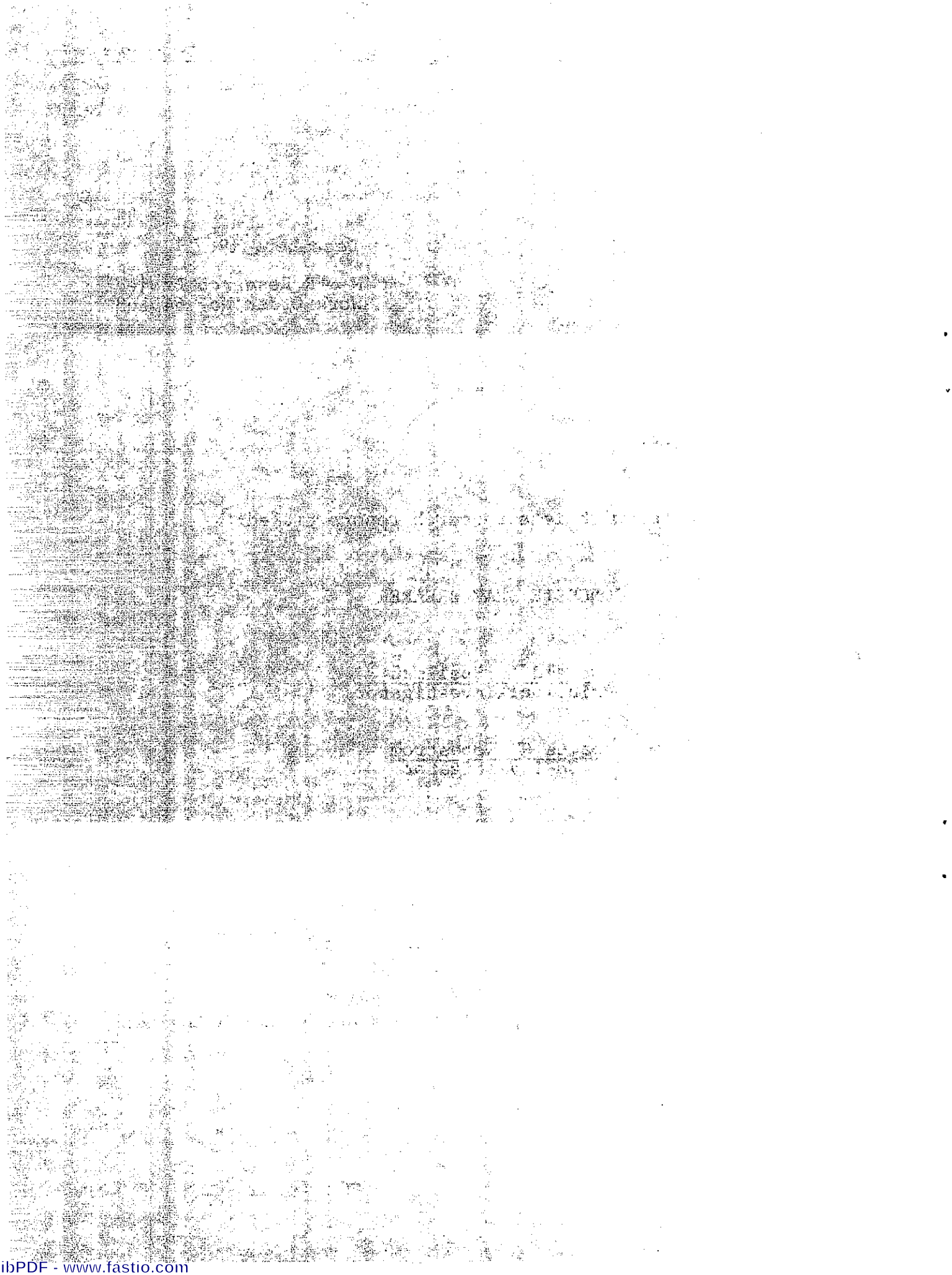

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Reference: Spellman, D. L., Woodstrom, J. H., "Concrete Beam Breaker", State of California, Department of Public Works, Division of Highways, Materials and Research Department. Research Report No. 645168, December, 1967.

Abstract: The laboratory evaluation of a commercially available concrete beam testing device is reported. Results indicate the Rainhart Beam Tester, Model 416TL, to be satisfactory for determining the flexural strength of concrete by the third-point loading method, and to have several advantages over the device presently used in the field. The advantages include both safety and convenience factors.

Key Words: Beam Tests, Concretes, Flexural Strength, Modulus of Rupture, Pavement Design, Testing Equipment.

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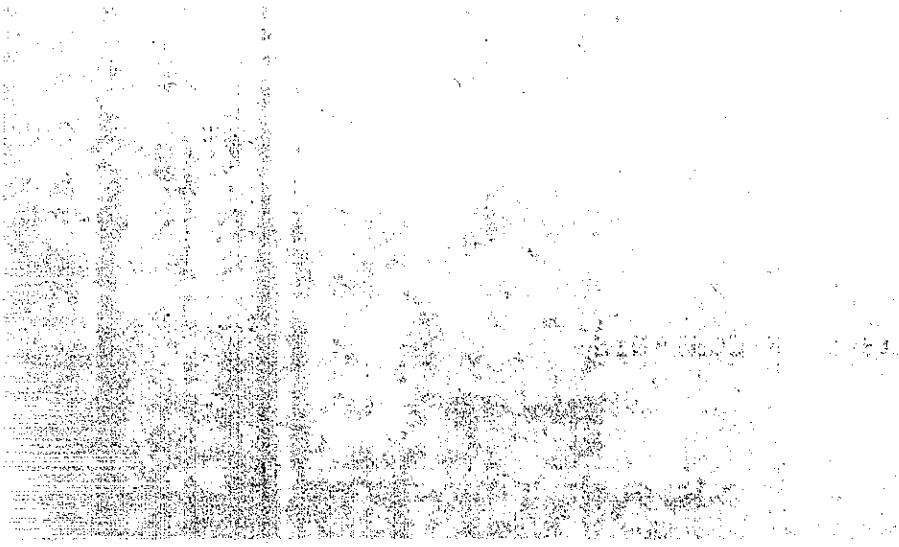

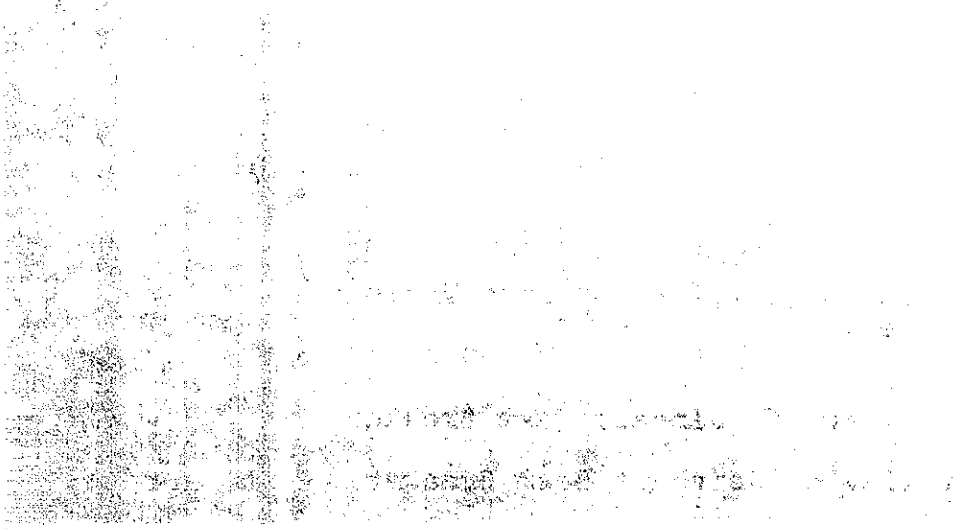

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CONCRETE BEAM BREAKER

INTRODUCTION

The current method of field testing for the flexural strength of concrete involves the use of testing equipment that has proven to be antiquated in design and hazardous to the operator. Use of the device requires placing a heavy concrete specimen onto unstable bearing surfaces only a few inches above the ground or other working surfaces. Back injuries have occurred due to this awkward working position, resulting in lost time industrial accidents. In addition, hands and fingers have been bruised when placing the specimen onto the bearing surfaces.

During the past few years, research has been underway to develop a safer and more convenient test. In a recent report published by the Materials and Research Department[1], it was concluded that a flexural strength test is the most suitable test available for determining when a concrete pavement may be opened to traffic. Modifications of the present test procedure however, were considered most desirable.

[1]A Study of Flexural Strength vs. Indirect Tensile Strength (Tensile Splitting) of Concrete, January, 1967.

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CONCLUSIONS

The Rainhart Beam Tester, Model 416TL, appears to be completely satisfactory as a device for determining the flexural strength of concrete beams in the field. Some of its advantages over the presently used device are:

1. A shorter and lighter weight test specimen can be used, thus reducing the safety hazard due to lifting.
2. Placing a beam into the device is more convenient. (Difficulty in placing the test specimen in our presently used breaker has been a constant source of complaint.)
3. Applying a load to a test beam is simple and requires little instruction or practice, thus reducing operational discrepancies.
4. The required load rate can be adhered to easily by use of a pacing line on a chart.
5. A permanent record is provided of both the loading rate and the total load at failure.
6. The use of a third-point loading is compatible with our recently adopted design method for portland cement concrete pavements, and provides more representative values of the flexural strength of concrete.

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NEW BEAM BREAKER

In developing a new beam breaking device, consideration was given to safety factors, improvement of test method, and concrete pavement design methods.

The recently adopted method of concrete pavement design utilizes the 28-day flexural strength of concrete as determined from test beams broken under third-point loading. This type of loading is almost universally accepted as superior for determining the flexural strength of concrete. It shows the probable minimum strength of the middle third of a test beam, thus providing more reliable engineering data. Our present method, using centerpoint loading, measures the strength at only the one point under load - the point at which the maximum bending moment occurs.

To reduce the weight of the test specimens, the beam breaker was designed to test beams as short as 20 inches (18-inch span). Beams of this length have been routinely used in this laboratory for many years with satisfactory results.

A prototype beam breaker was designed and fabricated incorporating the above-mentioned criteria. Preliminary testing revealed two major deficiencies in the design. (1) The hydraulic loading system was unsatisfactory for the high pressures involved; it also loaded the specimen with pulses rather than a continuous increase, and (2) a pacing device was needed or at least deemed

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advisable to control the rate of loading.[2] A chart recorder was considered desirable since it would provide a record of both the loading rate and the total load at beam failure.

During this investigation, it was found that the Rainhart Company of Austin, Texas, manufactured a beam breaker incorporating practically all of the features which were considered important in our design, including a chart recorder. (See photographs.) Arrangements were made to evaluate their device, and modifications to the laboratory developed breaker were suspended pending this evaluation.

[2]ASTM Designation: C 78 specifies that the load may be applied rapidly up to approximately 50% of the breaking load, after which it shall be applied at such a rate that the increase in extreme fiber stress does not exceed 150 psi per min.

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TESTING PROGRAM

A testing program was planned to compare flexural strength results of beams broken with a Rainhart breaker to those obtained by our standard laboratory test procedure using a universal testing machine. Test specimens for this comparison were 6x6x20-inches. The third-point loading was used in each machine. In addition, limited testing was done to compare flexural strength results obtained with the two above machines to that of the center-point loading field device. For tests with the field beam breaker, specimens were 6x6x34-inches.

Test specimens were fabricated at the laboratory from ready-mixed concrete. Twelve 20-inch and three 34-inch beams were made each day for four days. The beams were broken at various ages to provide a range in strength results. Three beam breaks on each machine were averaged for one test and results are shown in Table 1.

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DISCUSSION

The operation of the Rainhart beam tester was simple and instructions were sufficiently clear and easy to follow. Several individuals operated the equipment in a competent manner after but a short period of time to become familiar with the machine. All were able to load a beam at the same rate by following a pacing line on the chart.

The results shown in Table 1 indicate that flexural strengths obtained with the Rainhart breaker correspond closely to those determined on the Laboratory's universal testing machine. Although there were minor variations in the results, the Rainhart machine is considered sufficiently accurate for construction control use.

A comparison between the Rainhart breaker and the presently used field beam breaker is also shown in Table 1. The limited data show the field breaker to give higher values at all strength levels. The reason for the disproportionately higher value for the field breaker in Test No. 4A is not known.

Our Standard Specifications require that concrete in pavements have a minimum flexural strength of 450 psi (using centerpoint loading and a 30-inch span) before opening to traffic. This would be equivalent to about 400 psi determined by the Rainhart machine using third-point loading and an 18-inch span.

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Considering the adequate correlation of the Rainhart Beam breaker with the universal testing machine, the simplicity and ease of operation, the high quality construction, the relatively low cost and ease of procurement, further attempts to develop a comparable laboratory design will be abandoned.

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TABLE 1

Flexural Strengths of Beams with Various Breaking Devices, PSI
(Each value an average of 3 beams)

Test No.	Rainhart (3rd point) 18" Span	Universal Testing Machine (3rd point) 18"Span	Field Breaker (Centerpoint) 30" Span
1A	260	240	300
2A	530	565	585
3A	570	605	620
4A	600	615	755
Avg.	490	505	555
1B	390	395	None
2B	555	600	"
3B	645	675	"
4B	670	725	"
Overall Average	530	555	

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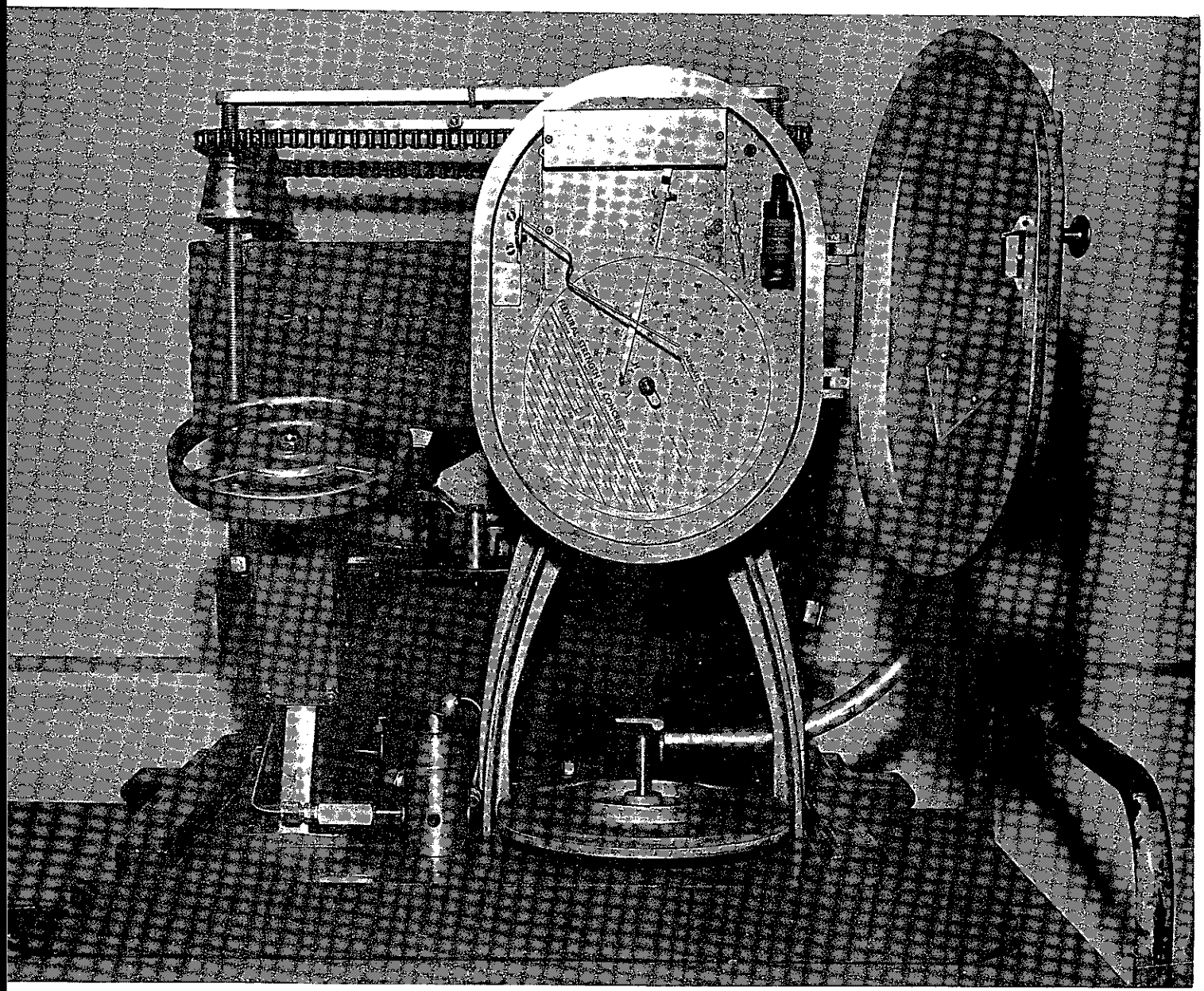

Figure 1 - Front view of Rainhart Beam Breaker

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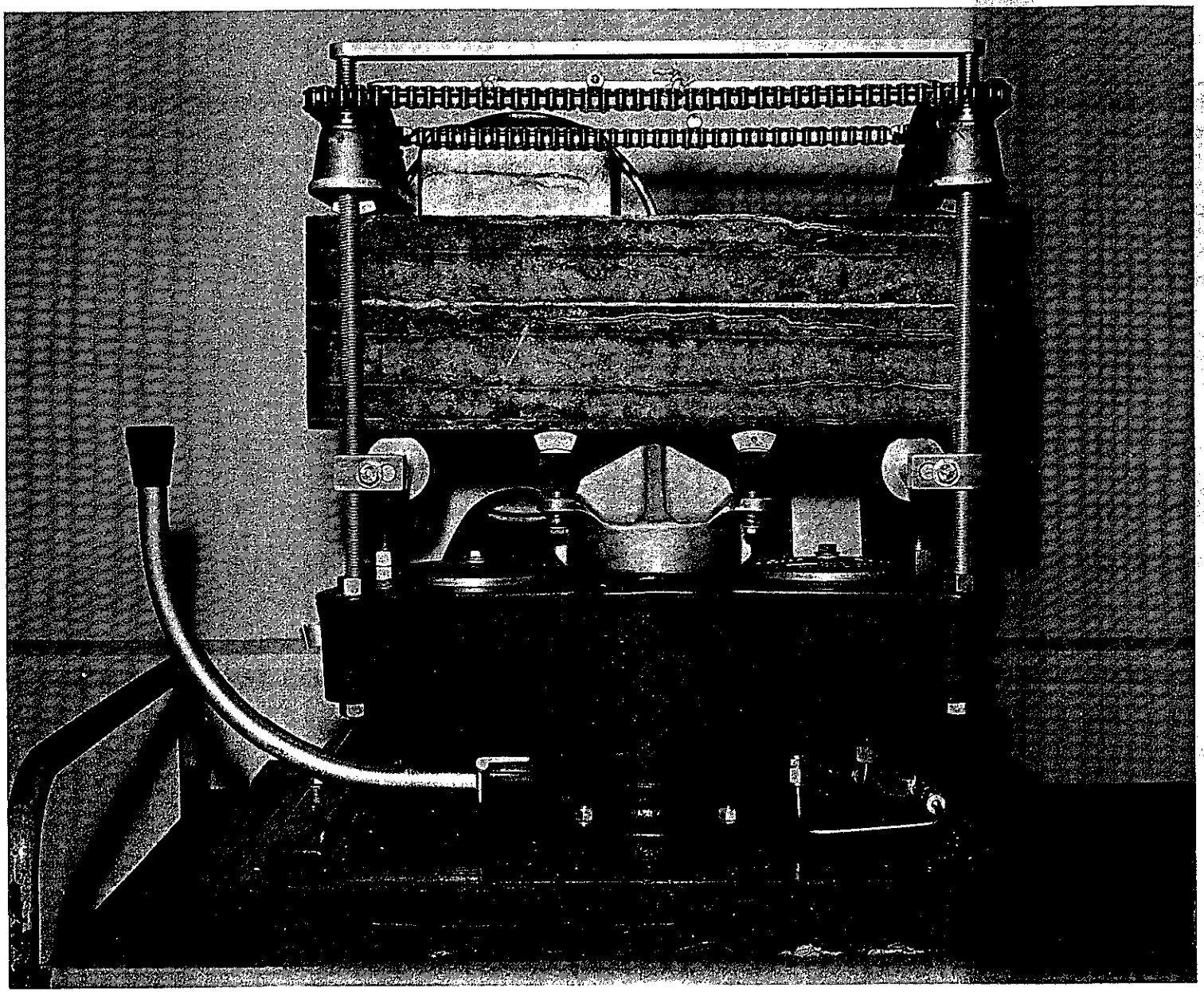

Figure 2 - Rear view of Rainhart Beam Breaker

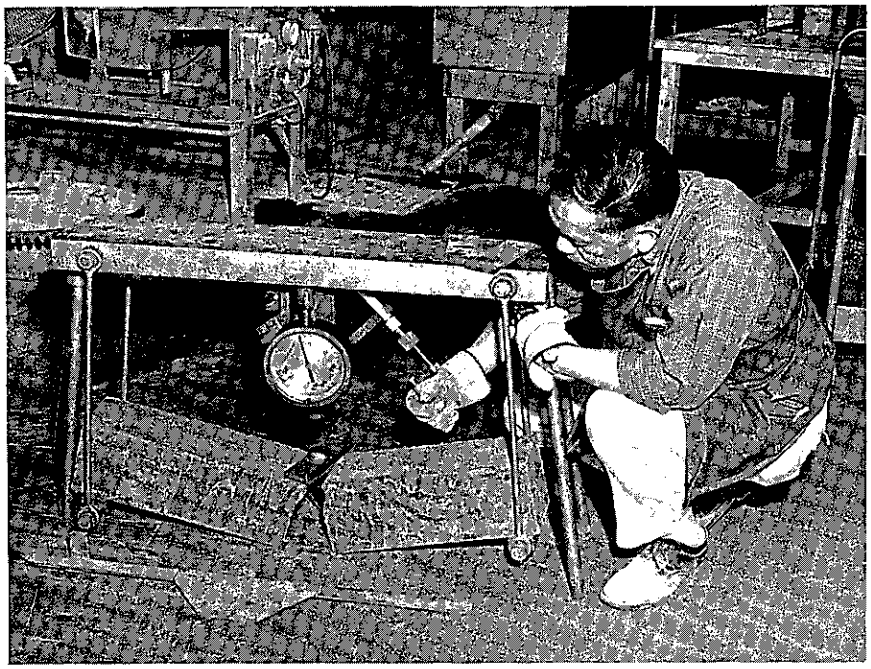

Figure 3 - Beam breaker currently used for field testing

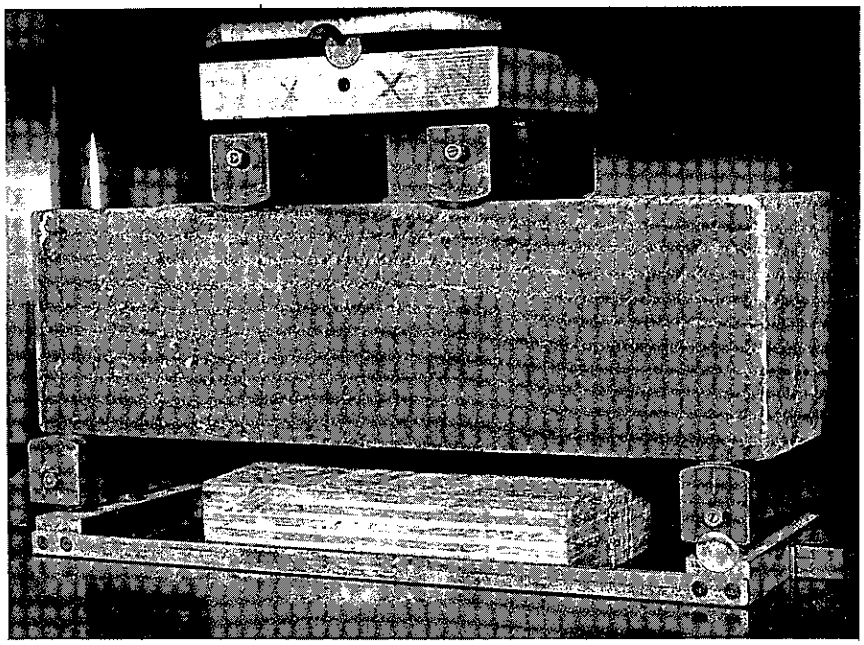

Figure 4 - Breaking device used in the Laboratory

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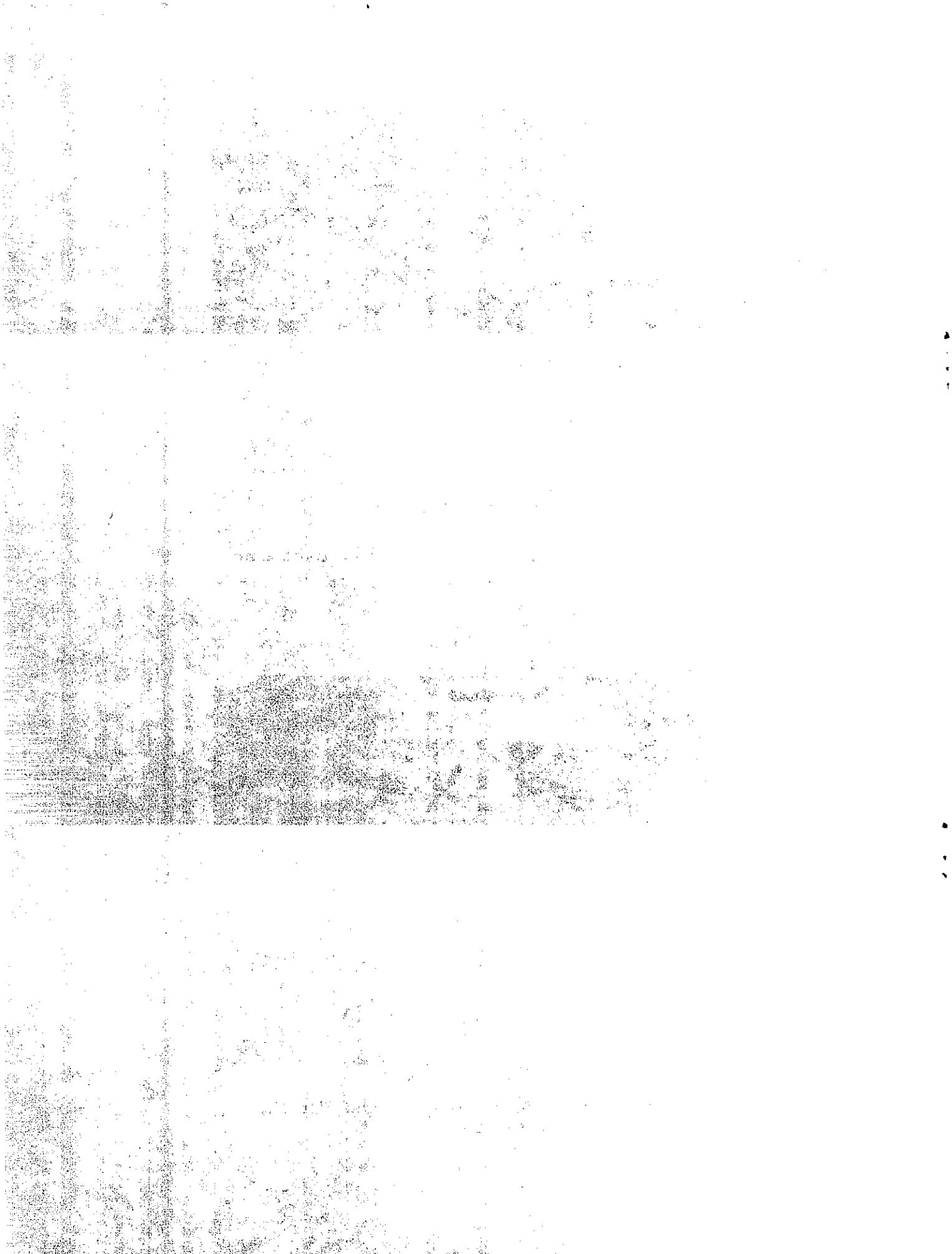

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