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A Survey of Earth-Borne Vibrations and Their Probable Effects on Talley Corporation

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Barton, J.E. and W. Chow

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16. ABSTRACT

This survey was initiated by Mr. A.D. Mayfield, Supervising Highway Engineer, District VII, to study the possible effects of highway traffic-induced earth-borne vibrations due to the proposed widening and realignment of VII-Ven-2-B (new VII-Ven-101), on the operations of Talley Corporation located in Newbury Park.

Talley Corporation is a machine shop manufacturing missile and aircraft mechanical actuators, hot air valves, gearhead motors, ball jacks, jack screws, and gear boxes.

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November 2005, Division of Research and Innovation

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A SURVEY OF EARTH-BORNE VIBRATIONS AND THEIR PROBABLE EFFECTS ON TALLEY CORPORATION

MARCH 1964

64-08

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State of California
Department of Public Works
Division of Highways
Materials and Research Department

March 1964

Proj. W. O. S-64330

Mr. A. W. Hoy
District Engineer
District VII
Division of Highways
Los Angeles, California

Dear Sir:

Submitted for your consideration is:

A SURVEY OF EARTH-BORNE VIBRATIONS
AND THEIR PROBABLE EFFECTS
ON TALLEY CORPORATION

Study made by . . . . . Structural Materials Section
Under supervision of . . . . . E. F. Nordlin
Report prepared by . . . . . J. E. Barton and W. Chow

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

WC:mw

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I. INTRODUCTION

This survey was initiated by Mr. A. D. Mayfield, Supervising Highway Engineer, District VII, to study the possible effects of highway traffic-induced earth-borne vibrations due to the proposed widening and realignment of VII-Ven-2-B (new VII-Ven-101), on the operations of Talley Corporation located in Newbury Park.

Talley Corporation has expressed their concern that realignment of the freeway from a present distance of approximately 100 feet to a proposed distance of approximately 75 feet from their plant would subject their plant to earth-borne traffic vibrations and adversely affect their precision machining operations. An official of the company has stated verbally that machining tolerances are often held to 1/10,000" or 10×10^{-5} in.

Talley Corporation is a machine shop manufacturing missile and aircraft mechanical actuators, hot air valves, gearhead motors, ball jacks, jack screws, and gear boxes.

II. SUMMARY AND CONCLUSIONS

Exhibit 1 summarizes and tabulates the pertinent vibration test data with bar graph comparisons. The data and survey indicate the following:

1. Lowboy truck-induced earth-borne vibrations from the present highway were immeasurable with our equipment at distances of 55 and 96 feet normal from the pavement edge alongside the Talley plant. At a distance of 25 feet normal from the pavement edge, truck-induced earth-borne vibrations were smaller than the concrete floor vibrations alongside Talley's Hydrabrasive grinding machine. At a distance of 8 feet normal from the pavement edge, truck-induced earth-borne vibrations were smaller than Talley's UCIMU Universal grinder while the grinder was in operation.

2. Lowboy truck-induced earth-borne vibrations on a 6 foot high retaining wall located 78 feet normal from edge of Glendale-Golden State Freeway pavement were immeasurable with our equipment. A proposed retaining wall alongside the Talley plant will be located approximately 52 feet away from edge of pavement (25 feet from the Talley building) and would not magnify or accentuate earth-borne vibrations.

3. Vibration isolation pads or mounts were not in evidence under any of Talley's heavy machinery nor

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was there an isolated vibration-free area provided for their critical measurements.

4. Manufacturing areas were not subjected to critical ambient temperature controls nor was an area provided for this in their critical measurements.

5. Conclusions from this survey indicate that the realignment of VII-Ven-2-B 26 feet closer to Talley Corporation cannot affect their operations since their in-plant vibrations are larger than the earth-borne vibrations 8 feet away from the present pavement edge. Talley Corporation is now operating with their self-induced in-plant vibrations and without any means of vibration isolation on their machinery.

   Realignment of edge of pavement to within 77 feet of Talley's plant will not affect their operation since no earth-borne vibrations were measurable at a point 55 feet away from the edge of pavement.

   A retaining wall, at a point 55 feet from edge of pavement, alongside Talley would not affect their operations for the reasons mentioned above.

III. TEST PROCEDURE

The test procedure consisted of recording earth-borne lowboy truck vibrations on the Ventura Freeway adjacent to Talley Corporation, recordings of earth-borne vibrations on the Glendale-Golden State Freeway in the vicinity of a retaining wall and vibration recordings in the plant of Talley Corporation.

IV. DISCUSSION

This department over a five year period has made five different vibration observations concerning freeway earth-borne vibrations affecting a private home, three manufacturing plants, and an art museum.

Test data from these studies have indicated that earth-borne traffic vibrations were usually immeasurable 100 feet normal from the freeway or if measurable would be very small in magnitude. It was felt that the present vibration complainant's claims would be no different.

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However, since the proposed realignment of the Ventura Freeway would bring the pavement edge to within approximately 75 feet of and parallel Talley's plant, Exhibit 2, from an original parallel distance of approximately 100 feet, it was felt desirable to ascertain the existence or non-existence of traffic vibrations.

Vibration survey was conducted in and around Talley's plant on February 4 and on the Glendale and Golden State Freeway interchange on February 5, 1964. Exhibit 3 shows a plan view of Talley's plant. The plant is approximately 1215 feet long by 40 feet wide and is a sheet metal frame building. The building parallels the freeway the full length. The freeway by the northerly end of the building is on a 35 foot ± fill and tapers down to level roadway by the southerly end of the building.

A lowboy truck, Exhibit 4, loaded with a Caterpillar blade and scraper was obtained and used as a controlled test truck to create earth-borne vibrations. The load on the lowboy axles are also shown on the exhibit. Note that axles 2 and 3 were loaded to 67% and axles 4 and 5 were loaded to 77% of the legal load limit of 36,000 pounds.

A California Highway Patrol officer and sedan provided escort for the lowboy so that a speed of 50 to 60 mph could be obtained while passing by Talley's plant during a vibration test run.

Vibration observations during a test run were recorded simultaneously with three vertical vibration testers. The three testers were placed in a line normal to the pavement edge and at appropriate distances from each other in order to measure the vibration drop-off with distance. Vibrations emanating from the lowboy passing a test location were automatically recorded on an oscillograph. Exhibit 5 is a view of the recording equipment prior to the installation in a car. Block diagram of the equipment is shown on Figure 6.

Locations A, B, and C, Exhibit 3, were indicated by Talley officials as being critical areas where vibrations could not be tolerated. A, B, and C are Talley's quality control, grinding and prototype-drill areas respectively. Vibration tests were conducted at these locations.

Two lowboy passages were made past each A, B, and C locations. Exhibits 7, 8, and 9 show the plan and elevation views with the vibration results and Exhibits 10 through 14 are photographs of the locations. Only the largest vibrations of one of the two passages are tabulated on the plan views.

Note that vibrations are immeasurable at all three locations with our equipment at a distance of 55 and 96 feet from the pavement edge.

A contention brought up by Talley's officials was that the erection of a retaining wall alongside their plant would amplify and be conductive to earth-borne vibrations. A retaining wall area in the vicinity of the Glendale-Golden State Freeway interchange

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was chosen for a vibration survey since it was typically similar to the fill and structural section of the proposed retaining wall adjacent to Talley.

Exhibit 15 shows the plan and elevation views with the vibration results at this location. Four passages were made with the lowboy in this area with the largest vibrations entered in Exhibit 15. The maximum lowboy speed obtained was 45 mph. Results obtained indicate immeasurable vibrations on the retaining wall at 78 feet from edge of pavement.

A visual inspection tour of Talley's plant was made to determine if any in-plant vibrations existed and Talley's means of isolating them. From the inspection it was decided to measure in-plant vibrations at the three critical locations of A, B, and C.

No vibrations were measurable with our equipment on the quality control floor area of location A. This was to be expected since there were no manufacturing machines in this area.

Large vibrations were measured in the grinding area of location B. See Exhibit 16. Note that the Hydrabrasive grinder, Exhibit 17, produced vibrations on the concrete floor larger than that at a point 25 feet away from the edge of pavement during lowboy passage. The Landis Universal grinder, Exhibit 18, produced vibrations on the concrete floor of almost the same magnitude as the vibrations produced by the lowboy passage at a point 26 feet away from the pavement edge. Note in all cases the large amounts of vibrations measured on the three machines.

It is significant to note that the Jones & Lampson optical comparator, Exhibit 19, a precision measurement instrument, is located within a radius of 29 feet ± of these heavy vibration producing machines and presumably functioning without vibration problems.

Vibration measurements were made in Talley's mill and gear area although this area was not called out as one of their critical areas. See Exhibits 20 and 21. In general the floor vibrations induced by the gear cutting machine were small compared to the grinding area.

Vibration measurements were made in Talley's prototype-drill area, location C, one of the critical areas to vibrations. See Exhibit 22. Results show that the LeBlond 14" lathe, Exhibit 23, induced into the concrete floor vibration displacements of the same magnitude as a point 25 feet away from pavement edge during passage of a lowboy. No vibrations were measurable on the concrete floor by the Society Genevoise jig bore.

In general, it appeared that many of Talley's machines were not in operation, and it is concluded that floor vibrations would be much larger had more machinery been in operation.

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It was noted that Talley did not provide facilities for ambient temperature controls in their manufacturing areas or in their quality control areas. It would appear the ambient temperature changes would affect their machining and precision measurements to the magnitude of precision Talley is interested in. For example, a 2" steel bar would change its length 12×10^{-5} inches when the ambient temperature changed 10° F. Talley has stated their machinings and precision measurements are made to 10×10^{-5} inches and that vibrations would affect both machinings and measurements.

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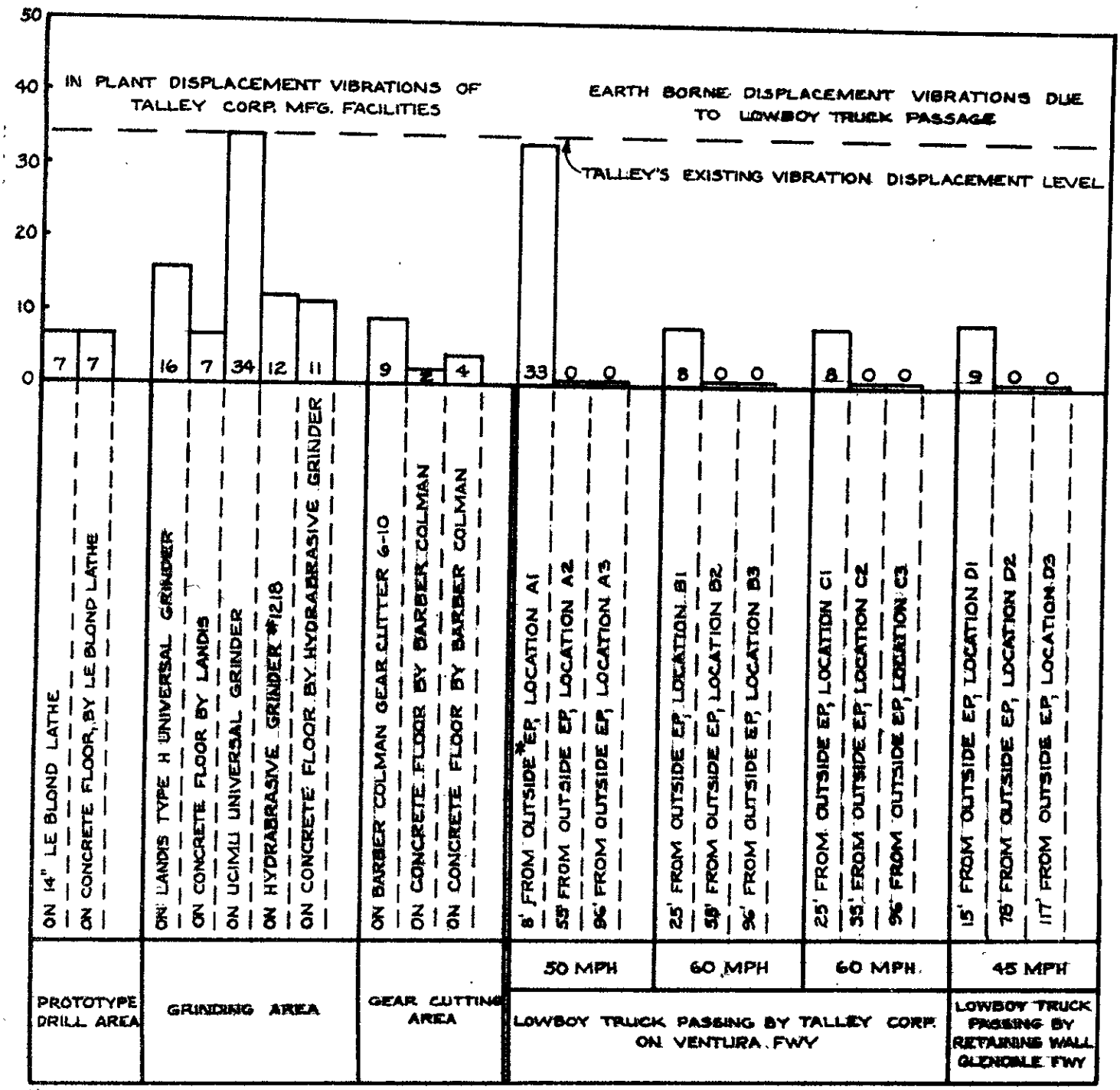
COMPARISON OF VIBRATION MEASUREMENTS AT INDICATED LOCATIONS

TALLEY CORP. VII-VEN-2-B (NEW VII-VEN-101)



* EP - EDGE OF PAVEMENT

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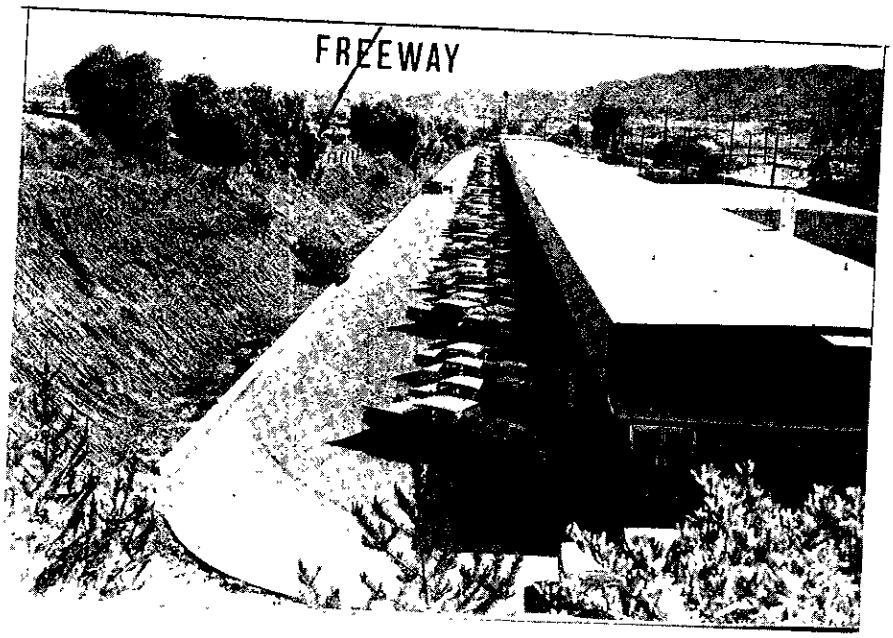
EXHIBIT 2



Location of freeway adjacent to Talley's plant.

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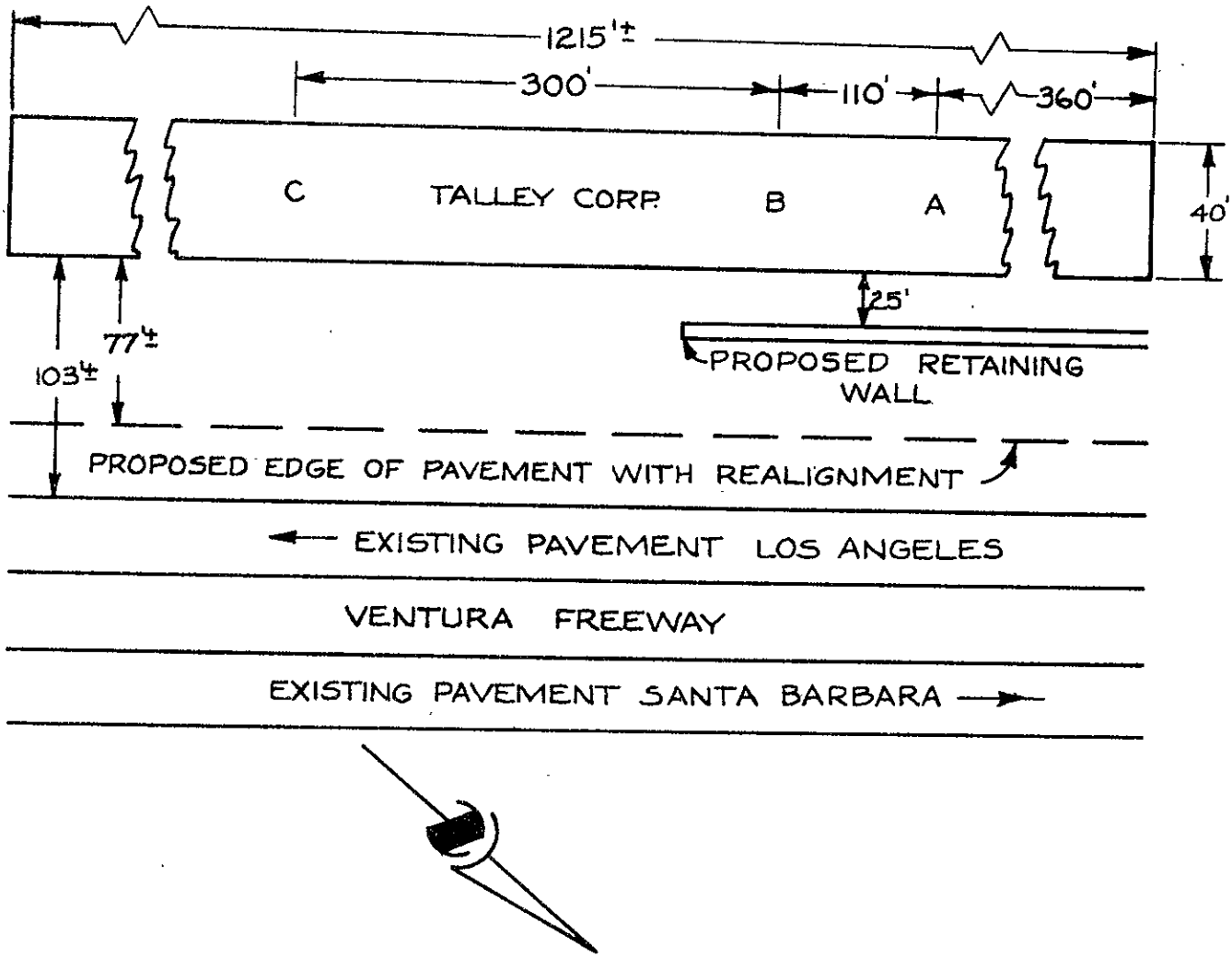
EXHIBIT 3

PLAN VIEW OF CRITICAL TEST LOCATIONS AND LOCATION OF FREEWAY WITH RESPECT TO TALLEY'S PLANT



VIBRATION TEST LOCATIONS - CRITICAL AREAS

A = QUALITY CONTROL AREA
B = GRINDING AREA
C = PROTOTYPE - DRILL AREA

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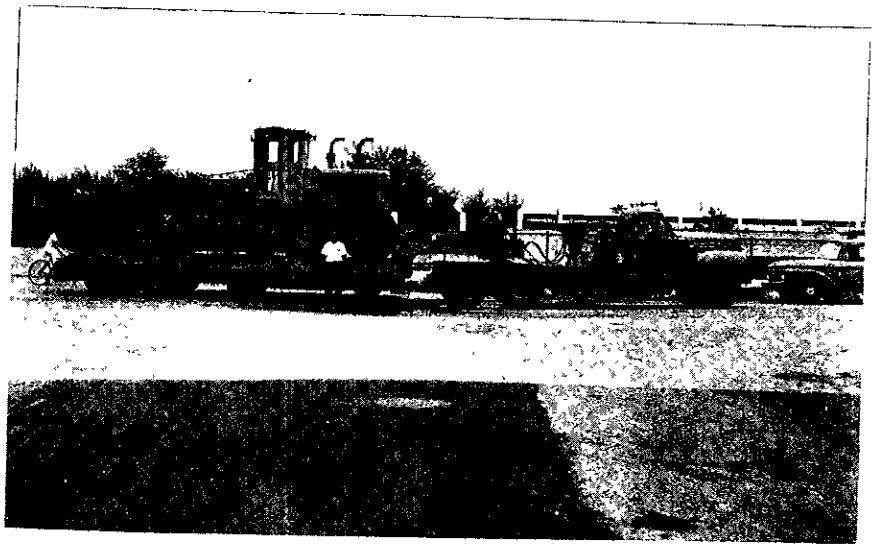
EXHIBIT 4



Lowboy truck loaded with grader.

Axle 1	=	8920 pounds
Axles 2 & 3	=	23940 pounds
Axles 4 & 5	=	27640 pounds

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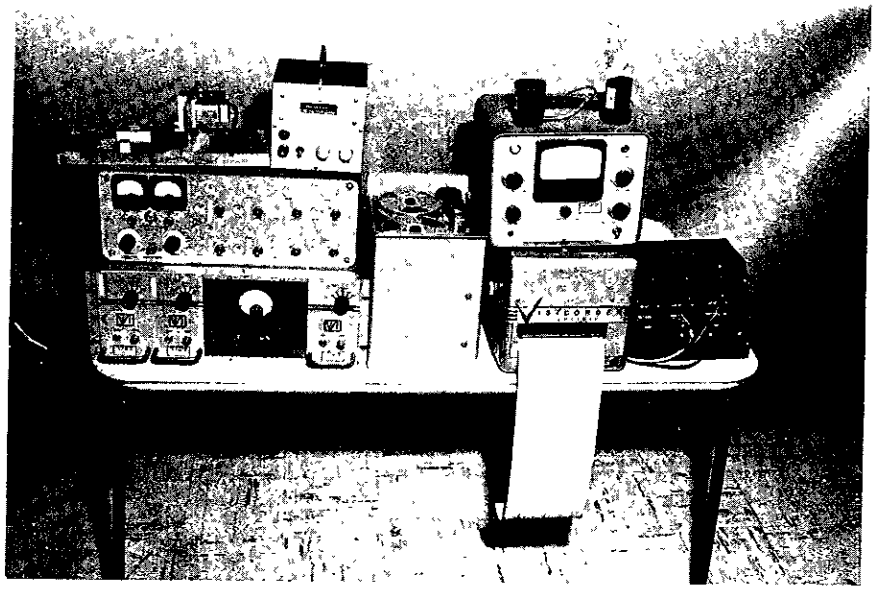
EXHIBIT 5



Vibration Recording Equipment.

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BLOCK DIAGRAM
VIBRATION TEST EQUIPMENT

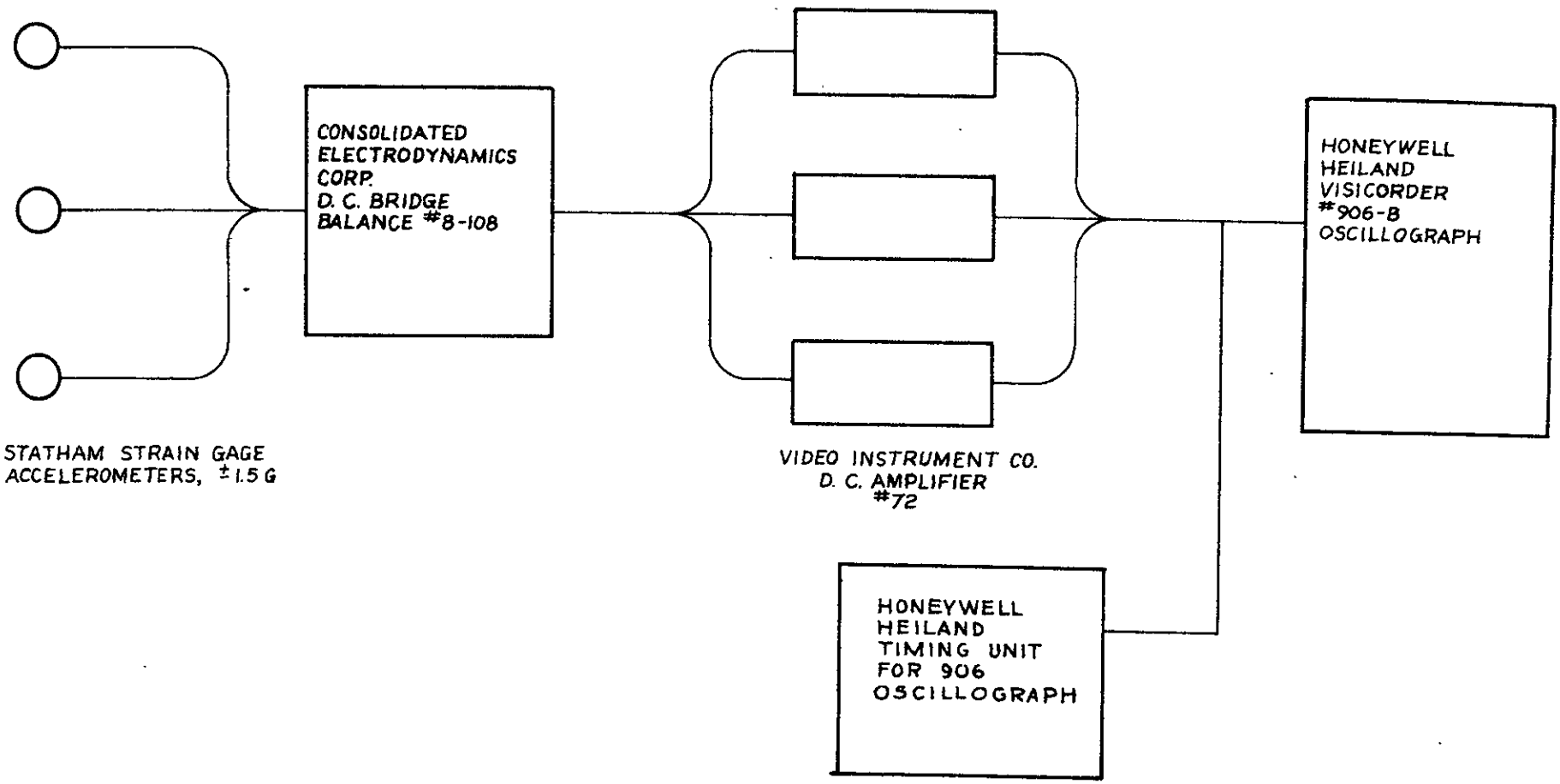

EXHIBIT 6

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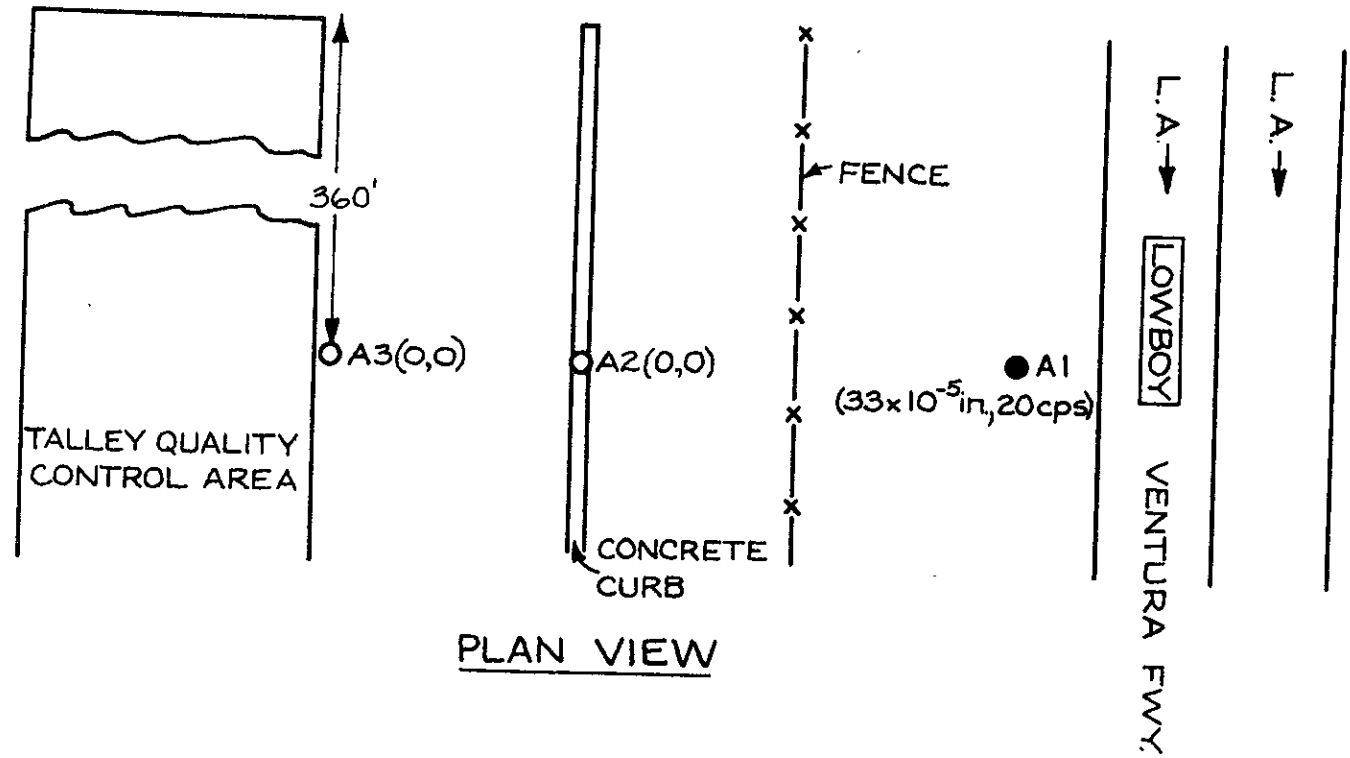
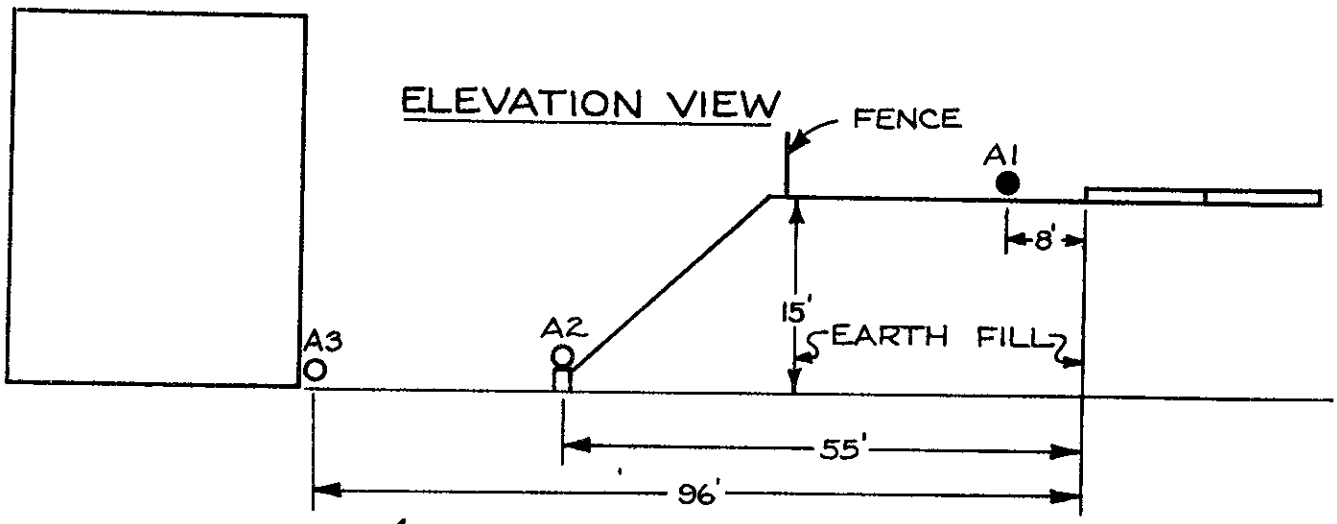
EXHIBIT 7

VIBRATION MEASUREMENTS
(NO SCALE)

EARTH-BORNE VIBRATIONS DUE TO LOWBOY TRAVELING 50 MPH ON VENTURA FWY
TALLEY CORP. VII VEN-2-B (NEW VII-VEN-101)



PLAN VIEW



● VIBRATION TESTER ON ASPHALT
O VIBRATION TESTER ON CONCRETE
CPS = FREQUENCY IN CYCLES PER SECOND

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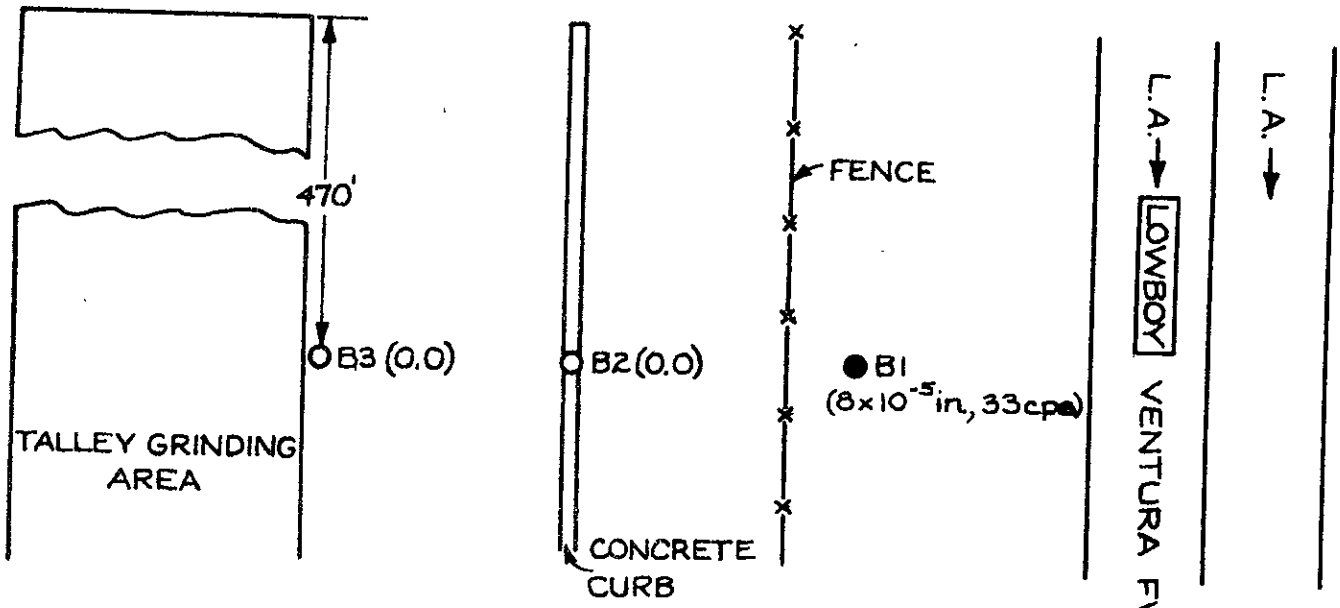
EXHIBIT 8

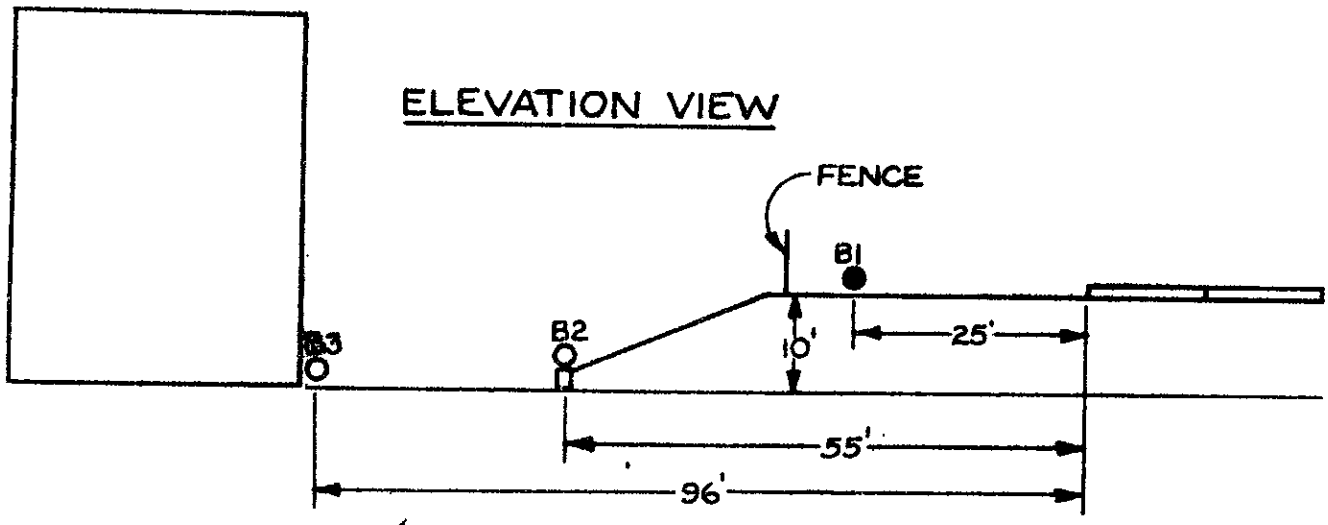
VIBRATION MEASUREMENTS

(NO SCALE)

EARTH-BORNE VIBRATIONS DUE TO LOWBOY TRAVELING 60 MPH ON VENTURA FWY
TALLEY CORP. VII VEN-2-B (NEW VII-VEN-101)



PLAN VIEW



ELEVATION VIEW

● VIBRATION TESTER ON EARTH FILL
O VIBRATION TESTER ON CONCRETE

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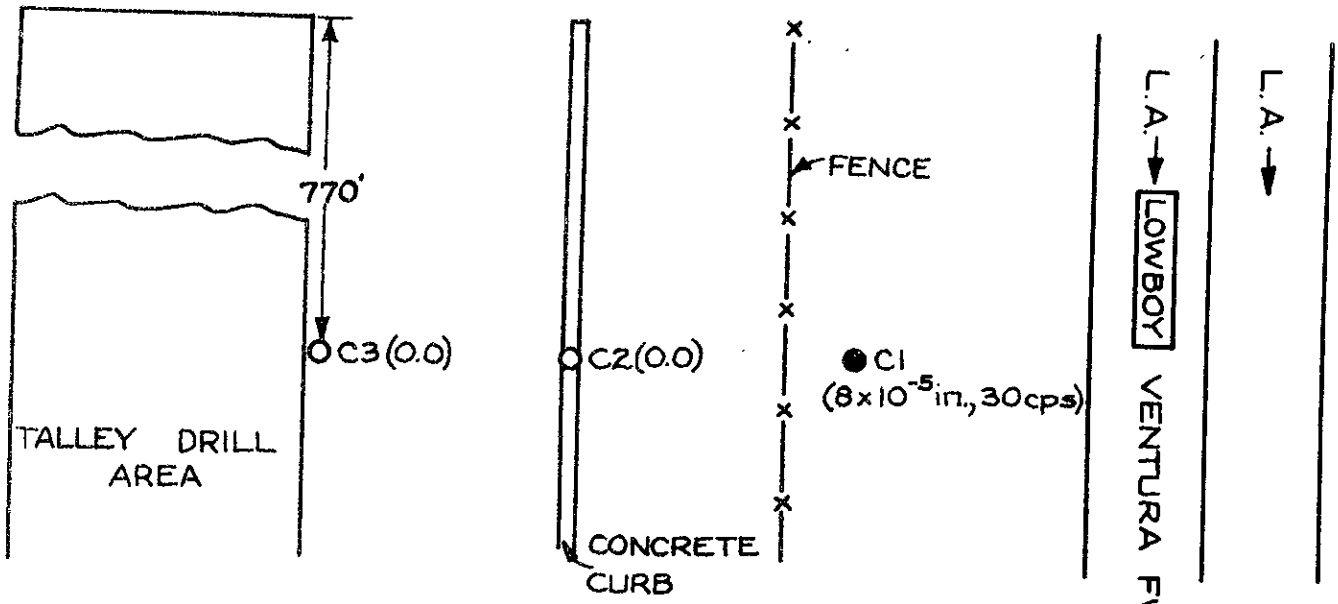
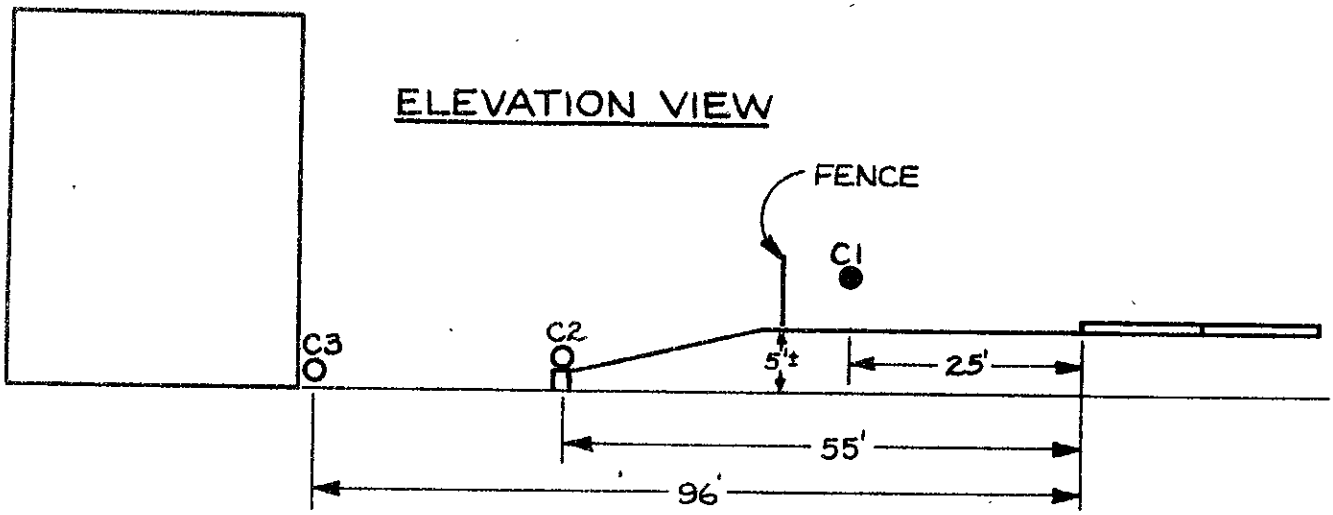
VIBRATION MEASUREMENTS
(NO SCALE)

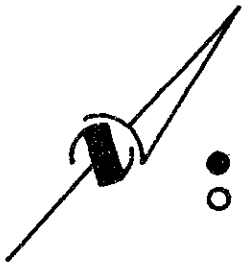
EARTH-BORNE VIBRATIONS DUE TO LOWBOY TRAVELING 60 MPH ON VENTURA FWY
TALLEY CORP. VII VEN-2-B (NEW VII -VEN-101)



PLAN VIEW



ELEVATION VIEW



● VIBRATION TESTER ON EARTH FILL
O VIBRATION TESTER ON CONCRETE

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Location A-1.

Location A-2.

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EXHIBIT 11

Location A-3.

Location B-1.

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Location B-2.

Location B-3.

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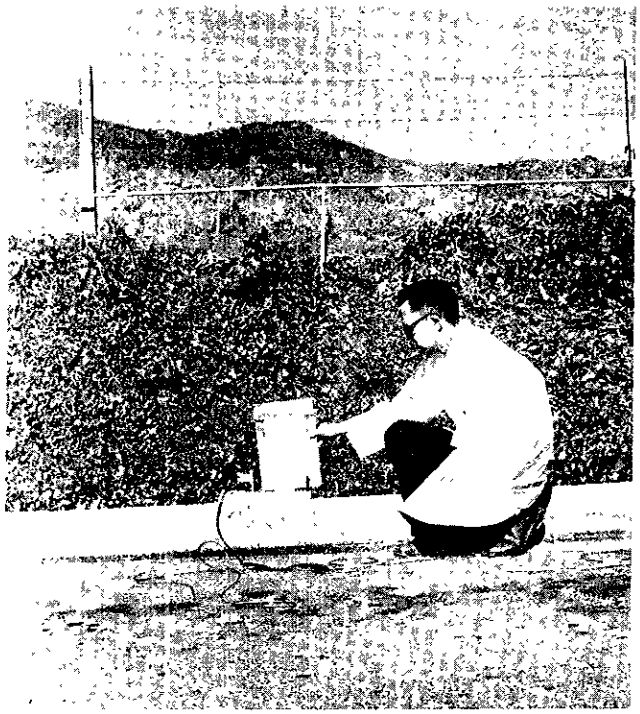
Location C-1.



Location C-2.

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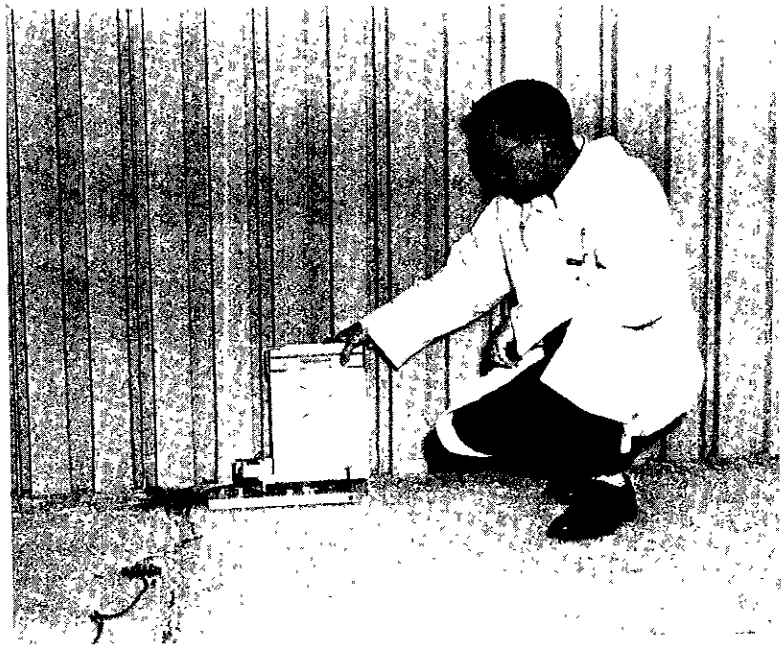
EXHIBIT 14.



Location C-3.

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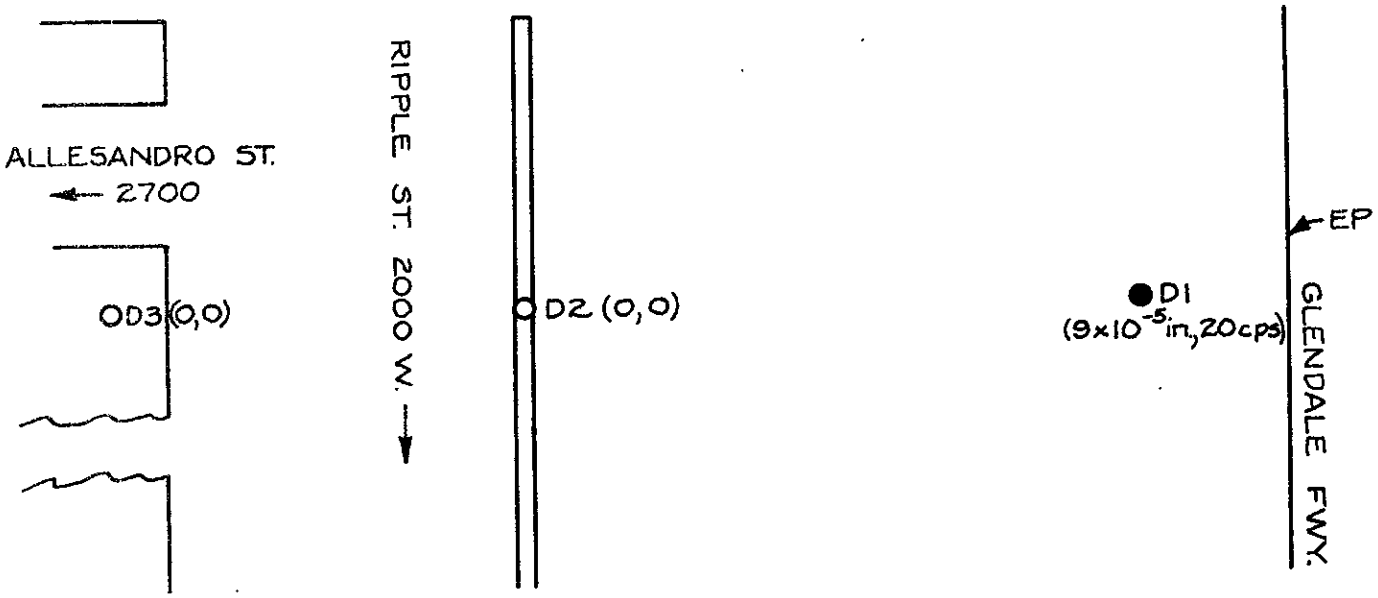
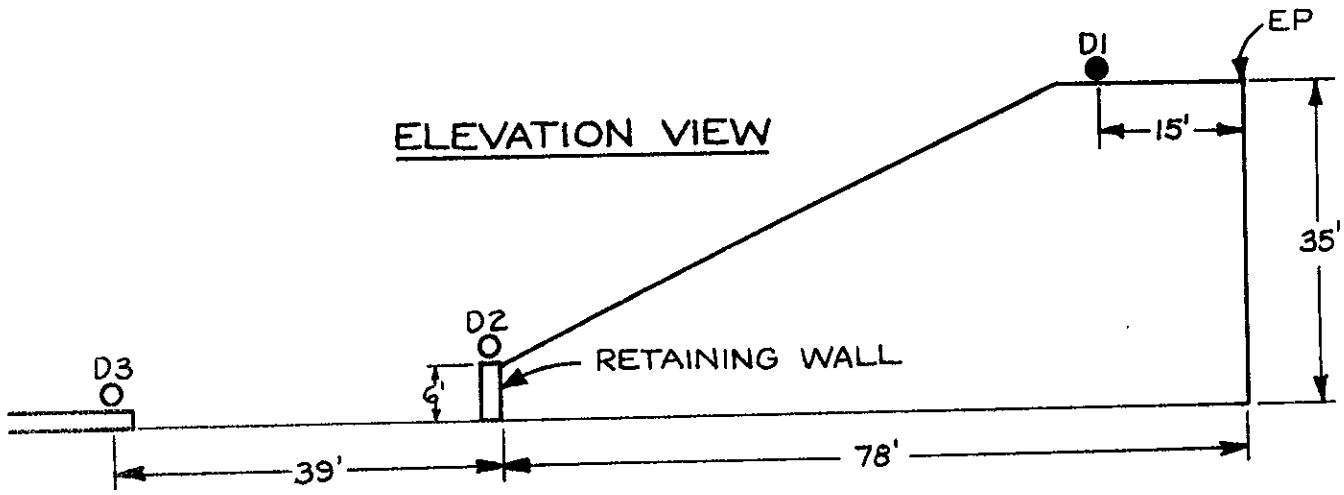
VIBRATION MEASUREMENTS
(NO SCALE)

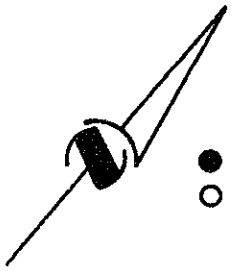
EARTH-BORNE VIBRATIONS DUE TO LOWBOY TRAVELING 45 MPH ON GLENDALE FWY
VII-LA-161-LA (NEW-VII-LA-5) & VII-LA-162-LA (NEW VII-LA-2)



PLAN VIEW



ELEVATION VIEW



● VIBRATION TESTER ON ASPHALT
O VIBRATION TESTER ON CONCRETE

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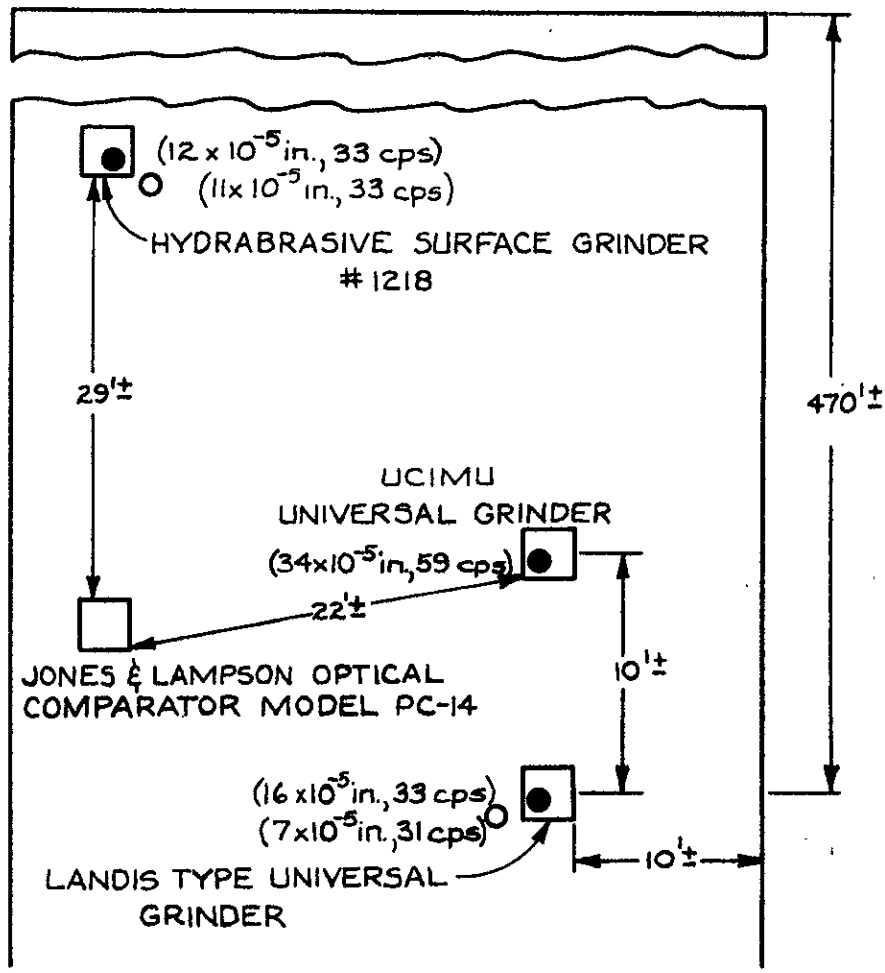
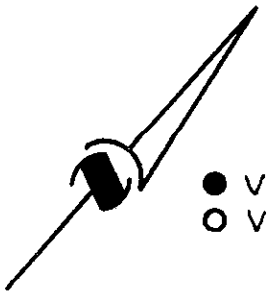
VIBRATION MEASUREMENTS
(NO SCALE)

IN PLANT VIBRATIONS IN THE GRINDING AREA
TALLEY CORP. VII -VEN-2-B (NEW-VII-VEN-101)





● VIBRATION TESTER ON MACHINE
O VIBRATION TESTER ON CONCRETE FLOOR

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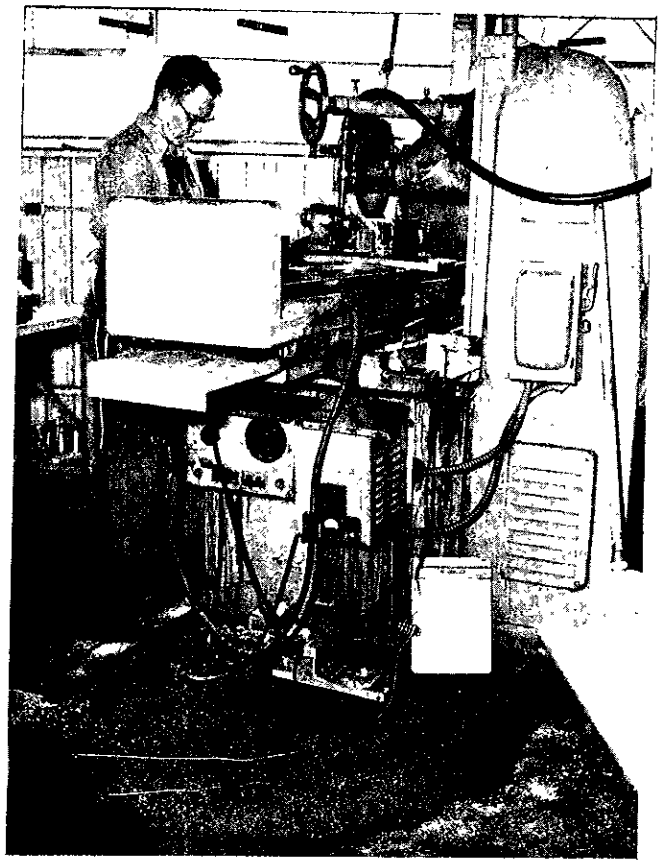
EXHIBIT 17



Hydrabrasive Grinder.

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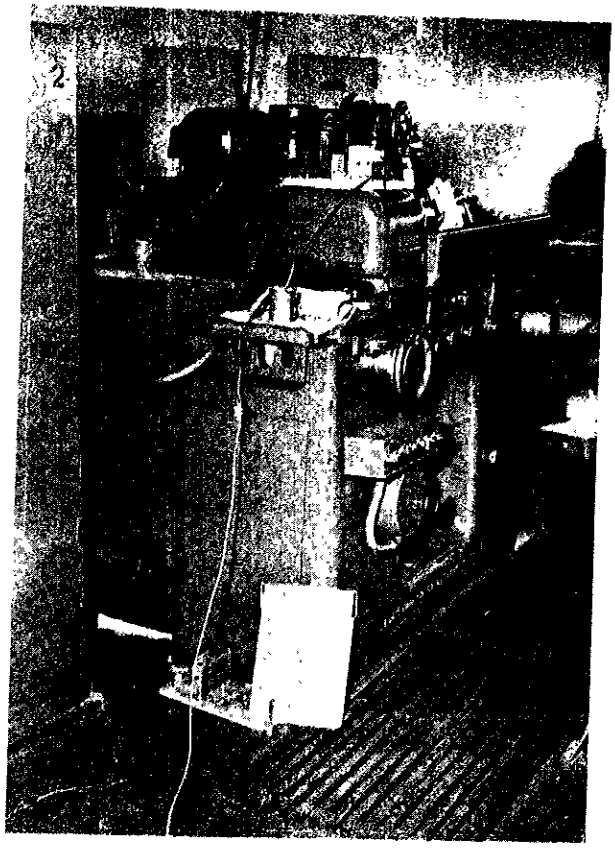
EXHIBIT 18



Landis type H Universal Grinder.

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EXHIBIT 19

Jones & Lampson Optical Comparator.

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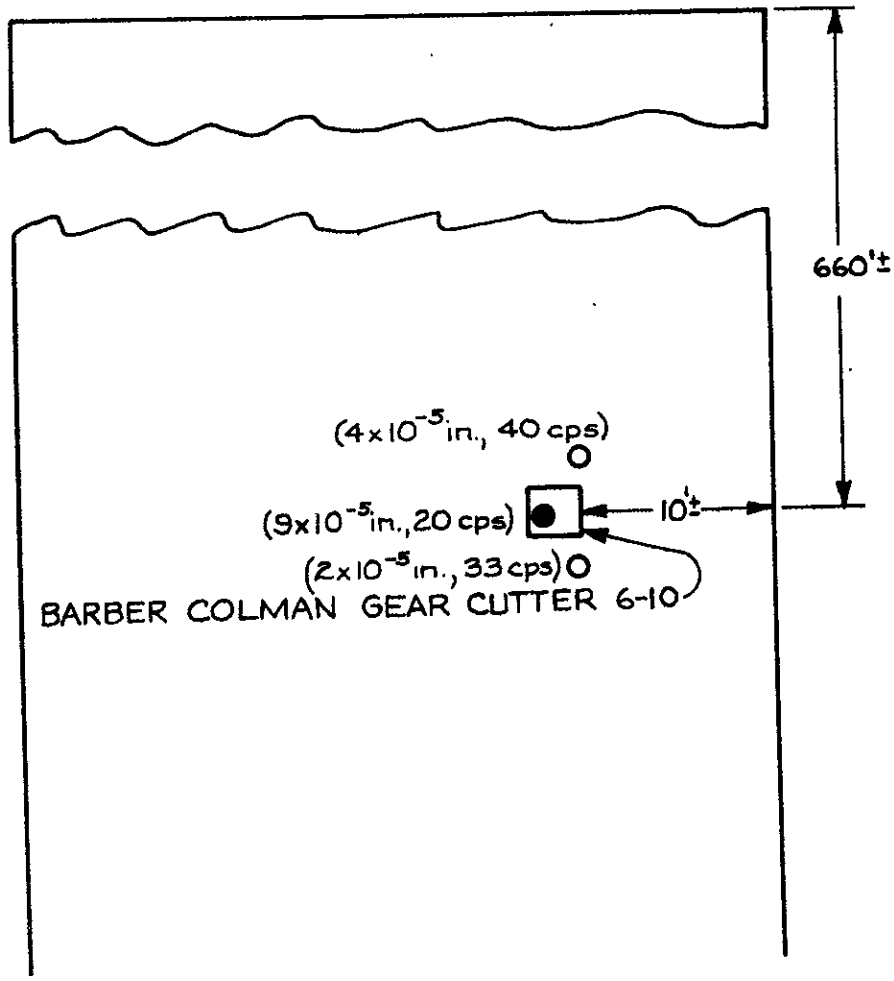
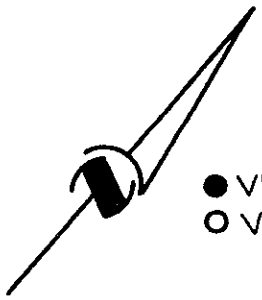
VIBRATION MEASUREMENTS

(NO SCALE)

IN PLANT VIBRATIONS IN THE MILL AND GEAR AREA
TALLEY CORP. VII-VEN-2-B (NEW VII-VEN-101)





● VIBRATION TESTER ON MACHINE
O VIBRATION TESTER ON CONCRETE FLOOR

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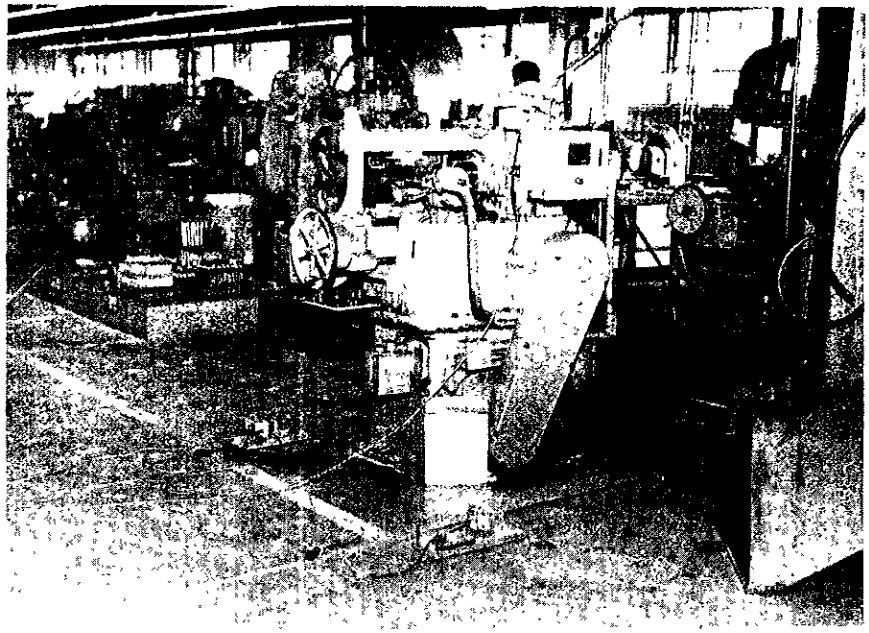
EXHIBIT 21



Mill and Gear Area.

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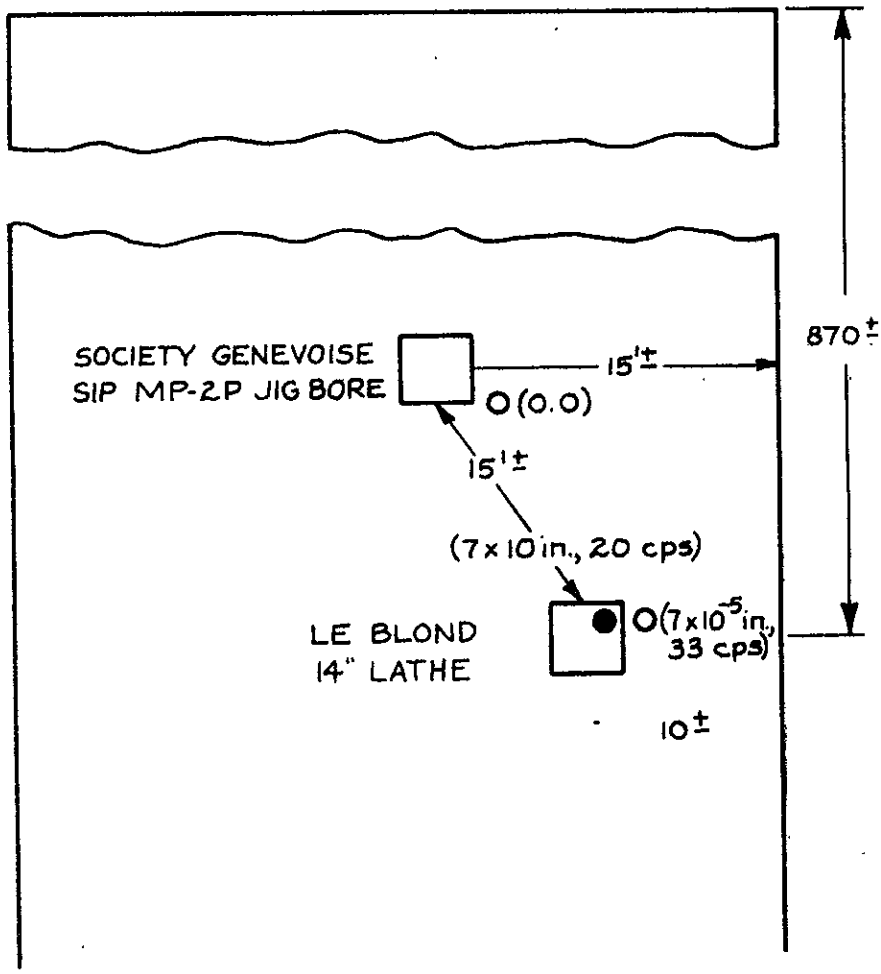
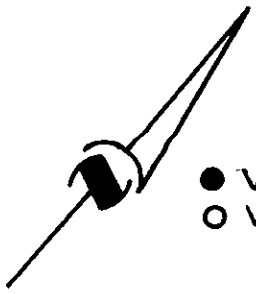
VIBRATION MEASUREMENTS

(NO SCALE)

IN PLANT VIBRATIONS IN THE PROTOTYPE DRILL AREA
TALLEY CORP. VII-VEN-2-B (NEW VII-VEN-101)





● VIBRATION TESTER ON MACHINE
O VIBRATION TESTER ON CONCRETE FLOOR

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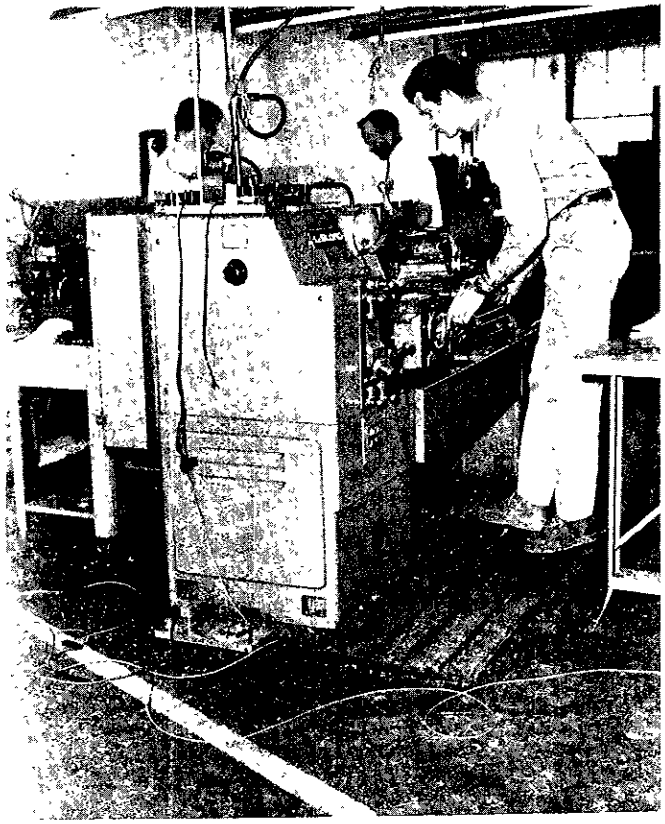
EXHIBIT 23



Le Blond 14" Lathe in Prototype-Drill Area.

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