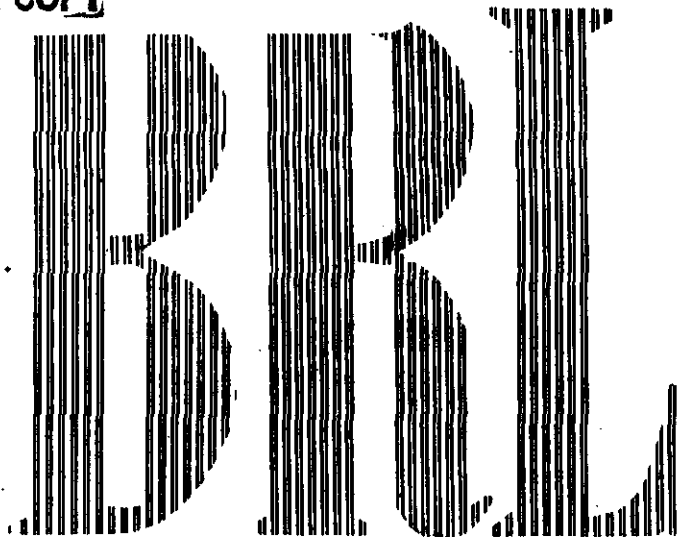
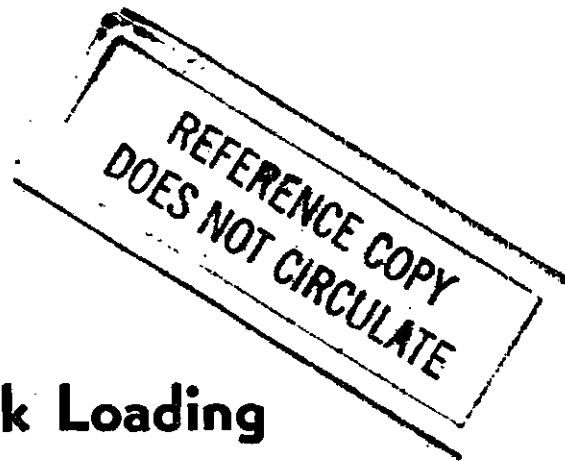


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TECHNICAL NOTE No. 842
AFSWP NO 767



Records of Air Shock Loading On A Three Dimensional Model

GLENN P. BEICHLER

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DEPARTMENT OF THE ARMY PROJECT Nos. 598-09-003 AND 503-04-002
ORDNANCE RESEARCH AND DEVELOPMENT PROJECT No. TB3-0112

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TECHNICAL NOTE NO. 842

JANUARY 1954

RECORDS OF AIR SHOCK LOADING ON A THREE
DIMENSIONAL MODEL

Glenn P. Beichler

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Department of the Army Project Nos. 598-09-003
and 503-04-002
Ordnance Research and Development Project No. TB3-0112

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ABERDEEN PROVING GROUND, MARYLAND

BALLISTIC RESEARCH LABORATORIES

TECHNICAL NOTE NO. 842

GPBeichler/ddh
Aberdeen Proving Ground, Md.
January 1954

RECORDS OF AIR SHOCK LOADING ON A THREE
DIMENSIONAL MODEL

ABSTRACT

Tracings are presented of the original records of air blast loading obtained in the 24-inch BRL shock tube on the front, top and rear surfaces of a rectangular shaped three-dimensional model. The records were obtained at incident shock pressures of approximately 3, 5 and 8 psi using a 2" x 4" x 2" "Oilite" model. Since essentially, the variations in loading are over in less than one millisecond the incident shock wave is a step shock.

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INTRODUCTION

A primary objective for the Ballistic Research Laboratories Shock Tube Facility has been to reduce to a routine operation the obtaining of accurate blast loading data on three-dimensional models. This has been done on a series of models for Ballistic Research Laboratories AFSWP Project 3.28.1. The results on the first model of this series are presented here. While the work presented here does not represent the ultimate perfection of the art nor even a fair example of the far more advanced present state of measurement techniques, it is a typical series of curves which may be useful to others in interpreting field data or theoretical work or, perhaps, in planning future model work for the shock tube. No analysis of the records is attempted; no conclusions are drawn.

EXPERIMENTAL PROCEDURE

The Model

The 2" x 4" x 2" model was made of "Oilite", a highly compressed powdered metal made of copper and tin and impregnated with oil, in an effort to achieve some internal damping and consequent reduction of vibration. One 2" x 4" face was instrumented with five piezoelectric pressure gauges as shown in sketch 1. The model could then be oriented in the shock tube as this instrumented face is normal to the shock front, side-on, or facing away from the direction of shock wave approach. The model was mounted on a large flat plate extending across the shock tube in such a way that leads from the five gauges could be readily brought out from the tube.

The Gauges

The one-half inch overall diameter piezoelectric gauges were constructed with 0.2" diameter tourmaline crystal elements. Complete description of gauge design and construction may be found in BRL Technical Note No. 860 by C. Benjamin Granath. Recording was accomplished with the eight channel Armour oscillograph which in addition provided calibration and time measurements.

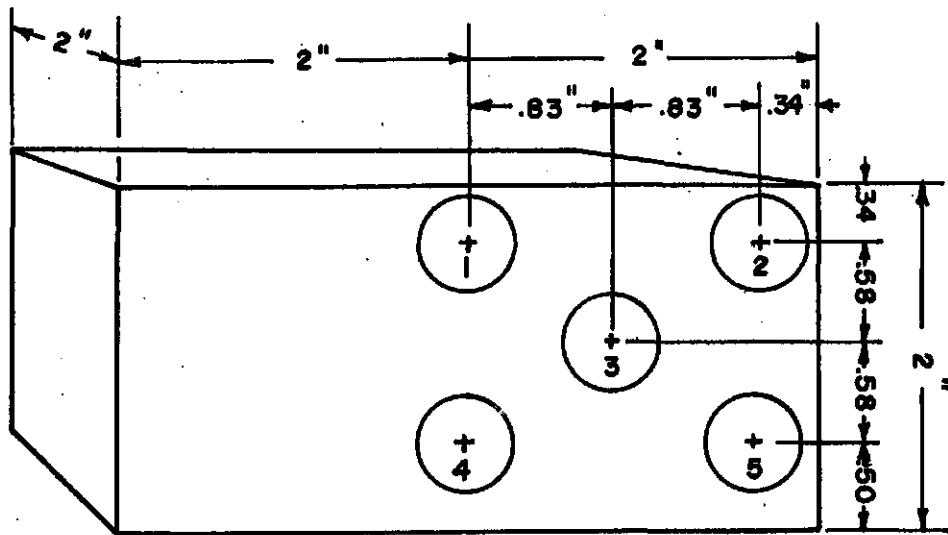
RESULTS

Pressure versus time curves are presented at five different points on the 2" x 4" front, top, and rear surfaces of a 2" x 4" x 2" three-dimensional model using incident step shock strengths of approximately 3, 5, and 8 psi. The position at which the pressure-time curve was taken is indicated in the little sketch adjacent to each curve. Incident pressure is also indicated for each curve as P_1 . For the short times presented, the incident pressure is essentially a constant. Rough pressure and time coordinates are indicated. Timing marks are in milliseconds. More precise measurements may be made by using the pressure and time factors given for each curve. For the pressure-time curves for the model top positions

the direction of approach of the shock wave is denoted by an arrow on the diagram and the approximate time of arrival of the shock at the front face is shown on the pressure-time curve with a caret (\wedge).

GLENN P. BEICHLER

Glenn P Beichler



GAUGE POSITIONS 1 THRU 5

SKETCH 1
OILITE MODEL

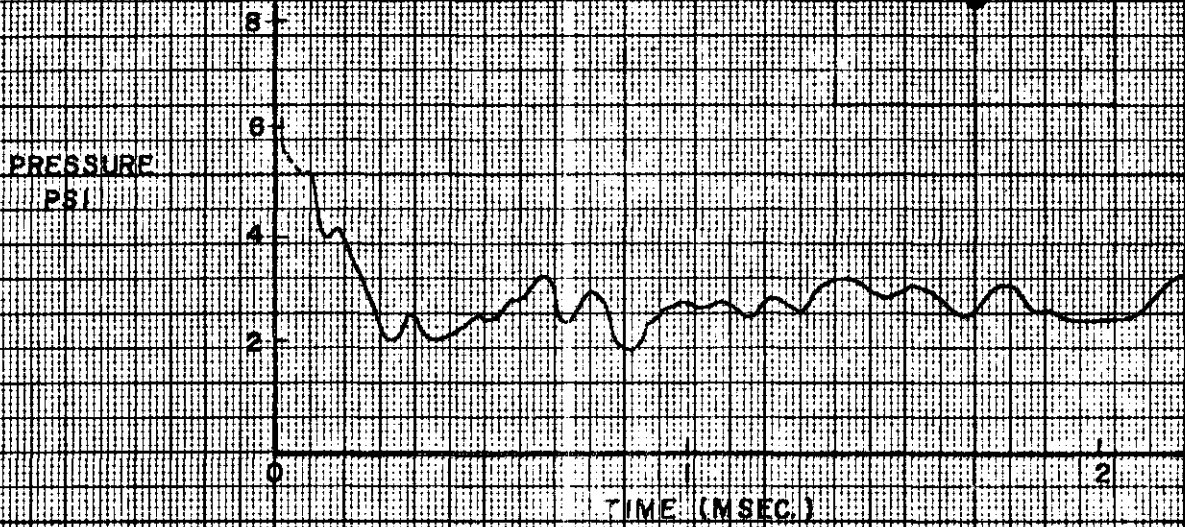
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OILITE MODEL

POSITION 1

IMM = .306 PSI
IMM = .0170 MSEC.
P = 2.94

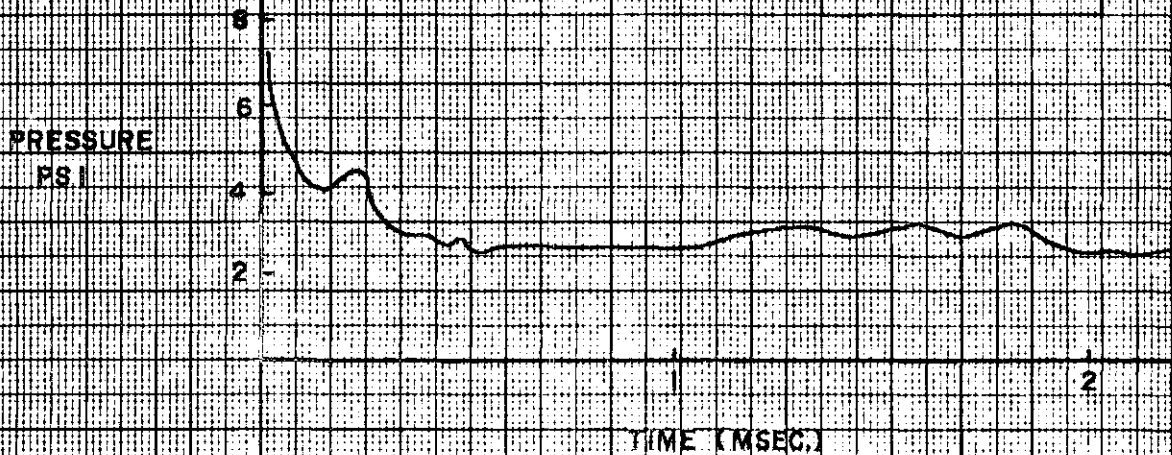
FRONT FACE



POSITION 2

FRONT FACE

IMM = .1625 PSI
IMM = .0170 MSEC.
P = 2.94

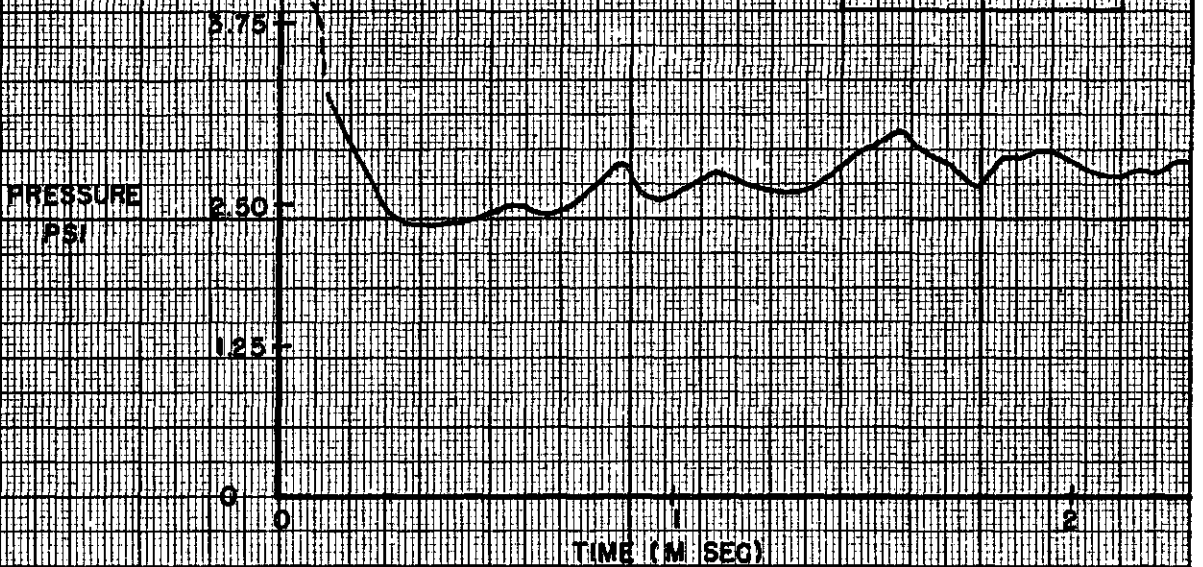


OILITE MODEL

$P_1 = 0.594$ PSI
 $\Delta P = 0.075$ M SEC
 $P_2 = 2.38$

POSITION 3

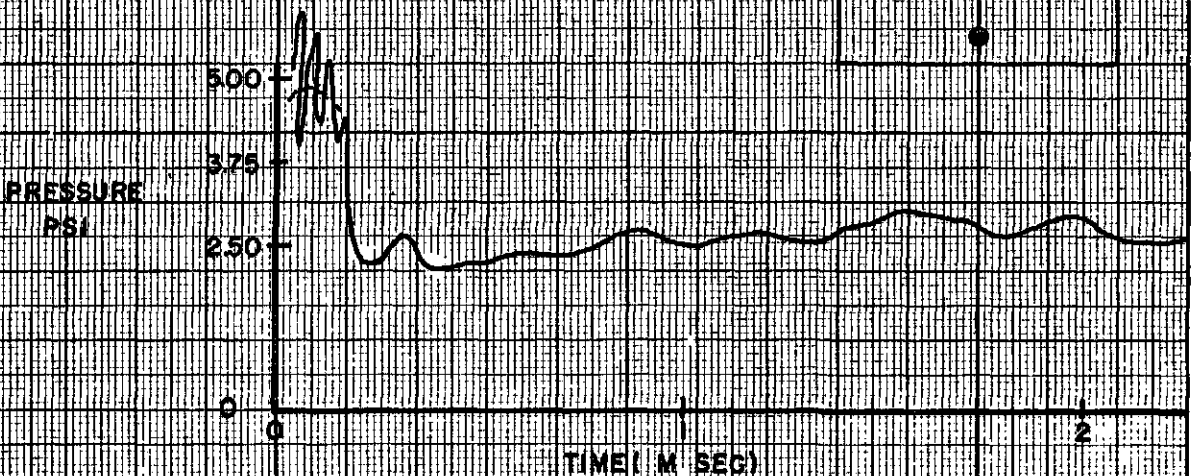
FRONT FACE



$P_1 = 1.054$ PSI
 $\Delta P = 0.073$ M SEC
 $P_2 = 2.38$

POSITION 4

FRONT FACE

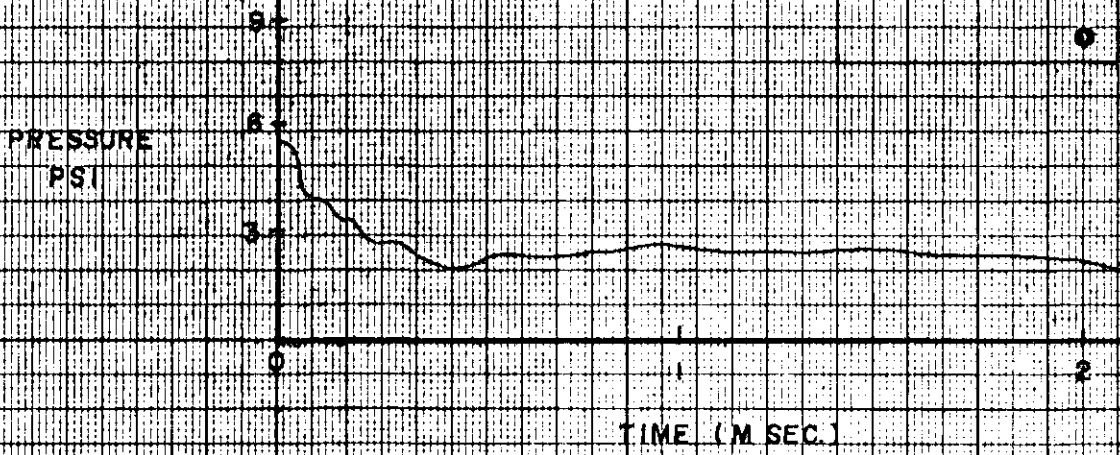


OILITE MODEL

POSITION 5

MM = 1030 PSI
NM = 0174 MSEC
P_i = 2.38

FRONT FACE



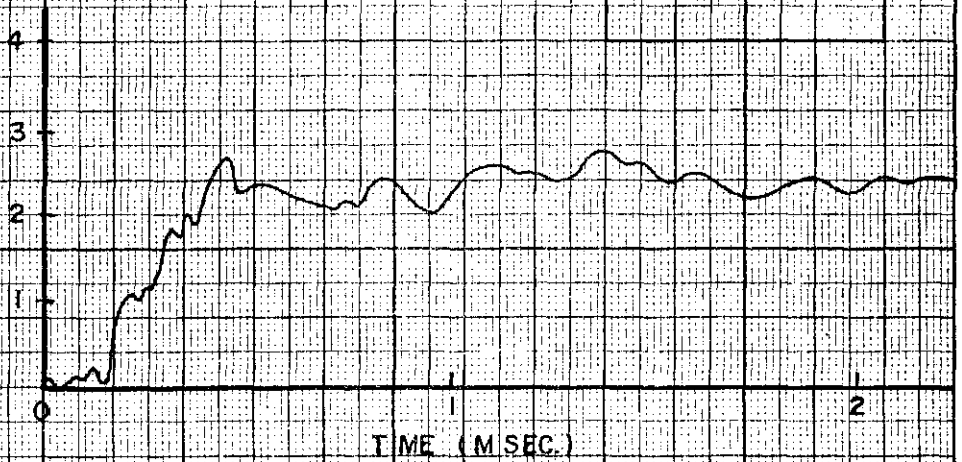
OILITE MODEL

POSITION 1

BACK FACE

$P_{MM} = 1081 \text{ PSI}$
 $T_{MM} = 0170 \text{ M SEC.}$
 $P_1 = 3.30$

PRESSURE
PSI

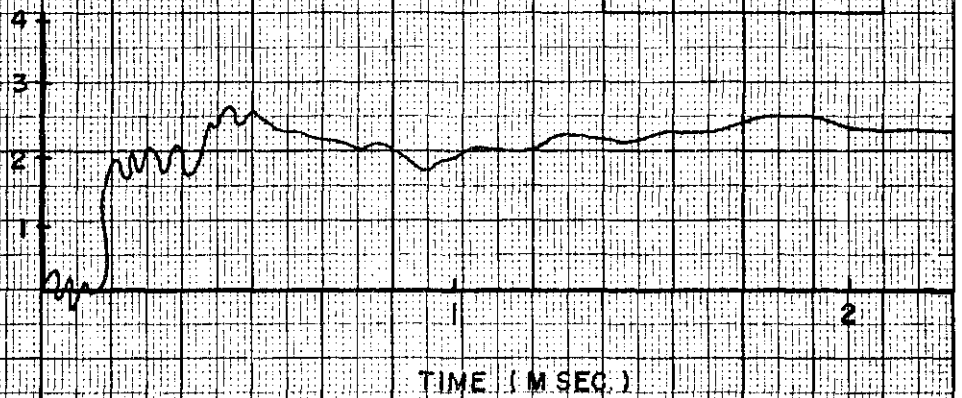


POSITION 2

BACK FACE

$P_{MM} = 103 \text{ PSI}$
 $T_{MM} = 0173 \text{ M SEC.}$
 $P_1 = 3.30$

PRESSURE
PSI



OILITE MODEL

IMM = .0255 PSI
IMM = .0172 MSEC.
PI = 2.44

POSITION 3

BACK FACE

G

PRESSURE
PSI

2.5
2
1.5
1
.5

TIME (MSEC.)

2

IMM = .0397 PSI
IMM = .0172 MSEC.
PI = 2.44

POSITION 4

BACK FACE

PRESSURE
PSI

3
2.5
2
1.5
1
.5

TIME (MSEC.)

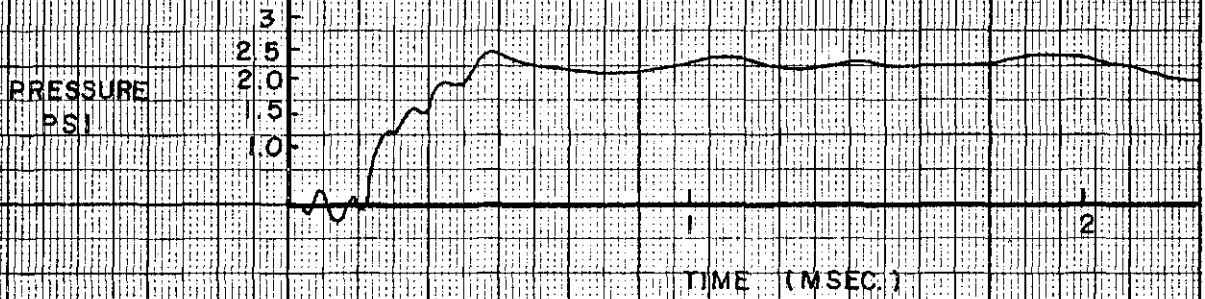
2

OILITE MODEL

POSITION 5

BACK FACE

$P_{IMM} = 1118 \text{ PSI}$
 $t_{IMM} = 0.72 \text{ MSEC}$
 $P_1 = 2.44$



OILITE MODEL

POSITION 1

TOP FACE

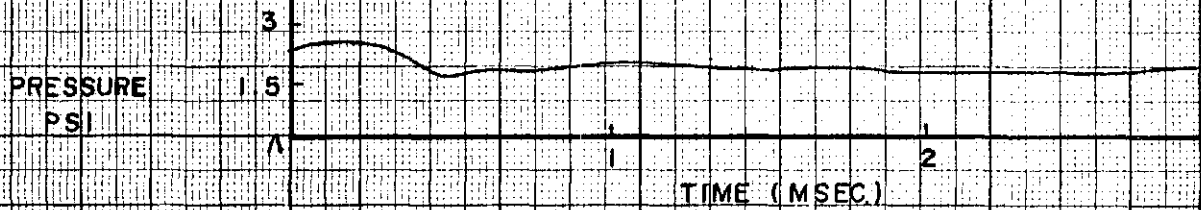
IMM = .135 PSI
IMM = .022 MSEC.
P₁ = 2.31



POSITION 2

TOP FACE

IMM = .186
IMM = .022 MSEC.
P₁ = 2.31



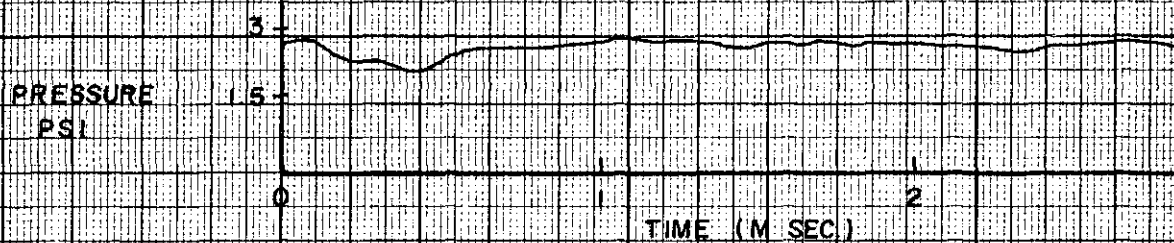
△ = INDICATES TIME SHOCK WAVE STRUCK MODEL

OILITE MODEL

POSITION 3

TOP FACE

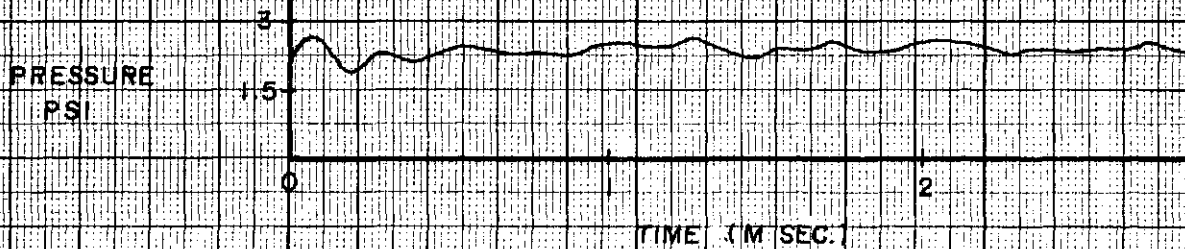
$\Delta MM = .143 \text{ PSI}$
 $\Delta MM = .022 \text{ M SEC}$
 $P_i = 2.31$



POSITION 4

TOP FACE

$\Delta MM = .15 \text{ PSI}$
 $\Delta MM = .022 \text{ M SEC}$
 $P_i = 2.31$



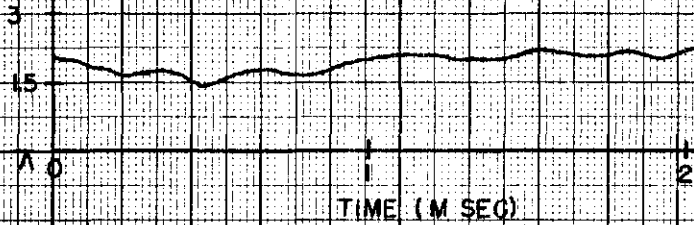
OILITE MODEL

POSITION 5

TOP FACE

$\Delta P = .15 \text{ PSI}$
 $\Delta P = .022 \text{ M/SEC}$
 $P_1 = 2.31$

PRESSURE
PSI



A = INDICATES TIME SHOCK WAVE STRUCK MODEL

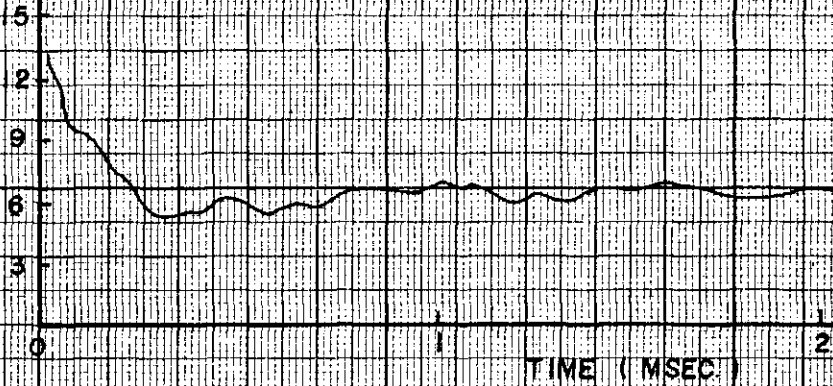
OIL TE MODEL

POSITION 1

FRONT FACE

IMM = .336 PSI
IMM = .0175 MSEC
P_i = 5.33

PRESSURE
PSI

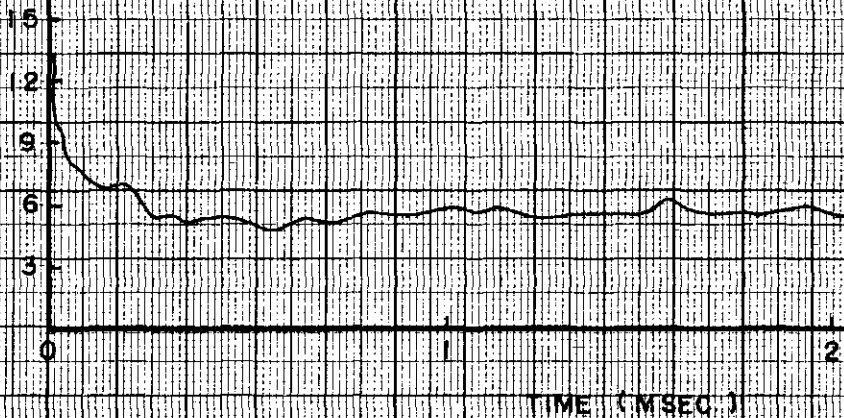


POSITION 2

FRONT FACE

IMM = .336 PSI
IMM = .0175 MSEC
P_i = 5.33

PRESSURE
PSI

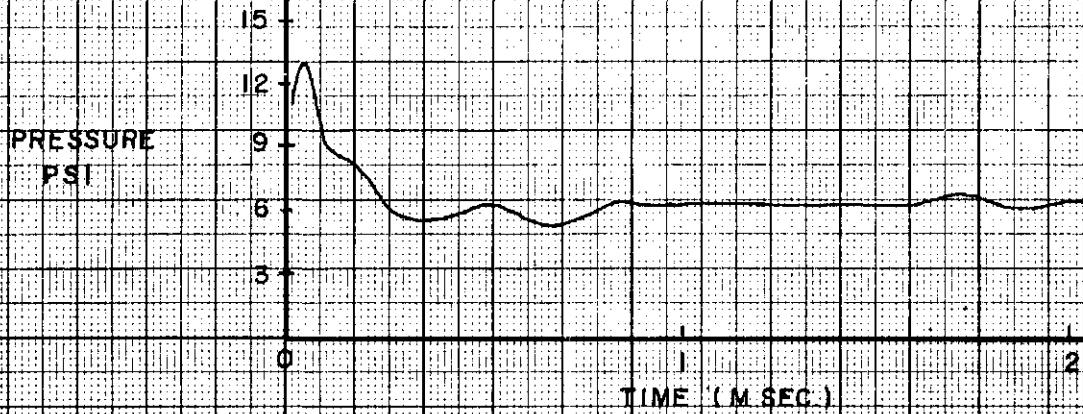


OILITE MODEL

POSITION 3

FRONT FACE

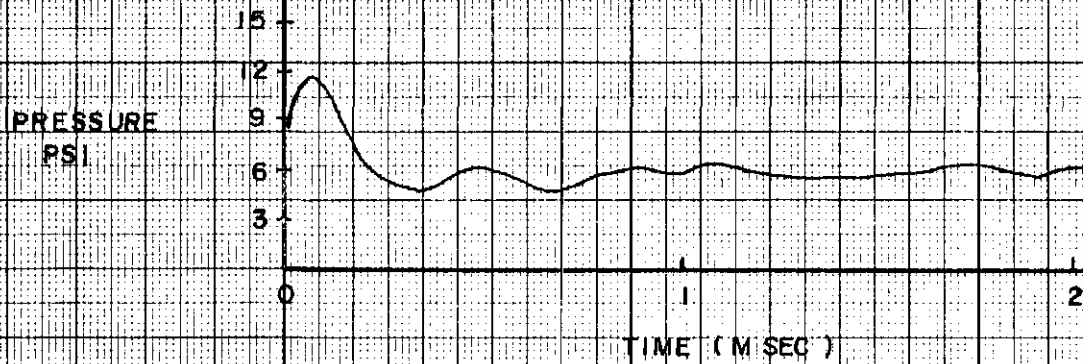
$\Delta P = .322$ PSI
 $\Delta t = .0175$ M SEC.
 $P_1 = 5.33$



POSITION 4

FRONT FACE

$\Delta P = .42$ PSI
 $\Delta t = .0175$ M SEC.
 $P_1 = 5.33$



OILITE MODEL

POSITION 5

FRONT FACE

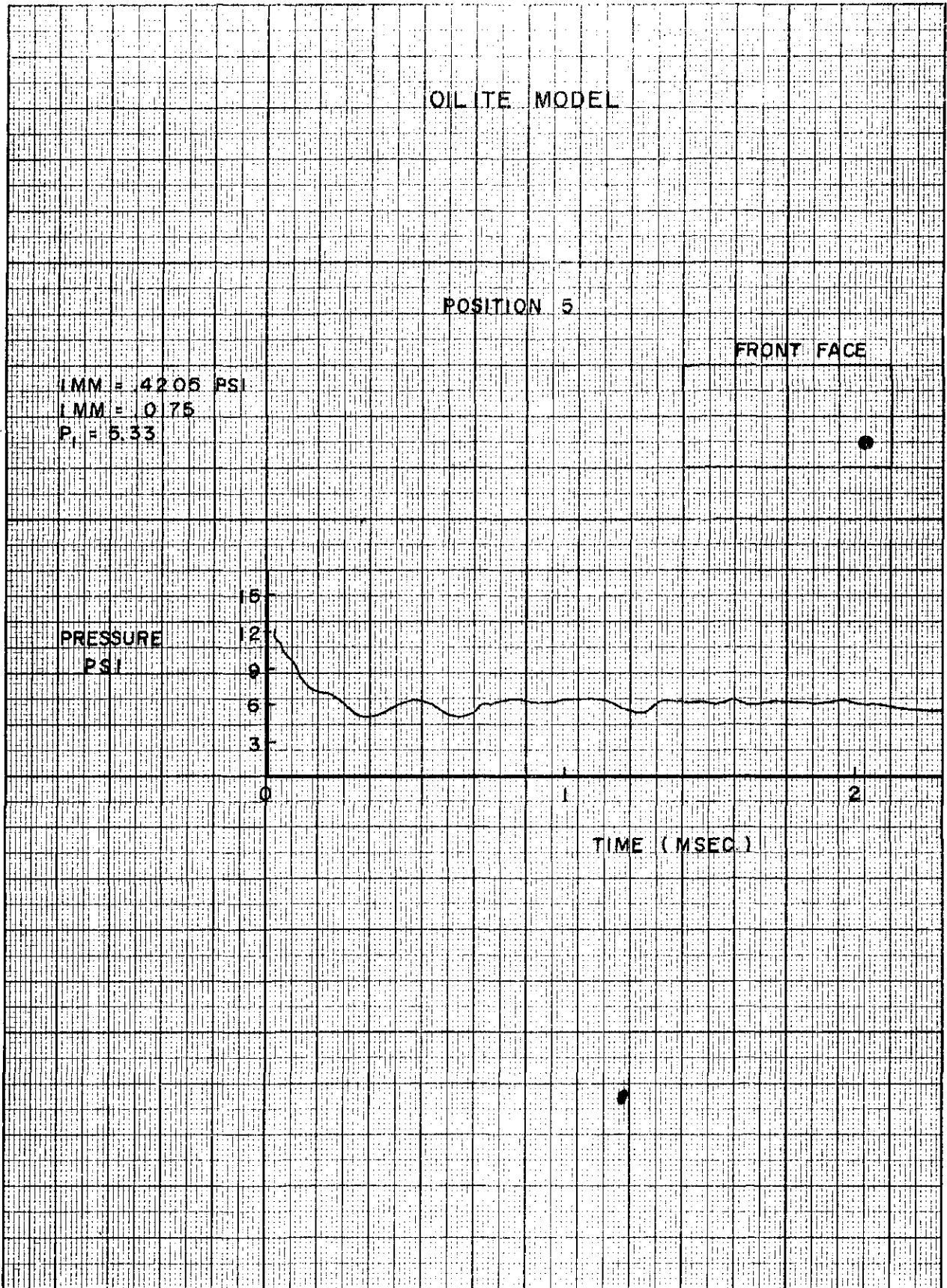
LMM = 42.05 PSI
LMM = 0.75
P_i = 5.33

PRESSURE
PSI

15
12
9
6
3
0

TIME (MSEC.)

0 1 2



OILITE MODEL

POSITION 1

BACK FACE

IMM = .082 PSI
IMM = .0174 MSEC.
P_i = 5.5

PRESSURE

PSI

5
3.75
2.5

TIME (MSEC)

2

POSITION 2

BACK FACE

IMM = .0893 PSI
IMM = .0172 MSEC.
P_i = 5.5

PRESSURE

PSI

5
3.75
2.5

TIME (MSEC)

2

SHOCK MODEL

IMM = 0.465 PSI
IMM = 0.185 MSEC.
P_i = 5.08

POSITION 5

BACK FACE

PRESSURE
PSI

5
3.75
2.5

(TIME MSEC.)

2

IMM = 0.568 PSI
IMM = 0.182 MSEC.
P_i = 5.08

POSITION 4

BACK FACE

PRESSURE
PSI

5
3.75
2.5

TIME (MSEC.)

2

OILITE MODEL

POSITION 5

BACK FACE

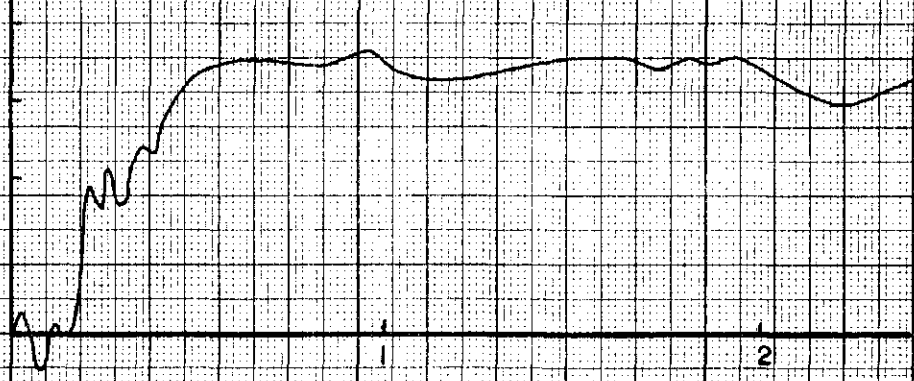
IMM = .112 PSI
IMM = .0185 MSEC.
P₁ = 5.08

PRESSURE
PSI

5
3.75
2.5

TIME (MSEC.)

1 2

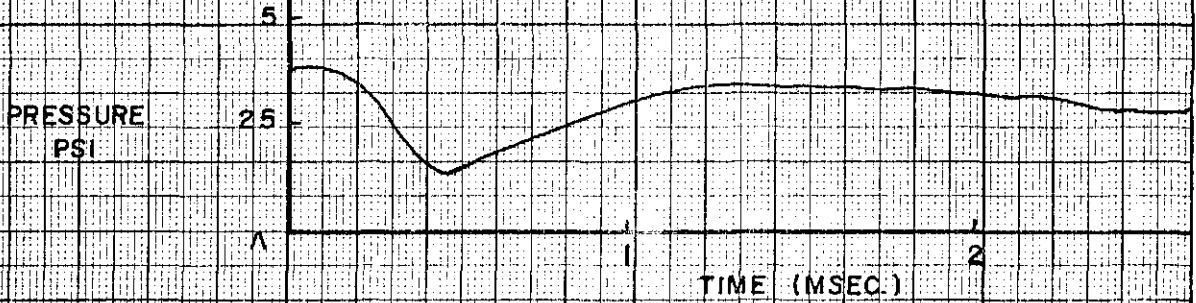


OILITE MODEL

POSITION 1

TOP FACE

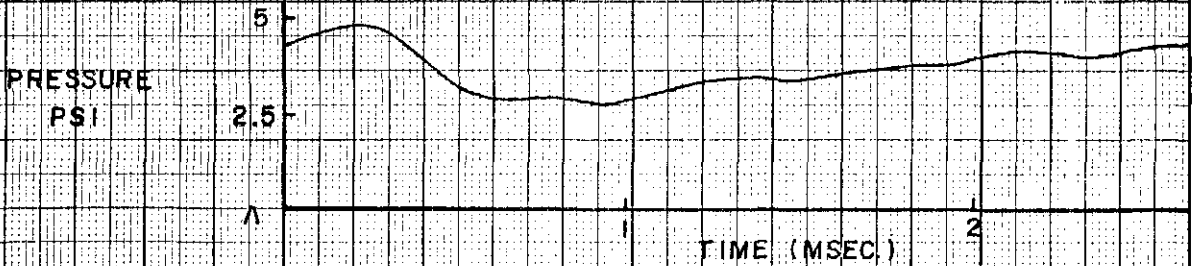
LMM = .164 PSI
LMM = .020 MSEC
 $P_1 = 4.34$



POSITION 2

TOP FACE

LMM = .189 PSI
LMM = .020 MSEC
 $P_1 = 4.34$



λ = INDICATES TIME SHOCK WAVE STRUCK MODEL

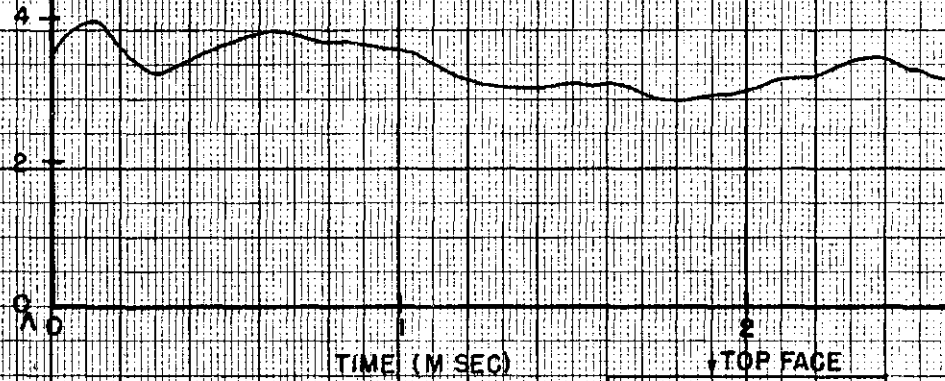
OILITE MODEL

POSITION 3

TOP FACE

Δ MM = .0969 PSI
TMM = .020 M SEC
 $P_1 = 4.34$

PRESSURE
PSI

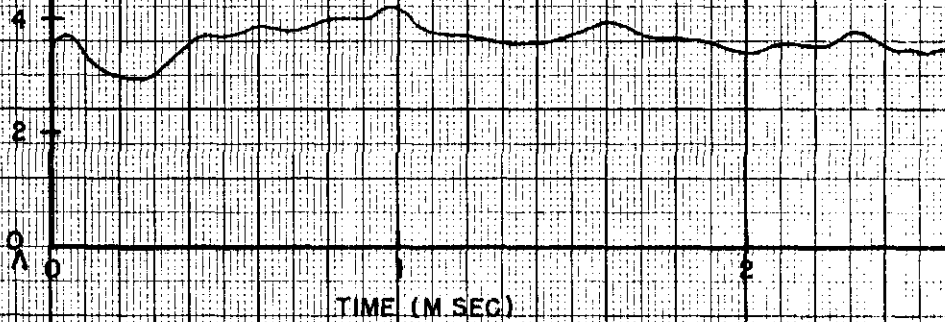


POSITION 4

TOP FACE

Δ MM = .117 PSI
TMM = .020 M SEC
 $P_1 = 4.34$

PRESSURE
PSI



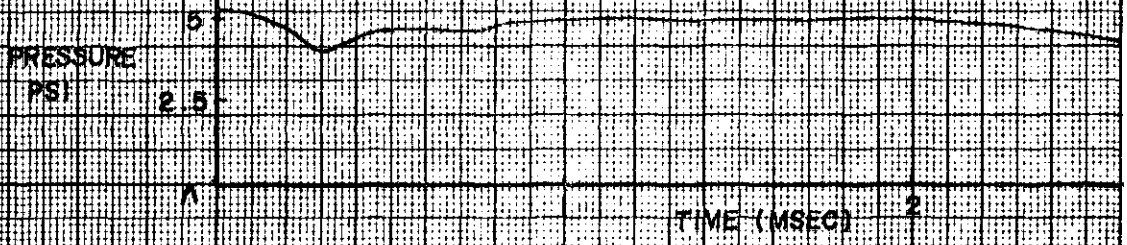
Δ = INDICATES TIME SHOCK WAVE STRUCK MODEL

OILITE MODEL

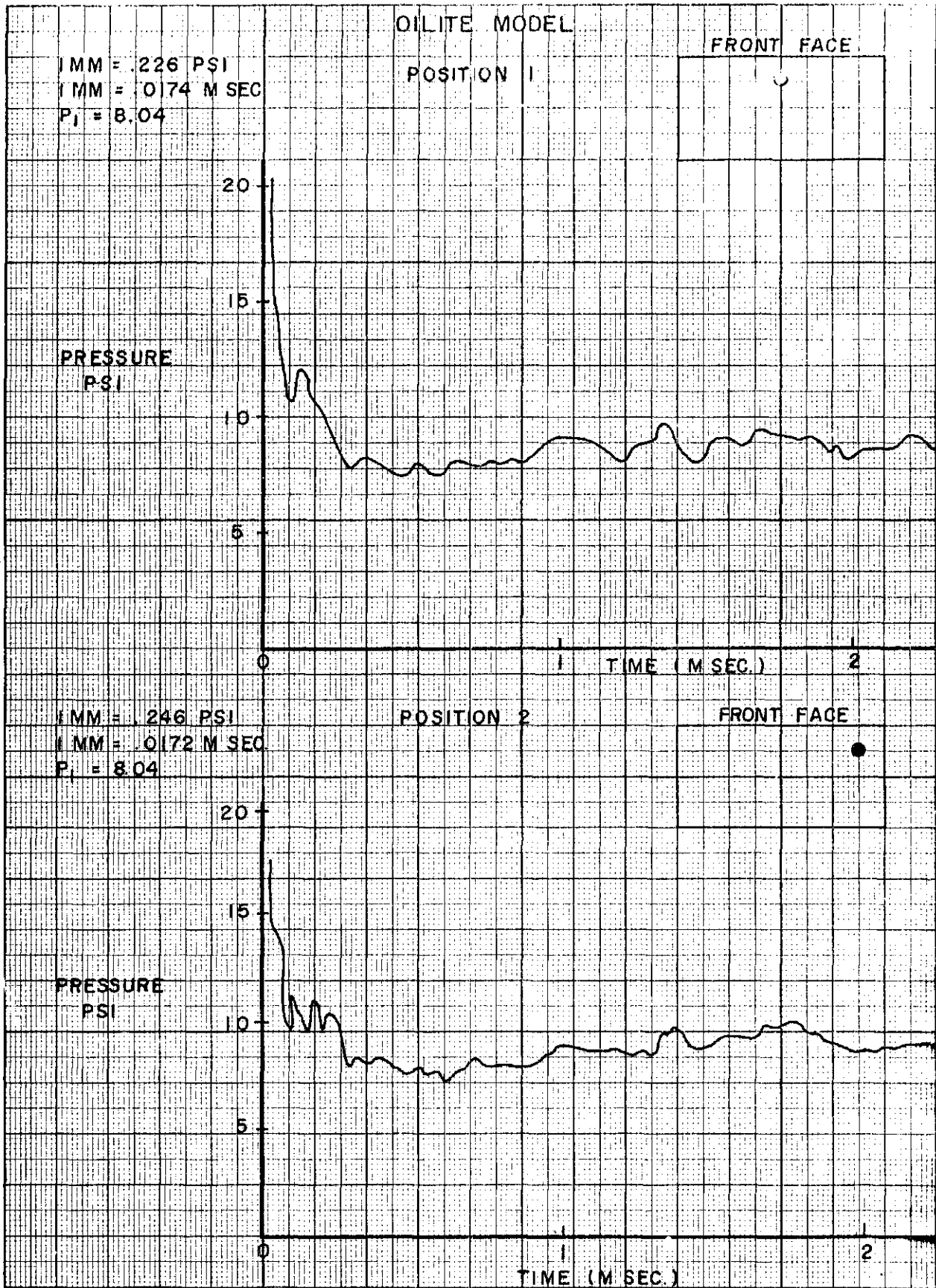
POSITION 5

TOP FACE

MM = 148 PSI
MM = 022 MSEC
P₁ = 4.34



▲ INDICATES TIME SHOCK WAVE STRUCK MODEL



OLITE MODEL

POSITION 3

FRONT FACE

MM = .264 PSI
MM = .0171 MSEC.
P_i = 0.09



POSITION 4

FRONT FACE

MM = .323 PSI
MM = .0174 MSEC.
P_i = 0.49



OILITE MODEL

POSITION 5

IMM = 26 (PS)
IMM = 0.170 MSEC
R = 8.30

FRONT FACE

PRESSURE
(PS)

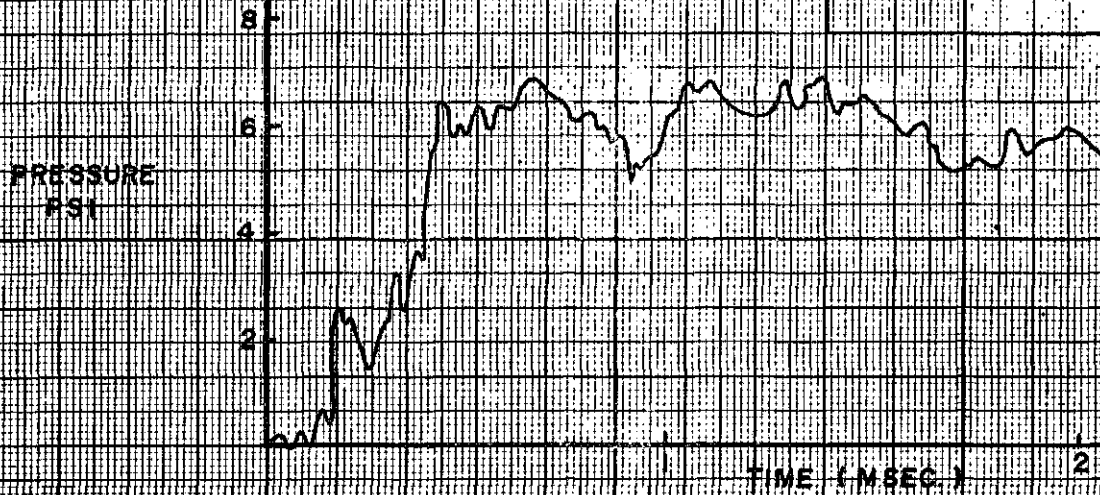


OILITE MODEL

POSITION 1

BACK FACE

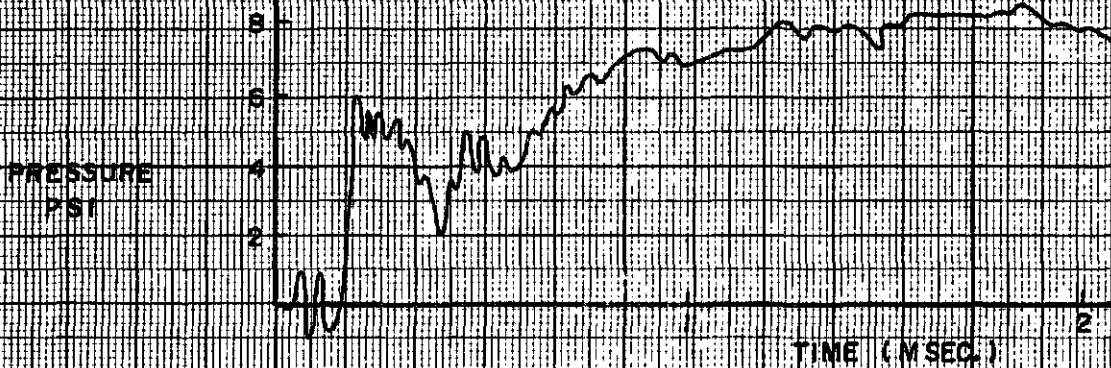
IMM = 130 PSI
IMM = 0.172 MSEC.
P₁ = 8.3



POSITION 2

BACK FACE

IMM = 198 PSI
IMM = 0.171 MSEC.
P₁ = 8.3



OILITE MODEL

POSITION 3

BACK FACE

IMM = 0.96 PSI
IMM = 0.172 MSEC.
P_i = 7.84

PRESSURE
PSI

TIME (MSEC.)

POSITION 4

BACK FACE

IMM = 1.14 PSI
IMM = 0.172 MSEC.
P_i = 7.84

PRESSURE
PSI

TIME (MSEC.)

OILITE MODEL

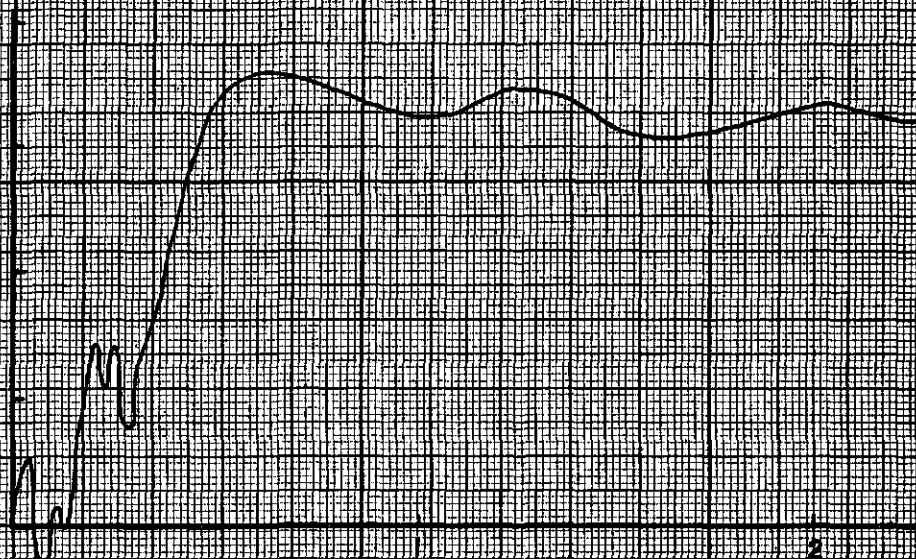
POSITION 5

BACK FACE

IMM = .10 PSI
IMM = .0172 MSEC
P₀ = 7.84

PRESSURE
PSI

8
6
4
2



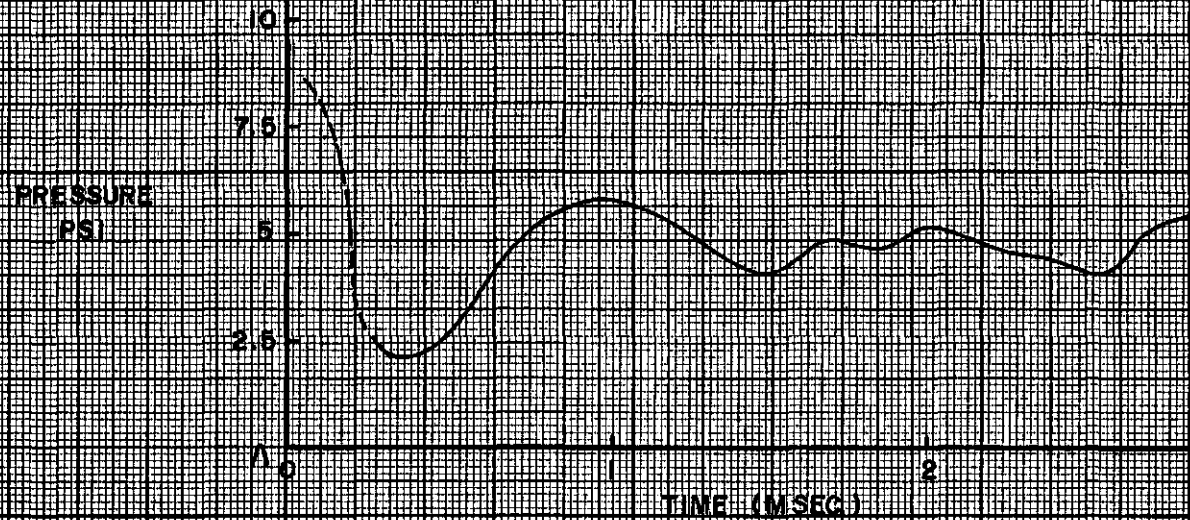
TIME (MSEC)

OILITE MODEL

POSITION 1

TOP FACE

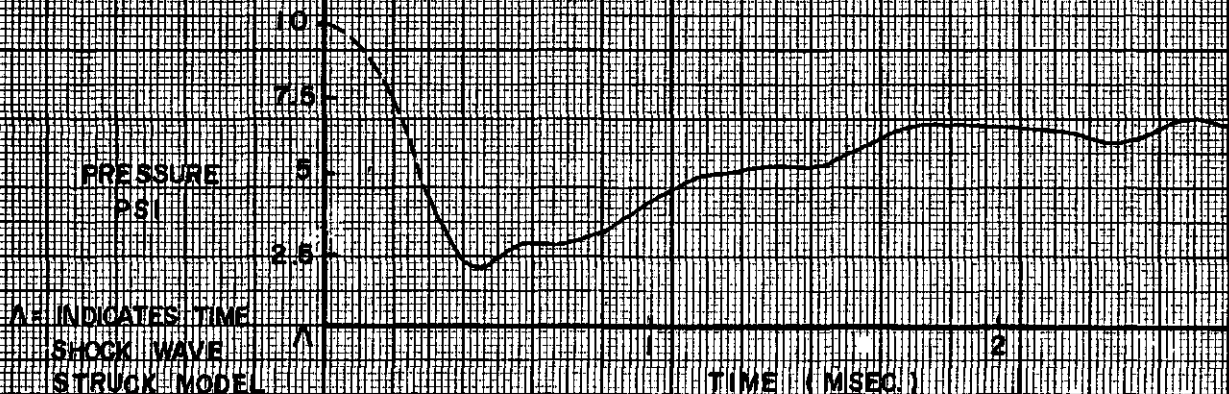
$P_{MM} = 16$ PSI
 $P_1 = 9.01$
 $t_{MM} = 0.22$ MSEC



POSITION 2

TOP FACE

$P_{MM} = 123$ PSI
 $t_{MM} = 0.22$ MSEC
 $P_1 = 9.01$



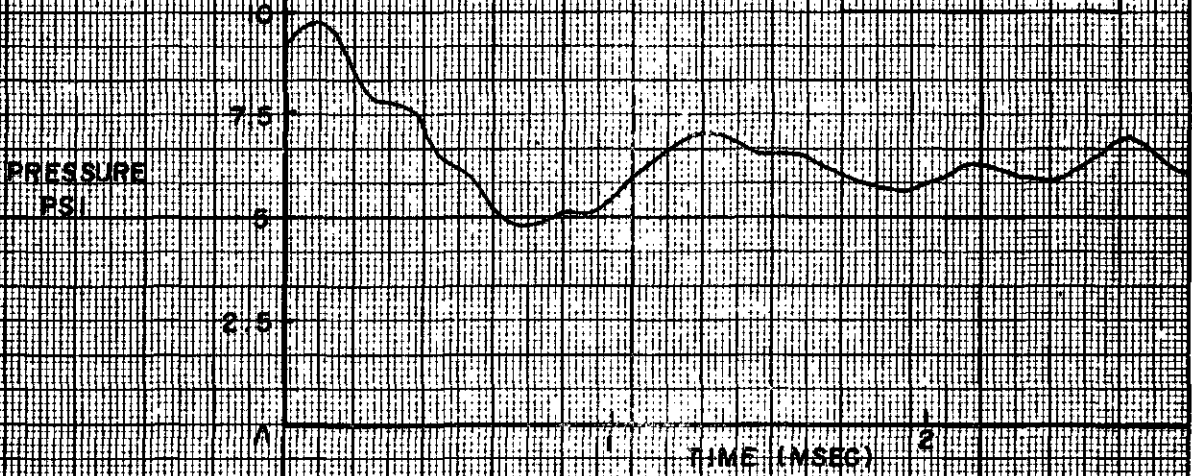
A = INDICATES TIME
SHOCK WAVE
STRUCK MODEL

OILITE MODEL

POSITION 3

TOP FACE

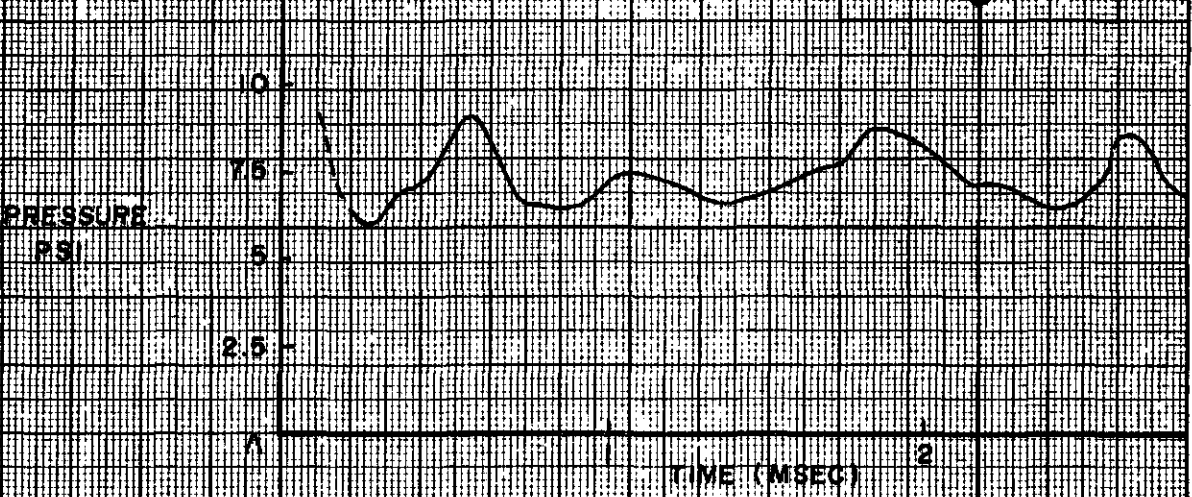
$P_1 = 168 \text{ PSI}$
 $\Delta T = .022 \text{ MSEC}$
 $P_2 = 9.01$



POSITION 4

TOP FACE

$P_1 = 196 \text{ PSI}$
 $\Delta T = .022 \text{ MSEC}$
 $P_2 = 9.01$



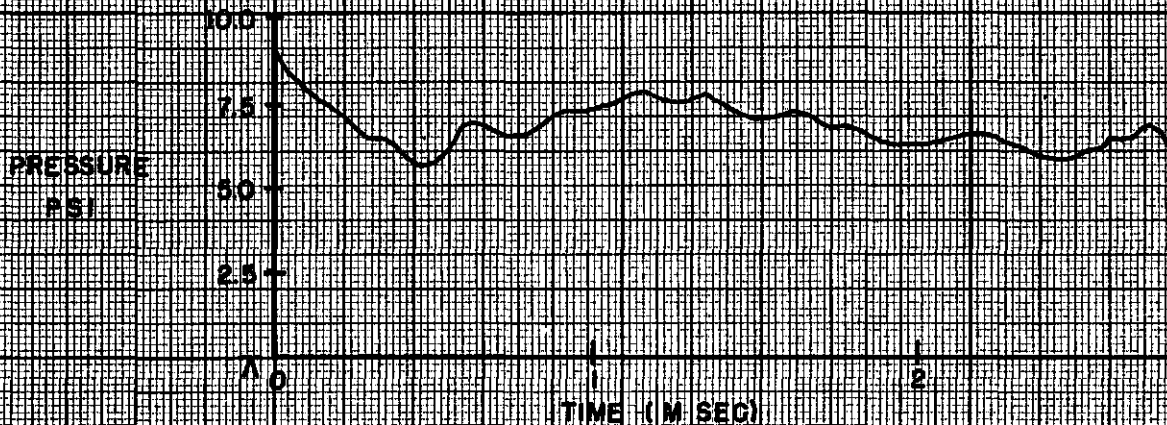
A = INDICATES TIME SHOCK WAVE STRUCK MODEL

OILITE MODEL

POSITION 5

TOP FACE

IMM = .2038 PSI
IMM = .022 M/SEC
P = 901



A - INDICATES TIME SHOCK WAVE STRUCK MODEL

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