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THE SENSITIVITY OF NITROGLYCERIN TO IMPACT

NAVAL ORDNANCE LAB WHITE OAK MD

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The Sensitivity of Nitroglycerin to Impact

By

Donald Levine and Carl Boyars

ABSTRACT: Experimental studies are reported on the initiation-deflagration process occurring in nitroglycerin (NG) and nitroglycerin solutions as a result of impact. The instrumented apparatus used permitted determination of the pressure-time relationships due to the momentum of the impacting weight and to the resulting deflagration. As a result, impact sensitivity testing of liquids is placed on a sounder basis. A gradual decrease in impact sensitivity is observed as desensitizer concentration is increased up to 16% by weight; a more rapid decrease in sensitivity is found beyond this point. bis(2-Fluoro-2,2-dinitroethyl)-formal (FEFO), a relatively insensitive energetic liquid, did not show any especially desirable desensitizing properties; the impact sensitivity of FEFO itself is about the same as that of NG solutions containing 29% conventional desensitizer.

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White Oak, Silver Spring, Maryland

NOLTR 64-177 20 October 1964

Nitroglycerin is an essential component of many high specific impulse propellants. The use of highly concentrated nitroglycerin solutions in propellant processing has resulted in a number of disastrous explosions. This report covers an experimental investigation designed to improve our understanding of the factors affecting the sensitivity of nitroglycerin.

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Captain, USN
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By direction

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INTRODUCTION

The objectives of the investigation reported here are (1) to determine the effect of desensitizers on the impact sensitivity of nitroglycerin (NG), (2) to study the pressure-time history of the sample during impact and subsequent explosion in order to define impact sensitivity more precisely, and (3) to investigate the feasibility of using relatively insensitive, energetic liquids as desensitizers for NG. The reason for this interest in the characteristics of NG is its extensive use in propellant technology. In the manufacture of cast double-base propellant, the NG with appropriate stabilizers and desensitizers (casting solvent) is added to granules consisting of nitrocellulose plus other ingredients. In the more energetic propellants, e.g., the second stage Polaris A-2, these other ingredients can include aluminum, ammonium perchlorate, and even solid high explosives. As higher and higher specific impulses are sought (the Polaris A-3), the desensitizer content has been reduced, and dangerously sensitive concentrations of NG are used in propellant processing. The result has been a series of disastrous explosions with much loss of life and considerable property damage. This investigation is undertaken, therefore, with the ultimate objective of developing suitable casting solvents of high energy but low sensitivity.

The initiation of explosion by impact has been the subject of much study. Many apparatuses have been designed in attempts to obtain reproducible results, to simulate potential causes of accidents, or to relate sensitivity to other physical and chemical properties. These devices have varied in size, from small units, such as the Picatinny Arsenal machine[1] in which a 20 mg sample is impacted by a 2 kg weight falling a maximum of 1 meter to the large impact tester at the Bureau of Mines[2] in which an 80 g sample is impacted by a 200 kg weight dropping a maximum of 7.5 meters.

Most of these drop weight testers were designed specifically for solids. Investigators have adapted them for liquids, and these modifications have generally proven unsatisfactory. The major difficulty in obtaining reasonable and reproducible test results probably lay in failure to obtain reproducible confinement of the sample or to include a known gas volume in the sample cavity.

In a general account of the mechanism of initiation of explosion in liquids, Bowden and Yoffe[3] have reported that the sensitivity of liquid explosives, as measured by impact, was markedly dependent upon the presence or absence of gas bubbles

within the liquid. They concluded that initiation begins in hot spots resulting from the adiabatic compression of gas bubbles present with the liquid. Based on this theory, the Olin-Mathieson (O-M) Drop Weight Tester[4] was devised specifically for liquid samples. Emphasis was placed on accurate measurement of sample volume, inclusion of a controlled gas volume, and complete sealing of the sample cavity to prevent leakage during the impact and explosion. In 1959 the Joint Army-Navy-Air Force Panel on Liquid Propellant Test Methods adopted this apparatus as the standard method for determining the impact sensitivity of liquids.

EXPERIMENTAL

The Olin-Mathieson drop weight tester contains three basic components: (1) a drop weight assembly, (2) an impacting section and (3) a sample cup assembly. The drop weight assembly has a rigid base containing four leveling screws. This base is bolted to a steel plate which in turn is bolted to a table top of $1\frac{1}{4}$" thick stone. Two guide bars (one calibrated in centimeters) equipped with an adjustable support for the weights and a release mechanism complete the drop weight assembly.

The impacting portion of the O-M Tester is of conventional design except that weights may be varied from one to seven kg in 50 g increments. The sample holder assembly (Fig. 1a) is relatively simple, consisting of a sample container formed by a steel cup, a Buna-N O-ring (0.239 ± .005 inch i.d. and 0.379 ± .003 inch o.d.), a steel diaphragm (0.015 inch thick, 0.363 inch diameter), a piston which rests on the diaphragm, and a retainer ball which prevents the piston from rebounding if an explosion occurs. The liquid charge volume is 0.03 cc. Proper functioning of the O-ring seal requires the assembly to be pre-compressed. This is accomplished by tightening the sample assembly cap with a torque wrench to a reading of 7 inch-pounds, which results in a compression of the gas from an initial volume of approximately 0.026 cc to a final volume of approximately 0.007 cc.

The following test procedure was used in determining the 50% rupture points of the liquid samples under investigation. First, all components of the sample cup assembly were carefully cleaned and dried. The vent hole in the piston, as well as the threads on the sample cup assembly were also carefully cleaned and dried. The guide rods containing the weights were lubricated each day to insure minimum frictional losses. After these preliminary operations were completed, the sample cup was fitted with an O-ring making certain that it was properly seated at the bottom of the cup. The liquid sample (0.03 cc) was then transferred (by means of a 50 microliter syringe) to the cavity formed

by the O-ring and the cup. The diaphragm was then carefully placed on top of the O-ring, and the piston placed on top of the diaphragm. The cup was then placed in the body and the retainer ball positioned on top of the piston. The cap was then screwed to the body and tightened with the torque wrench to 7 inch-lb. The whole assembly was then placed into the specially designed holder (Fig. 1b) on the base of the tester. The weights were released and the results recorded. After the explosion, the body assembly was removed from the base and each part was carefully examined. If serious physical damage were discovered, the part was discarded.

The instrumented sample holder which has been developed in this investigation consists of all the standard sample holder components with the sample cup resting on a 9.3 mm piston-type pressure gauge (Fig. 1a), which measures pressure over the range of 400 to 100,000 psi. Characteristics of this gauge are simplicity of design and construction, reliability, and rapid response time[5]. It is machined from a single piece of metal stock and consists of a piston, a column, and a threaded base which serves only to anchor the gauge. The sensing elements are strain gauges which are bonded to the face of the column. To compensate for any bending of the column while pressure is being applied to the piston face, two strain gauges are placed in similar positions on opposite faces of the column. The output of this transducer is fed to two oscilloscopes and recorded on two Polaroid Land Cameras. Two switches which can trigger the oscilloscopes are mounted on the drop weight apparatus. From the oscilloscope records, the time of fall of the weight (to verify free fall), impact pressure, rate of pressurization, ignition delay time, and pressure developed within the sample cavity as a function of time during explosion can be determined. The gauge was calibrated with a hydraulic press, and its response was found to be linear up to 100,000 psi. A perforated metal pedestal on which the sample cup rests was constructed in order to facilitate proper alignment of the assembly with the impacting weight and to allow for electrical connection to the bridge circuit.

NG, desensitized with acetone, was supplied by the U.S. Naval Propellant Plant, Indian Head, Maryland. The acetone was removed by flushing the solution for 6 hours with dry, purified nitrogen. Analysis of the NG, slightly modified from Becker's method[6], consisted of reducing the nitrate groups with a solution of ferrous ammonium sulfate and titrating the resulting ferric ions with titanous chloride, using ammonium thiocyanate as an indicator.

RESULTS AND DISCUSSION

The impact test. Difficulties were encountered in the initial application of the impact test to a series of desensitized NG samples. For material of this nature, the recommended test procedure[4] involved varying the height between 1 and 20 cm using a constant weight of 1 kg (which is the weight of the carriage without added weights). When this procedure was used, it was found that the results were not reproducible. Deviations in obtaining the 50% point were observed to be as large as 200%. These large deviations were reduced, however, when the tests were conducted by maintaining the carriage at a constant height of 1 cm and varying the weight between 2 and 7 kg.

Pressure studies were initiated to define some of the variables involved in impact testing. In order to verify whether free fall was occurring, an oscilloscope was triggered by the release of the weight. When the weight contacts the retainer ball, a pressure increase is observed. The time of fall taken from the oscilloscope record agrees very closely with the calculated times (Table 1). The slight differences may be due to difficulties encountered in placing the carriage (containing the weights) at exactly the desired height.

Pressure-time records for various impact energies were obtained on a standard sample volume (0.03 cc) of glycerol. Fig. 2 shows the pressure-time plot following impact of a 1 kg weight dropped from heights of 2, 4, and 6 cm. Fig. 3 shows the pressure-time curve for the sample impacted with 2, 4, and 6 kg weights from a height of 1 cm. Fig. 4 contains records of 2 and 3 kg weights impacting from heights of 2, 4, and 6 cm. Data derived from these records are given in Table 2. It appears that rate of pressurization is a function of velocity of the impacting weight and not of its mass.

A comparison of Figs. 2, 3, and 4 also reveals the reason for the lack of reproducibility of test results on nitroglycerin solutions when a 1 kg weight is used. Considerable oscillation occurs in the pressurization, and the sample container is actually subjected to a series of compressions and expansions. Amplitude of the oscillation increases somewhat with increasing drop height (and therefore terminal velocity) of the dropped weight. Oscillation amplitude also appears to be increased considerably by use of the 1 kg weight. When weights of 2 kg and greater are dropped from a height of 1 cm, the oscillation is negligible (Fig. 3). It would seem likely that testing under conditions in which amplitude of oscillations equals a substantial fraction of the peak pressure due to impact would provide poorly reproducible results.

The momentum, mv, of the impacting weight is readily calculated using the relationship, $v = (2gh)^{\frac{1}{2}}$. The impulse, I, delivered by the piston to the cup of the impact apparatus can be measured readily by graphical integration (planimeter or weighing of curve area) of the oscillographic P-t plot, knowing the area of the piston face ($I = \int_{P=0}^{P=max} F dt$; F = P x area). The impulse delivered to the cup, ideally, is equal to the momentum of the free-falling impacting weight; actually, frictional and other losses reduce the delivered impulse. Table 3 compares momentum and impulse for various heights and weights. It is seen that the losses are proportionately higher with the 1 kg mass than with the greater masses. In impact testing it is common practice to report results as a weight-height product, thereby implying an equivalence of the factors. This erroneous practice is contrary to the elementary principles of mechanics, and the momentum and impulse data of Table 3 emphasize this.

As shown above, the rate of pressurization of the sample charges as the height is varied. In order to eliminate this variable, tests should be made at a constant height, as far as practicable, so that variation of the energy delivered is obtained by varying the weights only.

Where ignitions occur, the P-t oscillographic plots show a second, much higher pressure peak subsequent to the peak due to impact impulse alone. The published test method requires the diaphragm to be punctured for a positive result. It was observed, however, that occasionally the sample would ignite and appear to react completely yet fail to burst the diaphragm. These cases are due to leakage caused by failure of the O-ring; there is visual evidence of rupture of the O-ring and a raised point at the edge of the diaphragm where the gases escaped. For samples which puncture the diaphragm, the rate of decrease of the pressure is very much greater (see Fig. 5). It is illogical to classify these ignitions which do not burst the diaphragm as negative results, and they were therefore reported as positive.

Wear or erosion of the sample cups had important effects on the results. The cups were subject to erosion from the gas escaping around the seal between the top of the O-ring and the diaphragm. In time the cups became pitted. When this occurred the results were unreliable, therefore only cups and pistons in the best physical condition were used. Scrupulous cleanliness is also necessary for reproducibility of results.

In the course of our measurements, it was observed that NG samples which did not ignite on impact appeared to have a

light yellowish color. Analysis of the impacted sample showed 97.72 ± .05% NG. NG (99.93 ± .02%) placed in the sample cup for fifteen minutes (the estimated length of time the samples were normally in contact with the O-ring) but not impacted also appeared to be slightly yellow when withdrawn from the sample cup. However, the analysis indicated only a slight change had occurred, i.e., 99.44 ± .03%. NG was next placed in the sample cup assembly for 24 hours and then withdrawn for analysis. After 24 hours in contact with the O-ring, a deep yellow color was noted, as well as a think black film. The results of this analysis (93.29 ± .04%) indicated that NG leached material from the Buna-N O-ring. The difference between the analysis of the impacted versus non-impacted NG with the same exposure time is presumably due to additional material being extracted from the O-ring on impact. It is therefore important that the contact time between NG solutions and the O-ring be reduced to a minimum (approximately 5 minutes).

The effect of desensitizers. The impact sensitivity of NG with three added desensitizers - triacetin (TA), dimethyl phthlate (DMP), and dibutyl phthlate (DBP) - was studied to measure sensitivity as a function of composition and to determine whether a particular composition was safe to handle. The effect of addition of bis(2-fluoro-2,2-dinitroethyl)formal (FEFO), a relatively insensitive, energetic liquid, to NG was also studied. Drop weight data obtained on these solutions are shown in Fig. 6. At least twenty trials were conducted on each solution in order to obtain the 50% probability of ignition point. All tests were made from a constant height of 1 cm using varying weights. The decrease in sensitivity with the addition of 5-16% TA, DMP, or DBP appears to be relatively small. A larger rate of change is observed, however, between 16-30%. FEFO appears to be much less effective in desensitizing NG than the conventional, inert desensitizers are. The impact sensitivity of FEFO itself is about the same as that of NG solutions containing 29% conventional desensitizer.

Using oscillographic P-t plots from trials which failed to ignite at the 50% point, delivered impulses were determined by graphical integration. In Fig. 7 are shown plots of momentum and impulse versus concentration of desensitizer. The impulse delivered to the sample at the 50% point increases from 73 to 209 kg cm/sec as concentration of desensitizer is increased from 0 to 29.4%.

Fig. 8a is a reproduction of typical oscilloscope records of the pressures developed during impact and subsequent deflagration of a standard sample (.03 cc) of NG. The NG was initiated by a 2 kg weight falling from a 1 cm height, which is the 50%

probability level for this compound. During the pre-ignition period, the pressure developed due to the impacting weight was about 6800 psi. After peak impact pressure was obtained, an ignition delay is observed; the pressure falls until the sudden increase which denotes ignition. The NG undergoes deflagration, with the pressure rising to its maximum value in 0.6 ms. In the case of a detonation, a much shorter pressure rise time would be expected. The impulses generated in this apparatus are not very strong. The maximum pressure which can develop is about 100,000 psi, the bursting point of the diaphragm. It is thus not unexpected that these experiments usually result in a deflagration rather than a detonation.

In Fig. 8 typical pressure versus time records are shown for a series of NG/TA, NG/DMP and NG/FEFO solutions. In all of these tests drop weights which caused a 50% ignition probability were used. In each case a normal deflagration is seen to occur with the time required to reach maximum pressure increasing from 0.6 ms to 4.0 ms as diluent (TA or DMP) concentration increases from 0-30.5%. In the case of FEFO solutions, however, the burning time ranges from 0.80 ms to 1.16 ms. The O-ring appears to seal the cavity satisfactorily up to the limiting pressure of 100,000 psi. The sudden decrease in pressure after a peak pressure of 100,000 psi is reached indicates puncture of the diaphragm. These results are summarized in Table 4.

Ignition of these NG solutions is preceded by an induction period. The initiation delay times, measured from the peak of the impact pressure to the first indication of a subsequent deflagration pressure, increase from about 0.2 to about 1.5 ms as the concentration of desensitizer is increased from 0 to 30.5% (Fig. 9 and Table 4).

The "memory effect". Some three dozen trials, involving repeating the impact test with the same weight and at the same height on the same sample which had just failed to ignite, resulted in a positive test every time. Most of these trials were carried out at the 50% point and some below this point. This "memory effect" indicates that the first impact sensitized the NG solution in some way. One obvious hypothesis is that some inhibitory substances were removed or some autocatalytic species, e.g., NO_2, were formed during the first impact. Since we have found that material is apparently extracted from the Buna-N O-ring upon impact, there is also the possibility that some sensitizing substance gets into the NG solution in this manner. Further investigation of this phenomenon is called for, using O-rings which do not interact with the NG solution, because the implication that such solutions may be made more sensitive by earlier rough treatment is of considerable practical importance.

SUMMARY AND CONCLUSIONS

Addition of a strain gauge and oscillographic equipment to the conventional O-M impact test apparatus for liquids allows measurement of pressurization rate, maximum pressure, and impulse due to impact. Availability of such data helps to explain the difficulty in getting reproducible test results on liquid explosives when the impacting weight is small. With this equipment, sensitivity of liquid explosives may be characterized in terms of initiation delay and relative rate of deflagration as well as in terms of the impacting force. A clearer understanding of the initiation-deflagration process resulting from impact and of the effect of desensitizers on this process is gained thereby. The commonly used method of reporting impact sensitivity as a weight-height product is without theoretical foundation or experimental justification. Deflagrations rather than detonations occur in the impact test. At the 50% point the pressure rises to its maximum of 100,000 psi (bursting point of the diaphragm) in 0.6 - 4.0 ms, after initiation delay times of about 0.2 - 1.5 ms, these times increasing as the concentration of desensitizer in the NG increases from 0 to 30.5%. The impulse delivered to the sample at the 50% point increases from 73 to more than 200 kg cm/sec over this concentration range. A gradual decrease in impact sensitivity is observed as desensitizer concentration is increased up to 16% by weight; a more rapid decrease in sensitivity is found beyond this point. FEFO did not show any especially desirable desensitizing properties; the impact sensitivity of FEFO itself is about the same as that of NG solutions containing 29% conventional desensitizer. A "memory effect" has been found, which may indicate that NG is made more sensitive by earlier impact.

ACKNOWLEDGEMENT

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Table 1. Comparison of measured and calculated data (assuming free fall) for various drop heights of 1 kg weight

Ht. Measured h (cm)	Time Measured t (μsec)	Time Calc. $t_c = (2h/g)^{\frac{1}{2}}$	Ht. Calc, $h_c = \frac{1}{2}gt^2$
1	45.3	45.2	1.008
2	63.8	63.9	1.996
4	92.0	90.4	4.147
6	112.0	110.1	6.146

Table 2. Rates of pressurization for 0.03 cc of glycerol impacted by various weights from various heights

Weight (kg)	Height (cm)	Max. P 10^2 psi	Av.dev.	Time to Achieve Max.P (μsec)	Av.Dev.	Rate (psi/μsec)	Av.Dev.
6	1	11.6	± .6	580	± 50	20	± 3
4	1	9.5	.5	480	20	20	2
2	1	6.8	.3	350	50	19	4
3	2	15.3	.8	450	50	34	5
2	2	12.9	.6	370	35	35	5
1	2	6.8	.3	200	20	34	5
3	4	22.8	.5	420	40	54	6
2	4	19.0	.9	310	10	61	5
1	4	11.6	.6	240	20	48	6
3	6	27.2	.9	400	40	69	9
2	6	23.1	.7	320	20	72	7
1	6	15.6	.6	240	40	65	14

Table 3. Comparison of momentum of impacting weight and impulse delivered to sample

Height (cm)	Weight (kg)	Impulse (kg-cm/sec)	Momentum (kg-cm/sec)	% Difference
1	1	30	44	32
2	1	47	63	25
4	1	62	89	30
6	1	79	108	27
1	2	73	89	18
2	2	120	125	4
4	2	164	177	7
6	2	196	217	10
1	2.6	94	115	18
1	3	105	133	21
2	3	170	188	10
4	3	252	266	5
6	3	307	325	6
1	4	137	177	23
1	5	169	222	24
1	6	209	266	21

Table 4. Effect of FEFO on desensitizers - triacetin (TA) and dimethyl phthlate (DMP) - on the deflagration rate and induction period of nitroglycerin (NG) solutions at the 50% point

Sample	Impact Weight (kg) from 1 cm height	Time to 10^5 psi (msec)	(av.dev.)	Deflagration Rate (psi/μsec)	(av.dev.)	Delay Time to Ignition (msec)	(av.dev.)
NG	2.0	0.60 ±	.04	167 ±	11	0.19 ±	.04
FEFO	5.8	1.16	.09	86	7	.39	.04
NG/TA 90.32/9.68	2.6	1.00	.07	100	7	.20	.03
NG/DMP 89.88/10.12	2.6	.93	.03	108	3	.18	.06
NG/DMP 87.09/12.91	3.0	1.15	.07	87	5	.32	.14
NG/TA 85.52/14.48	2.8	1.25	.18	80	12	.39	.07
NG/TA 82.20/17.80	3.5	1.64	.07	61	3	.45	.06
NG/TA 80.45/19.55	3.8	2.00	.20	50	5	.59	.04
NG/FEFO 80.17/19.83	2.5	0.69	.07	145	15	.15	.08
NG/DMP 79.01/20.99	4.4	1.85	.15	54	4	.56	.19
NG/TA 75.34/24.66	5.0	2.60	.20	39	3	.94	.11
NG/DMP 70.60/29.40	6.0	2.80	.49	36	6	.85	.12
NG/TA 69.55/30.45	6.3	4.07	.32	25	2	1.50	.50
NG/FEFO 60.92/39.08	3.0	.80	.15	125	24	.20	.10
NG/FEFO 39.16/60.84	3.5	1.10	.10	91	8	.25	.10
NG/FEFO 9.80/90.20	5.5	1.10	.70	91	17	.31	.05

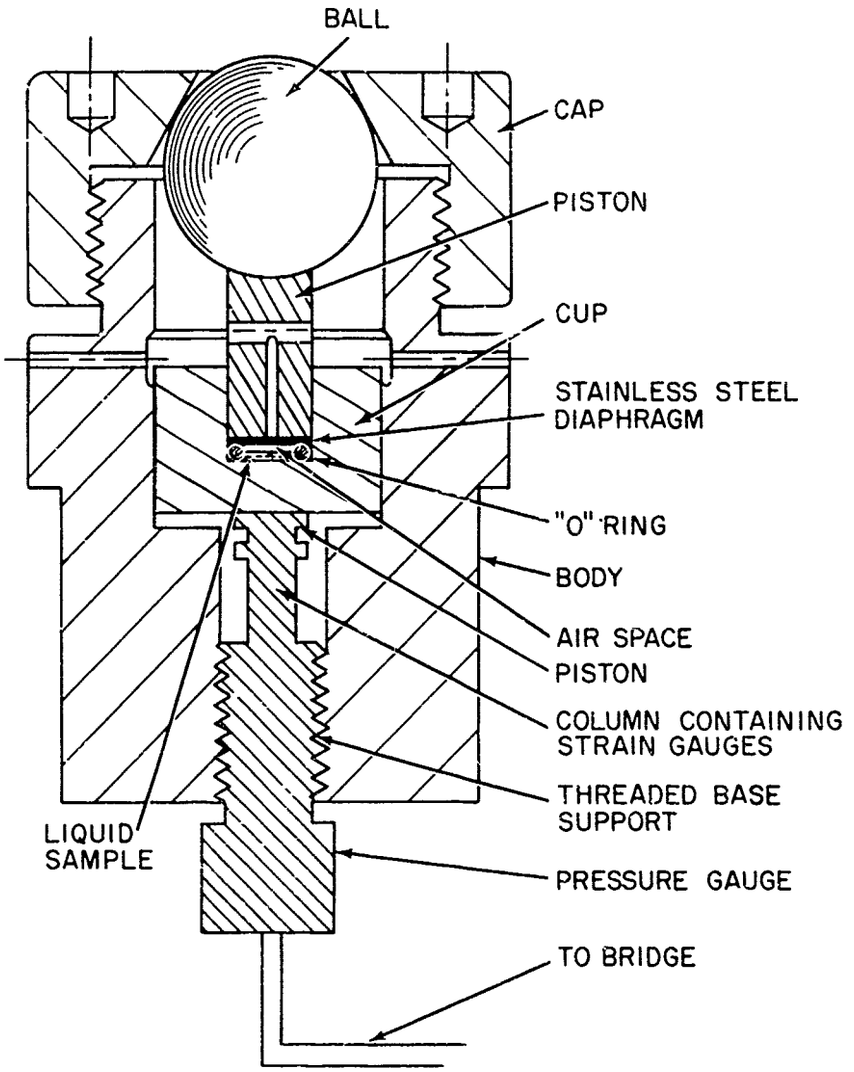

FIG. 1a DETAILS OF SAMPLE CUP ASSEMBLY CONTAINING PRESSURE GUAGE

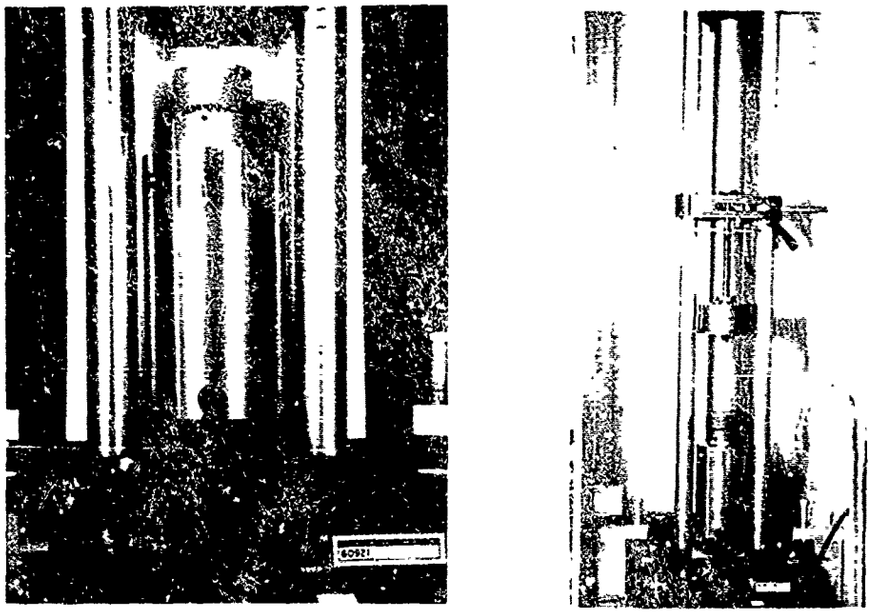

FIG. 1b DROP WEIGHT TESTER SHOWING SAMPLE ASSEMBLY HOLDER

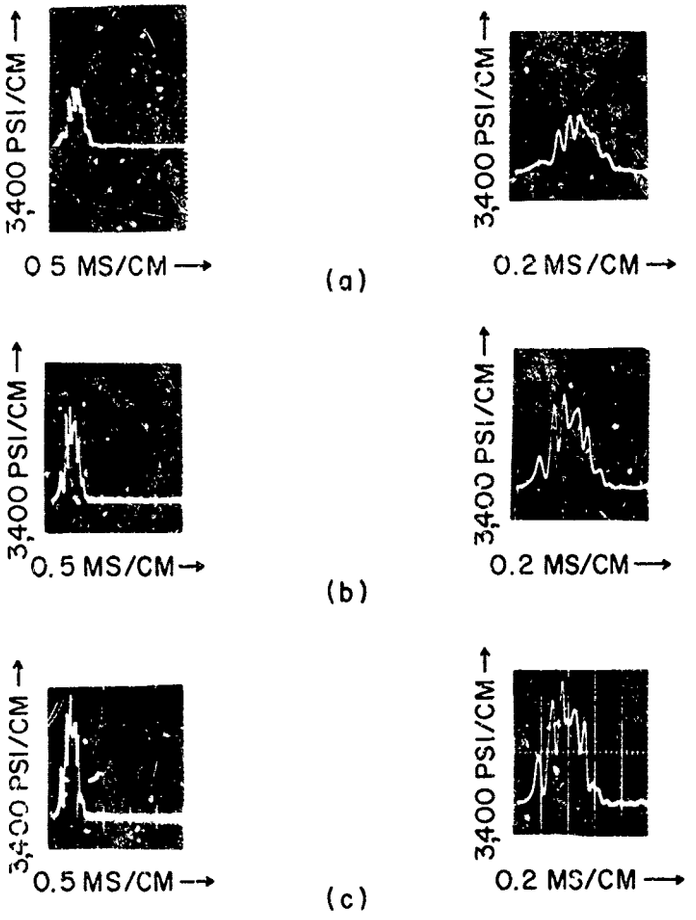

FIG. 2 PRESSURE VS TIME FOR 0.03 CC OF GLYCEROL IMPACTED BY A 1 KG WEIGHT FROM (a) 2 CM, (b) 4 CM, (c) 6 CM

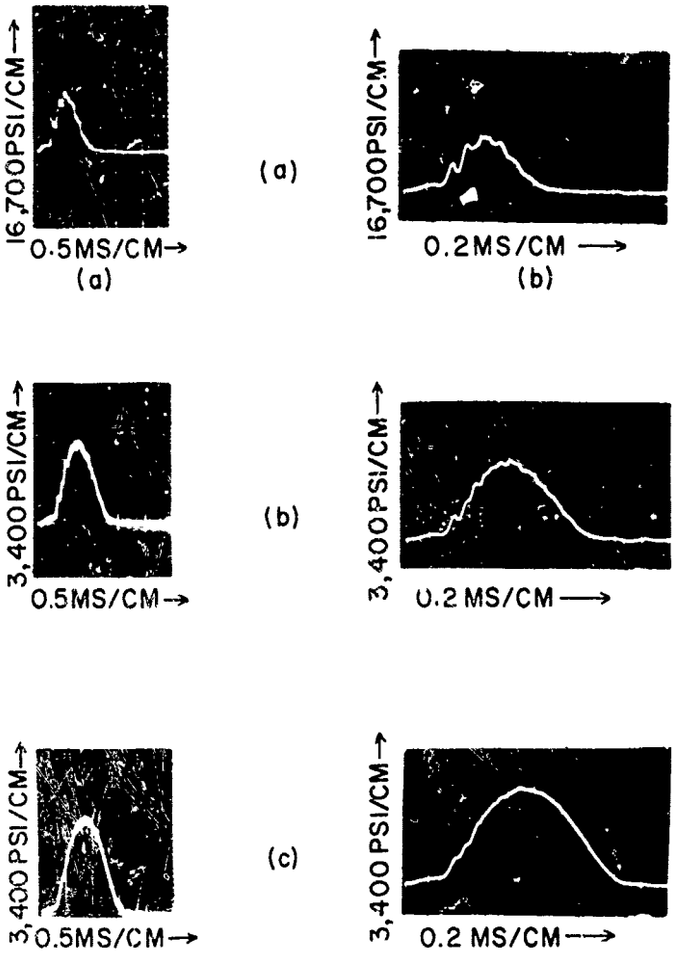

FIG. 3 PRESSURE VS TIME FOR 0.03 CC OF GLYCEROL IMPACTED FROM A HEIGHT OF 1 CM FROM (a) 2 KG, (b) 4 KG, (c) 6 KG

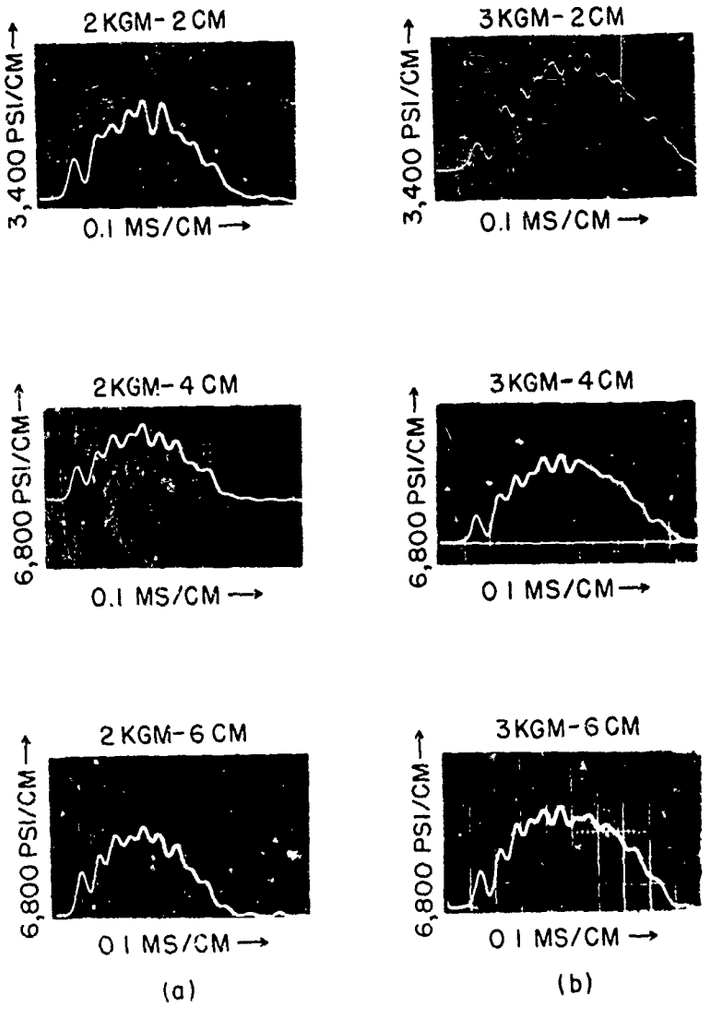

FIG. 4 PRESSURE VS TIME FOR 0.03 CC OF GLYCEROL IMPACTED BY (a) 2 KG FROM 2, 4, AND 6 CM AND (b) 3 KG FROM 2, 4, AND 6 CM

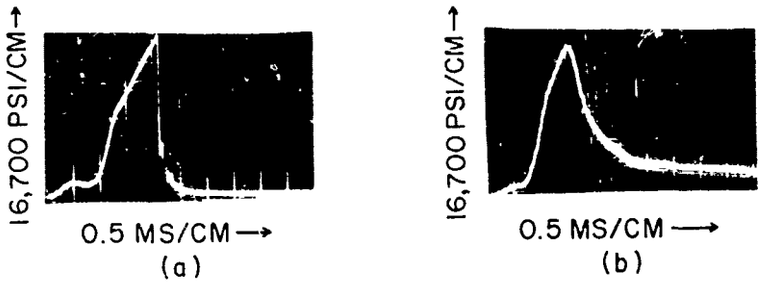

FIG. 5 PRESSURE -TIME HISTORY OF SAMPLE WHICH (a) PUNCTURED DIAPHRAGM AND (b) DID NOT

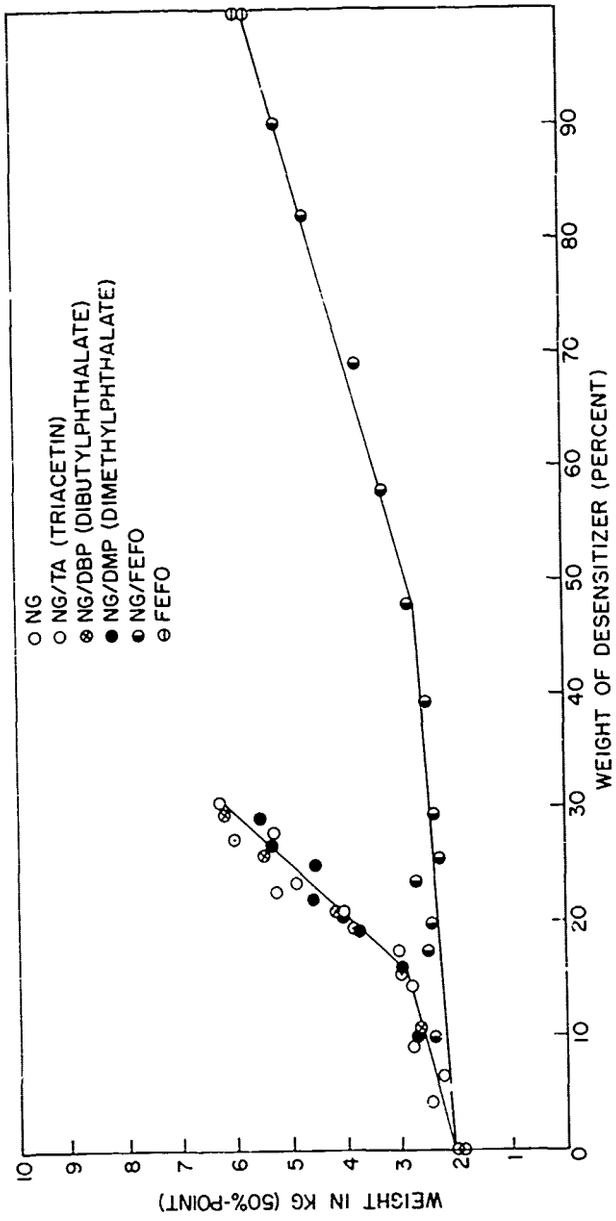

FIG 6 IMPACT SENSITIVITY (50% POINT) OF NG SOLUTIONS USING A CONSTANT HEIGHT OF 1 CM AND VARYING THE WEIGHTS

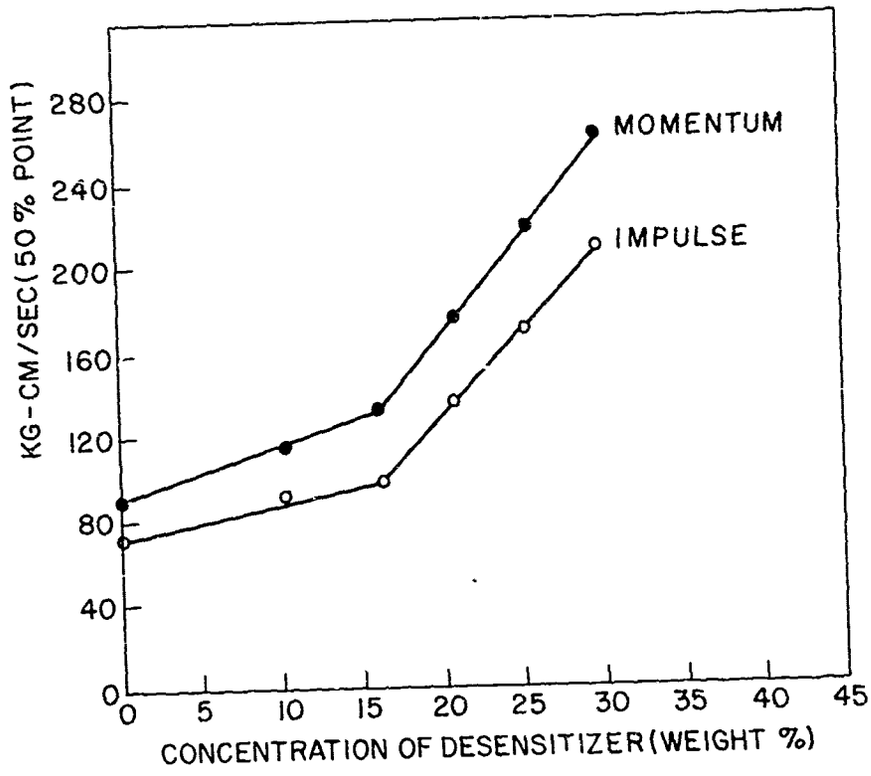

FIG. 7 MOMENTUM AND IMPULSE FOR NG SOLUTIONS AT 50% POINT (USING A CONSTANT HEIGHT OF 1 CM AND VARYING THE WEIGHTS

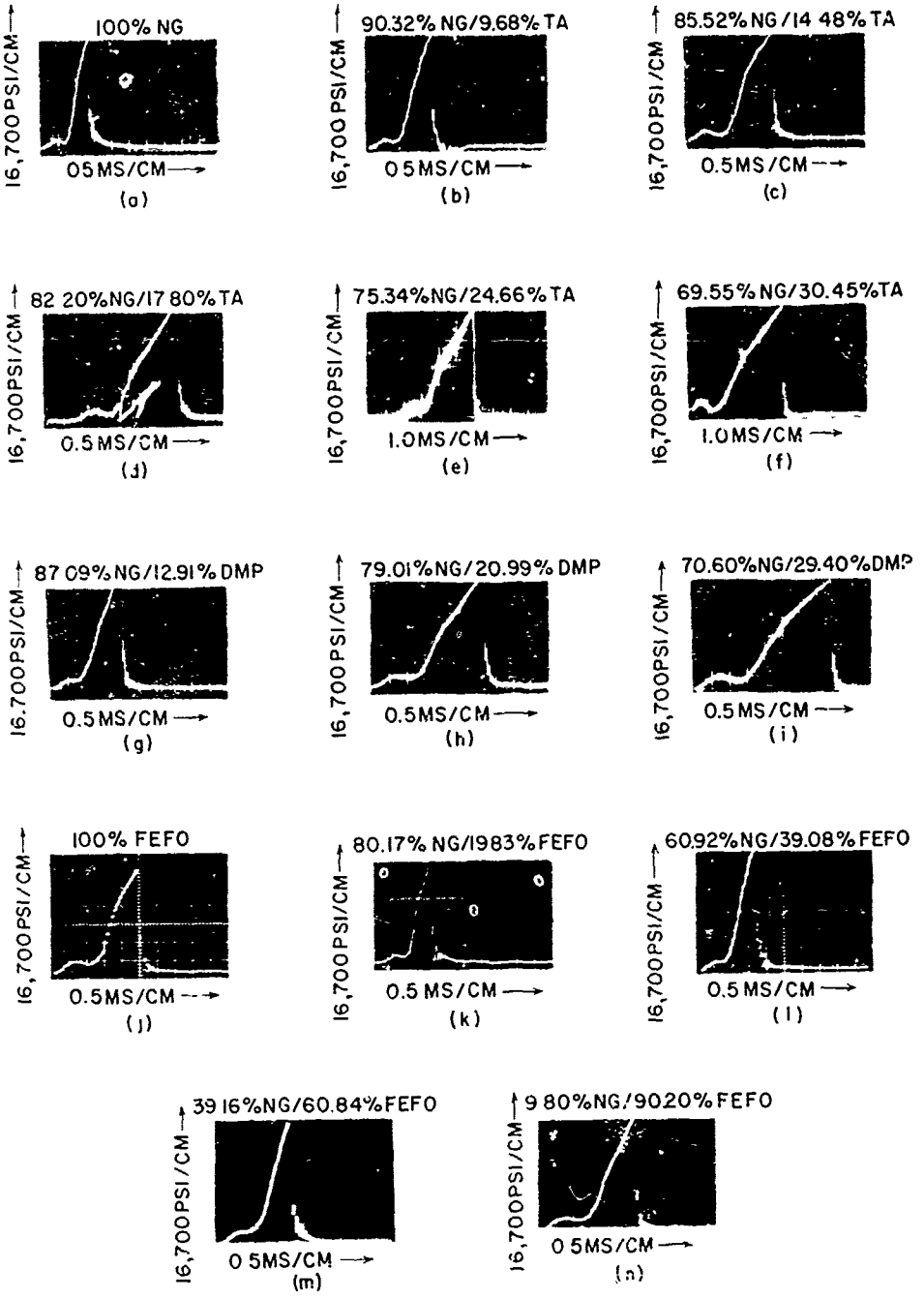

FIG 8 PRESSURE VS TIME FOR 0.03CC OF VARIOUS NG SOLUTIONS IMPACTED FROM A HEIGHT OF 1 CM WITH (a) 2.0 KG, (b) 2.6 KG, (c) 2.8 KG, (d) 3.5 KG, (e) 5.0 KG, (f) 6.3 KG, (g) 3.0 KG, (h) 4.4 KG, (i) 6.0 KG, (j) 5.8 KG, (k) 2.5 KG, (l) 3.0 KG, (m) 3.5 KG, (n) 5.5 KG ((a) PURE NG, (b)-(f) WITH TA, (g)-(i) WITH DMP, (j)-(n) WITH FEFO)

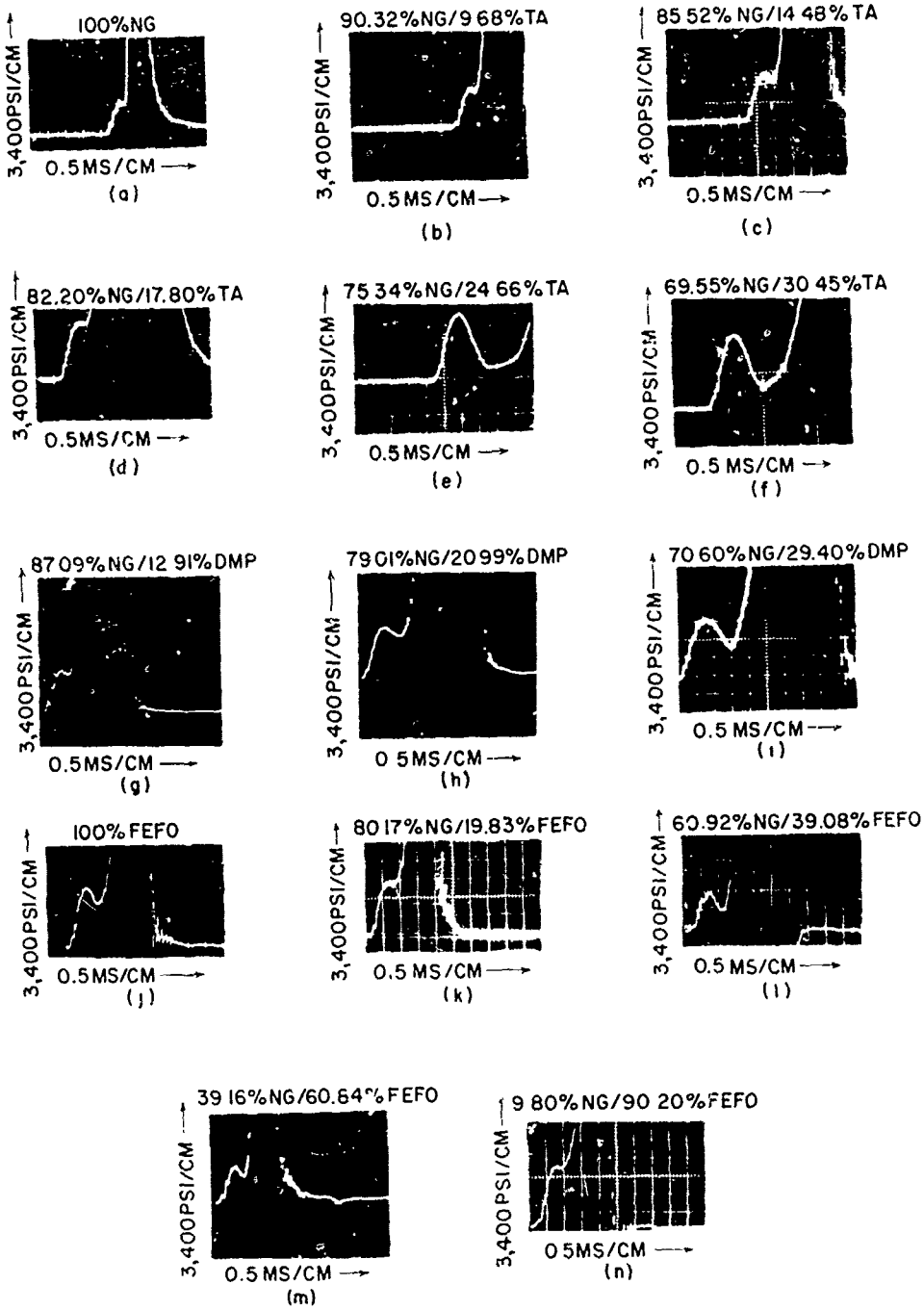

FIG. 9 PRESSURE-TIME HISTORY SHOWING DELAY TIMES FOR 0.03CC OF VARIOUS NG SOLUTIONS IMPACTED FROM A HEIGHT OF 1CM WITH (a) 2.6 KG, (b) 2.5 KG, (c) 2.8 KG, (d) 3.5 KG, (e) 2.0 KG, (f) 2.3 KG, (g) 2.0 KG, (h) 2.4 KG, (i) 2.5 KG, (j) 2.0 KG, (k) 2.5 KG, (l) 2.0 KG, (m) 2.5 KG, (n) 2.0 KG (a-e WITH TA, g-i WITH DMP, j-n WITH FEFO)

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13 ABSTRACT

Experimental studies are reported on the initiation-deflagration process occurring in nitroglycerin (NG) and nitroglycerin solutions as a result of impact. The instrumented apparatus used permitted determination of the pressure-time relationships due to the momentum of the impacting weight and to the resulting deflagration. As a result, impact sensitivity testing of liquids is placed on a sounder basis. A gradual decrease in impact sensitivity is observed as desensitizer concentration is increased up to 16% by weight; a more rapid decrease in sensitivity is found beyond this point. bis(2-Fluoro-2,2-dinitroethyl)formal (FEFO), a relatively insensitive energetic liquid, did not show any especially desirable desensitizing properties; the impact sensitivity of FEFO itself is about the same as that of NG solutions containing 29% conventional desensitizer. (C)

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14 KEY WORDS	LINK A		LINK B		LINK C	
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