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DETONATION PROPAGATION TESTS ON AQUEOUS SLURRIES OF TNT, COMPOSITION B, M-9 AND M-10

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DARL WESTOVER - PICATINNY ARSENAL

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FACILITIES & PROTECTIVE TECHNOLOGY DIVISION
MANUFACTURING TECHNOLOGY DIRECTORATE
PICATINNY ARSENAL
DOVER, NEW JERSEY

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By

George Petino, Jr. - Hazards Research Corporation
Darl Westover - Picatinny Arsenal

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FACILITIES & PROTECTIVE TECHNOLOGY DIVISION
MANUFACTURING TECHNOLOGY DIRECTORATE
PICATINNY ARSENAL
DOVER, NEW JERSEY

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I. INTRODUCTION

This report summarizes the results of a series of experiments performed by Hazards Research Corporation, Denville, New Jersey under the technical direction of the Facilities and Protective Technology Division, of the Manufacturing Technology Directorate located at Picatinny Arsenal, Dover, New Jersey. The work was funded under Contract No. DAAA21-73-C-0772.

The objective of this program was to investigate the detonation propagation characteristics of aqueous slurries of TNT, Composition B, M-9 and M-10 in 2 inch, schedule 40, stainless steel pipes of various lengths. Two operational modes were studied; the dynamic or pumping mode and, the static, or settled slurry mode. The dynamic condition was simulated by adding an inert gelling agent to a homogeneous, aqueous, explosive slurry. Information generated by this program will be used in support of the United States Army's munitions manufacturing and loading facilities by supplying data to aid in the design and operation of the feed system for the propellant and explosive incinerators installed at various Army Ammunition Plants.

II. SUMMARY

A test program has been performed to establish the detonation propagation characteristics of aqueous slurries of TNT, Composition B, M-9 and M-10 in 2 inch, schedule 40, stainless steel pipes 24 and 40 inches long. The slurry concentrations tested were prepared on a weight percent basis. The following table summarizes the results of this program:

Summary of Detonation Propagation Test Results

Sample Material	Slurry Type	Concentration - Weight Percent No Propagation	Concentration - Weight Percent Full Propagation	Detonation Class
TNT	Gelled	40	60	High order
TNT	Settled	40	55	High order
Comp. B	Gelled	30	40	High order
Comp. B	Settled	35	45	High order
M-9	Gelled	40	50	High order
M-9	Settled	40	50	High order
M-10	Gelled	50	70	Low order
M-10	Settled	12.5	15	High order
M-10	Settled	-	65	Low order

From the results of this program it is concluded that for the specific conditions tested, aqueous slurries of TNT and Composition B will not support a propagating detonation at concentrations of 30% or lower, in either the gelled or settled condition. M-9 propellant test results indicate that gelled slurries of 40% or lower concentration do not propagate a detonation while the settled slurries require further testing below the non-propagating concentration of 40%. In the gelled condition, slurry concentrations of 50% M-10 did not support propagation; but in the settled condition both high and low order detonations occurred at widely varying concentrations (15-65%) which indicates that further testing is required to identify the safe levels of operation.

III. EXPERIMENTAL PROGRAM

A. Materials

The following materials were supplied by Picatinny Arsenal for use in this test program:

(1) TNT, Finely divided #60 mesh, 32.6% water, Lot KNK 3096

(2) Composition B, Finely divided, #60 mesh, 30.5% water, Lot HOL-050-5414

(3) M-9, Flake, Length nominal 0.007", Lot RAD. PE-178-7

(4) M-10, Flake, Web nominal 0.023", Lot RAD 2-63 of 73

Hazards Research Corporation furnished the following materials:

(1) 2-inch schedule 40, seamless, 304 SST pipe

(2) E-83 blasting caps

(3) Tetryl boosters

(4) Detonation Velocity Probes

(5) CMC gelling powder, type 7H, by Hercules Inc.

Two 2-inch diameter by 1-inch long Tetryl pellets were used as a booster in each test. Each pellet weighed 80 grams.

In those tests that simulated a dynamic flow system condition, a gelling agent was used to suspend the explosives in a homogeneous mixture with water. The gelling agent used was Hercules Cellulose Gum Type 7H. It is 99.5% purified sodium carboxymethylcellulose (CMC) which is a water soluble polymer. When mixed with water at a concentration of 1.5% by weight, it yields a gel with a viscosity of 6000 centipoises.

B. Description of Experiments

All tests performed during this program were conducted in the test set-up shown in Figure 1. The sample slurry was mixed thoroughly and carefully poured into the open end of an upright, 2-inch, schedule 40, stainless steel pipe. A plastic diaphragm taped to the bottom end provided a leak proof seal. After the pipe was filled, a second plastic diaphragm was taped over its open end. A detonation velocity probe was then inserted through the plastic diaphragm and into the slurry. The probe-diaphragm interface was sealed with a plastic sealing compound. Two probe lengths were used, 24 inches and 40 inches. These lengths were dictated by the length of pipe tested since they had to be of equal numerical value.

For the gelled slurry tests the loaded pipe was placed in the horizontal position, charged with a 160 gram Tetryl booster plus an E-83 cap, armed and fired. The resultant detonation velocity trace was displayed on an oscilloscope and recorded by a Polaroid camera.

Settled slurry tests followed the same basic procedure outlined above. The exception to the procedure was that after the velocity probe was positioned it was necessary to maintain a mixed slurry up to the time when the pipe was placed in the horizontal firing position. Once placed, the test required that the solids in the aqueous slurry settle out into a fairly uniform layer.

In order to meet this requirement a series of preliminary screening tests were performed to establish the settling characteristics of each sample material. Sample aqueous slurries containing 30% Composition B, 40% TNT, 35% M-9 and 50% M-10 were prepared. A 48-inch long, 2-inch inside diameter, Pyrex tube was used to simulate the physical confines of the steel pipe. Each slurry was poured into the Pyrex tube, which was then vigorously shaken about its longitudinal axis. The tube was then placed on a horizontal surface and the settling pattern of its contents was observed. Results revealed that the M-9 and M-10 settled immediately upon cessation of pipe motion. The Composition B and TNT took 30 minutes to settle.

These preliminary settling tests resulted in the establishment of a technique for continuously oscillating the pipe prior to its placement on a level surface. Once placed, the solid contents of the pipe settled out in a fairly predictable and reproducibly uniform level. In addition, a standard settling time of 15 minutes was established for the M-9 and M-10 propellants while 30 minutes was allowed for the Composition B and TNT slurries.

C. Description of Test Methods

1. Preparation of Homogeneous, Gelled Slurries

The gelled slurries (consisting of the material to be tested, gelling agent and water) were made in two steps. First, a 5-gallon batch of gelled water was prepared. This mixture contained 1.5% by weight of CMC polymer and 98.5% water. Next, the sample material was added to a predetermined quantity of gelled water to yield the required percentage called for in the test. After approximately 20 minutes of low speed agitation, the slurry was homogeneous and ready to be poured into a test fixture.

Once the slurry was prepared, it was constantly stirred at a low speed until it was poured into the test pipe. Total time elapsed between loading and detonating each pipe was never more than 17 minutes. This procedure reduced the probability of any significant settling of the sample in the pipe.

In all tests the percentage composition reported is the percentage of dry sample material contained in the total slurry weight of water, sample material, and gelling powder. The moisture content of the Composition B and TNT was taken into account in all calculations of explosive weight percent concentration. The M-9 and M-10 were received dry and did not require a correction for moisture content.

2. Preparation of Settled Slurries

The settled slurries were individually mixed by slowly adding the required quantity of explosive or propellant to a weighed amount of water. An air operated mixing motor provided the variable speed drive required for the mixing operation. The slurry was agitated in a plastic bucket by 3, vertically mounted, plastic impellers. Visual inspection provided the indication that all of the sample material was thoroughly wetted and ready for test.

3. Characterization of Detonation Propagation Phenomena

The distance that a booster-initiated, high or low order reaction propagated through the slurries was determined by two techniques; physical inspection of the pipes after a test and detonation velocity measurements.

(a) Physical Inspection

High order detonations produce a totally shrapnellized pipe. Low order, decaying type reactions, normally result in a peeling back of the pipe wall along its longitudinal axis beginning at the booster end and no physical damage to the remaining pipe section. In addition, unreacted slurry is expelled onto the surrounding area due to the impulse generated by the booster.

A reference point for evaluation of the physical damage is obtained by testing a pipe filled with water. This provides evidence of the damage caused by the booster charge. All other test results can compared to this datum point. On this program two datum points were obtained; one for water and a second for gelled water.

(b) Detonation Velocity Measurement

The detonation velocity of sample material was measured using the continuous velocity probe developed by the U. S. Bureau of Mines[(1)]. This technique is a convenient method of determining the capability of a material to sustain a high-order reaction. The sample is placed in a steel pipe with a booster charge set against the base of the pipe. The booster is separated from the sample by a thin plastic diaphragm. Initiation of the booster triggers an oscilloscope which monitors the output of a constant-current power supply as a function of time. A detector circuit consisting of a fine skip-wound resistance wire passed through a thin aluminum tube is mounted on the major axis of the tube containing the sample. As the

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[(1)] J. Ribovich, et al AIAA Journal, 6, 1260, (1968)

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shock wave passes along the detector, the aluminum tube is crushed onto the resistance wire, shortening the circuit. Essentially all the resistance of the circuit is in the wire, which is uniform, so the power supply adjusts the voltage to maintain constant current. The voltage-time trace is readily convertible to detonation velocity. If no detonation occurred in the sample, the probe circuit registers the velocity of sound. Figures 2 and 3 show the details of the velocity probe and the system's operational concept respectively.

4. Verification of Limits of Propagation

The no propagation, decaying detonation, and full detonation weight concentrations were established for the four materials tested using 24-inch long pipes. A repeat test was then performed at the no propagation concentration to verify the original observation. This was followed by a repeat test at the detonation concentration using a 40-inch long pipe.

D. Test Results

A total of 70 detonation propagation tests were performed on this program, 31 on gelled slurries and 39 on settled slurries. Figures 4 through 11 contain the detonation velocity traces for the entire test program. The test data is presented in Tables I through VIII. Table IX provides a summary of test program results.

1. Gelled, Aqueous Slurries

(a) M-9 Propellant

A series of 7 detonation propagation tests were performed on aqueous, gelled slurries of M-9 propellant. One additional test was performed on gelled water in order to establish the datum point for physical damage for the entire gelled series of tests.

Table I presents the tabulated test results and Figure 4 contains the 8 detonation velocity traces for this series. It can be seen that the gelled M-9 slurries did not propagate a detonation over the concentration range of 20-40%. A decaying detonation occurred at 45% concentration while a high order detonation (4850 m/sec.) occurred at the 50% concentration. The repeat test at 50% concentration, in a 40-inch long pipe, confirmed the high order detonation result (5400 m/sec.).

(b) M-10 Propellant

The limits of detonation propagation were characterized for aqueous, gelled M-10 slurries in 7 tests. Table II presents the tabulated results and Figure 5 contains the 7 detonation velocity traces. No propagation was evident at the 50% concentration level. Over the 55-65% concentration range, the degree of propagation increased with increasing M-10 concentration. At 70% concentration (Run No. 10), a low order detonation occurred (3250 m/sec.) which completely shrapnellized the pipe. Run No. 12 was a repeat of the 70% concentration test and was performed in a 40-inch long pipe. Results were the same as those of Run No. 10, i.e., a low order (2900 m/sec.) detonation that completely shrapnellized the pipe. Run No. 15 was a repeat of the nonpropagating concentration level of 50%. The results duplicated that of Run No. 13 and confirmed that 50% was the non-propagating concentration.

(c) TNT

A series of 9 tests were performed on aqueous, gelled TNT slurries. Table III presents the tabulated test results and Figure 6 contains the 9 detonation velocity traces. These tests established that over the weight concentration range of 30-40% there was no detonation propagation. From 45 to 55% TNT the propagation increased with increasing concentration and at 60% high order detonations occurred. Duplicate tests at 40% and 60% TNT concentrations confirmed that these were the boundaries for no propagation and full propagation respectively.

(d) Composition B

Table IV and Figure 7 contain the tabulated results and detonation velocity traces respectively for this series of 7 tests. The results indicate that there is a difference of only 10% between the non-propagating concentration (30%) and the propagating concentration (40%). Two extra tests were performed (69 and 70) at the 40% concentration for high speed photography purposes.

2. Settled, Aqueous Slurries

(a) Composition B

A series of 8 detonation propagation tests were performed on aqueous, settled slurries of Composition B. One additional test was performed on a pipe filled with water in order to establish the datum point for physical damage for this test series.

Table V presents the tabulated test results and Figure 8 contains detonation velocity traces for this series. It can be seen that there was no propagation at the 30-35% concentration, some propagation at 40%, and high order detonations at 45 and 50%. Repeat tests at the 35% and 45% concentrations (Runs 37 and 38) verified that these were the non-propagating and propagating concentrations respectively.

(b) TNT

Examination of the tabulated results for this series of 8 tests presented in Table VI and the detonation velocity traces of Figure 9 reveals that 40% TNT did not propagate a detonation. In addition, the 45-50% concentrations produced decaying reactions while high order detonations resulted at the 55 and 60% levels. Repeat tests performed at 40 and 55% concentrations confirmed that these were the limiting concentrations for non-propagating and full propagating reactions.

Reproductions of the detonation velocity traces for Tests 39 - 70 contain dual velocity traces. Sweep #1 is calibrated to yield 20 μ sec. per cm. on the x-axis and Sweep #2 is calibrated at 50 μ sec. per cm. This effect was achieved using a dual beam oscilloscope. It allows the event to be monitored over two time periods, namely, 200 μ sec. and 500 μ sec. The result is an increase in accuracy especially when a reaction starts out high order and is attenuated over a period of time which is greater than 200 μ seconds.

(c) M-9 Propellant

Table VII and Figure 10 contain the results and detonation velocity traces, respectively, for this series of 7 tests on aqueous, settled slurries of M-9 propellant. A high order detonation occurred at the 50% concentration of M-9, decaying detonation at 45%, and no propagation at the 40 and 35% concentrations. Results were verified with repeat tests at the 50% and 40% concentrations.

It is worth noting the detonation velocity trace of Test No. 51. This was performed on a 50% concentration, aqueous, M-9 settled slurry in a 40-inch long pipe. The Sweep #1 trace clearly shows a change in the slope at the 60 μ sec. point in the test. The shock wave slows down for 28 μ sec. and then resumes its original speed. This phenomena indicates that there was an uneven layer of M-9 at the point where 60 μ sec. had elapsed. This is calculated to be at a distance of 16 inches from the booster end. The shallow layer was 3 inches long based on the 28 μ sec. time during which the shock velocity decreased.

The uneven layer of M-9 caused the shock wave to be attenuated and resulted in 1.5 inches of the pipe being recovered, 5.5 inches peeled and the remaining completely shrapnellized. A repeat of this test resulted in a high order detonation.

Test No. 51 provides a good example of the value of the continuous velocity probe in this type of test work. It provides an instantaneous profile of the phenomena that is occurring during a detonation. Any inconsistencies in the reacting medium that can effect the energy input to the detonation are instantaneously recorded on the detonation velocity trace.

(d) M-10 Propellant

A series of 15 tests were performed on aqueous, settled slurries of M-10 propellant. Table VIII presents the results of these tests and Figure 11 contains the detonation velocity traces for each test. Results of this test series revealed that settled, aqueous slurries of M-10 propagate high order detonations at the low concentrations of 15-35%. Above these concentrations there is a partial propagation region (45-60%), and a low order detonation region (65% and above). No propagation occurred at 10 and 12.5% concentration of M-10 since the settled height was below the critical dimension for detonation.

Examination of the runs in the decaying detonation range (Runs 53, 54, 55 and 57), reveals that as the concentration of M-10 was increased the degree of attenuation increased. This is the reverse of what has been observed on all of the other tests on this program.

The existence of both high and low order detonations at the concentrations indicated can be readily explained if one considers the dependence of the heat of explosion, of an explosive, on density. For example, consider the following table taken from reference 2.

Heat of Explosion and Some Reaction Products for TNT as a Function of Density

Density (g/cc)	Heat of Explosion (Kcal/g)	Major Products (moles/kg)			
		CO	CO_2	H_2O	H_2
0.30	0.62	24.3	0.5	1.4	5.5
0.80	0.79	16.2	3.3	2.6	1.1
0.95	0.87	12.1	5.2	2.4	0.9
1.11	0.98	8.5	6.6	2.5	0.2
1.27	1.07	4.5	8.3	1.9	0.1
1.47	1.13	1.8	9.5	1.3	-
1.59	1.16	1.0	10.0	1.0	-
1.65	1.17	0.6	10.0	0.8	-

The standard for TNT is taken as 1.1 Kcal/g which is the heat of explosion when the density is 1.4 g/cc. The reaction is slightly more energetic at high densities, and is considerably lower as the bulk density decreases. The energy output for a given quantity of highly compressed TNT, density = 1.65, is almost twice that for an equal quantity of loosely packed powder having a density of 0.30 g/cc. The reason for this is that the equilibrium

(2) The Science of High Explosives, Melvin A. Cook, pg. 286, American Chemical Society Monograph Series, Reinhold Publishing Corporation, New York (1958)

constants which control the distribution of the products, CO, CO_2 etc. are pressure dependent. At higher packing densities the detonation pressure is higher which favors the production of CO_2, at lower densities the lower detonation pressure favors the formation of CO. Since the energy produced in the formation of a CO_2 molecule is more than twice the energy produced in the formation of a CO molecule, the net effect, since the reaction is limited by the number of oxygen atoms, is the production of higher energies when the starting density is higher.

The range of density variation for the aqueous, settled slurries of M-10 tested is given in the following table:

Table of Bulk Loading and Settled Layer Densities
M-10 Aqueous Slurries

Bulk Loading		Settled Layer	
Composition Wt. (%) M-10	Density (lb. /cu. ft.)	Composition Wt. (%) M-10	Density (lb. /cu. ft.)
10	64.4	40	80
12.5	64.9	40	80
15	65.4	40	80
20	66.5	40	80
25	67.6	40	80
35	70.0	40	80
45	52.6	45	52.6
50	49.2	50	49.2
55	50.8	55	50.8
60	44.4	60	44.4
65	42.7	65	42.7

Examination of the table reveals that for the weight concentrations from 10 to 35% the density of the settled M-10 layer and its composition were constant (40% M-10 at 80 lb./cu. ft. density). The density of the settled layer for this range of concentrations was the highest in the test program. Therefore, this resulted in high order detonations for the 15 to 35% concentration ranges. Below the 15% M-10 concentration the settled layer thickness was below the critical dimension for propagation. All samples tested in the 10-35% range were true slurries, i.e., when they were agitated in a pipe and allowed to settle the composition and density of the settled layer were independent of the proportions of M-10 and water mixed. Above the 40% M-10 concentration, a true slurry did not exist. What existed was M-10 flakes wetted with water. At this point the bulk density is equal to the so-called settled layer density.

As the weight concentration of M-10 increased, the bulk density decreased. The spaces between the M-10 flakes became less filled with water. This resulted in a decrease in detonation propagation characteristics with increasing M-10 concentration. At the 65% M-10 level the density is almost half of that at the 35% concentration. A low order detonation occurs at this level, indicating that there is sufficient energy available in the reacting M-10 to vaporize the small amount of water surrounding the M-10 flakes. However, the bulk density is not high enough to cause a high order reaction.

IV. CONCLUSIONS

As a result of the 70 detonation propagation tests performed on aqueous slurries containing either TNT, Composition B, M-9 or M-10, which are confined in horizontal, 2-inch diameter, schedule 40, stainless steel pipes up to 40 inches in length, it is possible to conclude the following:

1. Settled slurries containing 15-35% by weight of M-10 propellant propagate high order detonations while 65% M-10 concentrations result in low order detonations. Concentrations of M-10 at and below 12.5% do not propagate a detonation. Partial propagation, which decreases in severity with increasing M-10 content, occurrs over the 45-60% range.

2. Gelled M-10 slurries propagate low order detonations at the 70% M-10 concentration, partially propagate between 55 and 65% and do not propagate at 50% concentrations.

3. Gelled Composition B slurries propagate high order detonations at 40% Composition B concentrations, partially propagate at 35% and do not propagate at the 30% concentration.

4. Settled Composition B slurries propagate high order detonations at 45% Composition B concentration, partially propagate at 40% and do not propagate at 30 or 35% concentration.

5. Gelled M-9 propellant slurries propagate high order detonations at 50% M-9 concentrations, partially propagate at 45% and do not propagate over the 20 to 40% range tested.

6. Settled slurries of M-9 propellant propagate high order detonations at 50% concentrations of M-9, partially propagate at 45% and do not propagate over the 35-40% range.

7. Gelled slurries of TNT propagate high order detonations at 60% TNT concentrations, partially propagate over the 45-55% range and do not propagate over the 30-40% range.

8. Settled slurries of TNT propagate high order detonations at 55% TNT concentrations, partially propagate over the 45-50% range and do not propagate at the 40% concentration.

9. M-10 propellant in settled slurry form is the most sensitive to propagation, it is followed in descending order by gelled Composition B, gelled or settled M-9 and settled TNT.

10. The high nitrocellulose content of M-10 propellant (98%), results in the absorption of large quantities of water at the lower settled slurry concentrations (15-35%) which produces a high settled slurry bulk density. This high density slurry, when initiated, results in a high order detonation. High concentrations of M-10 results in a 50% decrease in bulk loading density which produces a low order detonation upon initiation by a booster.

V. RECOMMENDATIONS

It is recommended that additional detonation attenuation tests be performed on M-9 propellant in the settled slurry mode over the ranges of 5 to 30% by weight concentration of M-9. In addition, further propagation tests should be performed on 15% M-10 settled slurries using boosters of decreasing size in order to ascertain the sensitivity to initiation of the slurry.

Consideration should be given to performing detonation propagation tests on any propellant that contains a high percentage of nitrocellulose and is considered a candidate for use in the saturated water slurry condition in munitions processing plants.

TABLES AND FIGURES

TABLE I - Results of Detonation Propagation Tests on Aqueous, Gelled Slurries of M-9 Propellant

Test No.	Slurry Composition Wt. (%) M-9	Wt. (gms) H_2O	Wt. (gms) M-9	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Midpoint	Final	Physical Evidence	Conclusion
1	20	1122	281	24 in.	4150	1571	830	15 in. O. K., 9 in. peeled at booster end.	Detonation did not propagate
2	0	1320	0	24 in.	3850	2152	830	13 in O. K., 11 in. peeled at booster end.	Booster calibration run.
3	50	808	808	24 in.	4850	4850	4850	Pipe Completely shrapnellized	Detonation
4	35	999	540	24 in.	6200	2152	760	13 in. O. K., 11 in peeled at booster end.	Detonation did not propagate
5	40	940	627	24 in.	4250	1827	750	13 in. O. K., 11 in peeled at booster end	Detonation did not propagate
6	45	874	715	24 in.	5900	3377	760	6 in. O. K., 10 in peeled, 8 in. shrapnellized	Decaying detonation
7	35	999	540	24 in.	*	900	*	14 in. O. K., 10 in. peeled at booster end	Detonation did not propagate
8	50	1346	1346	40 in.	5400	5400	5400	Pipe completely shrapnellized	Detonation

*Velocity trace not legible at this point

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE II - Results of Detonation Propagation Tests on Aqueous, Gelled Slurries of M-10 Propellant

Test No.	Slurry Composition Wt. (%) M-10	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) M-10	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
9	60	376	563	24 in.	4850	1356	400	7 in. O. K., 11 in. peeled, 6 in. shrapnellized	Decaying Detonation
10	70	257	600	24 in.	3250	3250	3250	Pipe completely shrapnellized	Detonation
11	65	316	588	24 in.	3450	3720	450	6 in. peeled, 18 in. shrapnellized	Decaying Detonation
12	70	411	960	40 in.	2900	2900	2900	Pipe completely shrapnellized	Detonation
13	50	574	574	24 in.	6500	523	520	13 in. O. K., 11 in. peeled	Detonation did not propagate
14	55	484	591	24 in.	4150	443	420	11 in. O. K., 13 in. peeled	Decaying Detonation
15	50	574	574	24 in.	5300	515	520	13 in. O. K., 11 in. peeled	Detonation did not propagate

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE III - Results of Detonation Propagation Tests on Aqueous, Gelled Slurries of TNT

Test No.	Slurry Composition Wt. (%) TNT	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) TNT	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Midpoint	Final	Physical Evidence	Conclusion
16	30	1048	450	24 in.	4500	803	1350	15 in. O. K., 9 in. peeled	Detonation did not propagate
17	35	995	535	24 in.	5150	1827	1450	14.5 in. O. K., 9. 5 in. peeled	Detonation did not propagate
18	50	753	753	24 in.	5450	2284	900	9 in. O. K., 8 in. peeled, 7 in. shrapnellized	Decaying detonation
19	60	642	963	24 in.	5950	5950	5950	Pipe completely shrapnellized	Detonation
20	40	923	616	24 in.	5450	1225	1210	13 in. O. K., 9 in. peeled, 2 in. shrapnellized	Detonation did not propagate
21	45	833	681	24 in.	5200	934	900	12 in. O. K., 9in. peeled, 3 in. shrapnellized	Decaying detonation
22	40	905	604	24 in.	5300	2297	1070	13 in. O. K., 9 in. peeled, 2 in. shrapnellized	Detonation did not propagate
23	55	640	783	24 in.	5500	5363	780	0. 5 in. O. K., 11. 5 in. peeled, 12 in. shrapnellized	Decaying detonation
24	60	1100	1651	40 in.	5700	5700	5700	Pipe completely shrapnellized	Detonation

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE IV - Results of Detonation Propagation Tests on Aqueous, Gelled Slurries of Composition B

Test No.	Slurry Composition Wt. (%) Comp. B	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) Comp. B	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
25	30	1081	463	24 in.	*	*	*	14.5 in. O.K., 9.5 in. peeled	Detonation did not propagate
26	40	989	660	24 in.	7000	7000	4900	Pipe completely shrapnellized	Detonation
27	35	996	536	24 in.	7850	1076	1100	11.5 in. O.K., 8.5 in. peeled 4 in. shrapnellized	Decaying Detonation
28	30	1036	444	24 in.	5500	983	970	13.5 in. O.K., 8.5 in. peeled 2 in. shrapnellized	Detonation did not propagate
29	40	1553	1036	40 in.	5550	5550	5550	Pipe completely shrapnellized	Detonation
69	40	1553	1036	40 in.	5360	5360	5360	Pipe completely shrapnellized	Detonation
70	40	1553	1036	40 in.	5360	5360	5360	Pipe completely shrapnellized	Detonation

*Velocity probe malfunctioned

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE V - Results of Detonation Propagation Tests on Aqueous, Settled Slurries of Composition B

Test No.	Slurry Composition Wt. (%) Comp. B	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) Comp. B	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
30	0	1320	0	24 in.	2650	1500	701	14 in. O. K., 10 in. peeled	Booster calibration test
31	30	1081	463	24 in.	6400	1028	1000	13 in. O. K., 9 in. peeled 2 in. shrapnellized	Detonation did not propagate
32	40	989	660	24 in.	5600	3979	430	7.5 in. O. K., 10 in. peeled, 6.5 in. shrapnellized	Decaying detonation
33	50	822	822	24 in.	5650	5650	5650	Pipe completely shrapnellized	Detonation
34	45	883	722	24 in.	5250	5250	5250	Pipe completely shrapnellized	Detonation
35	40	989	660	24 in.	4550	3503	1000	7.0 in. O. K., 7.25 in. peeled, 9.75 in. shrapnellized	Decaying detonation
36	35	996	536	24 in.	5180	588	650	16 in. O. K., 5 in. peeled, 3 in. shrapnellized	Detonation did not propagate
37	35	996	536	24 in.	6750	3157	520	10 in. O. K., 6 in. peeled, 8 in. shrapnellized	Detonation did not propagate
38	45	1471	1204	40 in.	5150	5150	5150	Pipe completely shrapnellized	Detonation

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, Schedule 40, stainless steel pipe (Type 304).

TABLE VI - Results of Detonation Propagation Tests on Aqueous, Settled Slurries of TNT

Test No.	Slurry Composition Wt. (%) TNT	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) TNT	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
39	60	712	1068	24 in.	5880	5880	5880	Pipe completely shrapnellized	Detonation
40	50	753	753	24 in.	5084	2457	765	11 in. O. K., 7 in. peeled, 6 in. shrapnellized	Decaying detonation
41	45	833	681	24 in.	6400	2396	610	9.5 in. O. K., 6 in. peeled, 8.5 in. shrapnellized	Decaying detonation
42	40	923	616	24 in.	4965	700	700	15 in. O. K., 6 in. peeled, 3 in. shrapnellized	Detonation did not propagate
43	55	640	783	24 in.	5540	5540	5540	Pipe completely shrapnellized	Detonation
44	55	1067	1305	40 in.	6900	657	560	27 in. O. K., 10 in. peeled, 3 in. shrapnellized	Detonation did not propagate. Results not logical. Booster may have moved.
45	40	923	616	24 in.	4600	874	820	14 in. O. K., 9 in. peeled, 1 in. shrapnellized	Detonation did not propagate
68	55	1067	1305	40 in.	5500	5500	5500	Pipe completely shrapnellized	Detonation

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE VII - Results of Detonation Propagation Tests on Aqueous, Settled Slurries of M-9 Propellant

Test No.	Slurry Composition Wt. (%) M-9	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) M-9	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
46	35	999	540	24 in.	6890	1168	890	13.5 in. O.K., 4.5 in. peeled, 6 in. shrapnellized	Detonation did not propagate
47	45	874	715	24 in.	5900	2924	380	8.5 in. O.K., 8 in. peeled, 7.5 in. shrapnellized	Decaying detonation
48	50	808	808	24 in.	6120	6120	6120	Pipe completely shrapnellized	Detonation
49	40	940	627	24 in.	5319	2483	999	14 in. O.K., 4.5 in. peeled, 5.5 in. shrapnellized	Detonation did not propagate
50	40	940	627	24 in.	5026	1522	571	12 in. O.K., 8 in. peeled, 4 in. shrapnellized	Detonation did not propagate
51	50	1347	1347	40 in.	7350	2318	1150	1.5 in. O.K., 5.5 in. peeled, 33 in. shrapnellized	Decaying detonation probably due to uneven layer approximately 16 inches away from booster end
52	50	1347	1347	40 in.	6037	6037	6037	Pipe completely shrapnellized	Detonation

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE VIII - Results of Detonation Propagation Tests on Aqueous, Settled Slurries of M-10 Propellant

Test No.	Slurry Composition Wt. (%) M-10	Slurry Composition Wt. (gms) H_2O	Slurry Composition Wt. (gms) M-10	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Measured Detonation Velocity (m/sec.) Midpoint	Measured Detonation Velocity (m/sec.) Final	Physical Evidence	Conclusion
53	50	520	520	24 in.	4386	2050	609	1 in. O. K., 14 in. peeled, 9 in. shrapnellized	Decaying detonation
54	55	484	591	24 in.	5100	1990	300	7.5 in. O. K., 8 in. peeled, 8.5 in. shrapnellized	Decaying detonation
55	60	376	563	24 in.	6210	588	356	11 in. O. K., 10 in. peeled, 3 in. shrapnellized	Decaying detonation
56	65	316	588	24 in.	2837	2837	2837	Pipe completely shrapnellized	Detonation
57	50	573	573	24 in.	5086	4913	320	2.5 in. O. K., 12 in. peeled, 9.5 in. shrapnellized	Decaying detonation
58	45	613	500	24 in.	5020	4913	300	0.5 in. O. K., 6 in. peeled, 17.5 in. shrapnellized	Decaying detonation
59	35	962	518	24 in.	5275	5275	5275	0.5-1.0 in. wide frag. strips up to 17 in. long	Detonation
60	25	1072	358	24 in.	5536	5536	5536	0.5-18 in. long frag. strips	Detonation

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE VIII (Con't.) - Results of Detonation Propagation Tests on Aqueous, Settled Slurries of M-10 Propellant

Test No.	Slurry Composition Wt. (%) M-10	Wt. (gms) H_2O	Wt. (gms) M-10	Pipe Length	Measured Detonation Velocity (m/sec.) Initial	Midpoint	Final	Physical Evidence	Conclusion
61	20	1159	290	24 in.	5180	5180	5180	1 in. wide by 3 to 19 in. long frag. strips	Detonation
62	15	1212	214	24 in.	5259	5259	5259	5 peeled pieces, each 1-1.5 in. wide by 9 in. long	Detonation
63	10	1263	140	24 in.	*	*	*	16.5 in. O.K., 6 in. peeled, 1.5 in. shrapnellized	Detonation did not propagate
64	10	1263	140	24 in.	2828	1384	1400	12.5 in. O.K., 11.5 in. peeled	Detonation did not propagate
65	12.5	1237	177	24 in.	3883	2128	487	15 in. O.K., 9 in. peeled	Detonation did not propagate
66	15	2020	357	40 in.	4861	4861	4861	0.5-2 in. wide frag. strips up to 24 in. long	Detonation
67	15	1212**	214	24 in.	5199	5199	5199	1-3 in. wide frag. strips up to 24 in. long	Detonation

*Velocity probe malfunctioned
**Water decanted off top of settled propellant. Height of settled M-10 was 0.721 inches.

Note: All tests were performed using a 160 gm. Tetryl booster and 2 inch, schedule 40, stainless steel pipe (Type 304).

TABLE IX - Summary of Detonation Propagation Test Results

Sample Material	Slurry Type	Slurry Concentration (Wt. %) for Propagation: No Propagation	Complete Propagation	Partial Propagation
TNT	Gelled	30-40	60 (1)	45-55
TNT	Settled	40	55-60 (1)	45-50
Comp. "B"	Gelled	30	40 (1)	35
Comp. "B"	Settled	30-35	45-50 (1)	40
M-9	Gelled	20-40	50 (1)	45
M-9	Settled	35-40	50 (1)	45
M-10	Gelled	50	70 (2)	55-65
M-10	Settled	10-12.5	15-35 (1)	45-60
M-10	Settled	-	65 (2)	-

(1) High Order Detonation

(2) Low Order Detonation

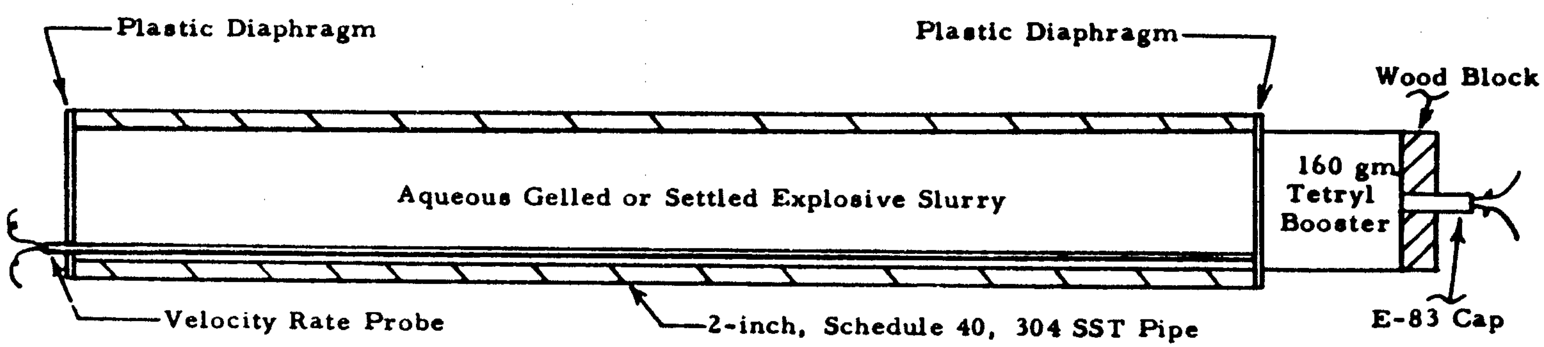


FIGURE 1. Horizontally Fired Detonation Propagation Test Set-Up

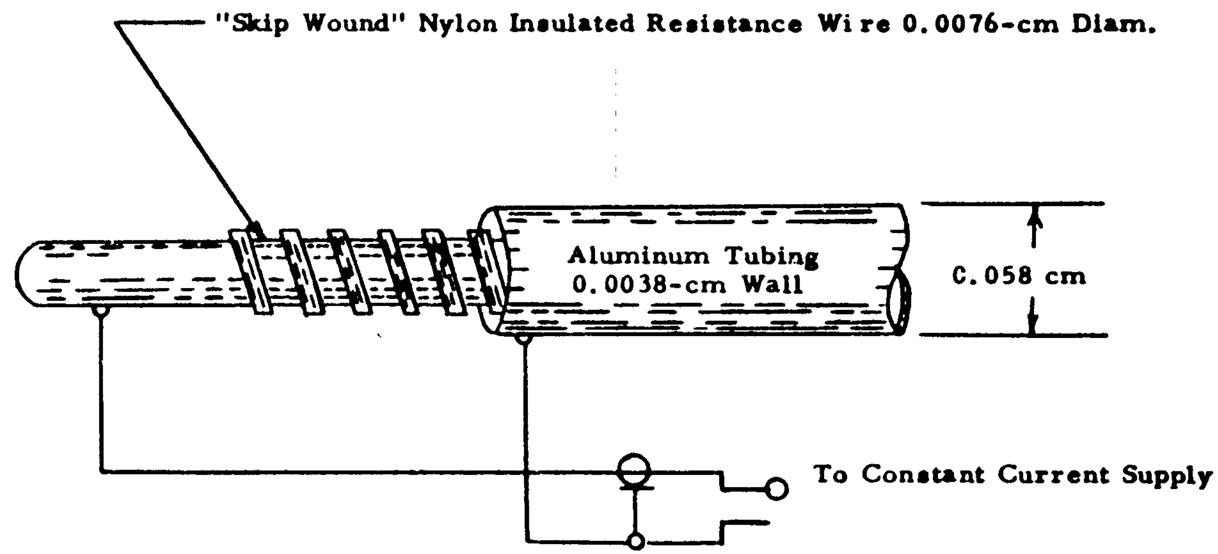


FIGURE 2 Details of Detonation Velocity Probe

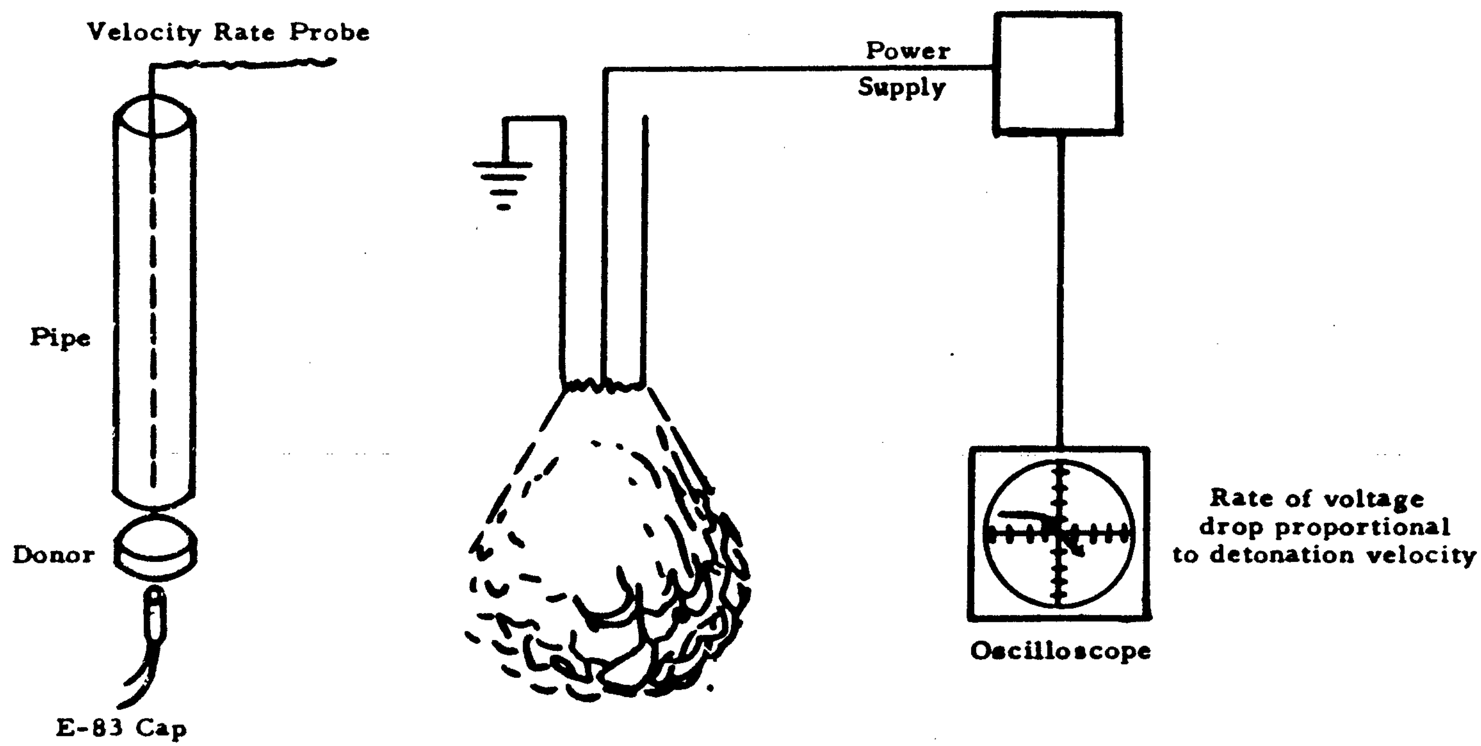
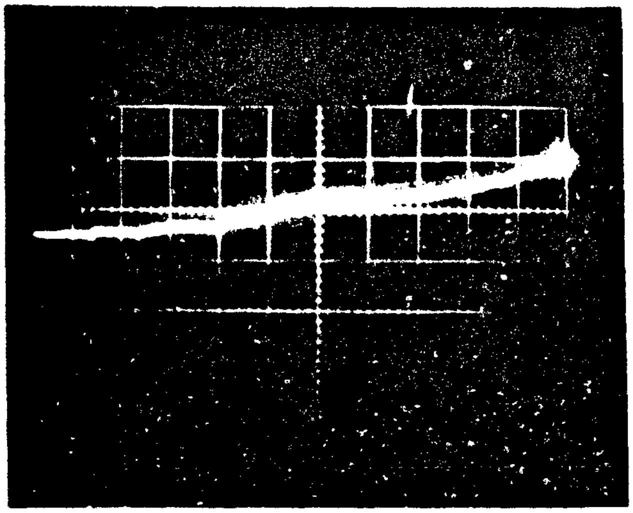


FIGURE 3 Detonation Velocity Test System

Wt. % M-9 | **Test No.**

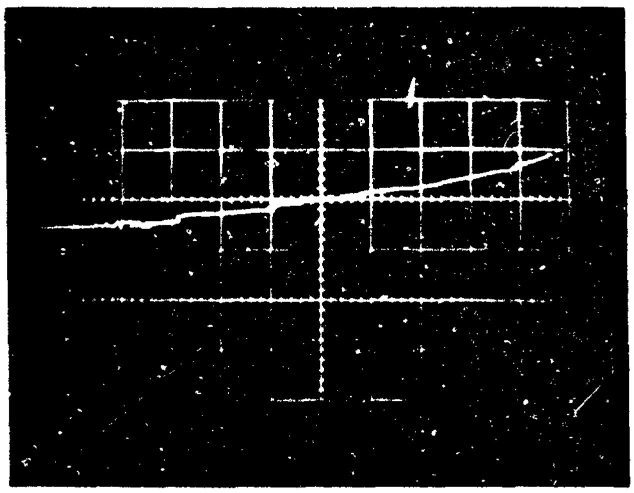
20



1

Time ←
1 div. = 50 μ sec.

0



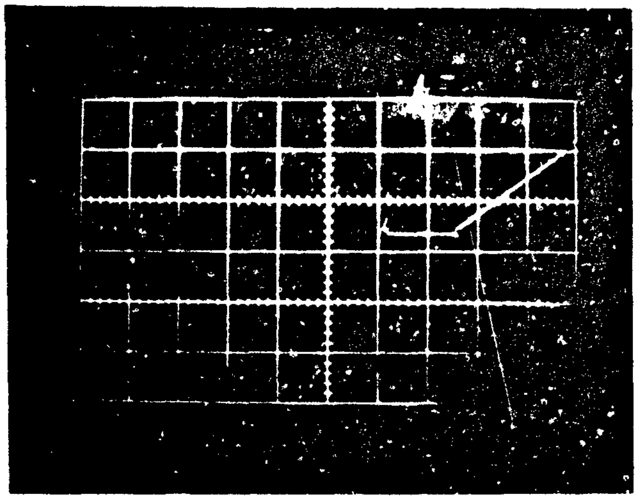
2

Time ←
1 div. 50 μ sec.

FIGURE 4 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-9 Propellant.

Wt. % M-9 **Test No.**

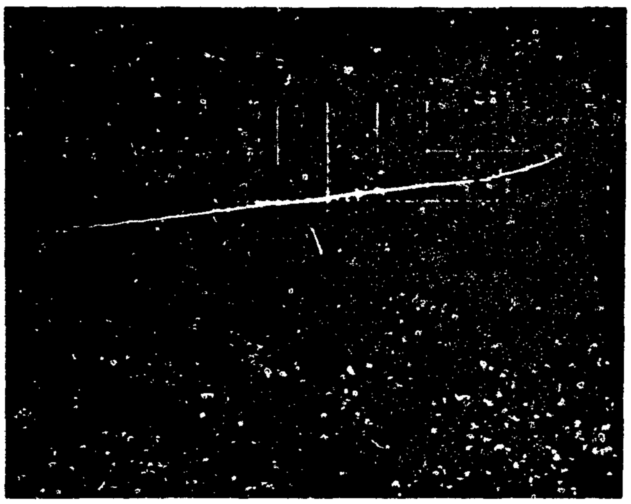
50



3

Time ←
1 div. = 50 μ sec.

35



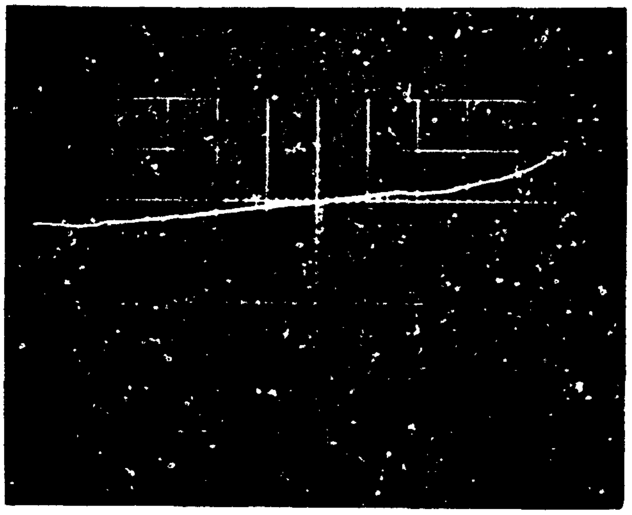
4

Time ←
1 div. = 50 μ sec.

FIGURE 4 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-9 Propellant.

Wt. % M-9 | **Test No.**

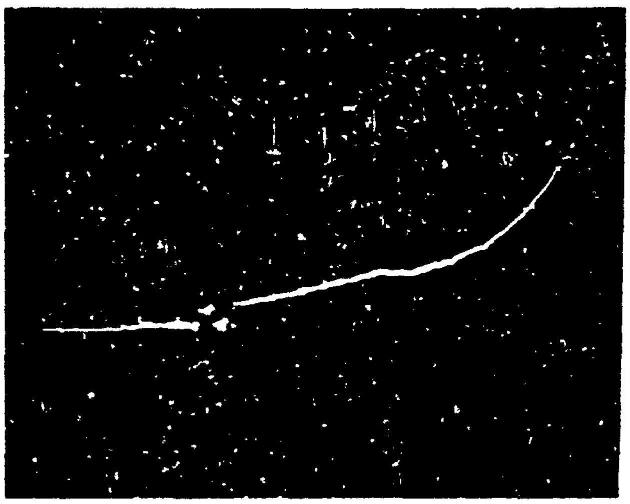
40 | 5



Time ←

1 div. = 50 μ sec.

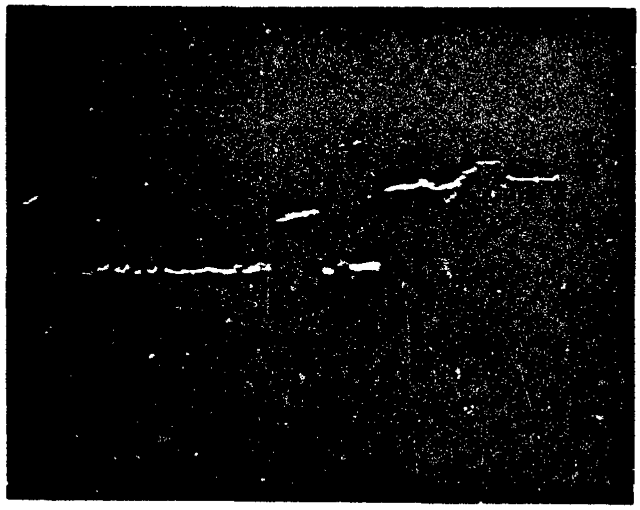
45 | 6



Time ←

1 div. = 50 μ sec.

FIGURE 4 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-9 Propellant.

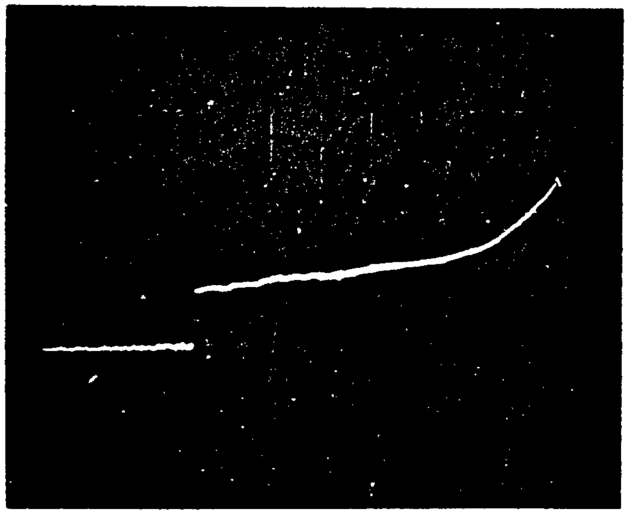
Wt. % M-9		Test No.
35		7

Time ←
1 div. = 50 μ sec.

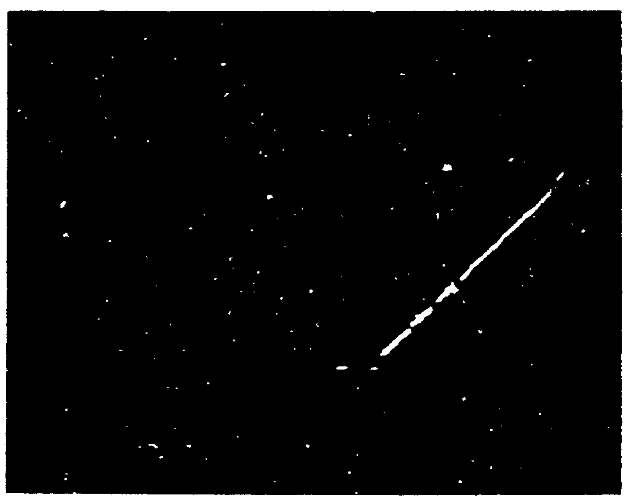
50		8

Time ←
1 div. = 50 μ sec.

FIGURE 4 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-9 Propellant.

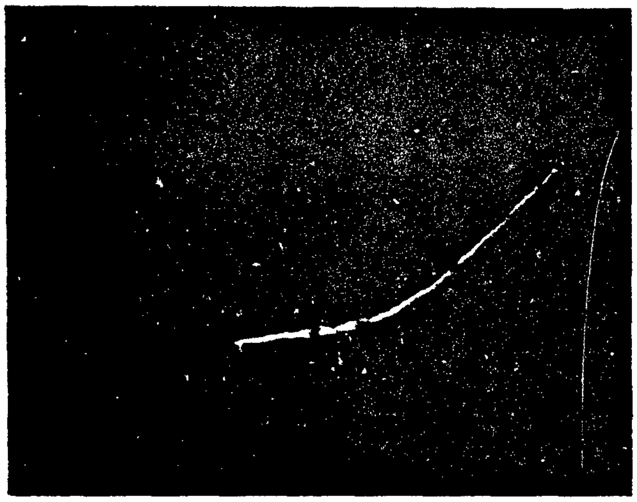
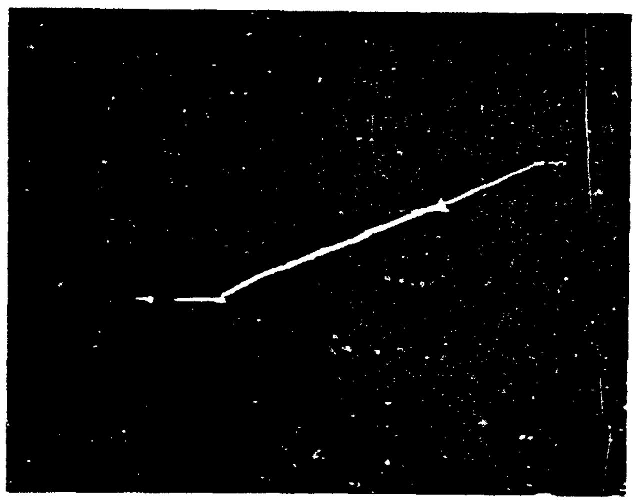
Wt. % M-10		Test No.
60		9

Time ←
1 div. = 50 μ sec.

70		10

Time ←
1 div. = 50 μ sec.

FIGURE 5 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-10 Propellant.

Wt. % M-10		Test No.
65		11
70		12

Time ←
1 div. = 50 μ sec.

Time ←
1 div. = 50 μ sec.

FIGURE 5 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-10 Propellant.

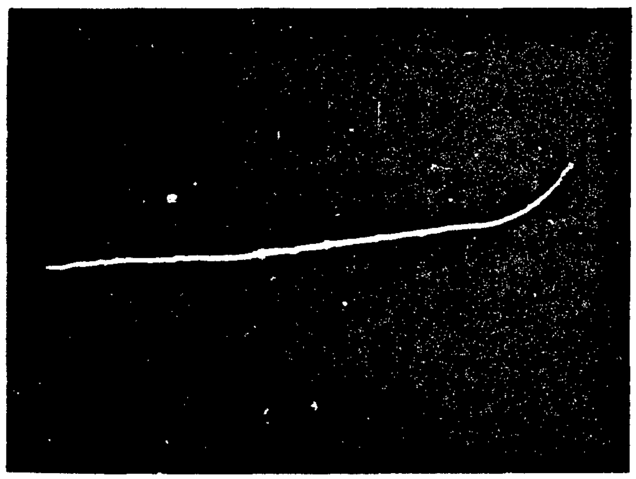
Wt. % M-10		Test No.
50		13

Time ←
1 div. = 50 μ sec.

55		14

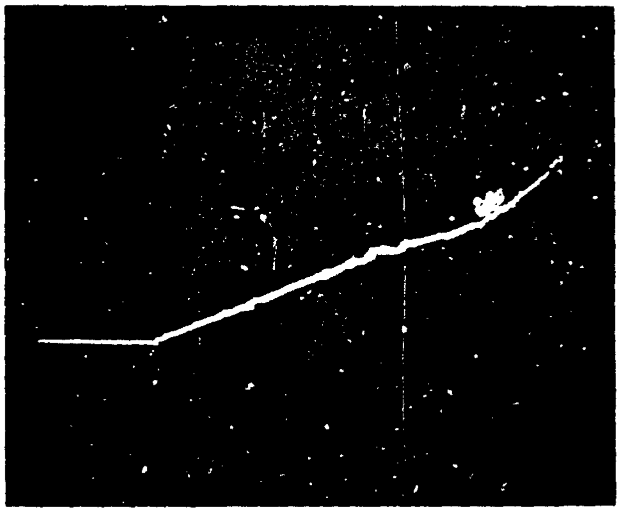
Time ←
1 div. = 50 μ sec.

FIGURE 5 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-10 Propellant.

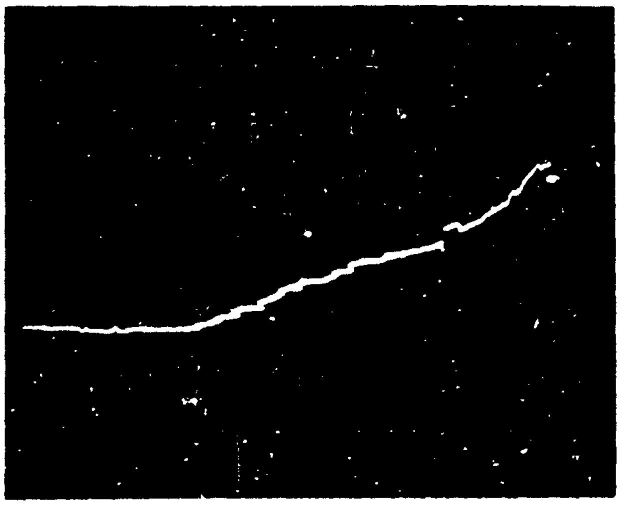
Wt. % M-10		Test No.
50		15

Time ←
1 div. = 50 μ sec.

FIGURE 5 Detonation Velocity Traces for Aqueous, Gelled Slurries of M-10 Propellant.

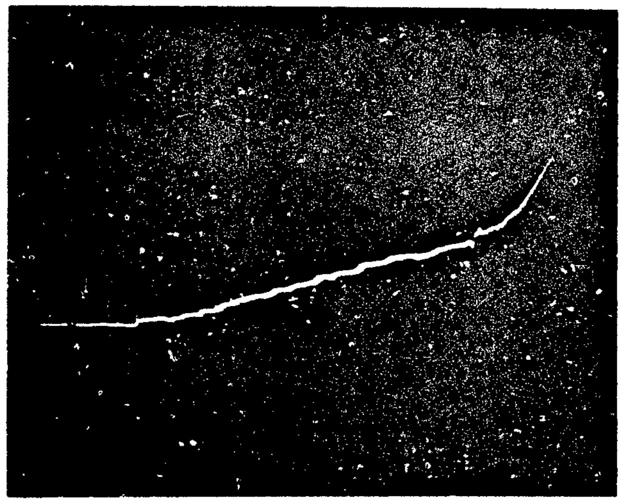
Wt. % TNT		Test No.
30		16

Time ←
1 div. = 50 μ sec.

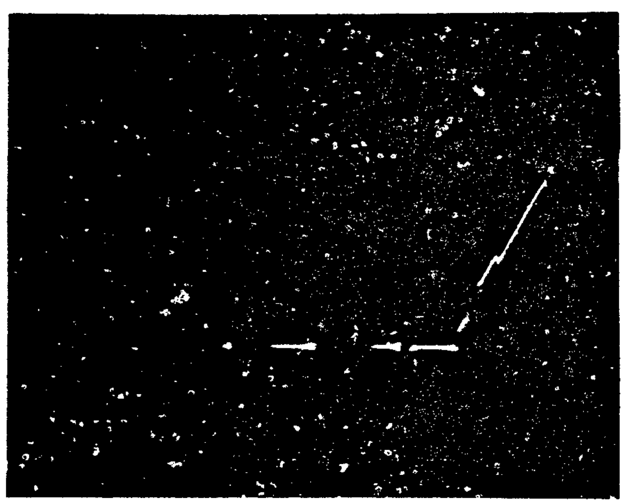
Wt. % TNT		Test No.
35		17

Time ←
1 div. = 50 μ sec.

FIGURE 6 Detonation Velocity Traces for Aqueous, Gelled Slurries of TNT.

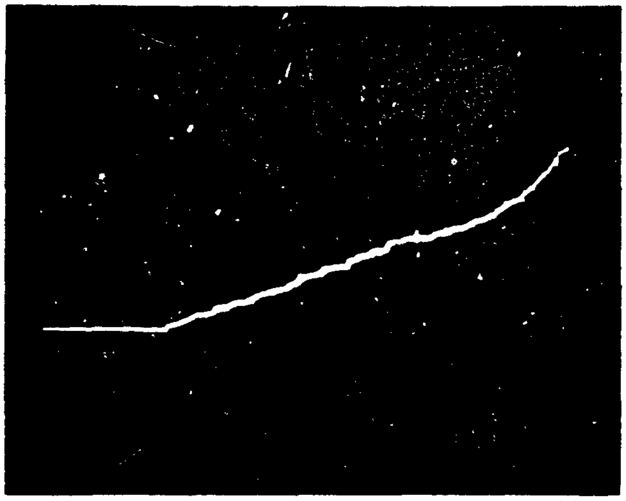
Wt. % TNT		Test No.
50		18

Time ←——
1 div. = 50 μ sec.

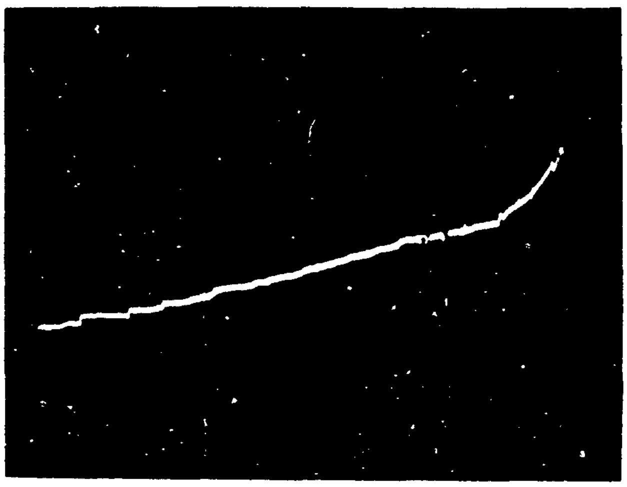
60		19

Time ←——
1 div. = 50 μ sec.

FIGURE 6 Detonation Velocity Traces for Aqueous, Gelled Slurries of TNT.

Wt. % TNT		Test No.
40		20

Time ←
1 div. = 50 μ sec.

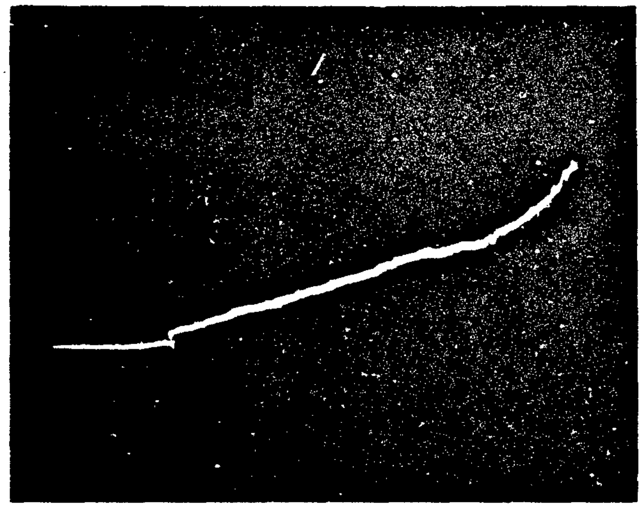
45		21

Time ←
1 div. = 50 μ sec.

FIGURE 6 Detonation Velocity Traces for Aqueous, Gelled Slurries of TNT.

Wt. % TNT | **Test No.**

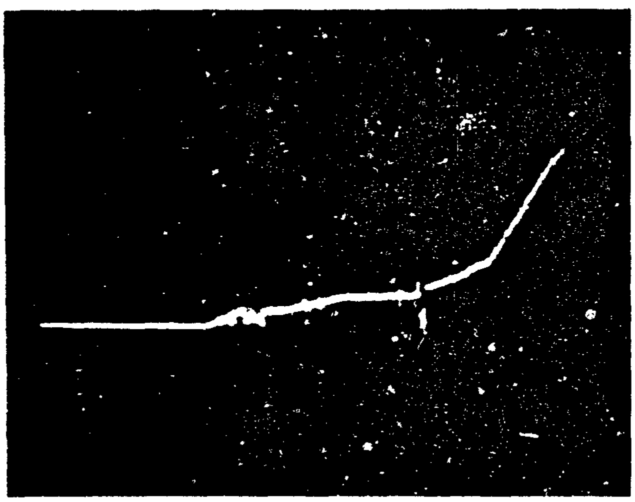
40



22

Time ←
1 div. = 50 μ sec.

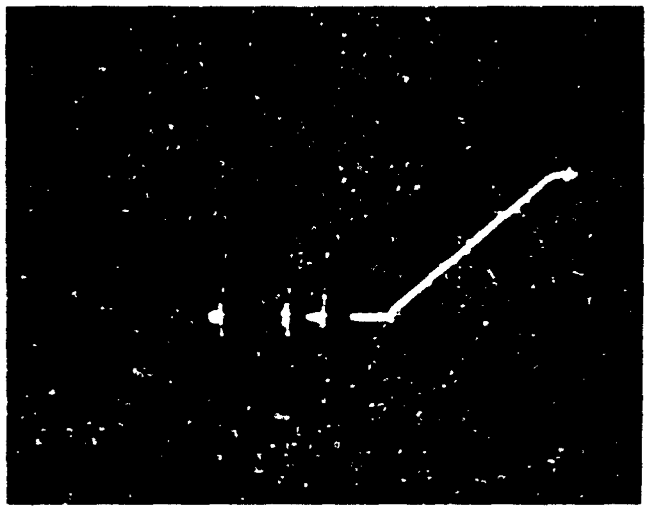
55



23

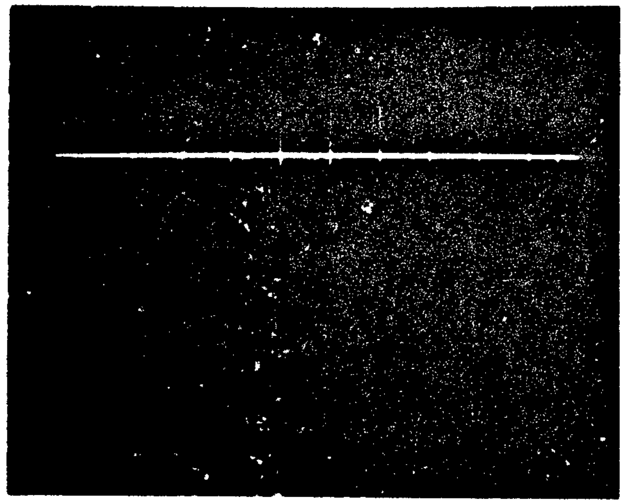
Time ←
1 div. = 50 μ sec.

FIGURE 6 Detonation Velocity Traces for Aqueous, Gelled Slurries of TNT.

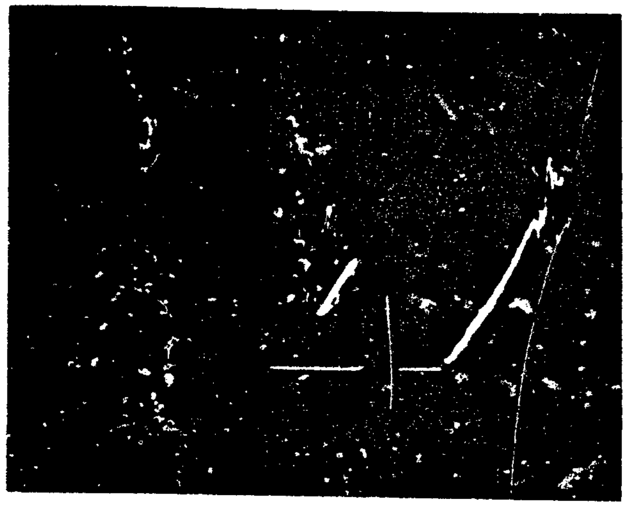
Wt. % TNT		Test No.
60		24

Time ←
1 div. = 50 μ sec.

FIGURE 6 Detonation Velocity Traces for Aqueous, Gelled Slurries of TNT.

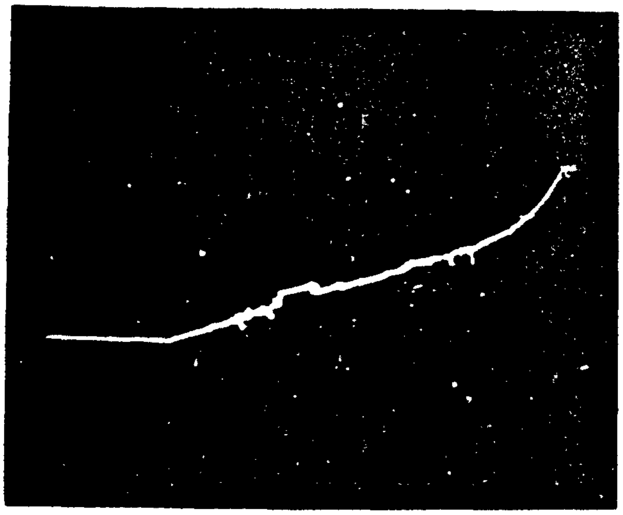
Wt. % Comp. B		Test No.
30		25

Time ———
1 div. = 50 μ sec.

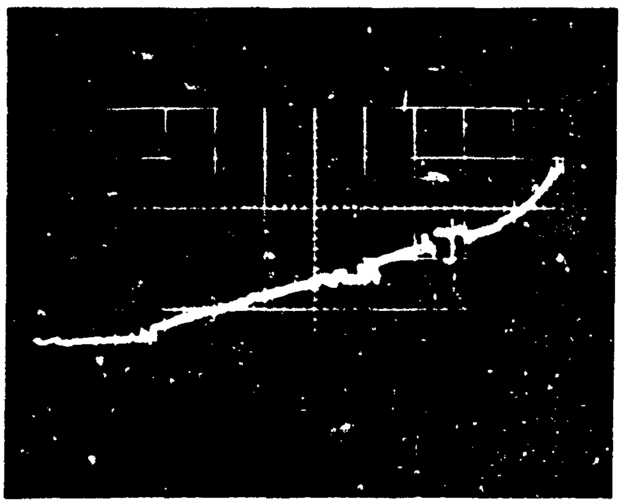
40		26

Time ———
1 div. = 50 μ sec.

FIGURE 7 Detonation Velocity Traces for Aqueous, Gelled Slurries of Composition B.

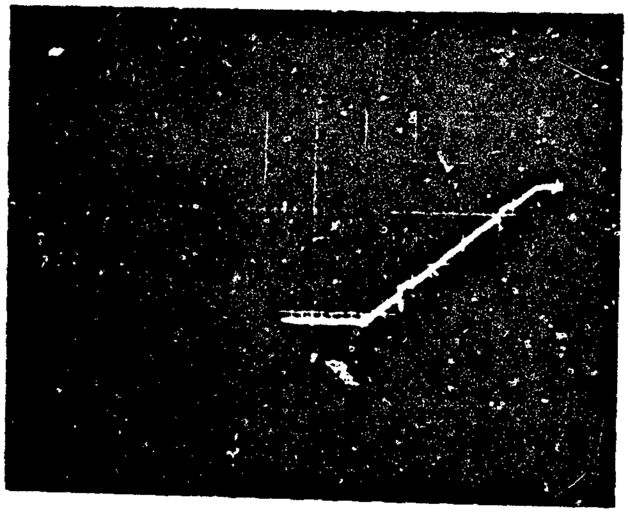
Wt. % Comp. B		Test No.
35		27

Time ←
1 div. = 50 μ sec.

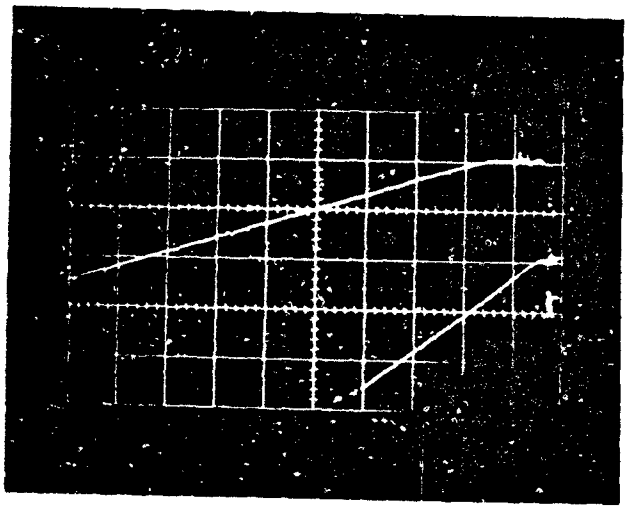
30		28

Time ←
1 div. = 50 μ sec.

FIGURE 7 Detonation Velocity Traces for Aqueous, Gelled Slurries of Composition B.

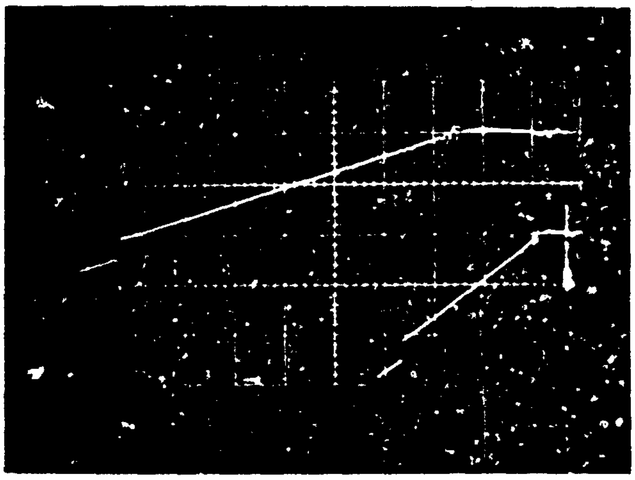
Wt. % Comp. B		Test No.
40		29

Time ←
1 div. = 50 μ sec.

40		69 Sweep #1 Sweep #2

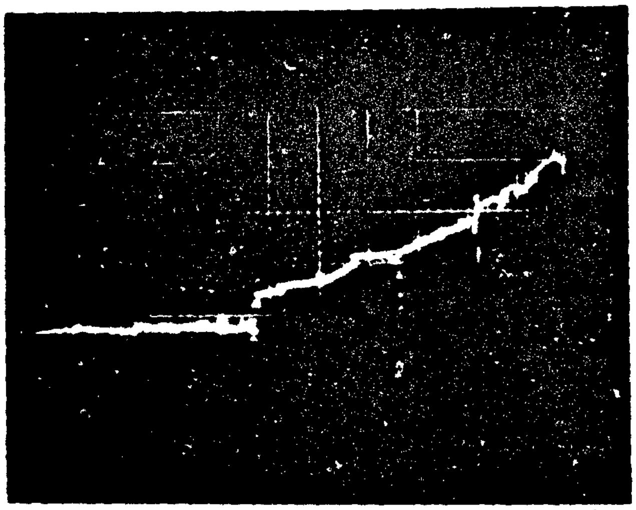
Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 7 Detonation Velocity Traces for Aqueous, Gelled Slurries of Composition B.

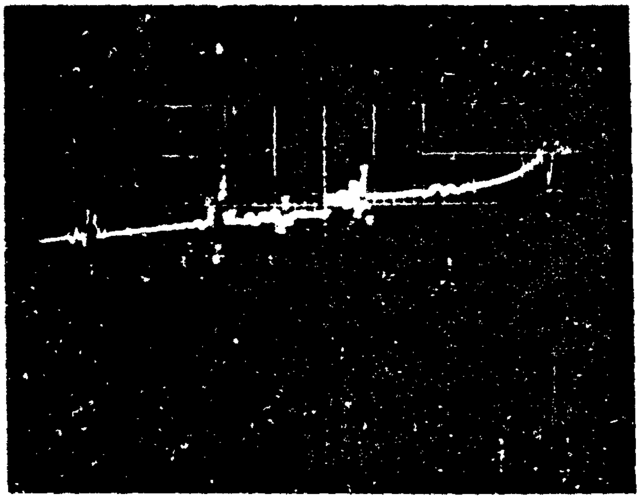
Wt. % Comp. B		Test No.
		70
40		Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 7 Detonation Velocity Traces for Aqueous, Gelled Slurries of Composition B.

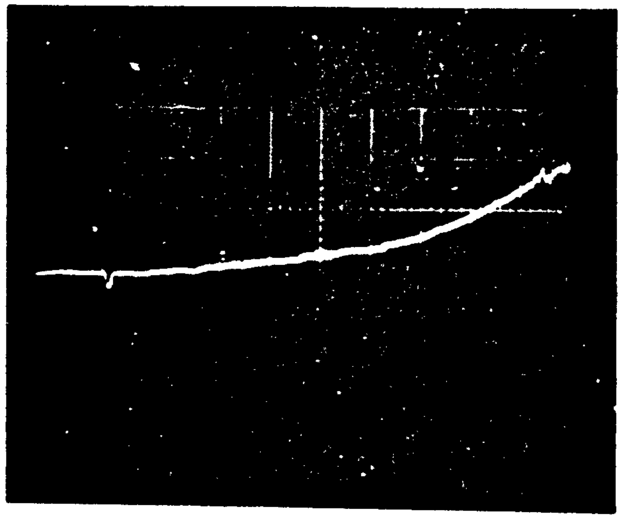
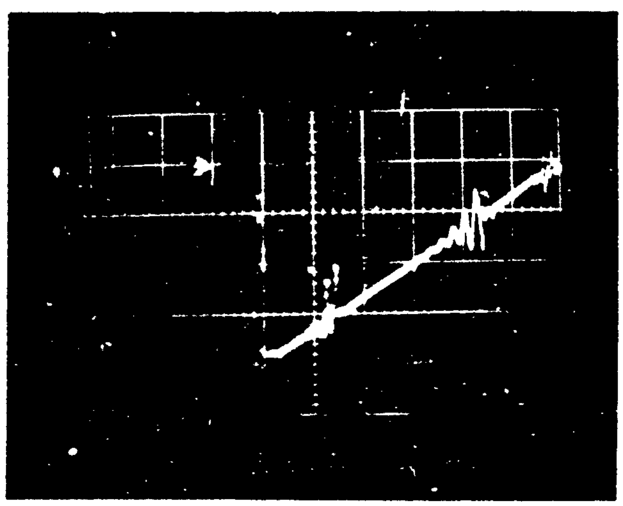
Wt. % Comp. B.		Test No.
0		30

Time ←
1 div. = 50 μ sec.

30		31

Time ←
1 div. = 20 μ sec.

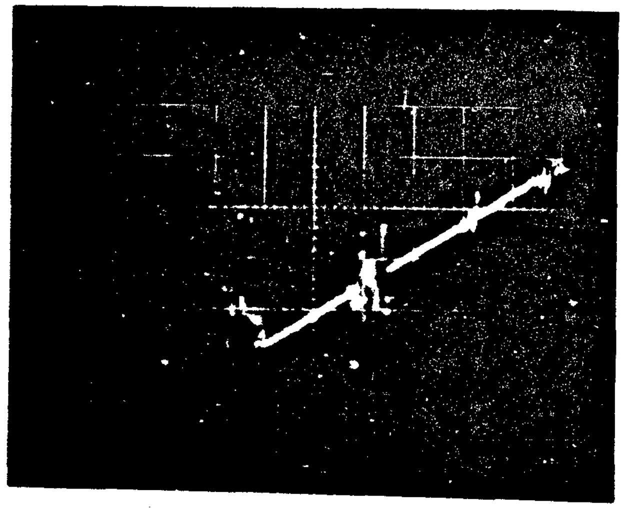
FIGURE 8 Detonation Velocity Traces for Aqueous, Settled Slurries of Composition B.

Wt. % Comp. B		Test No.
40		32
50		33

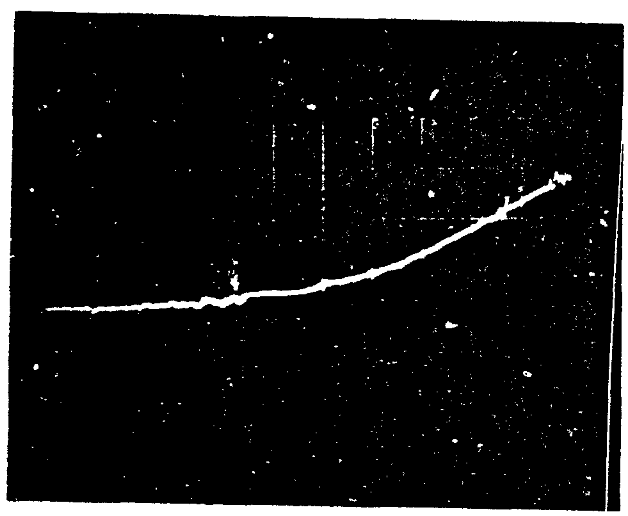
Time ←—
1 div. = 20 μ sec.

Time ←—
1 div. = 20 μ sec.

FIGURE 8 Detonation Velocity Traces for Aqueous, Settled Slurries of Composition B.

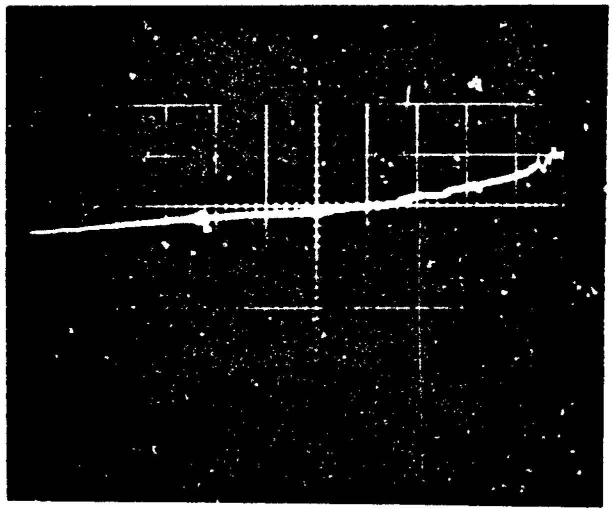
Wt. % Comp. B.		Test No.
45		34

Time ←
1 div. = 20 μ sec.

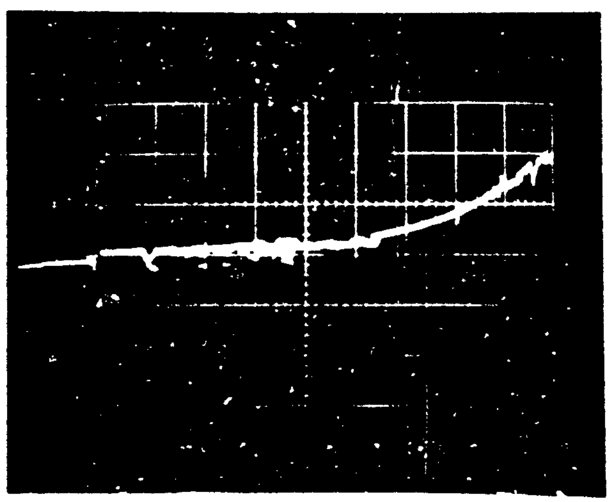
40		35

Time ←
1 div. = 20 μ sec.

FIGURE 8 Detonation Velocity Traces for Aqueous, Settled Slurries of Composition B.

Wt. % Comp. B.		Test No.
35		36

Time ←
1 div. = 20 μ sec.

35		37

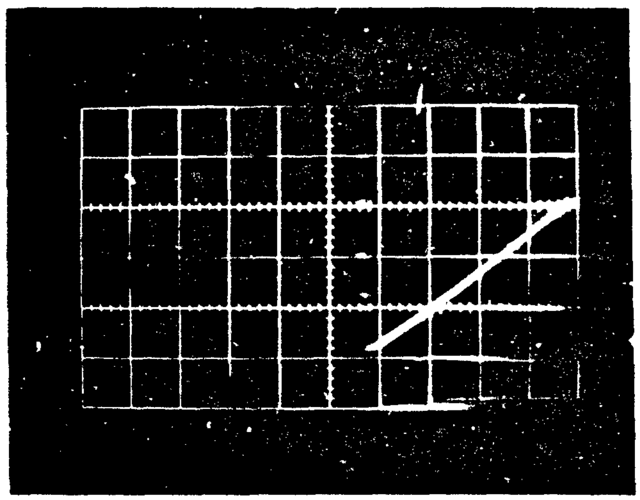
Time ←
1 div. = 20 μ sec.

FIGURE 8 Detonation Velocity Traces for Aqueous, Settled Slurries of Composition B.

Wt. %
Comp. B.

Test
No.

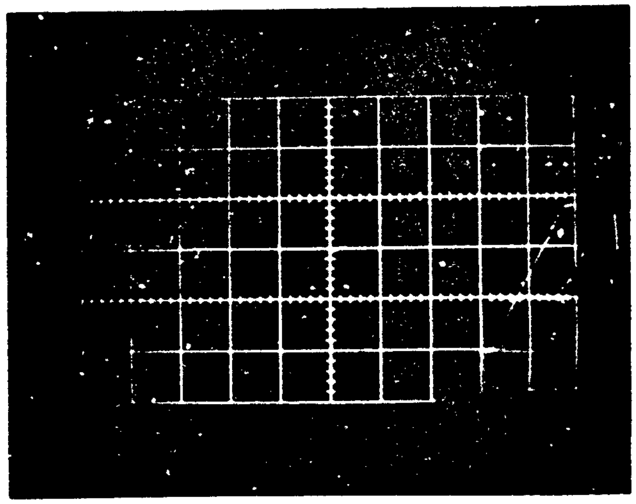
45



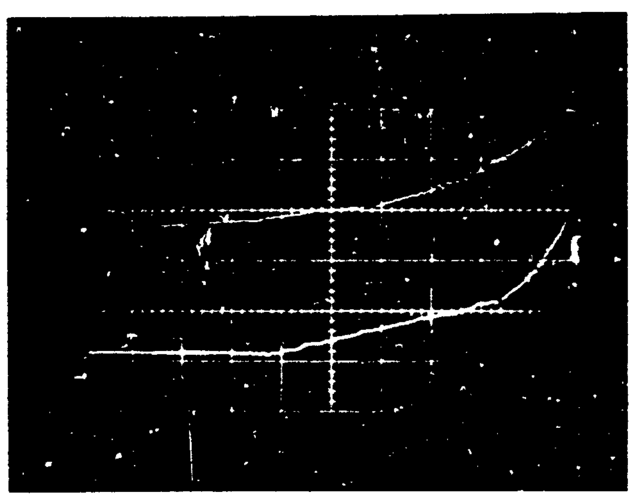
38

Time ←
1 div. = 50 μ sec.

FIGURE 8 Detonation Velocity Traces for Aqueous, Settled Slurries of Composition B.

Wt. % TNT		Test No.
60		39 Sweep #1 Sweep #2

Time ←
Sweep #1   1 div. = 20 μ sec.
Sweep #2   1 div. = 50 μ sec.

50		40 Sweep #1 Sweep #2

Time ←
Sweep #1   1 div. = 20 μ sec.
Sweep #2   1 div. = 50 μ sec.

FIGURE 9 Detonation Velocity Traces for Aqueous, Settled Slurries of TNT.

Wt. % TNT		Test No.
45		41 Sweep #1 Sweep #2

Time ←

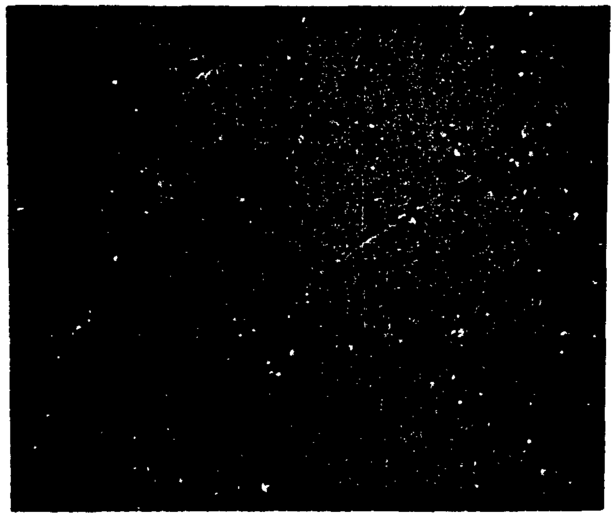
Sweep #1	1 div. = 20 μ sec.
Sweep #2	1 div. = 50 μ sec.

Wt. % TNT		Test No.
40		42 Sweep #1 Sweep #2

Time ←

Sweep #1	1 div. = 20 μ sec.
Sweep #2	1 div. = 50 μ sec.

FIGURE 9 Detonation Velocity Traces for Aqueous, Settled Slurries of TNT.

Wt. % TNT		Test No.
		43
		Sweep #1
55		Sweep #2

Time ←

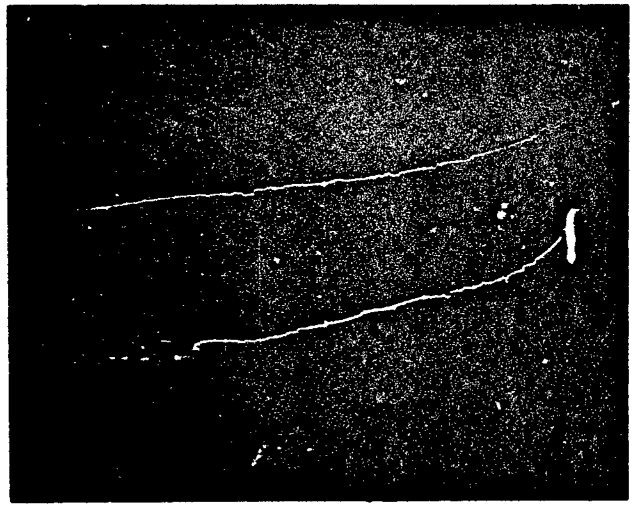
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

		44
		Sweep #1
55		Sweep #2

Time ←

Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

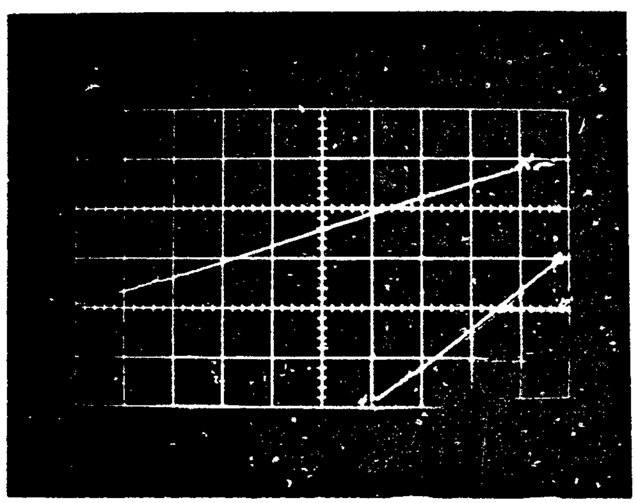
FIGURE 9 Detonation Velocity Traces for Aqueous, Settled Slurries of TNT.

Wt. % TNT		Test No.
40		45 Sweep #1 Sweep #2

Time ←

Sweep #1 1 div. = 20 μ sec.

Sweep #2 1 div. = 50 μ sec.

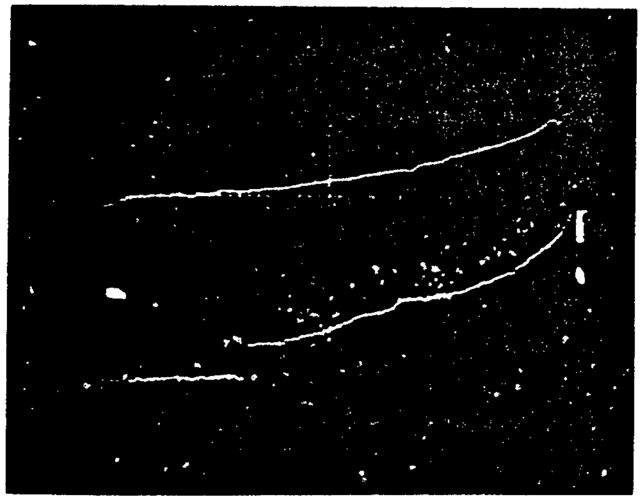
55		68 Sweep #1 Sweep #2

Time ←

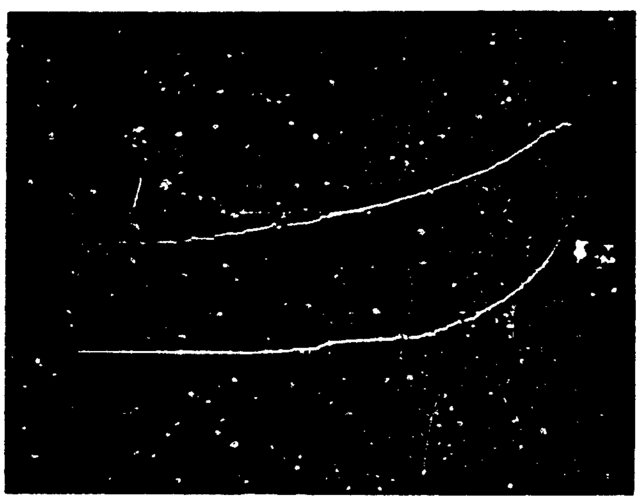
Sweep #1 1 div. = 20 μ sec.

Sweep #2 1 div. = 50 μ sec.

FIGURE 9 Detonation Velocity Traces for Aqueous, Settled Slurries of TNT.

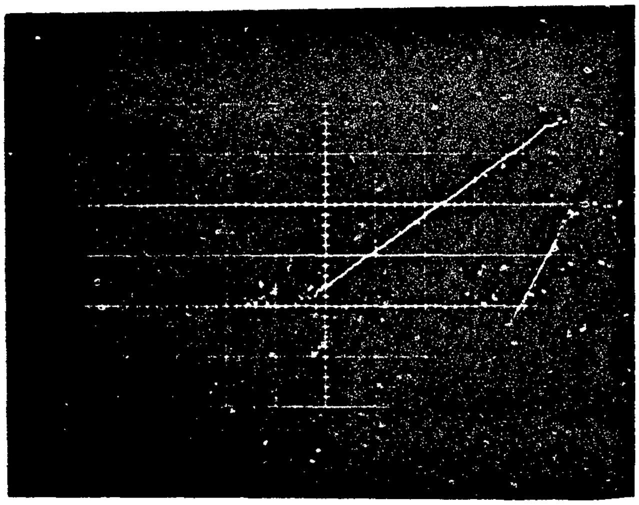
Wt. % M-9		Test No.
35		46 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

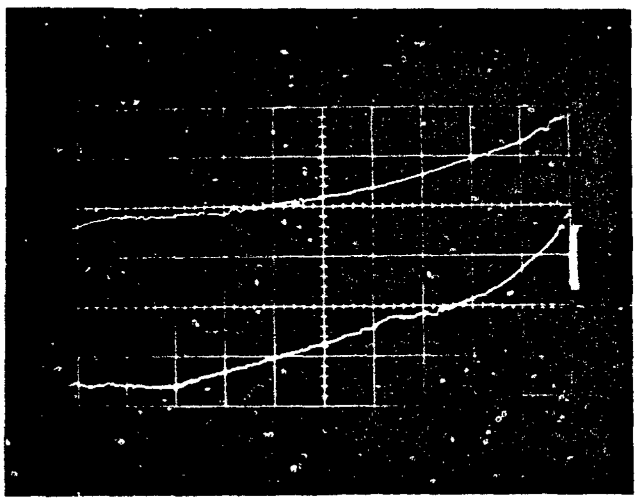
45		47 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 10 Detonation Velocity Traces for Aqueous, Settled Slurries of M-9 Propellant.

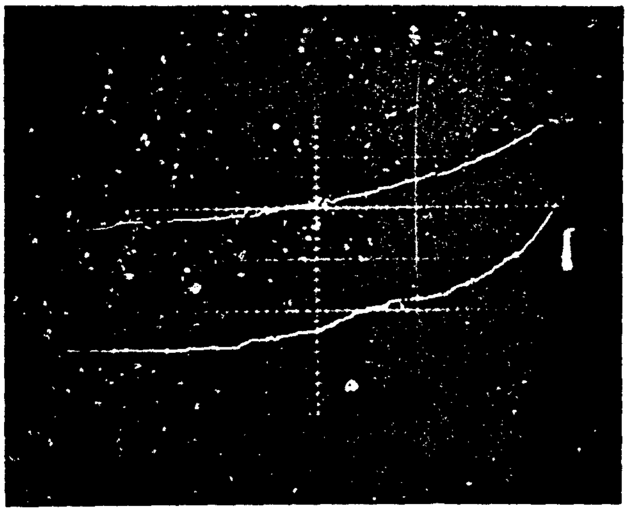
Wt. % M-9		Test No.
50		48 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

40		49 Sweep #1 Sweep #2

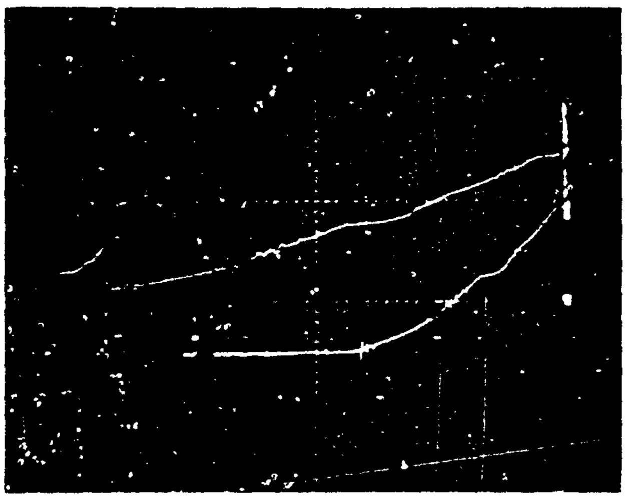
Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 10 Detonation Velocity Traces for Aqueous, Settled Slurries of M-9 Propellant.

Wt. % M-9		Test No.
40		50 Sweep #1 Sweep #2

Time ⟵

Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

50		51 Sweep #1 Sweep #2

Time ⟵

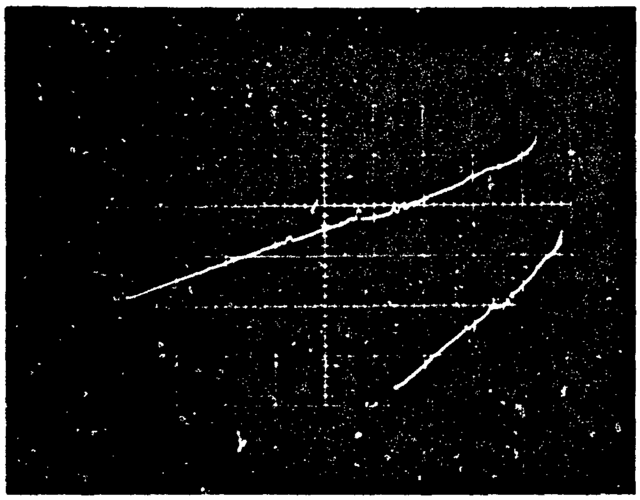
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 10 Detonation Velocity Traces for Aqueous, Settled Slurries of M-9 Propellant.

Wt. % M-9 | | Test No.

52

50

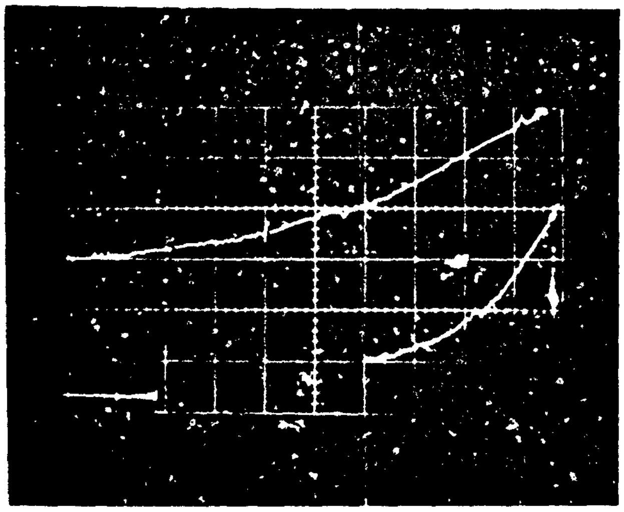


Sweep #1

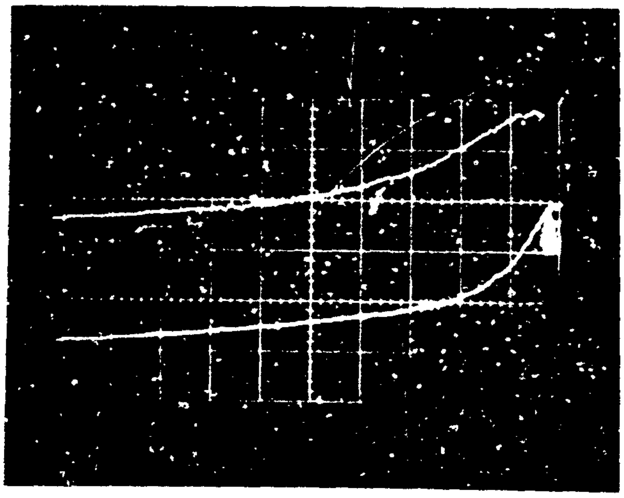
Sweep #2

Time ←——
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 10 Detonation Velocity Traces for Aqeuous, Settled Slurries of M-9 Propellant.

Wt. % M-10		Test No.
		53
		Sweep #1
50		Sweep #2

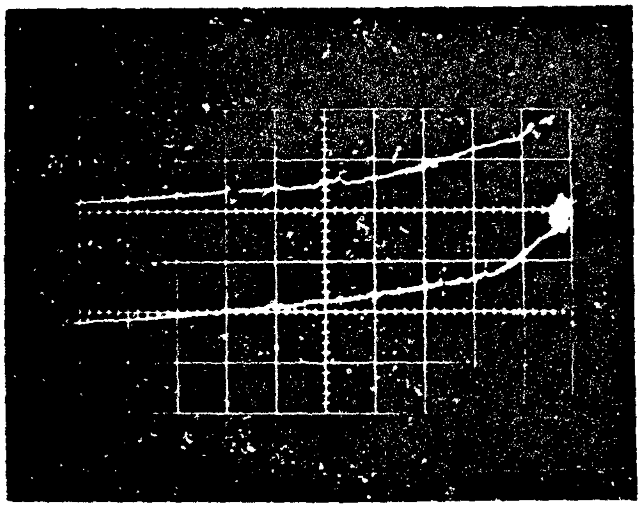
Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

		54
		Sweep #1
55		Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

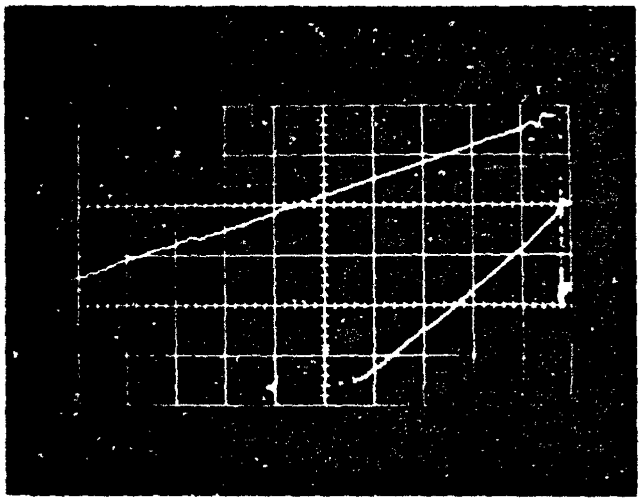
FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

Wt. % M-10		Test No.
		55
		Sweep #1
60		Sweep #2



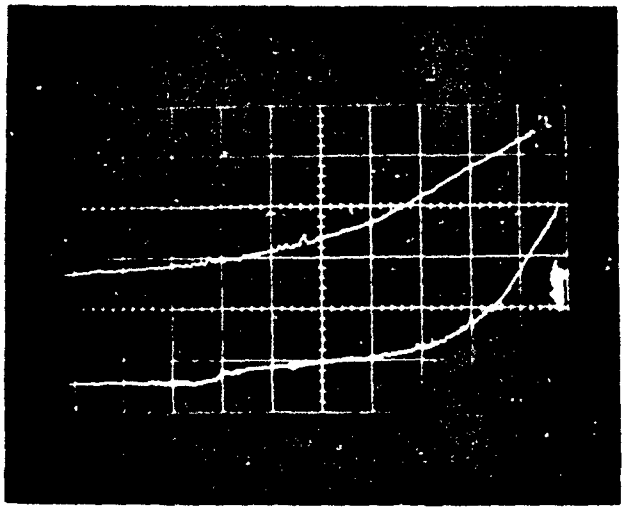
Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

		56
		Sweep #1
65		Sweep #2

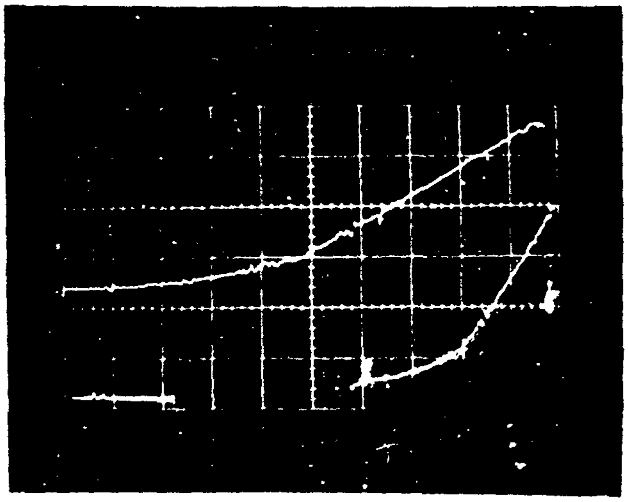


Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

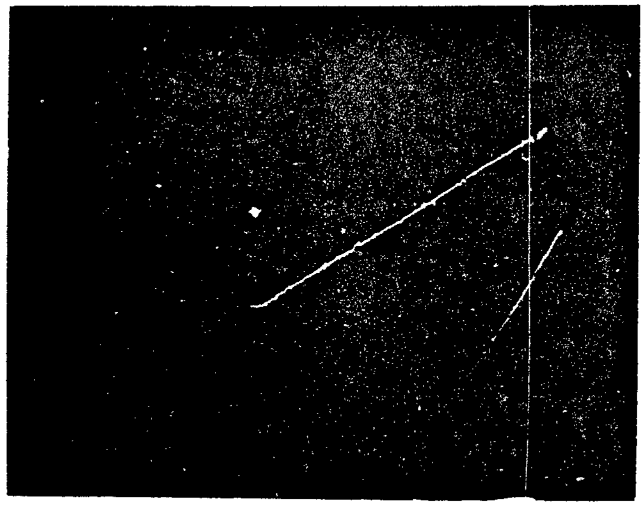
Wt. % M-10		Test No.
50		57 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

45		58 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

Wt. % M-10		Test No.
35		59 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

25		60 Sweep #1 Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

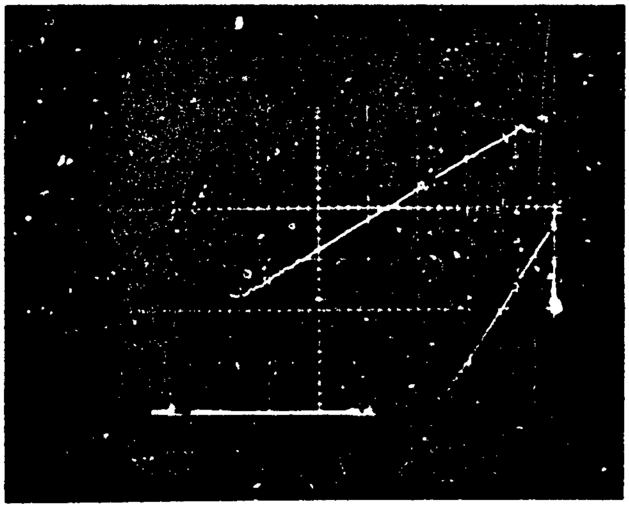
FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

Wt. % M-10 | Test No.

20 | 61

Sweep #1

Sweep #2

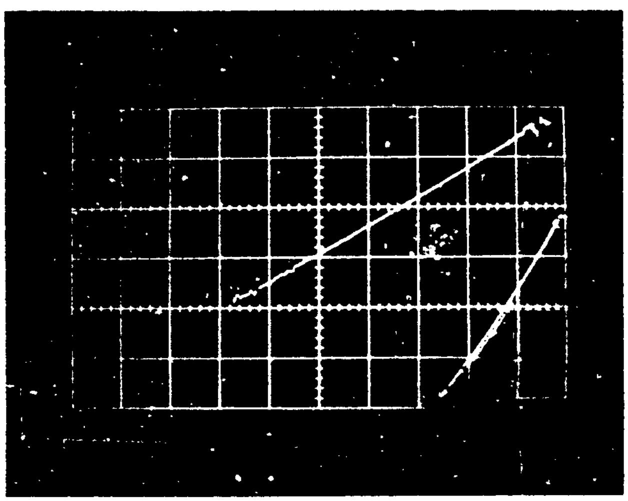


Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

15 | 62

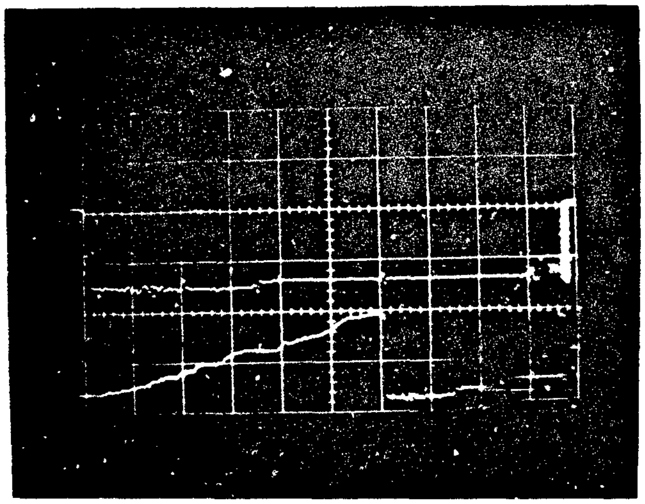
Sweep #1

Sweep #2

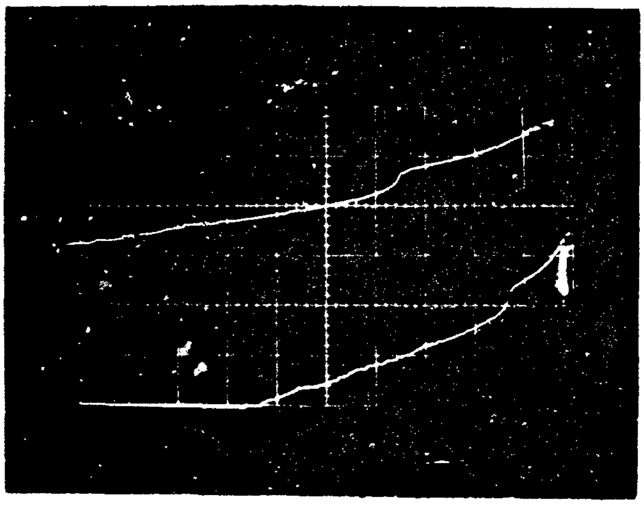


Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

Wt. % M-10		Test No.
		63
10		Sweep #1
		Sweep #2

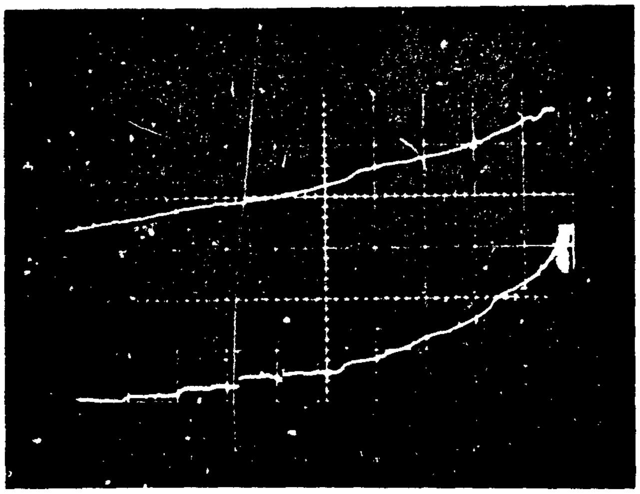
Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

		64
10		Sweep #1
		Sweep #2

Time ←
Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

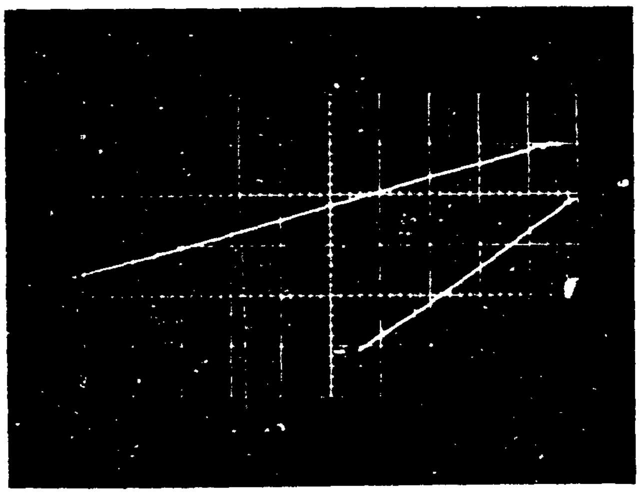
Wt. % M-10		Test No.
12.5		65 Sweep #1 Sweep #2



Time ←

Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

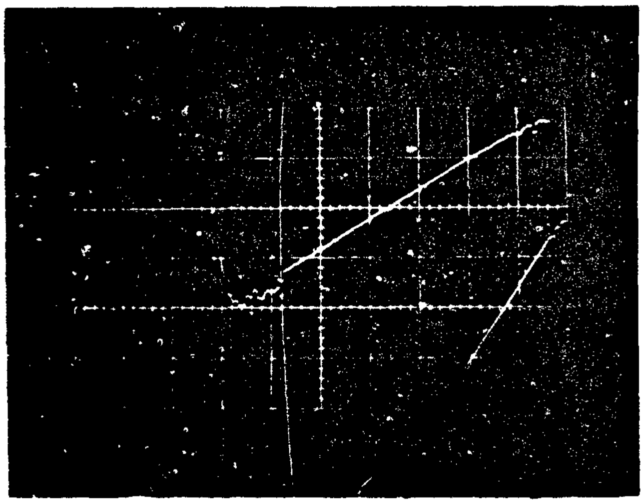
15		66 Sweep #1 Sweep #2



Time ←

Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant.

Wt. % M-10		Test No.
15		67 Sweep #1 Sweep #2

Time ←

Sweep #1 1 div. = 20 μ sec.
Sweep #2 1 div. = 50 μ sec.

FIGURE 11 Detonation Velocity Traces for Aqueous, Settled Slurries of M-10 Propellant

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Darl E. Westover - Picatinny Arsenal

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13. ABSTRACT

The objective of this program was to investigate the detonation propagation characteristics of aqueous slurries of TNT, Composition B, M-9 and M-10 in 2 inch, schedule 40, stainless steel pipes of various lengths. Two operational modes were studied; the dynamic or pumping mode and, the static, or settled slurry mode. The dynamic condition was simulated by adding an inert gelling agent to a homogeneous, aqueous, explosive slurry. Information generated by this program will be used in support of the United States Army's munitions manufacturing and loading facilities.

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	ROLE	WT	ROLE	WT	ROLE	WT
Detonation						
Propagation						
TNT						
Composition B						
M-9 Propellant						
M-10 Propellant						
Dynamic						
Static						
Gelled Slurries						
Settled Slurries						
Homogeneous						
Aqueous						

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