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SETBACK SENSITIVITY STUDY

SUMMARY REPORT

Contract DAI-19-020-501-ORD-(P)-59

NN-P-32

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SUMMARY REPORT

NN-P-32

MARCH 1956

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NATIONAL NORTHERN

West Hanover, Massachusetts

SETBACK SENSITIVITY STUDY

Contract DAI-19-020-501-ORD-(P)-59

SUMMARY REPORT

NN-P-32

MARCH 1956

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1.

SUMMARY

The object of this investigation, in general, has been to determine the sensitivity of explosives to initiation by "setback" pressure. Specifically, National has investigated the effect of cavitation in samples of Composition B. In the course of this investigation, National has assisted in the later engineering modifications of the apparatus originated and designed at Picatinny Arsenal.

It has been determined that detonation of the samples by this method is a statistical event. These results indicate that the probability of detonation increases with increased pressures, with larger cavity volumes, and with cavities located within the sample rather than on the surface.

The apparatus is believed to be able to withstand pressures within the ranges necessary to initiate Composition B.

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INTRODUCTION

This investigation was begun at Picatinny Arsenal¹ for the purpose of determining the most probable causes of premature functioning of HE shell, particularly those loaded with Composition B. The investigation has been limited to the HE filler, and Picatinny Arsenal experiments have been designed to scan cavitation, adiabatic compression, density variations, grit, and desensitizers as suspect in initiating HE shell prematurely. National's part in this effort has been specifically the study of cavitation. The investigation has been under the direct guidance of Picatinny Arsenal, particularly Mr. Louis Jablansky.

In the test-program described in this Report, National has been concerned solely with cavitation in Composition B samples. Although there is some very significant evidence presented, conclusions are made with reservations because of the obvious statistical nature of the method. There is a real need for additional work on this phase of the study alone.

¹ Technical Report 2235, Picatinny Arsenal, Sept. 1955.

THE EXPERIMENTAL METHOD

General

A simplified block diagram, Figure 1, shows the complete apparatus. The test fixture is a piston-cylinder machine based on the Picatinny Arsenal design. Pressure is generated in a chamber by burning propellant powder and is applied to the explosive sample through a movable piston. This chamber pressure is monitored by a transducer and recorded from an oscilloscope by photography. A control unit serves to trigger a single sweep on the oscilloscope, fire the propellant charge, and monitor the transducer circuit.

The Setback Sensitivity Test Fixture

Figure 2 is a photograph of the test fixture used to obtain all of the data in this Report. A cross-sectional drawing, Figure 3, shows the general assembly of the fixture. The operational principles are readily apparent from the drawing.

This test fixture incorporates all of the major changes in the first Picatinny Arsenal prototype, and is, basically, a copy of the machine used at Picatinny Arsenal at the present time.

National's principal modification has been a change in the piston design, shown in Figure 4. In the early tests, positive samples left the former piston bent at the stopping-shoulder. The stopping-shoulder is intended to prevent the piston from continuing out of the cylinder when the sample subassembly is removed by detonation. It was believed that the piston was bent by a torque produced when some of the fragments of the sleeve or punches were not cleared from the path of the piston. To reduce this possibility, the shoulder was moved forward and the shank of the piston was brought out to the cylinder dimensions, as shown in Figure 4. To reduce further the possibility of bent pistons, three escape ports were drilled through the cylinder approximately an inch past the piston face. The intent was to allow the contained gases to escape harmlessly when the piston moved forward and uncovered these escape ports. With the addition of two Neoprene rings to absorb some of the shock of stopping the piston, no piston damage has been encountered in over 300 tests and some 25 positive samples.

Other modifications were made for the purpose of strengthening metal parts. The channel-iron bed which supports the entire apparatus was distorted by the torque of the moving piston and stop. The channel-iron was straightened and reinforced by steel legs along both sides. Bolts holding the stop and chamber to the channel-iron were found to be distorted by the same torque. Additional bolts, hardened for maximum strength, were ordered. There is still some strain and distortion of these bolts, but it is not now as serious as before. At the present time, the test fixture is well-aligned and operating satisfactorily.

The recoil of the entire fixture when the piston was accelerated forward was the probable cause for another series of breakdowns. On two occasions the pressure cell failed, and it was noticed that the pressure relief valve was being bent at the point where it protruded from the chamber block. The Baldwin-Lima-Hamilton Corporation repaired the cell on each occasion and found loosened electrical parts within the cell. They presumed it to be faulty manufacture and replaced plastic mountings with stainless steel. In view of the damaged pressure relief valve, there was reason to believe that the entire test fixture underwent violent recoil, particularly on positive samples. The pressure relief valve and the pressure cell are each mounted normal to the longitudinal axis of the test fixture. This situation has been satisfactorily corrected by shoring the entire fixture against heavy timbers, redesigning the pressure-relief valve with a stouter shank and lighter head, and replacing the plastic parts of the pressure cell.

A less serious defect has been corrected by modification of the copper obturation cup used for sealing the high pressure gases in the chamber. At the suggestion of Mr. Jablansky of Picatinny Arsenal, new cups were made with a 3/8-inch lip rather than the former 1/4-inch lip, and the cups were spun from .007 inch copper stock rather than the former .013 inch stock.

The pressure-relief valve was found to be seated in the chamber block rather than in the cylinder liner. As a result, the gases were escaping from the chamber through the port intended for pressure relief and then between the liner and the chamber block. Reseating the valve in the liner has corrected this situation. At the present time, the operation of the test fixture is completely satisfactory.

The test fixture was fabricated in an outside machine shop in accordance with Picatinny Arsenal drawings. National's Engineering Department effected design modifications with the technical assistance of Mr. Jablansky of Picatinny Arsenal.

The Monitor and Control Equipment

The control unit shown in the block diagram was designed and built by National's Research Department especially for this project. The unit contains circuits for triggering a single sweep on the oscilloscope, firing the propellant charge in the chamber of the test fixture, and monitoring and operating the pressure cell.

Power for the pressure cell is provided by two twelve-volt storage batteries connected in series. Voltage for the pressure cell is adjusted by a potentiometer and monitored by a voltmeter, both in the control unit. The storage batteries are replenished periodically by a special 24-volt charger made by National's Research Department.

The oscilloscope is a DuMont type 324, chosen for high signal amplification, making preamplifiers unnecessary. The camera is the DuMont type 302, a Polaroid Land Camera for rapid processing of photographs.

The pressure cell is a Baldwin SR-4-HF5000 with an upper-frequency limit of about 40,000 cycles per second and an upper-pressure limit of about 5000 pounds-per-square-inch. The signal output, calibrated by the manufacturer with the cable attached, is 1.947 millivolts per volt at full capacity. The voltage used, as recommended by the Baldwin-Lima-Hamilton Corp., is 24 volts, making the signal 46.728 millivolts for a chamber pressure of 5000 pounds-per-square-inch. Assuming a mechanical advantage of sixteen from the ratio of the areas of the piston-face and punch-face, 5000 pounds-per-square-inch chamber pressure represents a "setback" pressure of 80,000 pounds-per-square-inch. In terms of the oscillography employed, each millivolt of signal indicates 1712 pounds-per-square-inch "setback" pressure.

Materials

The samples used in all of these tests were prepared by National's Terminal Ballistics Department. Special molds, .500 inch diameter and one-half and one-inch in length, were ordered. Bases were machined to accommodate these molds and to provide nipples with the dimensions of the cavity desired for each series of tests.

The cavity in each pellet was formed by casting the molten Composition B in the proper mold. The solid end of each sample was formed by facing the pellet, still in the mold, on a steam-heated plate. The pellets were allowed to cool in the molds and were removed and identified for X-Ray photographs.

The Composition B used in Tables A through F was made especially for this project from TNT, Lot No. WLD-887, 4-43, and RDX, Lot No. HOL 4-27. The Composition B used in Tables G and H was from Picatinny Arsenal Lot No. HOL 7-1489. The propellant used was M-9 60 mm. Mortar propellant, Army Lot No. 18819, supplied by Picatinny Arsenal. M1A1 squibs used to fire the propellant were from National stores, Lot No. 4.

Maintenance of the equipment involved greases and lubricants, principally Aeroshell High-Temperature Grease 11, Dow-Corning Silicone Stopcock-Lubricant, and Marvel Mystery Oil.

The propellant was fired in silk bags to eliminate as much carbon sludge as possible. These were procured from, and fabricated by, outside vendors.

EXPERIMENTAL PROCEDURES

Certain precautions were taken throughout the experiments to provide conditions as uniform as possible from one test to the next. The condition of the sample pellet in the punch-and-sleeve subassembly was of primary concern, since this is the focal point of the whole experiment. All the pellets were photographed by X-Ray to show any flaws or foreign matter. Before they were inserted in the

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sleeves, they were cleaned of dust and powdered explosive. The sleeves and punches were degreased in acetone and cleaned of dirt and machining chips. Selected pellets were inserted in the sleeves without lubrication, and the punches were inserted at either end with a thin film of stopcock grease for lubrication. Some sleeves and punches were discarded when misfits were indicated. When the complete subassembly had been made, all parts were checked for snug fit, and the subassembly inserted in the test fixture. The piston, sample subassembly, and stop-bolt were adjusted so that the same volume was obtained in the chamber for each sample and so that there was no slack in the complete assembly.

With the sample inserted in place, the selected quantity of propellant powder was carefully weighed and placed in a silk bag with an M1A1 squib. The squib was connected to the terminals on the firing head, and the firing head inserted in the chamber. A steel cover was placed over the sample to prevent fragments from escaping. The firing line from the control unit was then connected to the firing head in accordance with National's normal safety-procedures.

At the oscilloscope, the proper adjustment of the gauge, the firing circuit, and the trigger circuit was assured, and the test preparation was complete. Before the actual firing, a warning horn outside the building was sounded to alert personnel in the immediate vicinity that a test was underway.

The tests were carried out in a building used only for this project. The test fixture was in one room of the building and the control and monitor equipment in another. The room containing the test fixture had four walls and a ceiling made of 3/8-inch steel and a floor of concrete, eliminating all danger to personnel in the vicinity. The only entrance to this room was through the room containing the control and monitor equipment.

After completing a test, the sample assembly was salvaged. Positive shots provided fragments which were saved for possible future use. Negative shots usually left the subassembly of sample, sleeve, and punches jammed together. These were photographed by X-Ray and examined for unusual characteristics (bulge, extrusion, misalignment, etc.). Some of the negative shots provided sleeves from which both punches were easily removed. These were taken to a hand pellet-press, and the pellet was removed for closer examination by X-Ray. These X-Ray photographs are shown and explained later in this Report.

EXPERIMENTAL DATA

Cast Composition B was the explosive used throughout these experiments. The eight cavity conditions tested are best shown by the cross-section drawing, Figure 10. In each case, the basic pellet is a cylinder, one-half inch in diameter and one inch in length. Those pellets fired with only one cavity at one end of the pellet (Tables A and B) were cast in one piece. Pellets with internal cavities, or double cavities, were cast in two pieces, each piece one-half inch in diameter and one-half inch in length. The cavities were formed as indicated in Figure 10, and

the test data are reported in the appropriate Tables.

In addition to the tests made on explosive samples, an additional check of the pressure obtained in the sleeve was made by means of copper crusher pellets. These indicated that the "setback" pressures have been correctly determined.

In each of the Tables presented, the first column indicates the number of the test, the second column the weight of propellant used to produce the pressure, and the last column the identifying number of the pellet or pellets in an X-Ray photograph. In all of the X-Ray photographs, the pellets are numbered from left to right and from top to bottom in numerical sequence.

Under "Results", only those tests which clearly detonated are indicated by "POSITIVE". There were no cases in which detonation was doubtful. Pressures and times were read from oscillograms in pounds-per-square-inch and milliseconds, respectively. Under "Time to Peak", a correction has been made to account for a relatively long, slow rise in pressure, usually to under 1000 psi "setback" pressure, then a sharp increase to the final peak pressure. In no case, in which the results were positive, could the exact point on the oscillogram where the sample detonated be found. With the exception of a rapid decrease in pressure when the piston was forced out of the cylinder, the pressure pulses in the case of non-detonation were found to be the same form as those from positive-sample pulses.

DISCUSSION OF RESULTS

General

Four hundred thirty-one tests were made during this investigation. Three hundred and seventy-nine of these tests, 27 of which produced detonations, are considered for statistical purposes. The remaining tests were (1) made for alignment and checking purposes, or (2) were tests in which no oscillographic records were obtained because of some malfunction of control unit, oscilloscope, pressure cell, or camera.

These samples are considered for each experimental condition in the following paragraphs. A summary of these considerations is presented in Table I and shown in graphic form in Figure 14. In those cases in which the sample pellet could have specific orientation with respect to the test fixture, care was taken to place the sample in the fixture in the same manner for each test and, in all cases, the cavity end of the sample was placed toward the firing head. This was the case with those samples reported under Tables A, B, and G.

Table A

The first series of tests completed were those on cast Composition B

samples with a 1/4 x 1/4-inch cylindrical cavity at one end of the sample. As noted above, all of these samples were oriented so that the cavity was at the end of the sample near the firing head. The 1/4 x 1/4-inch cylindrical cavity has a volume of approximately .049 cubic inch.

Thirty-six samples were tested under this condition, and five of them were positive. Thirty of these samples were fired in the range 58,000 to 63,000 psi "setback" pressure. Of these 30 samples, four were positive, giving an average of approximately 13% positive samples in this range. One sample was fired at approximately 69,000 psi "setback" pressure and was positive. It is probable that more information could be obtained on this situation by increasing the pressure range to establish higher "percent-positive" points.

Table B

Those results reported under this Table were on samples with 3/8-inch diameter by 1/4-inch depth cavities having a volume of approximately .096 cubic inch. Again, these cavities were oriented with respect to the test fixture as described above. Forty-three samples were tested, seven of which were positive. Thirty-one of these samples were tested in the pressure range of 52,000 to 57,000 psi "setback" pressure, and six of these samples were positive, giving an average of approximately 19% positive samples in this range. Again, it is felt that more information can be gained by adding to the tests in the higher pressure ranges.

Table C

With the next series of tests, an investigation was begun of the effect of internally-located cavities. The cavity dimensions for this particular series were 3/8-inch diameter by 1/4-inch depth. This cavity was formed by casting half the cavity in each of two half-inch-long pellets, and placing the assembled sample in the test sleeve in the manner shown in Figure 10. Again, the volume of such a cavity is approximately .096 cubic inch.

One hundred and twenty four tests were made on this type of sample, and five of these tests were positive. Twenty-seven of these tests were made in the range of 43,000 to 49,000 psi "setback" pressure and, of these, four tests were positive, giving an average of approximately 15% positive results. Ninety-nine of these tests were in the relatively narrow range of 35,000 to 40,000 psi "setback" pressure, and only one test was positive. This test was very nearly at the top of the range, at 39,400 psi "setback" pressure. This would give a strong indication of a "1%-positive-point" near 40,000 psi.

Figures 14 A and B show these two points on a "% positive-log-setback" graph. Again, there is an indication that more work must be done to establish firmly a curve on such a graph. It is believed that choosing such wide ranges for obtaining average "percent-positive" samples increases the significance of the conclusions drawn from these experiments.

Table D

The 1/4 x 1/4-inch cylindrical cavity was again studied with the cavity located in the center of the pellet as shown in Figure 10. Twenty-six tests were made on this type of sample, none of which was positive. Twenty-four of these tests were made in the range 46,000 to 51,000 psi "setback" pressure. Again, the cavity volume is approximately .049 cubic inches.

This series would indicate less than 4% positive samples in the range of 46,000 to 51,000 psi "setback" pressure.

Table E

The cavity volume was increased in this series. A 3/8 x 3/8-inch cylindrical cavity was located in the center of the Composition B sample. The cavity volume was approximately .144 cubic inches.

Fifty tests were made on this type of sample, none of which was positive. Forty-four of these tests were between 34,000 and 40,000 psi "setback" pressure. This would indicate under 2% positive results for this sample between 34,000 and 40,000 psi.

Table F

In Table F, the results of another increase in cavity volume are indicated. This cavity was the largest used in all of these tests, and was the practical limit for the size of the sample employed. The cavity was again located within the center of the sample. The cavity dimensions were 3/8-inch diameter by 1/2-inch depth, or an approximate volume of .192 cubic inch.

Fifty samples of this type cavity were tested, two of which were positive. Forty-eight of these samples were in the range of 31,000 to 40,000 psi "setback" pressure, and include the positive samples. This gives an average of approximately 4% positive samples in this range. Divided into two ranges, from 31,000 to 35,000 psi and 36,000 to 40,000 psi, the lower range (39 tests) indicates about 2% positive samples, and the upper range (nine tests) about 11% positive samples.

Table G

In this series of tests, a double cavity was introduced, one of which was at one end of the pellet and the other was located within the pellet. This is shown in Figure 10. Both cavities were 3/8-inch diameter and 1/4-inch depth. These samples were carefully oriented with respect to the test fixture so that the end-cavity was facing the firing-head, as in the other end-cavity samples. The total volume of the cavities was approximately .192 cubic inch, each cavity having an approximate volume of .096 cubic inch.

Forty-three tests were made on this type of sample, six of which were positive. These positive samples were scattered throughout the tests in such a manner, however, as to cause doubt concerning the validity of the test, or to indicate that this cavity condition was extremely sensitive for some unknown reason. Of the 43 tests, 21 were in the range of 34,000 to 42,000 psi "setback" pressure. Of these 21 tests, three were positive, indicating approximately 14% positive samples in the range. In 18 tests in the 23,000 to 30,000 psi range, however, three tests were positive, indicating approximately 17% positive samples. There is a need for verification of these results on this type of sample. It might be added here that more extrusion of the explosive than was considered normal was indicated in this series. The dimensions of the punch-and-sleeve subassemblies were checked, and found to conform within tolerances to all of those previously used. Again, no definite conclusions can be reached on these tests without additional work.

Table H

Another double-cavity condition was tested in this series. In this case, the 3/8-inch diameter by 1/4-inch depth cavities were located at either end of the sample pellet as shown in Figure 10. The volumes were those of the previous series, approximately .096 cubic inch for each cavity and approximately .192 cubic inch total.

Seventeen tests were made on this type of cavity, two of which were positive. Thirteen of these tests were made in the range of 30,000 to 35,000 psi "setback" pressure, and none were positive. This would indicate under 7% positive samples in this range. The two positive tests were obtained at 35,100 and 37,800 psi "setback" pressure. Two additional negative samples were obtained at 40,400 and 42,100 psi. These data are too few to permit conclusions to be drawn.

X-Ray Photographs

All of the sample pellets used for these tests were photographed by X-Ray before they were assembled into the test sleeves. Those pellets which contained casting flaws or foreign matter and those of imperfect form were rejected. After the tests, the negative samples were again photographed by X-Ray. Those samples which were jammed into the sleeves by the tests were photographed through the sleeves. When the punches could be easily removed, the samples were pressed out of the sleeves by a hand pellet-press. These were photographed by X-Ray.

All of the X-Ray photographs made of the samples before test are presented in Figures 15 through 21. It is doubtful whether flaws in the pellets can be shown in reproduction, since usually they were found on the original X-Ray plate only by careful examination with a radiograph illuminator in a darkened room. For the most part, very few samples were found imperfect.

Important examination of the pellets after they had been tested and removed

from the steel sleeves was made by X-Ray photograph. Figures 22 and 23 provide some information on the structure of the sample after the test. In Figure 22, a good indication of the manner in which the cavity collapsed is provided. This test was made for the purpose of checking the test fixture and instrumentation in the very early part of the investigation. The sample was a perfect Composition B pellet with a $1/4 \times 1/4$ -inch cylindrical cavity formed in one end by casting. The sample was subjected to approximately 12,000 psi "setback" pressure, far below the range used in later tests. At this pressure, the explosive began to fold into the cavity, apparently trapping a quantity of air as a bubble at the bottom of the cavity. In the case of those samples subjected to higher pressures, no indication of a bubble was found. In those samples shown in Figure 23, all of which had internal cavities, there was no evidence of air trapped within the sample pellet in the form of a bubble. A region of high-density explosive was indicated at each face of what had been a cylindrical cavity. The explosive between these faces apparently came from the cavity-forming lip of the samples.

X-Ray photographs made through the steel sleeves did not provide any evidence of the internal structure of the sample pellet, except that there were no major cavities remaining in the samples. This is more readily seen on those samples removed from the sleeves. Typical X-Ray photographs of this type are shown in Figures 24 through 27. The sleeve at the extreme right in Figure 24 contained a $3/8 \times 1/4$ -inch internal-cavity sample before testing. This was provided to enable the determination of the resolution to be expected from these photographs. The samples shown have apparent differences in pellet length. This is caused by more or less extrusion of explosive around the punches when the samples were subjected to very high and sudden pressures.

CONCLUSIONS

General

The occurrence of detonations by "setback" pressures is seen to be a statistical problem, as are all sensitivity tests. The data included in this Report indicate that samples may be expected to detonate with higher frequency at higher "setback" pressures. This is entirely reasonable and was expected. There are strong indications that samples may be expected to detonate with increasing frequency as the volume of the cavity increases. Figure 14A and Figure 14B show this graphically. The information presented in this Figure is taken from Table I, Summary of Results. Higher percentages of positive samples are obtained at a given "setback" pressure when cavities of the same volume are located internally. This is shown graphically in Figure 14A. There is insufficient evidence for drawing any conclusions from the data on the double-cavity samples tested. There is sufficient evidence in these tests, however, to indicate that there may be a different mechanism operative under double-cavity conditions.

Table A

On the basis of 30 samples, a 13% point is indicated for this condition in the pressure range of 58,000 to 63,000 psi "setback" pressure. If normal logarithmic distribution is assumed in sensitivity experiments¹, and if the slope of the curve is taken from the fairly well established points in Table C, the indications are that 50% of the samples might be expected to detonate at about 70,000 psi "setback" pressure. There is no iron-clad reason for assuming these slopes to be similar, but such an assumption may be made from the similarity of the tests for each condition. This is done for the purpose of directing future experiments.

Table B

On the basis of 31 samples in the pressure range of 52,000-57,000 psi "setback" pressure, a 19% point was indicated. Making the same assumptions as for Table A, a 50% point is indicated at approximately 65,000 psi.

Table C

More tests were made under this cavity condition than any other. Twenty-seven samples tested in the range of 43,000-49,000 psi "setback" pressure indicate a statistical average of 15% positive tests. Ninety-nine samples tested in the range of 35,000-40,000 psi "setback" pressure indicate a 1% point. With these two points, a slope is estimated, again assuming logarithmic distribution to be normal. Extending the curve to the 50% point shows that half of these samples would detonate near 55,000 psi "setback" pressure.

Table D

Twenty-four samples tested in the range of 46,000-51,000 psi indicate a statistical average at less than 4%. None of these samples detonated. In the same manner, the 50% point is indicated at less than 65,000 psi "setback" pressure.

Table E

Forty-four samples were tested in the range of 34,000-40,000 psi "setback" pressure, none of which detonated. Assuming a statistical average at less than 2% for this condition, a 50% point is extrapolated to be near 50,000 psi "setback" pressure.

Table F

A total of 48 samples tested between 31,000 and 40,000 psi "setback" pressure

¹ Statistical Analysis for a New Procedure in Sensitivity Experiments, NDRC, AMP Report No. 101.1R, SRG-P No. 40 - July 1944.

gives a statistical average of 4% positive samples. If this range is broken down further, 39 samples tested between 31,000 and 35,000 psi "setback" pressure indicate 2% positive samples. Nine samples between 36,000 and 40,000 psi "setback" pressure indicate 11% positive samples. Using these two points, another curve is shown in Figure 14B. The slope of this curve approximates that found in Table C. Extrapolating this curve, as before, the 50% point is found near 55,000 psi "setback" pressure.

Table G

Table G contains information obtained to date on the double-cavity series of samples with one cavity internal and the other at one end of the sample. The necessity for additional work is indicated by the results. A higher percentage of positive samples was obtained at a lower pressure. This is shown in Table I, where 21 samples in the range of 34,000-42,000 psi "setback" pressure give an average of 14% positive tests, while 17% positive tests are indicated in the lower range of 23,000-30,000 psi "setback" pressure.

Table H

An insufficient number of samples has been tested under this cavity condition to provide even the most general conclusions. Briefly, these indicated "50% points" may be arranged in the following order:

.049	cubic inch	"end cavity"	70,000 psi
.049	cubic inch	"internal cavity"	65,000 psi
.096	cubic inch	"end cavity"	65,000 psi
.096	cubic inch	"internal cavity"	55,000 psi
.144	cubic inch	"internal cavity"	50,000 psi
.192	cubic inch	"internal cavity"	55,000 psi

FUTURE WORK

Although a considerable number of tests has been made on Composition B in these experiments and those completed at Picatinny Arsenal, it is believed that many more are necessary for adequate information on the effect of cavitation in Composition B. The series described in this Report have tended to seek those "setback-pressure" levels at which very low percentages of detonation will be found. From statistical considerations, many more tests must be performed to establish a respectable level of confidence for any one of the eight separate cavity conditions presented here. It is believed that a complete survey of any one of the eight conditions, including information on both sides of the statistical "50% point", would be of great assistance in designing future experiments of this type on all of the principal explosives. This work must necessarily be conducted with flawless samples as well as with those containing cavities, various grits, desensitizers, etc. It would be expected that distinctly different effects on sensitivity under each of these conditions would be revealed.

ACKNOWLEDGMENT

We should particularly like to acknowledge the sponsorship provided for this effort by Picatinny Arsenal. The personal direction and assistance of Mr. Louis Jablansky, of the High Explosives Section, were especially helpful, and we are very grateful.

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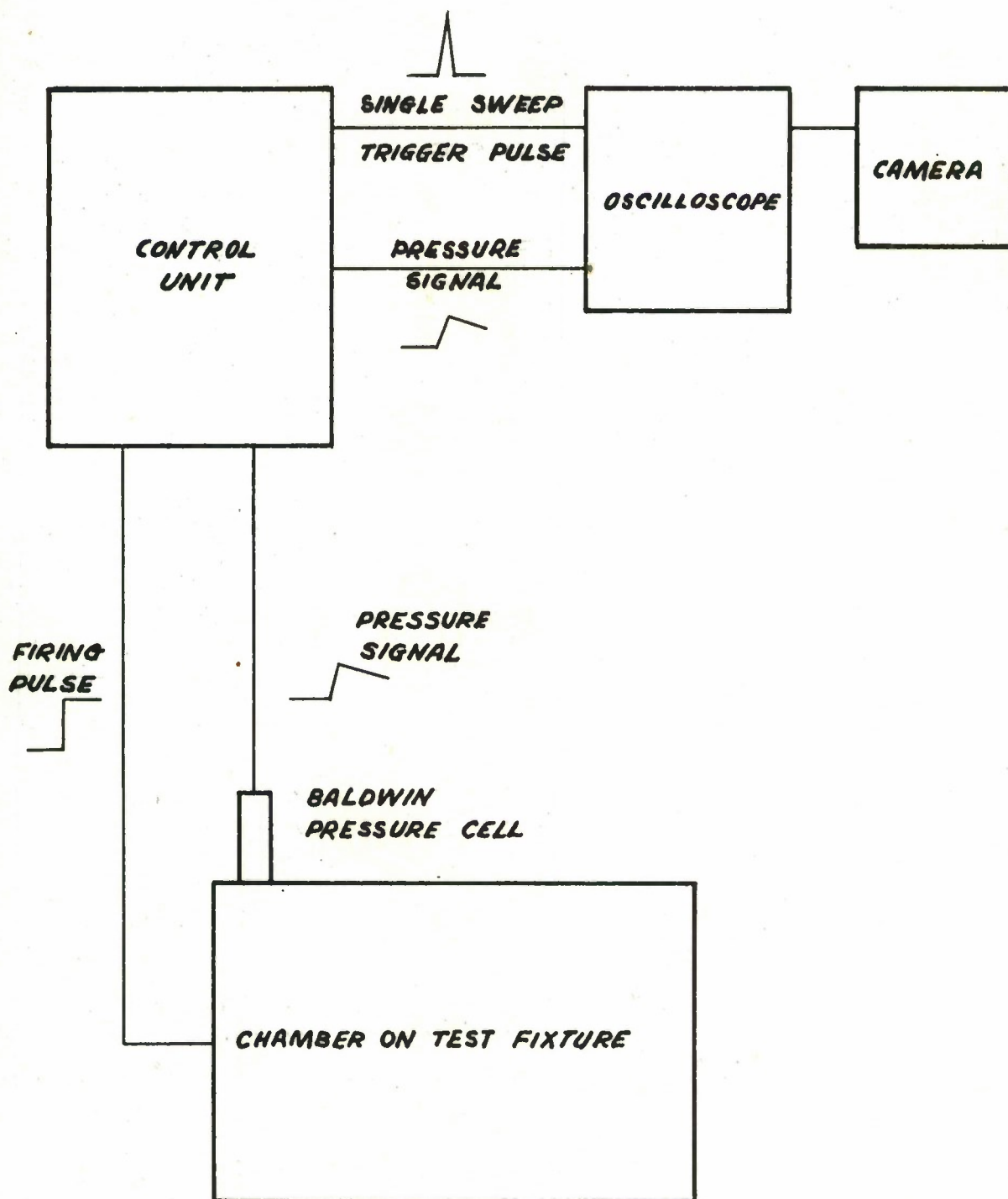
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FIGURE 1. SETBACK SENSITIVITY APPARATUS
BLOCK DIAGRAM



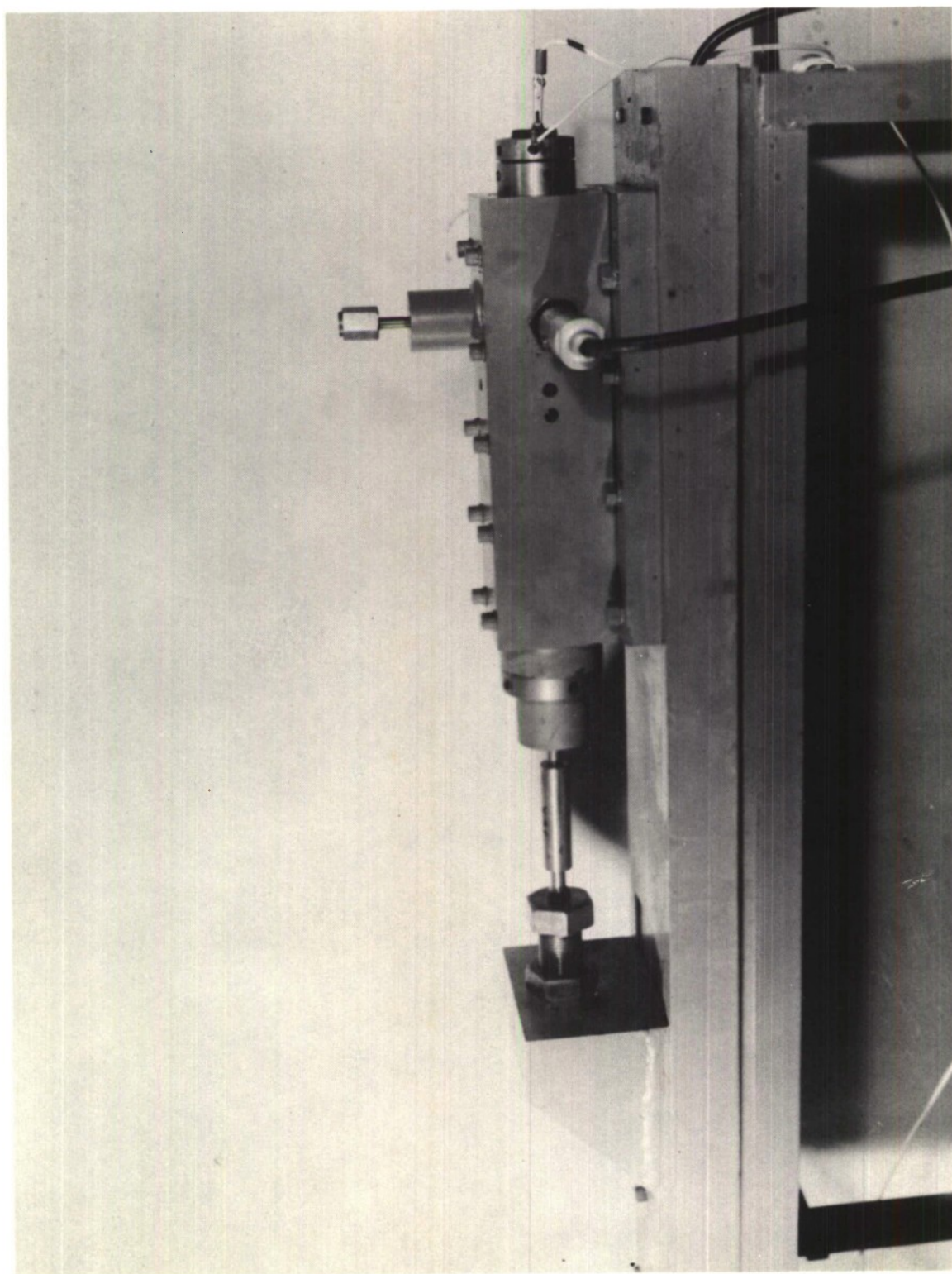
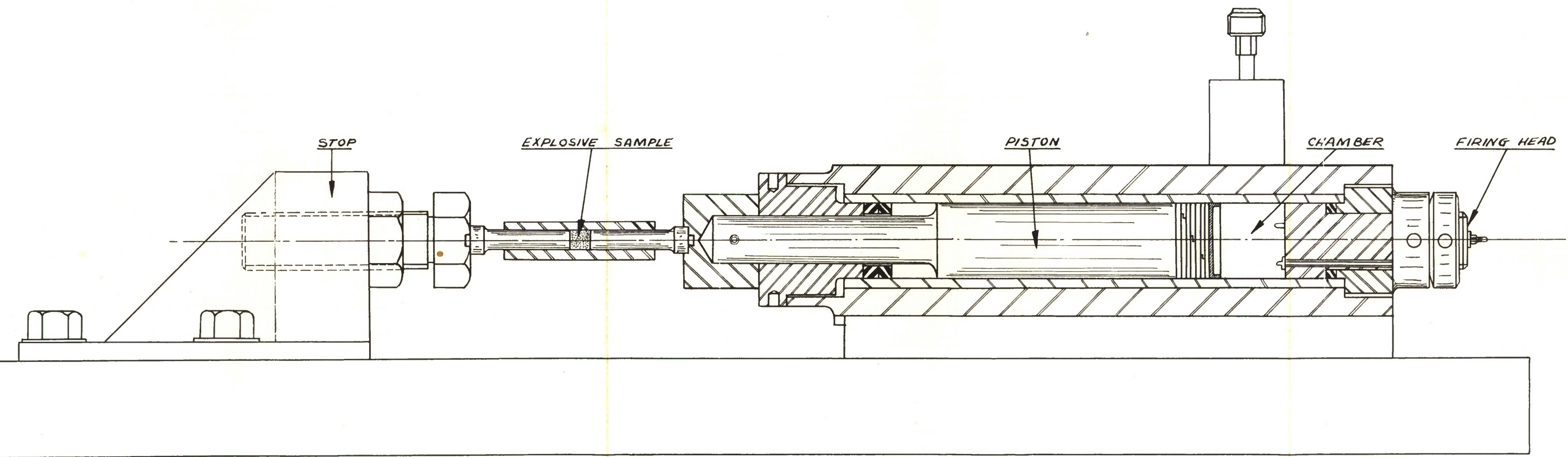


Figure 2. Setback Sensitivity Test Fixture

FIGURE 3. SETBACK SENSITIVITY
TEST FIXTURE
CROSS SECTION



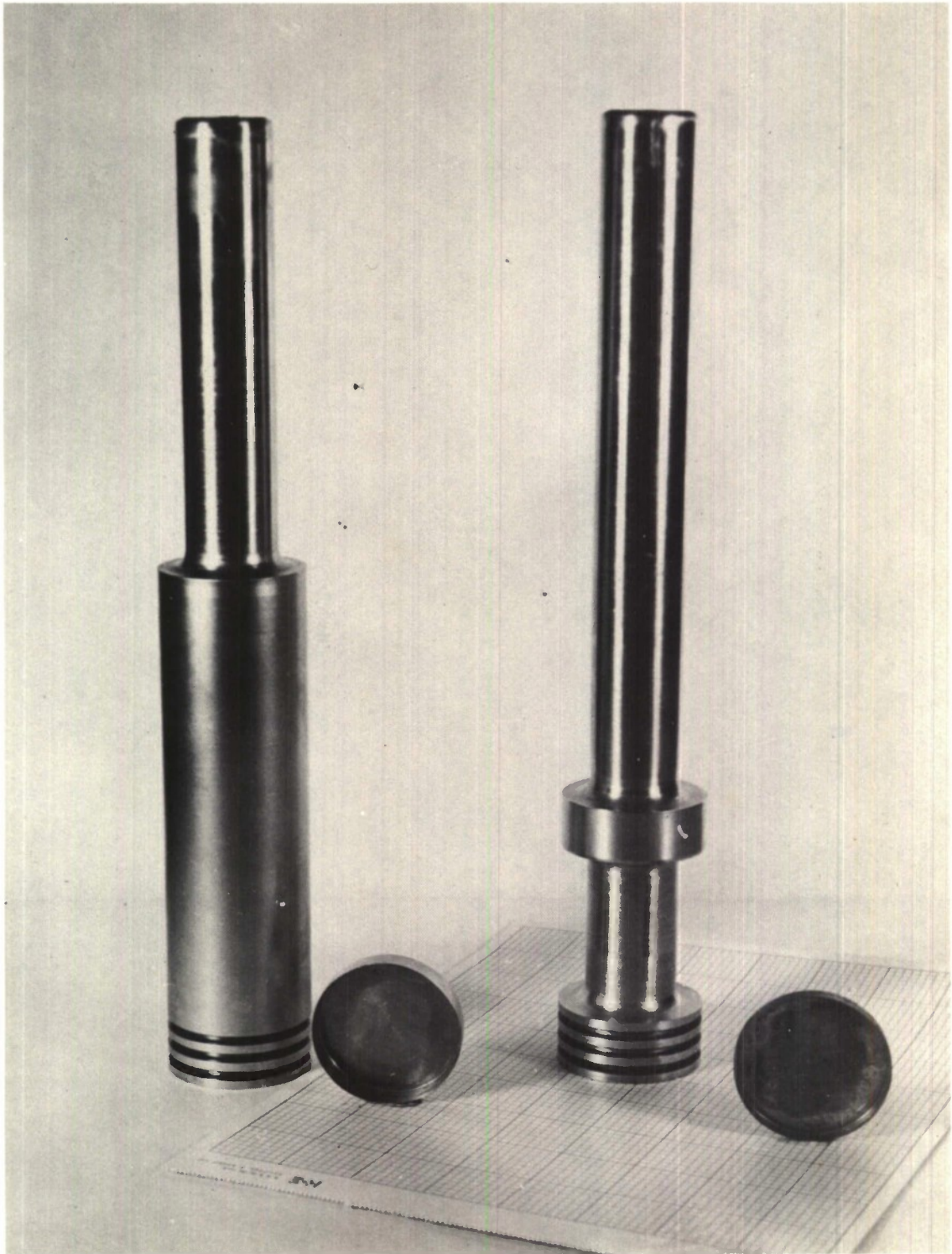


Figure 4. Piston Modification

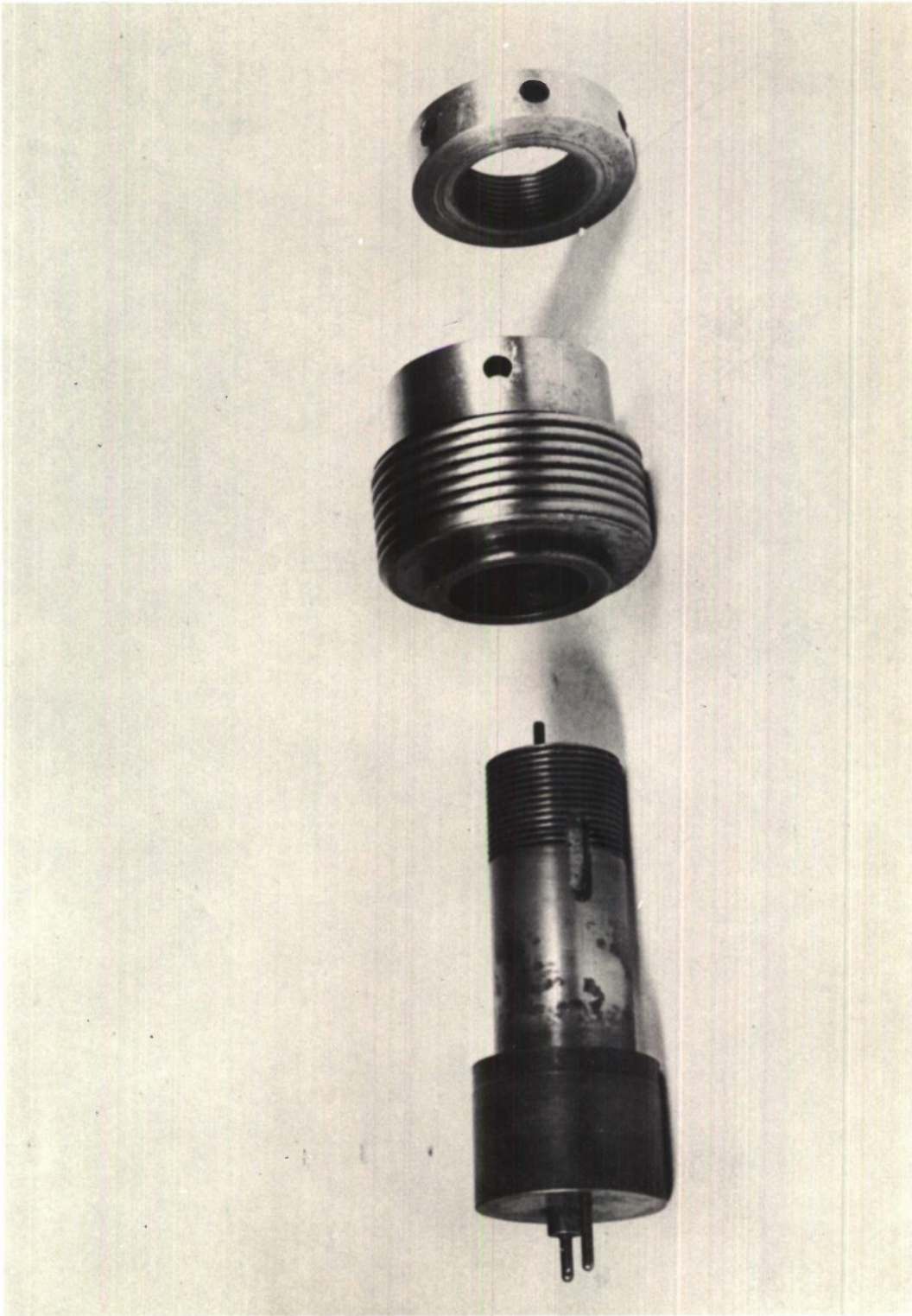


Figure 5. Firing-Head Subassembly



Figure 6. Pressure Cell, Baldwin SR-4-HF5000

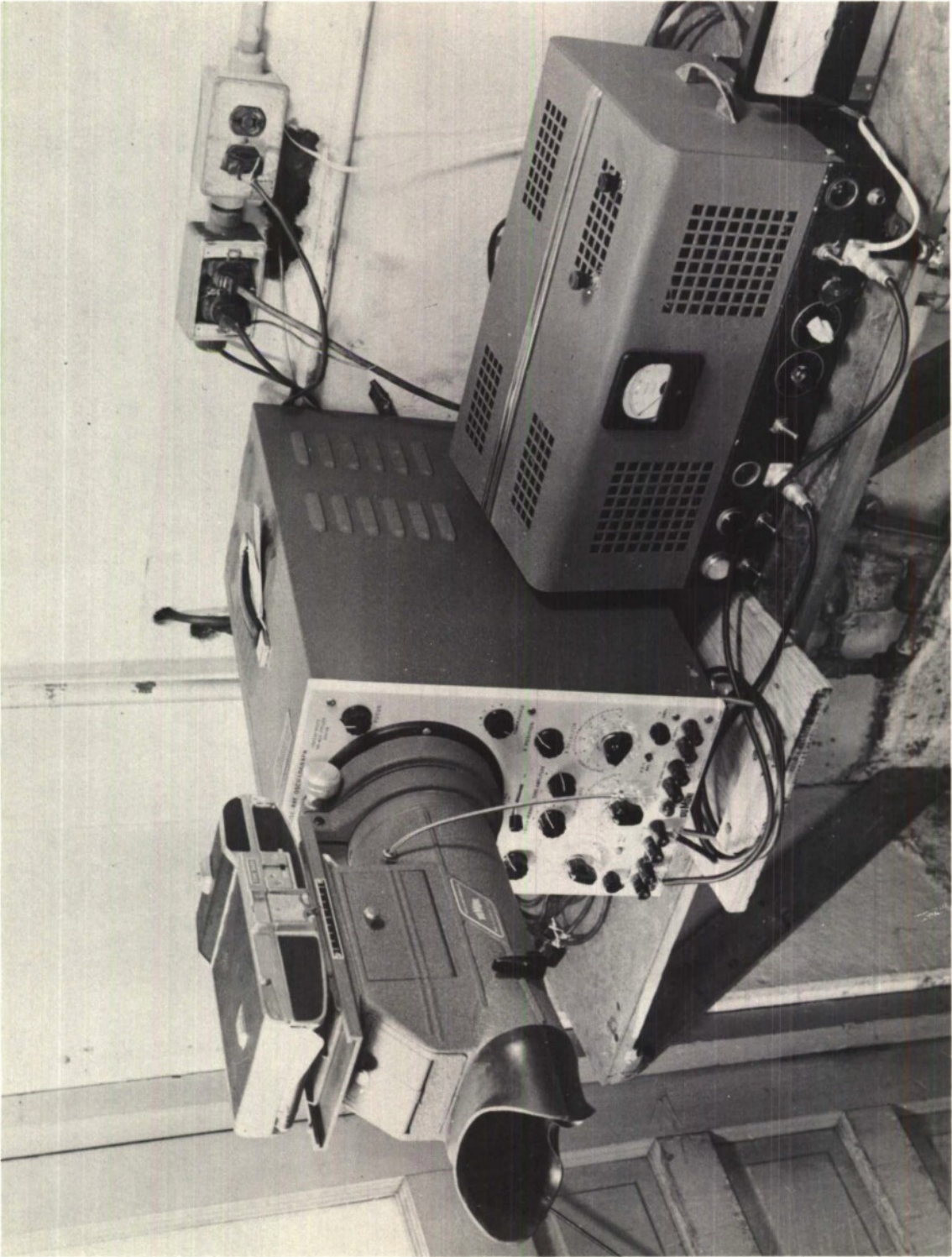


Figure 7. Oscilloscope and Control Unit

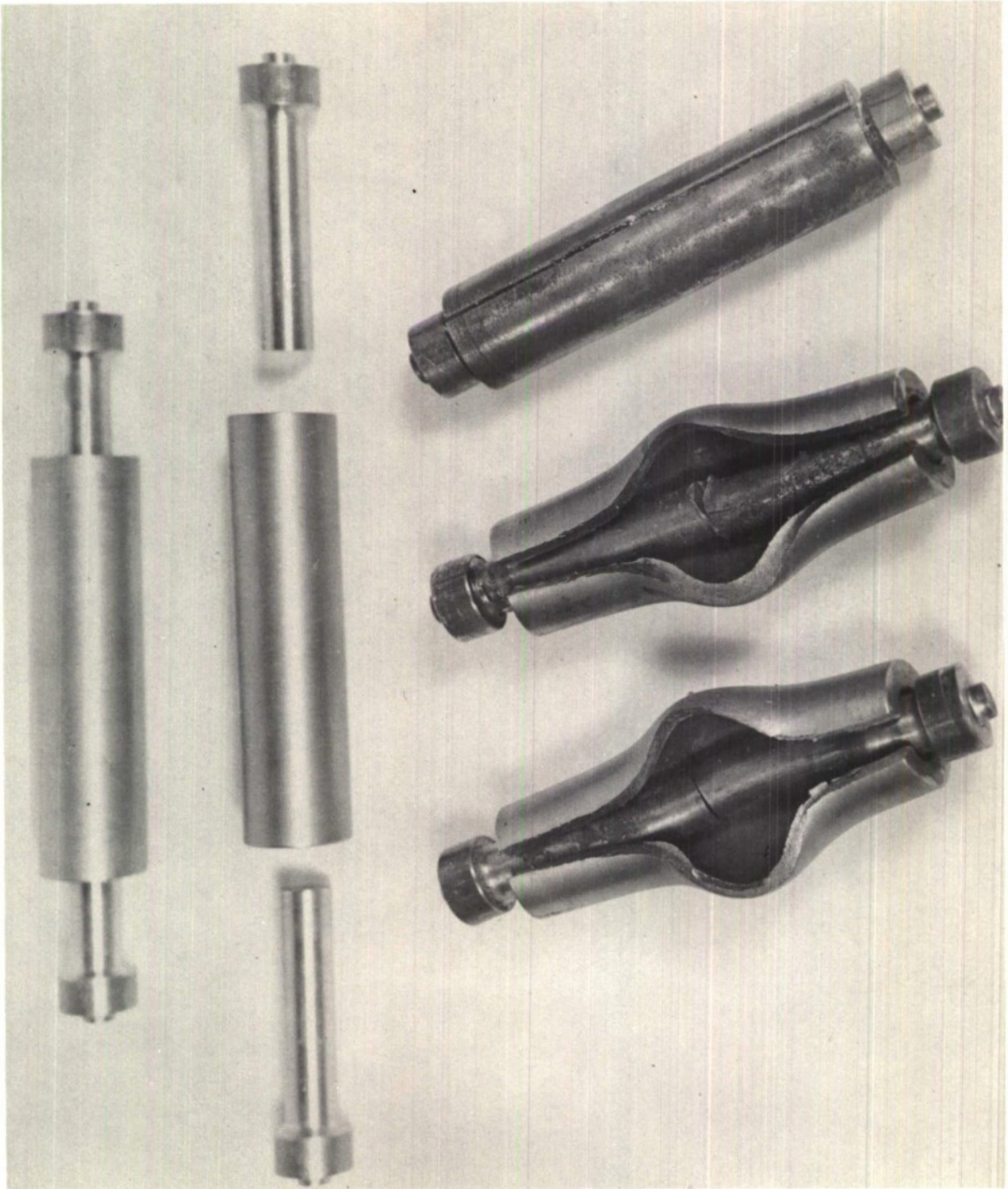


Figure 8. Punch and Sleeve Subassemblies

FIGURE 9. PRESSURE CELL CIRCUIT - SCHEMATIC
DIAGRAM

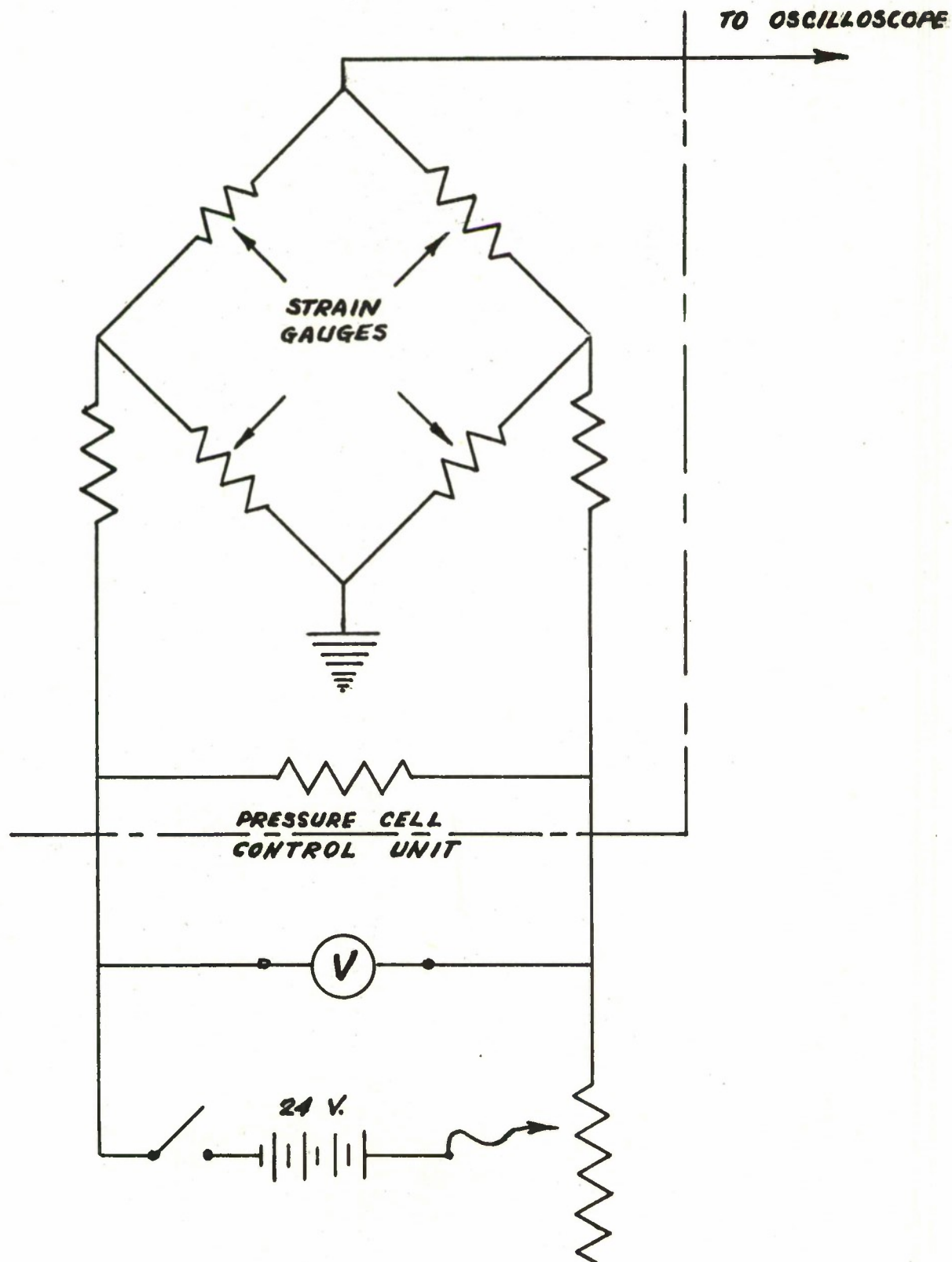
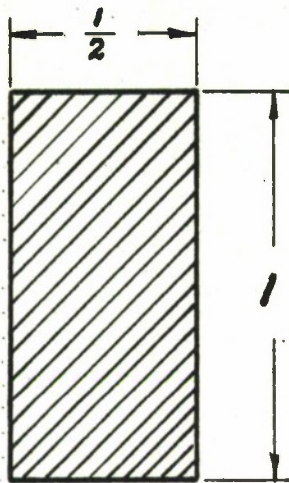


FIGURE 10. PELLET PROFILES - CROSS SECTION



**BASIC
PELLET**

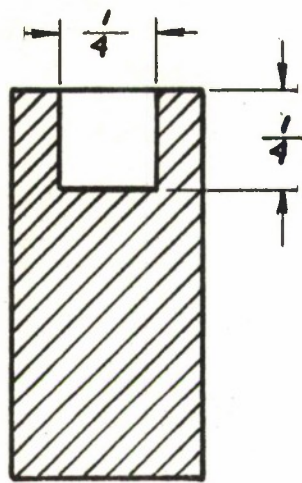


TABLE A

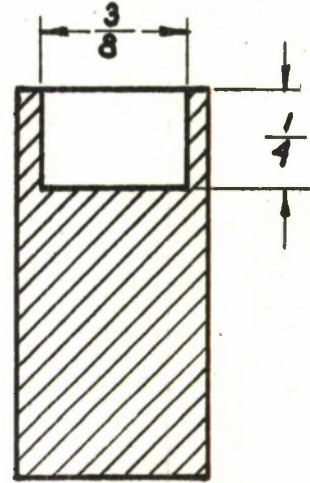


TABLE B

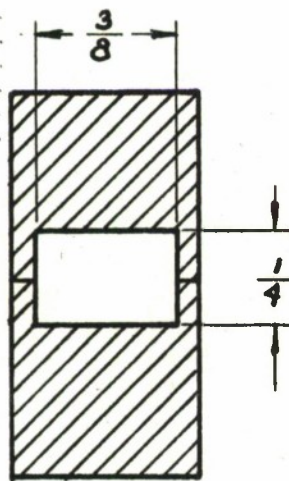


TABLE C

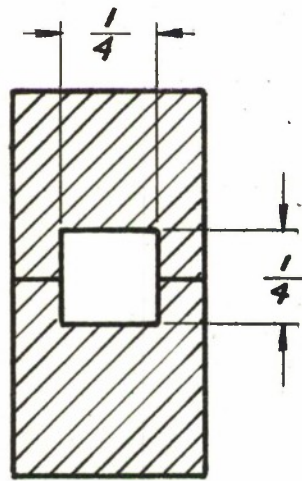


TABLE D

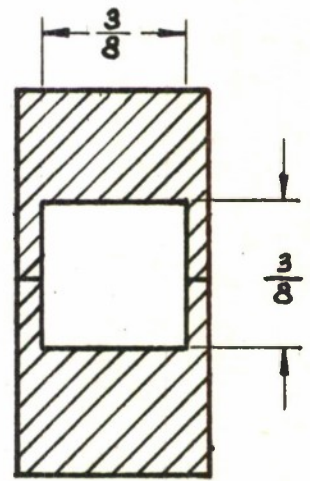


TABLE E

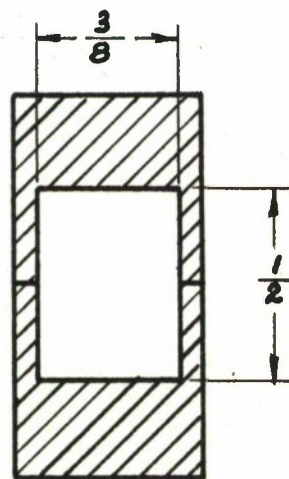


TABLE F

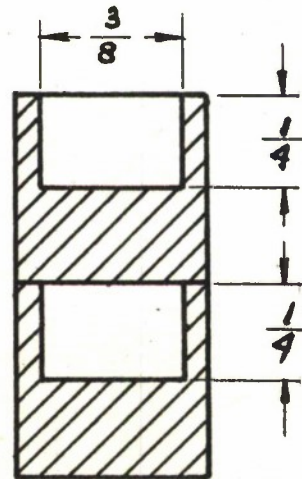


TABLE G

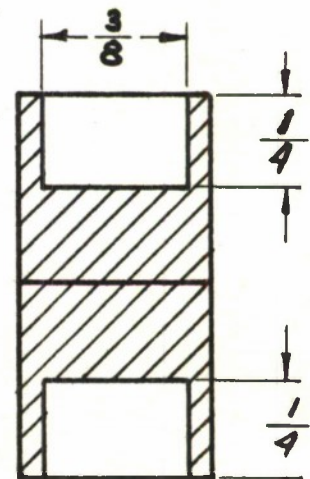


TABLE H

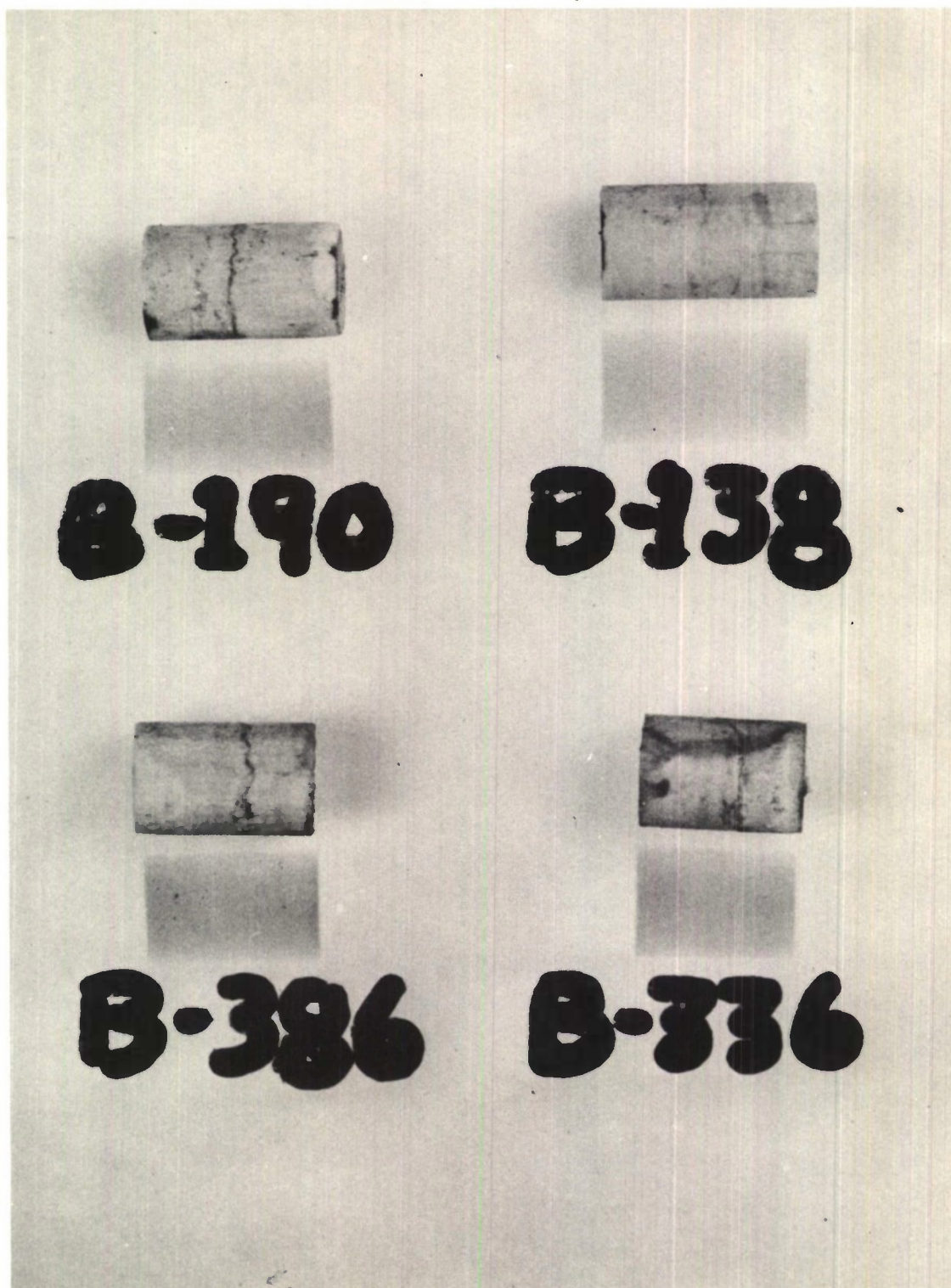


Figure 11. Negative Samples Recovered

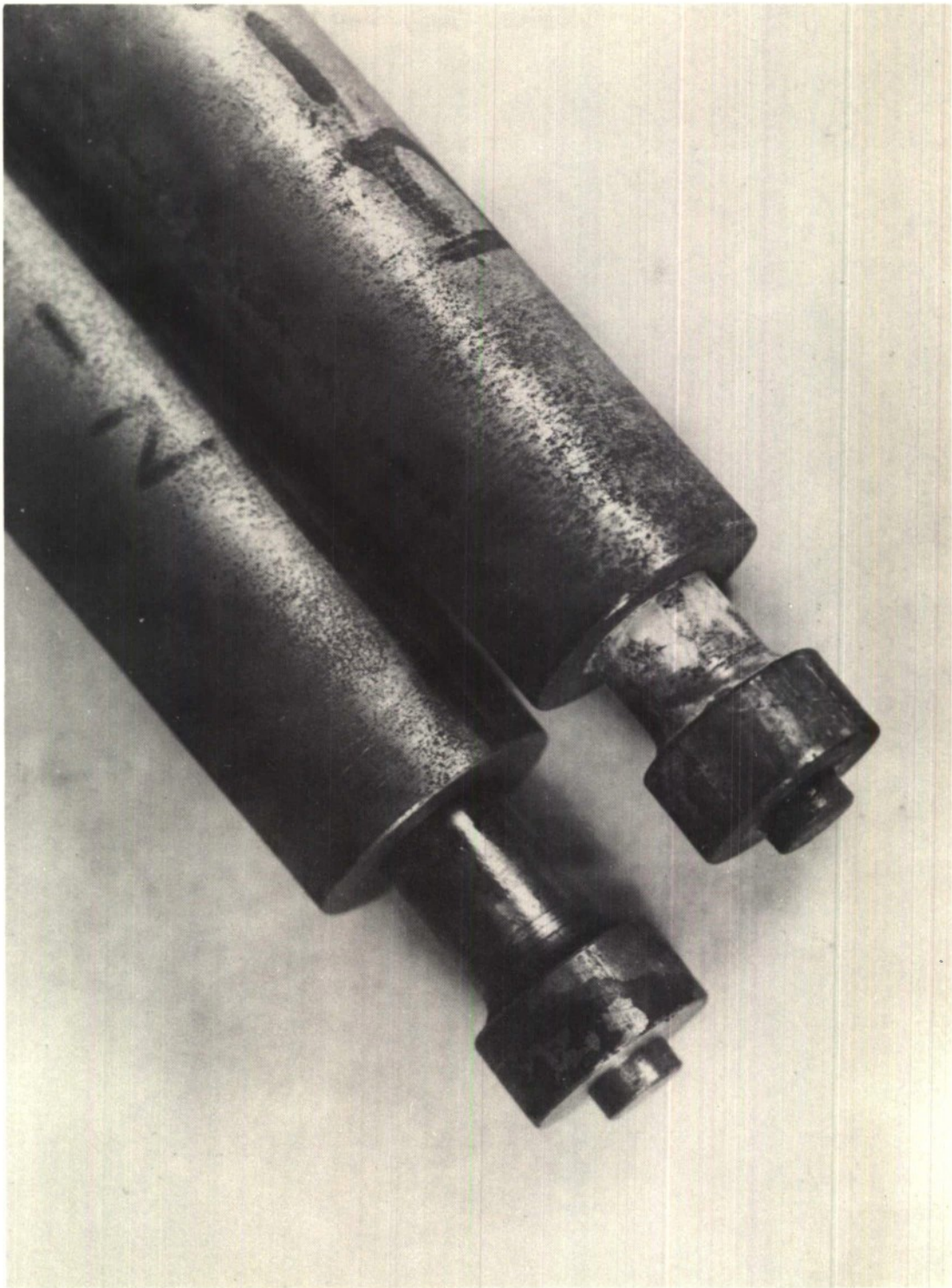
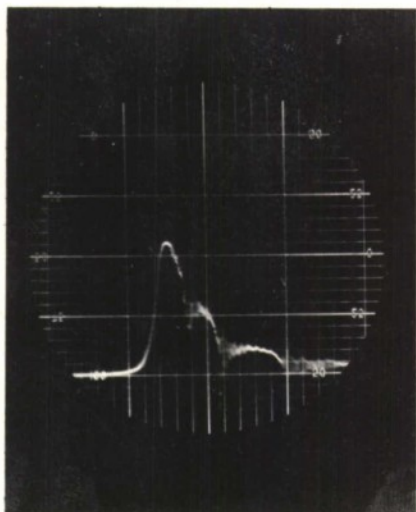


Figure 12. Negative Samples Showing Extrusion and Burning



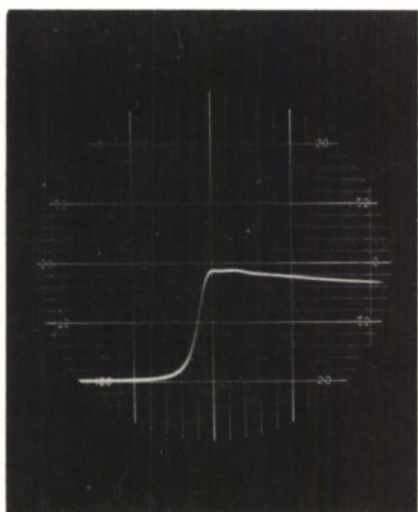
B-396 POSITIVE

Setback Pressure: 37800 psi

Sweep Rate: 10 milliseconds per
major grid

Gain: 10 millivolts per
major grid

(1 mv = 1712 psi)



B-403 NEGATIVE

Setback Pressure: 31200 psi

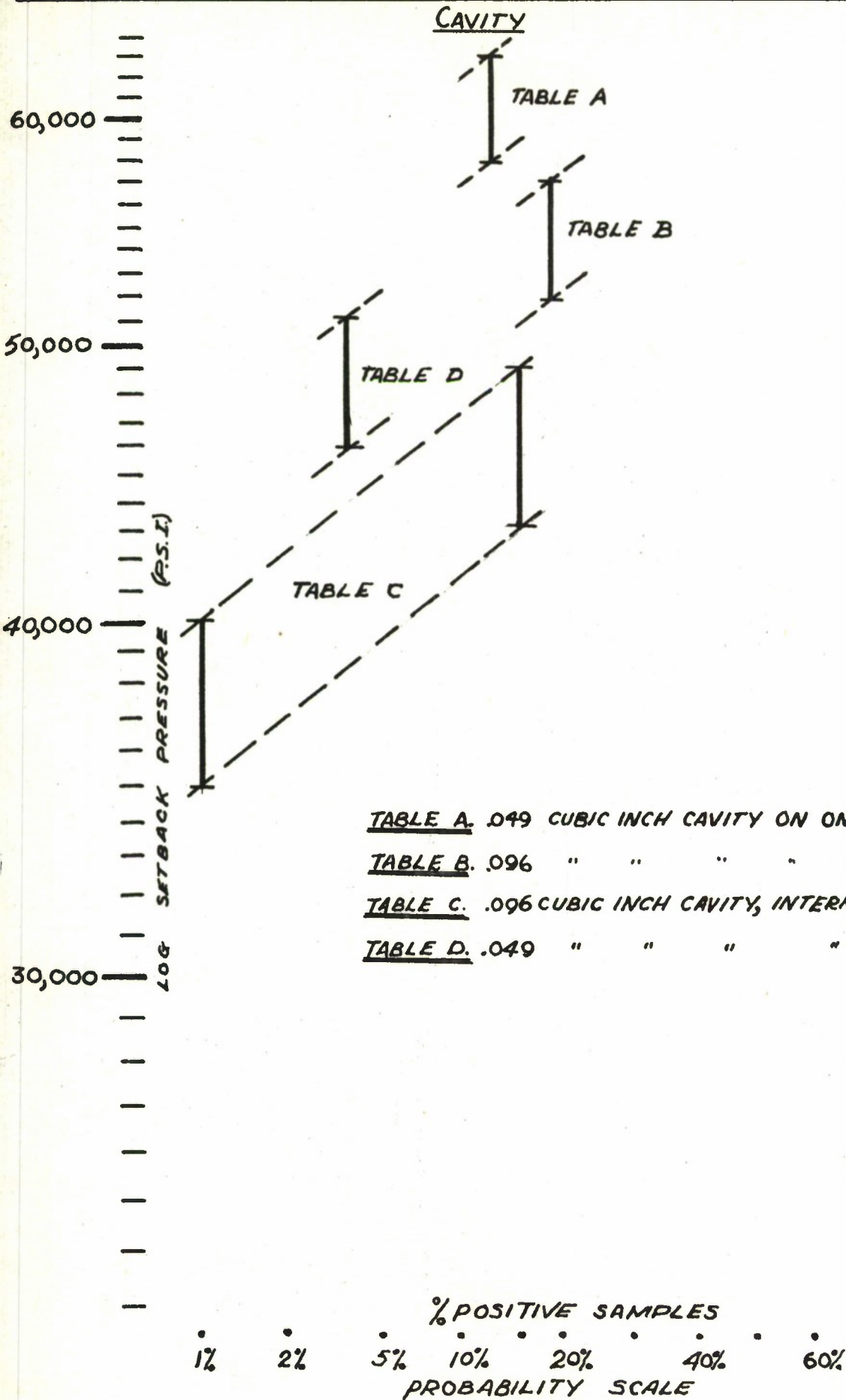
Sweep Rate: 10 milliseconds per
major grid

Gain: 10 millivolts per
major grid

(1 mv = 1712 psi)

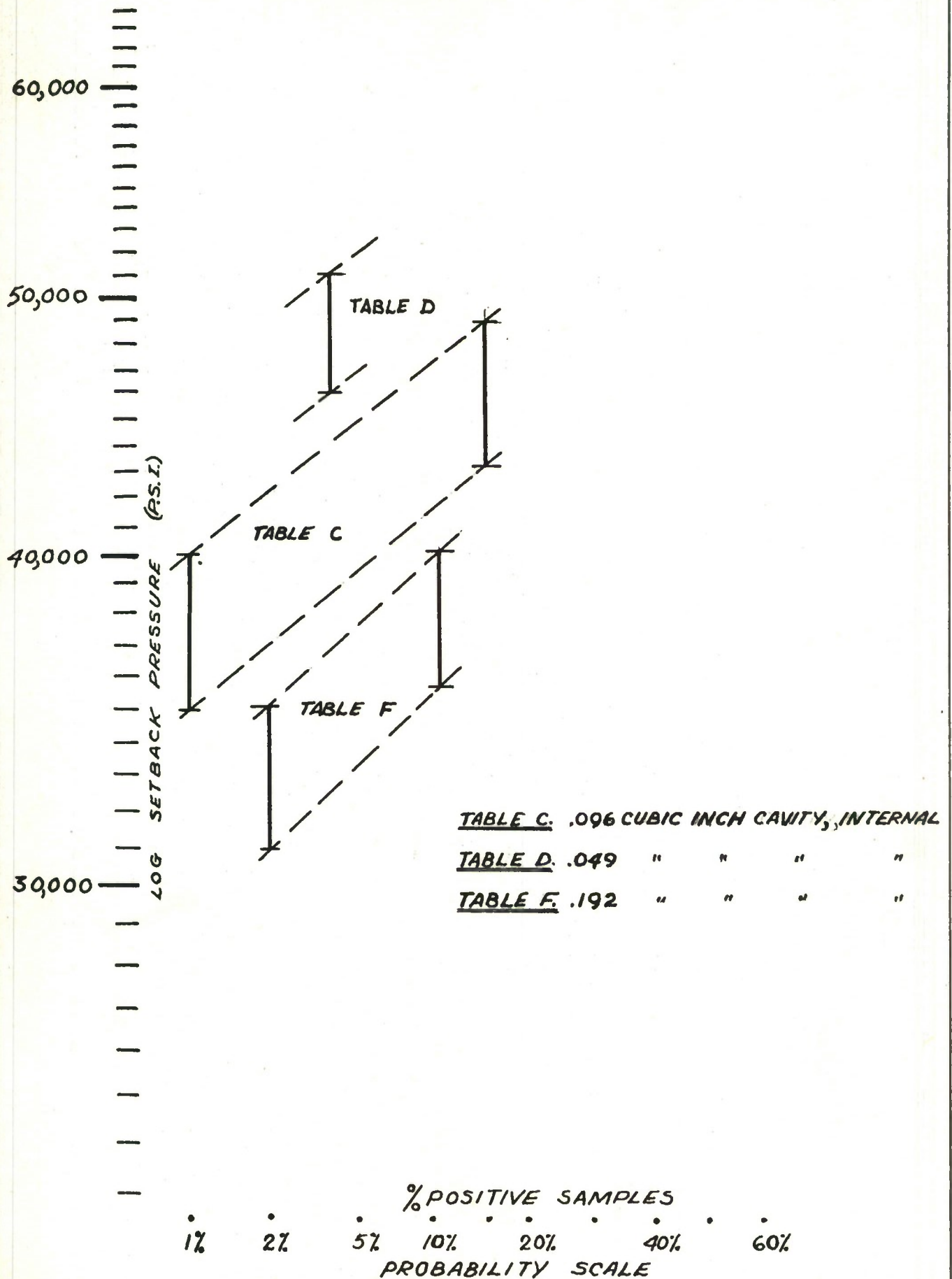
Figure 13. Typical Oscillograms

FIGURE 14A GRAPHIC SUMMARY OF EFFECT OF LOCATION AND VOLUME OF



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FIGURE 14B GRAPHIC SUMMARY OF EFFECT OF VOLUME OF INTERNAL CAVITY

~~CONFIDENTIAL~~

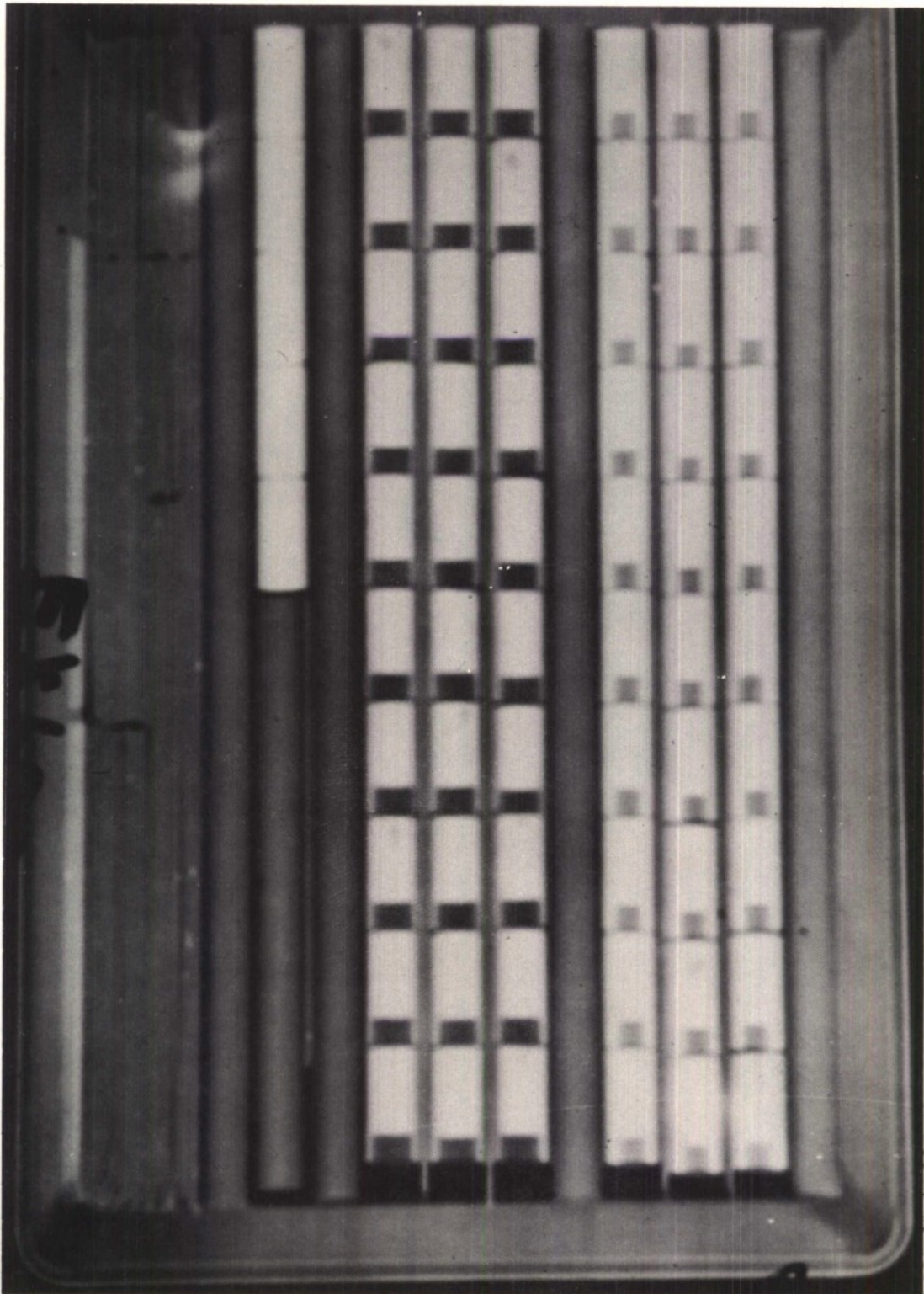


Figure 15. X-Ray Photograph. Exposure A

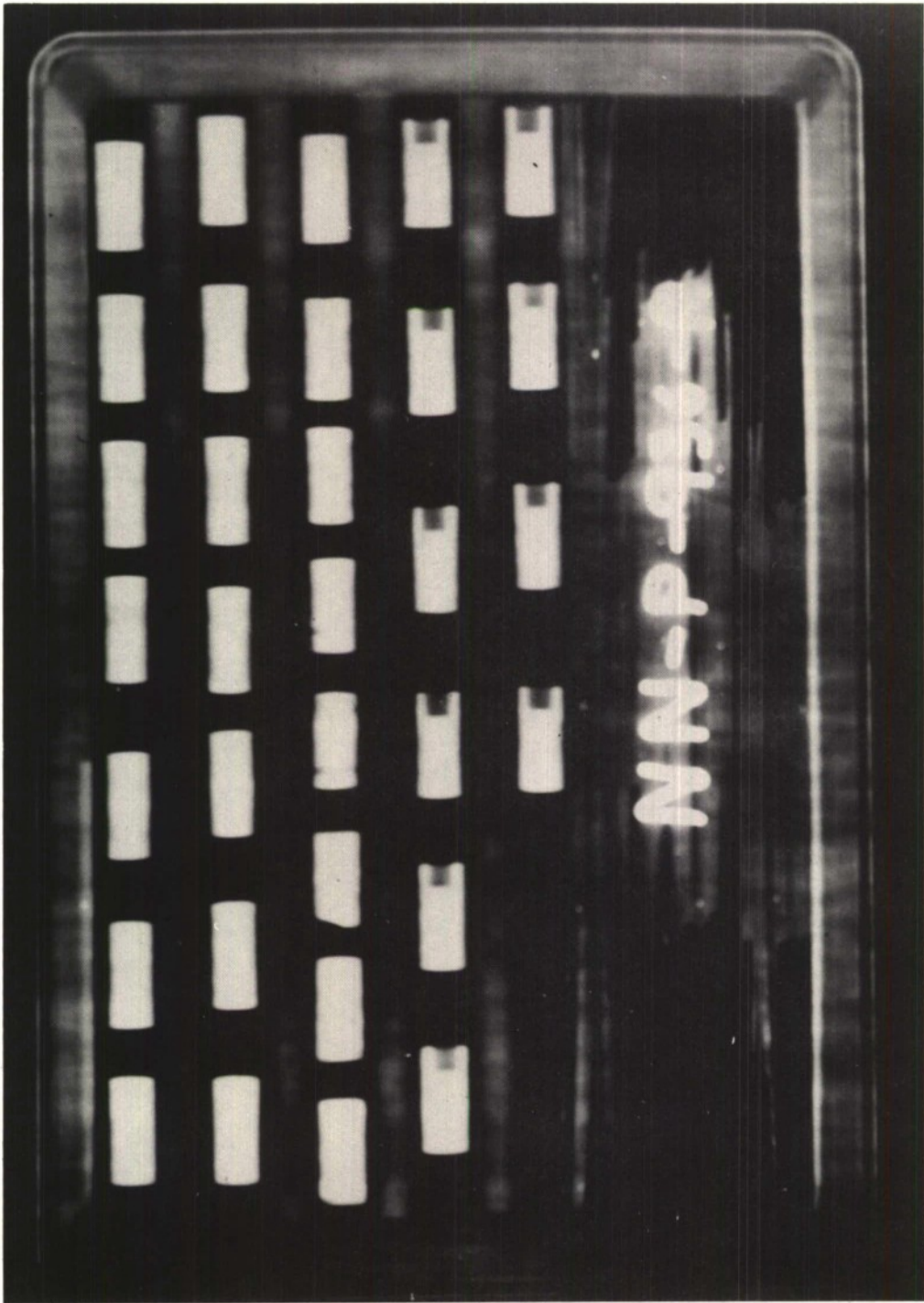


Figure 16. X-Ray Photograph. Exposure B

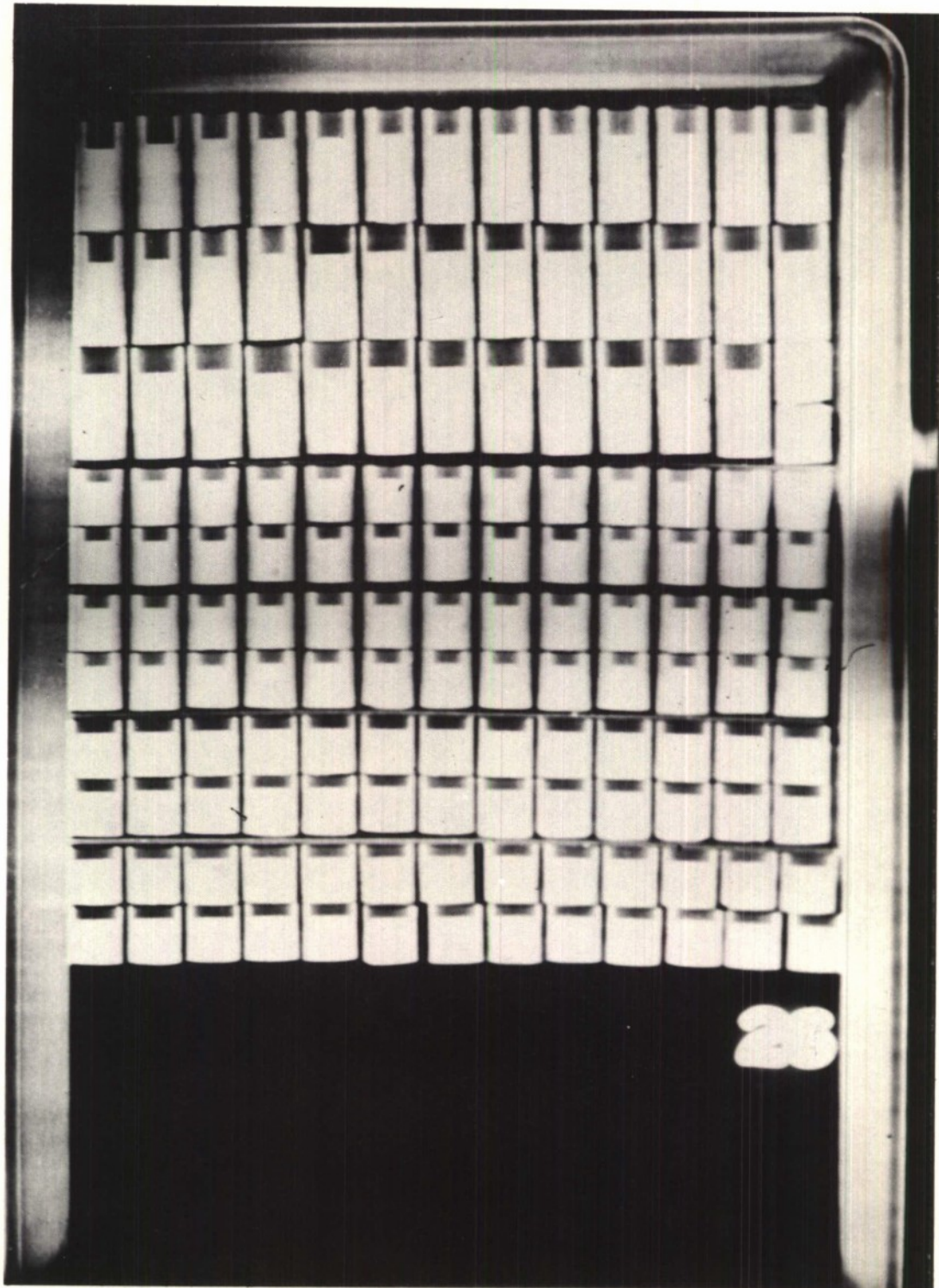


Figure 17. X-Ray Photograph. Exposure C

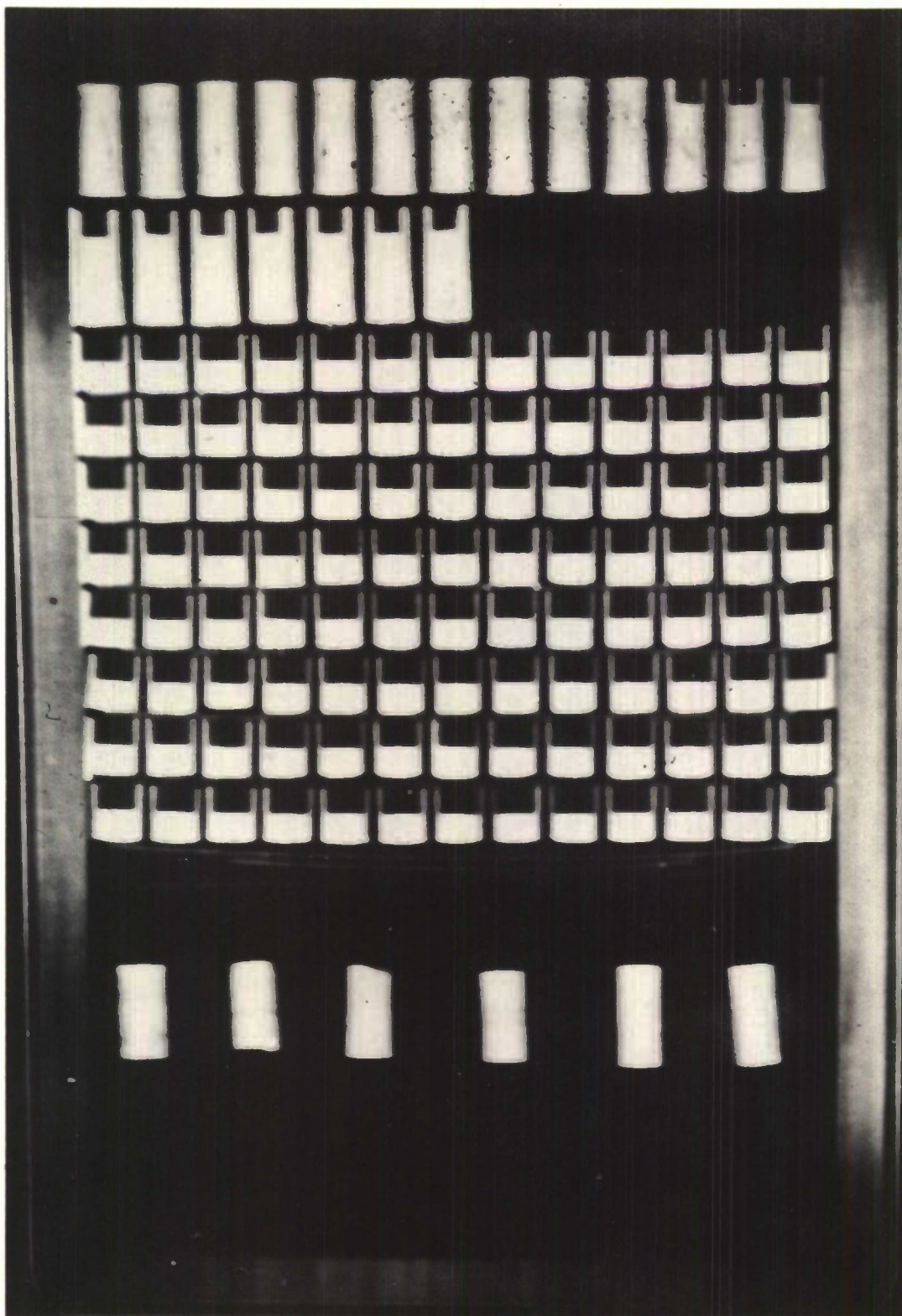


Figure 18. X-Ray Photograph. Exposure D

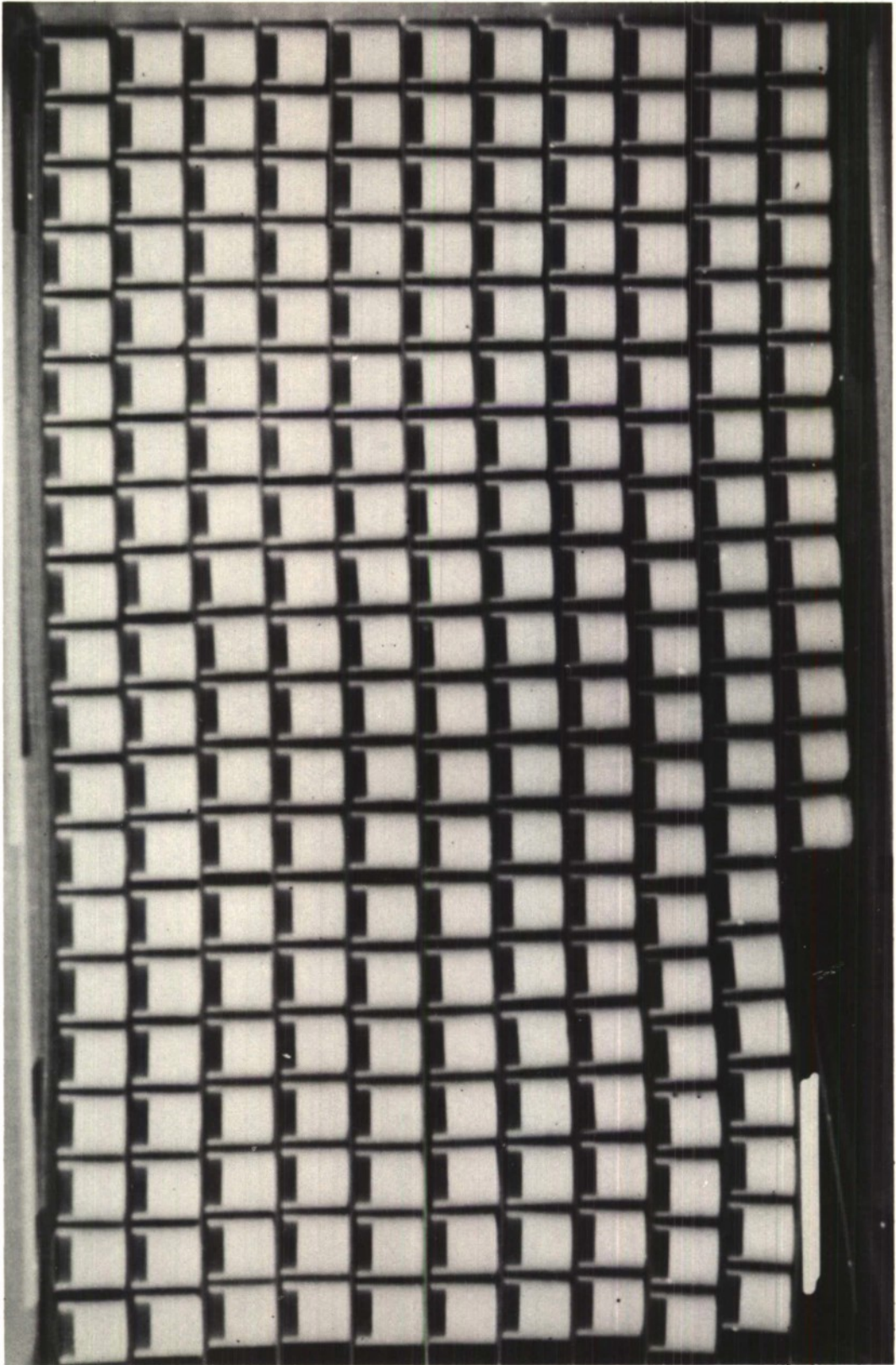


Figure 19. X-Ray Photograph. Exposure E

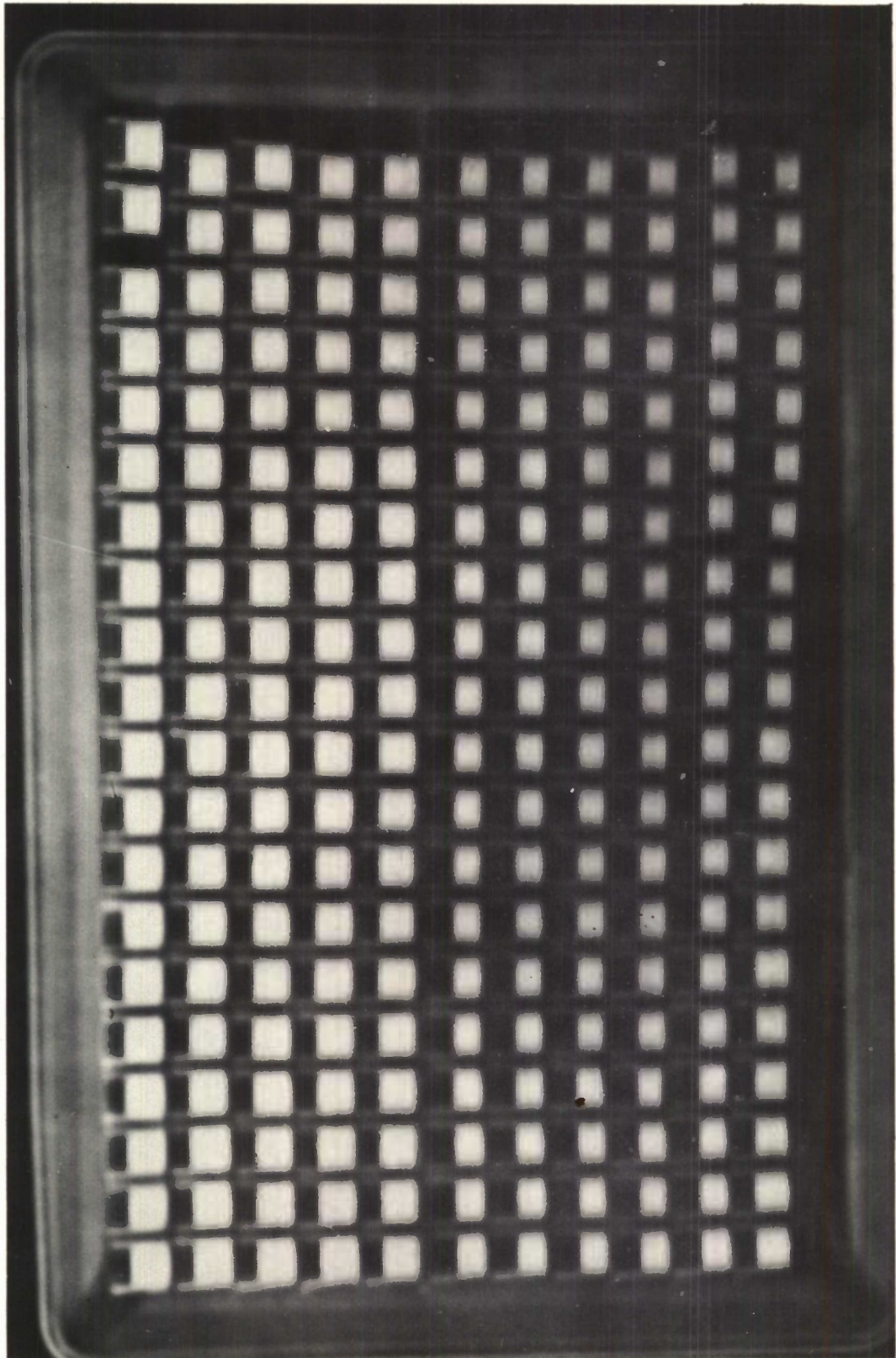


Figure 20. X-Ray Photograph. Exposure F

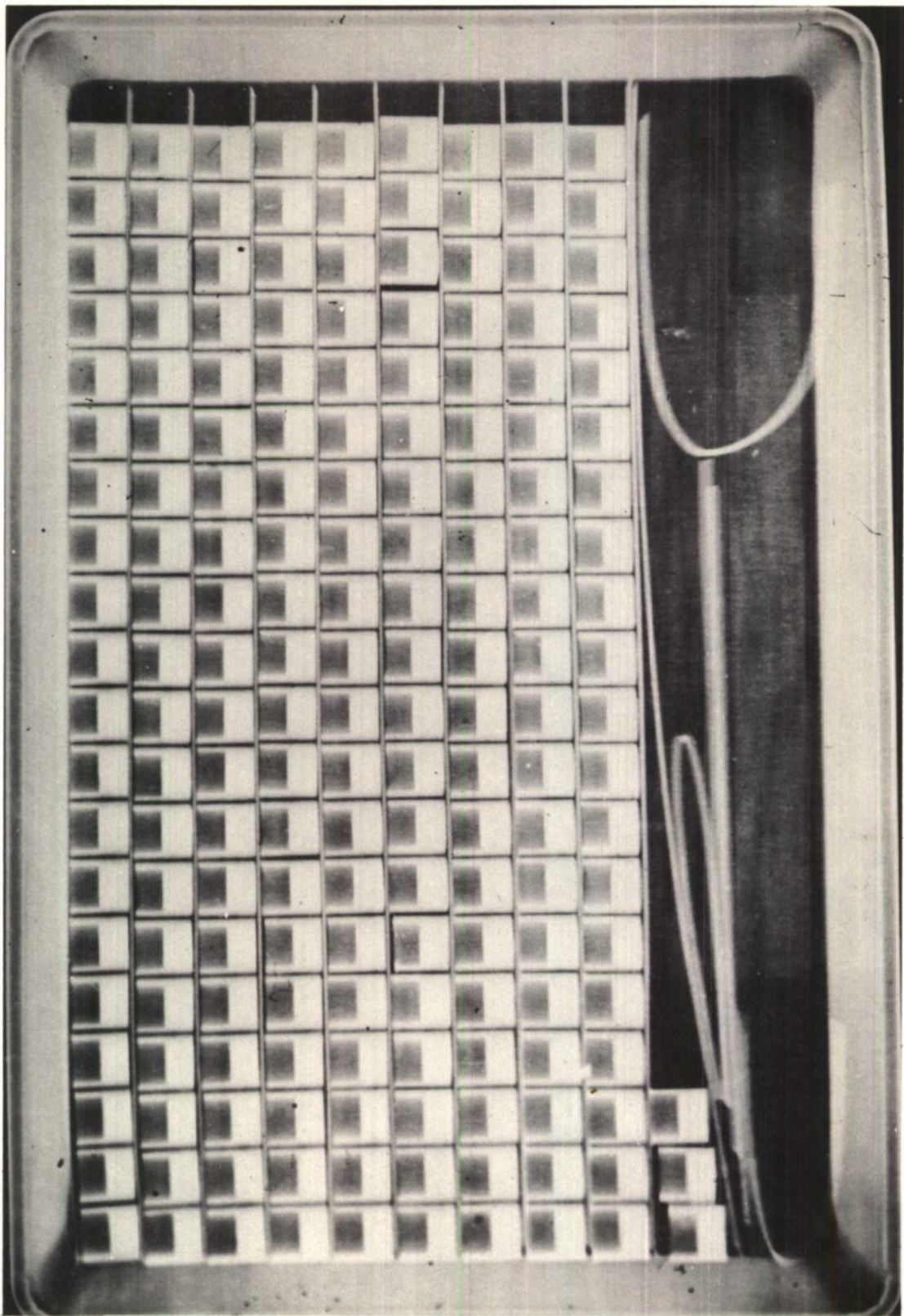


Figure 21. X-Ray Photograph. Exposure G

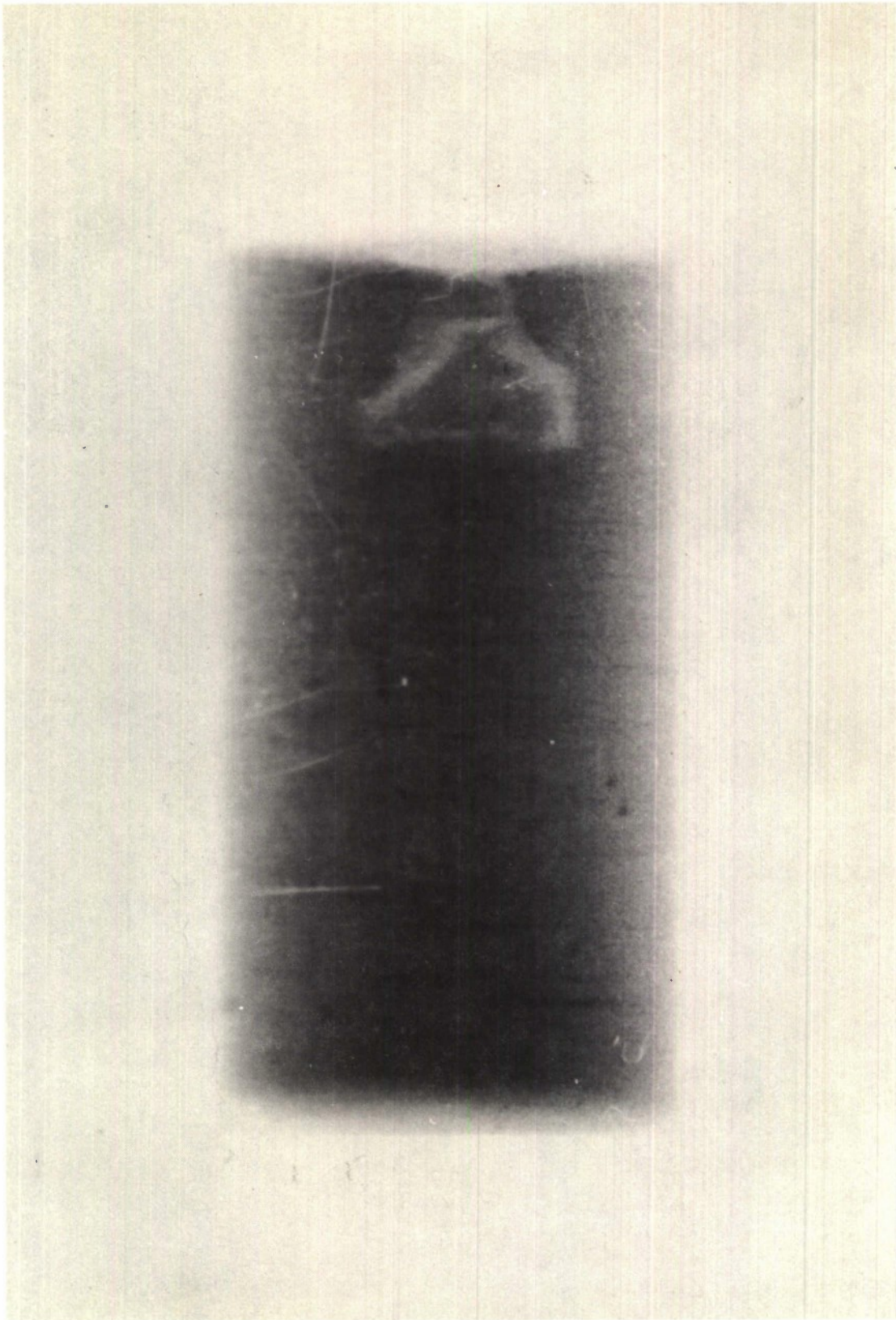


Figure 22. X-Ray Photograph Showing Partial
Collapse of Cavity. Magnification 5.5X

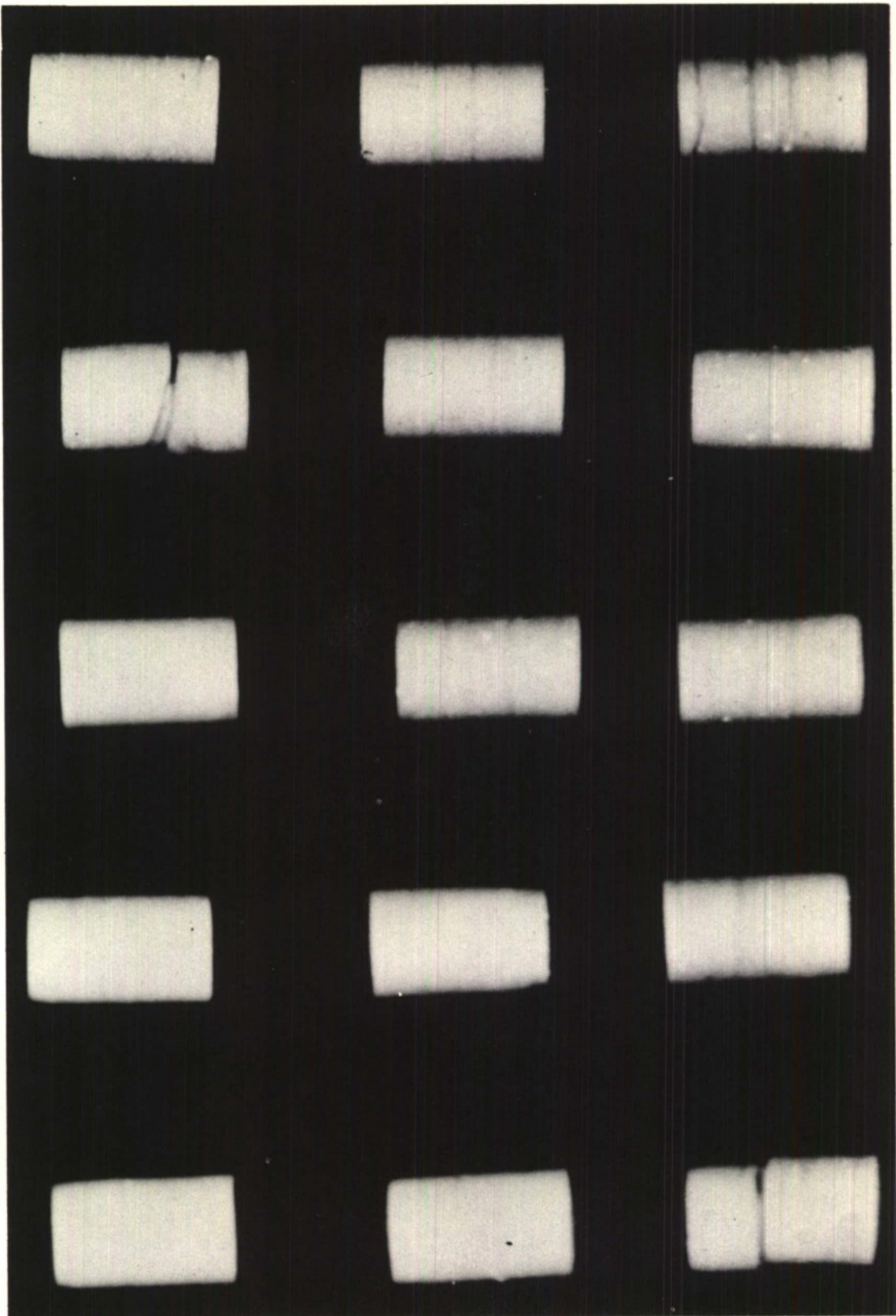


Figure 23. X-Ray Photograph of Samples Removed from
Sleeves. Approximately Normal Size

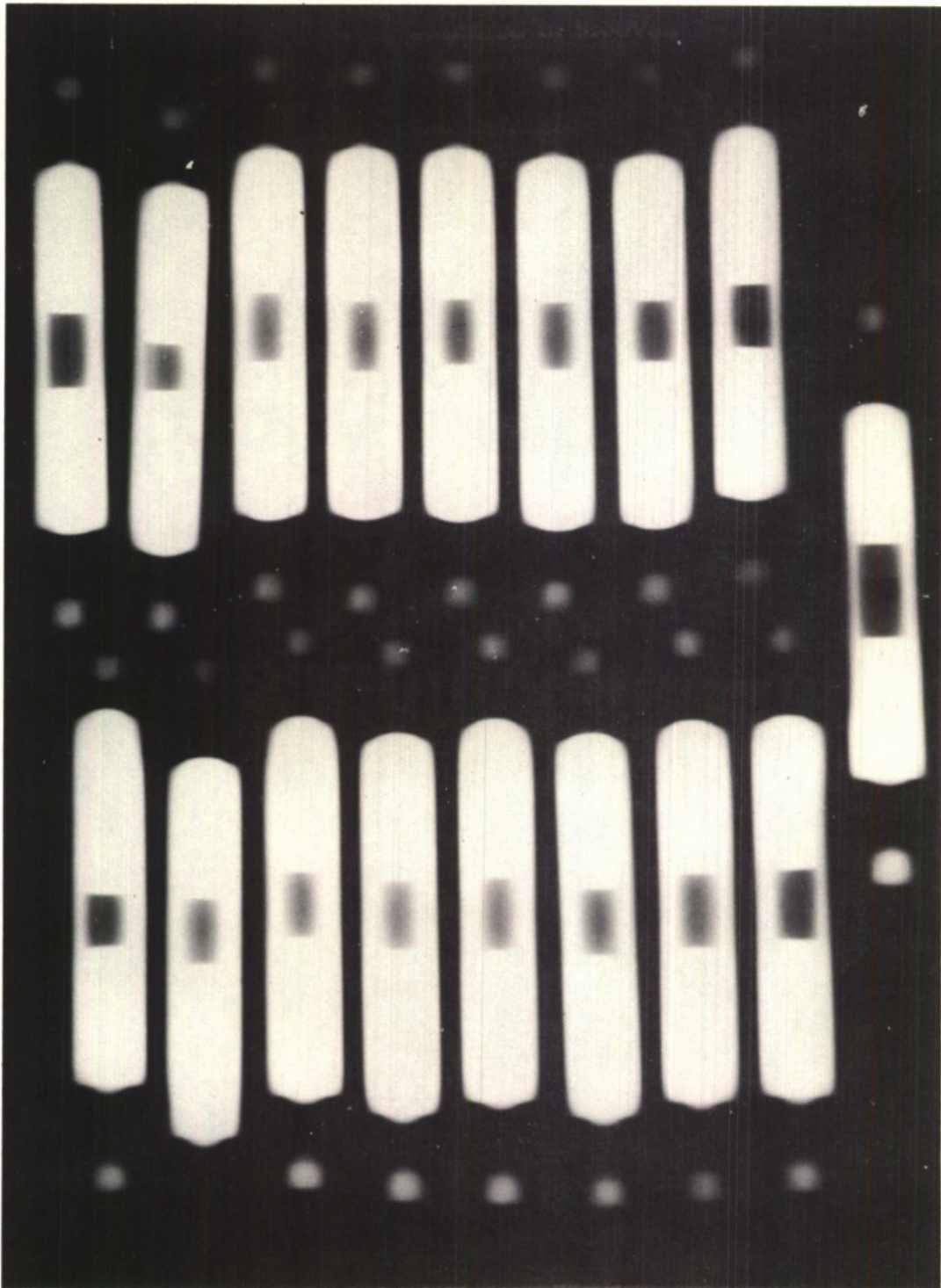


Figure 24. X-Ray Photograph of Typical Negative Samples
Jammed in Sleeves

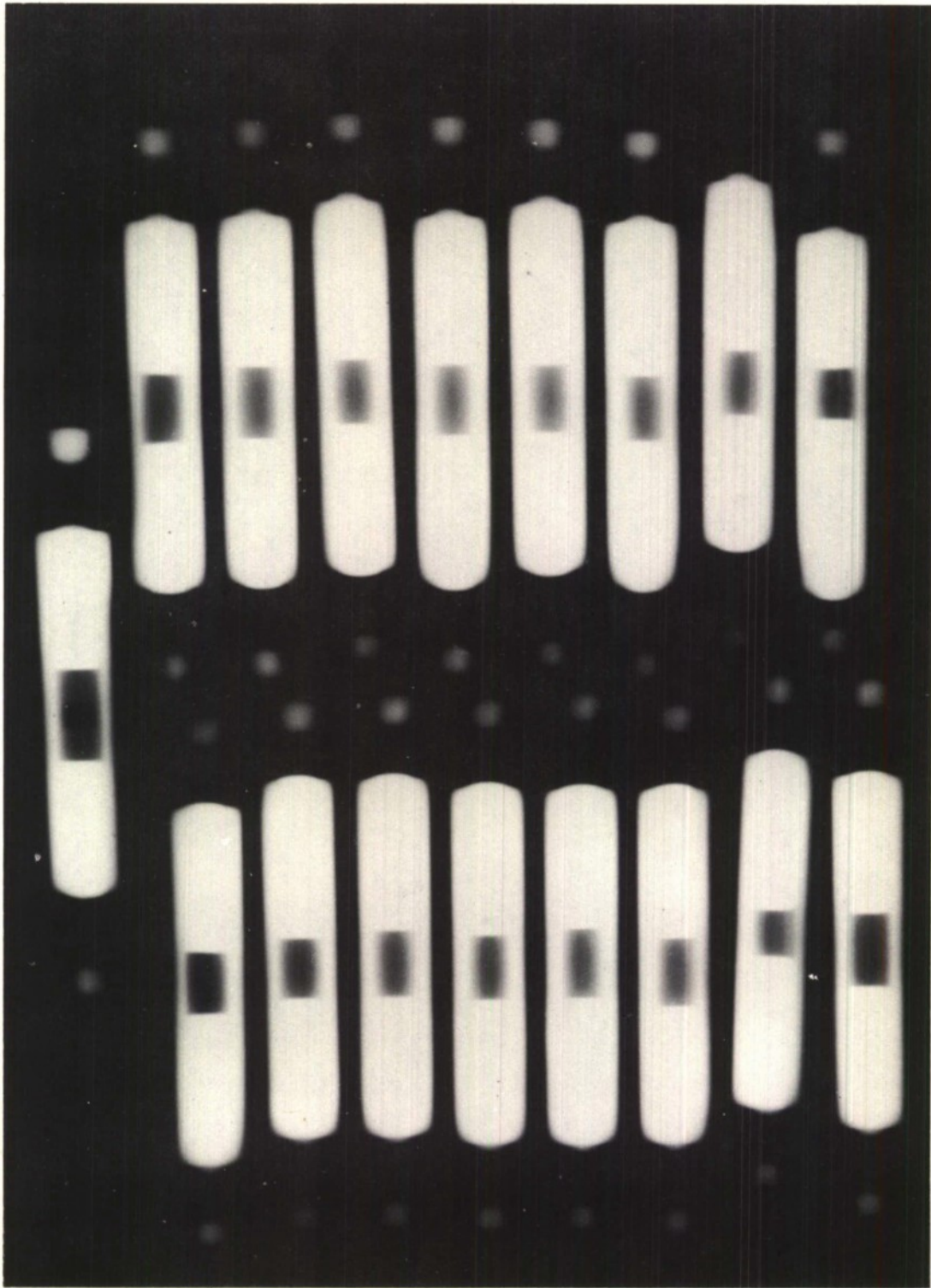


Figure 25. X-Ray Photograph of Typical Negative Samples
Jammed in Sleeves

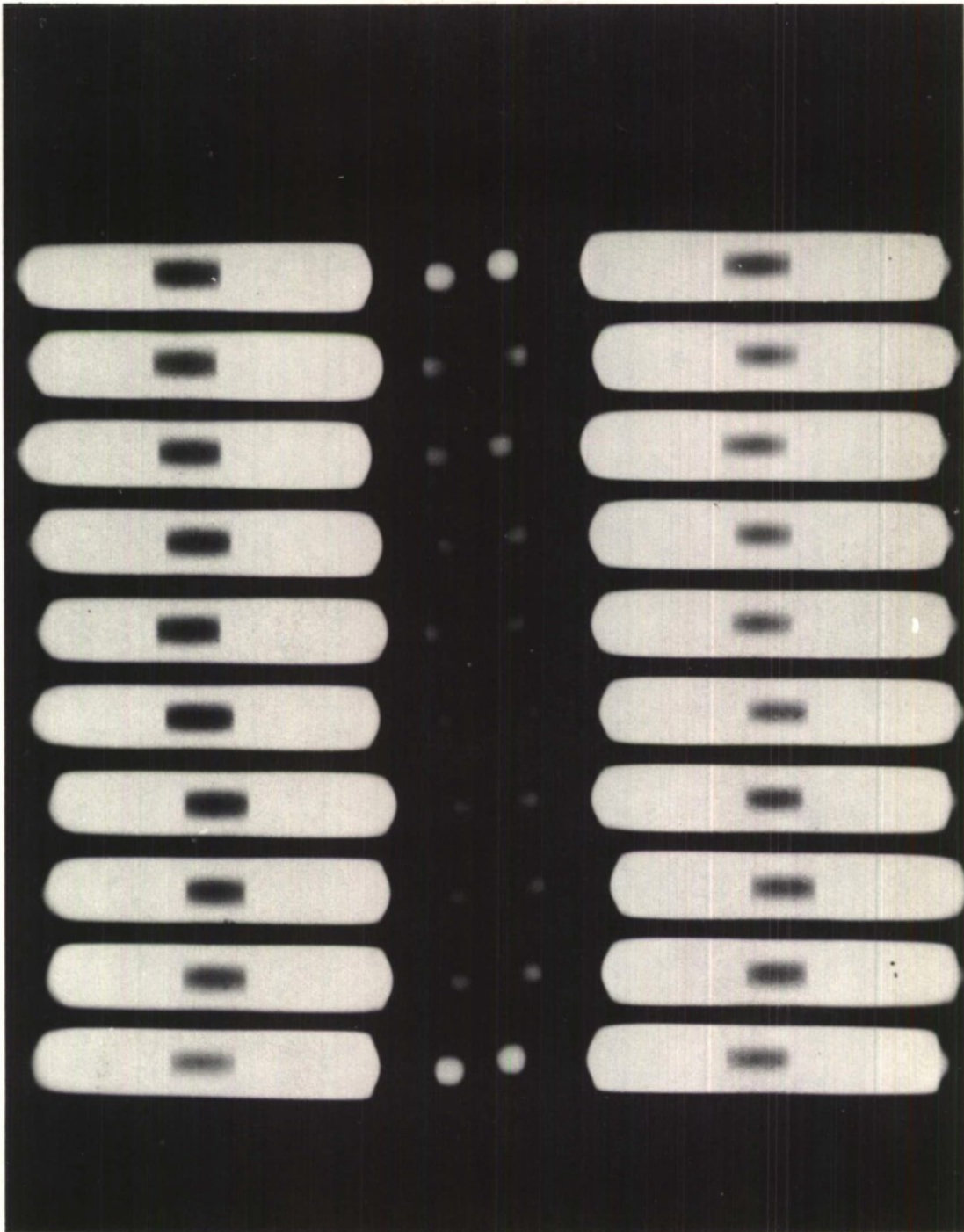


Figure 26. X-Ray Photograph of Typical Negative Samples
Jammed in Sleeves

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TABLE A
COMPOSITION B
SETBACK SENSITIVITY DATA SUMMARY

1/4 x 1/4 inch End Cavity

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak Setback Pressure (psi)</u>	<u>Time To Peak (ms)</u>	<u>Rate of</u>		<u>Pellet No.</u>	
					<u>Rise</u>	<u>Decay</u>	<u>Identification</u>	
					<u>(psi/ms)</u>		<u>Exp.</u>	<u>No.</u>
B-30	3.67		58550	1.8	33430	361	A	44
B-31	3.67		58300	1.3	52000	124		50
B-32	3.67		56600	1.3	45250	547		54
B-33	3.75		56700	2.3	25180	85		36
B-34	3.75		55200	1.8	31600	381		43
B-35	4.00	POSITIVE	69490	1.3	55500	13900		63
B-37	3.67		59900	1.0	59900	225		55
B-38	3.67		57000	1.4	40800	228		65
B-39	3.67		58500	1.5	39000	244		40
B-40	3.67		54250	2.1	26100	294		57
B-41	3.75		63900	0.7	91000	214		42
B-65	3.67		61700	1.6	39300	737	B	2
B-66	3.67		61700	1.5	42500	1260		3
B-68	3.67		59900	1.3	45100	685		5
B-69	3.67		58600	1.6	36800	611		6
B-70	3.67	POSITIVE	60500	1.5	41700	24200		7
B-71	3.67		58900	1.7	34800	571		8
B-72	3.67	POSITIVE	62200	1.1	57500	12400		9
B-73	3.67	POSITIVE	63400	1.2	52400	23000		10
B-77	3.67		61800	1.3	46800	846	C	1
B-78	3.67		59900	1.6	36550	342		2
B-79	3.67		60000	1.7	34700	514		3
B-80	3.67		60100	1.5	41450	857		4
B-81	3.67		59200	2.0	30700	685		5
B-82	3.67		61200	1.7	35800	720		6
B-83	3.67		63500	1.3	30800	429		7
B-84	3.67		60800	1.8	33800	722		8
B-85	3.67		61400	2.0	30700	1040		9
B-86	3.67	POSITIVE	61100	2.0	29950	5100		10
B-87	3.67		59900	2.1	28250	427		11
B-88	3.67		60000	1.7	35300	856		12
B-89	3.67		59200	2.0	29800	237		13
B-90	3.67		61400	2.8	22300	343		14
B-91	3.67		58700	1.7	34300	214		15
B-92	3.67		58500	1.2	49200	380		16
B-93	3.67		59000	2.0	30500	402		17

TABLE B

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/4 inch End Cavity

<u>Sample</u>	<u>Propellant Charge</u> <u>(gms)</u>	<u>Results</u>	<u>Peak Setback Pressure</u> <u>(psi)</u>	<u>Time To Peak</u> <u>(ms)</u>	<u>Rate of</u>		<u>Pellet No.</u>	
					<u>Rise</u>	<u>Decay</u>	<u>Exp.</u>	<u>No.</u>
B-25	2.50		27400	2.5	10950	234	A	21
B-26	3.00		32000	2.3	14200	214		24
B-27	3.50		41100	2.0	20500	342		18
B-28	3.67		56300	1.8	31200	381		77
B-29	3.67		58150	1.8	33200	324		10
B-36	3.67		61600	1.3	49250	446		32
B-42	3.67	POSITIVE	54800	1.5	36800	6850		27
B-43	3.50		54400	2.0	27200	202		22
B-44	3.50		54800	1.3	42100	204		12
B-45	3.50		53600	1.5	35800	104		26
B-46	3.50		53800	1.5	35800	219		19
B-47	3.50		54700	1.4	39000	209		23
B-48	3.67		61800	1.3	49300	88		34
B-49	3.67		59100	1.5	39400	216		17
B-50	3.67		58600	1.9	30800	240		16
B-51	3.67	POSITIVE	58900	1.3	47100	8420	C	35
B-52	3.67		57500	2.2	26200	209		6
B-53	3.67	POSITIVE	62760	1.4	44700	12500		9
B-54	3.67		55500	1.3	44400	209		14
B-55	3.67		57100	2.0	28600	239		31
B-56	3.67		61600	2.1	29400	480		29
B-57	3.67		62000	1.0	68000	560		8
B-58	3.67		56200	1.5	37400	480		20
B-59	3.67		55800	1.8	31000	900		15
B-60	3.75		61000	1.1	56500	980		11
B-61	4.00		67400	1.2	56100	830	C	33
B-63	4.00		62000	1.3	46900	835		25
B-94	3.67		54200	1.7	31500	403		1
B-95	3.67		54900	2.0	27400	4100/95		2
B-96	3.67	POSITIVE	54600	1.9	28400	6820		3
B-97	3.67	POSITIVE	56800	1.1	52600	11370		4
B-98	3.67		52550	2.0	26700	766		5
B-99	3.67		52200	2.1	24600	5160/304		6
B-101	3.67	POSITIVE	55100	1.6	34400	7350		8
B-105	3.67		54800	2.1	26100	856		9
B-106	3.67	POSITIVE	55050	1.8	30400	16400		10
B-107	3.67		55400	1.8	31000	686		11
B-108	3.67		54500	2.1	26000	668		12

TABLE B (cont'd)

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak Setback Pressure (psi)</u>	<u>Time To Peak (ms)</u>	<u>Rate of</u>		<u>Pellet No.</u>	
					<u>Rise</u>	<u>Decay</u>	<u>Identification</u>	<u>No.</u>
					<u>(psi/ms)</u>		<u>Exp.</u>	
B-109	3.67		53400	2.1	25700	778		13
B-110	3.67		55100	1.3	41400	744		14
B-111	3.67		53900	1.5	36700	713		16
B-112	3.67		54600	1.9	29200	611		17
B-113	3.67		55150	1.6	33900	658		18
B-114	3.67		54800	2.0	27700	778		19
B-115	3.67		54600	2.9	18700	713		20
B-116	3.67	POSITIVE	53100	1.5	34500	10600		21

TABLE C

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/4 inch Center Cavity

Sample	Propellant Charge (gms)	Results	Peak	Time	Rate of		Pellet No.	
			Setback Pressure (psi)	To Peak (ms)	Rise	Decay	Identification Exp.	No.
B-76	3.67		57200	1.2	47700	535	C	14/1(a)
B-102	3.50	POSITIVE	58600	1.7	33800	14400		22/9(b)
B-103	3.25	POSITIVE	48300	1.4	34500	9700		13.26(b)
B-104	3.00		39400	1.9	39400	540		3/17(b)
B-117	3.12		44500	2.0	21900	428		19/7(b)
B-118	3.12	POSITIVE	45850	1.9	23600	12100		15/1(b)
B-120	3.12		46000	2.0	23000	1000		5/6(b)
B-121	3.12		44400	2.0	22200	1200		14/18(b)
B-122	3.12		48000	2.0	24000	2140		8/23(b)
B-123	3.12		46050	1.2	38400	1700		25/10(b)
B-124	3.12		46600	1.3	35700	1050		21/24(b)
B-125	3.12		46200	1.7	27200	1140		11/20(b)
B-126	3.12		48800	2.5	19500	860		15/2(a)
B-127	3.12		47900	1.8	27400	122		16/3(a)
B-128	3.12		49600	3.0	16500	950		17/4(a)
B-129	3.12		47500	2.9	16400	660		18/5(a)
B-130	3.12		46800	2.9	16100	745		19/6(a)
B-131	3.12		47900	2.6	18400	285		20/7(a)
B-132	3.12	POSITIVE	47400	2.6	18200	7900		21/8(a)
B-133	3.12		43100	3.4	12700	685		22/9(a)
B-134	3.12		44200	1.9	23250	172		23/10(a)
B-135	3.12		46700	1.8	25950	850		24/11(a)
B-136	3.12		46600	1.9	25200	850		25/12(a)
B-137	3.12		46750	2.0	23400	813		26/13(a)
							(Exposure E)	
B-164	3.00		43300	2.2	19700	290		1-2
B-165	3.00		43400	2.0	21700	310		3-4
B-166	3.00		43600	2.3	19000	310		5-6
B-167	3.00		44500	3.1	14300	490		7-8
B-168	3.00		45800	2.3	20000	360		9-10
B-169	3.00	POSITIVE	44300	2.0	22100	7400		11-12
B-170	2.75	POSITIVE	39400	2.0	18700	7900		13-14
B-171	2.50		35000	2.0	17900	286		15-16
B-172	2.40		35400	2.1	16900	244		17-18

TABLE C (cont'd)

Sample	Propellant	Results	Peak	Time	Rate of		Pellet No.
	Charge		Setback	To Peak	Rise	Decay	Identification
	(gms)		(psi)	(ms)	(psi/ms)		(Exp. E)
B-173	2.40		35800	1.8	19900	285	19-20
B-174	2.60		38500	2.0	19250	263	21-22
B-175	2.60		39350	3.5	11250	264	23-24
B-176	2.60		39200	1.9	20600	286	25-26
B-177	2.60		39900	2.1	19000	256	108-110
B-178	2.60		39400	2.7	14600	367	29-30
B-179	2.55		39400	2.1	18700	311	31-32
B-180	2.56		37500	2.0	18800	297	33-34
B-181	2.56		36600	3.0	12200	622	35-36
B-182	2.57		36800	2.1	17500	411	37-38
B-183	2.57		36500	2.0	18200	856	39-40
B-184	2.58		37300	2.8	13300	590	41-28
B-185	2.58		36800	3.0	12300	596	43-44
B-186	2.59		37700	2.9	13000	622	45-46
B-187	2.59		37000	2.5	14800	623	47-48
B-188	2.59		37800	1.8	21600	685	49-50
B-189	2.60		37700	1.8	20900	571	51-53
B-190	2.58		36800	2.3	16000	535	54-55
B-191	2.58		36000	2.8	12800	274	56-57
B-192	2.58		35900	2.2	16300	514	58-59
B-193	2.58		36500	3.4	10800	535	60-61
B-194	2.58		35900	3.2	11200	519	62-63
B-195	2.58		35900	1.5	24700	463	64-65
B-196	2.58		37100	2.4	19600	535	66-67
B-197	2.58		36000	2.1	17100	236	68-69
B-198	2.58		37600	2.0	18700	476	70-71
B-199	2.59		39300	1.9	20700	617	73-72
B-200	2.59		37800	2.4	16800	552	74-75
B-201	2.59		38500	2.0	19250	540	76-77
B-202	2.59		37000	2.6	14200	850	78-79
B-203	2.59		36800	1.9	19400	521	80-81
B-204	2.59		36300	--	--	503	82-83
B-205	2.59		38000	2.0	19000	570	84-85
B-206	2.59		37200	2.1	17900	95	86-87
B-207	2.59		37700	7.2	5400	590	88-89
B-208	2.59		37600	2.4	15700	685	90-91
B-209	2.59		38200	2.0	19600	561	92-93
B-210	2.59		34800	3.7	9400	548	94-95
B-211	2.59		32500	1.7	19100	392	96-97
B-212	2.59		33200	2.0	16600	456	98-99

TABLE C (cont'd)

Sample	Propellant Charge (gms)	Results	Peak	Time	Rate of		Pellet No. Identification (Exp E)
			Setback Pressure (psi)	To Peak (ms)	Rise (psi/ms)	Decay (ms)	
B-213	2.59		33550	2.7	12400	522	100-101
B-214	2.59		33500	2.6	12900	612	102-103
B-215	2.67		33900	2.1	16100	684	104-105
B-216	2.70		35100	2.3	15600	518	106-107
B-217	2.75		36800	3.2	11500	550	111-112
B-218	2.75		36950	2.4	15400	518	113-114
B-219	2.35		35900	3.3	10900	507	115-116
B-220	2.35		35950	1.6	22500	570	117-118
B-221	2.35		35950	2.8	20500	519	119-120
B-222	2.35		35100	2.8	12500	440	121-122
B-223	2.35		36300	2.1	17300	529	123-124
B-224	2.35		36300	3.8	9500	545	125-126
B-225	2.35		36100	3.1	11700	526	127-128
B-226	2.35		35700	3.0	11900	545	129-130
B-227	2.35		35950	3.2	11200	534	131-132
B-228	2.35		36800	3.0	12300	310	133-134
B-229	2.40		37700	2.6	14500	604	135-136
B-230	2.40		37850	3.4	11100	496	137-138
B-231	2.40		39100	1.9	20600	571	139-140
B-232	2.40		38850	3.7	10500	551	141-142
B-233	2.40		37300	2.1	17900	590	143-144
B-234	2.40		39300	1.9	20700	--	145-146
B-235	2.40		39900	2.0	20000	662	147-148
B-236	2.40		37650	2.1	17900	556	149-150
B-237	2.40		37350	2.5	14900	543	151-152
B-238	2.40		38900	2.6	15000	611	153-154
B-239	2.40		37500	2.1	17800	519	155-156
B-240	2.40		37200	2.8	13300	593	157-158
B-241	2.40		37350	2.7	13800	625	159-160
B-242	2.40		36600	2.3	15900	856	161-162
B-243	2.40		37100	1.4	26500	600	163-164
B-244	2.40		37600	2.0	18800	598	165-166
B-245	2.40		37800	2.2	17200	616	167-168
B-246	2.40		37150	3.4	10900	571	169-170
B-247	2.40		36950	2.3	16100	556	171-172
B-248	2.40		37150	1.9	19500	536	173-174
B-249	2.40		37250	2.1	17800	638	175-176
B-250	2.40		37000	2.0	18500	634	177-178
B-251	2.40		37150	2.7	13800	603	179-180
B-252	2.40		37500	2.6	14400	600	181-182
B-253	2.40		36300	1.9	19100	713	183-184

TABLE C (cont'd)

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak</u>	<u>Time To Peak (ms)</u>	<u>Rate of</u>		<u>Pellet No. Identification (Exp. E)</u>
			<u>Setback Pressure (psi)</u>		<u>Rise</u>	<u>Decay</u> (psi/ms)	
B-254	2.40		35700	2.1	17000	503	185-186
B-255	2.40		36800	1.7	21600	497	187-188
B-256	2.40		37650	2.2	17100	321	189-190
B-257	2.40		37750	1.9	19900	336	191-192
B-258	2.40		38000	2.6	14600	263	193-194
B-259	2.40		38500	1.6	24100	367	195-196
B-260	2.40		37800	2.1	18000	253	197-198
B-261	2.40		37600	2.2	23000	373	199-200
B-262	2.40		38350	2.4	16000	379	201-202
B-263	2.40		39000	3.0	13000	293	203-204

TABLE D
COMPOSITION B
SETBACK SENSITIVITY DATA SUMMARY

1/4 x 1/4 inch Center Cavity

Sample	Propellant Charge (gms)	Results	Peak Setback Pressure (psi)	Time To Peak (ms)	Rate of		Pellet No.	
					Rise	Decay	Identification	
					(psi/ms)		Exp.	No.
B-138	3.12		49100	1.8	28100	950	C	14/1(b)
B-139	3.12		47900	1.6	29900	950		15/2(b)
B-140	3.12		50200	2.0	25100	950		16/3(b)
B-141	3.12		49000	1.8	28000	780		17/4(b)
B-142	3.12		47600	2.1	22700	880		18/5(b)
B-143	3.12		51000	2.0	25500	1010		19/6(b)
B-144	3.12		47600	2.2	22100	950		20/7(b)
B-145	3.12		49200	2.8	17600	900		21/8(b)
B-146	3.12		46900	1.9	24700	860		22/9(b)
B-147	3.12		47900	2.4	20000	950		23/10(b)
B-148	3.12		48000	1.5	33100	815		24/11(b)
B-149	3.12		46200	2.3	20000	778		25/12(b)
B-150	3.12		48400	1.5	31200	854		26/13(b)
B-151	3.12		48600	2.1	23150	925		14/1(a)
B-152	3.12		48400	2.0	24200	850		15/2(a)
B-153	3.12		47500	2.0	23750	744		16/3(a)
B-154	3.12		47950	2.0	24000	1070		17/4(a)
B-155	3.12		46800	1.9	25300	796		18/5(a)
*B-156	3.12		58600	1.9	30900	1550		19/6(a)
*B-157	3.12		58300	2.1	27800	245		20/7(a)
B-158	3.12		49300	2.2	22900	190		21/8(a)
B-159	3.12		50100	2.2	22800	235		22/9(a)
B-160	3.12		49650	1.9	26100	132		23/10(a)
B-161	3.12		49950	1.7	29400	163		24/11(a)
B-162	3.12		49600	1.8	27500	171		25/12(a)
B-163	3.12		51300	1.6	32100	163		26/13(a)

*On these two shots, the propellant-chamber did not have the usual volume because of the absence of an extra gasket used in all other shots.

TABLE E

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 3/8 inch Center Cavity

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak</u>	<u>Time</u>	<u>Rate of</u>		<u>Pellet No. Identification Exposure F</u>
			<u>Setback Pressure (psi)</u>	<u>To Peak (ms)</u>	<u>Rise</u>	<u>Decay</u> (psi/ms)	
B-264	2.25		33900	5.0	6780	214	1-2
B-265	2.25		32500	6.0	5410	172	3-4
B-266	2.30		37600	4.0	9400	155	5-6
B-267	2.30		34200	3.0	11400	161	7-8
B-268	2.30		39300	3.0	13100	194	9-10
B-269	2.30		35500	3.5	10100	256	11-12
B-270	2.30		35100	3.7	9500	226	13-14
B-271	2.30		38500	3.3	11900	214	15-16
B-272	2.30		36800	2.5	14700	257	17-18
B-273	2.30		30700	3.2	9600	264	19-20
B-274	2.30		33900	2.9	11700	285	21-22
B-275	2.30		34200	2.5	13100	342	23-24
B-276	2.35		34300	3.1	11100	516	25-26
B-277	2.35		33400	2.7	12400	500	27-28
B-278	2.40		36000	3.0	12000	428	29-30
B-279	2.40		36800	2.8	13200	640	31-32
B-280	2.40		34200	2.6	13100	490	33-34
B-281	2.40		36500	3.1	11800	571	35-36
B-282	2.45		37700	2.3	16400	544	37-38
B-283	2.45		36500	3.0	12200	550	39-40
B-284	2.45		37000	3.2	11600	500	43-G
B-285	2.45		35900	3.1	11600	507	44-45
B-286	2.45		37300	3.2	11700	551	46-47
B-287	2.45		37400	3.3	11300	571	48-49
B-288	2.45		no oscillographic record				50-51
B-289	2.45		36600	3.4	10800	502	52-53
B-290	2.45		38100	3.4	11200	465	54-55
B-291	2.45		36700	3.5	10500	522	56-57
B-292	2.45		37700	3.1	12200	500	58-59
B-293	2.45		37700	2.7	13900	526	60-62
B-294	2.45		36300	2.8	13000	551	64-65
B-295	2.45		36400	2.1	17300	249	66-67
B-296	2.45		38350	2.4	16000	692	68-69
B-297	2.45		37500	2.1	17900	600	70-71
B-298	2.45		37300	2.8	13300	616	72-73
B-299	2.45		37300	2.9	12900	683	74-75

TABLE E (cont'd)

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 3/8 inch Center Cavity

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak Setback Pressure (psi)</u>	<u>Time To Peak (ms)</u>	<u>Rate of Rise Decay (psi/ms)</u>	<u>Pellet No. Identification Exposure F</u>
B-300	2.45		36000	2.9	12400 684	77-78
B-301	2.45		34800	2.7	12900 ---	79-80
B-302	2.45		37150	2.8	13300 661	81-82
B-303	2.45		no oscillographic record			83-84
B-304	2.45		36900	2.6	14200 400	87-88
B-305	2.45		38700	2.4	16100 532	89-90
B-306	2.45		37300	2.7	13800 643	91-92
B-307	2.45		36800	3.2	11500 544	93-94
B-308	2.45		35900	2.1	17100 500	95-96
B-309	2.45		36600	2.4	15200 507	97-98
B-310	2.45		37000	1.9	19400 521	99-100
B-311	2.45		35800	2.9	12300 507	A-B
B-312	2.45		37700	2.2	17100 380	C-D
B-313	2.45		36300	2.3	15800 546	E-F
B-314	2.45		35800	1.8	19900 479	H-I
B-315	2.45		35600	2.1	16900 524	J-K

TABLE F
COMPOSITION B
SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/2 inch Center Cavity

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak Setback Pressure (psi)</u>	<u>Time To Peak (ms)</u>	<u>Rate of Rise (psi/ms)</u>	<u>Decay (psi/ms)</u>	<u>Pellet No. Identification Exposure F</u>
B-316	2.45		36600	2.3	15900	451	2-3
B-317	2.50		36100	2.0	18100	489	4-5
B-318	2.50		33400	2.7	12400	489	6-7
B-319	2.60		39000	1.9	20500	374	8-9
B-320	2.60		37700	2.0	18800	410	10-11
B-321	2.70		39200	2.0	19600	364	12-13
B-322	2.70		39900	1.8	22100	387	14-15
B-323	2.70	POSITIVE	39700	2.3	17300	4900	16-17
B-324	2.70		38600	2.4	16100	594	18-19
B-325	2.50		38000	2.8	13600	503	20-21
B-326	2.50		35900	2.0	18000	750	22-23
B-327	2.50	POSITIVE	35800	2.7	13300	4500	24-25
B-328	2.00		28800	3.0	9600	480	26-27
B-329	2.25		34700	2.3	15100	540	28-29
B-330	2.25		32700	2.9	11300	500	30-31
B-331	2.25		32200	2.1	15300	398	32-33
B-332	2.25		33700	3.1	10900	510	34-35
B-333	2.25		32200	3.0	10700	500	36-37
B-334	2.25		31500	2.5	12600	428	38-39
B-335	2.25		34900	2.9	12000	442	41-42
B-336	2.25		34300	2.9	11800	534	43-44
B-337	2.25		31300	2.4	13000	541	45-46
B-338	2.25		33400	3.2	10400	455	47-48
B-339	2.25		no oscillographic record				49-50
B-340	2.25		32300	2.9	11100	500	51-52
B-341	2.25		32500	3.1	10500	458	53-54
B-342	2.25		34100	1.7	20000	455	55-56
B-343	2.25		32000	1.8	17800	452	57-58
B-344	2.25		29700	2.5	11900	445	59-60
B-345	2.25		32500	3.0	10800	435	61-62
B-346	2.25		32400	2.3	14100	394	63-64
B-347	2.25		32100	3.1	10300	480	65-66
B-348	2.25		31500	2.7	11700	467	67-68
B-349	2.25		31900	3.6	8900	438	69-70
B-350	2.25		32500	3.1	10500	214	71-72

TABLE F (cont'd)

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/2 inch Center Cavity

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak</u>	<u>Time</u>	<u>Rate of</u>		<u>Pellet No. Identification Exposure F</u>
			<u>Setback Pressure (psi)</u>	<u>To Peak (ms)</u>	<u>Rise</u>	<u>Decay</u> (psi/ms)	
B-351	2.25		32900	2.8	11900	490	73-74
B-352	2.25		33200	3.2	10400	514	75-76
B-353	2.25		32500	2.8	11600	416	77-78
B-354	2.25		no oscillographic record				79-80
B-355	2.25		31700	3.0	10600	467	81-82
B-356	2.25		32600	3.1	10500	457	83-84
B-357	2.25		34000	3.2	10600	522	85-86
B-358	2.25		32600	3.9	8400	414	87-88
B-359	2.25		33000	2.9	11400	446	89-90
B-360	2.25		31000	2.5	12400	413	92-93
B-361	2.25		31900	3.4	9400	432	94-95
B-362	2.25		32000	2.4	13300	439	96-97
B-363	2.25		32600	3.0	10900	460	98-99
B-364	2.25		33600	2.4	14000	495	100-K
B-365	2.25		32600	3.6	9100	443	L-M
B-366	2.25		32700	2.6	12600	428	N-O
B-367	2.25		34300	2.7	12700	473	P-Q

TABLE G

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/4 inch Cavities at One End and Center

<u>Sample</u>	<u>Propellant Charge</u> <u>(gms)</u>	<u>Results</u>	<u>Peak Setback Pressure</u> <u>(psi)</u>	<u>Time To Peak</u> <u>(ms)</u>	<u>Rate of Rise</u> <u>(psi/ms)</u>	<u>Rate of Decay</u> <u>(psi/ms)</u>	<u>Pellet No. Identification</u> <u>Exposure G</u>
B-368	2.50		35600	3.3	10800	285	1-2
B-369	2.50		35800	2.8	12800	283	3-4
B-370	2.50		41100	2.7	15200	214	5-6
B-371	2.55		37700	2.8	13500	244	7-8
B-372	2.55		36600	2.8	13100	236	9-10
B-373	2.70		40300	2.6	15500	257	11-12
B-374	2.70		40400	3.0	13500	243	13-14
B-375	2.70		39300	1.5	26200	244	15-16
B-376	2.80		41000	2.0	20500	230	17-18
B-377	2.80		40900	2.2	18600	270	19-20
B-378	3.00		44900	2.1	21400	274	21-22
B-379	3.00		43100	2.0	21500	171	23-24
B-380	3.00	POSITIVE	45900	2.6	17700	5700	25-26
B-381	2.75		41500	1.8	23000	214	27-28
B-382	2.75		41100	2.2	18600	171	31-32
B-383	2.75		42800	2.0	21400	153	29-30
B-384	2.75	POSITIVE	40000	no oscillographic record (estimated setback pressure)			
B-385	2.60		37500	2.1	17900	320	35-36
B-386	2.70	POSITIVE	40700	2.0	20300	4070	37-38
B-387	2.60	POSITIVE	37000	1.9	19500	4600	39-40
B-388	2.45		34200	2.0	17100	410	41-42
B-389	2.45		34300	2.0	17200	430	43-44
B-390	2.45		34900	2.1	16700	400	45-46
B-391	2.45		35900	2.0	17900	233	47-48
B-392	2.45		36900	2.4	15400	247	49-50
B-413	2.20		29800	2.4	12300	180	95-96
B-414	2.20	POSITIVE	29000	1.8	16100	7300	97-98
B-415	2.00		26900	2.8	9600	171	99-101
B-416	1.90		25200	4.3	5900	425	102-103
B-417	1.90		26200	2.3	11400	190	104-105
B-418	1.90		26700	3.9	6900	142	107-108
B-419	1.90		25100	4.0	6300	195	109-111
B-420	1.90		26600	3.9	6800	194	112-114

TABLE G (cont'd)

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/4 inch Cavities at One End and Center

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak</u>	<u>Time</u>	<u>Rate of</u>		<u>Pellet No. Identification Exposure G</u>
			<u>Setback Pressure (psi)</u>	<u>To Peak (ms)</u>	<u>Rise</u>	<u>Decay</u> (psi/ms)	
B-421	1.90		25300	3.1	8200	160	115-116
B-422	1.90		no oscillographic record				
B-423	1.90		26500	3.8	7000	149	119-120
B-424	1.90		27200	4.2	6500	287	122-123
B-425	1.90		27000	3.1	8600	183	124-125
B-426	1.90	POSITIVE	24800	3.1	8100	4100	142-147
B-427	1.75		23600	4.6	5100	190	129-130
B-428	1.90		27200	3.5	7700	204	131-132
B-429	1.90		27600	4.7	5900	286	133-134
B-430	1.90		26500	4.1	6400	160	135-137
B-431	1.90	POSITIVE	27200	3.2	8500	3400	138-139

TABLE H

COMPOSITION B

SETBACK SENSITIVITY DATA SUMMARY

3/8 x 1/4 inch Cavities at Either End

<u>Sample</u>	<u>Propellant Charge (gms)</u>	<u>Results</u>	<u>Peak Setback Pressure (psi)</u>	<u>Time To Peak (ms)</u>	<u>Rate of Rise (psi/ms)</u>	<u>Decay</u>	<u>Pellet No. Identification Exposure G</u>
B-394	2.70		40400	1.9	21200	245	55-56
B-395	2.70		42100	3.0	14000	214	57-58
B-396	2.70	POSITIVE	37800	2.4	15700	5700	59-60
B-397	2.45	POSITIVE	35100	2.1	17500	4600	61-62
B-398	2.20		no oscillographic record				63-64
B-399	2.20		31000	2.0	15500	154	66-67
B-400	2.20		32000	2.2	14500	149	68-69
B-401	2.20		32100	2.8	11500	184	70-71
B-402	2.20		32700	3.3	9900	214	72-73
B-403	2.20		31200	2.5	12500	201	74-75
B-404	2.20		32500	2.7	12100	190	76-77
B-405	2.20		31700	2.9	10900	155	78-79
B-406	2.20		32500	2.4	13600	201	80-82
B-407	2.20		31000	2.5	12300	217	83-84
B-408	2.20		33000	3.9	8500	180	85-86
B-409	2.20		no oscillographic record				87-88
B-410	2.20		30800	3.0	10300	137	89-90
B-411	2.20		32000	2.3	13900	139	91-92
B-412	2.20		31900	2.8	11400	190	93-94

TABLE I

SUMMARY OF RESULTS

	<u>Pressure Range (Setback psi)</u>	<u>Number of Samples</u>	<u>% Positive Samples</u>
Table A	58,000-63,000	30	13%
Table B	52,000-57,000	31	19%
Table C	43,000-49,000	27	15%
	35,000-40,000	99	1%
Table D	46,000-51,000	24	less than 4%
Table E	34,000-40,000	44	less than 2%
Table F	31,000-40,000	48	4%
	31,000-35,000	39	2%
	36,000-40,000	9	11%
Table G	34,000-42,000	21	14%
	23,000-30,000	18	17%
Table H	30,000-35,000	13	less than 7%

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