

UNCLASSIFIED

AD 4 3 9 4 8 8

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.



CHARACTERISTICS OF HIGH CURRENT FIRING PULSES

ON

SQUIBS AND BLASTING CAPS

by

Kenneth A. Kartchner

PUBLICATION REVIEW

This report has been reviewed and is approved



ALEX D. PERESICH  
Chief  
Service Engineering Division  
2705th Airmunitions Wing

APRIL 1964

2705TH AIRMUNITIONS WING  
OGDEN AIR MATERIEL AREA  
AIR FORCE LOGISTICS COMMAND  
UNITED STATES AIR FORCE  
Hill Air Force Base, Utah

OOY-TR-64-103

NOTICES

The information furnished herewith is made available for study with the understanding that the Government's proprietary interests in and relation thereto shall not be impaired. It is desired that the Judge Advocate's Office, (WCJ), Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, be promptly notified of any apparent conflict between the Government's proprietary interests and those of others.

The conclusions and recommendations in this report are not to be considered directive in nature. This type information becomes official only when published in Technical Orders or other applicable Air Force publications.

Qualified requesters can obtain this report from the Defense Document Center, Cameron Station, Alexandria, Virginia (22314).

## ADMINISTRATIVE DATA

## PURPOSE OF TESTS:

The purposes of these tests were to extend the direct current firing characteristics curve for some of the most common squibs and blasting caps and to set up radio frequency firing characteristic curves for these squibs and blasting caps.

## MANUFACTURER:

E.I. Du Pont De Nemours and Company, Pennsylvania Grove, NJ

## MANUFACTURER'S PART NUMBER AND FEDERAL STOCK NUMBER:

S-67	NSL
S-68	1375-035-6021-M846
E-76	1375-035-6019-M135
E-81	1375-041-1312-M138

## DRAWINGS AND SPECIFICATIONS:

<u>PART NUMBER</u>	<u>DRAWING NUMBER</u>	<u>MAXIMUM NO FIRE</u>	<u>MINIMUM FIRE</u>	<u>RESISTANCE OHMS</u>
E-76	DuPont EL3470		0.55 Amp	0.44
E-81	DuPont EL3496		0.38 Amp	1.5
S-67		0.4 Amp	0.7 Amp	0.65
S-68		0.3 Amp	0.38 Amp	1.37

## SECURITY CLASSIFICATION:

Unclassified

## DATE TEST COMPLETED:

December 1962

OOY-TR-64-103

TEST CONDUCTED BY:

OOAMA (OOYT - 2705th Airmunitions Wing)

Test Director: Richard O. Miller, Captain, USAF

Project Engineer: Kenneth A. Kartchner, Electronic Engineer

## ABSTRACT

Charts were available which gave the low current characteristics of Du Pont squibs and blasting caps. These charts did not extend up to the desired current levels. The objective of the test was to extend these charts to include the high current characteristics. Also an attempt was made to determine the minimum time required to fire the squibs when using short high current pulses.

From this test it was determined that the E-81 Blasting Cap could be functioned in 70 micro-seconds using 140 volts supplied by a direct current arc welder. The charts which were available did not include any curves showing what the squibs and blasting caps reaction would be when exposed to radar frequencies. To determine what this reaction would be both pulsed and continuous wave power was applied to the squibs and blasting caps.

During the radio frequency part of the test, an ART-13 transmitter, set at 8 megacycles, was used to function the test items. The current and time of each firing was recorded using an oscilloscope and Polaroid camera.

An analysis of the test data revealed that even though the direct current arc welder could supply over 300 amperes, this amount was never drawn. A maximum current was not obtained because of inductance in the leads and generator windings.

The functioning of squibs and blasting caps with high direct current and with radio frequency current required several times as much time as the maximum pulse width of our present radar transmitters.

TABLE OF CONTENTS

	PAGE
Notices . . . . .	ii
Administrative Data . . . . .	iii
Abstract . . . . .	v
Table of Contents . . . . .	vi
Introduction . . . . .	1
Description . . . . .	1
Figure 1 . . . . .	2
Figure 2 . . . . .	3
Equipment . . . . .	4
Test Procedures . . . . .	4
Test Results . . . . .	5
Figure 3 . . . . .	6
Figure 4 . . . . .	6
Figure 5 . . . . .	7
Figure 6 . . . . .	7
Figure 7 . . . . .	8
Figure 8 . . . . .	8
Figure 9 . . . . .	9
Figure 10 . . . . .	9
Figure 11 . . . . .	10
Figure 12 . . . . .	10
Figure 13 . . . . .	11
Figure 14 . . . . .	11
Figure 15 . . . . .	12
Figure 16 . . . . .	12
Figure 17 . . . . .	13
Figure 18 . . . . .	13
Figure 19 . . . . .	14
Figure 20 . . . . .	14
Figure 21 . . . . .	15
Figure 22 . . . . .	15
Figure 23 . . . . .	16
Figure 24 . . . . .	16
Figure 25 . . . . .	17
Figure 26 . . . . .	17
Figure 27 . . . . .	18
Figure 28 . . . . .	18
Figure 29 . . . . .	19
Figure 30 . . . . .	19
Figure 31 . . . . .	20
Figure 32 . . . . .	20

## TABLE OF CONTENTS (Cont)

	PAGE
Figure 33 . . . . .	21
Figure 34 . . . . .	21
Figure 35 . . . . .	22
Figure 36 . . . . .	22
Figure 37 . . . . .	23
Figure 38 . . . . .	23
Figure 39 . . . . .	24
Figure 40 . . . . .	24
Figure 41 . . . . .	25
Figure 42 . . . . .	25
Figure 43 . . . . .	26
Figure 44 . . . . .	26
Figure 45 . . . . .	27
Figure 46 . . . . .	27
Figure 47 . . . . .	28
Figure 48 . . . . .	28
Figure 49 . . . . .	30
Figure 50 . . . . .	30
Figure 51 . . . . .	31
Figure 52 . . . . .	31
Figure 53 . . . . .	32
Figure 54 . . . . .	32
Figure 55 . . . . .	33
Figure 56 . . . . .	33
Figure 57 . . . . .	34
Figure 58 . . . . .	34
Figure 59 . . . . .	35
Figure 60 . . . . .	35
Figure 61 . . . . .	36
Figure 62 . . . . .	36
Figure 63 . . . . .	37
Figure 64 . . . . .	37
Figure 65 . . . . .	38
Figure 66 . . . . .	38
Figure 67 . . . . .	39
Figure 68 . . . . .	39
Conclusions . . . . .	40
Recommendations . . . . .	40
Distribution List . . . . .	41

OOY-TR-64-103

THIS PAGE INTENTIONALLY LEFT BLANK

viii

## INTRODUCTION

The manufacturer of squibs and blasting caps gave charts showing the characteristics of these items when subjected to normal and low currents. However, the characteristics at high currents were not given on any of these charts. It was expected that the ignition delay would become shorter with higher currents, however, how much shorter this firing time could become, was not known. New high power transmitters are being installed in locations which are near areas in which airmunitions are transported and handled. These new transmitters not only have higher power but have longer pulse widths. These tests were designed to determine how close the radar pulse time length was to the ignition time of the squibs and blasting caps.

The test was designed to determine the amount of current and time required to function these items using radio frequency current, compared to the functioning time required using direct current. Also taken into consideration, was the finite time required to heat the bridge wire hot enough to cause ignition.

This test was conducted under Test Directive S-2-1019-Y issued in May 1962 by the Air Launch Missiles Branch (OOYEA) and necessary tests were performed by the Test Squadron (OOYT, 2705th Airmunitions Wing (OOY)).

## DESCRIPTION

The squibs and blasting caps used were all of the common type used throughout the Air Force in many electro-explosive devices.

The squib is inclosed in a metal shell. The shell is closed on one end and sealed on the other end by two or three crimpings around a 3/8 inch long rubber plug. The lead wires are copper and are molded into the rubber plug. Across the inside ends of these wires a resistance wire (bridge wire) is connected. Around the bridge wire is a sensitive explosive mixture known as the ignition bead. In the squib the ignition bead ignites the charge (Figure 1). In the blasting caps the ignition bead ignites the filler charge which ignites a primer charge and this sets off the base charge (Figure 2). The bridge wire is heated by any current which passes through it, when the bridge wire reaches a designed temperature, ignition takes place.

OOY-TR-64-103

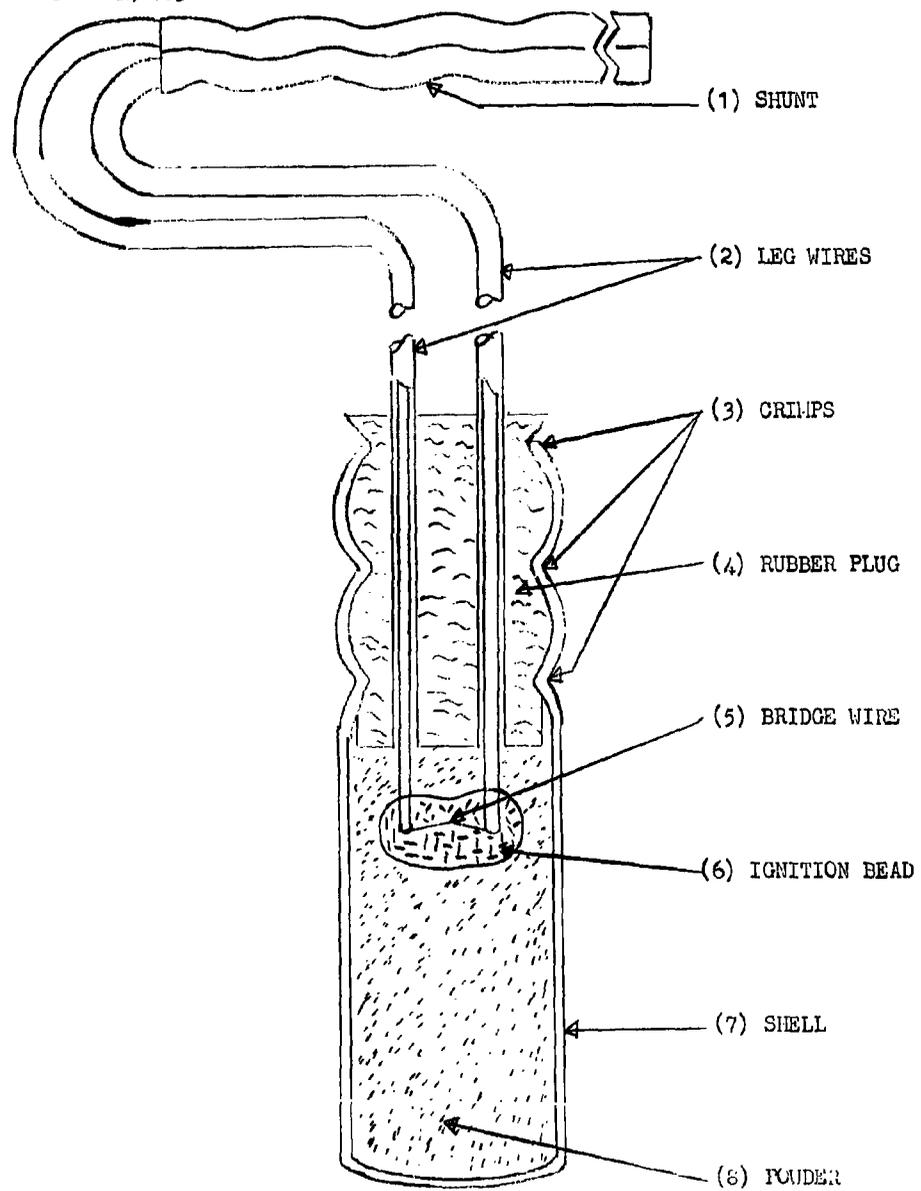


FIGURE 1. Cross-Section Drawing of Squib.

COY-TR-64-103

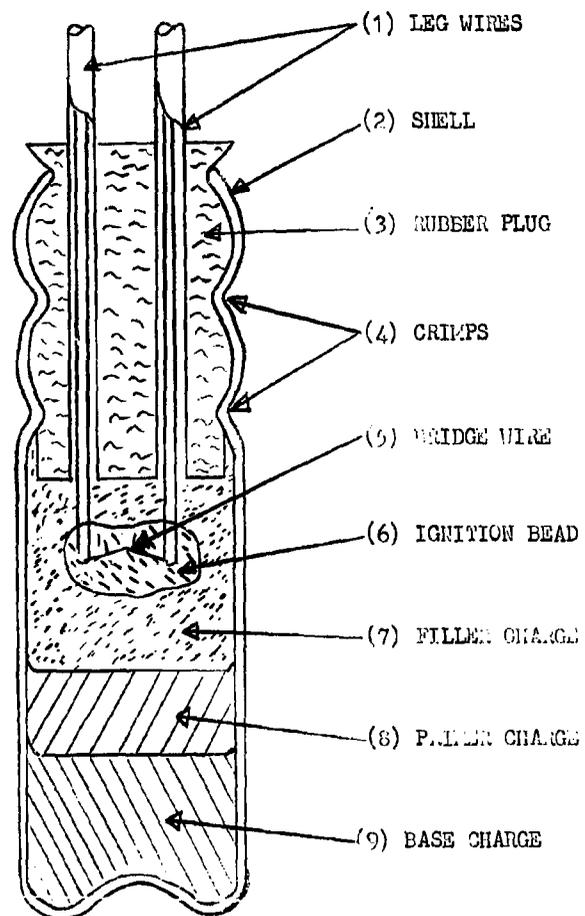


FIGURE 2. Cross-Section Drawing of Elasting Cap.

OOY-TR-64-103

#### EQUIPMENT

The following equipment was used in performance of this test:

Portable Aircraft Rectifier (0-100 Amperes)

Portable Direct Current Arc Welder

Oscilloscope

Polaroid Camera and Oscilloscope Attachment

Instrument Shunt (100 Amperes)

A 28 Volt DC to 115 Volt 400 Cycle Converter

ARC-27 Transmitter

ART-13 Transmitter

#### TEST PROCEDURES

All squibs and blasting caps were visually inspected for rough handling, dents and broken wires before being used in the test.

The wires from the direct current arc welder were connected to a 300 ampere relay. The other terminal of the relay was connected through an instrument shunt. This relay was placed in series with the positive cable. These wires were then connected to the squib or blasting cap. Shielded coax cable was used to connect the output from the shunt to the oscilloscope. Another shielded coax cable was connected across the terminals of the squib and used to provide a voltage signal to the oscilloscope. A single beam dual trace oscilloscope was used to display the current and voltage signals. A polaroid camera mounted on the front of the oscilloscope was used to record the traces of voltage and current during each firing. The camera shutter was set on one second and the shutter was opened at the same time as the current was applied to close the firing relay. The current to the squibs or blasting caps was controlled by increasing the voltage of the DC arc welder in 10-volt steps. Five items were functioned with each voltage setting.

The radio frequency portion of the test was conducted using two transmitters. The first transmitter used was the ARC-27. This transmitter was operated at 300 megacycles with a peak power of 9 watts and an average power of three (3) watts. The second transmitter used was an ART-13. This transmitter was set to operate at eight megacycles with a peak power of 100 watts. The length of coax cable between the transmitter and the squib or blasting caps was varied to determine a length which would give the best power transfer and impedance match. Shielded cables were used for firing and instrumentation lines. Both continuous wave and voice transmission were used during this test. The measurement of RF current was taken from a noninductive resistance placed in the firing line as close to the squib or blasting cap as possible.

#### TEST RESULTS

A visual inspection of all squibs and blasting caps used in this test indicated that they were in serviceable condition. A considerable variation was obtained in the firing time and current for each type of squib or blasting cap. The minimum time and current required to function the E-75 blasting cap was 100 microseconds and 25 amperes of direct current. The minimum time and current required to function the E-81 blasting cap was 70 microseconds and 50 amperes of direct current. The minimum time and current required to function the S-68 squibs was 130 microseconds and 30 amperes of direct current.

Each of the above types of squibs and blasting caps were functioned using higher current. However, the time required to function those receiving higher current was longer than the values given above. When using high firing currents, other factors built into the squibs and blasting caps had as much control over the length of time required to function as did the applied current. Examples of traces obtained when firing with direct current are given in Figures 3 through 48.

OOY-TR-64-103

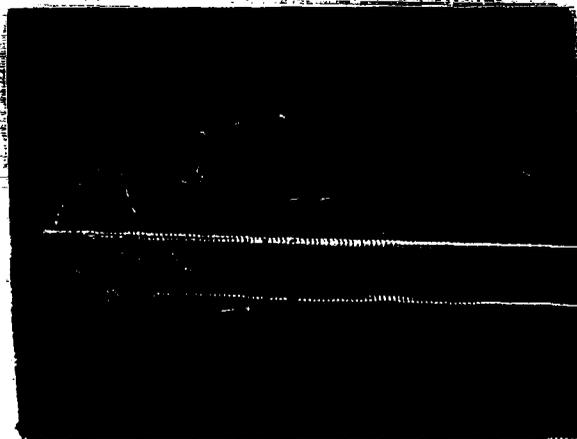


FIGURE 3. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 28 Amperes for 121 Microseconds.

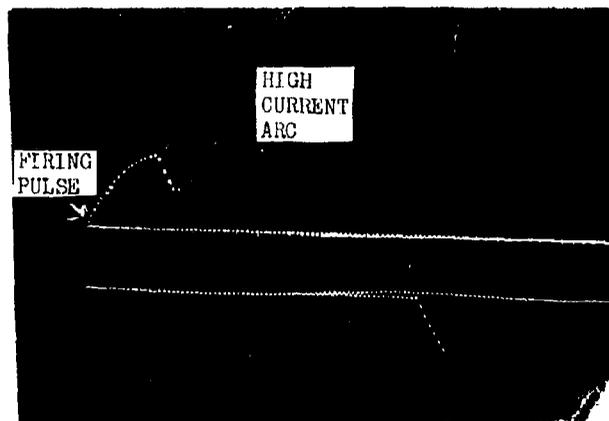


FIGURE 4. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 26 Amperes for 140 Microseconds.

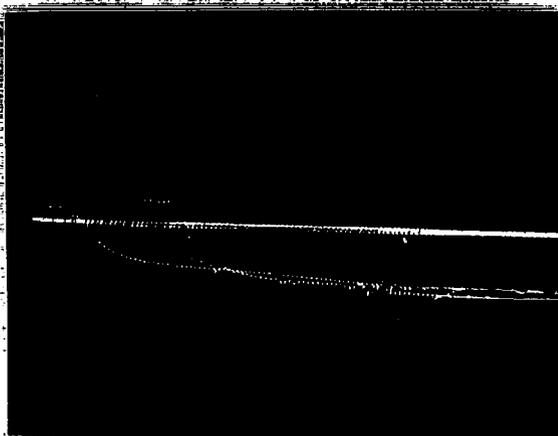


FIGURE 5. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 26.4 Amperes for 130 Microseconds.

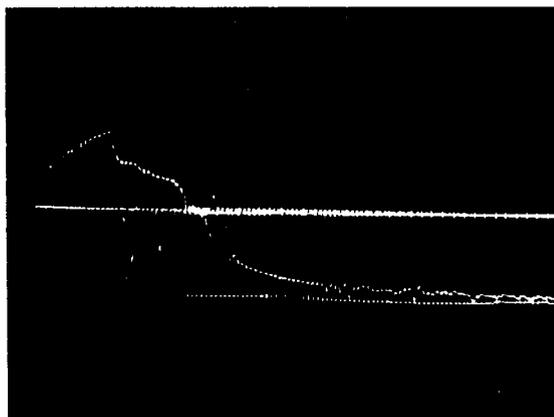


FIGURE 6. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 28 Amperes for 140 Microseconds.

DDY-TR-64-103

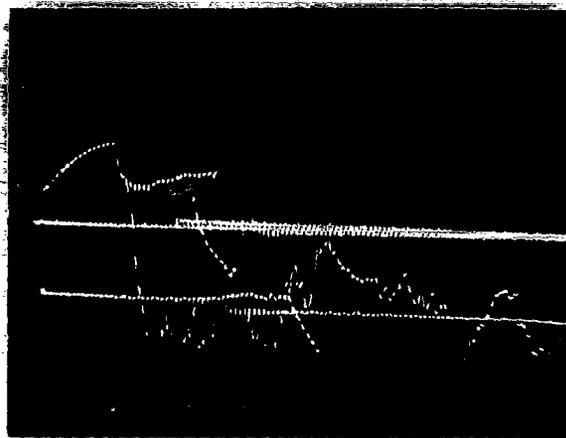


FIGURE 7. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 30 Amperes for 160 Microseconds.

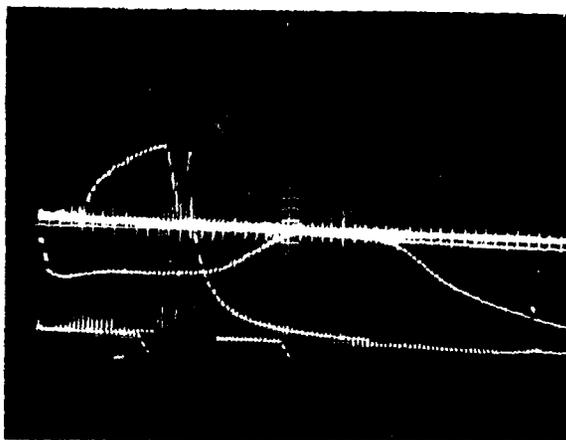


FIGURE 8. Oscilloscope Trace of EI Firing Pulse on E-76  
Blasting Cap - 30 Amperes for 160 Microseconds.

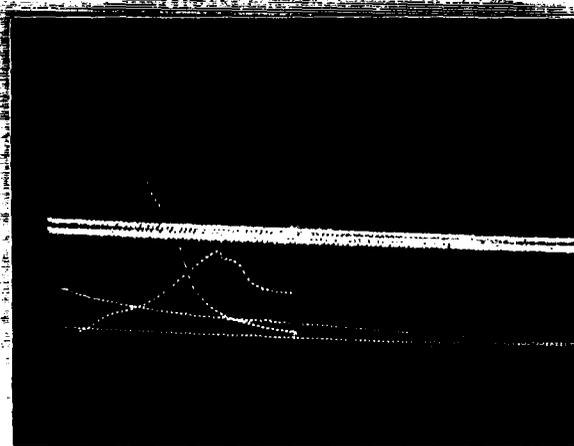


FIGURE 9. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 28 Amperes for 125 Microseconds.

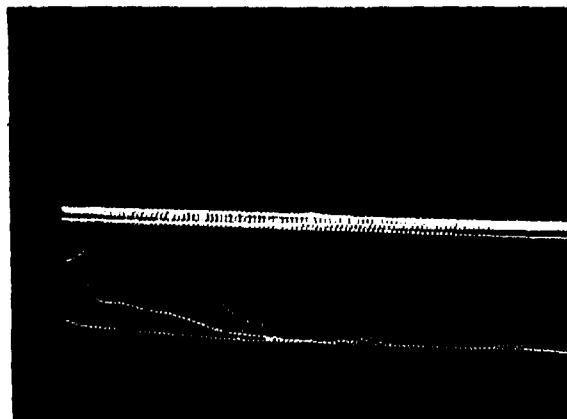


FIGURE 10. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 24 Amperes for 190 Microseconds.

OOY-TR-64-103

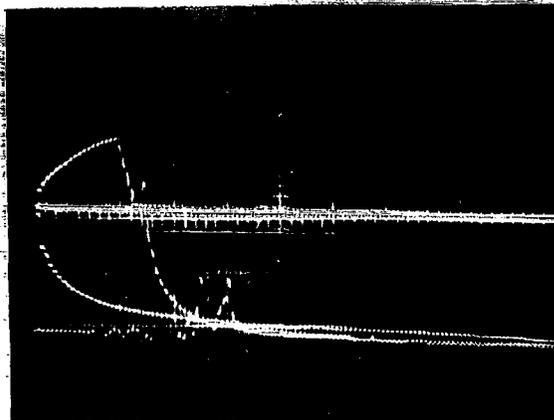


FIGURE 11. Oscilloscope Trace of DC Firing Pulse on E-76.  
Blasting Cap - 28 Amperes for 160 Microseconds.

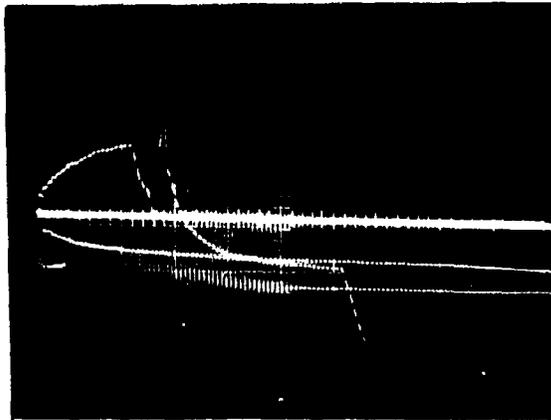


FIGURE 12. Oscilloscope Trace of DC Firing Pulse on E-76.  
Blasting Cap - 28 Amperes for 180 Microseconds.

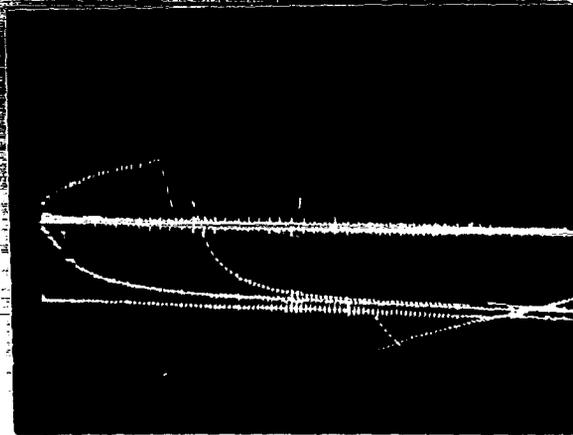


FIGURE 13. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 22 Amperes for 220 Microseconds.

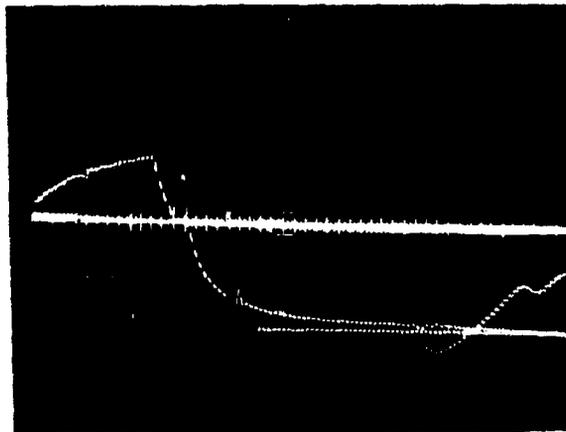


FIGURE 14. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 24 Amperes for 220 Microseconds.

00Y-TR-64-103

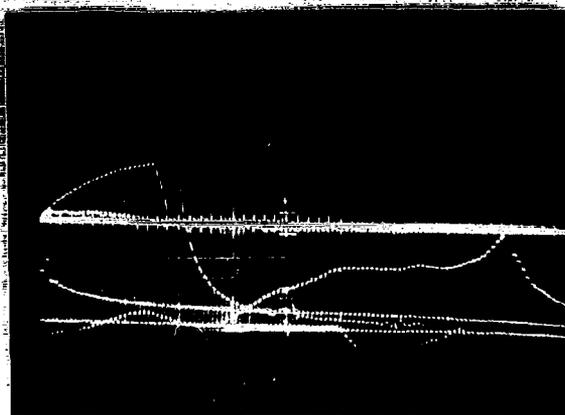


FIGURE 15. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 22 Amperes for 220 Microseconds.

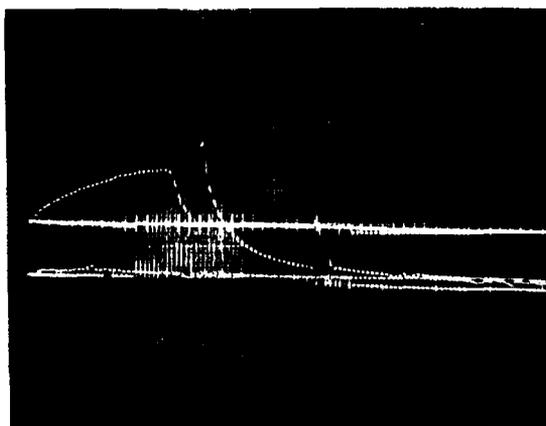


FIGURE 16. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 20 Amperes for 260 Microseconds.

00Y-TR-64-103

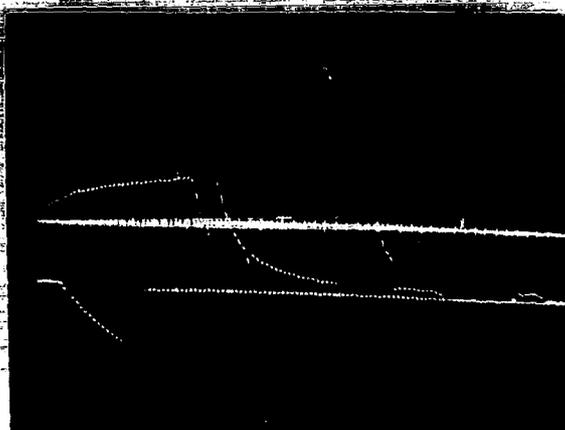


FIGURE 17. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 18 Amperes for 290 Microseconds.

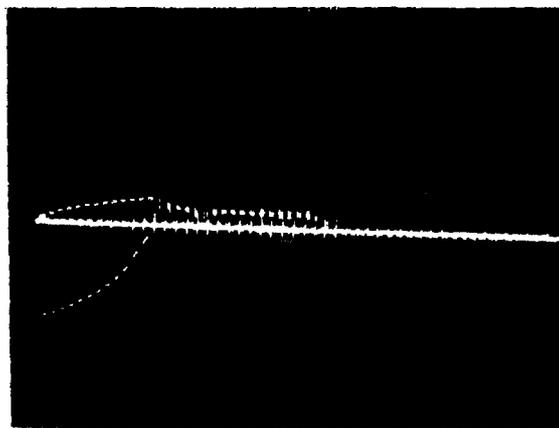


FIGURE 18. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 16.7 Amperes for 115 Microseconds.

OOY-TR-64-103

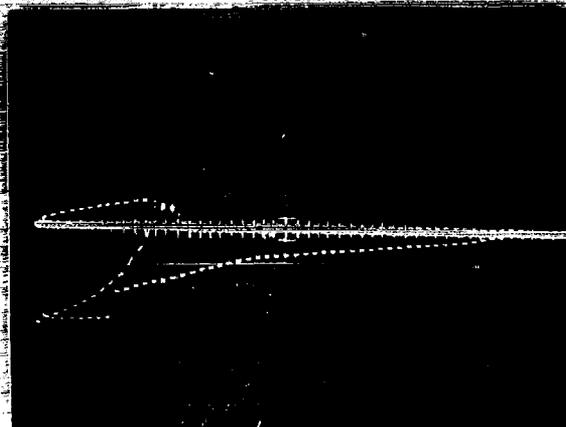


FIGURE 19. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 16.7 Amperes for 112 Microseconds.

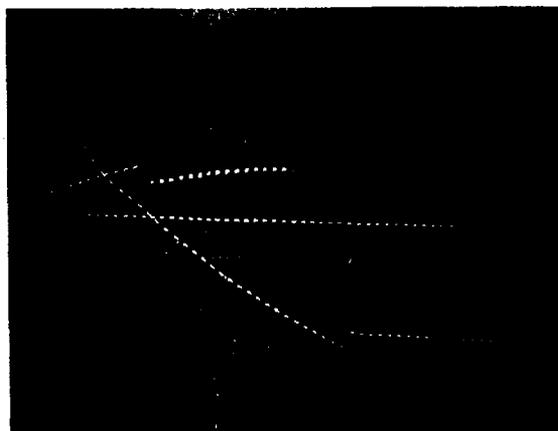


FIGURE 20. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 25 Amperes for 105 Microseconds.

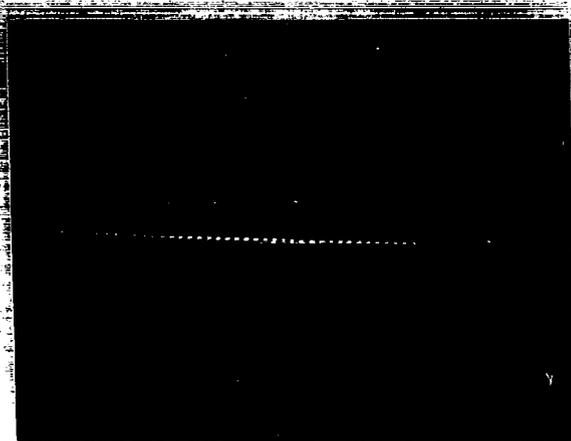


FIGURE 21. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 25 Amperes for 100 Microseconds.

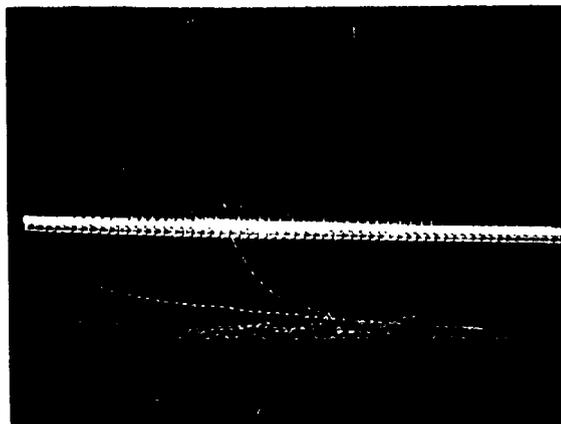


FIGURE 22. Oscilloscope Trace of DC Firing Pulse on E-76  
Blasting Cap - 27.5 Amperes for 105 Microseconds.

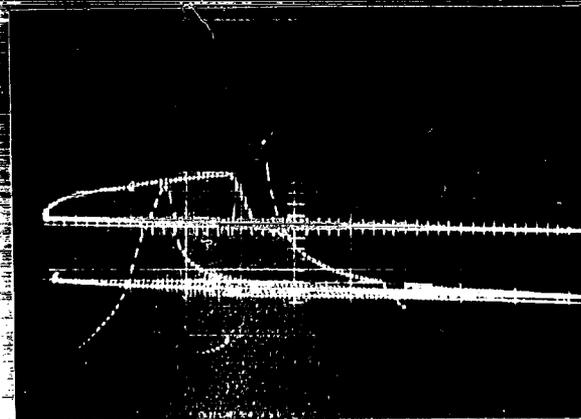


FIGURE 23. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 18 Amperes for 340 Microseconds.

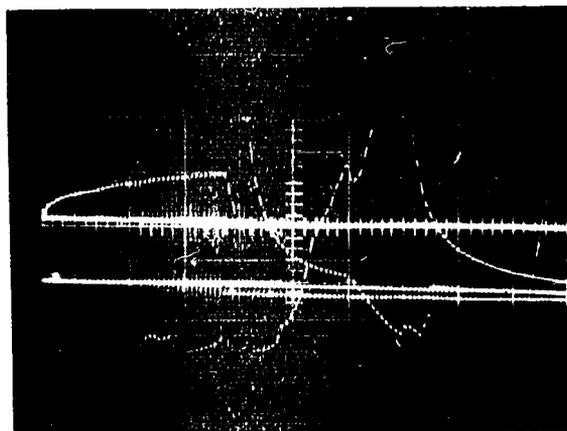


FIGURE 24. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 18 Amperes for 230 Microseconds.

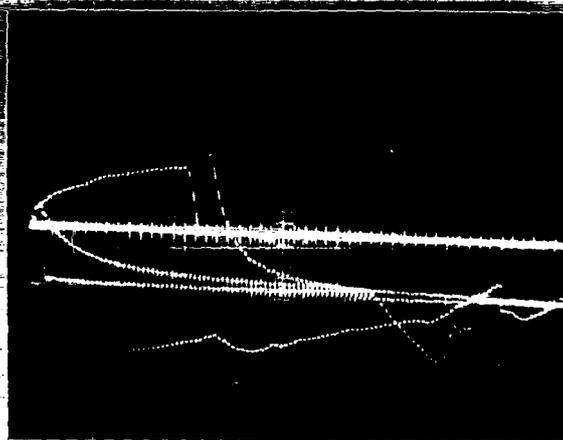


FIGURE 25. Oscilloscope Trace of DC Firing Pulse on E-81  
 Blasting Cap - 24 Amperes for 270 Microseconds.

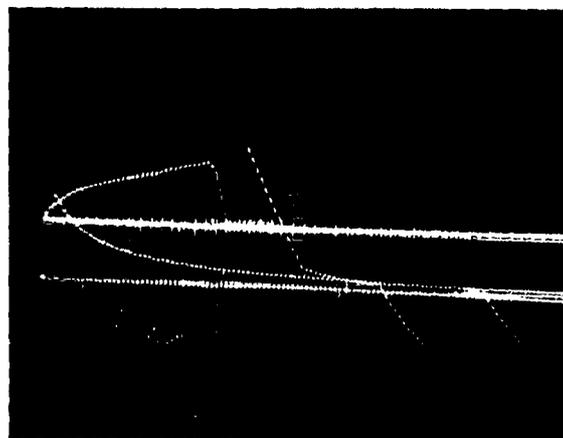


FIGURE 26. Oscilloscope Trace of DC Firing Pulse on E-81  
 Blasting Cap - 24 Amperes for 310 Microseconds.

OOY-TR-64-103

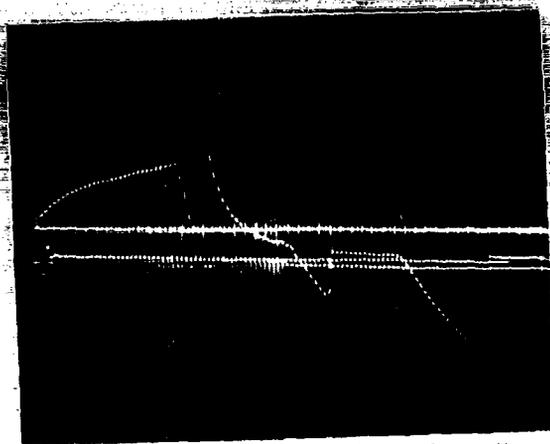


FIGURE 27. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 25.2 Amperes for 280 Microseconds.

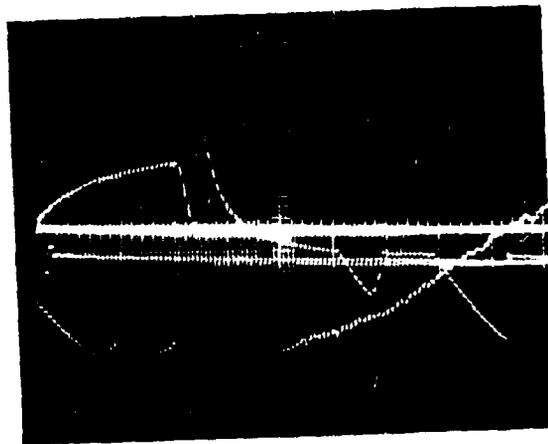


FIGURE 28. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 26 Amperes for 265 Microseconds.

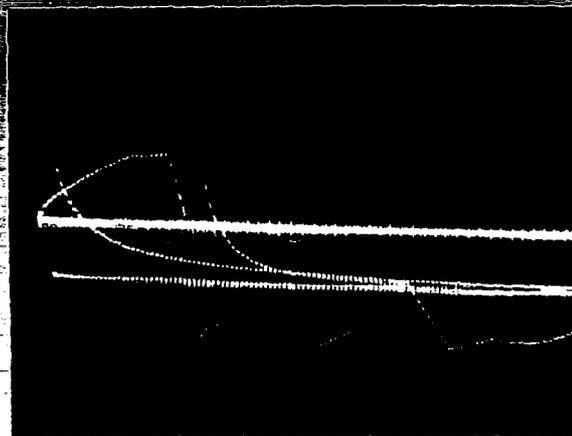


FIGURE 29. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 26 Amperes for 270 Microseconds.

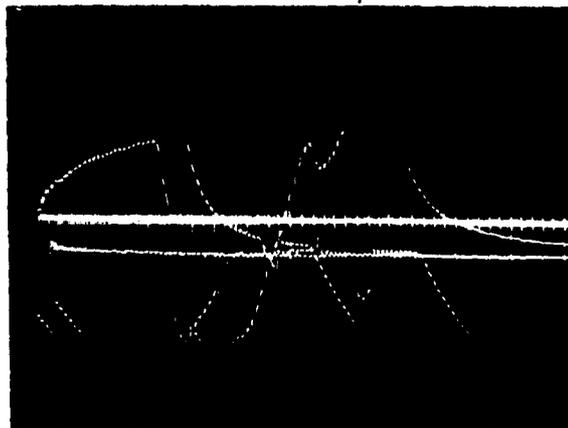


FIGURE 30. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 28.4 Amperes for 190 Microseconds.

OOY-TR-64-103

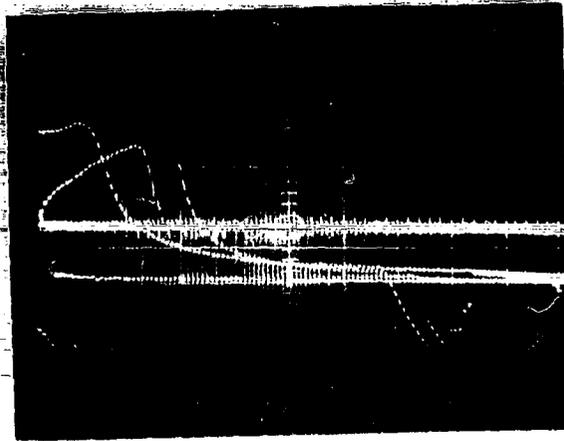


FIGURE 31. Oscilloscope trace of AC Firing Pulse on E-81  
Blasting Gap - 30 Amperes for 200 Microseconds.

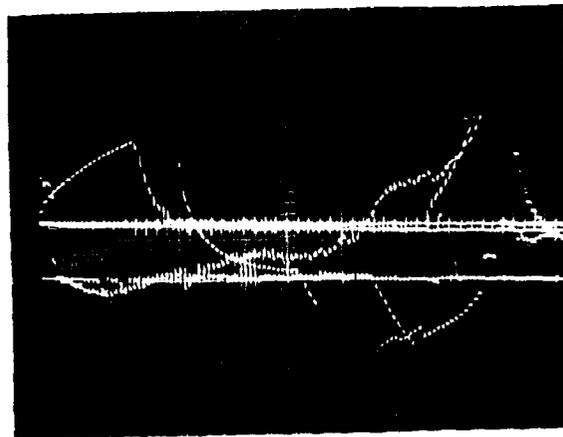


FIGURE 32. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Gap - 30 Amperes for 170 Microseconds.

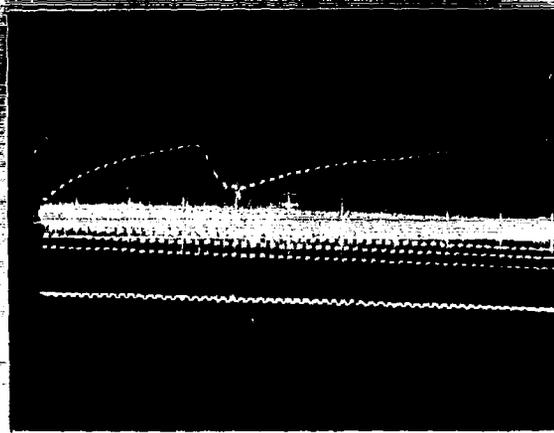


FIGURE 33. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 28 Amperes for 150 Microseconds.

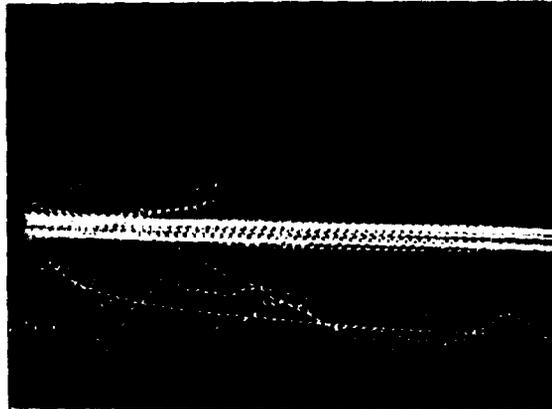


FIGURE 34. Oscilloscope Trace of DC Firing Pulse on E-81  
Blasting Cap - 28 Amperes for 135 Microseconds.

00Y-TR-64-103



FIGURE 35. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 7.2 Amperes for 350 Microseconds.

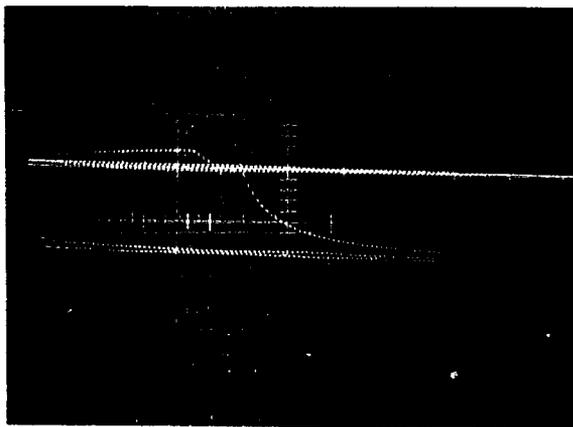


FIGURE 36. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 6.5 Amperes for 300 Microseconds.

00Y-TR-64-103

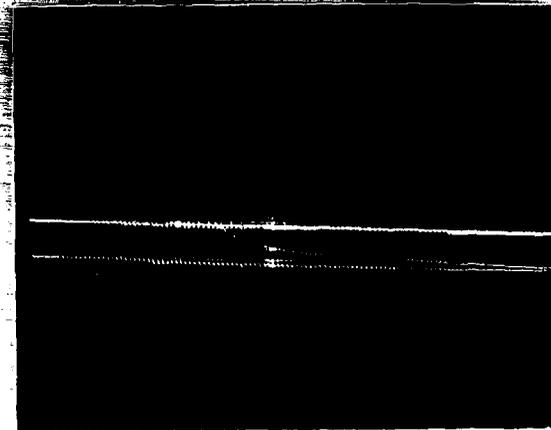


FIGURE 37. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 24.4 Amperes for 220 Microseconds.

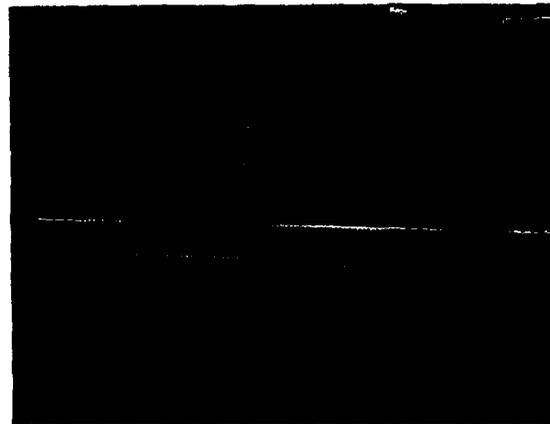


FIGURE 38. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 24 Amperes for 280 Microseconds.

OOY-TR-64-103

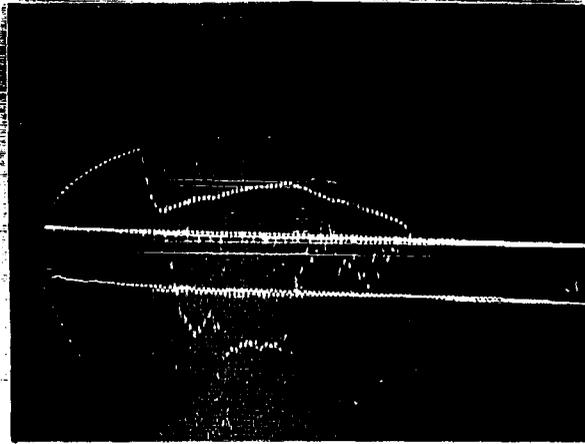


FIGURE 39. Oscilloscope Trace of DC Firing Pulse on S-68  
Squib - 20 Amperes for 170 Microseconds.

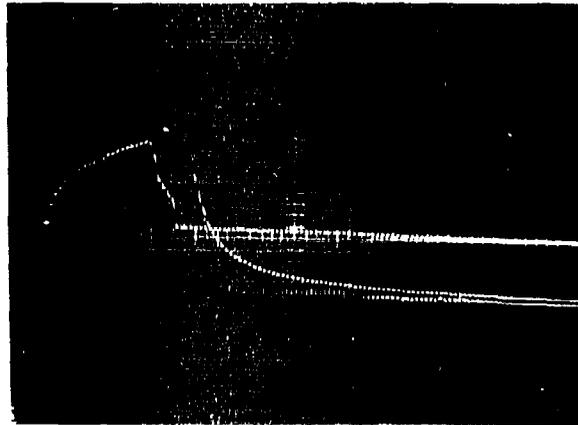


FIGURE 40. Oscilloscope Trace of DC Firing Pulse on S-68  
Squib - 11.5 Amperes for 150 Microseconds.



FIGURE 41. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 31.6 Amperes for 180 Microseconds.

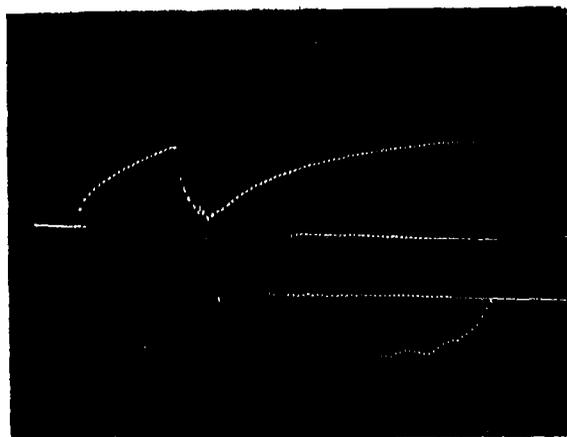


FIGURE 42. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 32 Amperes for 190 Microseconds.

OOY-TR-64-103

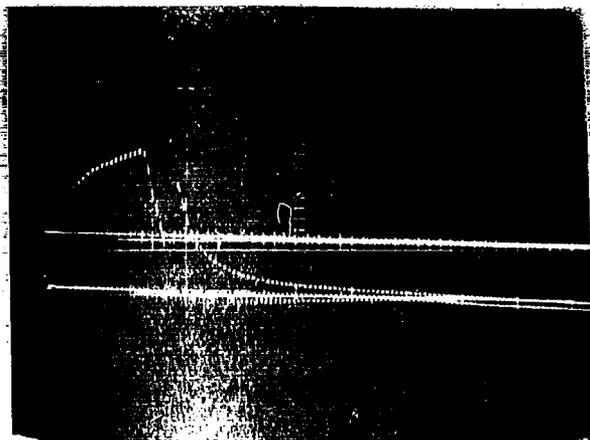


FIGURE 43. Oscilloscope Trace of DC Firing Pulse on S-68  
Squib - 20 Amperes for 180 Microseconds.

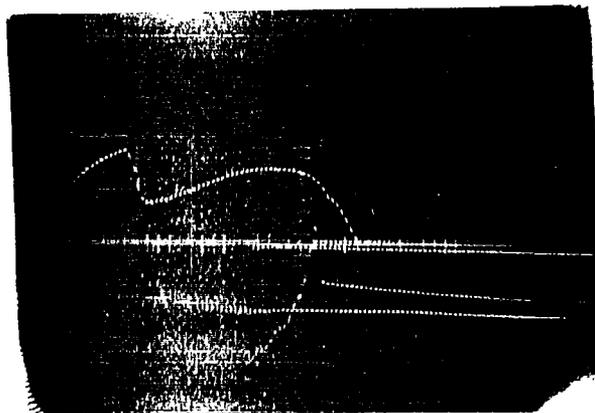


FIGURE 44. Oscilloscope Trace of AC Firing Pulse on S-68  
Squib - 20 Amperes for 180 Microseconds.

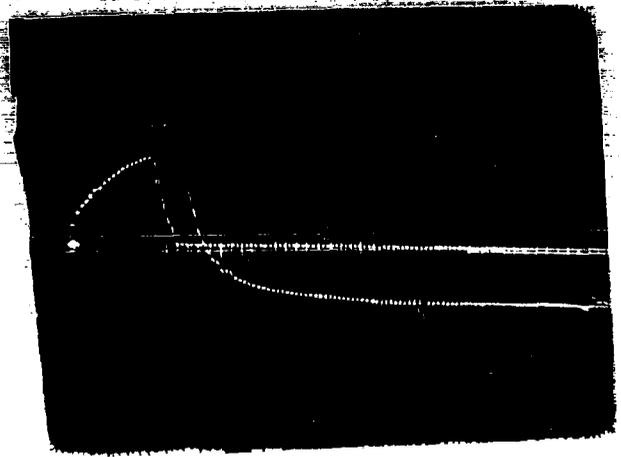


FIGURE 45. Oscilloscope Trace of DC Firing Pulse on S-6  
 (Scale: 2 Amperes for 138 Microseconds).

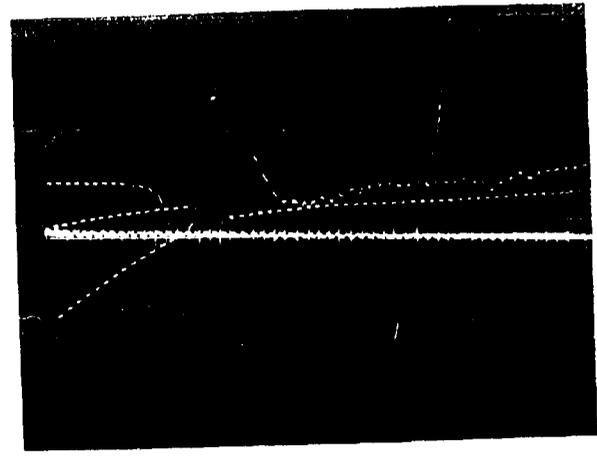


FIGURE 46. Oscilloscope Trace of DC Firing Pulse on S-6  
 (Scale: 2 Amperes for 138 Microseconds).

OOX-TR-64-103

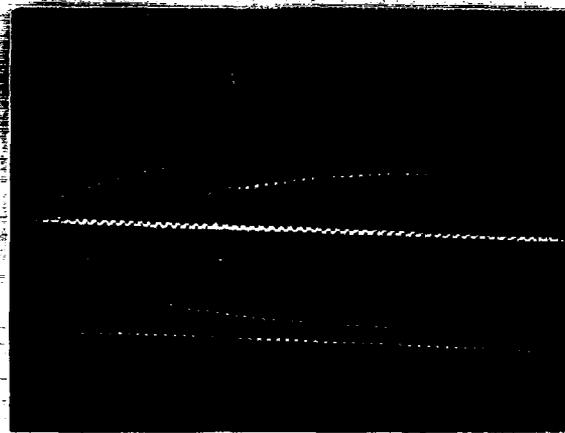


FIGURE 47. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 27.5 Amperes for 125 Microseconds.

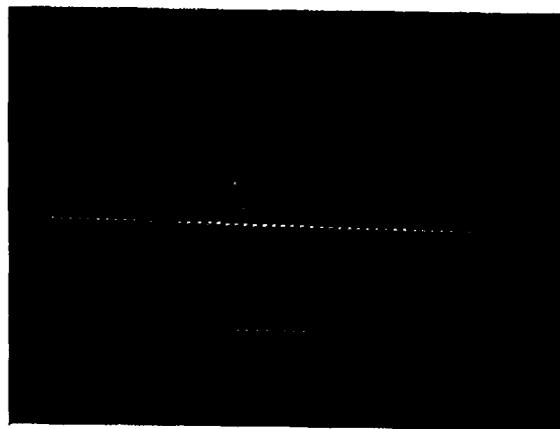


FIGURE 48. Oscilloscope Trace of DC Firing Pulse on S-68 Squib - 25 Amperes for 120 Microseconds.

The first test using RF Energy was made using a 300 megacycle transmitter. No squibs or blasting caps were functioned with this transmitter. The low impedance of the bridge wire and the length of the leads prevented any squibs or blasting caps being functioned with the low power supplied by this transmitter. The next step was performed using an eight (8) megacycle transmitter (ART-13). A number of squibs and blasting caps were functioned with this transmitter using both continuous wave (CW) and voice modulated (MVC) outputs. An analysis of the data obtained during the CW firings did not establish any trends. The ignition time and current levels measured were random. The best photographs of the traces when using CW are given in Figures 49 through 56. When using voice modulation the transmitter power builds up slower than it does in CW operation. Most of the items in which voice modulation was used functioned while the power was still increasing. Therefore, when a little higher power was required to function the items a longer ignition time was obtained. This condition indicated only that a higher current was required and not that the items would not function in a shorter time if a higher current had been obtained sooner. The trace in Figure 57 is of a blasting cap which did not function. The best photographs of the traces when firing with MVC are given in Figures 58 through 68. It is noted that the photographs given in Figures 3 through 68 do not cover all the items for which data is available. Many other photographs were readable but were not clear enough for reproduction.

During the voice modulated firings, three firings were made in which a loop of 1/4 inch metal tape was placed on the blasting cap leads. This metal tape produced a pulse just after the blasting cap functioned. This pulse is shown in Figure 60. The next two firings were made using two loops of the 1/4 inch metal tape. The loops were placed about one-half inch apart. In the first firing using the two loops the pulse occurred just before the blasting cap functioned. This trace is shown in Figure 61. In the second firing using two loops the pulse was delayed until 45 milliseconds after the blasting cap functioned. The photograph of this firing trace is given in Figure 62. It can be seen from these traces that some energy is absorbed by the metal tape and then given back again at another time. It is possible that this method could reduce the RF Energy going to the squib or blasting cap. However, if the energy absorbed by the metal tape was returned to the electrical circuit before the item functioned, as shown in Figure 61, the presence of the metal tape could add to the RF Energy hazard.

OUT-TR-64-103

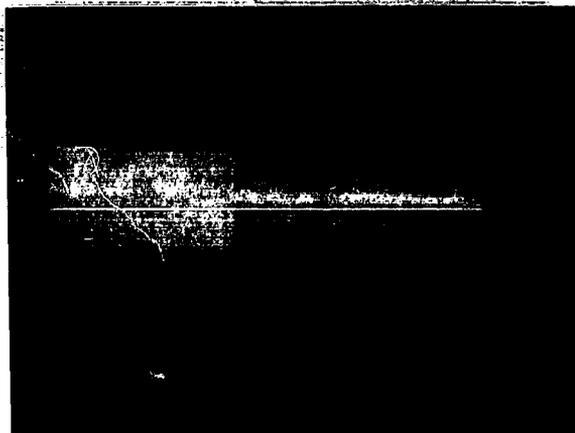


FIGURE 49. Oscilloscope Trace of 8 Megacycle CW Firing Signal  
E-76 Blasting Cap - 9.5 Amperes for 300 Milliseconds

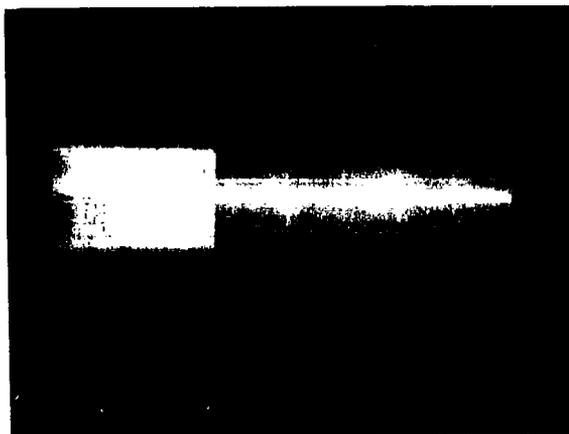
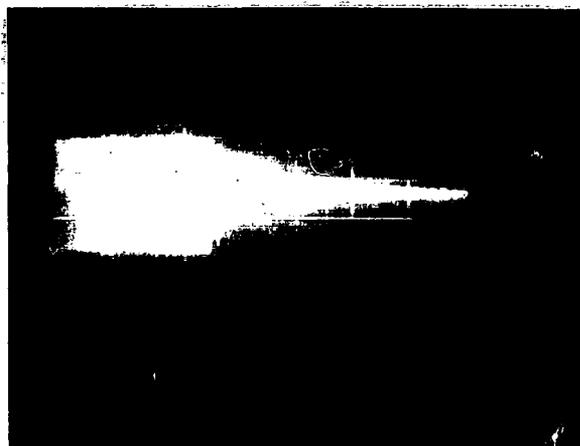
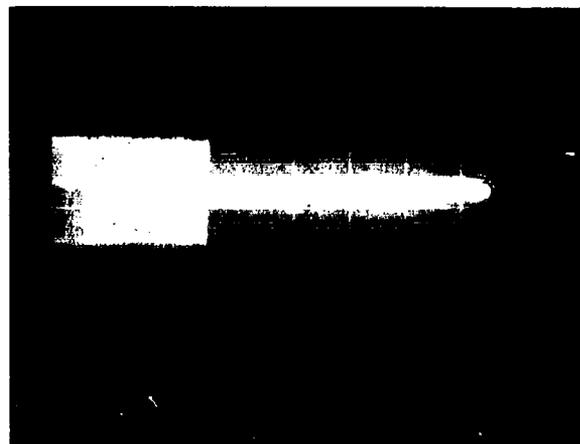


FIGURE 50. Oscilloscope trace of 8 Megacycle CW Firing Signal  
E-76 Blasting Cap - 9.5 Amperes for 300 Milliseconds



**FIGURE 51.** Oscilloscope Trace of 8 Megacycle CW Firing Pulse on E-76 Blasting Cap - 10 Amperes for 280 Milliseconds.



**FIGURE 52.** Oscilloscope Trace of 8 Megacycle CW Firing Pulse on E-76 Blasting Cap - 9.5 Amperes for 290 Milliseconds.

DDY-TR-67-103

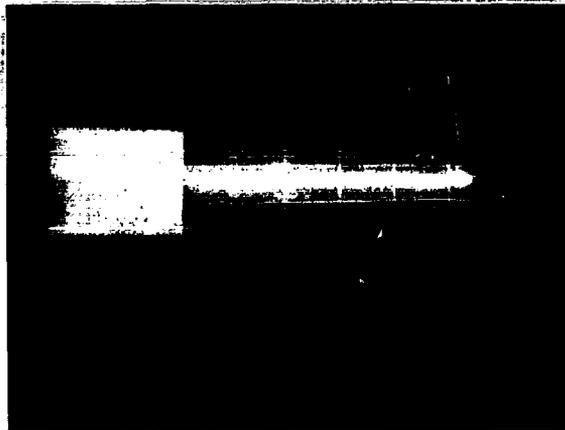


FIGURE 53. Oscilloscope Trace of 8 Megacycle CW Firing Pulse on S-68 Squib - 10 Amperes for 250 Milliseconds.

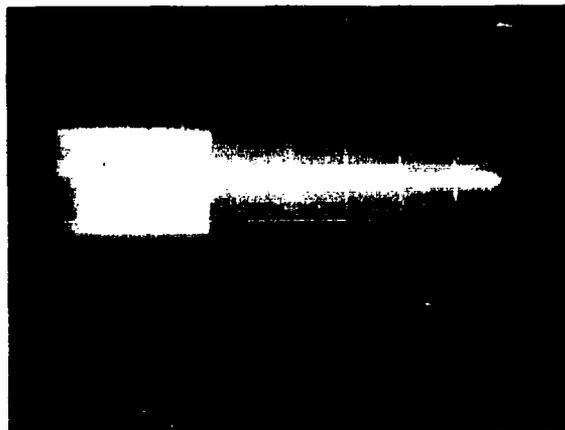


FIGURE 54. Oscilloscope Trace of 8 Megacycle CW Firing Pulse on S-68 Squib - 10 Amperes for 290 Milliseconds.



FIGURE 55. Oscilloscope Trace of 8 Megacycle CW Firing Pulse of S-68 Squib - 9.5 Amperes for 270 Milliseconds.

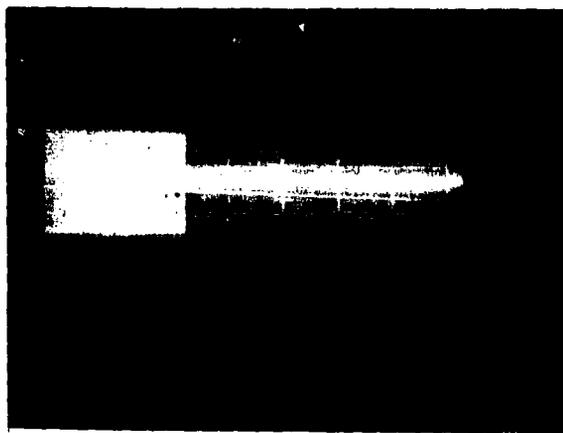


FIGURE 56. Oscilloscope Trace of 8 Megacycle CW Firing Pulse of S-68 Squib - 9.5 Amperes for 260 Milliseconds.

OOY-TR-64-103

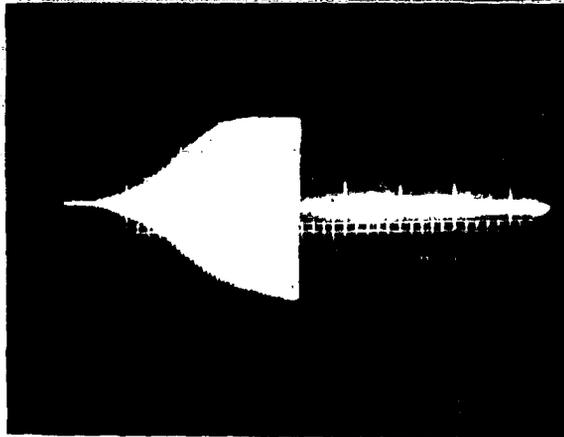


FIGURE 57. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on E-76 Blasting Cap - 16.5 Amperes for 440 Milliseconds.

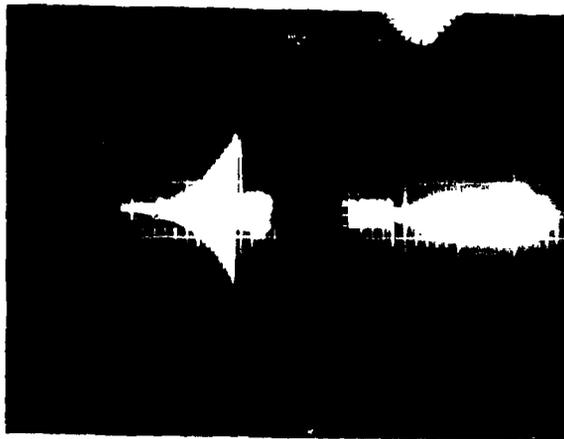


FIGURE 58. Oscilloscope Trace of 7 Megacycle MVC Firing Pulse on E-76 Blasting Cap - 13.6 Amperes for 125 Milliseconds.

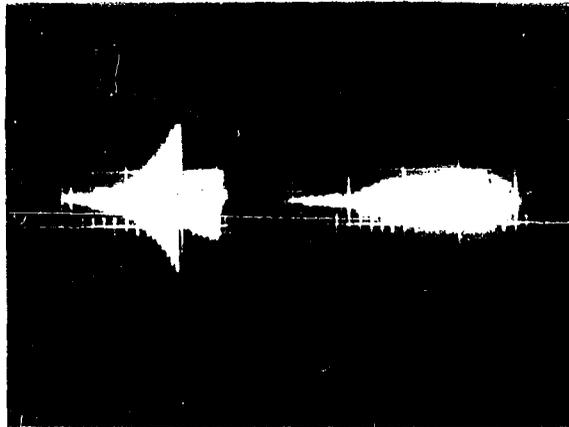


FIGURE 59. Oscilloscope Trace of Voltage of 2000 Cycle Pulse (0.5 Amps) with 2.5 Millisecond

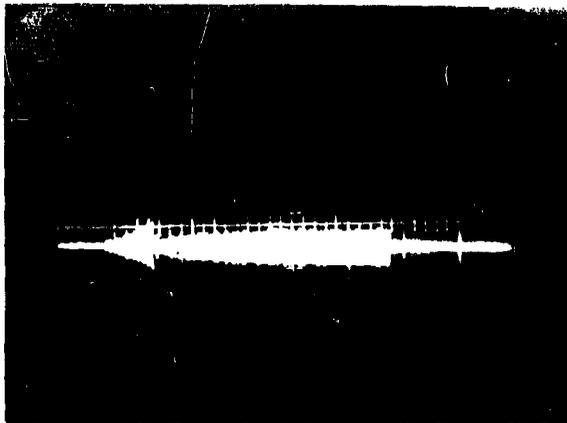


FIGURE 60. Oscilloscope Trace of 8 Megacycle MV. Pulse (0.5 Amps) with 2.5 Millisecond

00Y-TR-64-103

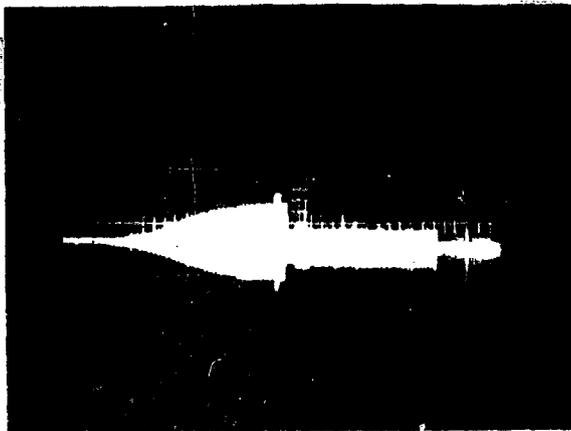


FIGURE 61. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on E-21 Blasting Cap - 7 Amperes for 320 Milliseconds.

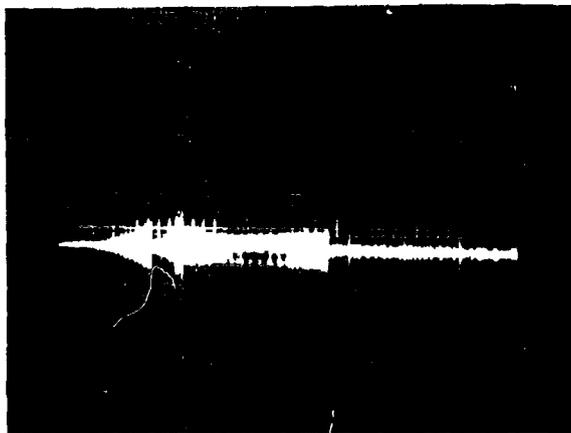


FIGURE 62. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on E-21 Blasting Cap - 4.5 Amperes for 100 Milliseconds.

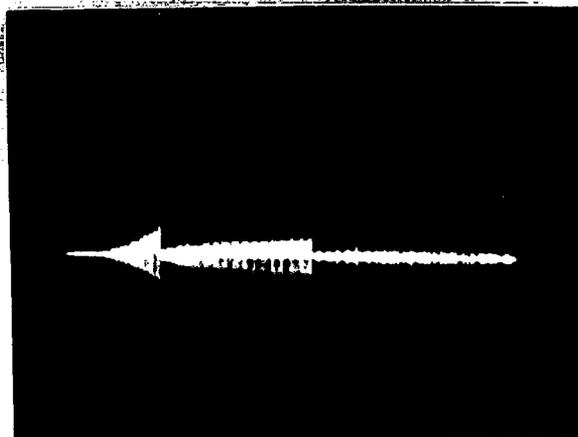


FIGURE 63. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on E-81 Blasting Cap - 5 Amperes for 100 Milliseconds.

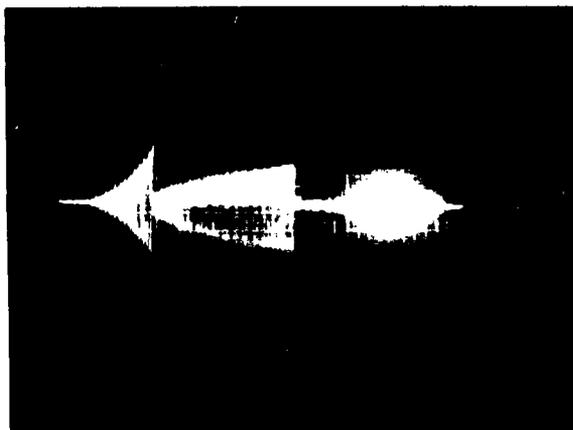


FIGURE 64. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on E-81 Blasting Cap - 10.5 Amperes for 110 Milliseconds.



FIGURE 65. Oscilloscope Trace of 8 Megacycle MV Firing Pulse on E-81 Electrode - 11.5 Amperes for 130 Milliseconds.

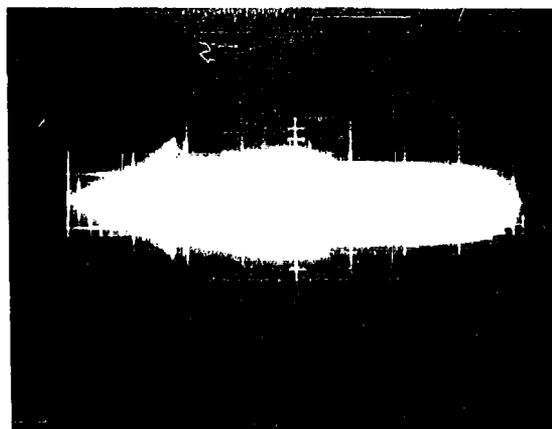


FIGURE 66. Oscilloscope Trace of 8 Megacycle MV Firing Pulse on S-68 Squib - 11.5 Amperes for 130 Milliseconds.

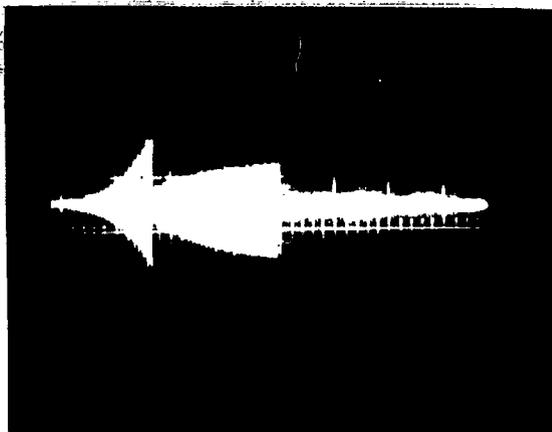


FIGURE 67. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on S-68 Squib - 12 Amperes for 130 Milliseconds.

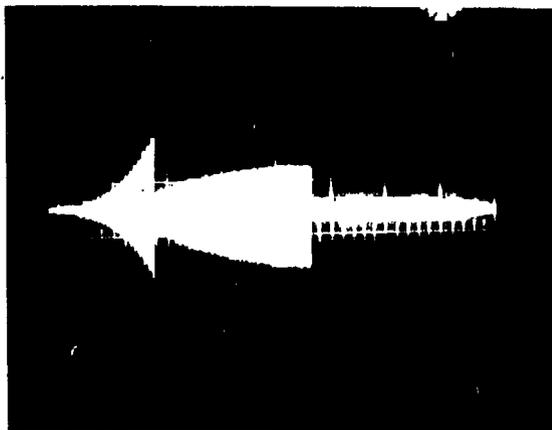


FIGURE 68. Oscilloscope Trace of 8 Megacycle MVC Firing Pulse on S-68 Squib - 13 Amperes for 130 Milliseconds.

OOY-TR-64-103

#### CONCLUSIONS

When using high current it is possible to function some items in 70 microseconds. This time is more than twice that produced by any of our present transmitters. The firings with RF Energy required somewhat longer times due to the lower current levels available. It is concluded from these tests that functioning of squibs or blasting caps with RF Energy is due to thermal stacking rather than to a single pulse.

#### RECOMMENDATIONS

It is recommended that in future tests of this kind a battery or capacitor type of power source be used. This will provide a faster rise time for the DC portion of this test.

## DISTRIBUTION LIST

- 3 Dep, Inspector General, Director of Aerospace Safety (Dep, TIG for Safety), Hq USAF (AFTAS-G2), Norton AFB, Calif
- 1 Hq USAF (AFSSS-AE), Wash 25, DC
- 2 AFLC (MGSWT & MCI-A-E), Wright-Patterson AFB, Ohio
- 1 AUL, Maxwell AFB, Ala
- 20 DDC (TISR), Cameron Stn, Alexandria, Va (22314)
- 1 Bureau of Naval Wpns (Code RMMO-5), Dep of the Navy, Wash 25, DC
- 1 US Army Mat Comd, Fld Safety Agcy, Charlestown, Ind
- 1 Safety Div (AMCAD-SA), US Army Mat Comd, Wash 25, DC
- 1 US Army Ammo Procurement and Supply Agcy (SMUAP-Q), Joliet, Ill
- 1 Hq AFSC (SCMMS-3), Andrews AFB, Wash 25, DC
- 1 CO, Picatinny Arsenal (Tech Info Lib), Dover NJ
- 1 MATS (MAMSS/SBG), Scott AFB, Ill
- 1 US Naval Propellant Plant (Tech Lib Code T2), Indian Head, Md
- 10 COAMA (1-OOYIT, 1-OOYIT-1, 1-OOYSS, 1-OOYEO, 1-OOAEP, 5-OOYEA), Hill AFB, Utah
- 3 ESD (ESSGD, ESSGE, ASRRM), Hanscom Field, Bedford, Mass
- 1 AFSC (SCSN), Andrews AFB, Wash 25, DC
- 2 ASD (ASSME, ASNDTE), Wright-Patterson AFB, Ohio
- 1 GEEIA (ROZIPS), Griffiss AFB, NY
- 2 E.I. DuPont De Nemours and Co, Pennsylvania Grove, NJ

<p>10 2705th Airborne Wing (OWMA), Hill Air Force Base, Utah CHARACTERISTICS OF HIGH CURRENT PULSED BEAMS AND BLASTING CAPS, by Kenneth A. Kertchauer, April 1964, 519 text, diagrams. (007-28-64-103) Unclassified Report</p> <p>Charts were available which gave the low current characteristics of the test squibs and blasting caps. These charts did not extend up to the desired current levels. The objective of the test was to extend these charts to include the high current characteristics. Also an attempt was made to determine the minimum time required to fire the squibs when using short high current pulses. From this test it was determined that the E-81 Blasting Cap could be functioned in 70 microseconds using 140 volts supplied by a direct current arc welder. The charts which were available did not include any curves showing what the squibs and blasting caps reaction would be when exposed to radio frequencies. An observation about this data related the test conditions were power was applied to the squibs and blasting caps. During the radio frequency part of the test, an ER-13 transmitter, set at 8 megacycles, was used to function the test items. The current and the radio frequency part of the test, on ER-13 transmitter, Polarisat camera. An analysis of the test data related that even though the direct current arc welder could supply over 300 amperes, this amount was never drawn. A maximum current was not obtained because of limitations in the leads and generator windings. The functioning of squibs and blasting caps with high direct current and with radio frequency current required several times as much time as the maximum pulse width of our present radar transmitters.</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>
<p>10 2705th Airborne Wing (OWMA), Hill Air Force Base, Utah CHARACTERISTICS OF HIGH CURRENT PULSED BEAMS AND BLASTING CAPS, by Kenneth A. Kertchauer, April 1964, 519 text, diagrams. (007-28-64-103) Unclassified Report</p> <p>Charts were available which gave the low current characteristics of the test squibs and blasting caps. These charts did not extend up to the desired current levels. The objective of the test was to extend these charts to include the high current characteristics. Also an attempt was made to determine the minimum time required to fire the squibs when using short high current pulses. From this test it was determined that the E-81 Blasting Cap could be functioned in 70 microseconds using 140 volts supplied by a direct current arc welder. The charts which were available did not include any curves showing what the squibs and blasting caps reaction would be when exposed to radio frequencies. An observation about this data related the test conditions were power was applied to the squibs and blasting caps. During the radio frequency part of the test, on ER-13 transmitter, set at 8 megacycles, was used to function the test items. The current and the radio frequency part of the test, on ER-13 transmitter, Polarisat camera. An analysis of the test data related that even though the direct current arc welder could supply over 300 amperes, this amount was never drawn. A maximum current was not obtained because of limitations in the leads and generator windings. The functioning of squibs and blasting caps with high direct current and with radio frequency current required several times as much time as the maximum pulse width of our present radar transmitters.</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>	<p>UNCLASSIFIED</p> <p>1. Squibs 2. Blasting Caps 1. Kenneth A. Kertchauer</p>