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VOLTAGE BREAKDOWN OF KDNBF AND KDNBF/DE SAMPLES

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AUGUST 1972

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PICATINNY ARSENAL

DOVER, NEW JERSEY

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13. ABSTRACT

The voltage breakdown or dielectric strength for KDNBF and KDNBF/DE was determined by two methods - the teflon tube method and the ball method. In this report, each method is described and the results are listed. The samples were pressed at 5,000 and 15,000 psi. The values obtained by the ball method are higher since the samples were not confined and the edge effects were much smaller. In both cases, the test results indicate that the dielectric strength decreases as the density increases.

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KDNBF/DE (KNDBF/diatomaceous earth)						
Teflon tube method for determining voltage breakdown						
Ball method for determining voltage breakdown						
Dielectric strength						
Apparatus						
Brass shot						
Effects of confinement						
Edge effects						
Effects of density (by pressing at 5,000 and 15,000 psi)						
Pulsed electron beams						
Electroexplosive devices						
Effects of vacuum						

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by
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ABSTRACT

The voltage breakdown or dielectric strength for KDNBF and KDNBF/DE was determined by two methods - the teflon tube method and the ball method. In this report, each method is described and the results are listed. The samples were pressed at 5,000 and 15,000 psi. The values obtained by the ball method are higher since the samples were not confined and the edge effects were much smaller. In both cases, the test results indicate that the dielectric strength decreases as the density increases.

INTRODUCTION

Current studies of the effects of pulsed-electron beams on electroexplosive devices have developed a need to know the breakdown voltage for the explosive materials used in these devices. This report describes the techniques used to determine the dielectric strength of potassium dinitrobenzofuroxan (KDNBF) and a 50/50 mixture of KDNBF and diatomaceous earth (50/50 KDNBF/DE).

EXPERIMENTAL PROCEDURES

In determining the dielectric breakdown voltage of KDNBF and 50/50 KDNBF/DE, two experimental techniques were used. One is designated the teflon tube technique while the other is called the ball method.

The first technique, called the dielectric breakdown voltage method using the teflon tube, was developed by W. Voreck (Ref 1). A sketch of the apparatus is shown in Figure 1 while the fixture is pictured in Figure 2.

The explosive mixture was loaded into the teflon tube and tests were performed in the following way: From .110 inch O.D. drill rods, 1/2 inch long steel pins were cut with flat surfaces. Two steel pins were force fitted together in a teflon tube. Each assembly was weighed and its overall length was measured. Then one pin was removed and weighed charge was poured into the tube with one pin as the base. The steel pin which had been removed was then reinserted by forced fit into the tube and the charge was consolidated in a press at the pressure desired with a dwell time of at least 20 seconds. The assembly (Fig 3) was then reweighed and the new overall length was measured. From this, the thickness and density of the explosive wafers were determined.

The explosive-loaded fixture was then replaced in a dc circuit as shown in the diagram (Fig 3). The voltage was slowly increased by adjusting the powerstat. The maximum voltage is recorded because, when the dielectric strength of the explosive is overcome, there is a significant drop in the voltage.

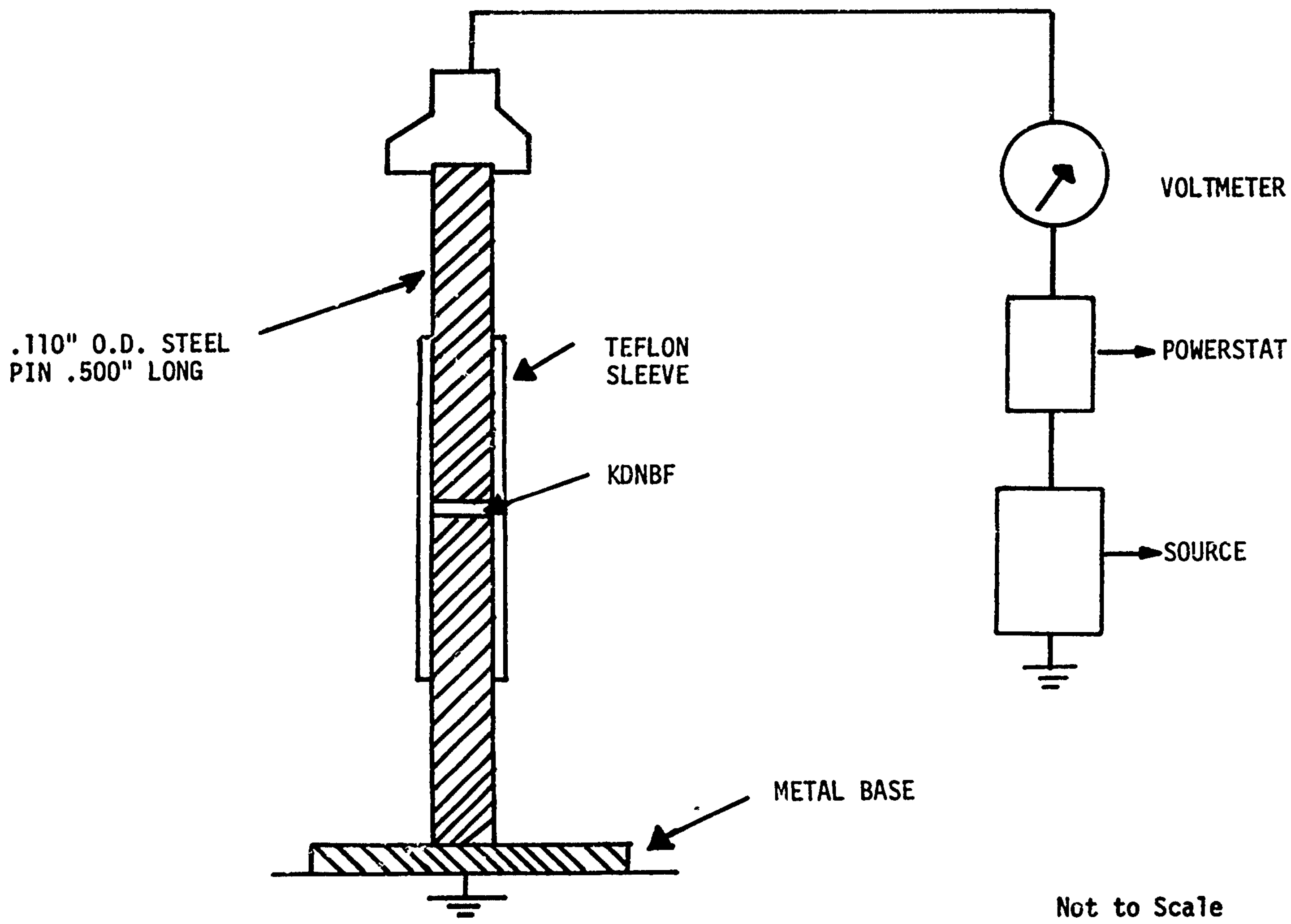

FIGURE 1 - Diagram of dielectric breakdown voltage method using the Teflon Tube

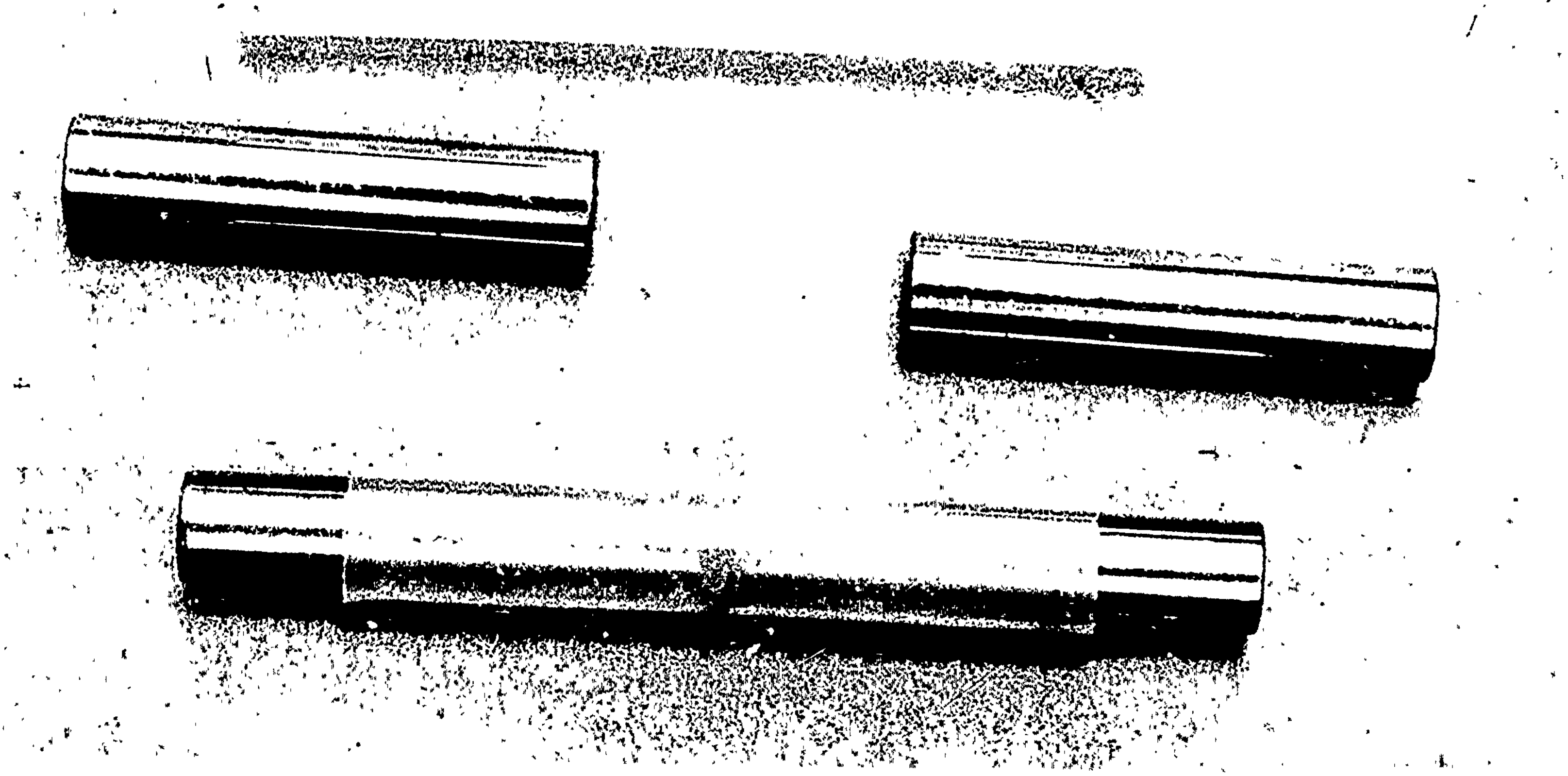

FIGURE 2 - Teflon Tube Fixture for breakdown voltage test

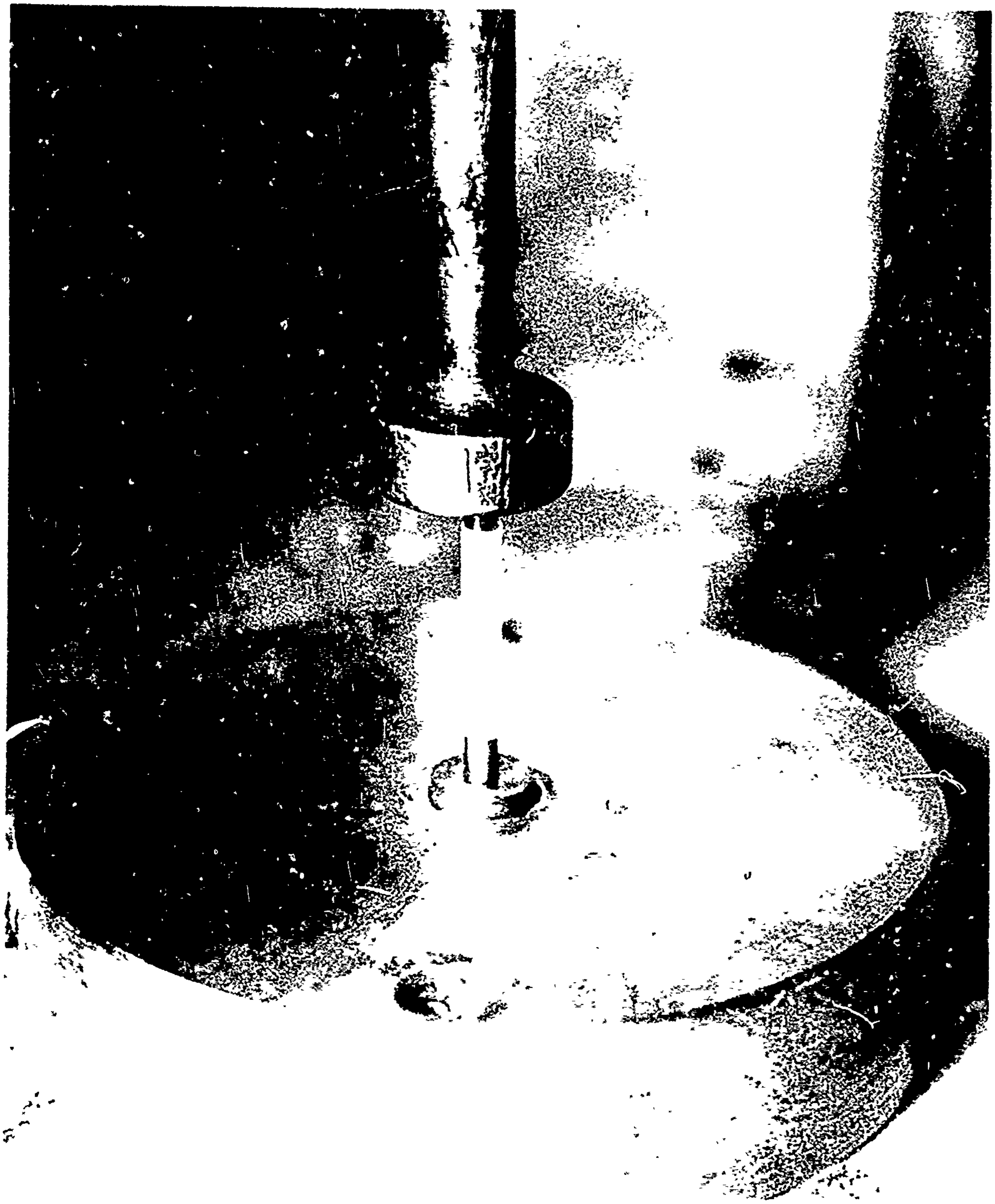

FIGURE [illegible] apparatus

The second method is relatively simple. An explosive wafer 1/8 inch in diameter is placed on a metal base plate. On this pellet, is placed a 1/8 inch brass ball (weighing 350 mg) around which a copper coil is wrapped to insure proper contact. This diagram, as designed by B. Pollock (Ref 2), is sketched in Figure 4 and the actual fixture is pictured in Figure 5. The brass sphere is kept in contact with the top surface of the pellet. As in the first method, the voltage is increased until the breakdown occurs.

In this program, the explosives came from materials on hand. The KDNBF came from P.A. Lot SMUPA 7172 while the 50/50 KDNBF/DE mixture, already prepared, was composed of KDNBF from Atlas Lot X81-16K and commercial diatomaceous earth. In order to simulate the loading pressures encountered in the electro-explosive devices, the explosive materials were consolidated at two pressures, one group at 5000 psi and the other at 15,000 psi for both methods. For tests using the teflon tube method, the explosive material was compressed in the tube by applying the indicated pressure between the pins for 20 seconds. For tests of the second method, two groups of 0.125-inch-diameter pellets of each mixture were pressed, one group at 5,000 psi and the other at 15,000 psi, both with a dwell time of 20 seconds.

RESULTS

The dielectric strength or breakdown firing voltage results obtained by the teflon tube method are listed in Table 1. Although the number of samples was small for most of these tests, the results indicate that, for the Picatinny Arsenal-manufactured KDNBF, the dielectric strength was 43.0 volts/mil for samples pressed at 5,000 psi with an average density of 1.666 g/cc and a thickness of .0221 inch. The KDNBF samples pressed at 15,000 psi with an average density of 1.881 g/cc and a thickness of .0253 inch produced a dielectric strength of 34.8 volts/mil.

The KDNBF/DE samples which consisted of KDNBF from Atlas Lot X81-16K and commercial diatomaceous earth were manufactured at the same loading pressures. For the 5,000 psi samples, the average density was 1.063 g/cc and the thickness .0215 inch. The dielectric strength for the 5,000 psi KDNBF/DE samples was 40.9 volts/mil. For 15,000 psi, the density was 1.371 g/cc, the thickness .0206 inch, and the dielectric strength 40.6 volts/mil.

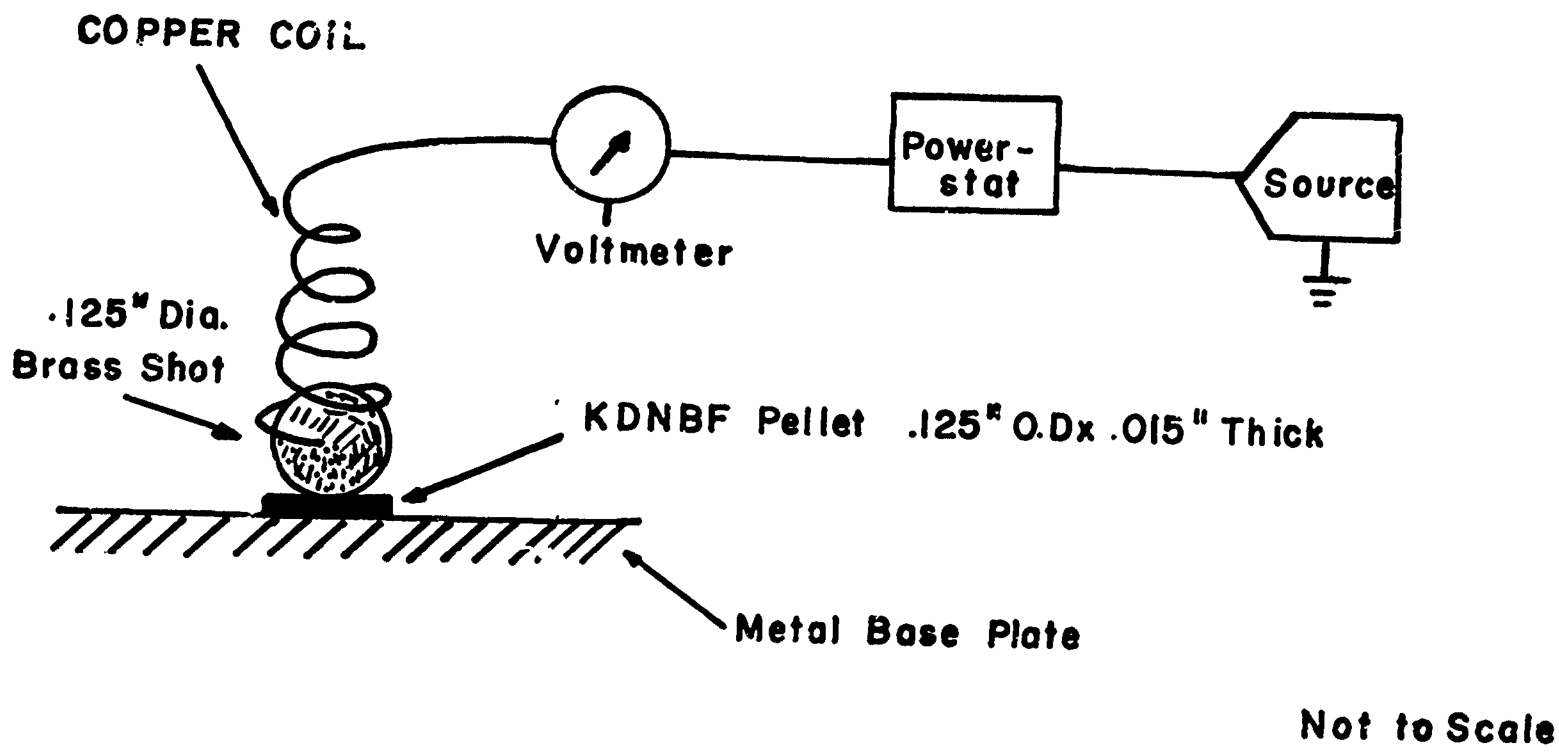

FIGURE 4 - Diagram of dielectric breakdown voltage method using brass shot

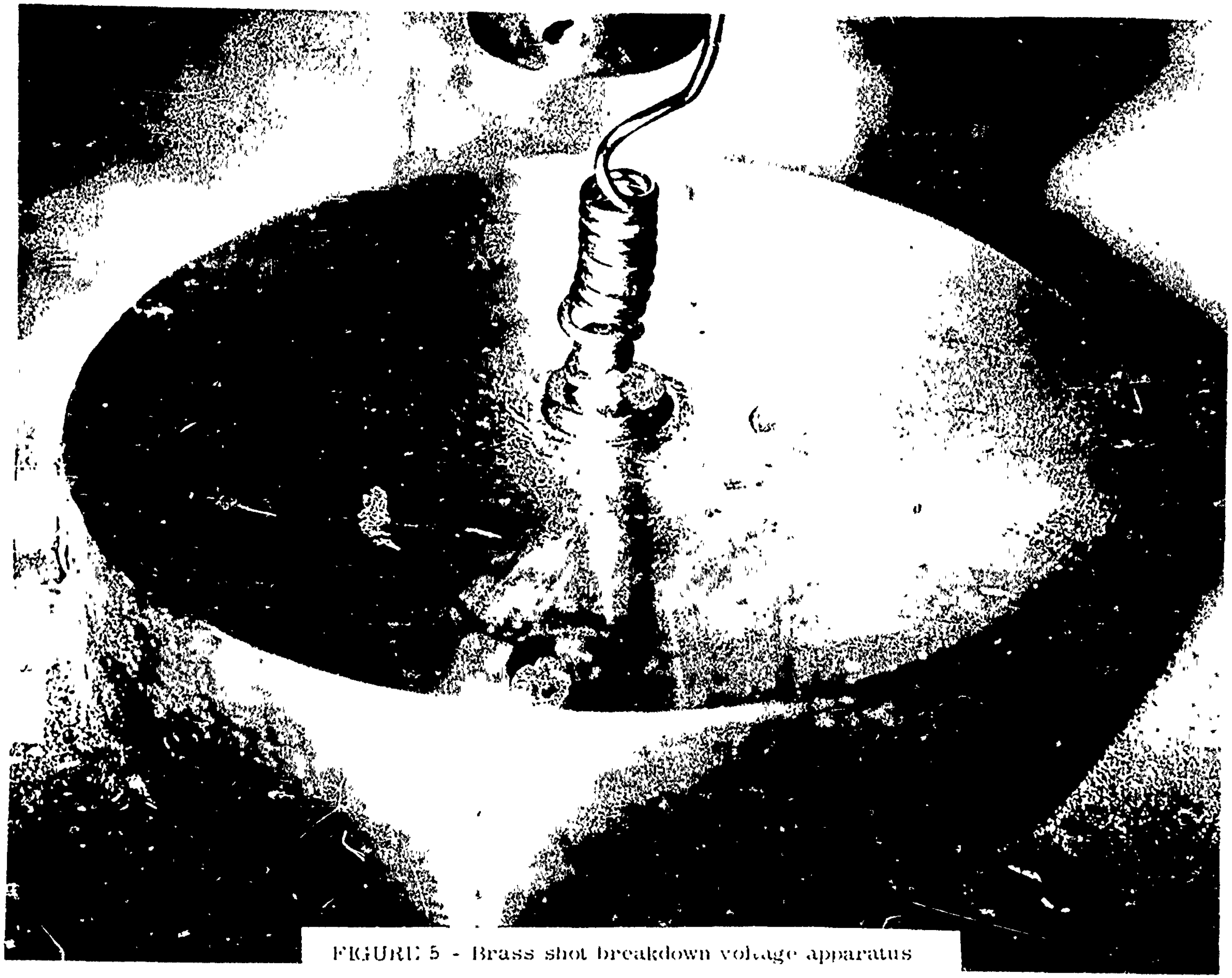

FIGURE 5 - Brass shot breakdown voltage apparatus

TABLE 1

Dielectric strength or breakdown voltage
by teflon tube method for KDNBF

Explosive	Pressure PSI	Weight G	Length Inch	Density g/cc	Peak Voltage Volts	Dielectric Strength Volts/Mil
KDNBF	5000	.0050	.0193	1.664	900	46.6
(P.A. Lot	5000	.0055	.0227	1.556	900	39.6
SMUPA 7172)	5000	.0058	.0227	1.641	900	39.6
	5000	.0060	.0217	1.776	1000	46.1
	5000	.0064	.0243	1.691	2700	111.1*
	Ave. 5000	.0057	.0221	1.666	1280	43.0
KDNBF	15000	.0086	.0288	1.918	900	31.3
(P.A. Lot	15000	.0088	.0313	1.805	900	28.8
SMUPA 7172)	15000	.0057	.0190	1.926	800	42.1
	15000	.0070	.0254	1.770	900	35.4
	15000	.0068	.0220	1.985	800	36.4
	Ave. 15000	.0074	.0253	1.881	860	34.8
KDNBF/DE	5000	.0036	.0221	1.055	900	40.7
(Atlas Lot	5000	.0036	.0230	1.011	900	39.1
X81-16K)	5000	.0035	.0213	1.052	800	37.5
	5000	.0035	.0206	1.100	900	43.7
	5000	.0035	.0207	1.095	900	43.5
	Ave. 5000	.0035	.0215	1.063	880	40.9
KDNBF/DE	15000	.0034	.0161	1.356	900	55.9
(Atlas Lot	15000	.0045	.0216	1.326	800	37.0
X81-16K)	15000	.0043	.0197	1.415	800	40.6
	15000	.0043	.0207	1.346	900	43.4
	15000	.0045	.0207	1.353	900	43.4
	15000	.0047	.0215	1.398	800	37.2
	15000	.0046	.0218	1.361	800	36.7
	15000	.0047	.0217	1.379	800	36.8
	15000	.0046	.0217	1.352	800	36.8
	15000	.0046	.0209	1.426	800	38.2
	Ave. 15000	.0044	.0206	1.371	830	40.6±6.01

NOTE: R.T. 69°F
R.H. 58%

*Omitted from average

The results obtained for the ball method are listed in Table 2. It is to be noted that the voltage was very slowly increased until the breakdown occurred. The breakdown was usually observed as a flash, as a noise, and/or as a leakage in the voltmeter reading. The KDNBF pellets gave a noise and the residues were black. However, with the KDNBF/DE pellets the breakdowns were noted by a flash and partial disintegration of the pellet with evidence of partial burning.

The KDNBF pellets pressed at 5,000 psi had an average density of 1.15 g/cc for a thickness of .015 inch. The dielectric strength for these pellets was 104.8 volts/mil. With a loading pressure of 15,000 psi, the density was 1.337 g/cc with the same thickness. An average value of 86.0 volts/mil was obtained for the dielectric strength.

The KDNBF/DE pellets were also in two groups, one pressed at 5,000 psi and the other at 15,000 psi. For the 5,000 psi group, the average density was 0.85 g/cc with a thickness of .015 inch. These pellets produced a dielectric strength of 128.5 volts/mil. The KDNBF/DE pellets pressed at 15,000 psi had an average density of 1.07 g/cc for the same thickness. The dielectric strength for these pellets was 118.8 volts /mil.

SUMMARY AND CONCLUSIONS

The results for the dielectric strength or voltage breakdown for KDNBF and KDNBF/DE samples as performed by the teflon tube and the ball method indicate on a general basis that the dielectric strength decreases as the density increases.

Athough the explosive samples in the teflon tube method were pressed between two plates with the diameter large compared to the thickness, the possibility of edge effects cannot be ruled out even though each sample was confined.

In the ball method test, the diameter was a little larger but the contact area between the ball and the explosive was much smaller even though the thickness was also smaller. It is believed that the smaller contact area resulted in the higher dielectric strength values by a factor of two for both types of KDNBF samples.

TABLE 2

Dielectric strength or breakdown voltage
by ball method for KDNBF

Explosive	Pressure PSI	Diameter Inch	Thickness Inch	Weight G	Density g/cc	No. of Tests	Ave. Voltage Volts	Ave. Dielectric Strength Volts/Mil
KDNBF	5000	0.125	.015	.0036	1.15	11	1573	104.8 $\pm$ 14.3
KDNBF	15000	0.125	.015	.0041	1.337	10	1290	86.0 $\pm$ 13.0
KDNBF/DE	5000	0.125	.015	.0024	0.85	11	1927	128.5 $\pm$ 20.9
KDNBF/DE	15000	0.125	.015	.0032	1.07	11	1782	118.8 $\pm$ 25.8

NOTE: R.T. 69°F
R.H. 58%

Further tests should be conducted to obtain a more precise value. However, if this work is pursued, it should be conducted under vacuum conditions to simulate testing conditions with pulsed-electron beam machines. In the study of the properties of these materials, the next logical step is to determine the dielectric constant and dissipation factor for these materials as a function of frequency.

REFERENCES

1. W. Voreck, "Spontaneous Detonation of Initiating Devices Research and Development Program Control Document", Report No. 1, August 16 - September 1969

2. B. Pollock, unpublished work.