1912

Testing explosives

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TESTING EXPLOSIVES

by

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and

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T H E S I S

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Approved by C.R. Forbes
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TABLE OF CONTENTS.

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LIST OF ILLUSTRATIONS.

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INTRODUCTION.

The following tests and experiments were carried on to determine: first; the utility of a certain well known method of making comparative tests of explosives and second; to show some of the conditions that influence the force and effect of a blast, such as the size of detonator, the use of tamping, the size of bore hole, and the size and number of free faces exposed to the blast.

COMPARATIVE TESTS OF EXPLOSIVES.

The method of testing the comparative strength of the explosives was by discharging them inside of lead cylinders and measuring the deformation produced.

This method is variously known as the Abel block, the Tranzl block or the lead block test, and has been used by many experimenters in the past.

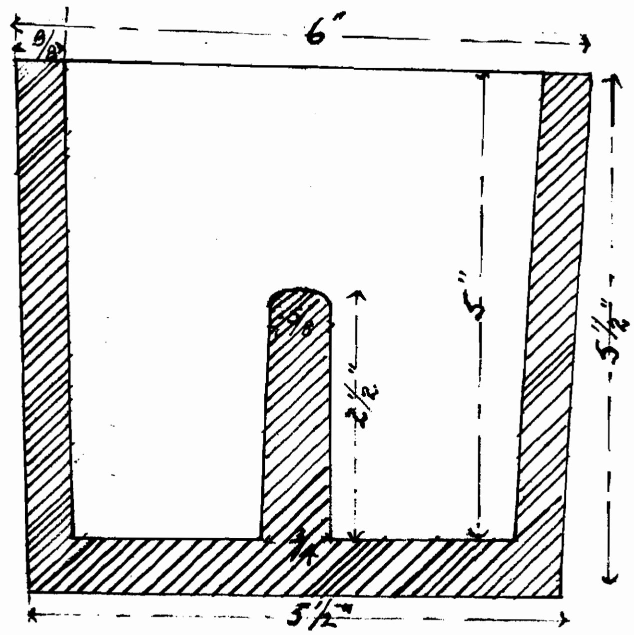
The lead blocks used for these tests were 5" in diameter and 5" high, with a hole in the center 2 1/2" deep and tapering from 3/4" in diameter at the top, to 5/8" in diameter at the bottom.

Casting cylinders and blocks:- The greatest obstacle encountered was finding a simple and effecient means of melting and casting the lead into cylinders and blocks.

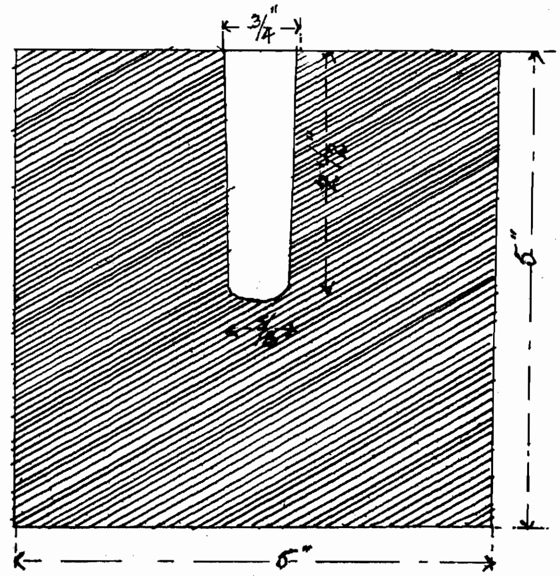
Our first experiment consisted in the employment of a small, water-jacketed, lead blast furnace. A thick bed of hot coke was obtained in the furnace, the tuyeres were then closed, and the lead dropped in from above. By this method the lead was melted very rapidly, but, owing to the fact that sufficient equipment was lacking for the tapping of the blast furnace, it was found impossible to use this means as no regular flow of lead could be obtained and the castings made were layered or otherwise imperfect. It was also found that much lead was lost through volatilization, even though the tuyeres were kept closed.

The next scheme, and the one afterward followed, was the use of a small slag pot, the capacity of which was approximately 900 pounds, and around which brick walls were built to form a small furnace. Wood was used for firing and very little difficulty was experienced in melting the lead. It was possible to bring it to a sufficiently high temperature so that it could be easily ladeled and poured into molds without layering and thus procuring a homogeneous casting.

The molds used for casting the cylinders were of cast iron of the dimensions as shown in sketch, and were made especially for this work. For some of



Cast iron mold for casting lead cylinders.



Lead cylinder used in tests.

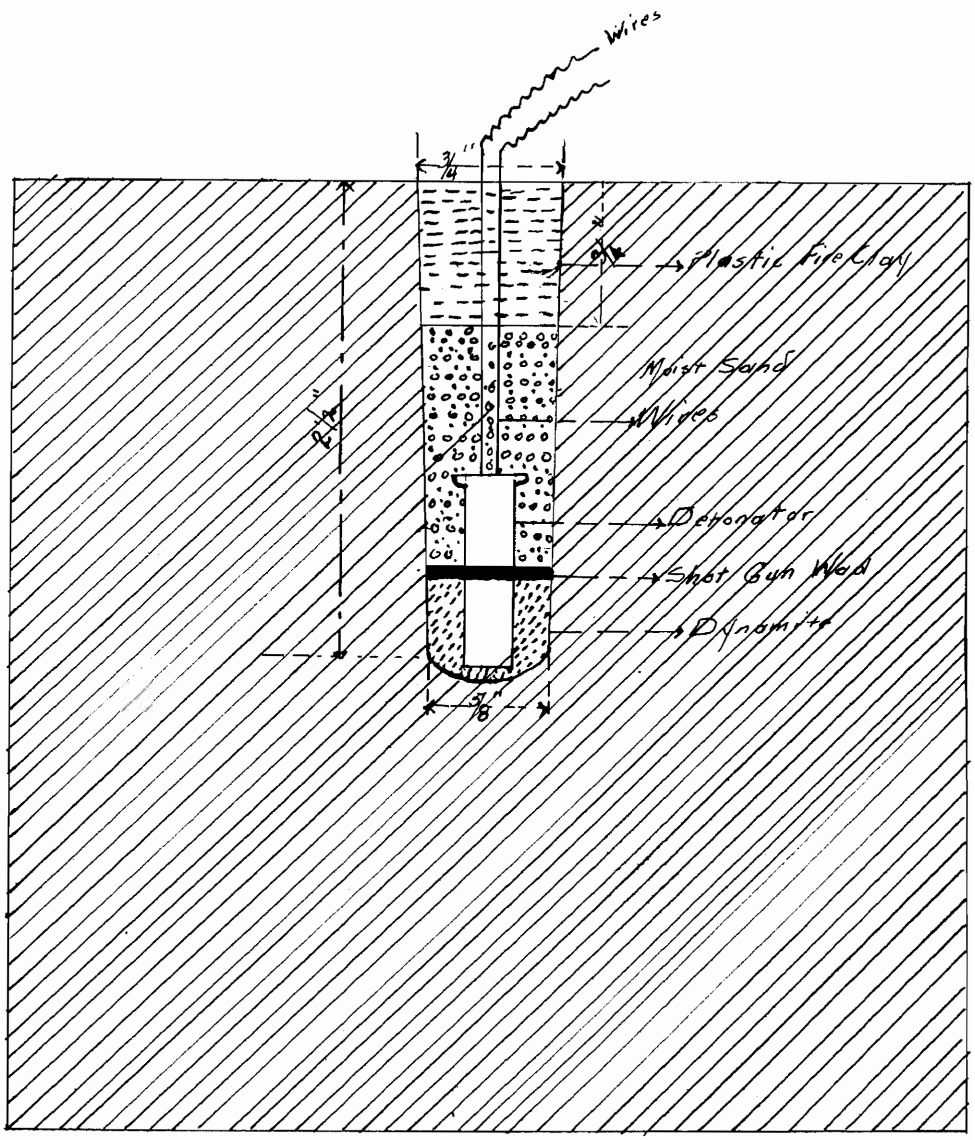
the experiments square blocks were cast in molds made of fire clay brick.

Charging and firing:- Before charging, the holes were measured with water from a burette and the capacity in cubic centimeters determined and recorded. They were then thoroughly cleaned and dried.

The charge of dynamite, which had been carefully weighed on a balance, was either poured into the hole, as a loose powder, or confined in a paper cartridge and inserted. Practically no difference could be detected in results of charges loaded in these different ways, so the former method was used for most of the shots as the holes could be loaded more quickly this way.

After pouring the dynamite into the hole and tamping it very lightly with a wooden stick, the electric detonator was inserted and pushed to the bottom of the hole.

To separate the charge from the tamping a shot-gun wad, with a hole through it for the detonator, was placed on top of the charge. This wad was slipped over the detonator before the latter was inserted and afterwards the dynamite was rammed compactly into the bottom of the hole by pressing on the wad with a wooden stick.



Showing method of tamping.

The charge was tamped with moistened sand, sifted through a 40 mesh sieve, until within 3/4" of the top and then the hole was filled with plastic, fire clay, as shown in the accompanying figure. Great care was taken to tamp all the charges as nearly alike as possible, although, with hand tamping, some variations were bound to occur.

In order to prevent the tamping from blowing out and to completely confine the gases, from the explosion, two steel plates, 1/8" in thickness, with small holes in the center to allow for entrance of wires, were placed on top of the cylinder and were clamped to it and held in position by two large, cast iron clamps, as shown in the photograph. The charges were fired with a DuPont No.2 "push down" battery.

After firing, the hole was thoroughly cleaned, measured with water, and its capacity recorded. The form of hole is shown in photograph.

The amount of deformation was obtained from the differences in volume before and after firing. This deformation was that produced by the combined action of cap and dynamite, but it was found, from separate tests, that the deformation produced by the cap alone was so little that for practical purposes it need not be condidered.

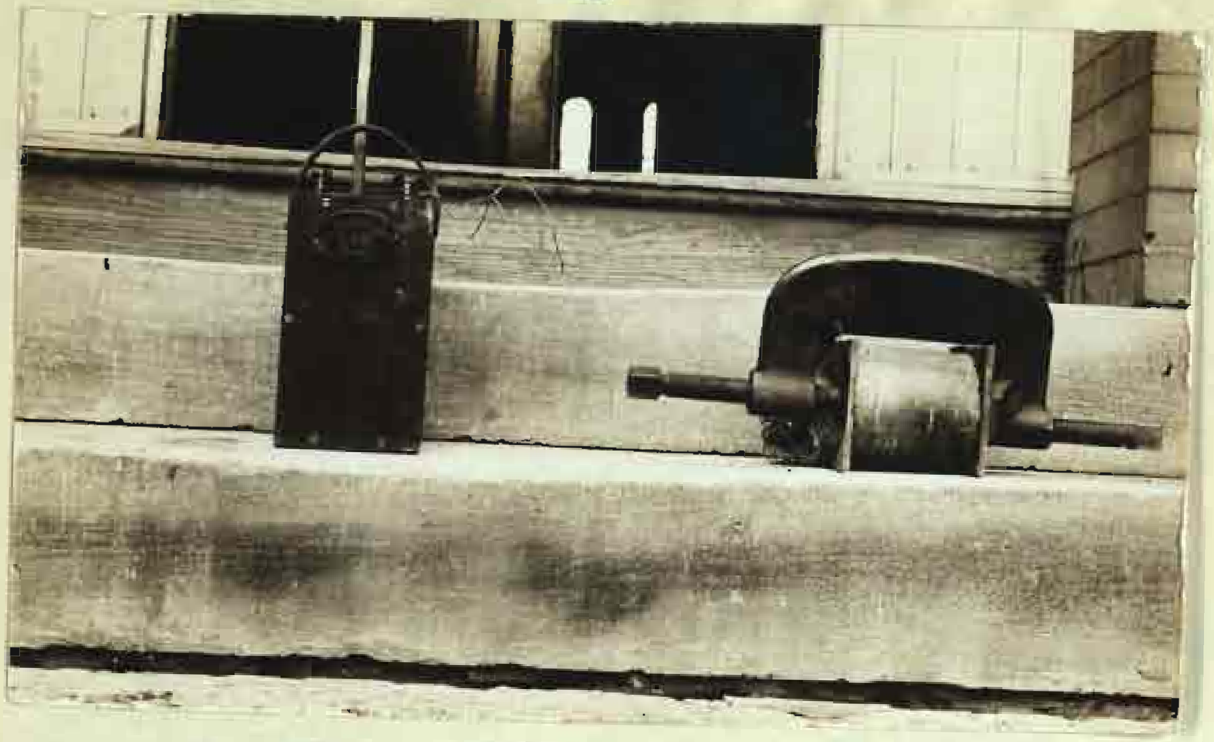
Some of the blocks were sawed in two, after firing, in order to inspect the shape and form of cavity produced and to note any differences that might exist in cavities formed from different explosives.

Explosives tested:- Tests were made on the following explosives:

DuPont Red Cross Dynamite 25%.

DuPont Red Cross Dynamite 40%.

DuPont Red Cross Dynamite 60%.



Lead block, ready for firing.

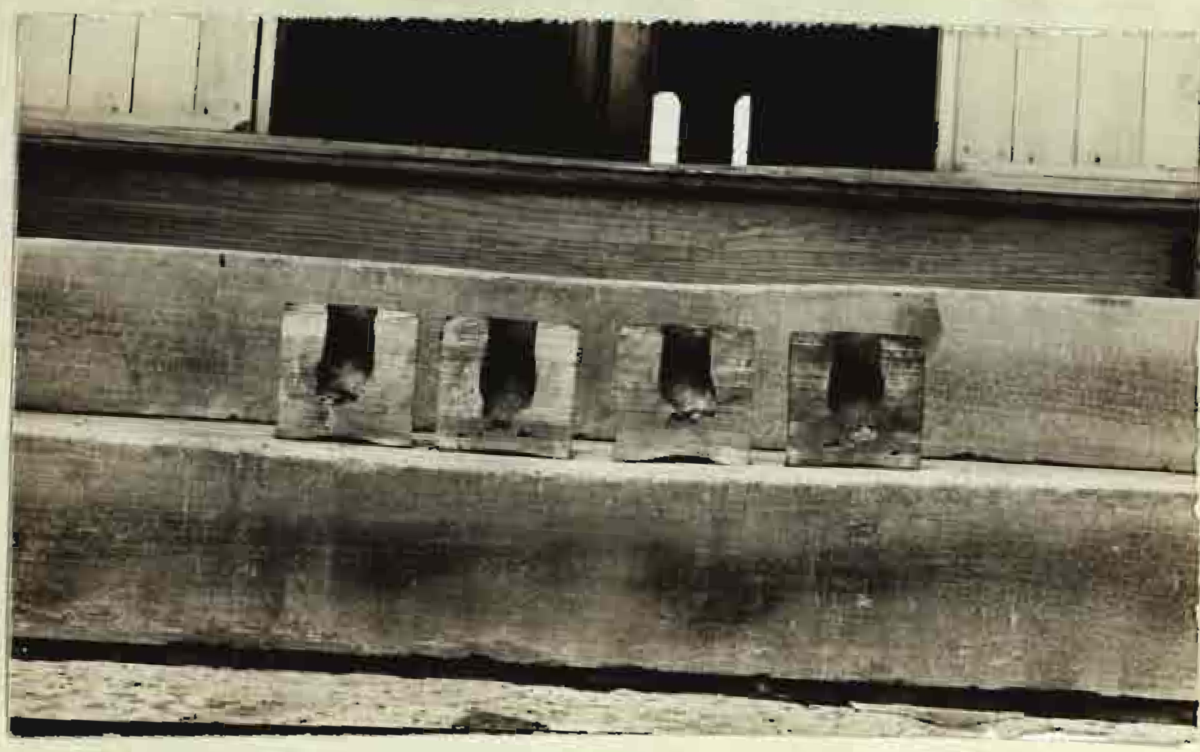
Cross-sections showing form of hole after firing.

Results of tests:-

Table I.

Showing results obtained using 60% dynamite.

No.	Charge grams	Size caps	Capacity before c.c.	Capacity after c.c.	Deformation c.c.	Remarks
1	0.5	6X	28.5	44.8	15.3	
2	1.0	6X	28.5	51.8	23.3	
3	1.0	6X	28.5	53.8	25.3	
4	1.5	6X	28.5	66.6	36.1	Paper cartridge used
5	1.5	6X	28.5	67.4	38.9	Paper cartridge used
6	2.0	6X	28.5	79.0	50.5	
7	2.0	6X	28.5	77.8	49.3	
8	2.5	6X	28.5	104.0	75.5	
9	2.5	6X	28.5	102.0	73.5	
10	2.5	6X	28.5	109.0	80.4	Paper cartridge used
11	2.5	6X	28.5	108.0	79.5	Paper cartridge used
12	3.0	6X	28.5	111.8	83.3	
13	4.0	5X	28.8	163.1	134.3	
14	4.0	5X	28.8	163.4	134.6	
15	5.0	5X	28.2	205.1	176.9	



Block No.1, Table II showing effect of defective casting.

Table II.

Showing results obtained using 40% dynamite.

No.	Charge grams	Size caps	Capacity before c.c.	Capacity after c.c.	Deformation c.c.	Remarks
1	4.4	5X	28.8	139.2	110.4	Blew into air hole(see photograph)
2	4.5	5X	28.8	149.8	120.0	
3	4.5	5X	28.8	162.6	133.8	

Table III.

Showing results obtained using 25% dynamite.

No.	Charge grams	Size caps	Capacity before c.c.	Capacity after c.c.	Deformation c.c.	Remarks
1	2.0	6X	28.5	71.0	42.5	First melt
2	2.0	6X	28.5	71.0	42.5	First melt
3	3.0	5X	29.5	83.1	53.6	Second melt
4	3.0	5X	29.5	84.5	55.0	Second melt
5	4.0	6X	29.5	105.7	76.2	Second melt
6	4.0	6X	28.5	119.0	90.5	First melt
7	5.0	6X	29.5	159.4	129.9	Second melt
8	5.0	6X	29.5	160.2	130.7	Second melt

<u>Conclusions:-</u> The following conclusions, as to the utility of the lead block as a means of making comparative tests on explosives, may be drawn from inspection of the foregoing tables:

First; Reasonably accurate results can be obtained by this test as shown by results of duplicate charges.

Second: The blocks used in making comparative tests <u>must</u> be of the same melt and should be poured at the same temperature. Also the temperatures of the cylinders should be uniform when fired. This is not shown by the tables but it was observed in doing some of the work in cold weather that this temperature had a decided influence on the effect of the explosion.

Third: The tests can only be applied for testing explosives exactly similar in character: thus, two lots of a certain 40% dynamite can be compared or the 40% dynamite made by different manufacturers might be compared, but no comparison can be made between a 40% and a 60% or between one kind of an explosive and another; for example, a gelatine and a dynamite.

TESTING DETONATORS.

Detonators were tested in a manner similar to the dynamites.

Holes 5/16" in diameter and 2 1/2" to 3" deep were drilled into lead blocks or cylinders at a sufficient distance apart to insure their not blowing into each other. The caps were placed in the holes and tamped with sand, clay, or water. These were fired in a manner similar to case before mentioned and the deformation produced measured.

Detonators tested:-

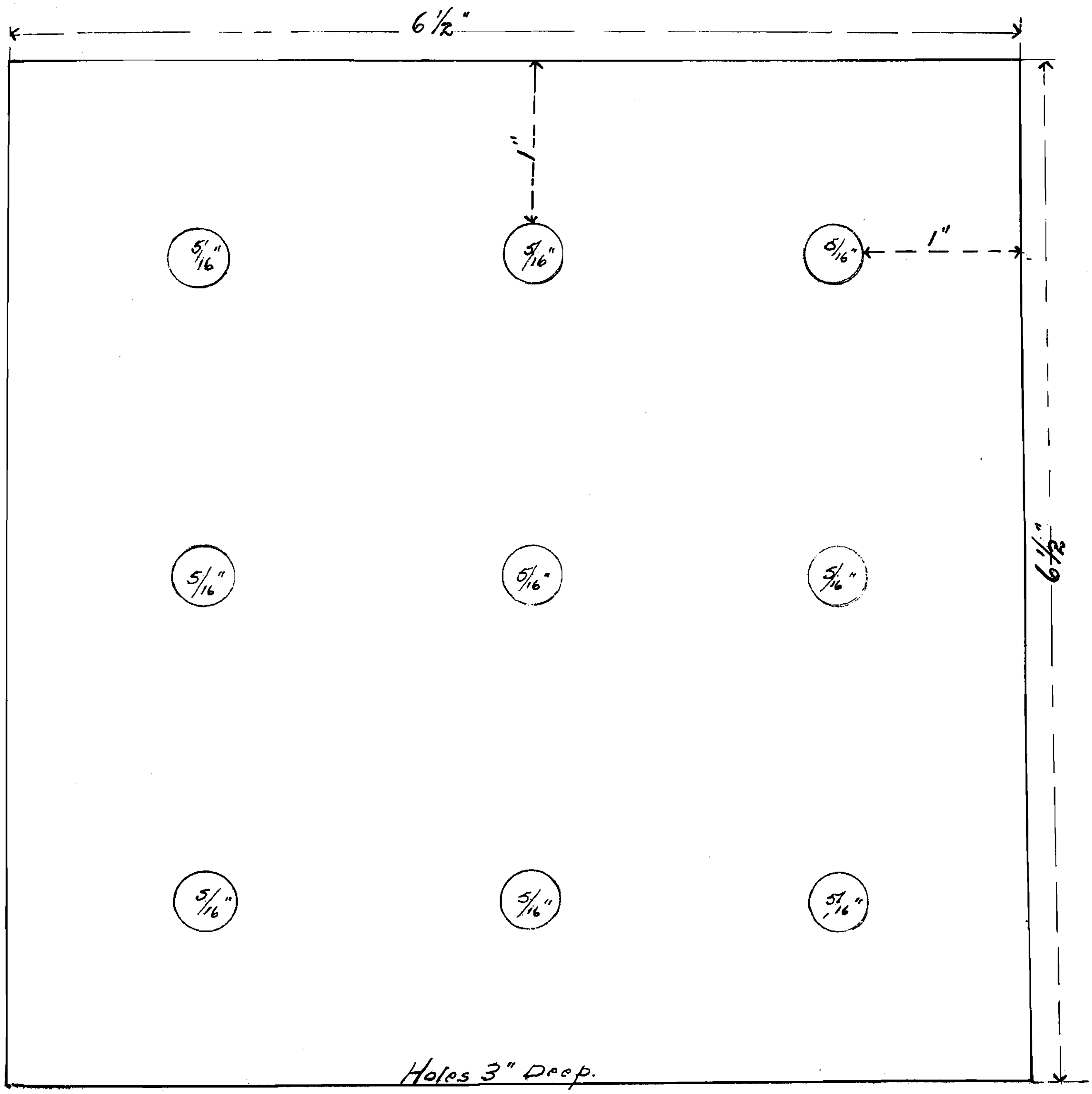
Electric Detonators

DuPont Nos. 4, 5, 6, 7, and 8.

Results of tests or detonators:

Table IV.

No.	Size hole in.	Size caps	Capacity before c.c.	Capacity after c.c.	Deformation c.c.	Remarks
1	5/15	4X	3.6	12.1	8.5	Tamped with water and sand.
2	5/16	4X	3.3	11.9	8.6	Tamped with water and sand.
3	5/16	4X	3.6	12.4	8.8	Tamped with water.
4	5/16	4X	3.6	13.0	9.4	Tamped with water.
5	5/16	5X	3.7	13.3	9.6	Tamped with water.
6	5/16	5X	3.5	12.8	9.3	Tamped with water.
7	5/16	6X	3.7	15.2	11.5	Tamped with water.
8	5/16	6X	3.8	17.0	13.2	Tamped with water.
9	5/16	7X	3.9	23.0	19.1	Tamped with water.
10	5/16	7X	3.8	23.4	19.6	Tamped with water.
11	5/16	8X	3.6	33.6	30.0	Tamped with water.
12	5/16	8X	3.6	33.1	29.5	Tamped with water.



Sketch of block and arrangement of holes for testing detonators.

<u>Conclusions:-</u> This test for detonators, as seen from the foregoing table, is fairly accurate and is believed to be much better than the ordinary lead plate test because, with the latter test, the deformation can only be estimated approximately.

In testing detonators by this method the same care, in the use of the homogeneous lead blocks, must be exercised, as mentioned under testing explosives. The use of water tamping is thought to be the most uniform method of making these tests.

TESTING EFFECT OF DIFFERENT SIZED DETONATORS ON FORCE OF BLAST.

For making these tests the lead cylinders were used in exactly the same way as in previous tests. The same charge of 5 grams of 25% dynamite was shot with different sized caps and results recorded as given below.

Table V.

No.	Charge grams	Size caps	Capacity before c.c.	Capacity after c.c.	Defor-mation c.c.	Remarks
1	5	4X	29.5	147.1	117.6	
2	5	4X	29.5	146.5	117.0	
3	5	5X	28.8	153.6	124.8	
4	5	6X	29.5	159.4	129.9	
5	5	6X	29.5	160.2	130.7	
6	5	7X	29.5	165.2	135.7	
7	5	7X	29.5	164.3	134.8	
8	5	8X	29.5	171.3	141.8	
9	5	8X	29.5	168.8	134.3	
10	no dy-namite	4X	29.5	32.1	2.6	
11	"	6X	28.5	34.0	5.5	
12	"	8X	29.5	45.4	15.9	

<u>Conclusions:-</u> From results shown in table V, no reliable deductions can be shown concerning the influence of detonator on force of blast. The deformation, shown by this table, increases with the size of detonator used but it is quite probable that this increased deformation is that caused by the cap itself and is not due to a more complete detonation of the charge.

In order to show the effects of different sized detonators it would be necessary to experiment on a much larger scale because with the small charges used in these experiments the cap extended practically through the entire charge and complete detonation was practically assured with even the smallest sized caps.

TESTING EFFECT OF TAMPING.

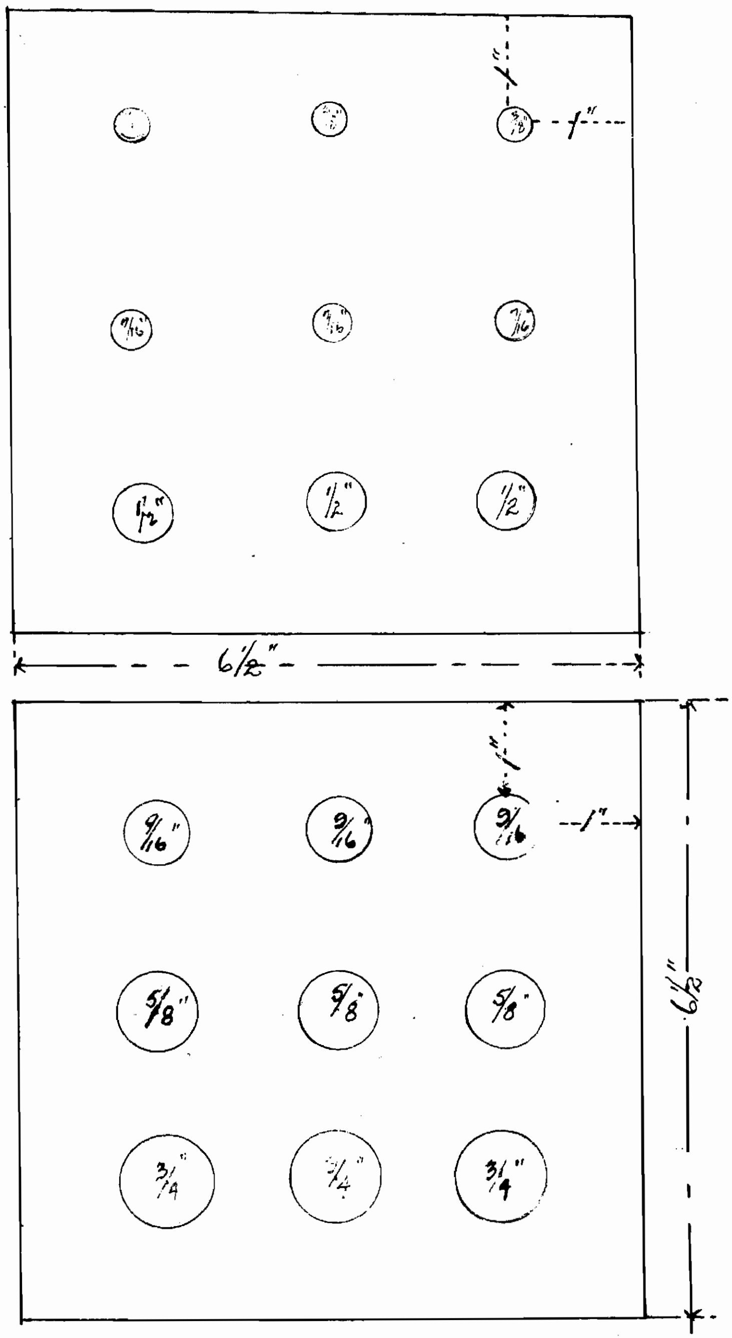
For making this test some of the lead cylinders were shot without tamping the charge and others with tamping but without using clamps.

When no tamping was used the deformation produced was, of course, very much less than when the charge was tamped. The charges shot without the use of clamps gave slightly lower results than when clamps were used, indicating that the use of clamps was desirable to confine the gases as much as possible.

TESTING INFLUENCE OF SIZE OF BORE HOLE

AND SIZE AND NUMBER OF FREE FACES.

For making these tests square blocks were cast, as shown in the figure, and holes of different sizes bored in them. Similar charges were fired in the different holes, but owing to the smallness of the blocks and the relatively great diameter of the holes as compared to their depths, no conclusions could be drawn from these results, either as to influence of size of of hole or position of hole, with reference to the free faces.



Sketch of blocks and size and arrangement of holes.

INDEX.

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