BULLETIN 59. DEPARTMENT OF THE INTERIOR BUREAU OF MINES. INVESTIGATION OF DETONATORS AND ELECTRIC DETONATORS

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Bulletin 59

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
JOSEPH A. HOLMES, DIRECTOR

INVESTIGATIONS OF DETONATORS AND ELECTRIC DETONATORS

BY

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AND

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CONTENTS.

	Page.
Introduction	5
Preliminary considerations	7
Theory of detonation	9
Detonation of high explosives	10
Electric detonators tested	11
Explosives used in the tests	12
Tests previously used to determine strength of detonators and electric detonators.	14
Tests for determining directly the strength of P. T. S. S. electric detonators	18
Character of electric detonators tested	18
Squirted lead block tests	20
Cast lead block tests	21
Tests by explosion of detonating fuse (Cordeau detonant) by influence	22
Tests by depression of lead plates	24
The nail test	25
Tests for determining indirectly the strength of P. T. S. S. electric detonators	27
Rate-of-detonation tests	27
Tests with an explosive of class 1, subclass *a*	27
Tests with an explosive of class 1, subclass *b*	29
Tests with a 20 per cent "straight" nitroglycerin dynamite	31
Tests with a 40 per cent strength ammonia dynamite containing nitro-substitution compounds	32
Tests with a 40 per cent strength ammonia dynamite	33
Tests with a 35 per cent strength gelatin dynamite 2 years old	33
Tests with a 40 per cent strength gelatin dynamite, frozen	35
Tests with a 35 per cent strength gelatin dynamite 3 years old	35
Small lead block tests	36
Tests with a 20 per cent "straight" nitroglycerin dynamite with 6 per cent of added water	36
Tests with a 20 per cent "straight" nitroglycerin dynamite, frozen and containing less than 6 per cent of added water	37
Tests with a 20 per cent "straight" nitroglycerin dynamite, frozen and containing 6 per cent of added water	37
Tests with a 40 per cent strength ammonia dynamite with 6 per cent of added water	38
Tests with a 40 per cent strength gelatin dynamite, frozen	39
Explosion-by-influence tests	40
Tests with an explosive of class 1, subclass *a*	41
Tests with an explosive of class 4	41
Tests with a 40 per cent strength ammonia dynamite containing nitrosubstitution compounds	43
Tests with a 35 per cent strength gelatin dynamite 2 years old	43
Percentages of detonations in indirect tests of P. T. S. S. electric detonators.	44
Comparative explosive efficiency	44
Comparative explosive efficiency of P. T. S. S. electric detonators	46
Tests of four No. 6 electric detonators of different makes	46
Physical examination	47
Weight and composition of charges	47
Results of calorimeter tests	49
Squirted lead block tests	49
Cast lead block tests	50
Tests with lead plates	50
Detonators on end	50
Detonators on side	51

Tests of four No. 6 electric detonators of different makes—Continued. Page.
Nail tests ... 51
Rate-of-detonation tests ... 52
Tests with an explosive of class 1, subclass *a* ... 52
Tests with an explosive of class 1, subclass *b* ... 53
Tests with a 20 per cent "straight" nitroglycerin dynamite ... 53
Tests with a 40 per cent strength ammonia dynamite containing nitro-substitution compounds ... 53
Tests with a 35 per cent strength gelatin dynamite 2 years old ... 54
Tests with a 40 per cent strength gelatin dynamite, frozen ... 55
Tests with a 35 per cent strength gelatin dynamite 3 years old ... 55
Small lead block tests ... 56
Tests with a 20 per cent "straight" nitroglycerin dynamite ... 56
Tests with a 40 per cent strength ammonia dynamite ... 57
Tests with a 40 per cent strength gelatin dynamite, frozen ... 57
Explosion-by-influence tests ... 58
Tests with an explosive of class 1, subclass *a* ... 58
Tests with an explosive of class 4 ... 58
Tests with a 40 per cent strength ammonia dynamite containing nitrosubstitution compounds ... 59
Tests with a 35 per cent strength gelatin dynamite 2 years old ... 60
Trauzl lead block tests ... 61
Percentages of detonations in indirect tests of four kinds of No. 6 electric detonators ... 61
Comparative explosive efficiency ... 62
Comparative explosive efficiency of four kinds of No. 6 electric detonators ... 64
Relative strength of detonators and electric detonators ... 64
Tests with a trinitrotoluene detonating fuse ... 66
Tests with detonators distributed in charge ... 68
Use of two kinds of explosives in the same drill hole ... 71
Publications on mine accidents and tests of explosives ... 72

ILLUSTRATIONS.

Page.
PLATE I. Results of cast lead block tests of P. T. S. S. electric detonators ... 22
II. Scoring of lead plates by P. T. S. S. electric detonators Nos. 3, 4, 5, 6, 7, and 8 laid on end ... 24
III. Scoring of lead blocks by P. T. S. S. electric detonators Nos. 3, 4, 5, 6, 7, and 8 laid on side ... 24
IV. *A*, Results of nail tests of P. T. S. S. electric detonators Nos. 3, 4, 5, 6, 7, and 8; *B*, Results of nail tests of No. 6 electric detonators ... 26
V. *A*, Results of small lead block tests of P. T. S. S. electric detonators Nos. 3, 4, 5, 6, 7, and 8; *B*, Results of small lead block tests of No. 6 electric detonators; *C*, Scoring of lead plates by four No. 6 electric detonators laid on side ... 40
VI. Results of cast lead block tests of four No. 6 electric detonators ... 50
VII. Scoring of lead plates by four No. 6 electric detonators placed on end. 50
FIGURE 1. Cross-sectional view of six P. T. S. S. electric detonators ... 18
2. Nail in position for test of electric detonator ... 26
3. Comparative explosive efficiency of six grades of P. T. S. S. electric detonators as determined by indirect tests ... 46
4. Cross-sectional view of four No. 6 electric detonators of different makes ... 47
5. Comparative explosive efficiency of four kinds of No. 6 electric detonators as established by indirect tests ... 64

INVESTIGATIONS OF DETONATORS AND ELECTRIC DETONATORS.

By CLARENCE HALL and SPENCER P. HOWELL.

INTRODUCTION.

Among the more important factors involved in the use of high explosives in blasting operations is the means employed to bring about the detonation of the charge. When flame is applied to high explosives many of them may burn if not confined; but all of them when burning under certain conditions of confinement may detonate. Detonation may also be effected by mechanical means, such as frictional impact caused by a blow or by rubbing between surfaces. By this means, however, the full effect of the explosive charge may not be developed, so that a partial detonation, often accompanied by the burning of the explosive, results.

When nitroglycerin was first used it was fired by the application of flame, but considerable difficulty was experienced in exploding it with certainty and in obtaining uniform results. In 1864 Alfred Noble, a Swedish engineer, discovered that nitroglycerin could be surely and completely detonated by exploding in contact with it a small quantity of an initiatory explosive. Mercury fulminate was the substance then found capable of producing the best results There are many other fulminates and other substances that will produce complete detonation of commercial "high" explosives, but detonators or electric detonators containing mercury fulminate as the characteristic ingredient are still almost exclusively used in this country.

The term "detonator" is used in the publications of the Bureau of Mines to designate what the miner calls a "blasting cap"—a copper capsule containing a small quantity of some detonating compound that is ignited by a fuse. The term "electric detonator" is applied to a blasting cap that is similar except for being ignited by means of a small wire which is heated to incandescence or fused by the passage of an electric current.

One of the conditions prescribed by the Bureau of Mines for a permissible explosive [a] is that it shall be fired by a detonator, or preferably an electric detonator, having a charge equivalent to that of the standard detonator used at the Pittsburgh testing station. A further

[a] Permissible explosives have a short, quick flame and are intended especially for use in coal mines containing inflammable gases or dusts. (See Miners' Circular 6, Bureau of Mines.)

requirement is that this charge shall consist by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents).

At the request of a manufacturer of permissible explosives, an investigation was undertaken by the bureau to determine the relative strength of detonators and electric detonators having different compositions. The tests of electric detonators herein reported were conducted by H. F. Braddock, junior chemist; J. W. Koster, J. E. Tiffany, junior mining engineers; and A. S. Crossfield, junior explosives chemist, at the Pittsburgh testing station of the bureau. Similar tests of detonators were not conducted because it was believed that the results would not show sufficient variation to warrant such tests. It is hoped that the conclusions drawn from the tests made will be of service to those using explosives by enabling them to select the grade of detonator or electric detonator that will insure the most effective results. The conclusions are given in this bulletin, which is published by the Bureau of Mines as one of a series of publications dealing with the testing of explosives and the precautions that should be taken to increase safety and efficiency in the use of explosives in mining operations.

The results of the experiments described in this bulletin show that the average percentage of failures of explosives to detonate was increased more than 20 per cent when the lower grades of electric detonators were used instead of No. 6 electric detonators, and was increased more than 50 per cent when these lower grades were used instead of No. 8 electric detonators. It is noteworthy, however, that when sensitive explosives, such as 40 per cent strength ammonia dynamite (p. 33), were tested under conditions ideal for detonation, the same energy was developed irrespective of the electric detonator used. When tests were made with a less sensitive explosive, such as a 40 per cent strength ammonia dynamite containing nitrosubstitution compounds (p. 32), the energy developed increased with the grade of the electric detonator used. For example, the average efficiency of four different explosives was increased 10.4 per cent when a No. 6 electric detonator was used instead of a No. 4 electric detonator, and 14.9 per cent when a No. 8 electric detonator was used (see tabulation on p. 45). The results of the tests emphasize the importance of using explosives in a fresh condition, but as fresh explosives can not always be had in mining work, strong detonators should be used in order to offset any deterioration of explosives from age.

The results obtained substantiate the following conclusions: (1) That for any particular manufacturer's detonators or electric detonators the explosive efficiency increases with their grade, and (2) that the four No. 6 electric detonators, of different makes, tested have practically the same explosive efficiency as, and each is considered equivalent to, the Pittsburgh testing station standard No. 6 electric