

**INDUSTRIAL COMMISSION
OF
WISCONSIN**

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**GENERAL ORDERS ON
EXPLOSIVES**

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The orders marked with an asterisk (*) are existing orders relating to underground storage and use of explosives in mines, tunnels and caissons and were not considered by the Advisory Committee.

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GENERAL ORDERS ON EXPLOSIVES

The existing general orders of the Industrial Commission pertaining to the transportation, storage and use of explosives have proven inadequate on account of the increased use of explosives in construction and particularly in high-way construction. As a result of increased injuries by explosives and also owing to the fact that explosive regulations are not available in a single bulletin, the commission decided to revise its existing orders relating to this subject and to promulgate such new orders as were deemed necessary.

Following its usual practice in such matters, an advisory committee was appointed to make recommendations.

The personnel of this committee is as follows:

C. H. FISHER, Institute of Makers of Explosives,
Wilmington, Delaware.

W. J. MATHEWS, Institute of Makers of Explosives,
Chicago, Illinois.

JOHN MULLEN, Associated Contractors of Wisconsin,
Minneapolis, Minnesota.

F. S. CRAWFORD, United States Bureau of Mines,
Duluth, Minnesota.

E. L. ROETTIGER, Wisconsin Highway Commission,
Madison.

*LAWRENCE PETERSON, Montreal Mining Company,
Montreal.

*GEORGE CORMIER, Wisconsin Highway Commissioner's
Ass'n, Green Bay.

PROF. W. A. ROWLANDS, University of Wisconsin,
Madison.

ROBERT SPRAGUE, Wisconsin State Federation of Labor,
Milwaukee.

A. H. FINDEISEN, Industrial Commission of Wisconsin,
Madison.

* Deceased.

A meeting of the advisory committee was held in Madison on March 11, 1932 and proposed regulations were recommended to the commission for adoption. The commission held public hearings on the proposed regulations as follows: Milwaukee, August 29; Fond du Lac, August 30; Green Bay, August 31; Wausau, September 1; Eau Claire, September 2 and Madison, September 6.

The advisory committee held another meeting in Madison on November 4, 1932 and after consideration of suggestions and criticisms that had been made during and after the public hearings submitted a final report to the commission.

On February 18, 1933, the Industrial Commission voted to repeal the following orders or parts of orders:

Nos. 310 (f), 311 (a), (b), 312, Rules 41, 42, 43, 44, 45 of 345, 360 (g), (h), (i), 385, 386, 387, 388, 389, 611, 612, 613, 6090, 6091, 6092 and 6093.

At the same time it was voted to adopt the following new general safety orders: Nos. 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664 and 665. The repeal of the old orders and the adoption of the new orders to become effective thirty days after publication.

The orders were published on February 25, 1933 and became effective on March 27, 1933.

The first paragraph of order 663 was amended January 2, 1937.

Paragraph 1 of order 650 relating to transportation of explosives was amended May 12, 1948.

All orders of the Industrial Commission relating to explosives are published in this bulletin and for convenience are divided into sections as follows:

Section I. Contains those orders that are effective as of March 27, 1933.

Section II. Relates to the underground storage and use of explosives in mines.

Section III. Relates to underground storage and use of explosives in tunnels.

Note: Section 101.06 of the statutes makes it the duty of all employers to provide a safe place of employment. The Industrial Commission cannot by order relieve employers of this obliga-

tion. No matter how the orders of the Industrial Commission may read, the employer is responsible if he does not provide safe employment. If any employe is injured through a violation of any order, of the Commission, he can recover a 15% increase in compensation, from his employer, under the provisions of section 102.09 (5) (b). This order, consequently does not impose any obligation upon the employer which is not placed upon him by the statutes of the state, but makes it clear that this entire set of orders is not intended and cannot nullify the express provisions of section 101.06.

The attention of superintendents and foremen and of other persons having control of any employe or any operation, however, is directed to the fact that the term "employer" as used in section 101.01 is defined to include "every person, firm, corporation, agent, manager, representative, or other person having control or custody of any employment, place of employment, or of any employe." The duty to provide a safe place of employment rests not only upon the employer, but also upon the superintendent and foreman. Failure on the part of a superintendent or foreman to comply with any order contained in this code is a violation of law and renders him personally liable to a forfeiture of ten to one hundred dollars for each day and each instance of violation. This forfeiture can be collected at any time within two years after it is incurred through a civil suit brought by the attorney general. In such a suit the only possible defense is proof of compliance with the Commission's order.

Superintendents, foremen and others who are specifically charged with any duty by any order contained in these General Orders on Explosives will be held responsible by the Industrial Commission for the discharge of such duties. Employers, however, should also realize that they may become liable for increased compensation, if they do not see to it that the superintendents and foremen observe these orders.

GENERAL ORDERS ON EXPLOSIVES

SECTION I

Order 650—Scope.

These orders shall apply to the storage, handling and transportation of explosives but shall not include

1. Transportation upon vessels, railroad cars, or any truck or any semi-trailer attached to a tractor in conformity with the regulations adopted by the Interstate Commerce Commission.

2. The underground storage, handling or use of explosives in mines or tunnels.

Order 651—Construction of Orders.

Failure on part of superintendents, foremen, bosses and other persons having control of any place of employment, or of any employe and of any operations, to carry out any duty prescribed in these orders, is violation of such order by the employer.

Order 652—Definitions.

(a) *Superintendent*. The term "superintendent" when used in these orders shall mean the person having a general supervision of the work.

(b) *Foreman*. The term "foreman" when used in these orders shall mean a person who at any one time is charged with the immediate direction of the work.

(c) *Explosives*. The term "explosives" when used in these orders, shall mean and include any chemical compound or mechanical mixture that is commonly used or intended for the purpose of producing an explosion, that contains any oxidizing and combustible units or other ingredients in such proportions, quantities or packing that an ignition by fire, by friction, by concussion, by percussion or by detonator of any part of the compound or mixture may cause such a sud-

den generation of highly heated gases that the resultant gaseous pressures are capable of producing destructive effects on contiguous objects or of destroying life or limb.

(d) *Magazine*. The word "magazine" when used in these orders, means any building or other structure, used for the storage of explosives.

(e) *Primer*. The term "primer" when used in these orders shall be held to mean a capped fuse, electric exploder or other source of ignition inserted in a cartridge of explosive.

(f) *Approved*. The term "approved" shall be held to mean approved by the Industrial Commission.

(g) *Efficient Barricade*. The term "efficient artificial barricade" when used in these orders, shall be held to mean an artificial mound or properly revetted wall of earth of a minimum thickness of not less than three feet.

(h) *Blaster*. The term "blaster" shall mean any person or persons designated by the superintendent or employer to supervise blasting operations or to handle explosives.

(i) *Person*. The term "person" when used in these orders shall be held to mean and include a firm or body corporate as well as natural persons.

(j) *Building*. The term "building" or "buildings" when used in these orders shall be held to mean and include only a building or buildings occupied in whole or in part as a habitation for human beings, or any church, schoolhouse, railroad station, store or other building where people are accustomed to assemble.

(k) *Railroad*. The term "railroad" when used in these orders shall be held to mean and include any steam, electric or other railroad which carries passengers for hire.

Order 653—Storage of Explosives Within Cities and Villages.

(a) No nitroglycerin, dynamite, or other explosive preparations containing more than 60 per cent nitroglycerin or explosives of equivalent sensitiveness shall be kept or stored in any building, storeroom, wareroom, or in or on any premises within the corporate limits of any city or village.

(b) Not more than a total quantity of 50 pounds of explosives shall be kept or stored in or on any premises within the corporate limits of any city or village. Such 50 pounds or less of such explosives shall be kept and stored in a magazine made of fire resistive materials or of wood covered with sheet iron and mounted on wheels, and kept securely locked except when opened necessarily for use by authorized persons. Such magazine shall be plainly marked "Explosives" and located within the building, on the floor nearest the street level and within 10 feet from the street entrance.

(c) Not more than 50 pounds of gunpowder may be kept or stored in any building within the corporate limits of any city or village. Such gunpowder shall be kept and stored in closed metal cannisters of not more than 12½ pounds capacity each in a store or wareroom away from artificial light or heat, such place of storage to be approved by the Chief of the Fire Department.

(d) Where blasting operations within a city or village require larger quantities of explosives than those specified above, the Chief of the Fire Department may permit the keeping of larger quantities of such explosives in a portable magazine, but not in excess of the quantity actually needed for one day's operation.

(e) Not more than 5,000 blasting caps or detonators may be kept or stored within the corporate limits of any city or village. In no case shall explosives and blasting caps or detonators be kept or stored in the same magazine.

Blasting caps shall be kept or stored in a similar, but separate magazine, similarly placed, in accordance with the specifications provided for in paragraph (b) of this order.

(f) The Chief of the Fire Department shall be notified of the place, extent and manner of storage of explosives and blasting caps or detonators within the corporate limits of any city or village.

Order 654—Storage Outside Corporate Limits of Cities and Villages.

All explosives in excess of the supply authorized to be stored in cities and villages shall be kept or stored in specially constructed magazines located according to the Quantity and Distance Table.

Order 655—Storage with Other Materials.

No tools or other materials except wooden wedges and wooden mallets shall be kept or stored in any magazine containing explosives.

Order 656—Location of Magazines.

(a) All magazines in which explosives are had, kept or stored shall be located at a distance from buildings, railroads and highways in conformity with the following Quantity and Distance Table, unless otherwise authorized by the Industrial Commission.

The Quantity and Distance Table governing the keeping and storage of explosives is as follows:

QUANTITY AND DISTANCE TABLE

Quantity that may be had, Kept or Stored			Distance from Nearest Building Feet	Distance from Nearest Railway Feet	Distance from Nearest Highway Feet
Blasting and Electric Blasting Caps	Other Explosives (Dynamite, Blasting Powder, etc.)				
Number Over	Number not Over	Pounds Over Pounds Not Over	Feet	Feet	Feet
1,000	5,000	-----	30	20	10
5,000	10,000	-----	60	40	20
10,000	20,000	-----	120	70	35
20,000	25,000	-----	145	90	45
25,000	50,000	-----	240	140	70
50,000	100,000	50	360	220	110
100,000	150,000	100	520	310	150
150,000	200,000	200	640	380	190
200,000	250,000	300	720	430	220
250,000	300,000	400	800	480	240
300,000	350,000	500	860	520	260
350,000	400,000	600	920	550	280
400,000	450,000	700	980	590	300
450,000	500,000	800	1,020	610	310
500,000	750,000	900	1,060	640	320
750,000	1,000,000	1,000	1,200	720	360
1,000,000	1,500,000	1,500	1,300	780	390
1,500,000	2,000,000	2,000	1,420	850	420
2,000,000	2,500,000	3,000	1,500	900	450
2,500,000	3,000,000	4,000	1,560	940	470
3,000,000	3,500,000	5,000	1,610	970	490
3,500,000	4,000,000	6,000	1,660	1,000	500
4,000,000	4,500,000	7,000	1,700	1,020	510
4,500,000	5,000,000	8,000	1,740	1,040	520
5,000,000	7,500,000	9,000	1,780	1,070	530
5,000,000	7,500,000	10,000			
-----	-----	15,000			

QUANTITY AND DISTANCE TABLE—Continued

Quantity that may be had, Kept or Stored			Distance from Nearest Building Feet	Distance from Nearest Railway Feet	Distance from Nearest Highway Feet
Blasting and Electric Blasting Caps	Other Explosives (Dynamite, Blasting Powder, etc.)				
Number Over	Number not Over	Pounds Over Pounds Not Over	Feet	Feet	Feet
7,500,000	-----	-----	1,950	1,170	580
10,000,000	10,000,000	15,000	2,110	1,270	630
12,500,000	12,500,000	20,000	2,260	1,360	680
15,000,000	15,000,000	25,000	2,410	1,450	720
17,500,000	17,500,000	30,000	2,550	1,530	760
-----	-----	35,000	2,680	1,610	800
-----	-----	40,000	2,800	1,680	840
-----	-----	45,000	2,920	1,750	880
-----	-----	50,000	3,030	1,820	910
-----	-----	55,000	3,130	1,880	940
-----	-----	60,000	3,220	1,940	970
-----	-----	65,000	3,310	1,990	1,000
-----	-----	70,000	3,390	2,040	1,020
-----	-----	75,000	3,460	2,080	1,040
-----	-----	80,000	3,520	2,120	1,060
-----	-----	85,000	3,580	2,150	1,080
-----	-----	90,000	3,630	2,180	1,090
-----	-----	95,000	3,670	2,200	1,100
-----	-----	100,000	3,800	2,280	1,140
-----	-----	125,000	3,930	2,360	1,180
-----	-----	150,000	4,060	2,440	1,220
-----	-----	175,000	4,190	2,520	1,260
-----	-----	200,000	4,310	2,590	1,300
-----	-----	225,000	4,430	2,660	1,340
-----	-----	250,000	4,550	2,730	1,380
-----	-----	275,000			
-----	-----	300,000			

MAXIMUM ALLOWED. No quantity in excess of 300,000 pounds or in the case of blasting caps no number in excess of 20,000,000 caps, shall be had, kept or stored in any magazine in this state.

(b) *Separation of One Magazine from Another.* Magazines in which more than 50 pounds of explosives are kept and stored shall be detached from other structures, and magazines where more than 5,000 pounds of explosives are kept and stored shall be located at least 200 feet from any other magazine, except cap magazines. Magazines where quantities of explosives in excess of 25,000 pounds are kept and stored shall have an increase over 200 feet of $2\frac{2}{3}$ feet for each 1,000 pounds of explosives in excess of 25,000 pounds stored therein; provided, that the said distances between magazines may be disregarded where the total quantity stored in said magazines, considered as a whole, complies with the quantity and distance table in paragraph (a) of this order; except that, in all cases, the quantity of explosives contained in cap magazines shall govern in regard to spacing said cap magazines from magazines containing other explosives, but under no circumstances shall a magazine containing blasting caps be within a less distance than 100 feet, not barricaded, or 50 feet, barricaded, from any magazine other than cap magazine.

(c) *Reduction of Distances.* Whenever a magazine is effectually screened, from buildings, railroads or highways, either by natural features of the ground, or by an efficient artificial barricade of such height that any straight line drawn from the top of any sidewall of the magazine to any part of the building, to be protected, will pass through such intervening natural or efficient artificial barricade, and any straight line drawn from the top of any sidewall of the magazine, to any point 12 feet above the center of the railroad or highway to be protected, will pass through such intervening natural or efficient artificial barricade, the applicable distances, as prescribed by the quantity and distance table, in paragraph (a) of this order, and the distances separating magazines as prescribed in paragraph (b) of this order may be reduced one-half.

Order 657—Construction and Maintenance of Magazines.

All permanent magazines shall be constructed and maintained as follows:

(a) Every magazine shall be constructed of fire-resistant material and shall have no openings except for ventilation and entrance. Doors of such magazines shall be fire-resistant and at all times kept closed and securely locked except when it has to be entered by the person or persons in charge thereof. All nails in the interior of the magazine shall be countersunk. The ground around such magazines within 25 feet in all directions from the magazine shall be kept free from rubbish, dead grass, shrubbery, or other encumbrance.

Note: For the purpose of these orders, a magazine is fire resistant if constructed of cement mortar, tile or brick, and the door surfaced with sheet metal, or, if of wood construction consisting of double walls not less than 6 inches apart filled from sill to plate with dry, coarse sand and the structure completely surfaced on the outside with not less than No. 26 gauge galvanized iron. Inside locks are required.

For specifications and plans of magazines see pages 34—37.

(b) Upon each end of such magazine, above the side walls thereof, or upon its barricade, or on the premises, within a distance of 25 feet of the magazine, shall at all times be posted signs with the words "*Explosives—Keep Off*" legibly printed thereon in letters not less than 3 inches high.

(c) Magazines shall be ventilated and the openings for ventilation shall be so screened that sparks may not enter therein.

Note: Ventilation openings should be located at the top of the magazine and below the floor line to provide complete circulation of air.

(d) Magazines shall be at all times kept clean and dry.

(e) Magazines shall be in charge of a person especially appointed for the purpose, who shall have in his possession the keys of the magazine and shall be responsible for the safe storage of explosives contained therein.

(f) No naked lights or other sources of heat shall be introduced into a magazine where powder, explosives, or other inflammable substance are stored. Smoking shall not be permitted in a magazine, or while handling explosives.

(g) A wooden wedge and a wooden mallet shall be used for the opening of all explosive boxes.

Order 658—Storage, Daily Supply.

Where explosives in excess of immediate requirements are removed from a magazine and delivered in the vicinity of a blasting operation they shall be kept in a stout, tight box covered with not less than No. 24 gauge sheet iron and equipped with hinged lids, or, a small portable building similarly covered. Not more than 24 hours' supply of explosives shall at any time be kept or stored therein, and except when necessarily opened for use by authorized persons, shall at all times be kept securely locked. The magazine shall be located not less than 150 feet from the work in progress. Upon each such magazine there shall be kept conspicuously posted a sign with the words "*Explosives—Dangerous*" legibly printed thereon.

Order 659—Storage, Temporary Locations.

When the work is of a temporary nature, the magazine may be constructed in accordance with the specifications provided for in Order 658. The quantity of explosives kept on hand shall not exceed 24 hours' supply, and the magazine shall be located not less than 200 feet from any other structure, working place or public highway.

Exception: Where a distance of 200 feet cannot be obtained for storage within a city or village, storage is permitted at lesser distances provided there is no conflict with local regulations.

Note: Magazines should be located behind or under natural or artificial barriers to protect explosives from flying material when blasting. In no case should the magazine be located in direct line with the blast.

Order 660—Marking of Explosives.

Each package, except smokeless powder, shall be marked by means of a brand or stencil with the words "*Explosives—Dangerous*" followed by the specific name of the explosive, the name and address of the manufacturer, and a brief statement showing the net weight of the explosive.

Order 661—Explosives Unfit for Use.

Dynamite, blasting caps and fuse which have become deteriorated by age or improper storage shall not be used for blasting purposes and shall be immediately destroyed.

Note: Not more than 50 pounds of dynamite should be destroyed at one time. It should be taken to a safe distance from houses and roads, opening the cases very carefully, taking the cart-

ridges out, slitting them and spreading them over the ground instead of piling them up. If the dynamite appears to be too wet to burn readily, a little kerosene may be poured over it. A small pile of papers, shavings or other combustible material should be placed close enough to the dynamite so that the flame will burn along the paper and ignite the dynamite. After lighting the paper one should retire immediately to a safe distance until the dynamite is completely burned.

Order 662—Transportation of Explosives.

Motor trucks and (or) vehicles when used for transporting explosives, shall be marked or placarded on both sides and the rear with the words "*Explosives—Dangerous*" in letters not less than three inches high, or shall conspicuously display a red flag not less than twenty-four inches square marked with the word "*Danger*" in white letters not less than six inches high.

Vehicles transporting explosives shall be handled in a safe and careful manner and no person while smoking or under the influence of intoxicating liquor shall ride upon, drive, load or unload a vehicle carrying explosives.

No tools, blasting caps, matches, or other flame producing materials shall be carried in a vehicle containing explosives excepting tools for the operation and repair of such vehicle.

No stops except unavoidable stops shall be made during the journey and the speed of the vehicle shall not exceed 35 miles per hour.

Exposed metal parts in the interior of vehicles used to transport explosives shall be insulated from the explosives with wood, blankets or other fibrous material.

Explosives shall not be transported in any form of trailer, nor shall any trailer be attached to a motor truck or vehicle hauling explosives.

Order 663—Certificates of Competency for Blasters.

No person shall prepare explosive charges or conduct blasting operations unless such person holds a certificate of competency issued by the Industrial Commission.

Before issuing such certificate of competency the commission will determine the fitness of the candidate.

Persons authorized to prepare explosive charges or conduct blasting operations shall comply with all provisions of the General Orders on Explosives, and shall use every reasonable precaution to insure the safety of the workmen and general public.

This order shall not prevent the handling of explosives by other employes provided the work is done under the direct supervision of a person holding a certificate of competency.

Note: It is not intended that a person holding a certificate of competency shall delegate the work of blasting to a person who does not hold a certificate of competency. A person not holding a certificate of competency may act only as a helper.

Applicants for certificates are examined as to knowledge of the explosive regulations and the manufacturer's instructions which are provided in explosive packages.

Order 664—Blasting Caps, Fuses and Primers.

(a) No blasting caps or electric blasting caps shall be stored in any magazine containing other explosives.

Note: A special magazine with a hinged cover and kept securely locked at all times should be provided for the storage of blasting caps. This magazine should be waterproof and located in a dry place or building preferably not occupied by persons.

(b) All primers shall be exploded within 36 hours after making.

(c) No fuses shall be capped with blasting caps in any magazine or in any other place where blasting caps or other explosives are stored, but approved benches shall be provided at a safe distance from such storage place, where all fuses shall be capped.

(d) Only a crimper shall be used for attaching fuse to blasting caps. The operator shall furnish and keep in accessible places, ready for use, crimpers in good repair. Broad jaw crimpers shall be used.

(e) Blasting caps and fuse which have become deteriorated by age or improper storage shall not be used for blasting purposes and shall be destroyed.

Note: Blasting caps unfit for use should be destroyed by exploding. Burying in the ground or throwing caps into water is not recommended.

Order 665—Explosives, Blasting, Conveying, Misfires, Etc.

(a) *Blasters.* Only experienced qualified men who have been selected and regularly designated by the employer or the superintendent in charge shall handle, transport, prepare or use dynamite or other high explosives.

(b) *Number of Blasters, Responsibility.* There shall be one blaster in charge of blasting in each section of any operation. He shall enforce these orders and directions and personally supervise the fixing of all charges and all other blasting operations and shall use every precaution to insure safety.

(c) *Conveying Explosives.* Explosives shall be conveyed in a suitable covered wooden box or in sacks provided for that purpose. Detonators and fuse shall be conveyed separately from other explosives in approved containers provided for that purpose.

Note: The carrying container for fuse and detonators shall be of rigid construction and provided with a hinged cover.

After blasting is completed, all explosives and detonators shall be returned at once to the regular storage places, observing the same rules as when bringing them to the work.

(d) *Frozen Dynamite.* No blaster shall attempt to use dynamite that is frozen.

Note: No attempt should be made to thaw dynamite. Low-freezing dynamites are now available from manufacturers and if stored in magazines that are dry, well ventilated and insulated, these conditions will prevent absorption of moisture, maintain proper temperatures and thus reduce the tendency for freezing.

(e) *Counting Shots, Misfires.* When a blaster fires a round of holes he shall count the number of shots loaded and check against those exploded, except in cases of instantaneous blasting by electricity. If there are any misfires, or any doubt as to the total number of shots exploding, no person shall be permitted to approach the charges until at least one-half hour shall have elapsed lest the trouble be a hangfire and not a misfire.

Note: While the minimum requirement is given as one-half hour, it is strongly recommended that where possible at least one hour elapse before return to the location, and that a watch be used to determine the waiting period.

(f) *Misfires, Treatment.* Whenever feasible, a charge that has failed to explode shall be exploded by inserting a new primer in the hole on the old charge and detonating such primer.

(g) *Firing by Electricity.* When firing by electricity from power or lighting wires, a proper switch shall be furnished with lever down when "off". The switch shall be fixed in a box to which no person shall have access except the blaster. This box shall be constructed so that it can be closed and locked only when the switch is in the "off" position. The lead wires shall be furnished with plugs and shall not be connected with the switch till ready to fire. After blasting, the switch lever shall be pulled out, the wires disconnected, and the box locked before any person shall be allowed to return and shall remain so locked until again ready to blast. The lead wires shall be kept short-circuited and grounded until ready to be attached to the power switch or firing battery.

Note: Refer to illustrations and methods of grounding leading wires on pages 38 and 39.

(h) *Shot Firing Cables.* Rubber covered insulated wires shall be used for shot firing cables. Permanent lines shall be properly supported and mounted on insulators. Special precautions shall be taken to prevent temporary or portable lines from coming into contact with lighting, power or other circuits or with any metal pipe lines. All portable devices for generating or supplying electricity for shot firing shall be in charge of a boss or blaster. No person other than the boss or blaster shall connect the firing machine or battery to the shot firing leader and such connection shall not be made until all other steps preparatory to the firing of a shot shall have been completed and the men removed to a safe distance.

Note: When bomb proof shelters are not available, the leading wires should not be less than 500 feet, and in no case should they be less than 300 feet.

(i) *Examination After Blast.* Before drilling is commenced on any shift, all remaining holes shall be examined for unexploded explosives, using a wooden stick, or any other method giving equivalent protection. If any explosives are found they shall be refired before work proceeds.

New drill holes shall not under any circumstances be started in the sockets or remaining ends of old or blasted holes.

(j) *Tracing Firing Wires.* All wires in broken rock shall be carefully traced and search made for unexploded cartridges.

(k) *Galvanometers.* When firing electrically, individual electric detonators shall be tested with a galvanometer or circuit tester, both before and after loading.

Each new galvanometer and each galvanometer which has been repaired or which has been equipped with a new battery shall be subjected to a test by connecting it up to an electric blasting cap, with but little resistance in the circuit, for 30 seconds. This test will determine the possibility of the galvanometer detoning a blasting cap under favorable or unfavorable conditions.

(l) *Fuse Lengths.* No man shall "spit" more than 10 fuses at one time. In no case shall the length of any 40 second fuse be less than 24 inches or any 30 second fuse be less than 30 inches. The minimum length of fuse and the number of shots that any one person shall be permitted or required to light at any one time shall be in accordance with the following table:

TABLE OF FUSE LENGTHS

Number of Shots in Blast to be Lighted by Each Man	Minimum Length of Fuse Permissible for Each Shot			
	40 Second Fuse		30 Second Fuse	
	Inches	Time	Inches	Time
(1)	(2)	(3)	(4)	(5)
1	24	1 min. 20 sec.	30	1 min. 15 sec.
2	26		33	
3	28		36	
4	30	1 min. 40 sec.	39	1 min. 38 sec.
5	32		42	
6	34		45	
7	36	2 min. 0 sec.	48	2 min. 0 sec.
8	38		51	
9	40		54	
10	42	2 min. 20 sec.	57	2 min. 22 sec.

Note: a. Column (1) indicates the various numbers of holes up to 10 which may be lighted at one time by one person provided the length of fuse for each hole agrees with the number of

inches shown in column (2) if 40 second fuse is used or in column (4) if 30 second fuse is used. For convenience columns (3) and (5) are included to show the burning rate of 40 second and 30 second fuses respectively in steps of 6 inches each.

b. Each new supply of safety fuse should be tested for the rate of burning. This is accomplished by cutting off 3 foot lengths of fuse and timing the burning period. The number of seconds consumed divided by three will give the burning rate for one foot of fuse.

(m) *Warning Signals.* An audible warning signal shall be provided and sounded both before and after each shot with sufficient interval to permit persons to reach sheltered places and to announce that no further shots are to be fired.

(n) *Protection from Blasts.* Bomb-proof shelters sufficiently substantial to withstand flying objects from secondary shots shall be provided at a safe distance from the blasting operations and shall be of necessary capacity to accommodate the entire working crew.

Exception: Blasting shelters are not required if employes are required to retire to a distance of not less than 500 feet.

No shot shall be fired until all men are in the shelter provided for or have retired to a distance of not less than 500 feet.

Note: The required 500 feet should be paced or measured to insure the proper distance. Employes should not be permitted to stand in the open but a place behind some barrier or object sufficient to withstand the force of flying objects should be selected and used.

Where highways or buildings are located within the danger zone, employes shall be sent in each direction to warn the public when shots are to be fired. The persons giving the warning shall proceed not less than 500 feet from the blast and warning shall be accomplished by waving a red flag. A sign with the words "*Stop—Blasting*" printed thereon, in letters not less than 3 inches high, and attached to a pointed rod or standard, shall be provided and placed on the highway in addition to the red flag.

Note: Warning sign should be held or placed on the highway only for the duration of the blast and then removed when all danger from flying material or misfired shots ceases. Leaving signs posted after the warning is no longer required only leads to confusion of the traveling public.

(o) *Secondary Blasting.* Secondary blasting on rock piles when the mud-capping method is used shall be conducted by successive stages. Boulders located at the foot of the piles shall be blasted separately from the boulders located midway or near the top of the slope, thus preventing the rolling of rocks on unexploded charges and consequently being thrown to a considerable distance.

(p) *Tamping Bars and Powder Punches.* All tamping bars and powder punches shall be of wood.

(q) When blasting operations are conducted within the confines of villages and cities, shots shall be effectively screened with approved blasting mats to hold or catch flying material. Shots shall be spaced, located and charged with explosives in a manner as to minimize the danger of flying material. Permission for the use of explosives is subject to the approval of the local authorities, as the mayor, president of the village, or the chairman of the town board.

Exception: Blasting operations may be conducted in existing quarries and other locations without the use of blasting mats, provided buildings, thoroughfares and persons are not subject to the danger of flying material and charges of explosives are kept as light as practicable with the nature of the work.

Note: Additional precautions to be taken for the safe storage and use of explosives are provided in the Appendix.

ORDERS RELATING TO UNDERGROUND STORAGE AND HANDLING OF EXPLOSIVES IN MINES

SECTION II

Note: These orders are quoted from the General Orders on Mines.

Order 325—Storage, Transportation and Use of Explosives above Ground.

The handling, transportation and storage of explosives above ground shall be governed by the General Orders on Explosives.

Order 326—Storage, Handling and Use of Explosives Underground.

(a) *Supply Permitted.* Sufficient explosives may be stored within a mine to meet the estimated requirements of such mine during the succeeding week.

(b) *Storage.* Explosives shall be stored underground in approved magazines which shall consist of a separate tunnel or chamber where no men are employed, except the man in charge. The magazine shall be provided with a substantial door which shall be kept securely locked.

(c) *Storage in Working Places.* Not more than one shift's supply of explosives shall be kept for immediate use in any working place on any one level at any one time. Such explosives shall be kept in approved containers. Such containers shall be placed in locations not exposed to falling materials or derailments.

(d) *Smoking, Flammable Materials.* No loose flammable material shall be allowed within 60 feet of a magazine. Smoking shall not be permitted in, or in the vicinity of any magazine and no matches, igniter, tool, material, or appliances which might cause a spark or flame shall be carried into any magazine. Carbide shall not be stored with explosives.

(e) *Blasting Caps—Transportation of.* Detonators shall not be transported with explosives excepting that detonators may be carried to the face for immediate use, providing they are in one container and the explosive in a separate container.

(f) *Opening Containers.* Wooden or non sparking metal mallets and wedges shall be used to open boxes of explosives.

(g) *Carrying on Locomotives.* Explosives of any kind shall not be carried underground on electric locomotives and no one except the train crew or powder-man shall be allowed to ride on a train carrying explosives.

(h) *Location near Electric Wires.* Explosives shall not be placed near tracks or left less than 5 feet from electric wires or electric lights.

(i) *Smoking when Handling.* No person shall smoke in an explosive magazine or primer house, or while handling explosives.

Order 327—Blasting Caps, Fuses and Primers.

(a) *Storage of Detonators.* All detonators or blasting caps shall be stored above ground in an approved magazine, except that a sufficient supply for the needs of the mine during 48 hours may be stored underground, and if properly heated and ventilated storage is provided, one week's supply may be stored. No detonator shall be taken into any magazine containing other explosives.

(b) *Capping Fuses.* Fuses shall not be capped with blasting caps in any magazine or in any other place where explosives are stored.

(c) *Cap Crimpers.* Approved cap crimpers in sufficient quantities shall be provided.

(d) *Cutting and Capping Benches.* The cutting and capping of fuses shall be accomplished on a special bench properly located and protected against water.

(e) *Capped Fuses.* All primers and capped fuses shall be exploded within 36 hours after making unless stored in a dry, safe place.

Order 328—Blasting.

(a) *Tamping Sticks.* Wooden or non sparking metal tamping sticks shall be used for tamping explosives in bore holes. The diameter of the tamping stick shall not be less than the diameter of the explosive cartridge.

(b) *Warning.* Persons about to fire shots shall cause warning to be given in every direction and all entrances to the place or places where shots are to be fired shall be guarded.

(c) *Return to Misfires.* Where possible the number of explosions in every blast shall be counted by the men firing the same and if the total number of explosions heard is less than the number of charges fired, a report of the discrepancy shall be made as the employer shall direct. When a blast has been fired and there is reason to believe that any charge has not exploded, no person shall enter the place where such charge was placed within 30 minutes after the explosion.

Note: While the minimum requirement is given as one-half hour it is strongly recommended that where possible at least one hour elapse before return to a shot that has failed to explode.

(d) *Treatment of Misfires.* No person shall be permitted to extract explosives from a borehole, but shall, when possible, put in a new primer and blast again.

(e) *Spitting Fuses.* No man shall "spit" more than 15 fuses in a round of shots.

(f) *Fuse Lighters.* Where a carbide lamp or similar lighter is used in spitting fuses, a second light shall be kept burning as a safety measure, and such extra light shall be placed a safe distance from the blast.

Order 329—Electric Blasting.

(a) *Where Required.* Only electric or delay electric blasting caps shall be used in operations as follows:

- (1) In sinking shafts or winzes.
- (2) In cutting shaft stations.
- (3) In drifts, crosscuts, storage pockets and pump sumps where there is not enough protection for the men from flying rock or concussion.

(b) *Blasting Lines.* Blasting lines shall be kept clear from all power and lighting lines and from all grounded pipes, rails, etc. and shall be run on the side of the working opposite all power and lighting circuits.

(c) *Power Switches.* When firing by electricity from power wires, a proper switch shall be furnished with lever down when "off." The switch shall be fixed in a box to which no person shall have access except the blaster. This box shall be constructed so that it can be closed and locked only when the switch is in the "off" position. The lead wires shall be furnished with plugs and shall not be connected with the switch until ready to fire. After blasting, the switch lever shall be pulled out, the wires disconnected, and the box locked before any person shall be allowed to return and shall remain so locked until ready to blast. The lead wires shall be kept short circuited and grounded until ready to be attached to the power switch or firing machine. A suitable lightning arrester shall be installed on the live side of all firing switches located at or near the shaft.

(d) *Insulation of Firing Cables.* Rubber covered insulated wires shall be used for fixed shot firing cables. Permanent lines shall be properly supported and mounted on insulators. Connecting wires from the fixed firing cables to the blast shall be single conductor insulated wire. No persons other than the boss or blaster shall connect the lead wires to the firing machine or operate firing devices and such connection shall not be made until all other steps preparatory to the firing of a shot shall have been completed and the men removed to a safe distance.

ORDERS RELATING TO UNDERGROUND STORAGE AND HANDLING OF EXPLOSIVES IN TUNNELS AND CAISSONS

SECTION III

Note: These orders are quoted from the General Orders on Tunnel, Caisson and Trench Construction.

Order 614—Explosives, Conveying, Thawing, Blasting, Misfires, etc.

(a) Only experienced men who have been selected and regularly designated by the superintendent in charge and whose names have been posted in the field office or at the magazine shall handle, transport, prepare or use dynamite or other high explosives.

(b) There shall be one blaster in charge of blasting in each section and he shall enforce his orders and directions and personally supervise the fixing of all charges and all other blasting operations and shall use every precaution to insure safety.

(c) The composition of explosives shall be such as to cause the least amount of injurious gases. No explosives shall be used which have not been approved by the Industrial Commission.

Note: It will be the policy of the Commission to approve explosives which are listed as permissible by the U. S. Bureau of Mines. Therefore, such listed explosives may be used without submitting them to the Commission, unless upon due notice any such explosives have been disapproved by the Commission or have been improperly used or stored.

(d) No greater quantity of explosives than that which is required for immediate use shall be taken into the shaft or tunnel except for storage in any approved underground magazine.

Explosives shall be conveyed in a suitable covered wooden box or in sacks provided for that purpose. Detonators shall be conveyed to the working place in a separate container

from that for the explosive. The carrying container for fuse and caps should be of rigid construction, and have a soft lining for better protection of the detonators.

Explosives and detonators shall not be taken down the shaft on the same cage at the same time.

While explosives are being taken through locks, no men other than the lock tender and the carrier shall be permitted in the lock.

After blasting is completed all explosives and detonators shall be returned at once to the magazine, observing the same rules as when bringing them to the work.

Detonators and dynamite must be kept or stored separately underground.

Explosives shall not be left or placed near live electric wires.

(e) No blaster shall attempt to use dynamite that is frozen. Only approved methods of thawing shall be permitted. Dynamite or other high explosives shall not be thawed by placing it near a fire or near a steam boiler or by direct contact with steam.

(f) No naked light shall be used in the vicinity of open chests or magazines containing explosives, nor near where a charge is being primed.

(g) Detonators shall be crimped on the fuse only with a broad jaw cap crimper.

(h) No tools or other articles shall be carried with the explosives or with the detonators.

(i) All drill holes shall be of sufficient bore to admit of the free insertion to the bottom of the hole of a cartridge of explosive without the necessity of undue ramming or removing the dynamite from its original wrapper.

(j) When a blaster fires a round of holes he shall count the number of shots exploding, except in cases of instantaneous blasting by electricity. If there are any misfires, he shall remain until such misfires have been exploded or holes made safe.

Note: Misfires should not be approached even for the purpose of inspection until one hour has elapsed if fuse is used, or ten minutes have elapsed if electric blasting caps have been used, lest the trouble be a hangfire and not a misfire.

(k) Whenever feasible, a charge that has failed to explode shall be exploded by inserting a new primer in the hole on the old charge and detonating such primer.

(l) Blaster shall use only hardwood rods for tamping and he shall not tamp or load any hole with a metal bar, nor shall the wooden rod have any metal parts.

(m) When firing by electricity from power or lighting wires, a proper switch shall be furnished with lever down when "off". The switch shall be fixed in a locked box, to which no person shall have access except the blaster. There shall be provided flexible leads or connecting wires not less than 5 feet in length with one end attached to the incoming lines and the other end provided with plugs that can be connected to the switch on the inside shot-firing circuit when firing and that shall at all other times be connected to an effective ground. After blasting, the switch lever shall be pulled out, the wires disconnected and the box locked before any person shall be allowed to return, and shall remain so locked until again ready to blast, and blasting wires must be laid on the opposite side of the tunnel from the lighting and power wires.

(n) All power lines and electric light wires shall be disconnected at a point outside the blasting switch before the loading of holes is proceeded with. No current by grounding of power or bonded rails shall be allowed beyond blasting switch after explosives are taken in preparatory to blasting, and under no circumstances shall grounded current be used for exploding blasts.

(o) The blaster shall cause a sufficient warning to be sounded and shall be responsible that all persons retreat to safe shelter before he sets off blast, and shall also see that none return until he reports it safe for them. He shall report to the tunnel foreman and furnish names of all persons refusing to obey his caution.

(p) Before drilling is commenced on any shift, all remaining holes shall be examined with a wooden stick for unexploded charges or cartridges, and if any are found, same shall be refired before work proceeds.

(q) No person shall be allowed to deepen holes that have previously contained explosives.

(r) All wires in broken rock shall be carefully traced and search made for unexploded cartridges.

(s) Whenever blasting is being done, in a tunnel, at points liable to break through to where other men are at work, the foreman or person in charge shall, before any holes are loaded, give warning of danger to all persons that may be working where the blasts may break through, and he shall not allow any holes to be charged until warning is acknowledged and men are removed.

(t) When firing electrically individual electric detonators shall be tested with a galvanometer, both before and after loading.

(u) No blasts shall be fired with fuse, except electrically ignited fuse, in vertical or steep shafts.

(v) In shaft sinking where the electric current is used for firing a separate switch not controlling any electric lights shall be used for blasting and proper safeguards similar to those in tunnels shall be followed in order to insure against premature firing.

APPENDIX

Storage of Explosives

The American Table of Distances is considered a standard on which should be based the location of magazines in relation to surrounding improvements such as dwellings, railroads and highways. A magazine location should be selected with a view to both accessibility and safety. A good location in an isolated ravine where the surrounding hills provide protection and such location permits the reduction of distances to surrounding improvements.

Improper storage results in very rapid deterioration of explosives, particularly by the absorption of moisture and extremes in temperatures. A magazine properly constructed to provide good ventilation and insulation is required.

The size of the magazine depends upon the amount of explosives to be stored. The dimensions given in the following table are suitable for the amounts indicated.

Main Storage Magazines

<i>Quantity</i>	<i>DIMENSIONS</i>	
	<i>Width</i>	<i>Length</i>
1000 lbs. -----	6 feet	6 feet
2000 lbs. -----	6 feet	7 feet
5000 lbs. -----	8 feet	9 feet
10000 lbs. -----	10 feet	12 feet
15000 lbs. -----	12 feet	12 feet
20000 lbs. -----	12 feet	16 feet
25000 lbs. -----	12 feet	18 feet
30000 lbs. -----	12 feet	20 feet
40000 lbs. -----	14 feet	22 feet
50000 lbs. -----	14 feet	24 feet

Specifications for Storage Magazines

Permanent magazines should be constructed of soft brick or cement mortar but may be of wood construction covered with galvanized iron, the walls double sheathed and filled in with dry sand. The following specifications for a wood constructed magazine may be used:

Specifications for Wood Constructed Magazine

Dimensions ---9 feet 6 inches high in front; 8 feet 2 inches high in rear, and floor area according to capacity indicated.

Sills -----6 x 10 inches.

Floor Joists ---2 x 8 inches, spaced 16 inches center to center.

Sheathing ----Matched lumber, 1 inch material, either flooring, or outside and inside sheathing.

Roof -----1 inch lumber same as sidewalls and covered with No. 26 gauge galvanized iron.

Floor -----1 inch flooring, matched, and set back 2 inches from walls to provide ventilation.

Outside Wall --To be covered with galvanized iron, not less than No. 26 U. S. standard gauge.

Studding -----2 x 6 inches, spaced 12 inches center to center.

Door -----3 feet wide, 6 feet high, made of 3 inches of hard wood and covered on outside by 1/4 inch steel plate firmly secured to door by bolts.

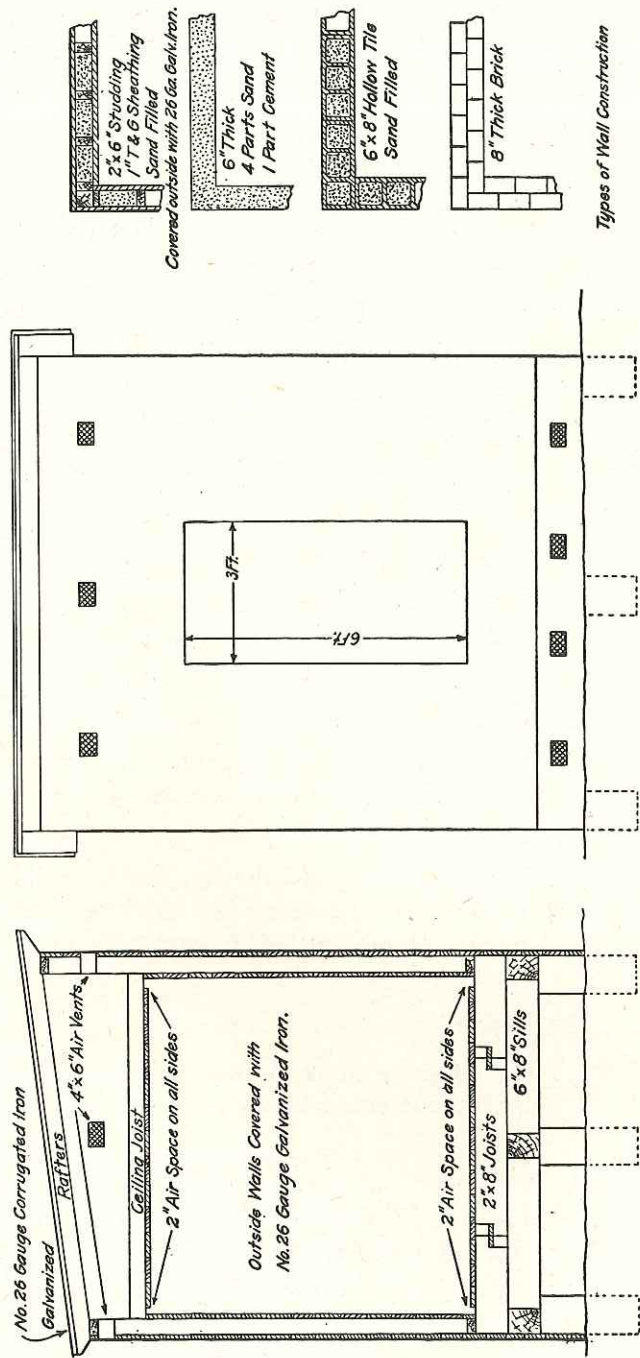
Sand Filler ---Space between outside and inside walls to be filled with coarse, dry sand or cement mortar consisting of 1 part cement to 6 parts sand.

Lock -----Inside lock.

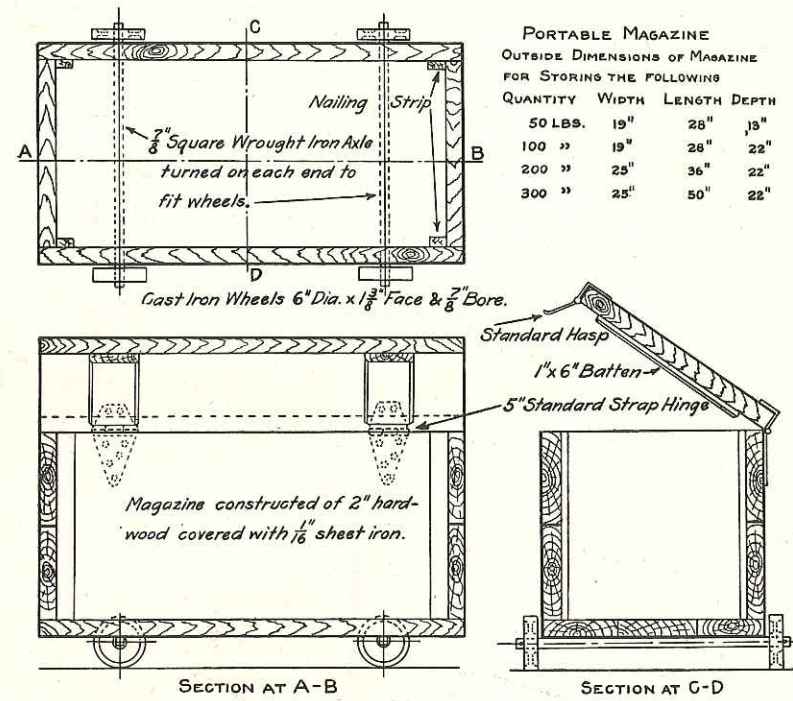
Foundation ---Set on posts about 1 foot above ground or continuous concrete walls.

Ventilation ---4 x 6 inch openings below roof line and floor level, covered with wire screen. The floor and ceiling must be set back 2 inches to provide air circulation.

Danger Signs--Signs with words "Explosives—Dangerous" to be posted on magazines or grounds.



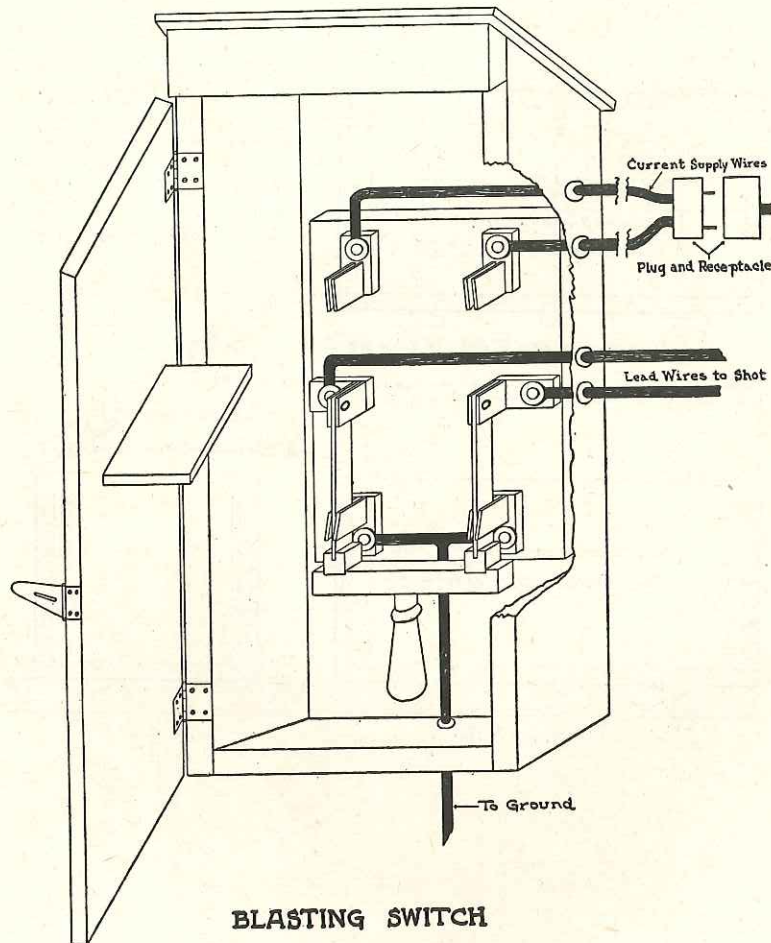
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Blasting Switch

The blasting switch consists of a two pole double throw switch. It must be wired so that the power supply is disconnected when the lever is in a "down" or "off" position. The current supply wires are connected to the upper poles.



BLASTING SWITCH

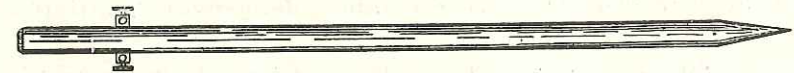
The leading wires supplying the shots are connected to the middle poles. The bottom poles are wired to an effective ground consisting of a pipe driven into moist soil or the water piping system.

When the switch is in an "off" position the shot wires are short circuited and grounded, preventing the introduction of "stray currents". The switch should be of the enclosed safety type and a locking device provided to lock the switch handle when in the "down" position. If an open knife switch is provided it must be mounted in a cabinet provided with a door and lock. The door must be designed so that it cannot be closed unless the switch handle is in the "down" or "grounded" position.

The switch box must be kept locked at all times except when in use and shall be operated only by the blaster. A plug and receptacle must be provided in the current supply line so that wires may be kept disconnected from the switch as an additional precaution.

Grounding Leading Wires, Portable Equipment

When firing shots with a portable blasting machine it is necessary to keep the leading wires short circuited and grounded to prevent a possibility of the introduction of stray currents and a premature blast.



Metal stake for grounding leading wires.

The grounding stake should consist of a pointed, metal rod or pipe preferably non-corrodible. Two binding posts are attached near the upper end to provide terminals for the leading wires. The grounding stake is driven into moist soil near the blasting machine and the leading wires attached before the opposite ends are connected with the shots.

Static and stray currents leaking from electric power lines, transformers, motors, etc. may enter the blasting circuit and it is, therefore, important to keep leading wires shorted and grounded when connecting to blasting cap wires.

SAFETY RECOMMENDATIONS

The following additional safety precautions are recommended by the makers of explosives and should be strictly observed at all times if accidents are to be prevented.

1. Drill holes becoming blocked when loading should be abandoned. It is safer to drill a new hole at a safe distance from the abandoned hole.
2. Allow a "sprung" or "chambered" bore hole to cool sufficiently before loading another charge.
3. High explosives, especially the primer, should not be forced into a bore hole.
4. It is dangerous to "spring" a hole next to a loaded hole.
5. The loading of drill holes or the preparation of shots should only be attempted after all equipment and persons are removed from the danger zone.
6. If not possible to safely reprime a misfired shot, it is recommended that a new hole be drilled at least 2 feet from the missed one.
7. Safety fuse lighters are now obtainable and recommended in lieu of matches or other methods of "spitting" fuses.
8. Storage of fuse in a hot place may injure the fuse and cause the waterproofing material to damage the powder train.
9. Fuse when cold is stiff and breaks easily. It should be warmed slightly before using. Avoid kinks in fuse and wires.
10. Cut fuse square across and not on slant. Cut off an inch or two of fuse to insure having fresh end in the blasting cap, and see that the fuse is seated against the detonating agent in the cap.
11. Fuse should not be laced through cartridges of explosives.
12. Fuse should not be lighted while holding primer cartridge in hand.
13. Do not use grease to waterproof capped fuses. Use only approved waterproofing material, hard soap or wax.
14. Avoid making sharp bends or kinks in fuse, especially in cold weather.

15. Blasting caps must be kept in locked containers at all times to prevent children or unauthorized persons from becoming injured. Do not carry them in pockets of clothing.

16. Do not leave packages of explosives or blasting caps uncovered.

17. Explosives or blasting caps should not be left exposed to the direct rays of the sun.

18. A wire, nail or other sharp instrument should not be used to remove blasting caps from a container.

19. Do not attempt to remove or investigate the contents of a blasting cap.

20. The use of damaged leading or connecting wire in blasting circuits should be avoided.

21. Electric blasting should not be attempted during the approach or progress of a thunder storm. If charges are already prepared, the ends of the wires should be twisted and grounded to a metal grounding rod.

22. Waterproof electric blasting caps having enameled wires should be used in very wet work.

23. Do not use electric blasting caps of different manufacturers in the same circuit.

24. Do not attempt to withdraw wires from an electric blasting cap.

25. Operate blasting machines with as much force as possible.

26. The use of storage batteries or dry batteries is not recommended.

27. When blasting electrically, hold the lead wires down with weights to prevent them from being thrown upward to contact live electric power wires.

28. Do not prime both ends of a cartridge of explosive when making primers of half cartridges with a blasting cap or electric blasting cap, before cutting it in two. Cut the cartridge in half and prime each piece separately.

29. When blasting near buildings keep windows and doors open to prevent the breaking of glass.

30. All explosive charges should be covered with sufficient stemming material.

31. Examine thoroughly all boulders and rock ledges before drilling to prevent possibility of drilling in a misfired shot or dynamite left from previous shots.

32. Magazines should be elevated from the ground to prevent explosives absorbing moisture.

33. Store explosives so that the cartridges do not stand on end.

34. Open explosive containers outside of magazine.

35. Do not throw packages of explosives violently down or slide them along floors or over each other or handle them roughly in any manner.

36. Explosives should not be handled near open lights, gasoline engines, flames or sparks.

37. Do not attempt to shoot into explosives with a rifle.

38. Dynamite boxes should not be used for kindling.

39. Do not use frozen dynamite.

40. Do not thaw dynamite unless means are provide to apply indirect heat such as a manure box or an approved hot water device.

41. Explosive charges or shots should not be primed (placing of a blasting cap in the dynamite cartridge) until ready to fire the blast.

42. Return all unused explosives to magazines immediately after loading operations are completed.

Blasting Accessories Required

The following accessories required by the regulations are listed below with their order numbers for easy reference:

Explosive magazines, Orders 653, 657, 658, 659, 664.

Wood wedge and mallet, Order 657 (g).

Warning sign for traffic, Order 665(n).

Signs for vehicles, Order 662.

Bench for cutting and capping fuses, Order 664(c).

Crimpers for blasting caps, Order 664(d).

Covered carrying case for dynamite, Order 665(c).

Covered carrying case for blasting caps, Order 665(c).

Electric blasting switch when using electric power, Order 665(g).

Electric firing machine, Order 665(h).

Rubber covered firing cables, Order 665(h).

Bomb proof shelter, Order 665(n).

Galvanometer for testing electric blasting caps, Order 665(k).

Wooden loading stick, Order 665(p).

Punch for making primer, Order 665(p).

Blasting mat to prevent flying objects, Order 665(q).

Literature on Explosives

All explosive manufacturers have pamphlets or handbooks available for distribution to users of explosives giving very complete information on the proper use of explosives. A particularly informative pamphlet is one entitled, "Safety in the Handling and Use of Explosives," issued by the Institute of Makers of Explosives, 103 Park Avenue, New York City.

Use of Explosives

The safe handling of explosives depends entirely upon the strict observance of safety rules. The blaster should not only be familiar with all the rules but should observe them in practice. It is the employer's duty to provide proper storage facilities, blasting accessories and to employ only qualified men to handle the explosives. The employer is also responsible for strict enforcement of the safety rules. Lack of interest and discipline will sooner or later result in infractions of the rules.