BLASTING SUPPLIES

DU PONT

E. I. DU PONT DE NEMOURS POWDER COMPANY,
WILMINGTON, DELAWARE, U.S.A.
ESTABLISHED 1802.

PRESS OF
DANDO COMPANY
PHILADELPHIA

Foreword

ALTHOUGH the explosive itself very naturally demands first consideration when blasting is to be done, the fact must not be overlooked that it cannot be properly exploded without certain materials and appliances especially designed for the purpose, and which are commonly known as "Blasting Supplies." In addition to those articles necessary to develop the energy of a charge of explosives, there are other devices which, although they may not be absolutely requisite, contribute to safety, certainty and economy in the use of explosives, and these are also included in the category of Blasting Supplies.

The importance of keeping Blasting Supplies up to the highest standard in every respect cannot be overestimated, for the very best grade costs but a trifle in comparison with the charge of explosives with which they are used. It is poor economy to attempt to detonate explosives with an inferior article, for this always results in a considerable waste of the value of the explosives. More than a hundred years' experience in the manufacture, sale and use of all kinds of explosives has taught us that the popularity of our products depends entirely on the results which consumers have with them. With this in view, we must, from a standpoint of "good business," if from no other, recommend only a high quality of Blasting Supplies.

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Electric Fuzes manufactured by The E. I. du Pont de Nemours Powder Co.

INTRODUCTION

Blasting Supplies and Their Use

ELECTRIC Fuzes are the detonators used when a high explosive, such as dynamite, is fired electrically. They consist of a copper capsule, or shell, containing a detonating charge surrounding a fine platinum "bridge," which joins the tips of two insulated copper wires of various lengths. The ends of the copper wires are secured in the copper shell by a composition plug, which also serves to keep moisture and water away from the charge. The electric fuze is detonated when sufficient current is passed through the copper wires, and across the platinum bridge, to heat the latter to a temperature high enough to ignite the charge surrounding it.

Electric Fuzes

Delay Electric Fuzes can be used to advantage in certain classes of tunnel or shaft excavating. These are made so that a very short space of time intervenes between their ignition by the electric current and their detonation. By their use, it is possible, with but one operation of the blasting machine, to fire one section of a blast, sufficiently ahead of the following section, for the material in the first to be out of the way when the next is blasted.

Delay Electric Fuzes

When several charges of explosives are to be detonated at one time with electric fuzes, it is necessary (unless the electric fuze wires are long enough to reach between the bore holes) to join them with Connecting Wire. Insulated copper wire is used for this purpose.

Connecting Wire

Leading Wire

Leading Wire, which is also insulated and in order to reduce resistance is of a larger size than connecting wire, connects the electric fuzes in the first and in the last bore hole with the source of the electric current.

Blasting Machines

The current for electric blasting is sometimes taken from a power or lighting system, but the source of current commonly used is known as a Blasting Machine. Although manufactured in several sizes and styles, they are usually designed on the same general principle.

Galvanometers

Owing to the many difficulties generally attending blasting, such as wet or cold weather, water in bore holes, necessity for hurry, and so on, it not infrequently happens that electric fuze wires are stripped or broken in tamping, connections are improperly made, poorly insulated and leaky; or the circuit is broken or interrupted in some other way, which results in the misfire of the explosives in some or all of the bore holes, causing serious loss and delay. In order to eliminate this trouble as far as possible, a Galvanometer has been designed, for testing out the blasting circuit before firing. It is possible with this instrument to detect a break or any considerable leaks in the blasting circuit. It will also detect extensive leaks or serious defects in the electric fuzes and locate the points at which the trouble exists.

Rheostats

The kind of work on which blasting machines are used is largely responsible for rough and careless handling, which often wears them out rapidly. The Rheostat is a simple but effective instrument, which should be used from time to time to test the capacity of blasting machines, so that there will be no danger of overloading them.

Leading Wire Reels

If the leading wire is to be kept in good condition, and handled easily and quickly, a Leading Wire Reel is necessary.

Electric Squibs

When blasting powder is the explosive used, Electric Squibs may take the place of electric fuzes. They are made on the same principle as electric fuzes, but cost less, as a heavy paper shell replaces the copper cap of the electric fuze. As the charge in Electric Squibs does not detonate, but burns or flashes, they will not detonate dynamite or other high explosives, and can be used only with blasting powder or similar low explosives.

Blasting Caps

Blasting Caps are used to detonate high explosives, when it is not necessary to fire more than one charge at a time, or when for some other reason electric firing is not feasible. They consist of a copper shell similar to that of the electric fuze, and which contains the same kind of a charge. The charge in the blasting cap, however, is not ignited electrically, but by a section of safety fuse on the end of which the blasting cap must be crimped.

Safety Fuse

Safety Fuse consists of a small train of fine grain fuse powder which forms the core of a rope of hemp, cotton or tape, generally covered with water proofing mixture. It is used for detonating blasting caps as described above, or for igniting directly charges of blasting powder into which it carries a spark.

Cap Crimpers

The Cap Crimper is a very convenient and serviceable little tool, which is used to attach the blasting cap securely to the safety fuse. Some styles are equipped with a fuse cutter.

Thawing Kettles

Many high explosives containing nitroglycerin freeze very easily, and become insensitive at temperatures from 45° F. to 50° F. These explosives cannot be used effectively in cold weather, unless they are thoroughly thawed and kept warm until they are loaded in the bore hole. Thawing Kettles are used for this purpose. There are several different designs, but all are constructed with a warm water jacket surrounding the explosives compartment.

Tamping Bags

Tamping Bags are paper containers for sand, clay or other material with which horizontal or pitching bore holes, or "uppers," are to be tamped. They are also used when making blasting powder into cartridges for use in similar bore holes.

Blasting Mats

Blasting Mats are woven mats of rope, which are spread on the ground above the bore holes, when blasting is done where flying pieces of rock will be dangerous. If heavy charges of explosives are used, it is the custom to place logs or railroad ties directly over the bore holes, and the blasting mats on top of these.

Blasting by Electricity

BLASTING by electricity is generally conceded to be the most effective and economical system, and to surpass any other in safety, expedition and certainty. In work where it is possible to blast more than one charge at a time, it will nearly always be found advantageous to do so. This can only be accomplished by electric firing. When several charges are fired simultaneously each tends to help the other, both in turning out and in breaking up the material blasted, with the result that a greater amount of work is done by a given quantity of explosives than if the several charges were fired successively. It is possible also to better protect against water and other causes of misfire the appliances used in electric blasting, thus insuring greater certainty. As delayed explosions, or "hang fires," are hardly possible, and as the blaster can always be a considerable distance away from the explosive when it detonates, this system reduces the possibility of accident to a minimum.

No method of blasting in gaseous or dusty coal mines, other than the electrical one, deserves consideration because in all others the ignition in the open of some burning substance is necessary, even though a device be used, whereby the safety fuse or squib can be ignited without exposing an open light or flame in a gaseous place.

It is believed by many authorities that disastrous explosions in coal mines have been caused by a blown-out shot occurring shortly after a number of other blasts have been fired. This cannot happen if the firing is done by electricity, when as many shots as desired are fired simultaneously. In submarine or other very wet work, no other system is feasible. In underground work, where ventilation is not good, burning safety fuse increases

Blasting Circuit Connected in Series

the smoke and fumes very materially. It is not uncommon for the fire to break through the side of the fuse, and ignite the charge of explosives before detonating the blasting cap, resulting in poor execution and increase in fumes. This cannot occur when the blasting is done by electricity.

The equipment necessary for electric blasting is as follows:

Electric Fuzes	**Connecting Wire**
Leading Wire	**Blasting Machine**

The following will also prove of much assistance and very often effect a saving of both time and money:

Leading Wire Reel **Galvanometer**
Rheostat

If the explosive used is blasting powder, and not a high explosive, Electric Squibs, which are less expensive, should replace Electric Fuzes in the above list.

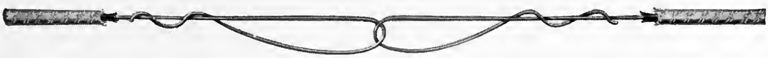
When the source of the electric current is a blasting machine, or "battery," of the usual type, the bore holes are connected in series; that is, one wire of the electric fuze in the first bore hole is joined (using connecting wire if necessary) to one wire of the electric fuze in the second bore hole, and the other wire of this electric fuze to one wire of the electric fuze in the third bore hole, and so on, until all of the bore holes are connected together with a free electric fuze wire in the first and the last bore holes; these free wires are to be connected to the leading wires and the leading wires to the blasting machine.

The Blasting Machines, described in this catalogue, are made for series connecting only and connections should not be made in "parallel," or any modification thereof. (See illustration, page 6).

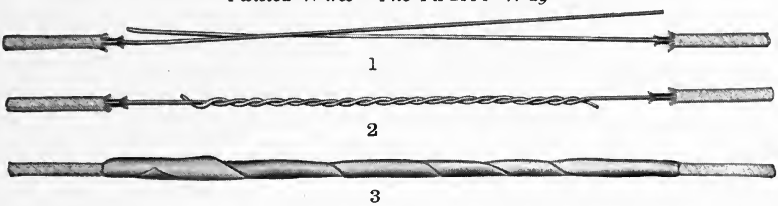
When making connections, care must be taken to see that all metal parts joining each other are scraped bright and clean. Another point of particular importance is that no part of the circuit which is not thoroughly insulated should come in contact with any other uninsulated part of the circuit, or with water, or with wet or damp ground. In order to accomplish this, all bare joints should be covered with insulating tape.

When making connections, do not loop the wires, but twist them tightly together.

Looped Wires—The WRONG Way



Twisted Wires—The RIGHT Way



The attempt to use old and damaged leading wire or connecting wire, is a great mistake and is often the cause of misfires. One of the principal objections to their use is that the wire itself frequently breaks inside the insulation, which will remain intact. When this occurs, the ends of the wire may touch and the circuit seem all right when tested, but a very slight movement of the wires afterwards may pull these ends apart, breaking the circuit and causing a misfire. A break of this kind is not easily located, and sometimes is responsible for the loss of the time of many workmen waiting for the shot to be fired.

DU PONT

Victor Electric Fuzes

Delay Electric Fuzes

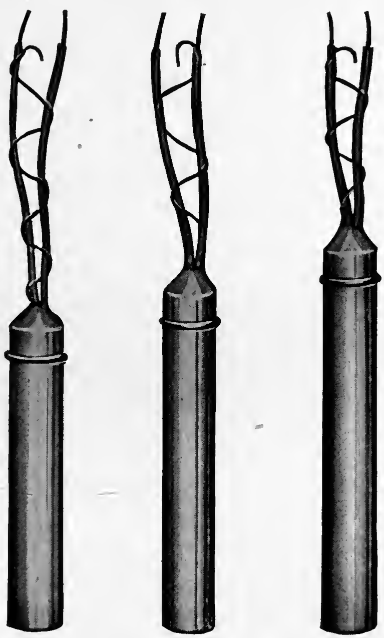
Du Pont Electric Fuze and Blasting Machine Works, Pompton Lakes, N. J.

Victor Electric Fuzes

VICTOR Electric Fuzes are made in three different strengths—No. 6, No. 7 and No. 8, each of which is put up with insulated copper wires of the following lengths:

4′	10′	16′	22′	28′
6′	12′	18′	24′	30′
8′	14′	20′	26′	

Special lengths not shown above will be manufactured on order.



No. 6 No. 7 No. 8

Victor Electric Fuzes (actual size)

The following table describes fully Victor Electric Fuzes of different strengths:

		No. 6	No. 7	No. 8
Grade		No. 6	No. 7	No. 8
Color of Label		Red	Brown	Green
Length of Shell		$1\frac{9}{16}''$	$1\frac{3}{4}''$	2″
Caliber of Shell		.273″	.273″	.273″
Weight of Charge	Grains	15.43	23.15	30.86
	Grams	1.00	1.50	2.00

Nothing weaker than Victor No. 6 electric fuzes can be relied on to develop the full force of any high explosives that are not too sensitive to handle or use with any degree of safety.

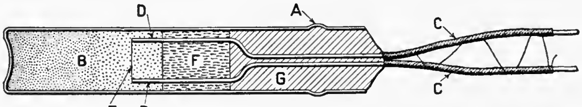
Victor Electric Fuzes are furnished for submarine work, with a special gutta percha covering, which is highly water resisting.

Victor Water Proof Electric Fuzes, having a special insulation, are also furnished for submarine and other very wet work.

GUTTAPERCHA COVERED
(FOR SUBMARINE WORK)

SECTION OF GUTTAPERCHA COVERED
(FOR SUBMARINE WORK)

The illustration below shows, in section, an Electric Fuze. "A" is the shell of copper, having a corrugation thrown out from the inside, which holds the composition plug more firmly in place; "B" is the chamber containing the explosive charge; "C," the insulated copper wires entering the cap; "D," the



bare ends of the copper wires, projecting through the plug into the charge; "E," the small platinum wire or "bridge" soldered to and connecting the two ends of the copper wires, which is heated by the electric current; "F," the composition plug holding the fuze wires firmly in place; "G," the filling material.

Electric Fuzes are packed in pasteboard cartons, which are enclosed in heavy wooden cases. The cartons contain either

25 or 50, depending on the length of the wires. Electric fuzes with wires from 4 feet to 16 feet long are packed for domestic trade 500 to the case, while those with longer wires are packed 250 to the case. The number of electric fuzes, with wires of different lengths, to the case, the dimensions, and the gross and net weight of case for domestic shipment are given in the table on page 14.

The storage of electric fuzes should always be given careful attention by the consumer. If they are permitted to remain for a considerable period of time in a very warm place, the water proofing material in the insulation dries out to such an extent that the insulation may break when the wires are bent, and misfires result if an attempt is made to use them in wet work.

The explosive charge in the electric fuzes is very easily affected by moisture, and if they are stored in a damp or wet place they may deteriorate. This charge is also very sensitive, and may be exploded by a moderately hard knock or jar. Electric fuzes should therefore be handled carefully. Careful handling is also necessary on account of the delicate bridge wire (see illustration, page 12), which may be broken, and which when broken renders the electric fuze absolutely useless. The wires must not be bent sharply or forcibly separated at the point where they enter the copper cap, as this may break or loosen the filling material and permit water to enter and damage the charge in the electric fuze.

The correct way to prime a high explosive cartridge with an electric fuze is to unfold the paper on one end of the cartridge and insert the fuze cap in the center, pointing it directly toward the opposite end; then fold the paper about the two wires and tie it firmly with strong twine. The primer may also be made by inserting the fuze cap in the side of the cartridge, near the end, and pointing it downward toward the opposite end, the wires to be tied to the side of the cartridge. The electric fuze should always be placed so that the loaded end will point toward the main portion of the charge of explosives it is to detonate. The hole for the fuze cap should be made in the cartridge with a pointed stick about the size of a lead pencil. The common custom of taking one or more loops, or half hitches, around the cartridge with the wires themselves, after inserting

VICTOR ELECTRIC FUZES

APPROXIMATE WEIGHTS AND DIMENSIONS OF PACKAGES FOR DOMESTIC SHIPMENT

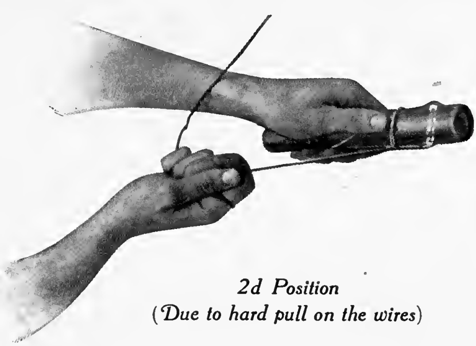
Quantity	Length	Gross Weight	Net Weight (In Cartons)	Outside Dimensions of Cases		
				Length	Width	Depth
500	4'	27 lbs.	19½ lbs.	22" x	9½" x	9½"
500	6'	32 "	24½ "	22" x	9½" x	9½"
500	8'	42 "	33 "	22" x	11½" x	9½"
500	10'	46 "	35 "	22" x	11½" x	9½"
500	12'	56 "	45½ "	22" x	15½" x	9½"
500	14'	61 "	49½ "	22" x	15½" x	9½"
500	16'	70 "	57½ "	22" x	17½" x	9½"
250	18'	45 "	32½ "	22" x	17½" x	9½"
250	20'	49 "	36½ "	22" x	17½" x	9½"
250	22'	52 "	39½ "	22" x	17½" x	9½"
250	24'	55 "	42½ "	22" x	17½" x	9½"
250	26'	57 "	44½ "	22" x	17½" x	9½"
250	28'	61 "	48½ "	22" x	17½" x	9½"
250	30'	65 "	52½ "	22" x	17½" x	9½"

Cases of ½" material. For inside dimensions, deduct 1" for length, width and depth.

the fuze cap in a hole made diagonally in the side of the cartridge near one end, is always to be condemned. The principal objection is that the looping of the wires may break the insulation causing short circuits or leakage of current in wet work, or may even break the wires themselves. Also, when a fuze cap from $1\frac{9}{16}$ inches to 2 inches long is pushed into the side of a cartridge 1 inch, $1\frac{1}{4}$ inches, or even $1\frac{1}{2}$ inches in diameter, it very often happens that the point, where the principal part of the detonating charge is located, goes entirely through the explosive itself, even though it may not break through the paper. As it is often the custom, when priming in this way, to point the fuze cap diagonally toward the end of the cartridge, which will be nearest the outside or top of the charge, it can readily be seen that any pull on the wires, hard enough to affect the position of the cap, will tend to bring it more to a right angle with the long axis of the cartridge, and thus force the point still farther out of the opposite side. (See accompanying illustrations.)

1st Position

While this does not always cause a failure, it is quite possible that lost shots may be attributed to it, especially when cartridges of small diameters are used. The series of illustrations on page 66 show very clearly the proper method of making a primer with blasting cap and fuse. The same method should be followed when an Electric Fuze is used. Although it may take a little longer to



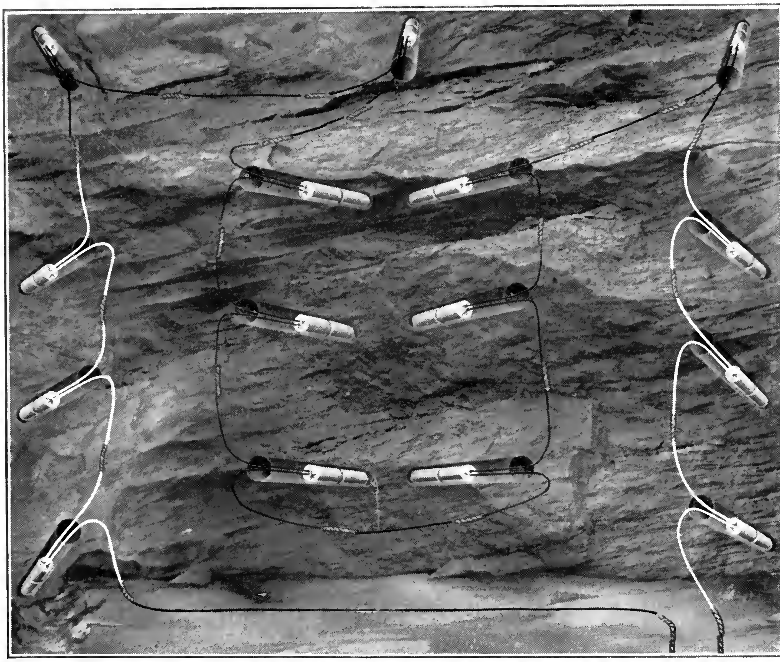
2d Position
(Due to hard pull on the wires)

make a primer in this way, it is probable that the reduction in the number of misfires will much more than repay for the trouble taken.

Care must be taken when tamping the bore hole not to break either the electric fuze wires or the insulation on them, or to pull the electric fuze cap out of the primer. Many misfires are probably due to carelessness in loading and tamping bore holes.

Although electric fuze wires are well insulated, they are not intended for extreme conditions, and if used in water, particularly under pressure, they may "leak"; that is, the electric current, or a part of it, may "short circuit" instead of passing through the bridge wire, which is of high resistance. Therefore, more current is necessary to insure good results in wet work than in dry work, unless electric fuzes with special insulation for wet work are used. These specially insulated electric fuzes are called Victor Water Proof Electric Fuzes.

In order to reduce as much as possible the expense of electric firing in gaseous or dusty coal mines, we manufacture Victor No. 6 Electric Fuzes with Iron Wires for this purpose or for other work where Electric Fuzes with wires longer than 8 feet are not required. We recommend nothing weaker than Victor No. 6 Electric Fuzes to detonate "Permissible Explosives." Electric fuzes with iron wires cost less than do those with copper wires, but will not prove satisfactory under all conditions of electric blasting. The principal reason for this is that iron wire, even when in good condition, is much inferior to copper wire as an electric conductor. Practically six times as strong a current is required to fire an Electric Fuze with iron wires as will fire one with the same length of copper wires. Iron wire also corrodes much more readily than copper wire. Victor No. 6 Electric Fuzes are made with iron wires 4 feet, 5 feet, 6 feet and 8 feet long. They will be furnished with longer wires if desired, but we do not recommend them, because of the poor conductivity of iron wire referred to above. They are packed in the same way as Electric Fuzes with copper wires, and require the same careful storage and handling.



Method of Connecting No Delay, First Delay and Second Delay Electric Fuzes

Du Pont Delay Electric Fuzes

IN some kinds of blasting, particularly in tunnel work, it is necessary to blast each round of bore holes in sections, and it is generally of considerable advantage in saving time if this can be arranged so that it will not be necessary to return to the working face after the first section has been blasted. When fuse and blasting caps are used to detonate the explosive, the sections of fuse for the different bore holes are cut in different lengths so that the charges will explode in the proper sequence if the fuses are lighted at about the same time. There is practically no limit to the number of charges which can be exploded in sequence with fuse and blasting caps in this way, but under most conditions there is nothing to be gained by dividing the round of holes into more than three sections. When the electric system of blasting is in effect, this can be accomplished on a single application of the electric current by using "No Delay," "First Delay" and "Second Delay" Electric Fuzes in the same blasting circuit. The "No Delay" is a special instantaneous electric fuze, manufactured for use with the "First Delay" and "Second Delay," and will not give satisfactory results if used in the same blasting circuit with Victor or any other instantaneous electric fuzes, nor can any instantaneous fuze other than the "No Delay" be used satisfactorily with "First Delay" and "Second Delay" Electric Fuzes. As signified by their name, "No Delay" Electric Fuzes detonate at the instant the electric current passes through them. "First Delay" and "Second Delay" Electric Fuzes contain a slow burning substance which is ignited by the electric spark and which, after burning a short period of time, ignites the detonating composition below it. The burning speed of this slow burning

No Delay Electric Fuze
(Actual Size)

First and Second Delay Electric
Fuzes (Actual Size)

substance cannot be made absolutely uniform under all conditions, and consequently Delay Electric Fuzes of the same period in a blasting circuit may not all explode simultaneously. There is, however, always a distinct period of time between the explosion of the "No Delays" and of the quickest of the "First Delays" and between the slowest of the "First Delays" and the quickest of the "Second Delays." This insures that section of the round which is primed with the "No Delays" being blasted out before the "First Delays" explode and the section primed with the "First Delays" being blasted out before the "Second Delays" explode.

These electric fuzes are easily distinguished from each other and from Victor electric fuzes by the color of the wires, the "No Delay" wires being red, "First Delay" white and "Second Delay" blue.

These electric fuzes require the same careful handling and storing as do Victor electric fuzes. They are made in the No. 6 (red label) grade only and with wires of the same length as those of Victor electric fuzes.

DU PONT

Electric Squibs

Charging and Pressing House, Du Pont Blasting Cap Works, Pompton Lakes, N. J.

DU PONT

Electric Squibs

EVER since blasting powder first came into use, the advantage of igniting the charge in the center has been evident to all, particularly when this charge is distributed for a foot or more along a bore hole of comparatively small diameter.

When a charge of blasting powder in a bore hole is ignited at one end, it is always possible for some of the coal or rock to fall before the entire charge is exploded, and thus cut off for an instant the remainder of the charge. This is most likely to happen when large charges are ignited at the end nearest the mouth of the bore hole. Then more or less of the powder at the back of the bore hole, where the burden is usually the heaviest, does very little execution, and a large flame and a great volume of smoke are projected into the working place.

Attempts to ignite the charge at the center are sometimes made by extending the fuse to that point; but this is seldom successful, owing to the fact that most fuse will spit fire from the sides and ignite the charge where the fuse enters it. Even the very best triple tape and gutta percha fuse will do this occasionally. The expense attached to the use of the highest quality of fuse has caused this method of igniting charges of blasting powder in bore holes to be practically abandoned.

"Miner's squibs," often used for igniting blasting powder charges in bore holes, are sometimes uncertain in their rate of burning, and may give but little time for the blaster to reach a place of safety after lighting them. This makes it necessary, when a number of shots are ready to be fired, for the blaster to return to the face several times, causing the loss of valuable time.

All of these disadvantages are overcome by the use of the Du Pont Electric Squib. These Electric Squibs are similar in general appearance to Victor Electric Fuzes, but have a heavy paper cap instead of a copper one. The charge in this cap does not detonate like that in electric fuzes, but merely shoots out a small flame. When Electric Squibs are used, the charge of blasting powder can be ignited in the center, giving a little quicker and stronger action, and insuring the explosion of the entire charge before any of the surrounding material can fall and cut off a portion of it. The bore hole, too, can be tamped solid, leaving no vent for a partial loss of the strength of the powder. When the entire charge is exploded at once, less smoke is given off by the explosive. This, with the elimination of smoke from burning safety fuse, results in purer air, making it possible for both miners and draught animals to do more work.

Electric Squib (Actual Size)

Other advantages in the use of Electric Squibs are that when more than one shot is to be fired all of the bore holes can be connected in series and fired at the same instant, resulting in a very considerable saving in both powder and time, and shot firers can cover a great deal more ground than when using fuse or miner's squibs.

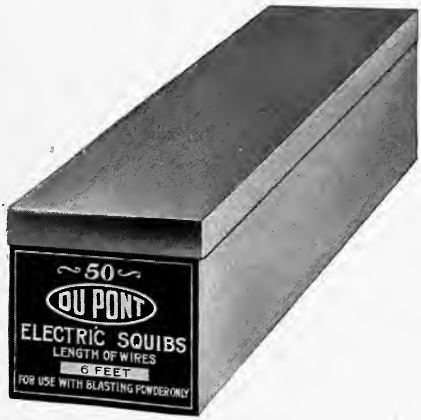
It is much safer to blast with Electric Squibs than with fuse or miner's squibs, because shots are not fired until everyone, including the blaster, is a safe distance away, and because danger of hang fires is entirely obviated.

In short, the advantages gained by the use of Electric Squibs may be summed up as follows:

More work from a given amount of blasting powder.
Everybody out of danger before the shots are fired.
No waiting; the firing is instantaneous.
Any number of shots fired simultaneously.
No fumes from burning safety fuse.
A minimum amount of smoke from the blasting powder.

In connecting up Electric Squibs for firing, the wires, where joined, should be clean and bright. Connections should be made in series in the same manner as Victor Electric Fuzes. (See illustration on page 6.)

Electric Squibs require the same storage conditions as Electric Fuzes, and although they cannot be exploded by shock or concussion like electric fuzes, they must be handled just as carefully, for their construction is necessarily delicate and they can be easily broken by rough handling.



They are manufactured with 4 feet, 5 feet, 6 feet, 8 feet, 10 feet and 12 feet copper or iron wires. Those with iron wires are somewhat less expensive, but require a stronger electric current to explode them, because of the inferior conductivity of iron as compared with copper wire. They are also more easily affected by moisture. We do not recommend electric squibs with iron wires longer than 8 feet, nor do we carry them in stock.

Electric Squibs are packed 50 to the carton and 10 cartons to the case. Gross and net weights of cases are as follows:

Quantity	Length	Gross Wt.	Net Weight (In Cartons)	Outside Dimensions of Cases
500	4′	25 lbs.	17½ lbs.	22″ x 9½″ x 9½″
500	5′	27½ "	20 "	22″ x 9½″ x 9½″
500	6′	31 "	23½ "	22″ x 9½″ x 9½″
500	8′	39 "	30 "	22″ x 11½″ x 9½″
500	10′	44 "	33 "	22″ x 11½″ x 9½″
500	12′	54 "	43½ "	22″ x 15½″ x 9½″

DU PONT

"Reliable" Blasting Machines
"Pull Up" Blasting Machines

"Reliable" or "U. S. Standard"
(Push Down)

"Pull Up"

Blasting Machines

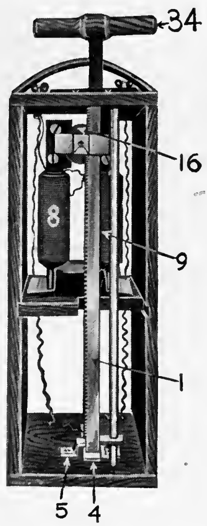
THE DU PONT COMPANY manufactures two different styles of blasting machines, but these are designed on the same general principle. They are:

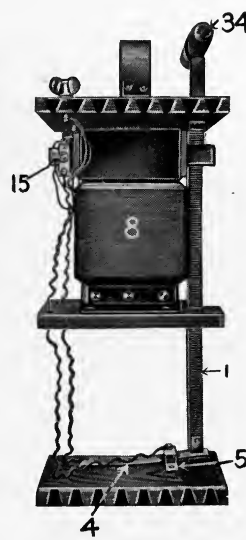
"Reliable" or "U.S. Standard" (Push Down)
"Pull Up"

The "Reliable" or "U. S. Standard"* Push Down Blasting Machine is manufactured in two sizes as follows:

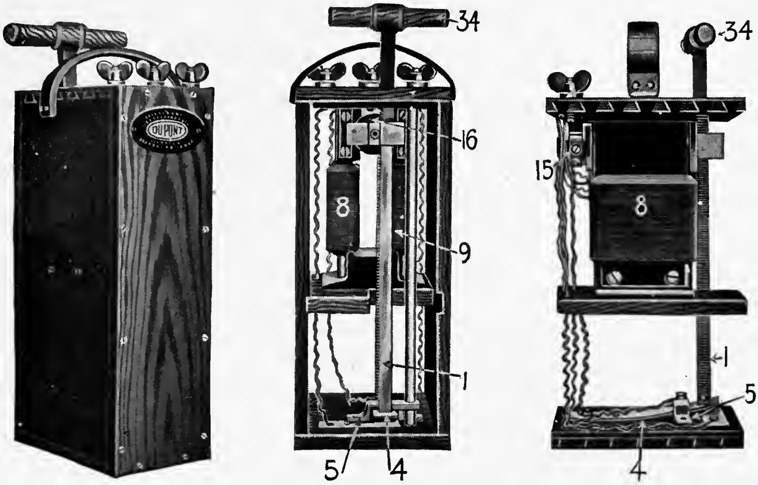
	No. 2 (2 Posts only)	No. 3 (2 Posts, unless specially ordered with 3 Posts)
Capacity	1 to 10 Electric Fuzes.	1 to 30 Electric Fuzes.
Dimensions	7″ x 8″ x 14″.	7″ x 10″ x 18″.
Net Weight	20 lbs.	25 lbs.
Weight, Boxed for Shipment	25 lbs.	30 lbs.

* U. S. Standard Blasting Machines are manufactured in No. 3 size only.



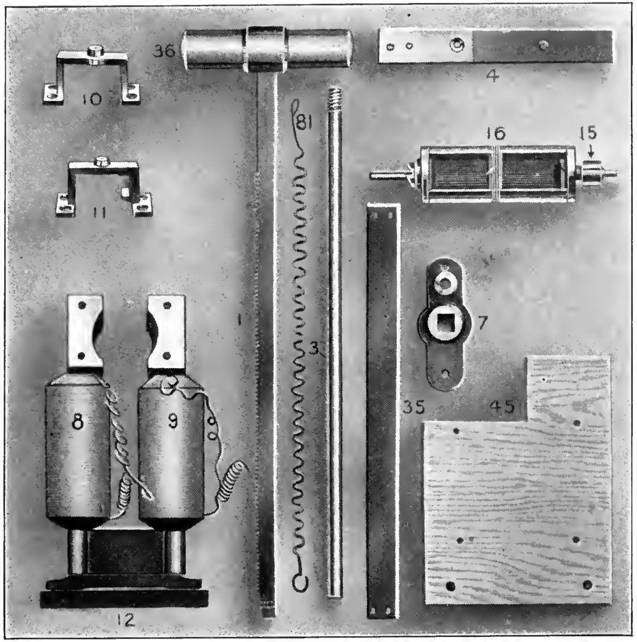


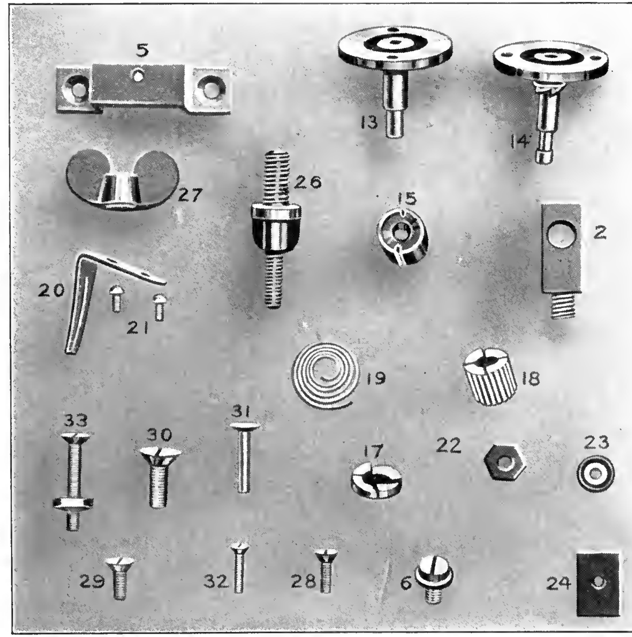
In the accompanying illustration, the parts marked 8 and 9 are field magnets, which are energized by the current from the revolving armature 16. The teeth of the armature pinion engage with the rack bar 1, and by clutching also engage with the armature shaft on the downward stroke (only) of the rack bar.



4 is the contact spring, which, when struck by the bottom of the descending rack bar, breaks the contact between two small platinum bearings, one on the upper face of the contact spring and the other on the under side of the bridge 5, and in this way throws the entire current through the "outside" circuit, that is, leading wire, electric fuzes and connecting wire; 15 is the commutator.

To operate the push down blasting machine, lift up the rack bar by the handle 34 to its full extent, and with one quick, hard stroke push it down to the bottom of the box with a *solid thud.* As the rack bar approaches the bottom, it becomes more difficult to operate, because of the "building up" of the blasting machine; but the speed of the thrust should not be diminished, because the finish of the operation is just as important as the start. Do not be afraid of pushing the rack bar down too hard. The machine is built to stand it, and this is the only way to use it successfully.



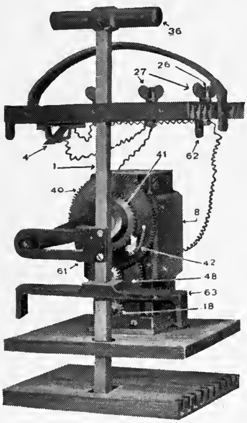


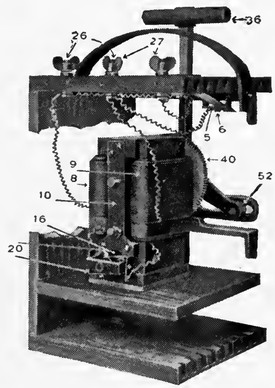
Parts of "U. S. Standard" and "Reliable" Blasting Machine

No.	NAME	No.	NAME	No.	NAME	No.	NAME	No.	NAME	No.	NAME
1	Rack Bar	7	Guide Plate	15	Commutator	21	Brush Screws	29	Bearing Screw	34	Mahogany Case
2	Guide Yoke	8 & 9	Fields	16	Armature	22	Brass Nut	30	Iron Screw for Base Block	35	Leather Strap
3	Guide Rod	10 & 11	Bearings	17	Clutch	23 & 24	Insulators	31	Copper Rivet	36	Wood Handle
4	Contact Spring	12	Base Block	18	Armature Pinion	26	Binding Post	32	Iron Screw	45	Shelf
5	Bridge	13 & 14	Armature Heads and Shafts	19	Pinion Spring	27	Wing Nut	33	Iron Screw with Nut, to bolt No. 12 to No. 45	81	Connecting Wire
6	Contact Screw			20	Brush	28	Armature Screw				

"Pull Up" Blasting Machines are manufactured in No. 5 size only, as follows:

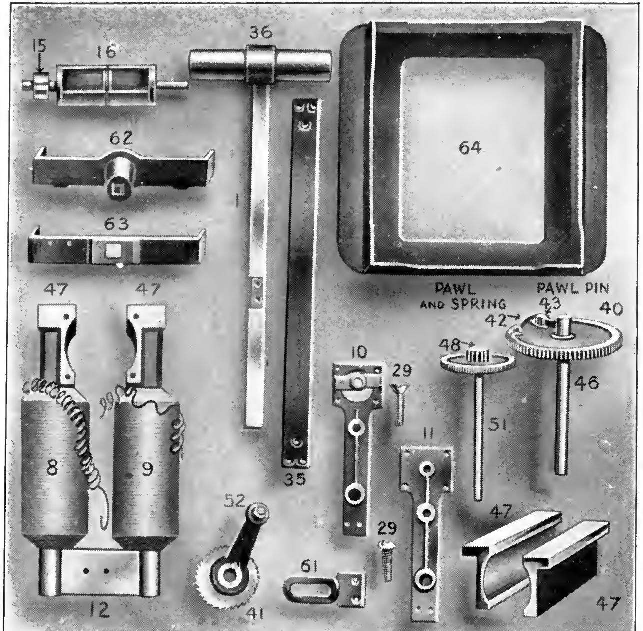
	No. 5 (3 Posts only)
Capacity	1 to 100 Electric Fuzes.
Dimensions	12″ x 14″ x 23″.
Net Weight	50 lbs.
Weight, Boxed for Shipment	65 lbs.

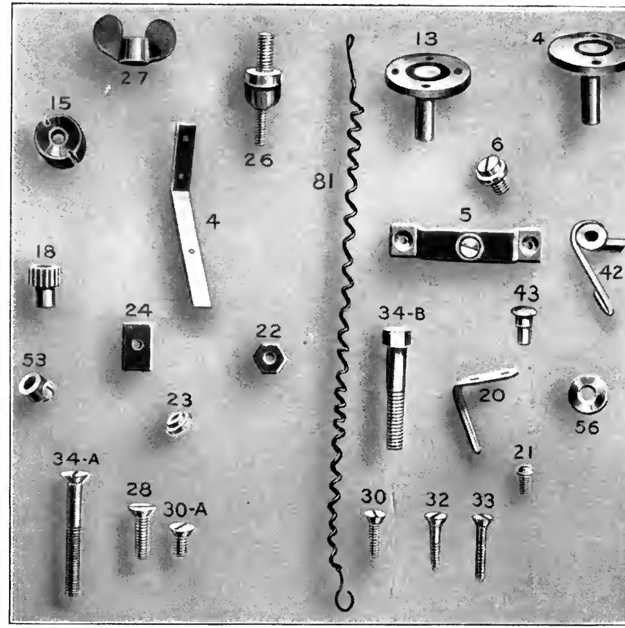




8 and 9 are the field magnets which are energized by current from the revolving armature 16. Motion is given to this by the upward stroke of the rack bar 1 operating on the crank 52 and the train of gears 40 and 48. The quicker the upward movement of the handle 36, the faster the armature pinion 18 is made to revolve, and consequently the greater the current generated. At the end of the upward stroke the impact of the arm 61 against the contact spring 4 causes the circuit to be broken between it and the bearing point of the contact screw 6. The current is, therefore, at that instant thrown into, and causes the firing of the electric fuzes.

To operate the "pull up" blasting machine: Stand with each foot planted firmly on the flanges on either side of the bottom of the blasting machine and *pull up* the rack bar to its full extent by the handle with a quick, hard jerk. As the limit of the pull is approached, the operation becomes more difficult, owing to the "building up" of the blasting machine; but the speed should not





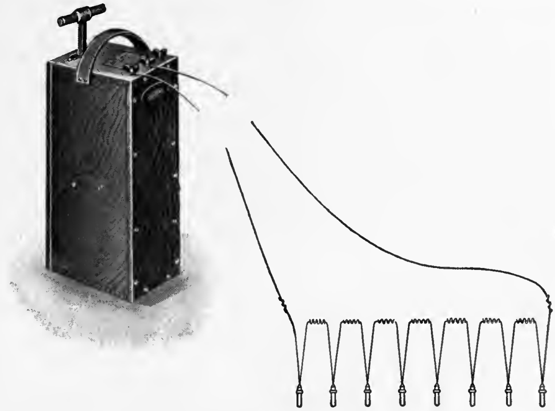
Parts of "Pull Up" Blasting Machine

No.	NAME	No.	NAME	No.	NAME	No.	NAME	No.	NAME	No.	NAME
1	Rack Bar	13 & 14	Armature Heads and Shafts	23 & 24	Insulators	34	Mahogany Case	41	Ratchet Gear	52	Crank with Roller
4	Contact Spring	15	Commutator	26	Binding Post	34-A	Screw for Holding Machine in Case	42	Pawl and Spring	53	Intermed. Brass Collar
5	Bridge	16	Armature	27	Wing Nut	34-B	Screw for Holding Machine in Case	43	Pawl Pin	56	Washer
6	Contact Screw	18	Armature Pinion	28	Armature Screw	35	Leather Strap	46	Large Shaft	61	Arm
8 & 9	Fields	20	Brush	29	Bearing Screws*	36	Wood Handle	47	Pole Pieces	62	Top Bracket
10 & 11	Bearings	21	Brush Screw	30	Iron Screw	40	Large Gear	48	Intermediate Gear and Pinion	63	Bottom Bracket
12	Base Block	22	Brass Nut	30-A	Rack Bar Screw			51	Intermediate Shaft	64	Iron Base
				32 & 33	Brass Wood Screws					81	Connecting Wire

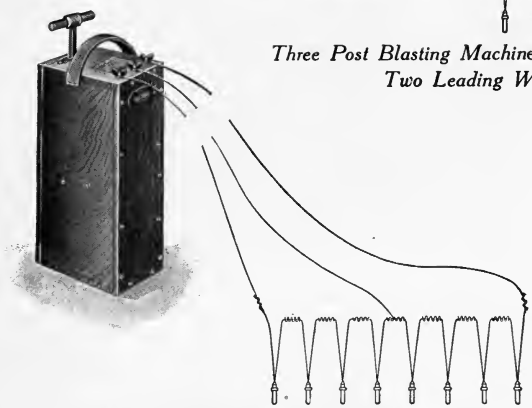
* Round Head for Flat Bearing Part No. 10 and Flat Head for Box Bearing Part No. 11.

be diminished, because the finish of the stroke is just as important as the start. Try to jerk the rack bar out of the top of the blasting machine. A half hearted attempt to operate this blasting machine may result in a failure.

The capacity of three post blasting machines is increased about 50 per cent. over that given in the preceding tables, when



Three Post Blasting Machine Connected with Two Leading Wires



Three Post Blasting Machine, Connected with Three Leading Wires

a third leading wire is run from the middle binding post, and connected to the middle of the blasting circuit, the leading wires from the two outside binding posts being connected to the first and last electric fuzes in the circuit. When only two leading wires are used with the three post machine, they must be connected to the middle binding post and either one of the outside binding posts, but never to the two outside binding posts.

Our blasting machines are strongly made, and will stand with little deterioration the treatment to which it is necessary to subject them. Their mechanism, though designed as simply as possible, is more or less complicated and delicate, and although they will withstand the usage to which it is *necessary* to put them, they must be treated with at least some consideration. There can be no possible excuse for throwing a blasting machine about, or permitting it to remain exposed to wet weather or lying in the mud. When a blasting machine is treated in this way, its life will be short and its usefulness limited.

Remember that good care will prolong the usefulness of the blasting machine, will reduce the necessity for repairs and will help to maintain its efficiency. The bearings and gearings should be lightly oiled occasionally, but on the commutator, which is the small copper covered wheel on the end of the armature shaft (see 15 in illustration on pages 31 and 33), use a little graphite, but *never use oil.* See that the two slots cut in the copper part of the commutator are clean, and with no particle of metal or anything else in them which might cause a short circuit. Keep the copper brushes (see 20 in illustration on pages 31 and 33) clean, and see that they bear firmly on the commutator. Keep the circuit breaking contacts clean and bright.

When a blasting machine is not in use, store it in a dry and comparatively cool place; not in a leaky tool box or on top of a boiler.

Every blasting machine is tested thoroughly before leaving the works, and if a new one does not give satisfactory results when received, it may have been injured by rough handling during transportation.

The parts of these blasting machines are all standard, and when worn out or broken can be replaced at a small cost. When ordering, give the style and number of the blasting machine in which they are used, as well as the number of the part as shown in illustrations on pages 31 and 33. Do not return a blasting machine to us to be repaired without first securing proper shipping directions from our nearest branch office, a list of which is given on the back of this catalogue.

DU PONT

Connecting Wire
Leading Wire
Leading Wire Reel

Du Pont Fulminate Plant, Pompton Lakes, N. J

Connecting Wire

CONNECTING WIRE is insulated copper wire (No. 20 Brown & Sharpe gauge). It is put up in 1 pound and 2 pound spools. A 1 pound spool is 3 inches in diameter, 4 inches long and holds about 210 feet of wire. A 2 pound spool is 3 inches in diameter, 5 ½ inches long and holds about 420 feet of wire.

Connecting Wire (1 lb. Spool)

Connecting Wire is used to join the wires of the electric fuzes together, when they are not long enough to reach between the adjoining bore holes. The ends of the connecting wire must be scraped bright before connections are made, and the joints should not be permitted to lie in water or on wet ground. If this cannot be prevented, the joint should be covered with insulating tape.

No. 21 (Brown & Sharpe gauge) Insulated Copper Wire is also used for connecting wire, but we do not recommend it because we consider it too small for best results.

A 1 pound spool of No. 21 Connecting Wire holds about 260 feet and a 2 pound spool about 520 feet.

DU PONT

Leading Wire

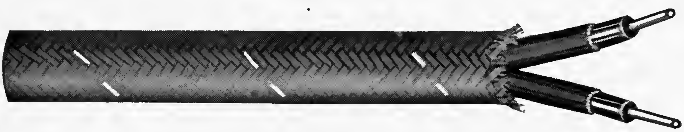
The wire commonly used for connecting electric fuzes to the blasting machine is known as Leading Wire. It is insulated copper wire (No. 14 Brown & Sharpe gauge) and is furnished in coils of the following lengths and weights:

Leading Wire

200 ft.	about	4 lbs.
250 "	"	5 "
300 "	"	5.8 "
500 "	"	9.6 "

Duplex Leading Wire is made by binding together two insulated copper wires with an outside insulation, giving it the effect of a single cable. It is somewhat higher in price, but generally more convenient than single leading wire.

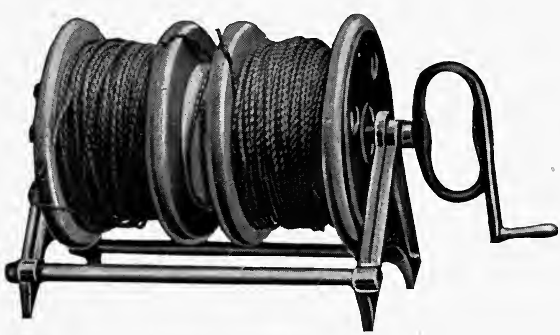
It weighs approximately twice as much as the same length of single leading wire, and can be had in coils of the same length.


Duplex Leading Wire (Actual Size)

DU PONT

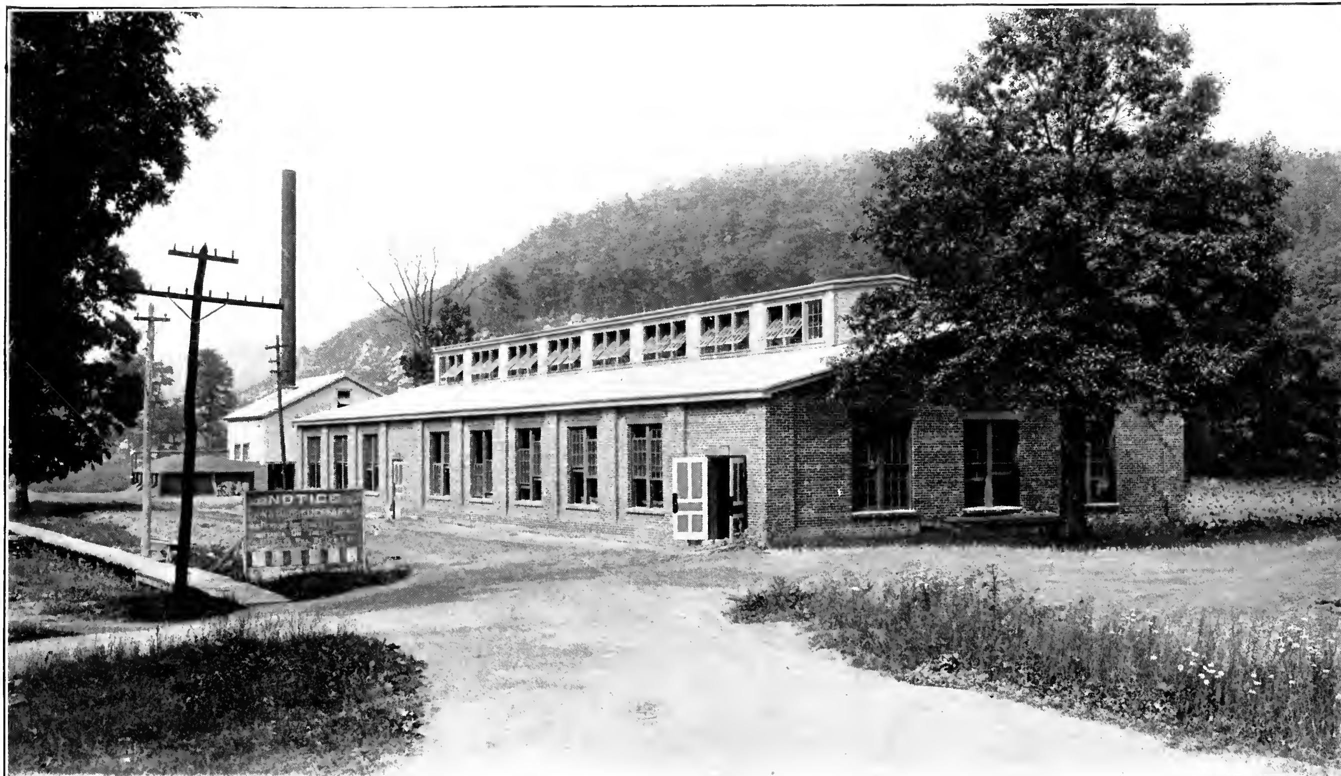
Leading Wire Reels

A Leading Wire Reel is very useful, and will soon pay for itself by keeping the leading wire in good condition and in saving time. It weighs empty about 16 pounds, and is 11¼ inches high, 18 inches long including handle, and has a maximum capacity of 800 feet (400 feet double) of No. 14 (Brown & Sharpe gauge) insulated wire.


Leading Wire Reel

DU PONT

Galvanometers



Shell Drawing Plant, Du Pont Blasting Cap Works, Pompton Lakes, N. J.

Galvanometers

THIS instrument comprises a galvanometer and a battery (Fig. 1, page 44), mounted in a suitable case of metal and hard rubber (Fig. 2), which in turn is contained in an outer case of sole leather equipped with a strong sling strap* (Fig. 3); the whole being designed with a thorough knowledge of the conditions prevailing on the work where electric blasting is done, and with a view to producing an instrument strong enough to withstand such conditions and at the same time retain sufficient delicacy to make reliable tests.

The Galvanometer is of the upright type, with a magnetic needle of such design that the pointer is held at the starting point of the scale by gravity alone, thus eliminating the necessity of holding the instrument with any reference to a north and south position, or of using a permanent magnetic field or springs of any kind in its construction. The only precaution as to position is

Fig. 2

Fig. 3

Du Pont Galvanometer

Dimensions (including case) . . . . 2" x 3" x 5½"
Weight (including case and strap) . . . . . 1 lb.

* Leather galvanometer cases are also made with a compartment for the Du Pont Rheostat.

that *it be held reasonably level.* The scale (see cut, Fig. 4) is graduated in a reverse direction, and the units thereon represent ohms resistance in the outer circuit. The idea is to not merely show whether a given circuit is "open" or "closed," but to give an approximate idea of the *resistance* of such circuit within the limitations of an instrument of this type. For instance, if the poles of the instrument be short circuited by means of a thick piece of wire of practically no resistance, the indicator needle or pointer will go across the entire scale and stop at zero. If the outer circuit has a resistance of 64 ohms, the needle will not be deflected so far, but will stop at 64, and so on. Changes in the strength of the battery cell will, of course, introduce errors into these readings, but by taking occasional trial readings through known resistances (such as those provided in the Du Pont Rheostat) and replacing the battery cell when it becomes weak, these errors will be minimized. The information given by this instrument will be found of great value, in testing a blasting circuit, for, rough as the resistance measurements may be, they serve to detect short circuits as well as breaks, and are a help in testing single electric fuzes, both before and after loading them into the bore holes.

Fig. 4

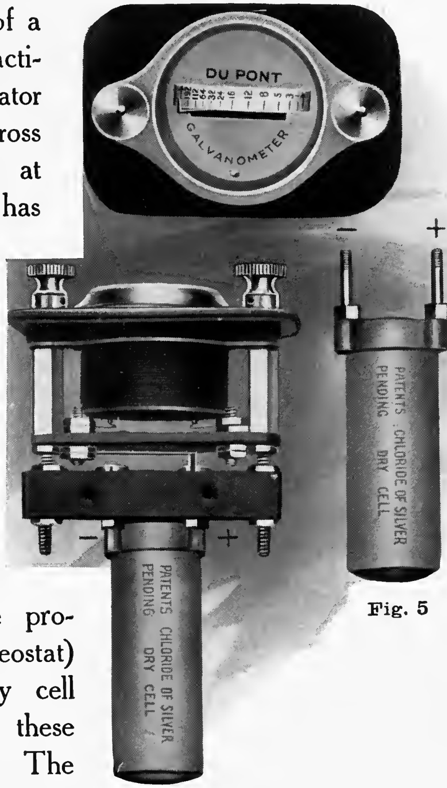


Fig. 5

Fig. 1

Parts of Du Pont Galvanometer

The battery cell (Fig. 5) is of a kind selected by us after a long series of experiments. While of long life and of great constancy, it is a very weak battery cell, and the current which is sent through an electric fuze when making a test with the *assembled instrument* is less than one-tenth of the strength required to explode it. The length of time a battery cell will last depends, of course, upon how frequently it is used and how long the current is allowed to flow in making each test. When properly used, one cell is sufficient for several thousand tests. The simple form of connector enables the user to replace the exhausted cell with a new one with but little trouble. The battery cell is very small and light and can be sent by mail.

To renew the battery cell, take out the four screws in the sides of the metal case. The working parts can then be lifted out entire, being all suspended from the hard rubber top. The exhausted battery cell is then removed by pulling downward, when its two poles will come out of the split bushings, leaving it free. The new battery cell is replaced by simply pushing its two poles into the split bushings, just as the old one was connected. The only precaution necessary is to be sure the + and — poles are connected to the corresponding bushings so marked.

In use, the instrument in its leather case is carried by the blaster at his side, slung from the strap which passes over his opposite shoulder, in the same manner as a field glass is carried. To make a test, it is only necessary to touch the ends of the two wires to the two binding posts, when the indicator will immediately move over the scale and, after a few oscillations, stop at a position corresponding with the resistance of the circuit, which can be read from the scale. On pages 50 and 51 will be found a table giving the average resistance of electric blasting circuits. If the test indicates a resistance greatly at variance with what it should be, the blaster knows at once that something is wrong. Breaks are quickly located, merely by following the simple instructions given later. The instrument and the methods of using it are such as apply to the requirements of the practical blaster, as distinguished from the trained electrician, whose finer instruments and methods would be at a disadvantage under the conditions prevailing on the ordinary electric blasting job.

We commend the instrument to our customers because it is a convenience and a time saver, and also because the more exact methods which it makes possible not only enable them to secure better execution from our goods, but most important of all, these exact methods minimize danger and lessen the risk of accidents.

Testing the Galvanometer

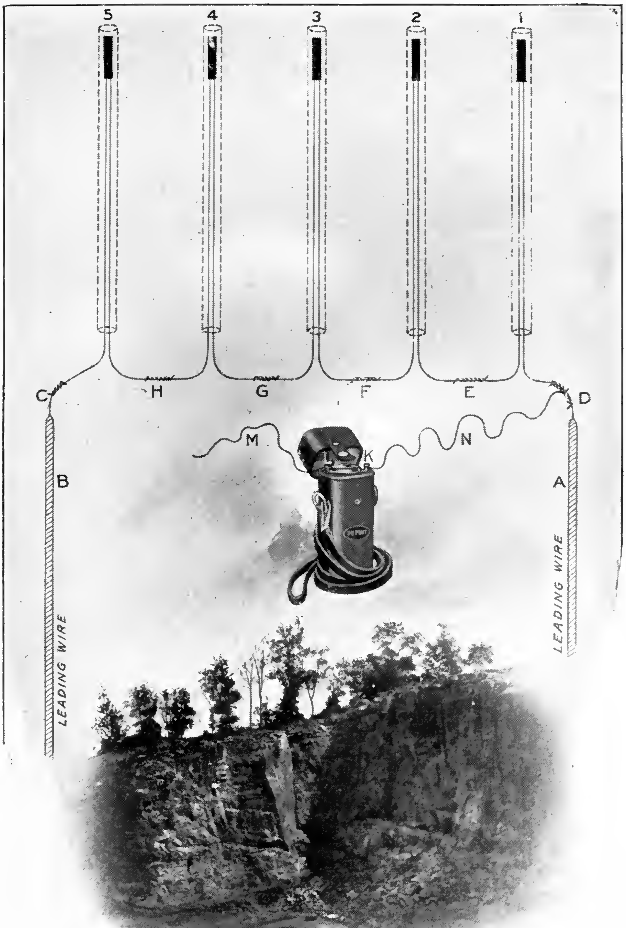
Before using, test the Galvanometer by placing a short piece of thick copper wire across its two binding posts. The wire having almost no resistance, the needle should be deflected to its widest limit, marked zero on the scale. If it does not move or go as far as zero, the battery cell is exhausted or weakened. Other useful tests, giving practice in the use of the instrument, can be made by means of the Du Pont Rheostat (see cut, page 55), with which known resistances can be tried on the Galvanometer, and its reading for those resistances verified.

Table of Resistances of Rheostat in Ohms

The resistances furnished between the different posts of the Rheostat are as follows:

Between 1 and 2	16 ohms
" 2 " 3	32 "
" 3 " 4	64 "
" 4 " 5	80 "
" 5 " 6	128 "
" 1 " 3	48 "
" 1 " 4	112 "
" 1 " 5	192 "
" 1 " 6	320 "
" 2 " 4	96 "
" 2 " 5	176 "
" 2 " 6	304 "
" 3 " 5	144 "
" 3 " 6	272 "
" 4 " 6	208 "

Fig. 7



Directions for Using

The operation of the instrument is as follows: When a passageway ("circuit") is offered, so that the electric current can pass from one binding post to the other, the current from the battery cell flows through this circuit, traversing the Galvanometer coil on the way, and causing its needle to be deflected. The amount of the deflection is *greater* when the circuit has *little resistance,* and *less* when the circuit has *greater resistance.*

Although the Galvanometer is comparatively simple in design, and as substantially made as possible for such an instrument, some of the parts are necessarily of delicate construction. It should, therefore, be handled carefully and kept perfectly dry.

To Test a Circuit

To test a circuit with the Galvanometer, connect or touch the leading wires to its two binding posts, after everything is made ready to fire. If the circuit is perfect, it will have the right resistance (see pages 50 and 51), and the needle will move to the corresponding number on the dial. If it moves too far, it shows that there is a "short circuit" or "leak," and that part of the electric current is not going through all the electric fuzes, but is escaping across some easier circuit. If the needle does not move at all, or not as far as it should, there is a break in the circuit, or some high resistance like a bad joint.

To Locate a Break

To locate a break, make sure that the ends of the leading wires, which you would attach to the blasting machine, are *separated* and not touching anything (see Fig. 7, page 47). Carry the Galvanometer with you to the loaded bore holes. Attach a piece of connecting wire "N" to one binding post "K" of the Galvanometer, long enough for you to fasten its other end to the joint "D," and still have slack enough to reach each of the other bore holes. Now touch the binding post "L" of the Galvanometer to the joint "C." If the Galvanometer now shows circuit, while it did not when the test was made from the other end of the leading wires, the break is in the leading wires. If it does not show circuit, find the break in the electric fuze circuit, by touching the binding post "L" (or a short piece of wire "M" connecting with binding post "L," whichever is more convenient) to each of the bare joints "E," "F," "G," and "H" in succession. As long as you are "inside" the break, these contacts will cause the needle to be deflected. As soon as you get beyond the break, or point of high resistance, you get either very slight deflection or none at all. In this way the trouble can quickly be traced to the particular electric fuze in which the break exists. For instance, if the electric fuze wire in bore hole No. 3 is broken, you get a deflection when "L" or "M" is touched to "F," but none on touching "G"; showing that the break is between "F" and "G."

Single electric fuzes can also be tested, both before and after putting them in the bore hole, simply by touching the ends of the electric fuze wires (scraped clean) to the two binding posts. (See Caution, page 52.) The resistance of one electric fuze is so small that it should cause a wide deflection.

Hold the instrument with the *dial level.* If the needle does not move at all when a test is made, jar it slightly to make sure it is not stuck.

Renew the battery cell in the Galvanometer when it is exhausted, and test the Galvanometer frequently to make sure it is in good working order.

How to Use the Tables on Pages 50 and 51

The numbers above the double lines at the head of the columns refer to the length of the wires of the electric fuzes used. Select whatever column refers to the length you are using, and, beginning at the top, follow it down to the *number* of electric fuzes in the circuit to be tested as shown in the first column. For instance, if you have three 12 foot electric fuzes, the resistance should be 3.7 ohms. If you have fifty 12 foot electric fuzes, the resistance should be 62.2 ohms, and so on. These resistances are only approximate, but they are sufficiently close to give useful information.

Table of Resistances of Blasting Circuits in Ohms

No. of Electric Fuzes in Circuit	LENGTH OF FUZE WIRES IN FEET													
	2	4	6	8	10	12	14	16	18	20	22	24	26	28
1	0.9	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8
2	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.5
3	2.8	3.0	3.2	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.2
4	3.7	4.0	4.2	4.5	4.7	5.0	5.2	5.5	5.7	6.0	6.3	6.5	6.8	7.0
5	4.6	4.9	5 3	5.6	5.9	6.2	6.5	6.9	7.2	7.5	7.8	8.1	8.5	8.8
6	5.5	5.9	6.3	6.7	7.1	7.5	7.8	8.2	8.6	9.0	9.4	9.8	10.1	10.5
7	6.5	6.9	7.4	7.8	8.3	8.7	9.1	9.6	10.0	10.5	10.9	11.4	11.8	12.2
8	7.4	7.9	8.4	8.9	9.4	9.9	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0
9	8.3	8.9	9.5	10.0	10.6	11.2	11.8	12.3	12.9	13.5	14.1	14.6	15.2	15.8
10	9.2	9.9	10.5	11.1	11.8	12.4	13.1	13.7	14.4	15.0	15.6	16.3	16.9	17.5
11	10.2	10.9	11.6	12.3	13.0	13.7	14.4	15.1	15.8	16.5	17.2	17.9	18.6	19.2
12	11.1	11.8	12.6	13.4	14.1	14.9	15.7	16.5	17.2	18.0	18.8	19.5	20.3	21.0
13	12.0	12.8	13.7	14.5	15.3	16.2	17.0	17.8	18.7	19.5	20.3	21.2	22.0	22.8
14	12.9	13.8	14.7	15.6	16.5	17.4	18.3	19.2	20.1	21.0	21.9	22.8	23.7	24.6
15	13.8	14.8	15.8	16.7	17.7	18.6	19.6	20.6	21.5	22.5	23.4	24.4	25.4	26.3
16	14.8	15.8	16.8	17.8	18.9	19.9	20.9	21.9	23.0	24.0	25.0	26.0	27.1	28.0
17	15.7	16.8	17.9	19.0	20.0	21.1	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.8
18	16.6	17.8	18.9	20.1	21.2	22.4	23.5	24.7	25.8	27.0	28.1	29.3	30.4	31.6
19	17.5	18.8	20.0	21.2	22.4	23 6	24.8	26.0	27.3	28.5	29.7	30.9	32.1	33.3
20	18.5	19.7	21.0	22.3	23.6	24.9	26.1	27 4	28.7	30.0	31.3	32.5	33.8	35.0
21	19.4	20.7	22.1	23.4	24.8	26.1	27.4	28.8	30.1	31.5	32.8	34.2	35.5	36.8
22	20.3	21.7	23.1	24.5	25.9	27.4	28.8	30.2	31.6	33.0	34.4	35.8	37.2	38.6
23	21.2	22.7	24.2	25.6	27.1	28.6	30.1	31.5	33.0	34 5	35.9	37.4	38.9	40.3
24	22.2	23.7	25.2	26.8	28.3	29.8	31.4	32.9	34.4	36.0	37.5	39.1	40.6	42.0
25	23.1	24.7	26.3	27.9	29.5	31.1	32.7	34.3	35.9	37.5	39.1	40.7	42.3	43.9
26	24.0	25.7	27.3	29.0	30.7	32.3	34.0	35.6	37.3	39.0	40.6	42.3	44.0	45.6
27	24.9	26.6	28.4	30.1	31.8	33.6	35.3	37.0	38.7	40.5	42.2	43.9	45.7	47.4
28	25.8	27.6	29.4	31.2	33.0	34.8	36.6	38.4	40.2	42.0	43.8	45.6	47.3	49.1
29	26.8	28.6	30.5	32.3	34.2	36.1	37.9	39.8	41.6	43.5	45.3	47.2	49.0	50.9
30	27.7	29.6	31.5	33.5	35.4	37.3	39.2	41.1	43.1	45.0	46.9	48.8	50.7	52.6
31	28.6	30.6	32.6	34.6	36.6	38.5	40.5	42.5	44.5	46.5	48.5	50.4	52.4	54.4
32	29.5	31.6	33.6	35.7	37.7	39.8	41.8	43.9	45.9	48.0	50.0	52.1	54.1	56.1
33	30.5	32.6	34.7	36.8	38.9	41.0	43.1	45.2	47.4	49.5	51.6	53.7	55.8	57.9
34	31.4	33.6	35.7	37.9	40.1	42.3	44.4	46.6	48.8	51.0	53.1	55.3	57.5	59 6
35	32.3	34.5	36.8	39.0	41.3	43.5	45.7	48.0	50.2	52.5	54.7	56.9	59.2	61.4
36	33.2	35.5	37.8	40.1	42.4	44.8	47.1	49.4	51.7	54.0	56.3	58.6	60.9	63 1
37	34.2	36.5	38.9	41.3	43.6	46.0	48.4	50.7	53.1	55.5	57.8	60.2	62.6	64.9
38	35.1	37.5	39.9	42.4	44.8	47.2	49.7	52.1	54.5	57.0	59.4	61.8	64.3	66.7
39	36.0	38.5	41.0	43.5	46.0	48.5	51.0	53.5	56.0	58.5	61.0	63.5	65.9	68.4
40	36.9	39.5	42.0	44.6	47.2	49.7	52.3	54.8	57.4	60.0	62.5	65.1	67.6	70.2
41	37.8	40.5	43.1	45.7	48.3	51 0	53 6	56.2	58.8	61 5	64.1	66.7	69.3	71.9
42	38.8	41.5	44.1	46.8	49.5	52.2	54 9	57.6	60.3	63.0	65.6	68.3	71.0	73.7
43	39.7	42.4	45.2	47.9	50.7	53.5	56.2	59.0	61.7	64.5	67.2	70.0	72.7	75.4
44	40.6	43.4	46.2	49.1	51.9	54.7	57.5	60.3	63.1	66.0	68.8	71.6	74.4	77.1
45	41.5	44.4	47.3	50.2	53.1	55.9	58.8	61.7	64.6	67.5	70.3	73.2	76.1	78.9
46	42.5	45.4	48.3	51.3	54.2	57.2	60.1	63.1	66.0	69.0	71.9	74.8	77.8	80.7
47	43.4	46.4	49.4	52.4	55.4	58.4	61.4	64.4	67.4	70.5	73.5	76.5	79.5	82.4
48	44.3	47.4	50.4	53.5	56.6	59.7	62.7	65.8	68.9	72.0	75.0	78.1	81.2	84.2
49	45.2	48.4	51.5	54.6	57.8	60.9	64.0	67.2	70.3	73.5	76.6	79.7	82.9	85.9
50	46.2	49.4	52 6	55.8	59.0	62.2	65.4	68.6	71.8	75.0	78.2	81.4	84.6	87.7

Decimals smaller than 0.1 ohm eliminated

Table of Resistances of Blasting Circuits in Ohms

No. of Electric Fuzes in Circuit	LENGTH OF FUZE WIRES IN FEET										
	30	32	34	36	38	40	42	44	46	48	50
1	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5
2	3.6	3.8	3.9	4.0	4.2	4.3	4.4	4.5	4.7	4.8	4.9
3	5.5	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4
4	7.3	7.5	7.8	8.0	8.3	8.6	8.8	9.1	9.3	9.6	9.8
5	9.1	9.4	9.7	10.1	10.4	10.7	11.0	11.3	11.7	12.0	12.3
6	10.9	11.3	11.7	12.1	12.5	12.8	13.2	13.6	14.0	14.4	14.8
7	12.7	13.2	13.6	14.1	14.5	15.0	15.4	15.9	16.3	16.8	17.2
8	14.6	15.1	15.6	16.1	16.6	17.1	17.6	18.1	18.7	19.2	19.7
9	16.3	16.9	17.5	18.1	18.7	19.3	19.8	20.4	21.0	21.6	22.1
10	18.2	18.8	19.5	20.1	20.8	21.4	22.0	22.7	23.3	24.0	24.6
11	20.0	20.7	21.4	22.1	22.8	23.5	24.2	24.9	25.6	26.3	27.1
12	21.8	22.6	23.4	24.1	24.9	25.7	26.4	27.2	28.0	28.7	29.5
13	23.7	24.4	25.3	26.1	27.0	27.8	28.6	29.5	30.3	31.1	32.0
14	25.5	26.3	27.3	28.2	29.1	29.9	30.8	31.7	32.6	33.5	34.4
15	27.3	28.2	29.2	30.2	31.1	32.1	33.1	34.0	35.0	35.9	36.9
16	29.1	30.1	31.2	32.2	33.2	34.2	35.3	36.3	37.3	38.3	39.3
17	30.9	32.0	33.1	34.2	35.3	36.4	37.5	38.5	39.6	40.7	41.8
18	32.7	33.9	35.0	36 2	37.4	38.5	39.7	40.8	42.0	43.1	44.3
19	34.6	35.8	37.0	38.2	39.4	40.6	41.9	43.1	44.3	45.5	46.7
20	36.4	37.7	38.9	40.2	41.5	42.8	44.1	45.3	46.6	47.9	49.2
21	38.2	39.5	40.9	42.2	43.6	44.9	46.3	47.6	49.0	50.3	51.6
22	40.0	41.4	42.8	44.2	45.7	47.1	48.5	49.9	51.3	52.7	54.1
23	41.9	43.3	44.8	46.3	47.7	49.2	50.7	52.1	53.6	55.1	56.6
24	43.7	45.2	46.7	48.3	49.8	51.3	52.9	54.4	55.9	57.5	59.0
25	45.5	47.1	48.7	50.3	51.9	53.5	55.1	56.7	58.3	59.9	61.5
26	47.3	49.0	50.6	52.3	54.0	55.6	57.3	58.9	60.6	62.3	63.9
27	49.1	50.9	52.6	54.3	56.0	57.8	59.5	61.2	62.9	64.7	66.4
28	50.9	52.7	54.5	56.3	58.1	59.9	61.7	63.5	65.3	67.1	68.9
29	52.8	54.6	56.5	58.3	60.2	62.0	63.9	65.7	67 6	69.5	71.3
30	54.6	56.5	58.4	60.3	62.3	64.2	66.1	68.0	69.9	71.9	73.8
31	56.4	58.4	60.4	62.3	64.3	66.3	68.3	70.3	72.3	74.2	76.2
32	58.2	60.3	62.3	64.4	66.4	68.4	70.5	72.5	74.6	76.6	78.7
33	60.0	62.1	64.3	66.4	68.5	70.6	72.7	74.8	76.9	79.0	81.1
34	61.8	64.0	66.2	68.4	70 6	72.7	74.9	77.1	79.3	81.4	83.6
35	63.7	65.9	68.1	70.4	72.6	74.9	77.1	79.4	81.6	83.8	86.1
36	65.5	67.8	70.1	72.4	74.7	77.0	79.3	81.6	83.9	86.2	88.6
37	67.3	69.7	72 0	74.4	76.8	79.1	81.5	83.9	86.3	88.6	91.0
38	69.1	71.6	74.0	76.4	78.9	81.3	83.7	86.1	88.6	91.0	93.4
39	70.9	73.4	75 9	78.4	80.9	83.4	85.9	88.4	90.9	93.4	95.9
40	72.8	75.3	77.9	80.4	83.0	85.6	88.1	90.7	93.2	95.8	98.4
41	74.6	77.2	79.8	82.5	85.1	87.7	90.3	93.0	95.6	98.2	100.8
42	76.4	79.1	81.8	84.5	87.2	89.8	92.5	95.2	97.9	100.6	103.3
43	78.2	81.0	83.7	86.5	89.2	92.0	94.7	97.5	100.2	103.0	105.7
44	80.0	82.9	85.7	88.5	91.3	94 1	96.9	99.7	102.6	105 4	108.2
45	81.9	84.7	87.6	90.5	93.4	96.3	99.1	102.0	104.9	107.8	110.7
46	83.7	86.6	89.6	92.5	95.5	98.4	101.3	104.3	107.2	110.2	113.1
47	85.5	88.5	91.5	94.5	97.5	100.5	103.5	106.5	109.6	112.6	115 6
48	87.3	90.4	93.5	96.5	99.6	102.7	105.7	108.8	111.9	115.0	118.0
49	89.1	92.3	95.4	98.5	101.7	104.8	108.0	111.1	114.2	117.4	120.5
50	91.0	94.2	97.4	100.6	103.8	107.0	110.2	113.4	116.6	119.8	123.0

Decimals smaller than 0.1 ohm eliminated

Caution

The question is often asked whether it is absolutely safe to pass, even the weak testing current, of this Galvanometer through a single electric fuze. The only answer we can give is that while we test many thousands of electric fuzes every month, by passing weak electric currents through them, without accidents, still there is nothing in the handling of explosives, or electric fuzes, that can be said to be entirely safe. Those who question the safety of testing a single electric fuze, or circuits containing electric fuzes, in the manner outlined above can insure greater safety when testing a single electric fuze, by placing it in a short piece of iron pipe, or similar receptacle, so that its accidental detonation would do no harm. In locating breaks in a circuit where the electric fuzes are in the bore holes, the tests can be made from a safe distance, through a pair of leading wires. The latter procedure involves, of course, the disconnecting of the Galvanometer from the ends of the lead wires, and a trip to the loaded bore hole, every time the connections are changed for a new test.

DU PONT

Rheostats

Unit—Du Pont Blasting Cap Works, Pompton Lakes, N. J.

DU PONT

Rheostats

THE purpose of a Rheostat is to provide a means of ascertaining the capacity of a Blasting Machine in an inexpensive way. For instance, if you have a blasting machine rated as capable of firing ten electric fuzes, there are two ways in which its ability to do this may be proved: First, a circuit of ten electric fuzes (Fig. 1, page 56) can be connected up, and the attempt made to fire them all; or, second, a circuit can be prepared, eliminating nine of the ten electric fuzes, and replacing them with an equivalent resistance (Fig. 2, page 56). If under these latter circumstances, the single electric fuze can be fired, it is presumptive evidence that the blasting machine is capable of firing ten electric fuzes, when connected as in Fig. 1, page 56, provided the resistance introduced at "R" (Fig. 2) has sufficient surplus to offset normal variations in the sensitiveness of different electric fuzes in the circuit.

Dimensions . . . . $\frac{3}{4}$" x $1\frac{3}{4}$" x $4\frac{13}{16}$"
Weight . . . . 5 oz.

The Rheostat is designed to furnish this artificial resistance, which replaces the electric fuzes included within the dotted lines (Fig. 1), the wires "X" and "Y" being connected with the Rheostat instead of with the nine electric fuzes as shown. The internal construction of the Rheostat is shown in Fig. 3, page 57. It is an arrangement of coils of high resistance wire of a certain length, with the binding posts 1 and 6 attached to its ends, and the binding posts 2, 3, 4 and 5 attached to it at intermediate points. The entire length of the resistance wire in the Rheostat has a resistance sufficient to represent a test of *one hundred 30 foot electric fuzes, with the leading wire, connecting wire and all connections in the blasting circuit.*

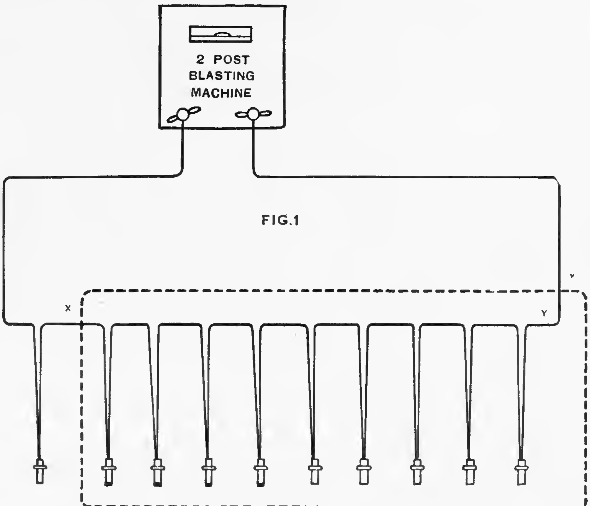


FIG. 1

It will be noted that the binding posts 1, 2, 3, 4, 5 and 6 are not attached to the resistance wire at equal distances. The purpose of this is to afford different resistances between different binding posts, each representing a test of a certain number of electric fuzes. If the wires "X" and "Y" (see Fig. 2, this page, and Fig. 4, page 57) are attached to binding posts 1 and 2, it represents a test of five electric fuzes; if to posts 2 and 3, ten electric fuzes; to posts 3 and 4, twenty electric fuzes; or to posts 4 and 5, twenty-five electric fuzes. But the wires "X" and "Y" need not be attached to adjoining posts. If, for instance, they are attached to posts 1 and 4, the test repre-

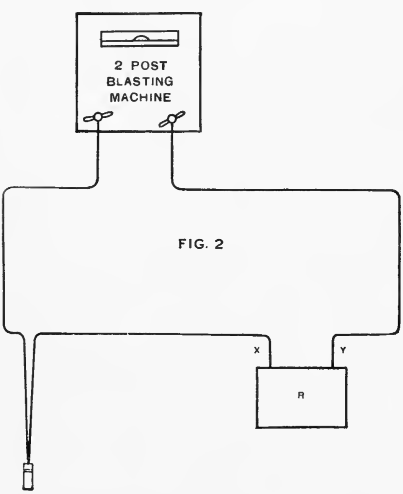


FIG. 2

sents the sum of the intervening numbers, five, ten and twenty, or a total of thirty-five electric fuzes.

As shown by the numbers stamped upon the hard rubber between the binding posts, a large number of tests, representing from five up to one hundred electric fuzes, can be easily made.

In testing a two post Blasting Machine (Fig. 2, page 56), if the wires "X" and "Y" are connected with the binding posts 2 and 4, the effect is to introduce all of the intervening resistance

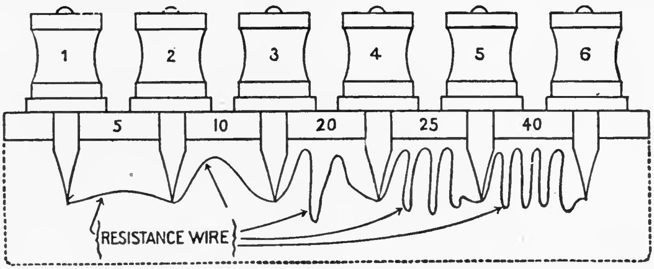


Fig. 3

into the circuit; and if a blasting machine so connected is able to fire the one electric fuze used as an indicator, it shows that it is capable of firing thirty electric fuzes in circuit.

A three post Blasting Machine (Fig. 4) is tested in practically the same way, except that there are two circuits to test; that between binding posts "N" and "O," shown by plain lines, and that between "M" and "O," shown by dotted lines. It will be seen at a glance that each of these circuits is identical with that shown in Fig. 2, page 56. If the blasting machine is a Reliable or U. S. Standard No. 3, the rated capacity of which is thirty electric fuzes between "N" and "O," or thirty electric fuzes between "M" and "O," it would appear that its capacity, when using three leading wires, should be the sum of these two tests, or sixty electric fuzes; but this is not the case, for

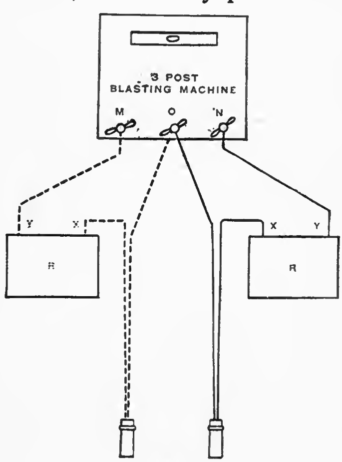


Fig. 4

when both circuits are used at one operation of the blasting machine, the capacity of each circuit is reduced to about twenty-two electric fuzes, making the total capacity of the blasting machine about fifty per cent. greater when three leading wires are used than it is when but two leading wires are used. This same principle applies to our other three post blasting machines.

If two Rheostats are available, both sides of the blasting machine can be tested at once if desired, using one Rheostat and one electric fuze connected as shown by the solid lines (Fig. 4, page 57), and the other Rheostat and another electric fuze connected up like the dotted lines. As in the previous tests, the capacity of the blasting machine is indicated by the sum of the numbers between the two binding posts on the Rheostat, to which the wires "X" and "Y" are attached.

The resistances in the Rheostat are based upon 30 foot electric fuzes and the required surplus resistance; so that, if the electric fuzes in use are of shorter lengths, it will be possible to fire a greater number than this test will indicate; even, in some cases, up to twice the number. On the other hand, there may be circumstances which will cut down the number that can be fired below what the Rheostat test will indicate. Chief among these will be leakage of electric current in some part of the blasting circuit, either from bare joints or wire touching damp ground, or other conductors, or from fluids of great penetrating qualities coming in contact with the insulation of the wires for too long a time before firing. Of these fluids, the worst are the strong saline liquids, even though they be in small amounts, found in salt mines, and the bore hole washings in certain kinds of rock. If the electric fuzes differ greatly in sensitiveness to the firing current, this will also cut down the number that can be depended upon to fire simultaneously.

In using a Rheostat, *do not connect more than one electric fuze in the same circuit as an indicator,* because the resistance of the Rheostat may so cut down the electric current from the blasting machine that only a very little would be left to pass through the electric fuzes. If, then, two or more electric fuzes be used, the resistance of one of them might be sufficient to reduce the electric current to such an extent that it would not heat up the bridge wire in the others quickly enough to explode them at the same instant that the first one exploded and broke the circuit. This being the case, it can be clearly seen that the Rheostat is not a true indicator of the capacity of the blasting machine when more than one electric fuze is used at one time with it.

Do not rely on one test, but repeat it a few times, so as to guard against accidentally using a bad electric fuze for the test. Again, in case a weak blasting machine is indicated in testing with the Rheostat, make sure that the Rheostat is in good condition, and if in doubt, try the blasting machine, before finally condemning it, on a circuit of electric fuzes equal to the rating of the blasting machine.

DU PONT

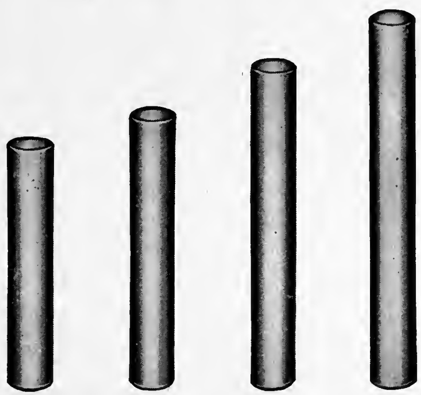
Blasting Caps

Part of Du Pont Blasting Cap Works, Pompton Lakes, N. J.

DU PONT

Blasting Caps

BLASTING CAPS are made in four different grades, according to the quantity of explosive material with which they are charged. This explosive material is very sensitive to shock, high temperature or a spark, which necessitates careful handling if accidents are to be avoided.



Du Pont No. 5 Gold Medal No. 5 | Du Pont No. 6 | Du Pont No. 7 | Du Pont No. 8

Blasting Caps (*Actual Size*)

The following table describes the Blasting Caps illustrated above:

Grade	Gold Medal No. 5	Du Pont No. 5	Du Pont No. 6	Du Pont No. 7	Du Pont No. 8
Color of Box	Black	Blue	Red	Brown	Green
Length of Shell	1¼"	1¼"	1⅜"	1⅝"	1⅞"
Caliber of Shell	.234"	.234"	.234"	.234"	.234"
Distance between Top of Charge and Top of Shell	.78"	.78"	.765"	.765"	.718"
Weight of Charge — Grains	12.34	12.34	15.43	23.15	30.86
Weight of Charge — Grams	.80	.80	1.00	1.50	2.00

They are packed in tin boxes, holding 100 blasting caps each. These are put up for shipment in strong wooden cases of the following capacity:

Case No. 0	. . . .	500 Blasting Caps
" " 1	. . . .	1,000 " "
" " 2	. . . .	2,000 " "
" " 3	. . . .	3,000 " "
" " 5	. . . .	5,000 " "

It will be noted that the number of the case, with the exception of Case No. 0, corresponds with the first figure of the number of caps packed in each case. As no case containing 4,000 is packed, there is no Case No. 4.

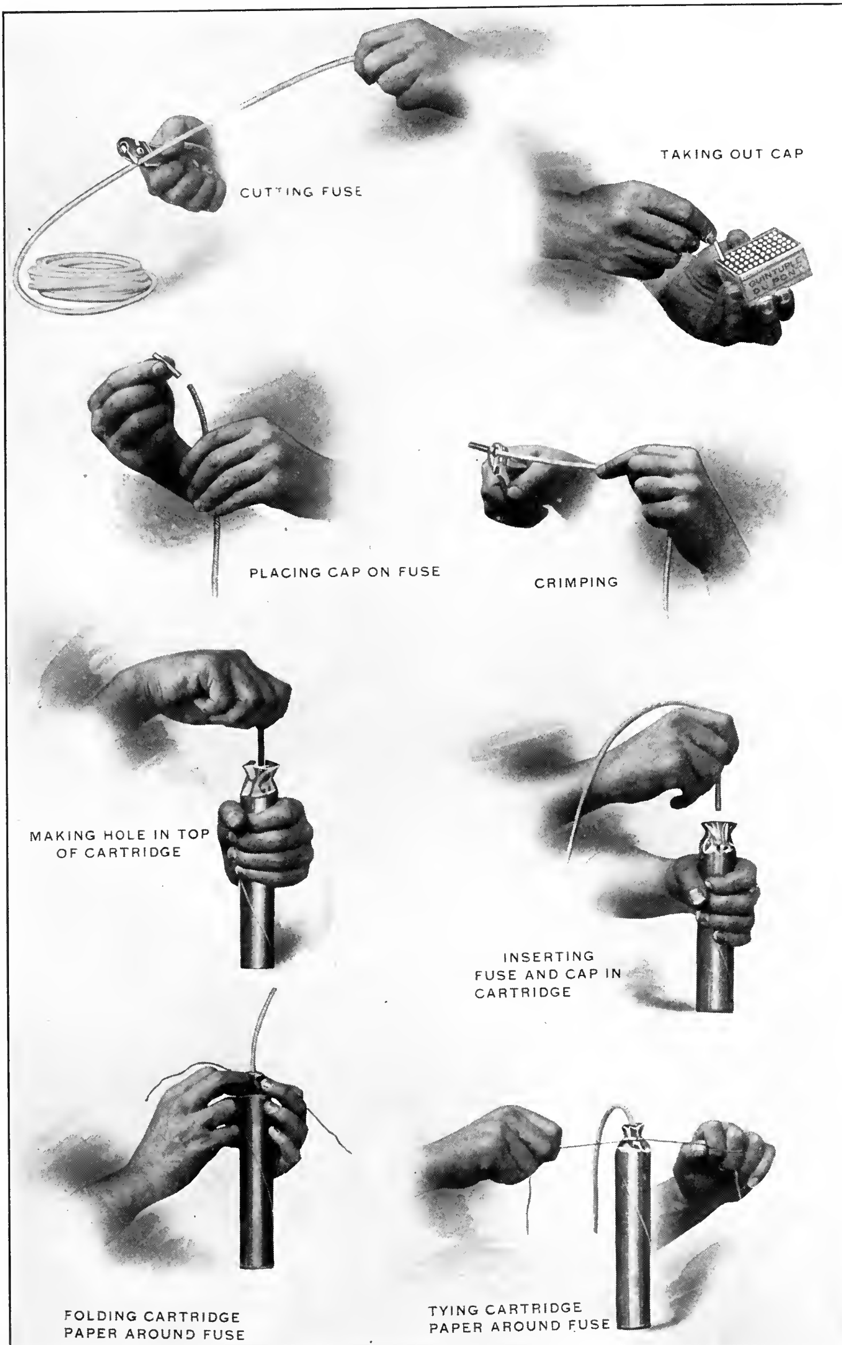
Blasting Caps should be stored in a dry place, and when conveying them to the work where they are to be used, no moisture whatever should be permitted to get into the charge which they contain. This charge is very easily affected by dampness, and will absorb moisture and deteriorate, unless the blasting caps are kept perfectly dry. Storage in damp places, such as tool boxes in mines, is likely to affect the charge in blasting caps, and, while a small quantity of moisture may not entirely prevent their exploding, it may weaken them to such an extent that they will not properly detonate high explosives.

Blasting Caps are detonated by means of safety fuse, and the methods of attaching the blasting cap to the fuse, and of priming high explosive cartridges with the blasting cap and fuse, are covered in that portion of this catalogue which treats of safety fuse.

Case of Blasting Caps

Blasting Caps manufactured by The E. I du Pont de Nemours Powder Co.

Safety Fuse



Priming a Dynamite Cartridge in the End

Safety Fuse

SAFETY FUSE may be used with blasting caps to detonate high explosives when it is not necessary to fire more than one charge at a time. It may also be used, without blasting caps, to explode blasting powder. Some grades can be used in comparatively wet work (provided care is taken not to injure the fuse when tamping the bore hole and provided the charge is fired promptly) if the joint between the safety fuse and blasting cap is made absolutely water proof with soap, tallow or similar substance. Oil or liquid grease should never be used, because they are likely to soak into the fuse and injure the powder train. Insulating tape can also be used to advantage for this purpose.

The different kinds of safety fuse may be divided into four general classifications, according to the nature of the work for which they are designed. These are:

Dry Work	**Wet Work**
Damp Work	**Under Water**

It must be remembered, however, that good results will not be had, even under this classification, unless the precautions in regard to loading, tamping, etc., outlined above are carefully observed. For example, several different kinds of safety fuse will burn through satisfactorily under water if they have only been under the water for a short time and at no appreciable pressure, but none of them will resist water under pressure for many hours.

Most fuse, when burning, spits fire from the sides and gives off a relatively large volume of smoke. This is highly objectionable in mines where the ventilation is not good and special brands in which these faults are reduced as much as possible are manufactured for this work. It is usually necessary, however, when reducing smoke and "side spitting," to sacrifice somewhat other desirable qualities, such as water resistance, regularity of burning, etc. These brands are listed in the following table as "Special."

Safety Fuse Classification

Dry Work	Damp Work	Wet Work
Hemp—White *	Single Tape—White *	Double Tape—White *
Hemp—Black †	Single Taped—Black †	Double Taped—Black †
Cotton *	Beaver *	Reliable *
Superior Mining *	Blue Label †	Victor †
	Sylvanite †	Anchor *
		Crescent *
Under Water	**Special**	Bear †
Triple Tape—White *	Special XX *	Western D. T. †
Triple Taped—Black †	Special XXX *	Comet †
Stag *	Panther †	
American Eagle †	Shield †	
Pacific †		
Acme †		
Eclipse †		

Hemp Fuse and Cotton Fuse are too small in diameter to properly fit the standard blasting cap, and should be used only for exploding blasting powder charges where, unless a dynamite primer is used, a blasting cap is unnecessary.

Safety fuse cannot be kept in good condition unless stored in a *cool, dry* place. If stored in a hot place, the heat is likely to melt the varnish, making the fuse soft and black; or it may dry it out so that it will break when unrolled. If stored in a damp place, the powder in the fuse soon absorbs moisture and fails to burn properly.

When handling safety fuse, do not twist or "break" it.

Always insert the fresh cut end of the fuse in the blasting cap, because the powder in the end of the fuse becomes damp and ineffective very quickly. It is also likely to spill out of the cut end after the fuse has been handled a little.

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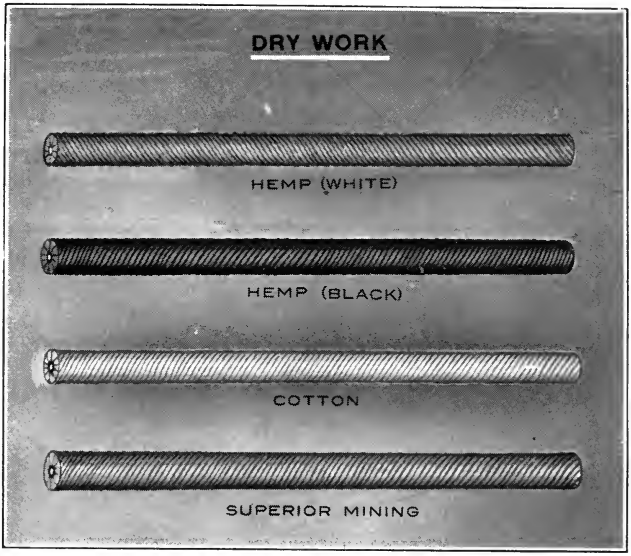
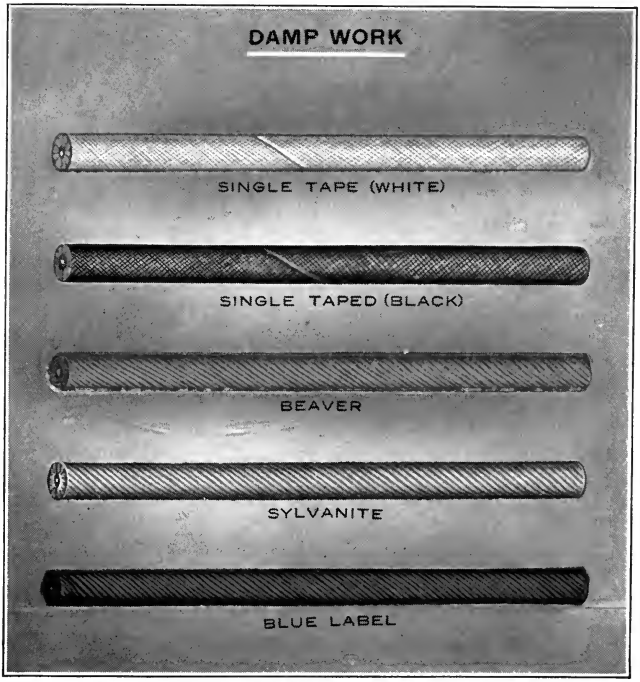
* Sold east of Montana, Wyoming, Colorado and New Mexico.

† Sold west of and including Montana, Wyoming, Colorado and New Mexico.


DRY WORK
HEMP (WHITE)
HEMP (BLACK)
COTTON
SUPERIOR MINING


DAMP WORK
SINGLE TAPE (WHITE)
SINGLE TAPED (BLACK)
BEAVER
SYLVANITE
BLUE LABEL

Safety Fuse

Always cut the end of the safety fuse which is to be inserted in the blasting cap squarely across and not diagonally, as the point made by a diagonal cut may be bent forward when the safety fuse is pushed into the blasting cap, and in this way prevent the spark from shooting into the blasting cap charge. Always press the end of the safety fuse gently against the charge in the blasting cap before crimping the blasting cap. All safety fuse, except Cotton and Hemp, is made to fit as snugly as possible into the blasting cap in order to prevent water or moisture from entering. If the safety fuse is found at any time to be a little too large to enter the blasting cap, do not attempt to cut off any of the tape or yarn, but swage or squeeze the end until it is small enough.

To prime a dynamite, or other high explosive cartridge, with a blasting cap and safety fuse, make a hole in the end of the cartridge after unfolding the paper shell, or in the side of the cartridge near the end, with a pointed stick about the size of a lead pencil. This hole should not be much larger in diameter than the blasting cap, for an air space around it always detracts from the force with which a bursting blasting cap strikes the explosive surrounding it. Do not bury the blasting cap so deep in the cartridge that the safety fuse will come in contact with the explosive for any appreciable distance, as the "side spitting" of safety fuse usually ignites the explosive.

Best results will be had if the blasting cap is pointed *straight down* into the primer cartridge.

When the blasting cap has been put in the end of the cartridge, the paper must be folded carefully about the safety fuse and tied securely with a piece of string.

When the blasting cap is inserted in the side of the cartridge near the end, the safety fuse is held in position by tying it to the cartridge with a double loop of string. Both of these methods of priming are clearly illustrated on pages 66 and 71. Never under any circumstances "lace" fuse through the primer cartridge, as this will almost invariably ignite the explosive before it is detonated, and *burning dynamite gives off exceedingly poisonous fumes.*

Each package of safety fuse contains two 50 foot rolls, one inside of the other.

SAFETY FUSE—Ensign-Bickford and Climax Brands

(Sold East of Montana, Wyoming, Colorado and New Mexico)

Approximate Weights and Dimensions of Packages for Domestic Shipments

COTTON AND HEMP

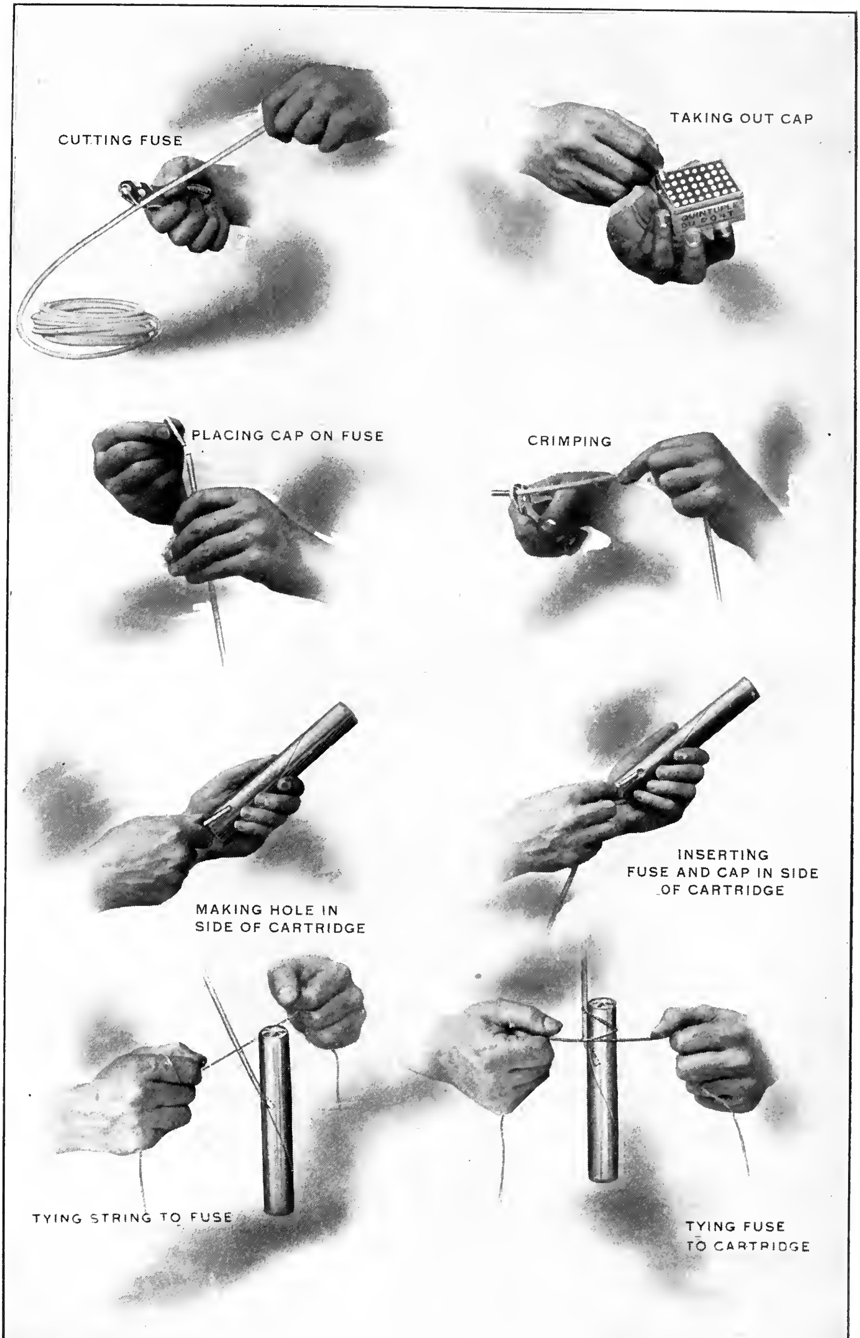
Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
0	500′ c/s wood	8 lbs.	3 lbs.	5 lbs.	7¼″ x 7½″ x 14¾″
1	1,000′ " "	13½ "	3½ "	10 "	6¾″ x 11¼″ x 13″
2	2,000′ " "	26 "	6 "	20 "	7¼″ x 13″ x 21¼″
3	3,000′ " "	36½ "	6½ "	30 "	13½″ x 13¾″ x 15″
4	4,000′ " "	55 "	15 "	40 "	14½″ x 15″ x 20½″
5	5,000′ " "	68 "	18 "	50 "	14½″ x 20½″ x 20½″
6	6,000′ " "	79 "	19 "	60 "	14½″ x 20½″ x 24″
8	8,000′ " "	102 "	22 "	80 "	14½″ x 20½″ x 27¾″
10	10,000′ " "	124 "	24 "	100 "	17″ x 20″ x 28½″
12	12,000′ " "	146 "	26 "	120 "	17″ x 20″ x 32½″
12	12,000′ bbl. "	145 "	25 "	120 "	23″ x 30″

SPECIAL XX, SPECIAL XXX, BEAVER, ANCHOR, CRESCENT, STAG

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
0	500′ c/s wood	10½lbs.	3 lbs.	7½lbs.	7″ x 7¾″ x 15″
1	1,000′ " "	19½ "	4½ "	15 "	7¼″ x 13¾″ x 14¾″
2	2,000′ " "	36½ "	6½ "	30 "	13½″ x 13¾″ x 15″
3	3,000′ " "	60 "	15 "	45 "	14½″ x 13¾″ x 20½″
4	4,000′ " "	78 "	18 "	60 "	14½″ x 20½″ x 20½″
5	5,000′ " "	94 "	19 "	75 "	14½″ x 20½″ x 24″
6	6,000′ " "	112 "	22 "	90 "	14½″ x 20½″ x 27¾″
8	8,000′ bbl. "	145 "	25 "	120 "	23″ x 30″

SINGLE, AND DOUBLE TAPE, SUPERIOR MINING, RELIABLE

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
0	500′ c/s wood	11 lbs.	3 lbs.	8 lbs.	7″ x 7¾″ x 15″
1	1,000′ " "	20½ "	4½ "	16 "	7¼″ x 13¾″ x 14¾″
2	2,000′ " "	36½ "	6½ "	32 "	13½″ x 13¾″ x 15″
3	3,000′ " "	63 "	15 "	48 "	14½″ x 15″ x 20½″
4	4,000′ " "	82 "	18 "	64 "	14½″ x 20½″ x 20½″
5	5,000′ " "	99 "	19 "	80 "	14½″ x 20½″ x 24″
6	6,000′ " "	118 "	22 "	96 "	14½″ x 20½″ x 27¾″
8	8,000′ bbl. "	153 "	25 "	128 "	23″ x 30″



Priming a Dynamite Cartridge in the Side

TRIPLE TAPE

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
0	500′ c/s wood	12 lbs.	3 lbs.	9 lbs.	7″ x 7¾″ x 15″
1	1,000′ " "	22½ "	4½ "	18 "	7¼″ x 13¾″ x 14¾″
2	2,000′ " "	42½ "	6½ "	36 "	13½″ x 13¾″ x 15″
3	3,000′ " "	69 "	15 "	54 "	14½″ x 15″ x 20½″
4	4,000′ " "	90 "	18 "	72 "	14½″ x 20½″ x 20½″
5	5,000′ " "	109 "	19 "	90 "	14½″ x 20½″ x 24″
6	6,000′ " "	130 "	22 "	108 "	14½″ x 20½″ x 27¾″
7	7,000′ bbl. "	151 "	25 "	126 "	23″ x 30″

SAFETY FUSE

(Sold West of and Including Montana, Wyoming, Colorado and New Mexico)

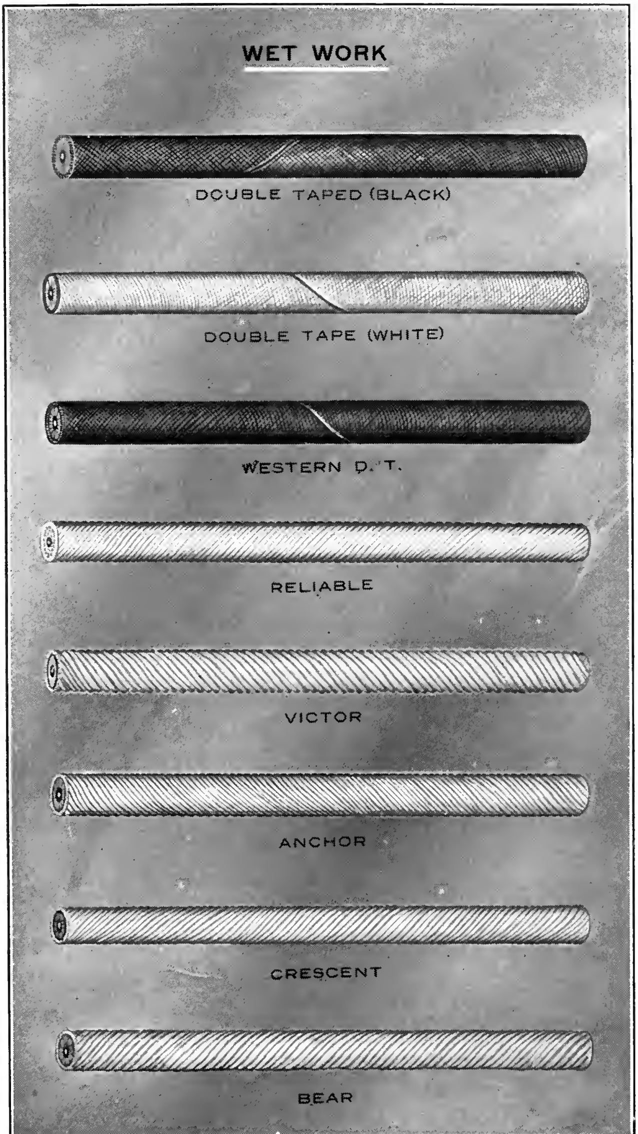
Approximate Weights and Dimensions of Packages for Domestic Shipments

SINGLE TAPE—WHITE — ACME
DOUBLE TAPE—WHITE — SHIELD
TRIPLE TAPE—WHITE — SYLVANITE
WESTERN D. T.

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	19½ lbs.	4¾ lbs.	14¾ lbs.	8″ x 12″ x 15¾″
2	2,000	38 "	8½ "	29½ "	8¼″ x 15″ x 24″
3	3,000	58 "	13¼ "	44¾ "	8½″ x 15¼″ x 34″
4	4,000	72½ "	13 "	59½ "	15¼″ x 15¼″ x 23½″
5	5 000	89¼ "	15 "	74¼ "	15¼″ x 15¼″ x 30″
6	6,000	105½ "	17 "	88½ "	15¼″ x 15¼″ x 35″

SINGLE TAPED—Black

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	23 lbs.	8 lbs.	15 lbs.	7½″ x 14½″ x 13″
3	3,000	59 "	15 "	44 "	8½″ x 15½″ x 37″
6	6,000	110 "	23 "	87 "	14½″ x 15½″ x 37″


WET WORK
DOUBLE TAPED (BLACK)
DOUBLE TAPE (WHITE)
WESTERN D. T.
RELIABLE
VICTOR
ANCHOR
CRESCENT
BEAR

Safety Fuse

DOUBLE TAPED—Black

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1 000	24 lbs.	8 lbs.	16 lbs.	8½″ x 14½″ x 13″
3	3,000	62½ "	15 "	47½ "	8½″ x 15½″ x 37″
6	6,000	119 "	23 "	96 "	14½″ x 15½″ x 37″

TRIPLE TAPED—Black

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	24 lbs.	8 lbs.	16 lbs.	8½″ x 14½″ x 13″
3	3,000	66 "	15 "	51 "	8½″ x 15½″ x 37″
6	6,000	125½ "	23 "	102½ "	14½″ x 15½″ x 37″

BLUE LABEL, VICTOR, AMERICAN EAGLE

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	23 lbs.	8 lbs.	15 lbs.	7½″ x 14½″ x 13″
3	3,000	60 "	15 "	45 "	8½″ x 15½″ x 37″
6	6,000	113 "	23 "	90 "	14½″ x 15½″ x 37″

BEAR

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	23 lbs.	8 lbs.	15 lbs.	7½″ x 14½″ x 13″
3	3,000	61 "	15 "	46 "	8½″ x 15½″ x 37″
6	6,000	117½ "	23 "	94½ "	14½″ x 15½″ x 37″

PACIFIC

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
1	1,000	23 lbs.	8 lbs.	15 lbs.	8½″ x 14½″ x 13″
3	3,000	60 "	15 "	45 "	8½″ x 15½″ x 37″
6	6,000	114 "	23 "	91 "	14½″ x 15½″ x 37″

HEMP *

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
10	10,000	114 lbs.	23 lbs.	91 lbs.	14½″ x 15½″ x 37″

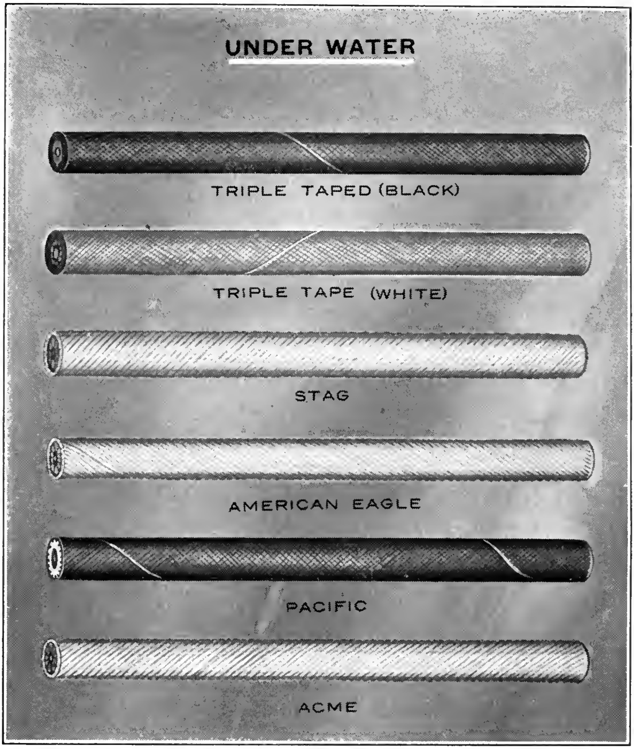
* Packed only in full cases 10,000′ each.

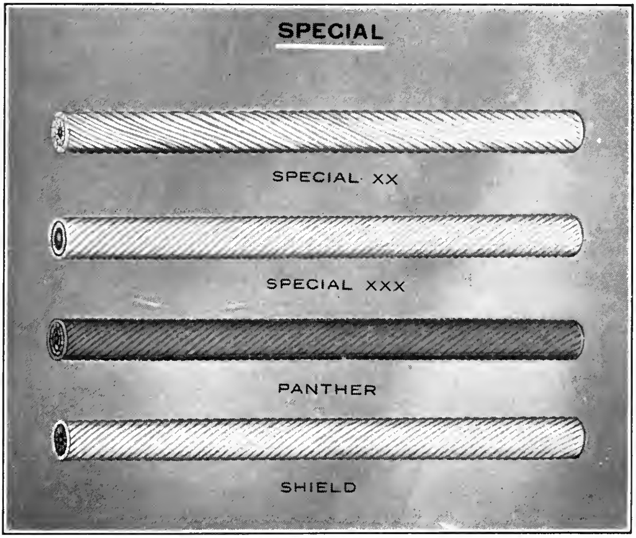
COMET

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
3	3,000	64 lbs.	14 lbs.	50 lbs.	8½″ x 15½″ x 37″
6	6,000	122 "	23 "	99 "	14½″ x 15½″ x 37″

ECLIPSE

Pkg. No.	Packages	Gross Weight	Tare	Net Weight	Outside Dimensions of Packages
3	3,000	60 lbs.	14 lbs.	46 lbs.	8½″ x 15½″ x 37″
6	6,000	116½ "	23 "	93½ "	14½″ x 15½″ x 37″


UNDER WATER
TRIPLE TAPED (BLACK)
TRIPLE TAPE (WHITE)
STAG
AMERICAN EAGLE
PACIFIC
ACME


SPECIAL
SPECIAL XX
SPECIAL XXX
PANTHER
SHIELD

Safety Fuse

DU PONT

Cap Crimpers

Thawing Kettles

Tamping Bags

Blasting Mats

View at Du Pont Blasting Machine and Electric Fuze Works, Pompton Lakes, N. J.

DU PONT

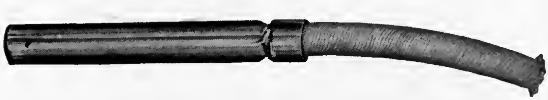
Cap Crimpers

NO blasting equipment, where safety fuse and blasting caps are used, is complete without a Cap Crimper. This inexpensive little tool will wear for years, and pay for itself many times over in a day; yet many blasters fail to appreciate its value, and resort to a knife or their teeth to fasten the blasting cap to the safety fuse. Besides being exceedingly dangerous, both of these methods are ineffective, and often responsible for expensive misfires.

The accompanying illustrations show plainly why a cap crimper, and not the teeth or a knife, should be used to attach the blasting cap to the safety fuse.

BLASTING CAP FASTENED ON FUSE WITH THE TEETH
No. 1

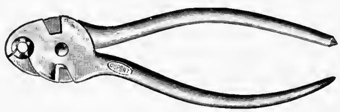
BLASTING CAP FASTENED ON FUSE WITH A KNIFE
No. 2



BLASTING CAP CRIMPED ON FUSE WITH A DU PONT CAP CRIMPER
No. 3

The blasting cap should be very securely fastened to the safety fuse, both to prevent the fuse from being pulled out of it when the primer cartridge is loaded and the bore hole tamped, and also to keep the charge in the blasting cap dry if water is present. This can only be accomplished by the use of an instrument made especially for the purpose.

The Du Pont Cap Crimper is equipped with an effective fuse cutter and has a straight arm with which the hole for the blasting cap can be made in the primer cartridge. The other arm has a hole in it for a string or chain, so that it can be attached to the blaster, and will not be somewhere else when it is most wanted.



Du Pont Cap Crimper

This crimper is so made that it cannot press the blasting cap far enough into the fuse to cut off the powder train and cause a misfire.

Thawing Kettles

Many high explosives containing nitroglycerin freeze and become insensitive in cold weather, and when frozen may burn instead of explode. Burning dynamite gives off fumes so poisonous that men have been killed by it. It is obvious, therefore, that when dynamite that freezes is to be used in low temperatures some provision must be made for thawing it and for *keeping it thawed* until it is loaded into the bore hole. As this dynamite, Red Cross excepted, freezes at about 45° F. or 50° F., the thawing problem is a troublesome one. On work where these explosives are used in large quantities, thawing houses* are necessary; but even then the Thawing Kettle should be employed to take the explosives from the thawing house to the place where they are to be used, in order to prevent them from becoming chilled or frozen again. If not more than two or three hundred pounds of explosives are used at one time, three or four large thawing kettles

*See our Booklet on Thawing Dynamite, mailed on application.

are all that are necessary, and will thoroughly thaw that quantity of frozen dynamite in a few hours.

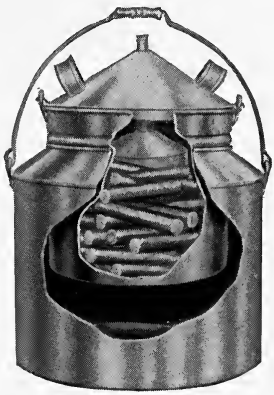
These thawing kettles are all made with a water tight compartment for the explosives (dynamite should never under any circumstances be permitted to come in contact with hot water), which is surrounded by the receptacle for the hot water. The Catasauqua Thawing Kettles are in one piece, but the Bradford Thawing Kettles consist of two receptacles, the one for the explosive fitting into the one for the hot water.

The Miners' Thawing Kettle has the hot water compartment surrounded by a jacket of non-conducting material. The water in this thawing kettle will remain warm for from five to eight hours, even in very cold weather. It will thaw from 21 to 28 pounds of dynamite without having the water compartment refilled.

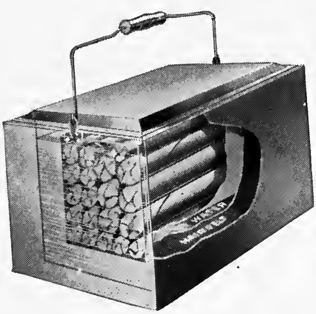
The Catasauqua and the Bradford Thawing Kettles will retain their heat about five times as long if they are kept in a barrel with dry hay surrounding them as they will if this is not done. This hay can be held in place by a cylinder of wire screen, so that the thawing kettle can easily be removed and replaced. If the barrel be mounted on two wheels with a tongue attachment, it can be readily drawn from point to point about the work, so that it will not be necessary to expose the dynamite to the cold air until it is to be loaded in the bore hole.

Under no circumstances must the water be heated in either the Catasauqua or Miner's Thawing Kettles, even though the explosives be first removed, because nitroglycerin exudes very readily from warm dynamite, and enough of it is likely to be found in the bottom of the explosives compartment of a thawing kettle that has been in use for some time, to cause a serious accident were the thawing kettle placed over a fire. In addition to this, the insulating jacket of the Miner's Thawing Kettle would be destroyed were it subjected to a high temperature. The water receptacle of the Bradford Thawing Kettle may be used for heating the water if the explosives receptacle be removed, but it is necessary with both the Catasauqua and Miner's Thawing

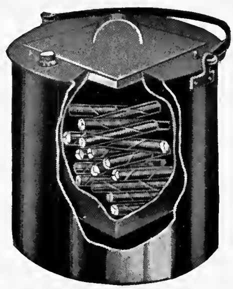
Kettles to heat the water in something else before filling the water jacket. **The hot water must always be tested before filling the dynamite compartment. If it is hot enough to burn the hand, do not put the explosives into the Thawing Kettle.** Never fill the water jacket unless the explosives compartment is empty, and see that the explosives compartment is perfectly dry before it is filled.



Bradford Thawing Kettle



Miner's Thawing Kettle



Catasauqua Thawing Kettle

	Capa-city	Weight Empty	Weight of Water	Total Wt. Filled	Outside Dimensions
Bradford No. 1 . . .	22 lbs.	14 lbs.	58½ lbs.	94½ lbs.	16″ x 21″
Bradford No. 2 . . .	60 "	20 "	110 "	190 "	21″ x 21″
Catasauqua No. 1 . .	30 "	12½ "	40 "	82½ "	14″ x 14½″
Catasauqua No. 2 . .	60 "	17½ "	77½ "	155 "	17½″ x 21″
Miner's	7 "	8½ "	7 "	22½ "	8½″ x 9″ x 12½″

DU PONT

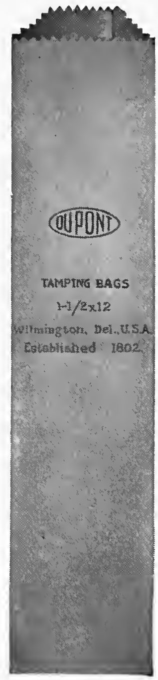
Tamping Bags

Tamping Bag (Full)

Tamping Bags of heavy paper are used in many places as containers for tamping and save time and trouble when loading bore holes, particularly the pitching ones and the "uppers."

They are also employed as containers for blasting powder when the miner or blaster desires to make up the charge in cartridge form, as is generally the custom when it is used in mines or in open work that is damp.

Tamping Bags are put up in bundles of 500 each and packed ten bundles to the bale. They are manufactured in the following sizes:



Tamping Bag (Empty)

Size No.	Size	No. in Bale	Shipping Weight per Bale
A	1″ x 8″	5,000	28 lbs.
B	1¼″ x 8″	5,000	31 "
C	1¼″ x 10″	5,000	37½ "
D	1¼″ x 12″	5,000	45 "
E	1½″ x 8″	5,000	36 "
F	1½″ x 10″	5,000	44 "
G	1½″ x 12″	5,000	48 "
H	1½″ x 16″	5,000	62 "
J	2″ x 18″	5,000	86 "

Tamping Bags are made approximately 2 inches longer than shown in the above table, in order to provide for folding at the end when in use.

Blasting Mats

Blasting Mats are made of woven rope. Hemp is generally used and is considered the best, although steel wire rope has been tried. The mats are made of 1 inch, 1 ¼ inch or 1 ½ inch rope, according to the demands of the customer. They are not carried in stock, but are woven on order and are made in any size required. If the blasting mats are to cover light charges of explosives, they may be spread on the rock directly over the bore holes; but if heavier charges are used, railroad ties or logs should be put down first and the mats on top of them. This arrangement is very effective in preventing the rock from being thrown into the air and should always be adopted when blasting is done near thoroughfares or buildings.

The Advantage of Strong Detonators

The Advantage of Strong Detonators

WHEN high explosives are detonated, the stronger or sharper the initial shock the quicker and more thorough is the detonation of the charge. It is a well known fact that certain detonating substances will exert this effect more powerfully than others. To obtain the full value of the explosive charge, it should be detonated as quickly and as completely as possible. If the detonation is slow and incomplete, a greater quantity of explosive is required to do the same work, and large volumes of poisonous gases are evolved—a matter of serious consequence when the work is underground, instances being known where workmen have been killed by gases given off from partially detonated or burning explosives. Quick and complete detonation results in a minimum of flame, a point of first importance with those explosives intended for use in the presence of inflammable gas or coal dust. Electric fuzes or blasting caps too weak to detonate a charge of high explosives frequently generate sufficient heat to ignite it, while slightly stronger ones may partially detonate it. Still stronger ones may cause complete detonation, but with insufficient rapidity to give best results.

The effect of a detonator on a charge of high explosives in a bore hole is not infinite, but decreases with distance. It is, therefore, easy to understand the necessity for using detonators sufficiently strong for the effect of the detonator itself to extend throughout the charge. It might be understood from this that the detonator should be located in the center of the charge; this would be correct had not numerous tests shown that the greatest effect of the detonator is straight away from its loaded end and in a line with its long axis.

In deep bore holes loaded with long charges, whether they be fired with fuse and blasting caps or with electric fuzes, it is well to place a blasting cap in a cartridge of the explosive, at intervals of about 5 feet throughout the charge, so that their effect will extend the entire length of the charge. It is also advisable to use two electric fuzes in deep bore holes, so that if one should be defective, the other may be depended on for the initial detonation. A point to be remembered in buying detonators is that the charge which they contain is readily affected by moisture, and consequently, unless storage conditions are of the best, a fair margin of safety in strength should be allowed. Blasting caps, being open at one end, are more quickly weakened by dampness than are electric fuzes.

Another strong argument for allowing a fair margin of safety when buying detonators is the very small cost of the detonator in comparison with that of the charge of explosives with which it is used. It is difficult to understand why anyone, in order to save a few cents on the price of a hundred detonators, would risk the misfire, partial detonation or imperfect work of the charge of explosives in a bore hole, which results at best in the loss of several dollars and may cost thousands if it burns in a gaseous coal mine or if unexploded dynamite happens to cause a fatal accident afterward.

The following from one of our customers who was driving a railroad tunnel shows how thoroughly those who have used strong detonators recognize their value. The 5X blasting cap referred to is now known as the Du Pont No. 5 and the No. 30 Special is the present Du Pont No. 8.

Montana, 11/30/07.

E. I. du Pont de Nemours Powder Co.

Dear Sir: In reply to your request for information as to the efficiency of your No. 30 Special Blasting Caps, I submit the following comparison:

	No. 5 X Caps	No. 30 Special Caps
No. of holes, average	34 per shift	25
No. sticks powder per hole	12	9
Minutes before force was able to return to work,	15	5

We have had great success with every hole since using your No. 30 Special, and the shift bosses, etc., are very enthusiastic about them.

The rock to be blasted was very hard granite in a tunnel. Great difficulty was experienced in breaking the rock, especially in the heading.

This was drilled about 6 feet, but all holes were shot twice. The section was only 8 feet x 16 feet, but a large number of holes was necessary on account of the hard and tough rock.

By the use of the No. 30 Special, we saved outright the work of one machine for one shift, and in that same shift 20 pounds of powder and at least 20 minutes time for the entire force of about 20 men.

This is quite a saving and demonstrates beyond a doubt that the No. 30 Special is the best cap for hard rock.

The above report shows the results of a test on which close account was kept for a period of 10 days.

Yours very truly, etc.

The extended study and tests of explosives, conducted during the past few years by the United States Bureau of Mines, have clearly demonstrated the economy of using only strong detonators. On page 52 of Bulletin 423, "A Primer on Explosives for Coal Miners," issued by the Department of the Interior, occurs the following:

"In the appendix setting forth the test requirements for permissible explosives, it is stated that electric or other detonators, containing not less than 1 gram of the fulminating composition, should be used in firing the charges. For use with high explosives in rock blasting, detonators of that strength are also best. Under no circumstances should an electric or other detonator be used of less strength than No. 5, containing 0.8 gram of the fulminating composition. The greater efficiency and certainty of the stronger detonator more than make up for the slightly greater cost."

The clause in the Appendix of Bulletin 423, referred to above, states: "That No. 6 detonators, preferably No. 6 electric detonators (double strength), are used of not less strength than 1 gram charge, consisting by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or its equivalent)," etc. The Du Pont No. 6 Blasting Cap and Victor No. 6 Electric Fuze, recommended throughout this catalogue for detonating high explosives, comply with the above specifications.

Strong electric fuzes and blasting caps should be used with all high explosives:

Because they insure complete detonation.

Because they increase the execution of the explosive.

Because they tend to counterbalance careless and improper usage.

Because they offset, to some extent, deterioration due to improper storage.

Because they reduce fumes from the explosive to a minimum.

Because they decrease the size and duration of flame.

Because they prevent the loss of the charge by burning.

Because their effect carries farther in long charges.

Because they reduce the chances of misfire.

The Elementary

Principles of Electricity

AS APPLIED TO ELECTRIC BLASTING

and

Some Useful Information as to Methods of Using, Preserving and

Testing the Blasting Equipment

From "PRINCIPLES OF ELECTRIC BLASTING," by W. G. Hudson, M. D.

No. 6 No. 7 No. 8

No. 5 No. 6 No. 7 No. 8

Du Pont Blasting Caps and Victor Electric Fuzes (actual size)

CHAPTER I

Elementary Electrical Principles

1. In Fig. 1 is shown an ordinary dry cell battery, with its two binding posts or connectors (A-B). These are called, respectively, the Positive and Negative Poles.

If the poles are connected with a piece of wire (C) an electric current will flow through it, in the direction indicated by the arrows, and will continue to flow until the chemicals are exhausted.

2. Such a wire affording a path for the current from the positive to the negative pole of a battery is called a circuit. The current only flows when the circuit is complete, and a single break in the continuity of the wire stops the flow of current throughout the entire circuit.

Fig. 1

The wire comprising the circuit can be much longer than shown in Fig. 1—even many miles in length—and still the current will follow it throughout its entire length, so long as some shorter or easier path between the two poles is not offered. If the wire is covered with some insulating material like silk, rubber or cotton, so as to prevent the current from escaping from it and following some shorter or easier course, then the wire may be wound many times around other objects, or make any number of bends and twists, and still the current will follow it from one pole of the battery to the other, with almost as much ease as it did the short piece of wire in Fig. 1.

3. Now, how do we know that a current is flowing through the wire in the manner described? We know it *by its effects,* and a few of these effects, which are of great importance in

understanding blasting by electricity, will answer for the present consideration.

Fig. 2

3-A. First, if part of the ordinary thick copper wire used in Fig. 1 be replaced by a very fine piece of wire ("G," Fig. 2), the fine wire being preferably of iron, platinum or German silver, then the difficulty which the current has in passing through this small piece of wire, or, as electricians say, "overcoming its resistance," will transform part of the current into heat. The fine wire will become red hot, and even melt if the current is strong. This is the principle made use of in firing electric fuzes. Another familiar application is the incandescent electric light, where a fine carbon wire is forced to carry a large amount of current, and becomes so intensely white hot (incandescent) that it gives out light.

3-B. Second, if wire insulated with cotton or silk* be wound many times around a bar of ordinary soft iron (Fig. 3, page 93), the ends of the wire being connected with a battery so that the current will flow through it, the iron bar will be found to become powerfully magnetic. As soon as the circuit is interrupted† at any point, whether by removing one or both wires from the battery, or breaking or cutting the wire anywhere throughout its length, nearly all the magnetism‡ immediately departs from the iron.

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* Non-conductors are those substances which do not carry the electric current. Conductors are those substances which carry it readily; poor conductors are those which carry it, but with difficulty. Strictly speaking, there are no perfect non-conductors, and no perfect conductors; but the terms are in common use and are convenient and unobjectionable if it is borne in mind that they are relative. Metals are the best conductors; silver heads the list, followed in turn by copper, zinc, iron, platinum, lead, mercury, etc. Among the best non-conductors are glass, rubber, sulphur, silk, cotton, paraffin, tar, resinous materials, oils, etc. Water is a representative of poor conductors, but its conductivity is greatly increased when various salts, such as those likely to be derived from rocks in drilling, are dissolved in it. Acids also increase the conductivity of water.

† Interrupting or breaking a circuit at any point is referred to by electricians as "opening" the circuit; re-establishing it, so that the current can pass, as "closing" the circuit.

‡ Soft iron readily loses nearly all its magnetism as soon as the current stops, and the softer the iron the more readily it becomes demagnetized, although it never loses all of it. Hard steel, on the contrary, retains a great deal of magnetism once it has been magnetized, and on this principle depends a permanent magnet. The magnetism left in an electromagnet after the current has ceased is called "residual magnetism."

As soon as the circuit is closed, the magnetism returns, even though the opening and closing of the circuit is performed many times a second, and the point of interruption is in a far distant part of the circuit. If another piece of iron for the magnet to attract is balanced by a spring over the magnet, every time the circuit is closed it will be drawn toward the magnet, and when the circuit is opened the spring will draw it away. Such a piece of iron provided for the magnet to act upon is called an armature. The telegraph sounder (Fig. 3½) works on this principle, the armature in its up and down movements causing a lever to strike resonant metal pegs, which give out the familiar "clicks," by the sound of which the operator reads the message. Many other electrical instruments also work on this same principle.

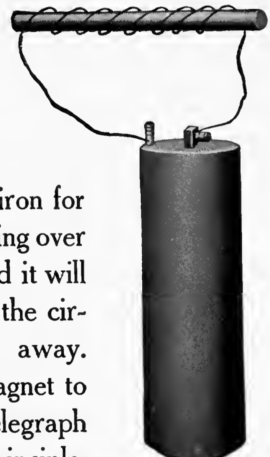

Fig. 3

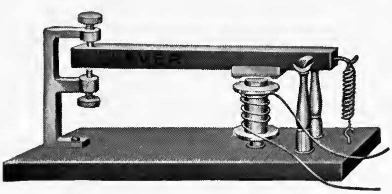

Fig. 3½

C. Third, that an electric current is flowing through the wire (Fig. 1, page 91) can be shown by crossing part of the wire over a compass as shown in Fig. 4. Ordinarily, of course, the needle of the compass will point north and south, and the wire above it should run in the same direction. But as soon as the connection with the battery is established the needle will be deflected, so that it will stand at right angles to the wire, or, in other words, point east and west. If the end of the wire that is connected with the positive pole of the battery be transferred to the negative pole, and vice versa (that is, if the "poles be changed") the *needle will*

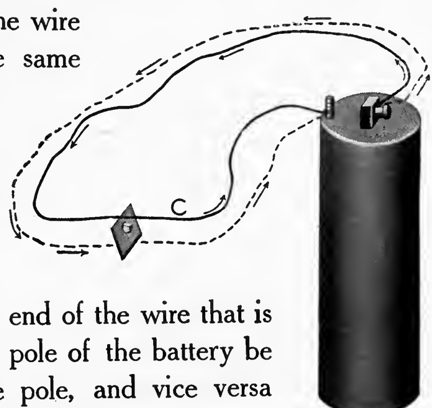

Fig. 4

reverse its direction, so that the end which pointed east before will now point west.

4. The needle will also reverse its direction if the wire "C," Fig. 4, be moved from its position above the needle to one below it, as shown by the dotted line. In other words, the direction of the electric current affects the direction in which the magnetic needle is deflected; and also deflects it one way when it passes above the needle and in the opposite way when it passes below it. This fact enables us to very greatly intensify the action of the current upon the magnetic needle, by putting a coil of insulated wire about the compass, as shown in Fig. 5. With such an arrangement, all the strands of wire above the needle are carrying the current in one direction and all those below in the opposite direction. They all, therefore, tend to deflect the needle in the same manner, and the effect is very greatly magnified; so much so, that such an instrument indicates the passage of currents that are too feeble to be detected by any other means. It is called a Galvanometer.

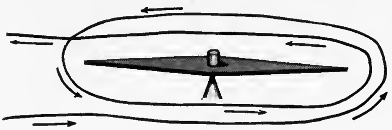

Fig. 5

5. Practical Magnets.—The electromagnet is much more powerful when, instead of winding the wires on a straight bar as in Fig. 3, page 93, the bar is bent U shape, as shown in Fig. 6-A, page 95, for in this position both ends can be made to act at once upon the same piece of iron, and they can attract it with double, or more than double force. It is also found that the wire in the middle of the electromagnet does not have as much of an effect as that near the ends, and for this reason the wire is not generally wound on the middle part, but only on the ends, as shown in Fig. 6-B. Again, it is ordinarily advantageous, from the manufacturing standpoint, to make the iron core of a magnet in sections, afterwards fastening them together, as shown in Fig. 6-C. The sections "H I" can then be wound with the wire, just like thread is wound on a spool, securing great efficiency as well as ease in manufacture (Fig. 6-D).

Such electromagnets, when of large size and actuated by powerful currents, are of tremendous power, and will lift masses of iron weighing tons.

6. If a piece of soft iron, *i. e.*, an armature (paragraph 3-B, page 92) be placed between the poles of a conveniently

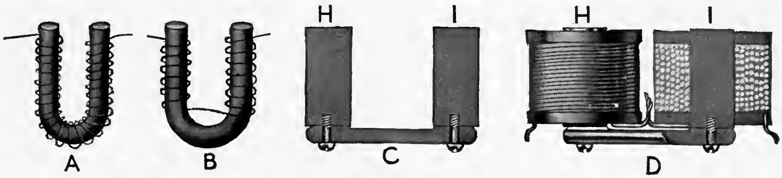

Fig. 6

shaped magnet, as shown in Fig. 7, the piece of soft iron is also caused to become magnetic. North polarity is induced in the end near, or in contact with, the south pole, and vice versa. If the position of the armature is reversed, so that the end "A" is nearest the south, and "B" nearest the north pole of the magnet, then the armature reverses its polarity, so as to always present its south end to the north end of the controlling ("field") magnet. This it does, even though the reversal of ends is very rapid, such as would result from fixing a shaft into the armature at "J," and rotating it rapidly in the direction shown by the arrows.

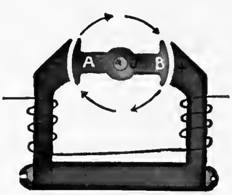

Fig. 7

We have seen (paragraph 3-B, page 92) how passing an electric current through wire wound upon a soft iron bar is capable of causing it to become magnetic. The reverse of this proposition, namely, the induction of an electric current in the wire about an iron bar by causing the bar to become magnetic, is also true with certain limitations. Take such a bar wound with wire ("A," Fig. 8, page 96) and connect the ends of the wire with a galvanometer (the construction of which is explained in paragraph 4, page 94), so that we will know whenever a current passes. Now cause the end of the bar to approach the live electromagnet "B," Fig. 8. All the time it is approaching "B," the galvanometer shows that an electric current is passing. When the movement is stopped, the current stops.

If the movement be reversed, that is, if the wire-wound bar be moved away from the magnet, the galvanometer will again show that a current is passing, but *in the opposite direction.*

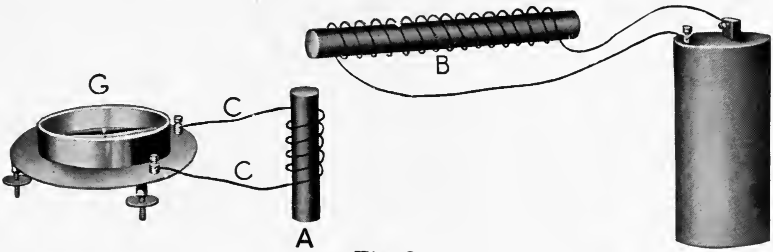

Fig. 8

The reason the current is set up (induced) in the wire around the iron bar is because the iron bar is caused to become magnetic as it approaches the live magnet (paragraph 6, page 95), and loses this induced magnetism as it is withdrawn; and there is a nautral law that *any change in the magnetic condition of an iron core will induce an electric current in wire around it.*

It may be argued that the result is not an electric current, but a series of electric pulsations. That is perfectly true; but if the pulsations are sufficiently frequent, through rapid rotation of the armature shaft, they produce similar enough effects to the steady flow of a battery current to be available for most purposes.

But the currents induced in the armature do more than pulsate. If the ends of the armature wire are connected with a galvanometer, and the armature slowly revolved so that the movements of the needle can be watched, the needle will be found to swing first to the east, then to the west, then east, then west again, changing direction with each half revolution of the armature. If the end of the galvanometer needle should be equipped with a

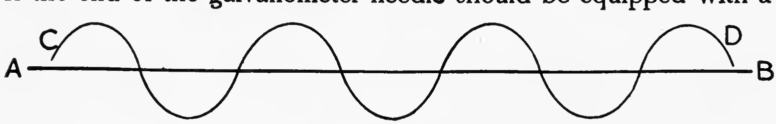

Fig. 9

pen, so that it could make a mark on a paper tape moved steadily beneath it by clockwork, the tracing that would be obtained by this experiment would look like Fig. 9.

In this illustration, the straight line "A B" is the mark the pen would make, if the paper were moved forward with the needle at rest and pointing to zero, or north. The wavy line "C D" is the mark made by the needle when such a current, continually reversing its direction, is sent through the apparatus. Such a current is called an *Alternating Current.*

But it is evident from what has already been said (paragraph 4, page 94) that such an alternating current would not do to energize the field magnet. In order to maintain the constant polarity of the field magnet, the current supplying it with energy must be in one direction, like the battery current. This is called a *Direct Current.* The alternating current induced in the armature is, therefore, rectified or changed into a direct current by means of the *Commutator* (Fig. 10).

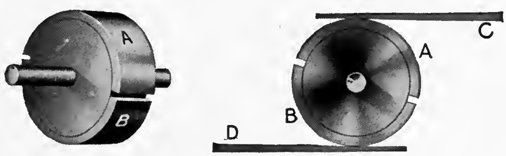

Fig. 10

The commutator consists of a cylinder of hard fiber or rubber, covered with copper, and mounted on the same shaft which drives the armature. The copper is cut lengthwise into two sections ("A" and "B," Fig. 10). These are firmly attached to the surface of the hard fiber very close together, but not touching; that is, they are insulated from each other by the fiber which carries them. One end of the armature wire is connected with section "A," the other with section "B."

The current is taken off of the commutator for use by "C" and "D" (Fig. 10), called *Brushes.* Now, as the commutator revolves with the shaft, while the brushes remain stationary, the section "A" is in contact with brush "C" for half a revolution, then with brush "D" for the other half. The same thing happens to section "B." Therefore, the effect of the commutator is to change the alternating armature current into a *Direct Current,* and the tracing which the record galvanometer will make on the tape, when it receives the current from the dynamo equipped with the commutator, is shown in Fig. 11.

Fig. 11

The alternating current would fire electric fuzes as well as the direct current; but if it were not converted into a direct current as it is, we would either have to energize the field magnet with a battery or use a permanent magnet. With the present arrangement, we simply lead the rectified current from the armature through the wire on the field magnet, which is thus energized by the current from its own armature. At the start, the very slight residual magnetism which is retained by the field magnet (see note ‡, paragraph 3, page 92) is sufficient to set up a feeble current in the armature. This in turn makes the field magnet stronger, and the stronger field magnet develops a stronger current in the armature. Thus the machine "builds up," as it is called, until after a few revolutions it is working at its full power. You can notice this when you push down the rack bar of a "push down" blasting machine. The first part of the stroke is easy, but after the armature has made a few revolutions, it pushes quite hard, because the magnet has become strong and pulls back on the armature, tending to resist our efforts to turn it.

The dynamo just described, which is used in most American blasting machines, is one of the simplest and earliest forms of dynamo. Those used for generating powerful currents for electric lighting, etc., are more complicated, and more efficient electrically than those made on this simple design; that is, if the blasting machine dynamo were constructed on modern principles, it would take less power for the same output of current or give greater output with the same amount of power, whichever way one chooses to look at it. But, for the purposes to which a blasting machine is put, considerations of simplicity outweigh this kind of efficiency. Blasters would rather exert a little more muscle in operating the blasting machine than pay for the increased cost of repairs to a more modern dynamo, not to mention the increased first cost. Indeed, it is doubtful if a more satisfactory blasting machine could be reasonably asked for than the ordinary "push down" blasting machine just as it is now made. Certainly no other piece of electrical machinery would stand the misuse to which many of these blasting machines are subjected in practice, and still continue to do good work, day after day and year after year, as so many of them do in spite of it all.

Let us now dissect an ordinary "push down" blasting machine, as a sort of review, and see how these electrical principles apply. Fig. 12 is a three post blasting machine while Fig. 13 shows a two post blasting machine. Note the field magnets

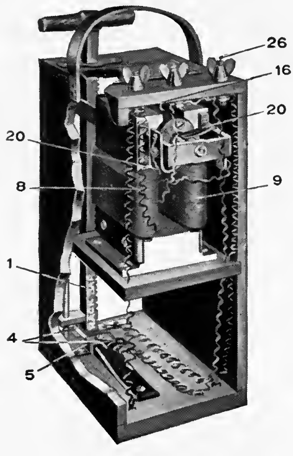

FIG. 12

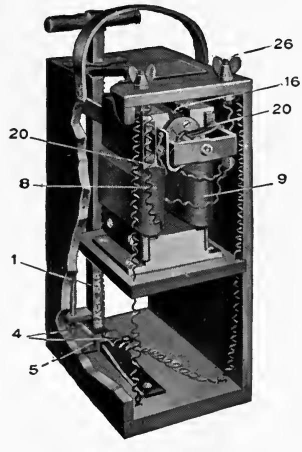

FIG. 13

"8" and "9" with their winding of coarse wire. In both figures the armature "16" can be seen with its winding of finer wire.

Note the brushes "20," bearing on the commutator just as already described, and see where the ends of the armature wire are soldered, each to its respective commutator section. On the other side is the rack and pinion ratchet movement, by which the downward thrust of the rack bar "1" imparts rotary movement to the armature. This is so simple that anyone can see at a glance how it works, and it need not be dealt with here.

There is one part of the blasting machine simple, but of great importance, which has not yet been taken up, and that is the "shunt," sometimes called the "circuit breaker." This is the brass contrivance "4" (Figs. 12 and 13) placed in the bottom of the box. It is really nothing but a brass spring which makes contact with the bridge "5," when in its normal position, the parts which come in contact being covered with platinum, so that they will remain bright and make a good electrical connection.

The function of this shunt is as follows: The spring "4," called the "contact spring," is connected by means of a piece of heavy copper wire to one of the binding posts, "26," representing one pole of the dynamo; the bridge is connected with the other binding post, representing the other pole of the dynamo, so that when the contact spring is up in contact with the bridge a short, easy circuit called a "shunt," of practically no resistance, is offered for the electric current to pass from one pole to the other—in the language of the electrician, the dynamo is "short circuited." While the rack bar is being pushed down, the blasting machine is "building up," the current generated passing across the shunt, so that by the time the rack bar is near the bottom of the stroke the dynamo is working at its maximum. When the rack bar strikes the contact spring, however, separating it from the bridge, the short circuit is broken, and the current of the dynamo has now no other way to pass from one pole to the other except by flowing out through the electric fuze circuit, which it does just at the instant when it is at its maximum strength. The fine platinum bridge wire in each electric fuze heats up almost instantly, causing them all to detonate at practically the same time.

Were it not for the shunt, operating as just described, current from the dynamo would begin to flow through the electric fuzes as soon as we started to push down the rack bar. It would be a very weak current at first, gradually increasing with the building up of the blasting machine. Such a current is not well adapted to fire a number of electric fuzes simultaneously, because it is impossible to make all of exactly the same degree of sensitiveness, and with the gradually increasing current, the more sensitive electric fuzes would fire first, breaking the circuit and causing the less sensitive ones to miss. By employing the shunt, on the other hand, no current is sent out from the blasting machine until there is ample power to fire even the least sensitive.

The three post blasting machine contains an ingenious device for increasing by approximately 50 per cent. the number of electric fuzes that the two post blasting machine would be able to fire.

When it is desired to take advantage of the three post feature of such a blasting machine, the electric fuze circuit is arranged as shown on page 34. Three leading wires are used, which really divide the blasting circuit into two separate circuits. The great increase in efficiency is brought about by equipping the contact spring with both an upper and a lower contact and arranging it so that it will throw the full power of the dynamo first into one circuit and then into the other. While the two circuits do not really fire simultaneously, the interval between them is so extremely short that we hear only one explosion. If it were not very short, the wires in one circuit would probably be broken by flying fragments of rock thrown out by the explosion of the charges in the other circuit.

By connecting one of the two leading wires to the middle binding post and the other to either of the outside ones, as is also shown on page 34, a three post blasting machine may be used as a two post blasting machine whenever the number of electric fuzes to be fired does not exceed the capacity of a two post blasting machine of that particular size. The great advantage in having a three post blasting machine is that when difficult conditions arise, which would ordinarily require a larger blasting machine, they can often be met in a very satisfactory manner merely by laying another leading wire and making use of the three post feature.

Nothing has been said thus far regarding the "pull up" blasting machine. It is not necessary to discuss it at any great length, since it is different from the "push down" blasting machine only in the mechanical detail, of using the upward movement of the handle as the driving stroke instead of the downward one. The mechanical application of the ratchet principle is slightly different, but not so much so that it cannot be seen at a glance. The construction of the dynamo is identical.

CHAPTER 2

Effective Use of Electric Blasting Apparatus

ALMOST anyone can use electric blasting supplies, and obtain good results, merely by following general instructions. However, the knowledge of the principles underlying their action, which will have been gained by reading the previous chapter, will be a great aid in obtaining their highest possible efficiency. Again, when the man who understands the principles encounters difficulties, he knows how to overcome them, while the man who does not understand has to be helped out of his troubles.

One who knows the internal construction of the blasting machine, and has learned from examination and study what a nice piece of mechanism it really is, will generally take good care of it. Keeping it, when not in use, in a clean, dry place is the first thing you can do to help the blasting machine help you. Down in a wet tunnel or mine is *not* a good place to store such an instrument, and if it must be used in such places, as is often the case, and it cannot be taken to the surface between times (which is sometimes the case), a water tight closet or box should be built for it, in as good a location as can be found. Remember that the case is only wood, and, if saturated with water, may swell and put the internal parts out of adjustment. Occasionally rubbing a *little* oil—preferably thick cylinder oil—into the grain of the wood will help it to resist the water. The best way to apply the oil is by rubbing the box with a greasy rag.

When you use the blasting machine, try to find a clean, level place to stand it on, such as a dry plank, so that the bottom will not be all wet when you put it away after using.

After the principles of its operation are thoroughly understood, the efficiency of the blasting machine may be kept up to the maximum, by occasional inspection and care of the internal parts, although they are so constructed as to seldom require much care.

The first thing to be done in caring for the dynamo and working parts is occasional oiling. And here much judgment should be used, for too much oil is worse than none at all. The only places that need it are the bearings of the armature shaft and of the armature pinion. The other iron parts that can be reached should be wiped off with a greasy rag to prevent them from rusting, more particularly the faces of the armature (not the wire). *No oil should be used on, or allowed to come in contact with, the brushes and commutator, nor with the contact spring and its contact points.* For this reason, the amount of oil used in any part of the blasting machine should be small, or it will afterwards flow over places where it is not wanted. This is especially the case with the rack bar. Too much oil here will inevitably flow down upon the contact spring and its contact points, and cause a poor electrical connection with the bridge. In fact, a poor electrical connection at this point is one of the most common causes of the poor work and erratic behavior of the blasting machine. Wiping off the rack bar and guide rod with a greasy rag will give them all the lubrication they require.

The friction incident to ordinary usage will generally be sufficient to keep the surfaces bright where the brushes bear upon the commutator, *unless* some misguided person has oiled them. In that case, the oil should be removed as well as possible by thorough cleaning with a rag saturated with gasoline. If the brushes seem to be too rapidly wearing into the commutator, so that they absolutely demand some kind of lubricant, use a little graphite taken from a soft lead pencil. After removing the oil by the use of gasoline, be sure that all the gasoline and its vapor are out of the box before closing it up, or the vapor may afterwards ignite and blow the box apart.

The contact points on the contact spring, bridge, etc., may be brightened up occasionally with very *fine* emery cloth, but be careful how you use emery cloth or paper in and about the machine, for the dust and finer particles from it, if they get into the working parts, will cause them to wear out rapidly. Also, when you use emery cloth on the platinum contact points, remember that all you are aiming to do is to remove any possible dirt or oxide from them, and do not go about it so vigorously as to grind off, after a few such inspections, all of the platinum points themselves. There is a very hot flash when the contact spring leaves the upper contact, and if the parts which touch are not of platinum (that is, if the platinum has all been ground away so that only brass touches) the brass quickly becomes oxidized, and fails to make a good contact.

The joints connecting together the various electric fuzes, leading wires, connecting wire, etc., that are to comprise the circuit often do not receive as much attention as they should. It is true that mere contact between perfectly clean wires is sufficient to permit the passage of the current, but it is almost impossible to get them perfectly clean, and the joint should, therefore, be made in such a manner as to press together a considerable amount of the wire, after it has been cleaned as thoroughly as possible. This preliminary cleaning or scraping should never be neglected. There is sure to be tar or grease present from the water proofing material used, as well as oxides, dirt and all manner of foreign material that may have adhered to the wire.

There are many methods of making joints, some of them good and some bad. The one generally recommended is made as shown in Fig. 17.

Fig. 17

Another good way, if one has pliers to finish up the joint with, is that shown in Fig. 18, page 106. This is made the same as in the previous figure, but afterwards the ends, which are left long for that purpose, are twisted together.

It is much easier to connect together wires of the same size than where the sizes differ, such as joining the leading and electric fuze wires together. For this purpose, a joint like that shown in

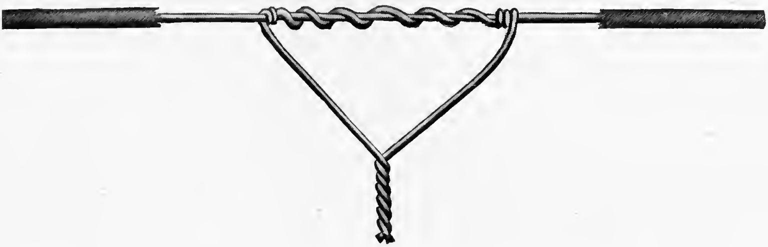

Fig. 18

Fig. 21 is good, the spring of the thick wire keeping up a tension on the small wire, and causing it to make a good contact. It is difficult to make a nice joint under such circumstances, but it can be made good electrically if the wires are first thoroughly cleaned.

Joints in the leading wire, when they must be made, should be made with special care. Those in the connecting and electric fuze wires, as a rule, only have to do service for a few minutes or hours; but those in the leading wire will be there while the leading wire lasts, and if poorly made will give trouble long after their location is forgotten. Fig. 17, page 105, shows how such joints should be made. The method is just the same as that recommended for the electric fuze wires, only these joints should be about 2 or 3 inches in length. *It pays* to have joints in the leading wire *soldered.* Some of the most peculiar and erratic troubles are due to defective joints in the leading wire, which

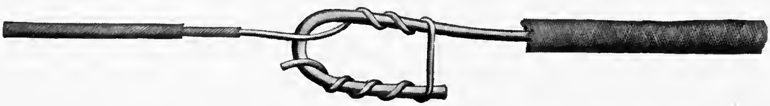

Fig. 21

worked satisfactorily for a number of shots, but afterwards became bad through corrosion having formed between the contact surfaces. The electrical condition of such a joint is liable to change on the slightest movement of the wire, good one minute and bad the next, and for that reason making a trouble difficult to locate.

Of course, wherever a joint has been made the wire will be bare of insulation at that point, and the question is often asked whether, in such cases, it is always necessary to use insulating tape for covering the bare places. Where these joints are in the leading wire, and especially where they are in electric fuze or connecting wire which is to be inside of the bore hole and covered with tamping, they should be taped. If the joints are not to go underground, it is not absolutely necessary to tape them, and it will be sufficient if they are elevated and kept off the ground, or from touching anything, by placing blocks of wood under the wire near the joint. Joints in the leading wire can be treated in this way also, thus avoiding the necessity of taping them; but it is a nuisance to have to go all over the line blocking up bare places before a blast, when the whole trouble could be avoided by a few turns of insulating tape. In fact, a well made, soldered and taped joint puts the leading wire in almost as good condition as when new, while a few questionable joints are sure at some time to be a source of annoyance, delay and danger. It is best not to have any more joints in the circuit than are absolutely necessary. Joints are especially objectionable when they have to be lowered into the bore hole because the electric fuze wires are too short. The electric fuze wires ought to be long enough to prevent the necessity of making this kind of joints. It is even better to have them long enough to connect directly with the wire of the electric fuze in the adjoining bore hole, thus avoiding the use of connecting wire as well as saving time. But when you do require connecting wire, *don't use old electric fuze wire* that is full of joints and bruises from having already been through a blast. Use new connecting wire. The use of old, damaged electric fuze or connecting wire is the worst kind of false economy. No experienced contractor needs to be told how expensive it is to have a long period of delay after the men have been ordered away from the work, while the blaster pokes around, looking for the "reason why the shot did not go off," all men, horses and machinery idle meanwhile.

Preparing the primer is really one of the most important steps in all blasting operations. And yet, how frequently we find this work entrusted to one of the least skilled among the workmen. It ought to be done in the safest suitable place that can be found, and it should also be done in the manner which is calculated to secure the best results. Yet both of these considerations are frequently violated, and the priming is done in the thawing house or magazine where an accidental explosion would be certain to cause widespread disaster, and is also done in a manner just the opposite to that recommended by the manufacturers of explosives and blasting supplies.

The most common way of making a primer is that shown in Fig. 24. That is, the electric fuze is inserted into some part of the cartridge of dynamite and kept from pulling out by taking one or more half hitches around the cartridge. But this is *not* the method recommended by the manufacturers. One trouble with this method is that all the strain comes at the two points marked "A," where one of the two wires bends sharply around the other. Should the strain be severe enough to cause the wires to cut through the insulation at this point, it will furnish the "shorter or easier path for the current" referred to in paragraph 2, page 91, and the current will escape across the short circuit, without going through the electric fuze, causing that particular bore hole to miss.

Fig. 24

In spite of the recommendations of the manufacturers, however, it is very seldom one finds a blaster making primers in the right way (see Fig. 25, page 109), the reason generally given being that "it is too much trouble to hunt up strings and tie them." Of all operations where results justify a little extra trouble, none can exceed in importance the making of the primer, for upon this depends the success of the entire blast. Of course, it takes a little longer to make primers in the proper way than it does by the half hitch method, but the extra time is well spent, and it should be borne in mind that it is the time of *one man,* while the time spent in "hunting trouble" is the *combined time of all the men, horses and machinery.* There never yet was a cheap misfire.

Where should the primers be made up? It is necessary that a location be selected in cold weather where they will not chill during and after the process; therefore, some kind of a heated building is almost of necessity selected. But it should not be one in which an accidental explosion would carry with it the entire contents of a magazine or thawing house.


Fig. 25

It is the warmth of a steam heated magazine or thawing house which in winter always makes them tempting spots for this work. The blacksmith will not tolerate the process in his domain, and still less will the "boss" tolerate it in his office; therefore, the poor fellow who does the work seeks out the only warm spot open to him.

There really ought to be a separate small building, heated by exhaust steam or hot water, set apart for this purpose, and in that case a closet in one corner might be used to store the blasting machine, leading wire and other non-explosive goods. Even a small supply of blasting caps and electric fuzes might be allowed there, provided their number be kept so small that they would not, in themselves, represent a considerable quantity of explosive material. But strict rules should be enforced to prevent the men from using this building as a lounging place or a place in which to eat their lunches and smoke. The Du Pont Company publishes and supplies a set of rules to be tacked up in magazines, and many of these rules would be applicable here. They are printed upon muslin, and are to be signed by the superintendent and can be obtained gratis by writing for them to our nearest branch office. (See list on the back of this catalogue.)

After the primers are made, they should be kept in a box, equipped with a tight fitting hinged cover to prevent the possible entrance of sparks. This box should be kept, until the primers are required, in the priming house, at a temperature of between 70° F. and 80° F., so that they will not become frozen or chilled.

The primer especially must be well thawed, and in the best possible condition. If the bore holes are wet, it is well to seal up the place where the detonator has been inserted in the cartridge by means of soap, tar or some other water proofing material, since, if the explosive immediately surrounding the detonator is impaired in any way, it is likely to cause a failure or inferior work of the entire blast.

Once the loading has commenced, a blast should be loaded and fired as expeditiously as possible. Many things may happen to detract from the efficiency of a charge after it is loaded, and the chances increase with every minute that elapses between loading and firing. The dynamite may freeze if the rock or ground is cold enough, water may work its way into the electric fuzes, and the insulation on the wires may be affected by moisture, so that the leakage of current will cause one or more charges to miss.

The blasting machine should always be operated with as much force as the operator can exert. Try especially to finish the last part of the stroke with your full power, for when the rack bar nears the end of the stroke it will push quite hard, tending to check the movement, and yet the end of the stroke is the most important of all. It takes a man with considerable strength, and with some skill to get the full force out of a large blasting machine.

It is, of course, obvious that no more current is required to fire stronger electric fuzes than weaker ones. Those with very long wires, however, do require more current, for the small copper wire which is used has some resistance. An electric fuze with 26 foot wires would take about twice as strong a current to fire it as it would if the current could be delivered close to the fuze cap, instead of having to go through the 26 foot wires.

Many careful blasters have long wished for some means to guard against misfires by which the blasting machine and the individual electric fuzes could be tested, before attempting to use them. If they could always be used just as they come from the factory, without being subjected to the unfavorable conditions they so often meet with in transportation and storage, it is probable that there would be little need for testing because every manufacturer carefully tests his goods before sending them out. The Du Pont Company tests them twice. Electric Fuzes are especially liable to damage during transportation and storage, and particularly so if they are stored in a damp place.

The Du Pont Rheostat (see page 55) should be used in testing blasting machines, and for testing electric fuzes and the blasting circuit the Du Pont Galvanometer (see page 43) is recommended.

A test with almost any kind of testing instrument would be sufficient to reveal the presence of a broken bridge in an electric fuze (see illustration, page 12), which is indeed the most usual defect. But it will not reveal those electric fuzes which are defective through a short circuit, such as where the electric fuze wires are not insulated from each other within the electric fuze cap, or have accidentally come into contact after having been manufactured. In such cases, they would fail to fire, of course, because the current would follow the short circuit and not go through the bridge. To identify electric fuzes defective from this cause, it is necessary to have some form of instrument which will show at least approximately the electrical resistance. The Du Pont Galvanometer can be used for this if very carefully observed, but a "Wheatstone bridge" is better.

When testing electric fuzes, they should always be placed in such a position that if one of them should happen to detonate accidentally no one will be injured. Placing them around the corner of a stone wall is an easy and safe way, or, if there are but a few of them, they can be buried under a foot of dry sand. If there are many, so that the total amount of fulminate is considerable, the particles of sand themselves would become projectiles capable of injuring anyone near by.

Of course, there are occasions, as for instance when there has been a misfire and it is necessary to locate the trouble, when some risk must be taken, even to making use of the galvanometer in testing electric fuzes that are loaded in bore holes with explosives, and often in such locations where the firing of the charge during the test would be disastrous to the tester. But under such conditions, the very remote danger of the test replaces a much greater danger, which always exists whenever a blast misfires, and the blaster is hunting about for the reason why. Under such circumstances, there is no doubt that a great saving in the total amount of risk results from locating the trouble with accuracy and celerity, even though there be a remote risk in the test itself.

But the chances of firing an electric fuze while testing are thousands of times greater when an ordinary series magneto telephone bell or other unsuitable instrument is used.

Several persons have been badly injured in this way because they not only made use of an improper testing instrument, but neglected to place the electric fuze in a safe location. It is remarkable what extensive damage the flying particles of copper from one of these electric fuzes are capable of doing.

The current from a magneto bell is of too small a volume to fire an electric fuze by heating its bridge, but it is of sufficient intensity to jump across small gaps, such as would result if an electric fuze had a broken bridge, and the broken ends were very close to each other. When the current jumps across such a gap, a spark is produced which is often sufficient to ignite the fulminate. Another way in which an electric fuze might become sensitive to the current from a magneto bell is by the formation of corrosion between the ends of a break, such as where, through the entrance of moisture, the copper wire had corroded off the platinum bridge at one of the soldered joints. Should the electric fuze subsequently dry out, it may show a resistance several hundred times greater than normal, and would be very likely to fire with the current from a magneto bell while there would be very little likelihood of its firing with the weak current from a suitable testing battery like that in the Du Pont Galvanometer.

What lulls the suspicion of a blaster who tests with a magneto (and the matter is mentioned here because there are many who do) is the fact that he is often able to test a great many electric fuzes with it before one of them fires in the testing process. But some day one that is defective in the manner above described is encountered—and then, too frequently, it means a maimed hand, blindness or worse. For this reason, the use of any kind of testing current, except that from a weak battery used in connection with a galvanometer, or Wheatstone bridge, is most earnestly condemned, and further, the electric fuzes should be placed in some location where they will do no harm if one should explode. When the test of a loaded bore hole must be made, and it is impracticable to attach the leading wires and test from a safe distance, the test should be undertaken with the full recognition that it is a risk, even though a remote one, when a suitable instrument is used, and no one but the tester himself should be exposed to the risk.

Precautions to be Observed in General with Regard to Explosives

DON'T forget the nature of explosives, but remember that with proper care they can be handled with comparative safety.

DON'T smoke while you are handling explosives, and DON'T handle explosives near an open light.

DON'T shoot into explosives with a rifle or pistol, either in or out of a magazine.

DON'T leave explosives in a field or any place where stock can get at them. Cattle like the taste of soda and saltpeter in explosives, but the other ingredients would probably make them sick or kill them.

DON'T handle or store explosives in or near a residence.

DON'T leave explosives in a wet or damp place. They should be kept in a suitable, dry place, under lock and key, and where children or irresponsible persons cannot get at them.

DON'T explode a charge to chamber a bore hole and then immediately reload it, as the bore hole will be hot, and the second charge may explode prematurely.

DON'T do tamping with iron or steel bars or tools. Use only a wooden tamping stick with no metal parts.

DON'T *force* a primer into a bore hole.

DON'T explode a charge before everyone is well beyond the danger zone and protected from flying debris. Protect your supply of explosives also from danger from this source.

DON'T hurry in seeking an explanation for the failure of a charge to explode.

DON'T drill, bore or pick out a charge which has failed to explode. Drill and charge another bore hole at least two feet from the missed one.

DON'T use two kinds of explosives in the same bore hole, except where one is used as a primer to detonate the other, as where dynamite is used to detonate Judson powder. The quicker explosive may open cracks in the rock and allow the slower to blow out through these cracks, doing little or no work.

DON'T use blasting powder, permissible explosives or high explosives in the same bore hole in coal mines.

DON'T use frozen or chilled explosives. Dynamite, other than Red Cross, often freezes at a temperature between 45° F. and 50° F.

DON'T use any arrangement for thawing dynamite other than one of those recommended by the DU PONT COMPANY.

DON'T thaw dynamite on heated stoves, rocks, bricks or metal, or in an oven, and don't thaw dynamite in front of, near or over a steam boiler or fire of any kind.

DON'T take dynamite into or near a blacksmith shop or near a forge on open work.

DON'T put dynamite on shelves or anything else directly over steam or hot water pipes or other heated metal surface.

DON'T cut or break a dynamite cartridge while it is frozen, and don't rub a cartridge of dynamite in the hands to complete thawing.

DON'T heat a thawing house with pipes containing steam under pressure.

DON'T place a hot water thawer over a fire, and never put dynamite into hot water or allow it to come in contact with steam.

DON'T allow thawed dynamite to remain exposed to low temperature, but use as soon as possible.

DON'T allow priming (the placing of a blasting cap or electric fuze in dynamite) to be done in a thawing house.

DON'T prime a dynamite cartridge or charge or connect bore holes for electric firing during the immediate approach or progress of a thunder storm.

DON'T carry blasting caps or electric fuzes in your pocket.

DON'T tap or otherwise investigate a blasting cap or electric fuze.

DON'T attempt to take blasting caps from the box by inserting a wire, nail or other sharp instrument.

DON'T try to withdraw the wires from an electric fuze.

DON'T fasten a blasting cap to the safety fuse with the teeth or by flattening it with a knife; use a cap crimper.

DON'T keep electric fuzes, blasting machines or blasting caps in a damp place.

DON'T attempt to use electric fuzes with the regular insulation in very wet work. For this purpose secure "Victor Water Proof" or "Gutta Percha Covered" Electric Fuzes.

DON'T worry along with old, broken leading wire or connecting wire. A new supply won't cost much and will pay for itself many times over.

DON'T handle safety fuse carelessly in cold weather, for when cold it is stiff and breaks easily.

DON'T store or transport blasting caps or electric fuzes with high explosives.

DON'T store safety fuse in a hot place, as this may dry it out so that uncoiling will break it.

DON'T lace safety fuse through dynamite cartridges. This practice is frequently responsible for the burning of the charge.

DON'T operate blasting machines half heartedly. They are built to be operated with full force. They must be kept clean and dry.

DON'T cut the safety fuse short to save time. It is a dangerous economy.

DON'T expect a cheap article to give as good results as a high grade one.

DON'T expect explosives to do good work if you try to explode them with a detonator weaker than a No. 6 (red label).

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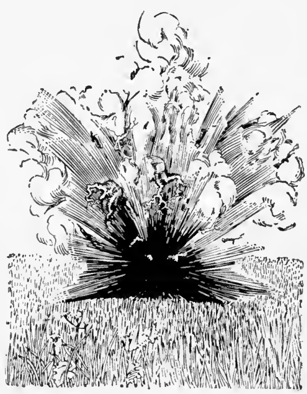

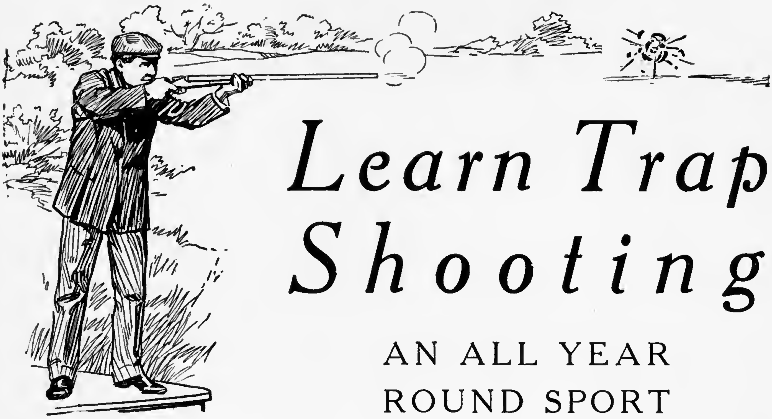

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